US Army Corps of Engineers®
Walla Walla District

FINAL

Lower Snake River Juvenile Salmon Migration Feasibility Report/ Environmental Impact Statement

APPENDIX I

Economics

February 2002

FEASIBILITY STUDY DOCUMENTATION

	Document Title
Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement	
Appendix A (bound with B)	Anadromous Fish Modeling
Appendix B (bound with A)	Resident Fish
Appendix C	Water Quality
Appendix D	Natural River Drawdown Engineering
Appendix E	Existing Systems and Major System Improvements Engineering
Appendix F (bound with G, H)	Hydrology/Hydraulics and Sedimentation
Appendix G (bound with F, H)	Hydroregulations
Appendix H (bound with F, G)	Fluvial Geomorphology
Appendix I	Economics
Appendix J	Plan Formulation
Appendix K	Real Estate
Appendix L (bound with M)	Lower Snake River Mitigation History and Status
Appendix M (bound with L)	Fish and Wildlife Coordination Act Report
Appendix N (bound with O, P)	Cultural Resources
Appendix O (bound with N, P)	Public Outreach Program
Appendix P (bound with N, O)	Air Quality
Appendix Q (bound with R, T)	Tribal Consultation and Coordination
Appendix R (bound with Q, T)	Historical Perspectives
Appendix S*	Snake River Maps
Appendix T (bound with R, Q)	Clean Water Act, Section 404(b)(1) Evaluation
Appendix U	Response to Public Comments

*Appendix S, Lower Snake River Maps, is bound separately (out of order) to accommodate a special 11 x 17 format.

The documents listed above, as well as supporting technical reports and other study information, are available on our website at http://www.nww.usace.army.mil/lsr. Copies of these documents are also available for public review at various city, county, and regional libraries.

STUDY OVERVIEW

Purpose and Need

Between 1991 and 1997, due to declines in abundance, the National Marine Fisheries Service (NMFS) made the following listings of Snake River salmon or steelhead under the Endangered Species Act (ESA) as amended:

- sockeye salmon (listed as endangered in 1991)
- spring/summer chinook salmon (listed as threatened in 1992)
- fall chinook salmon (listed as threatened in 1992)
- steelhead (listed as threatened in 1997).

In 1995, NMFS issued a Biological Opinion on operations of the Federal Columbia River Power System (FCRPS). Additional opinions were issued in 1998 and 2000. The Biological Opinions established measures to halt and reverse the declines of ESA-listed species. This created the need to evaluate the feasibility, design, and engineering work for these measures.

The Corps implemented a study (after NMFS' Biological Opinion in 1995) of alternatives associated with lower Snake River dams and reservoirs. This study was named the Lower Snake River Juvenile Salmon Migration Feasibility Study (Feasibility Study). The specific purpose and need of the Feasibility Study is to evaluate and screen structural alternatives that may increase survival of juvenile anadromous fish through the Lower Snake River Project (which includes the four lowermost dams operated by the Corps on the Snake River—Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams) and assist in their recovery.

Development of Alternatives

The Corps' response to the 1995 Biological Opinion and, ultimately, this Feasibility Study, evolved from a System Configuration Study (SCS) initiated in 1991. The SCS was undertaken to evaluate the technical, environmental, and economic effects of potential modifications to the configuration of Federal dams and reservoirs on the Snake and Columbia Rivers to improve survival rates for anadromous salmonids.

The SCS was conducted in two phases. Phase I was completed in June 1995. This phase was a reconnaissance-level assessment of multiple concepts including drawdown, upstream collection, additional reservoir storage, migratory canal, and other alternatives for improving conditions for anadromous salmonid migration.

The Corps completed a Phase II interim report on the Feasibility Study in December 1996. The report evaluated the feasibility of drawdown to natural river levels, spillway crest, and other improvements to existing fish passage facilities.

Based in part on a screening of actions conducted for the Phase I report and the Phase II interim report, the study now focuses on four courses of action:

- Existing Conditions
- Maximum Transport of Juvenile Salmon

- Major System Improvements
- Dam Breaching.

The results of these evaluations are presented in the combined Feasibility Report (FR) and Environmental Impact Statement (EIS). The FR/EIS provides the support for recommendations that will be made regarding decisions on future actions on the Lower Snake River Project for passage of juvenile salmonids. This appendix is a part of the FR/EIS.

Geographic Scope

The geographic area covered by the FR/EIS generally encompasses the 140-mile long lower Snake River reach between Lewiston, Idaho and the Tri-Cities in Washington. The study area does slightly vary by resource area in the FR/EIS because the affected resources have widely varying spatial characteristics throughout the lower Snake River system. For example, socioeconomic effects of a permanent drawdown could be felt throughout the whole Columbia River Basin region with the most effects taking place in the counties of southwest Washington. In contrast, effects on vegetation along the reservoirs would be confined to much smaller areas.

Identification of Alternatives

Since 1995, numerous alternatives have been identified and evaluated. Over time, the alternatives have been assigned numbers and letters that serve as unique identifiers. However, different study groups have sometimes used slightly different numbering or lettering schemes and this has led to some confusion when viewing all the work products prepared during this long period. The primary alternatives that are carried forward in the FR/EIS currently involve the following four major courses of action:

Alternative Name	PATH[1/] Number	Corps Number	FR/EIS Number
Existing Conditions	A-1	A-1	1
Maximum Transport of Juvenile Salmon	A-2	A-2a	2
Major System Improvements	A-2’	A-2d	3
Dam Breaching	A-3	A-3a	4

[1/] Plan for Analyzing and Testing Hypotheses

Summary of Alternatives

The **Existing Conditions Alternative** consists of continuing the fish passage facilities and project operations that were in place or under development at the time this Feasibility Study was initiated. The existing programs and plans underway would continue unless modified through future actions. Project operations include fish hatcheries and Habitat Management Units (HMU) under the Lower Snake River Fish and Wildlife Compensation Plan (Comp Plan), recreation facilities, power generation, navigation, and irrigation. Adult and juvenile fish passage facilities would continue to operate.

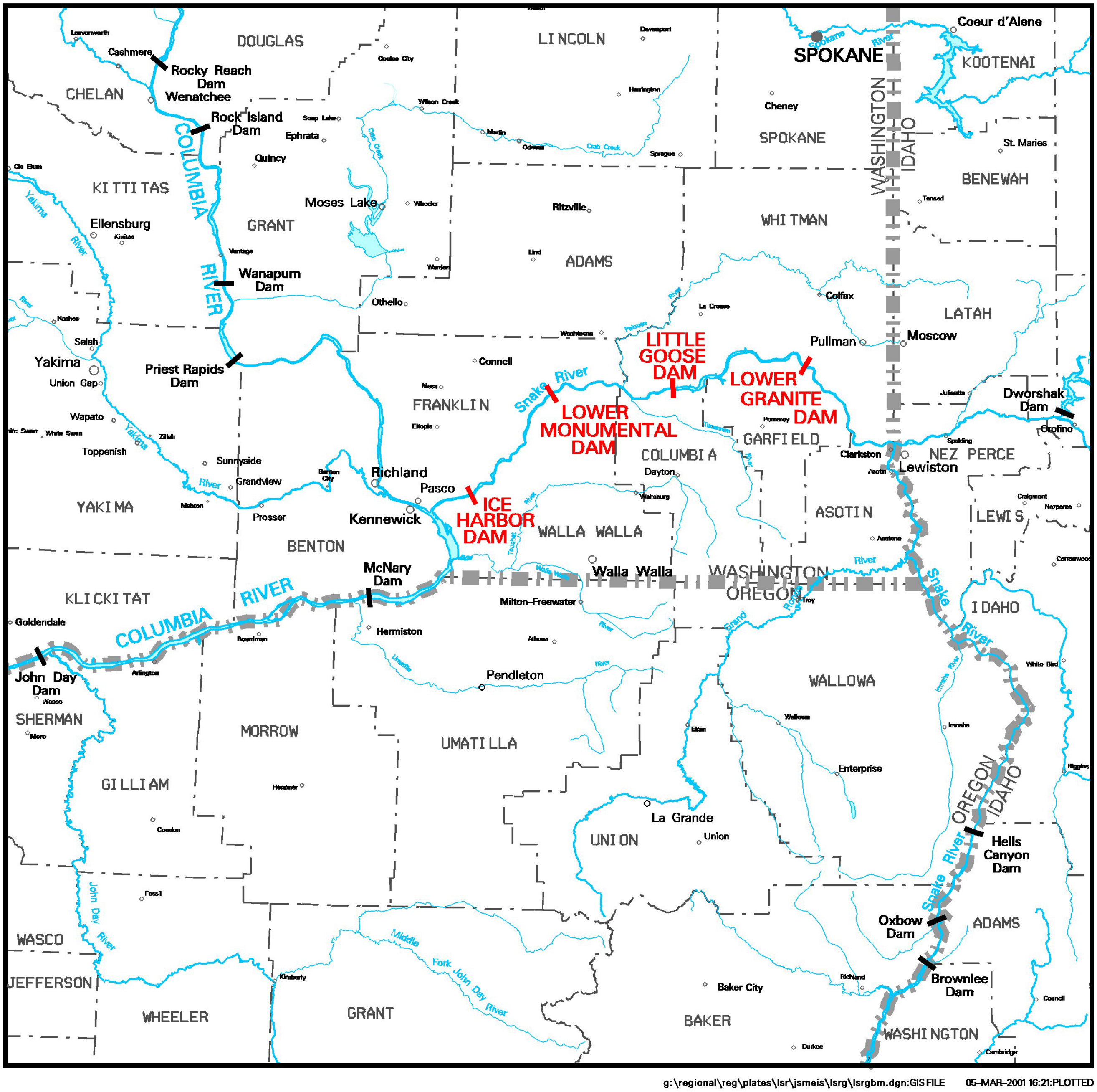
The **Maximum Transport of Juvenile Salmon Alternative** would include all of the existing or planned structural and operational configurations from the Existing Conditions Alternative. However, this alternative assumes that the juvenile fishway systems would be operated to maximize fish transport from Lower Granite, Little Goose, and Lower Monumental and that voluntary spill would not be used to bypass fish through the spillways (except at Ice Harbor). To accommodate this maximization of transport, some measures would be taken to upgrade and improve fish handling facilities.

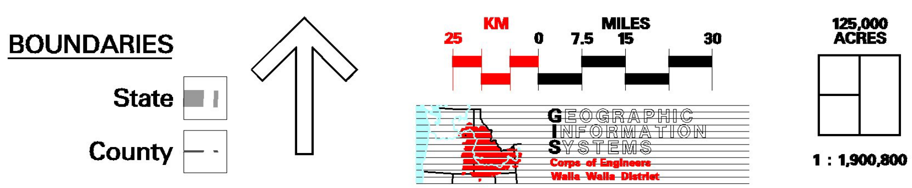
The **Major System Improvements Alternative** would provide additional improvements to what is considered under the Existing Conditions Alternative. These improvements would be focused on using surface bypass facilities such as surface bypass collectors (SBCs) and removable spillway weirs (RSWs) in conjunction with extended submerged bar screens (ESBSs) and a behavioral guidance structure (BGS). The intent of these facilities would be to provide more effective diversion of juvenile fish away from the turbines. Under this alternative, an adaptive migration strategy would allow flexibility for either in-river migration or collection and transport of juvenile fish downstream in barges and trucks.

The **Dam Breaching Alternative** has been referred to as the "Drawdown Alternative" in many of the study groups since late 1996 and the resulting FR/EIS reports. These two terms essentially refer to the same set of actions. Because the term drawdown can refer to many types of drawdown, the term dam breaching was created to describe the action behind the alternative. The Dam Breaching Alternative would involve significant structural modifications at the four lower Snake River dams, allowing the reservoirs to be drained and resulting in a free-flowing yet controlled river. Dam breaching would involve removing the earthen embankment sections of the four dams and then developing a channel around the powerhouses, spillways, and navigation locks. With dam breaching, the navigation locks would no longer be operational and navigation for large commercial vessels would be eliminated. Some recreation facilities would close while others would be modified and new facilities could be built in the future. The operation and maintenance of fish hatcheries and HMUs would also change, although the extent of change would probably be small and is not known at this time.

Authority

The four Corps dams of the lower Snake River were constructed and are operated and maintained under laws that may be grouped into three categories: 1) laws initially authorizing construction of the project, 2) laws specific to the project passed subsequent to construction, and 3) laws that generally apply to all Corps reservoirs.





LOWER SNAKE RIVER
Juvenile Salmon Migration Feasibility Study

REGIONAL BASE MAP

US Army Corps
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Final
Lower Snake River Juvenile Salmon Migration Feasibility Report/ Environmental Impact Statement

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Appendix I
Economics

Produced by

Foster Wheeler Environmental Corporation

Produced for

U.S. Army Corps of Engineers
Walla Walla District

February 2002

FOREWORD

Appendix I was compiled by the U.S. Army Corps of Engineers (Corps) and Foster Wheeler Environmental Corporation from technical studies developed by the Drawdown Regional Economic Workgroup (DREW). Members of DREW include representatives of various Federal and regional agencies, tribal representatives, and other interested parties. This appendix is one part of the overall effort of the Corps to prepare the Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement (FR/EIS).

The Corps has reached out to regional stakeholders (Federal agencies, tribes, states, local governmental entities, organizations, and individuals) during the development of the FR/EIS and appendices. This effort resulted in many of these regional stakeholders providing input and comments, and even drafting work products or portions of these documents. This regional input provided the Corps with an insight and perspective not found in previous processes. A great deal of this information was subsequently included in the FR/EIS and appendices; therefore, not all of the opinions and/or findings herein may reflect the official policy or position of the Corps.

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AAEV	average annual equivalent value
ABS	automatic block signals
ADFG	Alaska Department of Fish and Game
AECO	Alberta Energy Company
AEI	Agricultural Enterprises, Inc.
AFEP	anadromous fish evaluation program
AGC	Automatic Generation Control
aMW	average megawatt
BCAM	Barge Cost Analysis Model
BGS	behavioral guidance structure
BEA	U.S. Department of Commerce, Bureau of Economic Affairs
BIA	U.S. Bureau of Indian Affairs
BLM	Bureau of Land Management
BNSF	Burlington Northern Santa Fe
BOR	U.S. Bureau of Reclamation
BPA	Bonneville Power Administration
BRWG	Biological Requirements Working Group
BTU	British thermal unit
bu	bushel
CB	contingent behavior
CC	combined cycle
CCC	Civilian Conservation Corps
CEQ	Council on Environmental Quality
CFO	Canada Fisheries and Oceans
cfs	cubic feet per second
CO_2	carbon dioxide
COI/PDCI	California-Oregon Intertie/Pacific Direct Current Intertie
Collville	Confederated Tribes of the Colville Reservation
Comp Plan	Lower Snake River Fish and Wildlife Compensation Plan
Corps	U.S. Army Corps of Engineers
CPUE	catch per unit effort
CRFMP	Columbia River Fish Management Plan
CRI	Cumulative Risk Initiative
CRITFC	Columbia River Inter-Tribal Fish Commission
CRTAC	Columbia River Technical Advisory Committee
C&S	ceremonial and subsistence
CSRS	Columbia Snake River System
CTC	centralized traffic control
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CVM	Contingent Valuation Method
DGAS2	second phase of de-gasification construction project
DREW	Drawdown Regional Economic Workgroup
Ecology	Washington State Department of Ecology
EIA	Energy Information Administration

ACRONYMS AND ABBREVIATIONS

EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EQ	environmental quality
ESA	Endangered Species Act
ESBS	extended submersible bar screen
ESU	Evolutionary Significant Unit
FCRPS	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FGE	fish guidance efficiency
F.I.R.E.	Finance, Insurance, and Real Estate
FOC	Fisheries and Oceans of Canada
FR/EIS	Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement
FTE	full-time equivalency
FY	fiscal year
ha	hectare
HDR	HDR Engineering
HIT	Hydropower Impact Team
HMU	Habitat Management Unit
hp	horsepower
HYDROSIM	Hydro Simulation Program
HYSSR	Hydro System Seasonal Regulation Program
IDC	interest during construction
IEAB	Independent Economic Advisory Board
IMPLAN	Impact Analysis for Planning
INPFC	International North Pacific Fisheries Commission
ISO	Independent System Operator
IWR	Institute for Water Resources
JFTP	Juvenile Fish Transportation Program
Kg/ha	kilogram/hectare
Km	kilometer
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
LPMS	Lock Performance Monitoring System
LSR	lower Snake River
M&I	municipal and industrial
MAF	million acre-feet
MMBtu	million British thermal unit
MOA	Memorandum of Agreement
MOP	minimum operating pool
mph	miles per hour
MW	megawatt
MWh	megawatt-hour

ACRONYMS AND ABBREVIATIONS

NED	national economic development
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NP	Nez Perce Tribe
NPAFC	North Pacific Anadromous Fishery Commission
NPFMC	North Pacific Fishery Management Council
NPPC	Northwest Power Planning Council
NPV	net present value
NR CB	Natural River Contingent Behavior
NRCS	Natural Resource Conservation Service
NRDC	Natural Resources Defense Council
NRSA	nominal range sensitivity analysis
O&M	operation and maintenance
O,M,R,R&R	operation, maintenance, repair, replacement, and rehabilitation
ODFW	Oregon Department of Fish and Wildlife
OSE	other social effects
P&G	Principles and Guidelines for Water and Related Sand Resources
PATH	Plan for Analyzing and Testing Hypotheses
PFMC	Pacific Fishery Management Council
PNW	Pacific Northwest
PROSYM	Power System Model
PSC	Pacific Salmon Commission
PUD	Public Utility District
PUV	passive use values
PV	present value
RCAM	Rail Cost Analysis Model
RED	regional economic development
REIS	Regional Economic Information System
RM	River Mile
RoD	Record of Decision
SBC	surface bypass collector
SAR	smolt-to-adult survival rates
Shoshone-Bannock	Shoshone-Bannock Tribes of the Fort Hall Reservation
Shoshone-Paiute	Shoshone-Paiute of the Duck Valley Reservation
SOR	System Operation Review
SRP	Scientific Review Panel
TAC	Technical Advisory Committee
TAM	transportation analysis model
TCAM	Travel Cost Analysis Model
TCM	Travel Cost Method
TDG	total dissolved gas
TVA	Tennessee Valley Authority

ACRONYMS AND ABBREVIATIONS

Umatilla	Confederated Tribes of the Umatilla Reservation
URCS	Uniform Rail Costing System
USFWS	U.S. Fish and Wildlife Service
Wanapum	Wanapum Indian community
Warm Springs	Confederated Tribes of the Warm Springs Reservation of Oregon
WCSC	Waterborne Commerce Statistics Center
WRC	U.S. Water Resources Council
WSCC	Western Systems Coordinating Council
WTP	willingness to pay
WY	water year
Yakama	Confederated Tribes and Boards of the Yakama Indian Nation

Executive Summary

ES.1 Introduction

This appendix measures the economic and social effects of the alternatives proposed under the Lower Snake River Juvenile Salmon Migration Feasibility Study. Section 102 of the National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ) guidelines, which interpret NEPA, require that the economic and social effects be identified. Evaluation of these effects is critical to decision makers and also important to others interested in the outcome of this study. The evaluation presented in this document uses economic measures to evaluate efficiency changes in the nation's production of goods and services. This evaluation is designed to identify the gains and losses to society as a whole. The effects that the proposed alternatives would have upon the region and on specific groups of individuals are also examined.

Actions taken to improve fish passage and survival along the lower Snake River could have economic and social effects on local communities, the Snake River region, the Pacific Northwest, and the nation, as a whole. The economic effects of actions related to the lower Snake River have been analyzed by numerous entities throughout the region. To reduce conflicting analyses and pool resources for a more efficient effort, the Corps convened the Drawdown Regional Economic Workgroup (DREW) to develop a combined economic analysis. Members of DREW include representatives of various Federal and regional agencies, tribal representatives, and other interested parties.

ES.1.1 Structure of Analysis

The technical analyses necessary to assess the potential economic and social effects of the four alternatives were conducted by Federal employees and contractors following guidance from DREW.[1] These analyses address potential economic and social effects at three geographic scales—national, regional, and local. The overall structure of the economic and social analysis is based on the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* developed by the U.S. Water Resources Council (WRC) (WRC, 1983). These guidelines recommend that the evaluation and display of the effects of proposed alternatives be organized into four accounts:

- The national economic development (NED) account, which displays changes in the economic value of the national output of goods and services
- The environmental quality (EQ) account, which displays nonmonetary effects on significant natural and cultural resources
- The regional economic development (RED) account, which addresses changes in the distribution of regional economic activity
- The other social effects (OSE) account, which addresses potential effects from relevant perspectives that are not reflected in the other three accounts.

[1] Copies of the technical reports developed for each area of analysis are available on the Corps' website at: http://www.nww.usace.army.mil/.

The NED account is the only account required under the WRC guidelines. The guidelines do, however, recommend that other information that is required by law or that will have a material bearing on the decision-making process should be included in one of the other accounts (EQ, RED, or OSE) or in some other appropriate format. The four accounts and their relationship to this analysis are discussed in the following sections.

ES.1.1.1 National Economic Development

The NED account addresses the net effects of a proposed action upon the nation. NED analysis is concerned only with economic efficiency at the national level. Economic gains achieved by one region at the expense of another region are not measured as NED benefits. In most cases, this type of gain to one region is another region's loss, and the two effects represent a transfer of benefits that cancels out any net change. Regional impacts are addressed under the RED account.

Beneficial effects measured under the NED account include increases in the economic value of the national output of goods and services, the value of output resulting from external economies caused by the proposed alternative, and the value associated with the use of otherwise unemployed or under-employed labor resources. Adverse NED effects are usually the opportunity costs of resources used in implementing a plan. All resources are scarce, and we are forced to make choices when they are used. Choose more of one thing, and you are simultaneously choosing less of another.

The general measurement standard for the value of goods and services is defined as the willingness of users to pay for each increment of output associated with a proposed alternative. Since it is not usually possible to obtain actual willingness to pay values, alternative or proxy measures are used. These measures include actual or simulated market price, change in net income, cost of the most likely alternative, and administratively established values.

ES.1.1.2 Environmental Quality Account

The EQ account provides a means of displaying and integrating qualitative information on the effects of the proposed alternatives on significant resources and attributes of the human environment. Beneficial and adverse effects addressed in the EQ account include changes in the ecological, aesthetic, and cultural attributes of natural and cultural resources. The evaluation of tribal circumstances presented in Section 5 of this appendix may be considered part of this account. Tribal circumstances are also addressed as part of the NED account (see Section 3.6).

ES.1.1.3 Regional Economic Development

The RED account addresses changes in regional economic activity that would result from each alternative. Effects are addressed in terms of changes to regional business transactions, employment, and income. The majority of effects associated with the proposed alternatives would occur in the lower Snake River region. Effects were modeled for the lower Snake River region and three subregions. Impacts, such as increased power rates, that could affect the entire Pacific Northwest were modeled at the state level.

ES.1.1.4 Other Social Effects

The OSE account addresses potential effects from perspectives that are relevant to the evaluation process, but are not reflected in the other three accounts. Categories typically addressed as part of this account include community impacts; life, health, and safety factors; displacement; and long-term productivity. The social analysis developed as part of this study addresses some of the likely social impacts on selected local communities.

ES.1.2 Study Assumptions

A 100-year period of analysis was used to assess all project impacts. The base year for the analysis was fiscal year (FY) 1998, but the 100-year period of analysis extends from the implementation year (FY 2005) through 2104. Benefits and costs incurred during the period of analysis are discounted to the beginning of this period (FY 2005) using selected interest rates. Implementation expenditures and other economic costs and benefits that would occur prior to FY 2005 are brought forward to that date by charging compound interest at the project discount rate from the date that the costs and benefits occur. These costs and benefits are then converted into 1998 dollars and annualized to provide an average annual value for each alternative.

Numerous agencies and interests were involved in developing this economic analysis. As a result, effects are presented using three different discount rates: 6.875 percent—the rate used in economic analyses by the Corps, 4.75 percent—the rate customarily used by BPA, and 0.0 percent—included on behalf of the tribes represented by CRITFC. While these different discount rates were used to accommodate a variety of perspectives, the different rates had little effect on the ranking of the alternatives.

ES.1.3 Alternatives

The Lower Snake River Juvenile Salmon Migration Feasibility Study FR/EIS examines four alternatives. These alternatives are as follows:

Alternative 1—Existing Conditions. This alternative continues the fish passage facilities and project operations that were in place or under development at the time this Feasibility Study was initiated.

Alternative 2—Maximum Transport of Juvenile Salmon. This alternative includes all of the existing or planned structural and operational configurations from the Alternative 1—Existing Conditions Alternative. However, this alternative assumes that the juvenile fishway systems would be operated to maximize fish transport from Lower Granite, Little Goose, and Lower Monumental and that voluntary spill would not be used to bypass fish through the spillways (except at Ice Harbor).

Alternative 3—Major System Improvements. This alternative provides additional improvements to those considered under the Alternative 1—Existing Conditions. These improvements would be focused on using surface bypass collection (SBC) facilities in conjunction with extended submersible bar screens (ESBSs) and a behavioral guidance system (BGS). The intent of these facilities is to provide more effective diversion of juvenile fish away from the turbines.

Alternative 4—Dam Breaching. This alternative involves significant structural modifications at the four lower Snake River dams, allowing the reservoirs to be drained and resulting in a near-natural river that would remain unimpounded. Dam breaching would involve removing the earthen embankment sections of the four dams and then developing a channel around the powerhouses, spillways, and navigation locks. With dam breaching, the navigation locks would no longer be operational, and navigation for large commercial vessels would be eliminated. Some recreation facilities would close, while others would be modified, and new facilities could be built in the future.

ES.1.4 Biological Benefits

There are four species of fish in the lower Snake River system that have been listed as endangered by the National Marine Fisheries Service (NMFS) under the Endangered Species Act. These are spring/summer chinook, fall chinook, steelhead, and sockeye. The effects of the proposed alternatives in improving the chances of recovery and survival of these species are considered the "benefits" or "output" of undertaking the study alternatives. This section briefly discusses the Plan for Analyzing and Testing Hypotheses (PATH) results and the development and application of the NMFS jeopardy standards.

PATH is a formal and rigorous program of formulating and testing hypotheses by using a series of model simulations to estimate both past and future trends in fish abundance for each of the selected stocks. The primary objective of PATH's modeling is to enhance the survival opportunities of the affected Evolutionary Significant Units (ESUs) by considering the stock's response to jeopardy standards, which were defined by the Biological Requirements Working Group (BRWG) and largely accepted by NMFS (Peters et al., 1999).

The jeopardy standards include both survival and recovery goals as defined below:

- Survival standards (which set the threshold for survival) are based on projected probabilities that the spawning abundance will exceed a pre-defined survival threshold over a 24 or 100 year simulation period. Survival standards are met when that probability is 70 percent or greater.

- Recovery standards (which are required to consider de-listing of the species) are based on probabilities of exceeding a recovery threshold in the last eight years of a 48-year simulation period. This standard is met when the probability is 50 percent or greater.

Table ES-1 presents a comparison of alternative results based upon data provided by NMFS and PATH using 1998 model results. None of the alternatives meet all of the jeopardy standards using 1998 PATH model results. Alternative 4—Dam Breaching, comes the closest to meeting all of the jeopardy standards for both spring/summer and fall chinook (i.e., this alternative meets five out of six standards). The other three alternatives come relatively close to meeting all of the jeopardy standards, with the exception of the 48-year recovery standard for fall chinook.

PATH modeled only wild spring/summer chinook and fall chinook. The PATH group completed their initial estimates of the expected return rates for wild adult spring/summer chinook in 1998 and for fall chinook in 1999. The Scientific Review Panel (SRP), which was tasked to review the PATH analysis methods, found inconsistencies in the results of both the fall chinook and later the spring/summer chinook analysis developed by PATH. These inconsistencies or uncertainties, that were not totally resolved by PATH, included concerns about the differential delayed mortality factor (D-value) that PATH attributed to smolt transport, delayed hydrosystem mortality, and the fixed assigned survival rate for Alternative 4—Dam Breaching. Adjustments made to a number of factors of concern in the original PATH analysis resulted in higher adult return predictions under Alternatives 1 through 3, which reduced the net difference between the three dam retention alternatives and Alternative 4—Dam Breaching.

These modifications affected the model results for fall chinook. According to the Peters et al. (1999), the 1999 PATH model results had the following implications:

- All hydrosystem actions meet survival standards (probabilities of exceeding survival escapement thresholds are greater than 0.7), regardless of what is assumed about the estuary/ocean survival rate of transported fish.
- All drawdown actions meet recovery standards (probabilities of exceeding recovery escapement thresholds are greater than 0.5) regardless of what is assumed about the estuary/ocean survival rate of transported fish. The drawdown action (A3 [named Alternative 4 in this FR/EIS]) exhibited the most robust response across those uncertainties considered to date, and produced higher recovery probabilities (as well as higher average spawning escapements) than other actions. This conclusion is sensitive to assumptions about adult upstream survival.
- For each hypothesis about relative survival of transported fish, there is a non-breaching action (actions which do not involve drawdowns of dams) that meets the recovery standard, although there is no single non-breaching alternative option that meets recovery standards under all assumptions about the relative survival of transported fish. If transported fish are assumed to have high relative survival (i.e., high D), maximizing transportation will achieve recovery standards. If transported fish are assumed to have low relative survival (i.e., low D), then retaining current system configuration and allowing all smolts to migrate in-river achieves the recovery standards. Non-breaching actions are not as robust to the current level of uncertainty in relative survival of transported fish as are drawdown actions.

The 1999 PATH model results are not available in the same format as the 1998 model results reported in Table ES-1.

Table ES-1. Ability to Meet the NMFS Jeopardy Standards for Survival and Recovery Based Upon 1998 PATH Model Results (median values presented)

Biological Benefits	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Spring/Summer Chinook				
Survival in 24th year (standard is 0.70)	0.67	0.65	0.66	0.69
Recovery in 48th year (standard is 0.50)	0.48	0.45	0.46	0.84
Survival in 100th year (standard is 0.70)	0.79	0.78	0.79	0.89
Fall Chinook				
Survival in 24th year (standard is 0.70)	0.85	0.85	0.81	0.93
Recovery in 48th year (standard is 0.50)	0.22	0.22	0.28	1.00
Survival in 100th year (standard is 0.50)	0.83	0.83	0.78	0.98

Source: NMFS, PATH

The adjusted PATH 1999 results were supported by the Cumulative Risk Initiative (CRI) modeling results. The CRI analysis, which was performed by NMFS, used the same wild fish numbers (run reconstruction data) as that used by PATH except it was restricted to the period between 1980 and 1999. This period was used because NMFS believes that it is most representative of current conditions in the hydrosystem. The CRI analysis differed from the PATH analysis by not estimating the probability of achieving survival and recovery adult return standards, and also by estimating the chance of extinction occurring (which was not estimated by PATH). One of the main components used by CRI for estimating the chance of extinction was its estimate of population growth rate. While CRI did not specifically estimate returning numbers of fish under the dam breaching alternative, it did indicate that the PATH results for dam breaching and for all other alternatives were optimistic. CRI results indicate that little remaining survival improvements could be achieved from modification of the hydrosystem (i.e., Alternatives 1 to 3). However, while these results suggest that Alternative 4—Dam Breaching has a slight benefit over the other alternatives, these benefits were generally still inadequate by themselves to prevent extinction of all stocks. The CRI results suggest that the best chance of prevention of extinction would be from increasing survival and fitness in the early life history stages (egg to smolt stage) (e.g., from habitat improvements) and in increasing Columbia River estuary survival (e.g., from habitat improvements, predator control).

ES.2 National Economic Development

NED costs and benefits are the decrease or increase in the value of the national output of goods and services expressed in dollars. NED figures measure the costs and benefits to the nation and not to a particular region. The NED analysis conducted for this study addresses power, recreation, transportation, water supply, commercial fishing, tribal circumstances, flood control, and implementation/avoided costs. These resource areas are addressed in turn in the following sections.

ES.2.1 Power

The four lower Snake River dams are part of an integrated system of hydroelectric facilities located throughout the Columbia River Basin. This system provides a number of products and services, including firm and non-firm energy; peak and sustained capacity; daily load-following capacity; and other attributes that contribute to the reliability of the regional power system. Changing system hydropower operations affects the ability of the regional power system to generate electricity and the cost of generating that electricity. Changing hydropower operations also affects system reliability and capability, transmission, and ancillary services.

Changes in the regional power system's ability to provide energy and capacity, and the cost of providing these products, form the core of the power system cost analysis conducted by the DREW Hydropower Impact Team (HIT). The overall goal of the DREW HIT study was to develop an estimate of the net economic effects associated with the changes in hydropower under each of the alternatives. This involved a number of steps. The first step involved using system hydro-regulation studies to estimate how much hydropower generation would occur under the different alternatives and under different water conditions. This information was then incorporated into three different power system models to estimate how changes in hydropower generation would affect generation from other more costly power resources.

The range of net economic effects that was estimated based on the different power system models and different assumptions of future conditions is shown for the three project discount rates in Table ES-2. The point estimates used in the NED analysis are the midpoints between the minimum and maximum values.

Alternative 1—Existing Conditions is considered the base condition for this analysis. The results of the analysis for the other alternatives are compared with this condition. The DREW HIT analysis evaluated Alternative 2—Maximum Transport of Juvenile Salmon, and Alternative 3—Major System Improvements, as one cumulative alternative. The minor differences in generation that might occur between the two alternatives were not addressed in the DREW HIT analysis. This combined alternative would result in increases in system hydropower generation. It is not expected that the transmission system would be impacted with this combined alternative, and the changes in ancillary services are considered to be minimal. The point estimate of average annual net economic benefits is $8.5 million.

Under Alternative 4—Dam Breaching, the four lower Snake River hydropower facilities would no longer be operated, natural river levels would exist, and no hydropower generation would occur. The analysis of this alternative did not include any hydropower costs that may occur with changes in irrigation withdrawal from the lower Snake River reservoirs. The point estimate of average annual net economic costs consists of three components: 1) the point estimate of system costs ($238 million), 2) the point estimate of transmission reliability costs ($25 million), and 3) the estimate of ancillary service costs ($8 million). Using a 6.875 percent discount rate, this results in a point estimate of annual total net economic costs of $271 million (Table ES-2).

The preceding analysis assumes that any new replacement generating facilities would be natural gas combined-cycle combustion turbine plants. DREW HIT also examined the impact of using non-polluting resources to replace lost hydropower generation and found that conservation and renewable resources could be used to replace the lost generation. A conservation and renewable resource strategy would result in no net change in air pollution from the existing conditions. The costs could be similar to, but higher, than the combustion turbine plant strategy. The implementation of the conservation and renewable resource strategy would also require considerable government intervention, including subsidies, and implementation long before the dams are breached. The combustion turbine plant strategy would, in contrast, require almost no government intervention or subsidies.

Table ES-2. Estimated Net Average Annual Power Effects ($1,000s) (1998 dollars)

	6.875 % Discount Rate		**4.75 % Discount Rate**		**0.0 % Discount Rate**	
Benefits/Costs	**Minimum**	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Alternatives 2 and 3						
System	10,000	7,000	10,000	7,000	9,000	7,000
Transmission Reliability	0	0	0	0	0	0
Ancillary Services	0	0	0	0	0	0
Total	**10,000**	**7,000**	**10,000**	**7,000**	**9,000**	**7,000**
Total Point Estimate	**8,500**		**8,500**		**8,000**	
Alternative 4						
System	(221,000)	(255,000)	(220,000)	(256,000)	(217,000)	(260,000)
Transmission Reliability	(22,000)	(28,000)	(19,000)	(24,000)	(16,000)	(18,000)
Ancillary Services	(8,000)	(8,000)	(8,000)	(8,000)	(8,000)	(8,000)
Total	**(251,000)**	**(291,000)**	**(247,000)**	**(288,000)**	**(241,000)**	**(286,000)**
Total Point Estimate	**(271,000)**		**(267,500)**		**(263,500)**	

Note: Costs do not include implementation or avoided costs.
Source: Table 3.1-23 of the main Appendix I text

ES.2.2 Recreation and Tourism

A measure of the direct economic value of goods and services, including recreation activity, is the willingness-to-pay (WTP) of users. The recreation and tourism analysis conducted by the DREW

Recreation Workgroup employed the Travel Cost Method (TCM) to calculate net WTP for existing recreation activities and a hybrid TCM approach known as "contingent behavior" to estimate the value of river recreation under Alternative 4—Dam Breaching. Six recreation-use surveys were conducted as part of this study. Five of these surveys were designed to identify and value current recreation use through surveys of current users. Based on these surveys, existing reservoir use and annual benefits involved 509,760 trips worth $33,534,000 a year. Total existing recreation use identified through these surveys involved 1,147,659 trips worth $82,224,000 a year. Response rates could not be calculated for two of the surveys. Response rates for the other three surveys ranged from 59 to 72 percent.

The DREW Recreation Workgroup also surveyed a much larger sample of Washington, Idaho, Oregon, western Montana, and California residents to identify the type and number of recreation users who would visit the lower Snake River if the dams were breached. The survey described the new recreation conditions and asked whether the respondent would visit and, if so, how many times a year. Respondents were also asked the distance, travel cost, and travel time to the spot on the river that they would be most likely to visit. A total of 3,245 useable surveys were returned for an overall response rate of 41.4 percent. Response rates by state ranged from 21.3 percent in California to 46.3 percent in Montana. The survey findings were then applied to all Washington, Idaho, Oregon, western Montana, and California residents. The results of this survey indicate that a large percentage of total river recreation trips would be taken by visitors from more distant areas such as Portland, Seattle, and California. This differs from current conditions where a large proportion of outdoor recreationists and anglers reside within 50 miles of the four reservoirs.

Two demand estimates (Middle Estimates 1 and 2) and two estimates of WTP per trip (high and low) are presented for Alternative 4—Dam Breaching in Table ES-3. The DREW recreation analysis estimated that non-angling or general recreation visitors would demand 1,522,627 or 2,725,772 recreation days under Middle Estimates 1 and 2, respectively. Recreation use following dam breaching would be phased in over time as the natural river system recovered from breaching. Use would also be constrained by existing facilities — developed campgrounds, dispersed campgrounds, and boat ramp capacity. The DREW recreation analysis assumed that the number of developed campsites would double by the end of the first decade following breaching.[2]

Salmon and steelhead angling demand would be constrained by the projected availability of fish, and only a small fraction of projected angler demand would be met. Estimates of the economic value of angling were developed for three geographic areas; ocean, in-river mainstem, and in-river tributary.[3] The DREW Recreation Workgroup evaluated the NED effects associated with tributary fishing for salmon and steelhead, as well as those associated with resident fish in the lower Snake River reservoirs. The DREW Anadromous Fish Workgroup evaluated the NED effects associated with ocean and mainstem recreational fishing.

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[2] If dam breaching were to occur and these campsites were not built, the number of projected visitors who could be accommodated would be reduced. This would, in turn, reduce the projected NED benefits. If dam breaching were to occur and the campsites were built, the projected average annual recreation benefits would be reduced by $2.6 million each year (6.875 percent discount rate).

[3] This division of in-river harvest into mainstem and tributary is based on the 1998 preliminary PATH results. PATH divided its estimates into mainstem, the area downstream of Lower Granite Dam to the Columbia River estuary, and tributary, the area upstream of Lower Granite Dam. The tributary area encompasses the entire Snake River watershed above Lower Granite Dam, including Lower Granite Lake.

The average annual effects estimated by the DREW Recreation Workgroup are presented for Alternatives 2 through 4 in Table ES-3. These values, presented in 1998 dollars and calculated using a 6.875 percent discount rate, represent the net change from Alternative 1—Existing Conditions. The results of this analysis indicate that there would be significant recreation benefits associated with breaching the dams. There would also be benefits associated with small projected gains in salmon and steelhead fishing under Alternatives 2 and 3.

The low estimates presented for Alternative 4—Dam Breaching, are consistent with values in the literature for general recreation, while the high estimates are consistent with literature for river angling. A point estimate for the most likely value for Alternative 4—Dam Breaching was calculated by combining the low NED value for the general recreation Middle Estimate 2 ($59.5 million) with the high NED value for sportsfishing ($45.228 million) and subtracting the existing reservoir recreation value ($31.6 million). This composite results in a point estimate of average annual benefits of $73.128 million.

Table ES-3. Difference in Average Annual Value of Recreation Benefits from Alternative 1—Existing Conditions ($1,000s) (1998 dollars) (6.875 percent discount rate)

			4	
Alternative	**2**	**3**	**Low NED**	**High NED**
General Recreation				
Reservoir Recreation	0	0	(31,600)	(31,600)
River Recreation (Middle Estimate 1)			36,900	192,700
River Recreation (Middle Estimate 2)			59,500	310,500
Angling				
Resident and Steelhead	0.006	6	5,201	13,844
Steelhead-Tributaries	1,180	1,228	3,361	30,903
Salmon-Tributaries	29	24	122	481
Total Recreational Fishing	1,215	1,258	8,684	45,228
General Recreation and Angling				
Total Reservoir	1,215	1,258		
Total Middle Estimate 1			13,984	206,328
Total Middle Estimate 2			36,584	324,128
Total Point Estimate			**73,128**	

Notes: 1. Middle Estimate 1 uses only those respondents that would definitely visit, but then expands this proportion to the total number of households in the survey strata area.
2. Middle Estimate 2 uses those respondents that would definitely or probably visit, but only applies this to the proportion of households responding to the survey (assumes zero visitation for the proportion of households not returning the survey).
3. NED effects are average annual costs and benefits calculated over a 100-year project life.
4. This table presents the NED recreation effects estimated by the DREW Recreation Workgroup. The NED recreation effects estimated by the DREW Anadromous Fish Workgroup (ocean and mainstem recreational fishing) are not included in this table. They are, however, summarized in Table ES-4.

Source: Table 3.2-13 of the main Appendix I text

Total recreation benefits are further summarized in Table ES-4, which also includes the recreation benefits associated with ocean and mainstem angling ($732,000) (see Table ES-4, footnote 1). Adding these benefits increases the point estimate to $73.86 million. Subtracting the average annual costs that would be associated with the new campgrounds from this total results in a net average annual benefit of $71.255 million. Average annual values are also presented in Table ES-4 for the other two discount rates used in this analysis; 4.75 and 0.0 percent.

Table ES-4. Estimated Net Average Annual Recreation Effects ($1,000s) (1998 dollars)

	6.875 % Discount Rate	4.75 % Discount Rate	0.0 % Discount Rate
Alternative 2			
General Recreation	0	0	0
Recreational Fishing			
Ocean	0	0	0
Mainstem	190	197	182
Tributary	1,215	1,185	805
Total	**1,405**	**1,382**	**987**
Alternative 3			
General Recreation	0	0	0
Recreational Fishing			
Ocean	3	4	6
Mainstem	174	172	130
Tributary	1,259	1,195	673
Total	**1,437**	**1,371**	**809**
Alternative 4			
General Recreation	27,900	31,500	42,100
Recreational Fishing			
Ocean	107	134	207
Mainstem	625	824	1,496
Tributary	45,228	49,130	62,213
Campground Costs	(2,605)	(2,249)	(2,443)
Total	**71,255**	**79,339**	**103,573**

Notes:
1. Non-angling recreation and tributary recreational fishing estimates were calculated by the DREW Recreation Workgroup (see Table ES-3). Ocean and mainstem recreational fishing estimates were calculated by the DREW Anadromous Fish Workgroup (see Tables 3.5-12, 3.5-13, 3.5-14, and 3.5-15 of the main Appendix I text).
2. NED effects are average annual costs and benefits calculated over a 100-year project life.
3. NED benefits associated with resident fish in the lower Snake River are included in the tributary estimates developed by the DREW Recreation Workgroup.

Source: Compiled from Tables 3.2-3, 3.2-11, 3.2-12, 3.5-14, and 3.5-15 of the main Appendix I text

ES.2.3 Transportation

Alternative 4—Dam Breaching would have significant effects upon navigation because barges would no longer be able to operate. Commodities currently transported by barge on the lower Snake River would need to be shipped by rail or truck. The DREW Transportation Workgroup conducted a transportation analysis as part of this study to identify and quantify the direct economic effects resulting from disruption of the existing transportation system. This analysis was designed to measure the effect that breaching the four lower Snake River dams would have on the costs of transporting products that are currently shipped on the Columbia-Snake Inland Waterway. There would be no change to existing navigation facilities on the lower Snake River under Alternatives 1 through 3. These alternatives are, as a result, represented by the base case in the following discussion.

The economic effects of the loss of navigation are addressed in terms of costs associated with both current and projected future traffic volumes. Alternative routings for existing and projected lower Snake River shipments were identified based on origin and destination data compiled for each shipment. Commodities could, in most cases, either be rerouted via truck to river elevators located on the McNary pool or shipped by rail directly to export elevators on the lower Columbia River. Where rail access is currently available at country elevators, grain could either shift to rail direct from these locations, or be moved by truck to a rail distribution point where unit trains could be assembled. The costs of transportation, storage, and handling were calculated for the alternative routings of each affected origin-destination pair.

The DREW Transportation Workgroup analysis measured direct economic effects in terms of opportunity costs rather than market rates. In other words, the costs developed in this analysis assume a perfectly competitive market and do not take into account possible increases in rail and truck transportation rates that may occur in the absence of navigation. It was also assumed that current and projected levels of exports from the region would continue under the dam breaching scenario. During review of the Draft FR/EIS questions were raised about the assumption that grain-handling capacity could be expanded and other infrastructure improvements could be made without upward pressure on average costs. In response to these concerns, the DREW Transportation Workgroup determined that marginal costs and revenue of infrastructure improvements should be compared and that costs in excess of marginal revenue (fees and other revenue from handling and transporting grain that would be diverted from the lower Snake River) should be added to the NED costs of dam breaching.

The average annual effects are presented for Alternative 4—Dam Breaching, in Table ES-5. These values, presented in 1998 dollars, represent the net change from Alternatives 1 through 3, which serve as the base case for this analysis.

Table ES-5. Estimated Net Average Annual Transportation Effects ($1,000s) (1998 dollars)[1/]

Alternative 4	**6.875 % Discount Rate**	**4.75 % Discount Rate**	**0.0 % Discount Rate**
Grain	(22,566)	(22,731)	(23,156)
Non-Grain Commodities	(4,624)	(4,710)	(4,904)
Infrastructure	(16,001)	(9,149)	2,996
Total[2/]	**(43,191)**	**(36,589)**	**(25,064)**
Adjusted Total[3/]	**(37,813)**	**(33,346)**	**(25,064)**

1/ NED effects are average annual costs and benefits calculated over a 100-year project life.
2/ The DREW Transportation Workgroup analysis used 2007 as the base year. The “total” row presents the average annual costs adjusted to the base year of 2007.
3/ The adjusted totals discount the same costs back to 2005 to allow comparability with other elements of the study.
Source: Compiled from Tables 3.3-26, 3.3-28, 3.3-29, and 3.3-30 of the main Appendix I text

ES.2.4 Water Supply

The DREW Water Supply Workgroup addressed the effects of the Alternative 4—Dam Breaching on agricultural water users; municipal, industrial, and other use; and privately owned wells. Only Alternative 4—Dam Breaching would directly affect the operation of river pump station and wells used for irrigation and other uses. Approximately 37,000 acres of irrigated farmland currently rely on water pumped from the Ice Harbor reservoir. This represents about 12 percent of the irrigated farmland in Franklin and Walla Walla counties and about 2 percent of the irrigated farmland in Washington State. Additional farmland is irrigated by private wells. The cost of modifying the Ice Harbor pumping stations to provide current water supplies following dam breaching would be more than twice the value of the land they currently irrigate. The value used for this analysis is the estimated change in the value of the land if it were no longer irrigated.

The Municipal and Industrial (M&I) pump stations that withdraw from the lower Snake River are all located on the Lower Granite reservoir. Uses include municipal water system backup, golf course irrigation, industrial process water for paper production, and concrete aggregate washing. The values used for this analysis are based on the costs required to modify these systems. There is a range of costs because it is unknown what modifications would be necessary for the Potlatch Corporation's Lewiston facility. There are also approximately 209 functioning wells within 0.6 mile of the lower Snake River. The Corps estimates that about 40 percent, or 95, of these wells would require modification if dam breaching were to occur.[4]

The average annual cost of modifying these existing water withdrawal systems is summarized by category in Table ES-6. Total average annual costs would range from $13,919,500 to $16,927,800 using a 6.875 percent discount rate.

Table ES-6. Estimated Net Average Annual Water Supply Effects ($1,000s) (1998 dollars)

Alternative 4 Water Supply Category	6.875% Discount Rate	4.75% Discount Rate	0.0% Discount Rate
Loss of Irrigated Farmland Value	(9,241.1)	(6,438.1)	(1,342.4)
Municipal and Industrial Pump Stations	(792.6) to (3,800.9)	(552.2) to (2,648.1)	(115) to (552)
Privately Owned Wells	(3,885.8)	(2,707.2)	(564.5)
Total	**(13,919.5) to (16,927.8)**	**(9,697.5) to (11,793.4)**	**(2,021.9) to (2.458.9)**
Total Point Estimates	**(15,424)**	**(10,746)**	**(2,241)**

1/ NED effects are average annual costs and benefits calculated over a 100-year project life.

Source: Table 3.4-16 of the main Appendix I text

ES.2.5 Anadromous Fish

The DREW Anadromous Fish Workgroup identified the net economic costs associated with changes in commercial fishing and ocean and mainstem in-river recreational fishing. Estimates of the number of fish available for harvest in each area were developed by the DREW Anadromous Fish Workgroup based on the findings of the preliminary PATH analysis, with additional assumptions made to extend the PATH findings to all Snake River stocks. Harvests were allocated to user groups and geographic areas based on existing United States and Indian tribal agreements. Fish available after these obligations were met were distributed based on historical harvest distributions. Total harvest estimates and allocations for project year 25 are presented in Table ES-7. This table presents estimates for recreational ocean and in-river harvest, commercial ocean and in-river harvest, and other in-river harvest. In-river tribal harvest identified under the commercial in-river section includes both gillnet and ceremonial and subsistence harvest because the PATH results did not distinguish between these fisheries. Ceremonial and subsistence harvests are accounted for in the commercial treaty fishery category but are not assigned an additional intrinsic dollar value.

[4] Further engineering review of the well data indicated that 180, rather than 209, of the total 228 recorded wells were functioning and within the designated study area. About 71 of these wells, rather than the original estimate of 95, are expected to require modification if dam breaching were to occur. Total estimated well modification costs have been revised, increasing from $56.45 million to $67.04 million. This increase in cost has not been incorporated in the water supply analysis because it does not significantly change the relative size of the water supply economic effects.

The results of the DREW Anadromous Fish Workgroup's recreation analysis are summarized in Section ES.2.2. This section presents the results of the DREW Anadromous Fish Workgroup's commercial fishing analysis. The changes in commercial fishing NED values associated with changes in anadromous fish harvest were calculated as annual average values over a 100-year period of analysis and presented net of the base case (Alternative 1—Existing Conditions). These average annual values are presented for Alternatives 2 through 4 using three different discount rates in Table ES-8. Most of the totals shown here would be generated from the in-river fall chinook treaty fishery.

Table ES-7. Projected Harvest for All Fisheries for Year 25

Alternative	1	2	3	4
Recreation				
Ocean	608	608	732	5,079
Mainstem	29,943	32,466	31,613	43,937
Tributary	68,074	71,809	70,588	91,234
Subtotal Recreation	98,625	104,883	102,933	140,250
Commercial				
Ocean	3,596	3,596	4,329	30,050
In-river				
Non-treaty	2,387	2,655	2,852	20,078
Hatchery	51,679	60,533	57,986	132,257
Treaty Indian	101,869	108,491	106,792	169,125
Subtotal In-river	155,935	171,679	167,630	321,460
Subtotal Commercial	159,531	175,275	171,959	351,510
Other In-river	264	359	327	792
Total	**258,420**	**280,517**	**275,219**	**492,552**

Notes: 1. Harvest is in number of fish. Estimated harvest numbers are based on the "equal weights" PATH scenario.
2. These projections are "likely" modeling results that correspond to the PATH results for the 50th percentile output.
3. This analysis is based on the results of the PATH "base case" scenario for fall chinook and "equal weights" scenario for spring/summer chinook.
4. PATH divided its estimates into "mainstem," the area downstream of Lower Granite dam to the Columbia River estuary, and "tributary," the area upstream of Lower Granite Dam. The tributary area encompasses the entire Snake River watershed above Lower Granite Dam, including the Lower Granite reservoir.

Source: Table 3.2-1 of the main Appendix I text

Table ES-8. Estimated Net Average Annual Commercial Fishing Effects ($1,000s) (1998 dollars)

	6.875% Discount Rate	4.75% Discount Rate	0.0% Discount Rate
Alternative 2			
Ocean	0.00	0.00	0.00
Inriver	159.77	175.53	197.63
Total	**159.77**	**175.53**	**197.63**
Alternative 3			
Ocean	12.34	14.98	23.10
Inriver	145.53	154.95	158.79
Total	**157.87**	**169.93**	**181.89**
Alternative 4			
Ocean	380.65	476.98	735.90
Inriver	1,105.80	1,452.70	2,543.08
Total	**1,486.45**	**1,929.68**	**3,278.98**

Note: NED effects are average annual costs and benefits calculated over a 100-year project life.

Source: Tables 3.5-12, 3.5-13, 3.5-14, and 3.5-15 of the main Appendix I text

ES.2.6 Tribal Circumstances

There are 14 Native American tribes and bands in the region that could potentially be affected by the proposed alternatives. They are as follows:

- Confederated Tribes of the Colville Indian Reservation
- Confederated Tribes of the Umatilla Indian Reservation
- Confederated Tribes and Bands of the Yakama Nation
- Nez Perce Tribe
- Wanapum Band
- Burns Paiute Tribe
- Coeur d'Alene Tribe
- Confederated Tribes of the Warm Springs Reservation of Oregon
- Kalispel Indian Community of the Kalispel Reservation
- Kootenai Tribe of Idaho
- Northwestern Band of the Shoshoni Nation
- Shoshone-Bannock Tribes of the Fort Hall Reservation
- Shoshone-Paiute Tribes of the Duck Valley Reservation
- The Spokane Tribe of the Spokane Reservation.

The tribes and American Indian communities that the Corps believes would be most directly influenced by the proposed alternatives include four tribes with treaties signed by the United States government and one non-federally recognized Indian community. The four treaty tribes are the Confederated Tribes of the Umatilla Indian Reservation (Umatilla), the Confederated Tribes and Bands of the Yakama Nation (Yakama), the Nez Perce Tribe (Nez Perce) of Idaho, and the Confederated Tribes of the Colville Reservation (Colville). The non-federally recognized Indian community most likely to be affected is the Wanapum Indian community (Wanapum). Three of these tribes are directly addressed in a report on tribal circumstances prepared for this FR/EIS by Meyer Resources, Inc. in association with the Columbia River Inter Tribal Fisheries Commission (CRITFC) (Meyer Resources, 1999).[5] According to this report, the ancestors of these tribes historically valued the salmon first for cultural and spiritual purposes and then to feed their people. Salmon were also traded and exchanged for other valued goods, both within each tribe, and with peoples from other tribes.

The DREW Anadromous Fish Workgroup included In-river Treaty Indian fisheries as part of its Commercial Fishery category (see Table ES-7). This Treaty Indian fishery includes both treaty gillnet and ceremonial and subsistence harvests because PATH did not distinguish between these fisheries. As noted in Section ES.2.5, ceremonial and subsistence harvests are accounted for in the commercial treaty fishery category, but are not assigned an additional intrinsic dollar value. Estimated contributions to ocean treaty fisheries were very small and were, as a result, included as incidental harvests to other commercial fisheries in the DREW Anadromous Fish Workgroup's modeling.

The study tribes emphasize that while revenue obtained from commercial sales of salmon provides important income to tribal peoples it does not represent the greatest part of value that tribal peoples associate with salmon. The study tribes consider dollar revenue to be a severely limited indicator of tribal value that can provide an incomplete impression of full impact to the tribes. Tribal circumstances are, as a result, also addressed under the Environmental Quality Account (see Section ES.4).

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[5] This report entitled *Tribal Circumstances and Impacts of the Lower Snake River Projects on The Nez Perce, Yakama, Umatilla, Warm Springs and Shoshone Bannock Tribes* is available on the Corps' website at: http://www.nww.usace.army.mil/. This report, prepared as part of the DREW process, is referred to as either the Tribal Circumstances report or Meyer Resources (1999) throughout this document.

ES.2.7 Flood Control

Flood control benefits are not currently provided by the lower Snake River dams. Flood control benefits would not be provided under any of the proposed alternatives. As a result, there are no NED costs or benefits associated with this resource area.

ES.2.8 Implementation/Avoided Costs

Implementation costs considered in the following discussion include all project-related construction and acquisition costs and operation, maintenance, repair, replacement and rehabilitation costs (O,M,R,R&R) associated with construction and operation activities required under each alternative. The major cost categories include:

- Construction costs for fish-improvement projects and/or breaching the dams. Construction costs associated with the dam breaching alternative include mitigation costs, such as wildlife mitigation and cultural resources protection and mitigation, at each of the four dams
- Interest during construction (IDC), which reflects compound interest at the applicable borrowing rate, on construction costs incurred during the period of installation.
- Anadromous fish evaluation program (AFEP)
- Operation, maintenance, repair, replacement and rehabilitation costs associated with the new fish improvement projects (e.g., purchase of water from the Bureau of Reclamation (BOR) and the O&M costs associated with the screen bypass system proposed under Alternative 3—Major System Improvements).

Average annual costs are presented in Table ES-9. These costs vary depending upon which discount rate is used but the ranking of the alternatives remains constant. Alternative 2—Maximum Transport of Juvenile Salmon, is the lowest cost alternative, while Alternative 4—Dam Breaching, is the highest cost alternative, under all discount rates.

The avoided costs associated with each alternative include those costs that would no longer be required to operate and maintain the lower Snake River dams and associated lands. These costs are calculated by comparing the base case, Alternative 1—Existing Conditions, with Alternatives 2 through 4. Costs required under Alternative 1 that are not required under the other alternatives are considered avoided costs.

Avoided costs include:

- Costs of construction or major upgrades that would occur with Alternative 1—Existing Conditions, but not under other alternatives. These include major powerhouse system upgrades and specific additional major improvements to fish bypass, collection, and passage systems
- O&M costs incurred under Alternative 1—Existing Conditions, but not under other alternatives. These include future annual O&M costs and additional annual repair costs
- Disposition of equipment that could be surplused if the dams were breached represents a third type of cost included in this analysis. This represents a reduced opportunity cost for other Federal agencies seeking this type of property and may, therefore, be considered a form of avoided costs.

Table ES-9. Estimated Net Average Annual Implementation Cost Effects ($1,000s) (1998 dollars)

	6.875% Discount Rate	4.75% Discount Rate	0.0% Discount Rate
Alternative 2			
Investment Cost	1,610	1,090	210
AFEP Cost	1,850	1,470	450
OMRR&R Cost	0	0	0
Total	**3,460**	**2,560**	**660**
Alternative 3			
Investment Cost	(17,420)	(12,760)	(3,010)
AFEP Cost	(4,550)	(3,600)	(1,100)
OMRR&R Cost	(910)	(840)	(820)
Total	**(22,880)**	**(17,200)**	**(4,930)**
Alternative 4			
Investment Cost	(48,980)	(35,520)	(8,220)
AFEP Cost	3,020	2,400	730
OMRR&R Cost	(2,830)	(2,370)	(860)
Total	**(48,790)**	**(35,490)**	**(8,350)**

Note: NED effects are average annual costs and benefits calculated over a 100-year project life.
Source: Table 3.8-4 of the main Appendix I text

The average annual avoided costs associated with Alternative 4—Dam Breaching range from approximately $33.6 million to $35.4 million per year over the life of the study under the three discount rates (Table ES-10).

Table ES-10. Estimated Net Average Annual Avoided Cost Effects ($1,000s) (1998 dollars)

	6.875% Discount Rate	4.75% Discount Rate	0.0% Discount Rate
Alternative 2			
Turbine Rehabilitation	0	0	0
Dam-Related O,M,R,R&R	0	0	0
Surplus Property	0	0	0
Total	**0**	**0**	**0**
Alternative 3			
Turbine Rehabilitation	0	0	0
Dam-Related O,M,R,R&R	(10)	(60)	(1,520)
Surplus Property	0	0	0
Total	**(10)**	**(60)**	**(1,520)**
Alternative 4			
Turbine Rehabilitation	4,800	4,600	3,870
Dam-Related O,M,R,R&R	27,740	28,570	29,850
Surplus Property	1,030	720	150
Total	**33,570**	**33,890**	**33,870**

Note: NED effects are average annual costs and benefits calculated over a 100-year project life.
Source: Table 3.8-7 of the main Appendix I text

ES.2.9 Summary

The total NED costs and benefits identified in this analysis are presented in Tables ES-11 through ES-13. These costs, presented net of Alternative 1—Existing Conditions, were calculated for a 100-year period of analysis extending from 2005 to 2104. The values presented in these tables were discounted and converted into 1998 dollars. Tables ES-11, ES-12, and ES-13 show total NED costs and benefits discounted using 6.875, 4.75, and 0.0 percent discount rates, respectively.

NED costs are:

- Implementation costs, including all project-related construction and acquisition costs, interest during construction, and operation, maintenance, repair, replacement, and rehabilitation costs. Implementation costs also include water acquisition from BOR, mitigation costs for fish and wildlife programs, and cultural resources protection (Alternatives 3 and 4)
- Cost increases associated with the shift from hydropower to more expensive forms of replacement power (Alternative 4)
- Transportation cost increases associated with the shift of barge-transported commodities to more costly truck and rail systems (Alternative 4)
- Construction/O&M costs for irrigation and water supply systems (Alternative 4)
- Costs incurred under Alternative 3—Major System Improvements that would not be incurred under Alternative 1—Existing Conditions, or under Alternatives 2 and 4.

NED benefits are:

- Costs incurred under Alternative 1—Existing Conditions that would be avoided under Alternative 4—Dam Breaching. These include operations, maintenance, repair, and replacement costs, as well as the costs associated with the rehabilitation of existing infrastructure
- Recreation benefits from increased fish runs and the shift to a near-natural river
- Commercial fishing benefits from increased fish runs
- Implementation benefits from a decrease in costs related to fish-related improvements that would not be incurred under Alternative 2—Maximum Transport of Juvenile Salmon (Alternative 2)
- Power benefits from increases in system hydropower generation (Alternatives 2 and 3).

These summary tables indicate that Alternative 4—Dam Breaching, has significantly higher average annual net costs than the other alternatives under all three discount rates. Alternative 2—Maximum Transport of Juvenile Salmon is less costly than Alternative 1—Existing Conditions under all three discount rates. Alternative 3—Major System Improvements is also less costly than Alternative 1—Existing Conditions when a zero percent discount rate is used. Alternative 4—Dam Breaching is significantly higher primarily as a result of increased power costs, which are estimated to be $271 million using a 6.875 percent discount rate. The second largest average annual cost, implementation costs, is less than 20 percent of the average annual power costs. The largest average annual benefit, recreation is estimated to be $71.255 million under Alternative 4—Dam Breaching using a 6.875 percent discount rate.

Table ES-11. Summary of Estimated Net Average Annual Economic Effects ($1,000s) (1998 dollars) (6.875 percent discount rate)

Costs	Alternative 2	Alternative 3	Alternative 4
Implementation Costs	–	(22,880)	(48,790)
Power	–	–	(271,000)
Transportation	–	–	(37,813)
Water Supply	–	–	(15,424)
Avoided Costs	–	(10)	–
Total Costs	**–**	**(22,890)**	**(373,027)**
Benefits			
Avoided Costs	–	–	33,570
Recreation	1,405	1,437	71,255
Commercial Fishing	160	158	1,486
Implementation Costs	3,460	–	–
Power	8,500	8,500	–
Total Benefits	**13,525**	**10,095**	**106,311**
Net Benefits	**13,525**	**(12,795)**	**(266,716)**

Notes: 1. These costs and benefits are calculated for a 100-year period of study extending from 2005 to 2104, are discounted using a 6.875 percent discount rate and converted to 1998 dollars.
2. Costs and benefits are presented for Alternatives 2 through 4 net of the base case (Alternative 1).
3. A positive monetary value indicates that the alternative being evaluated has a lower cost or greater benefit than Alternative 1. A negative monetary value indicates that the evaluated alternative has a higher cost or lower benefit than Alternative 1. Positive monetary values, therefore, represent benefits, while negative values represent costs.

Source: Table 10-2 of the main Appendix I text

Table ES-12. Summary of Estimated Net Average Annual Economic Effects ($1,000s) (1998 dollars) (4.75 percent discount rate)

Costs	Alternative 2	Alternative 3	Alternative 4
Implementation Costs	–	(17,200)	(35,490)
Power	–	–	(267,500)
Transportation	–	–	(33,346)
Water Supply	–	–	(10,746)
Avoided Costs	–	(60)	–
Total Costs	**–**	**(17,260)**	**(347,082)**
Benefits			
Avoided Costs	–	–	33,890
Recreation	1,382	1,371	79,339
Commercial Fishing	176	170	1,930
Implementation Costs	2,560	–	–
Power	8,500	8,500	–
Total Benefits	**12,618**	**10,041**	**115,159**
Net Benefits	**12,618**	**(7,219)**	**(231,923)**

Notes: 1. These costs and benefits, calculated for a 100-year period of study extending from 2005 to 2104, are discounted using a 4.75 percent discount rate and converted to 1998 dollars.
2. Costs and benefits are presented for Alternatives 2 through 4 net of the base case (Alternative 1).
3. A positive monetary value indicates that the alternative being evaluated has a lower cost or greater benefit than Alternative 1. A negative monetary value indicates that the evaluated alternative has a higher cost or lower benefit than Alternative 1. Positive monetary values, therefore, represent benefits, while negative values represent costs.

Source: Table 10-3 of the main Appendix I text

Table ES-13. Summary of Estimated Net Average Annual Economic Effects ($1,000s) (1998 dollars) (0.0 percent discount rate)

Costs	Alternative 2	Alternative 3	Alternative 4
Implementation Costs	–	(4,930)	(8,350)
Power	–	–	(263,500)
Transportation	–	–	(25,064)
Water Supply	–	–	(2,241)
Avoided Costs	–	(1,520)	–
Total Costs	**–**	**(6,450)**	**(299,155)**
Benefits			
Avoided Costs	–	–	33,870
Recreation	987	809	103,573
Commercial Fishing	198	182	3,279
Implementation Costs	660	–	–
Power	8,000	8,000	–
Total Benefits	**9,845**	**8,991**	**140,722**
Net Benefits	**9,845**	**2,541**	**(158,433)**

Notes: 1. These costs and benefits, calculated for a 100-year period of study extending from 2005 to 2104, are discounted using a zero percent discount rate and converted to 1998 dollars.
2. Costs and benefits are presented for Alternatives 2 through 4 net of the base case (Alternative 1).
3. A positive monetary value indicates that the alternative being evaluated has a lower cost or greater benefit than Alternative 1. A negative monetary value indicates that the evaluated alternative has a higher cost or lower benefit than Alternative 1. Positive monetary values, therefore, represent benefits, while negative values represent costs.

Source: Table 10-4 of the main Appendix I text

Unresolved Issues

This section briefly addresses several areas of concern that were not evaluated as part of the NED analysis because at this time, it is unclear how these concerns will be addressed or if the costs will be implemented. Three potential areas of concern—water temperature concerns, total dissolved gas concerns, and mitigation/compensation concerns—are briefly described below:

- Water temperature and dissolved gas saturation levels are two of the principal water quality concerns in the lower Snake River. The Dworshak reservoir is currently operated to release approximately 1.2 million acre feet of cold water during July and August each year to reduce water temperatures within the lower Snake River reservoirs. No other actions are currently being studied to further reduce temperatures within the system. Therefore, no additional costs are evaluated in this study.
- To reduce total dissolved gas levels found at the lower Snake River reservoirs, structural modifications have been made at the dams, and additional modifications are being evaluated. Annual costs to address total dissolved gases are not included in the implementation cost analysis because it is unclear which, if any, of the possible range of costs may be implemented. (The possible range of costs is summarized in Table 3.8-9 of the main Appendix I text.)
- Federally required mitigation actions (for fish and wildlife programs and cultural resources) are included in implementation costs. However, it may also be socially desirable to consider mitigation or compensation actions that involve negatively impacted groups being compensated by those benefiting from the selected alternative. It is unclear which measures, if any, Congress may decide are appropriate to address. Therefore, these costs were not identified or included in the NED analysis.

ES.3 Passive Use Value Estimates

Economists generally recognize that there is a benefit associated with knowing that a resource exists, even if no use is made of it. These values are typically referred to as passive use, non-use, or existence values. There are, however, disagreements about how to measure passive use values. Although DREW originally requested that an original passive-use survey be conducted for this study, this was not possible and passive use values were estimated using a benefit transfer approach. Corps Planning Guidance does not allow passive use values to be included in NED analysis. However, since these values could be useful as a social indicator, they are presented here as additional information for the decision maker to consider.

The passive use value estimates for salmon were calculated on a per fish basis based on the preliminary PATH results, as extended by the DREW Anadromous Fish Workgroup. Values were calculated for Alternatives 2 through 4 net of Alternative 1. Based on these results, salmon and steelhead runs projected for Alternative 2—Maximum Transport of Juvenile Salmon were on average slightly lower than those projected for Alternative 1—Existing Conditions. There were, however, more fish in the first few decades under Alternative 2 then under Alternative 1, which resulted in small average annual increases in passive use values once discounting was taken into consideration. Net gains were estimated to range from $0.25 million to $4.02 million per year. Salmon and steelhead runs projected for Alternative 3—Major System Improvements were less than those projected for Alternative 1—Existing conditions, resulting in a net average annual reduction in passive use values under Alternative 3. Net reductions were estimated to range from about $0.7 million to about $31.1 million per year. Salmon and steelhead runs projected for Alternative 4—Dam Breaching were higher than those projected for Alternative 1—Existing Conditions. The average annual passive use value associated with Alternative 4—Dam Breaching, was estimated to range from $22.8 million to $301.5 million per year. The passive use value of a near-natural lower Snake River was estimated at $420 million per year.

Using the 1999 PATH model results would reduce the difference between Alternatives 1 through 3 and Alternative 4—Dam Breaching. This would lower the estimated passive use value for Alternative 4—Dam Breaching, which, as noted above, is calculated net of Alternative 1—Existing Conditions. The passive use values associated with the near-natural river would not change.

ES.4 Tribal Circumstances and Perspectives

This section draws information from a number of sources, including the Tribal Circumstances Report referenced in Section ES.2.6 (Meyer Resources, 1999). From the perspective of the WRC guidelines that establish the procedures used for the overall economic analysis conducted as part of this FR/EIS, the following discussion is part of the environmental quality account, which addresses non-monetary effects on significant natural and cultural resources

The implications of the proposed alternatives on tribal treaty rights and other concerns were evaluated based on certain general criteria, including the following:

- accessibility to usual and accustomed places for the exercise of treaty rights
- economic well-being of tribal communities using variables such as employment and income levels
- effects to the Snake River's seven index salmon stocks (wild and hatchery fish) relating to harvestable pounds of fish by species
- ownership of land by tribes or tribal members inclusive of the project area
- allowances for cultural survival and religious practices by providing access to culturally significant places (e.g., cemeteries/burial places, ethno-habitats like traditional fishing stations).

Alternative 4—Dam Breaching is anticipated to result in circumstances more conducive to the tribes exercise of off-reservation treaty rights and interests. Based on preliminary PATH analysis, there would be an 80 percent probability for recovery of culturally significant wild spring/summer chinook from their threatened status under ESA. According to the CRI analysis, Alternative 4—Dam Breaching could improve salmonid migration survival through the lower Snake River and may improve survival following the migration life stage. Estuarine survival could be improved by reducing some delayed mortality perceived by some as a consequence of passing through the hydrosystem. Access to culturally significant places could be greatly increased in the 140-mile stretch of river. Opportunities to practice socioeconomic and religious activities along significant lower Snake River traditional cultural landscapes and places may be possible. Based on the preliminary PATH analysis, Alternatives 1 and 2 may not change the current conditions for tribal harvest practices, (e.g., there is only a 30 to 42 percent range of probability that spring/summer chinook would be recovered after 48 years) and access to culturally significant places would not include reservoir inundated lands. Alternative 3 is projected to have similar results as Alternatives 1 and 2. These three alternatives are not anticipated to appreciably change tribal socioeconomic well-being. In addition, there would be no increased access to other inundated riverine culturally significant places, cemeteries, or resources.

According to the CRI analysis, the risk of extinction for the seven Snake River spring/summer chinook salmon index stocks is less than 15 percent for all the alternatives over the next 10-year time span. There are efforts being made to consider tribal interests and treaty rights through the proposed alternatives analysis. The goal of the proposed alternatives is to provide improvements for salmonid fish passage through Snake River hydropower facilities. Fish passage improvements have increased rates of juvenile downstream migration survival from Lower Granite reservoir to Bonneville Dam 40 to 60 percent above the levels measured in the 1960s. The CRI analysis concluded that even if mainstem survival were elevated to 100 percent, Snake River spring/summer chinook would likely continue to decline towards extinction due to other factors. However, even minor improvements in first year or estuarine survival rates could reverse the current population declines.

ES.5 Regional Economic Development

The Regional Economic Development (RED) account addresses regional economic impacts in terms of jobs and income resulting from the alternatives under consideration. Impacts on employment and income include direct, indirect, and induced effects. The job totals reported below are estimates of total impacts and include both full- and part-time employment.

The regional economic analysis developed for this study addresses the regional economic impacts of changes in spending projected by various DREW workgroups. These impacts, evaluated in terms of business transactions, employment, and income, were estimated using input-output models, which model the interactions among different sectors of the economy. Eight models were constructed to address the potential regional effects associated with the alternatives. Models were developed for Washington, Oregon, Idaho, and Montana, three subregions—the downriver, reservoir, and upriver subregions, and the lower Snake River study area, which consists of the three subregions. In addition, the DREW Anadromous Fish Workgroup estimated the economic impacts of changes in anadromous fish harvests. These impacts were evaluated for the Pacific Northwest states, Alaska, and British Columbia, Canada.

ES.5.1 Regional Impacts Associated with Alternatives 2 and 3

Regional impacts under Alternatives 2 and 3 are expected to be relatively minor and limited to those associated with changes in implementation and avoided costs.

ES.5.2 Regional Impacts Associated with Alternative 4

Construction activities resulting directly and indirectly from breaching of the four lower Snake River dams would generate increased business transactions of $2,271.6 million, 20,821 temporary jobs, and an increase of $678.8 million in personal income in the lower Snake River study area.

Table ES-14 presents point estimates of the maximum number of annual temporary jobs that would be generated by resource area. Major construction projects would include replacement power facilities (7,652 jobs) and transportation-related construction (9,826 jobs). The total change presented in Table ES-14 is the sum of the maximum annual temporary increase in employment for each resource area. These increases would not, however, occur in the same year. The maximum temporary employment increase in any one year would be 14,871 jobs (see Figure 6-1 of the main Appendix I text).

In the long term, the lower Snake River study area would experience a net decrease in business transactions of $66.3 million, a loss of 1,372 jobs, and a decrease of $63.4 million in personal income. Changes in long-term employment are presented in Table ES-15.

Impacts would also occur throughout the Pacific Northwest, throughout a state, or in an area of a State outside a subregion. Construction activities resulting directly and indirectly from dam breaching would temporarily generate increased short-term annual business transactions of $339.6 million, 2,849 temporary jobs, and $106.6 million in personal income in Pacific Northwest areas outside the subregions. These totals represent the maximum changes that could occur in one year.

Table ES-14. Short-term Employment Impacts under Alternative 4—Dam Breaching (jobs)[1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
Electric Power				
Power Plant Construction[3/]	0	0	5,572	**5,572**
Transmission Line Construction	0	0	2,080	**2,080**
Recreation				
Campground Construction	0	174	0	**174**
Transportation				
Rail Construction[4/]				**872**
Road Construction[4/]				**1,972**
Transportation Facilities Construction[4/]				**6,982**
Water Supply				
Well Modification	0	916	259	**1,175**
Pump Modification	844	0	0	**844**
Implementation				
Implementation	230	460	460	**1,150**
Total Change[5/ 6/]	**1,074**	**1,550**	**8,371**	**20,821**
1995 Total Employment	75,081	68,334	175,325	**318,740**
Change as % of 1995 Employment	1.43	2.27	4.77	**6.53**

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years.

2/ The lower Snake River study area is comprised of the upriver, reservoir, and downriver subregions.

3/ The DREW HIT assumed that a total of six replacement power plants would be built. The exact locations of these plants are unknown but DREW HIT assumed that three would be located in the downriver subregion, with the other three most likely located in the Puget Sound region. Construction of each power plant is estimated to generate 2,786 short-term jobs. The estimates shown in this table are the maximum number of these jobs that would be generated in any 1 year—5,572 in the downriver subregion, where two plants would be constructed simultaneously.

4/ These effects would occur in the lower Snake River study area but it is not known how they would be distributed among the subregions.

5/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River study area figure because some of the projected study area impacts were not distributed by subregion.

6/ These totals are the sum of the maximum annual short-term job gains for each resource area. With the exception of the implementation cost category, the jobs identified in this table would only last 1 or 2 years. The construction activities generating this projected employment would all have to take place in the same year for an annual gain of 20,821 jobs. This is not the case. The maximum temporary employment increase in any one year would be 14,871 jobs.

Source: Table 6-34 of the main Appendix I text

In the long-term, the Pacific Northwest areas outside the subregions would experience a net decrease in business transactions of $206.1 million, a loss of 918 jobs, and decrease of $189.5 million in personal income. Annual state-level employment impacts, excluding those impacts modeled for the subregions (see Tables ES-14 and ES-15), are presented in Table ES-16.

Total short- and long-term regional impacts are the sum of the above subregion and state-level excluding subregion totals. These impacts are summarized in Table ES-17. In the short-term, the Pacific Northwest as a whole would experience net increases of $2,611.2 million in business transactions, 23,670 short-term jobs, and $785.5 million in personal income. Short-term impacts would be temporary and these totals represent the maximum changes that could occur in one year. In the long-term, the Pacific Northwest as a whole would experience a net decrease in business transactions of $272.4 million, a loss of 2,290 jobs, and a net decrease of $252.92 million in personal income (see Table ES-17). These impacts would be permanent.

Table ES-15. Long-term Subregion Employment Impacts under Alternative 4—Dam Breaching (jobs)[1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
Increases in Long-term Employment				
Electric Power[3/]				
O&M Spending on Replacement Power Plants and New Transmission Lines	0	0	884	**884**
Recreation				
Increased Nonangler Spending	0	503	0	**503**
Increased Angler Spending	239	162	0	**401**
O&M Spending on New Campgrounds	0	26	0	**26**
Implementation				
Implementation	6	11	11	**28**
Total Increase	**245**	**702**	**895**	**1,842**
Decreases in Long-term Employment				
Water Supply				
Reduction in Irrigated Lands	0	(1,105)	(474)	**(1579)**
Avoided Costs				
Avoided Costs (Reductions in Corps' Spending)	(283)	(566)	(566)	**(1,415)**
Transportation				
Loss of Barge Transportation (Grain)[4/]	(221)	(407)	491	**(137)**
Reduced Cruise Ship Operations	(83)	0	0	**(83)**
Total Decrease	**(587)**	**(2,078)**	**(549)**	**(3,214)**
Net Long-term Employment Change	**(342)**	**(1,376)**	**346**	**(1,372)**
1995 Total Employment	75,081	68,334	175,325	**318,740**
Net Change as a % of 1995 Employment	(0.46)	(2.01)	(0.20)	**(0.43)**

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years.
2/ The lower Snake River study area is comprised of the upriver, reservoir, and downriver subregions.
3/ Estimates of the negative effects of electric rate increases are not available for the subregions and are excluded from this table. Rate increase effects are shown by state in Table 6-33.
4/ These figures are from Table 6-21, which summarizes the impacts associated with a loss of grain farm income due to increased transport cost (Table 6-15), loss of grain-transportation-related barge revenue (Table 6-17), increased grain transportation-related railroad revenue (Table 6-19), and changes in truck transportation (Table 6-20).
Source: Table 6-35 of the main Appendix I text

Table ES-16. Annual State-level Employment Effects for Alternative 4—Dam Breaching Excluding those Effects Modeled for the Subregions (jobs)[1/2/]

	Washington	Oregon	Idaho	Montana	Total
Short-term Effects[3/]					
Power Plant Construction	2,786	0	0	0	**2,786**
Tidewater Rail Car Storage Construction	0	63	0	0	**63**
Total	**2,786**	**63**	**0**	**0**	**2,849**
Long-term Effects[4/]					
Increased Electricity Bills[5/]	(1,136)	(810)	(366)	(70)	**(2,382)**
O&M Spending on new Power Plants	876	0	0	0	**876**
Loss of Barge Transportation (Grain)	224	210	(24)	0	**410**
Commercial Fishing[6/]					**171**
Ocean Recreational Fishing[6/]					**7**
Total	**(36)**	**(600)**	**(390)**	**(70)**	**(918)**

1/ These impacts are not the state totals. They are effects that occur throughout a state (increased electricity bills) or in areas of a state outside the subregions (the remaining categories).

2/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years.

3/ Short-term effects would be temporary. Power plant construction would occur over three one-year periods. Tidewater rail car storage construction would last for just one year.

4/ Long-term effects would be permanent.

5/ These estimates exclude the effects that would be associated with plant closures or business failures caused by increased electric bills.

6/ These projected increases would occur in Washington, Oregon, Idaho, Alaska, and British Columbia.

Source: Table 6-39 of the main Appendix I text

Table ES-17. Total Regional Effects for Alternative 4—Dam Breaching-Business Transactions, Employment, and Personal Income[1/]

	Business Transactions ($ million per year)		Employment (jobs)		Personal Income ($ million per year)	
Region	**Short-term**	**Long-term**	**Short-term**	**Long-term**	**Short-term**	**Long-term**
Subregions	2,271.62	(66.28)	20,821	(1,372)	678.81	(63.41)
State-level Effects (excluding those modeled for the subregions)	339.59	(206.08)	2,849	(918)	106.64	(189.51)
Total Regional Effects	**2,611.21**	**(272.36)**	**23,670**	**(2,290)**	**785.45**	**(252.92)**

1/ The short-term effects presented in this table are the maximum short-term effects that could occur in 1 year. The long-term effects are, in contrast, permanent effects that are expected to occur each year. This comparison results in a relative overstatement of the short-term effects. Figure ES-1, which presents projected net annual regional employment change for the years 2001 through 2051, combines projected annual long-term effects with annual short-term effects, rather than the maximum short-term effects that could occur in 1 year.

Source: Table 6-41 of the main Appendix I text

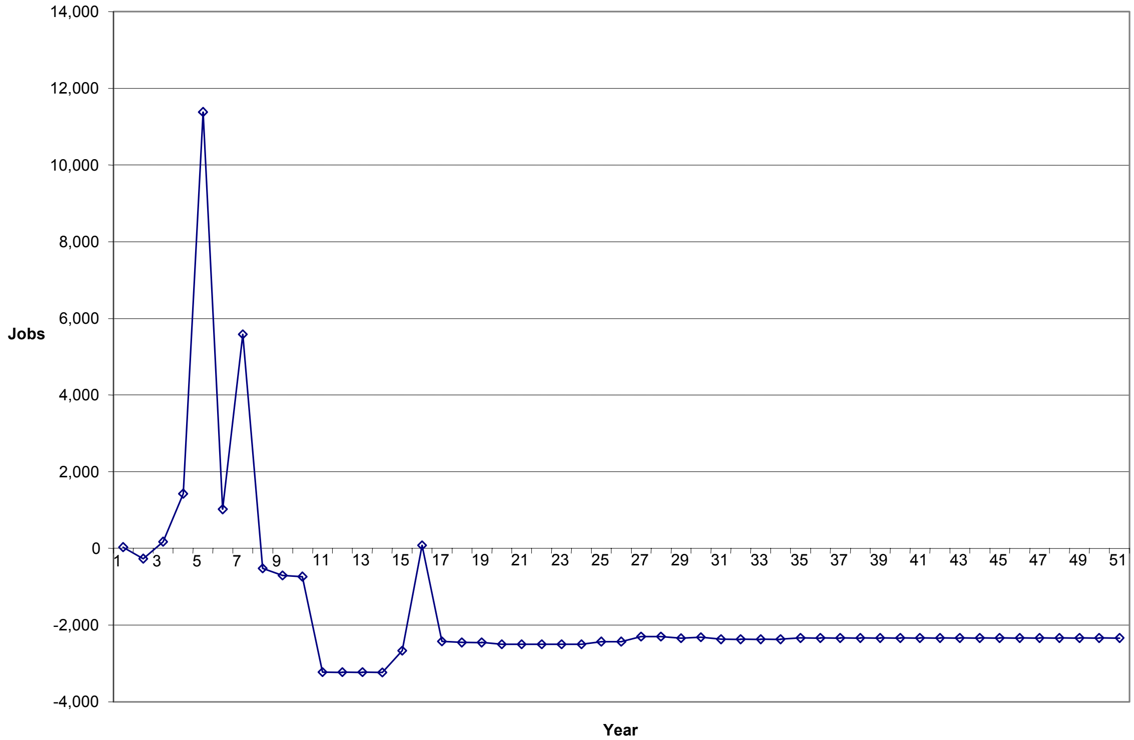

Figure ES-1. Net Annual Total Regional Employment Change (2001 to 2051)

ES.6 Social Analysis

The DREW Social Analysis examined nine focus communities: Clarkston, Colfax, Kennewick, Pasco, and Pomeroy in Washington; Lewiston, Orofino, and Riggins in Idaho; and Umatilla in Oregon. These communities were selected to capture a range of positive and negative impacts across different types of communities located throughout the region. These nine focus communities are divided evenly over the three subregions that comprise the lower Snake River study area. The following discussion addresses potential impacts that are likely to be common to other communities located in their respective subregions.

Alternative 1—Existing Conditions, is considered the base case for this analysis. Alternatives 2 and 3 would have little effect on the existing social and economic environment for most of the communities located in the lower Snake River region. Some communities, particularly those located upriver (e.g., Lewiston, Orofino, and Riggins), could be adversely affected by lower probabilities of salmon recovery. Uncertainty about the future of the four lower Snake River dams may also have negative social effects on some communities.

Breaching the four lower Snake River dams would change the physical and economic environment of the lower Snake River study area. Communities in the upriver region (e.g., Lewiston, Orofino, and Riggins) would likely experience net employment gains as a result of expected increases in recreation and tourism associated with a near-natural river, and to a lesser extent increased fish runs. The extent of the effects upon Lewiston and Orofino are, however, uncertain because the possible effects that the loss of river navigation could have upon the forest products industry have not been completely analyzed. Detailed industry studies would be needed to fully evaluate the extent of these effects. The effects of increased transportation costs to farmers would be most significant for communities located in the upriver subregion. Communities in Latah, Nez Perce, Idaho, and Lewis counties in Idaho would experience the largest increases in transportation costs.

Communities located in the reservoir subregion (e.g., Pomeroy, Colfax, and Clarkston) would likely experience a net decrease in employment due to reductions in Corps' employment and increased pressure on family farms caused by increased transportation, storage, and handling costs for agricultural products. This added pressure to an already depressed agricultural sector may lead to an increased rate of farm consolidation for those farms with a high debt to equity ratio.

Communities located in the downriver subregion (e.g., Pasco, Kennewick, and Umatilla) would likely experience employment loss if farms presently irrigating from the Ice Harbor reservoir go out of business. These losses could be partially offset by expected increases in transportation- and power generation-related employment.

Overall adverse community impacts associated with Alternative 4—Dam Breaching, that were identified by the DREW Social Analysis Workgroup include:

- decreased net farm income and increased financial pressure on dryland farmers throughout the region, particularly those farms located close to the lower Snake River
- risk of increased consolidation of family farms and a decrease in rural farm population
- decreased county property tax base in 20 regional counties from decreased farm land value and potential loss of irrigated lands
- dislocated full-time and seasonal workers from Ice Harbor irrigated agricultural lands and a loss of a source of local school revenue for communities close to the reservoir
- realignment of communities' economic bases and changed potential for future growth.

Communities would likely adjust to these changes. New individuals and businesses seeking new opportunities may replace those that have been displaced. Displaced human and capital resources may be employed in their next best use within the community. This type of adjustment does, however, take time and would vary by community. Community size has been identified as a critical factor affecting a community's ability to adapt to change, with smaller, less diverse communities tending to respond less favorably.

ES.7 Risk and Uncertainty

Uncertainty is inherent in any future-oriented planning effort. The period of analysis for this economic study is 100 years. Considerable uncertainty surrounds any attempt to forecast results 100 years into the future. Uncertainty is present in all aspects of the Lower Snake River Juvenile Salmon Migration Feasibility Study. The plan formulation, the biology, and the economics all have elements of uncertainty in their analyses. Uncertainty of this type surrounds key study assumptions, methodology, and data collection in all resource areas.

The economic analysis presented in this appendix addresses the role of uncertainty in two ways. First, each study team was asked to address risk and uncertainty issues in their analyses. Second, an overall risk and uncertainty assessment of the economic and social analyses presented here was conducted as a separate part of the DREW process. The primary source of information for this risk and uncertainty assessment was information provided by the DREW workgroups.

The purpose of the DREW risk and uncertainty assessment was to help assess the overall reliability of the economic analysis conducted for this study, and identify important unanswered questions for risk managers. The DREW risk and uncertainty assessment concluded that unresolved uncertainties about the economic costs and benefits of the four alternatives still remain (see Section 8 of the main Appendix I text). From a NED perspective, important uncertainties remain about the value of future recreation benefits under Alternative 4—Dam Breaching and the size of future anadromous fish stocks and the fisheries they would support. Further work by PATH, the DREW Anadromous Fish Workgroup, and the DREW Recreation Workgroup could significantly improve the reliability of these analyses. The new PATH estimates that were published in November 1999 need to be evaluated in the appropriate economic resource categories. Other NED uncertainties, although significant in an absolute sense, are unlikely to affect decisions about whether it would be more cost-effective to breach the four lower Snake River dams.

The driving uncertainties for the regional analysis are uncertainties due to currently unavailable data and uncertainties about how costs will be distributed. The latter cannot be resolved until decisions are made about how the future power supply system would be configured if the four lower Snake River dams were breached. At least some of what have been characterized as uncertainties due to currently unavailable data also cannot be resolved until specific information is developed about how the future power supply system would be configured.

The uncertainties that remain about dam breaching prevent the economic analysis from reaching a conclusion on whether it would be more cost-effective to breach the four lower Snake River dams. Further effort is needed to determine the economic feasibility of retaining or breaching the dams, including efforts to: 1) more precisely quantify the recreational benefits of the lower Snake River if the dams are breached; 2) more thoroughly assess the effect of dam removal on future anadromous fish stocks; and 3) further specify the configuration of the future power supply system if the dams are breached.

1. Introduction

1.1 Purpose of the Economic Appendix

The purpose of this appendix is to measure the economic and social effects of the alternatives proposed under the Lower Snake River Juvenile Salmon Migration Feasibility Study (Feasibility Study). Section 102 of the National Environmental Policy Act (NEPA) and Council on Environmental Quality (CEQ) guidelines, which interpret NEPA, require that the economic and social effects of the proposed alternatives be identified. Evaluation of these effects is critical to decision makers and also important to others interested in the outcome of this feasibility study. The analysis presented in this document uses economic measures to evaluate efficiency changes in the nation's production of goods and services. This analysis is designed to identify the gains and losses to society as a whole. The effects that the proposed alternatives would have upon the region and specific groups of individuals are also examined. The overall structure of this analysis is discussed in more detail in Section 1.3 below.

The economic and social effects of each proposed alternative are evaluated for the primary uses of the lower Snake River, which include electric power generation, recreation, transportation, and water supply. Economic effects are typically stated in monetary terms. In some cases, where monetary measures are not available, other types of quantitative and qualitative assessment are used.

1.2 Study Area

The geographic scope of the following economic analysis is consistent with the physical effects of the proposed alternatives. In general, economic effects were evaluated wherever significant physical effects were identified. In the case of the transportation analysis, for example, the study area includes grain-producing areas, as well as river origins and destinations for other commodity groups that are transported via the lower Snake River. The social analysis is, however, primarily limited to a series of focus communities intended to provide decision makers with information concerning potential impacts across a range of different communities. A regional base map that shows the location of the four lower Snake River dams and the surrounding region is presented in the foreword to this appendix.

1.3 Structure of Analysis

The structure of the economic and social analysis developed for this Feasibility Report/Environmental Impact Statement (FR/EIS) is based upon the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* developed by the U.S. Water Resources Council (WRC) (WRC, 1983). These guidelines recommend that the evaluation and display of the effects of proposed alternatives be organized into four accounts:

- The national economic development (NED) account, which displays changes in the economic value of the national output of goods and services
- The environmental quality (EQ) account, which displays nonmonetary effects on significant natural and cultural resources
- The regional economic development (RED) account, which addresses changes in the distribution of regional economic activity

- The other social effects (OSE) account, which addresses potential effects from relevant perspectives that are not reflected in the other three accounts.

The NED account is the only account required under the WRC guidelines. The guidelines recommend that other information that is required by law or that will have a material bearing on the decision-making process should be included in one of the other accounts (EQ, RED, or OSE) or in some other appropriate format. The four accounts and their relationship to this analysis are discussed in the following sections.[1]

1.3.1 National Economic Development

The NED account addresses the net effects of a proposed action upon the nation. NED analysis is concerned only with economic efficiency at the national level. Economic gains achieved by one region at the expense of another region are not measured as NED benefits. This is because the Federal objective in water resources planning is national economic development. If a Federal project induces a business to leave one region for another, the increase in regional income for the host region may well be a benefit to that area. However, from a national perspective, if the impacts to the new host region are included as a benefit, then the loss of income to the former host region must be included as a project cost. In most cases, this type of gain to one region is another region's loss, and the two effects represent a transfer of income that cancels out any net change. As a result, NED analysis does not consider these types of transfers. Regional impacts are instead addressed under the RED account, which is discussed in Section 1.3.3 below.

Beneficial effects measured under the NED account include increases in the economic value of the national output of goods and services, the value of output resulting from external economies caused by the proposed alternative, and the value associated with the use of otherwise unemployed or under-employed labor resources. External economies may be defined as benefits generated outside of a market transaction. Individuals may benefit from these types of external economies without having to reimburse the party responsible for the positive effect.

Adverse NED effects are usually the opportunity costs of resources used in implementing a plan. All resources are scarce and we must choose when to use them. Choose more of one thing, and we simultaneously choose less of another. If we make the best choice from a number of alternative uses of a river reach, at a minimum it costs us the opportunity to do the next best thing with the reach. The NED account distinguishes among implementation outlays, associated costs, and other direct costs. Implementation outlays are the financial outlays, including operation, maintenance, and replacement costs, incurred for implementation of the plan. Associated costs are those required in addition to implementation outlays. These are typically costs for measures needed to achieve project benefits. Other direct costs represent the uncompensated and unmitigated costs of resources that are affected by the project or plan.

The general measurement standard for the value of goods and services is defined as the willingness of users to pay for each increment of output associated with a proposed alternative. Because it is not usually possible to obtain willingness to pay values, alternative or proxy measures are used. These

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[1] This discussion of the four accounts is drawn from the WRC guidelines (WRC, 1983) and supplemented by additional material from the *National Economic Development Procedures Manual—Overview Manual for Conducting National Economic Development Analysis* (IWR Report 91-R-11). The interested reader is referred to these documents for additional information.

measures include actual or simulated market price, change in net income, cost of the most likely alternative (e.g., replacement cost of hydropower), and administratively established values.

The NED analysis presented here addresses power, recreation, transportation, water supply, anadromous fish, tribal circumstances, flood control, and implementation/avoided costs. A net gain in recreation use under Alternative 4—Dam Breaching, is an example of an NED benefit in this case. Beneficial NED effects are also associated with increased commercial fishing under this alternative. The loss of hydropower and the associated increase in the cost of generating electricity are examples of NED costs associated with Alternative 4—Dam Breaching. Another example of an NED cost associated with the dam breaching alternative is the net increase in transportation costs for commodities that are presently shipped on the lower Snake River.

The application of the NED analysis to each resource area is presented in Section 3 of this appendix.

1.3.2 Environmental Quality

The EQ account provides a means of displaying and integrating qualitative information on the effects of proposed alternatives on significant resources and attributes of the human environment (WRC, 1983). Beneficial and adverse effects in the EQ account address changes in the ecological, aesthetic, and cultural attributes of natural and cultural resources.

The Tribal Circumstances report developed for this analysis by Meyer Resources, Inc. (Meyer Resources, 1999a) in association with the Columbia River Inter Tribal Fisheries Commission (CRITFC) suggests that tribal circumstances and effects should be incorporated into the economic assessment under the EQ account.[2] While tribal assessments carried out by Federal agencies tend to concentrate on historic cultural resources, primarily sites and artifacts, the Tribal Circumstances report indicates that existing tribal communities and groups should also be considered under the definition of cultural resources.

The Tribal Circumstances report also suggests that the tribal effects analysis contains some information identified by the WRC guidelines as part of the OSE account—particularly with regard to the issues of Tribal health and displacement. Tribal circumstances are discussed in Section 5 of this appendix. They are also briefly addressed in the context of the NED analysis in Section 3.6.

1.3.3 Regional Economic Development

The RED account addresses the changes in regional economic activity that would result from each alternative. Two measures typically used in RED analysis to assess the effects on regional economies are income and employment. The regional analysis presented in this document addresses changes in income and employment. It also includes a third measure—business transactions, which are the estimated gross receipts received by a business (with the exception of those business in the trade sectors where it is the margin or the value added by that business). The regions typically used for RED analysis are those that would experience particularly significant project-related income and employment effects.

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[2] This report entitled *Tribal Circumstances and Impacts of the Lower Snake River Projects on the Nez Perce, Yakama, Umatilla, Warm Springs, and Shoshone Bannock Tribes* is available on the Corps' website at: http://www.nww.usace.army.mil/lsr. This report is referred to as the Meyer Resources (1999a) throughout this document.

The regional analysis presented in this document measures regional impacts using input-output models. This analysis, developed by the Drawdown Regional Economic Workgroup (DREW) Regional Analysis Workgroup, is primarily based on estimates of direct economic effects generated by other DREW workgroups as part of the NED analysis. Most effects associated with the proposed alternatives would occur in the lower Snake River region. This region is the primary focus of the regional analysis. Four input-output models were developed to assess the regional impacts of these effects. County data were aggregated into a 25-county study area that was further divided into three subregions. The counties that comprise the subregions and the combined lower Snake River study area are shown in Figure 1-1 and identified in Table 6-1. The subregion models are applied in cases where impacts are localized. Examples of localized impacts include possible reductions in agriculture irrigated from Ice Harbor reservoir that may occur under Alternative 4—Dam Breaching. Changes in recreation trips to the lower Snake River are another example of localized impacts.

Models were also developed for the states of Washington, Idaho, Oregon, and Montana. These state models are used to assess impacts that would occur either throughout the Pacific Northwest, throughout a state, or in an area of a state outside the subreagions. State-level impacts assessed with these models include those associated with possible increases in electricity rates under Alternative 4—Dam Breaching.

In addition, the DREW Anadromous Fish Workgroup assessed the regional economic impacts associated with commercial fishing, as well as the impacts associated with recreational fishing in the ocean and along the Columbia River and the lower Snake River below Lower Granite Dam. These impacts were calculated using economic base analysis techniques which rely on input-output models that translate direct fishing expenditures and hatchery costs into total personal income. United States, state, and Canadian province economic level ratios of personal income to total employment (full- and part-time) and personal income to business activity (cash receipts less cost of inventory) were used to estimate job and sales impacts.

The regional analysis is presented in Section 6 of this appendix.

1.3.4 Other Social Effects

The OSE account addresses potential effects from perspectives that are relevant to the evaluation process, but are not reflected in the other three accounts. Categories typically addressed as part of this account include community impacts; life, health, and safety factors; displacement; and long-term productivity. The social analysis presented in Section 7 of this appendix addresses some of the likely social impacts on selected local communities. The proposed alternatives would affect communities differently. One community may lose business and suffer an increase in unemployment and decreases in income and tax revenue, while other communities may benefit through increased investment or expenditures. The social analysis draws on the findings from the NED and RED analyses and primarily addresses nine focus communities (Clarkston, Colfax, Kennewick, Pasco, and Pomeroy in Washington; Lewiston, Orofino, and Riggins in Idaho; and Umatilla, Oregon). These communities are among those highlighted on Figure 1-1.

Tribal communities are not addressed in the Social Analysis conducted by the DREW Social Analysis Workgroup, but are addressed separately in the Tribal Circumstances report developed by Meyer Resources, Inc., in association with CRITFC. The findings of this report are summarized in Section 5 of this appendix.

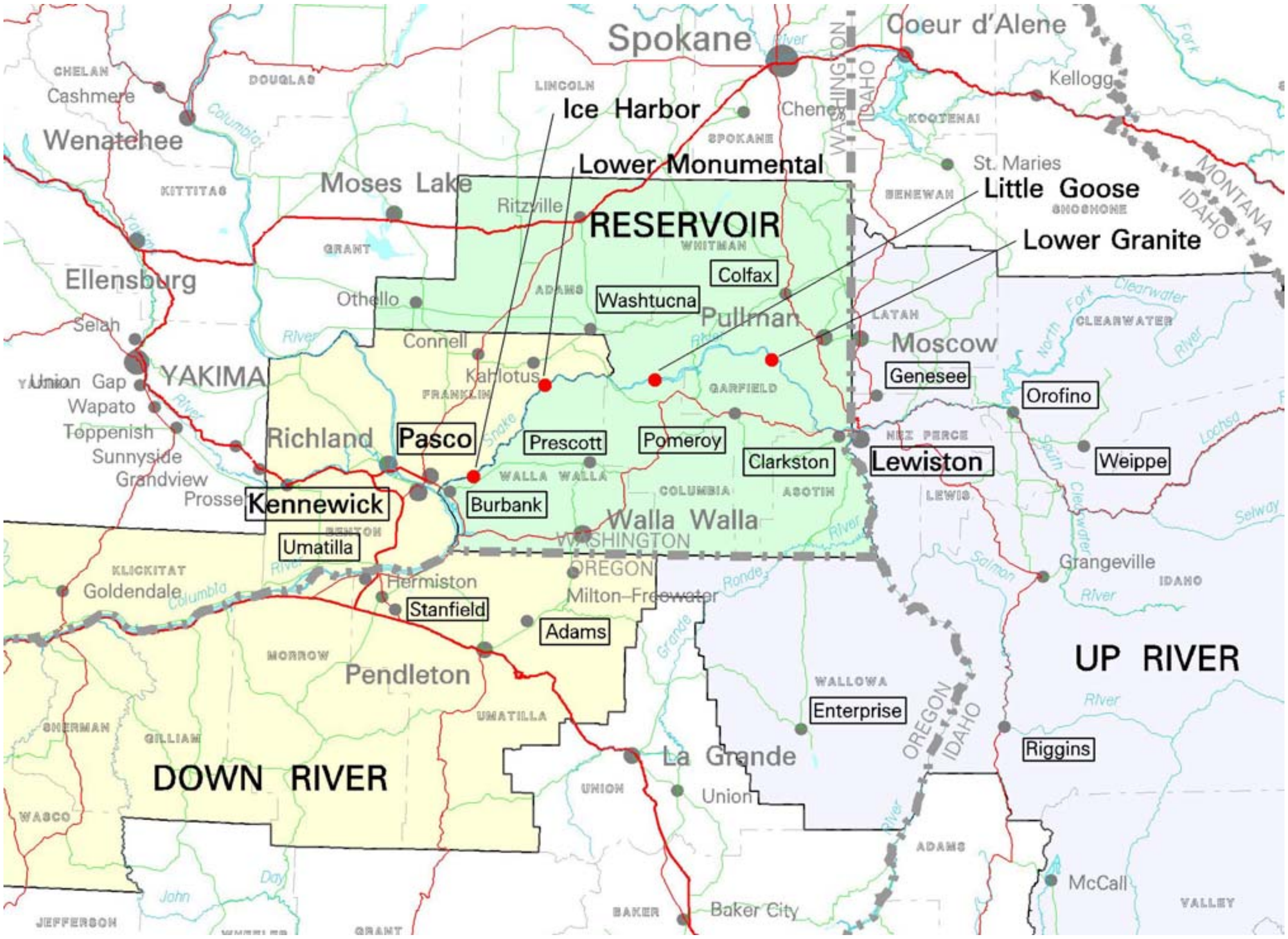

Figure 1-1. Subregions and Focus Communities

1.4 Drawdown Regional Economic Workgroup

The economic effects of actions related to the lower Snake River have been analyzed by numerous entities throughout the region. To reduce conflicting analyses and pool resources for a more efficient effort, the U.S. Army Corps of Engineers (Corps) convened DREW to develop a combined economic analysis. Members of DREW include representatives of the Corps, Bonneville Power Administration (BPA), Bureau of Reclamation (BOR), National Marine Fisheries Service (NMFS), U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), Northwest Power Planning Council (NPPC), CRITFC, and other interested groups. DREW meetings, held at various locations throughout the region on a roughly bi-monthly basis, were regularly advertised and open to the public. Members of the public regularly participated in and contributed to these meetings.

DREW conducted the necessary technical analyses to assess the economic impacts associated with each of the alternatives. Within DREW, smaller workgroups oversaw and provided technical support for each area of analysis. The Technical Report on Hydropower Costs and Benefits was, for example, developed by the DREW Hydropower Impact Team. Study design and technical analysis was, as a result, a collaborative process that aimed to encompass a range of viewpoints and technical skills. Work products produced by DREW were reviewed by the NPPC's Independent Economic

Analysis Board (IEAB), a group of economists drawn from academia and private industry. The IEAB provided independent peer review of work products and advice in resolving technical issues, as necessary.

The key areas of analysis evaluated by DREW were closely related to one another. Results from one workgroup were often required inputs to another. Technical reports were developed for each area of analysis. The analysis presented in this appendix is based on the findings of these reports, which are referenced, as appropriate. Copies of these reports and other supporting documents developed for this analysis are available on the Corps' website at: http://www.nww.usace.army.mil/.

1.5 Study Assumptions

1.5.1 Period of Analysis and Price Level

DREW determined that a 100-year period of analysis would be used to assess all project impacts. This long-term perspective reduces the likelihood that the comparison of alternatives will be influenced by short-term fluctuations in trends or market conditions.

The base year for this analysis is fiscal year (FY) 1998, but the implementation year is FY 2005. FY 2005 was selected because it was assumed to be the earliest "in-service" date (assuming that the implementation process begins on January 1, 2001). The 100-year period of analysis extends from the implementation year, FY 2005, through 2104. Benefits and costs incurred during the period of analysis are discounted to the beginning of this period (FY 2005) using selected interest rates (see Section 1.5.2). Implementation expenditures and other economic costs and benefits that would occur prior to FY 2005 are brought forward to that date by charging compound interest at the project discount rate from the date that the costs and benefits occur. Total costs and benefits are then converted into 1998 dollars and annualized to provide an average annual value for each alternative.

Due to the uncertainty associated with projecting socioeconomic parameters, projections of certain parameters, such as population, income, fuel prices, power loads, and commodities that would be transported on the lower Snake River, are limited to a 20-year period from 1998 though 2018. From that point on, constant levels are assumed to the end of the 100-year period of analysis. These parameters are identified in the text, as appropriate.

1.5.2 Discount Rate

For most water-related projects, the bulk of project costs tend to be incurred during project implementation. Benefits, on the other hand, are typically realized as uneven flows of income or monetary benefits over a much longer time. Although both costs and benefits are measured in dollars, the dollars spent on implementation today cannot be directly compared to the dollars that will be realized years from now. One million dollars today, for example, is not the same as $1 million 20 years from now. If the $1 million today could be put in a bank and earn 10 percent interest annually, in 20 years it would be worth $6.7 million. If, for example, a choice existed between building a $1 million project that would yield a $1 million benefit in 20 years or saving the money at 10 percent, clearly saving would be the best option from a purely economic perspective.

To account for differences in the time value of money, future benefits and costs of all components of the DREW analysis are discounted to a common date by using appropriate interest rates. This reduces the stream of benefits and costs that occur over the 100-year study period to a single value for each alternative. These present-worth values are then converted to average annual values. This practice is intended to allow reasonable cost comparisons among alternatives that have benefits and costs occurring at different times.

Selecting an appropriate discount rate for this type of economic analysis is often a source of controversy because it influences the attractiveness of allocating resources between the present and the future. Economic theory suggests that the discount rate used for project analysis should reflect the return that can be earned on resources employed in alternative private use. As a result, market interest rates tend to figure prominently in allocating investment funds among alternative project uses. Market interest rates reflect the typical rates of real return on investments in the private economy and are instrumental in determining the values of real assets such as farmland, buildings, and equipment. However, if a notional "social rate of discount," which reflects widespread social attitudes on the importance of remote or postponed future flows of output and consumption, is lower than the market rate of interest, then an argument can be made for discounting future costs and benefits at that lower rate.

Numerous agencies and interests were involved in developing the economic analysis presented in this appendix. As a result, impacts are presented using three different discount rates: 6.875 percent—the rate used in economic analyses by the Corps, 4.75 percent—the rate customarily used by BPA, and 0.0 percent, which was included on behalf of the tribes represented by CRITFC. The Corps' discount rate is based on the cost of government borrowing. The BPA rate is intended to represent the "real" cost of borrowing money and does not include general inflation. The Corps' rate in contrast does include general inflation. The use of a 0.0 percent discount rate favored by the CRITFC tribes is based on a desire for permanence of certain assets like fish and wildlife. Benefits associated with projected fish recovery would occur over a long term rather than a short term. These benefits are valued more highly when using a 0.0 percent discount rate versus the BPA rate of 4.75 percent or the Corps' rate of 6.875 percent. The appropriate use of discount rates has been the subject of some discussion within DREW and the IEAB. While three different discount rates have been used to accommodate a variety of perspectives, the use of these rates has little effect on the ranking of the alternatives.

1.5.3 Subsidies

The effects of subsidies are not addressed in all cases in the following analysis. Subsidies are primarily addressed in those cases where they are known and readily identifiable. This is particularly the case where components of the avoided cost analysis are subsidies. The costs to operate and maintain the navigation locks at the four lower Snake River dams, for example, are not directly transferred to users and are, therefore, considered by some to be subsidies. These costs are identified and presented as a savings or economic benefit in the Implementation and Avoided Costs analysis (Section 3.9). Possible subsidies to other groups, such as farmers, truck and rail services, and recreation users, were not researched as part of this study.

1.5.4 Uncertainty

Uncertainty is inherent in any future-oriented planning effort. The period of analysis for this economic study is 100 years. It is difficult to predict what will happen a few years into the future, let alone 100 years. Considerable uncertainty surrounds any attempt to forecast results 100 years into the future. In general, elements of uncertainty affect everything we do. The Corps' risk and uncertainty guidelines (Corps, 1992; 1995) state that, in the context of water resources planning, "uncertainty is simply the lack of certainty. It is the reality of inadequate information. When information is imprecise or absent, that is uncertainty." From this perspective, uncertainty is present in all aspects of the Lower Snake River Juvenile Salmon Feasibility Study. The plan formulation, the biology, and the economics all have elements of uncertainty in their analyses. Uncertainty of this type surrounds key study assumptions, methodology, and data collection in all resource areas.

The economic analysis presented in this appendix address the role of uncertainty in two ways. First, each study team was asked to address risk and uncertainty issues in their analyses. Second, an overall risk and uncertainty assessment of the economic and social analyses presented here was conducted as a separate part of the DREW process. The primary source of information for the second risk and uncertainty assessment was information provided by the DREW study teams. The results of this assessment and the implications that risk and uncertainty have for the findings of this analysis are presented in Section 8 of this appendix.

A number of resource areas assessed in this economic analysis draw, at least in part, on the number of fish projected to return under each alternative. These projections originally developed by Plan for Analyzing and Testing Hypothesis (PATH), were expanded by the DREW Anadromous Fish Workgroup to represent all Snake River wild and hatchery stocks (see Section 3.5.3). PATH's original data included both "unweighted" and "weighted" results. The anadromous fish, recreation, and regional economic development analyses developed for this study use the projected fish returns that are based on the unweighted preliminary PATH data (as suggested by NMFS in October 1999). The tribal circumstances analysis, in contrast, uses the projected fish returns based on the preliminary PATH data weighted by the PATH Scientific Review Panel. In addition, these analyses use the projected return data differently. The anadromous fish, recreation, and regional analyses use the projected fish numbers to derive economic impacts. For the anadromous fish and recreation analyses these effects are measured in NED dollar amounts. The regional analysis measures economic impacts in terms of changes to business transactions, jobs, and personal income. The tribal circumstances analysis, in contrast, presents the projected fish data as pounds of fish and does not attempt to value these quantities in dollar or regional impact terms.

In addition, the DREW Anadromous Fish Workgroup's estimates of the number of fish available for harvest have not been revised to incorporate the adjusted PATH 1999 results. The Scientific Review Panel, which was tasked to review the PATH analysis methods, found inconsistencies in the results of both the fall chinook and later the spring/summer chinook analysis developed by PATH. These inconsistencies or uncertainties, which were not totally resolved by PATH, included concerns about the Differential Delayed Mortality factor (D value) that PATH attributed to smolt transport, delayed hydrosystem mortality, and the fixed assigned survival rate for the dam breaching alternative. Adjustments made to a number of factors of concern in the original PATH analysis resulted in higher adult return predictions under alternatives 1 through 3, which reduced the net difference between the three dam retention alternatives and Alternative 4—Dam Breaching.

2. Existing Conditions and Alternatives

This section provides an overview of existing conditions and the four alternatives considered as part of this feasibility study.

2.1 Existing Conditions

The following section presents summary information on existing conditions. Section 2.1.1 addresses existing socioeconomic conditions in the general project area. A more detailed overview of the existing socioeconomic environment is provided in Section 4.14 of the main FR/EIS text. Section 2.1.2 briefly discusses the authorized project uses for the four lower Snake River dams Section 2.1.3 provides an overview of the facilities and programs currently in place at the four lower Snake River dams. A more detailed description of these facilities and programs is presented in Chapter 2 of the main FR/EIS text.

2.1.1 Socioeconomic Overview

Land use in the plateau country of Oregon and Washington is predominantly agricultural and open space. Large farms are prevalent with population centers widely dispersed. The eastern portion of the study area, which extends into western Idaho, is largely rural with the primary industries being agriculture and forest products. Local economies in the immediate vicinity of the four lower Snake River dams are largely oriented toward the river system, which provides transportation for agricultural and timber products, water for farmland irrigation, and serves as a location for recreational activity.

Communities located in the vicinity of the lower Snake River would be affected by the natural river alternative. These effects would be felt primarily within communities in the immediate vicinity of the lower Snake River. Effects would also be felt in nearby upland areas that draw water supplies from the river and more distant commodity production areas that rely on the river for transportation. Alternative 4—Dam Breaching, also has the potential to generate indirect economic effects throughout the region. Potential sources of indirect regional economic effects include changes in navigation, recreational activities, commercial fisheries, and power. The regional and social impacts associated with the proposed alternatives are discussed in Sections 6 and 7 of this appendix, respectively. The following sections provide an overview of population and employment in the study region.

2.1.1.1 Population

The majority of the area surrounding the lower Snake River is sparsely populated. Communities range in size from small rural towns with populations less than 200 to cities with populations ranging from 8,000 to almost 50,000. Major population centers in the region include the Tri-Cities (Richland, Kennewick, and Pasco), Walla Walla, the Quad-Cities (Pullman, Moscow, Lewiston, and Clarkston), and Hermiston/Pendleton. Only five communities in the lower Snake River study area have populations greater than 20,000.

Most of the region experienced fairly rapid rates of population growth in the 1970s. Growth rates were significantly slower in the 1980s with a number of counties experiencing absolute decreases in population. Population has grown more rapidly in the 1990s, with areas offering high quality scenery and recreation opportunities often experiencing particularly rapid growth rates.

Summary population data are presented in Table 2-1 for the states of Washington, Oregon, and Idaho, as well as the three subregions that comprise the 25-county study area identified by the DREW Regional Workgroup (see Figure 1-1 and Table 6-1).

Table 2-1. Population by State and Subregion, 1970 to 2000

	Population (1,000s)				Percent Change		
	1970	**1980**	**1990**	**2000**	**1970 to 80**	**1980 to 90**	**1990 to 2000**
Washington	3,413	4,132	4,867	5,894	21.1	17.8	17.4
Oregon	2,092	2,633	2,842	3,421	25.9	7.9	16.9
Idaho	713	944	1,007	1,294	32.4	6.6	22.2
State Total	**6,218**	**7,710**	**8,716**	**10,609**	**24.0**	**13.1**	**17.8**
Downriver Total	199	276	284	350	39.2	2.8	19.0
Reservoir Total	113	124	125	139	9.6	0.4	10.5
Upriver Total	101	115	114	128	13.5	(0.6)	10.5
Subregion Total	**413**	**516**	**523**	**617**	**24.8**	**1.4**	**15.3**

Source: U.S. Census Bureau, 1995; 2001

2.1.1.2 Employment

The economy of the Pacific Northwest has undergone substantial change over the past three decades. From 1969 to 1998, the number of jobs in Washington, Oregon, and Idaho increased at a faster rate than the national average (123 percent compared to 76 percent nationally). Employment increases ranged from 122 percent for Washington to 204 percent for Oregon. In 1998, Washington, Oregon, and Idaho accounted for 55 percent, 33 percent, and 12 percent of total employment in the three state area, respectively.

Full- and part-time employment in the lower Snake River study area increased by 84 percent between 1969 and 1998. This relative increase was smaller than the statewide increase (123 percent) but larger than the national increase (76 percent). Increases ranged from 74 percent in the upriver subregion to 194 percent in the reservoir subregion. In 1998, the upriver, reservoir, and downriver subregions accounted for about 24 percent, 22 percent, and 55 percent of total employment in the lower Snake River study area, respectively.

Employment increased in all sectors in the lower Snake River study area between 1969 and 1998, with the exception of mining (Table 2-2). There were, however, changes in the relative importance of various sectors. These trends broadly reflected those at the regional and national levels with relative declines in the farm [(7) percent], manufacturing [(5) percent], and government sectors [(2) percent], and increases in the services (6 percent) and retail trade (2 percent) sectors. In 1998 the largest employers were services (24 percent), government (18 percent), and retail trade (17 percent). These sectors were the largest employers for all three subregions, which have generally similar concentrations of employment by sector.

Table 2-2. Employment in the Lower Snake River Study Area, 1969 and 1998

	1969		1998		1969 to 1998	
	Jobs	Percent of Total Jobs	Jobs	Percent of Total Jobs	Absolute Change	Percent Change
Total full- and part-time employment[1/]	**181,125**	**100**	**332,557**	**100**	**151,432**	**84**
By Type						
Wage and salary employment	141,949	78	260,640	78	118,691	84
Proprietors' employment	39,176	22	71,917	22	32,741	84
Farm proprietors' employment	16,361	9	15,527	5	(834)	(5)
Nonfarm proprietors' employment	22,815	13	56,390	17	33,575	147
By Industry						
Farm employment	28,356	16	29,894	9	1,538	5
Nonfarm employment	152,769	84	302,663	91	149,894	98
Agriculture, Forestry, and Fishing	1,892	1	7,161	2	5,269	278
Mining	375	0	136	0	(239)	(64)
Construction	8,713	5	15,602	5	6,889	79
Manufacturing	24,958	14	30,678	9	5,720	23
Transportation	7,428	4	17,762	5	10,334	139
Wholesale Trade	4,513	2	9,701	3	5,188	115
Retail Trade	26,534	15	56,297	17	29,763	112
FIRE	8,046	4	15,427	5	7,381	92
Services	32,501	18	80,065	24	47,564	146
Government	36,893	20	60,289	18	23,396	63

1/ Employment data are by place of work, not place of residence, and could, therefore, include people who work in the area but do not live there. Employment is measured as the average annual number of jobs, full-time plus part-time, with each job that a person holds counted at full weight.
2/ The upriver, reservoir, and downriver subregions accounted for 24 percent, 22 percent, and 55 percent of total employment in 1998.
Source: U.S. Department of Commerce, Bureau of Economic Analysis, 2001

2.1.2 Authorized Project Purposes

Authorized project uses include power, navigation, recreation, and irrigation. The following sections provide a brief overview of each of these resources. These resources are discussed in more detail in Chapter 4 of the main FR/EIS and Section 3 of this appendix. Fish and wildlife is also an authorized use at all four dams. Fish and wildlife measures are addressed in Section 2.1.3 below.

2.1.2.1 Power

The integrated system of 30 Federal hydroelectric facilities in the Columbia River Basin, on average, accounts for approximately 60 percent of total regional energy and 70 percent of total electrical generating capacity. The four lower Snake River dams account for approximately 12 percent of hydropower sustained peak capacity in the Pacific Northwest and 8 percent of the region’s total sustained peak capacity.

When there is a surplus of hydropower, it is an important export product for the region. BPA markets and distributes the power generated by the Corps and the BOR at the Federal projects in the Columbia River Basin, including power generated by the four dams on the lower Snake River. This power is sold to public and private utilities in the region, utilities outside the region, and some of the region's largest industries. Power lines originate at generators at the dams and extend outward to form key links in the regional transmission grid. The Northwest grid is interconnected with Canada to the north, California to the south, and Utah and other states to the east. Power produced at dams in the Northwest serves customers both locally and thousands of miles away.

2.1.2.2 Navigation

The 465-mile-long Columbia-Snake Inland Waterway formed by the eight dams and locks on the lower Columbia and Snake rivers allows barge transportation from the Pacific Ocean to Lewiston, Idaho, the most inland port. This system is used for commodity shipments from inland areas of the Northwest and as far away as North Dakota. The 140-mile-long stretch of the waterway formed by the four lower Snake River dams extends from the confluence of the lower Snake and Columbia rivers to Lewiston, Idaho. The Corps maintains a navigation channel 250 feet wide and 14 feet deep along this portion of the waterway. This navigation channel accommodates tugs, numerous types of barges, log rafts, and recreational boats and connects the interior Columbia River Basin with deep water ports on the lower Columbia River.

Tonnage using at least a portion of the lower Snake River averaged about 3.8 million tons per year from 1980 through 1990. This average increased slightly to 3.9 million tons per year from 1991 through 1996. Grain shipments made up approximately 75 percent of this tonnage in 1995.

2.1.2.3 Recreation

There are 33 developed recreation sites adjacent to the lower Snake River reservoirs. Facilities at these sites include 28 boat ramps with 59 launch lanes, 5 moorage and marina facilities, 9 campgrounds with approximately 422 individual campsites, and 49 day-use facilities. Most of these sites are located in rural areas removed from population centers. Exceptions include the sites located at the Ice Harbor reservoir, which are close enough to be used by residents of the Tri-Cities, and sites located at the Lower Granite reservoir near the Lewiston-Clarkston area. Several of the larger developed sites were developed by the Corps and are operated by counties or port districts under lease.

Primary recreational activities, including sightseeing, fishing, boating, and water-skiing, occur year-round at most dams and reservoirs in the Columbia River Basin. However, the peak periods of use for all activities occur during the warm, dry summer months. The lower Snake River dams and reservoirs typically receive over 50 percent of average annual use from May through August. Approximately 2 million visitor days were recorded at the four dams and reservoirs in 1998. Many of these visitors live in relatively close proximity to the dams and reservoirs.

2.1.2.4 Irrigation

Water is withdrawn from the lower Snake River to support many uses. Irrigated agriculture is the dominant use, followed by municipal and industrial (M&I) water supply, wildlife habitat enhancement, and cattle watering. Nearly all of the lower Snake River water used for agricultural irrigation is withdrawn from the Ice Harbor reservoir. Private entities have developed the necessary infrastructure to grow irrigated crops by 14 pumping stations adjacent to the reservoir. Approximately 37,000 acres of agricultural land are presently irrigated using water withdrawn from the Ice Harbor reservoir. Cottonwood, which is grown for pulp and paper production, is the largest crop in terms of acreage, accounting for approximately 27 percent of total crop acreage irrigated with water withdrawn from the Ice Harbor reservoir in 1996 and 1997. These 37,000 acres represent about 12 percent of the irrigated farmland in Franklin and Walla Walla counties and about 2 percent of the irrigated farmland in Washington State.

There are eight M&I pump stations along the lower Snake River, all located on the Lower Granite reservoir. Water withdrawn via these stations is used for municipal water system backup, golf course irrigation, industrial process water, and park irrigation. Water withdrawn from the lower Snake River presently irrigates vegetation for ten wildlife Habitat Management Units (HMUs) that were established to compensate for wildlife habitat lost as a result of inundation by the lower Snake River dams. Cattle watering corridors provide access across government property for cattle to water from the lower Snake River reservoirs.

2.1.3 Facilities and Programs

The four lower Snake River dams (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor) are multi-purpose facilities that provide public benefits in many different areas. As noted above, the uses authorized by Congress for the four lower Snake River dams are navigation, hydropower, irrigation, recreation, and fish and wildlife. Project facilities include dams and reservoirs, hydroelectric powerplants and high-voltage transmission lines, navigation channels and locks, juvenile and adult fish passage structures, parks and recreational facilities, lands dedicated to project operations, and areas set aside as wildlife habitat.

All four lower Snake River dams are run-of-river facilities. These dams have limited storage capacity and pass water at nearly the same rate as the water enters each reservoir. Reservoir levels behind these dams vary only a few feet during normal operations. This limited storage is used for hourly regulation of powerhouse discharges to follow daily and weekly demand patterns. This storage is not enough to allow seasonal regulation of streamflows. Other Federal dams on the Columbia River and its tributaries were developed for storage purposes. Storage reservoirs, such as the Dworshak reservoir on the North Fork of the Clearwater River, are used to store water and adjust the river's natural flow patterns to conform more closely with water uses.

The normal operating ranges and usable storage volumes for the affected hydropower facilities are listed in Table 2-3. While it is physically possible to draw run-of-river reservoirs well below their normal minimum pool levels, the four lower Snake River facilities are not designed to operate below minimum pool levels.

Table 2-3. Characteristics of the Four Lower Snake River Facilities

Facility	Snake River Mile	Facility Ownership	Reservoir Name	Reservoir Capacity (normal operating range, acre-feet)	Reservoir Elevation (normal operating range, NGVD)
Lower Granite	107.5	Corps	Lower Granite Lake	49,000	733 to 738
Little Goose	70.3	Corps	Lake Bryan	49,000	633 to 638
Lower Monumental	41.6	Corps	Lake Herbert G. West	20,000	537 to 540
Ice Harbor	9.7	Corps	Lake Sacajawea	25,000	437 to 440

Note: NGVD=National Geodetic Vertical Datum

2.1.3.1 Adult and Juvenile Fish Facilities

Adult fish passage systems are provided at each of the four dams and include fish ladders, pumped attraction water supplies, and powerhouse fish collection systems. Adult fish passage facilities are operated in accordance with the Corps' Fish Passage Plan (Corps, 1999) as prescribed in the 1995 Biological Opinion and the 1998 Biological Opinion. The operation period is typically from March 1 through December of each year. Juvenile fish bypass facilities were developed or installed at each of the four lower Snake River dams as they were constructed. Current measures for collection and transportation of juvenile fish outmigration are identified in the 1995 Biological Opinion, 1998 Biological Opinion, and the ESA Section 10 Permit (No. 895) for the Juvenile Fish Transportation Program (JFTP). The Corps operates the JFTP in cooperation with NMFS and in accordance with the 1995 and 1998 Biological Opinions.

Juvenile fish are transported under the guidelines of the Fish Passage Plan and the Corps' JFTP. Juvenile fish are not transported at Ice Harbor Dam, but the majority are bypassed directly to the tailrace below the dam. At Lower Granite, Little Goose, and Lower Monumental Dams, juvenile fish that go through the bypass systems can be routed either directly back into the river below the dam, or to holding and loading facilities for loading into barges or trucks for transport. Trucks are used for transport when the number of fish collected is 20,000 or fewer per day at Lower Granite.

The transport barges and trucks carry the fish past the remaining projects for release below Bonneville Dam. River water circulates through the barges, allowing the fish to imprint the chemicals and smells of the water during the trip downriver. The adults use this "imprinting" mechanism during upstream migration to guide them to the location where they originated (e.g., spawning area or hatchery).

Collection of juvenile fish generally starts March 25 at Lower Granite Dam and a few days later at Little Goose and Lower Monumental Dams. Eight barges are used. Early in the season (typically the second week in April), a barge leaves Lower Granite every other day. As numbers of fish increase, barging is increased to every day. In order to follow the "spread-the-risk" policy described in the 1995 and 1998 Biological Opinions, the current goal is to transport about half of the juvenile Snake River salmon and steelhead. The remainder are either bypassed back to the river, pass through the turbines, or may pass over the spillway if spill occurs.

The lower Snake River dams are, as previously noted, run-of-river facilities and provide little storage of water. Therefore, when reservoirs are full and flows exceed the capacity of the powerhouse or power output needs, water is involuntarily spilled. Voluntary spills are those that are not required to pass excess flows downstream (e.g., at times when the powerhouse could pass the flows and there is sufficient power demand). Voluntarily passing water over dam spillways rather than through the powerhouse is an operations approach used to divert juvenile fish from the turbines as they approach a dam.

Dams upstream of Lower Granite Dam can regulate water for flood control, irrigation, and other uses, interrupting the seasonal river flow patterns in downstream areas. Flow augmentation (i.e., increasing river flows above levels that would occur under normal operation by releasing more water from storage reservoirs) can aid migration of juvenile salmon.

In the 1993 and 1995 Biological Opinions, NMFS requested the use of an additional 427,000 acre-feet from upstream storage in Idaho for flow augmentation. BOR has provided these flows each year by leasing or acquiring water supplies and by releasing water from uncontracted storage space in BOR-owned reservoirs. The Idaho statute that authorized release of the additional 427,000 acre-feet will expire on January 1, 2000. This was extended until January 1, 2001. The statute covers only the release of water from storage (not natural flows) and specifies that the amount of flow augmentation that BOR can provide from all sources is limited to 427,000 acre-feet in any year.

NMFS' 2000 Biological Opinion addresses flow augmentation. The action agencies (Corps, BPA, and BOR) are currently developing implementation plans in response to this opinion. Although flow augmentation levels could change as a result of the planning efforts, the 427,000 acre-feet is incorporated into each alternative evaluated in this FR/EIS.

In addition to the 427,000 acre-feet, Idaho Power Company (Idaho Power) also provides spring/summer storage releases from the Brownlee reservoir of about 237,000 acre-feet. Also during the summer period, the Corps releases about 1.2 million acre-feet (MAF) from the Dworshak reservoir. A total of approximately 1.9 MAF is made available for augmentation by these three entities (BOR, Idaho Power, and the Corps).

The 1995 Biological Opinion discusses the need to pursue the acquisition of additional water after 1998 if necessary to contribute to the survival and recovery of listed fish species. The 1998 Biological Opinion did not change this need. The 1998 Biological Opinion did, however, request that studies be conducted to evaluate an increase in flow above the 1995 amount, perhaps by another 1.0 MAF. BOR has conducted the study of the effects of providing 1.0 MAF, but no actions have been authorized or implemented because, based on initial study findings, the 1.0 MAF option did not meet Federal criteria for completeness and public acceptability. In addition, the acquisition of this much water was not considered as reasonably foreseeable in the future (BOR, 1999).

NMFS' 2000 Biological Opinion indicates that the existing seasonal flow objectives established by the 1995 Biological Opinion "represent a fair balance between flow and water quality/conditions." However, the issue of providing water from BOR's upper Snake Basin and Idaho Power's Hells Canyon projects to assist in achieving Snake River flow objectives is being addressed in a separate Section 7 consultation (NMFS, 2000).

2.1.3.2 Lower Snake River Fish and Wildlife Compensation Plan

The Lower Snake River Fish and Wildlife Compensation Plan (Comp Plan) was authorized by the Water Resources Development Act of 1976 to mitigate for fish and wildlife losses caused by construction and operation of the four lower Snake River dams. The Comp Plan consists of fish hatcheries, satellite fish facilities, a fish laboratory, wildlife habitat areas and development areas, and lands with fishing and hunting access. The facilities and lands of the Comp Plan are primarily located in the upper, middle, and lower subbasins of the Snake River Drainage, in the states of Washington, Oregon, and Idaho. The remaining facilities and lands are located in the upper Columbia, Yakima, and Mid-Columbia subbasins. Some development is located on existing Federal lands, but the majority is on additionally-acquired lands and easements.

Eleven fish hatcheries were modified or constructed under this plan, along with a number of collection facilities for gathering adults and acclimation ponds for acclimating juveniles to water sources where they would return as adults. These facilities are operated by the state fisheries agencies or the USFWS. Additional recently constructed acclimation facilities are operated by the Nez Perce and the Umatilla. In addition, the listing of the sockeye salmon resulted in a captive broodstock program that is funded by the BPA. Also, the Nez Perce has been transporting coho salmon from the lower Columbia River to the Clearwater Basin in an attempt to re-establish runs of these species.

The Comp Plan also includes 62 HMUs that were developed as mitigation for the loss of habitat associated with the four dams and reservoirs. These HMUs, developed for a wide variety of habitat and species, range in size from less than 1 acre to over 3,000 acres.

2.2 Alternatives Considered

In response to NMFS' 1995 Biological Opinion and the results of the Interim Status Report (Corps, 1996), the Corps continued its ongoing process of evaluating various system improvements. These measures are intended to improve the effectiveness of downstream migration by juvenile salmonids and upstream passage of adults. This appendix is a part of the FR/EIS that analyzes a range of possible actions on the lower Snake River. Other aspects of the Columbia River and upper Snake River operations are addressed under related study processes. These include investigations into drawdown of the reservoir at the John Day Project and studies associated with the Federal relicensing of Idaho Power's Hells Canyon dam complex on the Snake River.

The lower Snake River Feasibility Study has been underway since 1995 and numerous alternatives have been identified and assigned combinations of numbers and letters to serve as unique identifiers. Different study groups involved in the process have all used slightly different numbering or lettering schemes over the last 3 years. The primary alternatives that are being carried forward in this Feasibility Study currently involve four major concepts derived from three major pathways. The four alternatives that are being evaluated in detail are presented in Table 2-4 along with the naming conventions that have been used by various study groups involved in the study.

Table 2-4. Current Study Alternatives Naming Conventions

Pathway Name	Alternative Name	PATH Number	Corps Number	FR/EIS Number
Existing System	Existing Conditions	A-1	A-1	1
Major System Improvements	Maximize Transport of Juvenile Salmon	A-2	A-2a	2
Major System Improvements	Major System Improvements	A-2'	A-2d	3
Natural River Drawdown	Dam Breaching	A-3	A-3a	4

2.2.1 Existing Conditions

Alternative 1—Existing Conditions consists of continuing the fish passage facilities and project operations that were in place or under development at the time that this Feasibility Study was initiated. The existing programs and plans underway would be continued to meet the authorized purposes of the Lower Snake River Project. Project operations including all ancillary facilities such as fish hatcheries and HMUs under the Comp Plan, recreation facilities, power generation, and irrigation would remain the same, unless modified through future actions. Adult and juvenile fish passage facilities would continue to operate. Similarly, work on prototype testing of SBC at Lower Granite would continue. The Existing Conditions alternative also includes several other planned measures that would affect fish-related expenses. These include:

- new turbine cams that control the turbine blades and wicket gates
- new turbine runners that may reduce fish stress and mortality

- new upgrades to Lower Granite Dam Juvenile Fish Facilities
- up to seven new fish barges to replace two barges scheduled for retirement
- adult fish attraction modifications at fish ladders to ensure adequate water supply is maintained in the event of a pump failure
- trash shear boom at Little Goose Dam to capture more debris before it gets into the juvenile fish facilities
- fish separators to improve fish separation and to reduce stress, delay, and mortality at existing juvenile fish facilities
- cylindrical dewatering screens to reduce the amount of water needed for fish collection facilities at Little Goose, Lower Monumental, and Ice Harbor Dams
- spillway deflectors/pier extensions at Lower Granite, Little Goose, and Lower Monumental Dams to further reduce dissolved gas concentrations.

2.2.2 Maximize Transport of Juvenile Salmon

Alternative 2—Maximum Transport of Juvenile Salmon would include all of the existing or planned structural and operational configurations from the existing conditions alternative. However, this alternative assumes that the juvenile fishway systems would be operated to maximize fish transport and that voluntary spill would not be used to bypass fish through the spillways (except at Ice Harbor). To accommodate this transport, some measures would be taken to upgrade and improve fish handling facilities.

2.2.3 Major System Improvements

Alternative 3—Major System Improvements would provide additional improvements to those considered under the existing conditions alternative. These improvements would be focused on using surface bypass collector (SBC) facilities in conjunction with an extended submersible bar screen (ESBS) and a behavioral guidance system (BGS) located in the turbine intakes. The intent of these facilities is to provide more effective diversion of juvenile fish away from the turbines. This alternative would incorporate an adaptive mitigation strategy where the project facilities would be operated under a spread-the-risk policy. This policy would allow flexibility for implementing either in-river passage or juvenile transportation, or various combinations of each. A variety of options under this alternative could be implemented, depending upon results of ongoing or future tests of equipment, facilities, and approaches.

On additional option that is currently being tested is a removable spillway weir (RSW). The RSW is a new technology that would provide more flexibility for adjusting the balance between in river and out of river transportation for migrating juvenile salmon. Basically, when it is desirable to keep juvenile fish in the river instead of using the juvenile transport system, the SBCs would be shut off, and the BGS would be used to guide fish to the RSW (see Appendix E—Existing Systems and Major System Improvement Engineering for more information).

2.2.4 Dam Breaching

Alternative 4—Dam Breaching is also called the Drawdown Alternative in many of the Feasibility Study reports. The term drawdown, as used by many study groups since late 1996, represents the same alternative as dam breaching. There are, however, many types of possible drawdown activities. Therefore, the term dam breaching was created to more specifically describe the action behind the alternative. The reservoirs would be evacuated or drawn down by the act of breaching. Alternative 4—Dam Breaching would involve significant structural modifications at the four lower Snake River dams allowing the reservoirs to be drained resulting in a near natural river that would remain unimpounded. Dam breaching would involve removing the earthen embankment sections of the four dams and then developing a channel around the powerhouses, spillways, and navigation locks. With dam breaching, the navigation locks would no longer be operational, and navigation for larger vessels would be curtailed. Some recreation facilities would close while others would be modified and new facilities could be built in the future. The operation and maintenance of hatcheries and HMUs would also change although the extent of change would probably be small and is not known at this time. Dam breaching activities would take at least two full years after an estimated five year period necessary for preparation of a detailed design report and preparation of contracts. Structural modifications would include:

- modifying intake gates and bulkheads at generator intake bays
- removing generation equipment and dewatering draft tubes and drains
- modifying the powerhouse outlets
- placing sheetpiling or rock materials to stabilize the tailraces
- excavating a river channel around the dam structures with new levee construction
- removing embankment structures
- stabilizing highway and railroad bridges and embankments
- modifying the water siphons at the Lewiston levees and the adult fish ladder at Lyons Ferry Hatchery
- relocating roads, railroads, and other facilities at the new channel locations
- extending boat ramps and other facility modifications for water wells and other water dependent features.

Other alternatives have been considered by study groups including alternatives that would change upper Snake River flow augmentation levels. These alternative analyses are not presented here as flow augmentation changes are not being carried forward in this study at this time. However, several reports have been completed that evaluated flow augmentation changes and these include BOR's Snake River Flow Augmentation Impact Analysis report published in February 1999. This report is available on the Corps' website at: http://www.nww.usace.army.mil/.

3. National Economic Development Analysis

NED costs and benefits are the decrease or increase in the value of the national output of goods and services expressed in dollars. NED figures measure the costs and benefits to the nation and not to a particular region. The NED analysis conducted for this study addresses power, recreation, transportation, water supply, commercial fishing, tribal circumstances, flood control, and implementation/avoided costs. These resource areas are addressed in turn in the following sections.

3.1 Power System Impacts

3.1.1 Introduction

This section summarizes the findings in the Technical Report on Hydropower Costs and Benefits prepared by the DREW Hydropower Impact Team (HIT) (DREW Hydropower Impact Team, 1999). All tables and figures presented in this section were developed as part of the DREW HIT study. Sources of secondary information used by DREW HIT to develop these tables and figures are noted, as appropriate. The purpose of this hydropower analysis was to identify the net economic costs associated with changes in hydropower production at the four lower Snake River facilities. Changes in fish and wildlife implementation costs and existing hydropower system costs are not included in this section. They are included in Section 3.8, Implementation and Avoided Costs.

The scope of the hydropower impacts is large. Columbia River Basin hydropower projects serve as a major element in the Pacific Northwest electrical industry, and provide about 60 percent of the total regional energy needs and 70 percent of the total electrical generating capacity in the region on an average basis. The nature of hydropower is that it is available in different amounts from year to year depending on streamflow conditions. In wet years, the amount of hydropower generation can be significantly greater than the average conditions, and this energy (commonly referred to as secondary) can serve as a major part of the export market outside of the Pacific Northwest. In low water years, or high demand periods within a year, energy is often imported into the Pacific Northwest to meet the power demands. Consequently, any changes in the generation of Pacific Northwest hydropower could impact the amount of energy bought and sold, and the number of new generating facilities to be built, throughout the entire West Coast of the United States. For these reasons, the scope of this analysis is the entire western United States and parts of Canada as defined by the Western Systems Coordinating Council (WSCC). The WSCC is one of nine regional energy reliability councils that were formed due to a national concern regarding the reliability of interconnected bulk power systems. The WSCC comprises all or part of the 14 Western States and British Columbia, Canada, over 1.8 million square miles.

The hydropower study was conducted jointly by staffs of the Corps and the regional power marketing agency, BPA. As with other economic impact areas, an oversight group was formed to assist in the analysis and to provide a forum for interested parties to provide input. The HIT consisted of 10 to 20 members from numerous interested entities such as the NPPC, BOR, NMFS, regional tribes, river interest groups, and environmental groups. The HIT met regularly during the study to discuss appropriate approaches and assumptions to use in the analysis. The HIT also provided review and comments on drafts of the hydropower technical report.

The study process incorporated several elements to arrive at the estimate of economic effects associated with changes in hydropower with each of the alternatives. The process first considered how the impacted hydropower facilities currently function, and used system hydroregulation studies to estimate how much hydropower generation will occur with the different alternatives and different water conditions. This information was then incorporated into power system models to estimate how changes in hydropower generation will affect generation from other more costly power resources. Estimates of future market-clearing prices were also examined. The market price analysis examined economic effects by pricing the loss of hydropower generation based on the estimated future market prices for the base condition. A wide range of key study assumptions was investigated and the uncertainties associated with these assumptions were examined. Sensitivity tests were performed on some of the major study assumptions to assure that results were reasonable from a wide range of viewpoints. The financial impact on regional ratepayers and possible mitigation for these impacts were also investigated. The power system modeling tools were used to help identify the changes in air pollutant emissions with the different alternatives.

3.1.2 Hydropower Characteristics

The hydropower facilities of most interest to this study were the four lower Snake River facilities of Ice Harbor, Lower Monumental, Little Goose, and Lower Granite. However, almost all the hydropower projects in the Columbia-Snake system will be impacted under at least one of the alternatives being investigated. Table 3.1-1 describes some of the hydropower characteristics of each lower Snake River hydropower facility. Three of the lower Snake River facilities are essentially identical in terms of hydropower facilities. The Ice Harbor facility was constructed several years before the others and has less capacity. The overload capacity represents the maximum output that can be achieved. The average annual energy is presented in two different units: the average megawatt (MW) (aMW) which is the amount of generation averaged over all the hours of the year (8,760 hours), and the annual megawatt hours (MWh) which is the sum of all generation over the entire year. These energy data were taken from the average of 60 historic water years for the base condition.

Figure 3.1-1 shows an estimate of the average monthly generation of the four lower Snake River plants by month based on a system hydroregulation model for the base condition (Alternative 1—Existing Conditions). The amount of generation from these plants can change significantly in different water years (WY) and seasons. The figure compares the monthly generation for a 60-year average simulation (1929 to 1988), a low water year (1930 to 1931), and a high water year (1955 to 1956).

Figure 3.1-2 presents the monthly generation-duration curve based on the 60 water year conditions from 1928 to 1988, for the base condition. The generation in this figure is the combined monthly generation of the four lower Snake River facilities. This figure shows the percent of time in which average monthly generation equals or exceeds the generation in MW. For example, the monthly generation equals or exceeds 1,000 MW about 50 percent of the months of the 60 water years, and equals or exceeds 2,000 MW about 20 percent of the time.

The hourly operation of the lower Snake River plants is determined primarily by the amount of Snake River water arriving at Lower Granite because the four reservoirs have very limited storage capability and only minor tributary inflows into the other reservoirs. The ability to store water over the week, month, or season cannot occur at these facilities. The facilities can somewhat shape the amount of generation throughout the day with the limited storage within the top 3 to 5 feet of operating range over the juvenile fish non-migrating periods of November through March.

Table 3.1-1. Hydropower Plant Characteristics

	Ice Harbor	Lower Monumental	Little Goose	Lower Granite	Lower Snake Totals
Number of Units	6	6	6	6	**24**
In-Service Date	1 (1961) 2 (1962) 3 (1975)	2 (1969) 1 (1970) 3 (1979)	3 (1970) 3 (1978)	3 (1975) 3 (1978)	
Energy:					
Average Annual Energy (aMW) for Base Condition	264	332	317	333	**1,246**
Average Annual Energy (1,000 MWh) for Base Condition	2,313	2,908	2,777	2,917	**10,915**
Plant Factor Base Condition (%)	38	36	34	36	**36**
System Energy Comparisons:					
Percent of Pacific Northwest Federal System Avg Energy (Fed System = 11,136 aMW)	2	3	3	3	**11**
Percent of Total Pacific Northwest System Avg Energy (System = 24,479 aMW)	1	1	1	1	**5**
Capacity:					
Nameplate Capacity Per Unit (MW)	3 (90) 3 (111)	135	135	135	
Total Nameplate Capacity (MW)	603	810	810	810	**3,033**
Overload Capacity (Total Maximum Output) (MW)	693	931	931	931	**3,486**
System Capacity Comparisons:					
Percent of Pacific Northwest Federal System Peaking Capacity (Fed System = 23,824 MW)	3	4	4	4	**15**
Percent of Total Pacific Northwest System Peaking Capacity (System = 47,859 MW)	1	2	2	2	**7**

3.1.3 Power System Characteristics

Table 3.1-2 demonstrates to what extent each power-generating source is used in the Pacific Northwest. As can be seen in the table, hydropower makes up about 67 percent of the Pacific Northwest's total generating capacity, followed by coal. Next in terms of capacity available to meet demand is the import over the intertie system from regions outside of the Pacific Northwest. The firm energy amount shown in this table reflects that which can be generated in the low water year of 1936 to 1937. The year 1937 has been defined as the critical year for defining firm energy in many regional power planning studies.

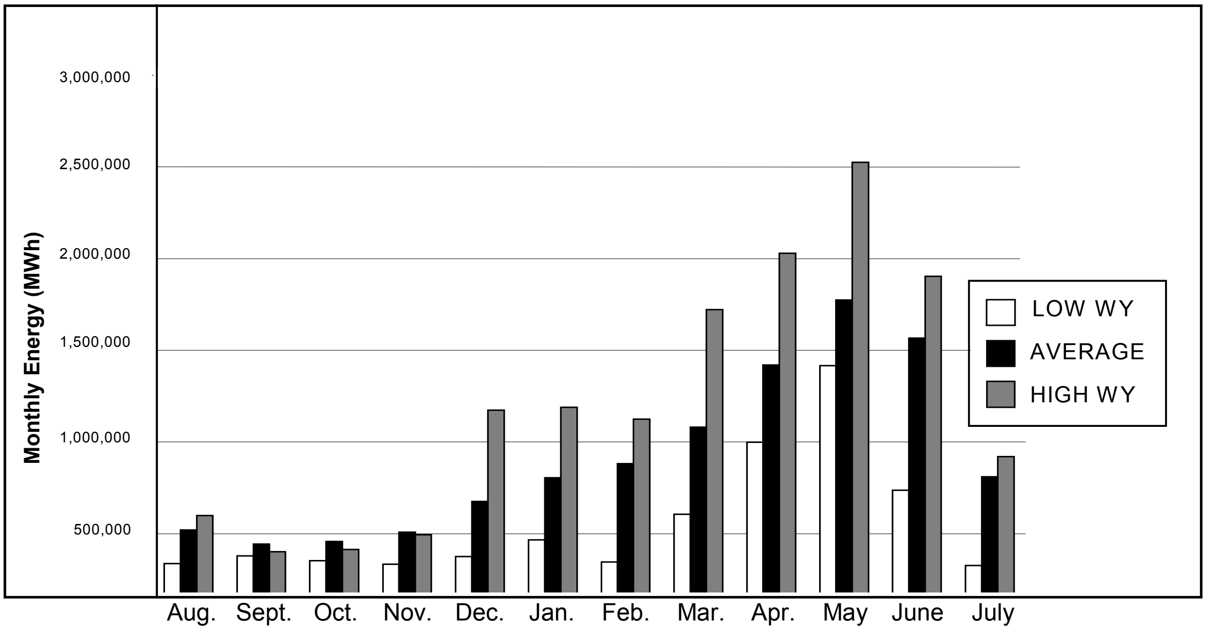

Figure 3.1-1. Alternative 1—Existing Conditions Results – Monthly Generation – Four Snake River Dams Low WY (1930), High WY (1955 to 56), and 60-year Average

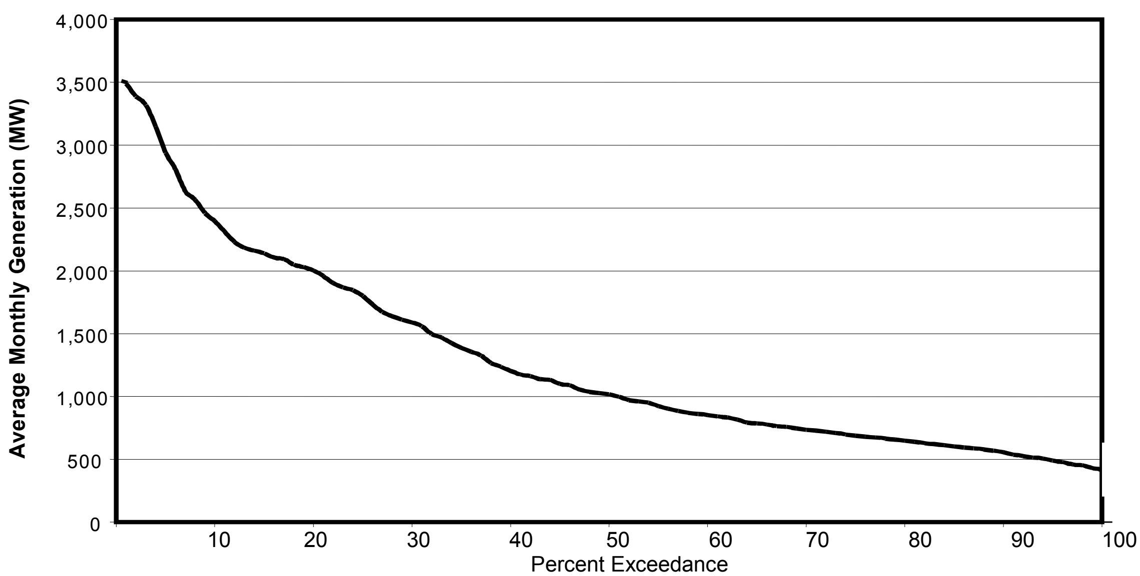

Figure 3.1-2. Lower Snake River Plants—Monthly Generation Duration

Table 3.1-2. The Pacific Northwest Electric Generating Resources 1997[1/]

Resource Type	Sustained Peak Capacity[2/] (MW)	% of Total Capacity	Firm Energy[2/] (aMW)	% of Firm Energy
Hydro	25,887	67	12,187	57
Coal	4,521	12	4.061	19
Nuclear	1,162	3	841	4
Imports	2,996	8	1,669	8
Combustion Turbines	1,665	4	753	4
Non-utility Generation	1,166	3	1,051	5
Cogeneration	775	2	675	3
Other	264	1	171	1
Total	**38,436**	**100**	**21,408**	**100**

1/ Source: BPA's *1997 FAST FACTS*
2/ For more information see BPA's *Pacific Northwest Loads & Resources Study*

A distinction is often made between firm (also referred to as primary) energy and non-firm (referred to as secondary) energy in power markets because the firm energy can be counted on even in the most extreme historical low water years.

Table 3.1-3 provides generation and capacity information for the entire WSCC, based on actual generation in 1997, rather than the firm energy. The most prominent source of generating capacity and energy in the WSCC is hydropower, but to a significantly less extent than in the Pacific Northwest. Coal and natural gas driven thermal plants provide a much larger share of capacity and energy in the WSCC than in the Pacific Northwest. However, hydropower makes up the vast majority of system capacity and generation in the Pacific Northwest, and is the largest contributor for the entire WSCC.

3.1.4 Hydroregulation Models

The first step in defining the power impacts was to identify the amount of hydropower generation with each alternative. The second step was to identify the economic effects of changes in the hydropower.

The study utilized two system hydroregulation models to perform the first step. The system hydroregulation models simulate the operation of hydropower plants with each alternative with historical water conditions encountered over 50 or 60 water years, depending on which model is used. The models were used to define the power impacts at each hydropower plant in the Pacific Northwest with the alternative operations of the system. The model used by the Corps was the Hydro System Seasonal Regulation Program (HYSSR) and the BPA model was the Hydro Simulator Program (HYDROSIM). The major output of either model was a month-by-month hydropower generation amount from each hydropower plant in the Columbia Basin, for each of the years simulated by the models. See Appendix G, Hydroregulations, of the FR/EIS for a detailed description of the hydroregulation models.

Table 3.1-3. Western Systems Coordinating Council Electric Generating Resources, 1997

Resource Type	Capacity (MW)	% of Total Capacity	1997 Energy (aMW)	% of Total Energy
Hydro-Conventional	61,043	39	33,367	39
Hydro-Pump Storage	4,316	3	533	1
Steam – Coal	36,325	23	28,378	33
Steam – Oil	746	<1	239	<1
Steam – Gas	23,241	15	5,018	6
Nuclear	9,258	6	7,472	9
Combustion Turbine	5,846	4	206	<1
Combined Cycle	3,777	2	779	1
Geothermal	3,060	2	2,270	3
Internal Combustion	293	<1	–	<1
Cogeneration	8,119	5	5,954	7
Other	1,891	1	1,317	2
Pump-Storage Pumping			(445)	(1)
Total	**157,915**	**100**	**85,089**	**100**

Source: 1998 WSCC Information Summary

Table 3.1-4 summarizes the total monthly Pacific Northwest system generation amounts for each of the alternatives as compared to the base case condition, Alternative 1—Existing Conditions. This table provides the monthly averages over all the water year simulations done by the HYSSR (60 years) and HYDROSIM (50 years). The table shows the total hydropower production in the Pacific Northwest (System Generation). The HYSSR and HYDROSIM models have slightly different definitions of which hydropower facilities are included in the Pacific Northwest system generation, and hence the total system generation amounts are slightly different. These differences in system-wide hydropower generation estimates are used later in this analysis to define the economic effects of each alternative. Sections 1 and 3 of Table 3.1-4 show the average system generation for each alternative from the HYSSR and HYDROSIM models. However, the most important element of this study is the change in generation from the base condition. Sections 2 and 4 show the change in generation from the base condition (Alternative 1—Existing Conditions) with each alternative. The last section in the table presents the differences in net generation as defined by the two hydro-regulation models. The differences in the two models' estimation of change in generation with each alternative are relatively small, on average, but can be significant for specific months and alternatives.

3.1.5 Power System Models

The study team used several models in the analysis. Figure 3.1-3 provides a schematic of how the several models were integrated to estimate the range of net economic effects. Specifics of each model are provided in the technical report (DREW Hydropower Impact Team, 1999).

Table 3.1-4. Hydropower Analysis: HYSSR and HYDROSIM Results by Alternative—System Generation (aMW)

HYSSR Results: Average Generation Over 60 Water-Year Simulations													
Alternatives	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**AUG**	**ANN. AVG.**
1	9,466	9,520	10,414	14,071	16,800	15,200	13,820	15,846	18,729	18,834	13,725	11,997	14,038
2 and 3	9,467	9,533	10,418	14,078	16,803	15,203	13,820	16,006	19,049	19,139	13,743	12,008	14,108
4	9,046	8,953	10,021	12,867	15,987	14,098	11,794	13,437	16,314	16,703	12,728	11,280	12,771

System Impacts HYSSR (Generation Difference From Alternative 1; Negative Means Loss In Energy From Alternative 1)														
Alternatives	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**AUG**	**ANN. AVG.**	**% OF ALT.1**
2 and 3	1	13	4	7	3	3	0	160	320	305	18	11	70	0.5
4	(420)	(567)	(393)	(1,204)	(813)	(1,102)	(2,026)	(2,409)	(2,415)	(2,131)	(997)	(717)	(1,267)	(9.0)

HYDROSIM Results: Average Generation Over 50 Water-Year Simulations													
Alternatives	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**AUG**	**ANN. AVG.**
1	10,572	11,558	12,735	15,935	19,669	16,435	14,858	17,777	20,487	19,960	15,333	13,108	15,702
2 and 3	10,572	11,558	12,735	15,935	19,671	16,435	14,858	17,927	20,732	20,202	15,343	13,108	15,756
4	10,183	10,865	12,244	15,031	18,677	15,324	13,057	15,676	18,168	17,923	14,220	12,352	14,477

System Impacts HYDROSIM (Generation Difference From Alternative 1; Negative Means Loss In Energy From Alternative 1)														
Alternatives	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**AUG**	**ANN. AVG.**	**% OF ALT. 1**
2 and 3	0	0	0	0	2	(1)	0	150	245	241	11	0	54	0.3
4	(389)	(693)	(491)	(904)	(992)	(1,111)	(1,801)	(2,101)	(2,319)	(2,037)	(1,112)	(755)	(1,225)	(7.8)

Differences in Impacts Between HYSSR and HYDROSIM (Negative Means HYSSR Difference is Larger)														
Alternatives	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**AUG**	**ANN. AVG.**	**% OF ALT. 1**
2 and 3	(1)	(13)	(4)	(7)	(1)	(4)	0	(10)	(75)	(64)	(7)	(11)	(16)	(0.1)
4	31	(126)	(98)	300	(179)	(9)	225	308	96	94	(115)	(38)	42	0.3

Because of the inter-related, market driven nature of the electric industry, it was decided that the evaluation of changes in hydropower production in the Pacific Northwest must be evaluated on a system-wide basis. This study uses two separate system production cost models, one by the Corps and one by BPA, to evaluate the net economic effects of changing power generation at the four lower Snake River facilities and John Day. A third approach developed by the NPPC was also utilized in this study.

These multiple approaches were undertaken to look at the impacts from different analytical viewpoints to assure that the economic effects are adequately bracketed in the final estimates. The study progressed by examining model results for each alternative with the different system approaches. To the extent possible the basic input assumptions were standardized among the models, and these assumptions are discussed below. Upon comparing results, the study team built a consensus on the best analytical approach.

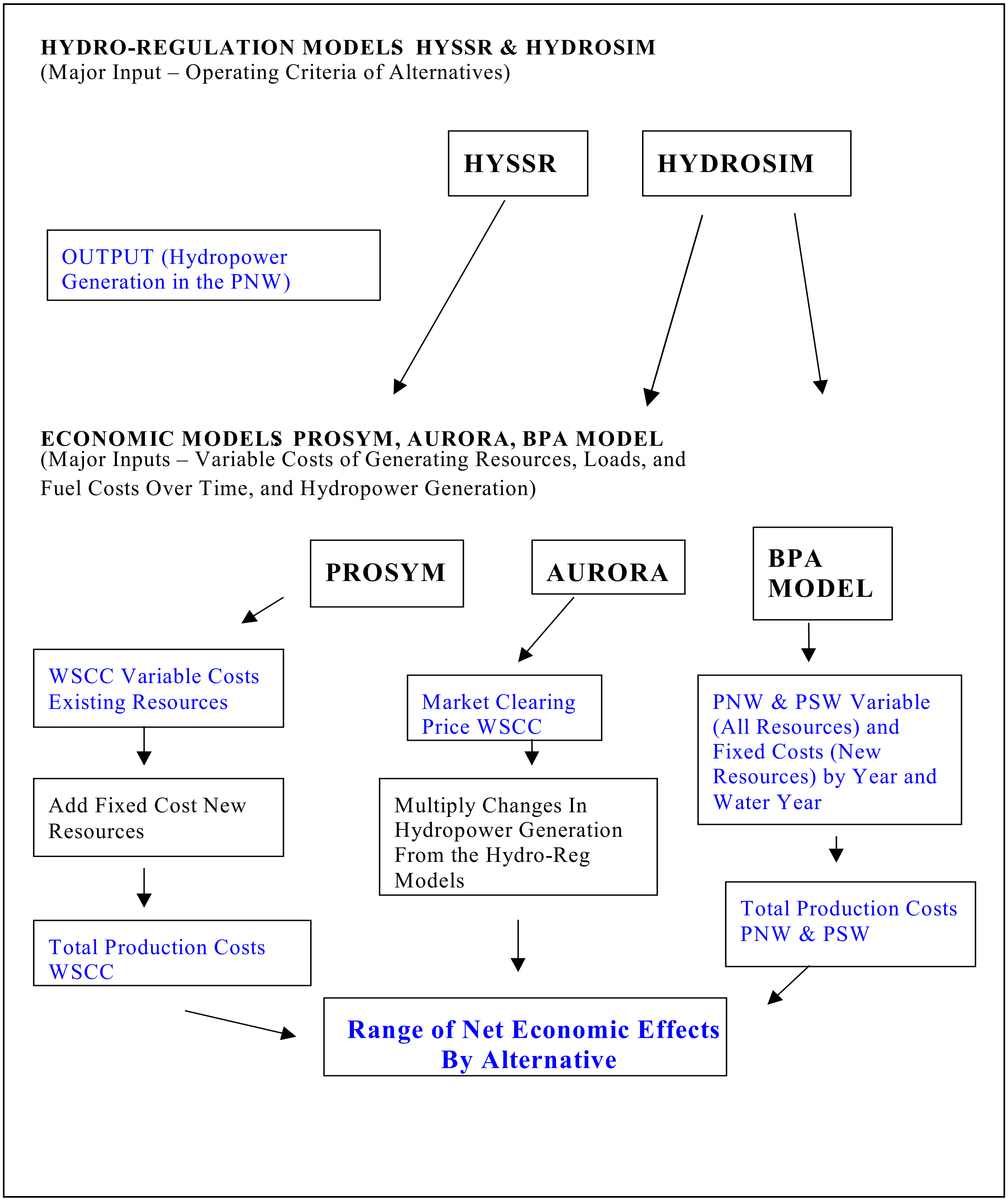

Figure 3.1-3. Schematic of Models Used in Hydropower Analysis

In general, the results from the hydroregulation models were fed into the economic models. Each economic model was used to place a dollar value on the changes in hydropower production.

The evaluation of the net economic effects on hydropower was based on two basic approaches: a market price analysis and a system production cost analysis. The Aurora model served as the basic tool for the market price analysis, and the PROSYM and BPA models were used for the system production costs analysis. It is important to note that the market price and system production cost approaches are intended to measure the same net economic effects, and hence are directly comparable.

Many similarities do exist in the three power system models used in this analysis. They are all designed to identify how the different power generating resources will be operated to meet projected power loads (demand). They do vary in scope from hourly models (Aurora and PROSYM) to a monthly model that stratifies hours in the month into different blocks of peak and non-peak hours. The geographic regions covered by each model are different. The treatment of constructing new power resources and retiring power plants varies among the models. The primary outputs of each model are different. The Aurora model identifies the marginal cost in each period and this is assumed to be the market-clearing price. PROSYM provides the production costs (variable costs) to meet loads by all regions in the WSCC. The BPA model also identifies production costs but also provides the fixed costs of new resources to arrive at the total system production costs.

3.1.5.1 Market Price Model

The conceptual basis for evaluating the benefits from energy produced by hydropower plants is society's willingness to pay for the outputs, which sometimes can be obtained through market prices. With the movement towards a deregulated market, the price of electricity in the California market and elsewhere is being priced at or near the marginal production cost of the last resource to provide the needed electricity. So, this part of the power analysis looked at valuing the incremental changes of hydropower generation at the market price, which was based on the marginal cost of the last resource used to meet load in the specific time frame.

As more competitive electricity markets develop, prices will not be set to average costs as they have been in the past. Rather, the various services provided, operating reserves, voltage stabilization, etc., will be available and priced separately. However, consumers will not have to purchase all of these services from separate suppliers. During most time periods in the power spot market, the generation price of electricity will be set by the operating costs of the most expensive generating unit needed to meet demand, or what is referred to in economics as the "marginal cost" of production. In general, a supplier will not be willing to sell power below the market price of the most expensive facility operating at a given time, because consumers will be willing to pay the higher price. Similarly, consumers will be unwilling to pay more than the cost of the most expensive operating available generator, since other suppliers will be offering lower prices. With prices set to marginal costs, the market will clear: all suppliers willing to provide power and all consumers willing to purchase power at the market price will be doing so.

Market prices were obtained from the NPPC study entitled *Analysis of the Bonneville Power Administration's Potential Future Costs and Revenues*, June 5, 1998, (NPPC, 1998). The market prices used in this study were developed with a model called Aurora, developed by a private firm, EPIS, Inc. The general elements of the Aurora model are provided here, and a more thorough description of Aurora is contained in the technical report (DREW Hydropower Impact Team, 1999). One of the principal functions of Aurora is to estimate the hourly market-clearing price at various locations within the WSCC.

Aurora estimates prices by using hourly demands and individual resource operating characteristics in a transmission-constrained chronological dispatch algorithm. The operation of resources within the WSCC is modeled to determine which resources are on the margin for each area in any given hour.

Aurora uses operating cost information for all the generating plants in the WSCC to build a least cost dispatch for the WSCC to meet energy demands. Units are dispatched according to variable cost, subject to non-cycling and minimum run constraints until hourly demand is met in each area. Transmission constraints, losses, wheeling costs and unit start-up costs are reflected in the dispatch. The market-clearing price is then determined by observing the cost of meeting an incremental increase in demand in each area. All operating units in an area receive the hourly market clearing price for the power they generate.

The hourly market clearing prices are developed on an area-specific basis. The analysis for this appendix uses the Oregon/Washington area price to value Pacific Northwest generation. This price can be interpreted as the average busbar price as seen by generation in the Oregon/Washington area. Charges for delivery within the Oregon/Washington area are not included in the price.

3.1.5.2 System Production Cost Models

The other approach to define net economic effects was a system production cost analysis. The economic effects were identified by comparing system production costs with the level of hydropower production from the different alternatives being investigated. Changes in hydropower generation result in different levels of operation of more costly thermal generating power plants. Hence, the economic values of different increments of hydropower energy were defined by the displacement of thermal resource generation.

For this analysis the total system production costs are defined as the sum of the variable operating costs for existing thermal and new resources (production costs) and the fixed costs (annualized capital costs) of new resources added to meet loads. The total system is defined by different geographic regions in each model. However the basic definition is:

Total System Production Costs	=	**Variable Costs**	+	**Fixed Costs**
		(Production)		(New Capacity)

Both BPA and the Corps have models that estimate the costs of meeting energy demand (loads) with available hydropower energy and thermal resources. The models identify the most cost-effective way to meet loads given all system constraints. These models estimate which resources will be operated to meet loads and the variable costs of these resources are summed to define variable production costs. Loads may also be met through purchase of energy from the Pacific Northwest, Pacific Southwest, or other regions. The purchase price reflects the variable generation costs and the transmission costs of the resource used to provide the energy. Production costs in the Pacific Northwest and Pacific Southwest will vary depending on how much Columbia River hydropower is generated. The output of hydroregulation models (HYSSR and HYDROSIM) served as the major input to the system energy production cost models.

The BPA model categorizes West Coast thermal resources into several production cost blocks based on the average efficiencies of the plants. The more inefficient plants tend to be the older plants that are operated last in the dispatch order. The BPA model compares the Pacific Northwest and Pacific Southwest loads to the monthly hydropower and thermal generation for each simulation year. As hydropower generation varies, the thermal generation amounts and costs change. The model identifies the marginal costs of the resources which hydropower will displace. The load is broken into three distinct periods of each week or month. These periods are the super peak (hours 7 a.m. to 10 a.m. and 5 p.m. to 8 p.m. each weekday), peak (hours 6 a.m. to 10 p.m. Monday through Saturday, not including the super peak hours) and non-peak hours (the remainder of the week). This stratification accounts for the significant variations in prices and resources used to meet loads in these different periods of the week.

The Corps utilized an existing proprietary hourly system production model entitled PROSYM, which has been used extensively by the Corps throughout the United States. PROSYM was developed and is maintained by Henwood Energy Services of Sacramento, California. The Corps used the model under a contract with Henwood. The PROSYM model has an extensive database, which includes operating characteristics of all WSCC power plants, current fuel prices, plant efficiencies, and inter-regional marketing conditions. The model dispatches thermal and hydropower resources on an hourly basis to meet energy demand. Hydropower resources are based on weekly energy amounts generated by the hydropower regulator models from the facilities in the study region, or weekly energy amounts input to the model. The model also includes a pollution emissions subroutine.

3.1.5.3 Model Inputs

This section describes the major inputs utilized by the system production cost models and the market price analysis. Most of these key model assumptions were taken from the NPPC (1998). A range of projections (low, medium, and high) was made for each key variable to account for the uncertainty associated with predicting future conditions.

Elasticity of Demand

One major simplifying assumption made in this analysis is that consumers of electricity have a zero price elasticity of electricity demand. This assumption does not account for the probable reduction in demand for electricity that will occur if electricity prices increase with the implementation of Alternative 4—Dam Breaching. There is significant evidence that there is price elasticity for electricity at both the wholesale and retail level. But, it was considered beyond the scope of this study to estimate elasticity for each consumer type.

System Loads

The system loads, or power demands, are shown in Table 3.1-5 for the starting year of 1997, by each of the 12 Aurora demand regions.

Demand was assumed to grow at equal rates in all of the demand areas. Although this will certainly not be the case, the team did not research every state's demand forecasts because these were likely to include a wide range of basic demographic assumptions. It was also felt that historical relative growth rates for states might not be a good indicator of future demand growth.

Table 3.1-5. Aurora Model—1997 Electric Loads by Demand Region

Region	Load (aMW)
Oregon/Washington	16,779
Northern California	10,730
Southern California	16,783
Canada	11,842
Idaho	2,644
Montana	1,554
Wyoming	1,455
Colorado	4,681
New Mexico	2,106
Arizona	6,474
Utah	2,481
Nevada	2,817
Total	**80,346**

Source: NPPC, 1998

For the medium case, demand was assumed to grow at 1.5 percent annually. In the low case, the assumption was 0.5 percent per year, and in the high case it was 2.5 percent. The load forecasts project the Pacific Northwest demand in terms of aMW by year up to year 2020.

Fuel Prices

The major component of production cost of any power system is the costs of fuels expended to generate the electricity. Hence, the fuel prices assumed to occur over time are a critical element of the system production cost modeling and the market price analysis. This section describes the assumptions made for the fuel prices in the different regions of the WSCC.

Natural Gas Prices

The NPPC Aurora model is currently structured to develop its natural gas price assumptions based on two pricing points, Henry Hub in Louisiana and Permian in Texas. Prices in the Aurora regions are then based on a series of differentials from these trading hubs. The results of making the differential adjustments are shown in Table 3.1-6. This table shows the assumed natural gas prices on a $/million British thermal unit (MMBtu) basis for 1997.

The final assumption for natural gas prices was the real escalation rate applied to the gas prices. Three different future economic scenarios were projected. For the medium economic forecast case, it was assumed the medium gas price escalation included in the Council's power plan, 0.8 percent per year escalation above general inflation. The low forecast assumed a negative 1 percent real escalation rate, while the high projection assumed a positive 2 percent real escalation. These assumptions translate into similar growth rate in all regions with one exception. In 1999 and 2000 significant expansions to pipeline capacity to export from Alberta to the East are expected to come online. This expanded export capacity will have the effect of increasing prices in Alberta and British Columbia, perhaps significantly. To reflect this it was assumed that the basis differential

Table 3.1-6. Assumed 1997 Natural Gas Prices by Region

Regions	Estimated 1997 Price ($/MMBtu)
Canada	1.45
British Columbia border at Sumas	1.70
Northwest from Alberta Energy Company	1.63
Northern California from AECO	1.95
Utah	1.80
Colorado	1.95
Wyoming	1.80
Montana	2.00
Idaho	1.97
Southern California	2.15
Arizona	2.10
New Mexico	1.95
Nevada	2.00

from Canadian markets to Henry Hub decreases in the medium case. The differential from Henry Hub for the Alberta Energy Company (AECO) Hub price in Alberta decreases from a ($0.65) to ($0.45) by the year 2001. The Sumas differential decreases from ($0.55) to ($0.40) during the same period. These differential decreases result in significant increases to Northwest natural gas prices in the early years of the analysis. A range of natural gas assumptions is explored in the analysis as presented Table 3.1-7.

Oil Prices

For the base year of 1997 it was decided to use the starting crude oil prices at $3.50 per MMBtu with a low real escalation rate of 0.5 percent per year. This escalation rate was applied to all oil fuels. The 1997 starting values that were selected for other oil fuels are shown in Table 3.1-8.

Because oil prices do not appear to play an important role in determining the future market price of electricity, oil prices ranges were not used in the analysis.

Coal Prices

The other fuel, besides natural gas, that plays a significant role in the market price of electricity is coal. It was assumed that coal prices would decline in real terms in the base and low cases and to remain constant in the high case. In the low case coal prices were assumed to decline by 2 percent a year. In the base case, they decline at 1 percent a year. These growth rates were based on the Energy Information Administration's *Annual Energy Outlook*.

Table 3.1-7. Summary of Natural Gas Price Assumptions

1997 Price	Low ($)	Medium ($)	High ($)
Henry Hub	1.80	2.00	2.25
Permian	1.60	1.80	2.15
Basis Differential			
AECO	(0.65) constant	(0.65) down to (0.45)	(0.65) down to (0.20)
Sumas	(0.55) constant	(0.55) down to (0.40)	(0.55) down to (0.10)
	(%)	**(%)**	**(%)**
Escalation Rates	(1.0)	+0.8	+2.0

Table 3.1-8. Fuel Oil 1997 Prices Used in Analysis

Fuel Oil Type	1997 Price ($/MMBtu)
Crude Oil	3.00
No. 1 Fuel Oil	5.00
No. 2 Fuel Oil	4.50
No. 3 Fuel Oil	4.25
No. 4 Fuel Oil	3.85
No. 5 Fuel Oil	3.50
No. 6 Fuel Oil	2.70

Resources—Existing and Future

To meet load growth over time it was necessary to project what kind of resources will be built in the future, and under what conditions these will be built. Each of the three models used in this analysis approached the addition of new thermal resources in different manners as discussed in the Fixed Production Cost section (Section 3.1.6.1). The type of resources to be added to the system was reviewed by the study team. It was found that the most predominate type of fuel plant that has been recently added to power systems on the West Coast have been natural gas-fired combined cycle combustion (CC) turbine plants. It was found that CC natural gas plants represented the most cost-effective new additions over a wide range of potential plant factors. It was assumed in the Corps and BPA models that all new thermal resources to be built through year 2017 would be natural gas-fired combined cycle power plants.

The NPPC as part of its Power Plan responsibilities keeps abreast of the latest construction and operating costs for all potential resources. The construction costs identified for CC plants of 250 MW capacity in the West Coast region were estimated to be $601 per kilowatt (kW) of installed capacity, at the 1998 price level. The average heat rate of the new CC plants in 1998 was assumed to be 7,045 British thermal unit (Btu) per kilowatt-hour (kWh). This heat rate was assumed to go down over time at the rate of change described in the next section. The construction costs were based on the most recent financing experienced by the industry. To include these costs in the annual simulations, the construction costs were adjusted to an annual fixed cost amount. The fixed costs used in the BPA model were in the 11.4 to 11.9 mills/kWh range, depending on the year of simulation. For comparison purposes the annualized values of the construction and fixed operation and maintenance (O&M) costs for gas powered combined-cycle powerplants, computed from a model developed by Federal Energy Regulatory Commission (FERC), were used only in the PROSYM studies. The annualized value used in the PROSYM study was $86/kW per year delivered to the distribution system.

Combustion Turbine Costs and Technology

Because new capacity additions are comprised of CC power plants, an effort was made to develop plausible and consistent assumptions regarding the evolution of the cost and performance of these plants over the study period.

Continuing advances in aerospace gas turbine applications are expected to lead to further reduction in the cost and increases in the efficiency of power generation equipment. For this study, cost reduction assumptions are based on projected improvement in gas turbine specific power.[1] Increases in specific power produce greater output with no increase in physical size, thereby reducing cost. Historical rates of improvement and estimated ultimately achievable rates of specific power suggest that over the study period specific power will continue to improve, on average, at constant rates. The resulting projections of annual cost reduction averaged (0.6) percent in the medium forecast, (1.2) percent in the low and (0.1) percent in the high forecast. These reductions were applied to both capital and operating costs of new CC plants.

State-of-the-art combined-cycle efficiency is forecasted to continue to improve, but at declining rates. Rates of efficiency improvement are based on alternative introduction dates of advanced turbine technologies, and decades by which ultimate turbine efficiency might be achieved. Using this approach, combined cycle plant efficiencies would improve from 48 percent in 1997 to 54 percent by 2020 in the medium forecast, to 57 percent in the low and to 53 percent in the high forecast.

Unserved Load

In each of the three models, not all load was met in each time period. The amount of load to be met by the available resources is a fixed input to each of the models. The models then identify the most cost-effective way to meet that load given the resources available to the model. System simulations are run with the different water years, and the amount of available energy to serve load can vary substantially with the different water years. There were instances in which not enough energy or capacity was available to meet each hourly demand. This was because the models were trying to meet load in every hour or block of hours.

Different approaches were taken to account for the economic costs of the unserved load. In the real world, if shortages like this occur, the system will start shedding loads by not meeting certain loads, and curtailing the amount of energy provided in a particular time frame to some or all electric customers. There will clearly be an economic cost associated with this curtailment. One approach considered for this study was to simply assign a relatively high cost for every shortfall in satisfying the load. This high value was assumed to represent a proxy for the economic cost of curtailment. Another approach used was to recognize that demand-side management measures could be instituted to reduce peak load during these critical hours.

[1] Specific power is the power output per unit mass of working fluid.

Although it is likely that the market will come up with innovative approaches to reducing peak demands in response to time of use pricing, it was assumed that the market could achieve up to 26 percent as the maximum peak reduction through demand side voluntary actions.

The NPPC developed a supply curve for demand-side resources based on the best available information. This supply curve was used in the Aurora model and is presented in Table 3.1-9.

Table 3.1-9. Demand-Side Supply Curve

Step	Share of Potential (%)	Mills/KWh
Step 1	First 20	50
Step 2	Second 20	100
Step 3	Third 20	150
Step 4	Fourth 20	250
Step 5	Last 20	500
Step 6	Unserved Peak	1,000

3.1.6 Net Economic Effects by Alternative

As described above, two different approaches were undertaken to estimate the net economic effects associated with changes in hydropower production in the Pacific Northwest system: production costs and market pricing.

3.1.6.1 System Production Costs Analysis

The economic effects provided in this section are based on the system production costs as defined by the two production cost models. A range of results is presented based on three assumptions of the key variables of fuel costs and loads. The future condition hereafter referred to as low, combines the lowest estimate of fuel prices, the most rapid advancement in generation technology, and the low estimate of future load growth for all regions in the WSCC. Likewise, the medium conditions combined the medium projections of fuel price, technology advancement, and load. The high condition combined the high projections of these three parameters.

Many of the tables in this section provide the description of total system production costs for each alternative as estimated by the BPA model and the PROSYM model. As can be seen from these tables, the BPA model was run over a much broader range of assumed conditions. This is a spreadsheet model, which has considerable flexibility. The PROSYM model is a much more complex hourly model, and time constraints did not allow for running this model for the full range of potential future conditions. Another major difference in the two models is that the BPA model was run for each of the 50 historical water years, while the PROSYM model was only run for an average water year based on the average of all 60 water years simulated by the HYSSR model. The scope of the BPA model is the Pacific Northwest and California, while the PROSYM model includes all of the WSCC region.

The terminology used here refers to variable and fixed costs, and this is similar to the energy and capacity costs used in other studies. Energy is defined as that which is capable of doing work, and is measured over a time period. Electrical energy is usually measure in kWh, MWh, or aMW (the average of MW produced over the entire year of 8,760 hours). Capacity is the maximum amount of power that a generating plant can deliver, usually expressed in kilowatts or megawatts. In the system production costs the variable costs are the costs associated with meeting energy requirements and they go up and down, as energy is needed to meet demand. The fixed costs are the costs needed to provide new capacity and this does not vary with hourly production. The fixed costs represent the annualized value of constructing the new capacity.

Variable Production Costs

The variable costs include the fuel costs and the variable operating costs of the many different thermal plants. If energy is transmitted between market regions, the cost associated with this transmission is also included in the variable production costs. Table 3.1-10 provides a summary of the variable production costs by generating resources as estimated by the BPA model for one specific year (2010), the medium forecast condition, the average of 50 water years, and two alternatives: Alternative 1—Existing Conditions, and Alternative 4—Dam Breaching. Table 3.1-11 provides the same type of information from the PROSYM model. These are provided as samples to demonstrate the nature of the estimated production costs for the Pacific Northwest and California in the BPA model and the entire WSCC in the PROSYM model. Similar results were computed for all the future years of 2002 to 2017, for the low, medium, and high conditions, and for each of the 50 water years with the BPA model. Comparing the total variable production costs for year 2010 for Alternative 1—Existing Conditions, and Alternative 4—Dam Breaching, shows that variable costs with Alternative 4—Dam Breaching, increase by $160 million and $202.6 million for the BPA and PROSYM models, respectively.

The results of the BPA model as shown in Table 3.1-10 are provided by resource type in the Pacific Northwest. Some thermal plants in the Pacific Northwest are classified as must run thermal which must be run due to the nature of the plant (i.e., nuclear) or long term contracts which require a constant level of production except during routine re-fueling and scheduled maintenance periods. The generation from these plants will not vary with the different alternatives, so the variable costs are not included in the table. The generation and variable costs from Pacific Southwest resources are presented in total in this table. The amount of generation from new CC plants is shown for Alternative 1—Existing Conditions and Alternative 4—Dam Breaching. However, more new CC plants were assumed to be constructed with Alternative 4—Dam Breaching, to replace some of the lost hydropower generation and capacity. The costs associated with transmitting energy between regions are also reported in this table.

One point of importance is how the loss in hydropower with Alternative 4—Dam Breaching (and other alternatives) is accounted for in these models. From Table 3.1-10 it can be seen that the HYDROSIM model estimated that with Alternative 4—Dam Breaching, the amount of hydropower production was less than with Alternative 1—Existing Conditions, by 1,225 aMW. This difference in hydropower generation was made up by a combination of thermal alternatives (primarily natural gas-fired combined-cycle combustion turbines) at a higher cost. It is these higher variable costs that made up the increased production costs, and a large component of the net economic effects.

Table 3.1-10. BPA Model System Production Costs

Year 2010, With HYDROSIM and BPA Model, Medium Forecast			
Variable Production Cost Summary with Alternative 1			
Type of Plant	**aMW**	**Variable Costs (1998 millions)**	**Average Variable Costs (mills/kWh)**
Pacific Northwest Plants:			
High Cost Coal	647	98.7	17.40
Low Cost Coal	2,414	207.0	9.79
Existing CT	55	11.2	23.26
Existing CC	1,594	214.7	15.37
New Region CC	5,135	609.4	13.55
Regional Firm Imports	1,477	120.0	9.27
Regional Hydropower[1/]	15,701	–	–
Curtailment/Demand-Side	89	48.7	62.72
Total Pacific Northwest:	**27,113**	**1,309.7**	
Pacific Southwest Plants:			
Existing Resources	8,066	1,654.4	23.41
New Region CC	3,075	388.3	14.42
Curtailment/Demand-Side	103	50.9	56.21
Total Pacific Southwest:	**11,244**	**2,093.7**	
Transmission Costs		31.5	
Total Variable Costs		**3,434.9**	
Variable Production Cost Summary with Alternative 4			
Type of Plant	**aMW**	**Variable Costs (1998 millions)**	**Average Variable Costs (mills/kWh)**
Pacific Northwest Plants:			
High Cost Coal	659	100.4	17.40
Low Cost Coal	2,436	208.8	9.79
Existing CT	53	10.8	23.26
Existing CC	1,658	223.4	15.37
New Region CC	6,063	722.9	13.61
Regional Firm Imports	1,480	120.3	9.27
Regional Hydropower[1/]	14,477	–	–
Curtailment/Demand-Side	78	42.9	63.10
Total Pacific Northwest:	**26,904**	**1,429.5**	
Pacific Southwest Plants:			
Existing Resources	8,249	1,692.6	23.42
New Region CC	3,094	390.7	14.42
Curtailment/Demand-Side	111	54.9	56.52
Total Pacific Southwest:	**11,454**	**2,138.2**	
Transmission Costs		27.5	
Total Variable Costs		**3,595.3**	
Differences from Alternative 1 (Alternative 4 - Alternative 1)			
Type of Plant	**aMW**	**Variable Costs (1998 millions)**	**Average Variable Costs (mills/kWh)**
Pacific Northwest Plants:			
Must Run	–	–	na
High Cost Coal	12	2	na
Low Cost Coal	21	2	na
Existing CT	(2)	(0)	na
Existing CC	64	9	na
New Region CC	928	114	na
Regional Import	3	0	na
Regional Hydropower[1/]	(1,225)	–	na
Curtailment/Demand-Side	(11)	(6)	na
Total Pacific Northwest:	**(209)**	**120**	na
Pacific Southwest Plants:			na
Must Run	–	–	na
Existing Resources	183	38	na
New Region CC	19	2	na
Curtailment/Demand-Side	7	4	na
Total Pacific Southwest:	**209**	**45**	na
Transmission Costs		(4)	na
Total Variable Costs		**160.4**	na

1/ See Section 3.8 for regional hydropower variable costs.

Table 3.1-11. PROSYM Production Cost Summary by Area, Year 2010 Conditions—Average of Water Years, Medium Forecast Conditions ($ million) (1998 dollars)

Transmission Area	Alternative 1 Total Area Production Costs ($)	Alternative 4 Total Area Production Costs ($)	Alternative 4 minus 1 Area Production Costs ($)
Alberta	693.8	698.7	4.9
Arizona	1,977.0	1,977.1	0.1
British Columbia Hydro	270.8	269.4	(1.4)
Comision Federal de Electricidad	681.0	674.8	(6.2)
Colorado/Wyoming	1,053.8	1,054.1	0.3
El Paso	97.2	97.1	(0.1)
Imperial Irrigation	51.3	51.3	(0.0)
Inland Northwest	543.7	553.3	9.6
Los Angeles Dept. of Water and Power	526.2	523.8	(2.4)
Montana	337.0	342.3	5.3
Northern California	3,266.9	3,272.3	5.4
Pacific Northwest	1,175.1	1,348.9	173.8
Palo Verde	978.3	978.2	(0.1)
Public Service of New Mexico	825.7	826.1	0.4
Southern California Edison	2,825.6	2,825.6	0.0
San Diego Gas and Electric	750.2	750.0	(0.2)
Southern Nevada	897.6	897.3	(0.3)
Utah	731.5	734.2	2.7
Wyoming	262.0	262.4	0.4
Total[1/]	**17,944.7**	**18,136.9**	**192.2**

1/ Results do not include small adjustments made for wheeling costs, energy adjustments, and other minor transaction adjustments. Hence, the values are slightly different than other referenced PROSYM values of $202.6 million.

Table 3.1-10 demonstrates that with the breaching of the four lower Snake River dams and the building of additional CC plants in the Pacific Northwest, the total generation in the Pacific Northwest in year 2010 will be 209 aMW less than in the base condition. At the same time, the generation in the Pacific Southwest will increase by 209 aMW to meet the 2010 loads in the Pacific Northwest and Pacific Southwest regions. So, on an annual basis, the Pacific Northwest will import an additional 209 aMW from the Pacific Southwest in 2010 with Alternative 4—Dam Breaching.

The system variable production costs shown in Table 3.1-11 from the PROSYM model is the combination from each of the 14 transmission areas within the WSCC.

The variable costs for hydropower generation in both power production cost models are shown as zero for all alternatives. This is because there is no cost of fuel for hydropower. It is recognized that there will be some differences in fixed O&M and capital costs for hydropower between the different alternatives, but these are not included in this hydropower analysis. The implementation costs analysis does include the differences in hydropower O&M and capital costs with all alternatives and including them in this hydropower analysis would have resulted in double-counting this impact. The interested reader is referred to the Implementation Cost section of this Appendix.

Fixed Production Costs

This section discusses the capacity costs, or the fixed costs. For either of the production cost models to meet the loads projected over time, new generating facilities will need to be constructed. With each alternative, a different mix of new generating facilities will be needed to account for the varying amounts of hydropower production. The decision of when and how much new capacity is to be built is an important element of the analysis.

On a simplified basis the market driven capacity addition decisions will probably be based on the following considerations. The market-clearing price for any selected time period will generally be based on the marginal costs of the last resource. Only during periods of extremely high demand (peak demand), typically on very hot summer (or cold winter) days, when the demand for electricity approaches the available generating capacity, would prices rise above the marginal costs of the most expensive generator operating. Because the amount of capacity available at any point in time is fixed, and new generating capacity cannot be built quickly, the only way in which demand and supply could be kept in balance during extremely high demand periods would be through an increase in the price, to a level that would encourage some consumers to reduce their usage. The frequency of these periods of high prices will help determine whether new generating resources will be built. The price adjustment during periods of peak demand can be thought of as representing the value consumers place on reliability.

This price signaling concept and the frequency of occurrence formed the decision criteria for construction of new resources in the BPA and Aurora models used in this power analysis. With these models new resources are assumed to be built when the marginal costs are sufficiently high and frequent to cover the cost of constructing the resource (in terms of the annualized fixed costs) and the variable operating costs. The BPA model, for example, first simulates each year without any new resources being added in that year. The model then tests to see if it is economically justified to add new resources. To be justified a new power unit must produce enough energy at the marginal costs to equal or exceed the fixed and variable costs of the new resource on a life-cycle basis. If the resource is economically justified it is added to resource mix and the model continues this process until an optimized amount of new resources is identified. The interest rates used in the BPA model for new capacity additions were based on the same financial assumptions used by the NPPC in the last draft of the regional power plan. The interest rates were based the most recent interest rates experience by merchant plant operators.

This economic justification approach was used in this study to estimate how many new resources would be built with each of the study alternatives, on a year-by-year basis from the present to year 2017. The additional fixed costs are included as a component of the total system production cost for identifying the net economic effects of each alternative. These costs are similar to the traditional capacity costs identified in past studies. Table 3.1-12 presents the resource additions projected to occur based on the BPA model results, which were also used in the PROSYM analysis.

Table 3.1-12. Power Resource Additions by Alternative BPA Model Results for Specific Years

	2010			**2018**		
Alternative	**Pacific Northwest (aMW)**	**Pacific Southwest (aMW)**	**Total (aMW)**	**Pacific Northwest (aMW)**	**Pacific Southwest (aMW)**	**Total (aMW)**
1	5,390	3,260	**8,650**	8,720	8,770	**17,490**
2 and 3	5,380	3,190	**8,570**	8,710	8,760	**17,470**
4	6,210	3,260	**9,470**	9,700	8,750	**18,450**
			Difference from Base Condition (aMW)			
2 and 3	(10)	(70)	**(80)**	(10)	(10)	**(20)**
4	820	–	**820**	980	(20)	**960**
			Difference from Base Condition (MW)			
2 and 3	(10)	(80)	**(90)**	(10)	(10)	**(20)**
4	890	–	**890**	1,070	(20)	**1,040**

Note: The amount of aMW includes all capacity additions up to and including this year.

It should be noted that this analysis identified only one power replacement scenario in which energy and capacity losses were replaced with natural gas fired CC plants. This was done because these were determined to have the lowest costs without considering any costs for the resulting increase in air pollution. Clearly, other options for replacement power could be considered and these could have lower air quality impacts. Section 3.1.6.4 examines the possibility of replacing the lost hydropower with conservation measures and renewable resources.

Total System Production Costs

Table 3.1-13 summarizes the total system production costs compared to Alternative 1—Existing Conditions, from the two models for year 2010, the medium projection condition, and the average over all water years. The total system production costs includes the variable costs of operating all the resources in year 2010 (column 2) and the fixed costs (column 4) associated with the additions of new resources that are needed to meet the projected load in that year. The variable costs in any given year include the operating costs for the resources added that year, and all resources in place in that year including new resources built prior to that date. The fixed costs are the annualized capital costs of new capacity. For example, with the BPA model the 820 aMW of new capacity under Alternative 4—Dam Breaching, was added up to year 2010 over the base condition. The annual fixed costs of this additional capacity was $88 million. The total system production costs in 2010 for Alternative 4—Dam Breaching, were the combination of the variable costs of $160 million and the fixed costs of $88 million.

Table 3.1-13. Hydropower Analysis: Total System Production Cost Summary. Cost Differences Compared to Alternative 1

Alternative	Variable Production Costs (1998 million)	Additional CC Capacity[1/] (aMW)	Additional Annual Fixed Costs (1998 million)	Total System Production Costs (1998 million)
HYDROSIM and BPA Models				
2 and 3	(0)	(80)	(8)	**(8)**
4	160	820	88	**248**
HYSSR and PROSYM Models				
Alternative	**Variable Production Costs (1998 million)**	**Additional CC Capacity[1/] (aMW)**	**Additional Annual Fixed Costs (1998 million)**	**Total System Production Costs (1998 million)**
2 and 3				
4	203	820	77	**280**

1/ Includes all capacity additions up to and including this year. This is aMW. To determine total new capacity, divide by the availability factor of 92 percent. For example, for Alternative 4 the new capacity up to and including 2010 is 890 MW (820/.92)

Note: Year 2010 simulation, medium forecast conditions. Costs compared to Alternative 1—Existing Conditions.

Table 3.1-14 presents the system production costs on a year-by-year basis for the medium projection condition. This table also provides the total present worth values for each alternative and the average annual costs based on the three different discount rates.

Table 3.1-15 provides the average annual production cost for each alternative and the low, medium, and high projection conditions.

The comparison of the BPA and PROSYM production cost models can be made with results shown in Tables 3.1-13 and 3.1-14. Because PROSYM is much more complicated model to operate, and the results were similar to the BPA model, it was not run for all study alternatives. PROSYM modeling was limited to the medium forecast conditions and average water year. Consequently, many of the tables in this section do not include PROSYM results for all scenarios. However, the study team considered the PROSYM results to be a valuable crosscheck of the other modeling results and it was a useful tool to test many elements of this study.

3.1.6.2 Market Price Analysis

The electric industry is moving towards a more competitive market, but is currently in a transition period which mixes wholesale pricing at marginal costs with most retail pricing based on average costs, and established contracts that may or not reflect either of these approaches. For these reasons, this appendix provides results from the two approaches of system production costs in the previous section and the market prices in this section.

To evaluate each of the alternatives, the market prices from Aurora, as defined by the marginal costs, are applied to the difference in Pacific Northwest hydropower generation from the base condition (Alternative 1—Existing Conditions). Since the marginal cost varies by transmission area and by time periods, the study team had to select which market prices would be most appropriate to evaluate impacts. The study team chose to multiply changes in Pacific Northwest hydropower generation by the Aurora market price developed for the states of Oregon and Washington. This price most accurately reflects the value of Pacific Northwest energy.

Table 3.1-14. Hydropower Analysis: Total System Production Costs Over Time. Cost Differences Compared to Alternative 1

Year	HYDROSIM and BPA Model Alternatives 2 and 3 ($ million)	Alternative 4 ($ million)
2005	0	0
2006	0	0
2007	0	242
2008	(8)	244
2009	(8)	246
2010	(8)	248
2011	(8)	249
2012	(9)	251
2013	(9)	253
2014	(9)	254
2015	(9)	257
2016	(9)	259
2017	(9)	261
2018	(9)	261
2019 to 2104	(9)	261
Results:		
NPV at 0.0%	(936)	25,963
NPV at 4.75%	(191)	5,347
NPV at 6.875%	(132)	3,705
Avg. Annual at 0.0%	(9)	260
Avg. Annual at 4.75%	(9)	256
Avg. Annual at 6.875%	(9)	255
	HYSSR and PROSYM	
2005	na	0
2006	na	0
2007	na	239
2008	na	253
2009	na	266
2010	na	280
2011	na	283
2012	na	286
2013	na	289
2014	na	291
2015	na	294
2016	na	297
2017	na	300
2018	na	300
2019 to 2104	na	300
Results:		
NPV at 0.0%	na	29,779
NPV at 4.75%	na	5,526
NPV at 6.875%	na	3,658
Avg. Annual at 0.0%	na	298
Avg. Annual at 4.75%	na	265
Avg. Annual at 6.875%	na	252

Note: Differences from Alternative 1. 1998 real million dollars, starting at in-service date, medium production cost assumptions.
na = not applicable

Table 3.1-15. Hydropower Analysis: Average Annual Total System Production Costs. Cost Differences Compared to Alternative 1

Average Annual Costs at Discount Rate 6.875%					
	Production Costs HYDROSIM and BPA Model ($)			**Production Costs HYSSR and PROSYM ($)**	
Alternative	**Low**	**Med.**	**High**	**Alternative**	**Med.**
2 and 3	(6)	(9)	(12)	2 and 3	
4	187	255	329	4	252
Average Annual Costs at Discount Rate 4.75%					
	Production Costs HYDROSIM and BPA Model ($)			**Production Costs HYSSR and PROSYM ($)**	
Alternative	**Low**	**Med.**	**High**	**Alternative**	**Med.**
2 and 3	(6)	(9)	(12)	2 and 3	
4	187	256	332	4	265
Average Annual Costs at Discount Rate 0.0%					
	Production Costs HYDROSIM and BPA Model ($)			**Production Costs HYSSR and PROSYM ($)**	
Alternative	**Low**	**Med.**	**High**	**Alternative**	**Med.**
2 and 3	(6)	(9)	(13)	2 and 3	
4	186	260	339	4	298

Note: Results from two different models. 1998 real million dollars, various in service dates, 100-year analysis. All amounts are cost differences from Alternative 1—Existing Conditions and do not include existing system hydropower costs, which are addressed in Section 3.8.

The marginal costs vary by hour, by day, and by month. To simplify the analysis hourly prices were allocated to peak and non-peak periods and averaged for each month to obtain estimates of peak and off-peak prices. Table 3.1-16 provides the monthly on-peak and off-peak market price defined by Aurora, for the medium projection condition, for the two specific years of 2005 and 2010, in nominal prices and real 1998 dollars. The general trend over time of the market prices based on the marginal costs was towards the marginal costs associated with CCs. This was expected because the Aurora model selected CC plants for all new resources in this study period. As the new CC plants become a larger share of the resource mix they are operated more and replace inefficient thermal plants as the marginal cost resource.

These prices are assumed to reflect normal market conditions in the future based on the long-term market developments. Any examination of the market prices recently seen on the California exchange market will demonstrate fairly wide swings in market prices at different times of the year. These price swings are expected in any real world market, but cannot be accurately forecasted with the long-term modeling tools used in this analysis. The Aurora model projected variations in prices on an hourly and seasonal basis, for the different years in the analysis. The model could not capture all the cyclical aspects of market price behavior that will likely occur during periods of commodity cycles and over, and under, building of new resources in particular years.

The average monthly prices for peak and non-peak were used to identify the economic effects associated with changes in hydropower generation. This was done by computing the change in hydropower generation from the current conditions, by subtracting the Pacific Northwest hydropower generation with each alternative from the base condition (Alternative 1—Existing Conditions). Adjustments were also made to the monthly hydropower generation by separating it

Table 3.1-16. Hydropower Analysis: Average Market-clearing Prices From NPPC Study

Medium Projection Condition For 2 Years (mills/kWh)

YEAR 2005

Month	On-Peak (nominal $)	Off-Peak (nominal $)	On-Peak (1998 $)	Off-Peak (1998 $)
Sep.	42.39	31.55	35.66	26.54
Oct.	32.32	28.60	27.19	24.06
Nov.	33.78	28.14	28.42	23.68
Dec.	37.58	32.81	31.62	27.60
Jan.	36.87	32.46	31.02	27.30
Feb.	34.63	29.97	29.13	25.21
Mar.	26.77	26.35	22.52	22.17
Apr.	25.95	20.02	21.83	16.84
May	20.05	18.17	16.87	15.29
June	24.37	17.59	20.50	14.80
July	32.10	25.32	27.00	21.30
Aug.	43.39	31.32	36.50	26.35
Avg.	**32.52**	**26.86**	**27.36**	**22.60**

YEAR 2010

Month	On-Peak (nominal $)	Off-Peak (nominal $)	On-Peak (1998 $)	Off-Peak (1998 $)
Sep.	54.40	32.79	40.45	24.38
Oct.	32.89	29.29	24.45	21.78
Nov.	36.13	31.01	26.87	23.06
Dec.	39.13	32.77	29.09	24.37
Jan.	37.78	35.20	28.09	26.18
Feb.	38.83	31.05	28.88	23.09
Mar.	36.58	27.14	27.20	20.18
Apr.	31.01	20.16	23.06	14.99
May	18.81	18.44	13.99	13.71
June	22.05	17.56	16.40	13.06
July	27.06	27.61	20.12	20.53
Aug.	41.35	39.91	30.74	29.67
Avg.	**34.67**	**28.58**	**25.78**	**21.25**

into peak and non-peak hours based on the historic distribution shaping of the monthly hydropower generation. Table 3.1-4 presented the hydropower generation changes for each alternative based on average monthly generation. Table 3.1-17 multiplies the projected market price (from Table 3.1-16) by the changes in hydropower output from the base condition using both HYSSR and HYDROSIM outputs. This table labels the economic effects as net economic costs to represent changes from the base condition.

Table 3.1-18 provides the average annual net economic costs based on the market price analysis, by different discount rates, by the two hydroregulation models, and for the high, medium, and low

Table 3.1-17. Hydropower Analysis: Net Economic Costs Computed from Market Prices. Cost Differences Compared to Alternative 1

	HYDROSIM	
	Alternatives	
Year	**2 and 3 ($ million)**	**4 ($ million)**
2005	0	0
2006	0	0
2007	0	237
2008	(8)	227
2009	(8)	226
2010	(7)	223
2011	(7)	231
2012	(7)	226
2013	(7)	223
2014	(7)	222
2015	(7)	218
2016	(7)	222
2017	(7)	216
2018	(7)	216
2019 to 2104	(7)	216
Results:		
NPV at 0.0%	(698)	21,719
NPV at 4.75%	(148)	4,586
NPV at 6.875%	(104)	3,213
Avg. Annual at 0.0%	(7)	217
Avg. Annual at 4.75%	(7)	220
Avg. Annual at 6.875%	(7)	221

	HYSSR	
Year	**2 and 3 ($ million)**	**4 ($ million)**
2002	0	0
2003	0	0
2004	0	0
2005	0	0
2006	0	0
2007	0	228
2008	(10)	235
2009	(10)	230
2010	(10)	227
2011	(10)	227
2012	(10)	223
2013	(10)	226
2014	(9)	220
2015	(9)	220
2016	(9)	220
2017	(9)	220
2018	(9)	220
2019 to 2104	(9)	220
Results:		
NPV at 0.0%	(943)	22,109
NPV at 4.75%	(199)	4,672
NPV at 6.875%	(140)	3,274
Avg. Annual at 0.0%	(9)	221
Avg. Annual at 4.75%	(10)	224
Avg. Annual at 6.875%	(10)	225

Note: Market clearing price multiplied by change in hydropower. Differences from Alternative 1—Existing Conditions. 1998 real million dollars, starting at in-service date. Medium condition projections.

Table 3.1-18. Hydropower Analysis: Average Annual Net Economic Costs from Market Prices

Average Annual Costs at Discount Rate 6.875%							
HYDROSIM and Aurora Prices ($)				HYSSR and Aurora Prices ($)			
Alternative	**Low**	**Med.**	**High**	**Alternative**	**Low**	**Med.**	**High**
2 and 3	(5)	(7)	(12)	2 and 3	(7)	(10)	(16)
4	151	221	347	4	154	225	353
Average Annual Costs at Discount Rate 4.75%							
HYDROSIM and Aurora Prices ($)				**HYSSR and Aurora Prices ($)**			
Alternative	**Low**	**Med.**	**High**	**Alternative**	**Low**	**Med.**	**High**
2 and 3	(5)	(7)	(12)	2 and 3	(7)	(10)	(16)
4	148	220	347	4	151	224	353
Average Annual Costs at Discount Rate 0.0%							
HYDROSIM and Aurora Prices ($)				**HYSSR and Aurora Prices ($)**			
Alternative	**Low**	**Med.**	**High**	**Alternative**	**Low**	**Med.**	**High**
2 and 3	(5)	(7)	(12)	2 and 3	(6)	(9)	(16)
4	141	217	346	4	143	221	353

Note: 1998 real million dollars, various in-service dates, 100-year analysis. All amounts are cost differences from Alternative 1—Existing Conditions.

economic forecast conditions. The values in this table were based on the differences from the base condition (Alternative 1—Existing Conditions). The results from the different hydroregulation models of HYDROSIM and HYSSR are not significantly different.

3.1.6.3 Reliability and Capacity Effects

This section describes how the changes in the hydropower capacity in the Pacific Northwest were investigated. Of particular interest is how will hydropower capacity reductions impact the generation reliability in the region and the WSCC in total, and to what extent additional thermal capacity will be built to replace losses in hydropower capacity.

To simplify the approach, the reliability of the system is broken into two components for this examination: generation reliability and transmission reliability. This section concentrates on the reliability of the generation capacity of the system. Section 3.1.7 will address the impacts that different alternatives will have on transmission reliability. It was assumed here that transmission reliability will not be allowed to change from existing conditions for any of the alternatives, and the costs of maintaining this transmission reliability are presented in Section 3.1.7.

Generation reliability can be evaluated numerous ways, but all approaches are generally based on how well the available generating resources can meet load in all time periods. In the Pacific Northwest the generation reliability of the power system primarily depends on the availability of water to generate hydropower. The scheduled and unscheduled (forced) outages of resources are also a significant component of any generation reliability analysis. The system power models used in the analysis account for the forced outages by either including random outages or de-rating the units. For example, the BPA model de-rates the new CC units by 5 percent to account for the probability of unscheduled outages and an additional 3 percent for the scheduled maintenance. The PROSYM model incorporates forced and maintenance outages on a plant by plant basis based on outages common to the different type of resources.

Traditionally, the Pacific Northwest generation reliability has been defined considering the dependable capacity of the hydropower system based on critical water conditions and high demand periods. This type of "firm planning" analysis has taken several forms over the years, all of which were geared towards assuring that loads are met with available generation with a high level of probability. However, as with other issues addressed in this appendix, the movement to a competitive electricity market affects how to analyze the issue of reliability and replacement capacity. With less regulation of the electrical industry and more independent power producers, many experts feel that market conditions will be the driving force to determine when new resources will be built. The expectation is that, in a competitive market, the decision to build new resources will be based on economic return rather than some regulatory convention. This assumption provided the conceptual basis for the reliability and replacement capacity portion of this appendix. As described in Section 3.1.6.1, it is expected that market conditions will help determine the appropriate level of capacity additions and system reliability. This section examines some of the important considerations associated with this assumption.

Several important elements of this generation reliability approach had to be considered by the study team. Of most interest in this analysis was: 1) the treatment of periods in which existing resources were insufficient to meet electricity load, and 2) consideration of system reserve requirements and dependable capacity.

Unserved Load and Demand-Side Resources

The model simulations of Pacific Northwest and WSCC systems identified time periods in which the projected load exceeded the amount of energy available to meet this load. When this situation occurred, the models reported this as unserved load and the number of megawatt hours in which this occurred was tabulated. In general the unserved load occurred in the model simulations during low water periods of the year, in low water years, and periods of high demand. How to treat this unserved load is a critical element of the generation reliability issue.

One approach considered for treating the unserved load in this analysis was to assume that a curtailment in energy provided will occur and the user will suffer the economic losses. The appropriate value to assign to this curtailment is not known, but in some studies it has been assigned a relatively high value that exceeds the marginal costs of all thermal resources. This approach was used in the PROSYM model.

The approach that was used with the Aurora and BPA models recognized that market prices will affect power demands, and included demand-side management measures as potential resources to address unserved loads. Instead of assuming curtailments will occur, the Aurora and BPA analyses assumed demand-side actions would be taken first to meet some of the peak demands. Section 3.1.5.3 described how the potential size of demand-side resources and their marginal costs were defined for this study. These resources were priced in blocks with each successive block being more costly. The demand-side resources were treated like any other resource in the dispatching routines. During periods of high demand when thermal and hydropower resources are nearing full dispatch, the models dispatch the blocks of demand-side resources as needed to meet load. The demand-side resources are considered in defining the marginal costs and production costs in the two models.

Since the demand-side resources are priced at relatively high levels, the extent to which they are dispatched will influence the optimizing routines and consequently help determine how many new resources would be built. The Aurora and BPA models utilized the demand-side resources in the dispatch routines and the optimizing routine for additional resources. Table 3.1-12 showed the amount of new thermal resources that were added by the BPA model for specific years of simulations, by alternative, and by the regions of the Pacific Northwest and Pacific Southwest. A sensitivity test was done by the study team to find out to what extent the pricing of the unserved load and demand-side resources influenced the amount of new generation capacity that would be built and the total system production costs.

As discussed above, the unserved load was met in the BPA and Aurora models by demand-side resources that were valued in blocks. The range of values (marginal costs) were from 50 to 500 mills/kWh depending on the size of unserved load. If any unserved load still occurred after dispatching all demand-side resources, it was assigned a marginal cost of 1,000 mills/kWh. To determine how significant these assumed block sizes and prices were, a test analysis was undertaken. In this test the BPA model was run by replacing all costs of demand-side resources and any unserved loads with a cost of 5,000 mills/kWh. As expected, with this higher cost for unserved load, more new resources were found to be economical and were added by the model. In the test case the amount of new CC resources built in year 2010 was 15,690 aMW in the Pacific Northwest and Pacific Southwest with Alternative 1—Existing Conditions, and 16,420 aMW with Alternative 4—Dam Breaching. This is an increase of 7,040 and 6,950 aMW for Alternative 1—Existing Conditions, and Alternative 4—Dam Breaching, respectively.

The increase in the amount of new resources in the test case reflected that new resources could capture the high values to a large enough extent to economically justify their construction. The amount of new resource additions is not the only significant factor to examine. The total system production costs in the test and the original cases were also compared. The total system production costs with the test case increased significantly due to the costs of adding about 7,000 additional aMW of new CC capacity. However, the variable production costs, relative to the original case, dropped in the test case. The new CC resources (about 7,000 aMW in the test case) are more efficient and have lower variable costs than many of the existing resources in the resource mix. With more of these relatively efficient resources available for the model (in the test case) to dispatch to meet the load, the use of older resources with higher variable costs was reduced.

The changes in total system production costs between Alternative 1—Existing Conditions, and Alternative 4—Dam Breaching, under both cases yielded some interesting results. Generally, it was found that losing the lower Snake River powerplants in a system with lots of excess capacity is not as costly as losing the plants in the original case.

In conclusion, this test showed that the treatment of the value of the unserved load in the model influences the amount of new thermal resources that are built by the model. Assigning a very high value to unserved load will result in more new CC capacity and substantial increases in the total system production costs (i.e., variable costs + fixed costs). However, the increase in fixed costs from adding more CCs are partially offset by reduced variable production costs. It was found that in both the test and original cases the total system production costs increased with the breaching of the lower Snake River dams. However, the valuing of unserved load did somewhat influence the magnitude of the total system production costs associated with breaching the dams. The significance of this influence appeared to be relatively small when compared to the substantial increase in the value of unserved load used in the test case. But, the study team decided to further examine the relationship of increasing fixed cost and reducing variable costs with capacity additions. The next section examines the significance of capacity additions to total system production costs.

System Reserves and Dependable Capacity Examination

As with any assessment of system reliability, criteria of acceptable reliability need to be devised and defined. Various criteria have been used historically in California and elsewhere in the West. These criteria have differed depending on the type of study, planning or operating, and the time period of the study. One measurement tool has been the planning reserve margin, which is expressed as a percentage of generation capability in excess of peak demand. The "correct" level of planning reserves in a deregulated market has yet to be established, and many argue that this level should be an economic decision made by market participants.[2]

The type of criteria that may be developed in the future is hard to determine at this time. The WSCC has operated under a number of voluntary criteria and these reliability criteria are currently under examination for revision. Based on all these proposals and their uncertainty, any attempt at this time to specifically define a set of reliability criteria would be subject to criticism and would be likely to change before any of the lower Snake River alternatives could be implemented. For this reason, the study team examined the effects of different reliability criteria on the net economic effects. In particular the team looked at Alternative 4—Dam Breaching (changes from Alternative 1—Existing Conditions) with medium economic forecasts, in a specific year of 2010. Varying levels of additional new generating capacity were examined with the BPA and PROSYM models. The different amounts of new capacity resulted in different levels of system reserves (hence reliability) in the Pacific Northwest and different system production costs.

The amount of additional CC generation capacity assumed to be built by year 2010 under Alternative 4—Dam Breaching, was computed by the BPA model to be 890 MW as shown in Table 3.1-12. Higher and lower amounts of CC additions were examined. Utilizing the BPA model the several different levels of new capacity were modeled to see how total system production costs (variable costs + fixed costs of new resources) would change. In addition, a scenario in which no additional resources were added above those assumed to occur with Alternative 1—Existing Conditions was also tested.

Figure 3.1-4 shows the results from the BPA model for these different scenarios. The figure shows the variable costs (production costs), the fixed costs (new capacity costs), and the total costs (total system production costs). This figure also shows the capacity addition level in which total system production costs are at their minimum. It can be concluded from this figure that the addition of 890 MW (820 aMW) of new capacity is at or near the point of economic optimum (point of minimal net economic costs). This was expected because the BPA model utilized an optimization routine to define the 890 MW level. One interesting point from this figure is at around 2,700 aMW of new additions the system variable costs go below zero. This means that if enough new CC plants are added to the system, with the breaching of lower Snake River dams, the system production costs (variable costs) will be less than if the dams were not breached. However, the fixed costs of these high level of capacity additions are so large that the total system production costs (variable + fixed) are much higher (about $300 million annually) than the base condition. The relatively flat slope of the total cost curve suggests that the selection of the most appropriate new capacity level may not be an extremely sensitive element of the hydropower study.

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[2] California Energy Commission, Karen Griffin, Memorandum 14 April 1998. Generation Reliability Study for ISO.

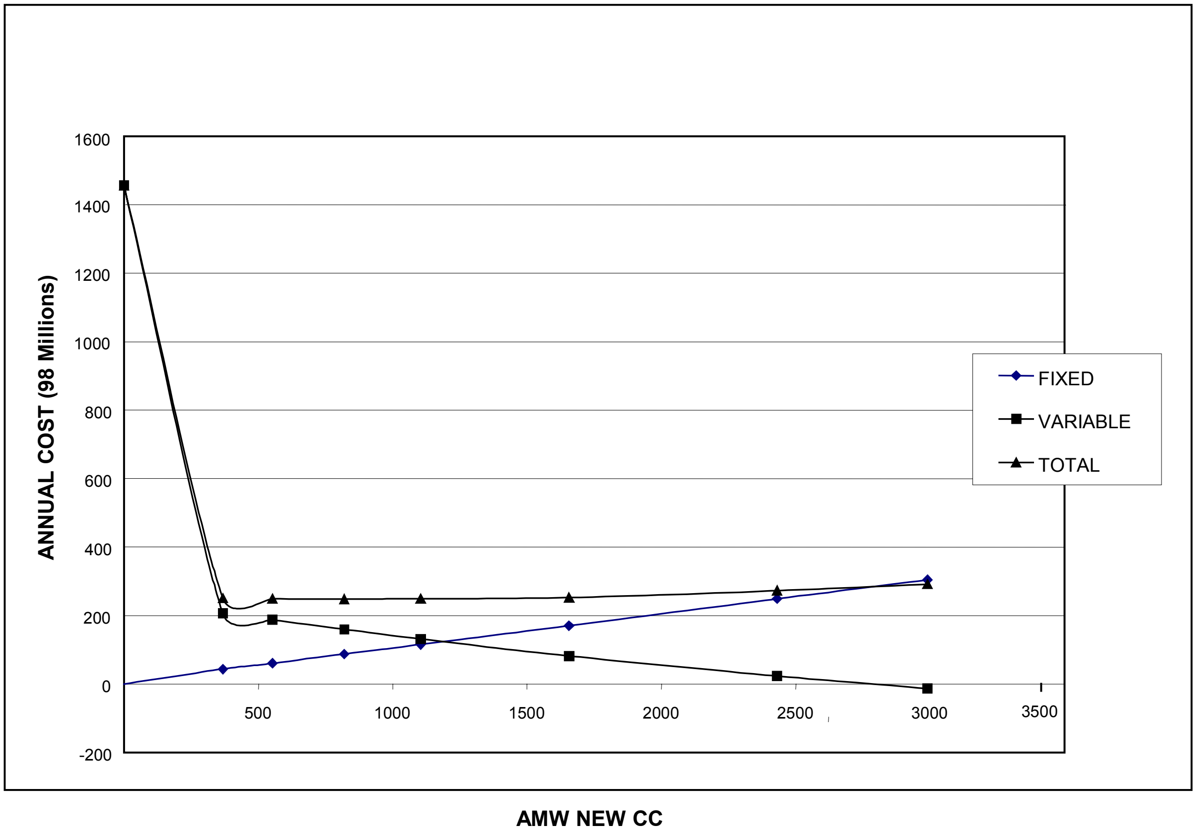

Figure 3.1-4. Total System Production Costs of Alternative 4 Compared to Alternative 1 – With Different CC Additions (Year 2010)

Note: The dip in the curve at approximately 550 aMW is a software graphing anomaly — Actual minimum is at 820 aMW.

This same type of analysis was done with the PROSYM model. The PROSYM model provides the planning reserve margin for each of the transmission areas in the model. The planning reserve margin is the percent of generation capacity in excess of the highest peak load hour in the year. The planning reserve margins for all regions except the Pacific Northwest were the same for Alternative 1—Existing Conditions, and Alternative 4—Dam Breaching. Three different levels of new capacity were examined. The resulting planning reserves in the Pacific Northwest for year 2010 were estimated at 4 percent, 10 percent, and 12 percent for CC additions of 890 MW, 2,640 MW, and 3,250 MW, respectively.

Reliability and Capacity Conclusions

This section presented the basic elements of the study dealing with additions of new generating capacity to replace the lost capacity associated with the breaching of the four lower Snake River dams. The replacement of the lost capacity relates to the general reliability of the power system over time and to what extent the market might pay for additional reliability. One complicating element of this hydropower analysis was the projection of what society might pick as the most appropriate reliability criteria in the study period of 2005 and beyond. The approach used in this study to estimate what level of new capacity would be built was to do an economic optimization to determine what level of new resources could be economically justified for construction. The study team, however, wanted to test the study results against other possible levels of new capacity and related generation reliability.

The study team was concerned whether different levels of replacement capacity and different approaches to the treatment of unserved loads would significantly change the estimates of increased system production costs. These two factors were tested with different approaches that lead to different levels on new capacity and planning reserve margins. With the higher levels of new generating capacity, the planning reserves were higher but so were the total system production costs. However, it was found that the total system production costs were not extremely sensitive (on a percentage basis) to different levels of assumed new generating capacity. So, the study team was satisfied that the capacity addition approach used in this analysis represented a reasonable estimate of the economic effects associated with the alternatives.

3.1.6.4 Power Replacement With Non-Polluting Resources

The purpose of this section is to examine alternative power generating resources to replace the losses associated with dam breaching. The goal of this examination is to maintain air emissions for electric power generation with the dam-breaching alternative to levels equivalent to that which occurs with the four Snake River dams. It will examine the costs associated with using non-polluting replacement resources and what it would take to implement this type of approach.

The economic analysis of power impacts was based on the assumption that any new replacement generating facilities would be natural gas-fired combined CC plants. This key assumption was based on the fact that CC plants are the most cost effective based on results of the system expansion components of the Aurora model and findings of the NPPC. This assumption was also supported by the fact that recent generation additions in the WSCC region have been predominately CC plants.

It was determined that with Alternative 4—Dam Breaching, the replacement of lost generation with CC plants would result in increases in polluting air emissions, as compared to Alternative 1—Existing Conditions. The results of the air quality analysis are presented in Appendix P and Section 5.2 of the FR/EIS. The main pollutant increase was determined to be carbon dioxide (CO_2), which is a contributor to the greenhouse effect. It was estimated that if the four Snake River dams are breached and replaced with CC plants, the CO_2 emissions for generation of electricity in the WSCC would increase by over 4 million tons per year (based on year 2010). The increase in system production costs (net economic costs) with the dam breaching alternative was estimated to be $250 million in year 2010 based on the BPA model, and $280 million based on the PROSYM model. This examination was done using the economic costs from the BPA model and the air emissions from the PROSYM model.

Replace Dams With Conservation Resources

A study was done to determine the cost of replacing the energy from the four lower Snake River dams with enough conservation such that no increase in CO_2 emissions would result. The first step was to estimate how much conservation would be needed to replace the four lower Snake River dams. Using the PROSYM model (see Section 3.1.5 for description), and an average shape for conservation resources, it was determined that removal of the four lower Snake River dams would require the acquisition of 1,152 aMW of conservation resources, by year 2010. The original analysis determined that 820 aMW of CC plants would be required to replace the lower Snake River dams, so, conservation would require more average megawatts. This amount of conservation would result in no increase in CO_2 emissions upon removal of the dams. It should be noted that this analysis did not include the transmission-related impacts.

The next step was to determine if there were enough potential conservation resources to meet this need. According to studies performed by the NPPC,[3] there are only 1,000 aMW of conservation available in the Pacific Northwest by the year 2010. Replacing the lower Snake River dams with this conservation would completely exhaust the currently identified Pacific Northwest supply. Replacement also requires an assumption that no conservation would be acquired in absence of dam removal. This assumption is debatable. In other words, for the 1,000 aMW of conservation to be available, no conservation would be acquired to help mitigate load growth in the Pacific Northwest, or for any other reason other than dam removal.

However, assuming this conservation would be available, the next step was to cost out this conservation. According to the NPPC, the cost of this conservation is approximately 24.6 mills/kWh in 1998 dollars. Using the BPA model (see Section 3.1.5 for description), the value of this conservation resource in year 2010 was estimated to be approximately $250 million. This value was determined by comparing the system production costs without the four dams and with combined CC, to the system costs without dams and with the load reduced with conservation added at no cost. This resulted in a system with a reduced cost of $250 million, and thereby a value of $250 million to this free conservation. Assuming an additional 152 aMW of non-polluting resources can be purchased at 24.6 mills/kWh, it was estimated that the conservation resource would cost approximately $250 million (1,152 aMW x 24.6 mills/kWh x 8,760 hrs/yr x 1,000 kWh/MWh). Hence, the additional cost to use conservation instead of combined cycle turbines was approximately zero. That is, the cost of replacing lost Snake River generation with conservation is about the same as with CC plants, provided enough conservation is available at this low cost.

The conservation replacement strategy assumes that currently available conservation is used exclusively to replace the loss of the lower Snake River dams, and would otherwise go undeveloped. This is unlikely since the most cost effective conservation will probably be utilized before year 2008 which is assumed to be the year of dam breaching. Though other conservation measures may be available to replace those used by 2008, they will be less cost effective and hence the conservation replacement strategy will be more costly.

Issues associated with use of this resource are discussed in detail in a recently published report by the Natural Resources Defense Council (NRDC).[4] The NRDC report is not directly comparable to the analysis in the FR/EIS because it uses different hydro-system assumptions.

Replace Dams With Renewable Resources

Alternatively, if the four lower Snake River dams were replaced with a more expensive alternative non-polluting resource, such as renewables like wind or geothermal, additional costs would be incurred. A renewable resource costing 35 mills/kWh, for example, might be approximately $130

[3] Appendix G, Conservation Cost, Performance and Value, Draft Fourth Northwest Conservation and Electric Power Plan, Northwest Power Planning Council, 1997.

[4] Marcus and Garrison, Going with the Flow: Replacing Energy From Four Snake River Dams, Natural Resources Defense Council, April 2000.

million more expensive annually than replacement with new combined cycle turbines, or conservation.

Because of the uncertainty associated with adequate availability of enough low cost conservation to replace all of the generation from the Snake River dams, a possible non-polluting option would be a combination of conservation and renewable resources. This combination would be more costly than the CC replacement strategy, to the extent that the renewable resources, at costs of around 35 mill/kWh, will be required to supplement the 24.6 mills/kWh conservation measures. For example, if 152 aMW of renewables and 1,000 aMW of conservation were developed to replace the Snake River generation, this could be done at a cost of about $262 [(152 x 8,760 x 35) + (1,000 x 8,760 x 24.6)] million per year, which is an increase of about $12 million over the CC replacement strategy.

Implementation and Uncertainty Concerns

One major difference between the replacement of hydropower generation with CC plants and conservation/renewables is the implementation process. Implementing replacement with CC plants is a market-based strategy that would require minimal implementation effort. An active market place now exists to purchase and sell electricity, and if the Snake River dams are breached the market should have sufficient time to build replacement resources such as CC plants. The conservation/renewables strategy would require government intervention to implement either through legislation or economic incentives to utilities or end users. For conservation resources, implementation could require the government to enforce new building codes, new standards for energy-consuming devices, and direct funding of conservation projects. Utilities or BPA may need to fund in total, or offer subsidies, to implement some conservation measures. For renewable energy resources, implementation efforts would probably require direct subsidies to build the renewable projects.

Of additional concern is the uncertainty associated with having enough achievable conservation resources in the time frame necessary to replace generation that would be lost with the breaching of the four Snake River dams. In their last power plan the NPPC projected that a reasonable estimate of implementation of conservation measures would be at a rate of about 75 aMW per year. To achieve sufficient conservation to meet the 1,152 aMW replacement amount would require nearly 15 years to implement at the 75 aMW pace. This could be speeded up with a concerted effort, but since no one conservation measure will provide a large output by itself, many individual measures will need to be implemented. This will require time and political will. Implementation of a widespread conservation/renewable plan will require an active implementation process that must proceed far in advance of the dam breaching. The timing issue, the need for economic incentives, and the need for strong political commitments all contribute to a relatively high degree of uncertainty of implementing a conservation/renewable plan that will completely replace the generation from the Snake River dams.

Effect of Costs of Potential CO_2 Tax

Another possible approach could be the imposition of a pollution tax on greenhouse gas. This would add costs to the continued use of combined cycle combustion turbines by imposing a tax on CO_2 emissions. It is possible that such a tax may be imposed by 2008. Estimates of its size range widely, but some experts assume it will range between $2.50 and $10 per ton of CO_2 emitted.

Assuming a mid-range of $5 per ton, and replacement of dams with combined cycle turbines, imposition of a CO_2 tax would result in an additional cost of dam removal of approximately $23 million annually, or about a 10 percent increase in costs.

Non-Polluting Alternative Summary

This cursory analysis examined the impact of using non-polluting resources such as conservation and wind to replace the lost hydropower generation if the four lower Snake River dams are breached. Conservation and renewable resources could be used to replace the hydropower generation from the four lower Snake River dams and result in no net change in air pollution from the existing conditions. The costs would be similar to, but higher, than the replacement with natural gas-fired combined CC plants. The uncertainty of the costs associated with a conservation/renewable strategy are relatively high because it is not known to what extent conservation measures will be available in the year 2008 time frame and at what costs. However, it is not known whether this uncertainty is any greater than gas price predictions that are critical to define the costs of the CC plant replacement strategy. The implementation of conservation/renewables will require considerable government intervention that must be initiated several years prior to dam breaching. The CC plant replacement strategy will require no government intervention, but will require several years of planning and licensing actions before plants can be built. The implementation of a conservation/renewable strategy will require an earlier implementation plan, economic incentives/subsidies from the government, and more government intervention than the CC replacement strategy.

3.1.7 System Transmission Effects

The analysis of power system effects up to this point assumed that transmission reliability and service would remain the same under all alternatives. The purpose of this section is to identify the costs associated with maintaining transmission reliability with all the alternatives. This section investigates the impacts that Alternative 4—Dam Breaching, would have on the Northwest transmission grid. Alternative 2—Maximum Transport of Salmon and Alternative 3—Major System Improvements, are not expected to have any significant impact to the transmission grid.

Alternative 4—Dam Breaching would breach the four lower Snake River dams, rendering the powerhouses inoperable, and thereby altering the source of power generation that feeds into the Northwest transmission grid. Loss of generation would affect the transmission system's ability to move bulk power and serve regional loads because the transmission grid was originally constructed in combination with the generation system and because they interact electrically.

The transmission analysis looked at transmission system impacts with and without replacement generation. Both transmission system reinforcements and generation additions were evaluated to mitigate the transmission system impacts caused by breaching the four lower Snake River dams. The initial phase of this transmission study assumed no replacement generation for the dams that are breached. The transmission improvements needed to maintain reliable service were then identified and costs estimates were prepared. However, it was recognized that the construction and location of replacement generating resources would have a profound effect on the transmission system impacts and reinforcement needs and may provide a most cost-effective solution. This phase of the study was done separately from the energy supply additions shown in Table 3.1-12. The energy supply studies indicated that Alternative 4—Dam Breaching would require 890 MW of new CC generation in 2010 to replace lost hydropower. This transmission study evaluated transmission system requirements if replacement generation were constructed in a location where it would provide transmission system benefits to mitigate the loss of hydropower. To the extent that more than 890 MW of new CC generation will be required for transmission reliability, the additional costs are added to the transmission impacts.

Preliminary cost estimates for capital additions are included in this summary. These costs are based on preliminary studies using typical costs for facilities. A range of cost is given since there is much uncertainty about the scope of the projects, routes, etc., which could affect project cost.

Transmission impacts were examined for two seasonal conditions, the summer and the winter peak situations. The following defines the expected impacts and the possible solutions. The study approach was to first identify the impact to the transmission system, then the possible solutions were examined. The final step of the analysis was to select the most cost-effective measure to address the identified transmission impact.

3.1.7.1 Summer Impacts

The summertime peaks are the largest in the Pacific Southwest and transmission from the Pacific Northwest over the California-Oregon Intertie/Pacific Direct Current Intertie (COI/PDCI) is important to meeting the Pacific Southwest demands.

Northwest to California Transfers

If the lower Snake River dams were breached and not replaced, the COI/PDCI transfers limits would decrease by 200 MW (from 7,200 to 7,000 MW). This would limit the ability to sell and transfer Pacific Northwest generation to the Pacific Southwest to meet peak demands. Three possible solutions were postulated: 1) reduce the COI/PDCI capacity by 200 MW and incur losses in sales (the economic costs of this approach were not quantified); 2) upgrade the COI/PDCI intertie to maintain its capacity at a cost of $65 million to $85 million; and 3) site thermal replacement plants in the locations that would reinforce intertie transfer capabilities. Further study of summer solutions to the Pacific Northwest to California impacts was not done since it was realized that the solutions to the summer impacts may be unnecessary because the solutions to the winter problems could also correct the summer impacts.

Northwest Regional Impacts

With the breaching of the four lower Snake River dams, there would be more stress on the transfer capability in the upper mid-Columbia area. Two transmission system cutplanes, north of John Day and north of Hanford, would be impacted. (A cutplane is a group of transmission lines whose total loading is an indicator of system stress.) These particular cutplanes measure how much power is flowing from the Upper- and Mid-Columbia area to COI/PDCI. With the elimination of generation from the lower Snake River facilities and a desire to have the same level of north to south transfers on the COI/PDCI, the flow across the cutplanes would need to increase. In other words, the generation from the lower Snake River facilities would be replaced with generation from Chief Joseph, Grand Coulee, and other northern and eastern powerplants. However, with this increase in generation, capacities across these cutplanes would be exceeded. Thus, the cutplane flows would need to be limited, which in turn would cause a reduction in the COI/PDCI transfer capability. To increase cutplane capability an improvement to the Schulz-Hanford transmission line and facilities would be required. The estimated costs are $50 to $75 million.

Montana to Northwest Transfer Capability

Capability west of Hatwai would be reduced about 500 MW if the lower Snake River dams were breached. This means that transfers from Montana and/or Western Montana Hydro would need to be reduced to maintain the Hatwai limit. Previous studies have shown that these problems would be mitigated with a Bell-Ashe 500-kilovolt (kV) line from Spokane to the Tri-Cities area. This line would require a new transmission corridor and cost between $100 to $150 million.

Summer Load Service

The Tri-Cities load area (south of Spokane and Central Washington) would be negatively affected by dam breaching. Specific transmission impacts would be different depending on the location of replacement generation. These include the new Schultz-Hanford line ($50 to $75 million) and reconductoring or rebuilding various other lower voltage lines at an estimated cost of $10 to 20 million. Additional voltage support would also be needed in the Tri-Cities area if the four lower Snake River dams were breached. Converting the generators at a hydropower plant to synchronous condensers would be an effective way to produce reactive support required to fix this voltage support problem for Tri-Cities area loads. This could be accomplished with converting the generators at Ice Harbor. Preliminary cost estimates for this conversion are $2 to $6 million.

The I-5 transmission corridor, which runs from Canada along I-5 down to Portland, is currently at its limit. The congestion along this corridor will be further aggravated by increasing Canadian imports and Upper Columbia generation to offset breaching the lower Snake River dams. Planning studies are currently being conducted to see what transmission fixes may help to relieve the existing I-5 congestion problem and specific system designs and related cost estimates are not available. The breaching of the Snake River dams will result in an incremental increase in costs to relieve the I-5 corridor congestion problem but to what extent cannot be estimated at this time.

3.1.7.2 Winter Impacts

The impacts to the transmission system under extreme winter load conditions in the Pacific Northwest were examined. An extreme cold winter load condition was examined since stress on the system is high under extreme weather. The extreme cold winter load level is an abnormal cold condition (arctic express) with minimum temperatures that have a 5 percent probability of occurring. The extreme cold winter load level is approximately 12 percent higher than the expected normal winter peak that has a 50 percent probability of occurring. This is the criteria BPA customers have agreed to in the past.

It was found that imports from the California interties could not meet the shortfall created by the loss of the lower Snake River dams. The import capability today on the COI/PDCI with the dams in place is around 2,400 MW during extreme winter load conditions. This 2,400 MW capability is needed today, with the four lower Snake River dams in place, to augment available generation and spinning reserve requirements in the Pacific Northwest. Without the four lower Snake River dams, either more intertie or more local generation would be required to meet system loads and maintain system reliability. The possible solutions examined were to develop replacement generation or to improve the COI/PDCI. The analysis shows that replacement generation would be about half as costly as intertie transmission improvements.

Pacific Northwest Replacement Generation

With the breaching of the lower Snake River dams it was found that 1,550 MW of new generating resources (replacement generation) strategically located in the Pacific Northwest would be sufficient to meet the winter extreme conditions if the COI/PDCI were not improved. This is about 510 MW more replacement generation than would be required for energy alone.

The new capacity assumed to be built in the future to replace energy lost under Alternative 4—Dam Breaching, was described in Table 3.1-12. The net economic costs identified in this technical report for Alternative 4—Dam Breaching, were based on adding 890 MW of new Pacific Northwest generating resources by year 2010 and 1,040 MW by year 2018. But this takes care of only regional energy losses at the breached dams. The winter transmission impacts of breaching could be mitigated if 1,550 MW of replacement generating resources were in place at the time of breaching of the lower Snake River dams (2007). The transmission system impacts of breaching would require more generation in place sooner (1,550 MW in 2006 versus 890 MW in 2010 and 1,040 MW in 2018).

The costs of providing additional replacement generation were examined using the system production cost approach as computed by the BPA model. The replacement capacity assumed to be built elsewhere in this analysis was 1,040 MW through year 2018 as shown in Table 3.1-12. To maintain the same transmission reliability an additional 510 MW (1,550 to 1,040) of generation capacity would need to be constructed in Pacific Northwest. Based on the CC construction costs of $601,000 per MW, the additional construction costs of replacement thermal would be about $306 million. These increased costs will be somewhat offset by the expected reduction in system variable costs from adding more generation than is required for energy alone. The annual equivalent economic costs associated with the additional generation capacity are $8.9 million at the 6.875 percent discount rate.

Improvements to COI/PDCI

The alternative solution to building new replacement capacity is intertie transmission system reinforcements. The improvements needed to meet load service requirements for extreme winter conditions include: a second Captain Jack-Meridian 500-kV line (a cross-Cascades line from Klamath Falls to Medford) and a second Big Eddy-Ostrander 500-kV line (a cross-Cascades line from The Dalles to Portland. Both of these new line additions would need to be on a separate right of way from the existing lines due to reliability reasons. The construction costs for a second Captain Jack Meridian line are estimated at $80 to $130 million. The addition of a second Big Eddy-Ostrander line would cost from $70 to $120 million. The average annual costs of these two lines, considering O&M, replacements, repair, and computed at 6.875 percent, were $5.6 to $9.0 million for Captain Jack Meridian and $4.9 to $8.3 million for Big Eddy-Ostrander. The mitigation costs of the transmission solution would be about twice as expensive as the generation solution.

Winter Local Load Service Limitations

There would also be wintertime load service limitations in the Tri-Cities area for extreme cold winter conditions if the lower Snake River dams were breached. A new 230/115-kV transformer in the Franklin area would be required. The estimated cost for adding this transformer is between $15 and $25 million.

3.1.7.3 Summary of Transmission Impacts

Table 3.1-19 provides the possible solutions and related annual costs based on the 6.875 percent discount rate. The table is broken into the impact areas and possible solutions. For each impact the lowest cost solution is recommended and included in the total economic effects.

Table 3.1-19 shows the range of construction costs as estimated by BPA. Also shown are the incremental O&M costs that would occur if the transmission improvements were built. To develop the annual costs associated with these measures a 45-year replacement cycle was assumed. As can be seen from this table the annual costs associated with improvements needed to maintain transmission reliability with the breaching of the four lower Snake River dams would about $22 to $28 million at 6.875 percent.

Identical summaries were made at 4.75 percent and 0.0 percent discounts rates. The annual costs were $19 to $24 million at 4.75 percent and $16 to $18 million at 0.0 percent discount rates.

3.1.8 Ancillary Services Effects

This section discusses the ancillary services and the estimated economic values of these services provided by the four lower Snake River facilities. These ancillary services are in addition to the energy, capacity, and transmission support benefits discussed elsewhere in this appendix. With the open access transmission ruling of the FERC, power suppliers are now charging for many of the ancillary services that in the past were bundled into the power rates and not charged separately. In 1998 BPA began to sell these ancillary services. Since these services are a necessary element of a safe and reliability power system, the loss of these services represents economic costs that must be accounted in this analysis.

The basis for the reserve cost and Automatic Generation Control (AGC) assumptions associated with dam breaching were largely based on expert judgment from knowledgeable staff at BPA. The Duty Scheduling office was consulted for the seasonal MW amounts for which the lower Snake River plants are currently relied upon. For simplification it was assumed that this usage would continue into the future, and no effort was made to determine the absolute capability of the lower Snake facilities to provide AGC or operating reserves. Should the restrictions on the Columbia River hydropower projects increase relative to the lower Snake River facilities it is quite likely that the MWs of AGC and operating reserves from the lower Snake River facilities would increase. The converse is also true, but to a lesser degree since the lower Snake River facilities are generally low priorities for ancillary services in the current operating environment. The ancillary service prices were developed using Trading Floor knowledge of the bilateral market for Ancillary Services in the Northwest and market data from the California Independent System Operator (ISO) that was available at the time of the report.

Table 3.1-19. Hydropower Analysis: Transmission Impacts with Alternative 4—Dam Breaching (Page 1 of 2)

Annual Values Based on 6.875%

Timing/ Location of Impacts	Impact Description	Possible Solutions	Estimated Construction Costs ($ millions)	Incremental O&M Costs ($ millions)	Total Annual Costs ($ millions)	Selected Solution Avg. Annual Costs ($ millions)
Summer: NW to California	Transfer limit is reduced (a cutplane problem)	Limit COI/PDCI transfer capability from 7,200 MW to 7,000 MW	Not qualified			
		Upgrade the COI/PDCI	65 to 85	0.3	5.1 to 5.9	
		Site thermal replacement plants to reduce impact	Not quantified			Proper siting 1,550 MW for winter could solve this problem
Summer: Upper/Mid Columbia Load Service	Thermal overloads	New Schultz-Hanford transmission line	50 to 75	0.17	3.6 to 5.2	3.6 to 5.2
Summer: Tri-Cities Service	Voltage support to the Tri-Cities	Ice Harbor generators converted to synchronous condensers	2 to 6	0.2	0.4 to 0.6	0.4 to 0.6
	Load service impacted	Local line transmission improvements	10 to 20	0	0.7 to 1.4	0.7 to 1.4
Summer: Montana transfer to Northwest	Transfer limit is reduced by 500 MW	New Bell-Ashe transmission line	100 to 150	0.38	7.2 to 10.5	7.2 to 10.5
Summer: Canada Transfer to Northwest	Increased congestion on I-5 transmission corridor	No solution offered	Not quantified			

Table 3.1-19 Hydropower Analysis: Transmission Impacts with Alternative 4—Dam Breaching (Page 1 of 2)

Timing/ Location of Impacts	Impact Description	Possible Solutions	Estimated Construction Costs ($ millions)	Incremental O&M Costs ($ millions)	Total Annual Costs ($ millions)	Selected Solution Avg. Annual Costs ($ millions)
			Annual Values Based on 6.875%			
Winter: Meeting extreme winter loads	Import capability is reduced and results in inability to meet extreme loads	Site 1,550 MW of replacement generation	306 capital costs for generation	Included in annual costs	8.9	8.9
		New transmission lines – Capt. Jack and Big Eddy – Ostrander	80 to 130 70 to 120	0.2 0.2	5.6 to 9.0 4.9 to 8.3	
Winter: Tri-Cities Load Service	Load service limitations	Local transmission improvements McNary – Franklin	15 to 20	0.1	1.1 to 1.5	1.1 to 1.5
Totals [1/]			**483 to 577**			**21.9 to 28.1**

1/ These totals include only costs for selected solutions.

The lower Snake River hydropower plants are used for AGC. Small but very frequent changes in generation are necessary to perform this function. Hydroelectric facilities, with stored water as their fuel, are extremely flexible and very useful for this purpose. If the four dams were breached, their contribution to this system would have to be spread over the remaining projects or replaced from other sources. To value the AGC, the BPA staff that deals with market sales of ancillary services was consulted. The economic value of AGC that would be lost with the breaching of the lower Snake River dams was based on the percent of time that AGC is utilized, the MW magnitude, and the market value. The average annual value was estimated to be $465,000.

The four lower Snake River dams are also used to provide part of the required reserves for the Federal power system. The WSCC has established reserve requirements for all utilities. These contingency reserves are expected to be "on-call" in the event of emergency loss of generating resources in the system. Utilities are required to have both operating and spinning reserves. The spinning reserve units must be synchronized with the power system and provide immediate response, while the operating reserves must be available within 10 minutes. BPA estimates that the Snake River facilities are used for reserves for about one half of the months of December and March and all of the months of January, February, April, May, and June. BPA relies on about 300 MW of reserves from these four facilities. The market values of these reserve services vary throughout the year. In the high demand winter months it was assumed that BPA would have to purchase reserves from the market at a value of $31 per MWh. During the rest of the year it was assumed BPA would sell this reserve at the average monthly market prices. The annual net economic cost associated with the loss of these reserves is estimated to be $7,183,000.

The total ancillary annual losses for Alternative 4—Dam Breaching are the combination of the AGC loss in Table 3.1-20 and the loss of reserve value in Table 3.1-21. This loss is $7,648,000, annually. This was rounded to $8 million for reporting purposes in the rest of this document.

3.1.9 Summary of Hydropower Net Economic Effects

This section combines all the net economic effects as defined by the medium projection conditions. These represent the most likely point estimates of economic effects. However, because of the uncertainty embedded into many of the key variables, a risk and uncertainty analysis was undertaken to provide a range of results.

With Alternative 4—Dam Breaching, there would be some savings to the nation because it would no longer incur the costs to operate these dams. This section does not include the savings in operation and maintenance costs that will occur with this alternative. These savings are included in the Avoided Cost category which is discussed in Section 3.8.5 and including them here would have resulted in double-counting these costs.

Table 3.1-22 presents the medium results for the two key approaches used to identify the net increases in costs to the power system as compared to the base condition. The costs in the table are the average annual equivalents with different discount rates. The two approaches used in the study were the system production costs and the market pricing approach. Different estimates of net economic costs were made by each of these approaches and models. But, the range of results from minimum to maximum is relatively small. The range is also relatively small over the three discount rates. For example, the annual net costs for Alternative 4—Dam Breaching, at 6.875 percent is from $220 to $226 million. The results for this alternative range from $216 to $226 million over all three discount rates.

The costs shown in Table 3.1-22 do not include the costs that would be incurred to maintain the same degree of reliability in the transmission system and the values for the loss of ancillary services. As shown in Tables 3.1-19, the region will have to build additional facilities at an average annual cost of $21.9 to $28.1 million (at 6.875 percent), $19.4 to $24.2 million (at 4.75 percent), and $15.6 to $17.9 million (at zero percent). The ancillary services lost with Alternative 4—Dam Breaching, were estimated in Section 3.1.8 as $8 million per year. Table 3.1-23 presents the total range of effects with the medium forecast conditions at the three different discount rates.

In summary, it can be seen from Table 3.1-23 that the total economic effects associated with changes in hydropower production with the different lower Snake River alternatives cover a wide range. With Alternative 2—Maximum Transport of Salmon, and Alternative 3—Major System Improvements, the net economic costs are negative, which is actually a benefit to the nation. The total net economic costs for these two alternatives range from ($7 million) to ($10 million), annually, at the 6.875 percent discount rate. The range of net economic costs is larger for Alternative 4—Dam Breaching, and represent a loss to the nation. The net economic costs for Alternative 4—Dam Breaching, range from $251 to $291 million, annually, at the 6.875 percent discount rate, with a most likely estimate of $271 million based on the average of this range.

Table 3.1-20. Automatic Generation Control Losses with Alternative 4—Dam Breaching

Month	Hours Per Month	MW Provided	Percent of Time (%)	Value Per Hour (1998 real $)	Monthly Value ($)
Jan	744	30	20	9.50	42,408
Feb	672	30	20	9.50	38,304
Mar	744	30	20	8.50	37,944
Apr	720	30	20	5.00	21,600
May	744	30	20	5.00	22,320
Jun	720	30	20	6.50	28,080
Jul	744	30	20	9.50	42,408
Aug	744	30	20	16.50	73,656
Sep	720	30	20	11.50	49,680
Oct	744	30	20	6.50	29,016
Nov	720	30	20	8.50	36,720
Dec	744	30	20	9.50	42,408
Annual (Rounded)	**8,760**	**30**	**20**		**465,000**

Table 3.1-21. Lost Annual Reserve Values with Alternative 4—Dam Breaching

Month	Heavy Load Hours	MW Provided	Purchase Percent of time (%)	Market Sale Percent of time (%)	Purchase Cost ($/MWh) (1998 Real $)	Market Value ($/MWh) (1998 Real $)	Monthly Value ($)
Dec 1/2	24	300	25	75	31.00	8.00	1,023,000
Jan	49	300	25	75	31.00	8.00	2,046,000
Feb	44	300	25	75	31.00	8.00	1,848,000
Mar 1/2	24	300	0	100	31.00	7.00	520,800
Apr	48	300	0	100	31.00	3.50	504,000
May	49	300	0	100	31.00	3.50	520,800
Jun	48	300	0	100	31.00	5.00	720,000
Annual (Rounded)	**2,648**	**300**					**7,183,000**

3.1.9.1 Consideration of Recent Events

Questions have arisen very late in the study process concerning the current state of the electricity industry in the WSCC and the possible impacts on the estimates of net economic effects associated with the dam breaching alternative. The purpose of this section is to summarize the possible impact of these late-breaking events on the economic analysis done by the HIT.

During the summer of 2000 and continuing into 2001 several significant events occurred in the electrical energy market in the WSCC. These events were:

- very high natural gas prices in regional and national markets
- Shortages of electricity, resulting in rolling blackouts in California, the declaration of energy emergencies in areas of the WSCC, extremely high electricity prices, and the call for voluntary emergency conservation measures by regional governors.

Table 3.1-22. Hydropower Analysis: Summary of System Costs (Production Costs and Market Prices)

Alternative	Production Costs	Market Price		Range of Costs:	
Discount Rate 6.875%					
	BPA Model	HYDROSIM	HYSSR	Minimum	Maximum
2 and 3	(9)	(7)	(10)	(10)	(7)
4	255	221	225	221	255
Discount Rate 4.75%					
Alternative	Production Costs	Market Price		Range of Costs:	
	BPA Model	HYDROSIM	HYSSR	Minimum	Maximum
2 and 3	(9)	(7)	(10)	(10)	(7)
4	256	220	224	220	256
Discount Rate 0.0%					
Alternative	Production Costs	Market Price		Range of Costs:	
	BPA Model	HYDROSIM	HYSSR	Minimum	Maximum
2 and 3	(9)	(7)	(9)	(9)	(7)
4	260	217	221	217	260

Note: Cost differences from Alternative 1—Existing Conditions. Medium projections, 1998 $ million, average of all water conditions. Various in-service dates, 100-year analysis.

Table 3.1-23. Hydropower Analysis: Total Average Annual Net Economic Effects Differences from Alternative 1—Existing Conditions

Alternative	System Costs ($)		Transmission Reliability Costs ($)		Ancillary Services Costs ($)	Total Effects ($)	
Discount Rate 6.875%							
	Minimum	Maximum	Minimum	Maximum		Minimum	Maximum
2 and 3	(10)	(7)	0	0	0	(10)	(7)
4	221	255	22	28	8	251	291
Discount Rate 4.75%							
Alternative	System Costs ($)		Transmission Reliability Costs ($)		Ancillary Services Costs ($)	Total Effects ($)	
	Minimum	Maximum	Minimum	Maximum		Minimum	Maximum
2 and 3	(10)	(7)	0	0	0	(10)	(7)
4	220	256	19	24	8	247	288
Discount Rate 0.0%							
Alternative	System Costs ($)		Transmission Reliability Costs ($)		Ancillary Services Costs ($)	Total Effects ($)	
	Minimum	Maximum	Minimum	Maximum		Minimum	Maximum
2 and 3	(9)	(7)	0	0	0	(9)	(7)
4	217	260	16	18	8	241	286

Note: Medium projections, 1998 $ million, average of all water conditions. Various in-service dates, 100-year analysis. All amounts are cost differences from Alternative 4—Existing Conditions and do not include existing system hydropower costs, which are addressed in Section 3.8.

High Natural Gas Prices

The spot market prices for natural gas experienced since the summer of 2000 have at times been several times the prices used in the HIT analysis. Volatile swings in market prices often occur in commodity markets. Even though the current price spikes are particularly high, many analysts expect that natural gas will return to much lower prices as the market adjusts for supply and demand. A long-term projection of natural gas prices has been published by the Energy Information Administration (EIA) in its report, *The Annual Energy Outlook 2001* (Report#: DOE/EIA-0383(2001), December 22, 2000). This report represents the most recent official projection of future energy prices. Figure 3.1-5 shows the base case projection of natural gas prices from the EIA report (adjusted for 1998 dollars and the West Coast market). This figure also shows the projections of natural gas prices used in the HIT analysis for the medium (most likely) and high scenarios. As can be seen in this figure, the EIA projects that natural gas prices will return to within the range of medium and high projections used in the HIT analysis in approximately year 2004. The breaching of the dams would not occur until after 2005. So, it is expected that natural gas prices will return to the range used in the HIT analysis, but based on the EIA forecast would be higher than the medium forecast used to represent the most likely future.

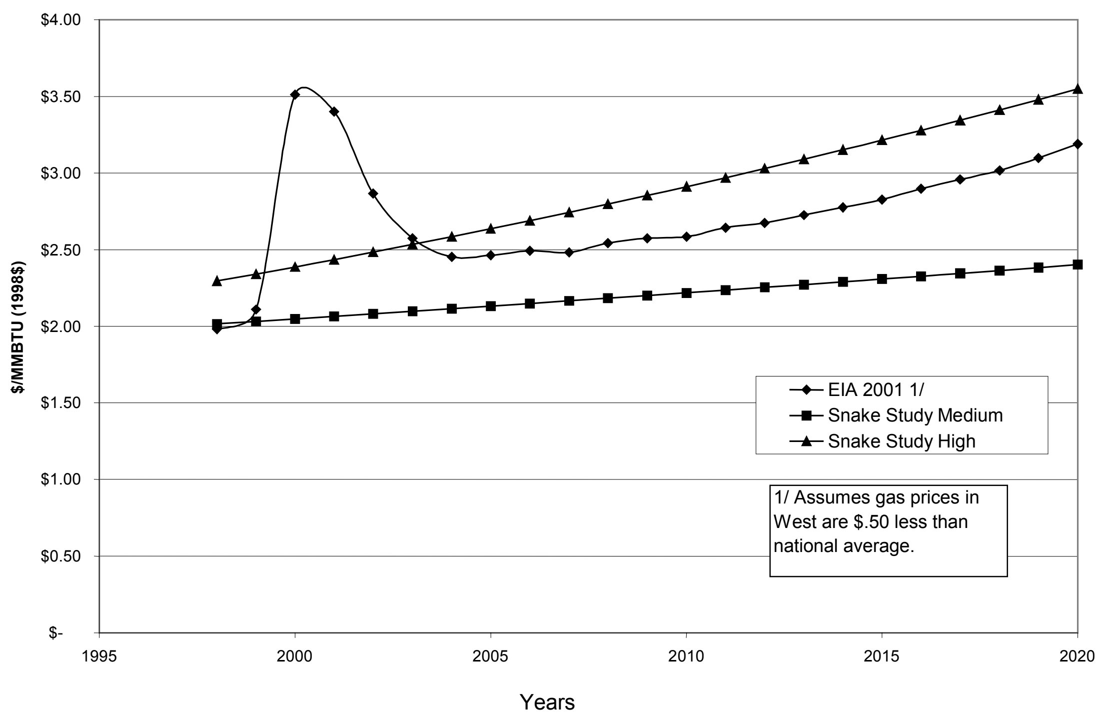

Figure 3.1-5. Natural Gas Prices – EIA 2001 Report and Snake River Analysis

If the HIT analyses were redone with this slightly higher price condition for natural gas, the hydropower net economic effects would be higher than the $251 to $291 million range of annual costs presented in this report. The economic costs would probably be closer to the annual impacts based on the "high" scenario presented in the HIT analysis, which was an annual cost range of $359 to $389 million.

These economic costs are based on the assumption that the hydropower lost from the breached dams would be replaced with natural gas driven CC plants. Section 3.1.6.4 examines the cost of replacing the Snake River generation with conservation and renewable resources. It was found that the Snake River plants could be replaced with conservation/renewables with costs similar, but slightly higher, than the CC costs (based on the medium forecast). So, if natural gas prices continue to be high, the least cost replacement strategy for lost Snake River hydropower may be with conservation and renewable resources. This would result in net economic costs of approximately $300 million, which is very close to the original HIT estimate with CC replacement.

The market price of electricity has also jumped substantially over this period and this could influence other assumptions in the HIT analysis. In particular, it used a market price analysis to estimate economic effects. A reexamination of the net economic effects with an updated market price analysis, or modified study assumptions, probably would yield a higher estimated economic impact. However, the market price analysis and a study assumption update would also be limited by the cost of replacing the Snake River hydropower with the conservation and renewable resources. So, there is no need to adjust the HIT analysis to account for current spikes in natural gas prices and increased electricity prices.

Adequate Generating Resources

The energy and capacity shortages experienced this winter in areas of the WSCC have resulted in concerns that the economic analysis of breaching the Snake River dams did not foresee these shortages and, hence, understated the impacts.

The HIT analysis fully recognized the need for additional generating resources to be built in the WSCC regardless of whether the lower Snake River dams are breached. In the base condition it was assumed that an additional 8,650 aMW of generating resources would need to be built in the WSCC by year 2010 (Table 3.1-12). By year 2018, it was assumed that 17,490 aMW of new resources would be needed in the WSCC, even if the Snake River dams were not breached.

The current shortages in the system can be attributed to the fact that few new resources have been added to the system in recent years. Other factors such as bad weather, unplanned plant outages, poor water conditions, and market adjustments associated with the shift to an unregulated electricity market in California have compounded the problem. The HIT analysis did not project the current crisis, but rather assumed that over time the market would adjust to needs and adequate resources would be built in the base condition, and with each of the alternatives.

Currently, there are a number of new generating plants being planned in the Pacific Northwest that will help meet the need for new resources. The long-run assumption of the HIT team may yet occur, albeit, not on the exact timeline estimated in the analysis. The key point to note is that short-term shortages and surpluses in supply are normal market conditions, and the long-run assumptions of the HIT analysis were intended to capture these fluctuation on an average basis. Hence, there is no need to adjust the HIT analysis based on current supply issues.

3.1.9.2 Revised Biological Opinions

The 2000 Biological Opinion had not been issued when the hydropower study began. Using conditions under the 1995 Biological Opinion as the baseline for the analysis slightly overstates the amount of energy generated by the four lower Snake River dams. Conditions have changed as a result of the 2000 Biological Opinion but not significantly. A comparison of average Snake River project generation between conditions under the 1995 Biological Opinion, the 1998 Biological Opinion, and those under the 2000 Biological Opinion is provided in Table 3.1-24. The comparison of the average annual generation with the 1995 Biological Opinion and the 2000 Biological Opinion, as defined by the HYSSR model, showed that annual generation from the four Snake River dams is about 6 percent lower with the 2000 Biological Opinion operation than with the 1995 Biological Opinion operation. The distribution of the changes over the average year is shown in Figure 3.1-6. As shown in this figure, the majority of the generation reduction occurs in the months of April, May and June. This is the time period when hydropower generation in the Pacific Northwest has the lowest economic value. So, the impact on power benefits from the Snake River dams would be considerably lower than the 6 percent reduction in annual generation with the 2000 Biological Opinion. For this reason, it was judged that the relatively small change was not significant enough to warrant a re-analysis of the economic impacts associated with reduction in hydropower with dam removal.

Table 3.1-24 Snake River Plants Average Generation Examination of Generation with 1995, 1998, and 2000 Biological Opinions Based on HYSSR Model Runs

Generation From Four Snake River Dams (aMW) – Base Condition													
	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AVE
1995 Biological Opinion	724	617	616	708	908	1,082	1,314	1,454	1,974	2,386	2,175	1,091	1,254
1998 Biological Opinion	724	709	737	595	964	1,009	1,154	1,424	1,772	2,114	2,083	1,109	1,200
2000 Biological Opinion	722	580	721	548	936	1,101	1,227	1,454	1,696	2,049	1,989	1,094	1,176
Difference: (2000 – 1995)	(1)	(37)	105	(160)	28	19	(87)	–	(278)	(337)	(186)	3	(78)
Difference: (% Change)	(0.2%)	(6.0%)	17.0%	(22.6%)	3.1%	1.8%	(6.6%)	0.0%	(14.1%)	(14.1%)	(8.6%)	0.3%	(6.2%)
Difference: (2000 – 1998)	(2)	(129)	(16)	(47)	(28)	92	73	30	(76)	(65)	(94)	(15)	(24)
Difference: (% Change)	(0.2%)	(20.9%)	(2.6%)	(6.6%)	(3.1%)	8.5%	5.6%	2.1%	(3.9%)	(2.7%)	(4.3%)	(1.4%)	(1.9%)
Difference: (1998 – 1995)	0	92	121	(113)	56	(73)	(160)	(30)	(202)	(272)	(92)	18	(54)
Difference: (% Change)	(0.0%)	13.0%	16.4%	(19.0%)	5.8%	(7.2%)	(13.9%)	(2.1%)	(11.4%)	(12.9%)	(4.4%)	1.6%	(4.5%)

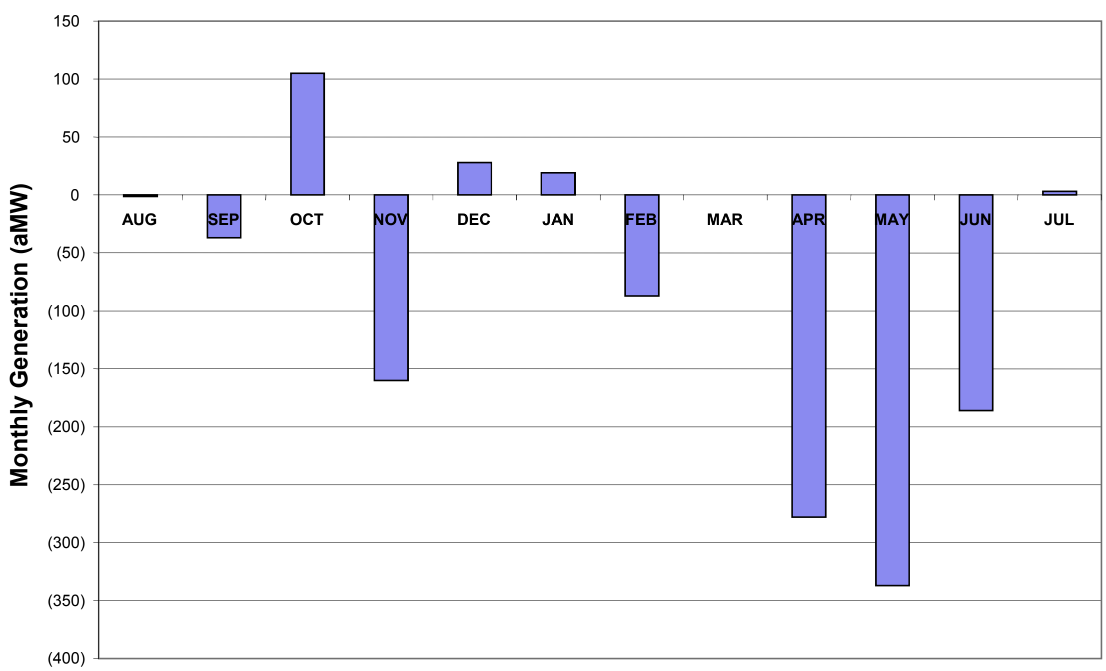

Figure 3.1-6. Difference in Snake River Generation (2000 Biological Opinion – 1995 Biological Opinion)

3.2 Recreation Use

3.2.1 Introduction

This introductory section presents and briefly discusses projected harvests for all fisheries under each alternative. Estimates of the number of fish available for harvest in each area were developed by the DREW Anadromous Fish Workgroup based on the findings of the 1998 PATH analysis, with additional assumptions made to extend the PATH findings to all Snake River stocks.[1] The harvest forecast methods and the allocation of projected runs to fisheries are discussed in Sections 3.5.2 and 3.5.3 of this document, respectively. PATH divided its estimates into "mainstem," the area downstream of Lower Granite Dam to the Columbia River estuary, and "tributary," the area upstream of Lower Granite Dam. The tributary area encompasses the entire Snake River watershed above Lower Granite Dam, including the Lower Granite reservoir.

Total harvest estimates for project year 25 are presented in Table 3.2-1. This table, which is an abbreviated version of Table 3.5-7, presents estimates for recreational ocean and in-river harvest, commercial ocean and in-river harvest, and other in-river harvest. In-river tribal harvest identified under the commercial in-river section includes both gillnet and ceremonial and subsistence harvest because the PATH results did not distinguish between these fisheries. Ceremonial and subsistence harvests are accounted for in the commercial treaty fishery category but are not assigned an additional intrinsic dollar value in the economic analysis presented in Section 3.5 of this document. The harvest estimates presented in Table 3.2-1 are based on the "equal weights" PATH scenario. The DREW recreation and anadromous fish economic analyses used harvest estimates based on this PATH scenario. The tribal circumstances economic analysis presented in Section 5 of this document employs the "mean of experts" PATH scenario. As a result, the treaty harvest numbers presented in Table 3.2-1 are not directly comparable with those presented in Section 5. The contribution of the affected stocks to ocean treaty fisheries is very small and is, therefore, included as incidental harvests to other commercial fisheries.

3.2.2 Overall Recreation Summary

This section provides a summary of the NED effects associated with recreation. Components of these benefits were estimated by different workgroups and are discussed in separate sections of this document. The purpose of this section is to combine these findings and present the total estimated recreation NED effects by alternative.

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[1] The PATH analysis completed their initial estimates of the expected return rates for wild adult spring/summer chinook in 1998 and for fall chinook in 1999. The Scientific Review Panel (SRP), which was tasked to review the PATH analysis methods, found inconsistencies in the results of both the fall chinook and later the spring/summer chinook analysis developed by PATH. Adjustments made to a number of factors of concern in the original PATH analysis resulted in higher adult return predictions under Alternatives 1 through 3, which reduced the net difference between the three dam retention alternatives and Alternative 4—Dam Breaching. The findings of these adjusted results, referred to as the adjusted PATH 1999 results, are discussed further in Section 3.5.1. The estimates of the number of fish available for harvest originally developed by the DREW Anadromous Fish Workgroup have not been revised to incorporate the adjusted PATH 1999 results or the findings of the Cumulative Risk Initiative (CRI).

Table 3.2-1. Projected Harvest for all Fisheries for Year 25

Alternative	1	2	3	4
Recreation				
Ocean	608	608	732	5,079
Mainstem	29,943	32,466	31,613	43,937
Tributary	68,074	71,809	70,588	91,234
Subtotal Recreation	98,625	104,883	102,933	140,250
Commercial				
Ocean	3,596	3,596	4,329	30,050
In-river				
Non-treaty	2,387	2,655	2,852	20,078
Hatchery	51,679	60,533	57,986	132,257
Treaty Indian	101,869	108,491	106,792	169,125
Subtotal In-river	155,935	171,679	167,630	321,460
Subtotal Commercial	159,531	175,275	171,959	351,510
Other In-river	264	359	327	792
Total	**258,420**	**280,517**	**275,219**	**492,552**

Notes:
1. Harvest is in number of fish.
2. These projections are "likely" modeling results that correspond to the PATH results for the 50th percentile output.
3. This analysis is based on the results of the PATH "base case" scenario for fall chinook and "equal weights" scenario for spring/summer chinook.
4. See Table 3.5-7 for the "low," "likely," and "high" modeling results by fishery, as well as geographic area. Tables 3.5-8 through 3.5-10 present this information for spring/summer chinook, fall chinook, and summer steelhead, respectively.

Source: Compiled from Table 3.5-7

Estimates of the direct economic effects associated with recreation were developed for angling and non-angling or general river recreation activities. Estimates of the economic value of angling were developed for three geographic areas; ocean recreational fishing, in-river mainstem recreational fishing, and in-river tributary recreational fishing. These economic analyses were based on the number of salmon and steelhead that would be available for harvest in these areas under each alternative. In addition, the DREW Recreation Workgroup developed estimates of the economic value associated with fishing for resident fish in the lower Snake River reservoirs. Recreation harvest estimates are presented for project year 25 by geographic area and alternative in Table 3.2-1. The DREW Recreation Workgroup also developed estimates of the economic value of non-angling or general river recreation along the lower Snake River.

Both the DREW Recreation and Anadromous Fish workgroups developed estimates of the NED values associated with recreational fishing. The DREW Recreation Workgroup evaluated the NED effects associated with tributary fishing for salmon and steelhead, as well as those associated with fishing for resident fish in the lower Snake River reservoirs. The DREW Anadromous Fish Workgroup evaluated the NED effects associated with ocean and mainstem recreational fishing.[2] These analyses employ different methods that may not be directly comparable. The anadromous fish economic evaluation uses a benefit transfer approach, while the analysis developed by the DREW Recreation Workgroup is based on survey data obtained as part of its analysis. Total NED recreation benefits are summarized in Table 3.2-2. This table combines the findings of the two

[2]Although they are not presented in this FR/EIS, the DREW Anadromous Fish Workgroup also developed estimates of the NED effects associated with tributary recreational fishing. These estimates are presented in their full-length technical report, which is available on the Corps website.

workgroups to present the total recreation NED benefits associated with each alternative. These estimates are presented net of the base case in Table 3.2-3. The DREW Recreation Workgroup estimates are discussed in the following sections. The DREW Anadromous Fish Workgroup's estimates are discussed in Section 3.5.

Table 3.2-2. Estimated Average Annual Recreation Benefits ($ million) (1998 dollars)

Alternative	1	2	3	4
General Recreation	31.6	31.6	31.6	59.5
Recreational Fishing				
Ocean	0.024	0.024	0.027	0.131
Mainstem	1.799	1.989	1.973	2.424
Tributary	19.955	21.170	21.214	65.184
Subtotal	21.778	23.183	23.215	67.739
Recreation Total	**53.378**	**54.783**	**54.815**	**127.239**

Notes: 1. General recreation and tributary recreational fishing estimates were calculated by the DREW Recreation Workgroup. Ocean and mainstem recreational fishing estimates were calculated by the DREW Anadromous Fish Workgroup.
2. NED benefits are average annual values calculated over a 100-year project life using a 6.875 percent discount rate.
3. NED benefits associated with resident fish in the lower Snake River are also included in the tributary estimates developed by the DREW Recreation Workgroup (see Section 3.2.7.1).

Source: Compiled from Tables 3-2-10 and 3.5-13

Table 3.2-3. Estimated Net Average Annual Recreation Benefits ($ million) (1998 dollars)

Alternative	2	3	4
General Recreation	0.000	0.000	27.900
Recreational Fishing			
Ocean	0.000	0.003	0.107
Mainstem	0.190	0.174	0.625
Tributary	1.215	1.259	45.228
Subtotal	1.405	1.437	45.96
Campground Costs	-	-	(2.605)
Recreation Total	**1.405**	**1.437**	**71.255**

Notes: 1. General recreation and tributary recreational fishing estimates were calculated by the DREW Recreation Workgroup. Ocean and mainstem recreational fishing estimates were calculated by the DREW Anadromous Fish Workgroup.
2. NED benefits are average annual values calculated over a 100-year project life using a 6.875 percent discount rate.
3. NED benefits associated with resident fish in the lower Snake River are also included in the tributary estimates developed by the DREW Recreation Workgroup (see Section 3.2.7.1).
4. The DREW Recreation Workgroup assumed that the existing number of campgrounds would double in the first decade following breaching. The average annual costs associated with these campsites are estimated to be $2.605 million (6.875 percent discount rate).

Source: Compiled from Tables 3-2-13 and 3.5-14

3.2.3 DREW Recreation Analysis

The economic values associated with recreation can be separated into direct and indirect economic values and it is important that the reader distinguish between these two types of value. In this FR/EIS, direct and indirect values are addressed as NED and RED values, respectively (see Section 2.1). This section addresses the NED recreation values, the recreation-related costs and/or benefits accrued to the nation as a whole as a result of the proposed alternatives.

Direct or NED recreation values represent the benefits that the visitor receives from participating in a recreation activity and may be considered an economic measure of the utility that the visitor obtains from the recreation experience. NED recreation benefits are measured in terms of consumer surplus or net willingness to pay (WTP), which is the amount that a visitor is willing to pay above the actual costs of the visit. This is distinctly different from indirect or RED recreation values, which measure the effects of actual recreation-related expenditures on local economies. The following sections summarize the findings of the DREW Recreation Workgroup, which estimated the NED effects of the proposed alternatives. All tables presented in the remainder of this section were developed as part of the DREW Recreation Workgroup Study. Sources of secondary data used by the DREW Recreation Workgroup to develop these tables are noted, as appropriate. The RED impacts associated with changes in recreation spending are addressed in Section 6 of this document.

3.2.3.1 Techniques Used to Measure Visitor Benefits

A general measure of the direct economic value of goods and services, including recreation activity, is the WTP of the users. For goods that are sold in a market, the WTP is the amount actually paid to obtain the good plus an additional amount that an individual would have been willing to pay for the chosen quantity of the good. This additional amount is generally referred to as the consumer surplus or net WTP and represents the value of the good over and above the amount actually paid. Put slightly differently, consumer surplus represents the surplus benefit over and above the cost—the difference between a consumer's gross WTP and the amount they actually had to spend. Increases in consumer surplus are considered as benefits to the consumer because this extra value is obtained without charge. Total consumer benefits to society are measured by summing the consumer surplus across all participants. In the case of valuing recreation, the amount charged for the activity is generally small or non-existent. Because there is no well-established market for the exchange of recreation goods, non-market approaches have to be employed to develop demand curves to estimate consumer surplus.

This analysis follows the WRC guidelines (WRC, 1983), which recommend that net recreation WTP be quantified by using either the Travel Cost Method (TCM) or the Contingent Valuation Method (CVM). Both of these methods are used by other Federal agencies and are frequently used by economists (Loomis and Walsh, 1997). In this study, TCM is applied to estimate the consumer surplus or net WTP associated with existing recreation activities. TCM uses the actual number of trips taken by an individual as the quantity variable and the visitor's travel cost as the price variable to trace out a statistical demand curve for recreation using multiple regression. The consumer surplus or net WTP is calculated as the area below the demand curve but above the price paid. Separate TCM models were developed for reservoir recreation, river recreation above Lewiston, Idaho, and recreation in the Snake River Basin in central Idaho. Models were developed for angling in all three areas, with non-angling or general river recreation models developed for the 140-mile lower Snake River and the Snake River Basin in central Idaho. The TCM models used to estimate net WTP for these different areas and activities are discussed in AEI/University of Idaho (1999a; 1999b; 1999c). Additional details on TCM demand models are available in Loomis and Walsh (1997).

Breaching the four lower Snake River dams would significantly affect recreation opportunities. Lake or flatwater-oriented recreation activities such as some types of pleasure boating, water skiing, fishing for some warm-water species, and sightseeing in the current type of tour boats that cruise between Portland, Oregon and Lewiston, Idaho would no longer be possible along the lower Snake River if breaching were to occur. Some activities that occur on or in the vicinity of lakes, such as certain types of boating, fishing, swimming, hiking, and wildlife viewing, could also occur along a free-flowing river. Breaching the dams would, however, expand opportunities for certain free flowing river-related recreational and tourist activities, such as drift boating, rafting, kayaking, and jet boating. The potential changes in recreation activities and facilities that could occur under Alternative 4—Dam Breaching are discussed in Section 5.12 of the main FR/EIS document.

As noted above, standard TCM models rely upon surveying existing users to obtain information on the actual number of trips taken by an individual and the associated travel cost. This approach is not possible for Alternative 4—Dam Breaching because free flowing river conditions do not presently exist. Therefore, a hybrid TCM approach, known as “contingent behavior” (CB), was used to estimate the value of river recreation under Alternative 4—Dam Breaching. This hybrid approach involved: a) describing the new recreation conditions (e.g., a free-flowing or near-natural river scenario); b) asking whether individuals would visit and, if so, how many times per year; and c) using the survey respondent’s distance, travel cost, and travel time to the spot on the river that they would most likely visit to estimate a demand curve. These variables are similar to those used in the TCM models developed to value current reservoir recreation. The same general recreation evaluation approach is applied to the data for all alternatives. The contingent behavior approach is widely used in economics, was applied in the Columbia River System Operation Review (SOR) (Callaway et al., 1995) and has proved to be reliable (Loomis, 1993). A discussion of the contingent behavior TCM is provided in the DREW Recreation Workgroup report (DREW Recreation Workgroup, 1999).

3.2.4 Existing Recreation Surveys and Findings

Five recreation visitor-use surveys were conducted of existing visitors. These surveys, designed to identify and value current recreation use, targeted three different stretches of the river and two general types of recreation activity. These surveys and their findings are summarized in Table 3.2-4 and briefly discussed in the following sections.

3.2.4.1 Lower Snake River Reservoirs

Two separate surveys, an angler survey and a general recreation survey, were mailed to a sample of recreationists who visited the lower Snake River reservoirs from May through October 1997. University of Idaho students stationed at recreation access points along the lower Snake River collected the names and addresses of visitors. In some cases, surveys were administered by telephone at the request of the respondents. A total of 537 angler surveys were returned for a

Table 3.2-4. Existing Recreation Surveys, Number of Trips, and Annual Benefits ($ millions) (1998 dollars)

Survey	Number of Completed Surveys	Response Rate (%)	Number of Trips[1/]	Willingness-to-Pay per Trip[1/]	Annual Benefits ($ millions)
Reservoir Angling[2/]	537	59	66,926	29.23	1.956
Reservoir General Recreation (excludes Angling) [3/]	408	65	442,834	71.31	31.578
Upriver Angler [4/]	247	72	11,393	35.71	.406
Central Idaho Angling [5/]	257	na	129,026	37.68	4.862
Central Idaho General Recreation (excludes Angling)[5]	190	na	497,480	87.24	43.400
Total	**1,639**	**na**	**1,147,659**	**na**	**82.224**

1/ The number of trips and the WTP per trip were estimated based on each survey. The surveys asked how many trips each individual takes a year and how much each trip costs. This travel cost is used to estimate the recreation demand curve. This recreation demand curve is then used to compute an individual's WTP for recreation. Annual benefits are calculated by multiplying the number of trips by the WTP per trip.

2/ Reservoir Angler Survey: Recreationists contacted at the reservoirs from May through October 1997 were asked to take part in the mail survey and provide their names and mailing addresses.

3/ Reservoir General Recreation Survey: Recreationists contacted at the reservoirs from May through October 1997 were asked to take part in the mail survey and provide their names and mailing addresses.

4/ Upriver Angler Survey: Anglers surveyed were generally fishing for steelhead in the 30-mile stretch of the Snake River, above the town of Lewiston, Idaho.

5/ Central Idaho Angling Survey: Surveys were distributed to anglers and rafters at a variety of points by using on-site contacts and guides so a response rate was not calculated.

Note: na = not available

response rate of 59 percent. A total of 408 completed general recreation surveys were returned for a response rate of 65 percent.

The average net WTP per trip of reservoir fishing was $29.23, which reflects the finding that many of these are short trips of a day or less. The number of reservoir angler trips was estimated by multiplying the number of annual trips per angler identified from the survey data by the estimated number of anglers. Normandeau et al. (1999) states that "(t)he number of anglers can be calculated from our sample values for hours per day fished and days fished per year, combined with the estimated total annual hours fished on the reservoirs." Using this approach, Normandeau et al. (1999) reports an estimated 66,926 angler trips for 1997. Multiplying the value per trip ($29.23) by the estimated number of annual trips (66,926) yields 1997 annual benefits of $1.956 million. Details of the per trip and annual TCM model methodology for the reservoir angler study, as well as a copy of the survey questionnaire, are presented in Normandeau et al. (1999a).

The average net WTP or net benefit per day of non-angling or general reservoir recreation such as boating and waterskiing was $71.31 per trip. Corps visitation data are used to estimate the total number of hours. Subtracting the estimate of angler hours obtained from the Normandeau et al. data yields hours of reservoir recreation. Using the AEI survey data on average length of stay allows an estimate of days, which can be converted to trips. Annual recreation benefits are calculated by multiplying the value per trip by an estimated 442,834 trips yields an annual recreation benefit of $31.578 million. Details of the per-trip and annual TCM benefits methodology for general reservoir recreation analyses can be found in AEI/University of Idaho (1999a), while the reservoir fishing is detailed in Normandeau et al. (1999).

These benefits per trip can be compared to the benefit estimate recreation travel cost method demand model used to evaluate the Lower Granite reservoir recreation for the SOR study. Callaway et al. (1995) estimated an average consumer surplus of $32.74 per day. This value is greater than the reservoir angling estimate, but lower than the general reservoir recreation value, even when adjusted to a per trip basis.

3.2.4.2 Upriver of Lewiston, Idaho

Anglers were surveyed along the 30-mile stretch of the Snake River above Lewiston, Idaho. Names and addresses of these anglers, who were generally fishing for steelhead, were collected between September 1997 and March 1998. A total of 247 completed surveys were returned for a response rate of 72 percent. The average net WTP for anglers fishing along this stretch was $35.71 per trip. Angler use estimates were made using a combination of aerial surveys, ground-based counts, and visitor intercept surveys. Specifically, the survey data indicated an average of 12.33 trips per angler and an estimated 924 anglers, yielding 11,393 trips. Multiplying the benefit per trip times the number of angler trips yields an annual value of $406,844. Details of the per trip and annual benefits of this upriver angler analysis can be found in Normandeau et al. (1999). The economic benefits associated with upriver steelhead fishing are included in the category labeled Steelhead Tributaries in the summary of recreation results discussion presented in Section 3.2.7.

3.2.4.3 Central Idaho

Two separate surveys, an angler survey and a general recreation survey, were distributed to anglers and non-anglers in the Snake River Basin in central Idaho using several methods, including contacts made on-site, as well as via guides and outfitters. A total of 257 useable responses were obtained from anglers, with 190 useable surveys returned by other recreation users, such as rafters. It is not possible to calculate a response rate for these surveys because the exact number distributed is unknown.

Anglers in Central Idaho had an average net WTP per trip of $37.68. This yields an annual benefit of $4,861,700 when multiplied by an estimated 129,026 steelhead trips (AEI/University of Idaho, 1999b). This value is divided between the categories labeled Steelhead Tributaries and Salmon Tributaries in the summary of recreation results discussion presented in Section 3.2.7.

The average net WTP per trip for general or non-angling upriver recreation, such as rafting, is $87.24. Using survey data information, the estimated use is 180,000 non-angler visitors to the region (AEI/University of Idaho, 1999c). It is estimated these visitors take 497,480 trips annually. Multiplying the trip value times the estimated number of trips yields an annual value of $43.4 million. At this time there is no empirical linkage to determine how this value would change with the four alternatives developed below. Thus, this information on the value of central Idaho general river recreation is part of the future with and future without environment and is not included in the detailed tables of each alternative.

3.2.5 Natural River Recreation Survey

3.2.5.1 Survey Distribution and Response Rate

As noted at the beginning of this section, in addition to the surveys of existing users discussed above, the DREW Recreation Workgroup also surveyed a much larger sample of Washington, Idaho, Oregon, western Montana, and California residents to identify the type and number of recreation users that would visit the lower Snake River if the dams were breached. The survey distribution was as follows:

- six thousand surveys were distributed to residents of 18 counties within 150 miles of the lower Snake River, based on population
- three thousand surveys were distributed to residents of Idaho, Oregon, Washington, and Montana (500 to residents of each state); and 1,000 surveys to residents of California
- one thousand surveys were distributed to current users identified through the reservoir recreation surveys.[3]

This large sampling region was chosen for several reasons. The most heavily sampled strata (6,000 surveys mailed) consists of those counties of the majority of current users. These counties were identified based on existing visitor survey data collected by the Corps.

However, a restored 140 mile near-natural river with no recreation permit rationing is a potentially significant enough recreation resource that the remainder of the households in the Pacific Northwest (eastern Idaho, western Oregon, western Washington, and Montana) and California were included in a second sample strata. California was included for two reasons. First, California was already included in the hydropower analysis and consistency suggested they be included for recreation. Second, with a population of more than 30 million people, California represents more than half the population in the western United States, and would certainly have an effect on the visitor demand for a significant recreation resource in the western United States such as a 140 mile near-natural river.

A stratified sample of 9,000 households and 1,000 current visitors were mailed an eight-page survey. A repeat mailing approach was used that included a personally addressed cover letter attached to the survey, a follow-up reminder postcard, a second survey mailing to non-respondents, and, finally, a U.S. Postal Service express mailing to remaining non-respondents. The third mailing was sent priority mail because delays in survey approval pushed the third mailing into the Thanksgiving-Christmas time period.

The total number of deliverable surveys and response rates are presented by state in Table 3.2-5. Of the approximately 9,000 surveys mailed, 1,162 surveys were classified as "no response" (83 deceased, 1,073 undeliverable, 6 moved out of study area, and 8 wrong state). Therefore, there were 7,830 net deliverable surveys. A total of 3,245 completed surveys were returned for an overall

[3]These 1,000 surveys distributed to current users were included as insurance in case there were insufficient household observations to estimate the travel cost model.

response rate of 41.4 percent.[4] Note that only a portion of the 3,245 respondents returning surveys indicated they would visit a free-flowing lower Snake River. A copy of this survey instrument is presented in the DREW Recreation Workgroup report. To simplify expanding the survey results to the population and because a sufficient number of potential visitors were obtained from the household survey, the current user surveys were not used in the analysis described below. The results of these household surveys were applied to all Washington, Idaho, Oregon, western Montana, and California households. Response rates varied by region and ranged from 21.3 percent in California to 46.3 percent in Montana (Table 3.2-5). One of the free-flowing river estimates adjusts for these response rates when generalizing from the sample to the population to minimize sample selection bias in the visitor use estimate.

Table 3.2-5. Numbers of Surveys and Responses, by State

State	Number of Surveys Mailed	Deliverable Surveys (Approx.)	Number of Usable Cases	Effective Response Rate by State (%)
Washington	5,545	4,858	2,109	43.4
Idaho	1,008	911	419	46.0
Oregon	944	847	365	43.1
Montana	450	374	173	46.3
California	1,001	840	179	21.3
Total	**8,948**	**7,830**	**3,245**	**41.4**

The relationship between the number of anglers and number of general river visitors as a function of distance from the lower Snake River is presented in Table 3.2-6. The general pattern is that the number of trips per year falls off with distance from the river. This is true for both anglers and for river visitors. For river visitors, there are three exceptions to this pattern. There is a slight increase in the number of trips per visitor between the 201 through 300 mile and 301 through 500 mile categories, with the number of trips per visitor increasing from 1.07 to 1.17. There is a larger increase between the 301 through 500 mile and 501 through 1,000 mile categories, with the number of trips per visitor increasing from 1.17 to 1.54. The average number of trips in the 501 through 1,000 mile category would, however, have been below one trip per visitor except for one angler who would take 8 trips per year. At mile 1,001 through 1,500, the number of trips per visitor falls below one per year because some river visitors indicated that their expected trips per year were zero. That is, they indicated they would definitely or probably visit the a free-flowing lower Snake River, but they might not make a visit every year. These responses are retained in the estimated TCM models and should help reduce the concern that potential visitors felt obliged to record at least one trip per year (as many did not). When looking at the individual cell frequencies in Table 3.2-6, the reader should keep in mind that some of the cell frequencies are rather small, and this may partially explain why the pattern is not always a monotonic decrease with distance. For example, for general recreation visitors there was one visitor at 1,501 miles or greater, and he indicated two trips per year, which was higher than the average reported by respondents from the next closest

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[4]This response rate is lower than the number reported in the Draft FR/EIS due to inadvertent inclusion of duplicate surveys in the database used in the Draft FR/EIS. These duplicate surveys have been removed from the data and analysis in the FR/EIS. Use of the corrected dataset also has resulted in some changes in the use and benefits estimates. Further, it should be noted that this response rate does not include responses to the 1,000 surveys mailed for insurance purposes.

Table 3.2-6. Relationship of Number of Visitors and Trips per Visitor with Dam Breaching

	Anglers				General River Visitors			
Miles from the lower Snake River	Number of Returned Surveys	Number of Anglers who Would Visit	Percent of Total[1/]	Trips/ Angler	Number of Returned Surveys	Number of Visitors	Percent of Total[1/]	Trips/ Visitor
0 to 50	181	166	91.7	9.71	582	208	35.7	4.56
51 to 100	259	245	94.6	3.61	710	182	25.6	2.16
101 to 200	126	117	92.9	2.97	353	73	20.7	1.65
201 to 300	69	67	97.1	1.79	237	39	16.5	1.07
301 to 500	34	33	97.1	1.5	126	17	13.5	1.17
501 to 1,000	25	22	88.0	1.25	111	11	9.9	1.54
1,001 to 1,500	6	6	100.0	1	28	4	14.3	0.5
1,501+	1	1	100.0	1	5	1	20.0	2

1/ This is the percent of survey respondents who indicated that they would definitely or probably visit a free-flowing lower Snake River.

distance zone. However, with just one visitor at that distance increment, this estimate has a very large implied variance, suggesting it could just as well be less than two trips.

3.2.5.2 TCM Demand Estimation and Benefit Calculation

Since the TCM model uses travel costs as the price variable when estimating the demand function, the net WTP from the TCM model is sensitive to how the travel costs are measured. Using survey respondents costs of travel (e.g., transportation, any lodging for long distance travelers, etc.) they reported in the survey, results in net WTP estimates that are higher than using just transportation alone. The reservoir recreation TCM models relied upon just transportation costs incurred traveling to and from the reservoirs as the definition of the travel cost variable, since a majority of the reservoir users were local and usually did not have lodging costs.

Using the contingent behavior TCM, the value per trip to a near-natural lower Snake River for salmon and steelhead fishing would be $292 per trip of 3.36 days or $87 per day. This value is fairly robust to different sample specifications and is also consistent with values reported for anadromous fishing in past literature reviews (Walsh et al., 1992). The value for free-flowing river recreation activities such as rafting, canoeing, kayaking, and swimming is estimated at $401 per trip of 2.5 days or $160 per day using survey respondents' reported trip costs (this is consistent with how the mainstem river anadromous fishing TCM benefits are calculated above). In the tables and analysis below, this river recreation value of $160 per day is considered the high NED value.[5] Although this value is higher than most reported values in the past literature for general river-based recreation it was fairly robust to different sample specifications. The survey instructed individuals to report their expected number of trips per year. The most frequent number of trips was one per year (37 percent), and then two per year (25 percent). However, nearly 10 percent reported an

[5] The values calculated using the contingent behavior TCM have been revised and are now slightly higher than those presented in the Draft FR/EIS. For salmon and steelhead fishing, the values are now $292 per trip or $87 per day compared to the $256 per trip and $76 per day values used in the analysis presented in the Draft FR/EIS. For free flowing activities, the values are now $401 per trip and $160 per day compared to $297 per trip and $114 per day used in the Draft FR/EIS. These increases in value per trip resulted from the revised TCM models that were re-estimated following removal of the duplicate surveys from the database used in the Draft FR/EIS.

expected number of trips of zero per year. This suggests that some people expected to visit a free-flowing lower Snake River only on occasional years. To allow for these low probability visits, to avoid truncation in the sample, and to be conservative, these zero visits were retained in the TCM model.

Using a definition of the cost-per-mile price variable in the TCM general river recreation demand function consistent with that identified in the reservoir recreation TCM model (AEI, 1999a), yields a value of $77 per trip of 2.5 days or $30.67 per day. This resulting value per day is more consistent with the literature on the value of non-boating types of river-related recreation activities that a majority of respondents indicated in the survey. This recreation value, $30.67 per day, is considered the low NED value for general river recreation in the following analysis. A similar definition of the price variable consistent with Normandeau et al.'s (1999) reservoir angler travel cost per mile is used with the contingent behavior TCM to estimate the value of salmon and steelhead fishing in the reservoirs ($38 per day) with the non-drawdown alternatives. This $38 per day is considered the low NED value for mainstem anadromous fishing under Alternative 4—Dam Breaching, while the $87 per day is considered the high NED value. The high NED value is more consistent with the value of salmon and steelhead river fishing in the literature reviewed in Walsh et al. (1992).

3.2.6 General River Recreation Methodology

3.2.6.1 Estimated General River Recreation Demand

In addition to providing data for valuation of near-natural river recreation, the contingent behavior survey also provided the means to estimate visitor use to a free-flowing lower Snake River. The contingent behavior survey allowed respondents to indicate whether they would: a) definitely visit the Lower Snake River if the dams were removed and the river restored; b) probably visit; c) probably not visit, d) definitely not visit. These four categories were used so that respondents could express their degree of certainty in their decision and to facilitate a sensitivity analysis in the estimation of visitor use. Research by Champ et al. (1997) indicates that respondents expressing a high degree of certainty in intended behavior had a much higher correspondence with actual behavior. Thus, using just visitation rates of those indicating they would definitely visit should yield a valid indicator of actual visitation of respondents. However, this estimate may have a conservative bias because it assumes zero visitation from those indicating they would probably visit. Some of the people indicating they would probably visit would likely visit, but perhaps not at as high a rate as they indicate in the survey. The second river recreation visitor use estimate includes these probably visit responses.

Besides certainty of visitation, the generalization of the sample to the population must account for response rate effects. One view might be that those without sufficient interest to return the survey would not visit at all. An alternative view is that some people just do not return surveys period, regardless of the topic and surely some of those people would visit a free flowing lower Snake River. Based on direction provided by the DREW Recreation Workgroup, the Draft FR/EIS presented the results for four different visitation estimates based on the response categories. Use estimates ranged from low (definitely yes, with the response rate adjusted) to high (definitely plus probably yes, with no response rate adjustment). In response to the IEAB comments that the river recreation analysis would be improved by just focusing on the most likely cases, this analysis now provides two estimates of river recreation demand and benefits.

The first visitor use estimate of demand is calculated by taking the visitation rate of just those respondents that indicated they would definitely visit (i.e., assuming no visitation from those that said they would probably visit) but assuming that households that did not respond to the survey would visit at the same rate as households that responded to the survey. The second visitor use estimate consists of households that indicated they definitely *or* probably would visit, but assumes that survey non-respondents would not visit.

Each of these estimates balances a conservative element with an optimistic one. The first estimate being conservative by only using visitors definitely certain they would visit, but then applying that fraction to all households in the sample strata (assuming survey non-respondent households will visit at the same rate as survey respondent households). For example, in Table 3.2-7 only 5.9 percent of households in the rural Washington counties surrounding the lower Snake River said they would definitely visit. This 5.9 percent was then extrapolated to the total number of households in this area (347,300) to calculate the number of visitors, assuming that households that did not respond to the survey would visit at the same rate as those that did respond. It should be noted that this assumes that only one person from each household would visit, which may be considered a conservative assumption.

The second estimate uses the visitation rates from survey respondents who said that they would definitely visit the river, as well as those who said they would probably visit. This combined visitation rate is then applied to just that proportion of local households equivalent to the survey response rate. For example, 25.9 percent of survey respondents from the rural Washington counties indicated that they would definitely or probably visit a free-flowing lower Snake River (see Table 3.2-7). Under Estimate 2, assuming that survey non-respondents would not visit, this 25.9 percent was then extrapolated to just the percentage of local households equivalent to the survey response rate (152,222 households) and not to the total number of households. These two approaches produce what are termed middle visitor use estimates that should be closer to the visitation rate that would be observed if Alternative 4—Dam Breaching were implemented and should provide a narrower range than the wider ranges produced by the original four estimates in the Draft FR/EIS. The application of these two approaches to each household sample strata is presented in Table 3.2-7.

The number of trips are converted to visitor days in Table 3.2-7 because the trips are of different lengths. This also facilitates valuation in subsequent tables where values are expressed on a per day basis. A minor, but important, change from the Draft FR/EIS is the average length of stay of the California trips. In the Draft FR/EIS this was calculated at 12 days per trip. In this analysis it ranges from 4 to 5.86 days per trip. The difference is largely due to removal of one outlier observation that reported a length of stay of 250 days.

Unlike current conditions, the contingent behavior survey results predict that a large percentage of total general recreation visitation to a free flowing lower Snake River would originate in distant areas, such as Portland, Seattle, and California. The two middle estimate scenarios presented here indicate, for example, that 20 percent to 45 percent of the total days would be from California, depending on the sample expansion assumptions. This percentage of days is consistent with the fact that California represents 60 to 70 percent of the population of the sampling area.

Table 3.2-7. Disaggregated Natural River General Recreation Demand Estimates

	Percent Visiting	Number of Households	Estimated Number of Visitors	Number of Trips per Visitor	Days per Trip	Total Days Demanded
Rural Washington						
Middle Estimate 1	5.9	347,300	20,491	6.7	2.96	406,372
Middle Estimate 2	25.9	152,222	39,425	3.41	2.36	317,280
Rural Oregon						
Middle Estimate 1	1.16	30,400	353	6	1.85	3,914
Middle Estimate 2	19.7	13,437	2,647	2.12	1.85	10,382
Rural Idaho						
Middle Estimate 1	7.3	38,700	2,825	9.25	1.41	36,846
Middle Estimate 2	22.5	17,527	3,944	5.13	1.47	29,739
Rest of Washington						
Middle Estimate 1	4.7	2,103,000	98,841	1.57	2.75	426,746
Middle Estimate 2	15.4	833,419	128,347	1.34	3.17	545,190
Rest of Oregon						
Middle Estimate 1	2.9	1,227,300	35,592	2	4.37	311,071
Middle Estimate 2	18.8	518,289	97,438	1.18	3.45	396,671
Rest of Idaho						
Middle Estimate 1	3.05	425,400	12,975	0.75	2.5	24,328
Middle Estimate 2	9.5	199,428	18,946	1.2	4.8	109,127
Montana						
Middle Estimate 1	0.7	337,800	2,365	2	3	14,188
Middle Estimate 2	8.3	156,266	12,970	1	3.79	49,157
California						
Middle Estimate 1	0.68	10,998,600	74,790	1	4	299,162
Middle Estimate 2	9.80	2,374,598	232,711	0.93	5.86	1,268,226
Total						
Middle Estimate 1			**248,231**			**1,522,627**
Middle Estimate 2			**536,427**			**2,725,772**

Notes: 1. Middle Estimate 1 uses only those respondents that would definitely visit, but then expands this proportion to the total number of households in the survey strata area.

2. Middle Estimate 2 uses those respondents that would definitely or probably visit, but only applies this to the proportion of households responding to the survey (assumes zero visitation for the proportion of households not returning the survey).

This change in distribution of the origin of visitors with the free-flowing river also is consistent with the pattern found in AEI's travel cost analyses of actual visitation. Specifically, the current reservoirs are primarily local-use areas with most visitors coming from within 100 to 120 miles (Normandeau et al., 1999; AEI/University of Idaho, 1999a). However, in the free-flowing river sections of central Idaho, 21 percent of the river visitors come from 1,000 miles or more away, with 12 percent coming from 1,500 miles or further (AEI/University of Idaho, 1999b, 1999c). This pattern is consistent with the lack of availability of substitute rivers of the size and magnitude of the lower Snake River with the dams breached. Thus, people are willing to travel greater distances to visit free-flowing rivers. Besides the limited number of major rivers in the western United States, many existing rivers such as the Rogue, Salmon, or Colorado have use limits, and permits are rationed by lottery. By contrast, reservoir visitors do not have to travel great distances as there are numerous reservoirs in the local area, including Lake Wallula downstream from Ice Harbor Dam very near the Tri-Cities area, Dworshak reservoir near Lewiston, Idaho, and three large lakes near Spokane, Washington.

3.2.6.2 Recreation Suitability and Carrying Capacity

These demand estimates are phased in over time as the natural river system recovers from dam breaching. Table 3.2-8 presents the expected suitability of the area for river recreation following dam breaching. This table, initially developed by Corps recreation planners, was refined and applied to the dam breaching household survey estimates of visitor demand. The numbers are expressed as a percentage of full suitability. Therefore, 60 percent suitable means that the area is suitable only for 60 percent of visitor demand. As can be seen in this table, some activities recover more slowly than others, but all reach 100 percent by 20 years after dam breaching. Fourteen recreation activities, identified by the DREW Recreation Workgroup in conjunction with Corps' recreation planners, were presented as choices in the contingent behavior household survey. Three of these activities involved angling. The remaining 11 non-angling or general recreation activities are grouped in Table 3.2-8 by similarity in terms of the river for that type of activity and the need for common facilities or recreation resources.

Further, the demand estimates were compared to the availability of developed campsites, dispersed camping areas, and boat-ramp capacity to determine how much of the estimated post-dam breaching demand could be accommodated by existing recreation facilities. The visitation estimates for general river recreation, presented in Table 3.2-8, reflect the application of these capacity constraints to the demand estimates. Corps recreation planners provided information on the number of boat ramps, developed campsites, and suitable areas for primitive camping. In order to calculate visitor day capacities, the recreation season was assumed to extend from April through October. This time period coincides with spring break through the steelhead fishing season, as well as summer vacations. This area is attractive in spring and fall, due to the warm temperatures. While rather hot during the summer, the area receives high use during the vacation months of July and August. Given the average party size of three persons, the maximum number of visitor days that could be accommodated between April and October was calculated based on the current number of developed campsites. This figure limited the amount of developed camping and primitive camping demand that could be accommodated.

By the end of the first decade, the river areas would have sufficiently stabilized and the number of developed campsites is assumed could be doubled, fully meeting the demand projected under Middle Estimate 1 and 2.[6] Primitive camping and picnicking would be substantially limited during the first few years until the receding beaches become suitable for camping and picnicking. The general river recreation benefits associated with each time increment (e.g., year 5, 10, 20 to 100) are presented in Table 3.2-9. The high and low NED values per day, $160 and $30.67, respectively, are multiplied by the annual use in each time period to calculate annual benefits per time period. These benefits per time period are then used to calculate Net Present Values (NPVs) which are then annualized into average annual equivalent values (AAEVs) (Table 3.2-9).

[6] The development and operation and maintenance costs associated with doubling the number of developed campsites are discussed in Section 3.2.8.

Table 3.2-8. General River Recreation Suitability Recovery Factors, Capacity Constraints, and Projected Visitor Use

Recreation Suitability Recovery Factors	Suitability Factors (Percent)			
ACTIVITY	**Year 1**	**Year 5**	**Year 10**	**Year 20 to 100**
Jet Boating, Jet Skiing	20	50	70	100
Raft/Kayak/Canoe	30	40	80	100
Swimming	20	40	100	100
Picnic/Prim Camp	80	100	100	100
Develop Camping	60	90	100	100
Hike and Mountain Bike	80	100	100	100
Hunting	50	80	100	100

Middle Estimate 2		Projected Visitor Use			
ACTIVITY	**Visitor Days Demanded**	**Year 1 Use**	**Year 5 Use**	**Year 10 Use**	**Year 20 to 100 Use**
Jet Boating, Jet Skiing	103,579	20,716	51,790	72,506	103,579
Raft/Kayak/Canoe	335,270	100,581	134,108	268,216	335,270
Swimming	329,818	65,964	131,927	329,818	329,818
Picnic/Prim Camp	763,216	<u>167,400</u>	<u>167,400</u>	<u>558,000</u>	<u>558,000</u>
Develop Camping	425,220	<u>219,294</u>	<u>219,294</u>	425,220	425,220
Hike and Mountain Bike	659,637	527,709	659,637	659,637	659,637
Hunting	109,031	54,515	87,225	109,031	109,031
Total Visitor Days	**2,725,772**	**1,156,179**	**1,451,381**	**2,422,428**	**2,520,556**

Note: Underlined numbers are constrained by available capacity.

Table 3.2-9. Projected General River Recreation Visitor Days and Recreation Benefits ($ millions) (1998 dollars) (6.875 percent discount rate)

	Year 1	**Year 5**	**Year 10**	**Year 20-100**	**Value**
Total Visitor Days	1,156,179	1,451,381	2,422,428	2,520,556	
High NED Recreation Value	$185.0	$232.2	$387.6	$403.3	
NPV at 6.875%					$4,516.5
AAEV at 6.875%					$310.5
Low NED Recreation Value	$35.5	$44.5	$74.3	$77.3	
NPV at 6.875%					$865.8
AAEV at 6.875%					$59.5

Notes: 1. NPV – net present value
2. AAEV – average annual equivalent values

Recreational Fishing Methodology

The DREW Anadromous Fish Workgroup provided estimates of the number of salmon and steelhead that would be available for recreational harvest under each alternative. These estimates were based on the preliminary PATH analysis with additional assumptions made to extend the PATH findings to all Snake River stocks. The DREW Anadromous Fish Workgroup also used information from various international and national fishery treaties to allocate total projected stocks to commercial, tribal, andrecreational catches (see Section 3.5.3). The biological availability of salmon and steelhead for recreational harvest was used to constrain the river angler demand calculated from the household survey data. Specifically, only the portion of river angler demand compatible with salmon and steelhead available for recreational harvest was counted in any given year. This resulted in only a small fraction of estimated river angler demand being met. This would be about 6 percent of the low estimate of salmon angler demand. The same pattern is evident for steelhead, where numbers of fish available for recreational harvest would limit anglers to an annual average of 100,000 days on the mainstem of the lower Snake River over the period of analysis. This represents 50 percent of the lowest estimated demand.

The following sections discuss the calculation procedures used to estimate the NED values associated with fishing for resident fish along the lower Snake River, as well as those associated with salmon and steelhead fishing in the tributary area, as defined by PATH.[7] The PATH tributary area encompasses the entire Snake River watershed above Lower Granite Dam, including the Lower Granite reservoir. In the case of steelhead, projected returns are divided between anglers on the Lower Granite reservoir (15 percent) and anglers upriver of Lewiston, Idaho (85 percent). This division is necessary to account for the difference in angler days calculated for these areas. The steelhead value per day calculated for a free-flowing lower Snake River was based upon the contingent behavior survey. The corresponding value for steelhead upriver of Lewiston was based upon the TCM survey of existing users (Normandeau et al., 1999).

The following sections describe the calculation procedures used to estimate the NED benefits associated with anglers:

- fishing for resident fish in the 140-mile stretch of the lower Snake River from Lewiston, Idaho to the lower Snake River's confluence with the Columbia River
- fishing for steelhead in the Lower Granite reservoir
- fishing for steelhead in the tributary area, which in this case is defined as the entire Snake River watershed above Lewiston, Idaho
- fishing for salmon in the tributary area, as defined by PATH—this area encompasses the entire Snake River watershed above Lower Granite Dam, including Lower Granite.

The recreational angling effects for salmon and steelhead below Lower Granite Dam, in the lower Columbia River, and in the ocean are addressed in Section 3.5.4.

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[7] This is an adjustment to the geographic areas covered in Sections 3.2 and 3.5 of the Draft FR/EIS appendix. This adjustment was necessary to ensure that anadromous fish-related recreation benefits were not double counted, while at the same time ensuring that none of the potential benefits were omitted.

3.2.7.1 Resident Fish and Lower Granite Reservoir Steelhead

Alternatives 1 through 3

In order to estimate the number of angler trips associated with resident fish and steelhead, information from the current reservoir fishing trips and fishing trips in the free-flowing stretch of the Snake River above Lewiston, Idaho were tabulated. These trips were separated into resident fish species and steelhead trips based on information from the Normandeau et al. (1999) analysis. Normandeau et al. generally concluded that there would be minor effects on resident fish under Alternatives 1 through 3, with existing resident fishing trips and their value likely continuing into the future. The remaining steelhead trips were related to baseline steelhead harvest figures to calculate the number of trips per steelhead harvested. This factor was applied to the future estimates of steelhead developed by the DREW Anadromous Fish Workgroup to calculate the number of future steelhead fishing trips under Alternatives 1 through 3. This catch per unit effort approach for steelhead is consistent with the approach used in Section 3.5.4 to calculate the recreation benefits of ocean and lower Columbia River fishing.

Alternative 4—Dam Breaching

Information on acres of habitat quantity and productivity per hectare (ha) was used to estimate the potential effects of dam breaching on mainstem resident fish (Normandeau and Bennett, 1999). With dam breaching, the surface area of habitat would fall from 13,715.3 to 5,326.7 ha (33,890 to 13,162 acres). However, estimated biomass (the total weight of all resident fish) would increase from 50.9 to 84.7 kilogram/ha (kg/ha) under free-flowing river conditions. Combining these two factors would result in a net loss because the loss in habitat area would be greater than the gained productivity. This net loss would be about a one-third reduction in resident fish carrying capacity with dam breaching. The estimated resident fishing benefits with Alternative 4—Dam Breaching would, therefore, be two-thirds of estimated current resident angler trips and benefits.

Two approaches were used to estimate the number of steelhead fishing days in the former Lower Granite reservoir stretch of the lower Snake River under Alternative 4—Dam Breaching. The first used the catch per unit effort approach, which involved taking the hours needed to harvest a steelhead and converting these angler hours to angler days. Because this was the same information used in formulating the baseline steelhead catch rate in the contingent behavior survey, the same number was used (24 hours to harvest one steelhead) (Idaho Department of Fish and Game). The average steelhead angler in the near-natural section of the lower Snake River fishes 7.2 hours per day (Normandeau et al., 1999). This approach assumes that angler days would increase in proportion to harvest levels. This first approach is similar to the DREW Anadromous Fish Workgroup's analysis of recreational fishing use in the lower Columbia River in response to increase availability of fish for recreational harvest. This approach is based on the view that increased harvestable fish will cause an entry or re-entry of anglers, and anglers taking more trips but that the value per day does not change.

An alternative approach suggested by the IEAB is that recreation use may not change, but that the value per day would change. Since the contingent behavior survey TCM did not lend itself to evaluating this approach, the IEAB suggested reliance on the Donnelly et al. (1985) analysis of how value per trip increases with greater catch rates. A value per day elasticity was calculated from the Donnelly et al. report and applied to the increase in projected recreational fish harvest assuming no change in angler days. This provided a lower bound estimate of the gain in recreational fishing benefits under each alternative. The IEAB noted that a best estimate likely lies between these two approaches with an increase in angler days, as well as an increase in the value per day occurring in response to increased numbers of fish available for harvest. The exact proportions of this change cannot, however, be determined with the available data at this time. Therefore, this analysis takes the mid-point of the two estimates to equally reflect both approaches. By itself this mid-point approach would lower the anadromous fishing recreation benefits from those presented in the Draft FR/EIS. However, clarification in PATH's fish numbers resulted in higher projected numbers of anadromous fish being available for recreation harvest, which partially offset the effect of using the midpoint approach.

The economic values associated with fishing for resident fish in the lower Snake River and fishing for steelhead in the Lower Granite reservoir are combined into one category (Resident and Steelhead) in the summary tables and discussion presented in Section 3.2.8.

3.2.7.2 Steelhead Fishing above Lewiston, Idaho

This analysis used an approach similar to that used to estimate the number of steelhead fishing days in the Lower Granite reservoir. The DREW Anadromous Fish Workgroup estimated recreational steelhead harvests in the tributaries for each alternative. Eighty-five percent of these estimated harvests were assigned to the tributary area above Lewiston, Idaho. The remaining 15 percent were assigned to the Lower Granite reservoir. Trips per steelhead above Lewiston in year zero were calculated by dividing the current number of steelhead fishing trips (129,026 trips) in central Idaho tributaries of the Snake River, as estimated by AEI/University of Idaho (1999b), by the number of steelhead projected to be available for recreational harvest in year zero. This steelhead-per-trip figure was then applied to the DREW Anadromous Fish Workgroup's estimate of the number of steelhead over the 100-year period of analysis. Both change in angler days and a change in value per angler day approaches were calculated, with the mid-point between these two analyses used for the main analysis.

The economic values associated with fishing for steelhead above Lewiston, Idaho are identified as Steelhead-Tributaries in the summary tables and discussion presented in Section 3.2.8.

3.2.7.3 Salmon Fishing above Lower Granite Dam

The number of days of salmon fishing for each alternative was estimated using the same methods described above for steelhead, except that the angler hours were specific to salmon, with an estimated 35 hours required to recreationally harvest one salmon. This information, obtained from a special recreational salmon fishing season on the Hanford Reach of the Columbia River, was used as the low salmon fishing catch rate baseline in the contingent behavior recreation survey. This figure was then applied to the DREW Anadromous Fish Workgroup's estimate of recreational harvest allocation for spring/summer and fall chinook salmon under each alternative and in each time period to estimate total hours of salmon fishing. As with steelhead, the average length of a fishing day was calculated as 6.72 hours for Idaho rivers based on AEI/University of Idaho (1999b). The same two approaches were used to estimate the number salmon fishing days under Alternative 4—Dam Breaching. The first approach assumed that the value per day would remain constant but the number of anglers days would increase in proportion with the increase in fish. The second approach adopted in response to the IEAB assumed that the number of recreation days would remain constant but the value per day would increase. The mid-point of these two approaches was then used as the value for the main analysis below.

The economic values associated with fishing for salmon in the Snake River watershed above Lower Granite Dam are identified as Salmon-Tributaries in the summary tables and discussion presented in Section 3.2.8.

3.2.7.4 Estimation of the Value per Angler Day

The estimate of salmon fishing benefits came from the contingent behavior survey performed by the DREW Recreation Workgroup (1999), described above. With Alternatives 1 through 3, mainstem lower Snake River salmon fishing would take place in a reservoir setting. Therefore, the salmon fishing value per day applied came from the demand curve scaled by the reservoir anglers' cost per mile obtained from the reservoir fishing analysis. This value was $38 per day for salmon fishing. This was also the low value for the free-flowing river under Alternative 4—Dam Breaching. The high value for Alternative 4—Dam Breaching reflected scaling the demand curve by the reported costs of anglers who said they would come to fish the free-flowing lower Snake River ($87 per day).

To estimate the benefits of steelhead fishing in the free-flowing lower Snake River, the contingent behavior TCM was used. The revision of this analysis yielded a low and high value per day ($38 and $87, respectively). The low NED value is based on the demand curve scaled by the cost per mile for reservoir anglers, which was developed from the results of the reservoir angler survey. The high NED value is based on the results of the Natural River Contingent Behavior survey.

To be consistent with McKean's TCM, fishing for anadromous fish in the reservoirs with Alternatives 1 through 3 is valued using the low NED value. Anadromous fishing in the free flowing river under Alternative 4—Dam Breaching, is shown using both the low NED value and the high NED value (although, for purposes of estimating a point estimate for Alternative 4—Dam Breaching, the high NED value for river angling for anadromous fish is used later).

3.2.8 Summary of Recreation Results

Annual values projected over the 100-year study period were used to calculate the present and annualized value of recreation. When using a positive discount rate, the timing of when the different recreation benefits were received would influence the present or annualized value of recreation under each alternative. The time profile of benefits would differ among the alternatives. Alternative 1—Existing Conditions currently provides non-fishing reservoir recreation benefits that would probably continue each year into the future. However, future fishing benefits would be influenced by recent actions taken to enhance steelhead and salmon populations. The fishery recreation benefits of Alternative 1—Existing Conditions would differ slightly from simply extrapolating the current annual benefits. The future recreational fishing benefits for Alternative 1—Existing Conditions were derived by using PATH estimates of steelhead and salmon recreational harvests. Alternatives involving major system improvements or dam breaching would require several years to deliver some of their benefits and several decades for the salmon fishing benefits to be fully realized.

Annual values projected over the 100-year study period were used to calculate the present and annualized value of recreation. To compare relative worth today, the present worth or present value was calculated using three discount rates: 6.875 percent, 4.75 percent, and 0.0 percent. Positive discount rates weigh benefits (and costs) in the near future more heavily than those in the more distant future. A discount rate of 0.0 percent, in contrast, weighs all benefits and costs equally over time. The present value of recreation benefits over the 100-year period was converted into average annual equivalent values. The ranking of the proposed alternatives is the same using the average annual or present values.

3.2.8.1 NED Benefits

Average annual NED recreation benefits are presented by alternative and discount rate in Tables 3.2-10 through 3.2-12. Each table calculates the benefits of Alternative 4—Dam Breaching using both the low and the high NED values per day. The low NED value is based on scaling the river recreation and river fishing demand curve using the cost per mile of reservoir visitors obtained from the reservoir fishing analysis. The high NED estimate is based on scaling the demand curve using the costs of visitors to the free-flowing section, as reported in the DREW Recreation Workgroup's contingent behavior survey. Overall benefit estimates are presented using the two middle-use estimates for river recreation. The first middle-use estimate uses the visitation rates from survey respondents who said that they would definitely visit, but then expands this proportion to the total number of households in the survey strata area (assuming survey non-respondent

Table 3.2-10. Annualized (AAEV) Value of Recreation Benefits over 100 Years ($ millions) (1998 dollars) (6.875 percent discount rate)

Alternative	1	2	3	4 Low NED	4 High NED
General Recreation					
Reservoir Recreation	31.600	31.600	31.600		
River Recreation (Middle Estimate 1)[1/]				36.900	192.700
River Recreation (Middle Estimate 2)[2/]				59.500	310.500
Angling					
Resident and Steelhead	2.073	2.079	2.079	7.274	15.917
Steelhead-Tributaries	17.731	18.911	18.959	21.092	48.634
Salmon-Tributaries	0.151	0.180	0.176	0.273	0.633
Total Recreational Fishing	19.955	21.170	21.214	28.639	65.184
General Recreation and Angling					
Total Reservoir	**51.555**[3/]	**52.770**	**52.814**		
Total Middle Estimate 1[1/]				**65.539**	**257.884**
Total Middle Estimate 2[2/]				**88.139**	**375.684**

1/ Middle Estimate 1 uses only those respondents that would definitely visit, but then expands this proportion to the total number of households in the survey strata area.

2/ Middle Estimate 2 uses those respondents that would definitely or probably visit, but only applies this to the proportion of households responding to the survey (assumes zero visitation for the proportion of households not returning the survey).

3/ The total annual benefits associated with Alternative 1—Existing Conditions ($51,555 million) do not match the existing benefits presented in Table 3.2-4 ($82,224). There are two main reasons for this difference. First, the Central Idaho General Recreation category ($43.4 million in Table 3.2-4) is not included in this table because general (i.e., non-angling) recreation in Central Idaho would be the same for all alternatives. Second, the annual benefits associated with steelhead angling in the tributaries are higher in this table than in Table 3.2-4. This is because the data presented in Table 3.2-4 are based on existing catch per year, while the values in this table are annualized values based on projected increases in harvest over the next 100 years. In addition, the estimates in Table 3.2-4 are based on the original TCM value per trip, while the estimates in this table use the contingent behavior TCM value per trip.

Table 3.2-11. Annualized (AAEV) Value of Recreation Benefits over 100 Years ($ millions) (1998 dollars) (4.75 percent discount rate)

				4	
Alternative	**1**	**2**	**3**	**Low NED**	**High NED**
General Recreation					
Reservoir Recreation	31.600	31.600	31.600		
River Recreation (Middle Estimate 1)1/				38.900	202.900
River Recreation (Middle Estimate 2)2/				63.100	329.200
Angling					
Resident and Steelhead	2.061	2.072	2.072	7.722	16.986
Steelhead-Tributaries	18.663	19.803	19.821	22.649	52.230
Salmon-Tributaries	0.169	0.203	0.195	0.348	0.807
Total Recreational Fishing	20.893	22.078	22.088	30.719	70.023
General Recreation and Angling					
Total Reservoir	**52.493**	**53.678**	**53.688**		
Total Middle Estimate 11/				**69.619**	**272.923**
Total Middle Estimate 22/				**93.819**	**399.223**

1/ Middle Estimate 1 uses only those respondents that would definitely visit, but then expands this proportion to the total number of households in the survey strata area.
2/ Middle Estimate 2 uses those respondents that would definitely or probably visit, but only applies this to the proportion of households responding to the survey (assumes zero visitation for the proportion of households not returning the survey).

Table 3.2-12. Annualized (AAEV) Value of Recreation Benefits over 100 Years ($ millions) (1998 dollars) (0.0 percent discount rate)

				4	
Alternative	**1**	**2**	**3**	**Low NED**	**High NED**
General Recreation					
Reservoir Recreation	31.600	31.600	31.600		
River Recreation (Middle Estimate 1)1/				44.700	233.400
River Recreation (Middle Estimate 2)2/				73.700	384.400
Angling					
Resident and Steelhead	2.127	2.142	2.139	9.330	20.748
Steelhead-Tributaries	22.263	23.009	22.895	28.017	64.600
Salmon-Tributaries	0.228	0.272	0.257	0.642	1.483
Total Recreational Fishing	24.618	25.423	25.291	37.989	86.831
General Recreation and Angling					
Total Reservoir	**56.218**	**57.023**	**56.891**		
Total Middle Estimate 11/				**82.689**	**320.231**
Total Middle Estimate 22/				**111.689**	**471.231**

1/ Middle Estimate 1 uses only those respondents that would definitely visit, but then expands this proportion to the total number of households in the survey strata area.
2/ Middle Estimate 2 uses those respondents that would definitely or probably visit, but only applies this to the proportion of households responding to the survey (assumes zero visitation for the proportion of households not returning the survey).

households would visit at the same rate as survey respondent households). The second estimate uses the visitation rates from survey respondents that would either definitely or probably visit, but only extrapolates this finding to the proportion of households responding to the survey (assuming zero visitation for the proportion of households not returning the survey) (see Section 3.2.6.1).

Fishing benefits would increase over time under all four alternatives, with PATH estimates showing the largest salmon and steelhead gains under Alternative 4—Dam Breaching. Applying the revised values per angler day and the mid-point approach to estimating river angling benefits yields an estimated annualized benefit (at 6.875 percent) of $21 million for Alternatives 2 and 3 (see Table 3.2-10), about $2 million less than the original estimate presented in the Draft FR/EIS. The estimate for the low NED value of Alternative 4—Dam Breaching is $29 million annually, and $65 million annually with the high NED, with the latter being about $10 million higher than the DEIS analysis. These estimates changed from the Draft FR/EIS analysis due to use of the midpoint of change in angler days and angler value in response to increases in anadromous fish available for harvest, as well as clarification of PATH estimates of the number of anadromous fish available for recreational harvest. The risk and uncertainty section discusses the range of benefit estimates from these two different approaches.

Under Alternative 4—Dam Breaching, increased recreational fishing benefits net of Alternative 1—Existing Conditions using the low and high NED values would be $8.684 million and $45.228 million, respectively, at a 6.875 percent discount rate (see Table 3.2-13). As discussed in the following paragraphs, the point estimate developed for this analysis uses the high annual NED value of $45.228 million. Summary harvest data for project year 25 presented in Table 3.2-1 suggests that a total of 91,234 tributary fish would be available for harvest under Alternative 4—Dam Breaching, a net increase of 20,646 fish over Alternative 1—Existing Conditions. The large projected increase in benefits is mainly the result of two factors. First, there is currently little or no salmon fishing in the tributary area. The addition of salmon fishing, which according to the Washington Department of Fish and Wildlife has a low average success rate of 35 hours per fish, generates a large number of angler days. Steelhead fishing, according to the Idaho Department of Fish and Game, has a higher average success rate of 24 hours per fish. Second, the high NED value for angling on a free-flowing river is higher than the corresponding value for reservoir angling, $87 per day compared to $38 per day. This would result in an increase in benefits under Alternative 4—Dam Breaching for fish caught in what is presently the Lower Granite reservoir even if the number of fish did not increase after dam breaching.

The NED values associated with recreational fishing on the lower Snake River below Lower Granite Dam, recreational fishing on the lower Columbia River, and recreational ocean fishing are discussed in Section 3.5.4.

Table 3.2-13 illustrates the net effects of Alternatives 2 through 4, as compared to Alternative 1—Existing Conditions, calculated using the Corps discount rate 6.875 percent. Specifically, Table 3.2-13 shows the gain or loss in recreation benefits of each alternative compared to Alternative 1—Existing Conditions, which is used as the future baseline. Based on the PATH fish estimates (as extended from the PATH stocks to all stocks by the DREW Anadromous Fish Workgroup), there would be small gains in salmon and steelhead fishing under Alternatives 2 and 3 as compared to Alternative 1— Existing Conditions. The gains in recreation benefits with the Alternative 4—Dam Breaching high NED value would be significant, amounting to gains between $206 and

Table 3.2-13. Difference in AAEV Value of Recreation Benefits from Alternative 1—Existing Conditions ($ millions) (1998 dollars) (6.875 percent discount rate)[1/]

			4	
Alternative	**2**	**3**	**Low NED**	**High NED**
General Recreation				
Reservoir Recreation	0.000	0.000	(31.600)	(31.600)
River Recreation (Middle Estimate 1)[2/]			36.900	192.700
River Recreation (Middle Estimate 2)[3/]			59.500	310.500
Angling				
Resident and Steelhead	0.006	0.006	5.201	13.844
Steelhead-Tributaries	1.180	1.228	3.361	30.903
Salmon-Tributaries	0.029	0.024	0.122	0.481
Total Recreational Fishing	1.215	1.258	8.684	45.228
General Recreation and Angling				
Total Reservoir	1.215	1.258		
Total Middle Estimate 1[2/]			13.984	206.328
Total Middle Estimate 2[3/]			36.584	324.128
Total Point Estimate			**73.128**	

1/ This table presents the NED recreation effects estimated by the DREW Recreation Workgroup. The NED recreation effects estimated by the DREW Anadromous Fish Workgroup (ocean and mainstem recreational fishing) are not included in this table.

2/ Middle Estimate 1 uses only those respondents that would definitely visit, but then expands this proportion to the total number of households in the survey strata area.

3/ Middle Estimate 2 uses those respondents that would definitely or probably visit, but only applies this to the proportion of households responding to the survey (assumes zero visitation for the proportion of households not returning the survey).

$324 million annually. In the low NED case, the gain in recreation benefits would be between $14 and $36 million annually.

A point estimate for the most likely value for Alternative 4— Dam Breaching was calculated by combining the low NED value for the general recreation Middle Estimate 2 ($59.5 million at a 6.875 percent discount rate) with the high NED value for angling ($45.228 million) and subtracting the existing reservoir recreation value ($31.6 million). This results in an average annual NED gross benefit of $73.128 million. Adjusting this total to account for the average annual costs of the assumed doubling of campground sites (see Section 3.2.8.2), which are estimated to be $2.605 million, results in a net NED average annual recreation benefit of $70.523 million. This estimate does not, however, include the NED values associated with recreational fishing on the lower Snake River below Lower Granite Dam, on the lower Columbia River, or ocean recreational fishing. The average annual values associated with mainstem and ocean recreational fishing are estimated to be $732,000. Adding this total to the average annual point estimate developed by the DREW Recreation Workgroup ($70.524 million) results in total net average annual recreation benefits of $71.255. The estimated values for mainstem and ocean recreational fishing are addressed in Section 3.5.

The low NED general recreation values are consistent with the values in the literature for general recreation. Middle Estimate 2 is used because it accounts for the possibility of sample selection effects or, put slightly differently, the possibility that people who have a particular interest in this topic may be over-represented in the population of responses. This is particularly a concern for those areas that have especially low response rates. Middle Estimate 2 accounts for this possibility by only applying the survey results to a portion of the study area households equal to the survey response rate and assuming zero visitation from households not returning the survey. Middle Estimate 2 is also consistent with the approach used to estimate the contingent behavior TCM curves, which were developed based on data from both definitely yes and probably yes survey respondents. Although Middle Estimate 2 accounts for the possibility of sample selection effects, it is actually higher than Middle Estimate 1 because the gain in trips from the "probably yes" visitors is larger than the reduction in trips from accounting for the sample selection effect. The high NED value is used for angling because when adjusted for inflation this value is consistent with the values for anadromous fishing reported in Walsh et al. (1992).

3.2.8.2 Doubling of Campground Sites

The DREW Recreation Workgroup assumed that the existing number of developed campsites would double in the first decade following dam breaching. The benefits from this assumed doubling of developed campsites were included in the Draft FR/EIS, but the associated construction and O&M costs were not. These costs are discussed below.

The Corps obtained construction estimates from three sources. Each source provided a high and a low option and included estimates for real estate, utilities, construction of minimal service buildings and a swimming pool, and maintenance equipment. There are presently 500 existing campsites located between Lower Granite and Ice Harbor. The Corps estimate assumes that five campgrounds with 100 campsites each would be developed. The average annual cost, calculated over the 100-year study period using a 6.875 percent discount rate, is $2.605 million. This cost estimate is for all 500 campsites and includes average annual O&M costs of $1.794 million. It is assumed that these campsites would be located along the lower Snake River and would, therefore, be within the Reservoir Subregion defined for the regional analysis (see Section 6).

These costs are not included in the Implementation Cost analysis because it is uncertain whether these costs would actually materialize under the dam breaching scenario. Development of these campsites is, however, an important part of the recreation analysis. If dam breaching were to occur and these campsites were not built, the number of projected visitors who could be accommodated would be reduced. This would, in turn, reduce the projected NED benefits. If dam breaching were to occur and the campsites were built, the projected average annual recreation benefits would be reduced by $2.605 million each year. This results in total net NED average annual recreation benefits of $71.256 million. This total includes benefits estimated for general recreation and ocean, mainstem, and tributary recreational fishing (see Table 3.2-3).

3.2.8.3 Risk and Uncertainty

As in any survey and statistical analysis, there is a degree of uncertainty regarding the exact magnitude of the estimates of visitor use and recreation benefits. This section expands upon the potential range of river-visitor use estimates and provides a range of benefits per trip associated with the various recreation uses.

General reservoir recreation represents about 60 percent of the benefits of Alternatives 1 through 3. The reservoir value per trip from AEI/University of Idaho (1999a) is $71.31. The 95 percent confidence interval around the mean would be $47 to $148 per trip. Using the 95 percent confidence interval, the annual value of recreation would change from the mean estimate of $31.6 million to a low of $20.8 million to a high of $65.5 million annually.

The reservoir angling value per trip from Normandeau et al. (1999) is $29.23. The 95 percent confidence level around this mean would be $23.98 to $37.27 per trip. Using these values, the annual value of reservoir angling would range from the mean estimate of $1.96 million to a low of $1.67 million and a high of $2.61 million.

The risk and uncertainty for recreational steelhead fishing in the tributaries under Alternative 1—Existing Conditions was also calculated using the 95 percent confidence interval on the TCM regression model estimates of the benefits per trip of fishing. The resulting range is from $12.82 million at the lower 95 percent confidence interval to $28.6 million at the upper 95 percent confidence interval.

General river recreation benefits comprise 38 percent of the benefits for Alternative 4—Dam Breaching. The mean benefit per trip using the low NED value is $77 with a 95 percent confidence interval of $41 to $551 per trip. For the high NED angler values the mean value per trip is $292 with a 95 percent confidence interval of $214 to $460 per trip.

The benefits of recreational fishing improvements associated with a free-flowing lower Snake River could vary for a number of reasons in addition to the inherent uncertainty involved in the biological analysis that underpins the forecast harvest numbers. There is of course uncertainty as to whether to use the high NED value per day of fishing based on the anglers' reported cost per mile as the price variable in the TCM demand function versus using a lower variable cost per mile more consistent with reservoir angler expenditures. Second, is the angler response to increased salmon and steelhead populations. The analysis presented in this document uses the mid-point of two possible angler responses:

(a) the approach used in the Draft FR/EIS analysis, which assumed that higher salmon/steelhead catch rates induce proportionate increases in the number of anglers visiting the lower Snake River and the number of trips each angler takes.

(b) the approach suggested by the IEAB, which assumes that higher salmon/steelhead catch rates induce an increase in the value per angler day, but no increase in number of anglers or trips.

The IEAB recognized that the more accurate was likely a combination of the two, so it was decided to use the mid-point of these two approaches in this analysis. For the purposes of risk and uncertainty, it is useful to mention that angler benefits were about $3 million higher for Alternatives 2 and 3 using approach (a) than they were using approach (b). The difference was larger for Alternative 4—Dam Breaching. Angler benefits for Alternative 4—Dam Breaching using the low NED value were approximately $5 million higher using approach (a) than they were using approach (b). Using the high NED value, angler benefits for Alternative 4—Dam Breaching were $12 million higher using the first approach than they were using the second approach. The mid-points used in the preceding analysis essentially reduce these differences by about half, lowering angler benefits from the values calculated using approach (a) by about $1 to 2 million in Alternatives 2 and 3, and by $2 to $6 million in the low and high NED case for Alternative 4—Dam Breaching.

3.2.8.4 Avoided Cost Analysis

Breaching the dams would not result in the reduction of any significant recreation management costs for the Corps. Most of the Corps recreation maintenance cost is related to the developed campground areas and other developed facilities that would remain under all alternatives. The labor costs associated with rangers would continue as well.

3.2.8.5 Mitigation

The reservoir recreation effects from breaching the dams would not be directly mitigated. Most of the same water-based recreation would probably continue as today, with the major exception being activities such as waterskiing. The availability of existing nearby reservoirs such as Lake Wallula downstream from Ice Harbor Dam and near the Tri-Cities, Dworshak reservoir near Lewiston, Idaho, and three large lakes near Spokane (Rufus Woods Lake, Lake Coeur d'Alene, and Lake Pend Oreille) would continue to provide opportunities for flat-water recreation.

3.2.8.6 Conclusion

The net change from the base case (Alternative 1— Existing Conditions) is presented for Alternatives 2 through 4 in Table 3.2-13. Alternatives 2 and 3 would both provide benefits of about $1.2 million annually. The benefits projected for Alternative 4—Dam Breaching are presented in Table 3.2-13 as a range with low and high NED values. The low NED values are consistent with literature for general recreation, while the high NED values are consistent with literature for river angling. A point estimate for the most likely value for Alternative 4— Dam Breaching was calculated by combining the low NED value for the general recreation Middle Estimate 2 ($59.5 million at a 6.875 percent discount rate) with the high NED value for angling ($45.228 million) and subtracting the existing reservoir recreation value ($31.6 million). This composite would result in the most likely estimate of gross annual benefits of $73.128 million for Alternative 4—Dam Breaching. If dam breaching were to occur and the assumed doubling of campsites were built, the projected gross average annual recreation benefits would be reduced by $2.605 million each year, for a net benefit of $70.523 million per year. This estimate does not, however, include the NED values associated with recreational fishing on the lower Snake River below Lower Granite Dam, on the lower Columbia River, or ocean recreational fishing. These values, which are addressed in Section 3.5, are estimated to be $732,000. Adding this total to the average annual point estimate developed by the DREW Recreation Workgroup ($70.523 million) results in total net average annual recreation benefits of $71.255.

3.2.9 Concerns with the Recreation Analysis

In response to comments/concerns regarding the results of the DREW recreation analysis, the Corps contracted Foster Wheeler Environmental and Dr. Charles Harris of the University of Idaho to conduct an assessment and evaluation of the areas of concern. This evaluation primarily focused on the non-angling recreation estimates presented in the DREW recreation analysis. Concerns raised about this analysis included a general concern that the potential recreation benefits associated with dam breaching may be significantly overstated. The Foster Wheeler Environmental and Harris evaluation involved a series of data collection and analysis efforts intended to assess the reliability and validity of the DREW Recreation Workgroup's non-angling visitation estimates in two main ways. The first approach compared the DREW Recreation Workgroup's non-angling recreation visitation estimates with data on existing unimpounded rivers or river stretches. The second approach examined the survey methodology and results that were used to develop these estimates. The key findings of this evaluation are summarized below and discussed in more detail in the Foster Wheeler Environmental and Harris report (Foster Wheeler Environmental and Harris, 2001), which is available on the Corps' website at: http://www.nww.usace.army.mil/.

The purpose of the report was to assess and document concerns raised by the Corps and others. This report was not used to change the DREW analysis which is summarized in the preceding parts of Section 3.2. Rather, it highlights the remaining outstanding concerns with the recreation analysis and is intended to provide guidance to the reader and future analysis. In most cases, these concerns could not be directly addressed without substantial new information.

3.2.9.1 Comparison with Existing Visitation Estimates

Comparison of the DREW Recreation Workgroup's visitation estimates with data on other existing unimpounded rivers resulted in the following findings. These findings are discussed in more detail in Foster Wheeler Environmental and Harris (2001).

Estimated Number of Visitors

Viewed in terms of numbers of visitors, the future non-angling or general recreation demand estimates developed by the DREW Recreation Workgroup are higher than current visitation to existing free-flowing rivers/unimpounded river stretches. Middle Estimate 1 is more than twice as large as the estimated existing visitation to the lower Salmon River, which is the most heavily visited of the rivers selected for comparison (see Foster Wheeler Environmental and Harris, 2001). Middle Estimate 2 is about three times as large. This difference could be explained by the relative size of a near natural lower Snake River, which would be longer (140 miles) than the lower Salmon River (73 miles). It would also have an average mean daily discharge about five times as large as that of the lower Salmon River. Note, however, that Middle Estimates 1 and 2 are only for general or non-angling recreation and benefits associated with projected angling visitation to a near natural lower Snake River comprise over 60 percent of the NED point estimate. The estimate for the lower Salmon River includes both angling and non-angling visitation.

Origin of Visitors

Reviewers expressed concerns about the DREW Recreation Workgroup's decision to include California in the contingent behavior survey area, suggesting that the study area should have been limited to the Pacific Northwest based primarily on existing use patterns. Other reviewers have questioned the rationale for limiting the study area to the Pacific Northwest states and California, arguing that this was based on existing use patterns, when evidence suggests that recreationists are attracted from longer distances to visit free-flowing rivers (ECONorthwest, 2001).

Middle Estimates 1 and 2 predict that visitors from California would account for 30.1 percent and 43.4 percent of total visitation to a near natural lower Snake River, respectively. Middle Estimate 2 is used by the DREW Recreation Workgroup to develop the point estimate presented in the Final FR/EIS. A review of visitation data for existing free-flowing rivers/unimpounded river stretches suggests that it is unlikely that visitors from California would comprise this large a share of total visitation. Visitors from California, for example, comprised 5 percent of nonmotorized boating visitors to the lower Salmon River in 1999 (Garson et al., 2000a) and 4 percent of boaters surveyed on the lower Deschutes River in 2000 (Brown, 2001). Visitors from California did, however, account for a larger proportion of nonmotorized boaters visiting the Middle Fork of the Salmon River in 1995 (20 percent of private boaters and 25 percent of commercial boaters) (Hunger, 1996). These proportions are still below those projected under Middle Estimates 1 and 2 and there would be limited similarity between the type of recreation experience offered by the Middle Fork of the Salmon River and a near natural lower Snake River (see Foster Wheeler Environmental and Harris, 2001).

The data presented above for other rivers are just for nonmotorized boating, which the DREW recreation analysis estimates would account for just 12 percent of total non-angling recreation days demanded under Middle Estimate 2 (Table 3.2-8). The limited available data also suggests that visitors from California would be unlikely to comprise 30.1 or 43.4 percent of total visitation for other types of recreation activities, such as picnicking/primitive camping or hiking and mountain biking (see Table 3.2-8).

Survey data from the main Salmon River, the Middle Fork of the Salmon River, and the lower Salmon River do, however, support the idea that between 30.1 and 43.4 percent of visitation may come from outside the Pacific Northwest. Note, however, that the percentage of visitors from outside the Pacific Northwest varies by river and ranges from somewhere over 50 percent for private boaters on the Middle Fork of the Salmon River to just 9 percent for the lower Deschutes River. Further, these survey data are only for boating. The proportion of total visitation originating outside the region is likely to vary by activity and be lower for non-boating activities.

3.2.9.2 Review of Methodology and Results

The review of the DREW Recreation Workgroup's methodology and results presented in Foster Wheeler Environmental and Harris (2001) identified the following concerns. Key concerns raised by the Foster Wheeler Environmental and Harris analysis pertain to representativeness, nonresponse and strategic bias, and aggregation and extrapolation. Concerns also remain regarding transfer of recreation benefits. Finally, Economists on the Corps' staff remain concerned about the values per angler day employed in the DREW recreation analysis. This issue, summarized below, is not addressed in detail in Foster Wheeler Environmental and Harris (2001), which primarily focuses on non-angling estimates.

Representativeness

The overall response rate to the DREW Recreation Workgroup's Natural River Contingent Behavior (NR CB) Survey was 41.4 percent, which was below the minimum response rate of 50 percent called for by the DREW Recreation Workgroup in its study plan (AEI/Normandeau Inc., 1997). Due to delays in getting approval for the survey, the initial mailings were delayed into the Thanksgiving and Christmas holiday season. In addition, the DREW Recreation Workgroup was not allowed to include the monetary incentive it had originally proposed to include with the survey. These factors may have affected the survey response rates. An unusual third mailing via U.S. Postal Service Priority Mail was made in an attempt to obtain higher response rates.

Low response rates raise serious concerns about the representativeness of those who do respond. A common way to address these concerns is through a short follow-up survey of nonrespondents designed to assess how representative those responding are of the overall sample population. The DREW Recreation Workgroup did not conduct this type of survey and, as a result, serious concerns remain about the representativeness of those responses received, especially with respect to California where the response rate was just 21.3 percent.

Twenty percent of those who returned the recreation survey and indicated that they would definitely or probably visit a near natural lower Snake River, did not complete questions about either the activities they would participate in during a visit or the numbers of trips their household would take. This nonresponse creates concern, not only over the reliability of estimates of future intended trips, but also whether respondents felt they could validly respond to the hypothetical questions posed to them.

Nonresponse and Strategic Bias

Problems with nonresponse bias and strategic bias are well documented for these types of surveys in the academic and professional literature. (See Foster Wheeler Environmental and Harris, 2001 for more information.) Responses to the NR CB survey suggest at least two possible indicators of bias. First, the high nonresponse rates suggest that those responding might be those more concerned about advocating either “side” with respect to dam breaching (self-selection bias). Second, over 42 percent of those who said that they had visited the lower Snake River reservoirs in 1997 indicated that they would not visit a near natural lower Snake River. This may reflect the commitment of these individuals to reservoir recreation or it may be a form of strategic bias, whereby respondents are expressing opposition to dam breaching by stating that they would not visit.

Number of Visits Per Year

The NR CB survey asked those who said that they would definitely or probably visit a near natural lower Snake River to identify how many trips they would make to the river each year. The survey did not allow respondents to indicate that they would visit less frequently than once a year. This raises concerns that individuals may have felt compelled to indicate that they would visit at least once a year. This concern was raised in the IEAB’s review of the recreation section presented in the Draft FR/EIS. Dr. John Loomis, the principal investigator for the DREW Recreation Analysis, responded that nearly 10 percent of those responding that they would definitely or probably visit, reported expected annual trips of zero. Dr. Loomis noted that he viewed this as an indication that respondents who might only visit on occasional years did not feel constrained to report at least one trip a year and incorporated these responses into the TCM model. While it is possible that respondents did not feel constrained, the survey responses themselves provide little evidence one way or the other. If respondents who would visit less frequently than once a year felt compelled to indicate that they would visit at least once a year, this would result in an overestimate of the number of trips from more distant areas, where people are likely to visit less than once per year.

Extrapolation

In addition to a series of questions relating to a near natural lower Snake River, the NR CB survey also asked respondents if they had visited the lower Snake River reservoirs in the previous year (1997). Responses to this question can be used to check the validity of the survey data and the assumptions used to extrapolate the future use findings of the analysis to the target population.

Potential problems with the survey results and the extrapolation methodology employed are illustrated by the data for California. The DREW recreation analysis reported that approximately 3 percent of survey respondents from California indicated that they visited the lower Snake River in 1997. Using the expansion methodology employed in Middle Estimate 1 (i.e., expanding this 3 percent to the rest of the households in California), results in an estimated 74,790 visitors to a near natural lower Snake River. Based on a survey of actual visitors to the lower Snake River in 1997, AEI estimated there were an estimated 53,000 actual unique non-angler visitors. (An individual who visits many times a year is considered to be one unique visitor). The optimistic assumption that 5 percent of the visitors to the lower Snake River in 1997 were from California results in an estimated total of 2,700 (53,000 times 5 percent) unique visitors from California. This discrepancy (74,790 versus 2,700) raises concerns about the validity of the survey results and this expansion methodology. It also raises concerns with the net recreation benefits calculated for Alternative 4—Dam Breaching, which are the delta between the existing and projected estimates developed by AEI.

Transfer of Recreation Benefits

Approximately 36 percent of respondents to the NR CB Survey, or 1,324 people, reported that they would definitely or probably visit a near natural lower Snake River sometime in the future. Of these respondents, 80.2 percent, or 1,062 people, reported that they currently visit other free-flowing rivers. Significantly, of these, only 15 percent reported that they would take fewer trips to other rivers. AEI used the responses to this question to check the findings of their TCM model and concluded that this variable was insignificant and made no change in trip benefits (AEI, 1999a). Some researchers have found that a new supply of recreation can create new demand (e.g., Whitehead et al., 2000); however, the DREW recreation analysis appears to assume that all of the visits to a near natural lower Snake River would be in addition to trips already taken. If potential visitors would otherwise visit another location offering a similar type of recreation experience, a portion of the estimated NED benefits may in fact be a transfer from one location to another and not NED benefits.

Value per Angler Day

The DREW recreation analysis calculated a point estimate of annual average NED benefits of $70.523 million (see Table 3.2-13). The angling component of this estimate employs a value per angler day for a near natural lower Snake River of $87 per day. This is compared to a corresponding value of $38 per day for reservoir angling estimated by AEI. As noted in Section 3.2.8.1, using these different values means that Alternative 4—Dam Breaching would result in an increase in NED angling benefits for fish presently caught in Lower Granite reservoir even if the number of fish remained the same. The DREW recreation analysis justifies this higher value because, when adjustments are made for inflation, it is consistent with the values for anadromous fishing reported in Walsh, Johnson and McKean (1992). This higher value is not, however, consistent with the value per angler identified in the survey of existing steelhead anglers in the unimpounded stretch of the Snake River above Lewiston ($87 versus $35.71) that AEI conducted specifically for this project (see AEI, 1999c).

Using these different values ($87 per day projected versus $38 per day existing actual) means that Alternative 4—Dam Breaching would result in an increase in NED angling benefits for fish presently caught in Lower Granite Reservoir even if the number of fish remained the same. Under Alternative 4—Dam Breaching, an estimated 42 percent increase in the number of salmon and steelhead available for harvest (from 98,625 to 140,260 [Table 3.2-1]) results in the associated NED benefits increasing by about 325 percent (from $3,747,750 [98,625 * $38 per day] to $12,201,750 [140,250 * $87 per day]). In contrast, the value per angler day for resident fish is assumed to be the same under both current conditions and the dam breaching scenario. The DREW recreation analysis assumes that resident fish populations would be reduced by a third if dam breaching were to occur and, as a result, NED benefits associated with current angling for resident fish would be reduced by a third.

3.2.9.3 Projected Salmon and Steelhead Harvest Numbers

Estimates of the number of salmon and steelhead available for harvest were developed by the DREW Anadromous Fish Workgroup based on the findings of the 1998 PATH analysis, with additional assumptions made to extend the PATH findings to all Snake River stocks. These data were the most current during the DREW process. Additional analyses have been conducted since, resulting in the final 1999 PATH results and the CRI analysis.

The Scientific Review Panel (SRP), which was tasked to review the PATH analysis methods, found inconsistencies in the results of both the fall chinook and later the spring/summer chinook analysis developed by PATH. Adjustments made to a number of factors of concern in the original PATH analysis resulted in higher adult return predictions under Alternatives 1 through 3, which reduced the net difference between the three dam retention alternatives and Alternative 4—Dam Breaching. The adjusted PATH results were supported by the CRI modeling results. While CRI did not specifically estimate returning numbers of fish due to Alternative 4—Dam Breaching, it did indicate that the PATH results for dam breaching and for all other alternatives were optimistic. CRI results suggest there are few remaining survival improvements that can be achieved from modification of the hydrosystem (i.e., Alternatives 1, 2, and 3); however, while these results suggest that Alternative 4—Dam Breaching has a slight benefit over the other alternatives, these benefits were generally still inadequate by themselves to prevent extinction of all stocks.

These analyses and the associated risk and uncertainty for the NED analysis conducted for this study are discussed in Sections 8.3 and 8.4. Using a 6.875 percent discount rate, recreational angling represents about 62 percent of the NED recreation benefits projected by the DREW Recreation Workgroup for Alternative 4—Dam Breaching.[8] These benefits are net of Alternative 1—Existing Conditions. If as the final PATH results and the CRI analysis suggest, the difference between the dam retention alternatives (Alternatives 1, 2, and 3) and Alternative 4—Dam Breaching is less than projected by the preliminary PATH results, the net NED angling recreation benefits for Alternative 4 would be lower than those estimated in the DREW recreation analysis.

[8] This total does not include the ocean and mainstem NED recreation benefits estimated by the DREW Anadromous Fish Workgroup (see Section 3.2.2).

The assumptions used by the DREW Anadromous Fish Workgroup could also have resulted in the net NED angling recreation benefits for Alternative 4—Dam Breaching being overestimated. The preliminary PATH results were expanded by the DREW Anadromous Fish Workgroup working in coordination with staff from NMFS and members of PATH to represent all Snake River wild and hatchery stocks. This expansion was necessary to assess the economic effects of future harvests under different alternatives and required that a number of assumptions be made. Existing hatchery production and operation policies were assumed to continue for all of the proposed alternatives.

This assumption resulted in hatchery stocks comprising a very large proportions of the projected harvest increases under Alternative 4—Dam Breaching; however, many of these hatchery operations were built as mitigation for the lower Snake River dams effects on anadromous fish stocks. If dam breaching were to occur, the original purpose of these hatcheries would be removed. The status of future hatchery operations has not yet been determined for Alternative 4—Dam Breaching, which raises questions about the magnitude of hatchery fish projected to be available for recreational harvest. This issue is discussed in more detail with regard to projected tribal harvests in Section 5.6.1.1.

3.3 Transportation

The four alternatives being evaluated in this FR/EIS are: Alternative 1—Existing Conditions, Alternative 2—Maximum Transport of Juvenile Salmon, Alternative 3—Major System Improvements, and Alternative 4—Dam Breaching. There would be no change to existing navigation facilities on the lower Snake River under the first three alternatives. Commercial navigation on the lower Snake River would, however, no longer be possible under Alternative 4—Dam Breaching. The following sections present a summary of the effects of dam breaching on the transport of commodities that are now shipped from ports on the lower Snake River. These alternatives are, as a result, represented by the base case in the following discussion.

The following sections address the methodology employed in this analysis, transportation system costs with and without dam breaching, including infrastructure requirements, and uncertainties surrounding the analysis. Details of the analysis are contained in the full-length report developed as part of this Feasibility Study (DREW Transportation Workgroup, 1999). All tables presented in this section were developed as part of the DREW Transportation Workgroup Study. Sources of secondary data used by the DREW Transportation Workgroup to develop these tables are noted, as appropriate.

3.3.1 Methodology

The methodological approach and analysis of commodity transportation costs is based in part upon analytical techniques that were employed in System Operation Review (SOR) studies performed during 1992 to 1993. The SOR study evaluated a variety of alternative system operating scenarios for the Columbia-Snake River System (CSRS) and quantified the economic effects of each scenario applying national economic development (NED) criteria. This evaluation of the economic effects that breaching the four lower Snake River reservoirs would have on the existing transportation system uses the same general approach as the SOR and builds upon the methodology and data developed for that study.

The direct economic costs that would result from breaching the four lower Snake River dams are measured and expressed as changes in the NED account. NED costs represent the opportunity costs of resource use, measured from a national rather than a regional perspective. In the case of dam breaching, the change in the cost of transporting products and commodities now shipped from ports on the lower Snake River is a NED cost, but the loss of revenue and profit by barge companies is not. Only the costs of resources actually used are included in the NED analysis. Although market prices (e.g., transportation rates) often reflect the total opportunity cost of resources, this is not always the case, and surrogate costs must sometimes be used to adjust or replace market prices (or published or contract rates). In this study it was judged appropriate to use modal costs computed through analysis of the actual fixed and variable costs of each transportation mode—barge, rail, and truck, rather than rates.

The Corps contracted TransLog Associates to examine whether the costs and rates for the transport of grain are actually significantly different.[1] TransLog Associates obtained rates for truck/barge and

[1] Lower Snake River Juvenile Migration Feasibility Study—Transportation Study, Implications of Changes in the Columbia-Snake River System Waterway on Grain Logistics from the Traditional Portland Market Gathering Territory, *Final Draft,* prepared by TransLog Associates, August 15, 1999.

truck/rail grain shipments for a sample of origins in Washington, Idaho, and Oregon. A total of 18 origins were compared—nine in Washington, eight in Idaho, and one in Oregon. The comparison showed that truck/barge rates are consistently higher than costs and range from about one percent above costs to over 50 percent above costs. In the case of truck/rail, the comparison showed that rates were below costs for 11 of the 18 origins with a range from about 3 percent below costs to 30 percent below costs. The remaining seven origins had truck/rail rates that were higher than costs with a range of from nearly 33 percent above costs to a low of about one percent above costs. The wide disparity between rates and costs suggests that in many cases rates are not set in a competitive environment, which is the condition required for rates to be used in NED analyses. The comparison of rates and costs is shown in Table 3.3-1.

Transportation system impacts that would occur under Alternative 4—Dam Breaching, were estimated using a transportation system model that was designed specifically to track and estimate the cost of transporting commodities that now move on the lower Snake River. Modeling information requirements and assumptions are summarized in the following sections.

3.3.1.1 Modeling Requirements

Measuring the direct economic effects of dam breaching on commercial navigation activity involved evaluating alternative shipping modes and costs, and identifying the most probable combination of storage, handling, and transport modes that would emerge in response to cessation of waterborne transport on the lower Snake River. Specific information required for this analysis included: 1) establishment of base and projected future commodity shipments, 2) identification of commodity origins and destinations with and without dam breaching, 3) estimates of modal costs and storage and handling costs at throughput facilities, 4) assessment of regional rail and truck capacity, and 5) assessment of a variety of other elements that characterize the regional transportation system. A brief description of how these data were derived and a description of the procedures and assumptions applied in the evaluation process are presented in the following paragraphs.

Base and Projected Future Commodity Shipments

Projections of future commodity shipments were developed through analysis of waterborne commerce data for the CSRS for the 1980s and 1990s. The analysis included assessments of exports, the volume of shipments on the Snake River, and the types of commodities shipped. Forecasts of future shipments were developed for each of eight commodity groups and later combined into five groups for the transportation system cost analysis.

Commodity Origins and Destinations

The study area considered in this analysis encompasses grain producing areas as well as origins and destinations for non-grain commodity groups that use the CSRS. Origins of grain transported by barge on the lower Snake River, derived from previous studies conducted in 1992 for the SOR and updated for this study, include areas within northeastern Oregon, eastern Washington, Idaho, Montana, and North Dakota. Origins or destinations for non-grain commodity groups in the lower Snake River region (such as petroleum or fertilizers) also generally fall within this area. The origins of non-grain commodities, which are relatively insignificant in terms of the overall volume of Snake River shipments, were taken directly from data developed for the SOR.

Table 3.3-1. Comparison of Truck/Barge and Truck/Rail Costs and Rates

State/County	Location	Truck/Barge $/ton (cost)	Truck/Barge $/ton (rate)	Difference Rate minus Cost	Way Point[1/]	Truck/Rail $/ton (cost)	Truck/Rail $/ton (rate)	Difference Rate minus Cost	Way Point[1/]
	Truck/Barge					Truck/Rail			
Washington									
Adams	FRD	7.74	12.23	4.49	Tri-Cities	16.34	13.24	(3.10)	Odessa1
Asotin	FRD	14.60	16.54	1.94	McNary	20.50	18.95	(1.55)	Pendleton1
Columbia	FRD	7.67	10.86	3.19	McNary	13.83	13.02	(0.81)	Pendleton1
Franklin	FRD	5.14	8.14	3.00	Tri-Cities	12.04	9.72	(2.32)	Plymouth
Garfield	Dodge	9.58	12.68	3.10	McNary	15.30	14.17	(1.13)	Pendleton1
Lincoln	Odessa2	10.68	15.63	4.95	Tri-Cities	14.69	14.20	(0.49)	Odessa1
Spokane	FRD	14.41	15.55	1.14	Tri-Cities	13.44	14.29	0.85	Spangle2
Walla Walla	FRD	5.94	8.82	2.88	McNary	12.70	9.01	(3.69)	Pendleton1
Whitman	FRD	10.47	15.10	4.63	Tri-Cities	19.20	14.37	(4.83)	Pendleton1
Idaho									
Bennewah	FRD	15.83	20.85	5.02	Tri-Cities	15.17	19.21	4.04	Spangle2
Boundary	FRD	15.71	24.71	9.00	Tri-Cities	23.83	16.69	(7.14)	Spangle2
Idaho	FRD	16.88	21.45	4.57	Tri-Cities	16.17	20.97	4.80	Grangeville
Canyon	FRD	17.65			Hogue Warner	15.24			Nampa1
Kootenai	FRD	15.83	19.34	3.51	Tri-Cities	17.33	14.60	(2.73)	Spangle2
Latah	FRD	15.29	18.88	3.59	Tri-Cities	19.15	19.39	0.24	Spangle2
Lewis	FRD	17.18	17.67	0.49	Tri-Cities	15.50	20.54	5.04	Craigmont
Nez Perce	FRD	15.68	17.14	1.46	Tri-Cities	16.71	19.99	3.28	Craigmont
Oregon									
Wallowa	FRD	13.37	17.89	4.52	Kennewick	15.13	16.48	1.35	Pendleton1

1/ Way point refers to the point where commodities would be transferred from truck to barge or rail or from truck to rail.
Note: FRD = Farm to River Direct

Commodity Growth Forecasts

The basis for commodity growth forecasts is the volume of grain and non-grain shipments that originate from the Snake River above Ice Harbor Dam. As a result, the forecasts developed for this analysis are limited to the volume of shipments on just the Snake River, rather than the combined CSRS. These forecasts were, however, derived from forecasts originally developed by the Portland District of the Corps for the Columbia River Channel Deepening Feasibility Study, in conjunction with analysis of historical data and anticipated trends in the volume of relevant commodities now moving on the lower Snake River. Using data developed for the Columbia River Channel study, waterborne traffic forecasts were developed for the 1997 to 2017 period for the Snake River segment of the CSRS. Projections for this 20-year period were made at five-year intervals for the various commodity groups. Due to the degree of uncertainty inherent in long range forecasting, projected volumes were assumed to remain level beyond 2017, no additional growth projected.

Two concerns about the commodity forecasts surfaced during review of the draft analysis presented in the draft FR/EIS. First, the grain forecast is based on a period of record ending in 1996 while data for 1997 was available. Since grain shipments for 1997 were approximately 20 percent lower than shipments in 1996 there is concern that the forecast used in the study maybe too high with the result being that grain transportation cost impacts of dam breaching estimated for the study are too high. This issue was reviewed during preparation of the FR/EIS and the data strongly suggests that the downturn in shipments of grain during 1997 was due to the soft Asian economy rather than a decrease in demand for, or production of, grain grown in the Snake River hinterland. On this basis, the downturn in 1997 is judged to be an anomaly and not representative of the long-term trend in grain shipments. Accordingly, the forecast used for this study is considered appropriate.

The second concern that was raised during review of the draft FR/EIS was that the forecasts made for this study were developed from forecasts of commodity movements on the lower Columbia River deep-draft navigation channel, which were originally developed as part of the Columbia River Channel Deepening Feasibility Study. The forecasts developed for this study were obtained by simply prorating the forecast presented in the Columbia River Channel study based on the Snake River's historic share of shipments on the lower Columbia River. Critics of this methodology argue that a more accurate basis for the forecast would be an analysis of sources of commodities in the Snake River hinterland. The Corps agrees that analysis of the sources of commodities shipped on the Snake River should result in a more reliable long-term forecast. However, the level of detail required to conduct this type of analysis was beyond the scope of this study.

Transportation System Cost Estimating Procedures

A Microsoft Access database was developed to estimate transportation-related costs associated with the base condition and the dam breaching scenario. The database was used to quantify the costs (transportation, storage, and handling) of shipping commodities under existing conditions and in the absence of commercial navigation on the lower Snake River. The results of these two analyses were then compared to determine the effect that river closure would have on transportation system costs. This comparison is simply the difference between transportation costs with dam breaching versus transportation costs without dam breaching.

The model is not an optimization model. It is simply a database of existing and alternative routings of grain and non-grain commodity movements from origins to destinations. Transportation costs under the base case are based on existing routings. Most likely alternative routings are used in the dam breaching case. At least two alternative routings for commodities from each origin are included in the database, and the model is designed to select the lowest-cost routing. Storage and handling costs associated with each alternative routing are added to the transportation cost to determine the total cost associated with each routing. The model accumulates transportation, storage, handling, and total costs for the lowest-cost routings and compiles summary reports on movements and costs by state, county or region, and mode of transportation. In addition, bushel-miles (for grain), and ton-miles (for non-grain) are similarly compiled and reported.

Modal Cost Estimating Procedures

Modal costs for barge, rail, and truck were developed using transportation analysis models (TAMs) for each mode. The models used were developed and copyrighted by Reebie Associates, Transportation Management Consultants. The specific models used are briefly described below:

- **Barge Cost Analysis Model**

  The Barge Cost Analysis Model (BCAM) is designed to facilitate the analysis of barge-load shipments on the nation's inland waterways. The design concept involves bringing data about the river systems, locks and dams, barges, towboats, and commodities to the processing capabilities of the personal microcomputer. All of the inland waterways on which commercial barge-load shipments are made are built into the model. This includes the Mississippi River System, in the central part of the country and the Columbia/Snake River System in the Pacific Northwest. The user running the model specifies shipment characteristics, cost factors, operating factors, and routing.

  During the course of this study it was determined that there is a large difference between barge costs as estimated by the Reebie Barge Model and rates that are actually charged by the barge industry. For example, the Reebie Model estimates a cost of $3.07 per ton for shipping grain from Almota, Washington to Portland, Oregon, compared with the actual rate charged by the industry of about $6.07 per ton. Industry representatives have stated on numerous occasions that the costs estimated by the Reebie Barge Model are incorrect (too low). In response to the comments by representatives of the barge industry, Corps analysts reviewed three other studies of barge costs. The finding was that all of the studies showed that rates are significantly higher than costs. In addition, input data for the Reebie Model were provided to an industry representative for review and comment. No comments on the input data were ever received from representatives of the industry. On the basis of currently available information, barge costs produced by the Reebie model are considered appropriate for use in the study. The effect of using higher costs in the model, as has been suggested by representatives of the barge industry, would be to reduce the transportation system cost impacts of dam breaching and possibly indicate a large shift of grain from barge to rail.

- **Rail Cost Analysis Model**

  The Rail Cost Analysis Model (RCAM) is an enhanced personal computer application of the Interstate Commerce Commission's Uniform Rail Costing System (URCS) methodology. The URCS is a complex set of procedures that transforms annually reported railroad expense and activity data into estimates of the costs of providing specific services. It is based on analysis of cause and effect relationships between the production of railroad output ("service units" such as car miles or gross ton miles) and the associated expenses defined by the model's accounting system. These relationships define a series of "unit costs," for example, crew costs per train mile, that are applied to the service units generated by a shipment to produce the estimated cost of providing the service.

- **Truck Cost Analysis Model**

The Truck Cost Analysis Model (TCAM) provides the ability to determine the underlying cost and revenue requirements for truck shipments. The TCAM data input process is divided into three sections: primary shipment specifications (11 variables), driver and utilization factors (10 variables), and detailed costing factors (25 variables). Default values are built into the model for all input variables.

During review of the draft analysis it was discovered that truck costs used in the transportation system model are significantly higher than truck costs estimated for the Corps in a study by TransLog Associates.[2] A preliminary review of the Reebie Model truck costs for a sampling of movements showed that there is an error in the way driver costs were calculated, making them much higher than they apparently should be. For example, the TransLog study reported a total allocated cost for long-haul truck movement of grain of $1.04 per mile, with a driver cost of $0.29 per mile. By comparison the cost for one movement of 870 miles (round-trip) in the transportation system model has a cost of $2.716 per mile, with a driver cost of $1.315 per mile. Correction of errors in truck costs used in the model would significantly lower the cost of truck movements of commodities and could change (decrease) the volume of grain that is predicted to shift to rail if dam breaching were to occur. However, since truck costs affect both rail and barge shipments without correction of the model and reanalysis of transportation system costs, there is no way of knowing how cost of the barge and rail modes would actually be affected. Also, because truck costs are embedded in rail and barge costs in the model summary results, there is no way of knowing the actual magnitude of the truck cost component of modal transportation costs. In spite of this, since the only error identified in the preliminary review was for driver costs, adjusting the per mile cost in the model for the example cited above by replacing the driver cost of $1.315 that was used in the model with a driver cost of $0.29, as reported in the TransLog study would reduce truck costs from $2.716 to $1.691 per mile, compared with $1.04 per mile in the TransLog study. While the total effect of this adjustment on total transportation system costs is not known, it is clear that truck costs are significantly overstated by the current analysis. If dam breaching is considered for further study, this is an issue that would need to be addressed.

The transportation system model defines long-haul truck movements of grain as movements of 150 miles or more and uses a cost that is based on the availability of a two-way haul (backhaul). However, the study conducted for the Corps by TransLog Associates found that the break between short-haul (local market) and long-haul-truck movements is 250 miles. This distance was defined on the basis of the finding that this is the distance where rail shipment of grain becomes competitive with truck shipment. The TransLog study further found that long-haul shipment of grain only

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[2] Lower Snake River Juvenile Migration Feasibility Study—Transportation Study, Implications of Changes in the Columbia-Snake River System Waterway on Grain Logistics from the Traditional Portland Market Gathering Territory, *Final Draft,* prepared by TransLog Associates, August 15, 1999.

occurs in the presence of two-way haul opportunities. This finding is consistent with modeling done by the Corps that assumes the presence of backhaul for all long distance (150 miles or more) truck shipments of grain. The finding of the TransLog study suggests that higher short-haul costs for grain transportation should have been used for some movements (up to 250 miles one-way rather than 150 miles). If this is the case, the model used for this study slightly understates truck costs. The magnitude of this error is unknown but is believed to be relatively insignificant. However, if dam breaching is recommended and authorized for further study, this is an issue that should be investigated.

3.3.1.2 Modeling Assumptions

Grain Storage and Handling Costs and Assumptions

Storage costs are a function of two factors, the duration of storage and the monthly cost. The duration of storage is a function of the relationship between harvest and demand. Thus, the duration of storage in the model is the same with and without dam breaching. Differences in costs between the two cases are due to the difference in the cost of storage at the various types of elevators. Elevator storage costs at country and river elevators were reviewed for this study. The review revealed that monthly storage costs at country elevators are about $0.006 per bushel higher than storage costs at river elevators. Thus, the difference in storage cost is due to use of country elevator storage with dam breaching, rather than the cheaper river elevator storage. Storage costs are incurred at all elevator types, with the exception of export terminals. A cost for on-farm storage is not estimated because it would be the same with and without dam breaching.

Handling costs are a function of the number of times grain is required to transfer to a different mode of transportation or to go into or out of storage. The types of movements included in the model are as follows:

Base Case:

- farm-to-river-to-export terminal
- farm-to-country elevator-to-river-to-export terminal.

Note: The model does not include any farm-to-rail-to-river movements, even though these types of movements have been reported for ports in the Lewiston area and the Port of Wallula.

Dam Breaching:

- farm-to-alt river-to-export terminal
- farm-to-country elevator-to-alt river-to-export terminal
- farm-to-railhead-to-export terminal
- farm-to-country elevator-to-railhead-to-export terminal.

Storage and handling costs are assumed to be the same for all country elevators, including those with unit-train loading facilties. Handling costs at the export terminals were assumed to be the same for both rail and barge grain deliveries.

During final preparation of the Draft FR/EIS it was discovered that model estimates of storage and handling costs for grain shipped to the Northwest from the states of Montana and North Dakota amount to nearly $6.50 per bushel. This is almost double the market value of wheat and is clearly not representative of the long-run equilibrium condition that the model is supposed to represent. This error has not been corrected in the model because these costs are exactly the same with and without dam breaching. Therefore, the error has virtually no effect on the change in the system transportation costs with dam breaching.

Another issue with storage and handling costs is the use of "rates" rather than costs. In this regard, the model is inconsistent because costs are used for alternative transportation modes, but rates are used for handling and storage. One effect of the use of rates is that the model uses the same handling rate for rail and barge shipments at the downriver export terminals. This is consistent with actual practice because the terminal operators do in fact charge the same handling rate for both rail and barge shipments. However, industry representatives have stated that handling costs for rail shipments are actually about 40 percent higher than for barge shipments. Review of these issues during preparation of the final report resulted in a determination that the use of rates for handling and storage is appropriate because they are set in a competitive market. However, if dam breaching were authorized for more detailed study it would be appropriate to investigate export terminal costs of handling barge and rail grain shipments to determine if there are significant differences. In addition, differences between handling costs at country elevators with and without rail handling facilities should be investigated.

Capacity Assumptions

Two general assumptions about capacity are fundamental to the analysis and the construction of the transportation system model. The first assumption is that the current system is in equilibrium in terms of storage, handling, and transport mode capacity. On the basis of this assumption, it was unnecessary to model capacity in the base case. With dam breaching, essentially all grain elevators on the Snake River would be abandoned. To offset the loss of these facilities and to enable barge transportation of grain through the Tri-Cities a new facility would need to be constructed at that location. The second assumption is that with dam breaching, modal, handling, and storage capacity can be expanded on a regional basis to meet geographic shifts in demand without significant increases in long-run marginal and average costs. The Economic Procedures and Guidelines used by the Corps to determine project benefits and costs reason that if inland navigation capacity is reduced, competing surface transport modes would either possess or add the capacity necessary to accommodate additional traffic. Similarly, it is assumed that elevator throughput capacity could be increased with little impact upon long-run marginal and average costs. As a consequence, it is judged possible that additional transportation capacity could be made available with no significant increase in its unit cost. For non-grain commodities, storage, and handling costs were assumed to be generally equivalent under either scenario. On the basis of this second assumption, modeling of capacity in the dam breaching case was also unnecessary. However, specific assessments of capacity infrastructure improvements that would be needed with dam breaching were made.

During review of the draft FR/EIS, questions were raised about the validity of the assumption that grain-handling capacity could be expanded (new facility at the Tri-Cities) and other infrastructure improvements could be made without upward pressure on average costs. In response to these questions, it was determined that marginal costs and revenue of infrastructure improvements should be compared and that costs in excess of marginal revenue (fees and other revenue from handling and transporting grain that would be diverted from the lower Snake River) should be added to NED costs of dam breaching.

In the event of dam breaching and closure of the lower Snake River to barge traffic, 12 river elevators could be abandoned. In 1998 these facilities handled a combined total of over 100 million bushels of grain.[3] If dam breaching were to occur, the Tri-Cities area would become the alternate port area. Construction of replacement facilities in the Tri-Cities could cost from over $70 million to over $300 million. During review of the draft FR/EIS it was suggested that a less costly alternative maybe to continue using some of the existing facilities as railroad loading facilities. In particular, the location of the facilities at Central Ferry might make them an attractive railhead alternative. Review of this suggestion during preparation of the final FR/EIS lead to the conclusion that there would be no need for these facilities as rail loading facilities under a dam breaching scenario and that their use would not reduce the need for grain handling capacity at the Tri-Cities. However, if dam breaching were considered for further study, it would be appropriate to include this option in a revised transportation model to determine if conversion of these facilities to railhead facilities would lower overall costs. For this option to be viable, new model studies would have to show an increase in the shift of grain from barge to rail.

Seasonality of Shipments

Shipments of both grain and non-grain commodities experience some month-to-month or season-to-season fluctuations in volume. On a year-to-year basis, many of these fluctuations are due to fluctuations in market conditions rather than the underpinning demand factors. Grain exports from the lower Columbia River may, for example, vary significantly from one month to the next because of market conditions while the demand for grain remains relatively constant. These types of monthly fluctuation are not built into the model used for this analysis. Instead, the model was constructed and operates based on the implicit assumption that volumes of shipments of both grain and non-grain commodities are uniform from month to month.

Alternative Routings

For the base case analysis, the model is designed to replicate a non-optimized base condition based on projected future commodity movements under existing conditions. For the dam breaching scenario, the model evaluates transportation, storage, and handling costs associated with the shift of projected future volumes of commodities to alternative modes of transportation and routings. The model includes at least two alternative routings for commodities from each origin. In general, alternative routings developed for the SOR were used. These alternative routings were, however, reviewed and updated to take into account changes in unit-train rail loading facilities at country elevators. Alternative rail origins for grain were limited to those having a car-loading capacity of at least 25 cars. This requirement was imposed because for rail transport to be feasible a minimum unit-train loading capability of 25 to 26 cars is needed. This requirement reduced the number of country elevators identified in the base case as having rail access from over 100 to 14. Those facilities that were eliminated are those with a loading capacity of fewer than 25 cars. In addition, facilities within 15 miles of a facility included in the model were excluded on the basis that costs associated with these facilities would be the same as for those already in the model.

Construction of the model further assumes that as grain or other commodity transport is impaired by dam breaching, shipments would be rerouted by motor carriers to river elevators located on the McNary Pool and transshipped by barge, or would be shipped by rail directly to lower Columbia export elevators. The model includes unit costs for transportation, storage, and handling associated with each of the alternative routings for each origin-destination pair affected by waterway closure. Distances between origins and

[3] Tidewater Barge Lines, Inc. July 1999. "Yearly Estimated Volumes of Grain by Facility—1998."

destinations were identified and are included in the model. The overall method employs the assumption that current and projected levels of exports from the region would continue to be maintained.

Adjustment of Model Results

A fundamental assumption made for this analysis is that the existing transportation of grain represents the least-cost condition. Therefore, it was assumed that the cost of all movements of grain with dam breaching should be at least as costly as under the base condition. Actual operation of the model, however, showed that this was not the case. The model results showed that a number of grain movements were found to be less costly with dam breaching than with the existing transportation system. Since this conflicts with the assumption that the existing system is the least-cost system, the model includes a check that identifies whether the cost of a movement is less with dam breaching than under the base condition. If the cost with dam breaching is less, the difference is calculated and added to the transportation costs with dam breaching. Although the use of this type of adjustment is somewhat unconventional and was opposed by the IEAB, there was insufficient time or resources to determine why the grain movements in question actually move as they do. In the absence of this information, use of the adjustment was considered appropriate. The total adjustment amounted to slightly less than $0.8 million. This represents just slightly more than 3.6 percent of the total increase in transportation costs with dam breaching. At this magnitude, the potential error in the estimate of the increase in transportation cost with dam breaching is not considered to be significant and verification of the assumption through acquisition of more data or revising the model to delete it is not considered warranted for the final FR/EIS. However, if dam breaching is recommended and authorized for further study, review of this issue and possible revision of the transportation model should be undertaken.

Taxes, Subsidies, and Price Level Changes

The analysis does not take into consideration the effects of taxes or subsidies, which represent transfer payments within the national economy. The effects of potential changes in relative prices are also not considered.

Effects on the Quantity of Land in Grain Production

In the short term, it is possible that some marginal land now used for production of grain could become unprofitable and be taken out of production. The actual impact on individual operators would depend on a number of factors including: the productivity of the land, the fixed cost of land, in the form of capital and interest payments and taxes, and, the actual increase in transportation costs. For most farms, however, the increase in transportation costs would simply mean that the return to fixed capital (such as land) would be reduced. Some land may go out of production in the short term. However, assuming that grain production is the highest and best use of the land currently used for this purpose, in the long-term grain production should continue on these lands. The long-run effect of the reduced economic return to land that would result from higher transportation costs would be reflected in a reduced value of land used for grain production. Analyses for this FR/EIS were conducted on the basis of the assumption that implementation of dam breaching would have no long-run effect on the amount land used for grain production. The effects of increased transportation costs on grain producers are discussed in more detail in Section 6 of this appendix.

NED Effects of Redirected Cross-River Road Traffic

Lower Monumental Dam is the connecting link between Lower Monumental Road (south side) and Devils Canyon Road (north side). Lower Granite Dam is the link between Lower Deadman Road (south side) and Almota Road (north side). The closest alternate route to Lower Monumental Dam is Washington 261, which crosses the lower Snake River at Lyons Ferry. Washington 127, which crosses the river at Central Ferry, is the closest alternate route to Lower Granite Dam. Use of these alternate routes could increase overall travel distance of users, depending on their origin and destination. While the other two dams, Ice Harbor and Little Goose, have road crossings, they do not appear to link major state or county roads and appear to be primarily used by project operators and tourists. During review of the draft FR/EIS, the IEAB stated that the NED effects of severing the roadways that are linked by the Snake River dams should be quantified. This issue was reviewed during preparation of the final FR/EIS and it was determined that NED costs associated with severing these roads would be relatively minor and would not result in a significant increase in currently estimated system transportation costs. However, if dam breaching is recommended and authorized for further study, this is an issue that should be addressed in more detail. These additional studies should obtain traffic counts, identify types of users and establish origins and destinations as the basis for determining the actual significance of NED costs of severing roads that now cross the Snake River on the dams.

Cruise Ship Industry Impacts

Cruise ships presently operate on the Columbia/Snake River system to Lewiston, Idaho. With dam breaching the Snake River would be too shallow to be navigated by these vessels. According to industry representatives, cruise operators would most likely abandon the Columbia River and move their vessels to other rivers where longer cruises would be possible. If this were to happen, there would be a potential regional impact of dam breaching ranging from no impact to a total of about $5 million annually. If cruise operators did actually abandon the Columbia/Snake River and were successful in relocating to other river systems, it is probable that there would be no NED impacts. The analysis for this FR/EIS assumes that this would be the case and there would be no NED impacts associated with effects to the cruise ship industry. If dam breaching is recommended and authorized for further study, impacts on the cruise ship industry should be studied in greater detail to determine if the industry would actually abandon the Columbia River and to further investigate potential NED costs and benefits.

Period of Analysis, Price Level, and Interest (Discount) Rates

The initial year of dam breaching implementation is assumed to be 2007, and NED effects are measured over the 100-year period, 2007 to 2106. For purposes of comparison with other fish restoration measures being evaluated in the feasibility study, annual economic costs were adjusted to a base year, 2005. Using 2007 rather than 2005 as the base year for waterborne traffic projections has only minor effects on average annual transportation costs and the results of the DREW transportation analysis.

Uncertainty

A considerable amount of uncertainty exists about modal rate behavior, infrastructure and capacity requirements, the potential for lost grain sales to export markets, and the overall transportation-related financial impacts associated with dam breaching. These issues and the sensitivity of the analysis to alternative assumptions are addressed later in this section.

3.3.2 Navigation Facilities

The Columbia-Snake Inland Waterway is a 465-mile-long water highway formed by the eight mainstem dams and lock facilities on the lower Columbia and Snake rivers. The waterway provides inland waterborne navigation up and down the river from Lewiston, Idaho, to the Pacific Ocean. This system is used for commodity shipments from inland areas of the Northwest and as far to the east as North Dakota. The navigation system consists of two segments: the downstream portion, which provides a deep-draft shipping channel, and the upstream portion, which is a shallow-draft channel with a series of navigation locks.

The deep-draft portion of the navigation system consists of a 40-foot-deep by 600-foot-wide channel that extends up the Columbia River from the Columbia Bar (River Mile [RM] 3.0) to Vancouver, Washington (RM 105.6). Major import-export terminals are located adjacent to the channel at the Columbia River ports of Vancouver, Longview, and Kalama in Washington, and Portland and Astoria in Oregon.

The shallow draft portion of the waterway is a Federally maintained channel and system of locks that extends from Vancouver, Washington, to Lewiston, Idaho. The channel extends up the Columbia River from Vancouver, Washington (RM 106), to Richland, Washington (RM 345), and from the mouth of the Snake River (Columbia River RM 325) to Lewiston, Idaho (Snake River RM 141). This channel has a minimum authorized depth of 14 feet at the minimum operating pool (MOP) elevations of each of the upstream dams.

The presence of the Columbia-Snake River Inland Waterway has led to the development of a sizable river-based transportation industry in the region. Riverside facilities managed by port districts and various other public and private entities are located on the pools created by the system of dams and locks. Fifty-four port and other shipping operations provide transportation facilities for agricultural, timber, and other products. There are 22 port facilities located along the shallow draft portion of the waterway, including nine on the lower Snake River. All of the ports on the lower Snake River have grain-handling capability.

3.3.3 Waterborne Commerce

3.3.3.1 Columbia River Deep-draft Channel

The Columbia River serves an extensive region that covers much of the western United States. Within the region, a variety of commodities, foodstuffs, and other products are produced. Of those industries within the region that generate waterborne commerce, agriculture predominates, particularly with respect to the production of grains such as wheat and barley. In addition, corn, which is produced outside of the region, represents a significant volume of shipments from export terminals on the lower Columbia River. Other regional industries that use water to transport products include aluminum, pulp and paper, petroleum products, and logs and wood products. In terms of volume, wheat and corn represent the major share of total commodities shipped on the deep-draft segment of the Columbia River channel. Other products include autos, containerized products, logs, petroleum, chemicals, and other miscellaneous products. Countries involved in the region's export trade are Japan, Korea, and Taiwan, as well as other Pacific Rim countries.

3.3.3.2 Columbia-Snake Inland Waterway

Products shipped on the shallow draft segment of the river system consist principally of grain, wood products, logs, petroleum, chemicals, and other agricultural products. Bulk shipments make up much of the waterborne traffic on the upstream channel. A number of commodities, principally non-grain agricultural and food products and paper products, are shipped via container. Approximately 97 percent of downriver-bound container shipments are destined for Portland, Oregon, with the remainder going to

Vancouver, Washington. Historically, the bulk of upriver barge shipments have been made up of petroleum products.

Analysis of data from the Waterborne Commerce Statistics Center (WCSC) and the Corps' Lock Performance Monitoring System (LPMS) showed that commodities from 37 commodity groups were shipped on the waterway in both 1996 and 1997. These commodity groups were aggregated into five groups for the purposes of this analysis—grain, petroleum products, wood chips and logs, wood products and other. Shipments from 1992 to 1996 are shown in Table 3.3-2.

Table 3.3-2. Tonnage of Shipments by Commodity Group on the Shallow Draft Portion of the Columbia-Snake Inland Waterway, 1992 to 1996

Commodity Group	Thousand Tons				
	1992	**1993**	**1994**	**1995**	**1996**
Grain	4,612.9	4,902.3	5,671.4	5,883.3	5,710.4
Petroleum Products	1,567.1	1,746.1	1,693.1	2,164.6	2,023.2
Wood Chips and Logs	1,837.3	2,130.8	2,056.4	1,779.2	1,281.9
Wood Products	61.3	44.7	63.1	73.4	28.1
Other	1,224.7	761.9	615.3	626.9	629.6
Total	**9,303.3**	**9,585.8**	**10,099.3**	**10,527.4**	**9,673.2**

Source: Waterborne Commerce Statistics Center (WCSC), New Orleans, LA, and Corps' Lock Performance Monitoring System (LPMS)

3.3.3.3 Lower Snake River

Commodity movement on the lower Snake River is dominated by grain (primarily wheat and barley), which made up 75.8 percent of the tonnage passing through Ice Harbor lock from 1992 to 1997. During the same period, wood products, including wood chips and logs, accounted for 15.8 percent, petroleum products accounted for another 3 percent, paper and pulp accounted for 2.3 percent, and all other commodities accounted for the remaining 3 percent. Table 3.3-3 provides a summary of the annual tonnage by commodity group passing through Ice Harbor lock from 1987 through 1996.

Table 3.3-3. Tonnage by Commodity Group Passing through Ice Harbor Lock, 1987 to 1996 (thousand tons)

Commodity Group[1/]	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Average
Grain	2,906	3,981	2,532	3,109	3,241	2,612	2,706	3,135	3,471	2,821	3051.4
Wood Chips and Logs	461	394	320	304	375	500	854	910	857	530	550.5
Petroleum	117	105	115	108	106	108	129	137	144	95	116.4
Wood Products	46	52	45	42	74	61	45	58	68	28	51.9
Other	96	127	203	166	159	80	57	74	82	85	112.9
Total	**3,626**	**4,659**	**3,215**	**3,729**	**3,955**	**3,361**	**3,791**	**4,314**	**4,622**	**3,559**	**3,883**

1/ All figures are rounded to the nearest 1,000.

Notes: Large movements of 1.2 million tons in 1988 and 1.4 million tons in 1989 have been omitted because they appear to have been one-time movements and would significantly skew the "All Other" category in which they were classified (see the DREW Transportation Workgroup report).
Ice Harbor lock was out-of-service from January 1 through March 9, 1996, while the downstream lift gate was being replaced.

Source: Waterborne Commerce Statistics Center (WCSC), New Orleans, LA, and Corps' Lock Performance Monitoring System (LPMS)

The Columbia-Snake Inland Waterway from Lower Granite pool through McNary Dam handled cumulative totals of approximately 6.7 million tons in 1990, 7 million tons in 1991, and 6.7 million tons in 1992. This included upbound and downbound cargo originating at Lower Granite, Little Goose, Lower Monumental, Ice Harbor, and McNary reservoirs (Corps and NMFS, 1994). Since 1980, cumulative cargo volumes have ranged from approximately 5 million to 8 million tons per year. Tonnage using at least a portion of the Snake River segment, as measured by data for Ice Harbor, averaged about 3.8 million tons per year from 1980 through 1990. This average increased slightly to about 4 million tons per year from 1992 through 1996 (see Table 3.3-3).

3.3.3.4 Projected Growth in Commodity Shipments

The Corps, Institute for Water Resources (IWR) developed a forecast of future commodity growth for the major commodity groups that are presently shipped on the lower Snake River. The basis for the forecast was the commodity forecast developed for the Corps' Columbia River Channel Deepening Feasibility Study. Historical data for Snake River shipments were compiled for aggregated commodity groupings for the 10-year period from 1987 through 1996. This data set was used as the basis for projecting future growth as a share of forecast growth for the Columbia River. Projections were initially established at 5-year increments to encompass a 20-year period, 2002 through 2022. As stated earlier, for the dam breaching option, the implementation date is assumed to be 2007; therefore, the evaluation used projections for the period from 1997 to 2017, with growth held constant thereafter. The rationale and basis for estimating future growth in volume for the respective commodity groups are described below.

Grain

Historic wheat and barley exports from the Lower Columbia are compared with shallow draft wheat and barley shipments from the lower Snake River above Ice Harbor in Table 3.3-4. From 1987 to 1996, shipments on the lower Snake River averaged about 23.4 percent of wheat and barley exports from the lower Columbia River and ranged from a high of 26.5 percent share in 1991 to a low of a 20.2 percent share in 1992. This is a relatively low range, with fluctuations from year to year probably being driven by variations in grain production among the regions. Also shown in the table is the year-to-year change in percent share for the Snake River.

Table 3.3-4. Wheat and Barley Exports from the Lower Columbia Compared with Shipments from the Lower Snake River above Ice Harbor, 1987 to 1996 (thousand tons)

Wheat & Barley	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Avg.
Lower Columbia Exports	12,085	14,945	10,458	11,778	12,233	12,762	13,428	14,908	14,603	13,691	13,089
Snake River Shipments	2,906	3,981	2,532	3,109	3,241	2,612	2,706	3,135	3,471	2821	3,051
Snake River %	24.0	26.6	24.2	26.4	26.5	20.5	20.2	21.0	23.8	20.6	23.38
Change in %	–	2.6	(2.4)	2.2	0.1	(6.0)	(0.3)	0.9	2.7	(3.2)	

Source: Waterborne Commerce Statistics Center (WCSC), New Orleans, LA, and Corps' Lock Performance Monitoring System (LPMS)

The average Snake River share of 23.4 percent of exports of wheat and barley from the lower Columbia River is used as the basis for forecasting future wheat and barley movements on the Snake River above Ice Harbor. The forecast was made by applying this percentage to projected exports for wheat and barley developed for the Columbia River channel deepening study. The resulting forecast is summarized in Table 3.3-5.

Table 3.3-5. Waterborne Traffic Projections above Ice Harbor Lock, 2002 to 2022 (thousand tons)[1/]

Commodity Group	Average	2002	2007	2012	2017	2022
Grain	3,019	3,647	3,799	3,798	3,892	4,052
Wood Chips and Logs	716	694	694	694	694	694
Petroleum Products	118	127	136	145	156	167
Wood Products	52	66	79	101	128	148
Other	81	97	110	128	148	167
Total	**3,986**	**4,631**	**4,818**	**4,866**	**5,018**	**5,228**

1/ These projections are the medium or "most likely" values projected in the navigation analysis. The Portland District's analysis also provided low ("likely minimum") and high ("likely maximum") values for each year. The averages are computed across all three values for each year.

Source: Snake River Commodity Projections, IWR Navigation Data Center, Ft. Belvoir, VA

Wood Chips and Logs

In terms of tons, the next largest commodity group using the Snake River above Ice Harbor, after wheat and barley, is wood chips and logs. Between 1987 and 1996, shipments of wood chips and logs varied from a low of 303,800 tons (1990) to a high of 909,600 tons (1994), with an average of 716,100 tons from 1991 to 1996. Although 1997 data were not available as this report was being compiled, data from the LPMS suggest 1997 wood chips and logs traffic was about 594,000 tons at Lower Granite Dam. Using this information as a proxy for 1997 movements on the Snake River above Ice Harbor, it appears this commodity group recovered some of the traffic lost in 1996, but did not attain the robust traffic levels experienced from 1993 to 1995. Adding in the 1997 estimate to the average base traffic calculation reduces this value to 694,200 tons. This is the amount carried forward into the forecast analysis.

With an R-squared of .37, the historic data for 1987 to 1997 do not indicate a clear linear trend that could be used for credible forecasting. The traffic in wood chips and logs appears to vary around an average level, increasing or decreasing with market conditions, but without the prospect of sustained long-term positive growth. This assessment has generally been confirmed in conversations between Portland District and commercial shippers who have reported future traffic expectations as "flat" or stable. For this reason, the forecast for wood chips and logs has been held steady at the adjusted (to include the 1997 estimate) average of 694,200 tons. Because no growth is being forecast for the base traffic, these figures are the same in each forecast year. The forecast is shown in Table 3.3-5.

Petroleum Products

Petroleum products, the third largest commodity group transported on the lower Snake River, generally account for approximately 80 percent of all upriver commodity movements above Ice Harbor lock (Corps and NMFS, 1994). Annual petroleum product shipments ranged from 95,000 tons in 1996 to 144,000 tons in 1995, with an average of 116,000 tons from 1987 through 1996. Conversations with terminal managers indicated that shipments of petroleum by barge tend to decline when excess refinery production in the Great Plains and Rocky Mountain regions further east becomes available by pipeline in the Spokane area. From there, petroleum products can be trucked in competitively. When those supply routes tighten and prices increase, barged petroleum from the Portland area becomes more competitive. The forecast assumes these competitive supply dynamics will continue in the future, but with a generally upward trend in barge traffic as the demand for petroleum products in the Snake River hinterland increases with general population and economic growth. Historic population data for the Snake River hinterland counties indicates an average annual increase of 1.4 percent since 1980 and 1.7 percent since 1990. Forecast growth is based on the longer-term population growth rate of 1.4 percent. The resulting forecast is shown in Table 3.3-5.

Wood Products and Other

Of the commodity categories being assessed in the present analysis, it was observed that "other farm products" (that is, all farm products other than wheat and barley) and "wood products" (including pulp and waste paper, paper products, and primary wood products) were most likely to be containerized. The forecast referenced above was adapted to the lower Snake River through an analysis of container movements on the Columbia and Snake rivers, with the assumption that the Snake River's share of the total would remain unchanged over the forecast period. The forecast for chemicals, which primarily consist of fertilizer and ammonia, was based on the forecast for grain with the assumption that the ratio of the grain to chemicals ratio would remain constant over time. The resulting forecasts are shown in Table 3.3-5.

Summary

In all, projections were made for eight commodity groups. These groups were then combined into the five groups and were included in the transportation model. The "other" commodity group includes other farm products, chemicals, containers, and all other. The medium or base forecast for each commodity group is shown in Table 3.3-5.

3.3.4 Base Condition Transportation Costs

3.3.4.1 Modeling Considerations

One of the key elements in determining commodity transport costs is identifying origins and destinations of product movements. Within the Columbia River Basin, country elevators located in one county may collect and store grain from sources in several adjacent counties. This means that grain may ultimately be transshipped to river elevators located in other counties. These movements, as such, tend to have a three-dimensional aspect in terms of origins and interim destinations. In order to reduce the complexity of data management, country elevators were considered to be the starting point for the movement of grain down-river, with the exception of those grain shipments made directly from farm to river elevators. This eliminated the need for a three-dimensional approach that would vastly enlarge the magnitude and complexity of the commodity flow data. The effect of this modeling convention on estimated costs is to understate costs by the amount of the cost to move grain from farms to country elevators; however, the overall costs of moving grain from farms to country elevators or other interim holding facilities are unlikely to differ significantly between base and dam breaching conditions. For modeling purposes, therefore, this simplifying assumption was applied except in those cases where grain is transported directly from farm to river elevators, without dam breaching. With dam breaching, modeling was based on the assumption that farm-to-river elevator shipments would now move directly from farms to country elevators with unit train loading capacity. This may not be the case for specific farms because some farm-to-river movements of grain may be determined by the relative location of farms to the river elevators. The assumption is, however, considered to be valid in general because with dam breaching other farms would be expected to be located near elevators with rail loading capacity.

Modal and Other Costs

The next step in computing transportation costs was to input modal costs for each origin/destination pair. As explained previously, modal costs were developed for the study using models developed and maintained by Reebie Associates. Costs assigned for the base condition, for example, included the cost of the grain movements by truck from country elevators to river elevators within the dam breaching reach, and then the cost to move the grain by barge to export terminals. Storage and handling costs are also included. These latter costs are based on rates charged for these services, rather than on NED-based costs, as is the case with modal costs.

Other Considerations

In the process of evaluating data obtained and applied in this analysis, it was determined that grain from Montana and North Dakota is normally shipped to the CSRS as a backhaul for building materials that are transported to these states and eastward as far as Chicago. Because backhaul shipments are only required to generate sufficient revenue to pay the incremental costs of the shipment, this significantly reduces costs. For this evaluation, it was judged that backhaul shipments of grain by truck from Montana and North Dakota origins to Lewiston would continue in the future. With dam breaching, however, the river destination would shift from Lewiston to the Tri-Cities area. It was further assumed that all long-distance grain movements (in excess of 150 miles) include backhauls. Accordingly, truck movements of grain of 150 miles or more were given a backhaul-based cost.

Storage and handling rates were obtained for each elevator type—country and river. In compiling these data, it was noted that there is a significant variation in rates that are charged. Further analysis indicated that the variation is due largely to market strategies of owners of multiple facilities. It was necessary to make adjustments to some of the raw data to derive the average rates that were used in the model.

3.3.4.2 Transportation Costs—Base Condition

For the base condition, grain transportation, storage, and handling costs were based upon current and projected levels of commodity flows (see Section 3.3.1). Model estimates of the costs displayed in Table 3.3-6 below are for projected grain movements for 2007. Costs are not shown for any of the other years included in the forecast because projected growth in the volume of grain does not have a significant effect on costs at the per bushel or even per ton levels. Total cost (in dollars), cost per bushel (in cents), and cost per ton (in dollars) are shown for each state. Estimates of total costs per bushel range from a high of about $7.10 for Montana to a low of $0.34 for Oregon. These costs are, however, simply estimates as the estimate for Montana clearly suggests. These costs, especially for storage and handling, at nearly $6.50 per bushel, are much higher than actual costs. The DREW Transportation Workgroup is aware of this problem, and corrections have been made to the model. These corrections were not made in time to be included in this document, but will be included in the next version. This does not, however, affect the primary objective of the analysis — to estimate the change in costs if dam breaching were to occur — because these costs are the same with and without dam breaching.

Table 3.3-6. Base Condition Grain Shipments and Transportation, Storage, and Handling Costs for 2007 Projected Volume, by State

State	Grain Quantity	Transportation Cost ($)	Storage Cost ($)	Handling Cost ($)	Total Cost ($)
Idaho					
Cost Per Bushel	32,289,941	0.35	0.15	0.22	0.71
Cost Per Ton	968,795	11.55	4.91	7.16	23.62
Total Cost		11,193,026	4,758,470	6,932,211	22,883,707
Montana					
Cost Per Bushel	6,537,310	0.72	3.10	3.31	7.10
Cost Per Ton	196,139	23.90	102.16	110.41	236.47
Total Cost		4,687,358	20,038,366	21,655,789	46,381,513
North Dakota					
Cost Per Bushel	2,458,172	1.33	0.0	0.0	1.33
Cost Per Ton	73,753	44.23	0.0	0.0	44.23
Total Cost		3,262,017	0	0	3,262,017
Oregon					
Cost Per Bushel	980,218	0.34	0.0	0.0	0.34
Cost Per Ton	29,409	11.28	0.0	0.0	11.28
Total Cost		331,837	0	0	331,837
Washington					
Cost Per Bushel	84,355,029	0.20	0.16	0.22	0.59
Cost Per Ton	2,530,904	6.77	5.24	7.46	19.46
Total Cost		17,127,974	13,258,963	18,868,710	49,255,647
Totals					
Cost Per Bushel	126,620,670	0.29	0.30	0.38	0.96
Cost Per Ton	3,799,000	9.63	10.02	12.49	32.14
Total Cost		**36,602,212**	**38,055,799**	**47,456,710**	**122,114,721**

Costs associated with grain transport under the base condition were converted to average annual amounts over the period of analysis from 2007 to 2106. These average annual amounts, that reflect 0.0, 4.75, and 6.875 percent rates of interest, are presented in 1998 dollars in Table 3.3-7.

Table 3.3-7. Base Condition—Grain, Average Annual Costs, 2007 to 2106 (1998 dollars)

Interest Rate (%)	Average Annual Costs ($)
6.875	126,042,205
4.75	126,963,320
0.00	129,337,780

Non-Grain Commodities

For purposes of analysis, non-grain commodities were combined into four groups: petroleum, logs and woodchips, wood products, and other. The other group is comprised of other farm products, containerized products, and chemicals. For the base condition, transportation costs reflect current and

Table 3.3-8. Base Condition Total Annual Transportation Costs for Non-grain Commodities for 2002, 2007, 2012, and 2017 (1998 dollars)

Year/Commodity Group	Base Case ($)
2002	
Petroleum	14,838,745
Logs and Wood Chips	47,879,179
Wood Products	4,380,282
Other	6,125,027
Total	**73,223,233**
2007	
Petroleum	15,893,106
Logs and Wood Chips	47,879,179
Wood Products	5,242,586
Other	6,946,350
Total	**75,961,221**
2012	
Petroleum	16,936,369
Logs and Wood Chips	47,879,179
Wood Products	6,703,299
Other	8,084,392
Total	**79,603,239**
2017	
Petroleum	19,511,230
Logs and Wood Chips	47,879,179
Wood Products	8,494,810
Other	9,345,900
Total	**85,231,119**

projected volume. Transportation costs associated with non-grain commodities for selected years under the base condition are presented in Table 3.3-8.

Costs associated with non-grain commodities were converted to average annual amounts over the period of analysis from 2007 to 2106 and are displayed below in Table 3.3-9. These average annual amounts, computed at 0.0, 4.75, and 6.875 percent rates of interest, are expressed in 1998 dollars.

Table 3.3-9. Base Condition Average Annual Costs for Non-grain Commodities, 2007 to 2106 (1998 dollars)

Discount Rate (%)	Average Annual Costs ($)
6.875	82,274,899
4.750	83,006,143
0.000	84,671,628

Base Condition Summary

Transportation costs associated with all commodities under the base condition are presented in Table 3.3-10. They were computed at 0.0, 4.75, and 6.875 percent rates of interest, expressed in 1998 dollars, and converted to average annual amounts for the period of analysis from 2007 to 2106.

Table 3.3-10. Summary of Base Condition Total Average Annual Costs—All Commodities, 2007 to 2106 (1998 dollars)

Discount Rate (%)	Average Annual Costs ($)
6.875	208,317,104
4.750	209,969,463
0.000	214,009,408

Adjustment of Annual Costs to the Base Year

Average annual costs in Table 3.3-11 were adjusted to the base year of 2005 to be consistent with analyses of other fish restoration alternatives. This was done by discounting the values from 2007 to 2106 (Table 3.3-10) by 2 years at the appropriate discount rate. The adjusted annual costs are shown in Table 3.3-11.

Table 3.3-11. Annual Costs Adjusted to the Base Year of 2005—All Commodities (1998 dollars)

Discount Rate (%)	Average Annual Costs ($)
6.875	182,377,458
4.750	191,358,639
0.00	214,009,408

3.3.5 Dam Breaching Condition

3.3.5.1 Geographic Scope of Impacts

The geographic scope of this analysis includes all communities, port facilities and terminals that are located adjacent to the lower Snake River and have direct access to the navigation channel. This scope also includes inland areas geographically distant from the CSRS that make significant use of the navigation system. Grain export-elevators on the lower Columbia River are part of the study area but export destinations, such as Pacific Rim nations in Asia as a practical matter, are not. A fundamental premise of the analysis is that with dam breaching, export markets will continue to be supplied with the same reliability as the existing system provides.

The analysis of the economic effects of dam breaching on grain producers is limited to the potential changes in how grain is shipped to export terminals in the Portland area and the associated changes in costs. The analysis and results are general in nature and do not apply directly to specific grain producers.

3.3.5.2 Alternative Transportation Modes and Costs

With loss of access to the Snake River portion of the CSRS, commodities would move by the next least costly available mode, such as rail direct to export elevators on the lower Columbia or by truck to river elevators located on the McNary pool. For the dam breaching scenario, the evaluation process in most cases considers the following two alternatives: the use of truck-barge combination to the closest river terminal unimpaired by dam breaching, or truck transport to the closest rail loading facility with multi-car loading facilities. Where rail access is presently available at country elevators, grain would either shift to rail direct from those locations, or be moved by truck to a rail distribution point where unit trains could be assembled. At country elevators where rail is presently the primary means of transport, this would remain the case with dam breaching. As with the base condition, modal costs were prepared for rail, barge, and truck movements using the Reebie models.

3.3.5.3 Alternative Origins

If dam breaching were to occur, grain now shipped via the lower Snake River would shift to alternative modes of transportation. Commodities would either be rerouted via truck to river elevators located on McNary pool or shipped by rail directly to export elevators on the lower Columbia River. To evaluate the transportation, storage, and handling costs associated with this shift, it was necessary to identify alternative origins and intermediate destinations. Alternative destinations were identified through review and revision of the alternative destinations identified in SOR (Corps, 1995). The alternative rail origins (intermediate destinations) of grain shifted from the lower Snake River to rail are shown in Table 3.3-12. Each of these facilities currently has the capability of loading unit trains of 26 or more railcars. The actual number of elevator facilities with unit-train loading capability is significantly greater than the number of facilities included in the model. On the Burlington Northern Santa Fe (BNSF) system, there are actually 39 facilities in eastern Washington and 4 in northern Idaho. These facilities have a combined storage capacity of just slightly less than 53.6 million bushels (bu). For grain now shipped through lower Snake River ports that would continue to be shipped by barge, the alternative barge origin (intermediate destination) is the area close to the confluence of the Snake and Columbia rivers, including the Tri-Cities.

Table 3.3-12. Alternative Rail Origins of Grain with Dam Breaching

Origin[1/]	County	Capacity (bu)[2/]	Railroad
Washington			
Coulee City	Grant	2,038,000	Palouse R. and Coulee City (PCC)
Plymouth	Benton	4,129,000	BNSF
Harrington (2)	Lincoln	2,579,000	BNSF
Odessa (Lamona)	Lincoln	638,000	BNSF
Spangle (3)	Spokane	1,235,000	PCC & BNSF
Spangle	Whitman	3,440,000	PCC & BNSF
Idaho			
Craigmont	Lewis	1,744,000	Camas Prairie RailNet
Grangeville	Idaho	1,552,000	Camas Prairie RailNet
Idaho Falls	Bonneville	na	Union Pacific
Pocatello	Bannock	na	Union Pacific
Nampa	Canyon	na	Union Pacific
Mountain Home	Elmore	na	Union Pacific
Bliss	Gooding	na	Union Pacific
Burley	Cassia	na	Union Pacific
American Falls	Power	na	Union Pacific
Blackfoot	Bingham	na	Union Pacific
Oregon			
Pendleton	Umatilla	na	Union Pacific

1/ There are multiple facilities at some locations, as indicated by the number in parentheses following the city name.
2/ na = not available.

3.3.5.4 Transportation Costs with Dam Breaching

Grain transportation costs under the dam breaching option were developed based upon the projected commodity flows that would be diverted to alternative modes and alternate intermediate destinations. Estimates of the costs associated with projected grain movements in 2007 are presented in Table 3.3-13. Storage and handling costs of grain movements are also shown. Total cost (in dollars), cost per bushel (in cents), and cost per ton (in dollars) are shown for each state. Data are presented for 2007 because this is the year that actual dam breaching would begin, and commodity shipments would be diverted away from the lower Snake River. If dam breaching were to occur, estimated grain transportation costs would range from 40.1 cents per bushel in Oregon to $7.30 per bushel in Montana. Most of the cost for Montana is due to storage and handling costs. While these charges are unrealistic, they were handled the same way in the model with and without dam breaching. As a result, the difference between the two cases is likely to be more realistic than the estimates for each case.

Table 3.3-13. Dam Breaching Grain Shipments and Transportation, Storage, and Handling Costs for 2007 Projected Volume, by State[1/] (1998 dollars)

State	Grain Quantity	Transportation Cost ($)	Storage Cost ($)	Handling Cost ($)	Total Cost ($)
Idaho					
Cost per Bushel	32,289,941	0.50	0.18	0.23	0.90
Cost per Ton	968,795	16.67	5.83	7.58	30.08
Total Cost		16,148,010	5,652,855	7,342,505	29,143,370
Montana					
Cost per Bushel	6,537,310	0.93	3.10	3.31	7.31
Cost per Ton	196,139	30.91	102.16	110.41	243.49
Total Cost		6,063,389	20,038,366	21,655,789	47,757,544
N. Dakota					
Cost per Bushel	2,458,172	1.43	0.00	0.00	1.43
Cost per Ton	73,753	47.78	0.00	0.00	47.78
Total Cost		3,523,573	0.00	0.00	3,523,573
Oregon					
Cost per Bushel	980,218	0.40	0.00	0.00	0.40
Cost per Ton	29,409	13.37	0.00	0.00	13.37
Total Cost		393,165	0.00	0.00	393,165
Washington					
Cost per Bushel	84,355,029	0.34	0.18	0.23	0.75
Cost per Ton	2,530,904	11.35	.586	7.75	24.96
Total Cost		28,714,849	14,838,964	19,605,738	63,159,551
Totals					
Cost per Bushel	126,620,670	0.43	0.23	0.38	1.14
Cost per Ton	3,799,000	14.44	10.67	12.79	37.90
Total Cost		**54,842,986**	**40,530,185**	**48,604,032**	**143,977,203**

1/ Totals exclude an adjustment of $794,781 calculated by the model and added to the regional total to prevent costs for any movement with dam breaching from being lower than without dam breaching.

Costs associated with grain transport under the dam breaching condition were converted to average annual amounts for the period of analysis 2007 to 2016. These average annual amounts, computed at 0.0, 4.75, and 6.875 percent rates of interest, in 1998 dollars, are shown below in Table 3.3-14.

Table 3.3-14. Dam Breaching Condition—Grain, Average Annual Costs, 2007 to 2106 (1998 dollars)

Discount Rate (%)	Average Annual Cost ($)
6.875	148,870,766
4.750	149,958,712
0.000	152,763,231

3.3.5.5 Non-grain Commodities

For purposes of analysis, non-grain commodities were combined into the same groupings used for the base condition analysis. Estimated transportation costs reflect projected commodity volumes. Transportation costs associated with non-grain commodities for selected years under dam breaching conditions are presented in Table 3.3-15.

Costs associated with non-grain commodities under dam breaching conditions are displayed in Table 3.3-16 as average annual amounts for the period of analysis from 2007 to 2106. These average annual amounts, computed at 0.0, 4.75, and 6.875 percent rates of interest, are expressed in 1998 dollars.

Table 3.3-15. Dam Breaching Condition Total Annual Transportation Costs for Non-grain Commodities for 2002, 2007, 2012, and 2017 (1998 dollars)

Year/Commodity Group	Dam Breaching Case ($ 1998)
2002	
Petroleum	15,350,816
Logs and Wood Chips	49,320,040
Wood Products	5,444,873
Other	6,643,160
Total	**76,758,889**
2007	
Petroleum	16,441,562
Logs and Wood Chips	49,320,040
Wood Products	6,516,753
Other	7,533,960
Total	**79,812,315**
2012	
Petroleum	17,520,827
Logs and Wood Chips	49,320,040
Wood Products	8,332,480
Other	8,768,272
Total	**83,941,619**
2017	
Petroleum	20,184,544
Logs and Wood Chips	49,320,040
Wood Products	10,559,403
Other	10,136,495
Total	**90,200,482**

Table 3.3-16. Dam Breaching Condition Average Annual Costs for Non-grain Commodities, 2007 to 2106 (1998 dollars)

Interest Rate (%)	Average Annual Costs ($ 1998)
6.875	86,898,809
4.750	87,715,836
0.000	89,575,894

3.3.5.6 Infrastructure Requirements and Costs

With dam breaching and a shift of commodities from shipment on the lower Snake River to shipment by rail, there would be a substantial increase in demand on the region's land-based transportation and grain handling infrastructure. This section addresses rail system requirements, rail car capacity, highway system requirements, and elevator capacity requirements. In all cases, a range of costs (low and high) was estimated due to uncertainties about actual needs and costs. The following sections briefly describe infrastructure needs and present a summary of the associated costs. The methodology employed to identify these costs is discussed in the DREW Transportation Report (DREW Transportation Workgroup, 1999).

Rail System Requirements

If dam breaching were to occur, rail system requirements would include improvements to existing rail lines in terms of interchanges between short-line and mainline carriers, track upgrades, and bridge upgrades. In addition, the stock of grain cars would have to be expanded.

Mainline (Class 1) Railroads

Both mainline railroads, BNSF and Union Pacific, would be impacted by dam breaching through the shift of grain and other commodities from the Snake River to rail. In this analysis, it is assumed that all commodities shifted to rail would eventually require the services of these mainline carriers to reach their final destinations at ports on the lower Columbia River. The increase in grain shipments alone would increase traffic on the mainline routes by from about 840 to about 940 railcar-trips per month. Assuming a train size of 108 cars, this represents an increase of from about eight to nine additional trains per month destined to ports on the lower Columbia River. This would be a significant increase in rail traffic, and improvements to the existing mainline system may be needed.

Estimates of mainline railroad infrastructure costs were based on a study conducted for the Corps by the Tennessee Valley Authority and Marshall University (TVA and Marshall University).[4] The study included modeling shipments of water borne traffic that would be diverted from the Snake River by rail to export facilities on the lower Columbia River, if dam breaching were to occur. The model was constructed and operated on the basis of the assumption that all Snake River traffic would shift to rail with dam breaching (actually only about 29 percent of the grain expected to be shipped on the Snake River in 2007 is predicted to shift to rail) and was focused on examination of line-haul capacity costs on the railroad route segments that connect the upper Snake River basin with the Portland export gateway.

[4] The Incremental Cost of Transportation Capacity in Freight Railroading: An Application to the Snake River Basin. The Tennessee Valley Authority and The Center For Business and Economic Research Lewis College of Business Marshall University, July, 1998.

Even with the assumption of full diversion of Snake River traffic to rail, the TVA and Marshall University study concluded that:

> "(i)n most cases, the line-haul segments that, together, form the routes over which regional rail traffic flows could be modified to accommodate Snake River barge traffic without placing a significant upward pressure on competitively developed railroad rates. While some specific route segments might require substantial incremental expenditures to accommodate additional traffic, the adverse rate effects of these expenditures would be largely offset by the efficiencies gained through expanding the capacity of related route segments."

In making the assessment of mainline railroad infrastructure needs and costs, estimates of diverted traffic, estimates of diverted traffic and generic or "rule of thumb" measures were used in the TVA and Marshall University study. Generic measures for costing the construction or modification of line capacity were developed for this purpose by civil engineers at the University of Tennessee Transportation Center. Preliminary estimates were discussed with engineering professionals from a number of Class 1 Railroads and with experts from private construction firms that are routinely engaged in rail project construction. Officials of the BNSF, Union Pacific and others reviewed these estimates as they apply to the Pacific Northwest rail system. The types of improvements that could be needed are as follows:

- improve a 71-mile segment of track by installing three 10,000-foot long sidings and upgrading 20 percent of the un-signaled track to automatic block signals (ABS)
- add 12 miles of secondary mainline trackage on existing right-of-way on an 80-mile long route segment
- construct two miles of a second main track and upgrade the remainder of a 25-mile long route segment from ABS to centralized traffic control (CTC) signals.

The cost estimates for implementing these improvements ranged from a low of about $14 million to a high of about $24 million.

With these improvements and assuming that future events and market outcomes unfold in ways that are not radically different from those foreseen at the present time, then the TVA and Marshall University analysis supports the following conclusions:

- The unavailability of variable inputs, such as locomotives, rail cars, and train crews, could lead to serious short-run capacity constraints. However, in the long-run optimal levels of these inputs would be acquired at prices that would not adversely affect rates if rail carriers face effective competition in rail-served markets.
- In most cases, the line-haul segments that, together, form the routes over which regional rail traffic flows, could be modified to accommodate Snake River barge traffic without placing a significant upward pressure on competitively developed railroad rates. While some specific route segments might require substantial incremental expenditures to accommodate additional traffic, the adverse rate effects of these expenditures would be largely offset by the efficiencies gained through expanding the capacity of related route segments.
- At least in the case of the diversion of lower Snake River traffic, concerns regarding terminal congestion and the adverse effects this congestion may have on railroad pricing are unfounded.

- The traditional Corps assumption of ample alternative modal capacity is valid for use in the analysis of Snake River navigation.

Short-Line (Class 2) Railroads

If dam breaching were to occur, short-line railroads in Idaho and Washington would likely experience increased shipments of grain. The magnitude of this increase was not projected for individual railroads or even to the short-line railroads as a group as part of this study. As a result, the assessment of impacts on these carriers and the estimates of costs of improvements are general in nature. Cost estimates were not specifically developed for this study. In the case of Washington railroads, costs were taken from a transportation impact study prepared for the Washington State Legislative Transportation Committee (HDR Engineering, Inc, [HDR], 1999). In the case of Idaho railroads, information about the potential shift of grain to rail was provided to representatives of each of the short-line railroads, with a request that they identify any improvements that might be needed and estimated costs, if any.

Current Conditions, Needs, and Costs

Infrastructure needs of the affected short-line railroads in Idaho and Washington would be relatively more impacted than the mainline railroads. The reason for this is that these rail lines are generally in poor condition at present. The poor condition of the lines stems from the fact that most of the short-line railroads are spin-offs of low volume, low revenue/profit segments of the mainline system, and maintenance tends to be deferred. Traffic on most of the operating short-line railroads is limited to speeds from 25 to 45 miles per hour. Assessments of current needs have been made for both Idaho and Washington and are included in the respective state railroad plans. These analyses identified current maintenance needs amounting to about $21 million. Completion of this maintenance work is needed even if the four lower Snake River dams are not breached.

Incremental Infrastructure Needs with Dam Breaching

To identify incremental improvements that might be needed with dam breaching, representatives of the railroads that would be impacted by dam breaching were contacted and asked to identify any potential additional improvements. In addition, information from other sources was used to identify needed improvements and costs. Needed improvements that were identified include interchanges with mainline railroads, track upgrading, and "other." All of the improvements that were identified were associated with railroads in Washington. To date, no needs have been identified for railroads in Idaho. The cost of the improvements for Washington railroads was estimated to range from about $20 million to $24 million.

Rail Car Capacity

If dam breaching were to occur, approximately 1.1 million tons of grain would transfer to rail. In analyzing available information on current railcar availability and costs, a range of the number of cars needed and their costs was developed. At present there is a large surplus of grain cars. For example, BNSF's grain car utilization rate for June 1999 was only about 50 percent. In spite of this, the analysis for this study is based on the premise that additional rail cars would have to be acquired over the long term to move the grain that would shift to rail with dam breaching. A number of factors were considered in the analysis, including the size of the cars, the turn rate, and the cost per car. The resulting costs ranged from about $14 million to about $37 million.

Rail System Congestion

If dam breaching were to occur, the rail system will experience increased traffic. This increase in traffic has the potential to cause congestion on mainlines and at loading and unloading facilities. Congestion on short-line railroads is not considered likely because those facilities are almost universally only lightly used at present. In the case of congestion at loading and unloading facilities, the DREW Transportation Workgroup believes that with implementation of the infrastructure improvements identified in this report there would not be a significant increase in delays due to congestion. In fact, it is likely that the system would become more efficient as it adjusts to a more significant role in the transport of grain within the region. This issue was specifically addressed in the TVA and Marshall University study (TVA and Marshall University, 1998). This study concluded: 1) improvements to the system may be needed to avoid congestion and 2) needed improvements could be made without increasing long-run marginal costs or putting upward pressure on rates. Transportation analysts at both railroads were asked to review and comment on the potential for congestion on BNSF and Union Pacific railroads. A representative of the BNSF railroad asserted that existing rail capacity is sufficient to handle the increase in traffic with dam breaching and that the improvements recommended by the TVA and Marshall University study would not be needed. The BNSF representative noted that a significant increase in rail capacity could be achieved simply by sending empty trains east by way of Stampede Pass. This route was closed for sometime and is now only very lightly used. Use of the Stampede Pass route for loaded trains is not desirable because of the relatively steep grade and the requirement to use additional engines. The UP did not respond to the request for review of the assessment of rail capacity impacts of dam breaching.

Highway System Requirements

Change in Highway Use

Impacts on highway capital and maintenance cost with dam breaching were determined on the basis of the change in the use of highways to transport grain. The change in highway use was computed as the change in truck miles if dam breaching were to occur. Estimates of the change in truck miles with dam breaching are shown in Table 3-17, by state. Because both rail and barge transport also require truck transportation to position grain at country and river elevators, the volume of grain that the truck mile estimate is based upon is equal to the total amount of grain that is currently transported on the lower Snake River. Also shown is the number of alternative origins/destinations for which truck miles would increase and decrease in each state. These changes range from a decrease of about 1.6 million miles in Idaho to an increase of about 3.4 million miles in Washington. The decrease in Idaho is explained by the shift of grain to rail, and the increase in Washington is explained largely by the change in the destination of truck shipments from ports on the lower Snake River to ports in the Tri-Cities area. Maintenance cost savings for Idaho were not estimated, and the change in truck miles for Oregon was considered to be too small to be significant. In the case of Washington, costs include miles for grain movements from Montana and North Dakota because the increase in truck miles would actually occur in Washington.

Highway Infrastructure Improvement Needs

Highway improvements that were identified as necessary to maintain adequate highway performance and minimal travel delay include intersection improvements, pavement replacement or overlay, and more frequent maintenance. Total estimated costs for these improvements range from about $84 million to $101 million. An annual increase in accident costs amounting to about $2 million was also estimated (HDR, 1999).

Highway Congestion

Based on an assumption of a truck capacity of 1,000 bushels (30 tons) of grain per truck-load in the highway congestion analyses, with dam breaching there would be an increase of approximately 95,200 truck trips to the Tri-Cities area in Washington. Based on assumptions used for this study, this would result in an increase of 370 average daily truck trips, or about 45 trips per hour. With the implementation of the highway improvements identified in this report, highway congestion should not increase, however, additional, more detailed, engineering and traffic studies would be required to determine what highway improvements would actually be needed.

Table 3.3-17. Summary of the Change in Truck Miles, by State and the Number of Alternate Origins/Destinations with Increased and Decreased Miles

				Number of Alternate Destinations and Change		
State	**Sum Of Total Bushels**	**Change in Bushel-Truck Miles**	**Change in Truck Miles [1/]**	**Miles Increased**	**Miles Decreased**	**Total Alternate Destinations**
Idaho	32,289,941	(1,643,257,066)	(1,888,801)	4	31	35
Oregon	980,218	40,175,108	46,178	1	0	1
Washington	84,355,029	3,429,355,830	3,941,788	11	4	15
Montana[2/]	6,537,310	1,007,893,915	1,158,499	6	0	6
N. Dakota[3/]	2,458,172	352,942,345	405,681	1	0	1
Totals	**126,620,670**	**3,187,110,133**	**3,663,345**	**23**	**35**	**58**

1/ For this analysis, number of bushels per truck equals 870.
2/ Montana is divided into regions.
3/ Nnorth Dakota is a single region.

Elevator Capacity Requirements

With dam breaching, it is projected that about 1.1 million tons of grain would shift from the river to rail. In addition, it is projected that an additional 2.7 million tons of grain would be shifted from lower Snake River ports by truck to the Tri-Cities for barging to ports on the lower Columbia River. Additional storage and handling capacity would be needed at both export facilities located on the lower Columbia River and at river ports in the Tri-Cities area.

Rail Car Unloading Capacity at Export Elevators

Analyses of current rail unloading capacity at export terminals showed a total daily capacity of about 85,000 tons (1.7 million tons per month). This amount excludes the new terminal planned at Hayden Island, which will have a capacity of 6 million tons per year or 500,000 tons per month. To determine if existing capacity could accommodate the increased rail shipments of grain with dam breaching, historical monthly rail car unloadings at Columbia River export elevators from 1988 to 1997 were analyzed. Based on this analysis of historic peak monthly volume and expected peak additional volume with dam breaching, the maximum expected demand on rail unloading facilities with dam breaching is estimated to be about 1.6 million tons, which is somewhat less than existing capacity. Based on this analysis, it was determined that no additional capacity would be needed with dam breaching.

Rail Car Storage at Export Elevators

With dam breaching there would be an increase of from eight to nine unit trains per month being delivered to export terminals, or from about 840 to about 940 rail cars. The actual amount of storage required, however, would be significantly less because of the turn rates. The turn rates used in the analysis reduce the number of additional rail cars actually needing storage from a range of 840 to 940 cars to a range of 280 to 670 cars. In addition, assuming an even flow of shipments only about one-half of the cars would be at the terminals for unloading at any one time. The other one-half would be in the process of being loaded. Thus, rail storage at export terminals or on rail sidings in the area would only be needed for about 140 to 325 additional cars. Except at Kalama, a facility that primarily handles corn, rail cars are not stored at the export terminals unless they are actually being unloaded. Loaded and empty cars must be shuttled between the terminals and sidings on a daily basis.

To meet this demand for additional rail car storage, the most likely option was determined to be construction of a single new siding long enough to accommodate the additional cars. The estimated cost of the siding, including track, rights-of-way, turnouts, and control points, ranges from about $2 million to $4.1 million.

River Elevators

Grain that would continue to be shipped to export terminals by truck/barge would be trucked to the Tri-Cities area before being loaded onto barges for the remainder of the trip. The estimated volume of grain is about 2.7 million tons (90 million bushels). Analysis of the operating characteristics of river elevators showed that additional capacity needed at the confluence or the Tri-Cities area would range from 10.8 million to 36 million bushels of storage and put-through capacity, depending on the turnover ratio ultimately achieved. Estimated costs for this range of capacity are from about $58.7 million to about $335.4 million, depending the type of facility (barebones or state-of-the-art) and capacity. These estimates include the cost of rail trackage and access roads.

Country Elevators

Based on information obtained from country elevator operators for the System Operation Review and updated for this study, the Corps believes that there is sufficient capacity at country elevators to accommodate the projected shift of grain from the Snake River to rail if dam breaching were to occur. In addition, the Corps believes that there are a sufficient number of existing country elevators with unit-train (25 or more cars) loading capacity to accommodate the shift. Improvements to loading and unloading facilities and railcar handling tracks would, however be needed. The Corps did not estimate costs to upgrade these facilities at country elevators. For this report, cost estimates prepared for the State of Washington in the report, Lower Snake River Drawdown Study, Appendix B, Technical Memoranda (HDR Engineering, Inc., 1999) are used. The estimated costs for upgrading facilities with rail access in Washington presented in this report ranged from $14.0 million to $16.9 million. Loading and unloading facilities at railhead country elevators in Idaho are considered to be adequate to accommodate the increase in rail shipment without any improvements. Washington and Idaho are the only states in which grain shipments would shift to rail with dam breaching.

3.3.5.7 Summary—Dam Breaching Condition

Annual NED Transportation Costs

Annual transportation costs associated with all commodities under the dam breaching condition, excluding NED infrastructure costs, are presented in Table 3.3-18. Annual costs are shown for discount rates of 0.0, 4.75, and 6.875 percent, are expressed in 1998 dollars, and are based on a 100-year period of analysis from 2007 to 2106.

Table 3.3-18. Summary of Dam Breaching Condition Total Average Annual Costs—All Commodities, 2007 to 2106 (1998 dollars)

Discount Rate (%)	Average Annual Cost ($)
6.875	235,769,575
4.750	237,674,548
0.000	242,339,125

Adjustment of Annual Costs to the Base Year 2005

Average annual costs in Table 3.3-18 were adjusted to the base year of 2005 to be consistent with analyses of other fish restoration alternatives. This was done by discounting the values for 2007 to 2106 (Table 3.3-18) by 2 years at the appropriate discount rate. The adjusted annual costs are shown in Table 3.3-19.

Table 3.3-19. Annual Costs Adjusted to the Base Year of 2005—All Commodities (1998 dollars)

Interest Rate (%)	Average Annual Costs ($)
6.875	206,411,548
4.750	216,608,063
0.000	242,339,125

Infrastructure Capital Costs

In addition to the annual NED costs shown above, expenditures on transportation infrastructure would also be required to increase the capacity of the system prior to actual implementation of dam breaching. These costs are not part of the cost of the Federal project to breach the four lower Snake River dams, but would be required as a direct result of implementation of dam breaching. Shipping, handling, and storage costs used in this analysis include the amortized capital and operating costs of all of the components of the transportation system. A key assumption in the analysis is that capacity can be added to the system at a cost that is no higher than the cost of the capacity that now exists. On this basis, the annual cost of infrastructure improvements is already embedded in the shipping, storage, and handling costs used in the analysis. Therefore, it is appropriate that infrastructure costs not be included in the estimated transportation costs with dam breaching. Summaries of infrastructure improvements that would be needed and estimated ranges of costs are provided below in Table 3.3-20.

Table 3.3-20. Summary of Estimated Costs of Infrastructure Improvements Needed with Dam Breaching (1998 dollars)

Infrastructure Improvements	Estimated Costs ($) Low	High
Mainline Railroad Upgrades	14,000,000	24,000,000
Short-Line Railroad Upgrades	19,900,000	23,800,000
Additional Rail Cars	14,000,000	36,850,000
Highway Improvements	84,100,000	100,700,000
River Elevator Capacity	58,700,000	335,400,000
Country Elevator Improvements	14,000,000	16,900,000
Export Terminal Rail Car Storage	1,985,000	4,053,000
Total	**206,685,000**	**541,703,000**

NED Cost of Infrastructure Improvements

Due to the relatively higher capital costs of infrastructure improvements to the rail and highway system and grain elevators it became evident during review of the transportation analysis prepared for the draft FR/EIS that these costs may exceed the revenue that would be available through the current rate structure to pay for them. It also became evident that if this were the case dam breaching would exert upward pressure on rates, an indication that there are NED costs associated with infrastructure improvements. It was, therefore, determined that infrastructure costs should be compared with available revenue from the grain that would be diverted from the lower Snake River if dam breaching were to occur. This comparison is based on the assumption that, with the exception of highway improvements, infrastructure improvements that would be necessary if dam breaching were to occur would need to be paid for with revenue that would be derived from the fixed cost component of the transportation and handling rates. It was also presumed that highway system improvements should be paid for by revenue from fuel and other taxes that would result from increased truck transport of grain. Revenue and capital costs are compared in the following paragraphs for each general category of infrastructure improvements.

Rail System

Revenue available from existing rail rates to pay for rail system infrastructure was estimated based on Reebie Model estimates of the percent of rail transportation rates that are attributable to fixed costs. Through analysis of a sample of rail movements of grain from Idaho, North Dakota, and Washington, it was determined that on average 27.4 percent of the total rail transportation rate is attributable to fixed costs. This is the amount of the rate that is theoretically available to pay for system capital costs. To obtain the amount of annual revenue available to pay for capital improvements with dam breaching, this percentage was applied to the change in total revenue (increase in rail transportation costs). For purposes of comparing revenue and costs, capital costs were converted to an annual amount using an interest rate of 6.875 percent and a project life of 50 years. The resulting comparison and estimate of the NED cost of rail system infrastructure improvements is shown in Table 3.3-21.

Table 3.3-21. Rail System Infrastructure Capital and Annual Costs, Annual Revenue, and Annual NED Costs with Dam Breaching (1998 dollars)

	Capital Cost	Annual Cost	Estimated Annual Revenue	Estimated NED Costs
Low	$ 49,884,848	$ 3,557,626	$ 1,444,778	$2,112,848
High	$ 75,703,030	$ 5,398,895	$ 1,444,778	$3,954,117

Highway System

Since fuel taxes and license fees pay for highway improvements, analysis of fixed and variable costs of truck transport was not considered relevant. Instead, the comparison of highway system costs and revenue was based on fuel and other taxes and fees that would be collected from new and existing trucks that would transport the diverted grain to rail terminals and a new barge facility at the Tri-Cities. Revenue from fuel taxes was estimated based on fuel consumption data from the Reebie Model and the change in total system truck miles estimated by the DREW transportation model for Washington, North Dakota, and Montana. Revenue from license and other fees was estimated based on data from the Reebie Model and the estimated number of additional trucks that would need to be added to the system. As with rail system costs, capital costs of highway system improvements were converted to an annual amount using an interest rate of 6.875 percent and a project life of 50 years. The resulting comparison of annual costs and revenue and the estimate of the NED cost of highway system infrastructure improvements are shown in Table 3.3-22.

Table 3.3-22. Highway System Infrastructure Capital and Annual Costs, Annual Revenue, and Annual NED Costs with Dam Breaching (1998 dollars)

	Capital Cost	Annual Cost	Estimated Annual Revenue	Estimated Annual NED Costs
Low	$84,100,000	$5,997,739	$1,826,937	$4,170,802
High	$100,700,000	$7,181,598	$1,826,937	$5,354,660

Elevator System

The revenue available to pay for elevator system improvements was estimated based on the fixed cost component of handling costs (46.7 percent) and the handling rates for river elevators ($0.10 per bushel) and country elevators ($0.176) that were used in the DREW transportation model. This fixed cost component and the handling rates were applied to the volume of grain that would be diverted from the lower Snake River to the Tri-Cities for shipment to export terminals in the Portland area. The river elevator-handling rate was applied to shipments that would be transported by barge. The country elevator-handling rate was used for shipments that would be transported by rail. Except for the higher rate at country elevators, this represents the revenue from grain handling that would be transferred to other elevators with closure of the Snake River. The fixed cost component of handling costs, obtained from Whitman County Grain Growers in Washington, was considered representative because Whitman County Grain Growers operate 14 elevators, a significant share of the elevators in the study area. The comparison of costs and revenue and the resulting estimate of the NED cost of elevator system infrastructure improvements are shown in Table 3.3-23.

Table 3.3-23. Elevator System Infrastructure Capital and Annual Costs, Annual Revenue, and Annual NED Costs with Dam Breaching (1998 dollars)

	Capital Cost	Annual Cost	Estimated Annual Revenue	Estimated NED Costs
Low	$2,700,000	$5,184,728	$7,212,736	($2,028,008)
High	$352,300,000	$25,124,894	$7,212,736	$17,912,158

Summary

Estimates of the combined annual NED costs for infrastructure improvements with dam breaching range from $4,255,600 to $27,221,000. Combined costs and revenue are shown in Table 3.3-24. These costs represent additions to the NED transportation system costs presented in the Draft FR/EIS and are included in other tables in the report, as appropriate. Readers and decision-makers should, however, be aware that the NED costs of infrastructure improvements were developed on the basis of incremental costs and benefits (revenue) that would occur as a direct result of dam breaching. The infrastructure improvements may have additional NED system benefits that have not been captured by this analysis. If dam breaching is recommended and authorized for more detailed study, NED costs associated with infrastructure improvements should be re-evaluated on a system basis.

Table 3.3-24. Summary of Total Infrastructure Capital and Annual Costs, Annual Revenue, and Annual NED Costs with Dam Breaching (1998 dollars)

	Capital Cost	Annual Cost	Estimated Annual Revenue	Estimated NED Costs
Low	$206,684,848	$14,740,094	$10,484,452	$4,255,642
High	$528,703,030	$37,705,387	$10,484,452	$27,220,935

3.3.6 Comparison of Base and Dam Breaching Conditions

3.3.6.1 Increase In Transportation Costs of Grain

The increased costs of transporting grain if dam breaching were to occur are presented in Table 3.3-25. Excluding NED infrastructure costs, the increase in cost per bushel ranges from about $0.06 per bushel in Oregon to $0.21 per bushel in Montana. The changes in costs for storage and handling are explained by the increased use of country elevators that have a slightly higher cost than river elevators whose use would decrease if dam breaching were to occur. The change in transportation costs is due to the difference in cost between alternative modes and changes in distance.

The estimated increase in grain transportation costs that would occur under the dam breaching scenario were converted to average annual values for the period of analysis from 2007 to 2106. These costs are presented in Table 3.3-26. Low and high estimates of NED infrastructure costs are also shown but without per bushel and per ton costs. The values shown reflect 1998 price levels.

3.3.6.2 Increase in Transportation Costs of Non-grain Commodities

The estimated additional transportation costs of non-grain commodity movements as a result of dam breaching were computed for each commodity group and for the same selected years as those used for grain. As with grain, no additional increase in volume is forecast beyond 2017. These costs are shown below in Table 3.3-27.

The estimated additional transportation costs of non-grain commodity movements were also converted to average annual values for the period of analysis from 2007 to 2106. These annual amounts, computed at three discount rates, are presented in 1998 dollars in Table 3.3-28.

Table 3.3-25. Increase in Grain Shipments and Shipping Costs with Dam Breaching for 2007 Projected Volume, by State[1/] (1998 dollars)

State/ Unit Cost	Volume (bushels)	Transportation ($)	Storage ($)	Handling ($)	Total ($)	Share of Cost (%)	Share of Grain (%)
Idaho	32,289,941	4,954,984	894,385	410,294	**6,259,663**	28.6	25.5
Cost per bu (cts)	32,289,941	15.3	2.8	1.3	**19.4**		
Cost per ton ($)	969,668	5.11	0.92	0.42	**6.46**		
Montana	6,537,310	1,376,031	0	0	**1,376,031**	6.3	5.2
Cost per bu (cts)	6,537,310	21.0	0.0	0.0	**21.0**		
Cost per ton ($)	196,139	7.02	0.00	0.00	**7.02**		
N. Dakota	2,458,172	261,556	0	0	**261,556**	1.2	1.9
Cost per bu (cts)	2,458,172	10.6	0.0	0.0	**10.6**		
Cost per ton ($)	73,753	3.55	0.00	0.00	**3.55**		
Oregon	980,218	61,328	0	0	**61,328**	0.3	0.8
Cost per bu (cts)	980,218	6.3	0.0	0.0	**6.3**		
Cost per ton ($)	29,409	2.09	0.00	0.00	**2.09**		
Washington	84,355,029	11,586,875	1,580,001	737,028	**13,903,904**	63.6	66.6
Cost per bu (cts)	84,355,029	13.7	1.9	0.9	**16.5**		
Cost per ton ($)	2,530,904	4.58	0.62	0.29	**5.49**		
Subtotals	**126,620,670**	**18,240,774**	**2,474,386**	**1,147,322**	**21,862,482**	100.0	100.0
Cost per bu (cts)	126,620,670	14.4	2.0	0.9	**17.3**		
Cost per ton ($)	3,802,423	4.80	0.65	0.30	**5.75**		
Total NED Infrastructure Costs—Low					**4,256,000**		
Total NED Costs—Low Infrastructure Costs					**26,118,482**		
NED Infrastructure Costs—High					**27,221,000**		
Total NED Costs—High Infrastructure Costs					**49,083,482**		

1/ Costs shown do not include the "adjustment" cost of $794,781 that was calculated by the model to prevent the cost of any movement with dam breaching from being less than it was estimated to be in the base condition.

Table 3.3-26. Average Annual Change in Shipping Costs of Grain with Dam Breaching at Selected Interest Rates[1/] (1998 dollars)

	Interest Rate		
	6.875%	**4.75%**	**0.00%**
Transportation Cost Increase			
Total ($)	18,827,438	18,965,029	19,319,712
Cost per Ton ($)	4.96	4.99	5.09
Cost per Bushel (cents)	14.87	14.98	15.26
Storage Cost Increase			
Total ($)	2,553,967	2,572,632	2,620,745
Cost per Ton ($)	0.67	0.68	0.69
Cost per Bushel (cents)	2.02	2.03	2.07
Handling Cost Increase			
Total ($)	1,184,223	1,192,877	1,215,186
Cost per Ton ($)	0.31	0.31	0.32
Cost per Bushel (cents)	0.94	0.94	0.96
Subtotal Annual Cost Increase			
Total ($)	22,565,628	22,730,538	23,155,643
Cost per Ton ($)	5.94	5.98	6.10
Cost per Bushel (cents)	17.82	17.95	18.29
Total NED Infrastructure Cost—Low	**4,255,642**	**402,653**	**(6,350,755)**
Total Annual Cost Increase—Low	**26,821,270**	**23,133,190**	**16,804,888**
NED Infrastructure Cost—High	**27,220,935**	**17,364,929**	**89,609**
Total Annual Cost Increase—High	**49,786,564**	**40,095,466**	**23,245,252**
Total Bushels	**126,620,670**		
Total Tons (33.33 bu/ton)	**3,799,000**		

1/ Unit costs are computed from the volume of grain projected for 2007.

Table 3.3-27. Average Annual Change in Shipping Costs for Non-grain Commodities with Dam Breaching, by Commodity Group, and at Selected Discount Rates (1998 dollars)

Year/Commodity Group	Cost Increase ($)
2002	
Petroleum	512,071
Logs and Wood Chips	1,440,861
Wood Products	1,064,591
Other	518,133
Total	**3,535,656**
2007	
Petroleum	548,456
Logs and Wood Chips	1,440,861
Wood Products	1,274,167
Other	587,610
Total	**3,851,094**
2012	
Petroleum	584,458
Logs and Wood Chips	1,440,861
Wood Products	1,629,181
Other	683,880
Total	**4,338,380**
2017	
Petroleum	673,314
Logs and Wood Chips	1,440,861
Wood Products	2,064,593
Other	790,595
Total	**4,969,363**

Table 3.3-28. Average Annual Change in Shipping Costs for Non-grain Commodities with Dam Breaching (1998 dollars)

Discount Rate (%)	Average Annual Cost ($)
6.875	4,623,910
4.75	4,709,693
0.00	4,904,266

3.3.6.3 Increase in Transportation Costs—All Commodities

Table 3.3-29 presents the average annual increase in shipping costs, including NED infrastructure costs that would result if dam breaching were to occur. High and low estimates that are shown reflect the range of costs estimated for the NED component of infrastructure costs. This increase presented at three discount rates addresses both grain and non-grain commodities. These costs include the adjustments referred to in Table 3.3-25, footnote 1.

Table 3.3-29. Average Annual Cost Increase—All Commodities, Adjusted to the Base Year of 2007 (1998 dollars)

	Average Annual Cost Increase—All Commodities		
Interest Rate (%)	**Most Likely**[1/]	**High**	**Low**
6.875	43,190,760	54,673,406	31,708,113
4.750	36,588,876	45,070,014	28,107,738
0.000	25,064,240	28,419,326	21,709,154

1/ Mid-Point

3.3.6.4 Adjustment of Annual Costs to the Base Year

Average annual costs in Table 3.3-29 were adjusted to the base year of 2005 to be consistent with analyses of other economic impacts. This was done by discounting the values for 2007 to 2106 (Table 3.3-29) by 2 years at the appropriate discount rate. The adjusted annual costs are shown in Table 3.3-30. Projected "most likely" annual cost increases are summarized by cost component and discount rate in Table 3.3-31.

Table 3.3-30. Average Annual Cost Increase—All Commodities, Adjusted to the Base Year of 2005 (1998 dollars)

	Average Annual Cost Increase—All Commodities		
Interest Rate (%)	**Most Likely**[1/]	**High**	**Low**
6.875	37,812,778	47,865,641	27,759,916
4.750	33,345,789	41,075,195	25,616,384
0.000	25,064,240	28,419,326	21,709,154

1/ Mid-Point

3.3.6.5 Modal Rate Implications of Dam Breaching

There is significant concern that closure of the lower Snake River would create a monopolistic condition for the railroads and rates would rise significantly above costs. This issue was addressed in a study conducted for the Corps by TransLog Associates. The report that resulted from the study is referenced earlier in this summary of transportation system impacts of dam breaching. The central issue addressed in the study is the logistical impact (rate changes and modal shifts) of dam breaching on grain shipments from the traditional lower Snake River origin freight territories.

The Translog Associates study included an assessment of the ability of each transportation mode (truck, rail, and barge) to change rates in response to dam breaching. The analysis considered two market areas, a long distance market at least 250 miles from the CSRS (Montana and North Dakota) and a local market

Table 3.3-31. Estimated Net Average Annual Transportation Effects ($1,000s) (1998 dollars)[1/]

Alternative 4	6.875 % Discount Rate	4.75 % Discount Rate	0.0 % Discount Rate
Grain	(22,566)	(22,731)	(23,156)
Non-Grain Commodities	(4,624)	(4,710)	(4,904)
Infrastructure	(16,001)	(9,149)	2,996
Total[2/]	**(43,191)**	**(36,589)**	**(25,064)**
Adjusted Total[3/]	**(37,813)**	**(33,346)**	**(25,064)**

1/ NED effects are average annual costs and benefits calculated over a 100-year project life.
2/ The DREW Transportation Workgroup analysis used 2007 as the base year. The "total" row presents the average annual costs adjusted to the base year of 2007.
3/ The adjusted totals discount the same costs back to 2005 to allow comparability with other elements of the study.
Source: Compiled from Tables 3.3-26, 3.3-28, 3.3-29, and 3.3-30

with a distance of up to about 250 miles from the CSRS. Actually, all of the region except Montana and North Dakota was included in the local market, including areas in southeastern Idaho that are more distant than 250 miles. This assessment concluded that the long distance market only includes truck shipments of grain because grain is a backhaul to carriers whose primary cargo is Northwest building materials that are shipped to eastern destinations as far away as Chicago. The study found that truck shipments of grain are made at below full costs but above incremental costs (costs specific to the trip). This means that as long as primary haul markets exist, grain will continue to be trucked to the Northwest. The study further found that rail rates are determined by factors other than truck-barge competition and that dam breaching would have no effect on rail rates in the long distance market.

In the local market, the study found that rail shipments of grain in this market are made at rates that are below fully allocated costs. Thus, from this viewpoint, these movements are currently unprofitable. This does not mean that the railroads lose money on the movements. The revenue from the shipments covers all of the variable costs and makes a contribution toward allocated fixed costs of the system. The railroads could theoretically indefinitely continue providing grain transport service to the Northwest at the current rate structure. However, because grain transport service does not provide sufficient revenue to pay the full cost of the service, the railroads do not have a strong incentive to adopt a rate strategy that would entice grain shippers away from the river, even with dam breaching. Nevertheless, the Translog Associates study found that rail rates are likely to increase with dam breaching. Lacking a strong profit incentive to increase market share, the railroads are expected to limit rate increases to the amount of the increase in the combined truck/barge rate with dam breaching. This strategy would slightly improve the railroads' revenue-cost ratios for Northwest grain transport service, but would leave the relative competitiveness of the two modes unchanged.

Another factor at play in the response of the railroads to dam breaching is their awareness of the sizeable margin of profit that the barge industry now has in grain transport on the CSRS. The railroads are aware that if they were to attempt to draw grain away from the CSRS, the barge industry's profit margin gives it the flexibility to adopt an aggressive rate strategy that would offset the increase in the truck component of the truck/barge transport option with dam breaching. Adoption of such a strategy by barge operators could significantly reduce the volume of grain expected to shift to rail. This in turn would significantly reduce the need for and cost of many of the infrastructure improvements that have been identified in this study. The TransLog Associates report concluded that the only strategy available to the railroads to increase market share, even with dam breaching, would be to introduce more efficient service packages—

26 and/or 52 car rates. This has not been done in past for two reasons. First, rail shipments of grain in the Northwest are unprofitable. And, second, there is no demand for this type of service.

3.3.7 Risk and Uncertainty

3.3.7.1 Findings of Other Studies

As a result of the intense regional interest in the potential of breaching dams on the lower Snake River, a number of other studies have been conducted or are in the process of being conducted. The results of all of these studies were not all available for inclusion in this report. However, due to concerns that many of the findings of these other studies are not in agreement with the findings of DREW Transportation Workgroup analysis, it was judged appropriate to include mention of these other studies and summaries of findings, if available, in this report. The more significant of these completed and ongoing studies are those conducted by the State of Oregon and Port of Portland and the State of Washington.

The State of Oregon and Port of Portland completed a study entitled *Breaching the Lower Snake Dams: Transportation Impacts in Oregon* (HDR Engineering, Inc., 2000). Key findings of this study include:

- Up to 9,000 full containers currently shipped through the Port of Portland each year could be diverted to the Puget Sound or other ports.

- Four of the six ocean carriers currently calling in Portland might stop if containers could no longer be shipped on the lower Snake River. Two are considered “likely” to stop calling; two others are considered “vulnerable.”

- If fewer ocean carriers serve Portland, shippers who use the Port of Portland to ship export containers may need to ship containers through Puget Sound area ports, with associated increases estimated at $200 per container on average. This would result in a possible loss of export markets, increased congestion and wear on road and rail infrastructure, and increased energy consumption and air emissions.

- Barge companies would lose between $4 and $11 million in business annually, and their rates to the remaining customers on the Columbia River would likely increase.

- Agricultural land with yields less than 45 bushels per acre may be at risk of being taken out of production due to higher transportation costs. Low yield dryland wheat farm acreage in Wallowa County, Oregon, and Lincoln and Adams counties, Washington is at greatest risk for being removed from production.

- Increased transportation costs could reduce the value of some farmland in eastern Oregon and Washington by an estimated $88 per acre.

The State of Washington (Washington State Legislative Transportation Committee) is in the process of conducting three studies concerning the effects of dam breaching on transportation in Washington State. One of the studies has been completed and the other two are apparently ongoing. A summary of the findings of the completed study and how it differs from the findings of this study is presented below. Summaries of the purpose of the other two studies are also presented below.

- The completed study conducted by HDR Engineering, referred to as the State of Washington/Port of Benton Hanford Investment Study (January 2000), shows that the practical capacity of the BNSF's Columbia River Gorge and Stevens Pass will be reached in 2005 or 2006, given current rail traffic growth rates and the capacity of Stampede Pass will be reached in the 2020s. The findings of this study differ significantly from the finding of the transportation impacts analysis conducted by the DREW Transportation Workgroup for the FR/EIS. As noted previously, studies for the FR/EIS found that the rail system could accommodate the projected shift of grain to rail with only minor system improvements if dams were breached in about 2007. Rail system representatives stated that the shift of grain to rail would have an insignificant effect on rail system capacity. If dam breaching is recommended and authorized for implementation, the issue of rail system capacity should be studied in greater detail and the differences between the State's study and studies conducted for the FR/EIS should be resolved.

- A second study being conducted by HDR Engineering for the Washington State Legislative Transportation Committee addresses the impacts of dam breaching on state highways and county and city roadways of Washington. The scope of this study is broader than the study that was completed by HDR in 1999 and used as the basis for estimates of highway system impacts and infrastructure costs that are presented in this report. If dam breaching is authorized for further study and/or implementation, the findings of the ongoing HDR study should be reviewed and incorporated in any further studies by the Corps of the impacts of breaching Snake River dams on the highway system in Washington.

- The third study being conducted by the State of Washington is a study funded by the Washington State Department of Transportation that addresses the benefits and impacts of 286,000-pound and 315,000-pound rail cars on light-density rail lines in Washington. Although heavier cars may help address capacity constraints on existing mainlines, most light-density lines do not have the necessary rail infrastructure to carry heavier cars. This study is not relevant to the findings of the DREW transportation analysis, which assumed that grain that would shift to rail with dam breaching would be transported on standard size rail cars. Data currently available about the short-line railroads shows that significant improvements to railroad beds would be needed to use the larger cars. The volume of grain that would be shifted to rail with dam breaching would not make these improvements economically feasible; therefore, it is judged that standard cars would continue to be used.

3.3.7.2 Sources of Risk and Uncertainty

The dam breaching alternative raises a considerable amount of uncertainty with regard to the magnitude of economic and/or financial impacts that could potentially be experienced with plan implementation. One primary area of uncertainty as it relates to dam breaching is the capability of the existing transportation system to adjust to accommodate the types of changes among modes and routings that are projected with river closure. A second area of uncertainty is the magnitude of financial impact that may be experienced by producers and shippers of commodities given the extensive transformation that would occur within the transport sector of the Pacific Northwest. Issues of risk and uncertainty include concerns about system capacity; the cost of improvements that may be needed, potential transportation rate impacts, impacts to roads and highways, and impacts on the rail system. To address the potential impacts of these and other related issues, several sensitivity analyses were developed in an attempt to identify the range of additional economic and financial costs that could potentially be experienced with river dam breaching. Following is a list of risk and uncertainty sources addressed in the DREW Transportation System Impacts Analysis Report, 1999. In addition, the sensitivity to the transportation model to alternative assumptions was assessed. A summary of this assessment is presented below in Section 3.3.7.3.

The following sources of risk and uncertainty were assessed during the study:

- capacity
- railroad
- export elevators
- river elevators
- roads and highways
- modal rates
- NED efficiency loss with monopoly increase in rates
- transportation system reliability
- construction of a petroleum pipeline
- grain forecast
- potential impacts on the export market for grain
- duration of transition to equilibrium with dam breaching
- incidence of infrastructure costs.

3.3.7.3 Sensitivity of Model Results to Input Values and Assumptions

The ACCESS database model used for the analysis of transportation system costs required a number of assumptions and estimated input values. Modifying any of these assumptions would change the results produced by the model. Key assumptions and input values used in the model were reviewed, and effects of the use of alternative assumptions and values were determined. The review, however, was limited to a qualitative assessment. An attempt at establishing probable ranges of values was not made, nor were additional model runs made using alternative assumptions. Summary results of the review and assessment are presented in Table 3.3-32.

Table 3.3-32. Qualitative Assessment of the Effect of Using Alternative Assumptions and Input Values in the Transportation Analysis Model

Variable and Existing and Alternative Assumptions	Effect on Model Results
Base Commodity Level • Assumption: Base commodity levels used are for 1996. • Alternate Assumption: Use 1997 levels.	• The assumption used results in a higher base volume for grain than if the volume for 1997 were used. If the volume in 1997 is representative of the future, the impact of dam breaching is overstated (1997 grain shipments decreased by about 20 percent from 1996). • Use of 1997 as the base would decrease the total volume of grain in the system and the amount that would be affected by dam breaching. This would reduce the estimated increase in cost by a proportional amount: i.e., by as much as 20 percent. If 1997 shipments were a deviation from the norm rather than the basis for a new trend, this would understate long-term impacts of dam breaching.
Commodity Forecast • Assumption: Forecasts were derived from forecasts developed for the Columbia River Channel Deepening Study. In the context of Snake River shipments, these are demand-based forecasts. • Alternate Assumption: Develop forecasts specific to the Snake River hinterland by analysis of changes in production by commodity group.	• The accuracy of the forecast used is entirely dependent on the accuracy of the forecast developed for the Columbia River Channel Deepening Study. The effect on model results is unknowable without development of an alternate forecast. Transportation costs for grain are not sensitive to the forecast at the per-ton or per-bushel level. • The alternate forecast methodology would link the forecast directly to production in the Snake River hinterland. As a result, such a forecast might be more defensible. It is not possible to predict whether this forecast would be higher or lower than the forecast used.
Commodity Origins • Assumption: Origins for grain are at the county level, except for Montana (six regions) and North Dakota (one region for the entire state). Origins for non-grain commodities (except farm commodities) are specifically defined. • Alternate Assumption: Expand the model to include greater detail.	• Distance for farm direct to river or rail is computed from the center of the origin county. Distance is not computed for farm to country elevator movements. Accuracy of the cost estimates is reduced for grain and other farm commodities. • The level of detail could be expanded to the farm level. This would improve accuracy and would allow all transportation costs to be estimated. Modeling cost would be much higher but transportation costs estimates would be much more accurate.

Table 3.3-32. Qualitative Assessment of the Effect of Using Alternative Assumptions and Input Values in the Transportation Analysis Model (continued)

Variable and Existing and Alternative Assumptions	Effect on Model Results
Storage Costs	
• Assumption: Storage costs are charged at country elevators and at river elevators. Duration of storage is the same with and without dam breaching. Average costs for each type of facility are used.	• The assumption that river elevators are used for long-term storage is questionable. Also, the assumption that all grain is stored is questionable. The assumption almost certainly overstates storage costs.
• Alternate Assumption: Base storage duration and costs on actual industry practice, including shipments of grain during harvest that does not require storage.	• Would increase the accuracy of the model. Would require more detailed data on storage costs by type of facility (river, country and railhead) and inclusion of a demand function in the model. Revisions would improve the accuracy of the model and it is likely that estimated storage costs would be reduced.
Handling Costs	
• Assumption: Handling costs are charged at each facility that grain moves through, except at export elevators. Costs used are for river elevators and country elevators. Costs at railhead facilities are assumed to the same as for other country elevators. And, costs at export terminals are assumed to be the same for rail and barge shipments.	• Assumptions that handling costs at railhead facilities are the same as at other country elevators and that handling costs at export terminals are the same for rail and barge shipments are probably incorrect. Handling costs may currently be over or understated.
• Alternate Assumption: Develop and include in the model estimates of handling costs for all types of elevators for both rail and barge modes.	• Would provide for a greater level of detail and would change estimated costs but the direction of the change is not certain.
Transportation Costs	
• Assumption: Reebie model estimates of modal costs are used.	• Reebie model estimates may contain errors in both truck and barge costs. Truck costs appear to be high and barge costs may be low. Correction of the errors is needed. Because costs tend to be lower than rates (except for long-haul truck), use of costs reduces estimated impacts of dam breaching.
• Alternate Assumption: Use existing rates in the model.	• Use of rates would change estimated changes in modal shift of grain and costs. Because truck rates are lower than estimated costs, use of rates would decrease estimated cost impacts. Because rail costs are only slightly lower than rates, use of rates may not change the current estimate of transportation cost impacts of dam breaching by a significant amount. Based on currently available information, barge rates are much higher than costs. As a result, use of barge rates in the model would make rail a much more attractive alternative and would reduce the estimated transportation cost impact of dam breaching. In addition, it is likely that the volume of grain predicted to shift from barge to rail would increase.

Table 3.3-32. Qualitative Assessment of the Effect of Using Alternative Assumptions and Input Values in the Transportation Analysis Model (continued)

Page 3 of 3

Variable and Existing and Alternative Assumptions	Effect on Model Results
Elevator Capacity • Assumption: The model does not include capacity or a capacity constraint. • Alternate Assumption: Include a capacity function in the model.	• The absence of a capacity function in the model does not allow for analysis of system capacity requirements or identification of potential capacity constraints at specific locations. This may lead to underestimation of capacity requirements. • To be very useful the capacity function would need to be elevator specific and alternative routings of grain movements in the event of a capacity constraint would need to be included in the model. This type of optimization model would greatly improve the accuracy of assessment of capacity needs with dam breaching but would require a significant data gathering and modeling effort.
Seasonality of Shipments • Assumption: The model does not include a demand function. • Alternate Assumption: Include a demand function in the model.	• The capability of the system to meet seasonal fluctuations in grain shipments was assessed by examining the peak historic single-month demand adjusted to what it would be with increased rail shipments. This showed that there is sufficient capacity in the existing system. A number of factors could cause this estimate to be either high or low. • Including a demand function in the model could potentially identify grain-handling constraints at hinterland and terminal elevators. Accurate modeling would require detailed data on handling capacity of all elevators, including rail car handling and unloading. This would require a significant modeling effort and it would be difficult because of the numerous variables to consider. The effect on model results is not predictable.

3.4 Water Supply

3.4.1 Introduction

This section presents the findings of the DREW Water Supply Workgroup and focuses on the evaluation of Snake River water users and the potential effects to these groups as a result of actions to improve anadromous fish returns. Although there are four different alternatives under consideration to improve anadromous fish returns, only Alternative 4—Dam Breaching, would directly affect the operation of river pump stations and wells used for irrigation and other purposes. All tables presented in this section were developed as part of the DREW Water Supply Workgroup Study. Sources of secondary information used by the DREW Water Supply Workgroup to develop these tables are noted, as appropriate.

Irrigation water for farm purposes is the dominant consumptive use of the water pumped from the river. Other potentially impacted water user groups that are included in the following analysis are M&I pump operators and private well users.

Section 3.4.2 of this analysis focuses on effects to irrigated agriculture. Section 3.4.2.1 provides a description of irrigated agriculture in Franklin and Walla Walla counties and Section 3.4.2.2 describes more specifically the farms that withdraw water from the lower Snake River at the Ice Harbor reservoir. Three separate approaches to measuring the economic effect to irrigators under dam breaching conditions are included. Section 3.4.2.3 describes the economic effects based on the modified cost approach. Section 3.4.2.4 indicates the economic effects based on the change in farmland values under dam breaching. Whereas Section 3.4.2.5 provides an estimate of economic effects based on the change in net farm income. Conclusions about the effect of dam breaching on irrigated agriculture are presented in Section 3.4.2.6.

Section 3.4.3 of this report discusses the effect on other water users, particularly users of M&I pumps and privately owned wells. The required modification costs to M&I pump stations and private wells provide the measurement of the economic effects to these other water users.

Section 3.4.4 of this report summarizes the economic effects to water users. Section 3.4.5 describes the sensitivity analysis of the economic effects to irrigated agriculture.

Basic Assumptions

- The economic analysis of water supply effects relied heavily on existing studies and data. In general, the analysis of economic effects was primarily limited to estimating the capital costs of system modifications. The rationale for the limits on the analysis were that the data from existing studies appeared reasonably good, net farm income analysis would be an extensive and expensive effort with probable limited returns, and relative to other NED costs water supply effects are small. For instance, under dam breaching conditions the total water supply NED effects are less than 10 percent of the hydropower costs.
- Irrigated farmland operators that currently pump water from the Ice Harbor reservoir will no longer be able to pump water from the reservoir under dam breaching conditions, and the value of the impacted 37,000 acres of farmland would be reduced to non-irrigated grazing land. This change in farmland value represents the economic effect of dam breaching on pump irrigators.

- Economic effects under dam breaching conditions to municipal and industrial pump station operators and privately owned well users are determined by estimating the system modification costs.
- The economic effects to water users that are described in this report would be incurred the year that dam breaching is implemented.

3.4.2 Irrigated Agriculture

3.4.2.1 Profile of Irrigated Agriculture, Franklin and Walla Walla Counties

The counties of Franklin, Walla Walla, Whitman, Columbia, Garfield, and Asotin in Washington and Nez Perce County in Idaho border the four lower Snake River reservoirs. However, this water supply analysis focuses on only those portions of the counties that are served by water from the four reservoirs or would be impacted by changes in these reservoirs.

Of the counties listed above irrigated agriculture is dominated by Franklin and Walla Walla. The very large river pumping stations used for irrigated farming that would most directly be impacted under dam breaching conditions are located in these two counties. Irrigation water is withdrawn from both the Columbia and Snake Rivers out of the McNary and Ice Harbor pools, respectively. However, this analysis is concerned with the lower Snake River water users located near the Ice Harbor reservoir in the counties of Franklin and Walla Walla.

Since the construction of Ice Harbor Dam in the early 1960s, private entities have financed the development of infrastructure necessary to grow irrigated crops in the region. The majority of the irrigated farmland adjacent to the Ice Harbor reservoir is irrigated by pumping water from the Snake River. Some additional land is irrigated using wells.

A review of irrigated acreage information from several sources indicates that there are about 37,000 acres using pumped Snake River water at the Ice Harbor reservoir. The Columbia River System Operation Review study that was completed in 1995 identified 36,400 acres of irrigated farmland using Snake River water pumped out of the Ice Harbor reservoir (Corps, 1995). A recent inventory effort completed by Corps, Portland District economists documented about 34,000 acres of irrigated cropland using water pumped out of Ice Harbor. Although specific documentation is not readily available some local agriculture experts indicated that they believe the actual number of acres irrigated with water pumped from Ice Harbor is somewhat greater than what the above estimates indicate. For instance, the Natural Resources Conservation Service (NRCS) regional field office estimated that there are over 50,000 acres of irrigated farmland adjacent to Ice Harbor. However, a breakdown between the acres irrigated with pumped water and well water was not provided. Consequently, it is surmised that a substantial amount of this additional acreage is irrigated using well water.

For purposes of analyzing the economic effects to pump irrigators under dam breaching conditions, it is estimated that approximately 37,000 irrigated acres in Franklin and Walla Walla counties would be impacted. Table 3.4-1 compares the statewide number of irrigated acres with these two counties. In addition, the table displays the number of acres of specific crops within these two counties.

Table 3.4-1. Acres by Crop Type: State of Washington Compared to Franklin and Walla Walla Counties

Crops	State of Washington Acres	Franklin County and Walla Walla County Acres	Two County Percentage of State Total (%)
Total Irrigated Acres	**1,705,000**	**318,281**	**18.7**
Field Corn	170,000	33,400	19.7
Potatoes	161,000	55,500	34.5
Asparagus	23,000	13,000	56.5
Peas	42,200	5,900	14.0
Onions	13,400	4,600	34.3
Sweet Corn, proc.	75,300	18,400	24.4
Apples	142,000	9,400	6.6
Cherries	14,000	1,700	12.1
Vineyards	31,000	2,300	7.4

Sources: Washington Agricultural Statistics, 1996/1997, Washington State Department of Agriculture, U.S. Census Bureau, 1997 (Agriculture)

Comparing the number of irrigated acres that would be impacted by the breaching of Ice Harbor dam to the total amount of irrigated acres within the two counties and statewide show that the quantity of impacted farmland is relatively small percentage. The 37,000 acres represents about 12 percent of the irrigated farmland in Franklin and Walla Walla counties and about 2 percent of the irrigated farmland in Washington State.

Information in Table 3.4-1 also shows the relative importance of specific crops in these two counties compared to the state total. Both Franklin and Walla Walla counties are important field corn producers, together accounting for a fourth of the state's production in 1995. Potatoes are an important crop as well. Franklin and Walla Walla counties contribute to the state harvest significantly and comprise about a third of the state production. Both Franklin and Walla Walla counties also have a lot of acreage devoted to vegetable crops, including asparagus, carrots, peas, onions and sweet corn. Some vegetable crops are found on farms that irrigate from the Ice Harbor reservoir, however the total acreage is not large. Both Franklin and Walla Walla counties have significant acreage in orchards for the production of apples, cherries and grapes as well. A fairly large amount of orchard crops also are grown on farmland adjacent to the Ice Harbor reservoir.

For a broader regional perspective of the relative importance of the affected farms, note that the 1997 Census of Agriculture shows 1,705,025 acres of irrigated cropland in Washington, 1,948,739 acres in Oregon, and 3,493,535 acres in Idaho.

3.4.2.2 Profile of Irrigated Agriculture at Ice Harbor Reservoir

This section provides information about non-Federal agricultural water users who pump from the Ice Harbor reservoir.

It has been determined, based on a survey of farms that at least 37,000 acres of land are presently irrigated with water pumped out of the Ice Harbor reservoir. Table 3.4-2 summarizes information about the pumping stations that are used to withdraw Snake River water for agricultural purposes. Data about the farm operations indicate that some additional acreage is irrigated using wells rather

Table 3.4-2. Crop Data for Agricultural Pumpers from Snake River, 1996/1997

Pump Stations (Ref. No.) 1/	Total Acreage	Total Acreage Irrigated from Snake River	Primary Crops	Notes
IH-1	1,500	1,500	Sweet corn, onions, potatoes	Shared ownership with IH-12
IH-2	4,500	4,500	Hybrid cottonwood	Land/station leased
IH-3	12,000	9,500	Potatoes, wheat, field corn, onions, sweet corn	
IH-5	4,100	4,100	Hybrid cottonwood	Land/station leased
IH-6	5,000	2,200	Field corn, wheat, potatoes	
IH-7	2,900	2,700	Grapes, apples	
IH-9	540	540	Apples	Shared station with IH-10
IH-10	4,000	1,800	Apples, cherries	
IH-11	6,017	4,008	Apples, cherries, sweet corn, potatoes, wheat, peas, field corn	Includes 1000 acres of orchards
IH-12	900	900	Field corn, potatoes, asparagus, wheat	Owns 30% of IH-1
IH-16	600	320	Apples, cherries	
IH-17	1,200	1,200	Potatoes, onions	
IH-18	225	165	Vineyards, apples	
IH-19	500	500	Not determined	Future station
Ice Harbor Total		**33,933**		

1/ This numbering system matches the numbering used in an earlier water supply analysis developed for the Corps (Anderson-Perry, 1991). Pump stations 1H-4, 1H-8, and 1H-13 through 1H-15 are not included in this table because water pumped via these stations is not used for agricultural production.
Source: A survey of farms conducted by the Corps, 1997/1998

than the Snake River pumps. For instance, one of the orchard operators has more horsepower than the river station pumps, and total irrigated acreage is considerably greater than the amount identified in Table 3.4-2. Changes to the economics of the pump irrigated land component of these farms may directly impact the economic viability of the land that relies on wells. It was, however, assumed for this study that as long as irrigation water is available the land remains economically viable.

Only a portion of the acreage is in permanent crops like fruit tree orchards or vineyards, and, therefore, acreage by crop varies from year to year as crops are rotated. Potatoes, for example, are grown on the same land only one year in three or four for disease control. An estimate of farmland relying on Ice Harbor water by crop type is presented in Table 3.4-3.

As Table 3.4-3 shows, cottonwood is the largest crop in percentage terms and is grown for pulp and paper production. Potatoes are the next biggest crop although this will vary year to year. Fruit tree orchards and vineyards are high valued crops, and recently the number of acres has been expanded primarily due to the planting of apple trees in the last 2 years. About 21 percent of the 37,000 acres is in permanent crops and represents about 51 percent of the estimated value of the 37,000 acres of irrigated land. Also, a relatively minor amount of acreage is in asparagus, peas, and other crops.

Table 3.4-3. Estimated Percentage of Crops by Type

Crop	% of Crop Types
Cottonwood/Poplar	23.2
Potatoes	14.9
Field Corn	13.5
Fruit Tree Orchards	11.1
Wheat	9.5
Vineyards	6.2
Sweet Corn	5.4
Onions	3.0
Undefined Percentage	13.2
Total (37,000 acres)	**100**

Source: A survey of farms conducted by the Corps, 1997/1998

Table 3.4-4 summarizes river station pump plant data on size and output for these farms. There are about 75 pumps with a total of about 42,000 horsepower. This does not include booster pumps that are situated between the river station and point of use at a higher elevation than the river station. Electrical usage is for 1996 except for IH-2, IH-5, and IH-16. Those data are for 1997. Table 3.4-4 was developed using information from a previous consultant's report (Anderson Perry, 1991), Walla Walla District engineers data, and farm manager interview data.

3.4.2.3 Economic Effects: Pump Modification Cost Approach

Introduction

The objective of the analysis of irrigation water users is to estimate the net economic losses under dam breaching conditions as compared to the base condition. A total of three different approaches are presented in this report. These are the pump modification cost approach, the farmland value approach, and the net farm income approach. The pump modification cost approach discussed in this section of the report is the estimation of the cost to modify or replace river pump stations so that the current water supply capability is maintained under dam breaching conditions.

The estimated modification costs discussed below provide an upper bound estimate of the economic effects to irrigators under dam breaching conditions. This approach to measuring the economic effects to irrigators is not intended to imply such investments are necessarily cost effective when compared to farm production and income. The true NED costs would be no greater and may be less than the cost to continue to provide equivalent quantities of water. That is, the farmer can always limit cost increases to the cost of modifying the pumping station (and higher O&M costs) but may be able to do better by changing crops, production techniques, etc.

Initially, the modification cost approach was to be the only analysis applied to measure the economic effects to water users under dam breaching conditions. As a result of significant increases in the estimated cost to modify the pump systems, the study group determined that the modification cost approach overstated the economic effects and additional economic analysis was warranted.

Table 3.4-4. River Station Pump Plant Data, Ice Harbor Reservoir

Pump Stations (Ref. No.)[1/]	River Mile	Number of Pumps	Horse-Power	Head (feet)	Electrical Usage	Water Usage acre-feet (year)	Notes
IH-1	12	8	2,650	360	$217,000	7,917 (95)	Station 30 percent by IH-12
IH-2	12	5	4,500	260	11,000,000 kW	14,000 (97)	
IH-3	17	11	13,500	460	$941,000 30,636,500 kW	29.5 in/ac average	
IH-5	12	5	4,700	260	9,000,000 kW	8,800 (97)	
IH-6	14	8	2,260	260	$112,440 4,591,000 kW	4,341 (96)	
IH-7	12	9	4,900	462	$229,688	12,216 (96)	
IH-9		6					Shared with IH-10
IH-10		8	4,400	410	$234,195	na	
IH-11	20	6	3,900	310	$182,607	7,275 (96)	
IH-12	12			415	about $72/ac	23 in/ac average	
IH-16	10	2	300	360	330,000 kW	2 in/ac (97)	Water usage will increase when trees mature
IH-17		4	1,300	350	$133,000		
IH-18		2	240	230		18 in/ac	
IH-19		1	125	6			Planned Station

1/ This numbering system matches the numbering used in an earlier water supply analysis developed for the Corps (Anderson-Perry, 1991). Pump stations 1H-4, 1H-8, and 1H-13 through 1H-15 are not included in this table because water pumped via these stations is not used for agricultural production.

Sources: Anderson Perry, 1991 and a survey of farms conducted by the Corps, 1997/1998.

Sections 3.4.2.4 and 3.4.2.5 of this report describe the other two approaches used to assess the economic effects to Ice Harbor water users. As shown later in this document, the high cost to modify the pumping system makes the farmland value approach summarized in Section 3.4.2.4 the most reasonable (least cost) estimate of economic effects to Ice Harbor water users.

The remainder of this section of the report summarizes the pumping station modification costs.

System Modification for Dam Breaching Conditions

Three significantly different options to supply equivalent water quantities were identified and considered. Each option is briefly described below. For additional details, refer to Technical Appendix D, Natural River Drawdown Engineering and Technical Appendix E, Existing Systems and Major System Improvements Engineering.

Important requirements of an acceptable modified irrigation system are that the system will be: operational prior to breaching of the Ice Harbor reservoir; function through a full range of river stages without interruption; and able to handle a potentially large quantity of suspended sediment.

Under current conditions, the pump stations withdraw water from the Ice Harbor reservoir and pump the water uphill several hundred feet to the individual farm distribution systems. The majority of pumps are vertical turbine type. Without the pool of water created by the Ice Harbor Dam, the pumping station intakes would be completely out of the water. Following are the modified systems that were considered.

Option 1

The first option, investigated conceptually in at least one previous study, is to modify each existing pump station by extending pipes and installing additional or bigger pumps according to increases in lift requirements (Anderson-Perry, 1991).

It was initially thought that this approach would function similar to the existing system and minimize the extent and cost of modifications. Unfortunately, during the review of this concept, the engineering study team identified a number of technical concerns. The team was not able to identify acceptable locations to place the new pump stations that would work with the fluctuating and meandering river conditions under dam breaching conditions. This stretch of the river has a wide, flat bottom with substantial silt, sand, and gravel deposits, and as the material erodes under dam breaching conditions, the river would likely meander and affect the availability of water at the pump stations. In addition, erosion at the pump stations could undermine the pump, piping, and intake structures. The engineering study team also indicated serious concern about how the sediment could be managed at many of the locations new pump stations would need to be established. Another issue raised by the team is the technical problems with constructing this new system without causing some interruption in irrigation water deliveries. Any untimely interruption of irrigation water would severely impact permanent crops such as orchard and vineyards.

Option 2

Replacement of river stations with groundwater sources is the second option that was considered. Based on discussions with Dr. Robert Evans, irrigation specialist in the County Extension office in Prosser, Washington, this does not appear to be a feasible option. Wells present numerous problems. There would likely be difficulties in receiving Ecology approval. These wells would need to be drilled deep, increasing both first costs and operating costs. Additionally, the well water would require treatment in order to counter high pH levels; and high sodium content in the well water could lead to soil sealing problems. There is also concern that this system could not be installed without some interruption in irrigation water deliveries, and the interruption of irrigation water deliveries would severely impact permanent crops such as orchard and vineyards.

Option 3

After consideration of Options 1 and 2, the study team focused its efforts on a third approach that they determined would technically work and would satisfy the other criteria noted above. This option includes one large pumping station and distribution system with a sediment basin. This system would provide water via a single river pump station and the water would be delivered to each farm through a main pipeline distribution system. Each farm level pump would also require modifications in order to connect to the main pipeline distribution system. A sediment basin/reservoir is included as a component of the one large pump station system because it is anticipated that sediment effects will be significant.

Locating the pump station at a narrow point in the river reduces problems with river fluctuation and meandering. Under dam breaching conditions, the water levels would still be deep in this stretch of the river and the rock channel would ensure that erosion would not impact the availability of water for pumping. Another advantage of this one pump station system is that sediment problems can be addressed using only a single sediment control basin.

Option 3 was selected to carry forward in this analysis because it avoids the problems and uncertainties associated with the others. In other words, Option 3 was the only approach that the engineering study team agreed would technically work. Some additional discussion of the selected modification system follows in the next subsection. For additional details, refer to Appendix D, Natural River Drawdown Engineering and Appendix E, Existing Conditions/Major System Improvements Engineering.

Description and Costs Associated with the Modified Irrigation System

The selected irrigation system to quantify economic costs under dam breaching conditions is a pressure supply system that will withdraw water at one river location (Option 3). The primary irrigation system consists of six main components: the pumping plant at the river; the pipe network; connections to existing irrigation systems; secondary pumping plants; a control system; and a sediment control reservoir.

Pumping Plant

The intake structure would be divided into five bays with a peak capacity of 850 cubic feet per second (cfs). Three 1,500 horsepower (hp) and two 600 hp vertical turbine pumps would be secured above each of the five bays. Electrical switchgear, valves to allow each pump to be isolated from the system for maintenance work, and appropriate screening would be included.

Pipe Network

The pipeline network would be epoxy lined and polyethylene coated steel pipe. The pipeline would begin at the pump station near RM 20 on the south shore of the Snake River, and would be 12 feet in diameter at the main pumping plant. The pipeline would then extend downstream about 5,200 feet at which point a branch of the system would cross the river. The branch of the pipe network would cross the river 2,700 feet to Emma Lake and then continue another 4,500 feet to the existing pump station at IH-11. The main pipeline would extend along the south shore of the lower Snake River for approximately 47,500 feet with branches as needed to connect the other stations to the main pumping plant.

Existing Irrigation System Connections, Secondary Pumping Plants, Control System

Two of the existing pumping plants are multi-pump configurations that would require reconfiguration in order to connect to the pipe network. Several of the existing pumping plants would require manifolds to be constructed and installed to connect each pump to the piping network. Additionally, at each existing and secondary plant, isolation valves would be required to allow for individual plant maintenance. Flow meters would also be installed. It is anticipated that about six air release/vacuum valves would be required for the system. Drain valves and discharge piping would be required to allow the pipeline to be drained. At each branch pipe and each significant directional change in the pipe network, concrete thrust blocks would be used to control potential thrust damage.

Sediment Control Reservoir

The construction of a reservoir addresses sediment concerns and surge control. The reservoir would be a holding pond with approximately 14,000 acre-feet storage which would be required to detain the water sufficient time for the settling of suspended solids.

In order for the modified irrigation system to be functional in time for use by irrigators, construction of the river intake, the pipeline network, and the reservoir would need to be initiated 18 months in advance of dam breaching.

Total construction costs for Option 3, the large pumping station with a sediment reservoir, are summarized in Table 3.4-5. The total construction costs are equal to $291,481,000.

The modified agricultural pump system will likely result in increased energy and other operation and maintenance expenses as well. Additional lift of the irrigation water with new pumps or the conversion of existing pumps will result in higher operating costs. Specifically, the greater horsepower will increase the cost of power to the water user. Additional equipment may also require greater maintenance expenditures and may increase the future replacement costs.

Increased maintenance necessary to treat sediment-related problems, even with a sediment control reservoir in place, is not easily predictable. Replacement of worn parts of pumps, valves, sprinklers, and filters may initially be significant.

Therefore, the extent of increased O&M expense associated with the modified irrigation system is not fully understood. Information documented in the Anderson Perry study (1991) is used as a placeholder value because no specific estimate of the additional O&M costs was completed. That study identified additional O&M expenses associated with modifying the existing pump stations equal to $3,573,000 per year (1998 dollars).

Table 3.4-5. Cost Estimate of Modifying Ice Harbor Agricultural Pumping Station (1998 dollars)

Component	Construction Costs ($)
Mobilization, Demobilization, and Preparation	11,896,148
Earthwork for Structures	5,207,616
Utilities	6,997,734
Access Road	4,849,592
Pipelines	71,865,100
Pumping Plant	9,243,520
Pumping Machinery	52,678,290
Subtotal, Pump Plant System	162,738,000
Subtotal, Sediment Reservoir	128,743,000
Pump Plant and Reservoir Total	**291,481,000**

Source: Cost estimates developed by the Corps, Walla Walla District, 1998

Construction costs are estimated to equal $291,481,000 with the added O&M expenses associated with the modifications to the irrigation pump stations at the Ice Harbor reservoir equal to $3,573,000 per year. The estimated modification cost provides an upper bound measurement of the economic effects to irrigators; and the true NED costs would be no greater than this estimate.

3.4.2.4 Economic Effects: Farmland Value Approach

Introduction

In this section of the report the measurement of the economic effects to irrigators under dam breaching conditions is determined based on a change in farmland values. In order to accomplish this, typical land values for farm properties at the Ice Harbor reservoir are presented. This information was compiled through discussions with farm managers, cooperative extension agents, farmland appraisers, agricultural economics professors, and the use of published enterprise budget sheets for a number of crops. An analysis of this data provides an estimate of typical farmland value and permits the quantification of the economic effect to the farmland under dam breaching conditions.

Approximately 37,000 acres of irrigated farmland currently rely on pumped water from the Snake River, specifically the Ice Harbor reservoir. In addition to the estimated 28,400 acres of the more traditional irrigated cropland there are 8,600 acres of poplar plantations.

Farmland Value

Following is a summary of the estimated value of the different types of irrigated farmland in southeastern Washington State.

Row Crops

A local farm manager knowledgeable about market values indicated that supply of land on the market is currently limited and demand is high, resulting in high prices for land. He estimates that row cropland, anchored by potatoes in the crop rotation, has an approximate value of $2,500 to $3,500 per acre. This estimate is based on potatoes generating net income of $450 per acre and other crops (wheat, sweet corn, alfalfa, beans, field corn) generating net income of $225 per acre. Assuming potatoes are grown one year in four, average net income per acre is approximately $280. Land appraisal data from other sources confirms that this is a reasonable estimate of the value of row cropland. Of course there are many variables that could cause actual values to vary from this range, such as terrain, soil, and accessibility to water.

Apples, Cherries

The Farm Business Management Report for red delicious apples states that the value "varies considerably depending on the age of trees and their current and potential production levels. The better apple orchards in this area are 10 to 20 years old with an annual production level of 40 bins or more per acre. Such an orchard is currently valued at about $12,000 per acre. Eventually the value of the orchard will decrease due to age of trees and the irrigation system to about $5,000 per acre."

In the opinion of an extension economist for Washington State University, valuation of $12,000 per acre for apple orchards is probably low for the Ice Harbor farms. The Farm Business Management Report is based on Wenatchee, Washington orchards. The orchards in the Ice Harbor vicinity are probably younger and more productive than Wenatchee orchards. The estimate of value is near $15,000.

Another, higher value estimate for fruit orchards was put forth by Benton County Cooperative Extension. Value increases with tree density, quality of irrigation system, frost-control equipment, trellised orchards, and tree maturity. In general, the Ice Harbor orchards are dense with good irrigation and frost control systems, and are trellised and have mature crops. For these farms establishment costs run from $25,000 to $32,000 per acre. Initial tree costs alone, assuming 1,000 trees per acre at $7 per tree, may account for $7,000 per acre of these establishment costs. The market value should reflect these establishment costs.

Appraised value data for four orchards sold within the last two years in southeastern Washington documented that the values of these properties ranged from $9,900 to $11,900 per acre. In the opinion of a local appraiser, $10,000 per acre is a reasonable average value to use for apple orchard land.[1]

Vineyards

Washington State University Farm Business Management Reports also provided estimates of the costs of establishing a Concord grape vineyard. For this perennial crop, four years are needed to develop a mature vineyard. Total investment costs over the four-year period, net of revenues, are about $7,000. Including the value of raw land, estimated at $2,500 per acre, raises the total value of a mature vineyard to $9,500. This assumes the market equilibrium price would eventually stabilize at a level to cover costs.

Local appraiser information indicates that $5,500 per acre for vineyard property is a reasonable average value estimate for the study area.

Poplars

Estimating the value of poplar/cottonwood acreage is difficult because of the lack of available historical market value data. Pacific Northwest Regional Extension Bulletin “High-Yield Hybrid Poplar Plantations in the Pacific Northwest” (PNW356) is one source of value information. The net present value per acre of the crop, defined as discounted future revenues less discounted future costs, varies with assumptions about product price, age at harvest, and productivity, among others. Table 9 of the bulletin lists present values for different combinations of these factors. For example, as pulp price varies from $20 to $32 the net present value per acre with harvest at age 7 ranges from ($44) to $431. This range reflects net present value sensitivity to price. Presumably, the market value of the property would be a combination of the raw land value and the market’s assessment of the net present value of the cottonwood crop at any point in the crop’s cycle. In addition, the market value should include the value of the irrigation system, if any.

[1] Regional land valuation experts that were contacted by the Walla Walla District economist provided appraisal data. Because this type of data for specific properties is usually confidential, the appraiser names and properties are not disclosed.

Information provided by local appraisers indicates that the tree farms are generally appraised similarly to row crop property. Therefore, the estimated market value of this type of farmland is $2,500 to $3,500 per acre.

Farmland Value Summary

Table 3.4-6 is a summary of the estimated market value of the primary types of irrigated farmland in the region. In addition, local farm appraisers and agricultural experts have indicated that farmland near the Ice Harbor reservoir is generally not suitable for growing non-irrigated crops such as wheat because of low rainfall. Therefore, this farmland without irrigation water is limited to some grazing a short period of the year and would sell for $75 to $150 per acre.

Table 3.4-6. Farmland Value Estimates for Selected Crops

Type of Cropland	Value per Acre ($)
Row Crops	2,500 to 3,500
Vineyards (at maturity)	5,500 to 9,500
Apple Orchards (at maturity)	10,000 to 32,000
Poplars	2,500 to 3,500
Non-irrigated Farmland	75 to 150

Estimated Economic Effect Based on a Change in Land Value

Detailed crop information for about 20,000 of the irrigated acres at Ice Harbor was collected through interviews with farm operators. The crop information in conjunction with the farmland value data described above was used to determine the average per acre value of irrigated farmland in the region. Table 3.4-7 summarizes the results of the analysis of six farms that comprise more than 20,000 of the irrigated acres that would be impacted under dam breaching conditions. Based on the farmland value approach, the average per acre value of irrigated farmland is $4,100. Corps planning guidance suggests that any economic analysis of the change in land values should be based on the market value of the property.

The procedure used to estimate the per acre value of farmland is summarized in Table 3.4-7 and briefly discussed in this paragraph. A total farm value estimate was developed for each of the six farms by multiplying the acres of each crop grown at each farm by the low-end range of the per acre crop land values presented in Table 3.4-6. The average per acre value of each farm was then determined by dividing the total farm value by the number of acres. The average per acre value of each farm was then multiplied by the percentage of the combined acreage associated with that farm and summed to give an overall average per acre value of irrigated farmland of $4,100.

By applying this average per acre value to the total amount of irrigated crop acreage, and adding the value of the poplar tree acreage, and then subtracting the value of non-irrigated cropland an estimate of the net economic impact to pump irrigators under dam breaching conditions is estimated.

Table 3.4-7. Estimated Market Value of Irrigated Acreage Served by Pumped Water from Ice Harbor Reservoir, Sample Farms (1998 dollars)

Farm/Crop Distribution	Acres	Per Acre Farmland Value ($)	Total Value ($)	Value/Acre by Farm ($)	Percent of Sample Acreage by Farm (%)	Average Per Acre Value of Total Farmland ($)
Farm A						
Potatoes	*	2,500				
Winter Wheat	*	2,500				
Grain Corn	*	2,500				
Onions	*	2,500				
Sweet Corn	*	2,500				
Total	**9,500**		**23,750,000**	**2,500**	**47**	
Farm B						
Potatoes	*	2,500				
Winter Wheat	*	2,500				
Grain Corn	*	2,500				
Total	**2,210**		**5,525,000**	**2,500**	**11**	
Farm C						
Red Delicious Apples	*	10,000				
Concord Grapes	*	5,500				
Total	**2,700**		**16,650,000**	**6,167**	**13**	
Farm D						
Red Delicious Apples	*	10,000				
Sweet Cherries	*	12,000				
Total	**1,800**		**18,100,000**	**10,056**	**10**	
Farm E						
Potatoes	*	2,500				
Winter Wheat	*	2,500				
Sweet Corn	*	2,500				
Hay	*	2,500				
Seed Peas	*	2,500				
Grain Corn	*	2,500				
Subtotal	**2,913**		**7,282,500**	**2,500**	**14**	
Farm F						
Red Delicious Apples	*	10,000				
Sweet Cherries	*	12,000				
Subtotal	**1,030**		**10,560,000**	**10,252**	**5**	
Average Value Per Acre, Sample Farms						**4,100**

Note: *=Distribution of acreage by crop confidential.

Therefore: ($4,100 * 28,400 acres) + ($2,500 * 8,600 acres) – ($100 * 37,000 acres) =

$116,440,000 + $21,500,000 – $3,700,000 = $134,240,000.

The economic effect of dam breaching measured on the basis of a change in farmland value is equal to $134,240,000.

3.4.2.5 Economic Effects: Net Farm Income Analysis

Introduction

This analysis is included to verify that the previously described market value approach provides reasonable land value estimates. For the net farm income analysis typical crop budgets and the associated net returns are evaluated. The capitalized value of net farm income for the different crops in the base condition compared to the dam breaching condition provides a measure of the economic effects to irrigation water users. Including the analysis of typical crop budgets provides an indication as to whether or not the land value analysis approach presents a realistic estimate of economic effects.

Approximately 37,000 acres of irrigated farmland currently rely on pumped water from the Snake River reservoirs. In addition to the estimated 28,400 acres of the more traditional irrigated cropland there are 8,600 acres as poplar plantations.

Estimated Economic Effect Based on a Change in Net Farm Income

An analysis of typical crop budgets and agricultural statistics is summarized in this section. All data are based on Farm Business Management Reports of Washington State University (Table 3.4-8 lists the crop budgets). The typical farm values discussed in the previous section are recalculated in this section by applying net economic returns using the crop budgets. For each crop they are calculated as the difference between revenues less variable costs and net fixed costs. Net fixed costs are defined as total fixed costs less land rents and establishment charges. Typically, the establishment charge includes costs such as the purchase and planting of trees/vines with the initial development of the farm property. By excluding land rents and establishment charges from fixed costs, the net return estimate reflects a return to land and investments over time in the enterprise. It is believed this return corresponds well to the market value of the enterprise on a capitalized basis.

Net Return = Total revenues – (Total Variable Cost + Net Fixed Costs)

Where Net Fixed Cost equals Total Fixed Cost less Land Rent and Establishment Charge.

Table 3.4-8 is a summary of the crop budget data for all crops but cottonwoods. The table identifies the specific Washington State University crop budgets used in the analysis.[2] The last column in this table provides an estimate of net returns per acre. These estimates do not, in fact, represent any one particular operation. Therefore, the farm income and value estimates must be viewed as general guidelines about typical income levels generated by the types of crops grown in Franklin and Walla Walla counties.

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[2] Budgets reflecting 1997 costs and returns are now available, but were not when the analysis was initiated. A brief review of the 1997 budgets and comparison to the older versions indicates that the overall per acre net income would be slightly higher than what has been used in this analysis.

Applying the net returns shown in Table 3.4-8 to the crop distributions of specific farms in the Ice Harbor area provides another method of determining the average per acre value of farmland. Net returns are applied only to the acreage now served by irrigation water from the Ice Harbor reservoir. The acreage and crop distribution information was collected through interviews with the farm operators.

The crop information in conjunction with the crop budget data is used to determine the average per acre value of irrigated farmland in the region. Table 3.4-9 summarizes the results of the analysis of the six farms constituting over 20,000 of the irrigated acres that would be impacted under dam breaching conditions. Total return is the product of acreage and net return per acre. For each farm, total return per crop is summed to derive a total for all acreage irrigated from the Snake River. This represents total annual net returns per farm. This annual value is capitalized in the column labeled "Present Value." A discount rate of 6.875 percent and a horizon of 20 years were assumed in calculating present value. This present or capitalized value of each farm, weighted by the number of acres provides an estimate of the market value of the land. This evaluation indicates that the average per acre value of irrigated farmland equals $4,500, a similar result compared to the land value approach.

By applying this average capitalized net return value to the irrigated crop acreage and adding the value of the poplar tree acreage, and then subtracting the value of non-irrigated cropland an estimate of the economic impact to pump irrigators under dam breaching conditions is estimated.

Therefore: ($4,500 * 28,400 acres) + ($2,500 * 8,600 acres) – ($100 * 37,000 acres) =

$127,800,000 + $21,500,000 – $3,700,000 = $145,600,000.

3.4.2.6 Conclusions about the Effect of Dam Breaching on Irrigated Agriculture at Ice Harbor

As noted in the introduction, the purpose of this analysis is to determine the direct economic effects to agricultural users of pumped water from the lower Snake River under dam breach conditions. As a result of unanticipated escalation in the estimated cost to modify the pump stations, the evaluation of farmland values and typical net returns using available information were introduced into the analysis. This approach was added to the analysis for comparison to the modification cost approach, and to determine whether or not it provides an acceptable estimate of NED costs. A summary of the estimated economic effects measured by each approach is provided in Table 3.4-10. This table shows that the economic effects to pump irrigators under dam breaching condition range from $134.2 to more than $300 million ($291.5 million construction plus O&M) based on the three approaches used in this analysis. The pump modification costs are significantly higher than the estimate of the change in land value, therefore, it is reasonable to conclude that this option is not economically viable, and is an overstatement of the economic effects. The land value approach is therefore carried forward as the approach to measure the economic effects to pump irrigators at the Ice Harbor reservoir.

Table 3.4-8. Per Acre Revenue, Cost, and Profit Data for Irrigated Cropland Served by Ice Harbor Reservoir Water (1998 dollars)

Crop	Price ($/unit)	Quantity (unit/acre)	Total Revenue ($/acre)	Total Variable Cost ($/acre)	Total Fixed Cost ($/acre)	Land Rent ($/acre)	Amortized Establishment Charge ($/acre)	Total Fixed Cost Less Land Rent and Establishment Charge ($/acre)	Per Acre Return to Land and Establishment ($/acre)
Potato	85	28.5	2,423	1,770	654	400	–	254	399
Alfalfa	95	8	760	258	340	180	59	101	401
Winter wheat	3.5	120	420	220	169	125	–	44	156
Grain Corn	102	5	510	430	193	125	–	68	12
Silage Corn	20	30	600	532	198	125	–	73	(5)
Sweet Corn	64	9	576	376	256	180	–	76	124
Concord Grapes	7	250	1,750	979	1,454	125	915	414	357
Sweet Cherries	925	7	6,475	3,916	2,628	240	1,528	860	1,699
Red Delicious Apples	125	40	5,000	2,325	1,916	–	765	1,151	1,524
Asparagus	0.50	4,000	2,000	1,431	752	150	301	301	268
Onions	90	27	2,430	1,671	561	200	–	361	398
Seed Peas	15	30	450	325	220	125	–	95	30

Sources: Selected Farm Business Management Reports Produced by Washington State University, Cooperative Extension.
EB1609, Cost of Establishing and Producing Sweet Cherries In Central Washington, Hinman et al., 1991.
EB1720, 1992 Estimated Cost of Producing Red Delicious Apples In Central Washington, Hinman et al., 1992.
EB1667, 1992 Enterprise Budgets for Alfalfa Hay, Potatoes, Winter Wheat, Grain Corn, Silage Corn, and Sweet Corn Under Center Pivot Irrigation, Hinman et al., 1992.
EB1572, Economics of Establishing and Operating a Concord Grape Vineyard, Schimmel et al., 1990.
EB1588, Establishment and Annual Production Costs for Washington Wine Grapes, Chvilicek et al., 1990.
EB1753, 1993 Estimated Cost and Returns for Producing Onions Under Rill Irrigation Columbia Basin, Washington, Hinman et al., 1993.
EB1666, 1992 Enterprise Budgets for Fall Potatoes, Winter Wheat, Dry Beans, and Seed Peas Under Rill Irrigation, Hinman et al., 1992.
EB1779, Asparagus Establishment and Production Costs in Washington, Joshua et al., 1994.

Table 3.4-9. Estimated Total Return and Market Value of Acreage Served by Pumped Water from Ice Harbor Reservoir, Sample Farms (1998 dollars)

Farm / Crop Distribution	Acres	Net Return per Acre (based on crop budgets) ($)	Total Return ($)	Present Value by Farm ($)	Value/Acre by Farm ($)	Percent of Sample Acreage by Farm (%)
Farm A						
Potatoes	*	399				
Winter Wheat	*	156				
Grain Corn	*	12				
Onions	*	398				
Sweet Corn	*	124				
Total	**9,500**		**2,000,700**	**21,477,819**	**2,261**	**47**
Farm B						
Potatoes	*	399				
Winter Wheat	*	156				
Grain Corn	*	12				
Total	**2,210**		**274,040**	**2,931,604**	**1,327**	**11**
Farm C						
Red Delicious Apples	*	1,524				
Concord Grapes	*	357				
Total	**2,700**		**1,430,000**	**15,305,233**	**5,669**	**13**
Farm D						
Red Delicious Apples	*	1,524				
Sweet Cherries	*	1,699				
Total	**1,800**		**2,751,950**	**29,439,599**	**16,355**	**10**
Farm E						
Potatoes	*	399				
Winter Wheat	*	156				
Sweet Corn	*	124				
Hay	*	12				
Seed Peas	*	30				
Grain Corn	*	12				
Subtotal	**2,913**		**588,681**	**6,297,541**	**2,162**	**14**
Farm F						
Red Delicious Apples	*	1,524				
Sweet Cherries	*	1,699				
Subtotal	**1,030**		**1,592,470**	**17,035,803**	**16,540**	**5**
Average Value Per Acre, Sample Farms						**4,500**

Note: *=Distribution of acreage by crop confidential.

Table 3.4-10 summarizes the present value estimates for the pump modification approach, the irrigated farmland value approach, and the net farm income approach. Included are the average annual costs using different discount rates. It has been determined that the most reasonable (least cost) estimate of the NED costs is provided by the approach that estimates the change in farmland value based on assessed values under dam breaching conditions.

Table 3.4-10. Comparison of the Approaches to Measure Direct Economic Effects to Pump Irrigators, under Dam Breach Conditions (1998 dollars)

Approaches to Measure Direct Economic Effects	Direct Economic Effect ($)	Average Annual Cost (6.875% Discount Rate) ($)	Average Annual Cost (4.75% Discount Rate) ($)	Average Annual Cost (0.0% Discount Rate) ($)
Pump Modification Cost Approach				
Construction:	291,481,000	20,065,550	13,979,400	2,914,800
O&M:		3,573,000	3,573,000	3,573,000
Total Annual Modification Cost		**23,638,550**	**17,552,400**	**6,487,800**
Loss of Irrigated Farmland Value:	-	-	-	-
1. Assessed Value Approach	134,240,000	9,241,100	6,438,100	1,342,400
2. Net Farm Income Approach	145,600,000	10,023,100	6,983,000	1,456,000

3.4.3 Other Water Users

3.4.3.1 Introduction

In this chapter, potential economic effects to other water user groups under dam breaching conditions are described and analyzed.

Specifically, the economic effects to M&I water users and private well users in close proximity to the reservoirs are measured. For these other water categories, the measurement of economic effects are based on the required system modification costs. These modification costs serve as a proxy measurement of the true NED costs.

This report is intended to provide only a brief summary of the modification costs. Additional details about the specific modifications required are provided in Appendix D, Natural River Drawdown Engineering and Appendix E, Existing Conditions/Major System Improvements Engineering.

3.4.3.2 Municipal and Industrial Pump Stations

There are several M&I pump stations all located on the Lower Granite pool. Uses range from municipal water system backup, golf course irrigation, industrial process water for paper production, and concrete aggregate washing.

Table 3.4-11 lists these facilities. The largest station is owned and operated by the Potlatch Corporation. Two of the stations of Public Utility District (PUD) No. 1 in Clarkston have not been operated in the past few years and there are no plans to use them in the immediate future. The District is considering moving one plant to a new location. One of the stations is a shared station between Atlas Sand and Rock and Lewiston Golf Club. Atlas uses water pumped from a 100 hp plant for washing aggregate and the golf club uses the smaller 60 hp pump to irrigate the course.

The remaining plants are small with limited horsepower. These smaller plants are used to irrigate golf courses and parks. Data for these plants are summarized in Table 3.4-11. Sources for this information include managers of the stations, Walla Walla District engineers, and previous consultant documentation (Anderson-Perry, 1991).

Table 3.4-11. Municipal and Industrial Pump Stations on Lower Granite Reservoir

Ref. No.	Station	River Mile	Use	Number of Pumps	Horsepower	Head (feet)	1996 Water Usage
GR-1	PUD No. 1	143	Water System Backup	3	450	300	Not used in several years
GR-2	PUD No. 1	143	Water System Backup	3	1,200	400	Not used in several years
GR-3	Clarkston Golf Course	137	Golf Course Irrigation (90 acres)	1	10	40	460,000 gal/day
GR-4	Potlatch Corp. (Clearwater River)	CW 4	Mill process water and steam generation	6	1,050	80	12,287,000,000 gal
GR-11a	Atlas Sand and Rock	142	Concrete aggregate washing	1	100	120	na
GR-11b	Lewiston Golf Club	142	Golf Course Irrigation	1	60	160	1.0-1.5 mgd in June to August

Sources: Survey of Station Managers; Walla Walla District Engineers 1997/1998; Anderson-Perry, 1991

Following is a summary of potential pump modifications.

- The two PUD stations have not been used in several years and will not be modified.
- The Clarkston Golf Course potential modifications include construction of a utility building, water intake system, and power supply.
- The Potlatch Corporation station modifications are extensive and include the primary plant intake and the plant diffuser, and potentially a water cooling facility.[3]
- The Atlas Sand and Rock facility potential modifications include construction of a utility building, water intake system, power supply.
- The Lewiston Golf Course potential modifications include construction of a utility building, water intake system, power supply.

The total estimated modification costs for these municipal and industrial pump stations on the Lower Granite reservoir (excluding the park stations) are $11,514,000 to $55,214,000. There is a cost range because the required modification costs for Potlatch Corporation depends on whether or not a discharge water cooling facility will be necessary. The Potlatch Corporation system modifications are either $10.8 or $54.5 million of the total.

[3] Final determination about the extent of required system modifications has not been made.

Increased energy costs for the modified M&I pump stations have not been quantified. Of the subset of M&I pump stations the largest pumps are owned by PUD No. 1 and the Potlatch Corporation which account for over 90 percent of total M&I horsepower. The PUD pumps, which are backup water supply pumps, have not been used in several years and there are no immediate plans for their use. Therefore, quantifying increased energy costs for the systems would be very speculative. The Potlatch pump does not face increased head and consequently energy costs would not be greater under dam breaching conditions compared to current conditions. The remainder of M&I pumps would experience increased pumping costs but the magnitude of those increased costs would be negligible compared to energy costs for agricultural stations.

3.4.3.3 Privately Owned Wells

The number of water wells within approximately 1-mile of the Snake River was compiled from well water reports. The well logs were obtained by searching and copying records of Ecology. Wells within the 1-mile distance were included as the range encompassing wells that might be affected under dam breaching conditions. The topographic features of the area, stratigraphy, and surface elevation directly influence which wells would be affected by the change in river water surface elevation.

A total of 228 well reports were counted. Review of the well reports showed that nine reports were for test wells, one for an abandoned well, two for replacement wells, and seven reports for wells that were deepened but not matched with original well reports. Adjusting the number of reports for test wells, abandoned wells, replacement wells, and possible duplication for deepened wells indicates the actual number of functioning wells may be as low as 209.

Some of the reports provided information about what the wells are used for and where they are located. Table 3.4-12 provides a breakdown of the well reports by county and use. In terms of number of well reports, domestic use appears to be the dominant use, followed by irrigation. About 11 percent of the reports had more than one use checked off. In almost all cases where more than one use was indicated, both irrigation and domestic use were indicated. Many of the older reports did not include any usage information.

Only 55 of the well reports indicated the horsepower of the pump. Many of the pumps were smaller sized although horsepower did range up to as large as 700 hp. Average horsepower was 70 and the median horsepower was 10. The average depth of the wells was about 270 feet. Table 3.4-13 summarizes information about the distribution of well pump capacities.

Examination of the individual reports indicates the larger pumps appear to be associated with irrigation usage. From previous information (Anderson-Perry, 1991) and recent phone conversations with farm operators, it is known that some of the agriculture operations have significant irrigation capability from wells. For example, one operation has four well pumps with 1,300 total horsepower irrigating 1,200 acres of potatoes, wheat, sweet corn and onions, while another operation has two wells with 240 hp irrigating 170 acres of vineyards and orchards. Another orchard operator has two 700 hp and five 500 hp well pumps (in addition to its eight river station pumps) for irrigation of orchards. It is likely that other agricultural operations also irrigate from wells, but identification of all irrigation well stations was beyond the scope of this analysis.

Table 3.4-12. Number of Well Reports Disaggregated by Use and County

Use	Asotin	Columbia	Franklin	Garfield	Walla Walla	Whitman	Total	Percent of Total (%)
Domestic	40	2	9	3	12	12	**78**	**35**
Industrial				1	2	3	**6**	**3**
Irrigation	7	1	18	1	9	4	**40**	**18**
Multiple	5	5	4	4	3	4	**25**	**11**
Municipal	7				2	1	**10**	**4**
Other	2		9	2	2	1	**16**	**7**
Test Well	3		4			2	**9**	**4**
Not Reported	3	4	5	2	15	12	**41**	**18**
Total	**67**	**12**	**49**	**13**	**45**	**39**	**225**	
Percent of Total (%)	**30**	**5**	**22**	**6**	**20**	**17**	**100**	

Note: County data could not be read on three well reports. Uses for these three included one test well and two not reported.
Source: Well record data, Ecology

Table 3.4-13. Distribution of Pump Horsepower for Wells

Horsepower	Number of Pumps
Less than 2	17
2 to 10	11
10 to 100	17
More than 100	10

Source: Well record data, Ecology

Further engineering review of the well data identified 180 of the original total 228 recorded wells functioning and within the designated study area. The Corps analyzed a representative sample of the existing wells to determine potential modifications to the wells and cost. Thirty-eight wells were selected and analyzed. Well log data coupled with topographic features of the area provided information on well depth, stratigraphy, surface elevation, and ultimately which wells would be affected by the change in river water surface elevation. Results of the analysis showed that 15 of the 38 sampled wells would be impacted under dam breaching conditions. Refer to the Annex P of Appendix D, Natural River Drawdown Engineering for a description of each of the 38 sampled wells.

For these 15 affected wells in the sample the amount of additional drilling and head that would be required for effective operation at natural river levels was determined. With this information the Corps calculated the necessary modifications, particularly in pump size and increases in well depth that would be required to maintain a constant water supply. The modification cost for the average well was also calculated.

The average cost per well was applied to the entire number of wells anticipated to be affected, as determined from percentages calculated in the representative sample. About 40 percent, or 71 wells, are expected to need modifications. Table 3.4-14 presents the total well modification cost by reservoir. Total costs are equal to $56,447,000, which includes direct, contingency, project management, and overhead costs.

Table 3.4-14. Well Modification Cost Estimates by Pool (1998 dollars)

Pool	Well Modification Cost ($)
Ice Harbor	18,373,000
Lower Monumental	12,462,000
Little Goose	7,797,000
Lower Granite	17,815,000
Total	**56,447,000**

Source: Cost estimates developed by the Corps, Walla Walla District, 1998

It should be noted that the estimated well modification costs shown in Table 5.10-6 have been revised since the economic analysis was completed; and the revised well modification costs are equal to $67,042,000. This increase in cost has not been incorporated in the analysis because it does not significantly change the relative size of the water supply economic effects. If it is determined that the dam breach alternative is the preferred alternative then additional analysis and refinement will be required. It is estimated that the change in well modification costs would change the conclusions of the water supply analysis by 4 to 5 percent.

The cost estimate was based on a typical cost per well with average increases in pump size and well depth. As a practical matter, each well would have to be considered individually under dam breaching conditions. Only by observing conditions after dam breaching has occurred can one determine exactly how deep a well would have to be drilled to produce water at current rates. It is recommended that all well modifications be performed after dam breaching has occurred. It is unclear what the water well users would do in the interim. An estimate for additional O&M expenses associated with the well modifications has not been determined.

3.4.3.4 Conclusions about the Effect of Dam Breaching on Other Water Users

Table 3.4-15 summarizes the cost of the water supply modifications that are required under dam breaching conditions. These modifications will allow the water users to continue to operate as they currently do. Estimated water supply economic losses are based on the costs of modifying pump stations and wells. Therefore, the water supply economic effects to M&I and private well users are equal to the total modification costs. Average annual costs are calculated using three different discount rates for the 100-year evaluation period.

3.4.4 Summary of Economic Effects to Water Users

Table 3.4-16 summarizes results of the analysis of effects to water users under dam breaching conditions. Three water user categories were evaluated in this report—loss of irrigated farmland value, municipal and industrial pump station modifications, and private well modifications. Results of the analysis of the economic effects are presented using three different discount rates.

The total economic effect associated with the three categories ranges between $202,201,000 to $245,901,000 (in present value terms). This range reflects uncertainty surrounding system modifications that might be required at the Potlatch facilities in Lewiston, Idaho. The loss in irrigated farmland value represents over 50 percent of the total water supply economic effects. It is anticipated that economic effects summarized in Table 3.4-16 would be incurred the year that dam breaching occurred. Therefore, the economic effects do not need to be adjusted to the base year 2005.

Table 3.4-15. Summary of Other Water Supply Modification Cost Estimate, M&I, and Private Wells (1998 dollars)

Water Supply Category	Construction Cost ($)	Average Annual Cost (6.875% Discount Rate) ($)	Average Annual Cost (4.75% Discount Rate) ($)	Average Annual Cost (0.0% Discount Rate) ($)
Municipal and Industrial Pump Stations	11,514,000 to 55,214,000	792,600 to 3,800,900	552,200 to 2,648,100	115,000 to 552,000
Privately Owned Wells	56,447,000	3,885,800	2,707,200	564,500
Total	**67,961,000 to 111,661,000**	**4,678,400 to 7,686,700**	**3,259,400 to 5,355,300**	**679,500 to 1,116,500**

Note: M&I cost range is due to the current uncertainty about the required modifications to the Potlatch Corporation system.

Source: Cost estimates developed by the Corps, Walla Walla District, 1998

Table 3.4-16. Summary of Economic Effects to Water Users (1998 dollars)

Water Supply Category	Economic Effect ($)	Average Annual Cost (6.875% Discount Rate) ($)	Average Annual Cost (4.75% Discount Rate) ($)	Average Annual Cost (0.0% Discount Rate) ($)
Loss of Irrigated Farmland Value	134,240,000	9,241,100	6,438,100	1,342,400
Municipal and Industrial Pump Stations	11,514,000 to 55,214,000	792,600 to 3,800,900	552,200 to 2,648,100	115,000 to 552,000
Privately Owned Wells	56,447,000	3,885,800	2,707,200	564,500
Total	**202,201,000 to 245,901,000**	**13,919,500 to 16,927,800**	**9,697,500 to 11,793,400**	**2,021,900 to 2,458,900**

Source: Cost estimates developed by the Corps, Walla Walla District, 1998

Total average annual economic effects to water supply, discounted at 6.875 percent, range from $13.9 million to $16.9 million, with a most likely estimate of $15.4 million.

3.4.5 Sensitivity Analysis of the Economic Effects to Irrigated Agriculture

A sensitivity analysis of key variables of the irrigated agriculture study is summarized in this section. The results of this sensitivity analysis do not change the estimated economic effects already described, but rather provide an indication of how the estimates would change given different assumptions. The results of the irrigated agriculture analysis present the most likely economic effect of dam breaching, given the available data and necessary assumptions. The intent of this sensitivity analysis is to provide some perspective about the uncertainty in our estimates and demonstrate how the application of different assumptions could change the results.

The sensitivity analysis is focused on two key components of the irrigated agriculture study: 1) the actual number of irrigated acres that would be taken out of production; and 2) the impact of varying the net income estimates. Three separate sensitivity scenarios are presented.

3.4.5.1 Sensitivity Analysis Scenarios

Scenario 1: Orchard and Vineyard Acreage Remains in Production under Dam Breaching Conditions

The irrigated agriculture analysis concluded that the most likely consequence of dam breaching would be the removal of about 37,000 acres access to irrigation water. This was concluded because no technically and economically viable modified irrigation delivery system was identified under dam breaching conditions. Early on in this study it was determined that not all system modification possibilities, including farm level modifications would be analyzed. And since all combinations were not evaluated it is possible, although speculative, that some of the farm operators would find a way to continue to provide irrigation water to a portion of the farmland, under dam breaching conditions. For this scenario it is assumed that all fruit orchards and vineyards could be kept in production under dam breaching conditions. A summary of the change in economic effects under this scenario follows.

Of the 37,000 acres that are likely to be impacted by dam breaching, approximately 7,750 acres or 21 percent are vineyards and fruit orchards. This 21 percent represents about 51 percent of the estimated value of the 37,000 acres of irrigated land. Consequently, if we assume in this sensitivity analysis that these permanent croplands could be kept in production the overall economic effect on the region would be reduced by about half. Under the assumption that all 37,000 acres go out of production, the estimated value of the property is reduced about $134,240,000. Whereas, keeping the permanent crops in production reduces the impact to a little more than $64,170,000.

As noted earlier, the intent of presenting these numbers is to show the sensitivity of the estimated economic effect to a reduction in the number of acres that are impacted. Again, no specific irrigation system was identified to permit this acreage to remain in production. In addition, on-farm or other irrigation system modification costs that would be required to allow irrigation to continue is not included, so the $64,170,000 estimate is unrealistically low. However, it is reasonable to conclude that under these assumptions the economic effects would be no less than $64,170,000.

Scenario 2: Additional Irrigated Acreage Impacted under Dam Breaching Conditions

This irrigated agriculture report has concluded that the most likely consequence of dam breaching would be the removal of access to irrigation water for about 37,000 acres. The estimated number of acres impacted under dam breaching conditions was determined through interviews with current farm operators. It is believed that the information compiled from the interviews provides a census of pump irrigated acreage that would be impacted under dam breaching conditions. However, during the development of this document some individuals indicated that they felt the actual number of acres that would be impacted is significantly higher. For instance, the NRCS indicated there are over 50,000 acres of irrigated farmland adjacent to Ice Harbor. In this analysis it was assumed that the majority of this additional acreage is irrigated with well water, and therefore the economic impacts under dam breaching conditions are captured in the well modification cost estimate.

However, if this assumption is incorrect then it is possible, although speculative, that the economic effect under dam breaching conditions is significantly higher. Following is a summary of the change in economic effects under this scenario.

Assuming the additional 13,000 acres are the same mix of crops as the 37,000 acres that were previously evaluated, the economic effects are 35 percent higher. Under the assumption that 37,000 acres go out of production the estimated value of the property is reduced about $134,240,000. Whereas, if we assume that 50,000 acres are impacted then the total economic effect increases to $181,224,000.

The intent of presenting these numbers is to show the sensitivity of the estimated economic effect to an increase in the number of acres that are impacted. Although there has been some speculation that the number of acres that would be impacted as a result of dam breaching may be greater than 37,000, no specific documentation could be identified.

Scenario 3: Net Return Estimates Decreased by as Much as 25 Percent

A major conclusion of the irrigated agriculture report is that breaching of the dams will eliminate access to irrigation water for about 37,000 acres of farmland. In determining the economic effect associated with the removal of irrigation water, an analysis of generic crop budgets for the primary crops was completed and an estimate of the value of impacted farmland was developed. Applying generic budgets to these 37,000 acres required significant generalization of many factors. Variables such as regional differences in irrigation pumping costs, adjustments for salvage values, and real estate taxes were not adjusted/incorporated in the crop budget analysis. In addition, uncertainty about what the political and economic future may hold for agriculture in terms of crop subsidies, impacts to capitalized land values due to changing risk factors, and crop prices received by farmers was not addressed.

As a result of the use of generalized crop budgets in this analysis, the true net return values for the major crops near the Ice Harbor reservoir may actually be lower than the values calculated and used to estimate farmland values. To test the influence of the applied net returns on the estimate of economic impacts, the net returns for all crops are reduced by 25 percent. Following is a summary of the change in economic effects under this scenario.

It was determined in the irrigated agriculture report the weighted value of farmland, based on net returns generated from generic crop budgets, is $4,100 per acre. Assuming that the net returns are actually 25 percent lower than the estimate used in the irrigated agriculture report the weighted value of farmland is $3,075 per acre. The estimated market value of poplar/cottonwood acreage is $1,875 per acre under this assumption. Applying the revised average per acre value to the total amount of irrigated crop acreage, adding the revised value of the poplar tree acreage, and then subtracting the value of non-irrigated cropland results in the following estimate:

($3,075 * 28,400) + ($1,875 * 8,600) – ($100 * 37,000) = $87,330,000 + $16,125,000 –

$3,700,000 = $99,755,000.

Conclusions of Sensitivity Analysis

The different sensitivity analysis scenarios are not directly combinable. However, the ranges of economic effects presented under the different scenarios do show how key variables influence the results.

The results presented in the preceding sections of this analysis reflect our best estimate of what is the most likely economic effect of dam breaching, given the available data and necessary assumptions. This sensitivity analysis provides some perspective about the uncertainty in our estimate and demonstrates how the application of different assumptions in this analysis could change the results.

As noted earlier, the intent of presenting these numbers is to show the sensitivity of the estimated economic effect to a change in farmland value estimates. Based on the results of this sensitivity analysis it is reasonable to conclude that the actual economic effect on irrigators is likely greater than $64,170,000 but less than $181,224,000.

3.4.5.2 Unresolved Issues

Although it is generally agreed that the water supply effects of breaching are not large when compared to the effects on hydropower, navigation, and recreation, reviewers and contributors to this document have identified issues which have not been resolved. Following is a list of the unresolved issues associated with the water supply analysis.

Irrigated Agriculture Effects

- Acceptance of the estimated land value for irrigated and non-irrigated acreage used to measure NED effects. Limited land value appraisal data were available. Therefore, generalized crop budgets were analyzed to verify the conclusions reached with appraisal/local expert opinion information. Questions as to whether the use of the generalized budgets truly corroborate the land value estimates continue. In addition the inclusion of a sensitivity analysis for this same issue does not fully address the issue. Further verification of land values would require supplementing existing appraisal data.
- Agreement as to whether or not it would be possible to keep some of the irrigated acres in production under dam breaching conditions.
- Acceptance of the modified irrigation system engineering cost estimates.

Effects to Municipal and Industrial Water Users and Privately Owned Wells

- Acceptance of the modified M&I water system engineering cost estimates.
- Acceptance of the procedures used to measure the number of wells that would be affected by dam breaching and the engineering cost estimates.

3.5 Anadromous Fish

3.5.1 Introduction

This section summarizes the findings of the Anadromous Fish Economic Analysis prepared by the DREW Anadromous Fish Workgroup. Details of this analysis are included in the full-length report developed as part of this feasibility study (DREW Anadromous Fish Workgroup, 1999). All tables and figures presented in this section were developed as part of the DREW Anadromous Fish Workgroup Study. Sources of secondary information used by the DREW Anadromous Fish Workgroup to develop these tables and figures are noted, as appropriate.

The DREW Anadromous Fish Workgroup analysis identified the net economic value associated with changes in commercial and recreational anadromous fish harvest. The commercial harvest addressed in this section includes both ocean and in-river harvest. The in-river commercial harvest category includes in-river tribal harvest. This in-river tribal harvest category includes both gillnet and ceremonial and subsistence harvest because the PATH results did not distinguish between these fisheries. Recreational harvest includes both ocean and "mainstem" in-river harvest, as defined by PATH. PATH divided its estimates into "mainstem," the area downstream of Lower Granite dam to the Columbia River estuary, and "tributary," the area upstream of Lower Granite Dam. The tributary area encompasses the entire Snake River watershed above Lower Granite Dam, including the Lower Granite reservoir.

Projected changes in fish harvest were based on the preliminary 1998 PATH data. PATH provided data for seven index stocks for Snake River spring/summer chinook, a comprehensive review of Snake River fall chinook, and a narrative description evaluating the correlation between Snake River spring/summer chinook and steelhead. In order to analyze the economic effects of future harvests under the different alternatives, the DREW Anadromous Fish Workgroup expanded the PATH results to represent all Snake River wild and hatchery stocks.

The Scientific Review Panel (SRP), which was tasked to review the PATH analysis methods, found inconsistencies in the results of both the fall chinook and later the spring/summer chinook analysis developed by PATH. These inconsistencies or uncertainties, that were not totally resolved by PATH, included concerns about the Differential Delayed Mortality factor (D value) that PATH attributed to smolt transport, delayed hydrosystem mortality, and the fixed assigned survival rate for the dam breaching alternative. Adjustments made to a number of factors of concern in the original PATH analysis resulted in higher adult return predictions under Alternatives 1 through 3, which reduced the net difference between the three dam retention alternatives and Alternative 4—Dam Breaching.

The adjusted PATH 1999 results were supported by the Cumulative Risk Initiative (CRI) modeling results. The CRI analysis, which was performed by NMFS, used the same wild fish numbers (run reconstruction data) as that used by PATH except it was restricted to the period between 1980 and 1999. This period was used because NMFS believes that it is most representative of current conditions in the hydrosystem. The CRI analysis differed from the PATH analysis by not estimating the probability of achieving survival and recovery adult return standards, and also by estimating the chance of extinction occurring (which was not estimated by PATH). One of the main components used by CRI for estimating the chance of extinction was its estimate of population growth rate. While CRI did not specifically estimate returning numbers of fish under the dam breaching alternative, it did indicate that the PATH results for dam breaching and for all other alternatives were optimistic. CRI results suggest there is little remaining survival improvements that can be achieved from modification of the hydrosystem (i.e., Alternatives 1 to 3). However, while these results suggest that Alternative 4—Dam Breaching has a slight benefit over the other alternatives, these benefits were generally still inadequate by themselves to prevent extinction of all stocks. The CRI results suggested that the best chance of prevention of extinction would be from increasing survival and fitness in the early life history stages (egg to smolt stage) (e.g., from habitat improvements) and in increasing Columbia River estuary survival (e.g., from habitat improvements, predator control). Both of these areas are outside of the hydrosystem direct control. The estimates of the number of fish available for harvest originally developed by the DREW Anadromous Fish Workgroup have not been revised to incorporate the adjusted PATH 1999 results.

The following analysis addresses commercial and recreational harvesting of wild and hatchery fish, sales of hatchery returns for egg, carcass, and food fish sales. Commercial and recreational harvests were allocated to user groups and geographic areas based on existing United States and Indian tribal agreements. Fish available after these obligations are met were distributed based on historical harvest distributions. Commercial economic values are based on ex-vessel values, while the recreational fishery value is based on a value per angler day. The DREW Anadromous Fish Workgroup estimated recreation harvest values for the ocean and the "mainstem" in-river area, as defined by PATH. These values are discussed in this section. Recreational harvest values for the "tributary" area, as defined by PATH, were estimated by the DREW Recreation Workgroup based on TCM surveys conducted as part of this study. The estimates developed by the DREW Recreation Workgroup are discussed in Section 3.2. Total recreational harvest values (ocean, mainstem, tributary) are presented in Section 3.2.

The following discussion is divided into five sections. The first section provides a general overview of the changing patterns of anadromous fish production in the Columbia River Basin and briefly discusses West Coast salmon management. This section establishes the context for the economic analysis. Sections 3.5.2 through 3.5.4 discuss anadromous fish harvest forecast methods, allocation to fisheries, and the economic evaluation employed in this analysis, respectively. The results of the economic analysis are presented in Section 3.5.4. Section 3.5.5 addresses risk and uncertainty issues associated with this analysis.

3.5.2 Overview

3.5.2.1 Changing Patterns of Anadromous Fish Production

To the Native American Indian tribes living along the Columbia River, salmon were their lifeblood, essential to their subsistence, their culture, and their religion. Salmon also played a key economic development role for European settlers. As early as 1828, various trading companies were purchasing and exporting salmon caught by Indians on the Columbia River. The first commercial use of fishery products in Oregon was salmon packing. Demand for salmon grew following development of the canning process in the mid-1800s. Total harvested pounds of salmon and steelhead in the early 1890s are estimated to have ranged from 21 million to 33 million pounds.

The history of Columbia River salmon harvest has been one of transition from spears and dip nets, to seine and gillnets, to diesel engines and ocean trolling poles. As salmon became scarcer, gas-powered engines allowed fishermen to venture further out into the ocean. As ocean fisheries developed, most of the fish produced in the Columbia River Basin were harvested in marine waters from California to Alaska. The long-term effects of economic development, hatchery production, and mixed-stock, open-access fisheries have been to reduce the total, and change the species and stock composition, of salmon returning to the Columbia River. Total poundage harvested commercially in the Columbia River Basin has declined from about 20 million pounds in the 1940s to a recent low of just over 1 million pounds in

1993 (Radtke and Davis, 1994). As fish numbers and commercial harvests have declined, so have the revenues to fishermen. As water-based economic development took place in the Pacific Northwest, natural-based production was supplemented by artificial propagation.

A host of salmon treaties and agreements affect salmon in the Columbia River system. These treaties and agreements include international understandings, harvest management agreement processes, agreements to rebuild stocks, obligations to northwest Indian tribes; and, most recently, Federal mandates to protect salmon stocks under the Endangered Species Act (ESA). International understandings include the 1992 International North Pacific Fisheries Commission Convention (Shepard and Argue, 1998), the United Nations Convention on the Law of the Sea, which entered into force in November 1994, and the Pacific Salmon Treaty between the United States and Canada. Harvest management agreement processes and agreements to rebuild stocks include the Pacific Fishery Management Council (PFMC) and the Northwest Power Planning Act, respectively.

The assumptions about salmon production, allocation agreements, and protection of natural runs used in this analysis took these understandings into consideration. The Pacific Salmon Treaty was being renegotiated at the time of this analysis, so applicable provisions of the new agreement were not included in modeling assumptions.

3.5.2.2 Columbia River Basin Anadromous Fish Production

Columbia River Basin anadromous fish production has shifted from upper river wild origin stocks, which were estimated to comprise 77 percent of runs during pre-development time periods, to lower river hatchery origin stocks. Upper river wild and hatchery origin were estimated to comprise 42 percent of runs in the 1980s. Production has changed from mostly wild spring and summer chinook (fall chinook estimated to be 14 percent pre-development run size) to hatchery fall chinook (hatchery origin fall chinook was estimated to be 34 percent of 1980s hatchery and wild run size) and coho. The production by watersheds and stocks and the geographic areas receiving benefits from production are shown in Figure 3.5-1. The Columbia River inland region only receives about 46 percent of the regional economic impacts from Columbia River Basin production. Fall chinook and coho have large ocean fisheries and, therefore, the effect of shifting production to the lower river stocks has resulted in a larger share of economic value from anadromous fish being exported out of the Columbia River inland region.

The trends in number of salmon and steelhead caught in the ocean by user group and by species are shown in Figure 3.5-2 and 3.5-3, respectively.[1,2] Most of the increase in commercially harvested anadromous fish has occurred in Alaska. Declining wild runs in British Columbia and on the United States West Coast have significantly decreased ocean fisheries, but on a site, species, and origin (natural or hatchery) specific basis.

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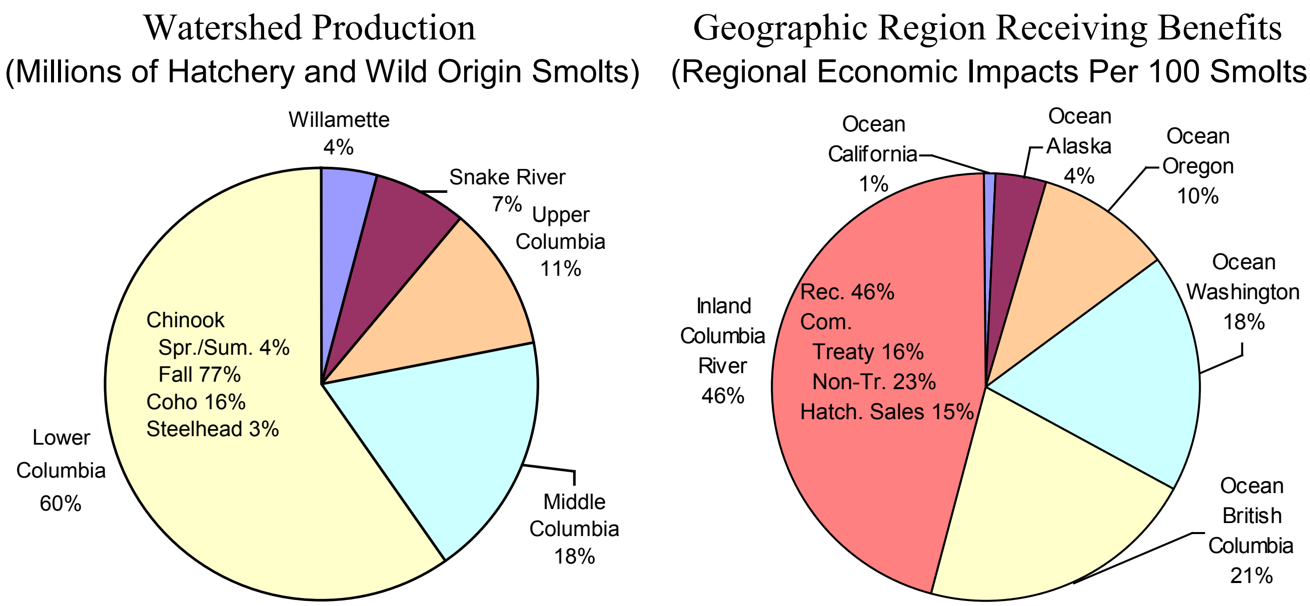
1 The geographical region includes southeast Alaska, the west coast of Vancouver Island, coastal British Columbia, coastal Washington, the Puget Sound region of Washington, coastal Oregon, and coastal California. The economic information about fisheries in these subareas is only for ocean harvest areas and excludes commercial, recreational, and treaty fisheries that take place inriver.

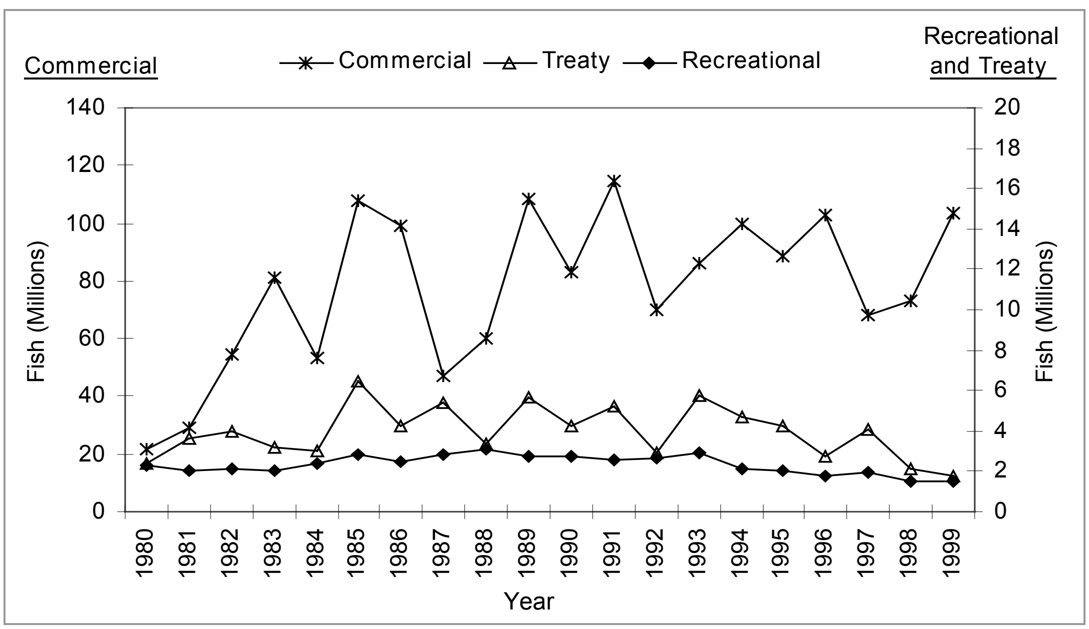
2 The sources of information for historical salmon and steelhead harvests are Pacific Fishery Management Council (PFMC), "Review of 1999 Ocean Salmon Fisheries," February 2000; Fisheries and Oceans of Canada (FOC), "1998 Post-Season Review: Status of Salmon Spawning Levels," March 12, 1999; personal communication with FOC, Catch Statistics Unit; and Alaska Department of Fish and Game, website extractions.



Notes: 1. Wild and hatchery origin smolt production is representative of the 1980s.
2. The regional economic impacts for the inland Columbia River region include inriver treaty and non-treaty commercial fisheries, inriver recreational fisheries, and hatchery return sales.

Source: NMFS (1995) and DREW Anadromous Fish Workgroup Study

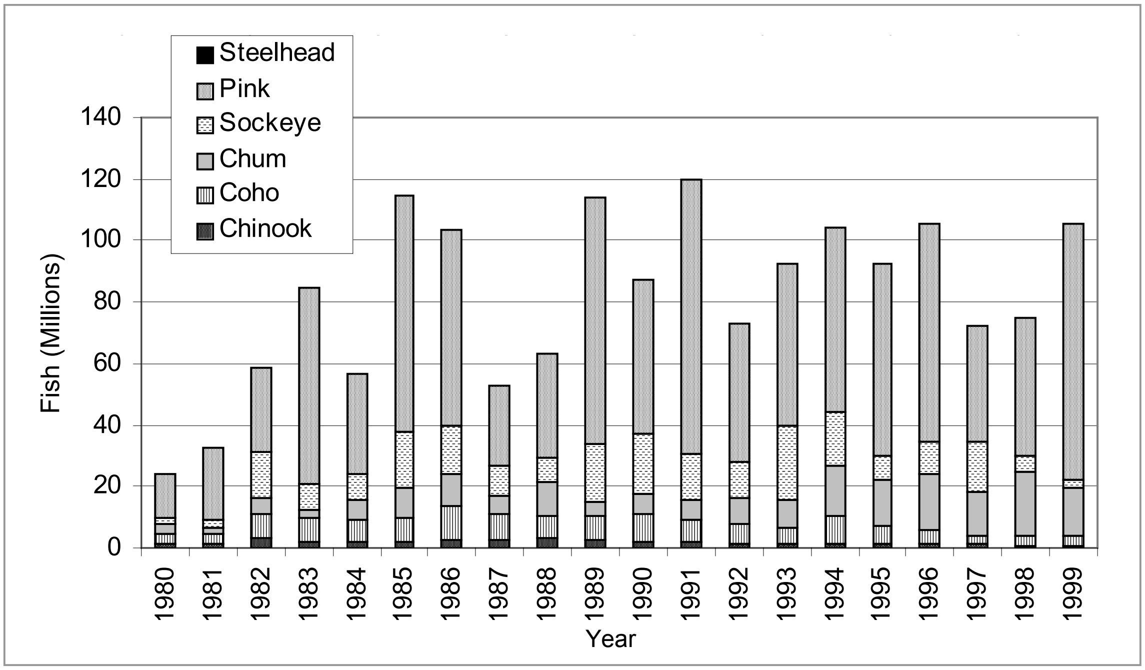
Figure 3.5-1. Shares of Columbia River Basin Anadromous Fish Production and Geographic Regions Receiving Economic Impacts from this Production



Note: Treaty includes United States treaty Indian and Canadian First Nations harvest.

Source: DREW Anadromous Fish Workgroup Study

Figure 3.5-2. Annual Salmon and Steelhead Harvest by User Group on the West Coast of North America in 1980 to 1999



Note: Commercial harvests do not include United States treaty Indian and Canadian First Nations harvest.
Source: DREW Anadromous Fish Workgroup, 1999

Figure 3.5-3. Annual Commercial Salmon and Steelhead Harvest by Species Along the West Coast of North America in 1980 to 1999

3.5.2.3 Bycatch of Snake River Anadromous Fish Populations in Other Fisheries

Snake River originating spring/summer and fall chinook and summer steelhead populations have wide ranges once they enter the ocean. For example, Myers, et al. (1996) found distributions of immature and mature steelhead originating from the populations throughout the Gulf of Alaska and as distant asnorthern Japanese islands. The study's data were from recoveries of external tags placed during North Pacific Anadromous Fishery Commission (NPAFC) related tagging experiments and recoveries of coded-wire tags placed in salmonids originating from United States streams. This distribution has the potential for steelhead being encountered in many foreign and United States fisheries. This indeed was the case when Japanese high seas salmon fisheries and other high seas drift net fisheries were occurring. The high seas squid fisheries were of particular concern because nets were fished shallow and steelhead are surface feeders. However, by international agreement, all of the high seas drift net fisheries are now illegal. In addition, under the Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean, there are no directed fisheries for anadromous fish anywhere outside of the 200 mile zone of the Convention parties (Canada, Japan, Russia, and the United States). The Pacific Fishery Management Council (PFMC), North Pacific Fisher Management Council (NPFMC), and Canada Fisheries and Oceans (CFO) do not allow foreign salmon fisheries within the respective 200 mile zones because stocks are fully utilized by domestic fishers and processors.

There is by-catch of anadromous fish during other species directed fisheries. A substantial body of annual reports and special studies discusses the by-catch of fish in domestic and foreign groundfish, halibut, shrimp, salmon mixed stock fisheries, pelagic species fisheries, and others (Williams, et al., 1998, Auster, et al., 1998). Some of the studies describing the by-catch issues used data from species specific sampling projects, some from special harvesting observer programs, and others from experimental full retention fisheries (Oregon Department of Fish and Wildlife [ODFW], 1997). Salmon are a prohibited species in these fisheries and retention is allowed only by an exempted permit. Bycatch and discards of the by-catch are an increasing concern for areas where there are stocks that have conservation problems, where there are allocation controversies, and where there is the perception that there is a waste of a public resource. Management measures for the other fisheries where there are incidental salmon harvests include techniques and procedures to minimize impacts to salmon stocks. In some cases, where rates exceed threshold amounts, fisheries can be discontinued for the year (PFMC, 1999).

In directed salmon fisheries, drop-offs, releases due to management size regulations, and other hooking-related mortalities increase the total mortality to about 30 percent of recorded landings. Mathews (1997) and others (Northwest Area Foundation, 1996) estimate the mortalities from by-catch in trawl and other high seas fishery would add another two percent. The mortality studies generally analyze impacts to marketable fish species and the biological impacts to recruitment rates and habitats. Since it is mostly hatchery reared stocks that receive coded wire tags, proxy hatchery stocks with similar wild stock distribution patterns are used to identify the commercial fisheries. Several annual reports summarize information from this database (Fuss et al., 1995).

The proportional contribution from the Snake River stocks to the total commercial catch in the various directed salmon and other fisheries was not analyzed in the DREW Anadromous Fish Workgroup study. The harvest rate of the Snake River stocks is so low in these fisheries, and as a result, there is little possibility that fishery management strategies, such as area, time, and gear restrictions, could selectively eliminate takings either for landings or hooking mortality from the stocks. There are decreasing impacts to Snake River stocks with further distance from the confluence of the Snake River and Columbia River. Inriver non-Indian and treaty commercial and recreational salmon and steelhead fisheries are managed by the Columbia River Technical Advisory Committee (CRTAC) specifically for impacts to Snake River stocks. Impacts to Snake River stocks have been considered in ocean management by the PFMC and in allocation agreements determined by the Pacific Salmon Commission (PSC), but have not been the constraining factor for managing measures in recent years (PFMC, 2000). If there were significant directed and incidental takings of Snake River stocks in the ocean commercial fisheries and drastic management measures could be invoked, then much or all of the economic contributions from the fisheries would be forgone.

3.5.3 Anadromous Fish Harvest Forecast Methods

The low rate of returning wild spawners in recent years has raised concerns about the eventual extinction of wild anadromous fish stocks in the Snake River system. During the early 1990s, for example, every two wild spring chinook spawners from the Snake River system returned about 1.2 spawners in the next generation (Smith, 1998). Factors affecting these return rates may include harvesting methods, habitat alterations, hatchery production, hydrosystem operations, and ocean conditions. The economic analysis presented here only addresses the causation factors considered in the PATH process. Information concerning forecasts of harvests and returning spawners is presented for each alternative in a number of PATH publications. NMFS (1999) provides a biological evaluation of PATH results to estimate the recovery probabilities of ESA-listed stocks.

Information contained in the PATH results is limited to seven index stocks for Snake River spring/summer chinook, a comprehensive review of Snake River fall chinook, and a narrative that addresses the correlation between Snake River spring/summer chinook and steelhead smolt-to-adult survival rates (SAR). For spring/summer chinook and fall chinook, the information includes numbers of fish harvested in the ocean, river mainstem, and tributaries and numbers of spawners. Harvest rates for ocean and mainstem are based on ocean escapement (estimated adult fish counts at the entrance of the Columbia River to the Pacific Ocean). Harvest rates for tributaries are based on Lower Granite Dam escapement (estimated adult fish counts passing over Lower Granite Dam). Results are reported in 5-year increments starting with year 5 (i.e., 5 years after an alternative is implemented).

The PATH analyses directly incorporated the potential effects of key uncertainties. Each alternative was analyzed across a range of assumptions reflecting alternative biological considerations, survival responses, and variations in future climate effects. As a result, the projected effects generated for each alternative by the PATH analyses were not simple point estimates. Summary statistics were used to compile possible combinations of key assumptions across the large number of model runs. In addition to expressing projections in terms of numbers of fish, PATH also summarized results in the context of the relative probability of exceeding survival and recovery criteria. Projected numbers of fish and harvest were summarized in terms of a standard set of fractions or percentiles of the total number of combinations run for each alternative (10th, 25th, 50th, 75th, and 90th percentiles). If the harvest reported at the 25th percentile was 100 fish, for example, that meant that 25 percent of the model runs for that particular alternative resulted in a harvest of 100 fish or less. If, for that same alternative, the harvest reported at the 75th percentile was 500, that meant that 75 percent of the runs for that alternative resulted in a projected harvest of 500 or less.

In order to analyze the economic effects of future harvests under the different alternatives, the DREW Anadromous Fish Workgroup expanded the PATH results to represent all Snake River wild and hatchery stocks.[3] This required that study assumptions be made for certain additional life-cycle modeling factors beyond those included in the PATH process. The use of these assumptions should not be considered an attempt to develop a separate life-cycle model. Wherever possible, PATH modeling factors were reused as proportions in the expansion methods. A generalized life-cycle representation for Snake River salmonids is presented as Figure 3.5-4. The assumptions for the life-cycle modeling factors are shown by species in Table 3.5-1.

The anadromous fish economic analysis also required that assumptions be made about future harvest management regimes and hatchery production and operation policies. Harvest management allocations were trended to meet treaty obligations and new fisheries were added to take advantage of increased hatchery origin fish availability. Existing hatchery production and operation policies, which involve constant production, were assumed to continue for the harvest forecast for each alternative. These assumptions were discussed with and approved by DREW.

The constant production assumption resulted in hatchery stocks comprising a large proportion of the increase in harvest levels projected under Alternative 4—Dam Breaching. The forecasted hatchery contribution to changed harvest levels for the dam breaching alternative over all stocks was, for example, about 83 percent. The hatchery contribution for summer steelhead was 95 percent. In addition to increased hatchery origin fishery harvests, economic contribution also comes from hatchery return surplus sales. Hatchery returns not needed for seeding are sold as food fish, carcasses to be used for fish meal,

[3] The Anadromous Fish analysis was developed by The Research Group, Corvallis, Oregon. Overview and monitoring for this analysis was provided by DREW. A subcommittee of DREW, the DREW Anadromous Fish Workgroup or the A-Fish Subcommittee, met regularly during the conduct of the study and the chair of this workgroup presented interim study results at DREW meetings. The authors of the DREW Anadromous Fish Workgroup report (available on the Corps website) were assisted in the analysis and report development by many other researchers and government representatives. Biologists and economists from NMFS were extremely cooperative in providing data and interpretations.

and eggs. These sales are considered budget revenues, with a portion spent locally for hatchery operation and maintenance.

As noted, the modeling employed in this analysis assumes existing hatchery production and operation policies. It can, however, be expected that, as hatchery surpluses increased, legal and institutional changes would follow. Production and operation policies would likely be reviewed to bring hatchery production into better balance with goals for mitigation and conservation of wild runs.

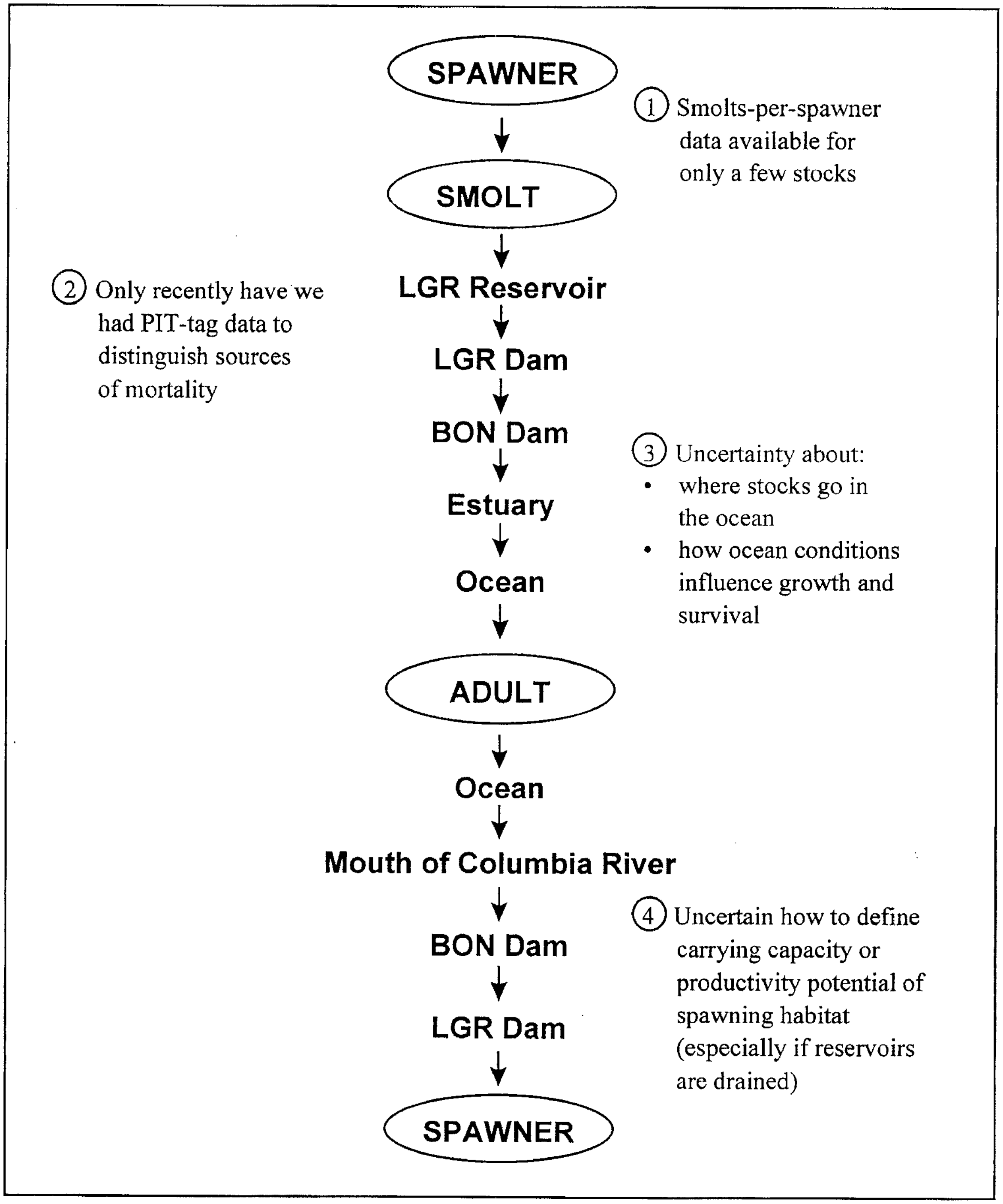
3.5.3.1 Smolt-to-Adult Return Rates

Salmon and steelhead typically reproduce in fresh water and spend a greater part of their adult life in the ocean. In their migratory route, they are exposed to a variety of predators. Survival rates from production to harvest are important components of how many adult fish will be available for harvest. The forecasts generated by PATH were presented in 5-year increments, starting with year 5 and ending with year 100 and did not include SARs. The PATH results were only for wild origin stocks, and only seven index stocks were analyzed for spring/summer chinook.

In order to extend the PATH information to all Snake River stocks, it was necessary to identify the year zero run size information and identify the SARs for the modeled runs. This was necessary to identify the changes PATH projected between years zero and 5. These ratios of change could then be applied to the other wild and hatchery stocks. Based on information from Beamesderfer et al. (1997) and the Technical Advisory Committee (TAC) (1997), the seven spring/summer chinook index stocks modeled by PATH accounted for 52 percent of all wild stocks from 1986 to 1995. The 10-year averages from 1986 to 1995 were adopted to provide the missing year zero information for run size, SARs, and harvest rates.

Historical information was available on the survival of hatchery-reared salmon and steelhead releases and some test wild-reared anadromous fish.[4] A survival rate was defined for the purposes of this analysis as total hatchery releases divided by the number of adults that subsequently appear in fisheries or in hatchery returns. Recent hatchery practices have mainly released fish at smolt age. Therefore, survival rates are identified as smolt-to-adult survival rates or SARs in this analysis. The 10-year average SARs (1986 to 1995) for hatchery stocks were 0.25 percent for spring/summer chinook, 0.6 percent for fall chinook, and 0.8 percent for summer steelhead. Survival rates for wild-origin fish can be calculated in a similar manner with total downstream migrating smolts divided by the number of fish harvested plus spawner escapement totals. The wild origin survival rate definition is similar to "SAR2" discussed by Petrosky and Shaller (1998). The SAR rates used for this economic analysis differ somewhat from rates used in the simulation modeling conducted by PATH. The definition change was needed to align expressions of wild adult returns with those reported in other publications for hatchery adult returns.

[4] These test wild-reared anadromous fish are wild smolts that are captured in their habitat. A coded wire that includes information on the stream segment where they were born is inserted into their snouts.



Notes: 1. Annotations show examples of points in the life cycle where empirical data are missing or incomplete.
2. BON Dam = Bonneville Dam. LGR Dam = Lower Granite Dam.

Source: NMFS, 1999

Figure 3.5-4. Straight-line Representation of a Generalized Lifecycle for Snake River Salmonids

Table 3.5-1. Additional Biological Assumptions Needed to Expand PATH Results for Use in the Anadromous Fish Economic Analysis

Life-Cycle/Modeling Factors	Spring/Summer Chinook	Fall Chinook	Summer Steelhead
Smolt downstream passage mortality	NA	NA	NA
Ocean incidental mortality	NA	NA	NA
Ocean harvest	NA	PATH results	NA
Run size total—wild	For year zero, 1986 to 1995 average from Table 2, Tab 1 and 2, TAC (1997). Future years calculated at the same percentage change as PATH results for index stock's ocean escapement. PATH results ocean escapement calculated using mainstem harvest divided by mainstem harvest rates.	For year zero, 1986 to 1995 average from Table 9, Tab 3, TAC (1997).	For year zero, 1986 to 1995 average (length method) for A and B runs Tables 12 and 13, Tab 8, TAC (1997). For future years, 37 percent spring/summer chinook SAR changes.
Run size total—hatchery	NA	NA	NA
Total adults—wild	Mainstem harvest + tributary harvest + pre-spawning mortality after LWG + spawners.	Total harvest + spawners + hatchery supplements. Pre-spawning mortality assumed to be zero.	Mainstem harvest + tributary harvest + pre-spawning mortality after LWG + spawners.
Total adults—hatchery	For year zero, hatchery smolt production goals in 1998 from Smith (1998) times SAR recent year averages in various CWT Missing Production Group Annual Reports (Fuss et al. 1994 and Garrison et al. 1995). For future years, hatchery production held constant and hatchery SAR same changes as wild SAR.	For year zero, hatchery smolt production goals in 1998 from Smith (1998) times SAR recent year averages in various CWT Missing Production Group Annual Reports (Fuss et al. 1994 and Garrison et al. 1995). For future years, hatchery production held constant and SAR same changes as wild SAR.	For year zero, hatchery smolt production goals in 1998 from Smith (1998) times SAR recent year averages in various CWT Missing Production Group Annual Reports (Fuss et al. 1994 and Garrison et al. 1995). For future years, hatchery production held constant and SAR same changes as 37 percent wild spring/summer chinook SAR.
Mainstem harvest—wild	For year zero, same proportion as PATH results index stocks. For future years, PATH results expanded to represent total production.	For year zero, Table 9, Tab 3, TAC (1997). For future years, PATH results.	Table 12 and 13, Tab 8, TAC (1997).

Table 3.5-1. Additional Biological Assumptions Needed to Expand PATH Results for Use in the Anadromous Fish Economic Analysis (continued)

Life-Cycle/Modeling Factors	Spring/Summer Chinook	Fall Chinook	Summer Steelhead
Mainstem harvest—hatchery	Proportion of PATH results for mainstem harvest to total wild adults.	Proportion of PATH results for mainstem harvest to total wild adults.	Table 12 and 13, Tab 8, TAC (1997).
Tributary harvest—wild	PATH results expanded to represent total production.	PATH results	Table A1d, Tab 8, TAC (1997).
Tributary harvest—hatchery	Proportion of PATH results for index stock's tributary harvest to total wild adults	NA	Table A1d, Tab 8, TAC (1997).
Upstream passage mortality	NA	NA	NA
LWG Dam escapement—wild	(tributary harvest + spawners) ÷ 0.9. The 10 percent LWG prespawning mortality factor is from Marmorek (personal communication 1999).	Tributary harvest + spawners + supplements, i.e., zero assumed pre-spawning mortality.	For year zero, 1986 to 1995 average (length method) for A and B runs, Table 12, Tab 8, TAC (1997). Future years calculated as same percentage change as PATH results calculated LWG escapement
LWG Dam escapement—hatchery	NA	NA	NA
Pre-spawning mortality—wild	10% of LWG escapement	zero assumed pre-spawning mortality.	10 percent of LWG escapement
Female fraction fecundity—wild and hatchery	Female fraction 50 percent and fecundity 3,500	Female fraction 50 percent and fecundity 3,500	Female fraction 50 percent and fecundity 2,500
Smolt capacity and egg survival rates—wild	Smolt carrying capacity and density dependent egg-smolt survival rate	Smolt carrying capacity and density dependent egg-smolt survival rate varying from 15 percent in year 5 to 2 percent in year 25+	Varying from 15 percent in year 5 to 2 percent in year 25+
Smolt capacity and egg survival rates—hatchery	67 percent fecundity	67 percent fecundity	67 percent fecundity

Notes: 1. NA—No assumption needed; SAR—smolt-to-adult survival rate; CWT—coded wire tag; LWG Dam—Lower Granite Dam.
2. Fecundity is the number of fertilized eggs that can be attributed to a spawning pair.

Source: DREW Anadromous Fish Workgroup Study

Indicator SAR rates were calculated for the PATH wild stocks by dividing the number of harvested fish plus spawner escapement totals by the number of smolts produced 5 years earlier. The numbers of smolts were calculated using a density-dependent, egg-to-smolt relationship applied to the number of spawners identified that year. These rates were then applied to all wild Snake River stocks and modeled for each alternative. The results of this modeling are presented graphically in Figure 3.5-5. An estimated SAR of up to 10 to 12 percent for fall chinook under Alternative 4—Dam Breaching, which exceeds the survival and recovery SAR of 4 to 6 percent, may be plausibly explained as a result of the out-plantings of first generation captured brood stock to supplement wild fish survival, as well as increased habitat in the dam's pool area. However, the estimated SAR of 30.85 percent calculated from the PATH 50-year escapement (Table 3.5-17) estimates for Snake River fall chinook would be unreasonable even with an outplanting or habitat restoration program. This is partially because more spawners return proportionally more next generation spawners from increased numbers of smolts produced, and surviving hydrosystem passage does not directly translate into these extremely high SAR values. Even if an outplanting or habitat restoration program for enhancing fall chinook production was highly successful and resulted in an extreme SAR above 10 percent, this extreme SAR would be instantaneous but transitory for a period of only 2 to 3 brood cycles (8 to 12 years). If this rate of population growth is feasible, then such growth would equilibrate at a lower sustainable population level following the transitory period near historical SARs of 4 to 6 percent due to density-dependence and cyclic flow and ocean regimes that variably influence large populations. The effect would artificially show very high natural adult returns. The PATH indicator SAR rate of change was also used to identify the change in hatchery SARs from year zero onward.

3.5.4 Allocation to Fisheries

There are three basic distribution patterns of Columbia River Basin produced salmon: north-turning fish (fall chinook), south-turning fish (coho), and some that tend to migrate in either direction (some of the above). Steelhead tend to scatter and migrate as far as Russian waters. Harvest rates by geographic area depend on migration patterns, as well as historic fishing patterns, and international and historic treaties and management policies. The same reports that were used to calculate survival rates were also used to calculate historic geographic and gear harvest shares. The harvest distributions used for this economic analysis were based on the assumption that future harvests will reflect recent historical catches. However, these distributions also depend on present Columbia River, U.S.-Canada, and Indian treaty allocations. Harvest allocation treaties change. The Pacific Salmon Treaty was, for example, being renegotiated at the time of this analysis. As a result, this analysis uses existing United States and Indian tribal agreements as the base for allocating harvests. What may be available after these obligations are met is distributed according to historical harvest distributions.

The economic effects of changes in anadromous fish harvest depend on the user group and geographic area where the harvest takes place. Table 3.5-2 shows the 1986 to 1995 average in-river harvest rates, based on run size measured at ocean escapement. The in-river and ocean user group distributions used in the modeling are shown in Table 3.5-3. These tables must be carefully interpreted if compared, because of the basis of the shares. Treaty rights are for 50 percent of the harvestable fish, regardless of the geographic area. Treaty harvests have consistently fallen below the treaty right share for composite (wild and hatchery) Snake River summer steelhead. To provide a realistic transition to this distribution, a 25-year trend was used. This means that summer steelhead recreational mainstem (about 10,000 fish) and tributary harvest (about 40,000 fish) are held relatively constant during the 25-year transition period. After the transition period, both treaty and recreational harvests are assumed to grow proportionally.

Tributary harvest of spring and summer chinook salmon was introduced as a fishery by PATH results. This recreational fishery has been absent since the 1970s in Idaho.[5] The PATH harvest rates for this fishery, for example, are about 6.5 percent run size at ocean escapement after 20 years, for Alternative 4—Dam Breaching. The corresponding rate for the inriver recreational mainstem fishery is 29.5 percent.

Run sizes can be measured at ocean escapement or at other geographic locations. The major anadromous fish stock's wild-origin run size measured at escapement past the uppermost dam on the lower Snake River over a recent historical period (1964 to 1996) and forecasts over the first 50 years of project life for each alternative are shown in Figures 3.5-6 through 3.5-9. Ocean and in-river harvests, as well as other river passage mortalities, have been accounted for in the wild run sizes. The forecasts show rapid recovery during the early project period and minor fluctuations in later years. These fluctuations, as explained by PATH documentation, are due to ocean regime shifts. The forecasted wild origin-run sizes are less than about one-third of the pre-dam historical levels for all alternatives.

The forecast of adult harvests over the project period is shown by alternative in Figure 3.5-10. The forecast is enveloped around point estimates based on PATH results variability. The point estimate harvests by origin (hatchery and wild) and species for each alternative is shown for selected project years in Table 3.5-4. Tables 3.5-5 and 3.5-6 show the low and high bounds for the harvests.

The harvests by fishery follow the distributional assumptions shown in Table 3.5-3. To display the harvests, Project year 25 was chosen as the equilibrium year.[6] Figure 3.5-11 shows the harvests for all species by fishery. Figure 3.5-12 shows harvests itemized by species for Alternative 4—Dam Breaching. The base case and other alternatives have similar harvest shares. Tables 3.5-7 through 3.5-10 show harvests for all species and itemized fishery by alternative.

The Treaty Indian fishery identified under Commercial Fishing in Tables 3.5-7 through 3.5-10 includes both the treaty gillnet and ceremonial and subsistence (C&S) harvest, because PATH results did not distinguish these fisheries. The Columbia River Fish Management Plan (CRFMP) has specific harvest rates for C&S. For example, the C&S entitlement is 10,000 spring/summer chinook or fish of equivalent quality. During years of very low abundance, states have provided tribes hatchery surplus fish from both within the Columbia River Basin and outside the basin to attain this minimum. The C&S harvest from Indian platform and gillnet fisheries was about 5,000 spring/summer chinook during the 1988 to 1995 time period

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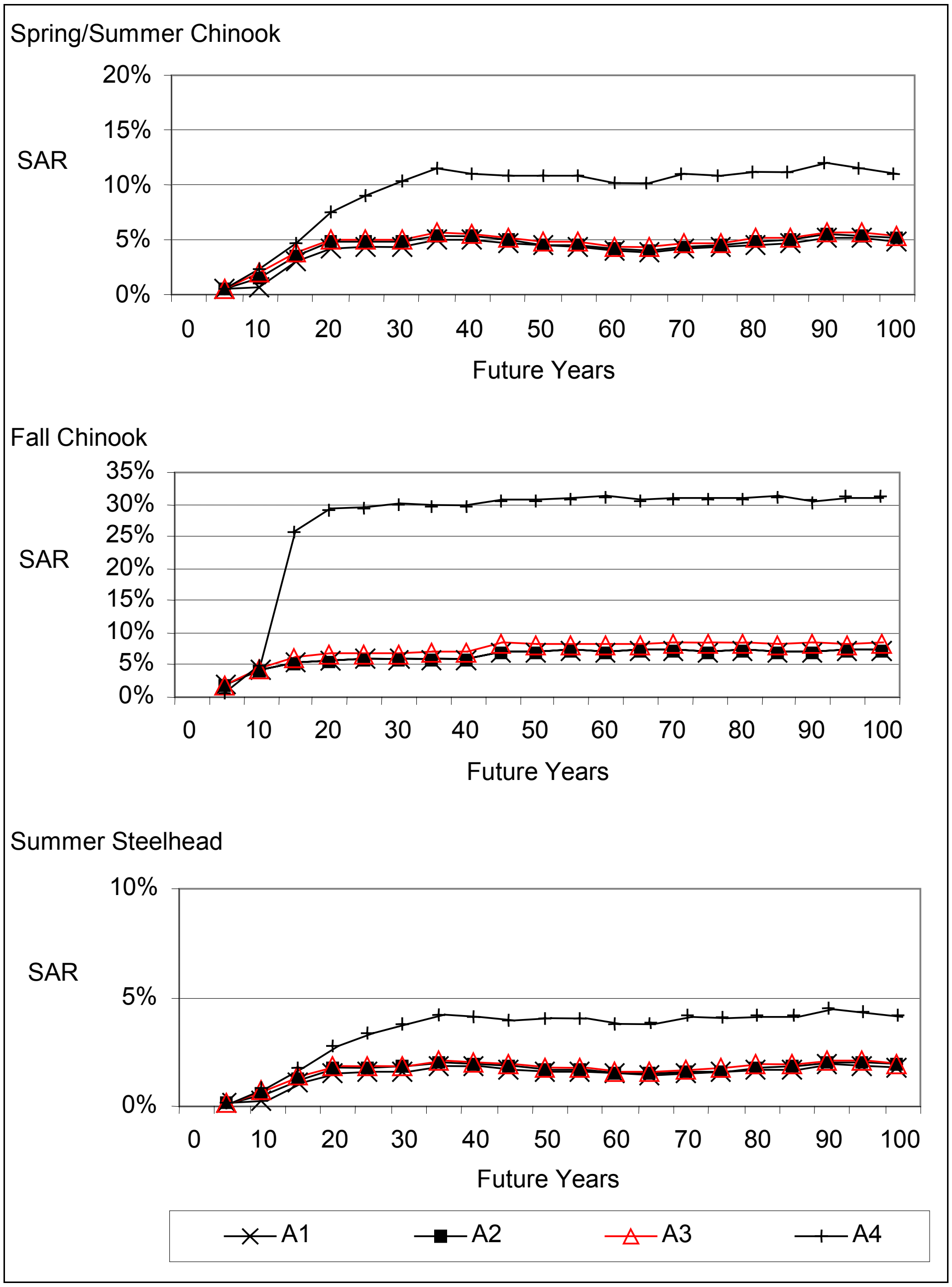
[5] Idaho has not had a general salmon fishery for over 20 years. There have been some spot fisheries recently where river constraints guarantee that only hatchery fish are impacted. The DREW Anadromous Fish Workgroup decided that the returns forecasted by PATH were sufficiently high that fishery managers would allow fisheries.

[6] The equilibrium measure of the population is the level at which the spawning recruits of a brood are exactly sufficient to replace their parental brood. With typical salmon life-cycle models, in the absence of environmental variations and assuming a constant harvest rate, the equilibrium population level is a stable point that a stock will approach over time. Simply put, the equilibrium is a measure of the number of fish a habitat can maintain with a specific set of management actions, including hydrosystem operations and fisheries regulations. The time period for anadromous fish recovery to reach equilibrium may differ depending on physical conditions, fishery management, and other factors. An undefined time period may be needed following dam breaching to return the river bed conditions to acceptable spawning habitat quality. While the river will cut through the soft sediments relatively quickly and create the surface layer of appropriate spawning gravels, it may take a large flood to scour the streambed to sufficient depth to clear embedded fine materials. Similarly, a demographic lag of many generations may occur at current commercial fish harvest rates prior to achieving spawning levels approaching full capacity. Following the geomorphologic changes that would occur with dam breaching, the transition period necessary to reestablish a macro invertebrate community to supply food to rearing fall chinook may take at least 10 years, according to research provided by PATH. Given the possible ranges for geomorphologic changes, microinvertebrate changes, and demographic responses, the time period to recovery for economic calculations is assumed to be 25 years.

(TAC, 1997). During this same period, C&S harvest of summer steelhead was about 6,000 fish. The proportion of Snake River stocks contributing to the C&S harvests were accounted for in the commercial treaty fishery distributional assumptions and assigned a food value, but were not assigned an additional intrinsic dollar value. Estimated contributions to ocean treaty fisheries were very small and were, as a result, included as incidental harvests to other commercial fisheries in the modeling. These contributions do, however, deserve mentioning since takings of ESA listed stocks can be constrained through management. Access to high numbers of ocean treaty fish with origin elsewhere can be limited by constraints associated with the takings of the low numbers of the ESA stocks.



Notes:
1. The Y-axis maximums are different for each species.
2. Smolt-to-adult rates are referenced as indicators because they are not based on age structures. The indicator rates are spawners, prespawning mortality, and harvest divided by smolts produced 5 years earlier and expressed as a percent. Smolts are calculated using a density-dependent, egg-to-smolt relationship and the number of spawners 5 years earlier.
3. Summer steelhead rates are based on changes to spring/summer chinook rates.
4. A1 through A4 refer to Alternative 1 through Alternative 4.

Figure 3.5-5. Snake River Wild-origin Fish Smolt-to-Adult Survival Rate Indicators by Alternative during Project Period

Table 3.5-2. Snake River Anadromous Fish In-river Harvests and Harvest Rates for 10-year Average, 1986 through 1995

		Existing Inriver Harvest and Harvest Rates									
		Mainstem						Tributary			
		Commercial Non-Treaty		Recreational		Treaty Indian		Lower Granite Escapement		Tributary Recreational	
Species/Stock	Ocean Escapement	Number	Rate (%)	Number	Rate (%)	Number	Rate (%)	Number	Rate (%)	Number	Rate (%)
Snake River											
Fall Chinook											
Wild	1,813	–	–	–	–	419	23.1	381	21.0	–	–
Hatchery	4,458	–	–	–	–	1,108	24.9	1,679	37.7	–	–
Total	**6,271**	**803**	**12.8**	**159**	**2.5**	**1,527**	**24.3**	**2,060**	**32.8**	–	–
Spring Chinook											
Wild	8,657	–	–	–	–	561	6.5	5,126	59.2	–	–
Hatchery	19,865	–	–	–	–	1,363	6.9	12,234	61.6	–	–
Total	**28,522**	**506**	**1.8**	**364**	**1.3**	**1,924**	**6.7**	**17,360**	**60.9**	–	–
Summer Chinook											
Wild	3,073	00.0	–	–	78	2.5	2.5	2,294	74.6	–	–
Hatchery	2,856	00.0	–	–	89	3.1	3.1	1,972	69.0	–	–
Total	**5,929**	**00.0**	**3**	**0.0**	**167**	**2.8**	**2.8**	**4,265**	**71.9**	–	–
Summer Steelhead											
Wild	21,187	0	0.0	0	0.0	4,115	19.4	16,225	76.6	0	0.0
Hatchery	105,598	0	0.0	10,733	10.2	25,972	24.6	72,795	68.9	40,248	38.1
Total	**126,785**	**0**	**0.0**	**9,846**	**7.8**	**29,636**	**23.4**	**89,020**	**70.2**	**40,248**	**31.7**

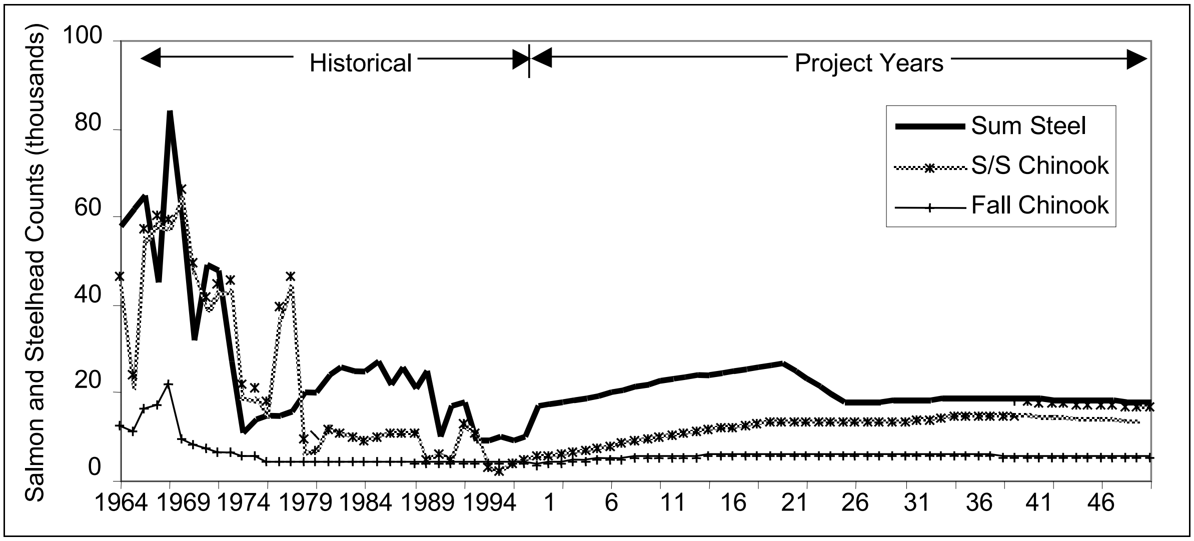
Notes:
1. Averages are based on 1986 through 1995 period.
2. Harvest rates are based on ocean escapement.
3. Upriver refers to mainstem escapement from the lower Columbia River into either the upper Columbia River or the Snake River.
4. All references to specific tables and tabs are found in TAC 1997.
5. Recreational mainstem and tributary harvests are assumed to be illegal and 0 for wild fall chinook, spring chinook, and summer chinook after 1990 and for summer steelhead after 1984.
6. Fall chinook
   a. Total fall chinook harvest from commercial, recreational, and treaty user groups is from Table 8, Tab E. The assumption is made that catch in zone 6 is treaty.
   b. Ocean and Lower Granite Dam escapement is from Tables 8 and 9, Tab 3.
   c. Treaty harvest of wild fall chinook is from Table 9, Tab 3. Hatchery harvest is the residual of total and wild salmon.
7. Spring chinook
   a. Total ocean escapement is the total upriver run size times and the proportion of Snake River spring chinook from Tables 1 and 2, Tab 1.
   b. Wild ocean escapement and Lower Granite escapement are from Tables 2 and 3, Tab 1.
   c. Hatchery Lower Granite escapement is from Table 3, Tab 1.
   d. Total commercial and total recreational Snake River harvests are estimated using upriver spring chinook mainstem harvests by user group and applying the proportion of mainstem escapement to Snake River.
   e. Treaty harvest of wild mainstem Snake River spring chinook is from Table 2, Tab 1. It is assumed that harvests in zone 6 are treaty harvest only. Total harvest is estimated using harvest of upriver spring chinook and a proportion of Snake River spring chinook. Treaty harvest of hatchery spring chinook is the residual of total and wild fish.
8. Summer chinook
   a. Wild ocean escapement and Lower Granite escapement are from Table 2, Tab 2.
   b. Hatchery ocean escapement and Lower Granite escapement are from Table 3, Tab 2.
   c. Total recreational mainstem harvest of summer chinook is estimated from harvest of upriver summer chinook and a proportion of Snake River summer chinook.
   d. Non-treaty commercial harvest in zones 1-5 for wild and hatchery summer chinook is zero. Table 1, Tab 2. Incidental non-retention is excluded.
   e. Treaty harvest of wild summer chinook is from Table 2, Tab 2. This assumes zone 6 harvest is treaty-only.
   f. Treaty harvest of hatchery summer chinook is from Table 3, Tab 2. This assumes zone 6 harvest is treaty-only.
9. Summer steelhead
   a. Non-treaty commercial harvest is assumed to be zero.
   b. Lower Granite escapement is from Tables 12 through 15, Tab 8. Lower Granite counts of group A and B were summed (based on the length method).
   c. Total tributary harvest is from Tables A1c and A1d.
   d. Wild hatchery ocean escapement is from Tables 12 through 15, Tab 8. Lower Granite with no mainstem fishery counts of group A and B were summed (based on the length method). This provides a minimum run size.
   e. Mainstem harvest rates are assumed to equal mainstem harvest rates for total upriver summer steelhead stocks.

Source: TAC, 1997

Table 3.5-3. Assumptions for Anadromous Fish User Group Distributions by Species and Geographic Area

	Anadromous Species		
	Chinook		
Geographic Area/User Group	**Spring/Summer (%)**	**Fall (%)**	**Summer Steelhead (%)**
Ocean Harvest			
Alaska			
a) Commercial	0.000	11.663	0.000
b) Sport	0.000	0.002	0.000
British Columbia			
a) Commercial	0.000	48.506	0.000
b) Sport	0.000	3.880	0.000
Subtotal Alaska/British Columbia	0.000	64.051	0.000
Washington ocean			
a) Commercial	0.000	19.027	0.000
b) Sport	0.000	8.456	0.000
Washington Puget Sound			
a) Commercial	0.000	0.002	0.000
b) Sport	0.000	0.002	0.000
Oregon			
a) Commercial	0.000	6.343	0.000
b) Sport	0.000	2.115	0.000
California			
a) Commercial	0.000	0.002	0.000
b) Sport	0.000	0.002	0.000
Subtotal WOC Ocean	0.000	35.949	0.000
Subtotal Ocean	0.000	100.000	0.000
In-river Harvest			
Treaty Year 0	50.000	62.219	37.200
Year 5	50.000	62.219	39.760
Year 10	50.000	62.219	42.320
Year 15	50.000	62.219	44.880
Year 20	50.000	62.219	47.440
Year 25-100	50.000	62.219	50.000
Non-treaty			
Mainstem	(less treaty)		(less treaty)
a) Freshwater sport	77.000	2.874	100.000
b) Commercial non-treaty	17.000	34.491	0.000
c) Other in-river Tributary	6.000	0.416	0.000
Tributary			
a) Freshwater sport	100.000	0.000	100.000
Returns to Hatcheries			
Requirement to Carcass	100.000	100.000	100.000
Surplus			
a) Carcass and egg sales	50.000	50.000	50.000
b) Food fish	50.000	50.000	50.000

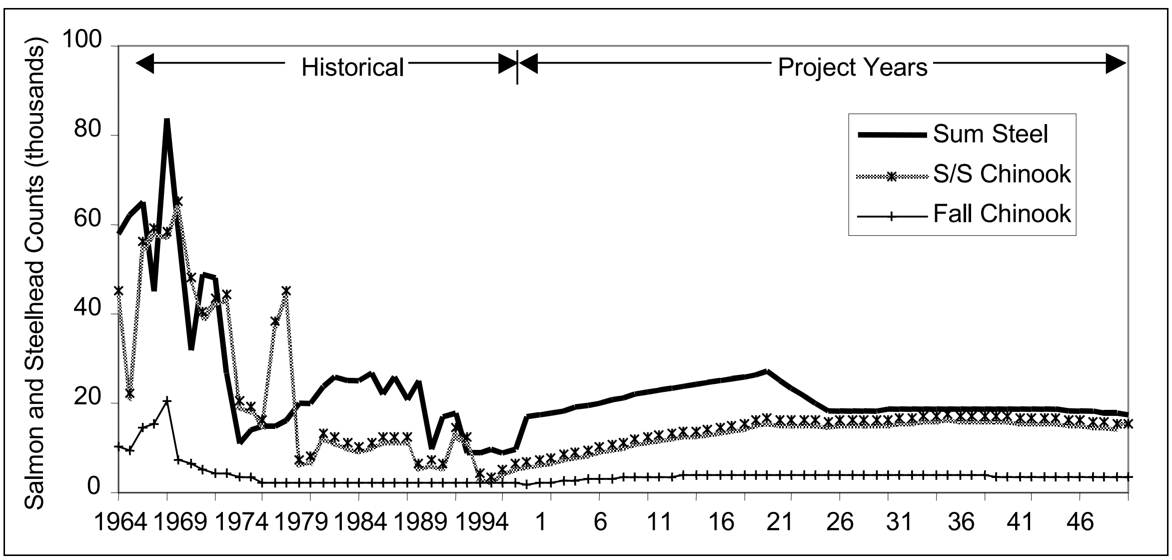
Notes:
1. Expressed as percent of fish harvested by the geographical fisheries.
2. Results assume 50 percent for treaty harvests and zero ocean harvests for spring/summer chinook and summer steelhead.
3. Treaty harvest percent of fish is based on all in-river harvestable fish (mainstem and tributary). It is assumed that all treaty harvests are in the mainstem.
4. Non-treaty mainstem harvests for spring/summer chinook and summer steelhead represent the distribution of the remaining mainstem harvestable fish by user group.
5. Non-treaty harvests for fall chinook represent shares of total in-river harvest.



Notes: 1. Adult wild salmon and steelhead counts at the uppermost dam on the Snake River below Lewiston (Ice Harbor Dam 1964 to 1968, Lower Monument Dam 1969—Little Goose Dam 1970 to 1974, Lower Granite Dam 1970 to 1974).
2. S/S = Spring/Summer

Source: DREW Anadromous Fish Workgroup Study and IDFG, 1998

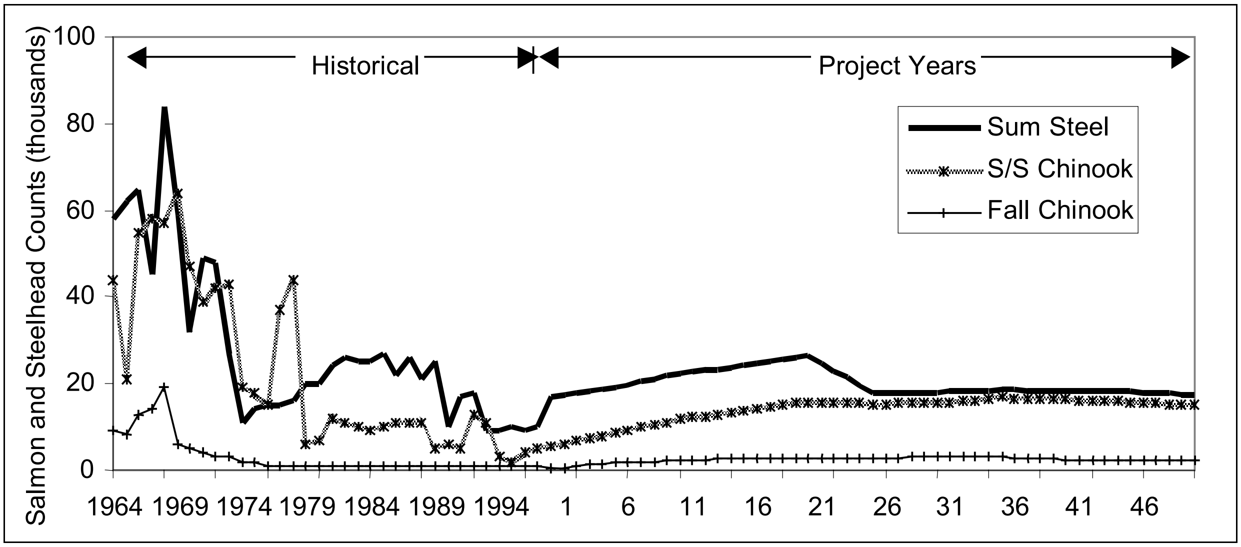
Figure 3.5-6. Historical and Project Year Wild-origin Stock Run Counts at Snake River Uppermost Dam, Alternative 1—Existing Conditions



Notes: 1. Adult wild salmon and steelhead counts at the uppermost dam on the Snake River below Lewiston (Ice Harbor Dam 1964 to 1968, Lower Monument Dam 1969, Little Goose Dam 1970 to 1974, Lower Granite Dam 1970 to 1974).
2. S/S = Spring/Summer

Source: DREW Anadromous Fish Workgroup Study and IDFG, 1998

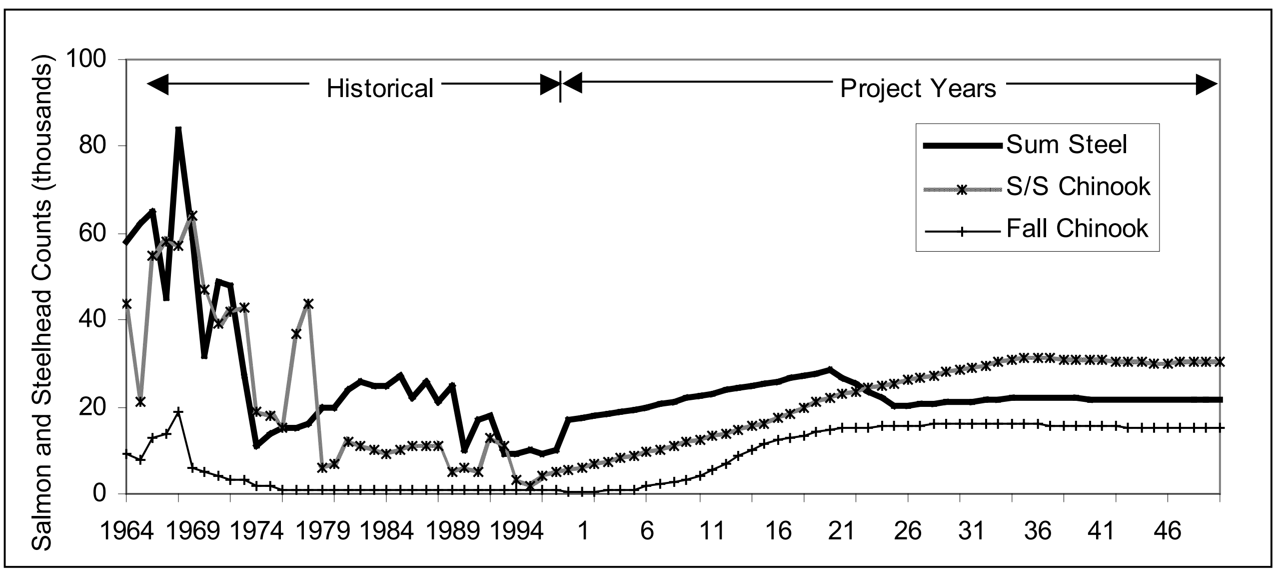
Figure 3.5-7. Historical and Project Year Wild-origin Stock Run Counts at Snake River Uppermost Dam, Alternative 2—Maximum Transport of Juvenile Salmon



Notes: 1. Adult wild salmon and steelhead counts at the uppermost dam on the Snake River below Lewiston (Ice Harbor Dam 1964 to 1968, Lower Monument Dam 1969, Little Goose Dam 1970 to 1974, Lower Granite Dam 1970 to 1974).
2. S/S = Spring/Summer

Source: DREW Anadromous Fish Workgroup Study and IDFG, 1998

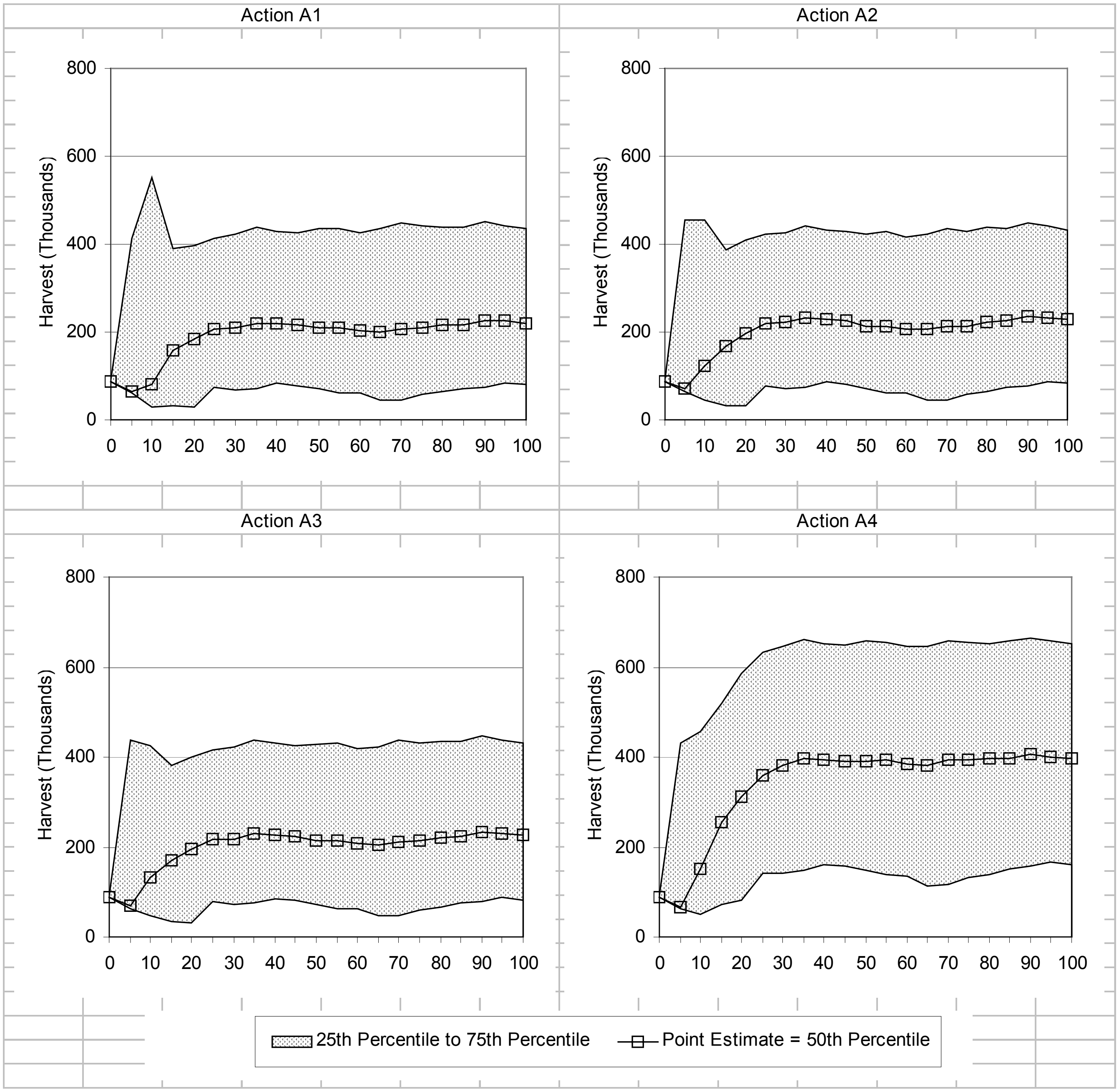
Figure 3.5-8. Historical and Project Year Wild-origin Stock Run Counts at Snake River Uppermost Dam, Alternative 3—Major System Improvements



Notes: 1. Adult wild salmon and steelhead counts at the uppermost dam on the Snake River below Lewiston (Ice Harbor Dam 1964 to 1968, Lower Monument Dam 1969, Little Goose Dam 1970 to 1974, Lower Granite Dam 1970 to 1974).
2. S/S = Spring/Summer

Source: DREW Anadromous Fish Workgroup Study and IDFG, 1998

Figure 3.5-9. Historical and Project Year Wild-origin Stock Run Counts at Snake River Uppermost Dam, Alternative 4—Dam Breaching



Notes:
1. Harvests include all ocean, mainstem, and tributary fisheries for all species.
2. The envelop (shaded area) around the point estimates (boxes) corresponds to PATH results for "high" (75th percentile) and "low" (25th percentile) modeling outputs. The point estimates are "likely" (50th percentile) modeling results.
3. The analysis is based on PATH results. Fall chinook forecasts are based on the "base case" scenario and spring and summer chinook forecasts are based on the "equal weights" scenario.
4. Action A1 = Alternative 1, etc.

Source: DREW Anadromous Fish Workgroup Study

Figure 3.5-10. Harvest Forecast for Snake River Stocks Over Forecast Period by Alternative for "Low," "Likely," and "High" Modeling Results

Table 3.5-4. Stock Origin Harvest Forecast for Snake River Stocks over Projected Period by Alternative for "Likely" Modeling Results

Stock/Year	Wild				Hatchery				Total			
	A1	A2	A3	A4	A1	A2	A3	A4	A1	A2	A3	A4
Spring/Summer Chinook												
5	1,409	1,557	1,607	1,675	269	451	377	347	**1,678**	**2,008**	**1,984**	**2,021**
10	2,875	3,148	3,188	3,478	549	1,862	1,803	1,900	**3,424**	**5,010**	**4,991**	**5,378**
25	6,130	6,790	6,803	13,804	4,737	8,164	6,681	12,160	**10,866**	**14,954**	**13,485**	**25,964**
50	6,471	5,957	6,265	19,145	5,015	7,141	6,140	16,441	**11,486**	**13,099**	**12,405**	**35,586**
100	7,257	7,431	7,528	20,020	5,723	8,997	7,437	17,069	**12,980**	**16,428**	**14,965**	**37,089**
Min.	1,409	1,557	1,607	1,675	269	451	377	347	**1,678**	**2,008**	**1,984**	**2,021**
Max.	8,224	8,320	5,520	22,313	6,385	9,979	8,350	19,093	**14,609**	**18,299**	**16,870**	**41,406**
Median	6,481	6,902	6,902	19,136	5,012	8,113	6,667	16,431	**11,493**	**15,015**	**13,568**	**35,567**
Mean	6,201	6,294	6,442	16,357	4,636	7,304	6,141	13,941	**10,837**	**13,598**	**12,583**	**30,298**
Fall Chinook												
5	2,019	2,019	2,013	994	1,852	1,852	1,864	2,569	**3,871**	**3,871**	**3,877**	**3,563**
10	2,749	2,749	3,018	5,161	3,997	3,997	4,413	13,276	**6,745**	**6,745**	**7,431**	**18,437**
25	3,451	3,451	4,052	18,017	5,674	5,674	6,787	70,650	**9,125**	**9,125**	**10,839**	**88,667**
50	3,383	3,383	4,079	18,513	6,857	6,857	8,228	74,064	**10,240**	**10,240**	**12,307**	**92,577**
100	3,473	3,473	4,105	18,520	7,037	7,037	8,309	73,945	**10,510**	**10,510**	**12,413**	**92,466**
Min.	2,019	2,019	2,013	994	1,852	1,852	1,864	2,569	**3,871**	**3,871**	**3,877**	**3,563**
Max.	3,473	3,473	4,184	18,770	7,037	7,037	8,446	75,059	**10,510**	**10,510**	**12,630**	**98,829**
Median	3,392	3,392	4,080	18,474	6,799	6,799	8,209	73,366	**10,158**	**10,158**	**12,280**	**91,785**
Mean	3,294	3,294	3,909	16,602	6,087	6,087	7,273	65,989	**9,381**	**9,381**	**11,182**	**82,590**
Summer Steelhead												
5	4,645	4,674	4,605	4,631	55,120	60,492	58,431	57,454	**59,765**	**65,166**	**63,035**	**62,086**
10	5,465	5,458	5,403	5,476	65,504	106,122	114,544	111,763	**70,969**	**111,580**	**119,947**	**128,239**
25	22,912	23,258	22,742	25,838	163,837	172,645	170,167	219,825	**186,749**	**195,904**	**192,909**	**245,664**
50	22,904	22,351	22,010	27,627	166,244	168,814	168,024	236,261	**189,148**	**191,165**	**190,034**	**263,888**
100	23,652	23,759	23,159	27,873	171,754	177,528	175,037	238,530	**195,405**	**201,286**	**198,196**	**266,402**
Min.	4,645	4,674	4,605	4,631	55,120	60,492	58,431	57,454	**59,765**	**65,166**	**63,035**	**62,086**
Max.	24,352	24,260	23,813	28,732	176,189	181,890	179,818	246,182	**200,541**	**206,150**	**203,631**	**274,914**
Median	22,908	22,805	22,401	27,608	165,829	170,730	169,096	236,160	**188,910**	**193,534**	**191,472**	**263,772**
Mean	19,759	19,689	19,266	23,240	155,075	162,366	161,339	215,988	**174,834**	**182,055**	**180,604**	**239,227**
Total												
5	8,072	8,250	8,224	7,300	57,241	62,795	60,672	60,370	**65,313**	**71,045**	**68,896**	**67,670**
10	11,088	11,354	11,609	14,115	70,050	111,981	120,760	137,939	**81,138**	**123,335**	**132,369**	**152,054**
25	32,493	33,499	33,598	57,659	174,247	186,484	183,635	302,636	**206,740**	**219,983**	**217,233**	**360,295**
50	32,757	31,691	32,354	65,285	178,116	182,812	182,392	326,766	**210,873**	**214,503**	**214,746**	**392,051**
100	34,381	34,663	34,792	66,412	184,514	193,562	190,782	329,545	**218,895**	**228,224**	**225,574**	**395,957**
Min.	8,072	8,250	8,224	7,300	57,241	62,795	60,672	60,370	**65,313**	**71,045**	**68,896**	**67,670**
Max.	35,923	35,927	36,517	69,440	189,353	198,648	196,614	338,306	**225,276**	**234,575**	**233,131**	**407,746**
Median	32,777	32,645	33,024	65,390	177,656	184,648	183,014	326,721	**210,327**	**217,243**	**215,990**	**392,475**
Mean	29,254	29,277	29,617	56,198	165,798	175,757	174,753	295,918	**195,052**	**205,034**	**204,370**	**352,115**

Note: A=Alternative

Table 3.5-5. Stock Origin Harvest Forecast for Snake River Stocks over Projected Period by Alternative for "Low" Modeling Results

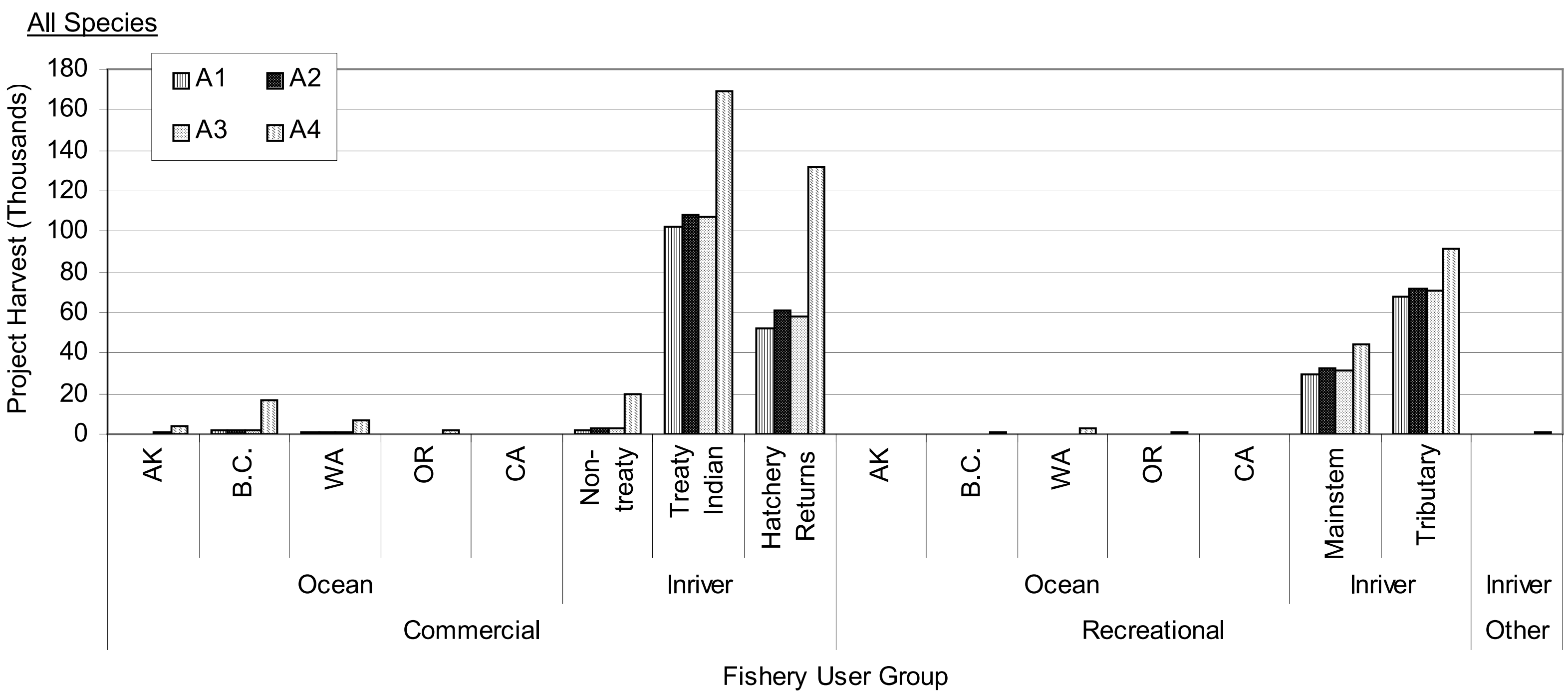
Stock/Years	Wild				Hatchery				Total			
	A1	A2	A3	A4	A1	A2	A3	A4	A1	A2	A3	A4
Spring/Summer Chinook												
5	651	722	752	777	221	372	314	286	**872**	**1,094**	**1,066**	**1,063**
10	1,149	1,274	1,311	1,409	391	594	474	434	**1,540**	**1,868**	**1,784**	**1,842**
25	2,420	2,782	2,758	5,650	473	1,789	1,577	4,527	**2,893**	**4,570**	**4,334**	**10,177**
50	2,374	2,302	2,373	8,191	455	1,359	1,246	7,116	**2,829**	**3,661**	**3,619**	**15,307**
100	2,800	3,039	3,064	8,801	810	2,106	1,853	7,707	**3,611**	**5,145**	**4,916**	**16,508**
Min.	651	722	752	777	221	372	314	286	**872**	**1,094**	**1,066**	**1,063**
Max.	3,249	3,475	3,523	10,089	1,079	2,443	2,118	8,810	**4,145**	**5,738**	**5,426**	**18,899**
Median	2,429	2,826	2,786	8,200	502	1,281	1,237	7,125	**2,930**	**3,928**	**3,877**	**15,325**
Mean	2,387	2,559	2,578	7,054	563	1,350	1,213	5,913	**2,950**	**3,909**	**3,791**	**12,967**
Fall Chinook												
5	973	973	955	485	893	893	885	1,253	**1,866**	**1,866**	**1,840**	**1,738**
10	1,322	1,322	1,425	2,587	1,408	1,408	1,504	1,645	**2,730**	**2,730**	**2,930**	**4,233**
25	1,731	1,731	2,017	8,834	2,534	2,534	3,101	38,025	**4,265**	**4,265**	**5,119**	**46,858**
50	1,688	1,688	2,063	8,930	3,490	3,490	4,319	40,184	**5,178**	**5,178**	**6,381**	**49,113**
100	1,746	1,746	2,047	8,970	3,607	3,607	4,286	40,376	**5,353**	**5,353**	**6,332**	**49,347**
Min.	973	973	955	485	893	893	885	1,253	**1,866**	**1,866**	**1,840**	**1,738**
Max.	1,746	1,746	2,073	9,193	3,607	3,607	4,319	41,125	**5,353**	**5,353**	**6,381**	**50,303**
Median	1,703	1,703	2,031	9,003	3,491	3,491	4,243	40,277	**5,179**	**5,179**	**6,270**	**49,265**
Mean	1,641	1,641	1,937	8,170	2,960	2,960	3,577	35,791	**4,601**	**4,601**	**5,514**	**43,961**
Summer Steelhead												
5	4,157	4,123	4,101	4,099	53,521	58,737	56,736	55,787	**57,677**	**62,861**	**60,837**	**59,887**
10	4,563	4,547	4,479	4,538	21,320	34,540	37,281	39,957	**25,882**	**39,088**	**41,760**	**44,495**
25	18,467	18,892	18,463	20,559	47,461	50,013	49,295	63,681	**65,929**	**68,905**	**67,758**	**84,240**
50	18,315	18,104	17,804	21,907	43,381	44,052	43,846	61,652	**61,696**	**62,156**	**61,650**	**83,559**
100	18,971	19,117	18,887	22,125	51,782	53,522	52,771	71,914	**70,753**	**72,639**	**71,658**	**94,039**
Min.	4,157	4,123	4,101	4,099	17,833	18,931	18,735	22,491	**22,971**	**24,224**	**23,890**	**27,959**
Max.	19,568	19,601	19,382	22,793	55,940	58,737	56,872	77,010	**75,263**	**77,049**	**75,970**	**99,379**
Median	18,398	18,516	18,134	21,878	42,450	43,795	43,369	56,930	**58,989**	**62,394**	**61,217**	**76,330**
Mean	15,897	15,942	15,683	18,459	38,664	40,758	40,444	53,346	**54,561**	**56,700**	**56,127**	**71,805**
Total												
5	5,781	5,819	5,808	5,361	54,635	60,001	57,934	57,327	**60,415**	**65,820**	**63,742**	**62,688**
10	7,034	7,143	7,214	8,534	23,119	36,543	39,259	42,035	**30,152**	**43,686**	**46,474**	**50,570**
25	22,618	23,404	23,238	35,042	50,469	54,336	53,974	106,233	**73,087**	**77,740**	**77,211**	**141,275**
50	22,377	22,095	22,240	39,029	47,326	48,900	49,410	108,951	**69,703**	**70,995**	**71,650**	**147,980**
100	23,518	23,902	23,997	39,897	56,199	59,236	58,910	119,997	**79,717**	**83,138**	**82,907**	**159,893**
Min.	5,781	5,819	5,808	5,361	20,727	22,166	22,264	42,035	**29,949**	**31,976**	**32,185**	**50,570**
Max.	24,525	24,784	24,949	42,006	60,512	63,580	63,228	126,069	**84,589**	**87,968**	**87,659**	**166,888**
Median	22,517	22,796	22,754	39,095	45,932	48,249	48,410	101,184	**65,498**	**68,408**	**68,526**	**140,032**
Mean	19,925	20,142	20,198	33,682	42,187	45,068	45,234	95,050	**62,112**	**65,210**	**65,431**	**128,733**

A=Alternative

Table 3.5-6. Stock Origin Harvest Forecast for Snake River Stocks over Projected Period by Alternative for "High" Modeling Results

Stock/Years	Wild				Hatchery				Total			
	A1	A2	A3	A4	A1	A2	A3	A4	A1	A2	A3	A4
Spring/Summer Chinook												
5	2,945	722	752	777	221	372	314	286	**872**	**1,094**	**1,066**	**1,063**
10	7,484	1,274	1,311	1,409	391	594	474	434	**1,540**	**1,868**	**1,784**	**1,842**
25	14,619	2,782	2,758	5,650	473	1,789	1,577	4,527	**2,893**	**4,570**	**4,334**	**10,177**
50	16,311	2,302	2,373	8,191	455	1,359	1,246	7,116	**2,829**	**3,661**	**3,619**	**15,307**
100	17,345	3,039	3,064	8,801	810	2,106	1,853	7,707	**3,611**	**5,145**	**4,916**	**16,508**
Min.	2,945	722	752	777	221	372	314	286	**872**	**1,094**	**1,066**	**1,063**
Max.	19,172	3,475	3,523	10,089	1,079	2,443	2,118	8,810	**4,145**	**5,738**	**5,426**	**18,899**
Median	16,292	2,826	2,786	8,200	502	1,281	1,237	7,125	**2,930**	**3,928**	**3,877**	**15,325**
Mean	15,084	2,559	2,578	7,054	563	1,350	1,213	5,913	**2,950**	**3,909**	**3,791**	**12,967**
Fall Chinook												
5	4,121	973	955	485	893	893	885	1,253	**1,866**	**1,866**	**1,840**	**1,738**
10	6,948	1,322	1,425	2,587	1,408	1,408	1,504	1,645	**2,730**	**2,730**	**2,930**	**4,233**
25	6,683	1,731	2,017	8,834	2,534	2,534	3,101	38,025	**4,265**	**4,265**	**5,119**	**46,858**
50	6,964	1,688	2,063	8,930	3,490	3,490	4,319	40,184	**5,178**	**5,178**	**6,381**	**49,113**
100	4,121	1,746	2,047	8,970	3,607	3,607	4,286	40,376	**5,353**	**5,353**	**6,332**	**49,347**
Min.	6,964	973	955	485	893	893	885	1,253	**1,866**	**1,866**	**1,840**	**1,738**
Max.	6,860	1,746	2,073	9,193	3,607	3,607	4,319	41,125	**5,353**	**5,353**	**6,381**	**50,303**
Median	6,634	1,703	2,031	9,003	3,491	3,491	4,243	40,277	**5,179**	**5,179**	**6,270**	**49,265**
Mean	1,641	1,641	1,937	8,170	2,960	2,960	3,577	35,791	**4,601**	**4,601**	**5,514**	**43,961**
Summer Steelhead												
5	4,157	4,123	4,101	4,099	53,521	58,737	56,736	55,787	**57,677**	**62,861**	**60,837**	**59,887**
10	4,563	4,547	4,479	4,538	21,320	34,540	37,281	39,957	**25,882**	**39,088**	**41,760**	**44,495**
25	18,467	18,892	18,463	20,559	47,461	50,013	49,295	63,681	**65,929**	**68,905**	**67,758**	**84,240**
50	18,315	18,104	17,804	21,907	43,381	44,052	43,846	61,652	**61,696**	**62,156**	**61,650**	**83,559**
100	18,971	19,117	18,887	22,125	51,782	53,522	52,771	71,914	**70,753**	**72,639**	**71,658**	**94,039**
Min.	4,157	4,123	4,101	4,099	17,833	18,931	18,735	22,491	**22,971**	**24,224**	**23,890**	**27,959**
Max.	19,568	19,601	19,382	22,793	55,940	58,737	56,872	77,010	**75,263**	**77,049**	**75,970**	**99,379**
Median	18,398	18,516	18,134	21,878	42,450	43,795	43,369	56,930	**58,989**	**62,394**	**61,217**	**76,330**
Mean	15,897	15,942	15,683	18,459	38,664	40,758	40,444	53,346	**54,561**	**56,700**	**56,127**	**71,805**
Total												
5	5,781	5,819	5,808	5,361	54,635	60,001	57,934	57,327	**60,415**	**65,820**	**63,742**	**62,688**
10	7,034	7,143	7,214	8,534	23,119	36,543	39,259	42,035	**30,152**	**43,686**	**46,474**	**50,570**
25	22,618	23,404	23,238	35,042	50,469	54,336	53,974	106,233	**73,087**	**77,740**	**77,211**	**141,275**
50	22,377	22,095	22,240	39,029	47,326	48,900	49,410	108,951	**69,703**	**70,995**	**71,650**	**147,980**
100	23,518	23,902	23,997	39,897	56,199	59,236	58,910	119,997	**79,717**	**83,138**	**82,907**	**159,893**
Min.	5,781	5,819	5,808	5,361	20,727	22,166	22,264	42,035	**29,949**	**31,976**	**32,185**	**50,570**
Max.	24,525	24,784	24,949	42,006	60,512	63,580	63,228	126,069	**84,589**	**87,968**	**87,659**	**166,888**
Median	22,517	22,796	22,754	39,095	45,932	48,249	48,410	101,184	**65,498**	**68,408**	**68,526**	**140,032**
Mean	19,925	20,142	20,198	33,682	42,187	45,068	45,234	95,050	**62,112**	**65,210**	**65,431**	**128,733**

A=Alternative



Notes:
1. Harvest is in number of fish.
2. PATH results fall chinook Alternative 1 is the same as Alternative 2. Fall chinook is the only significantly harvested species in ocean fisheries.
3. "Low," "likely," and "high" modeling results correspond to PATH results for 25th, 50th, 75th percentile outputs, respectively.
4. The analysis is based on PATH results' "base case" scenario for fall chinook and "equal weights" scenario for spring/summer chinook.
5. Total and subtotals may not equal sum of values due to rounding.
6. A = Alternative

Figure 3.5-11. Projected Harvest for All Species by Fishery User Group Using "Likely" Modeling Results by Alternative

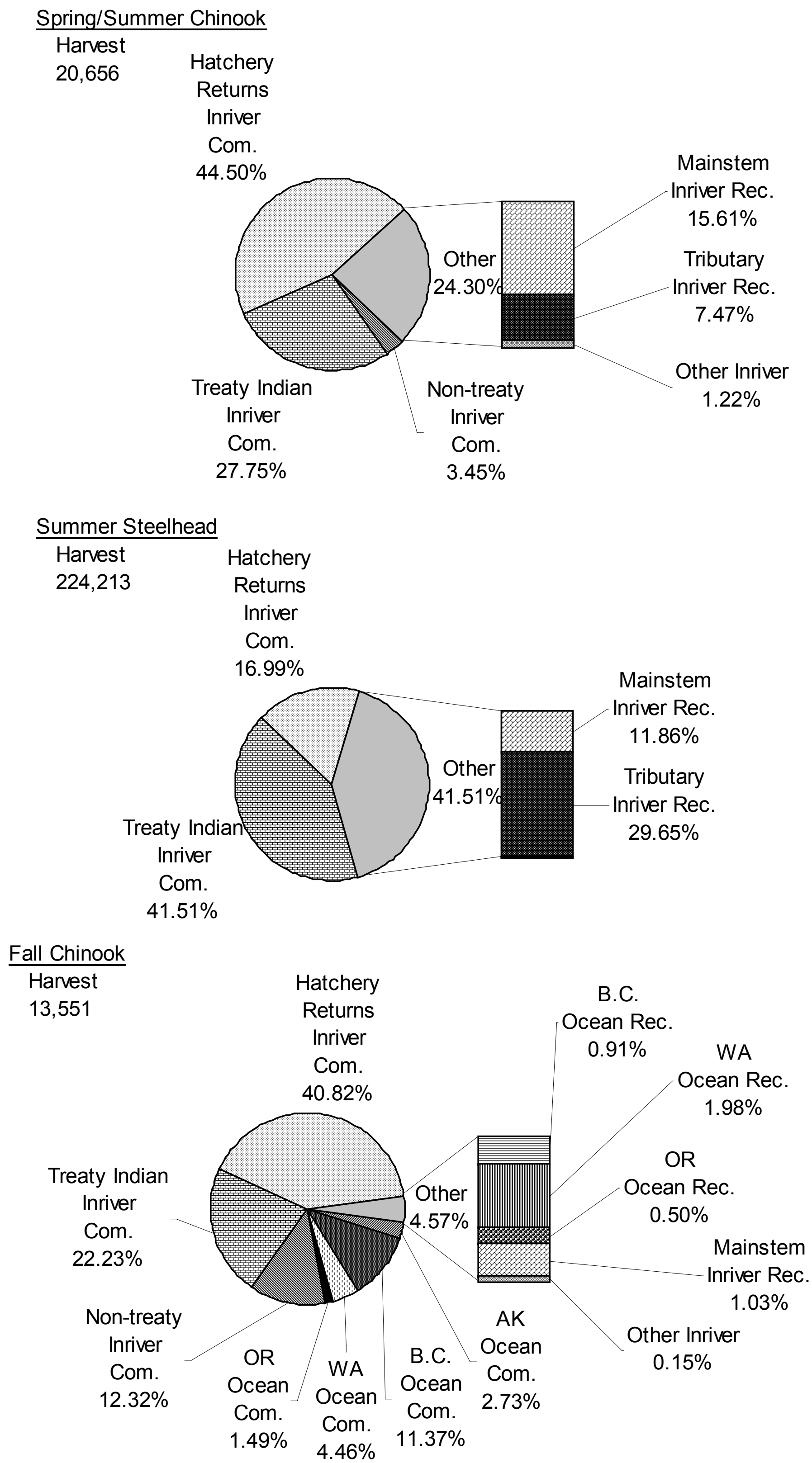


Figure 3.5-12. Projected Harvest by Species and Fishery User Group Using "Likely" Modeling Results for Alternative 4—Dam Breaching

Table 3.5-7. Ranges of Projected Harvest For All Fisheries by Alternative Using "Low," Likely," and "High" Modeling Results for Year 25

	A1			A2			A3			A4		
Anadromous Fish	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**
Commercial												
Ocean												
Alaska	212	490	1,065	212	490	1,065	257	590	1,282	1,994	4,097	7,753
British Columbia	882	2,039	4,429	882	2,039	4,429	1,067	2,455	5,331	8,294	17,039	32,246
WA Ocean	346	800	1,737	346	800	1,737	418	963	2,091	3,253	6,684	12,649
WA Puget Sound	0	0	0	0	0	0	0	0	0	0	1	1
Oregon	115	267	579	115	267	579	140	321	697	1,085	2,228	4,217
California	0	0	0	0	0	0	0	0	0	0	1	1
Subtotal Ocean	1,555	3,596	7,810	1,555	3,596	7,810	1,881	4,329	9,402	14,627	30,050	56,868
Inriver												
Non-treaty	1,029	2,387	4,847	1,137	2,655	5,377	1,280	2,852	5,870	10,946	20,078	35,279
Treaty Indian	35,934	101,869	203,597	38,260	108,491	207,250	37,863	106,792	203,268	65,724	169,125	294,004
Hatchery Returns	14,784	51,679	103,025	18,889	60,533	113,937	18,675	57,986	108,660	64,981	132,257	213,859
Subtotal Inriver	51,746	155,935	311,469	58,286	171,679	326,565	57,818	167,630	317,798	141,650	321,460	543,142
Subtotal Commercial	53,301	159,532	319,280	59,841	175,276	334,375	59,699	171,959	327,200	156,278	351,510	600,010
Recreational												
Ocean												
Alaska	0	0	0	0	0	0	0	0	0	0	1	1
British Columbia	71	163	354	71	163	354	85	196	426	663	1,363	2,579
WA Ocean	154	356	772	154	356	772	186	428	929	1,446	2,970	5,621
WA Puget Sound	0	0	0	0	0	0	0	0	0	0	1	1
Oregon	38	89	193	38	89	193	47	107	232	362	743	1,406
California	0	0	0	0	0	0	0	0	0	0	1	1
Subtotal Ocean	263	608	1,320	263	608	1,320	318	732	1,589	2,472	5,079	9,611
Inriver												
Mainstem	10,326	29,943	60,335	11,241	32,466	62,582	11,001	31,613	60,763	15,976	43,937	76,014
Tributary	23,906	68,074	135,517	25,171	71,809	136,206	24,760	70,588	133,126	31,166	91,234	158,406
Subtotal Inriver	34,231	98,016	195,852	36,412	104,274	198,788	35,761	102,201	193,889	47,142	135,171	234,420
Subtotal Recreational	34,494	98,624	197,172	36,674	104,882	200,108	36,079	102,933	195,478	49,614	140,250	244,031
Other Inriver	75	264	611	114	359	798	109	327	740	364	792	1,461
Total Commercial and Recreational	**87,871**	**258,419**	**517,062**	**96,629**	**280,516**	**535,281**	**95,887**	**275,219**	**523,419**	**206,256**	**492,552**	**845,501**

Notes: 1. PATH results fall chinook Alternative 1 is the same as Alternative 2. Fall chinook is the only significantly harvested species in ocean fisheries.
2. "Low," "likely," and "high" modeling results correspond to PATH results for 25th, 50th, 75th percentile outputs, respectively.
3. The analysis is based on PATH results' "base case" scenario for fall chinook and "equal weights" scenario for spring/summer chinook.
4. Total and subtotals may not equal sum of values due to rounding.
5. A = Alternative

Table 3.5-8. Ranges of Projected Harvest For Spring/Summer Chinook by Alternative Using "Low," Likely," and "High" Modeling Results for Year 25

	A1			A2			A3			A4		
Anadromous Fish	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**
Commercial												
Ocean												
Alaska	0	0	0	0	0	0	0	0	0	0	0	0
British Columbia	0	0	0	0	0	0	0	0	0	0	0	0
WA Ocean	0	0	0	0	0	0	0	0	0	0	0	0
WA Puget Sound	0	0	0	0	0	0	0	0	0	0	0	0
Oregon	0	0	0	0	0	0	0	0	0	0	0	0
California	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal Ocean	0	0	0	0	0	0	0	0	0	0	0	0
Inriver												
Non-treaty	185	689	1,619	293	958	2,150	273	859	1,964	681	1,612	3,036
Treaty Indian	1,447	5,433	13,217	2,285	7,477	17,409	2,167	6,742	15,824	5,088	12,982	27,333
Hatchery Returns	1,339	9,789	18,234	4,860	16,629	29,418	4,456	14,144	24,907	10,535	20,822	32,935
Subtotal Inriver	2,970	15,912	33,070	7,438	25,064	48,976	6,896	21,745	42,695	16,304	35,417	63,304
Subtotal Commercial	2,970	15,912	33,070	7,438	25,064	48,976	6,896	21,745	42,695	16,304	35,417	63,304
Recreational												
Ocean												
Alaska	0	0	0	0	0	0	0	0	0	0	0	0
British Columbia	0	0	0	0	0	0	0	0	0	0	0	0
WA Ocean	0	0	0	0	0	0	0	0	0	0	0	0
WA Puget Sound	0	0	0	0	0	0	0	0	0	0	0	0
Oregon	0	0	0	0	0	0	0	0	0	0	0	0
California	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal Ocean	0	0	0	0	0	0	0	0	0	0	0	0
Inriver												
Mainstem	837	3,123	7,335	1,327	4,338	9,736	1,237	3,889	8,896	3,086	7,303	13,753
Tributary	360	1,378	3,690	562	1,843	4,764	561	1,692	4,271	1,080	3,497	9,472
Subtotal Inriver	1,197	4,500	11,026	1,889	6,181	14,500	1,798	5,581	13,167	4,166	10,801	23,225
Subtotal Recreational	1,197	4,500	11,026	1,889	6,181	14,500	1,798	5,581	13,167	4,166	10,801	23,225
Other Inriver	65	243	572	103	338	759	96	303	693	240	569	1,072
Total Commercial and Recreational	**4,232**	**20,656**	**44,667**	**9,431**	**31,583**	**64,235**	**8,790**	**27,629**	**56,555**	**20,711**	**46,786**	**87,600**

Notes: 1. Harvest is in number of fish.
2. "Low," "likely," and "high" modeling results correspond to PATH results for 25th, 50th, 75th percentile outputs, respectively.
3. The analysis is based on PATH results' "equal weights" scenario for spring/summer chinook.
4. Total and subtotals may not equal sum of values due to rounding.
5. A = Alternative

Table 3.5-9. Ranges of Projected Harvest For Fall Chinook by Alternative Using "Low," Likely," and "High" Modeling Results for Year 25

	A1			A2			A3			A4		
Anadromous Fish	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**
Commercial												
Ocean												
Alaska	212	490	1,065	212	490	1,065	257	590	1,282	1,994	4,097	7,753
British Columbia	882	2,039	4,429	882	2,039	4,429	1,067	2,455	5,331	8,294	17,039	32,246
WA Ocean	346	800	1,737	346	800	1,737	418	963	2,091	3,253	6,684	12,649
WA Puget Sound	0	0	0	0	0	0	0	0	0	0	1	1
Oregon	115	267	579	115	267	579	140	321	697	1,085	2,228	4,217
California	0	0	0	0	0	0	0	0	0	0	1	1
Subtotal Ocean	1,555	3,596	7,810	1,555	3,596	7,810	1,881	4,329	9,402	14,627	30,050	56,868
Inriver												
Non-treaty	844	1,697	3,228	844	1,697	3,228	1,007	1,993	3,906	10,264	18,466	32,243
Treaty Indian	1,523	3,062	5,823	1,523	3,062	5,823	1,816	3,595	7,047	18,516	33,311	58,163
Hatchery Returns	2,592	4,425	7,290	2,592	4,425	7,290	2,947	4,930	8,006	39,884	61,167	93,336
Subtotal Inriver	4,958	9,185	16,341	4,958	9,185	16,341	5,770	10,518	18,959	68,664	112,944	183,742
Subtotal Commercial	**6,514**	**12,781**	**24,151**	**6,514**	**12,781**	**24,151**	**7,651**	**14,847**	**28,361**	**83,292**	**142,994**	**240,610**
Recreational												
Ocean												
Alaska	0	0	0	0	0	0	0	0	0	0	1	1
British Columbia	71	163	354	71	163	354	85	196	426	663	1,363	2,579
WA Ocean	154	356	772	154	356	772	186	428	929	1,446	2,970	5,621
WA Puget Sound	0	0	0	0	0	0	0	0	0	0	1	1
Oregon	38	89	193	38	89	193	47	107	232	362	743	1,406
California	0	0	0	0	0	0	0	0	0	0	1	1
Subtotal Ocean	263	608	1,320	263	608	1,320	318	732	1,589	2,472	5,079	9,611
Inriver												
Mainstem	70	141	269	70	141	269	84	166	326	855	1,539	2,687
Tributary	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal Inriver	70	141	269	70	141	269	84	166	326	855	1,539	2,687
Subtotal Recreational	**333**	**749**	**1,589**	**333**	**749**	**1,589**	**402**	**898**	**1,914**	**3,327**	**6,617**	**12,297**
Other Inriver	10	20	39	10	20	39	12	24	47	124	223	389
Total Commercial and Recreational	**6,857**	**13,551**	**25,779**	**6,857**	**13,551**	**25,779**	**8,066**	**15,769**	**30,323**	**86,743**	**149,834**	**253,296**

Notes:
1. Harvest is in number of fish.
2. PATH results fall chinook Alternative 1 is the same as Alternative 2.
3. "Low," "likely," and "high" modeling results correspond to PATH results for 25th, 50th, 75th percentile outputs, respectively.
4. The analysis is based on PATH results' "base case" scenario for fall chinook.
5. Total and subtotals may not equal sum of values due to rounding.
6. A = Alternative

Table 3.5-10. Ranges of Projected Harvest For Summer Steelhead by Alternative Using "Low," Likely," and "High" Modeling Results for Year 25

	A1			A2			A3			A4		
Anadromous Fish	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**
Commercial												
Ocean												
Alaska	0	0	0	0	0	0	0	0	0	0	0	0
British Columbia	0	0	0	0	0	0	0	0	0	0	0	0
WA Ocean	0	0	0	0	0	0	0	0	0	0	0	0
WA Puget Sound	0	0	0	0	0	0	0	0	0	0	0	0
Oregon	0	0	0	0	0	0	0	0	0	0	0	0
California	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal Ocean	0	0	0	0	0	0	0	0	0	0	0	0
Inriver												
Non-treaty	0	0	0	0	0	0	0	0	0	0	0	0
Treaty Indian	32,964	93,374	184,558	34,453	97,952	184,019	33,879	96,455	180,397	42,120	122,832	208,508
Hatchery Returns	10,853	37,465	77,500	11,437	39,479	77,229	11,272	38,912	75,747	14,562	50,268	87,588
Subtotal Inriver	43,817	130,839	262,058	45,889	137,431	261,248	45,152	135,367	256,144	56,682	173,099	296,096
Subtotal Commercial	**43,817**	**130,839**	**262,058**	**45,889**	**137,431**	**261,248**	**45,152**	**135,367**	**256,144**	**56,682**	**173,099**	**296,096**
Recreational												
Ocean												
Alaska	0	0	0	0	0	0	0	0	0	0	0	0
British Columbia	0	0	0	0	0	0	0	0	0	0	0	0
WA Ocean	0	0	0	0	0	0	0	0	0	0	0	0
WA Puget Sound	0	0	0	0	0	0	0	0	0	0	0	0
Oregon	0	0	0	0	0	0	0	0	0	0	0	0
California	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal Ocean	0	0	0	0	0	0	0	0	0	0	0	0
Inriver												
Mainstem	9,418	26,678	52,731	9,844	27,986	52,577	9,680	27,558	51,542	12,034	35,095	59,574
Tributary	23,546	66,696	131,827	24,609	69,966	131,442	24,199	68,896	128,855	30,086	87,737	148,935
Subtotal Inriver	32,964	93,374	184,558	34,453	97,952	184,019	33,879	96,455	180,397	42,120	122,832	208,508
Subtotal Recreational	**32,964**	**93,374**	**184,558**	**34,453**	**97,952**	**184,019**	**33,879**	**96,455**	**180,397**	**42,120**	**122,832**	**208,508**
Other Inriver	0	0	0	0	0	0	0	0	0	0	0	0
Total Commercial and Recreational	**76,782**	**224,213**	**446,616**	**80,342**	**235,382**	**445,267**	**79,031**	**231,821**	**436,541**	**98,802**	**295,931**	**504,605**

Notes:
1. Harvest is in number of fish.
2. "Low," "likely," and "high" modeling results correspond to PATH results for 25th, 50th, 75th percentile outputs, respectively.
3. The analysis is based on PATH results' "equal weights" scenario for spring/summer chinook.
4. Total and subtotals may not equal sum of values due to rounding.
5. A = Alternative

3.5.5 Economic Evaluation

The overall goal of this analysis is to calculate the economic values from harvesting the Columbia and Snake River anadromous fish stocks that would be affected by the proposed alternatives. While this analysis specifically addresses the economic effects of changes in wild and hatchery Snake River stocks, it is possible that production and harvest management policies may affect other anadromous fish runs in the Columbia River Basin. The economic values for anadromous fish harvests from the entire Columbia River Basin are, therefore, included in this analysis. The results of this analysis are presented in terms of net economic value or NED value, calculated over a 100-year project life. Annualized future values are discounted to year 0 using three interest rates. The current Corps rate of 6.875 percent, the current BPA rate of 4.75 percent, and 0.0 percent included on behalf of the tribes represented by CRITFC. Indian tribes generally do not discount future generation benefits (i.e., they use a 0.0 percent interest rate). Values are annualized using the Corps definition for annual average equivalent values. All values are in 1998 dollars.

Estimates of net economic value for commercial and recreational fishing are made using available studies and procedures developed by management agencies such as the ODFW, PFMC, and NMFS. Values calculated on a per-fish basis differ, depending on the type of harvest. Commercial economic values or NED benefits are based on ex-vessel values (the price paid to harvesters for their catch). Seventy percent of ex-vessel revenue is used as an indicator of net economic value. This value includes a 50 percent portion of the harvesting sector ex-vessel price and a 50 percent portion of the primary processing margin required to produce a market product from Columbia River Basin anadromous fish runs. The resulting 70 percent net value estimate is within the rate recommended by other studies (Rettig and McCarl, 1984). Commercial fishing economic data were compiled about ex-vessel values, primary processing prices, recovery rates, and costs of harvesting and processing for different species, gear, geographic areas, and user groups. Anadromous fish from the Snake River are commercially harvested by different means (troll—hand and power; net—gillnet, purse seine, and dip net) in different ocean areas (southeast Alaska, Canada, Washington, Oregon, and northern California), the Columbia River estuary, the main stem of the Columbia River, and its main tributaries. Primary seafood processing is included to evaluate the contribution at different stages of processing. For example, troll salmon are usually dressed and sold directly to processors. Net fish are usually sold to a fish buyer in the round. A tender, for a margin of 10 to 18 cents per pound, gathers the salmon and delivers them to the processors. Hatchery fish that escape harvesting return as hatchery surpluses. The surpluses are sold for eggs, carcasses, and sometimes food fish. The funds are usually returned to hatcheries to offset operating and capital improvement costs.

The recreational fishery value used in this analysis was developed using a benefit transfer approach to develop a value per angler day. This value was then multiplied by the number of angler days required to catch a fish. Information available on recreational fishing (success rates and trip expenditure patterns by trip mode, such as guided trips, etc.) associated with lower Snake River anadromous fish runs was compiled and synthesized. Angler days were determined using catch per unit effort (CPUE) data based on recent periods, which were then adjusted for abundance levels. The CPUE to determine angler days used recent period catch rates. Ocean recreational composite CPUE rates are 1 day per fish, Columbia River mainstem is 2 days per fish, and Snake River tributary is 5.88 days per fish. CPUE is influenced by fishing motivational factors and fishery management techniques. For example, all existing recreational steelhead fishing is selective for hatchery origin fish. If future wild-origin abundance levels allowed retention, then the CPUE (expressed as days per fish) would decrease. Modeling assumptions for CPUE incorporated decreasing tributary CPUE (expressed as days per fish) with increasing abundances. Economic value assumptions are presented for commercial and recreational fishing by species and fishery in Table 3.5-11.

NED values for recreational fishing were estimated by the DREW Anadromous Fish Workgroup and also the DREW Recreation Workgroup. These analyses, which address different geographic areas, employ different methods that may not be directly comparable. The DREW Anadromous Fish Workgroup's economic evaluation uses a benefit transfer approach, while the analysis developed by the DREW Recreation Workgroup is based on survey data obtained as part of their analysis. PATH divides its estimates into "mainstem," the area downstream of Lower Granite dam to the Columbia River estuary, and "tributary," the area upstream of Lower Granite Dam. The tributary area encompasses the entire Snake River watershed above Lower Granite Dam, including the Lower Granite reservoir. Recreational fishing estimates are based on these geographic divisions, with estimates developed for tributary, mainstem, and ocean recreational fishing. Estimates developed by the DREW Anadromous Fish Workgroup are used to evaluate the NED effects associated with ocean and mainstem recreational fishing. The survey-based estimates developed by the DREW Recreation Workgroup are used to evaluate the NED effects associated with tributary recreational fishing. This is discussed in more detail at the beginning of Section 3.2 of this document. The DREW Anadromous Fish Workgroup also developed estimates of the NED effects associated with tributary recreational fishing. These estimates are not presented here but are available in their full-length technical report, which is available on the Corps' website at http://www.nww.usace.army.mil/.

Although the results of the in-river tributary recreational analysis conducted by the DREW Anadromous Fish Workgroup are not presented in this document, they are included in the risk and uncertainty analysis developed for the anadromous fish economic analysis and presented in Section 3.5.5. The in-river tributary recreational estimates are included in this risk and uncertainty discussion to give a more complete depiction of the sensitivity associated with the data and modeling assumptions employed in the anadromous fish economic analysis.

The NED values associated with changes in anadromous fish harvest were calculated as annual average values over a 100-year period of analysis and presented net of the base case (Alternative 1—Existing Conditions). These annual average values, presented for Alternatives 2 through 4 in Table 3.5-12, address ocean and in-river commercial fishing and ocean and mainstem recreation fishing. Using a 6.875 percent discount rate, these combined NED benefits ranged from $0.35 million and $0.34 million for Alternatives 2 and 3, respectively, to $2.22 million for Alternative 4—Dam Breaching. Using a 0.0 percent discount rate, the average annual benefits under Alternative 4—Dam Breaching would be $4.98 million. Most of the totals shown here would be generated from the in-river summer steelhead mainstem recreational fishery and the in-river fall chinook treaty fishery. There would also be significant NED benefits associated with the in-river tributary recreational fishery. These benefits are addressed in the analysis conducted by the DREW Recreation Workgroup (see Section 3.2).

Table 3.5-11. Economic Value (NED Benefits) Assumptions by Species and Fishery

	Commercial	Recreational
Spring/Summer Chinook		
Ocean		
Alaska	33.83	
British Columbia	34.30	
Washington ocean	23.68	
Washington Puget Sound	21.19	
Oregon	21.65	
California	22.33	
Columbia Basin inland		
Mainstem	49.95	51.43
Tributary		63.23
Other	0.00	
Food fish	26.87	
Carcass and egg sales	0.00	
Fall Chinook		
Ocean		
Alaska	33.83	51.43
British Columbia	34.30	51.43
Washington ocean	23.68	51.43
Washington Puget Sound	21.19	51.43
Oregon	21.65	51.43
California	22.53	51.43
Columbia Basin inland		
Mainstem	23.53	51.43
Tributary		
Other	0.00	
Food fish	18.25	
Carcass and egg sales	1.23	
Summer Steelhead		
Ocean		
Alaska		
British Columbia	11.44	
Washington ocean		
Washington Puget Sound		
Oregon		
California		
Columbia Basin inland		
Mainstem	9.99	52.85
Tributary		
Other		
Food fish	8.73	
Carcass and egg sales	1.23	

Notes: 1. Average 1998 dollars per fish (commercial fisheries) and angler day (recreational fisheries).
2. Carcass sales assume $0.10 per pound for whole body dressed weight.
3. These assumptions are used to value the commercial and ocean and in-river mainstem recreational fisheries. The assumptions used to value the in-river tributary recreational harvest are discussed in Section 3.2.7.

Table 3.5-12. Net Average Annual NED Benefits (1998 dollars) ($ million)

Discount Rate	Alternative 2	Alternative 3	Alternative 4
6.875 Percent			
Commercial	0.16	0.16	1.49
Recreational	0.19	0.18	0.73
Total	**0.35**	**0.34**	**2.22**
4.75 Percent			
Commercial	0.18	0.17	1.93
Recreational	0.20	0.18	0.96
Total	**0.37**	**0.35**	**2.89**
0.0 Percent			
Commercial	0.20	0.18	3.28
Recreational	0.18	0.14	1.70
Total	**0.38**	**0.32**	**4.98**

Notes: 1. NED benefits measured by annual average equivalent values overa 100-year project life in millions of 1998 dollars. Alternatives 2 through 4 are presented net of the base case (Alternative 1—Existing Conditions).
2. Evaluation is for all modeled anadromous fish species and includes harvests and hatchery surplus use. The evaluation excludes the economic values for in-river recreational fishing.
3. The analysis is based on PATH results' "base case" scenario for fall chinook and "equal weights" scenario for spring/summer chinook using "likely" (50th percentile) modeling output.
4. Recreational totals presented here include the benefits associated with ocean and mainstem recreational fishing. NED values associated with tributary fishing for salmon and steelhead and resident fish in the lower Snake River reservoirs were estimated by the DREW Recreation Workgroup (see Section 3.2).

Average annual NED values are presented by fishery in tables 3.5-13 through 3.5-15. Values are presented for each alternative using "low," "likely," and "high" modeling results that correspond to PATH results for 25th, 50th, and 75th percentile modeling outputs, respectively. Tables 3.5-6 through 3.5-8 present this information using 6.875 percent, 4.75 percent, and 0.0 percent discount rates, respectively. Average annual NED values are presented graphically by species and alternative in Figure 3.5-13 using a 6.875 percent discount rate.

3.5.6 Risk and Uncertainty

The economic values from the Columbia River Basin anadromous fish runs are determined using forecasted harvests throughout their migration routes. The actual harvestable fish depends on the productivity of the inland water system, as well as the ocean system. Inland water system production factors can include harvesting methods, habitat alterations, hatchery production, hydrosystem operations, and ocean conditions. Strategies for recovery can address manmade factors, the more immediate remedies being harvesting methods, hydrosystem operations, and hatchery production. A short discussion of the variability in economic analysis results due to these factors is presented below. Sections 3.5.6.1 through 3.5.6.3 address these factors in terms of markets, smolt-to-adult survival rates, and harvest management. Section 3.5.6.4 discusses how the economic analysis results varied depending on which PATH scenario was used. The fifth and final section briefly discusses broader economic values that may be at risk if major changes or curtailment take place in production and harvest management on the Snake River.

The economic values of the in-river tributary recreational fishery calculated by the DREW Anadromous Fish Workgroup are included in the total NED benefits presented in the following sensitivity analysis. These values are included because much of the discussion concerns the effects

Table 3.5-13. Ranges of NED Benefits by Fishery and Alternative Using "Low," "Likely," and "High" Modeling Results and a 6.875 Percent Discount Rate (1998 dollars) ($1,000s)

	Alternative 1			Alternative 2			Alternative 3			Alternative 4		
Anadromous Fish	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**
Commercial												
Ocean												
Alaska	6.15	12.72	26.35	6.15	12.72	26.35	6.85	14.56	30.54	31.99	69.48	136.12
British Columbia	25.93	53.66	111.09	25.93	53.66	111.09	28.90	61.41	128.77	134.89	292.97	573.99
WA Ocean	7.02	14.53	30.08	7.02	14.53	30.08	7.83	16.63	34.87	36.53	79.34	155.44
WA Puget Sound	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Oregon	2.14	4.43	9.17	2.14	4.43	9.17	2.39	5.07	10.63	11.13	24.18	47.38
California	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
Subtotal Ocean	41.24	85.34	176.70	41.24	85.34	176.70	45.97	97.68	204.82	214.55	465.99	912.95
In River												
Non-treaty	21.50	45.76	96.49	23.09	51.36	110.14	24.26	52.75	113.84	120.47	223.36	409.35
Treaty Indian	293.52	702.77	2,003.61	323.81	795.22	2,062.65	323.18	789.90	1,992.09	564.64	1,287.11	2,771.28
Hatchery Returns	8.77	137.06	522.24	28.98	198.78	613.34	25.47	188.48	567.35	206.31	480.92	990.32
Subtotal In River	323.79	885.59	2,622.34	375.88	1,045.36	2,786.14	372.92	1,031.12	2,673.27	891.43	1,991.39	4,170.95
Subtotal Commercial	365.02	970.93	2,799.04	417.12	1,130.70	2,962.84	418.89	1,128.80	2,878.09	1,105.97	2,457.38	5,083.90
Recreational												
Ocean												
Alaska	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.02	0.04
British Columbia	3.11	6.44	13.32	3.11	6.44	13.32	3.47	7.37	15.44	16.18	35.14	68.84
WA Ocean	6.78	14.03	29.04	6.78	14.03	29.04	7.55	16.05	33.66	35.26	76.58	150.04
WA Puget Sound	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.02	0.04
Oregon	1.70	3.51	7.26	1.70	3.51	7.26	1.89	4.02	8.42	8.82	19.15	37.53
California	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.02	0.04
Subtotal Ocean	11.59	23.98	49.65	11.59	23.98	49.65	12.92	27.44	57.55	60.28	130.93	256.51
In River												
Mainstem	845.77	1,799.03	4,953.40	909.49	1,989.36	4,951.16	900.82	1,973.13	4,769.80	1,071.64	2,423.65	5,224.66
Subtotal In River	845.77	1,799.03	4,953.40	909.49	1,989.36	4,951.16	900.82	1,973.13	4,769.80	1,071.64	2,423.65	5,224.66
Subtotal Recreational	857.36	1,823.01	5,003.05	921.08	2,013.34	5,000.81	913.74	2,000.57	4,827.35	1,131.92	2,554.58	5,481.17
Total Commercial and Recreational	**$1,222.38**	**$2,793.94**	**$7,802.08**	**$1,338.19**	**$3,144.04**	**$7,963.64**	**$1,332.63**	**$3,129.38**	**$7,705.44**	**$2,237.89**	**$5,011.96**	**$10,565.07**

Notes:
1. NED benefits measured by annual average equivalent values over a 100 year project life using a 6.875 percent discount rate in thousands of 1998 dollars.
2. Evaluation is for all modeled anadromous fish species and includes harvests and hatchery surplus utilization. The evaluation excludes the economic values for in-river recreational fishing.
3. PATH results fall chinook Alternative 1 is the same as Alternative 2. Fall chinook is the only significantly harvested species in ocean fisheries.
4. "Low," "likely," and "high" modeling results correspond to PATH results for 25th, 50th, and 75th percentile modeling outputs, respectively.
5. The analysis is based on PATH results' "base case" scenario for fall chinook and "equal weights" scenario for spring/summer chinook.
6. Total and subtotals may not equal sum of values due to rounding.

Table 3.5-14. Ranges of NED Benefits by Fishery and Alternative Using "Low," "Likely," and "High" Modeling Results and a 4.75 Percent Discount Rate (1998 dollars) ($1,000s)

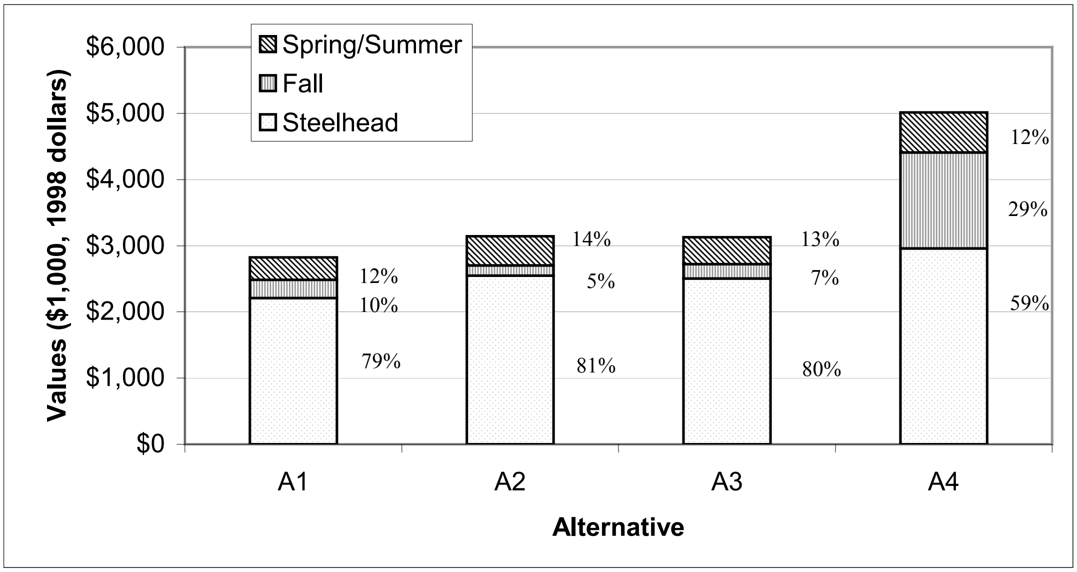
	Alternative 1			Alternative 2			Alternative 3			Alternative 4		
Anadromous Fish	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**
Commercial												
Ocean												
Alaska	6.42	13.71	28.66	6.42	13.71	28.66	7.33	15.94	33.65	39.67	84.82	163.84
British Columbia	27.07	57.80	120.87	27.07	57.80	120.87	30.91	67.22	141.87	167.30	357.68	690.88
WA Ocean	7.33	15.65	32.73	7.33	15.65	32.73	8.37	18.20	38.42	45.30	96.86	187.10
WA Puget Sound	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
Oregon	2.23	4.77	9.98	2.23	4.77	9.98	2.55	5.55	11.71	13.81	29.52	57.03
California	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
Subtotal Ocean	43.05	91.93	192.24	43.05	91.93	192.24	49.16	106.91	225.66	266.09	568.91	1,098.88
In River												
Non-treaty	23.38	52.57	110.98	25.38	59.30	127.02	27.08	61.25	132.53	155.22	287.02	514.37
Treaty Indian	309.67	821.38	2,175.04	341.58	920.20	2,246.11	341.37	911.40	2,177.94	677.23	1,601.70	3,238.98
Hatchery Returns	7.26	167.65	556.91	30.41	237.63	658.06	27.33	223.90	609.53	269.56	605.58	1,154.79
Subtotal In River	340.31	1,041.60	2,842.92	397.36	1,217.13	3,031.18	395.77	1,196.55	2,920.00	1,102.01	2,494.30	4,908.14
Subtotal Commercial	383.36	1,133.53	3,035.17	440.42	1,309.06	3,223.43	444.92	1,303.46	3,145.66	1,368.10	3,063.21	6,007.02
Recreational												
Ocean												
Alaska	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.02	0.04
British Columbia	3.25	6.93	14.50	3.25	6.93	14.50	3.71	8.06	17.02	20.07	42.90	82.86
WA Ocean	7.08	15.11	31.59	7.08	15.11	31.59	8.08	17.57	37.08	43.73	93.49	180.59
WA Puget Sound	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.02	0.04
Oregon	1.77	3.78	7.90	1.77	3.78	7.90	2.02	4.39	9.28	10.94	23.38	45.17
California	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.02	0.04
Subtotal Ocean	12.10	25.83	54.01	12.10	25.83	54.01	13.81	30.04	63.40	74.76	159.84	308.75
In River												
Mainstem	858.60	2,067.46	5,308.03	922.64	2,264.33	5,320.22	912.65	2,239.11	5,143.21	1,165.63	2,891.09	5,791.10
Subtotal In River	858.60	2,067.46	5,308.03	922.64	2,264.33	5,320.22	912.65	2,239.11	5,143.21	1,165.63	2,891.09	5,791.10
Subtotal Recreational	870.70	2,093.29	5,362.04	934.74	2,290.16	5,374.23	926.46	2,269.15	5,206.61	1,240.39	3,050.93	6,099.85
Total Commercial and Recreational	**$1,254.06**	**$3,226.82**	**$8,397.21**	**$1,375.15**	**$3,599.22**	**$8,597.66**	**$1,371.38**	**$2,299.19**	**$8,352.27**	**$2,608.50**	**$6,114.14**	**$12,106.88**

Notes:
1. NED benefits measured by annual average equivalent values over a 100 year project life using a 4.75 percent discount rate in thousands of 1998 dollars.
2. Evaluation is for all modeled anadromous fish species and includes harvests and hatchery surplus utilization. The evaluation excludes the economic values for in-river recreational fishing.
3. PATH results fall chinook Alternative 1 is the same as Alternative 2. Fall chinook is the only significantly harvested species in ocean fisheries.
4. "Low," "likely," and "high" modeling results correspond to PATH results for 25th, 50th, and 75th percentile modeling outputs, respectively.
5. The analysis is based on PATH results' "base case" scenario for fall chinook and "equal weights" scenario for spring/summer chinook.
6. Total and subtotals may not equal sum of values due to rounding.

Table 3.5-15. Ranges of NED Benefits by Fishery and Alternative Using "Low," "Likely," and "High" Modeling Results and a 0.0 Percent Discount Rate (1998 dollars) ($1,000s)

	Alternative 1			Alternative 2			Alternative 3			Alternative 4		
Anadromous Fish	Low	Likely	High	Low	Likely	High	Low	Likely	High	Low	Likely	High
Commercial												
Ocean												
Alaska	7.83	16.97	35.34	7.83	16.97	35.34	9.35	20.41	42.62	61.71	126.69	235.99
British Columbia	33.00	71.55	149.01	33.00	71.55	149.01	39.43	86.08	179.70	260.20	534.22	995.10
WA Ocean	8.94	19.38	40.35	8.94	19.38	40.35	10.68	23.31	48.66	70.47	144.67	269.48
WA Puget Sound	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03
Oregon	2.72	5.91	12.30	2.72	5.91	12.30	3.25	7.10	14.83	21.48	44.09	82.14
California	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03
Subtotal Ocean	52.48	113.81	237.00	52.48	113.81	237.00	62.72	136.91	285.82	413.87	849.71	1,582.76
In River												
Non-treaty	30.77	74.27	152.91	33.77	83.38	174.65	37.31	87.20	186.39	263.24	479.50	817.23
Treaty Indian	381.49	1,190.57	2,663.95	414.35	1,291.15	2,756.41	416.17	1,272.42	2,708.91	1,071.46	2,616.35	4,671.95
Hatchery Returns	7.40	255.19	635.86	37.97	343.14	761.36	37.13	319.21	709.59	468.72	967.27	1,602.86
Subtotal In River	419.65	1,520.04	3,452.72	486.10	1,717.67	3,692.42	490.61	1,678.83	3,604.88	1,803.42	4,063.12	7,092.04
Subtotal Commercial	472.13	1,633.85	3,689.72	538.58	1,831.48	3,929.42	553.33	1,815.74	3,890.71	2,217.29	4,912.82	8,674.80
Recreational												
Ocean												
Alaska	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.02	0.03	0.06
British Columbia	3.96	8.58	17.87	3.96	8.58	17.87	4.73	10.32	21.55	31.21	64.07	119.35
WA Ocean	8.63	18.70	38.95	8.63	18.70	38.95	10.31	22.50	46.97	68.02	139.64	260.11
WA Puget Sound	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.02	0.03	0.06
Oregon	2.16	4.68	9.74	2.16	4.68	9.74	2.58	5.63	11.75	17.01	34.93	65.06
California	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.02	0.03	0.06
Subtotal Ocean	14.75	31.98	66.59	14.75	31.98	66.59	17.62	38.47	80.31	116.28	238.74	444.71
In River												
Mainstem	945.85	2,914.82	6,328.99	1,002.23	3,096.92	6,384.08	988.97	3,044.45	6,247.28	1,539.33	4,411.10	7,484.29
Subtotal In River	945.85	2,914.82	6,328.99	1,002.23	3,096.92	6,384.08	988.97	3,044.45	6,247.28	1,539.33	4,411.10	7,484.29
Subtotal Recreational	960.60	2,946.80	6,395.58	1,016.98	3,128.90	6,450.67	1,006.59	3,082.92	6,327.59	1,655.61	4,649.84	7,929.00
Total Commercial and Recreational	**$1,432.73**	**$4,580.64**	**$10,085.30**	**$1,555.56**	**$4,960.38**	**$10,380.09**	**$1,559.92**	**$4,898.66**	**$10,218.30**	**$3,872.90**	**$9,562.66**	**$16,603.79**

Notes:
1. NED benefits measured by annual average equivalent values over a 100 year project life using a 0.0 percent discount rate in thousands of 1998 dollars.
2. Evaluation is for all modeled anadromous fish species and includes harvests and hatchery surplus utilization. The evaluation excludes the economic values for in-river recreational fishing.
3. PATH results fall chinook Alternative 1 is the same as Alternative 2. Fall chinook is the only significantly harvested species in ocean fisheries.
4. "Low," "likely," and "high" modeling results correspond to PATH results for 25th, 50th , and 75th percentile modeling outputs, respectively.
5. The analysis is based on PATH results' "base case" scenario for fall chinook and "equal weights" scenario for spring/summer chinook.
6. Total and subtotals may not equal sum of values due to rounding.



Notes:

1. NED benefits measured by annual average equivalent values over a 100 year project life using 6.875 percent discount rate in thousands of 1998 dollars.
2. Evaluation is for all modeled anadromous fish species and includes harvests and hatchery surplus utilization.
3. The PATH results for fall chinook were the same for Alternative 1 as they were for Alternative 2. Fall chinook is the only significantly harvested species in ocean fisheries.
4. The analysis is based on PATH results "base case" scenario for fall chinook, and "equal weights" scenario for spring/summer chinook, using "likely" (50th percentile) modeling output.

Figure 3.5-13. Average Annual NED Benefits by Species and Alternative (6.875 Percent Discount Rate)

of harvest management, and the recreational in-river tributary fishery is an important contributor to economic values. Tributary recreation NED benefits calculated by the DREW Recreation Workgroup and based on original surveys conducted for this FR/EIS (see Section 3.2) are used for the overall NED analysis presented in this document. The values calculated by the DREW Anadromous Fish Workgroup were not included in this analysis to avoid double-counting. These estimates are, however, presented in the DREW Anadromous Fish Workgroup's full-length technical report, which is available on the Corps' website at http://www.nww.usace.army.mil/. The purpose of this risk and uncertainty section is to discuss the sensitivity of the results. Therefore, the change to the fishery's economic value should be relatively proportional, no matter what the estimated value.

Commercial Fishing

For centuries, salmon have sustained the people of the Pacific Northwest. They were an important food source, cultural symbol, and means of trade for American Indians. As western development took place, salmon runs provided jobs and income to harvesters, cannery workers, and related industries throughout the region. As water-based economic development took place in the Pacific Northwest, natural-based production was supplemented by artificial propagation.

Artificial propagation was at first limited to egg incubation. For some salmon species, in order to increase SAR, the propagation process included fry and later-smolt releases. Smolt production may cost $0.50 to $1.00 per smolt. The high cost of smolt production and low overall survival rates of free ranging salmon (salmon ranching) have led to rearing salmon in cages (salmon farming) where smolts will survive at about 80 to 90 percent. The farming process is now providing about

50 percent of the world salmon market. The price of salmon for the fresh and frozen market is now generally set by farmed salmon. These prices depend on markets, but also on the main ingredient in farming salmon, the feed costs. A range of substitutes is available; therefore, no dramatic changes are expected in the price level of commercial salmon produced from the Columbia River Basin.

More variation may be expected in use of a substantial portion of the anadromous fish that return as "surplus" and are not harvested. For wild fish, this presently is not a problem. However, in some cases, returns to hatcheries beyond what is needed for propagation are a resource that could provide additional benefits to the Pacific Northwest region.

According to lower Columbia River processors, about 50 percent of the fall returning fish and 100 percent of the summer returning fish could be used for developed markets (personal communications with processor facility operators, April 1999). Development of markets would include the traditional fresh and frozen markets, as well as value-added products, such as ready-to-purchase fillet steaks and ready-to-eat portions. Other specialty products might also include canned and smoked products. Egg production for the Japanese market might also have a significant potential (Radtke and Davis, 1996).

The DREW Anadromous Fish Workgroup's analysis assumes that 50 percent of hatchery return surplus goes to egg and carcass sales and 50 percent for food fish. Changing this assumption and assuming that 0.0 percent of hatchery return surplus goes to egg and carcass sales and 100 percent for food fish would result in a gain of about $180 thousand or 1 percent in average annual NED benefits for Alternative 4—Dam Breaching. Assuming a 0.0 percent hatchery utilization would result in a $400 thousand loss in average annual NED benefits for Alternative 4—Dam Breaching.

Recreational Angling

Since World War II, there has been a steady increase in outdoor activity in the West. Between 1945 and the early 1970s, recreation activity on public lands grew by more than 10 percent per year, driven by rapid population growth, increased affluence, improvements in cars and interstate highways, decreased real gasoline prices, increased air travel, and the decline of the average work week to 40 hours and 5 days (Walsh, 1986). Population growth and the proportion of that population having a degree of affluence are the most significant factors contributing to the increases in recreation activity (English et al., 1993). The significant population increases expected for the West suggest that there may be major increases in recreation activity related to public resources in the future (Haynes and Horne, 1996).

In general, the assumption of one fish per day is used in this evaluation of the benefits of ocean recreational angling in ocean fishing. Past studies of ocean salmon fishing suggest that this success rate is a reasonable representation of historical trends. Since salmon/steelhead fishing has been curtailed inland during the last few years, no clear studies of motivation factors, such as fishing success rates needed to attract anglers, have been completed. The ODFW uses a one-fish-per-day success rate for ocean fishing and up to 2-day-per-fish success rates for inland fishing (Carter, 1999). The State of Idaho conducts annual surveys of anglers (Bowler, 1999). For tributaries above the Columbia River/Snake River confluence, a 2-day-per-fish success rate for wild, non-retained, and hatchery-retained fish has been experienced. For retained steelhead only, the day-per-fish ratio has been 5.88. A study by Reading (1999) suggests that the average success rate for anadromous fish in Idaho is one fish for about 6.5 days of fishing. Future demand for outdoor recreation suggests that a success rate as low as 10 days per fish may be enough to attract anglers to fish for anadromous fish in some inland waters.

Using a range of success rates or CPUE provides a wide range of potential benefits related to the anadromous resources of the Columbia Basin. The change in analysis results for the proposed alternatives is considerable. Changing to a success rate of three days per fish slightly lowers the average annual NED benefits (Table 3.5-16 and Figure 3.5-14), because model assumptions use a tributary summer steelhead CPUE of 5.88 in year zero trended to a CPUE of 2 over 30 years. Changing the success rate to 10 days per fish increases average annual NED benefits by about double.

3.5.6.1 Smolt-to-Adult Survival Rates

Smolt production and resulting adult harvests are the base for evaluating fishery benefits. The PATH results did not generate SARs as modeled outputs. It was possible to generate an indicator SAR using the 5-year increment outputs of harvests and spawners. These SARs are referenced as indicator rates because insufficient information about age-structures, interdam mortality, and other factors was available to determine a more precise rate. The wild-component indicator SARs byspecies and alternative are shown in Table 3.5-17. These wild component indicator SARs generally show the large increase necessary to attain the PATH results for forecasted spawners. In general, for Alternatives 1, 2, and 3, there must be a sevenfold increase in the indicator SARs for spring/summer chinook and a twofold to threefold increase for fall chinook between the initial project years and at year 50 for spawners to be at the SAR forecasted by PATH. SARs of 4 to 8 percent would be biologically reasonable and adequate for sustaining survival and recovery of spring/summer and fall chinook salmon. An increase in SAR resulting in a 50-year SAR of 1.6 to 1.7 would not be adequate for sustaining survival and recovery for Snake River steelhead. However, for Alternative 4 there must be a 19 fold increase in SARs for spring/summer chinook and steelhead and a 32 fold increase in SARs for fall chinook at year 50 for spawners to be at the SAR forecasted by PATH. Although a 19 fold increase resulting in a 50-year SAR of four for steelhead is biologically reasonable and feasible, the resulting 50-year SAR of 10.85 for spring/summer chinook is likely unreasonable. A 32 fold increase resulting in a 50-year SAR of 30.85 for fall chinook is particularly unrealistic, especially when held for every year across 50 to 100 years. This result lends support to the CRI analysis that the PATH estimates and the Anadromous Fish Workgroup extrapolation for hatchery fish for dam breaching is overly unrealistic.

3.5.6.2 Harvest Management

Hatchery Production

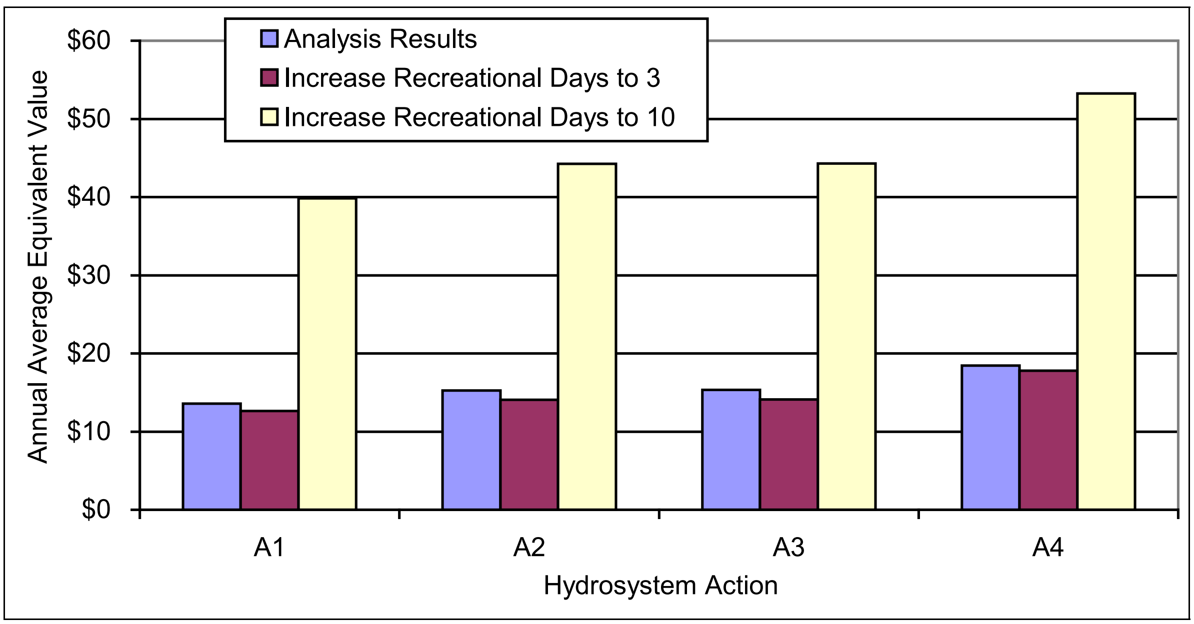
The DREW anadromous fish economic analysis assumes that hatchery management is based on past mitigation agreements and that hatchery release goals are defined by the present NMFS cap on hatchery releases. The role of supplementation hatcheries is not specifically included in this evaluation.

If natural resource-based recreation increases as discussed earlier, a challenge to management may be to convert hatchery surplus to inland recreational angling. The interplay between the conversion of hatchery surplus to recreational fishing and using different CPUE is shown in Table 3.5-18 and Figure 3.5-15. The CPUE, expressed as days per fish, generally decreases with increasing abundances. This is because increasing abundances generally mean harvest management would allow a more liberal bag limit (i.e., five fish per week rather than two). If the CPUE were changed to be slightly lower than the existing analysis, shifting hatchery surpluses would increase average annual NED benefits by about 40 percent.

Table 3.5-16. Average Annual NED Benefits with Different Angler Success Rate Assumptions by Alternative (1998 dollars)

	Alternative			
Category/Alternative	**1**	**2**	**3**	**4**
Analysis Results				
AAEV	13.59	15.27	15.33	18.46
Recreational Inland: Success Rate 3				
AAEV	12.64	14.08	14.10	17.78
Difference from analysis results	(0.95)	(1.18)	(1.23)	(0.68)
Recreational Inland: Success Rate 10				
AAEV	39.82	44.25	44.29	53.24
Difference from analysis results	26.22	28.99	28.96	34.78

Notes: 1. NED benefits measured by annual average equivalent value over a 100-year project life in millions of 1998 dollars.
2. AAEV = Average Annual Equivalent Value



Notes: 1. NED benefits measured by annual average equivalent value over a 100-year project life in millions of 1998 dollars.
2. A = Alternative

Figure 3.5-14. Average Annual NED Benefits for Different Angler Success Rate Assumptions by Alternative

Table 3.5-17. Wild Smolt-to-Adult Survival Indicator Rates by Species and Alternative for Selected Project Years

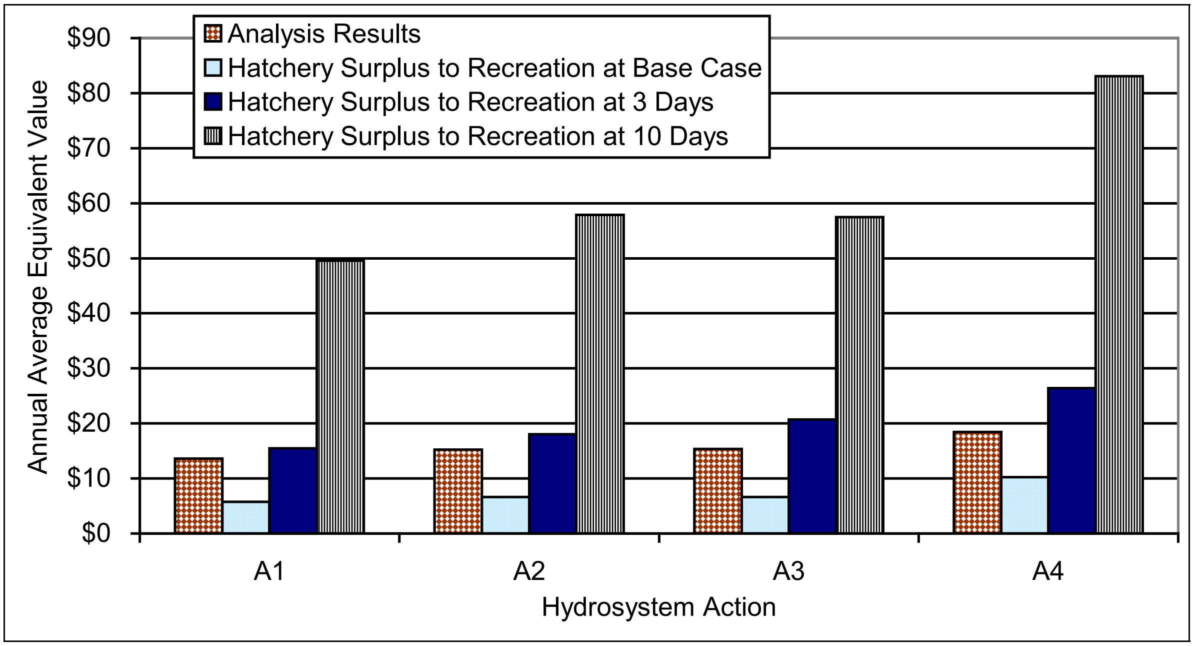
	Survival Rate Indicators	
	Project Year 5 (%)	**Project Year 50 (%)**
Spring/Summer Chinook		
Alternative 1	0.468	4.422
Alternative 2	0.514	4.495
Alternative 3	0.537	4.788
Alternative 4	0.557	10.850
Fall Chinook		
Alternative 1	1.889	7.195
Alternative 2	1.889	7.195
Alternative 3	1.877	8.385
Alternative 4	0.940	30.850
Summer Steelhead		
Alternative 1	0.173	1.636
Alternative 2	0.190	1.663
Alternative 3	0.199	1.772
Alternative 4	0.206	4.014

Note: Project year survival rate indicators are adult spawners and pre-spawning mortality plus harvest divided by smolts produced 5 years earlier expressed as a percent.
Source: DREW Anadromous Fish Workgroup Study and Petrosky and Schaller, 1998

Table 3.5-18. Average Annual NED Benefits with Different Harvest Management Assumptions by Alternative (1998 dollars)

	Alternative			
Category/Alternative	**1 ($)**	**2 ($)**	**3 ($)**	**4 ($)**
Analysis Results				
Average Annual Value	13.59	15.27	15.33	18.46
Convert Hatchery Surplus to Inland Recreational:	**Success Rate 1**			
Average Annual Value	5.75	6.66	6.64	10.22
Difference from analysis results	(7.85)	(8.60)	(8.69)	(8.24)
Convert Hatchery Surplus to Inland Recreational:	**Success Rate 3**			
Average Annual Value	15.49	18.04	20.71	26.40
Difference from analysis results	1.90	2.78	5.38	7.94
Convert Hatchery Surplus to Inland Recreational:	**Success Rate 10**			
Average Annual Value	49.59	57.88	57.49	83.05
Difference from analysis results	35.99	42.61	42.16	64.59

Note: NED benefits measured by annual average equivalent value over a 100-year project life in millions of 1998 dollars.



Notes: 1. NED benefits measured by annual average equivalent value over a 100-year project life in millions of 1998 dollars.
2. A = Alternative

Figure 3.5-15. Average Annual NED Benefits with Different Harvest Management Assumptions by Alternative

Under the NMFS cap, hatchery releases are to be below 197 million smolts per year. "The total hatchery production in 1999 is projected to range from 140 to 150 million smolts, down from the 185 to 195 million range of 1996 to 1998 releases. These reductions are due to ESA concerns, fiscal cutbacks, and the failure of some hatchery programs to receive enough spawning escapement in the last 2 years" (Pollard, 1999). This is, in effect, a 25 percent reduction in hatchery releases. Unless wild fish production increases, a reduction of about 25 percent in economic benefits could be anticipated if this reduction in hatchery release continues. The other expectation may be that decreased hatchery releases increases wild fish survival and that the reduction in hatchery releases increases the number of returning wild spawners, which, in turn, increases overall production.

User Group Allocations

The situation for shifting Snake River production between user groups is complicated because of the overriding influence of summer steelhead contributions to fisheries. There is very little non-treaty commercial use for steelhead. Spring/summer chinook do not have a significant ocean commercial fishery and have not had a viable river gillnet fishery since the late 1980s. Therefore, converting all species from recreational to commercial fisheries would have little effect on increasing economic values from commercial fisheries (Table 3.5-19 and Figure 3.5-16).

Table 3.5-19. Average Annual NED Benefits with Different User Group Allocations by Alternative (1998 dollars) ($1,000)

Category/Alternative	Alternative 1 ($)	2 ($)	3 ($)	4 ($)
Analysis Results				
Average Annual Value	13.59	15.27	15.33	18.46
Convert Recreational to Commercial				
Average Annual Value	12.02	13.54	13.60	16.34
Difference from analysis results	(1.58)	(1.73)	(1.72)	(2.12)
Convert Commercial to Recreational				
Average Annual Value	13.73	15.41	15.49	19.24
Difference from analysis results	0.14	0.15	0.16	0.78

Note: NED benefits measured by annual average equivalent value over a 100-year project life in millions of 1998 dollars.

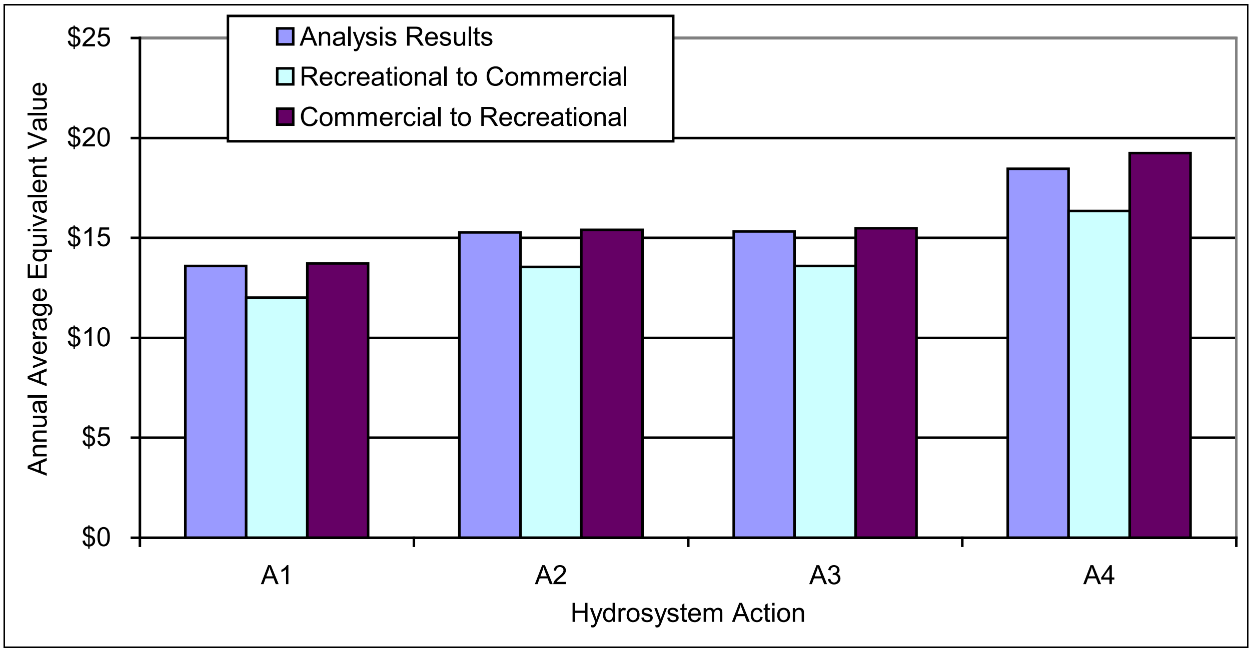
3.5.6.3 PATH Results Scenarios

The PATH process developed a large set of simulations based on different harvest management, smolt-to-adult survival rates, and other modeling factors. The combinations of assumptions were categorized under several scenario titles, including "equal weights" and "mean of experts." The latter refers to a panel of four experts (called the Science Review Panel, or SRP), which provided weights to seven different hypotheses about life-cycle modeling factors (Marmorek and Peters, 1998). Each of the four simulations that resulted from the weighting was averaged to be the mean-of-expert results. The PATH result scenario for mean-of-expert only applies to spring and summer chinook. The DREW anadromous fish economic analysis and the DREW recreation analysis used the "equal weights" results, while the tribal circumstances analysis summarized in Section 5 of this document used the "mean of experts" results. Some analysts argue that PATH results based on the expert opinions about key PATH model assumptions reflect better science and should be used by all researchers. NMFS (1999) recommends that the expert opinion PATH results be disregarded.

The simulations made to satisfy the weighting schemes by the SRP were greatly anticipated, because the research would be used to validate or reject the PATH process. While the mean-of-expert scenario was not used in the DREW anadromous fish economic analysis, this scenario can be useful for showing the range that occurs when using a different base to calculate the economic consequences. Table 3.5-20 shows the average annual NED benefits for the fall chinook, base-case scenario and the spring- and summer-chinook, mean-of-experts scenario. The equal-weights scenario results have slightly higher changed net average annual NED benefits for all of the proposed alternatives. Using the mean-of-experts scenario does not change the order of the alternatives. NED benefits would be larger for Alternative 4—Dam Breaching under both scenarios.

3.5.6.4 Columbia River Basin Anadromous Fish Economic Values

The recent low rate of returning wild spawners has raised concerns about maintaining and recovering wild anadromous fish species in the Snake River system. In a broader context, if major changes or curtailment take place in production and harvest management on the Snake



Notes: 1. NED benefits measured by annual average equivalent value over a 100-year project life in millions of 1998 dollars.
2. A = Alternative

Source: DREW Anadromous Fish Workgroup Study

Figure 3.5-16. Annualized Economic Value (NED Benefits) with Different User Group Allocations by Alternative

Table 3.5-20. Average Annual NED Benefits with Different PATH Scenarios

	Discount Rates					
	0.0%		4.75%		6.875%	
Alternative	**Amount ($)**	**Order**	**Amount ($)**	**Order**	**Amount ($)**	**Order**
AAEV Equal Weights						
2	0.97	2	1.56	3	1.67	3
3	0.86	3	1.59	2	1.73	2
4	8.65	1	5.81	1	4.87	1
AAEV Mean of Experts						
2	(0.64)	3	(0.35)	3	(2.6)	3
3	(0.04)	2	0.40	2	0.51	2
4	8.36	1	5.35	1	4.35	1
Difference						
2	1.61		1.92		1.93	
3	0.90		1.19		1.22	
4	0.30		0.46		0.51	

Notes: 1. NED benefits measured by annual average equivalent value over a 100-year project life in millions of 1998 dollars. Alternatives 2 through 4 are presented net of the base case (Alternative 1—Existing Conditions).
2. Negative values mean the base case (Alternative 1—Existing Conditions) benefits are greater than the alternatives being compared.
3. AAEV = Average Annual Equivalent Values

River, the economic values that may be at risk are all harvests of Columbia River anadromous fish. To model the economic effects of this type of curtailment, four future production and harvest management policy cases were used.[7] These policy cases range from present low run levels to double the runs experienced in the 1980s. The four cases were specifically designed to show a range of economic values (NED and RED benefits) that may be lost if a harvest curtailment occurs.[8] Table 3.5-21 describes the periods and assumptions used to devise the policy cases and describes the economic values. Figure 3.5-17 graphically shows the economic values. The size of the fish in the graphic is proportionally correct to the economic value for each species.

The economic loss to the nation in lost economic value (NED benefits) would be as high as $160 million per year for the doubling the runs policy. Projecting these values 100 years into the future, the net-present-value at the current social discount rate used by the Corps may be as high as $2 billion (NED benefits). The regional economic impacts (RED benefits) from averaging the contribution from fisheries to the economies where harvests occur in the 1980s is $108 million (personal income, 1998 dollars) per year. The early 1990s average dropped to $38 million per year. If it is possible to attain the NPPC's goal for doubling the runs experienced in the 1980s, then the regional economic impacts (RED benefits) may be as high as $233 million per year.

Another way of considering these policy cases' effects, is that it would be the value for eliminating most hatchery programs and thereby most harvesting of salmon and steelhead originating in the Columbia River Basin. The burden of these reductions would be felt all along the United States West Coast, Alaska, British Columbia and inland throughout the Columbia River Basin.

Table 3.5-21. Potential Economic Values (RED and NED Benefits) per Year for Four Cases of Columbia River Basin Anadromous Fish Production and Harvest Management Policies

Policy Case	Assumptions	RED Benefits Commercial	RED Benefits Recreational	Total	NED Benefits
I	Hatchery production at NMFS cap; SAR and harvests 30-year historical average	$49.43	$33.36	**$82.79**	**$55.33**
II	Hatchery production, SAR, harvests at 1980s historical average	$60.45	$47.08	**$107.53**	**$74.04**
III	Policy for "doubling the runs;" SAR adjusted to meet policy using NMFS cap hatchery production	$131.69	$101.58	**$233.27**	**$159.92**
IV	Hatchery production, SAR, harvests early 1990s historical average	$24.04	$13.59	**$37.63**	**$24.59**

Notes:
1. RED and NED benefits measured per year in millions of 1998 dollars.
2. SAR is smolt-to-adult survival rate. Adults are harvests and returns to hatcheries for hatchery origin anadromous fish. Adults are harvests and spawners plus prespawning mortality for wild origin anadromous fish.
3. Commercial includes ocean treaty and non-treaty harvests from California to Alaska, inriver treaty and non-treaty harvests, and hatchery surplus sales. Recreational includes ocean, inriver mainstem, and inriver tributary.
4. Total and subtotals may not equal sum of values due to rounding.

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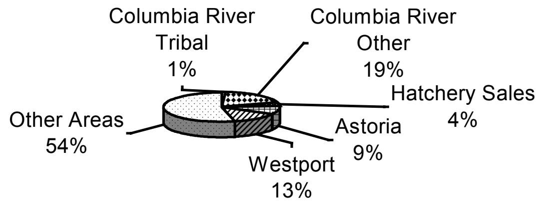
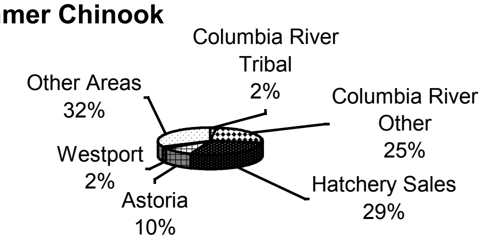
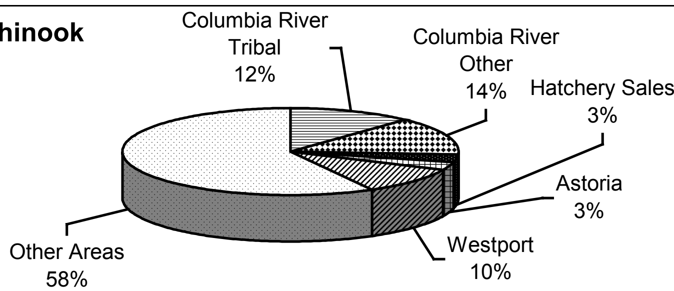
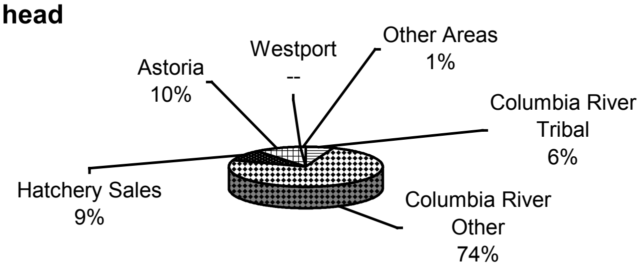
[7] These four policy cases are four possible future scenarios that are used to develop a range of estimates of the regional and national economic values that could be at risk if salmon and steelhead recovery programs in the Columbia River Basin are not successful. These four future scenarios are not connected with the four proposed alternatives considered in the Lower Snake River Juvenile Salmon Migration Feasibility Study. Rather, they simply portray different situations that either have occurred in the past or hypothetically may occur in the future.

[8] As discussed in Section 4 with respect to Snake River salmon, it is possible that residents in the Pacific Northwest and elsewhere in the country may value Columbia River Basin salmon even though they do not directly use or have any intention of using this resource. These types of values are typically referred to as passive use or existence values. This brief discussion of the Columbia River Basin economic values at risk only addresses NED and RED values, it does not address passive use or existence values.

<table>
<tr><th>West Coast Geographic Area Shares
of Case IV Regional Economic Impacts</th><th>Regional Economic Impacts</th><th>Net Economic Value</th></tr>
<tr><td>Coho

</td><td>Case I. $24.40
Case II. $28.61
Case III. $58.46
Case IV. $7.25</td><td>Case I. $18.69
Case II. $21.92
Case III. $44.82
Case IV. $5.55</td></tr>
<tr><td>Spring/Summer Chinook

</td><td>Case I. $11.09
Case II. $11.72
Case III. $33.82
Case IV. $3.03</td><td>Case I. $6.60
Case II. $6.97
Case III. $21.52
Case IV. $1.85</td></tr>
<tr><td>Fall Chinook

</td><td>Case I. $40.25
Case II. $50.18
Case III. $109.08
Case IV. $23.68</td><td>Case I. $23.56
Case II. $29.49
Case III. $64.72
Case IV. $13.81</td></tr>
<tr><td>Steelhead

</td><td>Case I. $7.05
Case II. $17.01
Case III. $31.90
Case IV. $3.67</td><td>Case I. $6.48
Case II. $15.66
Case III. $28.88
Case IV. $3.39</td></tr>
<tr><td>Total</td><td>Case I. $82.79
Case II. $107.53
Case III. $233.27
Case IV. $37.63</td><td>Case I. $55.33
Case II. $74.04
Case III. $159.92
Case IV. $24.59</td></tr>
</table>

Notes:
1. Net economic values (NED benefits) and regional economic impacts (RED benefits) are expressed as personal income in millions of 1998 dollars.
2. Case I is "NMFS Cap" policy case. Case II is "1980s Average" policy case. Case III is "Doubling of Runs" policy case. Case IV is "Early 1990s" policy case.
3. Columbia River other includes inriver commercial and recreational fisheries.
4. Size of graph depicts proportionately comparable size of a species regional economic impacts.
5. "—" is shown where impacts are zero.

Figure 3.5-17. Economic Values in West Coast Geographic Areas Attributable to Columbia River Produced Salmon (Hatchery and Wild) Under Four Policy Cases

3.6 Tribal Circumstances (NED)

There are 14 Native American tribes and bands in the region that could potentially be affected by the proposed alternatives. They are as follows:

- Confederated Tribes of the Colville Indian Reservation
- Confederated Tribes of the Umatilla Indian Reservation
- Confederated Tribes and Bands of the Yakama Nation
- Nez Perce Tribe
- Wanapum Band
- Burns Paiute Tribe of the Burns Paiute Indian Colony
- Coeur d'Alene Tribe
- Confederated Tribes of the Warm Springs Reservation of Oregon
- Kalispel Indian Community of the Kalispel Reservation
- Kootenai Tribe of Idaho
- Northwestern Band of the Shoshoni Nation
- Shoshone-Bannock Tribes of the Fort Hall Reservation
- Shoshone-Paiute Tribes of the Duck Valley Reservation
- The Spokane Tribe of the Spokane Reservation.

The tribes and American Indian communities that the Corps believes would be most directly influenced by the proposed alternatives include four tribes with treaties signed by the United States government and one non-federally recognized Indian community. The four treaty tribes are the Confederated Tribes of the Umatilla Indian Reservation (Umatilla), the Confederated Tribes and Bands of the Yakama Nation (Yakama), the Nez Perce Tribe (Nez Perce) of Idaho, and the Confederated Tribes of the Colville Reservation (Colville). The non-federally recognized Indian community most likely to be affected is the Wanapum Indian community (Wanapum). Three of these tribes are directly addressed in a report on tribal circumstances prepared for this FR/EIS by Meyer Resources, Inc. in association with the Columbia River Inter Tribal Fisheries Commission (CRITFC) (Meyer Resources, 1999).[1] According to this report, the ancestors of these tribes historically valued the salmon first for cultural and spiritual purposes and then to feed their people. Salmon were also traded and exchanged for other valued goods, both within each tribe, and with peoples from other tribes.

According to the Tribal Circumstances report, the five study tribes have substantial traditional values for salmon beyond that of simply an important food in their traditional diets. These values are founded in tribe's cultural and spiritual lifeways, which have been passed directly to them from the elders. When salmon were abundant, they along with other culturally significant aquatic species were traded and exchanged for goods and services, both within each tribe and with other tribes.

As salmon have declined, the "surplus" available to the tribes for trading and commercial sale—after ceremonial and subsistence needs are met—has become non-existent. Even subsistence fishing had not been possible in the past two decades along the lower Snake River until the summer of 2001. The Tribal Circumstances report notes that even ceremonial needs are not met for most of the study tribes. The Shoshone-Bannock, who live furthest upriver of the five study tribes, have an absolute prohibition against the commercial sale of salmon. The Nez Perce, whose reservation lies

[1] This report entitled *Tribal Circumstances and Impacts of the Lower Snake River Projects on The Nez Perce, Yakama, Umatilla, Warm Springs and Shoshone Bannock Tribes* is available on the Corps' website at: http://www.nww.usace.army.mil/. This report, prepared as part of the DREW process, is referred to as either the Tribal Circumstances report or Meyer Resources (1999) throughout this document.

more immediately above the four lower Snake River dams, has a policy of only selling salmon commercially after ceremonial and subsistence needs are met. In recent years, this has meant little or no sale of salmon harvested above the dams. The peoples of the Yakama, Nez Perce, Umatilla, and Warm Springs reservations all fish in Zone 6 on the mid-Columbia River. Tribal harvest in this zone supports a minimal level of commercial sales activity. Current harvests are identified for the five study tribes in Table 5-2.

Both historically and today, the study tribes emphasize that while revenue obtained from commercial sales of salmon provides important income to tribal peoples, it does not represent the greatest part of value that they associate with salmon. For example:

> My strength is from the fish; my blood is from the fish, from the roots and the berries. The fish and the game are the essence of my life. I was not brought from a foreign country and did not come here. I was put here by the Creator.
>
> (Yakama Chief Meninock, 1855 Yakama Treaty records)

> Salmon is very important to our Indian lives. I have trouble with thinking of salmon only as dollars. You can't drink dollars. You can't eat dollars. Salmon is important to our spiritual life. It helps our spirit survive.
>
> (Terry Courtney, Jr., Warm Springs Fish Commissioner)

Dollar revenue from commercial sales is considered to be an extremely limited indicator of tribal interest and benefits derived from salmon fisheries, and alone provides an incomplete impression of the full impact tribal fishing has on tribes. Consequently, the Tribal Circumstances report provides an assessment of the proposed alternatives that does not involve assigning dollar values to salmon. The key findings of this assessment are summarized in Section 5 of this appendix. A much lengthier discussion is provided in the Tribal Circumstances report (Meyer Resources, 1999). Based on the WRC guidelines used to develop the overall economic analysis conducted as part of this FR/EIS (see Section 1.3), the discussion presented in Section 5 may be considered part of the environmental quality account, which addresses non-monetary effects on significant natural and cultural resources.

While it is not possible to assign dollar values to tribal ceremonial and subsistence harvest or to the relationship between salmon and tribal culture, spirituality, material well-being and health, dollar values were assigned to tribal harvest as part of the NED economic analysis conducted by the DREW Anadromous Fish Workgroup. This analysis, summarized in Section 3.5, estimates the future value of tribal commercial harvest as a percentage of the total run sizes projected under each alternative. These projections are based on preliminary PATH data for wild salmon, with additional assumptions made by the DREW Anadromous Fish Workgroup to extend the PATH findings to all Snake River wild and hatchery stocks. The harvest estimates presented in Table 3.2-1 are based on the "equal weights" PATH scenario. The DREW recreation and anadromous fish economic analyses used harvest estimates based on this PATH scenario. The tribal circumstances economic analysis presented in Section 5 of this document displays the "mean of experts" PATH scenario from the Meyer Resources report. As a result, the treaty harvest numbers presented in Table 3.2-1 are not directly comparable with those presented in Table 50 of Meyer Resources (1999) or Figures 5-1, 5-2, and 5-3 of this appendix).

The preliminary PATH results were expanded by the DREW Anadromous Fish Workgroup to represent all Snake River wild and hatchery stocks. Existing hatchery production and operation policies were assumed to continue for all of the proposed alternatives. This assumption resulted in hatchery stocks comprising a large proportion of projected harvest increases under Alternative 4—Dam Breaching. However, many of these hatchery operations were built as mitigation for the lower Snake River dams effects on anadromous fish stocks. If dam breaching were to occur, the original purpose of these hatcheries would be removed. The status of future hatchery operations has not yet been determined for Alternative 4—Dam Breaching, which raises questions about the magnitude of hatchery fish projected to be available for tribal harvest. This issue is discussed in more detail in Section 5.6.1.1. The information summarized in Section 5 should be used to weigh effects between the alternatives on tribes rather than to draw literal interpretations of fish populations.

The DREW Anadromous Fish Workgroup includes In-river Treaty Indian fisheries as part of its Commercial Fishery category (see Tables 3.5-7 through 3.5-10). Tribal fisheries numbers include both treaty reserved ceremonial and subsistence (C&S) and commercial harvests because PATH did not distinguish between these fisheries. The proportion of Snake River stocks contributing to the C&S harvests were accounted for in the commercial treaty fishery distributional assumptions and assigned a food value. They were not assigned an additional intrinsic dollar value. Estimated contributions to ocean treaty fisheries were very small and were, as a result, included as incidental harvests to other commercial fisheries in the DREW Anadromous Fish Workgroup's modeling. Possible effects could, however, occur if access to ocean treaty fish with origin elsewhere were limited through management efforts designed to constrain ESA-listed stocks (see Section 3.5.4).

At least three concerns with the tribal portion of the DREW Anadromous Fish Workgroup analysis have been raised by the Columbia River Inter-tribal Fish Commission (CRITFC) on behalf of the Warm Springs, Nez Perce, Yakama, and Umatilla tribes. First, the tribes are concerned that dollar values assigned to tribal commercial harvests by the Anadromous Fish Workgroup's analysis are not high enough. Second, the projected adult salmon returns may be overestimates because PATH analysis did not consider negative effects to Columbia River/Snake River stocks in simulating the future population sizes. The year zero assumptions developed by the DREW Anadromous Fish Workgroup likely exceed PATH's present conditions by approximately 34 percent for spring/summer chinook, and 43 percent for fall chinook (Meyer Resources, 1999). Finally, the DREW Anadromous Fish Workgroup's analysis is based on unweighted PATH data, which was not considered as acceptable by Meyer Resources as the weighted PATH fish numbers developed by the Scientific Review Panel (SRP).

However, the Scientific Review Panel expressed concerns with its own weighting process. Consequently, unweighted PATH results were used in all analyses for this feasibility study. Further analysis of fish population trends by alternative was conducted through the NMFS Cumulative Risk Initiative (CRI) modeling exercises. CRI is an additional analytic modeling framework designed to examine salmon population growth trends based upon conservation principles applied to all northwest stocks listed under ESA. CRI uses lifestage survival estimates to examine effects due to habitat, harvest, hatchery and ocean, in addition to hydrosystem passage, where PATH concentrates on Snake River hydrosystem passage. CRI strengthens PATH by demonstrating where PATH's population trends are optimistic and by linking management actions with effects to predicted salmon populations outcomes to evaluate their extinction risks. CRI is discussed with respect to possible impacts to tribes in Section 5.6.1.1. More general and much more detailed information on the PATH and CRI analyses is presented in Appendix A, Anadromous Fish.

3.7 Flood Control

The following is a qualitative evaluation of the flood control impacts of the four dams in the Lower Snake River Project. A quantitative flood control analysis has been omitted from the Feasibility Study because flood control benefits currently are not provided by the lower Snake River dams. Flood control benefits also would not be provided under a dam breaching alternative. A flood control benefit is a reduction in river stage or flow due to project operations. This section describes current, and predicts future, flood conditions, and demonstrates that flooding after removing the earthen portions of the four lower Snake River dams would be no worse than under current operations or conditions.

3.7.1 Current Flood Control

The four lower Snake River dams (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite) were authorized for power, recreation, irrigation, transportation and fish and wildlife. They are not authorized by Congress for flood control. The four dams that make up the Lower Snake River Project were designed to operate as run-of-river facilities within small pool fluctuation ranges. The maximum and minimum authorized pool operating limit elevations for the four dams are measured at the project forebay gage of each dam, except for Lower Granite, which is measured at the gage located at the confluence of the Snake River and Clearwater River at Lewiston, Idaho. The authorized operating pool elevations and corresponding storage contents for that elevation range are summarized in Table 3.7-1.

The total storage capability contained within the operating range for the four projects is 137,400 acre-feet when inflows are low and the pool elevations are nearly flat between the forebay gage and the upstream end of the project. The pool elevations refer to the water surface elevation at the project forebay, except for Lower Granite. Its pool elevation refers to the Snake-Clearwater confluence gage. The Biological Opinion specifies that the pool elevations be restricted to the one foot range above minimum operating pool (MOP); therefore, the total usable storage is approximately 33,500 acre-feet.

Table 3.7-1. Authorized Operating Pool Elevations and Storage Contents

Project	Minimum Pool (feet)	Maximum Pool (feet)	Range (feet)	Storage (acre-feet)
Lower Granite	733.0	738.0	5.0	43,600
Little Goose	633.0	638.0	5.0	48,900
Lower Monumental	537.0	540.0	3.0	20,000
Ice Harbor	437.0	440.0	3.0	24,900

Source: Corps, Walla Walla District

This amount of usable storage is too small to make any measurable reduction in the flood flows of the Columbia River.

These projects have not been used for flood control on the Columbia River in the past; however, the potential to use storage space that would become available during a partial lower Snake River drawdown operation was evaluated during the Columbia River System Operating Review (SOR). All four lower Snake River dams must be drawn down for a flood control benefit to be realized at The Dalles (Corps, 1995). The drawdown referred to in the SOR was part of the partial drawdown system operation strategy (SOS 6b). The proposed partial drawdown elevations for SOS 6b were below authorized operating limits, but still high above natural river levels at the project forebays.

The lower Snake River dams were not designed and are not operated to provide flood control benefits because flood control is not a congressionally authorized project use. According to the 1995 Columbia River SOR EIS (BPA, 1995), the projects are physically capable of providing a minor benefit under a partial drawdown operation strategy, but only when coupled with major reconstruction of the projects. The reconstruction would be necessary to continue current congressionally authorized uses and operation of fish passage facilities. The Dworshak Project located upstream on the Clearwater River currently provides congressionally authorized flood control benefits for the lower Snake River and further downstream on the Columbia River. Dworshak's storage capability is 2 million acre-feet, which is approximately 15 times greater than the total storage capability of the lower Snake River projects and approximately 60 times greater than the total usable storage.

Before the project storage below the authorized operating limits (for a non-dam breaching alternative) could be used for flood control, each project's facilities would have to be rebuilt. This would include the spillways, powerhouse intakes and outlets, navigation facilities, fish facilities, and reservoir embankments. For example, the 1992 Lower Granite drawdown test demonstrated that the turbines would be damaged by excessive vibration and the transportation facilities would be damaged by slumping reservoir embankments.

A dam breaching alternative, which would involve removal of the earthen portions of each of the four dams, would not provide a flood benefit because there would be no reservoirs on the lower Snake River to store flood waters. There would be no physical capability to control flooding on the lower Snake River, except by Dworshak Dam, on the Clearwater River. The current Biological Opinion specifies that the lower Snake River pools elevations are to remain within 1 foot of the MOP elevation. This precludes the current projects from storing flood waters, which makes the current flood control capability the same as it would be under a dam breaching alternative.

3.7.2 Future Flood Control

Future flood stages without the four lower Snake River dams in place would be no worse (higher) than the current flood stages. Removing the earthen portions of the dams would lower future water surface elevations down to natural river levels from the current pool elevations. This reduction would be greatest at the project forebays and least at the project tailwaters; therefore, local flood control benefits would be provided, particularly at the project forebays. This benefit would not be provided downstream of Ice Harbor Dam. Removing the earthen portions of the dams would eliminate the potential to operate the project for flood control; however, this potential was never authorized and would be cost prohibitive due to the major project reconstruction that would be required to maintain authorized uses. Dworshak will continue to provide flood control benefits in the lower Snake River and downstream on the Columbia River.

The upstream extent of flood control effects due to removing the earthen portion of the dams would reach the Lewiston area. Lower Granite Dam creates a backwater upstream to Lewiston. Levees were constructed in this area to provide navigation and power generation benefits. They were not constructed to provide flood control benefits. No future water surface reduction would result from removal of the earthen portion of Lower Granite Dam, and no subsequent flood control benefit would be provided upstream of the backwater currently created by the project.

Under Alternative 4—Dam Breaching the tailwater elevation downstream of Ice Harbor Dam would be approximately the same as under current conditions. The upstream extent of backwater in the lower Snake River, due to McNary Dam on the Columbia River, typically does not reach Ice Harbor Dam. Public comments during outreach meetings with the Corps have included claims of flooding in the Burbank area prior to dam construction. Current flood control benefits near Burbank are provided by Dworshak, which will continue to the provide flood control benefits to the Burbank area in the future.

These flood control benefits are not expected to be reduced if the earthen portions of the dams are removed, unless the channel and floodplain are filled in by subsequent sediment deposition. These sediments would be scoured from the reservoir beds and banks of the four lower Snake River dams, during and after removal, and transported downstream. There is not enough information available to quantitatively evaluate, and accurately predict, flood control impacts due to deposition of sediments near the Columbia-Snake confluence (Reese, 1998). The Corps is proposing to monitor and measure sediment deposition near this confluence to mitigate for this potential impact.

Another potential change in future flood control benefits would result from changes in the operation of Dworshak. The issue lies in the amount of water released from the Dworshak reservoir for the purpose of flow augmentation in the lower Snake River. Flow augmentation reduces the potential for excessive low flows in the lower Snake River, as well as enhancing fish habitat by increasing water velocity and reducing water temperature. Currently, the details of the amount of flow augmentation included in the future alternatives, the subsequent changes in Dworshak operations, and the resulting impact on flood control are not known.

3.8 Implementation and Avoided Costs

The purpose of this section is to describe and display the implementation and avoided costs for each of the study alternatives under consideration. These costs are presented in present value terms as well as equivalent average annual values.

The following discussion is divided into seven main sections: discussion of alternatives, implementation costs, average annual implementation costs, avoided costs, risk and uncertainty, other considerations, and unresolved issues.

3.8.1 Discussion of Alternatives

The implementation and avoided costs for each alternative are presented in Sections 3.8.2, 3.8.3, and 3.8.4. The implementation costs are divided into two separate categories; the construction and acquisition costs plus the operation, maintenance, repair, replacement and rehabilitation costs (O,M,R,R&R) related to fish-improvement (see Sections 3.8-2 and 3.8-3). The operation, maintenance, repair, replacement and rehabilitation costs category of implementation includes the costs associated with the anadromous fish evaluation program and the purchase of water. The avoided costs include those costs that would no longer be required to operate and maintain the lower Snake River dams. Avoided costs include powerhouse rehabilitation expenses, surplus property associated with the dams, and routine dam operation and maintenance expenses (see Section 3.8.4). The implementation and avoided cost estimates are:

- based on engineering cost data provided by the Corps, Walla Walla District[1]
- based on a 100-year life cycle analysis at the concept level
- developed at a price level October 1, 1998 (e.g., the start of the fiscal year). The in-service date (or on-line date) of each alternative differs. Therefore, in order to facilitate the comparison of the alternatives, the stream of engineering costs for each alternative has been adjusted (discounted or brought forward) to the in-service date and then further adjusted to the base year, 2005. Because of these adjustments, a direct comparison of the cost estimates provided in this section to the costs presented in the engineering appendix is not possible.

Table 3.8-1 lists the four alternatives and when each project could be placed in-service.

Table 3.8-1. Summary of Alternatives

Alternative	Summary Description	Starting Year
1—Existing Conditions	Adaptive Management Strategy	2005
2—Maximum Transport of Juvenile Salmon	Maximum Transport of Juvenile Salmon	2005
3—Major System Improvements	Adaptive Management Strategy	2008
4—Dam Breaching	Channel Bypass or Near-Natural River Alternative	2007
Source: Corps, Walla Walla District		

[1] For further details on costs, the reader is referred to the detailed project schedule in Appendix D (Annexes A through X) and Appendix E (Annexes A through E).

The starting dates of the various alternatives, indicating when each project will be functional, range from 2005 to 2008. However, it should be noted that this schedule is based on the following assumptions:

- that a record of decision will be made with work commencing in FY 2001
- that funding and other limitations will not impact the implementation schedule.

Failure to reach a record of decision or delays for any other reason could delay the starting date of the projects.

3.8.1.1 Comparison of Annual Implementation Costs

Annual implementation costs are presented for the four alternatives in Figure 3.8-1. Note that the annual costs for Alternative 4—Dam Breaching are higher than those for the other alternatives from 2001 through 2009 because annual construction costs to breach the dams are significantly larger than the construction costs associated with improving the existing system. Construction costs are, however, completed for all alternatives by the year 2009. From 2011 until the end of the study period (2104), the on-going annual implementation costs are similar under all alternatives.

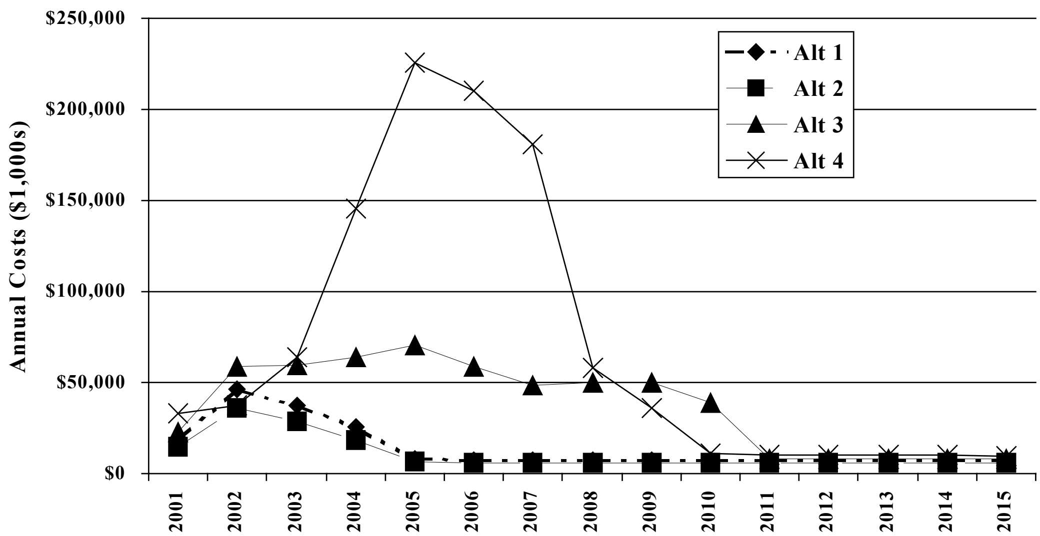


Figure 3.8-1. Comparison of Annual Implementation Costs

3.8.2 Implementation Costs

Implementation costs considered in the following discussion include all project-related construction and acquisition costs and operation, maintenance, repair, replacement and rehabilitation costs associated with each alternative. Implementation costs also include water acquisition by the BOR, mitigation costs for fish and wildlife programs, and protection of cultural resources. Mitigation costs are discussed in more detail in Section 13, Compensatory Actions.

3.8.2.1 Present Value of Construction and Acquisition Costs for Dam Retention Alternatives

Improvements designed to enhance the performance of existing fish facilities are planned for Alternative 1—Existing Conditions, Alternative 2—Maximum Transport of Juvenile Salmon, and Alternative 3—Major System Improvements. Improvements proposed to reduce fish fatality at the turbines at each of the four dams include cam field test improvement studies and related cam improvements on the turbines. Each of the dams has six turbines, which would be sequentially improved. As shown in Table 3.8-2, there are a series of fish-related improvements planned for each dam. Following is a summary of the proposed improvements for each alternative and the present value cost of each improvement using a 6.875 percent discount rate and adjusting to the base year, 2005. Refer to Appendix E, Existing Systems and Major System Improvements Engineering for a complete discussion of these fish-related improvements.

- Gantry crane modifications are needed at Lower Monumental to assist with the installation and maintenance of fish facilities at a cost of $630,000.
- Fish facility cylindrical de-water system improvement are needed to improve dependability and reduce stress to fish (Ice Harbor, Lower Monumental, and Little Goose but not at Lower Granite). These improvements are expected to cost $460,000 per affected project or $1.4 million for all three affected projects.
- Extended submersible bar screens (ESBSs) at turbine intakes, which would be modified to improve their operability and longevity, are expected to cost $1.8 million.
- Cam improvements will help optimize turbine efficiency and are estimated to cost $3.5 million.
- Improvements are needed to the trash boom (used to pickup trash and debris at the project) at Little Goose Dam at a cost of $5.3 million. The debris creates maintenance problems, such as plugging the orifices, which can lead to additional stress on fish.
- Separator improvements to facilitate better sorting of smolts for transportation are needed at Lower Monumental and Little Goose and are expected to cost approximately $7.3 million in total.
- Additional barges and improved barge moorage cells at Lower Granite, which are intended to improve and enhance the fish transportation program, are expected to cost $9.3 million (e.g., $6.7 million for five additional barges and $2.6 million for an improved barge moorage cell).
- Auxiliary water supplies are needed for fish ladders at each of the four lower Snake River projects and will result in a total cost of $10.8 million across all four projects.
- De-gasification improvements (DGAS) at Lower Monumental, Little Goose, and Lower Granite have already been implemented at Ice Harbor. These improvements, which include adding end bay deflectors and modifying the deflectors and pier extensions, are planned to decrease gasification and improve water quality. Under the base case (Alternative 1—Existing Conditions) and Alternative 3—Major System Improvements, the cost of these improvements is $33.7 million.
- Juvenile fish facility improvements are needed at Lower Granite to minimize stress to fish during transport and bypass and are expected to cost $24.3 million.

Additional Fish Facility Improvements (Alternative 3—Major System Improvements)

Additional major system improvements are planned under Alternative 3. The goal of these improvements is to improve fish survival. The primary components are listed below. Refer to Appendix E for a complete description of these items.

- A major component of the additional fish facility improvements for Alternative 3 consists of testing and finalizing designs for surface bypass collectors and behavioral guidance structures to attract fish away from the turbines, and removable spillway weirs to enhance fish bypass. All four dams require testing of the surface bypass collectors and removable spillway weir improvements. In addition, Ice Harbor, Lower Monumental, and Lower Granite require behavioral guidance structures. The total present value cost using a 6.875 percent discount rate and adjusting to the base year 2005 equals $183.8 million.
- New ESBS are required at Ice Harbor and Lower Monumental Dams for a total cost of $31.7 million.
- The third major component is a partial powerhouse structure at Little Goose Dam to divert fish passage. The estimated cost for a partial powerhouse structure is $37.6 million.

The total cost of these improvements is estimated to be $351.1 million (i.e., total present value adjusted to base year 2005).

3.8.2.2 Construction and Acquisition Costs for Alternative 4—Dam Breaching

The implementation costs associated with Alternative 4—Dam Breaching are summarized in this section. The construction costs associated with this alternative are also summarized in Table 3.8-2. The construction process includes modifying, removing, or protecting structures (e.g., roads, railroads, bridges, reservoir embankments, drainage structures, recreation access corridors, the hatchery at Lyons Ferry and like structures) that would remain after the dams are breached. The largest construction costs are for dam embankment removal and river channelization, which in combination, exceed $70 million at each of the dams. Each dam embankment is scheduled for removal concurrently over a three-year period between 2004 and 2007. There would be a need to shore-up the reservoir embankment prior to water release to prevent the undermining of the riprap and structures along the banks once the river is returned to a near-natural state. There would also be a need to re-vegetate the newly exposed banks of the river. In addition, before the dams are breached, temporary fish handling facilities would be needed.

The powerhouse turbine modifications identified in Table 3.8-2 would allow a controlled release of the water in the reservoirs behind the dams and are not the same as the turbine rehabilitation projects under dam retention strategies. Also planned is modification of cattle watering corridors,[2] modification of Habitat Management Units (HMUs), and protection of cultural resources after dam breaching and river channelization.

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[2] It should also be noted here that cattle watering corridor modification costs were included in the implementation costs because of deed requirements. Refer to the Engineering Appendix for further details regarding what constitutes implementation costs.

Table 3.8-2. Present Value of Construction and Acquisition Costs Adjusted to Base Year 2005 (1998 dollars) ($1,000)[1/]

Cost Category by Alternative	1	2	3	4
Improvements to Existing Fish Facilities				
Gantry Crane Modifications	630	630	630	–
Fish Facility Cylindrical Dewatering System	1,430	1,430	1,430	–
ESBS Modifications	1,780	1,780	1,780	–
Cam Improvements and Studies	3,550	3,550	3,550	–
Trash Boom	5,280	5,280	5,280	–
Separator Improvements	7,260	7,260	7,260	–
Additional Barges and Moorage Cells	9,270	9,270	9,270	–
Aux. Water Supply Fish Ladder	10,800	10,800	10,800	–
Degasification Efforts	33,680	10,380	33,680	–
Juvenile Fish Facility Improvements	24,310	24,310	24,310	–
Subtotal	*97,900*	*74,690*	*97,990*	–
Additional New Fish Facility Improvements				–
Testing/Finalizing Surface Bypass Collectors, Behavioral Guidance Structures and Removable Spillway Weirs	–	–	183,820	–
New ESBSs	–	–	31,730	–
Powerhouse Diverting Structure and Removable Spillbay Weir at Little Goose Dam	–	–	37,550	–
Subtotal	–	–	*253,100*	–
Dam Breaching Construction Costs	–	–		
Real Estate (Excessing Property)	–	–	–	840
Project Dam Decommissioning	–	–	–	5,010
Cultural Resources Protection	–	–	–	6,000
Cattle Watering Facilities	–	–	–	6,030
Drainage Structures Protection	–	–	–	8,830
Lyons Ferry Hatchery Modifications	–	–	–	9,050
HMU Modification	–	–	–	8,840
Recreation Access Modification	–	–	–	12,510
Railroad Relocations	–	–	–	21,910
Power House Turbine Modifications	–	–	–	30,950
Reservoir Revegetation (For Air and Water Quality)	–	–	–	26,340
Temporary Fish Handling Facilities	–	–	–	37,020
Bridge Pier and Abutment Protection	–	–	–	48,320
Railroad and Roadway Damage Repair	–	–	–	95,540
River Channelization	–	–	–	123,450
Dam Embankment Removal	–	–	–	158,770
Reservoir Embankment Protection	–	–	–	184,430
Subtotal	–	–	–	*783,840*
Mitigation Costs	–	–	–	25,700
Total	**97,990**	**74,690**	**351,090**	**809,540**

1/ These costs have been adjusted to base year 2005 using the 6.875 percent discount rate.
Source: Cost estimates developed by the Corps, Walla Walla District

Mitigation Costs (Alternative 4—Dam Breaching)

The mitigation costs under Alternative 4—Dam Breaching include those items associated with fish and wildlife habitat mitigation efforts and cultural resources protection associated with preserving and protecting habitat and cultural sites such as burial grounds. Fish and wildlife habitat mitigation and cultural resources protection are expected to equal a present value of $20.8 million and $4.9 million, respectively (discounted to 2005 using a 6.875 percent discount rate).

3.8.2.3 Operation, Maintenance, Repair, Replacement and Rehabilitation Costs for Dam Retention Alternatives

In addition to construction costs, operation, maintenance, repair, replacement and rehabilitation costs would also occur with implementation of the project-related or fish-improvement components of Alternatives 1 through 3. Some of the costs are associated with studies and others are related to operation and maintenance of the fish-improvement systems. The efforts to maintain and enhance existing fish-related facilities and operations are summarized in Table 3.8-3 (representing total present value costs adjusted to base year 2005, using a 6.875 percent discount rate) and include:

- Continued study of anadromous fish (called the anadromous fish evaluation program [AFEP]) involves a process for testing, researching and evaluating how well the proposed improvements meet fish-improvement goals and objectives. The AFEP study costs occur for approximately 25 years during construction and rehabilitation improvements. Total AFEP costs adjusted to base year 2005 are expected to range from a low of $55.5 million under Alternative 2—Maximum Transport of Juvenile Salmon to a high of $148.5 million under Alternative 3—Major System Improvements.
- BOR water acquisition costs allow an increased volume of water to pass over the dams during critical flow periods. The water is purchased from natural (irrigator) flow rights, changes in Snake River reservoir operations, and additional water from BOR storage reservoirs. Water purchases are expected to continue to occur throughout the study period to meet flow requirements, at an estimated total cost of $45.2 million over the 100-year study period adjusted to base year 2005 for the existing flow augmentation requirement of 427,000 acre-feet (AF) of water.[3] This estimate is based upon actual costs incurred in the recent past.
- Maintenance associated with screen bypass collector systems for Alternative 3—Major System Improvements is expected to cost $13.1 million over the 100-year life of the project adjusted to base year 2005.

[3] Water acquisition costs occur under all four project alternatives. The existing average price is $5.35 per acre-foot of water. If this cost changes in the future (increase or decrease), it will impact all alternatives in a similar manner.

Table 3.8-3. Present Value of Project-related O, M, R, R&R Costs (1998 dollars) ($1,000)[1/]

Cost Category by Alternative	Alternative 1 ($)	Alternative 2 ($)	Alternative 3 ($)	Alternative 4 ($)
Anadromous Fish Evaluation Program	82,410	55,490	148,480	38,430
BOR Water Purchase	45,240	45,240	45,240	45,240
Wildlife Monitoring	–	–	–	180
Vegetation Monitoring	–	–	–	380
Fish Monitoring Costs	–	–	–	32,440
Water Quantity Monitoring Costs	–	–	–	6,090
Air Quality Monitoring Costs	–	–	–	500
Sedimentation Monitoring Costs	–	–	–	1,550
Fish Improvement Related, Dam Operation, Maintenance and Repair	–	–	13,140	–
Total	**127,650**	**100,730**	**206,860**	**124,810**

1/ Costs are adjusted to base year 2005 using the 6.875 percent discount rate.
Source: Cost estimates developed by the Corps, Walla Walla District

3.8.2.4 Operation, Maintenance, Repair, Replacement and Rehabilitation Cost for Alternative 4—Dam Breaching

In addition to the mitigation and construction/acquisition costs, there are ongoing operation and maintenance (O&M) costs associated with the continued anadromous fish evaluation program, the purchase of water by the BOR, and the monitoring costs associated with dam breaching. These costs are also summarized in Table 3.8-3. Total AFEP costs for Alternative 4—Dam Breaching for the 100-year period of study are estimated to be $38.4 million and monitoring costs are estimated to equal $41.2 million, as adjusted to the base year 2005.

3.8.3 Average Annual Implementation Costs

3.8.3.1 Average Annual Costs of Fish Facility Improvements

This section presents a summary of the total and average annual implementation costs. Relevant costs are displayed in average annual equivalent terms taking into account the 100-year period of analysis and adjusted to base year 2005 in Table 3.8-4.

Costs incurred during the period of analysis were discounted to the beginning of this period using the applicable discount rates. Implementation costs incurred during the period of installation (following October 2000) were brought forward to the end of the installation period (project in-service date) by charging compound interest at the applicable discount rate from the date that the costs were incurred. These costs were then adjusted as necessary to the base year 2005 and annualized to provide an average annual value for each alternative and presented in 1998 dollars. This analysis presents average annual costs using three discount rates: the Corps' rate of 6.875 percent, the BPA rate of 4.75 percent, and 0.0 percent at the request of the five Tribes represented by CRITFC.

Table 3.8-4. Summary of Implementation Costs (1998 dollars) ($1,000s)

Discount Rate by Alternative	Construction and Acquisition Cost ($)	Interest During Construction Cost ($)	Total Investment Cost ($)	Average Annual Investment Cost ($)	Average Annual AFEP[1/] Cost ($)	Average Annual O,M,R,R&R Cost ($)[2/]	Average Annual Implementation Cost ($)
6.875 Percent							
Alternative 1	89,260	8,730	97,990	6,750	5,670	3,110	15,530
Alternative 2	67,900	6,790	74,690	5,140	3,820	3,110	12,070
Alternative 3	308,120	42,970	351,090	24,170	10,220	4,020	38,410
Alternative 4	759,100	50,440	809,540	55,730	2,650	5,940	64,320
4.75 Percent							
Alternative 1	89,240	5,970	95,210	4,570	4,500	2,880	11,950
Alternative 2	67,900	4,640	72,540	3,480	3,030	2,880	9,390
Alternative 3	330,630	30,610	361,240	17,330	8,100	3,720	29,150
Alternative 4	800,220	35,690	835,910	40,090	2,100	5,250	47,440
0.0 Percent							
Alternative 1	89,260	0	89,260	890	1,370	2,480	4,740
Alternative 2	67,900	0	67,900	680	920	2,480	4,080
Alternative 3	389,650	0	389,650	3,900	2,470	3,300	9,670
Alternative 4	911,120	0	911,120	9,110	640	3,340	13,090

1/ AFEP refers to the anadromous fish evaluation program
2/ These costs include BOR water acquisition costs
3/ The construction costs for Alternative 4—Dam Breaching include mitigation costs, such as wildlife mitigation and cultural resources protection. Mitigation costs are estimated to comprise $52,183,000 of the total.
Source: Cost estimates developed by the Corps (Walla Walla District, Portland District), BPA, and BST Associates

The major cost categories include:

- The construction costs for fish-improvement projects and/or to breach the dams. Construction costs associated with the Alternative 4—Dam Breaching include mitigation costs, such as wildlife mitigation and cultural resources protection.
- Interest during construction (IDC), which reflects compound interest at the applicable borrowing rate, on construction costs incurred during the period of installation.
- The anadromous fish evaluation program.
- The operation, maintenance, repair, replacement and rehabilitation costs associated with the new fish improvement projects (e.g., purchase of water from BOR and the O&M costs associated with the screen bypass system proposed under Alternative 3—Major System Improvements).

Average annual costs vary widely depending upon which discount rate is used but the ranking of the alternatives remains constant. Alternative 2—Maximum Transport of Juvenile Salmon is the lowest cost alternative. In fact, it has a lower cost than the base case, Alternative 1—Existing Conditions, which is the second lowest cost alternative. Alternative 3—Major System Improvements is the third lowest cost alternative and Alternative 4—Dam Breaching is the highest cost alternative under all discount rates.

3.8.4 Avoided Costs

The avoided costs associated with each alternative include those costs that would no longer be required to operate and maintain the lower Snake River dams and associated lands. These costs are calculated by comparing the costs required for continued operation of the four lower Snake River locks and dams under the base case condition (Alternative 1—Existing Conditions) with Alternatives 2 through 4. Costs under Alternative 1 that are not included in the other alternatives are considered avoided costs.

Avoided costs include:

- Costs of dam construction or major upgrades that would occur with Alternative 1—Existing Conditions but not under other alternatives. These include major powerhouse system upgrades and specific additional major improvements to fish bypass, collection, and passage systems.
- Dam O&M costs incurred under Alternative 1—Existing Conditions but not under other alternatives. These include future annual O&M costs and additional annual repair costs.
- Disposition of equipment that could be surplused if the dams were breached represents a third type of cost included in this analysis. This represents a reduced opportunity cost for other Federal agencies seeking this type of property and may, therefore, be considered a form of avoided costs.

3.8.4.1 Construction Costs

Turbine Rehabilitation

Under Alternative 4—Dam Breaching, the earthen embankment of the four lower Snake River dams would be removed. As a result, the powerhouse rehabilitation costs associated with the base case (Alternative 1—Existing Conditions) would no longer be required. Currently proposed rehabilitation includes all 24 turbine and generator units (including the turbines, the turbine blades, rewinding generators, and miscellaneous work). Over the 100-year study period, the Corps has determined that these rehabilitation efforts are expected to cost approximately $380 million for the entire system. This effort is underway at the present time at Ice Harbor Dam, which was built earlier than the other three lower Snake River dams, and will be required again in approximately 50 years. The 24 lower Snake River dam turbine units have an approximate life span of 25 to 50 years. It takes approximately 10 years to rehabilitate the six turbine units at each dam and only one turbine unit can be rehabilitated at a time for several reasons (including the need to continue generating power during the rehabilitation process and funding limitations). The costs that would be associated with these rehabilitation actions under Alternatives 1 through 3 are considered avoided costs under Alternative 4—Dam Breaching.

Other Construction Costs not included as Avoided Costs

The major fish-improvement cost incurred under Alternatives 1 and 2 that does not occur under Alternatives 3 or 4 is the second phase of the de-gasification construction project (DGAS2). The DGAS2 project is required to reduce nitrogen saturation resulting from additional flows. It is not required under Alternative 3 because this alternative involves additional collection efforts above the dams that would reduce the need for additional spills and related system improvements. The additional construction cost associated with the DGAS2 project is approximately $22 million.

There are, however, additional costs associated with Alternatives 2 and 3 that are not required under Alternative 1—Existing Conditions. As a result, net avoided costs for fish-related improvements only occur under Alternative 2—Maximum Transport of Juvenile Salmon. These costs are, however, included in the comparison of implementation costs and would be double-counted if included again as avoided costs.

3.8.4.2 Dam-Related Operation, Maintenance, Repair, Replacement and Rehabilitation

Avoided costs for dam-related operation, maintenance, repair, replacement and rehabilitation (O,M,R,R&R) that would be incurred under Alternatives 1 through 3 include:

- Approximately $7.7 million to operate and maintain the dams (i.e., average annual operation and maintenance costs). After breaching, there would no longer be a need to operate and maintain the dams.
- Approximately $3.1 million to operate and maintain the navigation system (i.e., average annual costs for lock operation and maintenance, dredging and other items related to navigation). After the dams are breached, there would no longer be a need to operate and maintain the navigation system.
- Approximately $2.7 million to operate and maintain the fish barge system (i.e., average annual operation and maintenance costs for barge and truck components of the fish barging program). After the dams are breached, there would no longer be a need to transport fish.
- Approximately $10.3 million to operate and maintain the buildings and grounds. After the dams are breached, there would no longer be a need to operate and maintain the grounds and buildings associated with the dams.

These costs would not be incurred under Alternative 4—Dam Breaching and are, therefore, considered avoided costs.

3.8.4.3 Surplus Property

Real property that could be disposed of under Alternative 4 once the dams are actually breached. Personal property that is currently utilized at the lower Snake River projects could be transferred to other Federal agencies and, hence, represents another avoided cost of dam breaching. The total value of personal property at the lower Snake River lock and dams calculated for those items with a value greater than $2,500 is approximately $14.9 million.

3.8.4.4 Continued Costs Not Avoided

Some of the existing annual O&M costs would continue to occur under Alternative 4—Dam Breaching and, hence, would not be avoided after dam breaching. These costs include:

- Approximately $2 million to operate and maintain the existing parks in each of the pools at the present time. With dam breaching, additional park facilities are needed, which would increase the O&M costs for recreational facilities to approximately $2.3 million per year.

- The mitigation plans for wildlife, which were placed into effect after construction of the lower Snake River dams, would continue in effect whether the dams are breached or not. These mitigation plans include maintenance of HMUs by irrigation, monitoring, and development. The existing program costs approximately $1.1 million per year.[4]
- The mitigation plans for anadromous and resident fish, which were placed into effect after construction of the lower Snake River dams, are assumed to continue in effect whether the dams are breached or not. This effort mainly consists of O&M of hatcheries. However, the purpose of these hatcheries may change from production (to compensate from losses occurring after the dams were constructed) to protection of brood stock and other items to enhance the survival of wild fish. These hatcheries cost approximately $14.5 million to operate, including the Dworshak hatchery (i.e., operated by the Corps with a budget of approximately $2.3 million per year) and other hatcheries operated by the states of Washington, Oregon, and Idaho and by the Nez Perce and Confederated Tribes of the Umatilla (i.e., these hatcheries are included in the Lower Snake River Fish Compensation Plan at a cost of approximately $12.2 million per year).

3.8.4.5 Summary of Avoided Costs

The average annual avoided costs are shown for each alternative in Table 3.8-5.

The average annual avoided costs associated with Alternative 4—Dam Breaching are approximately $34 million per year over the life of the study, under all discount rates. Using the 6.875 percent discount rate as an example, the avoided costs are calculated by subtracting the sum of the annual costs for turbine replacement; O,M,R,R&R costs; and surplus property value under the base case alternative ($72.3 million) from Alternative 4—Dam Breaching ($38.8 million), which equals an annual avoided cost of $33.6 million.

Dam-related O,M,R,R&R costs would be higher under Alternative 3—Major System Improvements than under Alternatives 1 and 2 resulting in a negative avoided cost figure. In the case of the 6.875 percent discount rate, for example, this difference is $10,000 (see Table 3.8-5).

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[4] The reader is referred to Appendix L, LSR Mitigation History and Status and Appendix M, Fish and Wildlife Coordination Act Report for further details on fish and wildlife mitigation plans.

Table 3.8-5. Summary of Average Annual Avoided Costs (1998 dollars) ($1,000s)[1/]

Discount Rate/Alternative	Turbine Rehabilitation ($)	Dam- Related O,M,R,R&R ($)	Surplus Property ($)	Subtotal ($)	Avoided Costs ($)
6.875 Percent					
Alternative 1	4,800	66,490	1,030	72,320	–
Alternative 2	4,800	66,490	1,030	72,320	–
Alternative 3	4,800	66,500	1,030	72,330	(10)
Alternative 4	–	38,750	–	38,750	33,570
4.75 Percent					
Alternative 1	4,600	61,440	720	66,760	–
Alternative 2	4,600	61,440	720	66,760	–
Alternative 3	4,600	61,500	720	66,820	(60)
Alternative 4	–	32,870	–	32,870	33,890
0.0 Percent					
Alternative 1	3,870	52,990	150	57,010	–
Alternative 2	3,870	52,990	150	57,010	–
Alternative 3	3,870	54,510	150	58,530	(1,520)
Alternative 4	–	23,140	–	23,140	33,870

1/ All costs were adjusted to base year 2005 using the appropriate discount rate.
Source: Cost estimates developed by the Corps (Walla Walla District, Portland District), BPA, and BST Associates

3.8.5 Risk and Uncertainty

The following section presents an evaluation of the risk and uncertainty associated with the implementation and avoided cost analysis. The range of uncertainty within each cost estimate is based on the following estimates of contingencies:

- Fifteen percent to 25 percent contingency range for construction and acquisition costs associated with the dam retention alternatives (with a most likely estimate of 20 percent)
- Twenty-five percent to 35 percent contingency range for construction and acquisition costs associated with the dam breaching alternative (with a most likely estimate of 30 percent)
- Zero percent to 25 percent contingency range for operations, maintenance, repair, replacement, and rehabitation costs under all alternatives (with a most likely estimate of 5 percent)
- These contingency estimates are explained in greater detail in U.S. Army Corps of Engineers Civil Works Cost Engineering Report (Corps, 1994).

3.8.5.1 Risk and Uncertainty in Average Implementation Costs

Based upon these contingencies, the range of costs for fish facility improvements is presented in Table 3.8-6. As shown, total average annual implementation costs (including all construction and other costs) range from $61.1 to $67.6 million under Alternative 4—Dam Breaching, with a most likely cost estimate of $64.3 million per year under a discount rate of 6.875 percent. The annual implementation costs net of the base case range from $46.4 to $51.2 million, with a most likely net

Table 3.8-6. Average Annual Implementation Costs—Risk and Uncertainty (1998 dollars) ($1,000s)[1/]

Discount Rate/ Alternative	Annual Implementation Costs ($) Most Likely	Low	High	Net of Base Case ($) Most Likely	Low	High
6.875 Percent						
Alternative 1	15,530	14,750	16,310	—	—	—
Alternative 2	12,070	11,470	12,670	3,460	3,280	3,640
Alternative 3	38,410	36,490	40,330	(22,880)	(21,740)	(24,020)
Alternative 4	64,320	61,100	67,540	(48,790)	(46,350)	(51,230)
4.75 Percent						
Alternative 1	11,950	11,350	12,550	—	—	—
Alternative 2	9,390	8,920	9,860	2,560	2,430	2,690
Alternative 3	29,150	27,690	30,610	(17,200)	(16,340)	(18,060)
Alternative 4	47,440	45,070	49,810	(35,490)	(33,720)	(37,260)
0.0 Percent						
Alternative 1	4,740	4,500	4,980	—	—	—
Alternative 2	4,080	3,880	4,280	660	620	700
Alternative 3	9,670	9,190	10,150	(4,930)	(4,690)	(5,170)
Alternative 4	13,090	12,440	13,740	(8,350)	(7,940)	(8,760)

1/ All costs were adjusted to base year 2005 using the appropriate discount rate.
Source: Cost estimates developed by the Corps (Walla Walla District, Portland District), BPA, and BST Associates

cost of $48.8 million. Table 3.8-6 includes all costs (i.e., construction and acquisition costs and O,M,R,R&R costs etc.), which results in a mixture of contingency rates.

Under the same discount rate, the average annual implementation costs for the three dam retention alternatives are estimated to be as follows:

- implementation costs for Alternative 1—Existing Conditions range from $14.7 to $16.3 million, with a most likely estimate of $15.5 million
- implementation costs for Alternative 2—Maximum Transport of Juvenile Salmon range from $11.5 to $12.7 million, with a most likely estimate of $12.1 million (e.g., ranging from $3.3 million to $3.6 million less than the base case)
- implementation costs for Alternative 3—Major System Improvements range from $36.5 to $40.3 million, with a most likely estimate of $38.4 million (e.g., ranging from $21.7 million to $24.0 million more than the base case).

3.8.5.2 Risk and Uncertainty in Average Annual Avoided Costs

Based upon a 5 percent contingency, the range of annual costs for non-project related operations, maintenance, repair, replacement and rehabilitation costs are presented in Table 3.8-7. As discussed above, there are a number of on-going annual costs incurred in dam retention alternatives that are avoided under the Alternative 4—Dam Breaching.

Table 3.8-7. Average Annual Avoided Costs—Risk and Uncertainty (1998 dollars) ($1,000s)[1/]

Discount Rate/ Alternative	Annual Non-Project Related Costs ($)			Avoided Costs ($)		
	Most likely	Low	High	Most likely	Low	High
6.875 Percent						
Alternative 1	72,320	68,700	75,940	–	–	–
Alternative 2	72,320	68,700	75,940	–	–	–
Alternative 3	72,330	68,710	75,950	(10)	(10)	(10)
Alternative 4	38,750	36,810	40,690	33,570	31,890	35,250
4.75 Percent						
Alternative 1	66,760	63,420	70,100	–	–	–
Alternative 2	66,760	63,420	70,100	–	–	–
Alternative 3	66,820	63,480	70,160	(60)	(60)	(60)
Alternative 4	32,870	31,230	34,510	33,890	32,190	35,590
0.0 Percent						
Alternative 1	57,010	54,150	59,850	–	–	–
Alternative 2	57,010	54,150	59,850	–	–	–
Alternative 3	58,530	55,600	61,460	(1,520)	(1,450)	(1,610)
Alternative 4	23,140	21,980	24,300	33,870	32,170	35,550

1/ All costs were adjusted to base year 2005 using the appropriate discount rate.
Source: Cost estimates developed by the Corps (Walla Walla District, Portland District), BPA, and BST Associates

Avoided costs are calculated by subtracting the annual costs associated with the base case from those associated with Alternative 4—Dam Breaching. For example, the most likely annual avoided costs are calculated by subtracting the dam breaching average annual costs of $38.8 million from the base case average annual costs of $72.3 million, which equals $33.6 million at a discount rate of 6.875 percent. The average annual avoided costs range between $31.9 and $35.3 million, with a most likely cost estimate of $33.6 million per year using a discount rate of 6.875 percent. Table 3.8-7 also presents the annual avoided costs using 4.75 percent and 0.0 percent discount rates.

3.8.6 Other Considerations

3.8.6.1 Repayment of Outstanding Debt

The BPA repays to the Federal Treasury costs allocated to hydropower from the Federal dams. The capitalized costs of the project (e.g., initial construction costs, replacement costs) are repaid by BPA over a 50-year period at designated interest rates. The current debt associated with the lower Snake River locks and dams is approximately $479 million for construction of the dams as of the end of 1998. In addition, there is also additional outstanding debt for the lower Snake River fish hatcheries and fish mitigation funds of approximately $271 million as of the end of 1998. There is also a construction work in progress account that will transfer to BPA as new additional debt.

If the lower Snake River locks and dams are removed, it is possible that Congress, through the authorizing legislation, will reduce some or all of this long-term debt. It is not known at this time what might be written off; however, this debt-relief is not considered an avoided cost. The debt cost is sunk and a write-off would not avoid it but rather would simply transfer the debt to a different party. The issue of payment of outstanding debt is addressed further under the finance section of the cost allocation report (see Section 12).

3.8.6.2 Relationship of Implementation Costs to NED Impacts

Estimates of the NED impacts of power, navigation, recreation, water supply and other study elements are presented in Sections 3.1 through 3.7 of this appendix. Care has been taken to eliminate potential double counting of costs. As an example, the avoided cost report documents the cost to operate the lower Snake River locks and dams under various dam retention alternatives. A major portion of this cost is for power facilities. Including the cost to provide power from the four lower Snake River dams in the power cost estimates would lead to a double counting of costs. Therefore, the costs of operating the existing plants are excluded from the hydropower analyses. Care has been taken in evaluating other NED impact estimates to assure that double counting is similarly avoided.

The avoided cost estimates indicated above have focused on Federal costs. However, there could also be impacts to state and local governments, private sector individuals and firms, and the Tribes. The NED impact estimates should account for the avoided costs to other parties that could partially offset national cost increases. There may, however, be some costs that have not been captured in other study elements. One example is the cost to reconstruct the natural gas line that crosses Lake Herbert G. West (Lower Monumental reservoir). Under Alternative 4—Dam Breaching, this reconstruction is estimated to cost $12.4 million. The study teams have not captured this cost. There may be other examples.

3.8.7 Unresolved Issues

The engineering cost estimates in this report have been revised to reflect additional engineering analysis conducted between the release of the Draft and Final FR/EIS. However, the cost estimates are at a planning level stage of refinement and could change if final design is undertaken.

Another unresolved issue involves the problems with dam operations and associated impacts to water quality. This issue is addressed in the following section.

3.8.7.1 Water Quality Concerns

Water temperature and dissolved gas levels within the lower Snake River reservoir system have been identified as important water quality parameters that affect fish and are sometimes found at levels above state standards. To reduce water temperatures within the lower Snake River reservoirs, Dworshak reservoir is currently operated to release 1.2 million acre-feet (MAF) of cold water during July and August each year. No other action or alternative is currently being studied to further reduce temperatures within the reservoir system.

To reduce total dissolved gas (TDG) levels found at the lower Snake River reservoir, structural modifications have been made at the dams and additional modifications are being studied.

The costs to reduce dissolved gas are briefly reviewed in the following section and are carried through to sensitivity analysis in the cost effectiveness and risk and uncertainty sections of the appendix.

The engineering alternatives to reduce dissolved gas include:

- additional end bay spillway deflectors
- powerhouse/spillway separation wall
- additional spillbays.

For more information on the engineering alternatives, the reader is referred to the Annex C to Appendix E, Existing Systems/Major System Improvements Engineering.

Additional End Bay Spillway Deflectors

Spillway flow deflectors have been installed at all four of the lower Snake River dams (Table 3-8.8). Deflectors consist of a horizontal lip 2.4 to 3.8 meters (8 to 12.5 feet) long placed on the spillway ogee section just below or near the minimum tailwater elevation.[5] The deflectors produce a thin discharge jet that skims the water surface of the stilling basin.

Though the skimming flow is highly aerated, spillway discharge is prevented from plunging and entraining air deep into the stilling basin. Reducing the depth of plunge, and thus the hydrostatic pressures acting on the aerated flow, reduces the production of TDGs.

Deflectors have lowered the levels of dissolved gasses generated by conventional spillways by as much as 15 to 20 percent TDG. The construction of additional flow deflectors on non-deflected spillbays will further reduce TDG production.

Both Lower Monumental and Little Goose spillways have deflectors on six of the eight spillbays. Thus, these are the only two facilities with the potential for adding end bay deflectors. Deflectors were not constructed in spillbays 1 and 8 on these projects because of adult fish passage concerns. Recent studies indicate adult passage rates may not be as sensitive to deflected flow conditions as previously expected. Adding end bay deflectors may further reduce the saturation of TDGs without adverse impacts to adult passage.

Table 3.8-8. Existing Deflectors

Dam	No. of Spillbays	No. of Deflectors	Deflector Elevation (meters)	Deflector Length (meters)	Deflector Transition (meters)
Ice Harbor	10	8	103.0 (338.0)	3.81 (12.5)	4.57 (15.0) radius
Ice Harbor	10	2	101.8 (334.0)	3.81 (12.5)	4.57 (15.0) radius
Lower Monumental	8	6	132.2 (434.0)	3.81 (12.5)	Flat
Little Goose	8	6	162.2 (532.0)	2.44 (8.0)	Flat
Lower Granite	8	8	192.0 (630.0)	3.81 (12.5)	4.57 (15.0) radius

Note: feet in parentheses (feet)
Source: Corps, Walla Walla District

[5] “Ogee” refers to the reverse curve shape of the spillway.

Powerhouse/Spillway Separation Wall

Spill released flows on lower Snake River projects retrofitted with deflectors will draw flow from the powerhouse into the stilling basin. The entrainment of powerhouse flow is visually evident in general physical hydraulic models of Ice Harbor and Lower Granite as well as at the four lower Snake River projects, John Day, and McNary Dams. Field tests at Little Goose and Ice Harbor Dams indicate as much as 100 percent of the powerhouse flow can be drawn into the stilling basin under certain operating conditions. Powerhouse flows entrained within in the spillway are exposed to aeration and pressures that saturate this flow to TDG levels typical of the spillway flow itself.

A cutoff wall (separation wall) constructed between the powerhouse and spillway will prevent powerhouse flow from becoming entrained and aerated within the spillway's stilling basin. This will allow mixing of powerhouse and spillway releases to occur downstream of the highly aerated spillway releases. This mixing in the downstream channel as opposed to the stilling basin will allow dilution of higher TDG spillway water with lower TDG powerhouse water which is normally at lower forebay TDG levels. In addition to the gas reduction benefits of the flow separation wall, the wall will prevent juvenile fish passed through the turbines from being drawn into the spillway. This condition has been observed at McNary Dam during the 1999 turbine survival studies. The separation wall will streamline powerhouse flow and improve current flow patterns below the juvenile fishway out-falls and will reduce or eliminate large eddies that might otherwise delay juvenile fish egress from both powerhouse and spillway tailrace regions.

Two concept level designs were developed based upon models of Lower Granite and Ice Harbor Dams. Both designs include two 75-foot long concrete monolithic structures that are post tensioned. The first design concept utilizes sheet pile to construct the wall forms and fills the form with mass tremie concrete. The second design concept utilizes pre-cast concrete cells set in place then filled with tremie concrete. The design and construction of a divider wall at either of the lower Snake River projects could take between 3 to 4 years.

The walls could be added with any of the surface bypass collector (SBC) types included in this appendix; however, more study is required to determine if the separator walls would be an appropriate addition to the dams. Because of this uncertainty, the walls were not included in Alternative 3—Major System Improvement described herein.

Additional Spillbays

Adding more spillbays at each dam would reduce the generation of TDG by reducing the unit spill discharge requirements and necessary stilling basin depths. Unlike conventional spillways designed to pass and adequately dissipate the energy of flow for the Spillway Design Flood, the additional spillbays could be designed for much less spill. The spillway would be designed specifically to reduce the saturation of TDG for normal or voluntary spill flows, while improving the spill passage efficiency and survival of juvenile fish.

Additional spillbays can be constructed in place of the earthen non-overflow embankments of the lower Snake River dams.

Combined Dissolved Gas Abatement Measures

Gas abatement measures may be grouped together to form a package of improvements. The improvements cited in the DGAS study are grouped together as alternatives. The following cost estimates are presented as average annual costs adjusted to base year 2005 using a discount rate of 6.875 percent (see Table 3.8-9)

Alternative a

Adding end bay deflectors at Little Goose and Lower Monumental Dams—Total cost about $18 million. The average annual cost would be approximately $1.3 million per year over the 100-year life of the project.

Alternative b

Adding end bay deflectors at Little Goose and Lower Monumental Dams plus powerhouse/spillway separation walls at each of the four lower Snake River dams—Total cost about $94 to $142 million. The average annual cost would range from approximately $3.4 million (low estimate) to $5.2 million (high estimate) per year over the 100-year life of the project.

Alternative c

Adding end bay deflectors at Little Goose and Lower Monumental Dams plus separation walls at each of the four lower Snake River dams, plus additional spillway bays at each lower Snake River dam—Total cost about $1.4 billion to $2.2 billion. The average annual cost would range from approximately $33.6 million (low estimate) to $53.6 million (high estimate) per year over the 100-year life of the project.

Alternative "b" provides a higher level of gas abatement than alternative "a," but at a higher cost. Likewise, alternative "c" provides a higher level of gas abatement than alternatives "a" or "b," but at a significantly higher cost. Due to uncertainty associated with the feasibility of these improvements, these potential improvements are considered unresolved. The costs presented in Table 3.8-9 are only intended to provide an indication of the magnitude of the cost to reduce dissolved gas.

Table 3.8-9. Summary of Preliminary Average Annual Costs Associated with Dissolved Gas Reduction Efforts (1998 dollars)[1/] ($1,000s)

Alternative	Low	High
Alternative a	(1,286)	(1,286)
Alternative b	(3,411)	(5,189)
Alternative c	(33,632)	(53,584)

1/ Assumes 6.875 percent discount rate
Source: Cost estimates developed by the Corps (Walla Walla District, Portland District)

4. Passive Use Values

Beneficial effects measured under the NED account include increases in the economic value of the national output of goods and services, the value of output resulting from external economies caused by the proposed alternatives, and the value associated with the use of otherwise unemployed or under-employed labor resources (WRC, 1983). Adverse effects are usually the opportunity costs of resources used in implementing a plan. These effects typically include implementation outlays, associated costs, and other direct costs.

The NED account addresses direct use value, which may be simply defined as the value that an individual derives from the direct use of a natural resource. Direct uses include "consumptive uses, such as fishing and hunting in which resources are harvested, and non-consumptive uses in which the activity does not reduce the stock of resources available for others at another time, such as bird watching or swimming" (NOAA, 1994). The unique characteristics of some resources have, however, caused some economists to question whether this type of analysis incorporates all of a resource's value. It has been argued that some individuals who are not directly using a resource might be willing to pay some amount of money just to know that the resource exists even though they have no intention of ever using it. Passive use or existence values of this type may be defined as "the values individuals place on natural resources independent of direct use of a resource by the individual. Passive use values include, but are not limited to: the value of knowing the resource is available for use by family, friends or the general public; and the value derived from protecting the natural resource for its own sake; and the value of knowing that future generations will be able to use the resource" (NOAA, 1994). Passive use values are not included as part of the NED accounting stance.

The preservation of endangered species and free-flowing rivers are well recognized as possible sources of passive use value (Krutilla and Fisher, 1975; Meyer, 1974; Randall and Stoll, 1983; Stoll and Johnson, 1984). Passive use values for Pacific Northwest salmon and steelhead populations may be motivated by the public's desire to preserve these species and their associated habitats for the enjoyment of future generations. These natural resources may be viewed as a significant component of what distinguishes the Pacific Northwest from other parts of the country. While a near-natural river is arguably less symbolic of the Pacific Northwest, the public may still be motivated to return the lower Snake River to a near-natural condition for the benefit of future generations even if they never visit or use it themselves. Passive use values are an example of what economists refer to as a public good—a good that can be simultaneously enjoyed by multiple consumers without diminishing its overall value. Recognizing the growing support for the use of passive use values in resource allocation analysis in the economics community, a passive use analysis was conducted as part of this project. This analysis estimates passive use values for both endangered salmon and steelhead stocks and also a near-natural lower Snake River.

4.1 Passive Use, Contingent Valuation, and Benefit-Transfer[1]

Passive use values for non-market goods cannot be estimated using market data because such goods are not exchanged in markets. Therefore, economists have turned to stated preference methods, most notably, contingent valuation methods to measure passive use values. These methods generally use surveys of a representative sample of the relevant population to obtain expressions of a stated preference based on hypothetical market conditions. These stated preferences are then directly or indirectly used to determine WTP for a good or service. This WTP value is contingent upon the nature of the constructed market described in the survey scenario, hence the name "contingent value."

The contingent valuation method is controversial because of the difficulty of establishing the validity of the public's value statements and of determining the applicability of these value statements to the relevant policy decisions. The reliability and validity of contingent values depend upon the extent to which they precisely and accurately measure true values. Many economists are skeptical because they believe that the actual exchange of dollars for goods is fundamental to truthful revelation of preferences, or because results do not seem reasonable. Without an actual monetary transaction, people may lack the incentive to carefully research their preferences and may be overly influenced by information provided in the survey. Some experiments have shown that stated values are largely independent of the scale of the resource that stated values are strongly related to the format of questioning, or that interpolation to numerous environmental goods implies unlikely or infeasible levels of payment. (See Hausman, 1993, for a critical assessment of contingent valuation.) Other studies, however, have shown that contingent values are sensitive to the scale of the good and that they are similar to (usually lower than) the value estimates obtained using other methods (Carson, 1997; Carson et al., 1996). A meta analysis of endangered species valuations demonstrates that willingness to pay (WTP) is sensitive to the change in population size survey respondents were asked to value (Loomis and White, 1996). The contingent valuation method has been given limited endorsement by a Blue-Ribbon panel chaired by two Nobel Laureate economists (Arrow et al., 1993).

The answers to Contingent Valuation Method (CVM) questions about passive use values tend to be internally consistent but sometimes exceed what people will actually pay. This internal consistency is evident in empirical studies, which have repeatedly found that the higher the dollar amount people are asked to pay, the less likely they are to agree to pay. This indicates that people take the dollar amount they are asked to pay seriously. All studies published in refereed journals find that CVM responses, even those to passive use values questions, are reliable. However, the few comparisons of CVM responses to real cash donations (which are subject to being a conservative measure of WTP due to real incentives to free-ride and avoid payment) for passive use values, suggest that CVM estimates do overstate what people would be actually willing to pay by a statistically significant amount. Even in these cases, the mean WTP amounts stated are in the range of $10 to $80 per year for endangered species, a very small fraction of households income.

DREW originally requested that the DREW Recreation Workgroup conduct a passive use survey. This survey was designed and pretested. Controversy surrounding the pretest mailing and

[1] Much of this section and the preceding introductory discussion is taken from the *Human Effects Analysis of the Multi-Species Framework Alternatives*, Appendix E, Northwest Power Planning Council (Pub. 2000-5), March 2000, which this appendix summarizes the current state of knowledge concerning passive use value and its measurement.

contingent valuation methodology prevented this survey from being conducted. Rather, passive use values were approximated using a benefit-transfer approach based on existing passive use value estimates. The benefit-transfer approach is generally considered a practical alternative to valuation methods that involve the collection of original data on preferences. The benefit-transfer approach involves "transferring" existing studies, value estimates, and WTP functions to new policy contexts, sites, and affected populations. The reliability and validity of such transferred values depends upon the quality of the original studies as well as the degree of similarity between the original context in which the values were estimated and the new policy context. At best, passive use values estimated using the benefit-transfer method can only be as accurate as the original studies on which they are based.

The passive use analysis conducted by the DREW Recreation Workgroup (1999) assumed that there are no passive use values associated with the existing lower Snake River dams and reservoirs. While it is possible that man-made objects such as dams may have existence value, economic theory and empirical evidence to date suggest that this is likely to be small (Lockwood et al., 1994). Scarcity and uniqueness are typically major determinants of the size of passive use values. Dams and reservoirs are not scarce in the Columbia River Basin or the Pacific Northwest. While dams and reservoirs are not scarce in the Pacific Northwest, the policy context that underlies this analysis is fairly unique. For some, the four lower Snake River dams are a planned manipulation of natural resources representative of human and technological progress. For these individuals, breaching these dams may be regarded as a retreat from technological progress. These individuals may value the continued operation of the dams, even though they may not directly benefit from or use the dams or reservoirs themselves. People may also hold passive use values for a traditional way of life, such as commercial fishing or the family farm. These values may not be reflected in the market price for the commodities that are produced in these sectors or the direct use values of the goods and services, such as hydropower and river navigation, that facilitate this way of life. Whether this value is large in relation to the direct and indirect effects on the regional economy remains the subject of ongoing research at this time (NPPC, 2000). As noted above, no effort is made to measure these types of value in this analysis. Instead, the majority of the value of development, such as dams or barge transport, is assumed to come from the market outputs created or the non-market recreation use values. Most public support for the dams, for example, can be traced to the economic or recreation benefits provided by dams and reservoirs. These direct use values are measured as part of the NED analysis presented in Section 3 of this document. A second source of public support for dams is the indirect local economic activity they generate. Local and regional indirect economic effects are addressed in the RED analysis presented in Section 6 of this document.

4.2 Salmon

Three approaches were used to transfer benefits from four existing studies to estimate the change in passive use value for lower Snake River salmon populations. While none of these existing studies precisely matches the policy setting of this study (which is why an original passive use value study was originally proposed by DREW), each provides an indication of the likely range of the passive use values for increasing salmon populations. All three of these approaches do a reasonable job of meeting the criteria for an ideal benefit transfer laid out by Boyle and Bergstrom (1992). The criteria identified by Boyle and Bergstrom are as follows: "(1) the nonmarket commodity valued at the study site must be identical to the nonmarket commodity to be valued at the policy site; (2) the populations affected by the nonmarket commodity at the study site and policy site have identical characteristics; and (3) assignment of property rights at both sites must lead to the same theoretically appropriate welfare measures (e.g., WTP versus willingness to accept compensation)." All four studies measure the same resource—salmon; three of the studies estimate passive use values for salmon in Washington State; and they all estimate these values based on the same measure—WTP.

The existing studies do not perfectly match the policy setting of the Lower Snake River Juvenile Salmon Migration Feasibility Study because no reference is made to threatened or endangered species in the surveys used in these studies. This suggests that the margin of error associated with applying the results of these studies to the threatened and endangered stocks of the lower Snake River is likely to be in the conservative direction. It is likely that if the original surveys had specifically addressed threatened and endangered stocks, the resulting values per fish would have been higher because people would be willing to pay more to save a species they perceive to be near extinction. Second, most of the existing studies valued a larger increase in the number of salmon than is being evaluated in the lower Snake River study. The law of diminishing marginal returns suggests that consumers will value each successive unit of a good less than its predecessor. This suggests that the average marginal value per fish is inversely related to the number of fish being evaluated. Diminishing marginal existence values were found in the existing studies used for this analysis and confirmed in other economic literature. Taking a marginal value per fish from a study that valued a large increase and applying it to a smaller increase on the lower Snake River will also underestimate the value of that smaller increment.

The following sections discuss the three benefit-transfer approaches employed in this analysis. The first approach estimates a WTP function from salmon based on the results from all four existing studies. The other two approaches each apply the results from just one of the four studies to the lower Snake River case.

4.2.1 Regression Approach

The first approach statistically estimates a WTP function for salmon using incremental existence values per salmon calculated from four contingent valuation method studies of west coast residents' WTP for increasing salmon populations. The four original studies (Olsen et al., 1991; Hanemann et al., 1991; Loomis, 1996b; and Layton et al., 1999) provided five estimates of the incremental value of an additional salmon (two estimates were obtained from Layton et al.). The regression function estimated from these five estimates has an explanatory power of 62 percent, and the number of salmon is significant at the 1 percent level, even given the limited degrees of freedom (see DREW Recreation Workgroup, 1999).

Using this function, the change in annual total passive use values with different levels of wild salmon and wild steelhead recovery was calculated for *non*-user households in the Pacific Northwest and California to avoid any double counting of passive use values and recreation use values. Data on wild salmon and steelhead run sizes were based on the 1998 PATH data extrapolated by the DREW Anadromous Fish Workgroup (1999) to represent all Snake River wild stocks. The change in annual total passive use value is measured in terms of the change from Alternative 1—Existing Conditions, which formed the baseline for this analysis. Passive use values were calculated for Alternatives 2 through 4 by applying the regression function to the estimated change in wild salmon and steelhead populations associated with each alternative. The results of this analysis are presented in Table 4.1. To make the results consistent with the NED values, which are annualized using three discount rates, including the Corps rate of 6.875 percent, the passive use values were annualized using a 6.875 percent discount rate. This has the effect of lowering the annual passive use values from the amount that was reported in the Draft FR/EIS. This occurs because the largest gains in wild salmon and steelhead occur many years into the future, and the associated benefits are now discounted.

Alternative 4—Dam Breaching, is estimated to yield wild salmon and steelhead populations that are 66 percent more than those estimated under Alternative 1—Existing Conditions. Based on the regression approach this increase in stocks would result in a $301.51 million average annual increase in passive use values. Wild salmon and steelhead run sizes projected for Alternative 2—Maximum Transport of Juvenile Salmon, were on average, slightly lower than Alternative 1, but the temporal distribution was such that there were more fish in the first few decades with Alternative 2 than with Alternative 1, resulting in a small annualized increase in passive use values once discounting was taken into consideration. However, Alternative 3—Major System Improvements, yielded substantially less wild salmon and steelhead than those projected for Alternative 1—Existing Conditions. As a result, there would be net annual reductions in passive use values of $31 million with Alternative 3 (Table 4-1).

Table 4-1. Passive Use Value Analysis for Salmon and Steelhead (Average Annual Equivalent Value) ($ millions) (1998 dollars)

Alternative	Average Annual Wild Return1/	Regression-Based Transfer2/	Elwha River Only3/	Transfer of 1999 Columbia River Estimates Only4/
1	71,110			Stable Baseline
2	70,682	$4.02	$0.539	$0.252
3	69,641	($31.09)	($1.41)	($0.657)
4	118,571	$301.51	$48.79	$22.77

1/ Average annual returns of wild salmon and steelhead are based on preliminary equal weight PATH data extrapolated by the DREW Anadromous Fish Workgroup to represent all Snake River wild stocks.
2/ This approach statistically estimated a willingness-to-pay function based on four existing studies (Olsen et al., 1991; Hanemann et al., 1991; Loomis, 1996b; and Layton et al., 1999).
3/ This approach is based on values generated in the Elwha River study only (Loomis, 1996b).
4/ This approach is based on a stated preference survey of Washington residents (Layton et al., 1999). The stable baseline condition assumed that fish populations stabilized at current levels over the next 20 years.

4.2.2 Transfer of Elwha River Estimates

A second approach to calculating the passive use value involved matching the change in anadromous fish populations in Alternative 4—Dam Breaching, to the one existing study that valued a similar size change in salmon and involved dam removal as the policy action (Loomis, 1996b) rather than using the statistical function estimated from all four studies. The change in salmon runs evaluated in the Elwha River study was around 300,000, about six times the size of the net annual increase projected for Alternative 4—Dam Breaching (Table 4-1). This suggests that application of the Elwha River study results to the lower Snake River may be a reasonable benefit transfer. The fact that both projects involve dam removal and are located in the state of Washington further supports the application of this study to the lower Snake River.

The household value calculated from a nationwide survey of residents WTP for salmon on the Elwha River was applied to non-user households in the Pacific Northwest and California. The value obtained for Washington residents in the Elwha study was applied to Washington non-user households. Ninety-three percent of this value was applied to residents in the rest of the Pacific Northwest and California. This adjustment is based on the results of the Elwha survey (Loomis, 1996a) which compared Washington residents' WTP for salmon on the Elwha River with the amount that residents in the rest of the United States would pay for the same increase in salmon on the Elwha River.[2]

Applying the respective values per household to non-user households in the Pacific Northwest and California yields an annualized gain in passive use value of about $48.79 million per year with dam breaching using a 6.875 percent discount rate. The results of this analysis are presented for each alternative in Table 4.1. These may be considered conservative estimates for four reasons. First, the lower Snake River salmon are threatened and endangered, while the salmon returning to the Elwha were not endangered when the survey was written. This suggests that transferring the values from the Elwha River study to the lower Snake River case is likely to underestimate the passive use values for the lower Snake River's threatened and endangered salmon. Second, the change in salmon on the Elwha River is about six times that expected on the lower Snake River, which further reinforces the conservative nature of the passive use value per fish calculated from the Elwha due to diminishing marginal existence values. Third, limiting passive use values to non-user households assumes that users receive no passive use values, an unlikely situation. Finally, this analysis does not account for passive use value for households located elsewhere in the United States, despite evidence from the Elwha River study that such households do receive passive use values from salmon recovery and dam removal (Loomis, 1996a, 1996b).

4.2.3 Transfer of Columbia River Estimates

The third approach used just the most recent stated preference survey of Washington residents (Layton et al., 1999) to estimate the passive use value of increasing salmon on the lower Snake River. Layton et al.'s survey asked Washington residents to rate four different scenarios that involved three different generic stocks of fish species (freshwater, migratory, and saltwater) in two geographic areas (eastern and western Washington). This study was designed to estimate the value to Washington households of changes in fish populations in Washington waters for a full range of fish under a variety of conditions.

The Layton et al. survey was designed to value incremental changes in the various types of fish populations over time relative to baseline conditions. Uncertainty over future baseline conditions led the authors to use two different baselines in their survey, which were presented to a split sample of respondents. The low baseline condition showed populations declining over the next 20 years at the same rate as the previous 20 years. In the stable baseline condition, populations stabilized at current levels over the next 20 years. Given the diminishing marginal value of incremental gains in fish, the stable baseline condition resulted in lower values per fish than the low baseline condition. Layton et al. found their estimated values per household were consistent with past passive use value studies of Loomis (1996) and Olsen et al. (1991) using the non-declining future baseline.

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[2]Ninety-three percent is an average for the nation and includes residents in the eastern United States where WTP was just 75 percent of the Washington value. Values in the rest of the Pacific Northwest and California were typically higher than 93 percent. Applying 93 percent of the Washington value to the rest of the Pacific Northwest and California may overstate the necessary downward adjustment (see Loomis, 1996b for a graph of the distance WTP function for Elwha River salmon).

The survey by Layton et al. was conducted by mail and had a respectable response rate of 68 percent. The survey design included a budget reminder exercise which involved households having to determine how their household spending would change with a reduction in monthly income that was equal to the dollar amounts they were asked to pay for the four different fish programs. The authors conducted a statistical analysis of the survey results and calculated a value per household for a 50 percent increase in the number of eastern Washington/Columbia River migratory fish (e.g., salmon and steelhead), an increase of 1 million fish. An increase of 50 percent is comparable to the relative change in projected salmon and steelhead from Alternative 1—Existing Conditions, to Alternative 4—Dam Breaching. The resulting value is $119 per household annually for each additional 1 million salmon and steelhead. The average annual difference between Alternatives 1 and 4 is estimated to be 47,461 fish. This suggests that transfer of the Layton et al. per fish value to the lower Snake River context would result in a conservative estimate due to diminishing marginal existence values. It should also be noted, however, that application of the Layton et al. value could represent an overestimate because this value includes both use and non-use values. To control for this, the Layton et al. values are applied only to non-user households. Those households with recreation use values were excluded to avoid double-counting these values.

This value from Washington residents was used for Washington, with 93 percent of it applied to households in the rest of the Pacific Northwest and California. This value is multiplied by the number of non-angler (e.g., non-user) households in the study region. Non-angler households were defined as those that do not hold fishing licenses. Households with a fishing license were assigned zero passive use value. This represents a conservative estimate because it assumes that all households holding fishing licenses would visit the lower Snake River. It also assumes that users receive no passive use value. Total WTP was then divided by 1 million to identify the passive use value per fish. This value per fish was applied to the number of wild salmon and steelhead that would return under each EIS alternative to estimate the passive use values associated with that alternative. Using the Layton et al. first scenario of an assumed stable future salmon population baseline, the annualized gain from Alternative 1—Existing Conditions to Alternative 4—Dam Breaching is $22.77 million annually (see Table 4-1).

4.3 Free-flowing River

While a free-flowing river is arguably less symbolic of the Pacific Northwest, the public may be motivated to return the lower Snake River to a near-natural condition for the benefit of future generations, even if they never visit or use it themselves. The DREW Recreation Workgroup estimated the passive use value for a near-natural lower Snake River based on two existing studies. These studies measure the same resource; free-flowing rivers, but address rivers located in Colorado and the upper Snake River in Idaho. The survey populations are geographically limited to Colorado residents in the first case and residents of the immediately surrounding counties in the upper Snake River case. The policy context is also notably different than the lower Snake River study. Both of the existing studies are concerned with preserving free-flowing rivers, while the present analysis is concerned with restoring the lower Snake River to a free-flowing condition by removing existing structures.

Sanders et al. (1990) conducted a mail survey of the willingness of Colorado households to pay to preserve free-flowing rivers. The annual WTP per household was $77 in 1983 dollars or $116 in 1996 dollars based on 51 percent response rate. Dividing this by the 555 miles being valued yields a value of 21 cents per mile. Multiplying this by the 140 miles of the lower Snake River yields a value per household of $29.40 per year per household. The rivers included in this list are all within Colorado and include the Yampa, Dolores, and Green Rivers.

Another study was a contingent valuation method estimate of preserving the 63-mile-long Black Canyon of the upper Snake River by not allowing development (Scott and Wandschneider, 1993). The University of Idaho conducted telephone interviews of residents of the four Southeastern Idaho counties that surround this section of the river. This survey, conducted on behalf of the Bureau of Land Management (BLM), had a response rate of 76 percent and a sample size of nearly 350.

The upper Snake River survey indicated that the slightly more than half of this sample population who were non-users (n=196) had an annual WTP of $58 for preservation of the upper Snake River (as compared to users who had a WTP of $92). Dividing this value by the 63 protected miles yields a value of 92 cents per mile per household. This value is relatively high because only individuals living in counties adjacent to the river were sampled. This value per household per mile was applied to non-user households in the counties surrounding the lower Snake River. Thus, a value of 92 cents times 140 miles, or $129, was multiplied by 305,467, the number of non-user households located in the counties surrounding the lower Snake River. This resulted in a $39.4 million in passive use value for restoring a near-natural lower Snake River. The Sanders et al. value of $29.40 was applied to the 12.95 million non-user households in the rest of Washington, Oregon, Idaho, Montana, and California, resulting in an estimated non-use value of $380.73 million for restoring the lower Snake River. Combining these two totals results in an aggregate passive use value for just the restoration of the free-flowing nature of the lower Snake River that is the sum of the two regions' values, or $420.13 million.

This value should be viewed with caution for at least two reasons. First, results taken from Colorado are applied to the entire Pacific Northwest and California with no allowance made for a possible distance willingness-to-pay function similar to the one that Loomis (1996a) identified for Elwha River salmon stocks. In addition, Colorado households may simply value free-flowing rivers differently than households in the Pacific Northwest and California. The difference in policy context—preservation versus restoration—may affect household WTP. Some households in the Columbia River Basin would be directly and negatively affected by breaching of the lower Snake River dams. They would experience loss of navigation and increased electricity rates, for example. This was not the case with the populations surveyed in the two existing studies. These types of direct use values may influence household passive use values for a free-flowing river.

4.4 Conclusion

The concept of passive use value is rarely challenged, but considerable controversy surrounds its measurement. The passive use values compiled in this study are not included in the NED account. The challenge in this study was to approximate passive use values based on the existing literature. Four studies, three of which valued salmon in the Pacific Northwest, were applied in different ways to estimate the passive use values of increases in salmon populations in the lower Snake River. The incremental passive use values for the increase in anadromous fish due to the dam breaching alternative ranges from a high of $301.51 million for households in the Pacific Northwest and California to a low of $22.77 million with a middle estimate of $48.79 million. These findings suggest that there is a passive use value associated with increases in wild Snake

River salmon and steelhead stocks, but the wide possible range identified for this value ($22.7 million to $301.5 million) underlines the difficulty in estimating this type of value from benefit transfer.

The DREW Recreation Workgroup also identified an annual passive use value of $420 million associated with returning the lower Snake River to a near-natural condition, independent of any effect on salmon populations. Again, this analysis suggests that a passive use value likely exists. But this estimate should be viewed with caution because the existing studies on which it is based evaluated different geographic regions, and those studies were performed under a different policy context than this study. Additionally, the reader is cautioned regarding the uncertainty considering the validity of the public's value statements.

Estimates of the number of wild salmon and steelhead available for harvest were developed by the DREW Anadromous Fish Workgroup based on the findings of the 1998 PATH analysis, with additional assumptions made to extend the PATH findings to all wild Snake River stocks. These data were the most current during the DREW process. Additional analyses have been conducted since, resulting in the final 1999 PATH results and the CRI analysis. The Scientific Review Panel (SRP), which was tasked to review the PATH analysis methods, found inconsistencies in the results of both the fall chinook and later the spring/summer chinook analysis developed by PATH. Adjustments made to a number of factors of concern in the original PATH analysis resulted in higher adult return predictions under Alternatives 1 through 3, which reduced the net difference between the three dam retention alternatives and Alternative 4—Dam Breaching. The adjusted PATH results were supported by the CRI modeling results. Using these revised results would lower the estimated passive use value for Alternative 4—Dam Breaching, which is calculated net of Alternative 1—Existing Conditions. The passive use values associated with a near-natural lower Snake River would not change.

5. Tribal Circumstances

5.1 Overview

Over several thousand years, the native cultures along the lower Snake River and mid-Columbia River developed subsistence-based economies that relied to varying degrees on fisheries. By the early 19th century, these cultures had a variety of effective ways for living in the unique environments of their respective areas and depended on hundreds of culturally significant natural resources and habitats found throughout the region. Established trade, political and social networks, and various alliances served to connect the region's different cultures and their economies. In these societies, villagers harvested local resources and hosted inter-band trade centers. Families commonly harvested resources in other areas through mutually beneficial agreements and concepts of exchange. Economic activities operated within the context of native cultures and were interconnected and reliant on other cultural systems such as religious, political, and social structures.

The current circumstances of tribes potentially affected by the proposed alternatives are understood in light of these former cultures, as much of the distinctive interest and legal rights of tribes associated with Corps lands and managed resources are derived from this context. Each of the mid-1800s treaties ratified by the U.S. Congress with the affected tribes specifically reserved tribal rights to continue to fish, hunt, gather, and/or pasture livestock outside of their reservations. The 1855 Stevens treaties specifically mention fishing grounds and stations and the right of erecting temporary buildings for curing. Tribes' rights and property interests pertaining to the lower Snake River may be constrained by a tribe's ceded land boundaries, usual and accustomed places, and Federal open and unclaimed lands and inter-tribal government agreements. State and Federal courts have been asked to help define such treaty rights and their geographic scope over the past century. Traditional subsistence economy based practices continue to be regulated by tribal governments, as well as religious laws and community sensibilities.

Pacific Northwest salmon play an important role in modern Native American communities as commercial, ceremonial, and subsistence harvests. Traditional fishing practices, religious values, community activities, and the long established cultural relationships with numerous native species and places define the cultural significance of Snake River habitats for Tribes. Several elements are considered by the tribes to be necessary to the meaningful exercise of fishing rights: a) harvestable amounts of native aquatic species including, but not limited to, salmon, pacific lamprey, and river mussel shell; b) access to traditional places where harvest and processing can occur; c) distribution of resources over the aquatic landscape in proportions adequate to be available for all affected tribes and the United States; d) availability of desired aquatic resources at culturally significant places (e.g., fishing stations and grounds); and e) sustainable aquatic resources and habitats to support present and future generations' harvest needs. There are 13 Federally recognized tribes and one non-Federally recognized Indian community in the study area. These tribes are identified in Section 3.6 of this appendix, Section 4.8 of the main FR/EIS, and Section 5.7 of Technical Appendix Q, Tribal Consultation and Coordination. The tribes and American Indian communities that would most directly be influenced by the proposed alternatives include four tribes with treaties signed by the United States government and one non-Federally recognized Indian community (the Wanapum). The four treaty tribes with ceded lands interests along the lower Snake River are the Confederated Tribes of the Umatilla Indian Reservation (Umatilla), the Confederated Tribes and Bands of the Yakama Nation (Yakama), the Nez Perce Tribe of Idaho (Nez Perce), and the Confederated Tribes of the Colville Reservation (Colville). Three of these tribes (Umatilla, Nez Perce, and Yakama) are addressed in a report on tribal circumstances prepared for this FR/EIS by Meyer Resources, Inc. in association with the Columbia River Inter Tribal Fisheries Commission (CRITFC) (Meyer Resources, 1999).[1] The following sections draw on the findings of this report.

Each tribe is unique with its own cultural history, native languages, and legal standing with the United States. However, many tribes have retained linkages over the years through blood ties; in cooperative pursuit of salmon and other traditional food; religion; native languages; and similarity of treaty rights. Some of the tribes potentially affected by the proposed alternatives live further away from the Snake River drainage and lack direct ties to the lower Snake River. There is a question between the Yakama and the Colville as to which government represents the Palouse descendants. The Palouse people once lived alongside the lower Snake River.

The Tribal Circumstances report presents information that represents the viewpoints of the four CRITFC tribes—the Nez Perce, Yakama, Umatilla, and the Confederated Tribes of the Warms Springs Reservation of Oregon (Warm Springs)—together with the Shoshone-Bannock Tribes of the Fort Hall Reservation (Shoshone-Bannock). These five tribes are referred to as the "study tribes" in the remainder of this section. The Shoshone-Bannock, as well as the Shoshone-Paiute of the Duck Valley Reservation (Shoshone-Paiute), would be affected to the degree that fish passage through the lower Snake River hydropower facilities affects tribal access to harvestable levels of Snake River salmon stocks within their ceded lands located in the Salmon River subbasin. Similar effects may be assessed for the Warm Springs to the extent their fisheries may be changed by Snake River fish passage conditions and associated factors exert fishing pressures on their tribal fisheries. The Colville and the Wanapum were not part of the Meyer Resources study, but are known to have comparable interests in the health and availability of aquatic resources/habitats as the five study tribes listed above. Therefore, the findings presented in the Tribal Circumstances report and summarized in the following sections are likely to be broadly representative of the Colville and Wanapum. These tribes all have close cultural and economic links to the salmon.

The six other tribes identified in Section 3.6 of this appendix, Section 4.8 of the main FR/EIS, and Section 5.7 of Technical Appendix Q, Tribal Consultation and Coordination are the Burns Paiute Tribe of the Burns Paiute Indian Colony of Oregon, the Kalispel Indian Community of the Kalispel Reservation, the Kootenai Tribe of Idaho, the Northwestern Band of the Shoshoni Nation of Utah, the Coeur d'Alene Tribe, and the Spokane Tribe of the Spokane Reservation. These tribes are not expected to be affected by the proposed alternatives as their "areas of interest" and/or ceded lands do not lie within the project area or its zone of influence.

In addition, as discussed in Section 3.5.4, it is not anticipated that the proposed alternatives would significantly contribute to ocean treaty fisheries or affect those tribes, such as the Chinook Indian Tribe/Chinook Nation and the Shoalwater Bay Indian Tribe, with ties to marine resources. Possible effects could, however, occur if access to ocean treaty fish with origin elsewhere were limited through management efforts designed to constrain ESA-listed stocks (see Section 3.5.4).

The study tribes emphasize that while revenue obtained from commercial sales of salmon provides important income to tribal peoples, it does not represent the greatest part of the benefit and value

[1] This report entitled *Tribal Circumstances and Impacts of the Lower Snake River Projects on The Nez Perce, Yakama, Umatilla, Warm Springs and Shoshone Bannock Tribes* is available on the Corps' website at: http://www.nww.usace.army.mil/. This report, prepared as part of the DREW process, is referred to as either the Tribal Circumstances report or Meyer Resources (1999) throughout this document.

that tribal peoples associate with salmon. As a result, the Tribal Circumstances report provides an assessment of the proposed alternatives that does not involve assigning dollar values to salmon.[2] The key findings of this assessment are summarized in this section. Further discussion is provided in the Tribal Circumstances report. This tribal economic circumstances discussion is part of the environmental quality account, which addresses non-monetary effects on significant natural and cultural resources.

The majority of the statistics presented in the following sections are derived from the Tribal Circumstances report and PATH baseline information. These statistics include comparisons of present social and economic well-being, estimates of historic and future tribal salmon harvest, and also describes the loss of tribal lands and assets. Information addressing sources of tribal income and the on- and off-reservation employment of tribal peoples was not available. As a result, the evaluation of the economic effects of the proposed alternatives on the study tribes is, as noted, primarily limited to information drawn from the Tribal Circumstances report.

5.2 Present Circumstances of the Study Tribes

The Tribal Circumstances report states that the peoples of the study tribes cope with poverty, high unemployment, and high rates of death. The Tribal Circumstances report includes a table that compares the recent present well-being of the study tribes with their non-tribal neighbors (reproduced here as Table 5-1).

The data presented in this table indicate that the proportion of study tribe families in poverty is notably higher than the corresponding state averages. Table 5-1 also shows that tribal unemployment rates range from 3 to 13 times higher than state averages. The higher portion of this range, derived by Meyer Resources (1999) from data compiled by the U.S. Bureau of Indian Affairs (BIA), is likely indicative of tribal employment during winter months and appears to reflect the seasonal employment of tribal members. Nevertheless, there is little doubt that tribal unemployment rates exceeded state-wide unemployment averages in 1990. The data in Table 5-1 also indicate that study tribe per capita income is less than state averages. Finally, Table 5-1 also indicates that the ratio of tribal death rates to non-tribal death rates ranges from 1.2 times to more than twice the state averages.

The Tribal Circumstances report uses the following quotation to more graphically describe current tribal circumstances:

> The personal suffering and tragic lives of many (Indian) people are not revealed in the cold reports of tribal and Federal governments. It can, however, be seen and felt in the towns and the countryside—in the eyes of men and the despair of mothers, with few options for change. When you can no longer do what your ancestors did; when your father or mother could not do these things either; when they or you found little meaning in and limited access to the ways of mainstream culture—the power of 70 percent winter time unemployment, and 46 percent of the population below the poverty level, is visible throughout the Nez Perce landscape.
>
> (Central Washington University, 1991)

[2] It should, however, be noted that the anadromous fish economic analysis presented in Section 3.5 includes In-river Treaty Indian fisheries as part of In-river Commercial fishery. These fish are assigned a food value in the anadromous fish economic analysis but are not assigned an intrinsic dollar value (see Section 3.5.4).

Table 5-1. Comparison of Present Well-being of the Study Tribes and Their Non-Tribal Neighbors

Indicator of Well-being[1/]	Nez Perce Tribe	Shoshone Bannock	Yakama Indian Nation	Umatilla	Warm Springs Tribes	State of Idaho	State of Oregon	State of Washington
Families in Poverty (%)	29.4	43.8	42.8	26.9	32.1	9.7	12.4	10.9
Unemployment[2/]								
US Census (%)	19.8	26.5	23.4	20.4	19.3	6.1	6.2	5.7
BIA (%)	62.0	80.0	73.0	21.0	45.0			
Per Capita Income ($1,000s)	8.7	4.6	5.7	7.9	4.3	11.5	13.4	14.9
Ratio of Tribal Death rate to Non-Tribal Death Rate[3/]	1.7	2.3	1.9	1.2	1.6			

1/ The data presented in this table are taken directly from the Tribal Circumstances report (Table 41). See the tribe by tribe sections in that report for further information.
2/ Census data (U.S. Bureau of the Census – 1990 Census of Population: Social and Economic Characteristics – American Indian and Alaska Native Areas) and BIA data (U.S. Bureau of Indian Affairs, 1995. Indian Service Population and Labor Force Estimates) are both included because census data is more rigorous but tends to overestimate employment. BIA numbers are less rigorous but more likely indicative of Tribal Circumstances, particularly over winter months.
3/ These data derived in part from the Indian Health Service, various years, are age-adjusted.
Source: Meyer Resources, 1999 (Table 41)

Tribal spokespersons are uncomfortable with just statistical treatments of their peoples because such data presented alone sometimes elicit a "blame the victim" reaction.

> I don't much like this talk of unemployment and poverty. Before the white man came, we had no such thing as poverty. We lived off the land. We fished, we hunted, we gathered roots and berries. We worked hard all year round. We had no time for unemployment.
>
> Poverty came with the Reservations. We were forced to live away from our salmon and our other resources. Our poverty is our lack of our Indian resources. These resources are being destroyed by the white man. That's what's causing our poverty.
>
> (Nathan Jim, Sr., Warm Springs Fish Commissioner)

5.3 Causes of Present Economic Circumstances for the Study Tribes

5.3.1 Losing Tribal Fisheries

The five study tribes have identified the decline in tribal fisheries and especially salmon declines as a drastic loss to tribal peoples. According to the Tribal Circumstances report, current tribal salmon harvests above the four lower Snake River dams are less than 1 percent of pre-contact levels (Table 5-2). The Tribal Circumstances report identifies the principal causes of historic reductions in tribal salmon harvest as preemption by competing non-Indian harvesters, and obstruction or denial of access to usual and accustomed fishing places—sometimes fenced off by non-Indian property owners. Many of these issues were eventually challenged in court. For further information on the tribal historical perspective see Meyer Resources (1999).

The transformation of the rivers to produce electricity, irrigation for agriculture, navigation services, etc., has affected salmon populations, which in turn have affected tribal salmon harvest (ceremonial, subsistence, and commercial). The Tribal Circumstances report states that as each dam was constructed, the tribes objected, calling on the government to reconsider. The tribes' arguments that these actions were contrary to their Treaties with the United States were unsuccessful. Furthermore, the use of treaty reserved Snake River fishing grounds and stations has been significantly encumbered. Tribes with ceded lands along the lower Snake River must travel outside their jurisdiction to fish for species such as pacific lamprey due to the lack of harvestable fish numbers passing through their respective fishing grounds. The implications are that an individual tribe with a treaty right to fish at its usual and accustomed fishing places must negotiate with other landowners to share with them their right to fish. The Nez Perce, Umatilla, Yakama, and Warm Springs tribes each have a treaty right to fish one-half of available fish with the other half to be shared with the United States (*United States v. Oregon*, 718 F.2d 299, (9th Cir. 1983). See Meyer Resources (1999) for additional information.

Table 5-2 demonstrates the relative changes in pounds of fish harvested by tribes over time. These numbers are approximate. It should also be noted that as fish population numbers have fluctuated over recent years, tribal fish harvests have also changed in response to governmental harvest regulations. The pre-contact harvest of 17.8 million pounds and mid-1800 period harvest of 7.9 million pounds of fish by the five study tribes is an estimate of historic tribal fishery production. Other studies, such as Hewes (1973), suggest that approximately 7.5 million pounds were harvested for the pre-contact period by these tribes. Hewes (1973) estimated the average pre-contact harvest for all Northwest Tribes at about 15 percent of the pre-contact estimated salmon run. Although Hewes assumes a relatively stable fish production rate during the early historic period, there were dramatic declines in the populations of native peoples between the mid-1750s to mid-1850s due to a series of large-scale epidemics. A corresponding reduction in tribal fish harvest production may have occurred in the inland northwest. As native people's populations rebounded, tribal fishing production likely increased, however, not to the highly efficient levels documented for non-Indian fisheries in the late 1800s. The early historic fluctuations in tribal fish harvests were in response to the natural fluctuations of the aquatic ecosystem resulting in variable cycles of fish populations, and other environmental conditions, such as ocean conditions. It appears evident that tribal populations could not physically over harvest any of the stocks until the more efficient fishing technologies were introduced by Euro-Americans.

As in historic times, the productivity of modern tribal fisheries is limited by harvest needs, catch methods, and the availability of fish. However, the modern circumstances of human and environmental effects on tribal fisheries has focused attention on fish supplementation programs (hatchery fish) to support tribal harvest needs and concerns for the viability of wild fish stock populations. Although tribes are strong advocates for actions leading to harvestable wild fish stocks conditions, the need for tribes to sustain harvestable levels of native fish has lead them to support actions promoting both wild fish stocks and hatchery fish. However, there is a concern that fish supplementation and out planting programs may dilute the wild fish gene pool and further push these stocks toward extinction. For example, since the 1970s, state hatchery programs have tried to artificially increase the total Columbia Basin wide steelhead population. However, wild steelhead fish populations now appear to be unstable and heading toward a risk of extinction despite apparent sustainable population numbers due to fish supplementation. Since the late-1980s, state and tribal efforts have acted to "boost" the Snake River fall chinook population through supplementation. Although initially the fish supplementation programs tended to produce more adult salmon, it appears to have been primarily due to above average river flows for smolt-outmigration and good ocean productivity. The NPPC's Independent Science Advisory Board's (ISAB's) review of fish

Table 5-2. Estimated Tribal Fish Harvests (1,000 lbs) [1/]—Traditional Times to the Present

	Nez Perce	Shoshone Bannock[2/]	Yakama	Umatilla	Warm Springs	Total
Estimated Pre-Contact Harvest[3/]	2,800	2,500	5,600	3,500	3,400	**17,800**
Estimated Harvest in the mid-1800s[3/]	1,600	1,300	2,400	1,600	1,000	**7,900**
Current Tribal Harvest[4/]	160	1	1,100	77 for both tribes		**1,338**
Present versus Pre-Contact Harvests (%)	5.7	0.04	19.6	1.1		**7.1**
Present versus mid-1800s Harvests (%)	10.0	0.08	45.8	3.0		**16.0**

1/ These data are presented in pounds of fish which are not easily compared to other fish data presented in this FR/EIS in terms of numbers of fish.
2/ Shoshone Bannock estimates include harvests by Shoshone-Paiute Duck Valley peoples.
3/ Pre-contact and mid-1800s, harvest estimates are based on estimated annual per capita consumption figures multiplied by estimated population totals for the early and mid-1800s. The population and per capita consumption estimates used to derive these numbers are discussed for each tribe in the Tribal Circumstances report.
4/ The peoples of the Yakama, Nez Perce, Umatilla, and Warm Springs reservations all fish in Zone 6 on the mid-Columbia River. CRITFC maintains data on the total tribal Zone 6 commercial catch. The Yakama and the Nez Perce also keep their own Zone 6 catch subtotals but the Umatilla and Warm Springs do not. The commercial component of the combined figure shown for the Umatilla and Warm Springs tribes was calculated by subtracting the Yakama and Nez Perce subtotals from the CRITFC total. The residual harvest not accounted for by the Yakama and Nez Perce estimates is assumed to be harvested by either the Umatilla or the Warm Springs. The totals presented in this table include these commercial harvest totals along with estimated ceremonial and subsistence totals obtained from each tribe. Ceremonial and subsistence data obtained from each tribe includes catches in tributary rivers and streams. These estimates are only approximate but the Tribal Circumstances report suggests that they may be considered accurate within a reasonable range of magnitude and sufficient to indicate that present day tribal harvests are less than estimated pre-contact and mid-1800 harvest levels.
5/ Only the Nez Perce fish both above and below the lower Snake River dams.
Source: Compiled from Meyer Resources, 1999

supplementation observes that adult salmon escapement becomes more difficult to sustain following the first few years and wild salmon populations are then only artificially sustained (Lichatowich, 2001).

The compelling nature of tribal cultural values concerning native fish resources has placed the meaningful exercise of tribes treaty reserved rights to fish in contrasting light with interpretations of ESA requirements to sustain wild fish stocks. Snake River wild chinook and steelhead populations are currently at risk of extinction and are fluctuating within a relatively narrow range of numbers from year to year. Pacific lamprey populations may also be at risk. The need for these fish have caused tribes to compromise and support programs that would artificially sustain fish numbers while providing for traditional harvest practices. Tribes view this as one of a series of compromises in the past century and a half made in order to maintain meaningful exercise of their legal right to fish.

5.3.2 Loss of Tribal Lands

The five study tribes control 2.6 million acres of their original Reservation lands—only 22 percent of the lands reserved in their treaties with the United States. Nine million acres of original tribal lands, together with the wealth those lands produce, are no longer in the hands of the tribes or their members. The estimated extent of tribal lands from traditional times to the present is indicated in Table 5-3. This table is taken directly from the Tribal Circumstances report, which states that the transfer of tribal wealth associated with Reservation lands into non-Indian hands was based on many injustices. For more information on this perspective see Meyer Resources (1999).

Table 5-3. Estimated Extent of Tribal "Own Lands"—Traditional Times to the Present (thousands of acres)

	Nez Perce	Shoshone Bannock	Yakama	Umatilla	Warm Springs
Tribal lands ceded to the United States by Treaty	7,500	E-NQ	10,400	6,400	9,400
Retained Treaty lands (1855)	7,500	–	1,600	510	578
Retained Treaty lands (1868)	–	2,000	–	–	–
Umatilla land retained after boundary "survey error"	–	–	–	245	–
Nez Perce land retained after "Nez Perce" of 1863	760	–	–	–	–
Lands owned today[1/]	94	544	1,126	158	658
Percent of Treaty lands owned today	1.2	27.2	70.4	31.0	100+

1/ Tribal lands owned today have been reduced from treaty times as a result of Dawes Act "surplusing" and sales, right-of-way takings, and other losses. Non-Indians often hold the highest valued lands within Reservation boundaries. Reservation lands held by Indians are often interspersed with lands held by non-Indians in a "checkerboard," exacerbating difficulties for tribal resource protection and economic development.
Note: E-NQ = extensive, but not quantified.
Source: Meyer Resources, 1999 (page xiii)

5.3.1 Tribal Perception Concerning the Adverse Circumstances of the Study Tribes

The Tribal Circumstances report provides current information on tribal perspectives. It indicates a tribal view that non-Indians have taken most Treaty-protected assets of value from the tribes—particularly their lands, waters, and salmon. Quotations illustrating the cumulative effects from a tribal perspective are presented in the Tribal Circumstances report. For example:

> My heart cries for my people, cuz we are no more Indians... All our horses are gone. No more cattle. All the pastures, the land, the hillsides, taken up by the farmers, by the white man.... Every inch of tillable ground is taken up. Where our houses used to be, they tear that down, and they put wheat in there or peas right on every inch of the ground. And they've taken down all the fences, and they've plowed through there. These big farmers, they've got everything in the world. The (Indian) owners have nothing. And they've taken everything.
>
> Like I say, they've taken our land, they've taken our rivers, they've taken our fish. I don't know what more they want.
>
> (Carrie Sampson, Umatilla Elder)

5.4 The Present Importance of Traditional Foods to the Tribes

Today, traditional foods such as salmon, pacific lamprey, deer, roots, and berries remain connected to the core of tribal community and spiritual life. When harvested, salmon is shared among the extended family, with elders, and the whole community. Once fundamental family and subsistence needs are satisfied and religious requirements fulfilled, tribes direct their salmon to commerce. Presently faced with bleak present circumstances, the tribes and their peoples still look first to the salmon with hope of a better future. This perspective is illustrated by the following quotations from Meyer Resources (1999):

> Traditional activities such as fishing, hunting and gathering roots, berries and medicinal plants build self-esteem for Nez Perce peoples—and this has the capacity to reduce the level of death by accident, violence and suicide affecting our people.

> When you engage in cultural activities you build pride. You are helped to understand "what it is to be a Nez Perce"—as opposed to trying to be someone who is not a Nez Perce. In this way, the salmon, the game, the roots, the berries and the plants are the pillars of our world.
>
> (Leroy Seth, Nez Perce Elder)
>
> The loss of the food and the salmon is monumental—and its all tied together. Food is a really big part of the Yakama culture—as it is elsewhere. Anywhere you look in the world, food carries culture. So if you lose your foods, you lose part of your culture—and it has a devastating effect on the psyche. You also lose the social interaction. When you fish, you spend time together—you share all the things that impact your life—and you plan together for the next year. Salmon is more important than just food. In sum, there's a huge connection between salmon and tribal health. Restoring salmon restores a way of life. It restores physical activity. It restores mental health. It improves nutrition and thus restores physical health. It restores a traditional food source, which we know isn't everything—but its a big deal. It allows families to share time together and builds connections between family members. It passes on traditions that are being lost. If the salmon come back, these positive changes would start.
>
> (Chris Walsh, Yakama Psycho-Social Nursing Specialist)
>
> Salmon are the centerpiece of our culture, religion, spirit, and indeed, our very existence. As Indians, we speak solely for the salmon. We have no hidden agenda. We do not make decisions to appease special interest groups. We do not bow to the will of powerful economic interests. Our people's desire is simple—to preserve the fish, to preserve our way of life, now and for future generations.
>
> (Donald Sampson, Umatilla)

Northwest communities have cultural values for salmon and use it as a part of their regional and local identities. Native American communities, represented by tribal governments, rely on harvests of native fish from the Snake and Columbia Rivers' ecosystems for daily food, community dinners (e.g., religious services, funerals, memorials, weddings), give-away ceremonies, trade, and religious purposes. Indian fishing is managed through religious laws, customs, and by both state and tribal government regulations. Native fish harvests directly support individual, family, and community standings and identities. Tribal needs are therefore linked strongly with sustainable native fish populations. Shifting emphasis away from recreational to commercial fisheries toward native fish like salmon would have little effect on increasing the economic values of non-Indian commercial fisheries (Appendix I, Section 3.5.5.3). However, such a shift would detract from tribal economic values and significantly affect community life, identity, and well being.

While fish resources can be supplemented with hatchery fish, tribes are not able to rely on commercially harvested fish as do non-Indian communities. This fact is in part attributable to the function of the traditional values and practices, native religions, and other cultural systems integral to modern Native American communities. The treaty rights of tribes to fish and their interests associated with Snake River resources are based in their traditional cultures and their understanding of what constitutes meaningful exercise of fishing rights. The distinctive elements of tribal interests and treaty-reserved rights require that fish be harvested according to customs as it serves to reinforce tribal identity and support the community life structure and individual's well-being. For example, local tribal fishing seasons are initiated with public salmon/root feasts in the context of religious services. An Indian boy's first catch is marked by a rites of passage ceremony that brings him into an adult role within the community. A man's continued role, even as a part time angler provides him social standing and respect, especially when he shares his harvests at family and community functions. Fishing is still considered an important occupation and a significant socioeconomic contribution to tribal communities. Continued use of fishing places and the teaching of younger generations of fishing laws and practices assures traditional cultural values, knowledge and community identity survive.

5.5 Reservation of the Tribal Right to Fish

The five study tribes each have treaties recognized by the Federal government as having reserved certain tribal government rights including the right to fish. Treaties between the United States and the five study tribes are identified in Table 5-4.

Table 5-4. Key Treaties between the United States and the Five Study Tribes

Treaty	Signing Date	Present Tribal Organization
Treaty with the Yakama Tribe	June 8, 1855	Yakama Nation
Treaty with the Umatilla Tribe	June 9, 1855	Confederated Tribes of the Umatilla Indian Reservation
Treaty with the Nez Perce Tribe	June 11, 1855	Nez Perce Tribe
Treaty with the Tribes of Middle Oregon	June 25, 1855	Confederated Tribes of the Warm Springs Reservations of Oregon
Fort Bridger Treaty	July 3, 1868	Shoshone-Bannock Tribes

Source: Meyer Resources, 1999 (page xvi)

Treaty negotiators representing native peoples were careful to protect their rights to fish and retain access to other key resources they depended on for survival in their treaties. The Tribal Circumstances report states that the following explicit protection can be found in each of the treaties of the Nez Perce, Yakama, Umatilla, and Warm Springs:

> Article 3: The exclusive right of taking fish in all streams, where running through or bordering said reservations, is further secured to said confederated tribes and bands of Indians, as also the right of taking fish at usual and accustomed places in common with the citizens of the Territory, and of erecting temporary buildings for curing them; together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed lands.

The Tribal Circumstances report also highlights the following article in the Fort Bridger Treaty between the United States and the Shoshone-Bannock:

> Article 4: The Indians herein named...shall have the right to hunt on the unoccupied lands of the United States so long as the game may be found thereon, and as long as peace subsists among the whites and the Indians on the borders of the hunting districts.

The Court in the State of *Idaho v. Tinno*, (497 P.2d 1386) stated that, in Article 4, "to hunt" also meant "to fish." The Tribal Circumstances report states that the intent of tribal negotiators during Treaty signings was to reserve the fish resources for harvest from river systems that were biologically functional and fully productive. It has been opined that if the tribal treaty negotiators believed they were bargaining to reserve "only a small fraction" of the salmon available to harvest in the mid-1800s, the treaty negotiations would have been much different—if they had occurred at all.

The Tribal Circumstances report also states that the treaty signers, both tribal and non-tribal, intended and designed the Treaties to take care of the needs of tribal peoples in perpetuity and subsequent to 1855 the United States government has not terminated tribal Treaty entitlements or treaty reserved rights to fish. The study tribes are thus said to maintain a legally binding entitlement to a fair share of the salmon harvest from all streams in their respective ceded area(s). For further discussion on this issue, see the Tribal Circumstances report (Meyer Resources, 1999).

5.6 Effects of the Lower Snake River Dams on the Study Tribes

As stated in Appendix A, Anadromous Fish, the four lower Snake River dams have played a part in the decline of the salmon. By the early 1960s, Snake River native fish stocks were already experiencing significant downward trends in their populations. The four lower Snake River dams were constructed between 1955 (Ice Harbor) and 1975 (Lower Granite) with construction activities ongoing at one or more of these dams throughout most of this time period. These activities likely introduced unfavorable conditions to fish in the lower Snake River and main-stem Columbia River. However, there were other unfavorable factors such as the effects of other dams on the middle Snake River and a number of low flow years for the Snake River in the 1970s as documented in the Walla Walla District's 60-year hydrographic flow record expressed in PATH salmon population simulation runs. These factors, along with other environmental conditions affected by human actions that decreased habitat suitability and increased reliance on hatchery fish production, have combined to increase the downward trend in native Snake River basin fish populations. Further declines in some fish stocks may be partially attributed to the fact that not all of the hydropower generators were installed until the mid-1980s. Fish passage improvements have increased rates of juvenile downstream migration survival from Lower Granite reservoir to Bonneville Dam 40 to 60 percent above the levels measured in the 1960s.

The construction of the four lower Snake River dams along with other mid-Columbia River dams affected the economies of tribes to the extent that native fish populations declined and tribal fish harvest reductions resulted (see Meyer Resources [1999] for additional tribal views). At the same time, the lower Snake River dams have increased the wealth of the region through enhanced production of electricity, agricultural products, transportation services, and other associated benefits. Tribes have not shared in this increased wealth at a commensurate rate and at the same time experienced losses in Treaty reserved property interests (Meyer Resources, 1999).

Historically, over 90 percent of fall chinook-spawning habitat on the Snake River was located above Hells Canyon Dam with the remaining habitat found between the confluence points of the Snake/Salmon Rivers and the Snake/Columbia Rivers. Two to five percent of the historic Snake River fall chinook spawning habitat was located in the 140-mile stretch of the lower Snake River, now in Corps ownership, and was of secondary suitability compared to the up river habitats. Based on a geomorphological analysis employing historic Snake River maps, an estimated 32 to 55 percent of the 140 miles of the currently impounded lower Snake River stretch historically served as spawning habitat. Currently, there is less than 1 percent suitable spawning habitat for fall chinook located in the four lower Snake River reservoir's tail-water areas. Construction of the four lower

Snake River dams inundated 140 river miles of privately owned land with usual and accustomed tribal fishing areas. The historical connections between modern tribes, native cultures, and the lower Snake River reservoirs are highlighted in Table 5-5, which is taken from the Tribal Circumstances report.

Several factors related to the four lower Snake River dams have contributed to wild salmonid stock declines including: a) fish passage losses; b) loss due to inundation of all but 1 percent of the 32 to 55 percent fall chinook spawning habitat and over 50 percent of the fall chinook rearing habitat historically present in the 140 miles of the lower Snake River; and c) altered river flow and temperature patterns in the lower Snake reservoirs. However, it is a challenge to assess the direct effect such unfavorable conditions have had on tribal economies. A cumulative impact report generated by CRITFC for the whole Columbia Basin has attempted to provide an analytical approach in assessing the effects of the Corps dams on tribal fisheries and economies (Beaty et al., 1999). Although the report does not focus on how the lower Snake River reservoirs have affected native fish stocks populations, it calculates that fish passage mortality rates for chinook and coho salmon through the lower Snake River reservoirs to range from 0.787 to 0.939 (Beaty et al., 1999). However, fish passage losses estimated by Beaty et al. (1999) may be unrealistically high when compared to CRI analysis that uses optimistic PATH results or when compared to actual harvest from the 1940s period and estimated pre-contact Tribal harvest published by Walter (1972) and Hewes (1973), respectively.[3]

Table 5-5. The Relationship between Present Tribal Groups, Pre-Treaty Tribal Groups, and Flooding of Lower Snake River Reservoir Areas

Present Tribal Group	Original Tribal Groups in lower Snake River Territory	Associated Flooding by lower Snake River Reservoirs
Nez Perce Tribe	Nez Perce Indians lived along the Clearwater River, and downstream along the lower Snake River to the Palouse River (north bank) and the Tucannon River (south bank).	Lower Granite, Little Goose, and Lower Monumental reservoirs.
Yakama Indian Nation	Palous peoples lived at the confluence of the Snake and Palouse rivers, and downstream along the north bank. Other bands near the mouth of the Snake River.	Lower Monumental and Ice Harbor reservoirs.
Confederated Tribes of the Umatilla Indian Reservation	Palous people lived at the confluence of the Snake and Palouse rivers, and downstream along the north bank. Walla Walla peoples lived from the mouth of the Tucannon River downstream along the south bank of the Snake River. Cayuse country extended to the Snake River.	Lower Monumental and Ice Harbor reservoirs.

Source: Meyer Resources, 1999 (Table 2)

The Beaty report suggests that the lower Snake River reservoirs may account for the majority of out-migrating juvenile salmon losses as the first dam encountered (Lower Granite Dam) may affect a higher proportion of migrating fall chinook juveniles. The same effect is not found for migrating spring/summer chinook salmon or steelhead. The Beaty report concludes that tribes have lost almost all of their lower Snake River usual and accustomed fisheries and millions of dollars of

[3] The Process for Analytical Testing of Hypotheses (PATH) and the Cumulative Risk Initiative (CRI) process are discussed in Section 5.6.1.1.

associated revenues. Beaty et al. (1999) also conclude that substantial impacts to both fishery habitats and tribal well-being have gone unmitigated.

5.6.1 The Alternatives and Their Impacts

The Lower Snake River Juvenile Salmon Migration FR/EIS considers alternatives for the four lower Snake River dams and their reservoirs, which would affect about 140 miles of the lower Snake River and approximately four miles of the lower Clearwater River. The effects of the four proposed alternatives on salmon and tribal fisheries/economies are discussed in the following sections.

5.6.1.1 Tribal Salmon Harvest

This section discusses the potential opportunities for tribes to harvest fish under the proposed alternatives. The section is divided into two main parts. The first part discusses the data available to assess the potential effects of the proposed alternatives on tribal harvest. This discussion addresses the tribal harvest estimates presented in the Tribal Circumstances report, as well as the preliminary 1998 PATH results, the final PATH results, and the Cumulative Risk Initiative (CRI) process. The second part of the section specifically assesses the potential effects of the proposed alternatives using data presented in the Tribal Circumstances report, as well as information from the final PATH results and the CRI process.

Projected Harvest Numbers

The Tribal Circumstances report presents tribal harvest estimates developed by the DREW Anadromous Fish Workgroup based on the weighted preliminary 1998 PATH results. The analysis presented in the Tribal Circumstances report converts the projected number of fish available for tribal harvest into pounds, assuming average weights of 20.1 pounds per spring and summer chinook, 19.1 pounds per fall chinook, and 8.5 pounds per steelhead. The resulting estimates for wild and for wild and hatchery fish are presented in Tables 5-6 and 5-7. Although the Tribal Circumstances report converts projected numbers of fish into pounds, it does not assign a dollar value to these fish.

The numbers presented for year 50 for each alternative in Tables 5-6 and 5-7 may be generally compared with the estimates of pre-contact harvests for the five study tribes addressed in the Tribal Circumstances report (see Section 5.3.1). Alternatives 1, 2, and 4 are projected to result in 146,100 pounds, 128,200 pounds, and 393,200 pounds of wild Snake River stocks available for tribal harvest by project year 50, respectively (Table 5-6). Estimated wild and hatchery stocks available for tribal harvest under Alternatives 1, 2, and 4 are projected to be approximately 524,000 pounds, 457,300 pounds, and 1.7 million pounds, respectively. These numbers may be compared with an estimated pre-contact harvest for the five study tribes of 17 million pounds (Meyer Resources, 1999). As noted in Section 5.3.1, other studies, such as Hewes (1973), suggest that approximately 7.5 million pounds were harvested in the pre-contact period by these tribes. This comparison provides some perspective on the projections summarized in Tables 5-6 and 5-7. It should be noted that the pre-contact estimates pertain just to the five tribes addressed in the Tribal Circumstances report. The projections summarized in Tables 5-6 and 5-7 address the amount of fish that would be available for harvest by all affected tribes and American Indian communities.

The Tribal Circumstances report cautions that the projections summarized in Tables 5-6 and 5-7 may be overestimates because the PATH analysis is built from present day conditions and fails to incorporate long-term, negative trends in Columbia River/Snake River stock sizes. The Tribal

Table 5-6. Estimated Tribal Harvest of Wild Snake River Stocks in Pounds by Species

Alternative/ Project Year	Spring/Summer Chinook (1,000 lbs)	Fall Chinook (1,000 lbs)	Summer Steelhead (1,000 lbs)	Total (1,000 lbs)	Total Change from Year 0 (1,000 lbs)	Total Change from Year 0 (%)
Alternative 1—Existing Conditions						
0	10.7	8.9	13	32.6		
10	28.2	16.8	19	64	31.4	96.3
30	54.7	21.9	93.6	170.2	137.6	422.1
50	62.4	21.5	94.8	178.7	146.1	448.2
Alternative 2—Maximum Transport of Juvenile Salmon						
0	10.7	8.9	13	32.6		
10	26.8	16.8	18.4	62	29.4	90.2
30	46.1	21.9	90.7	158.7	126.1	386.8
50	48.2	21.5	91.1	160.8	128.2	393.3
Alternative 4—Dam Breaching						
0	10.7	8.9	13	32.6		
10	27.2	24.6	18.9	70.7	38.1	116.9
30	149.3	133.1	113.1	395.5	362.9	1,113.2
50	174.6	133.6	117.6	425.8	393.2	1,206.1

Note: The Tribal Circumstances report does not address Alternative 3, but the impacts of this alternative on tribal harvest are likely to be similar to those projected for Alternative 2.

Source: Meyer Resources, 1999 (Table 50)

Circumstances report also suggests that the year zero assumptions, which were developed by the DREW Anadromous Fish Workgroup (see Section 3.5 of this appendix), likely exceed PATH's present conditions by approximately 34 percent for spring/summer chinook, and 43 percent for fall chinook (Meyer Resources, 1999).

Several other important qualifications need to be made with respect to these data. First, these data were the most current available during the DREW process. Additional analysis has been conducted since, resulting in the final PATH results released in 1999 and the CRI analysis. Second, the assumptions used by the DREW Anadromous Fish Workgroup have important implications for the pounds of hatchery fish estimated to be available for tribal harvest. Third, more recently some Snake River salmon stocks are approaching or exceeding the NMFS (1995) recovery standards. These issues are discussed in the following subsections. The final part of this section briefly discusses other culturally significant aquatic species that would also contribute to tribal treaty rights and interests.

PATH and CRI Comparison

The economic analyses presented in this appendix and the tribal analysis developed by Meyer Resources rely upon data originally derived from the preliminary 1998 PATH results. PATH continued to refine its model outputs and released its final results in 1999. After PATH was disbanded, the CRI process was initiated to assess the biological effects of the proposed alternatives. The following sections briefly describe the data used in the analysis presented in the Tribal Circumstances report and discuss the implications of the final PATH and CRI results for this analysis.

Table 5-7. Estimated Tribal Harvest of Wild and Hatchery Snake River Stocks in Pounds by Species

Alternative/ Project Year	Spring/Summer Chinook (1,000 lbs)	Fall Chinook (1,000 lbs)	Summer Steelhead (1,000 lbs)	Total (1,000 lbs)	Total Change from Year 0 (1,000 lbs)	Total Change from Year 0 (%)
Alternative 1—Existing Conditions						
0	20.6	36.2	255.7	**312.5**		
10	36.7	41.2	272.3	**350.2**	**37.7**	**12.1**
30	97	58.2	639.1	**794.3**	**481.8**	**154.2**
50	110.8	65.1	660.6	**836.5**	**524**	**167.7**
Alternative 2—Maximum Transport of Juvenile Salmon						
0	20.6	36.2	255.7	**312.5**		
10	35.3	41.2	269.9	**346.4**	**33.9**	**10.8**
30	82.4	58.2	606.2	**746.8**	**434.3**	**139.0**
50	86.4	65.1	618.3	**769.8**	**457.3**	**146.3**
Alternative 4—Dam Breaching						
0	20.6	36.2	255.7	**312.5**		
10	43.1	87.9	356.3	**487.3**	**174.8**	**55.9**
30	304.2	650.7	951.5	**1906.4**	**1593.9**	**510.0**
50	355	668	990.4	**2013.4**	**1700.9**	**544.3**

Note: The Tribal Circumstances report does not address Alternative 3, but the impacts of this alternative on tribal harvest are likely to be similar to those projected for Alternative 2.

Source: Meyer Resources, 1999 (Table 50)

Preliminary 1998 PATH Results. These data were the most current available during the DREW process. The information contained in the preliminary PATH results is limited to seven index stocks for Snake River spring/summer chinook, a comprehensive review of Snake River fall chinook, and a narrative that addresses the correlation between Snake River spring/summer chinook and steelhead SARs. The preliminary 1998 PATH results are discussed in more detail in Section 9.2.1 of this appendix. These results were expanded by the DREW Anadromous Fish Workgroup working in coordination with staff from NMFS and members of PATH to represent all Snake River wild and hatchery stocks. This expansion was necessary to assess the economic effects of future harvests under different alternatives and required that a number of assumptions be made. These included assumptions about future harvest management regimes and hatchery production and operation policies. Existing hatchery production and operation policies were assumed to continue for all of the proposed alternatives. This assumption resulted in hatchery stocks comprising very large proportions of projected harvest increases. Assumptions were also made to allocate projected returns to different fisheries. Harvest allocations were based on existing United States and tribal agreements, with the remaining harvest distributed based on historic allocations. The assumptions used to expand the PATH results and allocate them to different fisheries are discussed in greater detail in Sections 3.5.2 and 3.5.3 of this appendix.

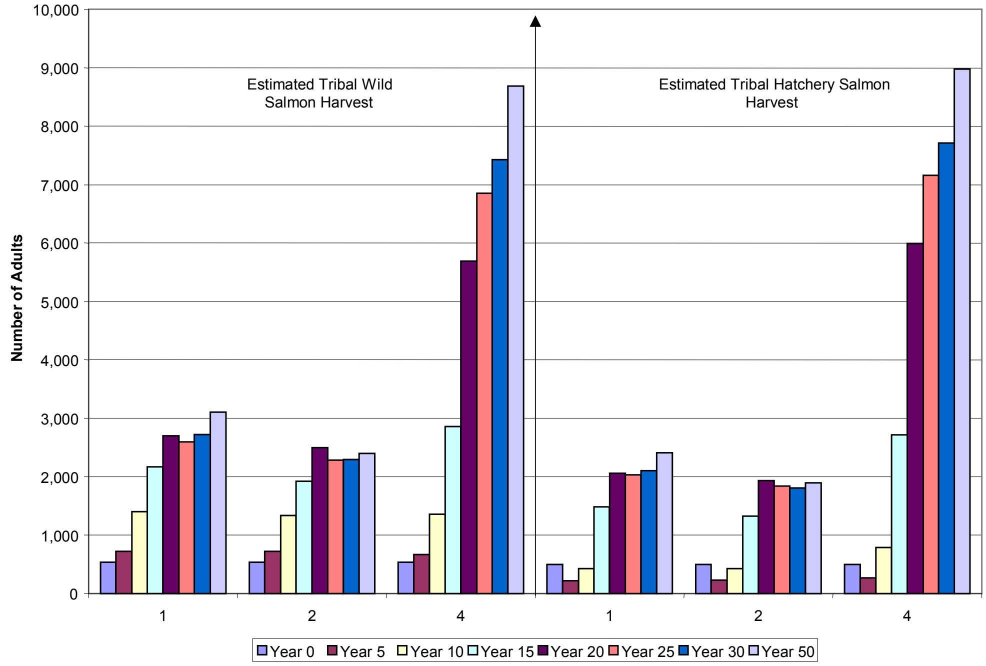
These harvest data were used by the DREW Anadromous Fish Workgroup (see Section 3.5), DREW Recreation Workgroup (see Section 3.2), and Meyer Resources to assess the economic effects of the proposed alternatives. The assessment presented in the Tribal Circumstances report uses projected harvest numbers based on preliminary PATH data weighted by PATH's panel of independent experts. This contrasts with the anadromous fish and recreation analyses, which use the DREW Anadromous Fish Workgroup harvest numbers that are based on unweighted preliminary PATH data.

Final Path Analysis Results. The Scientific Review Panel (SRP), which was tasked to review the PATH analysis methods, found inconsistencies in the results of both the fall chinook and later the spring/summer chinook analyses developed by PATH. Inconsistencies or uncertainties that were not totally resolved by PATH, included concerns about the Differential Delayed Mortality factor (D value) that PATH attributed to smolt transport, delayed hydrosystem mortality, and such factors as the fixed assigned lower Snake River survival rate of 85 to 96 percent for Alternative 4—Dam Breaching. Adjustments made to a number of factors of concern in the original PATH analysis resulted in higher adult return predictions under Alternatives 1 through 3, which reduced the net difference between the three dam retention alternatives and Alternative 4—Dam Breaching. The final PATH analysis results were released in 1999 after the economic analyses presented in this document were completed.

Cumulative Risk Initiative Model Results. The adjusted PATH 1999 results were supported by the CRI modeling results. The CRI analysis, which was performed by NMFS, used the same wild fish numbers (run reconstruction data) as that used by PATH except it was restricted to the period between 1980 and 1999. This period was used because NMFS believes this to be the most representative of the current conditions in the hydrosystem. The CRI analysis differed from PATH by not estimating the probability of achieving survival and recovery adult return standards, and also by estimating the chance of extinction occurring (which was not estimated by PATH). One of the main components used by CRI to estimate the chance of extinction was its estimate of population growth rate (lambda). While CRI did not specifically estimate returning numbers of fish due to Alternative 4—Dam Breaching, it did indicate that the PATH results for dam breaching and for all other alternatives were optimistic. CRI results suggest there are few remaining survival improvements that can be achieved from modification of the hydrosystem (i.e., Alternatives 1, 2, and 3). However, while these results suggest that Alternative 4—Dam Breaching has a slight benefit over the other alternatives, these benefits were generally still inadequate by themselves to prevent extinction of all stocks. The CRI results suggested that the best chance of prevention of extinction would be from increasing survival and fitness in the early life history stages (egg to smolt stage) (e.g., from habitat improvements) and in increasing Columbia River estuary survival (e.g., from habitat improvements and predator control).

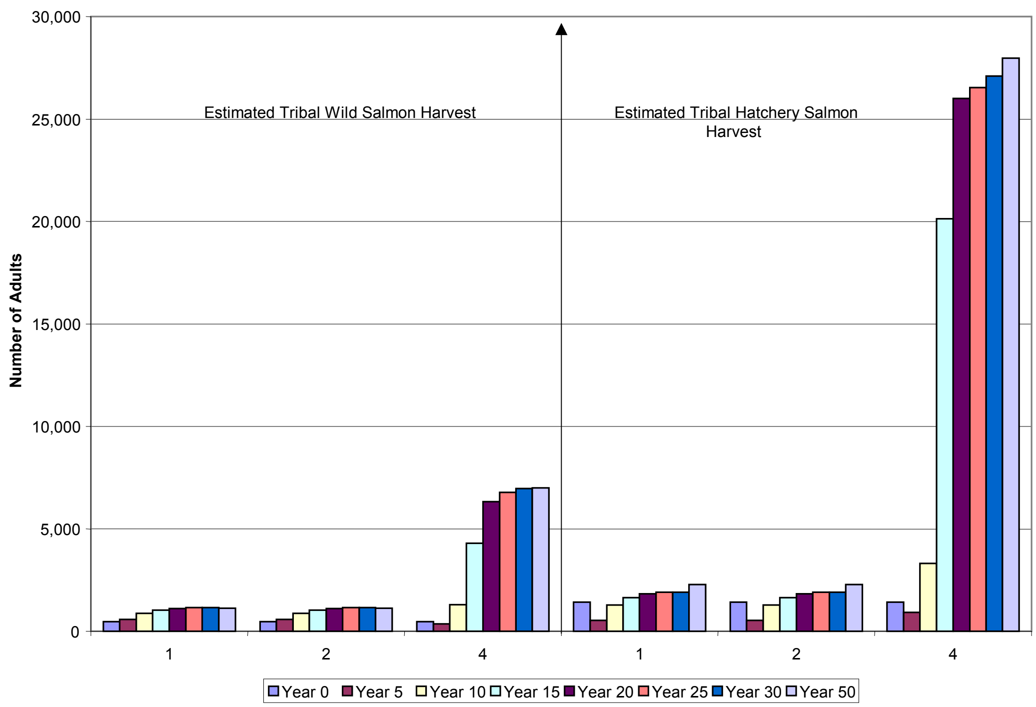
Hatchery Fish Assumptions

Figures 5-1, 5-2, and 5-3 present estimated tribal harvest data in numbers of fish. These data, obtained from Tables 48 and 49 of the Tribal Circumstances report, show projected tribal harvest numbers for wild and hatchery spring/summer chinook, fall chinook, and steelhead. Data were not provided for Alternative 3—Major System Improvements, but the effects of this alternative on tribal harvest are likely to be similar to those projected for Alternative 2—Maximum Transport of Juvenile Salmon. These figures illustrate the differences between the wild stock and hatchery population estimates.



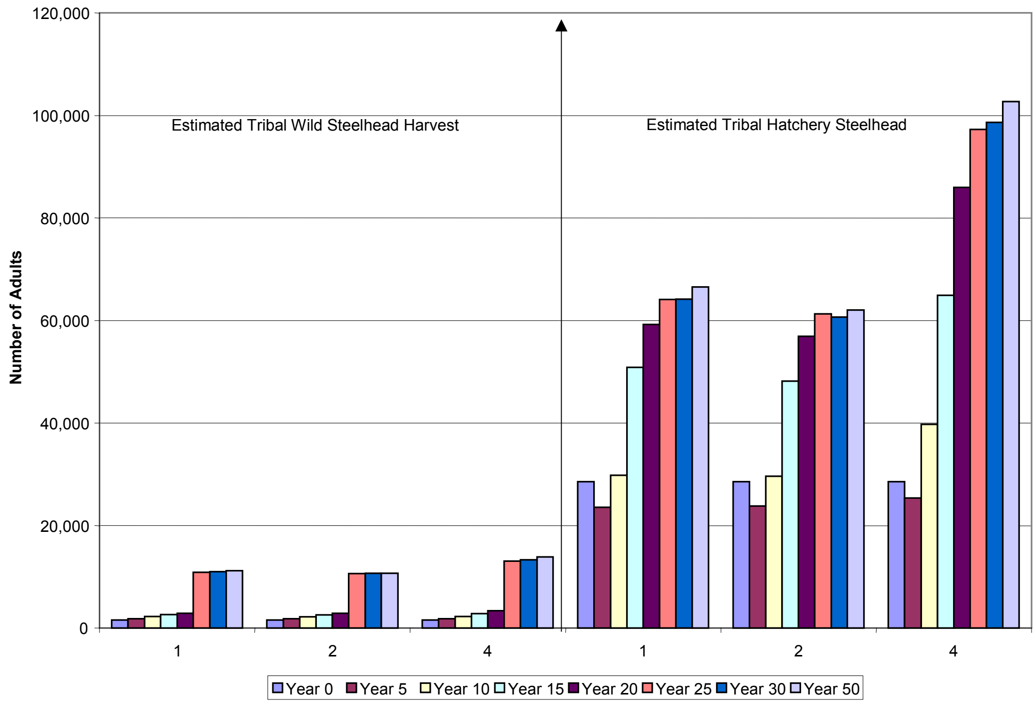
Source: Compiled from Meyer Resources, 1999 (Tables 48 and 49)

Figure 5-1. Estimated Tribal Harvest of Wild and Hatchery Spring/Summer Chinook



Source: Compiled from Meyer Resources, 1999 (Tables 48 and 49)

Figure 5-2. Estimated Tribal Harvest of Wild and Hatchery Fall Chinook



Source: Compiled from Meyer Resources, 1999 (Tables 48 and 49)

Figure 5-3. Estimated Tribal Harvest of Wild and Hatchery Steelhead

The data presented in Figures 5.1, 5-2, and 5-3 illustrate the effect of maintaining the hatchery and supplementation program at current levels for Alternatives 1, 2, and 4. These figures show that if current hatchery releases are maintained, a much larger harvest of hatchery fish is projected under Alternative 4—Dam Breaching than under the other alternatives. Assumptions about increases in passage survival contribute to this increase for all stocks. This is especially true for fall chinook and contributes to the large increase in hatchery production of fall chinook under Alternative 4—Dam Breaching (Figure 5-2). The DREW Anadromous Fish Workgroup assumed that hatchery survival would increase in proportion with the increase of wild fish survival for all alternatives and stocks. This assumption is very optimistic for fall chinook under Alternative 4—Dam Breaching because Lyons Ferry Hatchery, the only hatchery producing Snake River fall chinook, is located in the Lower Monumental reservoir, which is the second reservoir upstream from the mouth of the Snake River. If the benefit from dam removal is a function of increased survival for fish not having to pass through the four dams and reservoirs of the lower Snake River system, fall chinook hatchery fish would not receive the same level of benefit as wild stocks, which primarily originate upstream of Lower Granite Dam. Assuming the same level of increased survival for fall chinook hatchery fish, greatly overestimates the increase in survival of hatchery fish. As a result, the large projected increase in fall chinook salmon available for harvest, which consists of approximately about 80 percent hatchery fish, is not likely to be achieved.

As noted in the preceding paragraph, the projections of the number hatchery fish available for tribal harvest are based on the assumption that existing hatchery operations are maintained. However, many of these hatchery operations were built as mitigation for the lower Snake River dams effects on anadromous fish stocks. If dam breaching were to occur, the original purpose of these hatcheries would be removed. The status of future hatchery operations has not yet been determined for

Alternative 4—Dam Breaching. This raises questions about the magnitude of hatchery fish projected to be available for tribal harvest (see Figures 5-1, 5-2, and 5-3). Hatchery fish account for 80 percent, 51 percent, and 88 percent of projected total tribal harvest of fall chinook, spring/summer chinook, and steelhead, respectively.

Some of the future increase in "wild" fall chinook both for escapement and harvest is assumed to occur from the current and future supplementation program for all alternatives. Supplementation is the process of rearing fish in a hatchery for some portion of their life and then releasing them to the wild with the purpose of these fish returning to spawn with the wild and increasing the future "wild" population. As noted in Section 5.3.1, concerns have been raised about fish supplementation programs. Federal agencies (NMFS and U.S. Fish and Wildlife) and the ISAB are concerned that these programs allow for natural spawning of hatchery-reared salmon, which poses significant risks to wild salmon under most circumstances by diluting the gene pool of wild salmon and reducing their fitness and chances for survival (Lichatovich, 2001). ISAB stated that no empirical evidence exists supporting the artificial "boosting" of populations through hatchery supplementation. So, the assumed benefits of supplementation for all alternatives may not be achieved, resulting in fewer fall chinook for harvest than estimated for all alternatives by the DREW Anadromous Fish Workgroup.

Recent Fish Returns

The results of the preliminary PATH data are used in the following section, which assesses the alternatives and their impacts, to address whether the proposed alternatives would meet NMFS (1995) recovery standards. It should, however, be kept in mind that more recently some Snake River salmon stocks are approaching or exceeding these recovery standards. Recent escapement counts for Lower Granite Dam are compared with recovery levels in Table 5-8. The following paragraphs briefly discuss these data.

Snake River fall chinook have maintained low but stable population and spawning numbers above survival levels for most years since very low escapement in 1985. The data presented in Table 5-8 indicate that wild fall chinook stocks are below the evolutionary significant unit (ESU) recovery level. However, additional fish currently present within the system may bring this stock closer to recovery levels than the official count of "wild" fall chinook suggests. Many of the recent non-wild fall chinook include fish released upstream of Lower Granite Dam as part of the supplementation program and constitute members of the ESU that will contribute to the spawning individuals. As a result, these fish could be considered part of the 2,500 fish needed to reach recovery. Additionally, many Lyons Ferry hatchery origin Snake River fall chinook, which are also part of this ESU, are removed at lower Snake River dams before they reach Lower Granite Dam. As noted above the actual benefits of these fish for achieving recovery remains unclear. However, should these fish be allowed to pass upstream, they could also contribute to the spawning portion of the fall chinook possibly bringing the ESU closer to maintaining recovery levels. Maintaining the fall chinook hatchery program by removing fish at the dams may reduce the number of fish that could naturally spawn in the Snake River upstream of Lower Granite Dam.

Snake River spring/summer chinook in recent years have reached the recovery levels needed for the seven index streams indicated in the NMFS (1995) Biological Opinion. Also, the new recovery standard at Ice Harbor Dam (Table 5-8) has likely been achieved during 2001. The numbers of spring/summer chinook entering the Snake River are expected to exceed recovery standards during

Table 5-8. Recent Escapement Counts Over Lower Granite Dam Relative to Recovery Levels

Year	Fall Chinook Wild	Fall Chinook Non-Wild[1/]	Total	Spring/Summer Chinook Wild	Spring/Summer Chinook Hatchery	Spring/Summer Chinook Total
1998	306	1,603	**1,909**	8,426	5,816	**14,242**
1999	905	2,476	**3,381**	2,919	3,637	**6,555**
2000	906[2/]	2,690	**3,596**	8,895	28,861	**37,765**
2001	na	na	**na**	40,969[2/]	132,627	**173,596**[3/]
ESU Recovery	2,500[4/]			4,015[5/]		
ESU Recovery 2000				31,440[6/]		

1/ Includes Lyons Ferry hatchery fish, out of basin hatchery fish, and Snake River supplementation origin fish.
2/ Estimate based on the previous years ratio of wild to total fish, which is 22.4 percent for fall chinook, and 23.6 percent for spring/summer chinook, but not accounting for losses due to special harvests opened in zones during 2001.
3/ Through 6/19/01.
4/ NMFS (1995) Biological Opinion number over Lower Granite Dam.
5/ NMFS (1995) Biological Opinion number over Lower Granite Dam. This number is the total of seven index stream escapement numbers (NMFS, 2000).
6/ Number of wild spawners passing Ice Harbor Dam (NMFS, 2000)

2001, the first time since 1973 to 1978 that this has occurred (Corps, 1999). It should be noted that the escapement numbers also include fish not destined for the seven index streams that the recovery level number is based on. So the number of wild fish passing Lower Granite Dam and the recovery number shown in Table 5-8 are not exactly comparable.

While the recent trend, especially in 2001, is very encouraging for all stocks, this increasing escapement trend is brief and it is too soon to know if it will continue into the future.

Other Culturally Significant Aquatic Species

Although tribes are reliant on salmon, benefits to other culturally significant aquatic species would also contribute to tribes' treaty rights and interests. Fish species such as Pacific lamprey, river lamprey, Mountain whitefish, white sturgeon, sculpins, and bull trout are highly dependent on riverine ecology components, such as pool-riffle habitat, richness of food sources, spring warming of water temperatures, and unimpeded passage, that are currently restricted.

Ongoing studies indicate that structural improvements to adult fish ladders and juvenile passageways are beneficial to decreasing direct and indirect passage stress and mortality. A return to a normative riverine ecosystem would likely benefit population increases for Pacific lamprey and white sturgeon in the near future as compared to the other three alternatives, which limit fish passage. Bull trout likely would not be significantly affected by the proposed alternatives. However, there are unknowns as to how well some seasonal resident fish (e.g., bull trout and Mountain whitefish) pass through the dams. Certain traveling populations of resident fish need to exchange genetic information between Snake River tributaries in order to achieve recovery or maintain sustainable numbers. Thus, it is possible that Alternative 4—Dam Breaching could benefit certain native resident fish populations.

There is insufficient information to predict whether Pacific lamprey populations would contribute to future tribal harvest in either the Snake or Columbia Rivers. However, dam breaching would remove passage barriers for Pacific lamprey and allow for the unique conditions needed for lamprey fishing stations in the lower Snake, Clearwater, and Columbia Rivers above McNary Dam.

The estimated biomass for native resident fish species would significantly increase under Alternative 4—Dam Breaching (see Table 4-4 in Appendix B, Resident Fish). For example, while sucker species populations would remain productive under reservoir conditions, they would decline under Alternative 4—Dam Breaching. However, sucker species' biomass would almost double due to improved aquatic conditions following dam breaching. In general, predicted changes in population trends to non-native species (e.g., bass) would not contribute significantly to tribal circumstances under any alternative.

The Alternatives and their Impacts

The following sections summarize the findings of the Tribal Circumstances report with respect to the effects that the proposed alternatives would have upon tribal harvest and also the likelihood that salmon populations would meet salmon recovery standards. These conclusions are supplemented with information from the final PATH results and CRI, which were not completed in time to be included in the analysis presented in the Tribal Circumstances report.

Alternative 1—Existing Conditions

Alternative 1 would maintain existing conditions with scheduled improvements. The Tribal Circumstances reporting of PATH's assessment indicates that this alternative would not alter declines in Snake River salmon population trends toward extinction. The CRI analysis also found this. Meyer Resources (1999) states that based upon PATH there would be a 35 to 42 percent probability that wild spring/summer chinook would be removed from an endangered species listed status after 48 years, with limited changes for reaching salmon recovery thereafter. The data presented in the Tribal Circumstances report indicate that an estimated 32,600 pounds of wild Snake River stocks and 312,500 pounds of hatchery and wild stocks could be available for tribal harvest at year zero. Harvest of wild salmon and steelhead could increase by 96.3 percent by the 10-year benchmark and by 12.1 percent for both wild and hatchery fish (Tables 5-6 and 5-7).

The PATH 1999 analysis concluded that all hydrosystem actions would permit fall chinook stocks to meet the 1995 NMFS recovery standards with a greater than 0.7 probability of exceeding survival escapement thresholds regardless of influences from estuary and ocean on the survival rate of transported fish. The CRI analysis indicated that this alternative would not meet ESA guidelines as defined by the CRI analysis (NMFS, 2000) for steelhead or fall chinook recovery only has the potential to meet recovery for spring/summer chinook.

Alternative 2—Maximum Transport of Juvenile Salmon

The smolt transport assumptions utilized by PATH indicated that Alternative 2 would produce lower stock populations than Alternative 1. The Tribal Circumstances reporting of the PATH assessment indicates that this alternative would not alter declines in fish population trends toward extinction for Snake River salmon stocks and would result in lower salmon and steelhead stock populations than Alternative 1. The CRI analysis also found this to be the case. According to the preliminary PATH data, this alternative offers a 30 to 40 percent probability that spring/summer chinook would be delisted after 48 years and would be unlikely to meet tribal salmon sustainable harvest objectives (CRITFC, 1995).

The data presented in the Tribal Circumstances report indicate that harvest of wild salmon and steelhead could increase by 90.2 percent by the 10-year benchmark and by 10.8 percent for both wild and hatchery fish (Tables 5-6 and 5-7). Based on these data, tribal harvest of wild Snake River stocks under this alternative would potentially be about 7 percent lower than under Alternative 1—Existing Conditions and 6 percent lower for wild and hatchery stocks together.

The PATH 1999 analysis concluded that all hydrosystem actions would permit fall chinook stocks to meet the 1995 NMFS recovery standards with a greater than 0.7 probability of exceeding survival escapement thresholds regardless of influences from estuary and ocean on the survival rate of transported fish. The CRI analysis indicated that this alternative would not meet ESA guidelines for steelhead or fall chinook and only has the potential to meet recovery for spring/summer chinook.

Alternative 3—Major System Improvements

The Tribal Circumstances report does not address Alternative 3—Major System Improvements, but the impacts of this alternative on tribal harvest are likely to be similar to those projected for Alternative 2—Maximum Transport of Juvenile Salmon. According to the PATH 1999 analysis, transported fall chinook expected to have a high relative survival would meet recovery standards by maximizing transportation. If transported fish are assumed to have relative low survival, then allowing all smolts to migrate in-river through the current hydrosystem would achieve fall chinook recovery standards. However, transportation would not result in as high a probability of fish survival as a dam breaching action. CRI supports PATH's revised 1999 evaluation suggesting Alternative 3 would result in a higher probability of recovery than Alternative 2 due to provisions for in-river operations in Alternative 3.

Alternative 4—Dam Breaching

The Tribal Circumstances reporting of the PATH assessment indicates that wild fish stocks of spring/summer and fall chinook salmon and steelhead would likely be stabilized and in the long-term lead to increases in the populations to near recovery following breaching of the four lower Snake River dams. The CRI analysis also found this. Preliminary PATH information suggests that this alternative may offer an 80 percent probability that spring/summer chinook would be delisted after 48 years. Meyer Resources (1999) concluded that only Alternative 4 would redirect actions influencing aquatic resources toward significant improvement of resource conditions and the socioeconomic circumstances of the five study tribes.

The data presented in the Tribal Circumstances report indicate that harvest of wild salmon and steelhead could increase by 116.9 percent by the 10-year benchmark and by 55.9 percent for both wild and hatchery fish (Tables 5-6 and 5-7). This was estimated to mean that Alternative 4 could result in 2.4 times more tribal harvest opportunities of Snake River wild and hatchery fish than Alternative 1—Existing Conditions (Meyer Resources, 1999). However, as noted above, the large projected increase in hatchery fish available for tribal harvest under Alternative 4—Dam Breaching is unlikely to occur.

Breaching the four lower Snake River dams may increase population estimates for Pacific lamprey and sturgeon by removing passage barriers, reducing fish passage stress, and restoring critical juvenile rearing and adult spawning habitat given suitable river flow levels.

5.6.1.2 Impacts on Flooded Lands Important to the Study Tribes

Alternatives 1 through 3

Under Alternatives 1 through 3, tribal people would continue to be separated from the land in which their ancestors are buried along the lower Snake River and unable to care for their graves.

The four reservoirs prevent tribal fishing, hunting, and harvesting roots and berries at many usual and accustomed locations. These reservoirs also prevent traditional native peoples from holding religious and cultural ceremonies used to pass certain cultural knowledge and values to younger generations at locations that are below the present-day water levels.

The dams and reservoirs inundate lands associated with the substantial aspects of cultural, material, and spiritual life along the lower Snake River for affected tribal peoples—and separate tribal peoples from those culturally significant places.

Alternative 4—Dam Breaching

This alternative would draw the four lower Snake River reservoirs down, and could potentially create substantial benefits for affected tribes. According to the Tribal Circumstances report, the study tribes feel that this would allow tribal communities to renew their close religious/spiritual connection with approximately 34,000 acres of lands where their ancestors lived and are buried, and allow them to properly care for their graves. Dam breaching would expose more than 600 to 700 locations where they lived; fished; hunted; harvested roots and berries; conducted cultural and religious ceremonies; and pursued other aspects of their normal traditional lives. Renewed access to traditional ethno-habitats and places would in part be contingent on the physical condition of such lands following erosion control and land rehabilitation programs.

The Tribal Circumstances report indicates that tribal benefits associated with lands that are presently inundated could be obtained under Alternative 4—Dam Breaching in the following ways if these actions were implemented:

- by restoring treaty-based tribal access rights to usual and accustomed fishing places along the restored river sides
- by restoring treaty-based tribal access rights to hunt and gather on ceded, open, and unclaimed public lands alongside the restored river sides
- by making it possible to return any tribal individual allotment lands in the reservoir area, acquired by the Federal government when the reservoirs were built, to tribal hands (i.e., to the Native American families that may have held any such allotments)
- by making it possible to transfer uncovered reservoir lands to tribes. (Congressional legislation would be needed for implementation of this action.)

5.7 Cumulative Tribal Impacts of Lower Snake River Project Alternatives

The Tribal Circumstances report states that Alternative 4—Dam Breaching is the only viable alternative for restoring the tribal fishery and providing other benefits to the tribes.

Alternatives 1 through 3

The Tribal Circumstances report states that under Alternatives 1 through 3, the lower Snake River would continue to function at present levels, continue tribal losses of treaty-protected salmon due to the dams, and, therefore, maintain the distribution of benefits from the river primarily to non-tribal hands.

Alternative 4—Dam Breaching

The study tribes believe that selection of Alternative 4—Dam Breaching, which would return the lower Snake River to a near-natural condition, would have the opposite effect on cumulative trends along the lower Snake River. The Tribal Circumstances report notes that this alternative offers more than twice the tribal harvest projected under the other alternatives and would increase current study tribe harvests from all Columbia River/Snake River system salmon and steelhead stocks by 2.3 times. Note that this estimate relies on the assumption that current hatchery releases are maintained. If current hatchery releases are maintained, a much larger harvest of hatchery fish is produced under Alternative 4—Dam Breaching than under the other alternatives (see Figures 5-1, 5-2, and 5-3). This alternative would remove waters presently covering some 140-plus miles of shoreline and create access to important tribal locations along the lower Snake River. For additional tribal views on impacts associated with flooding and the lower Snake River reservoirs see the Tribal Circumstances report (Meyer Resources, 1999, Table 53).

According to the Tribal Circumstances report, from a cumulative policy perspective, the study tribes see selection of Alternative 4—Dam Breaching as reversing an almost century and one-half trend that cumulatively stripped the tribes of their valued and treaty-protected assets. The study tribes also think Alternative 4—Dam Breaching would move toward "rebalancing" distributions of the wealth that the lower Snake River can produce between the tribes and non-tribal peoples of the study area. Such actions may not result in immediate improvements to tribal material well-being and health, but the Tribal Circumstances report states that over future years, as the salmon stocks become stronger, so would the health and economic well-being of tribal members.

Table 5-9 summarizes the conclusions reported in the Tribal Circumstances report concerning the cumulative impact of the proposed alternatives on the five study tribes. This table indicates a general pattern of positive improvements under Alternative 4—Dam Breaching in the areas of tribal distribution of wealth; health and material well-being; religious and spiritual well being; and tribal self-sufficiency and self-empowerment.

5.8 Conclusion

This section describes the potential effects of the FR/EIS alternatives upon the socioeconomic interests and treaty rights of affected tribes and a non-Federal recognized American Indian community. Indicators of tribal communities' socioeconomic well being and cultural survival (e.g., tribal unemployment and health) were considered.

Table 5-9. Summary of Cumulative Tribal Impacts from the Proposed Alternatives

Tribal Impact	Alternative 1	Alternatives 2 and 3	Alternative 4
Wealth Distribution	Non-tribal interests continue to accumulate wealth. Tribal loss of valuable assets continues.	Same as Alternative 1, but slightly more adverse.	Begins rebalancing the river's production function. Some wealth transfers from non-Indian interests back to the tribes begin as inundated lands are exposed and salmon is restored.
Health and Material Well-being	Will continue to preempt tribal subsistence and economic activity. Will continue adverse effects on tribal nutrition and general health.	Same as Alternative 1, but slightly more adverse.	Will begin reversal of adverse cumulative nutrition and health circumstances. Will reduce tribal poverty over time. Will broaden the base for tribal subsistence and, where appropriate, tribal economies.
Spiritual/ Religious Well-being	Continues to endanger the salmon, one of the key elements that provide religious, spiritual, and cultural definition for the study tribes.	Same as Alternative 1, but slightly more adverse.	Will remove salmon from endangerment. This will generate major benefits for key elements of tribal religion and spirituality, which will be removed from endangerment as well.
Tribal Empowerment	Continues to discount the knowledge and recommendations of tribal peoples concerning survival of Snake River salmon, disempowering the tribes.	Same as Alternative 1.	Credits the knowledge and advice of tribal peoples on what is required for the Snake River salmon to survive and recover. This would increase feelings of empowerment and self-worth among tribal peoples.

Source: Meyer Resources, 1999 (Table 54)

Those tribes and American Indian communities most directly influenced by the alternatives include four tribes with treaties signed by the United States government and one non-Federally recognized Indian community. These tribes are the Umatilla, Yakama, Nez Perce, and Colville tribes and the Wanapum Indian community. The Colville and the Wanapum were not a part of the Meyer Resources study but are known to have cultures and interests in the health/availability of aquatic resources and habitats comparable to those of the five study tribes addressed by Meyer Resources. The Shoshone-Bannock, Shoshone-Paiute, and the Warm Springs may also be affected to the extent that their fisheries may be changed by the alternatives. The alternatives are not expected to affect the six other tribes identified in Section 3.6 as their “areas of interest” and/or ceded lands lie outside of the project’s zone of influence. As discussed in Section 3.5.4, it is not anticipated that the alternatives would significantly contribute to ocean treaty fisheries or affect those tribes, such as the Chinook Indian Tribe/Chinook Nation and the Shoalwater Bay Indian Tribe, with interests/treaty rights in marine resources. Possible effects could, however, occur if access to ocean treaty fish with origin elsewhere were limited through management efforts designed to constrain harvest of ESA-listed stocks (see Section 3.5.4).

The implications of these treaty rights and other tribal concerns were evaluated for the proposed alternatives based on various general criteria including, but not limited to, the following:

- accessibility to usual and accustomed places for the exercise of treaty rights
- economic well-being of tribal communities using variables such as employment and income levels
- effects to the Snake River's seven index salmon stocks (wild and hatchery fish) relating to harvestable pounds of fish by species

- ownership of land by tribes or tribal members inclusive of the project area
- allowances for cultural survival and religious practices by providing access to culturally significant places (e.g. cemeteries/burial places, ethno-habitats like traditional fishing stations, root and berry fields). The preservation/protection of culturally significant places, features and objects (archaeological sites and traditional cultural properties) is addressed in Appendix N, Cultural Resources.

The Shoshone-Bannock's treaty-reserved right to harvest fish includes both their reservation and their ceded lands. For the other four study tribes, treaty reserved fishing rights may extend beyond their ceded lands to include places where they once customarily fished. Improvements to fish populations will benefit tribes to the extent that they allow for harvestable numbers of fish to pass through their "areas of interest" in sufficient numbers for both themselves and the United States government with whom they share the right to fish. The interests of tribes, although closely linked to the health of native fish populations, are more directly related to the availability of and access to culturally significant fish for harvest.

Under Alternative 4—Dam Breaching, there could be more utilization of tribal off-reservation treaty rights and interests. Based on preliminary PATH analysis, there would be an 80 percent probability for recovery of culturally significant wild spring/summer chinook from their threatened status under ESA. According to the CRI analysis, Alternative 4—Dam Breaching could improve salmonid migration survival through the lower Snake River and may improve survival following the migration life stage. Estuarine survival could be improved by reducing some delayed mortality perceived by some as a consequence of passing through the hydrosystem. Access to culturally significant places would be greatly increased. Opportunities to practice socioeconomic and religious activities along significant lower Snake River traditional cultural landscapes and places may be possible. Based on the preliminary PATH analysis, Alternatives 1 and 2 may not improve conditions for tribal harvest practices (e.g., there is only a 30 to 42 percent range of probability that spring/summer chinook would be recovered after 48 years) and access to culturally significant places would not include reservoir inundated lands. Alternative 3 is projected to have similar results as Alternatives 1 and 2. These three alternatives may not improve or add to tribal socioeconomic well being. In addition, there would be no increased access to other riverine culturally significant places, cemeteries, or resources.

According to the CRI analysis, the risk of extinction for the seven Snake River spring/summer chinook salmon index stocks is less than 15 percent for all the alternatives over the next 10-year time span. Management aimed solely at improving in-river migration survival could stabilize, but would not reverse the Snake River spring/summer chinook salmon population declines. While dam breaching would not likely affect available spawning habitat for spring/summer chinook or first year survival, it could improve their estuarine survival considerably if the arguments for a low "D" (differential transport mortality) value is valid and breaching the four lower Snake River dams would eliminate spill causing total dissolved gas over 110 percent. In the Columbia Basin, the Snake River spring/summer chinook ESU is not at a greater risk of extinction for its wild stocks than any other ESU. However, spring/summer chinook is not likely a viable species under current conditions in the Snake River. Modest reductions in first year or estuarine fish mortality would reverse current population declines. The CRI analysis has concluded that even if mainstem survival were elevated to 100 percent, Snake River spring/summer chinook would likely continue to decline towards extinction. However, even minor improvements in first year or estuarine survival rates would reverse the current population declines. See Appendix A, Anadromous Fish for a more detailed discussion of the findings relating to PATH and CRI analysis of the four alternatives.

The majority of benefits to fall chinook would likely occur in their first year when they migrate downstream to the estuarine environment as the latent effects from dam passage would no longer be a survival factor. The critical variables affecting fall chinook stocks are inadequate distribution of suitable habitat on the mainstem Snake River and river temperatures that do not mirror the historic pattern needed for timing their migration to the ocean. The inclusion of hatchery fish reproduction further contributes to the declining trends in wild fish stocks, particularly for steelhead. Reductions in ocean and mainstem Columbia River harvests could stabilize salmon populations in Snake River, Lower Columbia chinook, and Upper Willamette River areas.

There are management actions and environmental factors within and outside the project area that could significantly influence native fish population trends and the recovery of listed or endangered wild fish. Efforts to increase the number and quality of fish habitat; limits on future increases in harvests of surplus fish numbers at ocean and/or mainstem Columbia River fisheries; limits on hatchery fish reproduction; improvements at Columbia River hydropower facilities for fish passage; and continued regulation of water flows and temperatures all would help improve depressed wild salmon stocks on the lower Snake River. Any efforts to simulate the normative river environment would, however, need to approximate the natural timing and environmental conditions of salmon out-migration, spawning and rearing to actually benefit anadromous fish species. Prioritizing ESU areas and fish stocks for future management attention and meeting habitat requirements of different aquatic species at the regional level would ultimately provide beneficial conditions for wild fish stocks.

While wild fish stocks decline toward extinction risk levels or fluctuate around species survival numbers, tribal fisheries could be supplied with hatchery fish numbers sufficient to sustain tribal harvest needs. However, fish supplementation could detract from positive wild fish population trends (CRI) and would not necessarily resolve fish passage or survival needs of other culturally significant species such as Pacific lamprey. Tribes and states currently operate fish supplementation programs. These supplementation programs may affect future wild Snake River fish population trends, however, their effects lie outside of the scope of this FR/EIS. Efforts to sustain native fish populations toward harvestable numbers would likely benefit tribes, especially if reliance on hatchery fish could be reduced.

The proposed dam breaching alternative is fundamentally an effort to improve passage of wild fish stocks through the lower Snake River reservoir system and to that extent it also serves to support affected tribes' interests and treaty rights. Federal land management that provides for both access to places of tribal interest and contributes to sustainable and harvestable populations of culturally significant aquatic/terrestrial communities has the greatest potential to provide for the meaningful exercise of treaty rights and the concerns of affected tribes. Alternative 4—Dam Breaching could support the fishing interests of affected treaty tribes by providing both the likelihood of reaching recovery for both wild fall and spring/summer chinook and steelhead and by restoring normative river conditions considered likely to improve other native wild fish populations.

Only Alternative 4—Dam Breaching would likely benefit both native aquatic and terrestrial habitats currently inundated and provide renewed access to culturally significant places. The return of normative river conditions would benefit both tribes and state agencies seeking to provide harvestable fish population levels by increasing their options to include both habitat restoration and existing fish supplementation and out planting programs. Those tribes that have lost opportunities within their ceded lands to catch fall, spring/summer chinook, and Pacific lamprey from their fishing grounds and stations would likely be able to renew their traditional fishing practices under Alternative 4 and expect to harvest spring/summer and fall chinook without a reliance on hatchery fish to meet harvest needs.

6. Regional Economic Development Analysis

6.1 Introduction

The following regional economic analysis is concerned with the impacts that the proposed alternatives would have on the local economy. The purpose of the RED account is to inform decision makers, business owners and managers, households, and investors about the projected impacts of the proposed alternatives on their enterprises and livelihood. Owners, managers, workers, and investors are all concerned with the future markets for their products and services. If certain markets are expected to weaken, owners and managers must plan for reductions in capital expenditures and layoffs of employees. Employees must start a job search and possibly plan to relocate in order to find employment. Investors may wish to reallocate their money to more promising ventures. If other markets are expected to expand, management, employees, and investors must plan for increases in capital spending and the hiring of new workers.

The NED sections of this appendix (Section 3) discuss the economic effects that the proposed alternatives would have on power, transportation, water supply, and other aspects of the national economy. Increased or reduced spending associated with these changes would also affect the regional economy. These effects would be larger than those directly associated with the initial change in spending because direct changes in one sector of the regional or local economy have indirect and induced effects on other sectors. An influx of funds, for example, is spent and re-spent in the local economy as expanding sectors hire labor and buy business inputs and services from local suppliers. This process is known as the multiplier effect. The more locally produced goods and services purchased, the larger the multiplier effect. A reduction in spending also has indirect and induced effects. Closure of a business in a particular community, for example, has predictable impacts on other firms located in that community. Loss of a business results in less local spending of workers' wages and salaries, and less local spending for business inputs and services, therefore, making the total impact to the economy larger than the initial change.

Business transactions are the driving force behind the economy from an input-output modeling perspective. Changes in employment, income, sales taxes, school enrollment, highway traffic, air, water, and noise pollution, and similar variables are directly related to changes in business transactions. As a result, regional impacts are created by transactions at every stage of production. These regional impacts are measured at each stage of production in this RED analysis using input-output models. The NED account, in contrast, counts only the transactions for final sales to the ultimate consumer to measure the contribution to domestic product or the national economy.

The regional economic analysis developed for this study addresses the regional economic impacts of changes in spending projected by various DREW workgroups. These impacts, evaluated in terms of business transactions, employment, and personal income, were estimated using input-output models, which model the interactions among different sectors of the economy. Business transactions are the estimated gross receipts received by a business (with the exception of those businesses in the trade sectors where it is the margin or the value added by that business). Employment is measured in full-time and part-time jobs. Jobs are usually viewed as the single most important outcome of increased business transactions and the greatest concern when economic growth falters. Personal income, the third measure used here, consists of wages, salaries, social insurance, and profit received by individuals. The impacts to regional business transactions, employment, and personal income summarized in the following sections are presented as net changes from existing conditions. The DREW Regional Analysis Workgroup projected changes to business transactions, employment, and personal income over the 100-year study period.

The economy of the lower Snake River study area and the Pacific Northwest as a whole has changed since 1970. Historically, important job sectors such as logging, mining, farming and ranching have declined or remained constant over this period, while employment in the services sector has dramatically increased. Non-labor sources of income, particularly transfer payments, have increased as a component of total regional income. Employment is projected to increase over the next 20 years in the lower Snake River study area. These projected increases and the evolving structure of the regional economy form a backdrop against which changes in employment projected for the proposed alternatives should be considered. Although employment in resource-based industries, such as logging and farming, will likely continue to decline as a share of total employment in the affected states, it will remain an important part of the region's economic base, especially in counties and communities where resource-based industry is the dominant form of economic activity. Projected job changes may represent a small percentage of total existing and projected employment, but the loss of these jobs could be significant for the counties and communities where they are concentrated. Potential impacts to local communities are discussed in the DREW Social Analysis report (DREW Social Analysis Workgroup, 1999) and Section 7 of this appendix.

The remainder of this section is divided into four parts. Section 6.2 provides a brief discussion of the input-output methodology employed for this analysis. Section 6.3 presents the results of this analysis by resource area. In many cases only Alternative 4—Dam Breaching creates economic change sufficiently large to warrant measurement. The impacts are summarized across the three measures employed in this analysis—business transactions, employment, and personal income—in Section 6.4. Section 6.5 provides a general discussion of the potential impacts of dam breaching on regional industries and businesses where there was not sufficient information available to quantify these impacts. All tables and figures presented in the remainder of this section were developed as part of the DREW Regional Analysis Workgroup's Study. Sources of secondary information used by the DREW Regional Analysis Workgroup to develop these tables and figures are listed, as appropriate.

6.2 Input-Output Methodology[1]

Input-output models estimate the impacts of changes in one economic sector on the rest of the regional economy. Input-output modeling employs an accounting system that includes all the industries in a study region. The input-output accounts measure the interdependence among industries and workers in an economy. The greater the interdependence among industry sectors, the

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[1] The following discussion was prepared by the DREW Regional Analysis Workgroup and applies specifically to the eight input-output models that they developed to assess the regional impacts associated with the power, recreation, transportation, water supply, implementation costs, and avoided costs (see Section 6.2.2). This discussion also generally applies to the models used by the DREW Anadromous Fish Workgroup to assess the regional impacts associated with commercial fishing and ocean recreational fishing. The DREW Anadromous Fish Workgroup's analysis for U.S. states also relies upon input-output models developed using the impact analysis for planning (IMPLAN) model (see Section 6.2.1).

larger the multiplier effect on the economy (and jobs) if a local industry makes sales to persons or firms outside the region or to government. The input-output technique is a model of sales flows among industries and government agencies that is based on historical purchase patterns for each industry and for consumers. The input-output model simultaneously considers the interdependent spending changes among industries in the region that provide goods as inputs (the indirect effects), and households in the region that provide labor and management services to directly and indirectly affected industries (the induced effects).

Sales to final demand are the portion of an industry's sales that are for export (from the defined study region), sales to government, or to create new physical investment. Sales to final demand are an important measure because they are the driving force that supports the economy. Exports, sales to government, or sales for investment (i.e., new physical capital or addition to inventory) are the only sources of new spending for a regional economy. In this analysis, the primary changes in final demand sales are sales to Federal government and exports. Sales to final demand have a multiplier effect on the economic activity of a region because the expanding sector employs local labor and buys inputs from local suppliers to create added output. Local suppliers must increase their purchases, spreading the expansion throughout the economy.

Each alternative has positive or negative changes in sales to final demand (including changes in government spending, changes in output of affected industries, and physical investments by private enterprise) which create indirect and induced changes in business transactions, employment, and personal income in the study regions. These economic changes are shown by input-output multipliers that are applied to the change in sales to final demand to calculate the cumulative economic impacts throughout the economy of a region. The secondary impacts for some industries are mainly local while other industries' impacts would occur at locations throughout the Pacific Northwest.

Economic changes created by the alternatives can be "short-run" or "long-run." Short run is used in this section to describe the impacts of construction or other temporary spending that lasts for less than 10 years. In contrast, long-run impacts are expected to last longer than 10 years and in some cases be permanent and continue for the 100-year period analyzed in this study.

6.2.1 Limitations of the Analysis

Regional economic impacts are measured in this analysis using input-output models with industry spending coefficients estimated or synthesized from national data rather than from surveys of local industry. These models were constructed based on the 1994 impact analysis for planning (IMPLAN) computer system originally developed by the U.S. Forest Service and now offered for general use by the Minnesota IMPLAN Group. This system can be used to construct county or multi-county models for any region in the United States. The regional models are based on technical coefficients from a national input-output model and localized estimates of total gross outputs by sector. IMPLAN adjusts the national level data to fit the economic composition and estimated trade balance of a chosen region. Some valid criticisms have been directed at synthesized input-output models as opposed to survey based input-output models. First, the synthesized industry spending coefficients are based on relationships between industries on a national scale. These generalized relationships may not apply to the specific region under study. An input-output model, unlike many other economic models, is constrained and consistent. The model is a double-entry bookkeeping system of accounts. Total sales must equal total purchases in each sector and for the economy as a whole and including imports and exports from the study region. A 90-industry input-output model (as used in this study) is equivalent to a sales maximizing linear program with 90 constraint equations that limit the outcomes. These built-in constraints limit most input-output models business transactions multipliers (direct, indirect, and induced effects) to lie between 1.5 and 3 regardless of the underlying data source. Recent IMPLAN models, which use much more refined data than earlier models, are typically within 10 percent plus or minus of the multipliers that would be found using survey data in place of national averages. This conclusion is based on experience with constructing about 30 direct survey input-output models. Furthermore, IMPLAN contains known sources of error that have been adjusted for in this analysis.

One limitation of this type of regional impact analysis is that it presents a picture of the economy at a single point in time. This picture is based on historical ratios between different sectors of the economy rather than a dynamic structure of changing relationships. This does not allow business owners to adapt to resource changes by making different investment decisions (Mendelsohn et al., 1994). When prices or costs change in response to public policy changes, consumers and producers respond by substituting among final goods, substituting among inputs to production, migrating among regions, and shutting down businesses that are no longer profitable. To evaluate these sorts of changes, economists must first use supply and demand models to estimate the direct effects, which are then used to drive the input-output model. Accurate estimates of regional change are dependent upon the projections of direct effects by sector that drive the input-output modeling.

Input-output analysis tends to overstate long-term impacts because it assumes that all possible adjustments to disturbance are permanent, and that individual responses to disturbances are limited. People who lose jobs, for example, are assumed to stay unemployed. In reality, people and businesses adjust over time, as they consider and try alternative occupations, technologies, and locations (IEAB, 1999).

6.2.2 Study Regions

The DREW Regional Analysis Workgroup constructed eight input-output models to address potential regional impacts associated with the alternatives. Models were developed for Washington, Oregon, Idaho, and Montana, three subregions, downriver, reservoir, and upriver, and the lower Snake River study area, which consists of the three subregions (see Table 6-1 and Figure 1-1). The downriver subregion consists of those counties adjacent to the upper stretch of the lower Columbia River, which would be the terminous of barge transport under Alternative 4—Dam Breaching. The reservoir subregion, which consists of those counties that adjoin the four lower Snake River reservoirs, would see changes in barge transport and gain free-flowing river recreation under Alternative 4—Dam Breaching. The upriver subregion consists of those counties in central Idaho and northeast Oregon that would lose barge transport and gain increased fishing opportunities.

The subregion models were developed to examine cases, such as a reduction in irrigated agriculture near the Ice Harbor reservoir, where impacts are relatively localized. Evaluating localized changes using a statewide model would tend to overestimate the impact. States are less dependent on imports than smaller regions and, therefore, tend to have larger multiplier effects. The state models are used to evaluate impacts that occur either throughout the Pacific Northwest, throughout a state, or in an area of a state outside the subregions.

Table 6-1. Regional Economic Analysis Study Area by State and County

Downriver Subregion	Reservoir Subregion	Upriver Subregion
Oregon	**Washington**	**Idaho**
Gilliam	Adams	Clearwater
Hood River	Asotin	Custer
Morrow	Columbia	Idaho
Sherman	Garfield	Latah
Umatilla	Walla Walla	Lemhi
Wasco	Whitman	Lewis
		Nez Perce
Washington		Valley
Benton		
Franklin		**Oregon**
Klickitat		Wallowa
Skamania		

The downriver and upriver subregions consist of counties from more then one state. Defining these subregions in this way prevents a presentation of net impacts by state because it is not possible to allocate the impacts estimated using these models to their constituent counties or states. Impacts can, however, be summarized for the Pacific Northwest but it should be noted that combining state and subregion impacts tends to obscure the potential significance of local impacts. The loss of 1,105 jobs in the reservoir subregion, for example, appears less significant when viewed in terms of total employment in Washington or the Pacific Northwest than it does when viewed at a more local level. Further, the loss of these jobs in a relatively localized area has different implications than if it were to occur throughout Washington State.

The DREW Regional Analysis Workgroup used these models to assess the regional impacts associated with the power, recreation, transportation, water supply, implementation costs, and avoided costs.

In addition, the DREW Anadromous Fish Workgroup assessed the regional economic impacts associated with commercial fishing and ocean recreational harvest. These impacts were calculated using economic base analysis techniques which rely on input-output models that translate direct fishing expenditures and hatchery costs into total personal income.[2] United States state and Canadian province economic level ratios of personal income to total employment (full and part-time) and personal income to business activity (cash receipts less cost of inventory) were used to estimate job and sales impacts.

6.3 Economic Impacts by Resource Category

This section presents the direct, indirect, and induced regional economic impacts of the proposed alternatives by resource category. Employment changes projected by the 1994 IMPLAN model were divided by 1.07 to adjust for inflation when using final demand changes in 1998 dollars. The

[2] The DREW Anadromous Fish Workgroup constructed input-output models for the Pacific Northwest states and Alaska, using the IMPLAN model and used an existing input-output model for British Columbia (Radtke, 1997).

IMPLAN model projects employment on the basis of jobs per dollar of transactions in 1994. Thus, without this adjustment, inflation would cause projected changes in jobs to be overstated. All impacts are shown in 1998 dollars. Readers are referred to the DREW Regional Analysis Workgroup (1999) report for a more detailed discussion of the methodology and findings of this analysis. This report is available on the Corps' website at http://www.nww.usace.army.mil/.

6.3.1 Power

6.3.1.1 Potential Rate Increases

If dam breaching were to occur, hydroelectric generation would no longer be possible at the four lower Snake River dams. This would lead to a need for replacement power generation. Construction and operation of the replacement power plants that would be necessary would lead to increased electricity bills to ratepayers.[3] In addition to increased power generation costs, there is also the question of how the costs of implementing the alternatives would be distributed. It is not possible to say how the costs associated with Alternative 4—Dam Breaching, would ultimately be paid. Before restructuring of the electricity industry, a large portion of the costs would have been BPA's responsibility and BPA would have raised its rates to recover increased costs. However, in the current restructured, competitive, wholesale power market, the price that BPA can charge its customers is effectively capped by the market price of electricity. BPA can no longer recover higher costs by raising its rates because utilities that buy power from BPA now have alternate sources of electricity supplied by the wholesale electricity market. A number of possible cost allocation scenarios exist ranging from BPA customers through the entire Pacific Northwest load. This is discussed further in the financial analysis presented in DREW Hydropower Impact Team (1999) model.

Increased electric rates may cause customers to switch from electricity and increase the demand for natural gas, propane, fuel oil, and insulation. Over time, more efficient household, commercial, and industrial electric appliances, machines, and processes would be substituted for electricity use. The long-run demand for electricity has been shown to be sensitive to price increases. As a result, increasing the price per kilowatt-hour (kWh) consumed would reduce the amount of electricity that must be produced and increase the demand for substitute products. If the increased electric bill were paid by an increased fixed monthly charge rather than a rate increase, the substitution effects would be minimal because few customers would be willing to give up their electricity connection.

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[3] The power analysis developed by DREW HIT assumed, as noted above, that any new replacement generating facilities would be natural gas combined cycle (CC) combustion turbine plants. DREW HIT also examined the impact of using non-polluting resources such as conservation and wind to replace the hydropower generation that would be lost if the four lower Snake River dams were breached. Conservation and renewable resources could be used to replace the hydropower generation from the four Lower Snake River dams and result in no net change in air pollution from the existing conditions. The costs could be similar to, but higher, than the CC replacement strategy. The implementation of conservation/renewables would require considerable government intervention including subsidies, and implementation long before the dams are breached. While the CC plant replacement strategy would require almost no government intervention or subsidies. The DREW HIT conservation and renewable energy analysis is discussed further in Section 3.1.6.4. The regional analysis presented in this section is based on the CC plant replacement strategy. Changes to this strategy, such as a shift to conservation/renewables, would likely have different regional effects than those discussed here. This type of change could, for example, affect the size and distribution of potential rate increases (Section 6.3.1.1), as well as replacement facility and transmission line construction and operation costs (Sections 6.3.1.3 through 6.3.1.6).

Electric bill increases would reduce net income for industries and reduce disposable income for households in the region. The extent to which business firms would leave the region or reduce output and employment in reaction to reduced net income is unknown. Some industries may be able to pass part of the increased electric bill on to their customers. Other industries, such as agriculture, cannot do this because of intense national or global competition. Higher electric bills paid by residential consumers, farmers, and business owners would reduce their disposable income, leading to reduced consumer spending for other goods and services. Projected increases in annual electricity expenditures are presented by state and sector in Table 6-2. These projected increases are distributed to sectors based on existing spending shares.

The economic impact of increased electricity bills on the aluminum sector is unknown because information is not available to predict the effects of increased operating costs on production and employment. The aluminum processing sector could be severely impacted. Based on their share of current electricity use, aluminum plants in Washington would have an increase in their annual electricity bill of $26 million, while plants in Oregon would have an increase of $12.88 million, and plants in Montana would have an increase of $4.58 million (Table 6-2).

Table 6-2. Annual Electricity Expenditure Increases Caused by Alternative 4—Dam Breaching by State and Sector (1998 dollars) ($ million per year)[1/]

	State							
Sector	**Washington**	**Oregon**	**Idaho**	**Montana**	**California**	**Nevada**	**Wyoming**	**Total**
Commercial	39.45	24.88	8.49	1.78	0.45	0.07	0.14	**75.26**
Industrial[2/]	35.24	22.35	12.44	5.10	0.22	1.08	0.27	**76.70**
Irrigation	3.39	1.74	4.06	0.12	0.18	0.01	0.01	**9.51**
Residential	53.94	30.26	12.26	2.38	0.71	0.82	0.41	**100.78**
Aluminum	26.00	12.88	0.00	4.58	0.00	0.00	0.00	**43.46**
Federal	2.67	0.00	0.00	0.00	0.00	0.00	0.00	**2.67**
Total	**160.69**	**92.11**	**37.25**	**13.96**	**1.56**	**1.98**	**0.83**	**308.38**

1/ Electricity spending increases are distributed to sectors based on the existing spending shares.
2/ These totals exclude the aluminum industry which is shown in a separate row below.
Source: Data provided by the DREW Hydropower Impact Team

Impacts on Residential and Farm Incomes

Increased electric bills to residential and farm irrigation customers, which are assumed to be paid by households, would create a reduction in household disposable income. The cost to individual households would rise by approximately one to six dollars per month depending on how many ratepayers were subject to the rate increase. The direct, indirect, and induced economic effects of reduced household income in the states of Washington, Oregon, Idaho, and Montana are estimated using input-output models for these four states. Alternative 4—Dam Breaching, is the only alternative that would create a significant change in household electricity bills (Table 6-2).

Table 6-3. Annual Regional Impacts of Increased Electric Bills to Residential and Farm Irrigation Customers under Alternative 4—Dam Breaching (1998 dollars) [1/]

	Initial Reduction in Household Personal Income ($ million per year)	Business Transactions ($ million per year)	Employment	Personal Income ($ million per year) [2/]
Washington	(57.32)	(134.56)	(743)	(78.39)
Oregon	(32.00)	(80.52)	(507)	(45.81)
Idaho	(16.32)	(37.10)	(248)	(22.22)
Montana	(2.50)	(5.26)	(36)	(3.11)
Total	**(108.14)**	**(257.44)**	**(1,534)**	**(149.53)**

1/ The impacts shown above are for the "middle" estimate of the change in electric bills. The impacts of the "low" estimate can be found by dividing these results by 1.284. The impacts of the "high" estimate can be found by multiplying the results shown above by 1.241 (DREW Hydropower Impact Team, 1999).
2/ The multiplier effect results in personal income decreasing by a multiple of the original change.

Increased electric power bills paid by residential and farm households would cause household personal income to fall in the states of Washington, Oregon, Idaho, and Montana. Initial decreases in personal income were multiplied by each state's input-output multipliers to identify their impacts on state business transactions, employment, and personal income. These results are presented by state in Table 6-3.

Impacts on Local Owners of Commercial and Industrial Firms

Although the effects on the viability and operating levels of electricity-intensive firms and plants are unknown, the impact on the personal income of in-state owners of many small commercial and industrial firms can be estimated (primary aluminum is excluded because it is not a locally owned small business). Projected increases in electricity bills for commercial and industrial firms are presented in Table 6-2. Based on unpublished payroll data, a rough estimate of in-state ownership for commercial and industrial firms is 50 and 30 percent, respectively (precise estimates would require knowledge of electricity consumption by many individual firms and industries). Thus, the commercial row of Table 6-2 was multiplied times 0.5 and the industrial row times 0.3 to find the increased electricity bills paid by in-state owners, if dam breaching were to occur. These estimates of increased electricity bills to local owners of commercial and industrial establishments are treated as reductions in their personal income.

Initial decreases in personal income were multiplied by each state's input-output multipliers to identify their impacts on state business transactions, employment, and personal income. These results are presented by state in Table 6-4.

6.3.1.2 Hydroelectric Operation and Maintenance

The four lower Snake River dams would no longer be able to generate electricity under Alternative 4—Dam Breaching. The resulting reduction in operation and maintenance costs (the plants require security and preservation services after shut down), referred to as avoided costs elsewhere in this document, would create negative direct, indirect, and induced economic impacts on the region. These impacts are presented in Section 6.3.7 of this document.

Table 6-4. Annual Regional Impacts of Increased Electric Bills to Local Owners of Commercial and Industrial Firms under Alternative 4—Dam Breaching (1998 dollars) [1/]

	Initial Reduction in Household Personal Income ($ million)	Business Transactions (1998 $ million per year)	Employment	Personal Income (1998 $ million per year) [2/]
Washington	(30.30)	(71.13)	(393)	(41.43)
Oregon	(19.15)	(48.18)	(303)	(27.41)
Idaho	(7.79)	(17.71)	(118)	(10.61)
Montana	(2.43)	(5.11)	(34)	(3.09)
Total	**(59.67)**	**(142.13)**	**(848)**	**(82.54)**

1/ The impacts shown above are for the "middle" estimate of the change in electric bills. The impacts of the "low" estimate can be found by dividing these results by 1.284. The impacts of the "high" estimate can be found by multiplying the results shown above by 1.241 (DREW Hydropower Impact Team, 1999).
2/ The multiplier effect results in personal income decreasing by a multiple of the original change.

6.3.1.3 Power Plant Construction

It is assumed that six new 250-megawatt (MW) CC, gas-fired electric power plants would be built to replace the electric power that would be lost if the four lower Snake River dams were breached. Two of the six plants would be needed to support system reliability. Its expected that three of these new plants would be located in the downriver subregion, with the first two constructed in Hermiston and the Tri-Cities in 2007 and going on line in 2008. A third plant would be built in 2008 in Tri-Cities. Three more plants would be constructed in the Puget Sound region in 2009, 2010, and 2016, respectively (DREW Hydropower Impact Team, 1999).

Each plant is assumed to take one year to construct. Plant construction costs are estimated to be $601,000 per megawatt or $150.25 million per plant. These costs would be incurred during the year of construction in each case. Based on the downriver subregion utility construction multipliers, each one-year construction project would generate business transactions of $332.40 million, 2,786 jobs, and an increase of $104.80 million in personal income. These impacts would be doubled in 2007 because two plants could be constructed simultaneously. Similar construction impacts would be expected in the Puget Sound area.

6.3.1.4 Power Plant Operation

According to BPA power system modeling, the new CC plants would operate at 90 percent of their design capacity. Operating costs of the new plants are estimated to be $13.61/megawatt hour (MWh) resulting in an annual operating cost of $26.80 million per year. Six new plants would generate operations spending of $160.80 million per year. Based on information on other CC plants, this operation spending would likely be distributed between labor (households) and labor-intensive services (21 percent), and the natural gas production, transmission, and distribution sector (79 percent) (DREW Hydropower Impact Team, 1999).

Annual spending increases in the lower Snake River study area to operate the plants would be $53.60 million ($26.8 million times 2) per year in 2008 and $80.40 million ($26.8 million times 3) per year in 2009 and thereafter. Annual spending increases in the Puget Sound region would be about $26.8 million per year in 2010, $53.60 million per year in 2011, and $80.40 million per year in 2017 and thereafter. The shortfall of power generated in the region would require electricity imports to the region prior to the construction of the new plants. It is assumed that these temporary electricity imports would not create any measurable changes in spending or employment within the study region.

Operation and maintenance spending on labor and labor-intensive services associated with the first two plants would be about $11.26 million. Based on lower Snake River study area multipliers, this would generate $26.70 million in business transactions, 168 jobs, and $4.16 million in personal income. These impacts would occur annually starting in 2008. Completion of the third plant in 2009 would increase these annual impacts to $40.05 million in business transactions, 252 jobs, and $6.24 million in personal income. The remaining three CC power plants would add to the impacts in a similar manner in the Puget Sound area in 2010, 2011, and 2017.

The major input to this type of power plant is natural gas. Natural gas would account for $42.34 million per year of purchases from the gas distribution sector for the first two plants. Based on lower Snake River study area multipliers, this would generate $67.10 million in business transactions, 416 jobs, and $11.56 million in personal income. These impacts would occur annually starting in 2008. Completion of the third plant in 2009 would increase these annual impacts to $100.65 million in business transactions, 624 jobs, and $17.34 million in personal income. The remaining three CC power plants would add to the impacts in a similar manner in the Puget Sound area in 2010, 2011, and 2017.

6.3.1.5 Transmission Line Construction

Total construction expenditure to modify electric transmission lines ranging from $177 to $271 million would occur over a 2-year period during the breaching process. A new transmission line from Spokane to Tri-Cities would account for $100 million to $150 million of the expense. The remainder of the spending would be for projects in the downriver subregion. All of these impacts are assumed to occur in the downriver subregion. Annual spending of $88.50 million to $135.50 million to modify power lines would result in $196.10 million to $300.30 million in business transactions, 1,643 to 2,516 jobs, and $61.90 to $94.70 million in personal income for two years. The mid-points of these ranges (i.e., $248.2 million in business transactions, 2,080 jobs, and $78.3 million in personal income) are presented in the summary tables in Section 6.4.1.

6.3.1.6 Transmission Line Operation and Maintenance

Annual spending of approximately $0.85 million would be necessary to operate and maintain new electric transmission lines. This spending, which is assumed to occur somewhere in the lower Snake River region, would generate $1.67 million in business transactions, eight jobs, and $0.35 million in personal income.

6.3.2 Recreation

Fishing trips and recreation and tourism trips by non-residents create new spending flows in the region where the visit occurs and are, as a result, considered exports that stimulate the local economy from an input-output modeling perspective. Changes in recreation projected by the DREW Recreation Workgroup (1999) would increase these types of exports from the lower Snake Study Area in two ways. First, the DREW Recreation Workgroup projected that the total number of trips per year would increase. Second, they projected that the share of trips made by non-residents would also increase.

Steelhead and salmon runs in all three subregions and along the coastal areas of the Pacific Northwest are expected to increase under Alternative 4—Dam Breaching (DREW Anadromous Workgroup, 1999). Breaching would, however, reduce the numbers of some species of fish that are currently harvested in the four lower Snake River reservoirs and the allocation of salmon for sportfishing harvest, even after breaching, is very small. While the number of fishing trips made to these areas is expected to increase in response to increased fishing opportunities, this increase would be limited by the number of available fish.

Alternative 4—Dam Breaching would also return the lower Snake River to near natural river conditions, suitable for rafting, kayaking and other river-based activities. A contingent behavior survey conducted by the DREW Recreation Workgroup (1999) projected that the number of recreation days associated with angling and non-angling visitation to the lower Snake River would increase significantly if dam breaching were to occur. The DREW recreation analysis compared the non-angling visitation estimates with the current availability of developed campgrounds, dispersed camping areas, and boat-ramp capacity and assumed that the number of campgrounds would double by the end of the first decade following breaching (see Section 3.2).

6.3.2.1 Sportfishing in the Upriver Subregion

Increases in sportfishing in central Idaho and northeast Oregon are projected under Alternative 4—Dam Breaching (Table 6-5).[4] Estimates of the net increase in angler days spent fishing for steelhead and salmon in Central Idaho under Alternative 4—Dam Breaching were provided by the DREW Recreation Workgroup. These estimates were developed based on the number of fish projected to be available for recreational harvest over time. Projections of the number of fish available for recreational harvest were developed by the DREW Anadromous Fish Workgroup based on preliminary PATH data (see Sections 3.5.3 and 3.5.4).

Alternatives 2 and 3 would not create significant upriver fishing impacts.

6.3.2.2 Sportfishing in the Reservoir Subregion

Increases in sportfishing in the reservoir subregion projected under Alternative 4—Dam Breaching would generate increases in business transactions, employment, and personal income (Table 6-6).[5]

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[4] These estimates, which are based on estimated angler days, have been revised since publication of the Draft FR/EIS and reflect changes made in the DREW recreation analysis (see Section 3.2). In general, the DREW Recreation Workgroup's estimated increases in angler days were revised in three ways. First, the estimated number of days per trip for California visitors was revised down from 12 days to a range from 4 to 5.86 days per trip. This difference is largely due to the removal of one outlier observation from the survey database that reported a length of stay of 250 days. Second, the analysis was revised to address the IEAB's comment that increased numbers of fish would result in increased WTP per trip, not an increase in the number of angler days, as assumed in the original DREW analysis. Third, the allocation of anadromous fish available for recreational harvest between the upriver and reservoir subregions was clarified and revised.

[5] See the preceding footnote. In addition, as discussed in the text, the analysis for the reservoir subregion was also revised to include angler day estimates for mainstem salmon and steelhead developed by the DREW Anadromous Fish Workgroup.

Table 6-5. Annual Economic Impacts of Recreational Fishing in the Upriver Subregion for Alternative 4—Dam Breaching (1998 dollars) [1/]

Year	Increase in Business Transactions ($ million per year)	Increase in Jobs	Increase in Personal Income ($ million per year)
2005	6.15	92	1.73
2010	5.3	80	1.49
2015	17.51	263	4.93
2020	13.44	202	3.79
2025	15.6	234	4.39
2030	15.84	238	4.46
2035 to 2104	16.92 to 17.93	254 to 269	4.77 to 5.05

1/ The increase in fishing trips is constrained by the supply of fish projected by PATH and the DREW Anadromous Fish Workgroup, 1999.
Source: DREW Recreation Workgroup, 1999

These increases were estimated based on the increases in angler days spent fishing for steelhead and salmon less the decrease in angler days that would be associated with reductions in the number of resident fish available for harvest. Estimates were provided for anglers:

- fishing for resident fish in the 140-mile stretch of the lower Snake River from Lewiston, Idaho to the lower Snake River's confluence with the Columbia River (DREW Recreation Workgroup)
- fishing for steelhead in the Lower Granite reservoir (DREW Recreation Workgroup)
- fishing for steelhead in the mainstem area, as defined by PATH. This area extends downstream from Lower Granite Dam to the mouth of the Columbia River (DREW Anadromous Fish Workgroup)
- fishing for salmon in the mainstem area, as defined by PATH. This area extends downstream from Lower Granite Dam to the mouth of the Columbia River (DREW Anadromous Fish Workgroup).

The workgroup providing each of these estimates is identified in parentheses. As this list suggests, the mainstem estimates provided by the DREW Anadromous Fish Workgroup also include changes in angler days for anglers on the lower Columbia River. It is, therefore, possible that some of the increase in business transactions, employment, and personal income identified in Table 6-6 would actually occur in the downriver subregion or further downriver closer to the mouth of the Columbia River. Given the relatively small projected changes overall, allocating this change to the reservoir subregion is unlikely to significantly affect the results of this analysis.

Estimated changes in angler days were developed by the DREW recreation and anadromous fish workgroups based on the number of fish projected to be available for recreational harvest over time. These harvest estimates were developed by the DREW Anadromous Fish Workgroup based on preliminary PATH data (see Sections 3.5.3 and 3.5.4).

Alternatives 2 and 3 would not create significant upriver fishing impacts.

Table 6-6. Annual Economic Impacts of Recreational Fishing in the Reservoir Subregion for Alternative 4—Dam Breaching (1998 dollars) [1/2/]

Year	Increase in Business Transactions ($ million per year)	Increase in Jobs	Increase in Personal Income ($ million per year)
2005	10.7	112	2.72
2010	7.97	84	2.03
2015	14.04	147	3.57
2020	15.2	160	3.87
2025	15.67	165	3.99
2030	15.58	164	3.97
2035 to 2104	15.96 to 16.85	168 to 177	4.06 to 4.29

1/ The increase in fishing trips is constrained by the supply of fish projected by PATH and the DREW Anadromous Fish Workgroup, 1999.

2/ PATH divided its estimates into "mainstem," the area downstream of Lower Granite Dam to the Columbia River estuary, and "tributary," the area upstream of Lower Granite Dam. The estimates presented in this table are based on projected fish numbers and associated angler days for the "mainstem" area, as well as for projected fish numbers and angler day estimates for the Lower Granite reservoir portion of the "tributary" area. The DREW Anadromous Fish Workgroup provided the mainstem salmon and steelhead estimates. The DREW Recreation Workgroup provided the steelhead estimates for the Lower Granite reservoir and resident fish estimates for the 140-mile long lower Snake River. The same estimated changes in angler days are used to estimate the recreational fishing NED benefits presented in Sections 3.2 and 3.5 and summarized in Section 3.2.2.

6.3.2.3 Recreation and Tourism in the Reservoir Subregion

Increases in non-angling or general recreation and tourism projected under Alternative 4—Dam Breaching would result in increases in business transactions, employment, and personal income (Table 6-7). The impacts shown are based on the DREW Recreation Workgroup's contingent behavior Middle Estimate 2 forecast (see Section 3.2.6.1).[6] Alternatives 2 and 3 would not affect existing and currently projected non-angling recreation and tourism in the reservoir subregion.

Table 6-7. Annual Economic Impacts of River Recreation in the Reservoir Subregion Middle Forecast for Alternative 4—Dam Breaching (1998 dollars)[1/]

Year	Increase in Business Transactions ($ million per year)	Increase in Jobs	Increase in Personal Income ($ million per year)
2005	9.26	125	2.67
2010	15.95	216	4.59
2015	37.98	513	10.94
2025 to 2104	40.21	543	11.58

1/ Assumes local contractors in the reservoir subregion are used for the construction project.

[6] These estimates, which are based on estimated visitor days, have been revised since publication of the Draft FR/EIS and reflect changes made in the DREW recreation analysis (see Section 3.2.6.1).

6.3.2.4 Development of New Campgrounds

The DREW recreation analysis assumes that the number of campgrounds would double by the end of the first decade following breaching (see Section 3.2.6.2).[7] It is assumed that these campsites would be located along the lower Snake River and would, therefore, be within the reservoir subregion. The DREW Recreation Workgroup assumes that these facilities would be developed by private entities in response to public demand, as there are currently no plans for the public development of developed campsites. The increases in business transactions, employment, and personal income that would be associated with construction and operation of these campgrounds are presented in Tables 6-8 and 6-9. The estimated construction and operation and maintenance (O&M) costs for these campgrounds are discussed in Section 3.2.8.2.

Table 6-8. Short-term Economic Impacts in the Reservoir Subregion Created by Construction of Additional Campsites for Alternative 4—Dam Breaching (1998 dollars)[1/]

Year	Increase in Business Transactions ($ million per year)	Increase in Jobs	Increase in Personal Income ($ million per year)
2007	17.94	174	6.18
2008	17.94	174	6.18

1/ Assumes local contractors in the reservoir subregion are used for the construction project.

Table 6-9. Annual Economic Impacts in the Reservoir Subregion Created by Operation of Additional Campsites for Alternative 4—Dam Breaching (1998 dollars)[1/]

Year	Increase in Business Transactions ($ million per year)	Increase in Jobs	Increase in Personal Income ($ million per year)
2009 and Thereafter	3.25	26	0.77

1/ Assumes local contractors in the reservoir subregion are used for the construction project.

6.3.3 Commercial and Ocean Recreational Fishing[8]

The DREW Anadromous Fish Workgroup constructed input-output models for the Pacific Northwest states and Alaska with the use of the IMPLAN model and used an input-output model for British Columbia from Radtke (1997). For the commercial sector, representative budgets from the fish harvesting sector and the fish processing sector, as well as a price and cost structure for primary

[7] This impact category and section has been added to the regional analysis since completion of the Draft FR/EIS and reflects a corresponding addition to the DREW recreation analysis (see Section 3.2.8.2). As noted in Section 3.2.8.2, development of these campsites is an important part of the recreation analysis. If dam breaching were to occur and these campsites were not built, the number of projected visitors who could be accommodated would be reduced. This would, in turn, reduce the projected RED benefits.

[8] This section has been expanded since completion of the Draft FR/EIS. The Draft FR/EIS combined the commercial and ocean recreational harvest regional impacts. Here the two categories are separated out. These figures do not, however, sum to those presented in the Draft FR/EIS. The numbers presented in the Draft FR/EIS were incorrect and have been corrected.

processing are used to estimate the impacts of changes.[9] For the recreational sector, a charter operator budget and recreational fishermen destination expenditures provide the basic data. Treaty commercial fisheries are evaluated using the same assumptions as for non-Indian commercial fisheries. The impacts from hatchery expenditures are proxied using sales of hatchery surpluses. Estimates of regional and local economic impacts for anadromous fish harvesting were reduced to a per fish value for commercial fishing, and per angler day value for recreational fishing.

Increases in commercial fishing would result in increases in business transactions, jobs, and personal income. The impacts are presented for Alternatives 2 through 4 net of Alternative 1—Existing Conditions in Tables 6-10 through 6-12.

Increases in ocean recreational fishing would result in relatively minor increases in business transactions, jobs, and personal income under Alternative 4—Dam Breaching (Table 6-13). Alternative 2—Maximum Transport of Juvenile Salmon would not affect ocean recreational fishing.

Projected increases under Alternative 3—Major System Improvements would be very minor, generating an average net increase of $10,000 in personal income over Alternative 1—Existing Conditions.

Table 6-10. Annual Economic Impacts of Commercial Fishing under Alternative 2—Maximum Transport of Juvenile Salmon[1/]

Year	Changes in Business Transactions ($ million per year)	Changes in Employment (jobs)	Changes in Personal Income ($ million per year)
5	0.27	2	0.09
10	1.77	16	0.56
25	1.57	14	0.50
50	0.86	8	0.27
100	1.36	12	0.43
Max	1.42	13	0.45
Min	0.27	2	0.09
Median	1.09	10	0.34
Mean	1.23	11	0.39

1/ These projected increases would occur in Washington, Oregon, and Idaho.

[9] The effects of revenue substitution are not included in economic base analysis. This even includes revenue substitutions within the fishing industry. The difficulty is in determining the relations between fishing for salmon and fishing for other species. Commercial fishing revenues can easily be distributed by species, but harvest costs are more difficult to allot by species. If particular fishing trips are fairly exclusive by species, then it is easy to account for variable costs. But if a given vessel engages in fishing trips that are exclusive of salmon harvesting, then the vessel's fixed costs must somehow be separated by salmon versus non-salmon fishing. Estimates of those breakdowns must account for not only the proportional effort spent in each of the two activities, but must also include certain assumptions about the response of vessels to salmon harvest changes (i.e., will a troller/crabber continue to fish for crab if salmon is not available? Will a salmon troller exit the fishery or switch to other species in response to salmon harvest restrictions?).

Table 6-11. Annual Economic Impacts of Commercial Fishing under Alternative 3—Major System Improvements[1/]

Year	Changes in Business Transactions ($ million per year)	Changes in Employment (jobs)	Changes in Personal Income ($ million per year)
5	0.18	2	0.06
10	2.12	19	0.67
25	1.29	12	0.41
50	0.85	8	0.27
100	1.08	10	0.34
Max	1.26	11	0.40
Min	0.18	2	0.06
Median	0.94	9	0.30
Mean	1.12	10	0.35

1/ These projected increases would occur in Washington, Oregon, Idaho, Alaska, and British Columbia.

Table 6-12. Annual Economic Impacts of Commercial Fishing under Alternative 4—Dam Breaching[1/]

Year	Changes in Business Transactions ($ million per year)	Changes in Employment (jobs)	Changes in Personal Income ($ million per year)
5	0.16	1	0.05
10	4.45	39	1.42
25	19.43	171	6.22
50	21.99	193	7.05
100	21.75	191	6.97
Max	22.22	195	7.12
Min	0.16	1	0.05
Median	21.89	192	7.01
Mean	19.52	171	6.25

1/ These projected increases would occur in Washington, Oregon, Idaho, Alaska, and British Columbia.

Table 6-13. Annual Economic Impacts of Ocean Recreational Fishing under Alternative 4—Dam Breaching[1/]

Year	Changes in Business Transactions ($ million per year)	Changes in Employment (jobs)	Changes in Personal Income ($ million per year)
5	(0.02)	0	(0.01)
10	0.21	2	0.07
25	0.82	7	0.27
50	0.84	7	0.27
100	0.82	7	0.27
Max	0.85	7	0.28
Min	(0.02)	0	(0.01)
Median	0.82	7	0.27
Mean	0.77	7	0.25

1/ These projected increases would occur in Washington, Oregon, Alaska, and British Columbia

6.3.4 Transportation

6.3.4.1 New Construction for Rail Transport

If dam breaching were to occur, a large portion of grain presently shipped via the lower Snake River would be diverted to rail. New railroad hopper cars costing from $14 million to $26.85 million would be required. For the purposes of analysis, it was assumed that construction of these railcars would take place outside the Pacific Northwest region.

Increased grain shipments via rail would result in an increase of 8 to 12 unit-trains or 900 to 1,330 cars being delivered to tidewater terminals each month. Rail storage at tidewater terminals would be needed for 450 to 650 of these cars. Existing rail car storage would be inadequate to accommodate this increase. Construction of tidewater railroad track for car storage, projected to cost between $1.99 million and $4.05 million, would generate from $4.74 million to $9.64 million in business transactions, 41 to 81 jobs, and $1.21 to $2.46 million in personal income for one year. These impacts were modeled using the IMPLAN new road construction sector multipliers for Oregon. The new road construction sector includes other heavy construction, such as railroad construction.

Upgrades to mainline track would be required. Construction spending associated with these upgrades is estimated to range from $14 million to $24 million. Upgrades would also be required for short-line railroads. These costs are estimated to range from $33.9 million to $47.8 million. This construction, which would take place in the lower Snake River region, was modeled using the IMPLAN new road construction sector multipliers for the lower Snake River study area. This new construction spending would generate from $86.73 to $122.29 million in business transactions, 723 to 1,020 jobs, and $23.16 to $32.66 million in personal income. This analysis assumed that railroad track improvements would have to be completed rapidly (within a year) to accommodate the projected increases in rail car traffic.

6.3.4.2 Impacts of New Construction for Road Transport

Dam breaching would also result in increased volumes of truck traffic on Washington highways. This increase in traffic would require one-time intersection and road improvements, with estimated construction costs ranging from $84.10 million to $100.70 million. This construction, which would take place in the lower Snake River region, was modeled using the IMPLAN new road construction sector multipliers for the lower Snake River study area. This new construction spending would generate from $215.16 to $257.63 million in business transactions, 1,794 to 2,149 jobs, and $57.46 to $68.80 million in personal income. Road and intersection improvements would have to be completed rapidly (within a year) to accommodate the projected increases in heavy truck traffic.

6.3.4.3 Impacts of New Construction for Transport-Related Facilities

The projected shift of grain from the lower Snake River to rail would require country grain elevator upgrades with estimated construction costs ranging from $14 million to $16.90 million. Construction costs for river elevator upgrades are estimated to range from $58.7 million to $335.4 million depending on the type of facility built. This construction, which would take place in the lower Snake River region, was modeled using the IMPLAN new industrial buildings sector multipliers for the lower Snake River study area. This new construction spending would generate between $202.95 million and $983.48 million in business transactions, 1,991 to 9,646 jobs, and $6.75 million to $329.96 million in personal income. (Note: the most likely impacts were set at 1.2

times the average impacts for transport-related facilities by the DREW Transportation Workgroup, 1999.) Grain elevator improvements would have to be completed rapidly (within a year) to accommodate projected increases in rail and truck use.

6.3.4.4 Impacts of Dam Breaching on Industries Using or Replacing Barge Transport[10]

The increased transportation costs that would occur as a result of dam breaching could have a number of effects on industries using barge transportation. First, a "substitution effect" could cause a search for alternate carriers or alternate routes to minimize the impact of increased transport costs. Lacking alternate carriers, routes for some products may shift away from the West Coast and the upriver subregion. Second, the "output effect" of increased transport costs could cause producers to reduce their outputs because they become less competitive in national and world markets when their cost of production increases. A third effect, the "stages of production" effect, occurs when shippers confronted with increasing transportation costs increase the stage of production of their shipped goods so that the materials shipped have a higher value per ton. This means transporting processed or semi-processed products rather than bulk materials.

The DREW Transportation Workgroup did not estimate "output" or "stages of production" effects in their analysis but assumed that shippers would employ alternate carriers and routes. The transportation economic analysis assumed that 2.7 million of the 3.8 million tons that would be diverted from the lower Snake River if dam breaching were to occur would be trucked to the Tri-Cities and then barged to Portland. The analysis assumed that the remaining 1.1 million tons would be transported to Portland via rail.

The analysis presented in the following sections addresses the regional impacts associated with grain shipments, which comprised about 76 percent of the tonnage passing through Ice Harbor lock between 1992 and 1997. There are not sufficient data available to analyze the regional impacts associated with the other commodities presently shipped on the lower Snake River. The following analysis is based on information developed by the DREW Transportation Workgroup and assumes that dam breaching would not affect transportation rates.

Grain Farms

Transportation costs would increase for grain farms throughout the region if dam breaching were to occur (Table 6-14). Increased transportation costs would result in a corresponding decrease in grain farm income that would negatively affect local and regional business transactions, employment, and personal income (Table 6-15). Job losses by state would, for example, range from one job in Oregon to 303 jobs in Washington. The upriver and reservoir subregions would lose 144 and 139 jobs, respectively. No jobs would be lost in the downriver subregion (Table 6-15).

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[10] This impact category and section has been revised since completion of the Draft FR/EIS. This section now addresses the potential regional effects of dam breaching on industries using or replacing barge transportation, using data from the DREW Transportation Workgroup that was not available in time to be included in the Draft FR/EIS. This revised section addresses the regional effects associated with:

- the loss of grain farm income due to increased transportation costs
- the loss of grain-transportation-related barge revenue
- increased grain transportation-related railroad revenue
- changes in grain truck transportation, storage, and handling.

Table 6-14. Increased Long-term Annual Transport Cost for Grain Farms by State and Subregion (1998 dollars)[1/]

State or Subregion	$ million per year
State	
Washington	21.82
Idaho	10.37
Montana	1.38
Oregon	0.06
North Dakota	0.58
State Total	**34.21**
Subregion	
Upriver Subregion	8.57
Reservoir Subregion	11.40
Downriver Subregion	0.01
Lower Snake River Study Area	**19.98**

1/ Assumes that transportation rates remain unchanged.

Source: Data provided by the DREW Transportation Workgroup

Table 6-15. Long-term Impacts of the Loss of Grain Farm Income due to Increased Transport Cost by State and Subregion (1998 dollars)

State or Subregion	Business Transactions ($ million per year)	Employment (jobs)	Personal Income ($ million per year)
State			
Washington	(51.22)	(303)	(8.02)
Idaho	(23.58)	(168)	(3.75)
Montana	(2.90)	(21)	(0.34)
Oregon	(0.15)	(1)	(0.03)
State Total	**(77.85)**	**(493)**	**(12.14)**
Subregion			
Upriver	(19.10)	(144)	(3.14)
Reservoir	(22.63)	(139)	(3.21)
Downriver	(0.02)	0	0.00
Lower Snake River Study Area	**(41.75)**	**(283)**	**(6.35)**

Barge Companies

If dam breaching were to occur, grain presently transported on the lower Snake River would be shipped to Portland via rail or trucked to the Tri-Cities and then barged to Portland. This would result in a loss of revenue for those barge companies that presently transport goods on the lower Snake River (Table 6-16) and negatively affect regional business transactions, employment, and personal income. Annual business transactions, employment, and personal income in Oregon, where the barge companies are located, would decrease by $7.44 million, 51 jobs, and $1.57 million, respectively (Table 6-17).

Table 6-16. Loss of Long-term Annual Grain Transport Revenues to Oregon Barge Companies by State (1998 dollars)[1/]

Source of Revenue	$ million per year
Washington Farms	1.58
Idaho Farms	1.06
Montana Farms	0.27
Oregon Farms	0.04
North Dakota Farms	0.10
Total	**3.05**

1/ Assumes that transportation rates remain unchanged.
Source: Data provided by the DREW Transportation Workgroup

Table 6-17. Long-term Annual Impacts of the Loss of Grain Transportation-related Barge Revenue in Oregon (jobs and 1998 dollars)

Impact Category	Oregon
Business Transactions ($ million per year)	(7.44)
Employment (jobs)	(51)
Personal Income ($ million per year)	(1.57)

Railroad and Trucking Revenues

The transfer of 3.8 million tons from the lower Snake River to alternate transportation modes would generate increased revenues for railroad firms and increase trucking, storage, and handling revenues in some areas, while reducing trucking, storage, and handling revenues in others (Table 6-18). The increases in railroad spending identified in this table would generate business transactions, jobs, and personal income in the states of Washington, Idaho, and Oregon, as well as the upriver and downriver subregions (Table 6-19). Changes in annual employment by state would, for example, range from 28 jobs generated in Washington to 199 new jobs in Oregon, with about 8 and 23 jobs generated in the reservoir and upriver subregions, respectively.

The changes in spending for trucking, storage, and handling identified in Table 6-18 would also affect regional business transactions, jobs, and personal income. These changes would generate annual business transaction, employment, and personal income gains in Washington, Montana, and Oregon, as well as the downriver subregion. Idaho and the upriver and reservoir subregions would experience a decline in annual trucking, storage, and handling-related business transactions, employment, and personal income (Table 6-20). Changes in annual employment by state would, for example, range from a loss of 111 jobs in Idaho to a gain of 534 jobs in Washington. Changes in annual employment in the subregions would range from a loss of 276 jobs in the reservoir subregion to a gain of 491 jobs in the downriver subregion.

Table 6-18. Change in Long-term Annual Grain Transportation Revenues by State and Subregion (1998 dollars)[1/]

	Railroads ($ million per year)	Trucking, Storage, and Handling ($ million per year)
State		
Washington	1.42	20.12
Idaho	1.60	(3.24)
Montana	na	0.82
Oregon	9.08	3.79
North Dakota	na	0.34
State Total	**12.11**	**21.83**
Subregion		
Upriver	1.10	(3.00)
Reservoir	0.51	(10.34)
Downriver	na	20.74
Lower Snake River Study Area	**1.61**	**7.39**

1/ Assumes that both rail and truck transportation rates remain unchanged.

Source: Data provided by the DREW Transportation Workgroup

Table 6-19. Long-term Annual Impacts of Increased Grain Transportation-related Railroad Revenue by State and Subregion (1998 dollars)

	Business Transactions ($ million per year)	Employment (jobs)	Personal Income ($ million per year)
State			
Washington	3.84	28	0.98
Idaho	4.17	34	1.08
Montana	0.00	0	0.00
Oregon	26.41	199	7.27
State Total	**34.42**	**261**	**9.33**
Subregion			
Upriver	2.72	23	0.72
Reservoir	1.06	8	0.28
Downriver	0.00	0	0.00
Lower Snake River Study Area	**3.78**	**31**	**1.00**

Table 6-20. Long-term Annual Impacts of Changes in Truck Transportation by State and Subregion (1998 dollars)

	Business Transactions ($ million per year)	Employment (jobs)	Personal Income ($ million per year)
State			
Washington	55.92	534	13.40
Idaho	(10.13)	(111)	(2.77)
Montana	1.85	21	0.32
Oregon	11.37	112	2.83
State Total	**59.01**	**556**	**13.78**
Subregion			
Upriver	(9.09)	(100)	(2.57)
Reservoir	(26.24)	(276)	(6.73)
Downriver	48.94	491	11.57
Lower Snake River Study Area	**13.61**	**115**	**2.27**

Table 6-21 presents the long-term net annual impacts of all grain-related barge transportation changes by state and subregion. Overall, dam breaching would generate increases in annual business transactions, employment, and personal income in Washington, Oregon, and the downriver subregion. Business transactions, employment, and personal income in Idaho would decline as a result of dam breaching. This would also be the case in Montana and the upriver and reservoir subregions. Net change by state in terms of employment would range from a loss of 245 jobs in Idaho to a gain of 259 jobs in both Washington and Oregon. Changes in annual employment in the subregions would range from a loss of 407 jobs in the reservoir subregion to a gain of 491 jobs in the downriver subregion.

6.3.4.5 Cruise Ship Impacts of Alternative 4—Dam Breaching

Existing cruise ships would not be able to operate on a free-flowing Snake River. Based on contacts made with a sample of cruise ship companies, it appears that breaching the lower Snake River dams would terminate the cruise-ship industry in the Lewiston/Clarkston area and probably on the Columbia River with the exception of day-trips (DREW Transportation Workgroup, 1999).

It is, however, likely that some of the cruise ship employment and retail sales to passengers would shift to the downriver subregion if the Snake River were unavailable following breaching.

Direct non-payroll purchases by the cruise ship sector in the upriver subregion are estimated at $2.64 million per year (DREW Transportation Workgroup, 1999). Cruise ship companies purchase engine fuel, jet boat services, laundry services, water supplies, and docking. The largest purchases are for prepaid jet boat tours and fuel, which account for about 46 and 45 percent of direct purchases, respectively. A reduction in direct purchases and payroll by cruise ship companies in the upriver subregion would result in a decrease of $7.96 million in annual business transactions, 76 lost jobs, and $2.11 million lost personal income per year. The total impact estimate also includes the impacts of direct cruise ship employment and payroll in the upriver subregion based on confidential reports (DREW Regional Workgroup, 1999).

Table 6-21. Summary of Long-term Annual Impacts of All Changes in Grain-related Barge Transportation by State and Subregion (1998 dollars)

	Business Transactions ($ million per year)	Employment (jobs)	Personal Income ($ million per year)
State			
Washington	8.54	259	6.36
Idaho	(29.54)	(245)	(5.44)
Montana	(1.05)	0	(0.02)
Oregon	30.19	259	8.50
State Total	**8.14**	**273**	**9.40**
Subregion			
Upriver	(25.47)	(221)	(4.99)
Reservoir	(47.81)	(407)	(9.66)
Downriver	48.92	491	11.57
Lower Snake River Study Area	**(24.36)**	**(137)**	**(3.08)**

About 21,315 passengers are estimated to travel to the upriver subregion by cruise ship (DREW Transportation Workgroup, 1999). Assuming that the average spending per passenger in Lewiston is $57, the annual loss of retail sales to cruise ship passengers in the upriver subregion would be about $1.21 million. The IMPLAN multipliers for retail trade apply on the sales margin, which is about 15 percent of actual retail sales. Lost retail sales would reduce total business transactions by $0.43 million, employment by 7 jobs, and personal income by $0.14 million in the upriver subregion.

Total impacts include the effects of lost sales to cruise ship companies, lost cruise ship payroll, and lost retail sales to passengers. Total direct, indirect, and induced losses in the upriver subregion are estimated at $8.39 million per year in business transactions, 83 jobs, and $2.25 million per year in personal income.

6.3.5 Water Supply

6.3.5.1 Agricultural Pump Stations

Approximately 37,000 acres of cropland are presently irrigated from the Ice Harbor reservoir. The analysis conducted by the DREW Water Supply Workgroup (1999) (see Section 3.4) suggested that in the absence of Congressional appropriation, the costs to modify the existing pump system would be prohibitive based on the estimated value of the land. The estimated change in farmland value would be in the reservoir subregion, but reduced farm spending would also occur in the downriver subregion. Therefore, the lower Snake River study area multipliers were used.

The following displays two scenarios of regional impacts. Assuming that the entire 37,000 acres would no longer be irrigated would result in an annual decrease in business transactions of $232.26 million, a loss of 2,256 jobs, and an annual reduction in personal income of $79.19 million. However, about 21 percent of the irrigated land might support the development of alternative water supplies to replace the lost irrigation water. If fruit orchards and vineyard production continued on 7,735 of the 37,000 acres, the direct value of production lost would be $38.37 million. In this case, annual business transactions would fall by $126.81 million, 901 jobs would be lost, and personal income would fall by $44.50 million per year. The mid-points between these two scenarios [i.e.,

($179.54) million in business transactions, (1,579) jobs, and ($61.85) in personal income] are presented in the summary tables in Section 6.4.1.)

6.3.5.2 Municipal and Industrial Pump Station Modifications

There are eight existing municipal and industrial pump stations along the lower Snake River, all located on the Lower Granite reservoir. Water withdrawn from these stations is used for municipal water system backup, golf course irrigation, industrial process water for paper production, concrete aggregate washing, and park irrigation. Under Alternative 4—Dam Breaching, the river elevation would be substantially lower and these pumping stations would require modification to maintain current water supplies (DREW Water Supply Workgroup, 1999).

Modification of municipal and industrial pump stations was estimated to cost between $11.51 million and $55.20 million (DREW Water Supply Workgroup, 1999). This wide range of costs reflects uncertainty about required modifications to the Potlatch Corporation system (DREW Water Supply Workgroup, 1999). The impacts of construction associated with these modifications were estimated using the upriver subregion utility construction multiplier and assumed to occur within one year. This spending would result in an increase in business transactions of $25.14 million to $120.56 million, an increase of 292 to 1,397 jobs, and increases in personal income that would range from $7.73 million to $37.10 million.

6.3.5.3 Construction Expenditures to Modify Private Wells

Approximately 209 functioning wells are presently located within one mile of the lower Snake River. About 95 of these wells are expected to require modification if dam breaching were to occur (DREW Water Supply Workgroup, 1999).

Construction spending in the lower Snake River region to modify private wells was estimated at $56.45 million (DREW Water Supply Workgroup, 1999).[11] About 22 percent of the wells were in the downriver subregion (Franklin County) and the rest were in the reservoir subregion. The impact of construction expenditures to modify private wells was estimated using the maintenance and repair not elsewhere classified transactions multiplier. Well modification in the reservoir subregion would result in a $107.76 million increase in business transactions, an increase of 916 jobs, and an increase in personal income of $29.52 million. Well modification in the downriver subregion would result in a $30.40 million increase in business transactions, an increase of 259 jobs, and an increase in personal income of $8.33 million. These impacts are assumed to occur within one year.

[11] Further engineering review of the well data indicated that 180, rather than 209, of the total 228 recorded wells were functioning and within the designated study area. About 71 of these wells, rather than the original estimate of 95, are expected to require modification if dam breaching were to occur. In addition, it should be noted that the estimated well modification costs of $56.45 million have been revised since the Draft FR/EIS, with projected well modification costs increasing to $67,042,000. This increase in cost has not been incorporated in the water supply analysis (see Section 3.4) because it does not significantly change the relative size of the water supply economic effects. In order to be consistent, this increased cost has not been incorporated in the revised RED analysis either. If dam breaching is the selected alternative, then additional analysis and refinement will be required. The DREW Water Supply Workgroup estimates that the change in well modification costs would change the conclusions of the water supply analysis by 4 to 5 percent.

6.3.6 Implementation Expenditure Impacts

Implementation of the selected alternative would require modifications to the operation and physical structure of the four lower Snake River dams, hydroelectric plants, and reservoirs. Implementation activities proposed under each alternative include new construction spending and spending on mitigation. There would be both short- and long-term implementation expenditure impacts.

Short-term implementation expenditure impacts are summarized in Tables 6-22 through 6-24.[12] Long-term implementation expenditure impacts are shown in Tables 6-25 through 6-27. These impacts were estimated based on information provided by the DREW Implementation Workgroup. Direct, indirect, and induced impacts are shown for business transactions, employment, and personal income by alternative and over time.

Table 6-22. Short-term Economic Impacts of Implementation on Business Transactions (1998 dollars) ($ million per year)[1/]

Year	Alternative 2—Maximum Transport of Juvenile Salmon	Alternative 3—Major System Improvements	Alternative 4—Dam Breaching
2001	(1.90)	1.00	11.03
2002	(7.36)	3.24	(8.92)
2003	(6.94)	11.39	20.63
2004	(5.15)	28.17	104.48
2005	0	54.37	202.27
2006	0	47.79	198.54
2007	0	40.54	169.37
2008	0	41.96	47.02
2009	0	41.80	24.71
2010	0	30.93	0

1/ These impacts would occur within the lower Snake River study area.

Source: Estimates based on data provided by the DREW Implementation Workgroup

Table 6-23. Short-term Economic Impacts of Implementation on Employment (jobs)[1/]

Year	Alternative 2—Maximum Transport of Juvenile Salmon	Alternative 3—Major System Improvements	Alternative 4—Dam Breaching
2001	(28)	15	165
2002	(110)	49	(134)
2003	(104)	170	309
2004	(77)	421	1,563
2005	0	813	3,026
2006	0	715	2,970
2007	0	606	2,533
2008	0	628	703
2009	0	626	370
2010	0	463	0

1/ These impacts would occur within the lower Snake River study area.

Source: Estimates based on data provided by the DREW Implementation Workgroup

[12] The short-term implementation cost impacts for Alternative 3—Major System Improvements are larger than those predicted in the Draft FR/EIS. This reflects changes to this alternative, which are outlined in Section 3.8.3.1 of this document. In addition, a new category, long-term implementation costs, has been added.

Table 6-24. Short-term Economic Impacts of Implementation on Personal Income (1998 dollars) ($ million per year)[1/]

Year	Alternative 2—Maximum Transport of Juvenile Salmon	Alternative 3—Major System Improvements	Alternative 4—Dam Breaching
2001	(0.78)	(0.41)	4.52
2002	(3.02)	(1.33)	(3.66)
2003	(2.84)	4.67	8.46
2004	(2.11)	11.55	42.84
2005	0	22.29	82.93
2006	0	19.59	81.40
2007	0	16.62	69.44
2008	0	17.20	19.28
2009	0	17.14	10.13
2010	0	12.68	0

1/ These impacts would occur within the lower Snake River study area.
Source: Estimates based on data provided by the DREW Implementation Workgroup

Table 6-25. Long-term Economic Impacts of Implementation on Business Transactions (1998 dollars) ($ million per year)[1/]

Year	Alternative 2—Maximum Transport of Juvenile Salmon	Alternative 3—Major System Improvements	Alternative 4—Dam Breaching
2001 to 2004[2/]	(2.21)	6.31	(7.86)
2005 to 2026[3/]	(2.21)	6.31	7.10
2027 to 2030[4/]	0	0.89	10.14
2031 to 2100	0	0.89	0

1/ These impacts would occur within the lower Snake River study area.
2/ Annual business transactions impacts under Alternative 4—Dam Breaching would range from ($6.20) million to ($8.41) million over this 4-year period. Over this period, the average annual reduction would be ($7.86) million.
3/ Annual business transactions generated under Alternative 4—Dam Breaching would range from $3.10 million to $11.15 million over this 24-year period. Over this period, the average annual gain would be $7.10 million.
4/ Annual business transactions generated under Alternative 4—Dam Breaching would range from $3.47 million to $13.29 million over this 4-year period. Over this period, the average annual gain would be $10.14 million.
Source: Estimates based on data provided by the DREW Implementation Workgroup

Table 6-26. Long-term Economic Impacts of Implementation on Employment (jobs)[1/]

Year	Alternative 2—Maximum Transport of Juvenile Salmon	Alternative 3—Major System Improvements	Alternative 4—Dam Breaching
2001 to 2004[2/]	(81)	230	(123)
2005 to 2026[3/]	(81)	230	111
2027 to 2030[4/]	0	32	159
2031 to 2100	0	32	0

1/ These impacts would occur within the lower Snake River study area.
2/ Employment impacts under Alternative 4—Dam Breaching would range from a loss of 87 jobs to a loss of 132 jobs over this 4-year period. Over this period, 123 jobs would be the average annual employment loss.
3/ Employment impacts under Alternative 4—Dam Breaching would range from a gain of 48 jobs to a gain of 176 jobs over this 24-year period. Over this period, 111 jobs would be the average annual employment gain.
4/ Employment impacts under Alternative 4—Dam Breaching would range from a gain of 54 jobs to a gain of 208 jobs over this 4-year period. Over this period, 159 jobs would be the average annual employment gain.
Source: Estimates based on data provided by the DREW Implementation Workgroup

Table 6-27. Long-term Economic Impacts of Implementation on Personal Income (1998 dollars) ($ million per year)1/

Year	Alternative 2—Maximum Transport of Juvenile Salmon	Alternative 3—Major System Improvements	Alternative 4—Dam Breaching
2001 to 2004 2/	(5.15)	14.70	(3.37)
2005 to 2026 3/	(5.15)	14.70	3.05
2027 to 2030 4/	0	2.07	4.35
2031 to 2100	0	2.07	0

1/ These impacts would occur within the Lower Snake River study area.
2/ Annual personal income impacts under Alternative 4—Dam Breaching would range from ($2.66) million to ($3.61) million over this 4-year period. Over this period, the average annual reduction would be ($3.37) million.
3/ Annual personal income generated under Alternative 4—Dam Breaching would range from $2.07million to $4.82 million over this 24-year period. Over this period, the average annual gain would be $3.05 million.
4/ Annual personal income generated under Alternative 4—Dam Breaching would range from $1.49 million to $5.71 million over this 4-year period. Over this period, the average annual gain would be $4.35 million.
Source: Estimates based on data provided by the DREW Implementation Workgroup

6.3.7 Avoided Cost Expenditure Impacts (Changes in Corps Operating Spending)

Alternatives 2 and 3 would result in relatively small modifications to Corps spending (DREW Implementation Workgroup, 1999). Alternative 4—Dam Breaching would, however, result in much reduced spending because of the shut down of electric generation operations, dam operations, and lock operations. Tables 6-28 through 6-31 summarize the impacts for Alternatives 2 and 3. The impacts of the reduced Corps operating costs under the Alternative 4—Dam Breaching, are presented in Table 6-31. Impacts are shown for business transactions, employment, and personal income over time. These impacts would primarily occur in the lower Snake River study area.

Table 6-28. Annual Economic Impacts of Avoided Costs on Business Transactions (1998 dollars) ($ million per year), Alternatives 2 and 3 1/

Year	Alternative 2—Maximum Transport of Juvenile Salmon	Alternative 3—Major System Improvements
2001 to 2026	(4.09)	2.18
2027 to 2100	0	1.26

1/ These impacts would occur in the lower Snake River study area.
Source: Estimates based on data provided by the DREW Avoided Cost Workgroup

Table 6-29. Annual Economic Impacts of Avoided Costs on Employment (jobs), Alternatives 2 and 3 1/

Year	Alternative 2—Maximum Transport of Juvenile Salmon	Alternative 3—Major System Improvements
2001 to 2026	(83)	44
2027 to 2100	0	25

1/ These impacts would occur in the lower Snake River study area.
Source: Estimates based on data provided by the DREW Avoided Cost Workgroup

Table 6-30. Annual Economic Impacts of Avoided Costs on Personal Income (1998 dollars) ($ million per year), Alternatives 2 and 3[1/]

Year	Alternative 2—Maximum Transport of Juvenile Salmon	Alternative 3—Major System Improvements
2001 to 2026	(2.36)	1.26
2027 to 2100	0	0.73

1/ These impacts would occur in the lower Snake River Study area.
Source: Estimates based on data provided by the DREW Avoided Cost Workgroup

Table 6-31. Annual Economic Impacts of Avoided Costs on Business Transactions, Jobs and Personal Income for Alternative 4—Dam Breaching (1998 dollars)[1/]

Year	Change in Business Transactions, 1998 ($ million per year)	Change in Employment (jobs)	Change in Personal Income, 1998 ($ million per year)
2001	0	0	0
2002	0	0	0
2003	0	0	0
2004	(1.94)	(39)	(1.12)
2005	(7.64)	(154)	(4.42)
2006	(37.79)	(763)	(21.83)
2007 to 2100	(64.61) to (83.77)	(1,322) to (1,693)	(37.79) to (48.40)

1/ These impacts would occur in the lower Snake River study area.
Source: Estimates based on data provided by the DREW Avoided Cost Workgroup

6.4 Summary of Impacts

6.4.1 Impacts at the Subregion Level

Impacts by subregion are discussed for business transactions, employment, and personal income in the following three sections. The impacts summarized in these sections were modeled using the upriver, reservoir, and downriver subregion and total lower Snake River study area input-output models. These models identify localized impacts associated with the proposed alternatives.

6.4.1.1 Business Transactions

Alternative 1—Existing Conditions

Alternative 1—Existing Conditions, represents the baseline for this analysis. Current business transactions estimated by IMPLAN are $34,427.47 million for the lower Snake River study area. Subregion totals range from $6,744.85 million for the reservoir subregion to $19,717.96 million for the downriver subregion.

Alternative 2—Maximum Transport of Juvenile Salmon

Changes to business transactions under this alternative would be relatively minor and limited to the implementation and avoided costs categories. The following projections are net of Alternative 1—Existing Conditions. Reductions in short-term implementation expenditures are projected to result in annual net losses in business transactions ranging from $7.36 million to $1.90 million from 2001 to 2004 (Table 6-22). Reductions in long-term implementation expenditures are expected to result in a net loss of $2.21 million in business transactions from 2001 to 2026 (Table 6-25). Changes in the Corps' operating expenditures (avoided costs) would result in an annual reduction of $4.09 million in business transactions from 2001 to 2026 (Table 6-28).

Alternative 3—Major System Improvements

Changes to business transactions under this alternative would also be relatively minor and limited to jobs associated with implementation and avoided costs. The projections discussed below are net of Alternative 1—Existing Conditions. Increases in short-term implementation expenditures are projected to result in annual net gains in business transactions ranging from $1.00 million to $54.37 million from 2001 to 2010 (Table 6-22). Increases in long-term implementation expenditures are expected to result in a net gain of $6.31 million in business transactions from 2001 to 2026 and $0.89 million from 2027 to 2100 (Table 6-25). Changes in the Corps' operating expenditures (avoided costs) would result in increased annual business transactions of $2.18 million from 2001 to 2026 and $1.26 million from 2027 to 2100 (Table 6-28).

Alternative 4—Dam Breaching

Short-term impacts under Alternative 4—Dam Breaching would be mainly associated with construction activities. These impacts would be temporary and, with the exception of implementation-related impacts, last 1 or 2 years (Table 6-33). Changes in business transactions would be distributed throughout the regional economy and not only concentrated in the sector where the initial change in spending occurs.

Construction activities resulting directly and indirectly from breaching the four lower Snake River dams would result in a temporary increase in business transactions in the lower Snake River study area. Table 6-32 presents point estimates of the maximum temporary increase in business transactions that would be generated by resource area. Major construction projects would include replacement power facilities and transportation-related construction. The total change presented in Table 6-32 is the sum of the maximum annual temporary increase in business transactions for each resource area. The construction activities generating these projected increases would all have to take place in the same year for a maximum annual temporary increase of $2,271.62 million in business transactions. This is not the case and the maximum temporary increase in business transactions projected for any one year would be about $1,622.39 million.

Average point estimates are presented for long-term annual changes in business transactions in Table 6-33. These point estimates suggest that in the long-term, annual business transactions in the lower Snake River study area would experience a net decrease of about $66.28 million, which represents less than 1 percent of current business transactions in the lower Snake River study area. Expenditures associated with replacement power facility operation, recreation, and implementation activities would increase annual business transactions by $216 million (Table 6-33). The lower Snake River study area would, however, also experience a reduction in annual business transactions of $282.31 million. These reductions would be mainly associated with a reduction in irrigated lands, avoided costs, and changes in grain transportation.

Table 6-32. Annual Short-term Business Transactions Impacts under Alternative 4—Dam Breaching (1998 dollars) ($ million per year)[1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
Electric Power				
Power Plant Construction[3/]	0	0	664.8	**664.8**
Transmission Line Construction	0	0	248.2	**248.2**
Recreation				
Campground Construction	0	17.94	0	**17.94**
Transportation				
Rail Construction[4/]				**104.51**
Road Construction[4/]				**236.4**
Transportation Facilities Construction[4/]				**711.86**
Water Supply				
Well Modification	0	107.76	30.4	**138.16**
Pump Modification	72.85	0	0	**72.85**
Implementation				
Implementation	15.38	30.76	30.76	**76.90**
Total Change[5/6/]	**88.23**	**156.46**	**974.16**	**2,271.62**
Total Existing Annual Business Transactions[7/]	7,964.66	6,744.85	19,717.96	**34,427.47**
Change as % of Existing Business Transactions	1.11	2.32	4.94	**6.60**

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the impacts vary by year over a number of years.

2/ The lower Snake River study area is comprised of the upriver, reservoir, and downriver subregions.

3/ The DREW HIT assumed that a total of six replacement power plants would be built. The exact locations of these plants are unknown but the DREW HIT assumed that three would be located in the downriver subregion, with the other three most likely located in the Puget Sound region. Construction of each power plant is estimated to generate $332.40 million in short-term business transactions. The estimates shown in this table are the maximum increase in business transactions that would occur in any one year—$664.80 million in the downriver subregion, where two plants would be constructed simultaneously.

4/ These impacts would occur in the lower Snake River study area but it is not known how they would be distributed among the subregions.

5/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River study area figure because some of the projected Study Area impacts were not distributed by subregion.

6/ These totals are the sum of the maximum annual gains in business transactions for each resource area. With the exception of the implementation cost category, the increases in business transactions identified in this table would only last 1 or 2 years. The construction activities generating these projected gains would all have to take place in the same year for an annual gain of $2,271.62 million in business transactions. This is not the case. The maximum short-term annual increase in business transactions is projected to be $1,622.39 million.

7/ Existing business transactions estimates were obtained from IMPLAN.

Table 6-33. Long-term Subregion Business Transactions Impacts under Alternative 4—Dam Breaching (1998 dollars) ($ million per year)[1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
Increases in Long-term Business Transactions				
Electric Power				
O&M Spending on Replacement Power Plants and New Transmission Lines[3/]	0	0	142.37	**142.37**
Recreation				
Increased Nonangler Spending	0	37.28	0	**37.28**
Increased Angler Spending	15.89	15.44	0	**31.33**
O&M Spending on New Campgrounds	0	3.25	0	**3.25**
Implementation				
Implementation	0.36	0.72	0.72	**1.80**
Total Increase	**16.25**	**56.69**	**143.09**	**216.03**
Decreases in Long-term Business Transactions				
Water Supply				
Reduction in Irrigated Lands	0	(125.68)	(53.86)	**(179.54)**
Avoided Costs				
Avoided Costs (Reductions in Corps' Spending)	(14.00)	(28.01)	(28.01)	**(70.02)**
Transportation				
Loss of Barge Transportation (Grain)[4/]	(25.47)	(47.81)	48.92	**(24.36)**
Reduced Cruise Ship Operations	(8.39)	0	0	**(8.39)**
Total Decrease	**(47.86)**	**(201.50)**	**(32.95)**	**(282.31)**
Net Long-term Change in Business Transactions	**(31.61)**	**(144.81)**	**(110.14)**	**(66.28)**
Total Existing Annual Business Transactions[5/]	7,964.66	6,744.85	19,717.96	**34,427.47**
Net Change as a % of Existing Annual Business Transactions	(0.40)	(2.15)	0.56	**(0.19)**

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the impacts vary by year over a number of years.
2/ The lower Snake River study area is comprised of the upriver, reservoir, and downriver subregions.
3/ Estimates of the negative impacts of electric rate increases are not available for the subregions and are excluded from this table. Rate increase impacts are shown by state in Table 6-38.
4/ These figures are from Table 6-21, which summarizes the impacts associated with a loss of grain farm income due to increased transport cost (Table 6-15), loss of grain-transportation-related barge revenue (Table 6-17), increased grain transportation-related railroad revenue (Table 6-19), and changes in truck transportation (Table 6-20).
5/ Existing business transactions estimates were obtained from IMPLAN.

6.4.1.2 Employment

Alternative 1—Existing Conditions

Alternative 1—Existing Conditions, represents the baseline for this analysis. Total full-time and part-time employment in the 25-county lower Snake River study area was 318,740 in 1995. Subregion totals ranged from 68,334 in the reservoir subregion to 175,325 in the downriver subregion.

Alternative 2—Maximum Transport of Juvenile Salmon

Employment change under this alternative would be relatively minor and limited to jobs associated with implementation and avoided costs. The projections discussed below are net of Alternative 1—Existing Conditions. Short-time employment associated with implementing this alternative from 2001 to 2004 is projected to range from a net loss of 110 to 28 jobs (Table 6-23). Reductions in long-term implementation expenditures are expected to result in a net loss of 81 jobs from 2001 to 2026 (Table 6-26). Changes in the Corps' operating expenditures (avoided costs) would result in a net annual loss of 83 jobs from 2001 to 2026 (Table 6-29).

Alternative 3—Major System Improvements

Employment change under this alternative would also be relatively minor and limited to jobs associated with implementation and avoided costs. Short-term employment associated with implementing this alternative from 2001 to 2010 is projected to range from an annual net gain of 15 jobs to a gain of 813 jobs (Table 6-23). Increases in long-term implementation expenditures are expected to result in net annual gains of 230 jobs from 2001 to 2026 and 32 jobs from 2027 to 2100 (Table 6-26). Changes in the Corps' operating expenditures (avoided costs) would result in net annual gains of 44 jobs from 2001 to 2026 and 25 jobs from 2027 to 2100 (Table 6-29).

Alternative 4—Dam Breaching

Short-term impacts under Alternative 4—Dam Breaching would be mainly associated with construction activities (Table 6-34). These impacts would be temporary and, with the exception of implementation-related impacts, last one or two years. Long-term impacts would be permanent (Table 6-35). Projected employment impacts include direct, indirect, and induced jobs and would, therefore, be distributed throughout the regional economy and not only concentrated in the sector where the initial change in spending occurs.

Construction activities resulting directly and indirectly from breaching the four lower Snake River dams would result in a number of temporary jobs being generated in the lower Snake River study area. Table 6-34 presents point estimates of the maximum number of annual temporary jobs that would be generated by resource area. Major construction projects would include replacement power facilities (5,572 jobs) and transportation-related construction (9,826 jobs). The total change presented in Table 6-34 is the sum of the maximum annual temporary increase in employment for each resource area. The construction activities generating these projected increases would all have to take place in the same year for a maximum annual temporary increase of 20,821 jobs. This is not the case and the maximum temporary increase in employment projected for any one year would be 14,871, as shown in Figure 6-1.

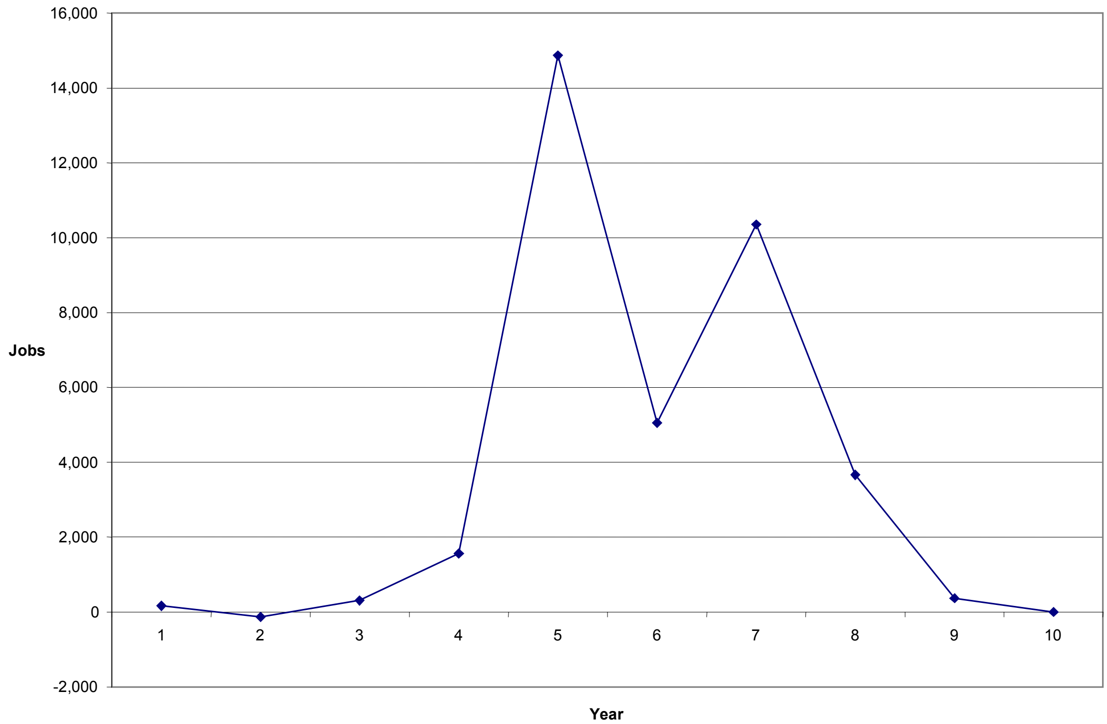

Figure 6-1. Net Annual Short-term Employment Change in the Lower Snake River Study Area (2001 to 2010)

Average point estimates are presented for long-term annual changes in employment in Table 6-35. These point estimates suggest that in the long-term, employment in the lower Snake River study area would experience a net decrease of 1,372 jobs, which represents less than 1 percent of jobs in the 25-county lower Snake River study area. The area would gain 1,842 jobs with an average personal income of $24,033 ($44.3 million in personal income[13]/1,842 jobs) (Tables 6-35 and 6-37). These jobs would mainly result from expenditures associated with replacement power facility operation, recreation, and implementation activities. The lower Snake River study area would, however, lose 3,214 jobs with an average personal income of $32,523 ($104.5 million in personal income/3,214 jobs) (Tables 6-35 and 6-37). The lost jobs would be mainly associated with farmland irrigated from the Ice Harbor reservoir, Corps' operations, and changes in grain transportation. The average annual income in the lower Snake River study area in 1995 was $32,088.

[13] Projected changes in personal income include changes associated with direct, indirect, and induced jobs. Therefore, average personal income projections calculated by dividing change in total personal income by change in jobs represent changes throughout the regional economy not just in the directly affected sectors. In addition, personal income, as used in this analysis, consists of wages, salaries, social insurance, and profit received by individuals. As a result, personal income figures calculated by dividing changes in total personal income by changes in jobs are not directly equivalent to the average wage or salary that would be received by the workers doing those jobs.

Table 6-34. Short-term Subregion Employment Impacts under Alternative 4—Dam Breaching (jobs)[1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
Electric Power				
Power Plant Construction[3/]	0	0	5,572	**5,572**
Transmission Line Construction	0	0	2,080	**2,080**
Recreation				
Campground Construction	0	174	0	**174**
Transportation				
Rail Construction[4/]				**872**
Road Construction[4/]				**1,972**
Transportation Facilities Construction[4/]				**6,982**
Water Supply				
Well Modification	0	916	259	**1,175**
Pump Modification	844	0	0	**844**
Implementation				
Implementation	230	460	460	**1,150**
Total Change[5/6/]	**1,074**	**1,550**	**8,371**	**20,821**
1995 Total Employment	75,081	68,334	175,325	**318,740**
Net Change as % of 1995 Employment	1.43	2.27	4.77	**6.53**

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the impacts vary by year over a number of years.

2/ The lower Snake River study area is comprised of the upriver, reservoir, and downriver subregions.

3/ The DREW HIT assumed that a total of six replacement power plants would be built. The exact locations of these plants are unknown but DREW HIT assumed that three would be located in the downriver subregion, with the other three most likely located in the Puget Sound region. Construction of each power plant is estimated to generate 2,786 short-term jobs. The estimates shown in this table are the maximum number of these jobs that would be generated in any one year—5,572 in the downriver subregion, where two plants would be constructed simultaneously.

4/ These impacts would occur in the lower Snake River study area but it is not known how they would be distributed among the subregions.

5/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River study area figure because some of the projected Study Area impacts were not distributed by subregion.

6/ These totals are the sum of the maximum annual short-term job gains for each resource area. With the exception of the implementation cost category, the jobs identified in this table would only last 1 or 2 years. The numbers provided for the implementation cost category are the average annual increase over a 10-year period. The construction activities generating this projected employment would all have to take place in the same year for an annual gain of 20,821 jobs. This is not the case (see Figure 6-1). The maximum temporary employment increase in any one year would be 14,871 jobs.

The regional economic analysis prepared for this study developed estimates of employment change for each year of the 100-year study period. High, medium, and low estimates were developed for each year. Point estimates of short- and long-term employment changes, presented in Tables 6-34 and 6-35, are primarily based on mid-point numbers or "most likely" estimates provided by the DREW workgroups. Averages are shown when impacts vary by year over a number of years. Figure 6-2 combines short- and long-term employment impacts and shows projected net annual employment change for the lower Snake River study area from 2001 to 2051. This figure shows a short-term increase in construction-related employment followed by a long-term net decrease in employment.

Table 6-35. Long-term Subregion Employment Impacts under Alternative 4—Dam Breaching (jobs)[1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
Increases in Long-term Employment				
Electric Power[3/]				
O&M Spending on Replacement Power Plants and New Transmission Lines	0	0	884	**884**
Recreation				
Increased Nonangler Spending	0	503	0	**503**
Increased Angler Spending	239	162	0	**401**
O&M Spending on New Campgrounds	0	26	0	**26**
Implementation				
Implementation	6	11	11	**28**
Total Increase	**245**	**702**	**895**	**1,842**
Decreases in Long-term Employment				
Water Supply				
Reduction in Irrigated Lands	0	(1,105)	(474)	**(1,579)**
Avoided Costs				
Avoided Costs (Reductions in Corps' Spending)	(283)	(566)	(566)	**(1,415)**
Transportation				
Loss of Barge Transportation (Grain)[4/]	(221)	(407)	491	**(137)**
Reduced Cruise Ship Operations	(83)	0	0	**(83)**
Total Decrease	**(587)**	**(2,078)**	**(549)**	**(3,214)**
Net Long-term Employment Change	**(342)**	**(1,376)**	**346**	**(1,372)**
1995 Total Employment	75,081	68,334	175,325	**318,740**
Net Change as a % of 1995 Employment	(0.46)	(2.01)	0.20	**(0.43)**

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the impacts vary by year over a number of years.
2/ The lower Snake River study area is comprised of the upriver, reservoir, and downriver subregions.
3/ Estimates of the negative impacts of electric rate increases are not available for the subregions and are excluded from this table. Rate increase impacts are shown by state in Table 6-39.
4/ These figures are from Table 6-21, which summarizes the impacts associated with a loss of grain farm income due to increased transport cost (Table 6-15), loss of grain-transportation-related barge revenue (Table 6-17), increased grain transportation-related railroad revenue (Table 6-19), and changes in truck transportation (Table 6-20).

The employment estimates developed throughout the RED analysis include both full-time and part-time employment. The average conversion factor from full-time and part-time employment totals to full-time equivalents (FTE) is 0.88.[14] This ratio is for the entire United States and not specific to any given state or region. Projected job losses and gains in the lower Snake River study area should be multiplied by 0.88 to obtain an indication of the number of full-time jobs these totals represent.

[14] These conversion factors vary from sector to sector. The FTEs for the retail and services sectors, for example, are 0.81 and 0.87, respectively. The FTEs for the civilian and Federal government and manufacturing sectors are both 0.97.

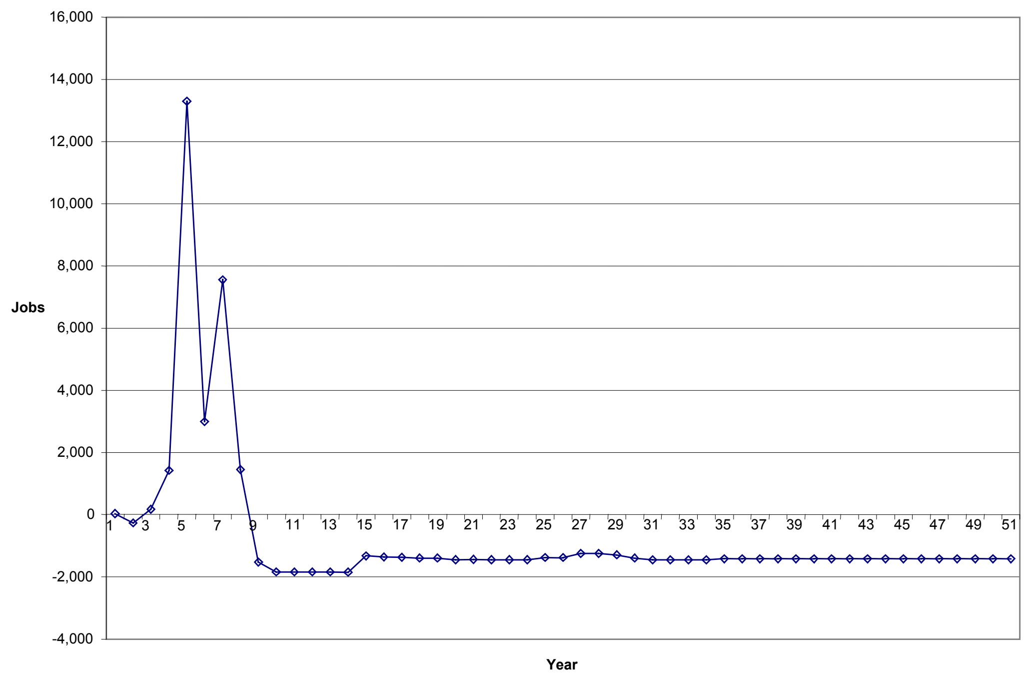

Figure 6-2. Net Annual Employment Change in the Lower Snake River Study Area (2001 to 2051)

6.4.1.3 Personal Income

Alternative 1—Existing Conditions

Alternative 1—Existing Conditions is the baseline for this analysis. Total personal income in the 25-county lower Snake River study area was $12,677 million in 1998. Subregion totals ranged from $2,630 million in the upriver subregion to $7,317 million in the downriver subregion.

Alternative 2—Maximum Transport of Juvenile Salmon

Changes in personal income under this alternative would be associated with implementation and avoided costs. The projections discussed below are net of Alternative 1—Existing Conditions. Short-term changes in personal income associated with implementing this alternative from 2001 to 2004 are projected to range from a net loss of $3.02 million to a net loss of $0.78 million (Table 6-24). Reductions in long-term implementation expenditures are expected to result in a net loss of $5.15 million in annual personal income from 2001 to 2026 (Table 6-27). Changes in the Corps' operating expenditures (avoided costs) would result in a net loss of $2.36 million from 2001 to 2026 (Table 6-30).

Alternative 3—Major System Improvements

Changes in personal income under this alternative would also be associated with implementation and avoided costs. The projections discussed below are net of Alternative 1—Existing Conditions. Changes in personal income associated with implementing this alternative from 2001 to 2010 are projected to range from a net annual loss of $1.33 million to a net annual gain of $22.29 million (Table 6-24). Increases in long-term implementation expenditures are expected to result in net gains of $14.70 million in annual personal income from 2001 to 2026 and $2.07 million from 2027 to 2100 (Table 6-27). Changes in the Corps' operating expenditures (avoided costs) would result in a gain of $1.26 million in personal income over Alternative 1—Existing Conditions, from 2001 to 2026 and $0.73 million from 2027 to 2100 (Table 6-30).

Alternative 4—Dam Breaching

Changes in personal income mirror the changes in jobs discussed in the preceding section. Short-term impacts, mainly associated with construction activities, would be temporary and, with the exception of implementation-related impacts, last one or two years. Long-term impacts would be permanent. Changes in personal income would be distributed throughout the regional economy and not just concentrated in the sector where the initial change in spending occurs.

Construction activities resulting directly and indirectly from breaching the four lower Snake River dams would result in a temporary increase in personal income in the lower Snake River study area. Table 6-36 presents point estimates of the maximum temporary increase in personal income that would be generated by resource area. Major construction projects would include replacement power facilities and transportation-related construction. The total change presented in Table 6-36 is the sum of the maximum annual temporary increase in business transactions for each resource area. The construction activities generating these projected increases would all have to take place in the same year for a maximum annual temporary increase of $678.81 million in personal income. This is not the case and the maximum temporary increase in personal income projected for any one year would be about $484.8 million.

Average point estimates are presented for long-term annual changes in personal income by subregion in Table 6-37. These point estimates suggest that in the long-run, total personal income in the lower Snake River study area would experience a net decrease of $63.41 million, which represents less than 1 percent of personal income in the lower Snake River study area (Table 6-37). Expenditures associated with replacement power facility operation, recreation, and implementation activities would increase total annual personal income by $44.27 million. The lower Snake River study area would, however, also see an annual decrease in personal income of $107.68 million. This decrease would be mainly associated a reduction in irrigated lands, avoided costs, and changes in grain transportation.

Table 6-36. Short-term Subregion Personal Income Impacts under Alternative 4—Dam Breaching (1998 dollars) ($ million per year)[1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
Electric Power				
Power Plant Construction[3/]	0	0	209.60	**209.60**
Transmission Line Construction	0	0	78.30	**78.30**
Recreation				
Campground Construction	0	6.18	0	**6.18**
Transportation				
Rail Construction[4/]				**27.90**
Road Construction[4/]				**63.10**
Transportation Facilities Construction[4/]				**202.00**
Water Supply				
Well Modification	0	29.50	8.30	**37.80**
Pump Modification	22.40	0	0	**22.40**
Implementation				
Implementation	6.31	12.61	12.61	**31.53**
Total Change[5/ 6/]	**28.71**	**48.29**	**308.81**	**678.81**
1998 Total Personal Income	2,630.00	2,731.00	7,317.00	**12,677.00**
Net Change as % of 1998 Income	1.09	1.77	4.22	**5.35**

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the impacts vary by year over a number of years.

2/ The lower Snake River study area is comprised of the upriver, reservoir, and downriver subregions.

3/ The DREW HIT assumed that a total of six replacement power plants would be built. The exact locations of these plants are unknown but the DREW HIT assumed that three would be located in the downriver subregion, with the other three most likely located in the Puget Sound region. Construction of each power plant is estimated to generate $104.8 million in personal income. The estimate shown in this table is for the maximum amount that would be generated in any one year—$209.6 million in the downriver subregion, where two plants would be constructed simultaneously.

4/ These impacts would occur in the lower Snake River study area but it is not known how they would be distributed among the subregions.

5/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River study area figure because some of the projected Study Area impacts were not distributed by subregion.

6/ These totals are the sum of the maximum annual gains in personal income for each resource area. With the exception of the implementation cost category, the increases in personal income identified in this table would only last 1 or 2 years. The construction activities generating these projected gains would all have to take place in the same year for an annual gain of $678.81 million. This is not the case. The maximum short-term annual increase in personal income is projected to be about $484.8 million.

Table 6-37. Long-term Subregion Personal Income Impacts under Alternative 4—Dam Breaching (1998 dollars) ($ million per year)[1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
Increases in Long-term Personal Income				
Electric Power				
O&M Spending on Replacement Power Plants and New Transmission Lines[3/]	0	0	23.60	**23.60**
Recreation				
Increased Nonangler Spending	0	10.72	0	**10.72**
Increased Angler Spending	4.48	3.93	0	**8.41**
O&M Spending on New Campgrounds	0	0.77	0	**0.77**
Implementation				
Implementation	0.15	0.31	0.31	**0.77**
Total Increase	**4.63**	**15.73**	**23.91**	**44.27**
Decreases in Long-term Personal Income				
Water Supply				
Reduction in Irrigated Lands	0	(43.30)	(18.55)	**(61.85)**
Avoided Costs				
Avoided Costs (Reductions in Corps' Spending)	(8.09)	(16.18)	(16.18)	**(40.45)**
Transportation				
Loss of Barge Transportation (Grain)[4/]	(4.99)	(9.66)	11.57	**(3.08)**
Reduced Cruise Ship Operations	(2.30)	0	0	**(2.30)**
Total Decrease	**(15.38)**	**(69.14)**	**(23.16)**	**(107.68)**
Net Long-term Change in Personal Income	**(10.75)**	**(53.41)**	**0.75**	**(63.41)**
1998 Total Personal Income	2,630.00	2,731.00	7,317.00	**12,677.00**
Net Change as a % of 1998 Personal Income	(0.41)	(1.96)	0.01	**(0.50)**

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the impacts vary by year over a number of years.
2/ The lower Snake River study area is comprised of the upriver, reservoir, and downriver subregions.
3/ Estimates of the negative impacts of electric rate increases are not available for the subregions and are excluded from this table. Rate increase impacts are shown by state in Table 6-40.
4/ These figures are from Table 6-21, which summarizes the impacts associated with a loss of grain farm income due to increased transport cost (Table 6-15), loss of grain-transportation-related barge revenue (Table 6-17), increased grain transportation-related railroad revenue (Table 6-19), and changes in truck transportation (Table 6-20).

6.4.2 Impacts at the State Level Excluding Those Effects Modeled for the Subregions (Alternative 4—Dam Breaching)

Several impact categories occur either throughout the Pacific Northwest or in an area of a state outside the lower Snake River study area. In addition, impacts associated with changes in commercial and ocean recreational fishing occur in the Pacific Northwest states, Alaska, and British Columbia, Canada. The effects of these impact categories upon business transactions, employment, and sales are summarized in Tables 6-38 through 6-40, respectively.

6.4.2.1 Short-term Impacts

Three CC electric power plants would be built in the Puget Sound region of Washington. Construction of each of these plants would occur in different years and would create about $332.40 million in business transactions, 2,786 jobs, and $104.80 million in personal income in the State of Washington over three one year periods.

Construction of tidewater rail car storage in Oregon is projected to cost about $3.02 million and create $7.19 million in business transactions, 63 jobs, and $1.84 million in personal income. These construction impacts would only last one year.

Table 6-38. Annual State-level Business Transaction Impacts for Alternative 4—Dam Breaching Excluding Those Impacts Modeled for the Subregions (1998 dollars) ($ million per year)[1/2/]

	Washington	Oregon	Idaho	Montana	Total
Short-term Impacts[3/]					
Power Plant Construction	332.40	0	0	0	**332.40**
Tidewater Rail Car Storage Construction	0	7.19	0	0	**7.19**
Total	**332.40**	**7.19**	**0.00**	**0.00**	**339.59**
Long-term Impacts[4/]					
Increased Electricity Bills[5/]	(205.69)	(128.70)	(54.81)	(10.37)	**(399.57)**
O&M Spending on new Power Plants	140.70	0	0	0	**140.70**
Loss of Barge Transportation (Grain)[6/]	12.32	25.30	(4.07)	(1.05)	**32.50**
Commercial Fishing[7/]					**19.52**
Ocean Recreational Fishing[7/]					**0.77**
Total	**(52.67)**	**(103.40)**	**(58.88)**	**(11.42)**	**(206.08)**

1/ These impacts are not the state totals. Rather they are impacts that occur throughout a state (increased electricity bills) or in areas of a state outside the subregions (the remaining categories).

2/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the impacts vary by year over a number of years.

3/ Short-term impacts would be temporary. Power plant construction would occur over three 1-year periods. Tidewater rail car storage construction would last for just 1 year.

4/ Long-term impacts would be permanent.

5/ These estimates exclude the impacts that would be associated with plant closures or business failures caused by increased electric bills.

6/ These figures are based on Table 6-21, which summarizes the impacts associated with a loss of grain farm income due to increased transport cost (Table 6-15), loss of grain-transportation-related barge revenue (Table 6-17), increased grain transportation-related railroad revenue (Table 6-19), and changes in truck transportation (Table 6-20). The numbers in this table are, however, presented by state net of the subregion impacts, also identified in Table 6-21, and, therefore, do not match the total state impacts identified in Table 6-21.

7/ These projected increases would occur in Washington, Oregon, Idaho, Alaska, and British Columbia.

Table 6-39. Annual State-level Employment Impacts for Alternative 4—Dam Breaching Excluding those Impacts Modeled for the Subregions (jobs)[1/2/]

	Washington	Oregon	Idaho	Montana	Total
Short-term Impacts[3/]					
Power Plant Construction	2,786	0	0	0	**2,786**
Tidewater Rail Car Storage Construction	0	63	0	0	**63**
Total	**2,786**	**63**	**0**	**0**	**2,849**
Long-term Impacts[4/]					
Increased Electricity Bills[5/]	(1,136)	(810)	(366)	(70)	**(2,382)**
O&M Spending on new Power Plants	876	0	0	0	**876**
Loss of Barge Transportation (Grain)[6/]	224	210	(24)	0	**410**
Commercial Fishing[7/]					**171**
Ocean Recreational Fishing[7/]					**7**
Total	**(36)**	**(600)**	**(390)**	**(70)**	**(918)**

1/ These impacts are not the state totals. Rather they are impacts that occur throughout a state (increased electricity bills) or in areas of a state outside the subregions (the remaining categories).

2/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the impacts vary by year over a number of years.

3/ Short-term impacts would be temporary. Power plant construction would occur over three 1-year periods. Tidewater rail car storage construction would last for just 1 year.

4/ Long-term impacts would be permanent.

5/ These estimates exclude the impacts that would be associated with plant closures or business failures caused by increased electric bills.

6/ These figures are based on Table 6-21, which summarizes the impacts associated with a loss of grain farm income due to increased transport cost (Table 6-15), loss of grain-transportation-related barge revenue (Table 6-17), increased grain transportation-related railroad revenue (Table 6-19), and changes in truck transportation (Table 6-20). The numbers in this table are, however, presented by state net of the subregion impacts, also identified in Table 6-21, and, therefore, do not match the total state impacts identified in Table 6-21.

7/ These projected increases would occur in Washington, Oregon, Idaho, Alaska, and British Columbia.

Table 6-40. Annual State-level Personal Income Impacts for Alternative 4—Dam Breaching Excluding those Impacts Modeled for the Subregions (1998 dollars) ($ million per year)[1/2/]

	Washington	Oregon	Idaho	Montana	Total
Short-term Impacts[3/]					
Power Plant Construction	104.80	0	0	0	**104.80**
Tidewater Rail Car Storage Construction	0	1.84	0	0	**1.84**
Total	104.80	1.84	0	0	**106.64**
Long-term Impacts[4/]					
Increased Electricity Bills[5/]	(119.82)	(73.22)	(32.83)	(6.20)	**(232.07)**
O&M Spending on new Power Plants	23.58	0	0	0	**23.58**
Loss of Barge Transportation (Grain)[6/]	5.61	7.34	(0.45)	(0.02)	**12.48**
Commercial Fishing[7/]					**6.25**
Ocean Recreational Fishing[7/]					**0.25**
Total	**(90.63)**	**(65.88)**	**(33.28)**	**(6.22)**	**(189.51)**

1/ These impacts are not the state totals. Rather they are impacts that occur throughout a state (increased electricity bills) or in areas of a state outside the subregions (the remaining categories).
2/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the impacts vary by year over a number of years.
3/ Short-term impacts would be temporary. Power plant construction would occur over three 1-year periods. Tidewater rail car storage construction would last for just 1 year.
4/ Long-term impacts would be permanent.
5/ These estimates exclude the impacts that would be associated with plant closures or business failures caused by increased electric bills.
6/ These figures are based on Table 6-21, which summarizes the impacts associated with a loss of grain farm income due to increased transport cost (Table 6-15), loss of grain-transportation-related barge revenue (Table 6-17), increased grain transportation-related railroad revenue (Table 6-19), and changes in truck transportation (Table 6-20). The numbers in this table are, however, presented by state net of the subregion impacts, also identified in Table 6-21, and, therefore, do not match the total state impacts identified in Table 6-21.
7/ These projected increases would occur in Washington, Oregon, Idaho, Alaska, and British Columbia.

6.4.2.2 Long-term Impacts

Increased electric power bills would cause business transactions, employment, and personal income to fall throughout Washington, Oregon, Idaho, and Montana, with the largest impacts occurring in Washington.

Operation and maintenance of the three CC power plants that would be built in the Puget Sound region would add $140.70 million in business transactions, 876 jobs, and $23.58 million in personal income.

Grain transportation changes would also affect long-term business transactions, employment, and personal income. These impacts would be associated with increased transportation costs for grain farms, the loss of revenue for Oregon barge companies, increased railroad revenues, and changes in trucking, storage, and handling revenues. The largest impacts would occur in Washington, followed by Oregon then Idaho, with relatively small impacts occurring in Montana and Idaho.

Increases in commercial and ocean recreation harvest of anadromous fish in the Pacific Northwest states of Washington and Oregon, Alaska, and British Columbia, Canada would add $20.29 million in business transactions, 178 jobs, and $6.5 million in personal income.

Net annual state-level employment change (excluding those impacts modeled for the lower Snake River study area) is presented for the years 2001 through 2051 in Figure 6-3.

Total short- and long-term regional impacts are the sum of the above subregion and state-level excluding subregion totals. These impacts are summarized in Table 6-41. In the short-term, the Pacific Northwest as a whole would experience maximum annual net increases of $2,611.2 million in business transactions, 23,670 short-term jobs, and $785.5 million in personal income. Short-term impacts would be temporary and these totals represent the maximum changes that could occur in one year. In the long-term, the Pacific Northwest as a whole would experience a net decrease in business transactions of $272.4 million, a loss of 2,290 jobs, and a net decrease of $252.92 million in personal income. These impacts would be permanent (Table 6-41). Net annual regional employment change is presented for the years 2001 through 2051 in Figure 6-4.

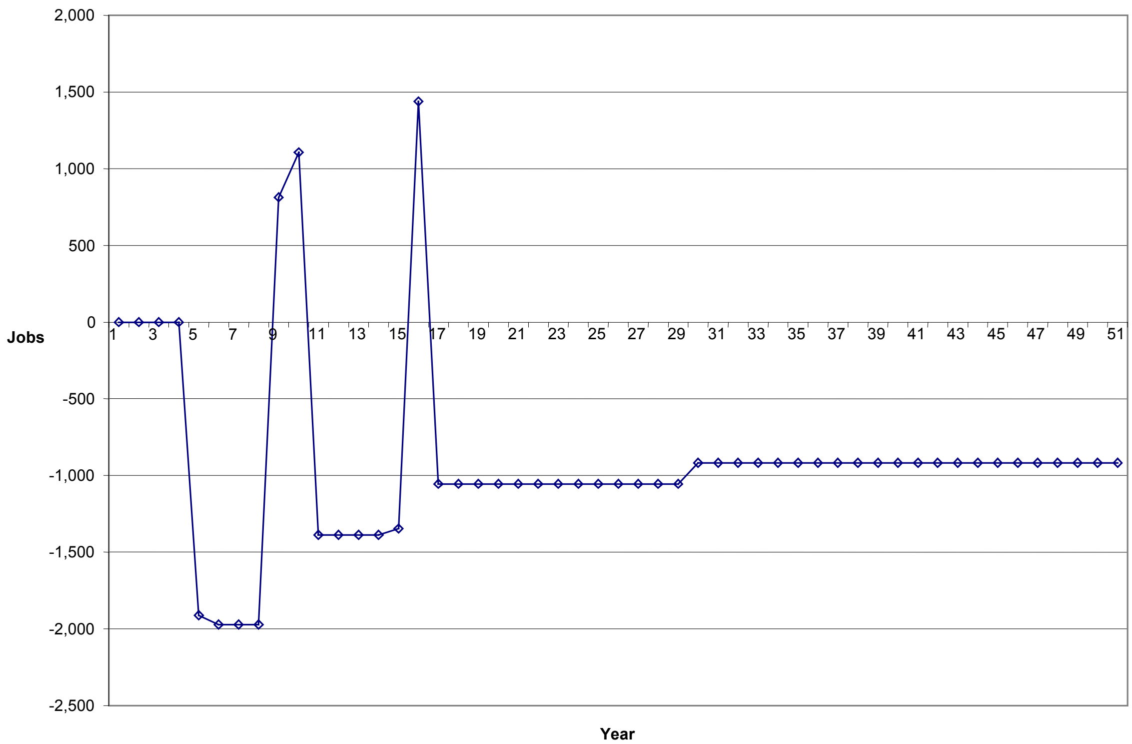

Figure 6-3. Net Annual State-level Employment Change (Excluding those Impacts Modeled for the Lower Snake River Study Area) (2001 to 2051)

Table 6-41. Total Regional Impacts for Alternative 4—Dam Breaching–Business Transactions, Employment, and Personal Income[1/]

Region	Business Transactions ($ million per year) Short-term	Business Transactions ($ million per year) Long-term	Employment (jobs) Short-term	Employment (jobs) Long-term	Personal Income ($ million per year) Short-term	Personal Income ($ million per year) Long-term
Subregions	2,271.62	(66.28)	20,821	(1,372)	678.81	(63.41)
State-Level Impacts (excluding those modeled for the subregions)	339.59	(206.08)	2,849	(918)	106.64	(189.51)
Total Regional Impacts	**2,611.21**	**(272.36)**	**23,670**	**(2,290)**	**785.45**	**(252.92)**

1/ The short-term impacts presented in this table are the maximum short-term impacts that could occur in 1 year. The long-term impacts are, in contrast, permanent impacts that are expected to occur each year. This comparison results in a relative overstatement of the short-term impacts. Figure 6-4, which presents Projected net annual regional employment change for the years 2001 through 2051, combines projected annual long-term impacts with annual short-term impacts, rather than the maximum short-term impacts that could occur in 1 year.

Source: Tables 6-32 through 6-40

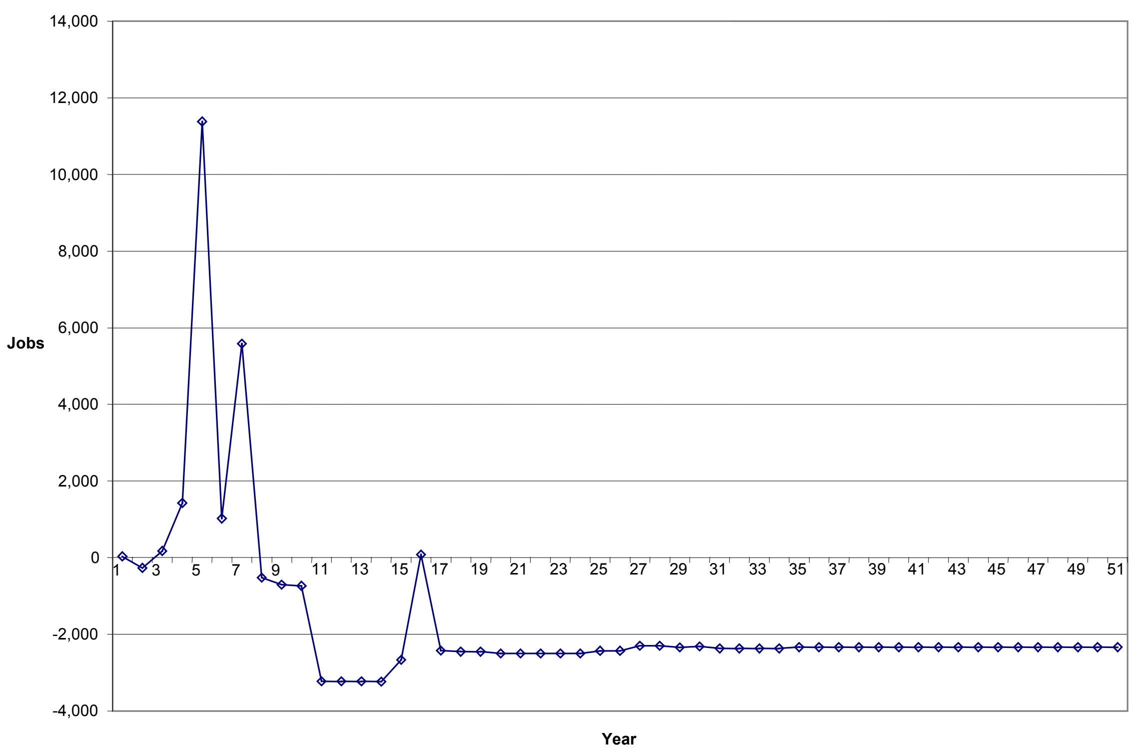

Figure 6-4. Net Annual Total Regional Employment Change (2001 to 2051)

6.4.3 Unresolved Issues

The previous sections discuss the regional impacts that would be associated with the projected costs and benefits for each alternative. There are also several areas of concern that were not evaluated as part of the NED or RED analyses because at this time, it is unclear how these concerns will be addressed or if the costs will be implemented. Three potential areas of concern pertain to the RED analysis: water temperature concerns, total dissolved gas concerns, and mitigation/compensation concerns. These concerns, which are discussed further in Section 10.2.4, are briefly described below:

- Water temperature and dissolved gas saturation levels are two of the principal water quality concerns in the lower Snake River. The Dworshak reservoir is currently operated to release 1.2 million acre-feet (MAF) of cold water during July and August each year to reduce water temperatures within the Lower Snake River reservoirs. No other actions are currently being studied to further reduce temperatures within the system. Therefore, no additional costs are evaluated in this study.
- To reduce total dissolved gas levels found at the lower Snake River reservoirs, structural modifications have been made at the dams, and additional modifications are being evaluated. Annual costs to address total dissolved gases are not included in the implementation cost analysis or RED analysis because it is unclear which, if any of the possible range of costs may be implemented.
- Federally required mitigation actions (for fish and wildlife programs and cultural resources) were included in implementation costs.
- However, it may also be socially desirable to consider mitigation or compensation actions that involve negatively impacted groups. Section 13.3 identifies potential impacts for which mitigation and/or compensation efforts could be considered. It is unclear which measures, if any, Congress may decide is appropriate to address. Therefore, these costs have not been identified or included in the NED or RED analyses.

6.5 Potentially Affected Businesses

The regional economic analysis depended primarily upon information from the DREW study teams as the basis for estimating economic impacts. Sufficient information was not, however, available to model the potential impacts that Alternative 4—Dam Breaching could have on a number of regional industries. This section provides a general discussion of the potential impacts of dam breaching on regional industries and businesses where there was not sufficient information available to quantify these impacts.

Dam breaching could affect regional businesses in both positive and negative ways. Regional recreation service and equipment providers, for example, could be affected positively. This is partially reflected in the recreation analysis presented in Section 6.3.2. More specifically, several major aluminum jet boat manufacturers are located in Lewiston, Idaho, and Moscow, Idaho is the home of one of the largest manufacturers and retailers of whitewater equipment in the world. An increase in free-flowing recreation opportunities in the region could benefit these and other similar businesses.

Other regional businesses could be affected negatively. Increases in costs for electric power and transportation, decreases in the availability of irrigated farm output, and removal of the reservoirs and locks could cause significant cost increases for energy and transport intensive industries or industries requiring reservoirs or inputs from agriculture. In some cases, it is possible that these cost increases could be large enough to cause affected plants or firms to close down or relocate to another region. Substantial proprietary information about each firm or plant, such as the cost and profit structure, would be required to allow prediction of those businesses that would close or relocate. It would also be necessary to forecast market prices for the potentially affected products into the future. These types of information are not publicly available and, therefore, it was not possible to identify those firms or plants that would be likely to close or relocate if dam breaching were to occur.

This section discusses some of the industries with businesses that might face increased costs and therefore respond by passing these costs on to consumers, restructuring, relocating, or closing, if dam breaching were to occur. These industries include: primary aluminum manufacturing (electricity-intensive), paper manufacturing (transport-intensive), and food processing (dependent on fruit and vegetable inputs from irrigated agriculture). The geographic extent of these potential impacts varies by industry. Potential increases in electricity rates associated with Alternative 4—Dam Breaching, would likely cause power costs to rise throughout the Pacific Northwest and could potentially affect primary aluminum manufacturers and other energy-intensive industries located throughout Washington, Oregon, and Idaho. Impacts associated with food processing and paper manufacturing would likely be more localized. Potentially affected food processing firms are located in the downriver and reservoir subregions. The portion of the paper manufacturing sector that has the most potential to be affected is concentrated in the upriver subregion.

Table 6-42 presents the estimated direct subregion and state employment in these sectors. This table identifies total direct employment in each sector in the subregions and region where unmeasured impacts may occur. It also identifies total employment in each sector for the lower Snake River study area and the states of Washington, Oregon, and Idaho and the shares of this employment that are at risk in each sector.

Table 6-42. Estimated Direct Jobs in Potentially-Affected Industries by Subregion

Geographic Area	Primary Aluminum Manufacturing	Food Processing (can/freeze)	Paper Manufacturing
Potentially Affected Jobs			
Upriver Subregion	0	0	1,778
Reservoir Subregion	0	1,917	0
Downriver Subregion	1,159	5,388	0
Lower Snake River Study Area Total	1,159	7,305	1,778
Pacific Northwest Total	6,260	7,305	1,778
Total Employment by Sector in the:			
Lower Snake River Study Area	1,159	7,305	2,423
Washington	5,300	21,705	11,579
Oregon	930	13,265	5,234
Idaho	30	9,275	1,780
Combined State Total	**6,260**	**44,245**	**18,593**
Lower Snake River Study Area	**100.0**	**100.0**	**73.4**
Combined State Total	**100.0**	**16.5**	**9.6**

Source: Data compiled from IMPLAN

The potentially affected jobs presented in Table 6-42 represent the maximum number of direct jobs that could be affected by sector and subregion (or states in the case of primary aluminum manufacturing). The extent of possible impacts on these industries are unknown at this time. It should also be noted, however, that these are just direct jobs and do not include the multiplier effect that would occur with business closure. If, for example, a primary aluminum manufacturing plant with 580 employees in the downriver subregion shut down, the resulting multiplier effect throughout the local economy would result in a loss of 820 jobs. This would result in a total job loss of 1,400.

Possible impacts on the food processing and paper manufacturing sectors are discussed further in the following sections.

6.5.1 Food Processing

The potential loss of 37,000 acres of agricultural land presently irrigated from the Ice Harbor reservoir could affect food processing businesses that purchase the agricultural products presently grown on this land. Preliminary estimates suggest that there are approximately 5,000 to 6,500 full- and part-time workers employed by food processing firms that may use products from the affected irrigated lands. Estimates from IMPLAN indicate that the food processing sector employs approximately 1,917 and 5,388 full- and part-time workers in the reservoir and downriver subregions, respectively (Table 6-42).

The 37,000 acres presently irrigated from Ice Harbor are currently used for orchards (apples, cherries, etc), potatoes, wheat, and other vegetables (Table 6-43). These crops and associated acreages were identified in the 1997/98 farm survey conducted by the DREW Water Supply Workgroup (see Section 3.4). These respective acreages were compared to the corresponding totals in the counties surrounding the Tri-Cities (Walla Walla, Benton, Franklin, Yakima counties, Washington; and Umatilla and Morrow counties, Oregon) and the states of Washington and Oregon. The 37,000 irrigated areas represent 4 percent of total irrigated lands in the surrounding counties and 1 percent of the Washington and Oregon total. The Ice Harbor acreages used for potatoes, vegetables, and orchards represent 8, 7, and 6 percent of the surrounding county total, respectively (Table 6-43). These comparisons suggest that the crops grown on the 37,000 acres comprise a relatively small share of regional and statewide production of these crops.

Representatives of local food processors contacted as part of this study indicated that there are dynamic linkages between the food production and processing sectors. Different businesses would be affected differently depending on the nature of these linkages. These relationships are complex and cannot be fully evaluated in the absence of an industry-specific study. Further, the industry representatives contacted are not necessarily representative of the entire industry and information for the largest food processors in the region was not available. Therefore, while it is possible to identify a possible range of impacts, this assessment should be considered preliminary.

Table 6-43. Ice Harbor Irrigated Acres as a Percent of State and Surrounding County Totals

Irrigated Crop	Total Ice Harbor Irrigated Acreage	Total Irrigated Acreage in Surrounding Counties[2/]	States of WA and OR Irrigated Acreage (1997)	Ice Harbor Acreage as a Percentage of Surrounding Counties[2/]	Ice Harbor Acreage as a Percentage of OR and WA
Potatoes	5,513	71,213	146,932	8	4
Wheat	3,515	115,123	401,363	3	1
Orchards	10,508	176,970	390,240	6	3
Vegetables	8,103	109,162	317,197	7	3
Total Harvested Irrigated Acres[1/]	**37,000**	**933,447**	**3,051,054**	**4**	**1**

1/ "Total Harvested Acres" figures from Ice Harbor do not equal totals of other lines because the Corps' survey was unable to identify the use of all the irrigated lands. In addition, 8,500 of the 37,000 acres are dedicated to hybrid poplar plantations.

2/ The surrounding counties are those contiguous to the hub of the Tri-Cities. Walla Walla, Franklin, Benton, Yakima, Umatilla, and Morrow counties were included in this supply region.

Source: Data provided by the DREW Social Analysis Workgroup

Contacts made with local food processors indicated that not all processors purchase products from Ice Harbor-irrigated lands. For those contacted firms that do purchase products from the Ice Harbor-irrigated lands, purchases, which included wine grapes, asparagus, potatoes, corn, and apples, ranged from 1 percent to 40 percent of their supply. Processors were asked to indicate the significance of the loss of this supply to their operations. Responses ranged from insignificant to devastating.

It should be noted that potential impacts to processors may vary by crop type. Some processors suggested that the impacts associated with perennial crops, such as asparagus, which takes more than one year to establish, would be more significant. One processor indicated that the acres irrigated from the Ice Harbor reservoir produce high-quality products and that loss of this supply would affect their high-quality product lines even though it represents a relatively small portion of total supply. Another processor suggested that the loss of this supply might increase competition for remaining supplies, which would be more harmful for some firms than others. Finally, one processor noted that while food processing firms would be unlikely to shut down, they could face supply problems and increased costs.

In addition to short-term effects on supply, increased competition for remaining raw materials, and associated increases in prices, industry representatives indicated that this loss of supply might have long-term detrimental effects on the food processing industry if alternate supplies are not developed. Less certainty that the region could meet food processors demands for raw materials may represent a set-back for the industry, making it a higher investment risk and possibly slowing investment-dependent technological growth within the industry.

While this assessment is preliminary, it suggests that dam breaching would be unlikely to cause immediate significant job loss among the workers presently employed in the food processing sector in the reservoir and downriver subregions.

6.5.2 Forest Products

Increased transportation and other costs associated with dam breaching could affect the forest products industry in north-central Idaho. Detailed industry studies would be needed to fully evaluate the effects of these cost increases. In the absence of these studies, the following qualitative discussion illustrates a range of possible impacts to this sector.

The Idaho forest products industry achieved roughly $2 billion in sales of lumber and wood products and $540 million in sales of pulp and paper in 1992 (Idaho Forest Products Commission, 1999). In 1993, lumber production totaled about 1.86 billion board feet with an estimated wholesale value of $874 million. The majority of this economic activity was centered in north-central Idaho. In 1990, approximately 60 percent of Idaho's forest income was earned in the northern counties.

Projected transportation cost increases for wood products (pulp and waste paper, paper products, primary wood products) and wood chips and logs (fuel wood; wood chips, wood in the rough, lumber, forest products not elsewhere classified) shipped on the lower Snake River were developed by the DREW Transportation Workgroup (Table 6-44). Transportation costs were projected to increase by $2.5 million if the dams were breached and transportation on the lower Snake River were no longer possible. This would represent a 20 percent increase for the higher value added wood products commodity group. The cost for the logs and wood chips category would increase by about 3 percent (Table 6-44).

Table 6-44. Projected Transportation Cost Increases for the North-Central Idaho Forest Products Industry (1998 dollars)

Product	2002 Volume in tons	Total Transportation Cost Increase ($)	Cost Increase per Ton ($)	Percentage Increase from Base Case Cost (2002)
Wood Products	66,000	1,064,591	16.13	20
Logs and Wood chips	694,000	1,481,295	2.13	3
Totals	**760,000**	**2,545,886**	**na**	**na**

Note: na=not available

Source: Data provided by the DREW Transportation Workgroup

North-central Idaho has a diverse mix of mills producing various degrees of value-added wood products such as wood chips, dimensional lumber, decking, and other forest products, as well as pulp and paper products. The byproducts of the milling process are bark, hogfuel, sawdust, and wood chips. These byproducts are consumed internally to generate electricity or heat, sold to a local pulp and paper mill, or shipped by barge to pulp mills in western Washington and Oregon.

Several wood products companies use the Lewiston, Clarkston, and Whitman County ports. These companies use the existing system of barges to ship dimensional lumber, raw logs, wood chips, and other value-added wood products. Employment data are not readily available for these companies. The facilities that would be most potentially affected by dam breaching are a pulp and paper mill and three chipping mills.

A large pulp and paper mill in the Lewiston/Clarkston valley operates three divisions (consumer products, pulp and paperboard, and wood products) and employs approximately 1,700 people, with annual sales estimated to range from $500 to $650 million. This mill is linked to many of the region's other mills because it is the region's major consumer of wood chips and sawdust (Robison, McKetta, and Peterson, 1996). It is estimated that a total of 170,000 tons or one-third of their total paperboard production is shipped via the lower Snake River.

In the absence of an industry-specific study that details the specific volumes of goods shipped on the lower Snake River by individual forest products companies, the actual increased power costs, water supply and treatment costs, the financial health of each company, and the relationships between these companies, it is impossible to quantitatively estimate the magnitude of the impacts to individual companies and the industry as a whole. Overall, the magnitude of the projected transportation cost increase alone appears to be small compared to the value of the overall production from region. Possible reactions to these cost increases are summarized in the first paragraph of Section 6.3.4.4.

7. Social Impact Analysis

7.1 Overview

Communities in the region of the lower Snake River can be characterized as primarily small rural towns that have moderate or low economic diversity and depend significantly on agricultural activities for their economic base. In addition to these rural communities, four urban trade centers, Walla Walla, Pendelton/Hermiston, the Tri-Cities (Richland, Pasco, Kennewick), and the Quad-Cities (Lewiston, Clarkston, Pullman, and Moscow), provide high economic diversity and educational opportunities in the region. With the exception of the Tri-Cities region, population and economic growth in the lower Snake River study area has lagged behind general Pacific Northwest and national growth trends. Two key industries that historically formed the base and currently provide an important component of the regional economy are wood products manufacturing and agricultural production. These two industries have not, however, been the engines of growth in the last decade. Agriculture, in particular, has experienced an absolute decline in employment and farm income has declined as a percentage of regional income. It is not anticipated that these sectors will be the engines of future regional growth. The agricultural sector would potentially be affected most significantly by Alternative 4—Dam Breaching.

The Social Analysis Report (DREW Social Analysis Workgroup, 1999) identified social impacts to nine focus communities, or case studies, taking into account the phases of project development for each of the proposed alternatives. These communities were chosen to capture a range of direct positive and negative impacts across types of communities and the geographic scope of the study area. The Social Analysis Report, which is available on the Corps website, provides additional detailed data and analysis that supports the conclusions presented in this section.

From the analysis of the nine case study communities, it appears that changes in the physical, biological, and economic human environment would have both adverse and beneficial impacts on communities throughout the study region. Each of the alternatives under consideration would create winners and losers, both socially and economically, within and between communities and the subregions. Economic and social losses for one community or group may present opportunities for gains by another community or group.

The remainder of this overview section summarizes potential effects by alternative (as compared to Alternative 1), compares effects by community, briefly discusses mitigation potential, and identifies the unresolved issues associated with this analysis.

7.1.1 Potential Effects by Alternative

7.1.1.1 Alternative 2—Maximum Transport of Juvenile Salmon and Alternative 3—Major System Improvements

Alternative 2—Maximum Transport of Juvenile Salmon, and Alternative 3—Major System Improvements would have little effect on the economic and physical human environment for most communities throughout the region and would provide a degree of economic security for those communities and businesses (grain farms, bulk commodity shippers, and irrigated agriculture) that use the lower Snake River system. Some communities, particularly in the upriver region, that depend on the salmon and steelhead fishery both socially and economically would be adversely affected by the lower probabilities of salmon recovery. Overall changes in regional employment would be minor as a result of implementing these actions. These changes would consist primarily of employment associated with increased Corps spending. Additionally, all communities in the region would be adversely affected by the lower probability of salmon recovery and eventual delisting due to the continued Federal oversight of local and regional economic development activities and continued uncertainty about the future of the lower Snake River system.

7.1.1.2 Alternative 4—Dam Breaching

Alternative 4—Dam Breaching, would change the economic and physical environment of the study region. Although the social and economic environment of the region is constantly changing due to market forces and demographic changes, this type of change to the human-built environment would present economic uncertainty, stress, and fear for some residents of the region. For other residents, it would represent hope for recovering endangered anadromous fish populations.

Employment Impacts of Alternative 4

Alternative 4—Dam Breaching would result in a long-term net employment gain in the downriver subregion and long-term net employment losses in the reservoir and upriver subregions (Table 6-35). Short-term, primarily construction-related, employment changes are shown by subregion in Table 6-34. There would be short-term gains in all three subregions.

The jobs presented in Tables 6-34 and 6-35 represent both full- and part-time employment. The average ratio of full-time equivalent jobs (FTEs) to full- and part-time jobs is 0.88 to 1.0. This ratio varies from sector to sector. The FTEs for the agricultural and government sectors are, for example, 0.81 and 0.97, respectively. The average long-term job changes for each subregion represent approximately (0.44) percent, (1.92) percent, and 0.19 percent of total 1995 employment in the upriver, reservoir, and downriver subregions, respectively (Table 6-35). In the long-term, the Pacific Northwest as a whole (including the subregions) would experience an average net loss of 2,290 jobs or approximately 0.04 percent of total employment in 1995.

The direct incomes associated with these job gains and losses would not be equal. Lost direct employment would be associated with irrigated farm owners and full-time and seasonal workers; Corps' employment related to the operation and management of the lower Snake River dams and facilities; and the loss of barge transportation for grain. Direct employment gained would be associated with operation and maintenance of new power plants and increased recreation and tourism. The average wage of Corps employees in the Walla Walla District is approximately $45,000, which is significantly above the regional per capita or median income. On the other hand, approximately 2,563 part-time and seasonal employees work on the farms on the Ice Harbor reservoir. According to the Washington State Employment Security Department, the average hourly wage for seasonal agricultural workers in southeastern Washington was $6.27, with an average annual salary of $12,500 for full-time workers.

According to the IMPLAN model, the average income per direct, indirect, and induced job created by the operations of new power facilities was approximately $27,000 per year. Because recreation and tourism are not distinct industries, the median wage in Riggins, Idaho, a town with a strong recreation and tourism base, is used to examine the income effects of increased employment in recreation. In 1994, earnings per worker were approximately $19,000, although this may be somewhat misleading because Riggins is an isolated community with a relatively low cost of living.

Average short-term employment change would contribute significantly to each of the study subregions. Projected job gains presented in Table 6-34 show the maximum annual short-term job gains for each resource area. With the exception of the implementation cost category, the jobs identified in this table would only last 1 or 2 years. The maximum changes for each resource area are unlikely to occur in the same year; however, if they were to occur in the same year, these short-term job gains would represent approximately 1.43 percent, 2.27 percent, and 4.77 percent of 1995 employment in the upriver, reservoir, and downriver subregions, respectively (Table 6-34).

Impacts by Subregion

The most significant social impact to the downriver region communities, including the case study communities of Pasco, Kennewick, and Umatilla, would be the potential lost agricultural employment from the Ice Harbor pool and the supply uncertainty faced by food processors and fruit packers. This direct employment loss might be partially offset by the expected increase in transportation and power-generation-related employment. The potential increased flow of commerce into these communities would contribute to traffic safety and congestion concerns. Other significant social impacts include concerns that breaching the four lower Snake River dams would inevitably lead to dam breaching on the Columbia River and the potential effect of these concerns on investments in the region.

The most significant impacts to communities in the reservoir region, including the case study communities of Pomeroy, Colfax, and Clarkston, would be the loss of Corps employment and the increased financial pressure on family farms caused by increased transportation, storage, and handling costs for agricultural products. This added pressure to an already depressed agricultural sector might lead to an increased rate of farm consolidation for those farms not fully owned and those with a high debt-to-equity ratio, increased stress in the farm sector, and an increased rate of loss of rural farm population. This impact would significantly affect the largest number of communities in both the reservoir and upriver regions. In addition, communities in the reservoir region would be affected by the short-term loss of recreation access and the increased flow of truck traffic on the two east-west highways (US 12 and SR 26) that cross the region.

The most significant impact to communities in the upriver subregion, including the case study communities of Lewiston, Orofino, and Riggins, would be the expected increase in the recreation and tourism industry under near natural river conditions. Lewiston and Orofino face economic uncertainty because it is unknown how significantly the loss of river navigation would affect the forest products industry. Additionally, the effects of increased transportation costs to farmers would be the most significant in Latah, Nez Perce, Idaho, and Lewis counties in Idaho.

Effects Widely Dispersed Across the Pacific Northwest

Although electrical rate increases would be expected across all communities and industries in these subregions, as well as across the states of Washington, Oregon, Idaho, and Montana, the estimated 2.8 to 9.4 percent increase for residential rates is relatively small considering existing low electricity costs. These increases are not expected to have significant social or economic impacts in any of the focus communities under consideration, although communities that purchase electricity from rural cooperatives or public utility districts might be more at risk for the higher rate increases. Effects on the aluminum industry are unknown, but significant regional impacts could occur, depending upon who pays the increased costs.

Responses to a Changed Social Environment

The responses of communities, industries, and individuals to these changes in the physical, biological, and economic human environment might be categorized as economic and social. According to the IEAB, the response to the economic impacts described above would either be a migration of individuals and businesses seeking new opportunities, or the reemployment of human and capital resources in their next-best use within the community (IEAB, 1999).

Social responses might include mobilizing resources to minimize adverse impacts, charting a new vision for the community, and taking advantage of new opportunities. Each community is distinct in its ability to respond to these challenges and overcome obstacles in its developmental path. Community size has been identified as a critical factor to a community's ability to adapt to change. Smaller communities may have less diverse economic bases and fewer human resources to draw upon in challenging times. In the case of the communities that would be potentially affected by the proposed alternatives, almost all of them have recently responded to economic booms and busts, as well as declining returns in the historically important agricultural sector. Social and economic impacts projected by this study are discussed in the context of recent historical changes and each community's potential responses in Section 7.4.

7.1.2 Comparison of Effects by Community

The significance of changes in the physical, biological, and socioeconomic environment in each of the nine focus communities was evaluated based on the criteria identified in Table 7-1. The significance of the potential effects measured by these criteria was determined as the difference between each alternative and the base case, Alternative 1—Existing Conditions. Some of the criteria are based on quantitative economic forecasts developed by other study teams, while others are based upon descriptions of physical changes in the study region. The economic impacts were estimated by disaggregating the regional employment and income effects identified in the regional study. Other criteria and the qualitative and quantitative data were developed specifically in the DREW Social Analysis Report (DREW Social Analysis Workgroup, 1999). A thorough literature review was conducted to determine how rural agricultural communities in eastern Washington and throughout the United States have been affected by economic and infrastructure changes. For more details on the methodology and the literature review, see the DREW Social Analysis Report (DREW Social Analysis Workgroup, 1999).

7.1.3 Mitigation Potential

The results of the DREW regional analysis indicate that in the long-term the Pacific Northwest as a whole would experience an annual average net loss of 2,290 jobs as a result of Alternative 4—Dam Breaching. This total is the net change in jobs and includes projected gains as well as losses. Total long-term annual job loss is projected to be approximately 5,596 jobs (3,214 jobs in the subregions [Table 6-35] and 2,382 jobs throughout the Pacific Northwest [Table 6-39]). Some of these potential job losses represent identifiable dislocated or displaced workers, while others (such as those related to power rate increases) are dispersed and difficult to identify. Of these losses, approximately 3,200 direct job losses might be classified as dislocated. In addition to these losses, the regional study estimated gains in recreation and tourism and related sectors, as well as in power

Table 7-1. Significance of Changes in the Physical, Biological, and Socioeconomic Environments

Alternative	Indicators/Impact Measure	Evaluation Criteria	Clarkston	Colfax	Kennewick	Lewiston	Orofino	Pasco	Pomeroy	Riggins	Umatilla
	Power										
4	Residential Rate Increases	Residential Rate Increase > 5 percent			X			X			
4		Residential Rate Increase < 5 percent	X	X		X	X		X	X	X
4	Rate Employment Impacts	Decrease in Employment > 1 percent									
4		Decrease in Employment< 1 percent	X	X	X	X	X	X	X	X	X
4	Power Provider Rate Risk	Public Owned Utility			X			X		X	
4		Investor Owned Utility	X	X		X	X		X		X
4	Fixed Income Ratepayers	Poverty Rate >10 percent of all families	X		X			X		X	X
4		Poverty Rate < 10 percent of all families		X		X	X		X		
4	New Power Plant Operation	Increase in Employment > 1 percent									
4		Increase in Employment < 1 percent			X			X			X
4	ST: New Plant Construction	Increase in Regional Employment > 5 percent			X			X			X
4		Increase in Regional Employment < 5percent									
4		Within 50 miles of Potential Plant Siting			X			X			X
	Recreation										
4	Non-fishing River Recreation	Increase in Employment > 1 percent									
4		Increase in Employment < 1 percent	X	X	X	X		X	X		
4		Short-term Displacement	X	X	X	X		X	X		
4		Short-term Crowding			X			X			X
4	Anadromous Fishing Recreation	Increase in Employment > 1 percent								X	
4		Increase in Employment < 1 percent	X	X	X	X	X	X			
4		Short-term Displacement	X			X	X	X			
4		Short-term Crowding					X	X			
4		Increased Local Fishing Opportunities	X	X	X	X	X	X	X	X	X
4	Site Access	Decrease in Site Access > 25 percent	X	X		X			X		
4		Decrease in Site Access < 25 percent			X		X	X		X	X

Notes: 1. ST=short-term employment associated with construction.
2. Uncertainty related to employment percentages is a result of uncertainties faced by other DREW workgroups, dynamics of local economies, and methodology for allocating regional impacts to local geographic areas.

Source: Compiled from DREW Social Analysis Workgroup report (1999) updated in 2001 using revised DREW data

Table 7-1. Significance of Changes in the Physical, Biological, and Socioeconomic Environments (continued)

Alternative	Indicators/Impact Measure	Evaluation Criteria	Clarkston	Colfax	Kennewick	Lewiston	Orofino	Pasco	Pomeroy	Riggins	Umatilla
4	Site Services	Decrease in Site Services > 25 percent	X	X		X			X		
4		Decrease in Site Services < 25 percent			X		X	X		X	X
4	Elderly Recreationists	Over 65 years > 20 percent	X	X					X		
4		Over 65 years < 20 percent			X	X	X	X		X	X
4	New Campground Construction	Increase in Employment > 1 percent									
4		Increase in Employment < 1 percent	X	X					X		
4	Campground Operation & Maintenance	Increase in Employment > 1 percent									
4		Increase in Employment < 1 percent	X	X					X		
	Transportation										
4	Loss of Barge Transportation (Grain)	Increase in Employment > 1 percent			X			X			
4		Increase in Employment < 1 percent	X	X		X	X		X		
4	Farm Spending Related Employment	Decrease in Employment > 1 percent		X							
4		Decrease in Employment < 1 percent	X			X	X		X	X	
4	Dryland Farm Income	Decrease in Total County Farm Income > 10 percent		X					X	X	
4		Decrease in Total County Farm Income < 10 percent	X			X	X	X			
4	ST: Road, Rail and Infrastructure	Increase in Employment > 1 percent	X	X	X	X	X	X	X		
4		Increase in Employment < 1 percent									
4	Grain Transportation Costs	Increase in Avg. Cost > 15 cents per bushel	X	X		X	X		X	X	
4		Increase in Avg. Cost < 15 cents per bushel						X			
4	Farm Consolidation (Dryland)	Risk of Increased rate of Farm Consolidation	X	X		X	X		X	X	
4	Transportation Costs (other shippers)	Increase in Transportation Cost	X	X		X	X		X	X	
4	Transportation Capacity Uncertainty	Increase in Transportation Uncertainty	X	X	X	X	X	X	X	X	
4	Highway Congestion	Increase in Traffic Volume > 2 percent						X	X		
4		Increase in Traffic Volume < 2 percent	X	X	X	X					
4		Decrease in Traffic Volume					X			X	

Notes: 1. ST=short-term employment associated with construction.
2. Uncertainty related to employment percentages is a result of uncertainties faced by other DREW workgroups, dynamics of local economies, and methodology for allocating regional impacts to local geographic areas.

Source: Compiled from DREW Social Analysis Workgroup report (1999) updated in 2001 using revised DREW data

Table 7-1. Significance of Changes in the Physical, Biological, and Socioeconomic Environments (continued)

Alternative	Indicators/Impact Measure	Evaluation Criteria	Clarkston	Colfax	Kennewick	Lewiston	Orofino	Pasco	Pomeroy	Riggins	Umatilla
4	Highway Safety	Increase in Highway Safety					X			X	
4		Decrease in Highway Safety	X	X	X	X		X	X		
	Water Supply										
4	Dislocated Agricultural Workers	Decrease in Employment > 1 percent			X			X			
4		Decrease in Employment < 1 percent									X
4	Farm Income	Decrease in Total County Farm Income > 10 percent						X			
4		Decrease in Total County Farm Income < 10 percent									
4	ST: Pump/Well Modifications	Increase in Employment > 1 percent				X	X				
4		Increase in Employment < 1 percent	X	X	X			X	X		
4		Increased Costs for Well Irrigators/users	X			X		X	X		
	Effects on Food Processors	Decrease in Local Produce			X			X			X
	Implementation/Avoided Costs										
4	Implementation Employment	Increase in Employment > 0.1 percent									
4		Increase in Employment > 0.1 percent	X	X	X	X	X	X	X		
4	ST: Implementation Employment	Increase in Employment > 1 percent	X	X			X		X		
4		Increase in Employment < 1 percent			X	X		X			X
3		Increase in Employment < 1 percent	X	X	X	X	X	X	X		
4	Outside Workers	Increase in Outside Workers >10 percent	X						X		
4		Increase in Outside Workers < 10 percent		X	X	X		X			
4	Human Movement Patterns	Loss of Project Bridges within 50 miles		X	X			X	X		
4	Operations Employment	Decrease in Employment > 1 percent									
4		Decrease in Employment < 1 percent	X	X	X	X		X	X		X
3		Increase in Employment > 0.1 percent									
3		Increase in Employment < 0.1 percent	X		X	X		X	X		X
	Anadromous Fish Recovery										
3 and 4	ST: Social Cohesion	Increased Social Cohesion		X	X			X	X	X	X

Notes: 1. ST=short-term employment associated with construction.
2. Uncertainty related to employment percentages is a result of uncertainties faced by other DREW workgroups, dynamics of local economies, and methodology for allocating regional impacts to local geographic areas.

Source: Compiled from DREW Social Analysis Workgroup report (1999) updated in 2001 using revised DREW data

Table 7-1. Significance of Changes in the Physical, Biological, and Socioeconomic Environments (continued) Page 4 of 4

Alternative	Indicators/Impact Measure	Evaluation Criteria	Clarkston	Colfax	Kennewick	Lewiston	Orofino	Pasco	Pomeroy	Riggins	Umatilla
3 and 4		Decreased Social Cohesion	X			X	X				
4	Recovery Uncertainty/Risk	Lower Uncertainty of Salmon Recovery	X	X	X	X	X	X	X	X	X
3		Higher Uncertainty of Salmon Recovery	X	X	X	X	X	X	X	X	X
3	Business Uncertainty/Risk	Lower Economic Uncertainty/Risk	X	X	X	X	X	X	X	X	X
4		Higher Economic Uncertainty/Risk	X	X	X	X	X	X	X	X	X
3	Extinction Risk/Existence Value	Higher Extinction Risk	X	X	X	X	X	X	X	X	X
4		Lower Extinction Risk	X	X	X	X	X	X	X	X	X
	Other Social Effects										
4	Population Impacts	Decrease in Population > 5 percent						X			
4		Decrease in Population < 5 percent		X	X				X		
4		Increase in Population > 5 percent									
4		Increase in Population < 5 percent	X			X	X			X	X
4	Total Long-term Employment	Employment Losses > 5 percent							X		X
4		Employment Losses < 5 percent	X	X	X	X	X	X			
4		Increase Net Employment > 1 percent									
4		Increase Net Employment < 1 percent				X				X	
4		Decrease Net Employment > 1 percent			X			X			X
4		Decrease Net Employment < 1 percent	X	X			X		X		
4	Total Short-term Employment	Increase in Employment > 5 percent	X	X		X			X		
4		Increase in Employment < 5 percent			X		X	X			X
4	Aesthetics	ST Exposed Shoreline	X	X	X	X	X	X	X		
4		LT Revegetated Shoreline	X	X	X	X	X	X	X		

Notes: 1. ST=short-term employment associated with construction.
2. Uncertainty related to employment percentages is a result of uncertainties faced by other DREW workgroups, dynamics of local economies, and methodology for allocating regional impacts to local geographic areas.

Source: Compiled from DREW Social Analysis Workgroup report (1999) updated in 2001 using revised DREW data

generation and related sectors. These jobs, in addition to the short-term construction jobs created by Alternative 4—Dam Breaching, might provide new economic opportunities in the region that would help mitigate potential losses. Direct, indirect, and induced long-term employment losses are distributed throughout the three subregions as follows: upriver (587) jobs, reservoir (2,078), and downriver (549) (Table 6-35). The state distribution of projected long-term employment losses (excluding those effects modeled for the lower Snake River study area) is approximately 36, 600, 390, and 70 for the states of Washington, Oregon, Idaho, and Montana, respectively (Table 6-39).

Approximately 67 communities in the lower Snake River subregion would be adversely affected by increased transportation costs. An additional 15 communities outside the designated study area would also be affected by increased transportation costs. These affected communities are primarily smaller than 1,000 inhabitants, but would also include the larger cities of Lewiston, Clarkston, Pasco, Kennewick, Richland, and Walla Walla.

Overall adverse community level social impacts within the nine case study communities, which are identified in the Social Analysis Report and through the Community-Based Impact Assessments (Harris, et al., 1999) conducted by the University of Idaho, include the following:

- decreased net farm income and increased financial pressure on dryland farmers throughout the region, particularly for those farms close to the lower Snake River
- risk of increased consolidation of family farms and decline in rural farm population
- decreased county property tax base in 20 regional counties from decreased farm land value and potential loss of irrigated lands
- dislocated full-time and seasonal workers from Ice Harbor irrigated agricultural lands and loss of a source of local school revenue for communities close to the reservoir
- minor realignment of communities' economic bases and changed potential for future growth.

Many of these community-level and employment impacts would be caused by increased transportation costs for trucking grain and by the loss of irrigated agriculture on the Ice Harbor reservoir (see Sections 3.3 and 3.4). These impacts could be minimized or eliminated in part by mitigation spending to modify the irrigation pumps and direct upgrades to expand rail capacity in the region. Another strategy would be to directly subsidize the farms currently shipping on the lower Snake River. In the absence of direct mitigation, employment- and community-level impacts could be mitigated or minimized as described below. Possible mitigation measures are discussed further in the Mitigation Section of the Social Analysis Report.

Potential mitigation expenditures for 2,500 to 3,500 dislocated workers are estimated to range from $45.1 million to $48.1 million to address employment losses through job retraining, income support, and academic training (DREW Social Analysis Workgroup, 1999). Potential mitigation for 82 affected communities has been estimated at between $4.3 and $12.9 million, based on previous Federal and state mitigation expenditures used to address the impacts of free trade, old-growth forest conservation, and dislocated workers.

Under Alternative 2—Maximum Transport of Juvenile Salmon, the lower probability of salmon recovery and eventual increased or resumed harvest would affect approximately ten communities in the lower Snake River region, an unknown number of tribal communities, and an unknown number of coastal fishing communities. No estimate for future mitigation is given under this alternative.

One proxy might be the opportunity cost of foregone fishing revenue as forecast by the Recreation Team and the Anadromous Fish Economic Team.

7.1.4 Unresolved Issues

At this time, the assessment of social impacts to the region and to focus communities is incomplete due to unresolved key issues such as the following:

- the lack of an industry-specific study detailing how the forest products industry of North Central Idaho might be affected by increased transportation costs
- the actual magnitude of net county tax impacts resulting from increased road maintenance activity and decreased agricultural land values for dryland farms and irrigated farms under Alternative 4—Dam Breaching
- the expected rate response for alternative modes of transportation and the effects of the rate changes on shippers under Alternative 4—Dam Breaching
- the degree of linkages between agricultural products from Ice Harbor and downriver food processors and alternative supply quantities under Alternative 4—Dam Breaching.

The remainder of this section presents the purpose and methods of the study, a characterization of the study region and a brief description of the case study community baselines, a more detailed comparison of alternatives by community and potential responses, and a discussion of possible compensation or mitigation measures.

7.2 Purpose, Scope, and Methodology

7.2.1 Purpose

The purpose of this section is to examine the range of potential social impacts that may occur as a result of implementing one of the four alternatives. This analysis focuses on the potential community level impacts resulting from changes in the local and regional biological, economic, and physical environment and attempts to outline the distributional and equity effects on specific communities within a broader regional context. This analysis focuses on communities because it is at this level that social impacts resulting from resource policy changes may be most keenly felt (Force and Machlis, 1997). This analysis has been designed to meet the requirements specified in the WRC Guidelines (WRC, 1983). The key issues addressed include the following:

- What the social impacts will be and when (timing)?
- Who will be affected?
- How the communities will be affected (beneficial/adverse)?
- How much the communities will be affected?
- How the communities may respond?

The social analysis, which addresses these issues by using qualitative and quantitative data to examine nine case study communities, is intended to provide a greater understanding of the anticipated impacts, as well as highlight the need for and location of potential mitigation measures. Uncertainty exists throughout this analysis because of the uniqueness of the proposed actions and the unknown nature of how markets, communities, and political entities will respond to the implementation of these actions, particularly the dam breaching alternative. The degree and magnitude to which this alternative will affect communities throughout the region depends in large part on how these communities, industries, families, and individuals respond to potential and actual changes.

7.2.2 Scope

The following analysis addresses four alternatives: Alternative 1—Existing Conditions, Alternative 2—Maximum Transport of Juvenile Salmon, Alternative 3—Major System Improvements, and Alternative 4—Dam Breaching. The effects of Alternatives 2 and 3 on the human environment generally do not differ significantly and are, therefore, discussed together.

The geographic scope of the analysis is limited to communities within the lower Snake River study area. This region includes the counties listed in Table 6-1 and approximately 101 communities within these counties. As previously discussed, the lower Snake River study area is divided into three subregions (see Section 6.2.2).

There are three distinct time phases to this analysis. Impacts do not occur just during the most intensive phases of project implementation, but also before and after implementation (Grambling and Freudenberg, 1992). The first phase includes the planning and decision-making period of the feasibility study from the initiation of the feasibility study and EIS scoping to the final selection of a preferred alternative. The second phase includes the implementation phase, proposed from 2002 to 2012, depending on the alternative selected (DREW Implementation Workgroup, 1999). The third phase includes the post-implementation social effects. Potential community-level impacts were examined across these three phases, but were limited to an overall study period of 20 years because forecasting the non-economic social impacts of the alternatives would be limited by the high degree of variability of social systems.

The scope of this social analysis neither provides a comprehensive assessment of all the communities within the defined study region, nor are the communities selected for this analysis representative of all communities in the region. Rather, the intent of the study is to provide decision-makers with information regarding the various impacts across a range of case study communities likely to be affected by the proposed alternatives. Tribal communities are not examined as part of this study. A study prepared for CRITFC by Meyer Resources (1999) documents the tribal perspective concerning the potential social, cultural, and economic effects of the proposed alternatives on tribal populations.

7.2.3 Methodology

In order to address the key study questions, the following steps were taken to obtain reliable information on potential social impacts:

- Develop an understanding of the issues raised in the original scoping the Corps conducted in 1995 and the public information meetings the Corps conducted during this study
- Select key focus communities to capture the range of possible direct impacts
- Select appropriate social indicators for the types of anticipated social impacts
- Describe the trends and history of the region and case study communities

- Develop estimates of potential impacts, the magnitude of these impacts, and the range of community responses using information provided by the DREW workgroups, NMFS, secondary data analysis, key informant interviews, and a thorough literature review.

This analysis is supplemented by information obtained through a series of interactive community forums, which included each of the focus communities. The community forum information includes each community's perceptions of its history, an assessment of its current situation, and a projection of potential social impacts under each of the proposed alternatives. For more information on the methodology and findings of the community-based assessments see Harris et al. (1999).

7.2.3.1 Selection of Focus Communities

Secondary data sources, including the 1990 Census of Population and Housing and the 1992 Census of Agriculture, as well as preliminary impacts identified by the DREW study teams, were consulted to evaluate communities for inclusion as case study focus communities. The study team examined the potential impacts of the three alternatives under consideration to identify a group of focus communities that met the following criteria:

- Communities that might experience large potential impacts (positive or negative) as a result of the project alternatives
- Communities that are diverse in size, economic activity, and potential socioeconomic impacts (level, type, and timing of impacts).

Table 7-2 lists the focus communities selected for this study.

7.3 Characterization of Study Region and Communities

7.3.1 Characteristics of Communities

The communities located throughout the study area are diverse in terms of their size, economic activity, and relationship to the lower Snake River. The purpose of this section is to describe these basic characteristics in order to place the selected focus communities in the context of the other 101 communities in the study region.

Communities in Washington State (45) represent nearly 50 percent of the communities in the study region, with Oregon and Idaho almost equally represented with 29 and 27 communities, respectively. With the exception of four communities in the upriver region, the Oregon communities are downstream of the lower Snake River. Two-thirds of the communities in Washington are located directly around the reservoirs. Approximately half of the Idaho communities are located at the eastern, upstream end of the Lower Granite reservoir.

7.3.1.1 Population

The total population of the study area was approximately 582,119 in 1995. Population is distributed unevenly among the 25 counties and three subregions that comprise the study area. The downriver subregion, which extends from the confluence of the Snake and Columbia Rivers to below Bonneville Dam, is the most populated, accounting for 322,888, or approximately 55 percent, of the study region's 1995 population.

Table 7-2. Selected Focus Communities

Region		Focus Community	Size	Primary Economic Activities	Primary Direct Impacts
Reservoir	WA	Clarkston	6,860	Medical services, wholesale and retail trade	Navigation, implementation, recreation, anadromous fish, power
		Colfax	2,865	Agriculture, state/local government, wholesale and retail trade	Transportation, recreation, implementation, anadromous fish
		Pomeroy	1,475	Agriculture, state/local/ Federal government	Navigation, recreation, implementation
Downriver	WA	Kennewick	48,010	Wholesale and retail trade, services, FIRE	Navigation, recreation, irrigation, implementation, power
		Pasco	22,370	Agriculture, transportation	Navigation, recreation, irrigation, implementation, power
	OR	Umatilla	3,155	Agriculture, state/local/ Federal government	Recreation, navigation, irrigation
Upriver	ID	Lewiston	30,271	Manufacturing, wholesale and retail trade	Navigation, implementation, anadromous fish, power, recreation
		Orofino	3,122	Timber, agriculture, state/local/Federal government	anadromous fish
		Riggins	495	Travel and tourism, ag., state/local/Federal government	Recreation, anadromous fish

Source: DREW Social Workgroup, 1999

In general the geographic area of northeastern Oregon, southeastern Washington, and north central Idaho is sparsely populated and rural. The size of communities ranges from small rural towns with populations less than 200 to cities with populations from 8,000 to almost 50,000. In general the communities in the lower Snake River study area are small. Sixty-six percent have populations lower than 1,500, and 60 percent have populations lower than 1,000. The major population centers are the Tri-Cities (Richland, Kennewick, and Pasco), Walla Walla, the Quad-Cities (Pullman, Moscow, Lewiston, and Clarkston), and Hermiston/Pendelton. Only five communities in the study region have populations that exceed 20,000. These larger population cities serve as regional trade and educational centers and provide a diversity of employment opportunities from manufacturing and professional services to tourism. These cities make up a large share of the economically diverse communities in the region.

7.3.1.2 Population Trends

Most rural areas in the dryland agricultural region of the Palouse (eastern Washington and north central Idaho) exhibited very slow growth over the 1980s and 1990s, while some rural areas offering high quality scenery and recreation have grown rapidly since 1990 (Johnson and Beale, 1994). Almost all the communities in the subregions have increased in population since 1990 and are expected to see moderate population growth over the next 15 years (Idaho Power, 1999; State of

Oregon, Office of Economic Analysis, 1997; State of Washington, Office of Financial Management, 1999).

7.3.1.3 Economic Characteristics

The economy of the Pacific Northwest has undergone substantial change over the past 3 decades. From 1969 to 1998, the number of jobs in Washington, Oregon, and Idaho increased at a faster rate than the national average (123 percent compared to 76 percent nationally). Employment increases ranged from 122 percent for Washington to 204 percent for Oregon. In 1998, Washington, Oregon, and Idaho accounted for 55 percent, 33 percent, and 12 percent of total employment in the three state area, respectively.

Full- and part-time employment in the lower Snake River study area increased by 84 percent between 1969 and 1998. This relative increase was smaller than the statewide increase (123 percent) but larger than the national increase (76 percent). Increases ranged from 74 percent in the upriver subregion to 194 percent in the reservoir subregion. In 1998, the upriver, reservoir, and downriver subregions accounted for about 24 percent, 22 percent, and 55 percent of total employment in the lower Snake River study area, respectively.

Employment increased in all sectors in the lower Snake River study area between 1969 and 1998, with the exception of mining. There were, however, changes in the relative importance of various sectors. These trends broadly reflected those at the regional and national levels with relative declines in the farm [(7) percent], manufacturing [(5) percent], and government sectors [(2) percent], and increases in the services (6 percent) and retail trade (2 percent) sectors. Historically, the lower Snake River study area had a larger concentration of employment in the farm sector then the region as a whole (16 percent compared to 6 percent in 1969), with smaller concentrations of employment in the other sectors, especially manufacturing, wholesale trade, and finance, insurance, and real estate (FIRE). The largest employers in 1969 were the government (20 percent), services (18 percent), and farm (16 percent) sectors. In 1998 the largest employers were services (24 percent), government (18 percent), and retail trade (17 percent). These sectors were the largest employers for all three subregions, which have generally similar concentrations of employment by sector.

Most of the region's towns are small and, therefore, have narrow economic bases with fewer industries and fewer firms per industry than larger communities. Agriculture dominates in these small communities. Almost half of the communities in the region have 20 percent or more of their employment in agriculture, while 68 percent of the communities have 11 percent or more employment in the agricultural sector.

Per Capita Income

The states of Washington, Oregon, and Idaho had respective per capita incomes of $23,974, $21,915, and $19,199 in 1995. United States per capita income in 1995 was $23,359. Per capita income in the 25-county study area was $17,570 in 1995, with little variation across the three subregions. Viewed in 1995 dollars, per capita income increased in the study area and all three subregions during the 1970s and ranged in 1980 from $15,732 in the upriver subregion to $21,287 in the downriver region. Since 1980, however, this figure has declined in both the downriver and reservoir subregions, while the upriver subregion has experienced modest increases. In 1995 per capita income in the 25 study area counties ranged from $14,576 in Morrow County, Oregon in the downriver subregion to $22,058 in Benton County, Washington also in the downriver subregion.

Sources of Personal Income

Total personal income includes earnings (wage and salary disbursements, other labor income, and proprietors' income); dividends, interest, and rent; and transfer payments. From 1969 to 1998, non-labor income (dividends, interest, and rent and transfer payments) as a share of total income in Washington, Oregon, and Idaho increased from 22 percent to 32 percent of total personal income. The manufacturing, farm, and retail trade sectors declined as a share of total personal income over this period, while the share accounted for by the services and FIRE sectors increased.

Non-labor income also increased as a share of total personal income in the lower Snake River study area, increasing from 21 to 37 percent between 1969 and 1998. The farm sector declined from 14 percent to 3 percent of total personal income over this period. The manufacturing [(6) percent], retail trade [(3) percent], and construction [(2) percent] sectors also declined as a share of personal income over this period, while the share accounted for by the services, transportation, and government sectors increased. The lumber and wood products sector also saw a relative decline over this period, decreasing from 5.4 percent to 1.5 percent of total personal income.

Land Tenure Characteristics

Agricultural land tenure has undergone significant changes in all three subregions. In all cases, these changes have involved a decrease in the number of farms and an increase in average farm size. The downriver subregion has the largest number of farms and acres farmed of the three subregions. Between 1959 and 1992, this subregion lost 1,279 farms or 18.4 percent of the 1959 total. The reservoir and upriver subregions over this period lost 1,544 and 1,537 farms, respectively, or 34.1 and 32.6 percent of their 1959 totals.

This has not, however, been a simple linear decline. Rather, all three subregions experienced both increases and decreases in the number of farms between 1959 and 1992. The average size of farms also fluctuated over this period. In general, the trend has been toward increasing farm size in all three subregions.

7.3.2 Focus Community Baseline Profiles

Community profiles are presented in the DREW Social Analysis Report (1999). The profiles describe why each community was selected and provide an overview of historical community trends. They also outline each community's social, cultural, and economic relationship with the lower Snake River. Information related to four dimensions of community life—economy, place, vision and vitality, and people—from 1970 to the present is also presented in these profiles. The information from these profiles provides the basis for evaluating potential impacts and community responses. Much of this information is included in case-by-case discussions in Section 7.4. To organize the assessments of social impacts, communities were organized by these four dimensions of community. The economic (jobs and wealth) dimension relates to the major businesses and sources of jobs in the community. The place (character) dimension refers to the built and natural environment of the community. The vision and vitality (organization and leadership capacity) dimension refers to the characteristics of the community's social organizations and ability to accomplish goals. The people (demographics) dimension relates to the characteristics of individuals or households in the community and changes. The following sections provide a brief description of the community selection criteria and community history in order to frame the subsequent discussion of community-level impacts for the proposed alternatives.

7.3.2.1 Clarkston, Washington

Clarkston is located in Asotin County, across the Snake River from Lewiston at the confluence of the Snake and Clearwater Rivers. It was selected as a focus community because of anadromous fish runs, navigation, construction, and recreation opportunities along the Snake River.

History

In 1899, a bridge across the Snake River connected Lewiston and Jawbone Flats, the area officially incorporated as Clarkston in 1902. Agriculture, particularly berry production, dominated the town's economy in the early 1900s. By the 1950s, agricultural production grew to include grains and hay, peas, and other fruits. Livestock were also raised. Transportation was by railroad and boat which brought supplies up from Portland and grain down on the return trip. As water transportation on the Snake improved into Hells Canyon, Clarkston became a gateway for tourists. Lower Granite Dam was completed in 1975, flooding much of the fruit orchards and beef processing plants along the river. A second bridge linking Clarkston and Lewiston was constructed in 1982. Today, Clarkston remains active as a regional trading center via its port, while agricultural production, outdoor recreational opportunities, and a growing retiree population add to its diversity.

7.3.2.2 Colfax, Washington

Colfax is located in Whitman County in the heart of the Palouse, the dryland wheat, barley, pea, and lentil region of eastern Washington and north central Idaho. It is approximately 19 miles north of the lower Snake River. It was selected as a focus community primarily because of navigation and recreation opportunities and access.

History

Incorporated in 1870, Colfax is the oldest town in eastern Washington. It was originally a sawmill town with cattle ranches and farms but, over the years, agriculture became the primary industry. Colfax became the county seat in 1871. A series of floods and fires threatened to destroy the community, but the residents rebuilt. In 1963, the Corps constructed a concrete flood control project to eliminate the flooding problem in the downtown area. With the arrival of slack water, the Port of Whitman County established new sites on the lower Snake River at Almota and Wilma. Colfax has recently completed a downtown revitalization project to widen Main Street, beautify the downtown, and enhance the business climate. The Port has also recently established a small industrial park on the outskirts of town.

7.3.2.3 Pomeroy, Washington

Pomeroy is located in Garfield County approximately 15 miles south of the lower Snake River in southeastern Washington. US 12 passes through town and connects Pomeroy to Clarkston and Lewiston to the east and Walla Walla and the Tri-Cities to the west. Pomeroy was selected because of navigation and recreation concerns.

History

Established in 1864, Pomeroy quickly experienced a rapid wave of population migration due to its location on the stagecoach line between the towns of Walla Walla and Lewiston. The economy was based primarily on cattle and vegetable farming. By 1878, the town had grown into a service and trade center containing a flour mill, retail stores, and a hotel. Arrival of the Starbuck-Pomeroy rail branch in 1885 further expanded Pomeroy's population, while serving as the major source of transportation for agricultural products. A pea cannery was built in 1942 and remained operational until the 1960s. The construction of Little Goose Dam in 1970, followed by Lower Granite Dam in 1975, significantly increased the local population and economic base in Pomeroy, as construction workers and their families moved in. The rail line was abandoned in 1981. In the 1990s, Pomeroy experienced many infrastructure improvements to its Main Street.

7.3.2.4 Kennewick, Washington

Kennewick is located in Benton County across the Columbia River from Pasco. It was selected as a focus community because of navigation, recreation, irrigation, and power concerns.

History

Incorporated in 1904, Kennewick is the largest community of the Tri-Cities. It began as a predominantly agricultural-driven economy, linked to the Northern Pacific Railroad route which moved its products to markets. World War II brought new prosperity to the region. In the 1940s, the plutonium production facilities at the Hanford Project were created. Hanford employees greatly expanded Kennewick's population, and the retail base grew to meet the needs of the increasing population. With the development of the Columbia Basin Project, irrigated agriculture expanded around the community, contributing to its rapid growth. Suspension of work at Hanford in the early 1980s and downsizing in the mid-1990s have greatly affected Kennewick's economy.

7.3.2.5 Pasco, Washington

Pasco is located in Franklin County to the north of the confluence of the Snake and Columbia Rivers. Pasco and the other Tri-Cities create a hub of human and commodity movements through the lower Columbia Basin. Pasco was selected as a focus community because of water supply issues, navigation/transportation, power, recreation opportunities and sites, and anadromous fish runs.

History

Officially incorporated in 1891, Pasco attributes its establishment and early growth to railroad construction near the Snake and Columbia Rivers in the 1870s. Steam-powered boats provided transportation into the region before the arrival of the railroad. Pasco soon moved from a single economy of rail to livestock and agricultural production made possible by pumping water from the rivers for irrigation in the 1890s. A more intensive irrigation project was developed in 1910. Airmail service to Pasco began in 1926, and a new airport by the rail was dedicated in 1929. In 1943, the Hanford nuclear project began. Although Pasco is located on the opposite side of the Columbia River from the Hanford facilities, it did receive some population and economic spillover, particularly with the 1985 creation of the I-182 highway bridge which connects Pasco to Richland. Suspension of work at Hanford in the early 1980s and downsizing in the mid-1990s have adversely affected the economy of the community. Work on environmental restoration in Hanford continues to provide economic benefits to Pasco. Dry land and irrigated agriculture in the surrounding countryside continues to play an important role in Pasco's development.

7.3.2.6 Umatilla, Oregon

Umatilla is located in Umatilla County, downstream from the confluence of the Snake and Columbia Rivers on the Columbia River. Umatilla was selected as a focus community because of navigation/transportation, recreational opportunities and sites, and irrigation.

History

Initially called Columbia, the town of Umatilla was founded in 1863 as a site for transferring gold on the Columbia River to the Walla Walla route. When mining declined, the town stagnated, but then grew into a local service center for increasing irrigated agricultural activity. The building of the Umatilla Army Depot in the 1940s and the McNary Dam in the 1950s contributed to a population boom. In 1963, a major portion of Umatilla was destroyed because of flooding caused by the John Day Dam, built 40 miles downriver.

7.3.2.7 Lewiston, Idaho

Lewiston is located in Nez Perce County at the confluence of the Clearwater and Snake Rivers. Three major U.S. highways in the region intersect in Lewiston and provide access to eastern Washington, northern Idaho, Montana, and southern Idaho. It was selected as a focus community for the following reasons: navigation at the Port of Lewiston (the only seaport in Idaho), recreational opportunities and access along the lower Snake River, construction impacts associated with implementation, and anadromous fish runs on the Snake and Clearwater Rivers.

History

Founded in May 1861, Lewiston was the second permanent settlement in Idaho and the first incorporated town. Because of its location on the junction of the Snake and Clearwater Rivers and seasonal navigation on the lower Snake River, Lewiston served as a supply center for regional mining operations. Following the gold boom, Lewiston continued to grow as a regional shopping, market, and distribution center for agricultural and timber operations. The Port of Lewiston was established in 1958. The Lewiston Orchards were annexed in 1969, doubling the town's area and population. Construction of Lower Granite Dam in 1975 brought slackwater to Lewiston, making it the most inland port on the 460-mile Columbia-Snake River transportation system.

7.3.2.8 Orofino, Idaho

Orofino is located in Clearwater County, 45 miles upstream from the lower Snake River at the confluence of the Northfork and Clearwater Rivers. US 12, the major highway connecting Lewiston to Montana, passes through the middle of town. National Forests, wild and scenic rivers, the Dworshak reservoir, and the Selway-Bitterroot Wilderness Area are close by.

Orofino was selected because of the anadromous fish runs on the Clearwater River, the sport fishing industry related to those runs, and the current conflict over flow augmentation from the Dworshak reservoir that affects recreation, but that is required under the 1995 Biological Opinion. Orofino markets itself as the "Steelhead Capital of the World" and boasts the world's largest steelhead fish hatchery.

History

Orofino's history is centered on its natural resources. Gold prospectors first settled Orofino in 1861 and then demolished it when ore deposits were found beneath the town. Orofino was later rebuilt in a different location at the confluence of Orofino Creek and the Clearwater River. In 1889, the Northern Pacific Railroad began service to the town, and the first post office was established in 1897. Starting in the 1900s, wood production dominated the economy and continues to do so today. Orofino was incorporated in 1925. By 1940, it was an established center for white pine logging. Agriculture also grew during this time. In 1962, the Lewis and Clark Highway was completed and was seen as a source of economic stimulation for tourism and commerce. In 1968, construction began on Dworshak Dam, contributing to population increases. Most of the population remained post-construction. Although timber production has declined over the past decade due to diminishing supplies of timber from National Forest lands, new opportunities in recreational tourism were created from the Clearwater River and the Dworshak reservoir. The nation's largest steelhead hatchery contributes to this tourism. The listing of Snake River salmon has negatively impacted these recreational developments.

7.3.2.9 Riggins, Idaho

Riggins is located in Idaho County, upstream from the lower Snake River along the Salmon River, a tributary to the Snake River. A major north-south highway (US 95) passes through the middle of town. Riggins was selected as a focus community because of the anadromous fish runs on the Salmon River, the recreational and sport fishing on the Salmon River, and the effects of listed salmon stocks on whitewater recreation.

History

The discovery of gold first attracted settlement in the Riggins area, which was officially named in 1908. Mining was replaced by livestock raising, which remained prominent until the 1950s. National Forests were established nearby. With the Civilian Conservation Corps (CCC) program of the 1930s, as well as other Federal projects, many roads, trails, fences, and water developments were established. During World War II, a sawmill was built, and logging became a dominant industry. The 1982 fire that destroyed the mill forced the community to rebuild their economy. The residents who stayed shifted to a recreation-based economy of fishing, river floating, and hunting, made possible by the resources of the Salmon River. In 1982, there was only one river outfitting company. Now, Riggins boasts 15, plus six motels, five restaurants, and three real estate agencies, among other services. The Salmon River Economic Development Association was formed in 1992 to assess the economic health of the area. Since its inception, many city improvements have occurred. Additionally, a medical clinic recently opened, the Goff Bridge has been replaced, and a new water system is being coordinated with the improvement of US 95.

7.4 Description and Comparison of Community Social Impacts

7.4.1 Comparison of Alternatives by Community

A major limitation to the evaluation of social impacts at the community level is the availability of information regarding the economic impact on key sectors in the study area. No information exists, for example, to forecast the employment impacts on waterway shippers such as forest products and their linkages to other mills in northeastern Oregon and north central Idaho. In addition, who will pay for increased electrical rates, how they will pay, and how much they will pay is presently unknown and, as a result, this analysis uses a mid-point estimate where Federal beneficiaries of BPA power would pay the costs.

In the absence of this information, the discussion of community-level impacts should be considered as preliminary. Despite these limitations, the following discussion will illustrate who may be affected, how they may be affected, and how they may respond to changes in the operation of the four lower Snake River dams. Although the impact matrix and evaluation of impacts are presented in Table 7-1 by resource area, the following discussion puts these changes in the context of the four dimensions used for the description of the base case. These dimensions are jobs and wealth (economics), place (character of the natural and built environment), vision and vitality (social organization and leadership), and people (demographic changes and effects on individual populations). Discussions of community-level impacts include the direct and indirect impacts, as identified in this study and other DREW studies. References to employment include direct, indirect, and induced employment changes in the community. The focus community analysis conducted is supplemented by the perceptions of community members who participated in the community-based assessments conducted by the University of Idaho (for detailed methodology and findings see Harris, et al., 1999). Finally, the communities' prior experience with change events place the identified impacts in a historical context.

7.4.1.1 Clarkston, Washington

The socioeconomic impacts of the three alternatives on the community of Clarkston could include changes in recreation activities, navigation/transportation, water supply, implementation, anadromous fish recovery, and costs of electrical power. Table 7-1 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 affect the probability of anadromous fish recovery while having minimal effect on the physical or economic human environment. Alternative 4 could have significant effects on specific populations in Clarkston. It would create both winners and losers through the loss of a navigable waterway, a shift in transportation modes, a change in recreational opportunities and access, an increased chance of anadromous fish recovery, and minor increases in power rates. In addition, the community could experience a dramatic short-term change in the character of the community as the reservoir is drained and a new shoreline is formed around the city. It is expected that Clarkston would realize short-term increases in implementation and municipal and industrial (M&I) water-supply, modification-related employment, as well as a temporary influx of outside workers. Overall, the community could experience both increases and decreases in employment, with a projected net gain in employment. Perhaps the most significant effect on the community could be the stranded social costs of planning and development activities structured around the continued existence of the four lower Snake River dams and a navigable waterway.

Jobs and Wealth

Overall, Alternatives 2 and 3 provide a higher degree of certainty about the economic future of Clarkston. They do not adversely affect jobs and wealth directly, although the lower probability of salmon recovery may indirectly affect those businesses related to recreational fishing. Alternative 4 adversely affects future economic certainty and increases future economic risks, because not all of the indirect and induced effects of these changes are known. For example, it is unclear how the increased capital costs of pump and well modifications would affect local pulp and paper operations, the golf course, or irrigators along the Lower Granite pool.

Negative effects on community employment from Alternative 4 could result from a reduction in county-wide farm income, loss of Corps-related jobs, loss of water-related port operations, loss of tour-boat-related employment, short-term decreased recreational opportunities, and increased residential electrical rates. Farmers and other shippers currently using the waterway to ship bulk products could experience increased costs to ship their goods. This might have a negative effect on employment in those economic sectors.

Positive impacts on community employment from Alternative 4 could result from increased truck transportation, post-implementation increases in river recreation-related activities, increased anadromous fishing opportunities, road maintenance, and the short-term increases in employment from implementation activities and modifications to wells and water pumps.

The effects of these changes on the largest employers could demonstrate the degree to which there would be winners and losers in Clarkston. A wood products corporation, the largest employer in the Lewiston-Clarkston Valley, could be negatively affected by higher shipping costs for some of its products. On the other hand, asphalt companies could benefit from both short-term construction-related implementation activities and long-term road maintenance.

Place

Clarkston's natural and built environment could change dramatically under Alternative 4 much like it did 25 years ago when the pools were filled and orchards were inundated. Adverse impacts from the loss of the Lower Granite pool include the short-term exposure of shoreline and mudflats. The community could lose recreational access sites at Chief Lookinglass Park and Nisqually John Landing, as well as losing some recreational site services at Chief Timothy State Park, Hells Canyon Resort, Southway Park, and Hells Gate State Park. In addition, the community could have some short-term displacement from steelhead and salmon fishing, as well as displacement from other river-related recreation. The identity of the community as a working water port could also be adversely affected, although it would still retain its identity as a Snake River community and the gateway to Hells Canyon.

Another adverse effect of Alternative 4 could be an increase in truck traffic through the community and the county with a corresponding increased risk of traffic accidents. Additionally, the financial pressures exerted on local farmers from higher transportation costs may lead to a greater consolidation of farms and a change in the rural-urban interface of Clarkston.

Long-term benefits of Alternative 4 could include the revegetation and restoration of a near natural lower Snake River and the community shoreline. Additionally, the increase of salmon would benefit the identity of the community as a place where salmon continue to exist, and local anglers continue to pursue this element of Clarkston's quality of life. Alternatives 2 and 3 have higher risks associated with salmon recovery and may, therefore, adversely affect the community's quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could all adversely affect Clarkston's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. Adverse effects of a change in the economic direction and identity of the community under Alternative 4 might include a pessimistic vision of not being able to control the community's future. The community has worked to develop recreational opportunities associated with the lower Snake River reservoirs, to bring tour boats from Portland into the community, to use the port as a development mechanism, and to develop retirement opportunities. Many of these plans could be significantly affected under this alternative. Additionally, the negative short- and long-term effects on both local and county property values and property tax revenue might create difficulties in obtaining sufficient funding to pursue new avenues of economic development and maintain the current level of community services.

People

Changes in the physical and economic human environment could affect distinct populations in the community. The high number of fixed-income families may have to pay a larger proportion of their income to power bills. The growing elderly population in Clarkston might be physically unable to engage in the new recreational opportunities on a near-natural lower Snake River. Finally, the influx of short-term, outside workers might disrupt traditional community patterns, although the number of forecast workers could be relatively small compared to the workforce that originally constructed the lower Snake River dams.

The forecast increase in long-term employment under Alternative 4 suggests that population would continue to increase. Given the uncertainties associated with the business climate, however, overall population might remain stable or decrease slightly given short-term job losses.

Historical Change Events and Potential Responses

Clarkston has a relatively high economic diversity and has undergone significant economic peaks and valleys over the past 25 years. During the construction of Lower Granite Dam and the dikes in the valley, unemployment was at a historical low. During the recession of the early 1980s, Asotin County lost over 1,200 jobs between 1980 and 1984. Clarkston has also experienced periodic layoffs in the wood manufacturing industry in the valley.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community, it appears that the changes in the human environment would be within historical bounds.

7.4.1.2 Colfax, Washington

The socioeconomic impacts of the proposed alternatives on the community of Colfax could include the effects of changed recreation activity, navigation/transportation, water supply, implementation, anadromous fish recovery, and power costs. Table 7-1 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 affect the probability of anadromous fish recovery, while having minimal effect on the physical or economic human environment. Alternative 4 could have significant effects on specific populations in Colfax. It could adversely affect the community primarily through the loss of a navigable waterway, a corresponding shift in transportation modes to more expensive rail and truck movements, a decrease in countywide net farm income, and a drop in property values for agricultural lands. It is expected that Colfax would realize short-term increases in implementation and well-modification-related employment, as well as a small temporary influx of outside workers. Overall, the community could experience both increases and decreases in employment, with a projected net loss in employment. The most significant effect on the community could be the additional financial pressures on grain farms from increased transportation, storage and handling costs, and uncertainty as to how the transportation system and individual farms would respond. The cumulative effects of Alternative 4 and the proposed phase-out of the loan deficiency payments under the Freedom to Farm Act could create even greater uncertainty for individual farmers and farm communities like Colfax.

Jobs and Wealth

Overall, Alternatives 2 and 3 would not adversely affect jobs and wealth directly. They could provide a higher degree of certainty about the economic future, although the degree of future regulatory oversight under these alternatives is unknown. Alternative 4 could adversely affect future economic certainty and increase future economic risks because not all of the indirect and induced effects of these changes are known. For example, it is unknown if some agricultural lands would go out of production or if none would go out of production, how many farm owners might be forced to sell, and how many would seek other employment.

Negative impacts on Colfax's employment from Alternative 4 could result from increased residential electrical rates, reduction in county-wide farm income, loss of Corps-related jobs, loss of water-related port operations, and short-term, decreased recreational opportunities. Farmers currently using the waterway to ship grains could experience increased costs to ship their goods. This could have a negative effect on farm income and further decrease jobs that support farm household expenditures. Total county farm income would probably decrease by at least 10 percent. The associated decrease in household spending would probably reduce employment in Colfax by more than 1 percent. With transportation, storage, and handling costs expected to increase an average of 17 cents per bushel for all grain production in the county, the value of agricultural land surrounding Colfax might be expected to fall by up to $140 per acre.

Positive impacts on community employment from Alternative 4 could result from an increase in truck and rail transportation employment, post-implementation increases in river recreation-related activities, increased anadromous fishing opportunities, and ongoing road maintenance. The increase in trucking- and rail-transportation-related employment might be higher than predicted by the allocation of employment impacts due to the large volumes of grain produced in the lands surrounding Colfax and the position of Colfax on the highway that would carry a large amount of the traffic. Short-term increases in employment could result from implementation activities, modifications to wells along the river, and upgrades to road and rail infrastructure.

Place

Colfax's natural and built environment may not change dramatically under Alternative 4. Changes would occur in the surrounding patterns of land ownership and in the access and recreational opportunities available on the nearby lower Snake River. Adverse impacts from the loss of the Lower Granite pool could include the loss of developed access at recreational sites such as Wawawai County Park, Ilia Dunes Landing, Willow Landing, Little Goose Landing, and Lyons Ferry Marina. Additionally, recreation services may diminish at sites such as Boyer Park and Marina, Central Ferry State Park, and Chief Timothy State Park. In addition, the community could experience short-term losses in recreational steelhead and salmon fishing and other river-related recreation as boat ramps are modified and the riverbank is re-vegetated. The identity of the community as agricultural may not be adversely affected by Alternative 4. The community should still continue to be the heart of the Palouse and a leader in wheat and lentil production.

Another adverse affect of Alternative 4 could be the financial pressures higher transportation costs would exert on local farmers. This might lead to a greater consolidation of farms and a decrease in the number of community members either directly or indirectly active in the farming industry. With or without a navigable waterway, Colfax would continue to be a transportation hub for the movement of grain commodities produced in Whitman and neighboring counties. Truck traffic patterns could shift from a north-south to an east-west orientation with an estimated slight increase in overall traffic through town. This might be economically beneficial, but would increase congestion and impact safety through downtown and on Washington Route 26 westbound. Finally, Colfax could lose a river crossing at the Lower Granite facility. This crossing provides an alternative transportation corridor between Colfax and Pomeroy in Garfield County.

Long-term benefits of Alternative 4 could include the revegetation and restoration of the normative Snake River. Additionally, the increase of salmon would benefit the identity of the community as a place where salmon would continue to exist and local anglers would continue to pursue this element of the Colfax's quality of life. Alternatives 2 and 3 could have higher risks associated with salmon recovery and might adversely affect this element of Colfax's quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could adversely affect Colfax's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. The community has been united in its opposition to Alternative 4. Adverse effects of a change in the economic direction and identity of the community under Alternative 4 might challenge the leadership and vision of the community to provide a cost-effective way to transport the large volumes of grains to market. One key factor is the uncertainty about the capacity of alternative modes of transportation to handle the volume of production currently shipped on the lower Snake River.

The community has worked with the Port of Whitman County to develop successful industrial and shipping facilities. Some of these developments such as industrial parks sited away from the river may be unaffected by the change in the waterway, while other facilities on the river may become obsolete. Perhaps the most significant impact on the vision and vitality of the community would be the expected drop in property tax revenue both from agricultural and non-agricultural lands. The community could face raising tax rates or cutting social services. Neither of these choices is harmonious with the community's future plans and could limit investments in the economic diversification efforts. One ameliorating factor could be that property tax revenue would not change overnight, but rather would be phased in over a 5-year period of decreased farm income being capitalized into the land.

People

Changes in the physical and economic human environment could affect distinct populations in the community. The poverty rate in Colfax is relatively low, as is the over-65 population; thus, large segments of the population may not be affected adversely by the increased electrical rates or the changes in slackwater recreation opportunities. Colfax might see a short-term influx of outside workers during the implementation, but this probably would not be a significant impact. The expected increased rate of land consolidation in the farm sector might contribute to a reduction in rural farm population.

Overall, the expected decrease in net employment under Alternative 4 suggests that community population would decrease slightly.

Historical Change Events and Potential Responses

Colfax's economy exhibits moderate economic diversity and has not experienced major economic peaks and valleys over the past 25 years, aside from the large cyclical swings in commodity prices and production yields. Community members have existed with the uncertainty associated with a farm-centered economy and lifestyle. Nevertheless, there is a strong cultural norm to make things work and build a future in this community.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community, it appears that the changes in the human environment might exceed historical experience in this community.

7.4.1.3 Pomeroy, Washington

The socioeconomic impacts of the three alternatives on the community of Pomeroy could include the effects of changed recreation activity, navigation/transportation, water supply, implementation, anadromous fish recovery, and power costs. Table 7-1 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 could affect the probability of anadromous fish recovery, while having a minimal effect on the physical or economic human environment. Alternative 4 could have significant effects on specific populations in Pomeroy. It could adversely affect the community primarily through the loss of a navigable waterway, a corresponding shift in transportation modes to more expensive rail and truck movements, a decrease in countywide net farm income, and a drop in property values for agricultural lands. Pomeroy probably would realize short-term increases in implementation- and well-modification-related employment, as well as a significant temporary influx of outside workers. Overall, the community could experience both increases and decreases in employment, with a projected net loss in employment. The most significant effect on the community could be the additional financial pressures on grain farms from increased transportation, storage, and handling costs and the uncertainty as to how the transportation system and individual farms would respond. The cumulative effects of Alternative 4 and the proposed phase-out of the loan deficiency payments under the Freedom to Farm Act could create an even greater uncertainty to individual farmers and farm communities like Pomeroy.

Jobs and Wealth

Overall, Alternatives 2 and 3 may not adversely affect jobs and wealth directly and could provide a higher degree of certainty about the economic future. Alternative 4 could adversely affect future economic certainty and increase future economic risks because not all of the indirect and induced effects of these changes are known. For example, it is unknown if some agricultural lands would go out of production or, if none went out of production, how many farm owners might be forced to sell out and seek other employment.

Negative impacts on Pomeroy's employment from Alternative 4 could result from reduction in countywide farm income, loss of Corps-related jobs, increased residential electrical rates, and short-term decreased recreational opportunities. Farmers currently using the waterway to ship grains could experience increased costs to ship their goods. This could have a negative effect on farm income and further decrease jobs that support farm household expenditures. Total county farm income could decrease by about 10 percent. The change in direct, indirect, and induced employment from a decrease in farm household spending probably would decrease employment in Pomeroy by less than 1 percent. With transportation, storage, and handling costs expected to increase an average of $0.07 per bushel of total grain production, the value of agricultural land surrounding Pomeroy might be expected to fall by up to $40 to $50 per acre.

Positive impacts on community employment from Alternative 4 could result from an increase in truck and rail transportation employment, post-implementation increases in river recreation-related activities, increased anadromous fishing opportunities, and ongoing road maintenance. The increase in trucking- and rail transportation-related employment might be higher than predicted by the allocation of employment impacts. Both the large volumes of grain produced in the lands surrounding Pomeroy and the position of Pomeroy on the highway that could carry a large load of the traffic from Idaho counties to ports on the Columbia River indicate that Pomeroy would see higher levels of transportation-related employment. Short-term increases in employment could result from implementation activities, modifications to wells along the river, and upgrades to road infrastructure.

Place

Pomeroy's natural and built environment may not change dramatically under Alternative 4. Changes could occur in the surrounding patterns of land ownership and in the access and recreational opportunities available on the nearby lower Snake River. Adverse impacts from the loss of the Lower Granite pool could include the loss of developed access at recreational sites such as Wawawai County Park, Ilia Dunes Landing, Willow Landing, Little Goose Landing, and Lyons Ferry Marina. Access to Boyer Park and Marina by crossing the Lower Granite facility would be lost. Additionally, recreation services could be diminished at sites such as Boyer Park and Marina, Central Ferry State Park, and Chief Timothy State Park. The community may also experience short-term losses in recreational steelhead and salmon fishing and other river-related recreation, as boat ramps were modified and the riverbank was revegetated. The identity of the community as agricultural should not be adversely affected by Alternative 4.

Another adverse affect of Alternative 4 could be the financial pressures exerted on local farmers from higher transportation costs. This might lead to a greater consolidation of farms and a decrease in the number of community members either directly or indirectly active in the farming industry. Without a navigable waterway and access to the ports of Whitman and Garfield counties, Pomeroy would be on the major transportation route for the movement of grain and other commodities from Idaho and Asotin County. Truck traffic patterns may increase total vehicle traffic on US 12 through Pomeroy by more than 2 percent. This might be economically beneficial to roadside services, but would be adverse for congestion and safety through downtown and on US 12 westbound. Finally, Pomeroy could lose a river crossing at the Lower Granite facility. The crossing currently provides an alternative transportation corridor between Pomeroy and Colfax in Whitman County.

Long-term benefits of Alternative 4 could include the revegetation and restoration of the normative Snake River. Additionally, the increase of salmon would benefit the identity of the community as a place where salmon would continue to exist and local anglers would continue to pursue this element of Pomeroy's quality of life. Alternatives 2 and 3 would have higher risks associated with salmon recovery and might adversely affect this element of Pomeroy's quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could adversely affect Pomeroy's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. Changes in the economic direction and base of the community under Alternative 4 might challenge the leadership and vision of the community to provide cost-effective means of transporting the large volumes of grains to market since Pomeroy does not currently have rail access in the county. Additionally, leadership may be challenged to further enhance economic diversification efforts and to develop a recreational sector with a new type of tourism in mind.

Perhaps the most significant impact on the vision and vitality of the community may be the expected drop in property tax revenue both from agricultural and non-agricultural lands. The community could face raising tax rates or cutting social services. Neither of these choices is harmonious with the community's future plans and could limit investments in the economic diversification efforts. One ameliorating factor could be that property tax revenue would not change immediately but, rather, would be phased in over a 5-year period of decreased farm income.

People

Changes in the physical and economic human environment could affect distinct populations in the community. The poverty rate in Pomeroy is relatively low, but Pomeroy has the highest median age and largest percentage of people over 65 in the study region. This retirement population could be adversely affected by loss of slack-water recreational opportunities on the lower Snake River.

Another significant impact for Pomeroy could be the short-term influx of outside workers during implementation. Pomeroy and Garfield County housed large numbers of outside workers during the construction of the last two lower Snake River facilities. The community and the county experienced the social stresses and economic boom associated with that activity. The level of workforce anticipated for the implementation of Alternative 4 is not expected to be as large or to extend over as long a period as the prior construction. These workers might, however, have different values and habits than the local residents and might cause short-term stress to the community.

Overall, the expected decrease in net employment under Alternative 4 indicates that community population could decrease slightly. In addition, the expected increased rate of land consolidation in the farm sector might contribute to further reduction in rural farm population and hinder attempts to keep young community members in the town.

Historical Change Events and Potential Responses

Pomeroy's economy exhibits moderate economic diversity and has experienced major economic peaks and valleys over the past 25 years including the boom and bust of the Lower Granite Dam construction and the large cyclical swings in the commodity prices and production yields. Community members have existed with the uncertainty associated with an agriculturally centered economy and lifestyle.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community, it appears that the changes in the human environment might not exceed historical experience in Pomeroy.

7.4.1.4 Kennewick, Washington

The socioeconomic impacts of the three alternatives on the community of Kennewick could include the indirect effects of irrigation, navigation/transportation, recreation activity, power costs, power production implementation, and anadromous fish recovery. Table 7-1 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 affect the probability of anadromous fish recovery while having minimal effect on the physical or economic human environment. Alternative 4 could have minor direct effects on Kennewick but might have significant indirect effects because Kennewick is the retail and service center for the Tri-Cities and the surrounding region. The loss of Ice Harbor irrigated agriculture probably could produce the most significant impacts. Beneficial effects might come from siting new power plants, increased operations and maintenance employment, and related spending, as well as anadromous fish recovery. Increased transportation activity in the Tri-Cities, primarily Pasco, probably would also produce economic benefits for Kennewick.

Kennewick probably would realize short-term increases in implementation and power plant construction employment. Overall, the community could experience both increases and decreases in employment, with a projected net loss in employment. Perhaps the most significant effect on the community could be the loss of agricultural production due to the drawdown of the Ice Harbor pool and the uncertainty regarding the effect of those losses on the community economic structure. Aside from the specific physical and economic changes in Kennewick, a significant impact might be the fear that the successful breaching of the lower Snake River projects could jeopardize the future viability of the Columbia River waterway and the values it holds for Kennewick residents.

Jobs and Wealth

Overall, Alternatives 2 and 3 may not adversely affect jobs and wealth directly and could provide a higher degree of certainty about the economic future. Alternative 4 could adversely affect future economic certainty and could increase future economic risks because not all of the indirect and induced effects of these changes are known.

Negative indirect impacts on Kennewick's employment from Alternative 4 could primarily result from the loss of irrigated agriculture and increased residential electrical rates. The water supply analysis indicated that modifying the Ice Harbor pumps would cost more that the total land value or the value of the crops produced. The effect could be that Ice Harbor irrigated farm owners may not be able to make the necessary modifications and operations would cease. The effects of this economic loss to the region could indirectly impact the large service and retail sectors and, to a lesser degree, the agricultural service sectors in Kennewick. Losses are estimated at approximately 2.3 percent of total employment. The effects of increased residential electrical rates are estimated at below 1 percent. Total long-term direct, indirect, and induced employment losses are estimated to be less than 2.5 percent of Kennewick's total employment.

Positive impacts on community employment from Alternative 4 could result from the operations and maintenance of new power plants in the region; increased trucking, rail, and barge transportation; post-implementation increases in river recreation-related activities; and road maintenance. Short-term increases in employment could result from power plant construction, transportation infrastructure upgrades, and implementation activities. The long-term gains could be an approximate 1.5 percent increase in Kennewick's total employment. The net long-term change in employment in Kennewick could be a loss of less than 1 percent of total employment.

The positive and negative effects of these employment changes may be felt primarily in the service and retail and wholesale trade sectors. It does not appear that any one business or service would be disproportionately affected. Overall, the most significant effect of Alternative 4 could be the heightened uncertainty about the fate of the Columbia River.

Place

Kennewick's natural and built environment may not change significantly under Alternative 4. Adverse impacts from the breaching of the four lower Snake River facilities could eliminate nearby developed recreational access sites such as the North Shore Ramp, Ayer Boat Basin, and Lyons Ferry Marina. Kennewick may also lose some developed recreational site services at Charboneau

Park, Levy Landing, Fishook Park, and Windust Park. Although this represents a small fraction of the recreational slack water recreational sites in the region, a more significant impact might be the short-term crowding at Columbia River sites from lower Snake River displaced recreationists. The identity of the community as a riverside retail and service urban center may not be affected adversely by this alternative.

Another indirect effect on Kennewick's place could be the increased traffic into the Tri-Cities. Traffic increases probably would not occur in the city of Kennewick, but could occur across the Columbia River in Pasco. Overall traffic volumes on highways from eastern Washington feeding into the Tri-Cities probably could increase between 2 and 6 percent. Some of this traffic might alter movement patterns by Kennewick commuters and might provide additional employment and income to Kennewick.

Long-term benefits of Alternative 4 could include the revegetation and restoration of the normative Snake River and the shoreline. Additionally, the increase of salmon would benefit the identity of the community as a place where salmon would continue to exist, and local anglers would continue to pursue this element of the Kennewick's quality of life. Alternatives 2 and 3 could have higher risks associated with salmon recovery and might adversely affect the community's future quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could all adversely affect Kennewick's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. The Chamber of Commerce has issued a position paper on the breaching of the lower Snake River facilities and has joined in rallies to save the dams. One significant impact on the vision and vitality of Kennewick of each of the alternatives, but primarily from Alternative 4, could be the fear that successfully breaching the dams, or the continued listing of the salmon and steelhead as endangered, would lead to the eventual breaching of the Columbia River facilities. The proposed alternatives of this study are seen as a first step to the removal of dams that provide the navigable waterway and recreational benefits to the community. Kennewick has been actively developing its waterfront, green areas, and Clover Island, and the fear of future loss of its waterfront represents a significant effect of each of the study's alternatives.

People

Changes in the physical and economic human environment could affect distinct populations in the community. Benton County has been designated as an economically distressed area and has a high level of poverty. More than 10 percent of the families are classified as below the poverty line. Families on low or fixed incomes may have to spend a larger portion of their income on electrical bills. The forecast decrease in net long-term employment under Alternative 4 signifies that population trends might not continue to increase at current or historical rates, although the community's thriving economy probably could continue to grow and attract new community members.

Historical Change Events and Potential Responses

Kennewick's economy exhibits high economic diversity and has experienced major economic peaks and valleys over the past 25 years. These trends are associated primarily with activities at the Hanford Reservation. Community members have existed with the uncertainty associated with the level of government activity on the reservation and have built a strong, retail-based community around that uncertainty. In the 1980s, suspension of work on the WPPSS facilities resulted in a loss of 15,000 jobs in the Tri-Cities area. During the 1990s, the Tri-Cities have lost an estimated 6,700 jobs since peaking in 1994. Approximately 1,000 jobs per year have been associated with Hanford workplace reductions. During this recent downturn, the community has not lost population, and school enrollment has continued to grow.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community, it appears that the changes in the human environment would not exceed historical experiences in Kennewick.

7.4.1.5 Pasco, Washington

The socioeconomic impacts of the three alternatives on the community of Pasco could include the effects of irrigation, navigation/transportation, recreation activity, power costs, implementation, and anadromous fish recovery. Table 7-1 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 affect the probability of anadromous fish recovery, while having a minimal effect on the physical or economic human environment. Alternative 4 could have significant effects on specific populations in and around Pasco. It could create both winners and losers through the shift in transportation modes and nodes, changes in recreational opportunities and access, lost irrigation acreage and employment, construction and operation of new power plants, loss of power produced at the four projects, and an increased chance of anadromous fish recovery.

Additionally, the community could experience a dramatic short-term change in the character of the community as grain from eastern Washington, Idaho, Montana, and North Dakota shipped on the lower Snake River is rerouted into the Pasco port and through the Pasco rail yards. It is expected that Pasco could realize short-term increases in implementation and power plant construction employment. Overall, the community could experience both increases and decreases in employment, with a projected net loss in employment. Perhaps the most significant effect on the community could be the loss of agricultural production on the Ice Harbor reservoir and the uncertainty of those losses on the community economic structure. Aside from the specific physical and economic changes in Pasco, a significant impact might be the fear that a successful breaching of the lower Snake River facilities could jeopardize the future viability of the Columbia River waterway.

Jobs and Wealth

Overall, Alternatives 2 and 3 may not adversely affect jobs and wealth directly and could provide a higher degree of certainty about the economic future. Alternative 4 could adversely affect future economic certainty and increase future economic risks because all of the indirect and induced effects of these changes are not known. For example, it is unclear how the loss of irrigated agricultural production from the Ice Harbor reservoir may affect the growing food processing facilities in Pasco or how displaced agricultural workers would adapt to lost employment.

Negative impacts on Pasco employment from Alternative 4 could result from the loss of irrigated agriculture, higher residential electrical rates, reduction in countywide farm income, and a loss of Corps-related jobs. The water supply analysis indicated that modifying the Ice Harbor pumps could cost more than the total land value or the value of the crops produced. Ice Harbor irrigated farm owners may not be able to make the necessary modifications and operations could cease. Approximately 20 percent of the land is located in Franklin County, and much of the agricultural service sector that supplies these farms could be affected. The direct, indirect, and induced employment losses in Pasco in just the agriculture/agricultural services sector are estimated to be approximately 9 percent of the agricultural sector, although the total loss of employment from this change is estimated to be less than 2.5 percent of Pasco's total employment. None of the other negative employment effects decreases employment by more than 1 percent. Total direct, indirect, and induced employment losses are estimated to be less than 2.5 percent of Pasco's total employment.

Positive impacts on community employment from Alternative 4 could result from increased trucking, rail, and barge transportation, post-implementation increases in river recreation-related activities; road maintenance, short-term increases in employment from power plant construction, transportation infrastructure upgrades, implementation activities; and modifications to lower Snake River wells. With Pasco becoming the closest port to eastern Washington and Idaho grain production, significant quantities of grain are forecast to move through the port rail and barge facilities. In effect, Pasco could receive a high percentage of the jobs lost by Lewiston, Clarkston, and the other lower Snake River water port operations. These gains are estimated to be approximately 1.5 percent of Pasco's total employment. The net long-term change in employment in Pasco could be a loss of less than 1 percent of total employment.

The effects of these employment changes on the largest employers in the community demonstrate the degree to which there will be winners, losers, and uncertain futures associated with Alternative 4. Local manufacturing operations depend to an unknown degree upon fiber plantations along the Ice Harbor reservoir. The loss of these plantations could place financial pressure on their operations, and a long-term investment could be stranded. Railroads, on the other hand, could stand to gain or capture traffic volume as farmers and other shippers searched for cost-effective means to ship their products to Portland. Finally, food processing plants could have a diminished source of primary product for food processing activities. The degree to which a decreased supply of agricultural products could affect employment is unknown.

Place

Pasco's natural and built environment may not change significantly under Alternative 4. Adverse impacts from the breaching of the four lower Snake River facilities could eliminate developed recreational access sites such as the North Shore Ramp, Ayer Boat Basin, and Lyons Ferry Marina. Pasco could also lose some developed recreational site services at Charboneau Park, Levy Landing, Fishook Park, and Windust Park. Although this represents a small fraction of the slack water recreational sites in the region, a more significant impact might be the short-term crowding from lower Snake River displaced recreationists. The identity of the community as a riverside transportation and agricultural urban center may not be adversely affected by this alternative.

The most significant change could be the increased truck traffic into the ports. Increased truck traffic could converge from Interstate 395, US 12, and SR 124 into the port facilities. Truck traffic into the city from the north probably would rise between 6 and 21 percent above current truck traffic volumes. Overall vehicle traffic is expected to increase between 2 and 6 percent. Although this traffic represents an economic benefit to the community, it might congest the feeder streets to the port facilities and increase the safety risk within and outside of the city. This added traffic could also have a negative impact on the condition of city streets.

Long-term benefits of Alternative 4 could include revegetation and restoration of the normative Snake River and the shoreline. Additionally, the increase salmon would benefit the identity of the community as a place where salmon would continue to exist and local anglers would continue to pursue this element of Pasco's quality of life. Alternatives 2 and 3 could have higher risks associated with salmon recovery and might adversely affect the community's future quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could all affect Pasco's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. The Chamber of Commerce has issued a position paper on the breaching of the lower Snake River facilities and has joined in rallies to save the dams. One significant impact on the vision and vitality of Pasco for each of the alternatives, but primarily for Alternative 4, could be the fear that successfully breaching the dams or the continued listing of the salmon and steelhead as endangered could lead to the eventual breaching of the Columbia River facilities. The proposed alternatives of this study are seen as a first step to the removal of the Columbia River dams that provide the navigable waterway and recreational benefits to the community. Alternative 4 might seriously challenge the leadership and vision of the community as community members work to address the large numbers of displaced full-time and seasonal workers from the irrigated lands on Ice Harbor. The community has worked to successfully develop the facilities at the Port of Pasco and to diversify the local economy by developing value-added food processing centers to the economic structure of Pasco. These plans and achievements might be affected adversely under this alternative.

Finally, the negative short- and long-term effects of lost agricultural production on both local and county property values and property tax revenue might create difficulties in obtaining enough funding to pursue new avenues of economic development and to maintain the current and anticipated increased levels of community services.

People

Changes in the physical and economic human environment could affect distinct populations in the community. Franklin County has been designated as an economically distressed area and has a high level of poverty. More than 10 percent of families are classified as below the poverty line, and these numbers might increase with the loss of employment on the Ice Harbor irrigated lands. These families on low or fixed incomes could have to spend a larger portion of their income on electrical bills. In addition, farm workers displaced from the Ice Harbor lands are primarily Hispanic, and Pasco's population is more than 40 percent Hispanic. The concerns related to the disproportional negative impacts of this alternative are addressed in the EIS's environmental justice discussion.

The forecast decrease in net long-term employment under Alternative 4 signifies that population trends might not continue to increase at current or historical rates.

Historical Change Events and Potential Responses

Pasco's economy exhibits high economic diversity and has experienced major economic peaks and valleys over the past 25 years. These changes are associated primarily with activities at the Hanford Reservation and the fortunes of agriculture. Community members have existed with the uncertainty associated with the level of government activity on the reservation and have built upon a strong transportation and agricultural base. Pasco has not been as directly affected by the benefits of the Hanford Reservation; nonetheless, some of the 15,000 jobs lost in the 1980s did occur in Pasco. More recently, the Tri-Cities have lost an estimated 6,700 jobs since peaking in 1994. Approximately 1,000 jobs per year have been associated with Hanford workplace reductions. During this recent downturn, the community has not experienced population declines, and school enrollment has continued to grow.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community, changes in the human environment probably would not exceed historical experiences in Pasco. The direct effects on the agricultural sector might, however, be more significant than previous experiences in the absence of mitigation.

7.4.1.6 Umatilla, Oregon

The socioeconomic impacts of the three alternatives on the community of Umatilla could include the effects of irrigation, navigation/transportation, recreation activity, power costs, power production, implementation, and anadromous fish recovery. Table 7-1 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 may affect the probability of anadromous fish recovery while having minimal effects on the physical or economic human environment. Alternative 4 could affect Umatilla through the siting of power plants to replace the lost hydroelectric power generated by the four lower Snake River facilities. The loss of Ice Harbor irrigated agriculture might adversely affect Umatilla food processors who obtain a small portion of their product from the Ice Harbor farms. Beneficial economic impacts might result from siting new power plants in the region and the associated increased operations and maintenance employment and related spending. Although not predicted in the Corps transportation model, the Port of Umatilla might experience increased activity due to the presence of grain-loading facilities and the projected shortages of these facilities in the Tri-Cities area. Overall, the community could experience both increases and decreases in employment, with a small projected net loss in employment. This net loss might change to a significant net increase if the replacement power plants were sited in Umatilla or nearby. Aside from the expected physical and economic changes in Umatilla, a significant impact might be the fear that the successful breaching of the lower Snake River facilities could jeopardize the future viability of the Columbia River Waterway and in particular the John Day Dam.

Jobs and Wealth

Overall, Alternatives 2 and 3 may have a higher degree of certainty about the economic future and may not adversely affect jobs and wealth directly. Alternative 4 could adversely affect future economic certainty and would increase future economic risks because not all of the indirect and induced effects of these changes are known.

Negative indirect impacts on Umatilla's employment from Alternative 4 could result from the loss of Ice Harbor irrigated agriculture and increased residential electrical rates. The water supply analysis indicated that modifying the Ice Harbor pumps could cost more that the total land value or the value of the crops produced. The effect could be that Ice Harbor irrigated farm owners would be unable to make the necessary modifications and operations would cease. The effects of this economic loss to the region could indirectly impact the agricultural and food processing sectors in Umatilla. The magnitude of these effects on the food processing sector are unknown. Sediment from the lower Snake River probably would not adversely affect irrigators out of the John Day pool. Overall employment losses are estimated to be less than 1 percent of total employment. The effects of increased residential electrical rates are estimated at below 1 percent.

Positive impacts on community employment from Alternative 4 could result from the operation and maintenance of new power plants in the region. Short-term increases in employment could result from power plant construction, transportation infrastructure upgrades, recreation activities, and implementation. The long-term gains would probably be less than a 1 percent increase in Umatilla's total employment, but might be significantly higher if the new power plants were to be sited in the Hermiston/Umatilla/Bordman area. Total net employment change is estimated to be less than a 1 percent decrease.

Overall, the most significant economic effect of Alternative 4 could be the heightened uncertainty about the fate of the Columbia River and the local irrigated agriculture that depends on river water.

Place

Umatilla's natural and built environment may not change significantly under Alternative 4 unless the new power plants were sited close to the community. It is beyond the scope of this report to analyze the effects of a proposed power plant, but adequate environmental and socioeconomic assessments would be required. Adverse impacts on recreation sites within 50 miles of Umatilla could include the elimination of the North Shore Ramp. Umatilla could also lose some developed recreational site services at Charboneau Park, Levy Landing, and Fishook Park. Although this represents a small fraction of the slack water recreational sites in the region, a more significant impact might be the short-term crowding at Columbia River sites from lower Snake River displaced recreationists. The identity of the community as the "Walleye Capital of the World" would not be adversely affected by this alternative.

Long-term benefits of Alternative 4 could include the revegetation and restoration of the normative Snake River and the shoreline. Additionally, the increase salmon would benefit the identity of the community as a place where salmon would continue to exist, and local anglers would continue to pursue this element of Umatilla's quality of life. Alternatives 2 and 3 could have higher risks associated with salmon recovery and might adversely affect future community quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could all adversely affect Umatilla's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. One significant impact on the vision and vitality of Umatilla of each of the alternatives, but primarily Alternative 4, could be the fear that successfully breaching the dams or the continued listing of the salmon and steelhead as endangered could lead to the eventual breaching of the Columbia River facilities. The proposed alternatives of this study are seen by community members as a first step to the removal of dams that provide the navigable waterway and recreational benefits to the community.

If the replacement power plants were sited near Umatilla or within Umatilla County, the community might achieve increased tax revenues to support essential county and community services.

People

Changes in the physical and economic human environment could affect distinct populations in Umatilla. A relatively high level of poverty exists for families in Umatilla, and these families could be expected to expend a larger of their income on increased electrical bills. The small forecast decrease in net long-term employment under Alternative 4 signifies that population trends might not continue to increase at current or historical rates. It is likely that in both the short and the long term, population could increase if the replacement power plants were sited close to the community.

Historical Change Events and Potential Responses

Umatilla's economy exhibits moderately high economic diversity and has experienced the cyclical flows associated with agriculture and food manufacturing. Irrigated agriculture expanded rapidly in the 1970s and 1980s. Recent years have seen a minor downturn in the food processing/ manufacturing industries.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community, it appears that the minor changes in the human environment could not exceed historical experiences in Umatilla.

7.4.1.7 Lewiston, Idaho

The socioeconomic impacts of the three alternatives on the community of Lewiston could include the effects of changed recreation activities, navigation and transportation, M&I water supply, implementation, anadromous fish recovery, and power costs. Table 7-1 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 could affect the probability of anadromous fish recovery, while having a minimal effect on the physical or economic human environment. Alternative 4 could have significant effects on the specific populations of Lewiston. It could create both winners and losers through the loss of a navigable waterway, loss of power produced at the four projects, a shift in transportation modes, a change in recreational opportunities and access, and an increased chance of anadromous fish recovery. In addition, the community could experience a dramatic short-term change in the character of the community as the reservoir was drained and a new shoreline was formed around the city with the existing levees left high above the new water line. It is expected that Lewiston could realize short-term increases in implementation and M&I water supply modification-related employment, as well as a temporary influx of outside workers. Overall, the community could experience both increases and decreases in employment, with a projected net gain in employment. Perhaps the most significant effect on the community could be the stranded social energy and costs of developing activities and plans centered around the continued existence of the four lower Snake River facilities, a navigable waterway, and an inland port.

Jobs and Wealth

Overall, Alternatives 2 and 3 may not adversely affect jobs and wealth directly and could have a higher degree of certainty about the economic future. Alternative 4 could adversely affect future economic certainty and increase future economic risks because not all of the indirect and induced effects of these changes are known. For example, it is unclear how the increased capital costs of pump and well modifications could affect local pulp and paper operations, the golf course, or local rock processors.

Negative impacts on Lewiston employment from Alternative 4 could result from a reduction in county-wide farm income, loss of Corps-related jobs, loss of water-related port operations, loss of tour boat-related employment, short-term decreased recreational opportunities, and an increase in residential electrical rates. Farmers and other shippers currently using the waterway to ship bulk products could experience increased costs to ship their goods. This might have a negative effect on employment in those and related economic sectors. None of the changes in the resource areas studied is projected to decrease employment in Lewiston by more than 1 percent.

Positive impacts on community employment from Alternative 4 could result from trucking transportation, post-implementation increases in river recreation-related activities, increased anadromous fishing opportunities, road maintenance, short-term increases in employment from implementation activities, and modifications to water pumps.

The potential effects of these changes on the largest employer, a local pulp and paper plant, demonstrate the degree of economic uncertainty associated with Alternative 4. It could be negatively affected by higher shipping costs for some of its products and by requirements to modify effluent and water intake systems. It is unknown how it would respond to these increased operational and capital costs, but these costs probably could be passed on to consumers.

Place

Lewiston's natural and built environment could change dramatically under Alternative 4, much like it did 25 years ago when the levees were built, the Lower Granite pool filled, and slackwater reached Lewiston. Adverse impacts from the loss of the Lower Granite pool could include the short-term exposure of shoreline and mudflats and the isolation of the levee parks from the water. The community could lose recreational access sites at Chief Lookinglass Park and Nisqually John Landing, as well as some recreational site services at Chief Timothy State Park, Hells Canyon Resort, Swallows Park, Clearwater Ramp, Southway Park, and Hells Gate State Park. In addition, the community could experience short-term losses in recreational steelhead and salmon fishing and other river-related recreation. The identity of the community as a working water port and the only inland water port in Idaho could also be adversely affected, although it could still retain its identity as a Snake River community surrounded by extensive natural features.

Another adverse affect of Alternative 4 could be the financial pressures exerted on local farmers from higher transportation costs. This might lead to a greater consolidation of farms and a change in the agricultural-urban identity of Lewiston.

Long-term benefits of Alternative 4 could include the revegetation and restoration of the normative Snake River and the community shoreline. Additionally, the increase of salmon would benefit the identity of the community as a place where salmon would continue to exist and local anglers would continue to pursue this element of Lewiston's quality of life. Alternatives 2 and 3 could have higher risks associated with salmon recovery and might adversely affect future community quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 all could adversely affect Lewiston's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. The city council has debated the issue and been split in its position. Adverse effects of a change in the economic direction and identity of the community under Alternative 4 might seriously challenge the leadership and vision of the community. The community has worked successfully to develop the facilities at the Port of Lewiston and to diversify the local economy by enhancing recreational opportunities associated with the lower Snake River pools, Hells Canyon, and surrounding natural areas. They have also successfully developed green areas along the waterway, providing local recreational opportunities. The port serves as a vehicle for manufacturing and industrial growth through its industrial properties and loading facilities. Many of these plans and achievements could be significantly affected under this alternative. The Port of Lewiston is in a good position to continue to act as a development mechanism, using both rail and highway access, but this is not the current direction of the port's activities. Additionally, the negative short- and long-term effects on both local and county property values and property tax revenue might make it difficult to obtain enough funding to pursue new avenues of economic development and maintain the current level of community services.

People

Changes in the physical and economic human environment could affect distinct populations in the community, although not to the degree seen in Clarkston. Families, including those on fixed incomes, could have to pay a larger proportion of their income to power bills. In addition, the influx of short-term outside workers might disrupt traditional community patterns, although the number of forecast workers is relatively small compared to the workforce required to construct the lower Snake River facilities.

The forecast increase in long-term employment under Alternative 4 signifies that population trends should continue to increase. However, overall population might remain stable or decrease slightly given short-term job losses and uncertain responses from businesses.

Historical Change Events and Potential Responses

Lewiston has a relatively high economic diversity and has undergone significant economic peaks and valleys over the past 25 years. During the construction of Lower Granite Dam and the Lewiston/Clarkston dikes, the valley unemployment was at a historical low. Lewiston lost more than 1,000 jobs between 1981 and 1982. More recently, Nez Perce County lost approximately 300 manufacturing jobs between 1990 and 1991 and from 1994 to 1995.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community it appears that the changes in the human environment would be within historical bounds.

7.4.1.8 Orofino, Idaho

The socioeconomic impacts of the three alternatives on the community of Orofino could include the effects of power costs, recreation activity, navigation and transportation, M&I water supply, implementation, and anadromous fish recovery. Table 7-1 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 could affect the probability of anadromous fish recovery, while having a minimal effect on the physical or economic human environment. Alternative 4 could have significant effects on specific populations in Orofino. It could create both winners and losers through an increased chance of anadromous fish recovery, a change in recreational opportunities and access, loss of a navigable waterway, loss of power produced at the four projects, and a shift in transportation modes. It is expected that Orofino could realize short-term increases in implementation, infrastructure improvements, and M&I water supply modification-related employment. Overall, the community could experience both increases and decreases in employment, with a projected net gain in employment. Perhaps the most significant effect on the community could be from the increased chance of wild salmon and steelhead runs on the Clearwater River and the enhanced status of Orofino as “Steelhead Capital of the World.”

Jobs and Wealth

Overall, Alternatives 2 and 3 may not adversely affect jobs and wealth directly and could provide a lower degree of certainty about the economic future. It is not anticipated that these alternatives would significantly improve fish returns; therefore, the planned development of the tourism sector of the economy might not grow as anticipated. Alternative 4 could adversely affect future economic certainty in the forestry and agricultural sectors and could increase future economic risks because not all of the indirect and induced effects of these changes are known. For example, it is unclear how the increased transportation costs would affect the timber industry's ability to sell wood chips or whether this increased cost would decrease the already unstable timber industry in Orofino. Alternative 4 could beneficially affect the future economic certainty of the tourism sector.

Negative impacts on community employment from Alternative 4 could result from increased transportation costs, reduction in countywide farm income, residential electrical rates, loss of Corps-related jobs, and short-term decreased recreational opportunities. Farmers and other shippers currently using the waterway to ship bulk products could experience increased costs to ship their goods. This could have a negative effect on employment in those economic sectors. A small volume of grain currently moves from Clearwater County on the lower Snake River while a larger volume of wood products move to Lewiston for eventual shipment down the waterway. These decreases are not expected to be larger than 1 percent, although the magnitude of the effect on forest product manufacturers is unknown.

Positive impacts on community employment from Alternative 4 could result from increased truck transportation, increased anadromous fishing opportunities, and the short-term increases in employment from implementation activities and modifications to water pumps. Given the established sport fishing industry and strong retail trade sector in Orofino, projected increases in wild fish returns after 20 years probably would likely increase employment in Orofino.

Lumber companies are two of the largest employers in Orofino. The effects of increased transportation costs are unknown, but the increased financial obligations might adversely affect these employers.

Place

Orofino's natural and built environment may not be significantly changed under Alternatives 2, 3, and 4. Flow augmentation water currently withdrawn from the Dworshak reservoir would continue under each of the proposed alternatives and would have negative effects on the local reservoir recreational opportunities and reservoir tourism. The loss of the Lower Granite pool could adversely affect the community's access to recreation sites on the lower Snake River within 50 miles of Orofino. The community could lose recreational access sites, including Chief Lookinglass Park and Nisqually John Landing, as well as some recreational site services at Chief Timothy State Park, Hells Canyon Resort, Southway Park, and Hells Gate State Park. The short-term displacement of Snake River recreationists might create crowding on the Dworshak reservoir and at sites on the Clearwater River. This might also provide a short-term economic benefit to the community. Finally, the financial pressures exerted on local farmers from higher transportation costs might lead to a greater consolidation of farms and a change in the rural land-use patterns around Orofino.

One long-term benefit of Alternative 4 could be the decrease in truck traffic along US 12 as grains from Montana and North Dakota move to new transportation corridors. This could have a positive effect of lessening traffic congestion and improving highway safety, but it might also decrease the existing economic benefits of truck traffic.

Other long-term benefits of Alternative 4 could include the revegetation and restoration of the normative Snake River. Additionally, the increase of salmon would benefit the identity of the community as a place where wild salmon would continue to exist and local anglers would continue to pursue this element of Orofino's quality of life. Alternatives 2 and 3 have higher risks associated with salmon recovery and might adversely community quality of life. The identity of the community as the "Steelhead Capital of the World" would be enhanced by Alternative 4 and adversely affected by Alternatives 2 and 3.

Vision and Vitality

Alternatives 2, 3, and 4 all adversely affect Orofino's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. In addition, all of the alternatives could continue with flow augmentation over the protests of Orofino residents. The community has worked to develop recreation and tourism alternatives in steelhead fishing and reservoir recreation to diversify its predominately timber-dependent economy. Those plans specific to the Dworshak reservoir could continue to be affected adversely by continued flow augmentation. Alternatives 2 and 3 could adversely affect development for the steelhead fishery and angling industries. Alternative 4 could provide support these development efforts. Additionally, the negative effects of decreased farm income on both local and county property values and property tax revenue might create difficulties in obtaining sufficient funding to pursue new avenues of economic development and maintain the current level of community services.

People

Changes in the physical and economic human environment could affect distinct populations in the community. The high number of fixed-income families could have to pay a larger proportion of their income for power bills.

The forecast increase in long-term employment under Alternative 4 suggests that recent population trends should continue to increase but, given the 10- to 20-year horizon for increased salmon populations, population might increase slightly.

Historical Change Events and Potential Responses

Orofino has a relatively high economic diversity and has undergone significant economic shifts over the past 25 years. During the construction of Dworshak Dam, employment boomed. Throughout the 1980s and 1990s, the historically important timber industry experienced continuing employment decreases. Between 1980 and 1990, the population of Orofino shrunk by almost one-quarter, or 1,000 people, primarily due to downturns in the timber industry.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community it appears that the minor changes in the human environment could be within historical bounds.

7.4.1.9 Riggins, Idaho

The socioeconomic impacts of the three alternatives on the community of Riggins could include the effects of changed recreation activity, navigation and transportation, anadromous fish recovery, and power costs. Table 7-1 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 could affect the probability of anadromous fish recovery, while having negative indirect effects on the physical or economic human environment. Alternative 4 could have significant effects on specific populations in Riggins and could create both winners and losers through an increased chance of anadromous fish recovery, a change in recreational opportunities and access, the loss of a navigable waterway, the loss of power produced at the four projects, and a shift in transportation modes. Overall, the community could experience both increases and decreases in employment, with a projected net gain in employment. Perhaps the most significant effect on the community could be the increased chance of wild salmon and steelhead runs on the Salmon River and the potential economic benefits of increased sportfishing.

Jobs and Wealth

Overall, Alternatives 2 and 3 may not adversely affect jobs and wealth directly and could provide a higher degree of certainty about the economic future. It is not anticipated that these alternatives would significantly improve fish returns; therefore, the planned development of the tourism sector of the economy might not grow as anticipated. While Alternative 4 could adversely affect future economic certainty and the health of the agricultural sector, it probably would beneficially affect the future economic certainty of the tourism sector.

Negative impacts on community employment from Alternative 4 could result from increased transportation costs, reduction in countywide farm income, and increased residential electrical rates. Farmers in the county currently using the waterway to move grains would experience increased transportation costs. This might have a negative effect on employment. A large volume of grain currently moves from Idaho County on the lower Snake River, and the county's farmers are expected to see the highest increase in shipping costs in the region. The reduction in total county farm income probably could be greater than 10 percent. These are significant impacts for the grain-producing regions of Idaho County on the Camas Prairie, but are not expected to significantly affect the economy of Riggins. Decreases in employment are expected to be less than 1 percent.

Positive impacts on community employment from Alternative 4 could result from increased anadromous fishing opportunities. The projected increases in wild fish returns after 20 years probably could increase employment by approximately 1 percent. Given the established sport fishing industry and the strong retail trade and service sectors in Riggins, the magnitude of this increase might be much greater given the potential future fish harvests.

Place

Riggins' natural and built environment may not be significantly changed under Alternatives 2, 3, and 4. The short-term displacement of lower Snake River recreationists might create crowding at sites on the Salmon River. This might provide a short-term economic benefit to the community. The financial pressures exerted on local farmers from higher transportation costs might lead to a greater consolidation of farms and a change in the rural land-use patterns around Riggins.

One long-term benefit of Alternative 4 could be the decrease in truck traffic along US 95 as grains from Southern Idaho move to new transportation corridors. This could have the positive effect of lessening traffic congestion and improving highway safety, but it might also decrease the existing economic benefits of through traffic.

Another long-term benefit of Alternative 4 could be the increased chance of salmon recovery. This could benefit the identity of the community as a place where wild salmon would continue to exist and local anglers would continue to pursue this element of Riggins' quality of life. Alternatives 2 and 3 would have higher risks associated with salmon recovery and might adversely community quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could affect Riggins' vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. The community has worked to develop recreation and tourism alternatives in steelhead fishing and whitewater rafting after the community sawmill burned down. Alternatives 2 and 3 could adversely affect the development of tourism related to anadromous fish. Alternative 4 could provide support for these development efforts. Additionally, the negative effects of decreased farm income on both local and county property values and property tax revenue might create difficulties in obtaining sufficient funding to pursue new avenues of economic development and maintain the current level of community services.

People

Changes in the physical and economic human environment could affect distinct populations in the community. The high number of fixed-income families could have to pay a larger proportion of their income to power bills.

The forecast increase in long-term employment under Alternative 4 suggests that recent population trends could continue to increase, but given the 10- to 20-year horizon for increased salmon populations, population might increase slightly in the interim.

Historical Change Events and Potential Responses

Riggins has moderate economic diversity and has undergone significant economic shifts over the past 25 years. The loss of the sawmill, the towns largest employer in 1982, was the most significant shift. The community relies on the seasonal and cyclical nature of the travel and tourism industry; thus it faces some economic uncertainty.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community, it appears that the minor changes in the human environment are within historical bounds.

7.5 Mitigation Analysis

7.5.1 Compensation Potential

The employment impacts identified in the regional analysis could be addressed by providing targeted job retraining and education credits to dislocated workers. The effects on net farm income due to increased transportation costs could be mitigated through a program similar to the Conservation Reserve Program, whereby farmers would receive compensation equal to the transportation cost increases.

Community-level impacts could be addressed by providing block grants to affected communities in the region for economic diversification activities. For example, to mitigate farm communities most affected by the loss of river transportation, economic development programs similar to those mentioned above could be used to create more local value-added products and decrease dependency on the export of unprocessed grains to foreign markets.

Under Alternative 2, the lower probability of and the higher degree of risk associated with anadromous fish recovery, negative economic and social impacts to sport-fishing-dependent communities could develop. These communities might lose an important component of their economic base and might need assistance to transition to another non-fishery-dependent job base.

8. Risk and Uncertainty

8.1 Introduction

This section presents the risk and uncertainty assessment of the economic and social analyses developed for this FR/EIS and summarized in this appendix. This feasibility study may affect decisions about environmental and economic values that people care about and want to protect. As such, it is important to consider the reliability of its findings. That is the purpose of this risk and uncertainty assessment. The overall conclusion of the risk and uncertainty assessment, in its most succinct form, is that unresolved biological, social, and economic issues do cause substantial uncertainty about whether it would be more cost-effective to breach the four lower Snake River dams. Uncertainty pervades the results of the entire study, but the highest level of uncertainty occurs in the following areas:

- How the value of future recreational use will benefit if the dams are breached
- How the future of anadromous fish stocks will be affected
- How the social and economic costs will be distributed.

Other economic uncertainties, although important, are unlikely to affect decisions about whether it would be more cost-effective to breach the four lower Snake River dams.

How best to assess risks and uncertainties in studies of natural resources management options is a difficult question to answer. Ignoring uncertainties can lead to bad decisions, but considering them can slow down the decision-making process. Two of the best references on the topic are *Confronting Uncertainty in Risk Management: A Guide for Decision Makers* (Finkel, 1990) and *Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis* (Morgan et al., 1990). Both advocate uncertainty analysis, but warn against "paralysis by analysis." A classic paper on right and wrong ways for dealing with uncertainty in making risk management decisions is "Witches, Floods and Wonder Drugs: Historical Perspectives on Risk Management" (Clark, 1980). A compilation of classic papers on making risk management decisions under uncertainty can be found in the Resources for the Future book *Readings in Risk* (Glickman and Gough, 1990). Finally, a more recent and somewhat more technical treatment of the topic can be found in *Uncertainty Analysis in Ecological Risk Assessment* (Warren-Hicks and Moore, 1998).

The approach for this particular risk and uncertainty assessment draws from the Corps' *Guidelines for Risk and Uncertainty Analysis in Water Resources Planning* (Corps, 1992) (the Guidelines) and was designed to incorporate the Corps' general recommendations. The Guidelines define a risk and uncertainty analysis as being composed of an assessment and an evaluation. Under the Guidelines' definition, this study is a risk and uncertainty assessment. When describing the end use of the risk and uncertainty assessment in the planning process, the Guidelines identify two basic issues:

- The risk and uncertainty assessment should provide a clear picture of the reliability of the overall assessment.
- The assessment should provide useful taxonomies and identification of important questions relevant to risk management. It should highlight where political and social judgments have to be made.

The remainder of this section addresses the methods and results of the risk and uncertainty assessment of the economic and social analysis developed for this FR/EIS. All tables and figures presented in this section were developed as part of the DREW Risk and Uncertainty Study. Sources of secondary information used by the DREW Risk and Uncertainty Workgroup to develop these tables and figures are noted, as appropriate.

8.2 Methods

The primary source of information for the risk and uncertainty assessment was the DREW workgroups. The workgroups provided three general types of information:

- point and range estimates of NED costs and benefits of alternatives under consideration
- verbal and/or written responses to a questionnaire designed to help ascertain the reliability of cost and benefit estimates and identify potentially important unanswered questions for risk managers
- risk and uncertainty discussions prepared as part of their study reports.

8.2.1 National Economic Development

The NED risk and uncertainty assessment used a combination of quantitative and qualitative methods described below. NED has the most fully developed risk and uncertainty assessment. Brief qualitative risk and uncertainty assessments for social/regional analysis and tribal circumstances were conducted as well. The methods for these assessments are discussed following the NED methods section.

8.2.1.1 Quantitative Methods

The quantitative methodology used for the risk and uncertainty assessment is nominal range sensitivity analysis (NRSA). Other methods developed by the DREW risk and uncertainty workgroup included a spreadsheet tool for estimating probability distributions of cost variables and an expert elicitation protocol for estimating probability distributions. NRSA provided a simpler way to identify important uncertainties than these probabilistic methods. This, in turn, allowed the workgroups to spend more time refining their models and assumptions, rather than trying to assign probabilities to variables that, with the advantage of hindsight, might be shown through NRSA to be unlikely to affect the cost-effectiveness ranking of alternatives.

NRSA involves holding all cost parameters except one at their nominal values (i.e., best estimates), while varying the remaining parameter from its low-end to high-end range estimate. Thus, for an additive model (e.g., a model that computes net benefit from component benefits and costs) the NRSA gives a set of 2n outputs describing the range of possible model outputs (net benefit) given the uncertainties of the input (component benefit and cost):

$$Y_{i,\,low} = \sum_{\substack{j=1 \\ j \neq i}}^{n} X_{j,\,nom} + X_{i,\,low} \qquad (i = 1, \ldots, n)$$

$$Y_{i,\,high} = \sum_{\substack{j=1 \\ j \neq i}}^{n} X_{j,\,nom} + X_{i,\,high} \qquad (i = 1, \ldots, n) \qquad (1)$$

Nominal and range estimates were provided by individual workgroups on an average annual basis. These data, presented in Table 8-1, were used to compute the nominal net benefit associated with Alternative 2—Maximum Transport of Juvenile Salmon, Alternative 3 —Major System Improvements, and Alternative 4—Dam Breaching relative to Alternative 1 —Existing Conditions at 6.875, 4.75, and 0.0 percent discount rates. This simply involved using the benefit and cost estimates reported in the nominal value column of Table 8-1. For example, the nominal net benefit, at the 6.875 percent discount rate, for Alternative 4 relative to Alternative 1 is computed using the Alternative 4 data from the nominal value column of the 6.875 percent discount rate section from Table 8-1:

= (70,524,000 + 2,218,000) – (48,790,000 + 271,000,000 – 33,570,000 + 37,813,000 + 15,424,000)
= ($266,714,000)

Similarly, the nominal net benefit at the 0.0 percent discount rate for Alternative 3 relative to Alternative 1 is computed using the Alternative 3 data from the nominal value column of the 0.0 percent discount rate section from Table 8-1:

= (673,000 +318,000) – (4,930,000 – 8,000,000 + 0 + 0 + 0)
= ($4,061,000)

The nominal range sensitivity analysis computed net benefits for nominal net benefits, except that the low-end or high-end range estimate for one parameter was substituted for its nominal value, as described by equation 1. Thus, the low-end nominal range estimate (varying the recreation benefits parameter at the 6.875 percent discount rate) for Alternative 4 relative to Alternative 1 is computed using the Alternative 4 data from the nominal value column of the 6.875 percent discount rate section from Table 8-1. This calculation is made for all parameters except recreation benefits, for which the value in the low-end range estimate column is substituted:

= (27,836,000+2,218,000) – (48,790,000 + 271,000,000 – 33,570,000 + 37,813,000 + 15,424,000)
= ($309,420,000)

As a final example, the high-end nominal range estimate (varying the power costs parameter at the 4.75 percent discount rate) for Alternative 2 relative to Alternative 1, is computed using the Alternative 2 data from the nominal value column of the 4.75 percent discount rate section from Table 8-1. This calculation (in $1,000s) is made for all parameters except power costs, for which the value in the high-end range estimate column is substituted:

= (1,485,000 + 372,000) – (2,560,000 – 7,000,000 + 0 + 0 + 0)
= ($11,417,000)

The nominal range sensitivity, computed as the absolute difference between the high- and low-end nominal range estimates, provides an estimate of the overall sensitivity of the nominal net benefit to the uncertainty in a particular parameter. For example, at the 4.75 percent discount rate, the nominal net benefit for Alternative 4 relative to Alternative 1 is ($231,923,000). The low- and high-end nominal range estimates for implementation costs are ($16,340,000) and ($18,060,000) so the nominal range sensitivity at the 4.75 percent discount rate is the absolute value of the difference:

= [($16,340,000) – ($18,060,000)]
= $1,720,000

Table 8-1. Point and Range Estimates for NED Costs and Benefits Difference from Alternative 1 (1998 dollars) ($1,000s)

6.875 PERCENT DISCOUNT RATE				
Varied Parameter	**Alternative**	**Nominal Value ($)**	**Low-end Range Estimate ($)**	**High-end Range Estimate ($)**
Implementation Costs	1	–	–	–
	2	3,460	3,280	3,640
	3	(22,880)	(21,740)	(24,020)
	4	(48,790)	(46,350)	(51,230)
Power Costs	1	–	–	–
	2	8,500	10,000	7,000
	3	8,500	10,000	7,000
	4	(271,000)	(251,000)	(291,000)
Avoided Costs	1	–	–	–
	2	–	–	–
	3	(10)	(10)	(10)
	4	33,570	31,890	35,250
Transportation Costs	1	–	–	–
	2	–	–	–
	3	–	–	–
	4	(37,813)	(27,760)	(47,866)
Irrigation & Water System Costs	1	–	–	–
	2	–	–	–
	3	–	–	–
	4	(15,424)	(13,919)	(16,928)
Recreation Benefits	1	–	–	–
	2	1,215	–	–
	3	1,259	–	–
	4	70,524	27,836	275,259
Anadromous Fish Benefits[1/]	1	–	–	–
	2	350	116	162
	3	335	110	(97)
	4	2,218	1,016	2,763

1/ The Anadromous Fish category includes ocean, mainstem, and tributary commercial fishing values, as well as ocean and mainstem recreational fishing values.

Table 8-1. Point and Range Estimates for NED Costs and Benefits Difference from Alternative 1 (1998 dollars) ($1,000s) (continued)

4.75 PERCENT DISCOUNT RATE				
Varied Parameter	**Alternative**	**Nominal Value ($)**	**Low-end Range Estimate ($)**	**High-end Range Estimate ($)**
Implementation Costs	1	–	–	–
	2	2,560	2,430	2,690
	3	(17,200)	(16,340)	(18,060)
	4	(35,490)	(33,720)	(37,260)
Power Costs	1	–	–	–
	2	8,500	10,000	7,000
	3	8,500	10,000	7,000
	4	(267,500)	(247,000)	(288,000)
Avoided Costs	1	–	–	–
	2	–	–	–
	3	(60)	(60)	(60)
	4	33,890	32,190	35,590
Transportation Costs	1	–	–	–
	2	–	–	–
	3	–	–	–
	4	(33,346)	(25,616)	(41,075)
Irrigation & Water System Costs	1	–	–	–
	2	–	–	–
	3	–	–	–
	4	(10,746)	(9,698)	(11,794)
Recreation Benefits	1	–	–	–
	2	1,485	–	–
	3	1,495	–	–
	4	78,381	31,499	199,347
Anadromous Fish Benefits[1/]	1	–	–	–
	2	372	121	200
	3	346	117	(45)
	4	2,887	1,354	3,710

1/ The Anadromous Fish category includes ocean, mainstem, and tributary commercial fishing values, as well as ocean and mainstem recreational fishing values.

Table 8-1. Point and Range Estimates for NED Costs and Benefits Difference from Alternative 1 (1998 dollars) ($1,000s) (continued)

0.0 PERCENT DISCOUNT RATE				
Varied Parameter	**Alternative**	**Nominal Value ($)**	**Low-end Range Estimate ($)**	**High-end Range Estimate ($)**
Implementation Costs	1	–	–	–
	2	660	620	700
	3	(4,930)	(4,690)	(5,170)
	4	(8,350)	(7,940)	(8,760)
Power Costs	1	–	–	–
	2	8,000	9,000	7,000
	3	8,000	9,000	7,000
	4	(263,500)	(241,000)	(286,000)
Avoided Costs	1	–	–	–
	2	–	–	–
	3	(1,520)	(1,450)	(1,610)
	4	33,860	32,170	35,550
Transportation Costs	1	–	–	–
	2	–	–	–
	3	–	–	–
	4	(25,064)	(21,709)	(28,419)
Irrigation & Water System Costs	1	–	–	–
	2	–	–	–
	3	–	–	–
	4	(2,241)	(2,022)	(2,459)
Recreation Benefits	1	–	–	–
	2	805	–	–
	3	673	–	–
	4	101,870	41,769	363,032
Anadromous Fish Benefits[1/]	1	–	–	–
	2	380	123	295
	3	318	127	133
	4	4,982	2,440	6,518

1/ The Anadromous Fish category includes ocean, mainstem, and tributary commercial fishing values, as well as ocean and mainstem recreational fishing values.

Paraphrasing, the estimate of the annual average net benefit of Alternative 4 relative to Alternative 1, at the 4.75 percent discount rate, has a sensitivity range of over $1.7 million due to uncertainty about implementation costs. While this level of uncertainty may seem high, uncertainty about implementation costs creates no uncertainty about the preferred alternative if one accepts the 4.75 percent discount rate, the nominal cost and benefit estimates, and the implementation costs range estimates for Alternative 4 relative to Alternative 1 provided in Table 8-1. At both the high and low ends of the sensitivity range, the annual net benefit of Alternative 1 exceeds the annual net benefit of Alternative 4 by over $25 million. In other words, uncertainty about implementation costs would not change a decision between Alternatives 1 and 4 based on a net benefit criterion. Alternative 1 would be the preferred alternative regardless of the value used for implementation costs.

The average of the high- and low-end nominal range estimates is a useful summary statistic for evaluating whether, given the parameter uncertainties, the point estimate of net benefits (the nominal value) is more likely to overestimate or underestimate the true value. So, looking again at the previous example, the average change for implementation costs at the 4.75 percent discount rate is:

= 0.5*[($18,060,000) – ($17,200,000)] + [($16,340,000) – ($17,200,000)]
= 0.5*[($860,000)+ $860,000]
= ($0)

The value of zero for the average change for implementation costs is an indication that the nominal value for Alternative 4 relative to Alternative 1 at the 4.75 percent discount rate is more likely to underestimate than overestimate the relative net benefit of Alternative 1.

A final statistic computed as part of the nominal range sensitivity analysis is the normalized nominal range sensitivity:

$$\text{Normalized nominal range sensitivity for parameter } i = \frac{\text{nominal range sensitivity for parameter } i}{\sum_{j=1}^{n} \text{nominal range sensitivity for parameter } j} \quad (2)$$

The normalized nominal range sensitivity provides an estimate of the relative sensitivity of relative net benefit to each parameter uncertainty. The normalized nominal range sensitivity falls between zero and one. Parameters with higher normalized nominal range sensitivities create greater uncertainty about relative net benefit than parameters with lower normalized nominal range sensitivities. Because they are relative values, normalized nominal range sensitivities are only comparable across parameters, not across alternatives or discount rates.

8.2.1.2 Qualitative Methods

Each DREW workgroup was asked to write a risk and uncertainty discussion as part of their study report. These sections tended to focus on describing data, methods, and results. Therefore, after reviewing the workgroups' risk and uncertainty discussions, follow-up questioning was conducted to better understand the choices and assumptions used in their analyses, how these affected results, and how they compared across workgroups. The follow-up questioning was necessary to understand the reliability of the overall assessment and important risk management questions, which again are the two basic risk and uncertainty assessment issues identified in the Guidelines (Corps, 1992). Workgroup leaders were asked to review an uncertainty worksheet and questionnaire after the risk and uncertainty workgroup leader interviewed them. The worksheet and questionnaire used by the workgroup leaders to prepare for their interviews with the risk and uncertainty workgroup leader are provided in Figures 8-1 and 8-2. Information gathered through interviews and other follow-up discussions with workgroup leaders was used to help interpret the results of the NRSA. The results presented below are based on the qualitative and quantitative data obtained by these methods.

Figure 8-1. Risk and Uncertainty Worksheet

This worksheet breaks out seven specific types of uncertainty. Please identify three to five uncertainties of each type that have the biggest potential impact on your workgroup's results and conclusions. The worksheet is intended to make it easier to respond to the questionnaire, so please complete the worksheet before starting the questionnaire. Thank you.

1. *Incomplete information*—missing data; also could include concerns about the representativeness of the available data.
2. *Natural variability*—conditions that change over time, vary among individuals, or change with location.
3. *Model structural uncertainty*—uncertainties about the correct way to describe something in a model, or approximation errors, due to the fact that models are just models, not perfect representations of the real world.
4. *Missing variables*—things not considered simply because we do not know about them, or enough about them, to include them in the analysis.
5. *Lack of understanding*—inability to fully understand available data and models.
6. *Disagreement*—legitimate differences of opinion about priorities or values that in turn affect the system being assessed or the questions we are trying to answer about it.
7. *Ambiguity*—sloppiness or imprecision in defining objectives, variables, assumptions, or decision criteria.

Figure 8-2. Risk and Uncertainty Questionnaire

- How reliable, representative, and complete were your data?
- What nagging concerns do you have about your data?
- How did you decide on the methods you adopted?
- What alternative methods might you have used?
- What nagging concerns do you have about your methods?
- How did you choose the models you used?
- What other models might you have used instead?
- What nagging concerns do you have about your models?
- What key assumptions did you make in your analysis?
- Why did you make these assumptions?
- What information would have been most useful to help you refine your assumptions?
- If you could change any of your assumptions, what would they be and why?
- If you generated scenarios, how extreme are your high and low scenarios?
- What is the most realistic scenario you can think of that would give results outside the range of scenarios you used? How likely is it?
- What is the most realistic scenario you can think of that would change your ranking of alternatives? How likely is it?
- In your opinion, what are the most important unanswered questions about your workgroup's piece of the project?
- If you had it to do over again, what would you do differently and why?

8.2.2 Social and Regional Analysis

The DREW Regional Analysis Workgroup reported that uncertainty is present in the regional economic impact analysis because of uncertainties in inputs received from other workgroups and uncertainties used to drive the models. The DREW Regional Analysis Workgroup was unable to engage in a meaningful risk and uncertainty assessment, beyond simply documenting the major omissions that are known to exist. Similarly, the methodology for assessing social risks and uncertainties was limited to documenting major sources of uncertainty. These concerns are discussed further in Section 8.5.2.

8.2.3 Tribal Circumstances

The methods used to develop the Tribal Circumstances report developed by a private contractor in association with the Columbia River Inter Tribal Fisheries Commission (Meyer Resources, 1999) differed from those described above. The Meyer Resources report (1999) examined tribal levels of cultural and material well being and distress. The report also evaluated risk and uncertainty separately, whereas the DREW workgroups combined the two related concepts.

The Tribal Circumstances uncertainty assessment focused on the reliability of the ordinal ranking of the proposed alternatives presented in the Tribal Circumstances report. This ranking was based on the estimated relative magnitude of salmon recovered for the tribes, as well as the direction and general effect of the estimated relative magnitude of salmon recovery on tribal culture, rates of death and health, poverty, employment/unemployment, and income. The study presented in the Tribal Circumstances report also evaluated the reliability of the ordinal ranking of alternatives based on duration of near-current levels of tribal pain and suffering.

The Tribal Circumstances risk assessment focused on the consequences of possible errors in PATH estimates on tribal levels of cultural and material well being and distress. This assessment evaluated the consequences of over-estimation and under-estimation errors to determine whether tribal levels of cultural and material well being and distress would increase or decrease, and whether they might undergo qualitative changes instead of just changes in degree (specifically, a change from pain and suffering to extinction). The Tribal Circumstances report also provided narrative assessments of two types of tribal risks:

- from delays in implementing measures affecting salmon recovery
- if tribal interests are ignored or marginalized in the process of implementing measures affecting salmon recovery.

8.3 Biological Evaluation

The evaluation of the biological output resulting from proposed actions is a critical step in determining the relative cost effectiveness of each alternative. The primary source about biological effectiveness for this study came from PATH. PATH is a formal and rigorous program of formulating and testing hypotheses by using a series of model simulations to estimate both past and future trends in fish abundance for each of the selected stocks. However, the assessment of biological effectiveness has continued to evolve during the course of the study as new information and hypotheses about salmon behavior have been tested and revised. The following sections describe the PATH modeling process and results, with a focus on the risk and uncertainty inherent in the model results.

8.3.1 Definition of Jeopardy Standards

The primary objective of PATH's modeling was to evaluate how to best enhance the survival and recovery opportunities of the affected ESUs by considering the probability of the stock's response to the jeopardy standards, which were defined by the Biological Requirements Working Group (BRWG) and largely accepted by NMFS (Peters et al., 1999).

The jeopardy standards include both survival and recovery goals as defined below:

- Survival standards (which set the threshold for survival) are based on projected probabilities that the spawning abundance will exceed a pre-defined survival threshold over a 24- or 100-year simulation period. Survival standards are met when that probability is 70 percent or greater.
- Recovery standards (which are required to consider de-listing of the species) are based on probabilities of exceeding a recovery threshold in the last 8 years of a 48-year simulation period. This standard is met when the probability is 50 percent or greater (PATH memo to IT team).

8.3.2 PATH Modeling Process[1]

PATH developed a prospective aggregate hypothesis based upon Monte-Carlo simulations of particular combinations of hypotheses for twelve specific uncertainties, including:

- Passage assumptions—uncertainty in direct survival of in-river fish, and the partitioning of in-river survival between dam and reservoir survival.
- Fish guidance efficiency (FGE)—uncertainty in the effectiveness of extended-length screens in diverting fish away from the turbines, relative to standard-length screens.
- Turbine/Bypass mortality—uncertainty in historical estimates of bypass and turbine mortality for some projects prior to 1980.
- Predator removal effectiveness—uncertainty in the effect of the predator removal program (i.e., removal of squawfish for bounties) on survival of salmon smolts in reservoirs.
- Transportation assumptions—uncertainty in the relative survival of transported and non-transported fish after the fish have exited the migration corridor (i.e., below Bonneville Dam).
- Stock productivity—uncertainty in the extent to which Snake River and lower Columbia stocks share common mortality effects.
- Extra mortality—uncertainty in the mortality of both transported and non-transported fish occurring beyond Bonneville Dam.
- Future climate—uncertainty in future patterns in climatic conditions.
- Habitat effects—uncertainty in the biological effects of future habitat management actions.
- Length of pre-removal period—the duration of time between a decision to proceed with dam breaching and actual removal of dams (pre-removal period) due to uncertainty in the Congressional appropriations process and the possibility of litigation.

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[1] Source: Summary of the PATH (Plan for Analyzing and Testing Hypotheses) Preliminary Decision Analysis Report on Spring and Summer Chinook (Review Draft - Preliminary Results Subject to Change) by Jim Geiselman, Fish and Wildlife Group, Bonneville Power Administration, March 1998.

- Length of transition period—duration of period between completion of dam removal and establishment of equilibrium conditions in the drawndown section of the river (transition period), reflecting uncertainty in the physical and biological responses to drawdown (e.g., short-term response of predators, release of sediment).
- Juvenile survival rate once river has reached equilibrium conditions after drawdown—uncertainty in the long-term physical and ecological effects of dam breaching (e.g., change in density of predators).

Each prospective aggregate hypothesis potentially yielded a unique biological response to an action. The combinations of all possible hypotheses under each uncertainty resulted in 5,148 different aggregate hypotheses in this preliminary analysis. One of the objectives was to determine which uncertainties have the most effects on performance measures and the resulting decision so attention could be focused on the most critical alternative hypotheses.

8.3.3 PATH 1998 Model Results

Data from the 1998 PATH analysis are used for a number of parts of this appendix for the Lower Snake River Juvenile Salmon Migration Feasibility Study. The summary results are also reported in this section.

8.3.3.1 Spring/Summer Chinook 1998 Model Results

Table 8-3 presents the net probability of Alternatives 2 through 4 [net of Alternative 1 —Existing Conditions (base case)] meeting the NMFS 24-year and 100-year survival standards and the 48-year recovery standards for spring/summer chinook using data from the 1998 PATH model results, as reported by NMFS. This table presents the median modeling results, which are considered the most likely outcome, as well as the 25th and 75th percentile model results, which bound the median result with a range from low to high outcomes.

24-year Survival Standard for Spring/Summer Chinook

Using the 1998 PATH model results, only Alternative 4—Dam Breaching provides a greater estimated probability of meeting the 24-year survival standard than Alternative 1—Existing Conditions (base case). Alternative 4 has a 2 percent positive margin over the base case at the median, an 8 percent positive margin at the low end and a 1 percent positive margin at the high end of the range.

48-year Recovery Standard for Spring/Summer Chinook

Using the 1998 PATH model results, Alternative 4—Dam Breaching provides a significantly greater estimated probability of meeting the 48-year recovery standard than Alternative 1—Existing Conditions (base case) (36 percent positive margin over the base case at the median, 43 percent positive margin at the low end, and a 27 percent positive margin at the high end). Alternative 2—Maximum Transport of Juvenile Salmon has a lower probability for the median and low end estimates [(3 percent) and (2 percent) respectively)] but a 1 percent higher probability at the high end. Alternative 3—Major System Improvements is slightly lower at the median (1 percent) but equal at the low and high ends.

Table 8-2. Net Probability of Attaining NMFS Jeopardy Standards for Spring/Summer Chinook Using Unweighted 1998 Model Results Relative to Base Case

Action	24-year Survival		
	Median (%)	25th percentile (%)	75th percentile (%)
Alternative 1—Existing Conditions	0.0	0.0	0.0
Alternative 2—Maximum Transport of Juvenile Salmon	(2.0)	(1.0)	0.0
Alternative 3—Major System Improvements	(1.0)	0.0	0.0
Alternative 4—Dam Breaching	2.0	8.0	1.0
	48-year Recovery		
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1—Existing Conditions	0.0	0.0	0.0
Alternative 2—Maximum Transport of Juvenile Salmon	(3.0)	(2.0)	1.0
Alternative 3—Major System Improvements	(2.0)	0.0	2.0
Alternative 4—Dam Breaching	36.0	43.0	27.0
	100-year Survival		
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1—Existing Conditions	0.0	0.0	0.0
Alternative 2—Maximum Transport of Juvenile Salmon	(1.0)	(3.0)	0.0
Alternative 3—Major System Improvements	0.0	(1.0)	0.0
Alternative 4—Dam Breaching	10.0	17.0	5.0

Source: Personal communication from NMFS

Table 8-3. Net Probability of Attaining NMFS Jeopardy Standards for Fall Chinook Using Unweighted 1998 Model Results Relative to Base Case

Action	24-year Survival		
	Median (%)	25th percentile (%)	75th percentile (%)
Alternative 1—Existing Conditions	0.0	0.0	0.0
Alternative 2—Maximum Transport of Juvenile Salmon	0.0	0.0	0.0
Alternative 3—Major System Improvements	(4.0)	(9.0)	(2.0)
Alternative 4—Dam Breaching	8.0	11.0	1.0
	48-year Recovery		
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1—Existing Conditions	0.0	0.0	0.0
Alternative 2—Maximum Transport of Juvenile Salmon	0.0	0.0	0.0
Alternative 3—Major System Improvements	6.0	2.0	7.0
Alternative 4—Dam Breaching	78.0	85.0	44.0
	100-year Survival		
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1—Existing Conditions	0.0	0.0	0.0
Alternative 2—Maximum Transport of Juvenile Salmon	0.0	0.0	0.0
Alternative 3—Major System Improvements	(5.0)	(7.0)	(3.0)
Alternative 4—Dam Breaching	15.0	26.0	2.0

Source: Personal communication from NMFS

100-year Survival Standard for Spring/Summer Chinook

Using the 1998 PATH model results, only Alternative 4—Dam Breaching provides a greater estimated probability of meeting the 100-year survival standard than Alternative 1 —Existing Conditions (base case). Alternative 4—Dam Breaching has a 10 percent positive margin over the base case at the median, 17 percent positive margin at the low end, and a 5 percent positive margin at the high end.

8.3.3.2 Fall Chinook Model Results

Table 8-4 presents the net probability of Alternatives 2 through 4 [net of Alternative 1 —Existing Conditions (base case)] meeting the NMFS 24-year and 100-year survival standards and the 48-year recovery standards for fall chinook using data from the 1998 PATH model results, as reported by NMFS. This table presents the median modeling results, which are considered the most likely outcome, as well as the 25th and 75th percentile model results, which bound the median result with a range from low to high outcomes.

24-year Survival Standard for Fall Chinook

Using the 1998 PATH model results, only Alternative 4—Dam Breaching provides a greater estimated probability of meeting the 24-year survival standard than Alternative 1 —Existing Conditions (base case). Alternative 4 has an 8 percent positive margin over the base case at the median, an 11 percent positive margin at the low and a 1 percent positive margin at the high end. The model results for Alternative 2 are the same as Alternative 1, for all three of the standards. Alternative 3—Major Systems Improvements has a lower probability of meeting the standards throughout the range.

48-year Recovery Standard for Fall Chinook

Using the 1998 PATH model results, Alternative 4—Dam Breaching provides a significantly greater estimated probability of meeting the 48-year recovery standard than Alternative 1—Existing Conditions (base case) (78 percent positive margin over the base case at the median, an 85 percent positive margin at the low and a 44 percent positive margin at the high end). Alternative 3 is slightly higher across the range (2 to 7 percent higher than Alternative 1).

100-year Survival Standard for Fall Chinook

Using the 1998 PATH model results, only Alternative 4—Dam Breaching provides a greater estimated probability of meeting the 100-year survival standard than Alternative 1—Existing Conditions (base case). Alternative 4 has a 15 percent positive margin over the base case at the median, a 26 percent positive margin at the low, and a 2 percent positive margin at the high end.

8.3.4 PATH 1999 Model Results

PATH results evolved during the course of the study based upon input from the technical review committee for statistically valid methodology (i.e., also known as the Scientific Review Panel [SRP]). The SRP was tasked to perform an interim review for fall chinook salmon in 1999, which identified inconsistencies in the model results. In response to the critique by SRP, they revisited the spring/summer chinook salmon evaluations, especially with respect to the differential delayed mortality (the D value) suggested by PATH attributable to smolt transport or latent hydro system passage effects. PATH did not complete the requested full list of critical uncertainties for which SRP was interested, such as those addressing drawdown (hard-wiring lower Snake River reach survivals at 85 to 96 percent, habitat restoration effects, among others).

A full model analysis was not performed for 1999, but rather a few sensitivity analysis producing adjusted probabilities for achieving NMFS survival and recovery criteria. These adjusted probabilities indicate that the number of adult spawners produced by the dam retention alternatives would increase and the differential between meeting survival and recovery probabilities; hence, the number of adult spawners between the dam retention and the dam breaching alternatives would decrease. The primary difference between 1998 and 1999 return trajectories would likely be the time in which the equilibrated carrying capacity for the population is reached, per alternative.

The conclusions and recommendations from the PATH weight of evidence workshop quantified the relative degree of belief in the seven key uncertainties that have the greatest effect on the outcomes of management actions. The seven key uncertainties include the following:

- passage and transportation assumptions (uncertainty in direct survival of in-river fish, the partitioning of in-river survival between dam and reservoir survival, and survival of transported versus non-transported fish after they have exited the migration corridor)
- extra mortality outside of the juvenile migration corridor that is not accounted for by productivity parameters in spawner/recruit relationships, by estimates of direct mortality in the migration corridor, or common year effects affecting both Snake River and lower Columbia River Stocks (delta model only)
- uncertainty in the extent to which Snake River and lower Columbia share common mortality effects
- length of the transition period between removal of dams and establishment of equilibrium in the drawndown section of the Snake River (reflecting uncertainty in physical and biological responses to drawdown)
- uncertainties in historical estimates of bypass and turbine mortality
- uncertainty in the effect of the predator removal program (i.e., squawfish bounties) on future survival of salmon smolts in reservoirs
- uncertainty of juvenile survival rate once equilibrium conditions have been reached.

Alternative hypotheses for each of these seven uncertainties were identified, and expert elicitation was used to determine belief in the hypothesis used versus the alternatives. Weighted averages were derived by four different experts for each hypothesis under each of the seven uncertainties. These weights were used to determine weighted averages for 24-year survival, 100-year survival, and 48-year recovery standards. The weighted averages show what the most likely outcomes of the actions will be, given uncertainties that affect future projections.

PATH probabilities for achieving 24-year, 48-year, and 100-year escapement levels for survival and recovery were generally used as fixed point values in the NED analysis. The PATH numbers were generated using monte carlo simulations that established distribution ranges for the returning salmon stocks. The NED analysis did not use these distribution ranges but instead used fixed point estimates from the ranges. This represents a significant uncertainty that was not accounted for in the NED analysis. Using a point estimate could significantly overestimate or underestimate the salmon population.

The SRP also considered whether there were any new hypotheses that should be included in the PATH models. One hypothesis that the SRP thought worth evaluating was that hatchery fish might affect the survival of wild fish. This hypothesis was believed to have significant results on survival. The implementation of this hypothesis was not considered feasible because:

- hatchery effects are confounded with development of the hydrosystem
- distinction between the hatchery hypothesis and other mortality hypotheses is not clear
- responses of different actions under this hypothesis are not clear.

The SRP also noted that in some cases the evidence for evaluating alternative hypotheses was poor or lacking. Because of this, the SRP recommended taking actions that 1) result in the best chance at survival and recovery of stocks, and 2) generate information to reduce uncertainties and improve future decision-making. Significant increases in mortality have the potential to change the rankings of the Alternatives 1, 2, and 4.

The SRP reviewed the PATH preliminary decision analysis report on Snake River spring/summer chinook. They concluded that uncertainties were extensively considered within the constraints imposed by bounding the system between the nursery habitat and above Bonneville. The SRP found, however, that there was not a consensus on the assumptions or analyses that precede the quantitative evaluation of uncertainty. Therefore, there is some uncertainty about the results of the 1998 PATH models. The SRP suggested designing and conducting a management experiment to resolve uncertainty. The SRP also believes that the role of uncertainty in the identification of models for spring and summer chinook salmon, and in the application of these models to prediction of management alternatives, may be underestimated. The SRP identified four problem areas for these models:

- uncertainty about the model structure
- uncertainty in the estimated model parameters
- propagation of model prediction errors
- design of experiments in order to reduce the critical uncertainties associated with the models.

The SRP felt that progress had been made on each of these problems, but that additional progress was needed, especially in the first two problem areas identified above. The SRP also felt that the three alternative hydrosystem actions (1, 2, and 4) may have been too narrowly defined and other alternatives or modeling approaches should have been evaluated at the beginning, rather than just focusing on uncertainty in the current models and alternatives. The SRP also suggested that an adaptive management approach could be used to resolve some of the remaining uncertainties. An adaptive management approach would involve systematically varying management options while carefully monitoring biological, economic, and social consequences of actions, in an attempt to reduce uncertainty and apply new information to the quantitative models.

The SRP also provided comments on the PATH final report for fiscal year 1998, some of which were relevant to uncertainties in the modeling. The SRP suggested that some of the uncertainties in the models could be evaluated more thoroughly using sensitivity analysis especially for 1) predator modeling (particularly the importance of temperature fluctuations), 2) evaluation of hatchery supplementation assumptions (including the hypothesis that hatcheries diminish returns), and 3) turbine mortality. The SRP suggested that PATH could calculate the expected value of perfect information for key uncertainties. These calculations would suggest how much it is worth to resolve key uncertainties. The SRP also suggested that PATH could extend the prospective models to stimulate the collection of new data and thereby the rate of learning about uncertain hypotheses. Alternative methods were suggested for incorporating uncertainty into the models, such as interval analysis and fuzzy arithmetic.

PATH made different assumptions about the current salmon population than the anadromous fish benefits group. PATH assumed that the current salmon populations have reached a steady state and based future predictions on this assumption. In contrast, the anadromous fish benefits group assumed that salmon populations are currently in a declining state, and based its predictions for the no-action alternative accordingly.

Changes in the PATH results will directly affect estimates under different alternatives for commercial and recreational fishing, regional and social analysis, tribal circumstances, and recreation use benefits. Likewise, estimates of passive use benefits would be affected by changes in PATH results. Uncertainties in each of these areas are multiplied by uncertainties in the PATH analysis; therefore changes in the PATH analysis can potentially change the ranking of alternatives. PATH has recently (November 1999) revised its estimates, but the economic studies presented in this document were developed using its previous estimates. This is a significant source of uncertainty in the NED analysis and may affect the ranking of alternatives.

These modifications affected model results for fall chinook. According to Peters et al. (1999):

- “All hydro system actions meet survival standards (probabilities of exceeding survival escapement thresholds are greater than 0.7), regardless of what is assumed about the estuary/ocean survival rate of transported fish.
- All drawdown actions meet recovery standards (probabilities of exceeding recovery escapement thresholds are greater than 0.5) regardless of what is assumed about the estuary/ocean survival rate of transported fish. Alternative 4—Dam Breaching, exhibited the most robust response across those uncertainties considered to date, and produced higher recovery probabilities (as well as higher average spawning escapements) than other actions. This conclusion is sensitive to assumptions about adult upstream survival.
- For each hypothesis about relative survival of transported fish, there is a non-breaching action (actions which do not involve drawdowns of dams) that meets the recovery standard, although there is no single non-breaching alternative option that meets recovery standards under all assumptions about the relative survival of transported fish. If transported fish are assumed to have high relative survival (i.e., high D), maximizing transportation will achieve recovery standards. If transported fish are assumed to have low relative survival (i.e., low D), then retaining current system configuration and allowing all smolts to migrate in-river achieves the recovery standards. Non-breaching actions are not as robust to the current level of uncertainty in relative survival of transported fish as are drawdown actions.”

8.3.5 Cumulative Risk Initiative Model Results

The Cumulative Risk Initiative (CRI) modeling performed by NMFS supports the adjusted results derived from PATH's 1999 sensitivity analyses. CRI used the same PATH run reconstruction data for wild fish, constrained the analyses time series to the period between 1980 to the most recent (1999) adult spawner return data. NMFS believes this time period to be the most representative of the hydro system configuration, as it presently exists. CRI does not estimate probability of survival and recovery, but calculates an estimated risk of extinction (for which PATH did not calculate) and annual population growth (production) rates (lambda). NMFS then estimates how much increase in lambda has to occur to reduce risk of extinction (or the inverse of survival and recovery) to an acceptable rate conducive for recovery. Although CRI did not specifically estimate returns due to dam breaching, CRI is consistent in showing that PATH estimates of returning adults are optimistic. CRI indicates that very little improvement in manipulating the hydro system dams with additional structural improvements is possible; hence, dam breaching would likely have a slight edge over the dam retention Alternatives 1 through 3 in reaching survival and production of additional adult spawners. CRI shows that best chance for marked improvements in year 1 (habitat) conditioning and growth of presmolts to produce large healthy individual smolts and passage through the Columbia River estuary (again related to smolt growth rate, size, and fitness).

8.4 Results and Conclusions

8.4.1 Net NED Costs/Benefits

Table 8-4 presents the results of the NRSA results. In general, Alternative 2 provides positive net benefits relative to Alternative 1. None of the uncertainties reported by the workgroups changed this finding.

Looking at the normalized nominal range sensitivity, it can be seen that the greatest contributor to uncertainty about Alternative 2 is power cost uncertainty (88 percent)[2] followed by implementation cost uncertainty (11 percent).

The greatest contributor to uncertainty about Alternative 3 is power cost uncertainty (55 percent) followed by implementation cost uncertainty (42 percent).

Looking at the 6.875 percent discount rate in Table 8-4, it can be seen that recreational benefits account for approximately 77 percent of the normalized nominal range sensitivity for Alternative 4 versus Alternative 1, followed by power cost uncertainty (12 percent). Power costs do not affect the ranking of alternatives unless the low end nominal range estimate is used with a 0.0 percent discount rate. The power costs risk and uncertainty is important because a) it is large relative to the other cost uncertainties, and b) as the following paragraph discusses, it is considered by the hydropower workgroup (elsewhere referred to as the DREW Hydropower Impact Team [DREW HIT]) to be a reliable risk and uncertainty estimate. Because the power risk and uncertainty is large relative to other cost uncertainties and is reliable (i.e., the risk and uncertainty estimate is unlikely to change), it serves to dampen any effects of possible changes in other cost range estimates. Other cost uncertainties are less important because they are small relative to the reliable power cost uncertainty estimates. There is only a limited chance that the power cost estimates would decrease because the

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[2] The percentages changed slightly between the Draft and Final FR/EIS as a result of changes in the NED costs and benefits.

power cost risk and uncertainty are reliable. Therefore, other parameters would need to increase greatly before they became important in the ranking of alternatives. Moreover, the power cost uncertainty does not affect the ranking of alternatives, so the other cost uncertainties are even less likely to do so. Therefore, the real driver in this analysis is the uncertainty about benefits. Following the discussion of the hydropower workgroup's NED analysis, the remainder of this section focuses on benefit uncertainty.

The hydropower workgroup reports that the data they used had a fairly high degree of reliability. Because they were forecasting future conditions, the most up-to-date data may have confirmed or slightly changed the forecasted values. Members of the workgroup had knowledge of recent data, however, and did not suggest any revisions in forecasts. The workgroup used a high-medium-low forecast for each key variable, and is confident that this covered likely future conditions. Of most importance in the workgroup's forecasts was the water supply available for power generation. They used two different hydro-regulation models to define this parameter, with actual historic water conditions over 60 years providing the model input data. The workgroup was not confident that their ancillary benefit estimates were based on the best data, but this element only made up 3 percent of the economic effects associated with dam removal. The hydropower workgroup used the three available power system models, from the Corps, BPA, and the NPPC. After examining many possible approaches, the workgroup agreed that a comparison of results from these three models would capture all the members' concerns about risk and uncertainty in the power systems component of their analysis. Any concerns the workgroup had were somewhat overcome once the members compared the results of the power system models. The workgroup found the results to be surprisingly close, so the results of any one model were confirmed by the others.

The hydropower workgroup identified three major assumptions in its analysis: zero price elasticity of electricity demand, the projected natural gas prices on the West Coast, and the projected demand for power (load forecasts). The zero price elasticity assumption does not account for the probable reduction in demand for electricity that will occur if electricity prices increase with the implementation of the Alternative 4. There is significant evidence that there is price elasticity for electricity at both the wholesale and retail level, but it was considered beyond the scope of the hydropower workgroup's analysis to estimate elasticity for each consumer type. The possible significance of this simplifying assumption can be qualified by looking at the examination of demand elasticity for electricity that was done in the Columbia River System Operation Review (SOR) on a cursory basis. The SOR evaluated economic effects of changes in hydropower generation in the Columbia River Basin using approaches similar to those used in this study. The SOR also looked at the economic effects using a price elasticity approach for the different consumer types. The SOR found that once price elasticity was accounted for, the economic effects of losses in hydropower were about 11 percent lower than with the analysis that ignored price elasticity. Though this finding is not directly applicable to the Snake River breaching analysis, it can be used to give a general feeling for the impact of not including price elasticity.

The price and demand assumptions used are well documented in the hydropower workgroup's report. The workgroup chose to use the forecasts of gas prices and loads developed by the NPPC in recent studies. The NPPC studies were done in a very open public forum and many experts had a chance to review, comment, and revise these forecasts. The workgroup felt that a major change in the natural gas supply would have a significant impact on costs, but while an interruption in natural gas supplies could happen, the work group believes the impacts would likely be short-lived. In the long run, repairs or market shifts would return the gas supply and prices within the workgroup's forecasted range. The workgroup reported that a major economic depression would push load forecasts outside the forecasted ranges.

The most important results of the risk and uncertainty assessment are for comparisons of Alternative 4—Dam Breaching to any of the non-breaching alternatives. Specifically, the analysis shows that the ranking of Alternative 4 is highly sensitive to uncertainty about power and recreation. The low-end and high-end range estimates presented in Table 8-4 may be confusing in that the high-end nominal range estimate is in some cases lower than the nominal value or low-end nominal range estimate. The reason for this is that the values reported are differences between the specified alternative and Alternative 1—Existing Conditions, rather than absolute ranges for Alternatives 2, 3, and 4. For the Alternative 4 to Alternative 1 comparison, the nominal range sensitivity to uncertainty about recreational benefits ranges from $247,423,000 at a 6.875 percent discount rate to $321,263,000 at a 0.0 percent discount rate (difference between the average annual net benefit of Alternative 4 and Alternative 1). The nominal range sensitivities for recreation benefits are relatively high, but the ranking of alternatives does not change if the discount rate is 4.75 percent or 6.875 percent. Looking again at Table 8-4, it can be seen that using either the low-end or high-end nominal range estimates, the ranking is Alternative 2, Alternative 1, Alternative 3, and Alternative 4 for the 6.875 percent and 4.75 percent discount rates. However, using a discount rate of 0.0 percent, the ranking does change between the low-end and high-end nominal range estimates. At the low-end, the ranking is Alternative 2, Alternative 1, Alternative 3, and Alternative 4, however, the ranking switches to Alternative 4, Alternative 2, Alternative 3, and Alternative 1 at the high-end. In other words, whether breaching the four lower Snake River dams will give a positive or negative net NED benefit is unknown at the 0.0 percent discount rate, because of the current level of uncertainty about the value of recreational benefits. However, there is no uncertainty about ranking using a 6.875 percent or 4.75 percent discount rate.

Even though the question of whether to breach the four lower Snake River dams is somewhat sensitive to uncertainty about recreational benefits, the NRSA probably underestimates the recreational benefits uncertainty because it does not account for uncertainty in PATH estimates. The recreational benefits estimate is based on a point estimate of the size of the recreational fishery that would be available if the four lower Snake River dams were breached. Current PATH results predict a high level of unfulfilled recreational fishing demand (on the order of 95 percent of demand unfulfilled) indicating that the recreational fishing benefit is likely sensitive to the PATH estimate.

The interview with the DREW Recreation Workgroup revealed two others factors that would tend to increase the average annual net benefits of Alternative 4 relative to Alternative 1. First, the recreation benefits report characterizes the estimates of California visitation as conservative (low). Although the degree of conservatism has not been quantified, any increase would increase the average annual net benefits of Alternative 4 relative to Alternative 1. California households make up about 70 percent of the study region's population. Second, the analysis has not accounted for the short-term value of observing natural recovery of the lower Snake River if the dams are breached.

There is a great deal of uncertainty in the recreational benefits of Alternatives 1, 2, 3, and 4 that is not reflected in the NED analysis. Uncertainties about the best methods for estimating these values are represented, but uncertainties within the methods themselves are not. General reservoir recreation benefits represent 60 percent of the recreational benefits of non-dam breaching alternatives (1, 2, and 3) and the confidence intervals are large ($47 to $148 a trip), indicating a

Table 8-4. Nominal Range Sensitivity Analysis of Net Benefit Difference from Alternative 1 ($1,000s and percent) Page 1 of 3

Varied Parameter	Alternative	Nominal Value ($)	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	Change (Low) (%)	Change (High) (%)	Change (Low) ($)	Change (High) ($)	Nominal Range Sensitivity ($)	Average Change ($)	Normalized Nominal Range Sensitivity (%)
6.875 PERCENT DISCOUNT RATE											
Implementation Costs	2	13,525	13,345	13,705	(1)	1	(180)	180	360		11
	3	(12,795)	(11,646)	(13,926)	9	(9)	1,140	(1,140)	2,280		42
	4	(266,716)	(264,274)	(269154)	1	(1)	2,440	(2,440)	4,880	—	2
Power Costs	2	13,525	15,025	12,025	11	(11)	1,500	(1,500)	3,000	—	88
	3	(12,795)	(11,286)	(14,286)	12	(12)	1,500	(1,500)	3,000	—	55
	4	(266,716)	(246,714)	(286,714)	7	(7)	20,000	(20,000)	40,000	—	12
Avoided Costs	2	13,525	13,525	13,525	0	0	—	—	—	—	0
	3	(12,795)	(12,795)	(12,795)	0	0	—	—	—	—	0
	4	(266,716)	(268,394)	(265,034)	(1)	1	(1,680)	1,680	3,360	—	1
Transportation Costs	2	13,525	13,525	13,525	0	0	—	—	—	—	0
	3	(12,795)	(12,795)	(12,795)	0	0	—	—	—	—	0
	4	(266,716)	(256,661)	(276,767)	4	(4)	10,053	(10,053)	20,106	—	6
Irrigation & Water System Costs	2	13,525	13,525	13,525	0	0	—	—	—	—	0
	3	(12,795)	(12,795)	(12,795)	0	0	—		—	—	0
	4	(266,716)	(265,210)	(268,219)	1	(1)	1,505	(1,505)	3,009	—	1
Recreation Benefits	2	13,525	12,310	12,310	(9)	(9)	(1,215)	(1,215)	—	(1,215)	0
	3	(12,795)	(14,045)	(14,045)	(10)	(10)	(1,259)	(1,259)	—	(1,259)	0
	4	(266,716)	(309,402)	(61,979)	(16)	77	(42,688)	204,735	247,423	81,024	77
Anadromous Fish Benefits	2	13,525	13,291	13,337	(2)	(1)	(234)	(189)	46	(211)	1
	3	(12,795)	(13,011)	(13,218)	(2)	(3)	(225)	(432)	207	(329)	4
	4	(266,716)	(267,917)	(266,170)	0	0	(1,203)	545	1,747	(329)	1

Table 8-4. Nominal Range Sensitivity Analysis of Net Benefit Difference from Alternative 1 ($1,000s and percent) Page 2 of 3

4.75 PERCENT DISCOUNT RATE

Varied Parameter	Alternative	Nominal Value ($)	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	Change (Low) (%)	Change (High) (%)	Change (Low) ($)	Change (High) ($)	Nominal Range Sensitivity ($)	Average Change ($)	Normalized Nominal Range Sensitivity (%)
Implementation Costs	2	12,618	12,787	13,047	(1)	1	(130)	130	260	—	8
	3	(6,919)	(5,999)	(7,719)	13	(13)	860	(860)	1,720	—	35
	4	(231,923)	(230,153)	(233,693)	1	(1)	1,770	(1,770)	3,540	—	2
Power Costs	2	12,618	14,417	11,417	12	(12)	1,500	(1,500)	3,000	—	90
	3	(6,919)	(5,359)	(8,359)	22	(22)	1,500	(1,500)	3,000	—	61
	4	(231,923)	(211,423)	(252,423)	9	(9)	20,500	(20,500)	41,000	—	17
Avoided Costs	2	12,618	12,618	12,618	0	0	—	—	—	—	0
	3	(6,919)	(6,919)	(6,919)	0	0	—	—	—	—	0
	4	(231,923)	(233,623)	(230,223)	(1)	1	(1,700)	1,700	3,400	—	1
Transportation Costs	2	12,618	12,618	12,618	0	0	—	—	—	—	0
	3	(6,919)	(6,919)	(6,919)	0	0	—	—	—	—	0
	4	(231,923)	(224,194)	(239,653)	3	(3)	7,730	(7,730)	15,459	—	7
Irrigation and Water System Costs	2	12,618	12,618	12,618	0	0	—	—	—	—	0
	3	(6,919)	(6,919)	(6,919)	0	0	—	—	—	—	0
	4	(231,923)	(230,875)	(232,971)	0	0	1,048	(1,048)	2,096	—	1
Recreation Benefits	2	12,618	11,432	11,432	(11)	(11)	(1,485)	(1,485)	—	(1,485)	0
	3	(6,919)	(8,354)	(8,354)	(22)	(22)	(1,495)	(1,495)	—	(1,495)	0
	4	(231,923)	(278,805)	(110,958)	(20)	52	(46,882)	120,966	167,848	37,042	71
Anadromous Fish Benefits	2	12,618	12,666	12,745	(2)	(1)	(251)	(172)	79	(212)	2
	3	(6,919)	(7,088)	(7,250)	(3)	(6)	(228)	(391)	162	(310)	3
	4	(231,923)	(233,456)	(231,101)	(1)	0	(1,533)	822	2,355	(355)	1

Table 8-4. Nominal Range Sensitivity Analysis of Net Benefit Difference from Alternative 1 ($1,000s and percent)

0.0 PERCENT DISCOUNT RATE

Varied Parameter	Alternative	Nominal Value ($)	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	Change (Low) (%)	Change (High) (%)	Change (Low) ($)	Change (High) ($)	Nominal Range Sensitivity ($)	Average Change ($)	Normalized Nominal Range Sensitivity (%)
Implementation Costs	2	9,845	9,805	9,885	0	0	(40)	40	80	—	4
	3	2,541	2,781	2,301	9	(9)	240	(240)	480	—	19
	4	(158,443)	(158,033)	(158,853)	0	0	410	(410)	820	—	0
Power Costs	2	9,845	10,845	8,845	10	(10)	1,000	(1,000)	2,000	—	89
	3	2,541	3,541	1,541	39	(39)	1,000	(1,000)	2,000	—	80
	4	(158,443)	(135,943)	(180,943)	14	(14)	22,500	(22,500)	45,000	—	12
Avoided Costs	2	9,845	9,845	9,845	0	0	—	—	—	—	0
	3	2,541	2,541	2,541	0	0	—	—	—	—	0
	4	(158,443)	(160,133)	(156,753)	(1)	1	(1,690)	1,690	3,380	—	1
Transportation Costs	2	9,845	9,845	9,845	0	0	—	—	—	—	0
	3	2,541	2,541	2,541	0	0	—	—	—	—	0
	4	(158,443)	(155,088)	(161,798)	2	(2)	3,355	(3,355)	6,710	—	2
Irrigation and Water System Costs	2	9,845	9,845	9,845	0	0	—	—	—	—	0
	3	2,541	2,541	2,541	0	0	—	—	—	—	0
	4	(158,443)	(158,224)	(158,661)	0	0	219	(219)	437	—	0
Recreation Benefits	2	9,845	9,040	9,040	(8)	(8)	(805)	(805)	—	(805)	0
	3f	2,541	1,868	1,868	(36)	(36)	(673)	(673)	—	(673)	0
	4	(158,443)	(218,543)	102,719	(38)	165	(60,101)	261,162	321,263	100,531	84
Anadromous Fish Benefits	2	9,845	9,588	9,760	(3)	(1)	(257)	(85)	172	(171)	8
	3	2,541	2,350	2,356	(8)	(8)	(191)	(185)	6	(188)	0
	4	(158,443)	(160,985)	(156,906)	(2)	1	(2,542)	1,536	4,078	(503)	1

great deal of uncertainty in the values. The range of recreational benefits for Alternative 4 reflects different treatment of the data based on assumptions about non-respondent behavior. However, the range of recreational benefits used in the NED analysis were based on only one assumption about non-respondent data. Non-respondents were either assumed to not visit or non-respondent use was assumed to be the same as respondent use with only the rates for definite rather than definite and probable visitors used. General river recreation benefits represent 38 percent of the recreation benefits of Alternative 4. The low-end range estimate was based on scaling the river recreation and fishing demand curve using the cost per mile of reservoir visitors (travel cost method). A mean value of $71.36 per trip was used for the low end, but does not reflect the large confidence intervals for this method (95 percent confidence interval of $39 to $446 per trip). The high-end range estimate was based on scaling the demand curve using costs of visitors to free-flowing river sections as reported in a contingent behavior survey. A mean value of $297 per trip was used for the high end, which does not reflect the large confidence intervals for this method (95 percent confidence interval of $181 to $831 per trip). The nominal recreational benefits reflect the average of the mean of these two methods. Therefore, the Alternative 4 benefits reflect uncertainty about which method is the best estimator, but do not reflect uncertainty in the methods themselves. Also, recreational suitability recovery for various activities under Alternative 4 was based on point estimates, rather than range estimates, and no confidence limits were determined. If the confidence limits were included in the NED analysis, a larger range of possible values for recreational benefits would have occurred.

8.4.2 Social and Regional Analysis

The driving uncertainties in the regional analysis are identified omissions, which are identified in the DREW Regional Analysis Workgroup (1999) report. The regional analysis workgroup reports that uncertainty is present in the regional economic impact analysis because of uncertainties in inputs received from other workgroups and uncertainties used to drive the models. The regional analysis workgroup noted that any errors in the input data received from the other workgroups would be multiplied when the data are used in the regional economic impact model. The DREW Regional Analysis Workgroup identified the following specific examples of omissions and uncertainty in the input data they used in their analysis:

- The data for the 100-year fishing and outdoor recreation projections were based on 1998 PATH data, which have since been revised. This has repercussions for the comparisons of outcomes in the recreation section of the regional analysis.
- The analysis of the impacts of dam breaching on industries using or replacing barge transportation focused on grain shipments, which comprised about 76 percent of the tonnage passing through Ice Harbor lock between 1992 and 1997. There was not sufficient data available to analyze the regional impacts associated with other commodities presently shipped on the lower Snake River.
- The effects of dam breaching on primary aluminum manufacturing, the food processing sector, and the forest products industry are unknown.
- The required road investment outside Washington under Alternative 4 is unknown, as are future increases in spending for road maintenance.
- The future distribution of electricity rate increases under Alternative 4 across regions, industries, or consumers is unknown.

The DREW HIT elaborated on this last point in its interview with the DREW Risk and Uncertainty Workgroup. The members identified the possible rate impacts to regional power ratepayers as the only major risk and uncertainty concern. The workgroup expressed confidence in the reliability of its NED cost range estimate, but not in its ability to define who will pay these costs. This impacts the regional analysis and may be of significant social importance. The hydropower workgroup cannot improve the rate analysis until Congress determines the methods for funding dam removal. This would be done in the authorizing legislation if Alternative 4—Dam Breaching were selected.

Section 6.2 of this appendix discusses risk and uncertainty associated with the input-output economic analysis technique. First, industry spending calibrations are based on national averages, which may not apply to the specific region under study. Estimates using the national averages are, however, likely to be within plus or minus 10 percent of multipliers that would be found using survey data. Second, the input-output analysis provides a "snapshot" of the economy at a point in time rather than a dynamic structure of changing relationships. No model can make accurate predictions of future changes in technology, prices, trade patterns, or consumer tastes and preferences, therefore, all models would suffer this same uncertainty. Third, the input-output model is driven by exogenous estimates of changes in sale to final demand (exports, investment, and certain components of government spending).

Finally, the DREW Social Analysis Workgroup identified four sources of uncertainty about the appropriateness of some of the assumptions used in the social analysis:

- The allocation of sub-regional employment impacts to local communities based on a proportion of local employment to regional employment changes may understate or overstate the magnitude of impacts.
- The use of social indicators, such as: steelhead fishing licenses to represent the contribution of anadromous fish to local quality of life; poverty rates to identify populations sensitive to economic changes; and developed recreation sites to indicate quality of life.
- The use of county level farm data to make generalizations about the expected changes to farming communities within the county.
- The assumption that positive gains in employment are positive and negative losses in employment are negative for a given community.

The social analysis report additionally identified significant uncertainty in the economic effects of Alternative 4 on upriver communities because it is unknown how significantly the loss of river transportation would affect the forest products industry. Also, the effects of electrical rate increases on the aluminum industry are unknown, but could have significant regional impacts. The report also identified five key uncertainties that make the prediction of impacts on individual farms, farm regions, counties, and rural farm communities difficult to determine:

- The future of farm deficiency payments may be extended.
- International market conditions and prices received for export agricultural products vary greatly from year to year.
- The fixed and variable costs of farming have increased over time and may continue to do so while at the same time new crops and rotations are being introduced to the region.

- Technological advances in crop production and seasonal variations in rainfall make forecasting average yields difficult for more than 1 year in advance.
- The actual magnitude of total transportation cost increases, including price adjustments for alternative modes of transportation in the absence of barges, is unknown at this time.

8.4.3 Tribal Circumstances

The tribal circumstances risk and uncertainty assessment was obtained from the Tribal Circumstances report (Meyer Resources, 1999).

8.4.3.1 Uncertainty

The Tribal Circumstances report identifies positive associations between abundance of tribal harvest of salmon and tribal levels of cultural and material well being, or, alternatively, distress—indexed by perception of self, rates of death, health, poverty, unemployment, and per capita income. Given information presently available, Meyer Resources (1999) notes that it is not possible to establish certain cardinal measurement linkages between such “cause and effect” parameters; either in the immediate term, or cumulatively.

The Tribal Circumstances report ranked the alternatives based on the relative magnitude of salmon recovered for the tribes under each project alternative, and respecting the direction and general effect of such respective magnitudes of salmon recovery on tribal culture, rates of death, health, poverty, employment/unemployment, and income. Similarly, the Tribal Circumstances report provides a clear separation with respect to the length of time over which tribal pain and suffering would continue at close to present levels, under each project alternative.

The Tribal Circumstances report indicates that changes in underlying biological assumptions regarding recovery would result in some changes to cardinal estimates of salmon recovery. It further explains that such changes are not likely to substantially change the certainty associated with the ranking of tribal impacts from alternative project choices.

8.4.3.2 Tribal Risk

According to the Tribal Circumstances report, the tribes face four major elements of risk within the context of the lower Snake River Feasibility Study process.

First, the Tribal Circumstances report identified the close dependence of the study tribes on salmon, the declines in salmon available to the tribes from treaty times to the present, and the consequent endangerment of not only the salmon, but the cultural and material well being of the tribes as well.

Given present diminished stock levels, if the PATH estimates are too optimistic, there is a risk that the subject salmon species will become extinct—with attendant risks for continued survival of tribal peoples.

Second, if PATH recovery estimates are too pessimistic, differences in the magnitude and timing of salmon recovery between alternatives would be understated, thus, reducing comparative net benefits posed for the alternative most likely to restore salmon.

Third, if the selected alternative forecasts salmon recovery that will need a time period far into the future before significant harvests are returned to the tribes, the Tribal Circumstances report indicates that tribal peoples will continue to risk unacceptable levels of pain, suffering, and premature death, while bureaucrats “test and study.”

Finally, the Tribal Circumstances report identifies that in almost all prior processes concerning Columbia/Snake River system dams, tribal concerns and the impact on tribes have been ignored or marginalized. The Tribal Circumstances report indicates that if marginalization occurs during the present process, the cumulative transfer of the river system's wealth from tribal to non-tribal residents of the region will continue, hence, tribal peoples will continue to suffer and be disempowered, regardless of existing treaty protections—and environmental injustice, as defined by EPA, will be exacerbated.

8.4.4 Passive Use

Passive use values (PUVs) have been estimated for preservation of endangered species and for creation of a near-natural river using a benefit transfer methodology, which transfers the benefits from passive use estimates made in other studies to the lower Snake River (see Section 4, Passive Use). There has been concern expressed about the validity of these estimates. As the IEAB stated in its review of the FR/EIS:

> "The IEAB agrees that, for a variety of theoretical and empirical reasons, PUVs for salmon and for free flowing rivers are very difficult to estimate. In this particular case, the IEAB believes that these problems have led to a very large uncertainty, and probably to an upward bias in the PUV estimates reported in the EA (Economic Appendix).
>
> ... the PUVs need to be kept explicitly separate from the other values, and the large uncertainty and possible biases of these estimates emphasized."

The DREW Recreation Workgroup indicated in their passive use report that the nature of the existing surveys used for the benefit transfer study resulted in a number of factors that suggested that the resulting estimates might be called conservative. These include the following:

- Survey respondents were not told that they were evaluating threatened and endangered stocks. Providing respondents with this information would likely result in higher estimates of passive use benefits.
- Most existing studies evaluated a larger fish increase than is being evaluated in the lower Snake River. Because studies find that larger increases have diminishing returns on willingness to pay, applying these numbers to the lower Snake River likely underestimates its passive use benefits.
- The estimate of passive use benefits assumed zero benefit for angler households in the study area and zero benefit for all households outside of the study area.

The estimated PUVs are as follows:

- The increases in wild Snake River salmon and steelhead stocks are estimated to have a range of passive use values from $22.7 million to $301.5 million per year.
- The annual passive use value of a near-natural river is estimated at $420 million per year (no range is reported).

The range of values presented for passive use benefits of salmon reflect different approaches for estimating values, rather than uncertainties in the methods themselves. A single point estimate was available for the free-flowing river passive use benefits, and no confidence intervals were determined. Because of the high level of uncertainty, the passive use estimates are reported here for the reader's interest but are not compared with other numbers in the FR/EIS economic appendix.

8.5 Cost Effectiveness Comparisons

Section 8.4 evaluated the relative costs and benefits of each of the alternatives. However, it should be emphasized that an over-riding determination is the cost effectiveness of each of the alternatives, which takes into account both the relative cost and the biological effectiveness of the alternatives.

8.5.1 Methodology

The following section provides a tabular comparison of the risk and uncertainty associated with the range of cost estimates (e.g., based on the low-end and high-end nominal range sensitivity analysis estimates presented in Section 8.4) and the range of biological effectiveness of alternatives (based on the results of Section 8.3). Cost effectiveness is determined by evaluating the additional cost to gain an additional percent of probability of meeting the NMFS jeopardy standards. As in the Cost Effectiveness chapter, the net NED costs and biological effectiveness for spring/summer chinook and fall chinook are reported separately because there are no PATH/NMFS estimates of the combined probabilities of meeting the jeopardy standards for both spring/summer and fall chinook salmon.

8.5.1.1 Cost Estimates

As documented in Section 8-2.1.1, the NRSA approach involves holding all cost parameters except one at their nominal values (i.e., best estimates), while varying the remaining parameter from its low-end to high-end range estimate. The resulting range estimates (low-end and high-end) provide a useful assessment of the risk and uncertainty inherent in each of the variables considered in the NED analysis. This analysis considers the cumulative cost of the NRSA range over the three relevant NMFS time spans (e.g., 24-year survival, 48-year recovery, and 100-year survival standards).

The cost estimates are calculated by multiplying the annual nominal range cost estimate by the number of years of the applied standard for each of the variable inputs. As an example, Alternative 4—Dam Breaching, costs approximately $6.34 to $6.46 billion to implement over a 24-year period from the low-end to the high-end of the nominal range for implementation costs:

- **Low-end estimate for implementation costs for the 24-year NMFS survival standard:** 24 years times the annual cost of $264,274,478 (Source: Table 8-4 using the 6.875 percent low-end sensitivity range for implementation costs) equals $6,342,587,000 (reported in Table 8-5)

- **High-end estimate for implementation costs for the 24-year NMFS survival standard:** 24 years times the annual cost of $269,154,478 (Source: Table 8-4) equals $6,459,707,000 at the high-end of the nominal range for implementation costs (also reported in Table 8-5).

A similar process is used to calculate all cumulative net NRSAs across each of the three NMFS time spans for both species of chinook salmon.

8.5.1.2 Estimates of Biological Effectiveness

The estimates of net biological effectiveness are calculated across each of the alternatives (2, 3 and 4) net of the base case (Alternative 1) for each of the three NMFS jeopardy standards for spring/summer chinook and fall chinook as reported in Section 8.3.3:

- **Low-end estimate for biological effectiveness for the 24-year NMFS survival standard for spring/summer chinook:**
  At the low-end (25th percentile), Alternative 2 provides 1 percent less effectiveness than the base case, Alternative 3 has the same effectiveness as the base case, and Alternative 4 has an 8 percent higher effectiveness than the base case, using the PATH 1998 model results.

- **High-end estimate for implementation costs for the 24-year NMFS survival standard for spring/summer chinook:**
  At the high-end (75th percentile), Alternatives 2 and 3 have the same effectiveness as the base case and Alternative 4 has an 1 percent higher effectiveness than the base case, using the PATH 1998 model results.

8.5.1.3 Cost Effectiveness Methodology

The cost effectiveness assessment, provided in Tables 8-5 through 8-7 for spring/summer chinook and Tables 8-8 through 8-10 for fall chinook, considers two separate but related calculations:

- cost (or saving) per 1 percent increase in probability of meeting the jeopardy standards
- decreased cost in providing the same level of biological output.

These calculations are described below.

Cost (or Saving) per 1 percent increase in probability of meeting the jeopardy standards:

The additional costs (or savings) to increase the probability of meeting each jeopardy standard are calculated:

- if Alternatives 2 through 4 meet the jeopardy standard
- if Alternatives 2 through 4 provide a net biological advantage over Alternative 1 (base case)
- if Alternative 1 (base case) does not meet the jeopardy standard, the additional cost (or savings) to achieve an additional probability percentage is calculated.

For example, none of the alternatives meet the NMFS 24-year survival standard for spring/summer chinook. Thus, moving from one alternative to another is not meaningful (represented as NM in Tables 8-5 through 8-10).

As another example, only Alternative 4 meets the NMFS 48-year recovery standard for spring/summer chinook, and it is estimated to cost $295,004,000 (Source: low-end estimate in Table 8-6 for implementation costs) over the 48-year period to gain each additional percentage of increase.

This estimate is calculated as follows:

- Low-end range estimates equals ($12,685,175,000) divided by the net increase in meeting the standard 43 percent (indicated in low-end probability net of the base case) equals 295,004,000 per additional percentage gained (12,685,175,000/43).

Decreased cost in providing the same level of biological output

If the following conditions are met, the cost savings to provide the same level of biological output as occurs under Alternative 1 (base case) is calculated as follows:

- if Alternatives 2 through 4 meet the jeopardy standard
- if Alternatives 2 through 4 provide the same level of biological output as the base case alternative but at a lower cost than Alternative 1 (base case) the net savings is calculated.

For example, Alternative 2 provides the same biological effectives as the base case for the 24-year survival standard applied to spring/summer chinook but costs $328,922,000 less over the 24-year period.

8.5.2 Cost Effectiveness Assessment 1—All Costs Applied to Spring/Summer Chinook

Tables 8-5 through 8-7 present a comparison of the net cost and biological effectiveness to achieve the NMFS' jeopardy standards for spring/summer chinook for the various alternatives under consideration. This cost effectiveness assessment considers the entire cost of the alternatives applied to spring/summer chinook.

8.5.2.1 24-year Survival Standard

Using the 1998 PATH model results, there is no net biological benefit from selecting Alternative 2, 3, or 4 over Alternative 1, base case to meet the 24-year survival standard (i.e., 70 percent). At the low end, none of the alternatives meets the standard and at the high end all alternatives meet the standard.

Alternative 2 provides the same probability of meeting the 24-year survival standard as Alternative 1 but at a lower cost. The cost savings from selecting Alternative 2 range from $288 to $329 million, depending on the variable evaluated using the 6.875 percent discount rate. The savings decrease slightly with the lower discount rates. Using a 0.0 percent discount rate, Alternative 3 provides a cost savings to provide the same probability as the base case at the high end of the assessment. The savings range from $81 million to $97 million over the 24-year period (see Table 8-5).

8.5.2.2 48-year Recovery Standard

Using the 1998 PATH model results, there is no net biological benefit from selecting Alternative 2 or 3 over Alternative 1 (base case) to meet the 48-year recovery standard (i.e., 50 percent). At the low end, only Alternative 4—Dam Breaching meets the standard and at the high end all alternatives meet the standard.

There is, however, a biological benefit from Alternative 4—Dam Breaching at the low end NRSA estimates. Each additional percentage of probability gained by selecting Alternative 4 costs a cumulative amount of $275 million to $345 million over the 48-year period, depending on the variable evaluated (see Table 8-6).

8.5.2.3 100-year Survival Standard for Spring/Summer Chinook

Only Alternative 4—Dam Breaching meets the 100-year survival standard (i.e., 70 percent) at the low end of the NRSA and probability assessment. The additional cost to provide an additional percent of probability costs $1.5 billion to $1.8 billion over the 100-year period. All alternatives meet the 100-year survival standard at the high end of the assessment.

Alternative 2 provides the same probability of meeting the 100-year survival standard as Alternative 1 but at a lower cost at the high-end of the assessment. The cost savings from selecting Alternative 2 range from $1.2 billion to $1.4 billion, depending on the variable evaluated using the 6.875 percent discount rate. The savings decrease slightly with the lower discount rates. Using a 0.0 percent discount rate, Alternative 3 provides a cost savings to provide the same probability as the base case at the high end of the assessment. The savings range from $306 million to $406 million over the 100-year period (see Table 8-7).

8.5.3 CE Assessment 2—All Costs Applied to Fall Chinook

Tables 8-8 through 8-10 present a comparison of the net cost and biological effectiveness to achieve the NMFS' jeopardy standards for fall chinook for the various alternatives under consideration. This cost effectiveness assessment considers the entire cost of the alternatives applied to fall chinook.

8.5.3.1 24-year Survival Standard for Fall Chinook

Using the 1998 PATH model results, there is no net biological benefit from selecting Alternative 2, 3, or 4 over Alternative 1 (base case) to meet the 24-year survival standard (i.e., 70 percent). All alternatives meet the standard under both the low end and high end of the assessment.

Alternative 2 provides the same probability of meeting the 24-year survival standard as Alternative 1 but at a lower cost. The cost savings from selecting Alternative 2 range from $288 million to $360 million, depending on the variable evaluated using the 6.875 percent discount rate. The savings decrease slightly with the lower discount rates (see Table 8-8).

8.5.3.2 48-year Recovery Standard for Fall Chinook

Using the 1998 PATH model results, there is no net biological benefit from selecting Alternative 2 or 3 over Alternative 1 (base case) to meet the 48-year recovery standard (i.e., 50 percent). At the low-end, none of the alternatives meet the standard and at the high-end all alternatives meet the standard. There is a benefit from selecting Alternative 4—Dam Breaching at the low-end NRSA estimates. Each additional percentage of probability gained by selecting Alternative 4 costs a cumulative amount of $139 million to $175 million over the 48-year period for each additional percent of probability gained, depending on the variable evaluated.

At the high end, Alternative 2 provides the same biological output as Alternative 1 but at a lower cost. The savings range from $577 million to $658 million, depending on the variable considered (see Table 8-9).

8.5.3.3 100-year Survival Standard for Fall Chinook

All alternatives meet the 100-year survival standard under the low-end assessment except for Alternative 3. All alternatives meet the 100-year survival standard under the high-end assessment.

At the low and high ends of the assessment, Alternative 2 provides the same biological output as Alternative 1 but at a lower cost. The savings range from $1.2 billion to $1.5 billion over the 100-year period, depending on the variable considered (see Table 8-10).

8.6 Summary

The purpose of the risk and uncertainty assessment was to help 1) assess the overall reliability of the economic analysis conducted for this study, and 2) identify important unanswered questions for risk managers. Unresolved uncertainties still remain about the economic costs and benefits of the four alternatives considered by DREW. The most important uncertainties from a NED perspective are uncertainties about the value of future recreational use benefits if the dams are breached, and uncertainties about the size of future anadromous fish stocks and the fisheries they would support.

Further work by PATH, the DREW Anadromous Fish Workgroup, and the DREW Recreation Workgroup could significantly improve the reliability of these analyses. The new PATH estimates published in November 1999 need to be evaluated in the appropriate economic resource categories. Other NED uncertainties, though significant in an absolute sense, are unlikely to affect decisions about whether it would be more cost-effective to breach the four lower Snake River dams.

The driving uncertainties for the regional analysis are of two types: uncertainties due to currently unavailable data and uncertainties about how costs would be distributed. The latter cannot be resolved until decisions are made about how the future power supply system would be configured if the four lower Snake River dams were breached. At least some of what have been characterized as uncertainties due to currently unavailable data also cannot be resolved until specific information is developed about how the future power supply system would be configured.

Uncertainties about dam breaching remain that hinder reaching a conclusion on whether it would be more cost-effective to breach the four lower Snake River dams. In order to confirm the economic feasibility of retaining or breaching the dams, further effort is needed, including efforts to: 1) more precisely quantify the recreational benefits of the lower Snake River if the dams are breached, 2) more thoroughly assess the effect of dam removal on future anadromous fish stocks, and 3) further specify the configuration of the future power supply system if the dams are breached.

Table 8-5. Cost Effectiveness Comparison for 24-year Survival Standard for Spring/Summer Chinook ($1,000s and percent)

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6.875 PERCENT DISCOUNT RATE											
				Spring/Summer Chinook							
		Low-end	High-end	Probability of Meeting Standard		Probability Net of Base Case		Cost or Saving per % Increase		Decrease in Cost if Meets Standard	
Varied Parameter	Alternative	Nominal Range Estimate ($)	Nominal Range Estimate ($)	(Low) (%)	(High) (%)	(Low) (%)	(High) (%)	(Low) ($)	(High) ($)	(Low) ($)	(High) ($)
Implementation Costs	2	320,282	328,922	54	75	(1)	0	NM	NM	NM	328,922
	3	(279,494)	(334,214)	55	75	0	0	NM	NM	NM	NM
	4	(6,342,587)	(6,459,707)	63	76	8	1	NM	NM	NM	NM
Power Costs	2	360,602	288,602	54	75	(1)	0	NM	NM	NM	288,602
	3	(270,854)	(342,854)	55	75	0	0	NM	NM	NM	NM
	4	(5,921,147)	(6,881,147)	63	76	8	1	NM	NM	NM	NM
Avoided Costs	2	324,602	324,602	54	75	(1)	0	NM	NM	NM	324,602
	3	(306,854)	(306,854)	55	75	0	0	NM	NM	NM	NM
	4	(6,441,467)	(6,360,827)	63	76	8	1	NM	NM	NM	NM
Transportation Costs	2	324,602	324,602	54	75	(1)	0	NM	NM	NM	324,602
	3	(306,854)	(306,854)	55	75	0	0	NM	NM	NM	NM
	4	(6,159,875)	(6,642,419)	63	76	8	1	NM	NM	NM	NM
Irrigation & Water System Costs	2	324,602	324,602	54	75	(1)	0	NM	NM	NM	324,602
	3	(306,854)	(306,854)	55	75	0	0	NM	NM	NM	NM
	4	(6,365,039)	(6,437,255)	63	76	8	1	NM	NM	NM	NM
Recreation Benefits	2	295,442	295,442	54	75	(1)	0	NM	NM	NM	295,442
	3	(337,070)	(337,070)	55	75	0	0	NM	NM	NM	NM
	4	(7,425,655)	(1,487,502)	63	76	8	1	NM	NM	NM	NM
Anadromous Fish Benefits	2	318,980	320,078	54	75	(1)	0	NM	NM	NM	320,078
	3	(312,258)	(317,223)	55	75	0	0	NM	NM	NM	NM
	4	(6,430,008)	(6,388,068)	63	76	8	1	NM	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-5. Cost Effectiveness Comparison for 24-year Survival Standard for Spring/Summer Chinook ($1,000s and percent)

4.75 PERCENT DISCOUNT RATE

Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	Spring/Summer Chinook: Probability of Meeting Standard (Low) (%)	Probability of Meeting Standard (High) (%)	Probability Net of Base Case (Low) (%)	Probability Net of Base Case (High) (%)	Cost or Saving per % Increase (Low) ($)	Cost or Saving per % Increase (High) ($)	Decrease in Cost if Meets Standard (Low) ($)	Decrease in Cost if Meets Standard (High) ($)
Implementation Costs	2	306,898	313,138	54	75	(1)	0	NM	NM	NM	313,138
	3	(143,981)	(185,261)	55	75	0	0	NM	NM	NM	NM
	4	(5,523,679)	(5,608,639)	63	76	8	1	NM	NM	NM	NM
Power Costs	2	346,018	274,018	54	75	(1)	0	NM	NM	NM	274,018
	3	(128,621)	(200,621)	55	75	0	0	NM	NM	NM	NM
	4	(5,074,159)	(6,058,159)	63	76	8	1	NM	NM	NM	NM
Avoided Costs	2	310,018	310,018	54	75	(1)	0	NM	NM	NM	310,018
	3	(164,621)	(164,621)	55	75	0	0	NM	NM	NM	NM
	4	(5,606,959)	(5,525,359)	63	76	8	1	NM	NM	NM	NM
Transportation Costs	2	310,018	310,018	54	75	(1)	0	NM	NM	NM	310,018
	3	(164,621)	(164,621)	55	75	0	0	NM	NM	NM	NM
	4	(5,380,648)	(5,751,669)	63	76	8	1	NM	NM	NM	NM
Irrigation & Water System Costs	2	310,018	310,018	54	75	(1)	0	NM	NM	NM	310,018
	3	(164,621)	(164,621)	55	75	0	0	NM	NM	NM	NM
	4	(5,541,007)	(5,591,311)	63	76	8	1	NM	NM	NM	NM
Recreation Benefits	2	274,378	274,378	54	75	(1)	0	NM	NM	NM	274,378
	3	(200,501)	(200,501)	55	75	0	0	NM	NM	NM	NM
	4	(6,691,330)	(2,662,982)	63	76	8	1	NM	NM	NM	NM
Anadromous Fish Benefits	2	303,986	305,891	54	75	(1)	0	NM	NM	NM	305,891
	3	(170,104)	(173,998)	55	75	0	0	NM	NM	NM	NM
	4	(5,602,948)	(5,546,422)	63	76	8	1	NM	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-5. Cost Effectiveness Comparison for 24-year Survival Standard for Spring/Summer Chinook ($1,000s and percent)

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Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	Spring/Summer Chinook Probability of Meeting Standard (Low) (%)	(High) (%)	Probability Net of Base Case (Low) (%)	(High) (%)	Cost per Percent Increase (Low) ($)	(High) ($)	Decrease in Cost if Meets Standard (Low) ($)	(High) ($)
0.0 PERCENT DISCOUNT RATE											
Implementation Costs	2	235,314	237,234	54	75	(1)	0	NM	NM	NM	237,234
	3	103,224	91,704	55	75	0	0	NM	NM	NM	91,704
	4	(3,792,785)	(3,812,465)	63	76	8	1	NM	NM	NM	NM
Power Costs	2	260,274	212,274	54	75	(1)	0	NM	NM	NM	212,274
	3	121,464	73,464	55	75	0	0	NM	NM	NM	73,464
	4	(3,262,625)	(4,342,625)	63	76	8	1	NM	NM	NM	NM
Avoided Costs	2	236,274	236,274	54	75	(1)	0	NM	NM	NM	236,274
	3	97,464	97,464	55	75	0	0	NM	NM	NM	97,464
	4	(3,843,185)	(3,762,065)	63	76	8	1	NM	NM	NM	NM
Transportation Costs	2	236,274	236,274	54	75	(1)	0	NM	NM	NM	236,274
	3	97,464	97,464	55	75	0	0	NM	NM	NM	97,464
	4	(3,722,103)	(3,883,147)	63	76	8	1	NM	NM	NM	NM
Irrigation & Water System Costs	2	236,274	236,274	54	75	(1)	0	NM	NM	NM	236,274
	3	97,464	97,464	55	75	0	0	NM	NM	NM	97,464
	4	(3,797,381)	(3,807,869)	63	76	8	1	NM	NM	NM	NM
Recreation Benefits	2	216,954	216,954	54	75	(1)	0	NM	NM	NM	216,954
	3	81,312	81,312	55	75	0	0	NM	NM	NM	81,312
	4	(5,245,042)	2,465,262	63	76	8	1	NM	NM	NM	NM
Anadromous Fish Benefits	2	230,108	234,235	54	75	(1)	0	NM	NM	NM	234,235
	3	92,884	93,024	55	75	0	0	NM	NM	NM	93,024
	4	(3,863,629)	(3,765,750)	63	76	8	1	NM	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-6. Cost Effectiveness Comparison for 48-year Recovery Standard for Spring/Summer Chinook ($1,000s and percent)

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6.875 PERCENT DISCOUNT RATE												
				Spring/Summer Chinook								
				Probability of Meeting Standard		Probability Net of Base Case		Cost or Saving per % Increase		Decrease in Cost if Meets Standard		
Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	(Low) (%)	(High) (%)	(Low) (%)	(High) (%)	(Low) ($)	(High) ($)	(Low) ($)	(High) ($)
Implementation Costs	2	640,565	657,845	29	66	(2)	1	NM	NM	NM	NM
	3	(558,987)	(668,427)	31	67	0	2	NM	NM	NM	NM
	4	(12,685,175)	(12,919,415)	74	92	43	27	(295,004)	NM	NM	NM
Power Costs	2	721,205	577,205	29	66	(2)	1	NM	NM	NM	NM
	3	(541,707)	(685,707)	31	67	0	2	NM	NM	NM	NM
	4	(11,842,295)	(13,762,295)	74	92	43	27	(275,402)	NM	NM	NM
Avoided Costs	2	649,205	649,205	29	66	(2)	1	NM	NM	NM	NM
	3	(613,707)	(613,707)	31	67	0	2	NM	NM	NM	NM
	4	(12,882,935)	(12,721,655)	74	92	43	27	(299,603)	NM	NM	NM
Transportation Costs	2	649,205	649,205	29	66	(2)	1	NM	NM	NM	NM
	3	(613,707)	(613,707)	31	67	0	2	NM	NM	NM	NM
	4	(12,319,751)	(13,284,839)	74	92	43	27	(286,506)	NM	NM	NM
Irrigation & Water System Costs	2	649,205	649,205	29	66	(2)	1	NM	NM	NM	NM
	3	(613,707)	(613,707)	31	67	0	2	NM	NM	NM	NM
	4	(12,730,079)	(12,874,511)	74	92	43	27	(296,048)	NM	NM	NM
Recreation Benefits	2	590,885	590,885	29	66	(2)	1	NM	NM	NM	NM
	3	(674,139)	(674,139)	31	67	0	2	NM	NM	NM	NM
	4	(14,851,310)	(2,975,004)	74	92	43	27	(345,379)	NM	NM	NM
Anadromous Fish Benefits	2	637,959	640,155	29	66	(2)	1	NM	NM	NM	NM
	3	(624,516)	(634,447)	31	67	0	2	NM	NM	NM	NM
	4	(12,860,015)	(12,776,136)	74	92	43	27	(299,070)	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-6. Cost Effectiveness Comparison for 48-year Recovery Standard for Spring/Summer Chinook ($1,000s and percent)

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4.75 PERCENT DISCOUNT RATE												
				Spring/Summer Chinook								
				Probability of Meeting Standard		Probability Net of Base Case		Cost or Saving per % Increase		Decrease in Cost if Meets Standard		
Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	(Low) (%)	(High) (%)	(Low) (%)	(High) (%)	(Low) ($)	(High) ($)	(Low) ($)	(High) ($)
Implementation Costs	2	613,795	626,275	29	66	(2)	1	NM	NM	NM	NM
	3	(287,962)	(370,522)	31	67	0	2	NM	NM	NM	NM
	4	(11,047,357)	(11,217,277)	74	92	43	27	(256,915)	NM	NM	NM
Power Costs	2	692,035	548,035	29	66	(2)	1	NM	NM	NM	NM
	3	(257,242)	(401,242)	31	67	0	2	NM	NM	NM	NM
	4	(10,148,317)	(12,116,317)	74	92	43	27	(236,007)	NM	NM	NM
Avoided Costs	2	620,035	620,035	29	66	(2)	1	NM	NM	NM	NM
	3	(329,242)	(329,242)	31	67	0	2	NM	NM	NM	NM
	4	(11,213,917)	(11,050,717)	74	92	43	27	(260,789)	NM	NM	NM
Transportation Costs	2	620,035	620,035	29	66	(2)	1	NM	NM	NM	NM
	3	(329,242)	(329,242)	31	67	0	2	NM	NM	NM	NM
	4	(10,761,296)	(11,503,338)	74	92	43	27	(250,263)	NM	NM	NM
Irrigation & Water System Costs	2	620,035	620,035	29	66	(2)	1	NM	NM	NM	NM
	3	(329,242)	(329,242)	31	67	0	2	NM	NM	NM	NM
	4	(11,082,013)	(11,182,621)	74	92	43	27	(257,721)	NM	NM	NM
Recreation Benefits	2	548,755	548,755	29	66	(2)	1	NM	NM	NM	NM
	3	(401,002)	(401,002)	31	67	0	2	NM	NM	NM	NM
	4	(13,382,661)	(5,325,964)	74	92	43	27	(311,225)	NM	NM	NM
Anadromous Fish Benefits	2	607,973	611,782	29	66	(2)	1	NM	NM	NM	NM
	3	(340,208)	(347,997)	31	67	0	2	NM	NM	NM	NM
	4	(11,205,895)	(11,092,845)	74	92	43	27	(260,602)	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-6. Cost Effectiveness Comparison for 48-year Recovery Standard for Spring/Summer Chinook ($1,000s and percent)

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0.0 PERCENT DISCOUNT RATE

Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	Spring/Summer Chinook: Probability of Meeting Standard (Low) (%)	Probability of Meeting Standard (High) (%)	Probability Net of Base Case (Low) (%)	Probability Net of Base Case (High) (%)	Cost or Saving per % Increase (Low) ($)	Cost or Saving per % Increase (High) ($)	Decrease in Cost if Meets Standard (Low) ($)	Decrease in Cost if Meets Standard (High) ($)
Implementation Costs	2	470,628	474,468	29	66	-2	1	NM	NM	NM	NM
	3	206,449	183,409	31	67	0	2	NM	NM	NM	NM
	4	(7,585,570)	(7,624,930)	74	92	43	27	(176,409)	NM	NM	NM
Power Costs	2	520,548	424,548	29	66	-2	1	NM	NM	NM	NM
	3	242,929	146,929	31	67	0	2	NM	NM	NM	NM
	4	(6,525,250)	(8,685,250)	74	92	43	27	(151,750)	NM	NM	NM
Avoided Costs	2	472,548	472,548	29	66	-2	1	NM	NM	NM	NM
	3	194,929	194,929	31	67	0	2	NM	NM	NM	NM
	4	(7,686,370)	(7,524,130)	74	92	43	27	(178,753)	NM	NM	NM
Transportation Costs	2	472,548	472,548	29	66	-2	1	NM	NM	NM	NM
	3	194,929	194,929	31	67	0	2	NM	NM	NM	NM
	4	(7,444,206)	(7,766,294)	74	92	43	27	(173,121)	NM	NM	NM
Irrigation & Water System Costs	2	472,548	472,548	29	66	-2	1	NM	NM	NM	NM
	3	194,929	194,929	31	67	0	2	NM	NM	NM	NM
	4	(7,594,762)	(7,615,738)	74	92	43	27	(176,622)	NM	NM	NM
Recreation Benefits	2	433,908	433,908	29	66	-2	1	NM	NM	NM	NM
	3	162,625	162,625	31	67	0	2	NM	NM	NM	NM
	4	(10,490,084)	4,930,524	74	92	43	27	(243,955)	NM	NM	NM
Anadromous Fish Benefits	2	460,216	468,470	29	66	-2	1	NM	NM	NM	NM
	3	185,769	186,048	31	67	0	2	NM	NM	NM	NM
	4	(7,727,259)	(7,531,500)	74	92	43	27	(179,704)	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-7. Cost Effectiveness Comparison for 100-year Survival Standard for Spring/Summer Chinook ($1,000s and percent) Page 1 of 3

6.875 PERCENT DISCOUNT RATE

Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	Spring/Summer Chinook: Probability of Meeting Standard (Low) (%)	Probability of Meeting Standard (High) (%)	Probability Net of Base Case (Low) (%)	Probability Net of Base Case (High) (%)	Cost or Saving per % Increase (Low) ($)	Cost or Saving per % Increase (High) ($)	Decrease in Cost if Meets Standard (Low) ($)	Decrease in Cost if Meets Standard (High) ($)
Implementation Costs	2	1,334,510	1,370,510	65	87	(3)	0	NM	NM	NM	1,370,510
	3	(1,164,556)	(1,392,556)	67	87	(1)	0	NM	NM	NM	NM
	4	(26,427,448)	(26,915,448)	85	92	17	5	(1,554,556)	NM	NM	NM
Power Costs	2	1,502,510	1,202,510	65	87	(3)	0	NM	NM	NM	1,202,510
	3	(1,128,556)	(1,428,556)	67	87	(1)	0	NM	NM	NM	NM
	4	(24,671,448)	(28,671,448)	85	92	17	5	(1,451,262)	NM	NM	NM
Avoided Costs	2	1,352,510	1,352,510	65	87	(3)	0	NM	NM	NM	1,352,510
	3	(1,278,556)	(1,278,556)	67	87	(1)	0	NM	NM	NM	NM
	4	(26,839,448)	(26,503,448)	85	92	17	5	(1,578,791)	NM	NM	NM
Transportation Costs	2	1,352,510	1,352,510	65	87	(3)	0	NM	NM	NM	1,352,510
	3	(1,278,556)	(1,278,556)	67	87	(1)	0	NM	NM	NM	NM
	4	(25,666,148)	(27,676,748)	85	92	17	5	(1,509,773)	NM	NM	NM
Irrigation & Water System Costs	2	1,352,510	1,352,510	65	87	(3)	0	NM	NM	NM	1,352,510
	3	(1,278,556)	(1,278,556)	67	87	(1)	0	NM	NM	NM	NM
	4	(26,520,998)	(26,821,898)	85	92	17	5	(1,560,059)	NM	NM	NM
Recreation Benefits	2	1,231,010	1,231,010	65	87	(3)	0	NM	NM	NM	1,231,010
	3	(1,404,456)	(1,404,456)	67	87	(1)	0	NM	NM	NM	NM
	4	(30,940,230)	(6,197,924)	85	92	17	5	(1,820,014)	NM	NM	NM
Anadromous Fish Benefits	2	1,329,082	1,333,656	65	87	(3)	0	NM	NM	NM	1,333,656
	3	(1,301,075)	(1,321,764)	67	87	(1)	0	NM	NM	NM	NM
	4	(26,791,699)	(26,616,951)	85	92	17	5	(1,575,982)	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-7. Cost Effectiveness Comparison for 100-year Survival Standard for Spring/Summer Chinook ($1,000s and percent) Page 2 of 3

				4.75 PERCENT DISCOUNT RATE							
				Spring/Summer Chinook							
				Probability of Meeting Standard		Probability Net of Base Case		Cost or Saving per % Increase		Decrease in Cost if Meets Standard	
Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	(Low) (%)	(High) (%)	(Low) (%)	(High) (%)	(Low) ($)	(High) ($)	(Low) ($)	(High) ($)
Implementation Costs	2	1,278,740	1,304,740	65	87	(3)	0	NM	NM	NM	1,304,740
	3	(599,921)	(771,921)	67	87	(1)	0	NM	NM	NM	NM
	4	(23,015,327)	(23,369,327)	85	92	17	5	(1,353,843)	NM	NM	NM
Power Costs	2	1,441,740	1,141,740	65	87	(3)	0	NM	NM	NM	1,141,740
	3	(535,921)	(835,921)	67	87	(1)	0	NM	NM	NM	NM
	4	(21,142,327)	(25,242,327)	85	92	17	5	(1,243,666)	NM	NM	NM
Avoided Costs	2	1,291,740	1,291,740	65	87	(3)	0	NM	NM	NM	1,291,740
	3	(685,921)	(685,921)	67	87	(1)	0	NM	NM	NM	NM
	4	(23,362,327)	(23,022,327)	85	92	17	5	(1,374,255)	NM	NM	NM
Transportation Costs	2	1,291,740	1,291,740	65	87	(3)	0	NM	NM	NM	1,291,740
	3	(685,921)	(685,921)	67	87	(1)	0	NM	NM	NM	NM
	4	(22,419,368)	(23,965,287)	85	92	17	5	(1,318,786)	NM	NM	NM
Irrigation & Water System Costs	2	1,291,740	1,291,740	65	87	(3)	0	NM	NM	NM	1,291,740
	3	(685,921)	(685,921)	67	87	(1)	0	NM	NM	NM	NM
	4	(23,087,527)	(23,297,127)	85	92	17	5	(1,358,090)	NM	NM	NM
Recreation Benefits	2	1,143,240	1,143,240	65	87	(3)	0	NM	NM	NM	1,143,240
	3	(835,421)	(835,421)	67	87	(1)	0	NM	NM	NM	NM
	4	(27,880,543)	(11,095,758)	85	92	17	5	(1,640,032)	NM	NM	NM
Anadromous Fish Benefits	2	1,266,610	1,274,545	65	87	(3)	0	NM	NM	NM	1,274,545
	3	(708,767)	(724,994)	67	87	(1)	0	NM	NM	NM	NM
	4	(23,345,615)	(23,110,093)	85	92	17	5	(1,373,271)	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-7. Cost Effectiveness Comparison for 100-year Survival Standard for Spring/Summer Chinook ($1,000s and percent) Page 3 of 3

0.0 PERCENT DISCOUNT RATE											
				Spring/Summer Chinook							
				Probability of Meeting Standard		Probability Net of Base Case		Cost per % Increase		Decrease in Cost if Meets Standard	
Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	(Low) (%)	(High) (%)	(Low) (%)	(High) (%)	(Low) ($)	(High) ($)	(Low) ($)	(High) ($)
Implementation Costs	2	980,474	988,474	65	87	(3)	0	NM	NM	NM	988,474
	3	430,102	382,102	67	87	(1)	0	NM	NM	NM	382,102
	4	(15,803,272)	(15,885,272)	85	92	17	5	(929,604)	NM	NM	NM
Power Costs	2	1,084,474	884,474	65	87	(3)	0	NM	NM	NM	884,474
	3	506,102	306,102	67	87	(1)	0	NM	NM	NM	306,102
	4	(13,594,272)	(18,094,272)	85	92	17	5	(799,663)	NM	NM	NM
Avoided Costs	2	984,474	984,474	65	87	(3)	0	NM	NM	NM	984,474
	3	406,102	406,102	67	87	(1)	0	NM	NM	NM	406,102
	4	(16,013,272)	(15,675,272)	85	92	17	5	(941,957)	NM	NM	NM
Transportation Costs	2	984,474	984,474	65	87	(3)	0	NM	NM	NM	984,474
	3	406,102	406,102	67	87	(1)	0	NM	NM	NM	406,102
	4	(15,508,763)	(16,179,780)	85	92	17	5	(912,280)	NM	NM	NM
Irrigation & Water System Costs	2	984,474	984,474	65	87	(3)	0	NM	NM	NM	984,474
	3	406,102	406,102	67	87	(1)	0	NM	NM	NM	406,102
	4	(15,822,422)	(15,866,122)	85	92	17	5	(930,731)	NM	NM	NM
Recreation Benefits	2	903,974	903,974	65	87	(3)	0	NM	NM	NM	903,974
	3	338,802	338,802	67	87	(1)	0	NM	NM	NM	338,802
	4	(21,854,341)	10,271,925	85	92	17	5	(1,285,549)	NM	NM	NM
Anadromous Fish Benefits	2	958,783	975,979	65	87	(3)	0	NM	NM	NM	975,979
	3	387,019	387,599	67	87	(1)	0	NM	NM	NM	387,599
	4	(16,098,456)	(15,690,626)	85	92	17	5	(946,968)	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-8. Cost Effectiveness Comparison for 24-year Survival Standard for Fall Chinook ($1,000s and percent) Page 1 of 3

Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	Fall Chinook: Probability of Meeting Standard (Low) (%)	Fall Chinook: Probability of Meeting Standard (High) (%)	Fall Chinook: Probability Net of Base Case (Low) (%)	Fall Chinook: Probability Net of Base Case (High) (%)	Fall Chinook: Cost or Saving per % Increase (Low) ($)	Fall Chinook: Cost or Saving per % Increase (High) ($)	Fall Chinook: Decrease in Cost if Meets Standard (Low) ($)	Fall Chinook: Decrease in Cost if Meets Standard (High) ($)
6.875 PERCENT DISCOUNT RATE											
Implementation Costs	2	320,282	328,922	78	97	0	0	NM	NM	320,282	328,922
	3	(279,494)	(334,214)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(6,342,587)	(6,459,707)	89	98	11	1	NM	NM	NM	NM
Power Costs	2	360,602	288,602	78	97	0	0	NM	NM	360,602	288,602
	3	(270,854)	(342,854)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(5,921,147)	(6,881,147)	89	98	11	1	NM	NM	NM	NM
Avoided Costs	2	324,602	324,602	78	97	0	0	NM	NM	324,602	324,602
	3	(306,854)	(306,854)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(6,441,467)	(6,360,827)	89	98	11	1	NM	NM	NM	NM
Transportation Costs	2	324,602	324,602	78	97	0	0	NM	NM	324,602	324,602
	3	(306,854)	(306,854)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(6,159,875)	(6,642,419)	89	98	11	1	NM	NM	NM	NM
Irrigation & Water System Costs	2	324,602	324,602	78	97	0	0	NM	NM	324,602	324,602
	3	(306,854)	(306,854)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(6,365,039)	(6,437,255)	89	98	11	1	NM	NM	NM	NM
Recreation Benefits	2	295,442	295,442	78	97	0	0	NM	NM	295,442	295,442
	3	(337,070)	(337,070)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(7,425,655)	(1,487,502)	89	98	11	1	NM	NM	NM	NM
Anadromous Fish Benefits	2	318,980	320,078	78	97	0	0	NM	NM	318,980	320,078
	3	(312,258)	(317,223)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(6,430,008)	(6,388,068)	89	98	11	1	NM	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-8. Cost Effectiveness Comparison for 24-year Survival Standard for Fall Chinook ($1,000s and percent) Page 2 of 3

4.75 PERCENT DISCOUNT RATE

Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	Fall Chinook Probability of Meeting Standard (Low) (%)	Fall Chinook Probability of Meeting Standard (High) (%)	Probability Net of Base Case (Low) (%)	Probability Net of Base Case (High) (%)	Cost or Saving per % Increase (Low) ($)	Cost or Saving per % Increase (High) ($)	Decrease in Cost if Meets Standard (Low) ($)	Decrease in Cost if Meets Standard (High) ($)
Implementation Costs	2	306,898	313,138	78	97	0	0	NM	NM	306,898	313,138
	3	(143,981)	(185,261)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(5,523,679)	(5,608,639)	89	98	11	1	NM	NM	NM	NM
Power Costs	2	346,018	274,018	78	97	0	0	NM	NM	346,018	274,018
	3	(128,621)	(200,621)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(5,074,159)	(6,058,159)	89	98	11	1	NM	NM	NM	NM
Avoided Costs	2	310,018	310,018	78	97	0	0	NM	NM	310,018	310,018
	3	(164,621)	(164,621)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(5,606,959)	(5,525,359)	89	98	11	1	NM	NM	NM	NM
Transportation Costs	2	310,018	310,018	78	97	0	0	NM	NM	310,018	310,018
	3	(164,621)	(164,621)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(5,380,648)	(5,751,669)	89	98	11	1	NM	NM	NM	NM
Irrigation & Water System Costs	2	310,018	310,018	78	97	0	0	NM	NM	310,018	310,018
	3	(164,621)	(164,621)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(5,541,007)	(5,591,311)	89	98	11	1	NM	NM	NM	NM
Recreation Benefits	2	274,378	274,378	78	97	0	0	NM	NM	274,378	274,378
	3	(200,501)	(200,501)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(6,691,330)	(2,662,982)	89	98	11	1	NM	NM	NM	NM
Anadromous Fish Benefits	2	303,986	305,891	78	97	0	0	NM	NM	303,986	305,891
	3	(170,104)	(173,998)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(5,602,948)	(5,546,422)	89	98	11	1	NM	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-8. Cost Effectiveness Comparison for 24-year Survival Standard for Fall Chinook ($1,000s and percent)

				Fall Chinook							
		0.0 PERCENT DISCOUNT RATE									
				Probability of Meeting Standard		Probability Net of Base Case		Cost per % Increase		Decrease in Cost if Meets Standard	
Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	(Low) (%)	(High) (%)	(Low) (%)	(High) (%)	(Low) ($)	(High) ($)	(Low) ($)	(High) ($)
Implementation Costs	2	235,314	237,234	78	97	0	0	NM	NM	235,314	237,234
	3	103,224	91,704	69	95	(9)	(2)	NM	NM	NM	NM
	4	(3,792,785)	(3,812,465)	89	98	11	1	NM	NM	NM	NM
Power Costs	2	260,274	212,274	78	97	0	0	NM	NM	260,274	212,274
	3	121,464	73,464	69	95	(9)	(2)	NM	NM	NM	NM
	4	(3,262,625)	(4,342,625)	89	98	11	1	NM	NM	NM	NM
Avoided Costs	2	236,274	236,274	78	97	0	0	NM	NM	236,274	236,274
	3	97,464	97,464	69	95	(9)	(2)	NM	NM	NM	NM
	4	(3,843,185)	(3,762,065)	89	98	11	1	NM	NM	NM	NM
Transportation Costs	2	236,274	236,274	78	97	0	0	NM	NM	236,274	236,274
	3	97,464	97,464	69	95	(9)	(2)	NM	NM	NM	NM
	4	(3,722,103)	(3,883,147)	89	98	11	1	NM	NM	NM	NM
Irrigation & Water System Costs	2	236,274	236,274	78	97	0	0	NM	NM	236,274	236,274
	3	97,464	97,464	69	95	(9)	(2)	NM	NM	NM	NM
	4	(3,797,381)	(3,807,869)	89	98	11	1	NM	NM	NM	NM
Recreation Benefits	2	216,954	216,954	78	97	0	0	NM	NM	216,954	216,954
	3	81,312	81,312	69	95	(9)	(2)	NM	NM	NM	NM
	4	(5,245,042)	2,465,262	89	98	11	1	NM	NM	NM	NM
Anadromous Fish Benefits	2	230,108	234,235	78	97	0	0	NM	NM	230,108	234,235
	3	92,884	93,024	69	95	(9)	(2)	NM	NM	NM	NM
	4	(3,863,629)	(3,765,750)	89	98	11	1	NM	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-9. Cost Effectiveness Comparison for 48-year Recovery Standard for Fall Chinook ($1,000s and percent) Page 1 of 3

6.875 PERCENT DISCOUNT RATE											
				Fall Chinook							
				Probability of Meeting Standard		Probability Net of Base Case		Cost or Saving per % Increase		Decrease in Cost if Meets Standard	
Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	(Low) (%)	(High) (%)	(Low) (%)	(High) (%)	(Low) ($)	(High) ($)	(Low) ($)	(High) ($)
Implementation Costs	2	640,565	657,845	15	56	0	0	NM	NM	NM	657,845
	3	(558,987)	(668,427)	17	63	2	7	NM	NM	NM	NM
	4	(12,685,175)	(12,919,415)	100	100	85	44	(149,237)	NM	NM	NM
Power Costs	2	721,205	577,205	15	56	0	0	NM	NM	NM	577,205
	3	(541,707)	(685,707)	17	63	2	7	NM	NM	NM	NM
	4	(11,842,295)	(13,762,295)	100	100	85	44	(139,321)	NM	NM	NM
Avoided Costs	2	649,205	649,205	15	56	0	0	NM	NM	NM	649,205
	3	(613,707)	(613,707)	17	63	2	7	NM	NM	NM	NM
	4	(12,882,935)	(12,721,655)	100	100	85	44	(151,564)	NM	NM	NM
Transportation Costs	2	649,205	649,205	15	56	0	0	NM	NM	NM	649,205
	3	(613,707)	(613,707)	17	63	2	7	NM	NM	NM	NM
	4	(12,319,751)	(13,284,839)	100	100	85	44	(144,938)	NM	NM	NM
Irrigation & Water System Costs	2	649,205	649,205	15	56	0	0	NM	NM	NM	649,205
	3	(613,707)	(613,707)	17	63	2	7	NM	NM	NM	NM
	4	(12,730,079)	(12,874,511)	100	100	85	44	(149,766)	NM	NM	NM
Recreation Benefits	2	590,885	590,885	15	56	0	0	NM	NM	NM	590,885
	3	(674,139)	(674,139)	17	63	2	7	NM	NM	NM	NM
	4	(14,851,310)	(2,975,004)	100	100	85	44	(174,721)	NM	NM	NM
Anadromous Fish Benefits	2	637,959	640,155	15	56	0	0	NM	NM	NM	640,155
	3	(624,516)	(634,447)	17	63	2	7	NM	NM	NM	NM
	4	(12,860,015)	(12,776,136)	100	100	85	44	(151,294)	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-9. Cost Effectiveness Comparison for 48-year Recovery Standard for Fall Chinook ($1,000s and percent) Page 2 of 3

4.75 PERCENT DISCOUNT RATE

Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	Fall Chinook: Probability of Meeting Standard		Fall Chinook: Probability Net of Base Case		Fall Chinook: Cost or Saving per % Increase		Fall Chinook: Decrease in Cost if Meets Standard	
				(Low) (%)	(High) (%)	(Low) (%)	(High) (%)	(Low) ($)	(High) ($)	(Low) ($)	(High) ($)
Implementation Costs	2	613,795	626,275	15	56	0	0	NM	NM	NM	626,275
	3	(287,962)	(370,522)	17	63	2	7	NM	NM	NM	NM
	4	(11,047,357)	(11,217,277)	100	100	85	44	(129,969)	NM	NM	NM
Power Costs	2	692,035	548,035	15	56	0	0	NM	NM	NM	548,035
	3	(257,242)	(401,242)	17	63	2	7	NM	NM	NM	NM
	4	(10,148,317)	(12,116,317)	100	100	85	44	(119,392)	NM	NM	NM
Avoided Costs	2	620,035	620,035	15	56	0	0	NM	NM	NM	620,035
	3	(329,242)	(329,242)	17	63	2	7	NM	NM	NM	NM
	4	(11,213,917)	(11,050,717)	100	100	85	44	(131,928)	NM	NM	NM
Transportation Costs	2	620,035	620,035	15	56	0	0	NM	NM	NM	620,035
	3	(329,242)	(329,242)	17	63	2	7	NM	NM	NM	NM
	4	(10,761,296)	(11,503,338)	100	100	85	44	(126,603)	NM	NM	NM
Irrigation & Water System Costs	2	620,035	620,035	15	56	0	0	NM	NM	NM	620,035
	3	(329,242)	(329,242)	17	63	2	7	NM	NM	NM	NM
	4	(11,082,013)	(11,182,621)	100	100	85	44	(130,377)	NM	NM	NM
Recreation Benefits	2	548,755	548,755	15	56	0	0	NM	NM	NM	548,755
	3	(401,002)	(401,002)	17	63	2	7	NM	NM	NM	NM
	4	(13,382,661)	(5,325,964)	100	100	85	44	(157,443)	NM	NM	NM
Anadromous Fish Benefits	2	607,973	611,782	15	56	0	0	NM	NM	NM	611,782
	3	(340,208)	(347,997)	17	63	2	7	NM	NM	NM	NM
	4	(11,205,895)	(11,092,845)	100	100	85	44	(131,834)	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-9. Cost Effectiveness Comparison for 48-year Recovery Standard for Fall Chinook ($1,000s and percent)

0.0 PERCENT DISCOUNT RATE

Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	Fall Chinook: Probability of Meeting Standard (Low) (%)	Fall Chinook: Probability of Meeting Standard (High) (%)	Fall Chinook: Probability Net of Base Case (Low) (%)	Fall Chinook: Probability Net of Base Case (High) (%)	Fall Chinook: Cost or Saving per % Increase (Low) ($)	Fall Chinook: Cost or Saving per % Increase (High) ($)	Fall Chinook: Decrease in Cost if Meets Standard (Low) ($)	Fall Chinook: Decrease in Cost if Meets Standard (High) ($)
Implementation Costs	2	470,628	474,468	15	56	0	0	NM	NM	NM	474,468
	3	206,449	183,409	17	63	2	7	NM	NM	NM	NM
	4	(7,585,570)	(7,624,930)	100	100	85	44	(89,242)	NM	NM	NM
Power Costs	2	520,548	424,548	15	56	0	0	NM	NM	NM	424,548
	3	242,929	146,929	17	63	2	7	NM	NM	NM	NM
	4	(6,525,250)	(8,685,250)	100	100	85	44	(76,768)	NM	NM	NM
Avoided Costs	2	472,548	472,548	15	56	0	0	NM	NM	NM	472,548
	3	194,929	194,929	17	63	2	7	NM	NM	NM	NM
	4	(7,686,370)	(7,524,130)	100	100	85	44	(90,428)	NM	NM	NM
Transportation Costs	2	472,548	472,548	15	56	0	0	NM	NM	NM	472,548
	3	194,929	194,929	17	63	2	7	NM	NM	NM	NM
	4	(7,444,206)	(7,766,294)	100	100	85	44	(87,579)	NM	NM	NM
Irrigation & Water System Costs	2	472,548	472,548	15	56	0	0	NM	NM	NM	472,548
	3	194,929	194,929	17	63	2	7	NM	NM	NM	NM
	4	(7,594,762)	(7,615,738)	100	100	85	44	(89,350)	NM	NM	NM
Recreation Benefits	2	433,908	433,908	15	56	0	0	NM	NM	NM	433,908
	3	162,625	162,625	17	63	2	7	NM	NM	NM	NM
	4	(10,490,084)	4,930,524	100	100	85	44	(123,413)	NM	NM	NM
Anadromous Fish Benefits	2	460,216	468,470	15	56	0	0	NM	NM	NM	468,470
	3	185,769	186,048	17	63	2	7	NM	NM	NM	NM
	4	(7,727,259)	(7,531,500)	100	100	85	44	(90,909)	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-10. Cost Effectiveness Comparison for 100-year Survival Standard for Fall Chinook ($1,000s and percent)

6.875 PERCENT DISCOUNT RATE

Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	Fall Chinook: Probability of Meeting Standard (Low) (%)	Probability of Meeting Standard (High) (%)	Probability Net of Base Case (Low) (%)	Probability Net of Base Case (High) (%)	Cost or Saving per % Increase (Low) ($)	Cost or Saving per % Increase (High) ($)	Decrease in Cost if Meets Standard (Low) ($)	Decrease in Cost if Meets Standard (High) ($)
Implementation Costs	2	1,334,510	1,370,510	78	97	0	0	NM	NM	1,334,510	1,370,510
	3	(1,164,556)	(1,392,556)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(26,427,448)	(26,915,448)	89	98	11	1	NM	NM	NM	NM
Power Costs	2	1,502,510	1,202,510	78	97	0	0	NM	NM	1,502,510	1,202,510
	3	(1,128,556)	(1,428,556)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(24,671,448)	(28,671,448)	89	98	11	1	NM	NM	NM	NM
Avoided Costs	2	1,352,510	1,352,510	78	97	0	0	NM	NM	1,352,510	1,352,510
	3	(1,278,556)	(1,278,556)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(26,839,448)	(26,503,448)	89	98	11	1	NM	NM	NM	NM
Transportation Costs	2	1,352,510	1,352,510	78	97	0	0	NM	NM	1,352,510	1,352,510
	3	(1,278,556)	(1,278,556)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(25,666,148)	(27,676,748)	89	98	11	1	NM	NM	NM	NM
Irrigation & Water System Costs	2	1,352,510	1,352,510	78	97	0	0	NM	NM	1,352,510	1,352,510
	3	(1,278,556)	(1,278,556)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(26,520,998)	(26,821,898)	89	98	11	1	NM	NM	NM	NM
Recreation Benefits	2	1,231,010	1,231,010	78	97	0	0	NM	NM	1,231,010	1,231,010
	3	(1,404,456)	(1,404,456)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(30,940,230)	(6,197,924)	89	98	11	1	NM	NM	NM	NM
Anadromous Fish Benefits	2	1,329,082	1,333,656	78	97	0	0	NM	NM	1,329,082	1,333,656
	3	(1,301,075)	(1,321,764)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(26,791,699)	(26,616,951)	89	98	11	1	NM	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-10. Cost Effectiveness Comparison for 100-year Survival Standard for Fall Chinook ($1,000s and percent) Page 2 of 3

4.75 PERCENT DISCOUNT RATE											
				Fall Chinook							
				Probability of Meeting Standard		Probability Net of Base Case		Cost or Saving per % Increase		Decrease in Cost if Meets Standard	
Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	(Low) (%)	(High) (%)	(Low) (%)	(High) (%)	(Low) ($)	(High) ($)	(Low) ($)	(High) ($)
Implementation Costs	2	1,278,740	1,304,740	78	97	0	0	NM	NM	1,278,740	1,304,740
	3	(599,921)	(771,921)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(23,015,327)	(23,369,327)	89	98	11	1	NM	NM	NM	NM
Power Costs	2	1,441,740	1,141,740	78	97	0	0	NM	NM	1,441,740	1,141,740
	3	(535,921)	(835,921)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(21,142,327)	(25,242,327)	89	98	11	1	NM	NM	NM	NM
Avoided Costs	2	1,291,740	1,291,740	78	97	0	0	NM	NM	1,291,740	1,291,740
	3	(685,921)	(685,921)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(23,362,327)	(23,022,327)	89	98	11	1	NM	NM	NM	NM
Transportation Costs	2	1,291,740	1,291,740	78	97	0	0	NM	NM	1,291,740	1,291,740
	3	(685,921)	(685,921)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(22,419,368)	(23,965,287)	89	98	11	1	NM	NM	NM	NM
Irrigation & Water System Costs	2	1,291,740	1,291,740	78	97	0	0	NM	NM	1,291,740	1,291,740
	3	(685,921)	(685,921)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(23,087,527)	(23,297,127)	89	98	11	1	NM	NM	NM	NM
Recreation Benefits	2	1,143,240	1,143,240	78	97	0	0	NM	NM	1,143,240	1,143,240
	3	(835,421)	(835,421)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(27,880,543)	(11,095,758)	89	98	11	1	NM	NM	NM	NM
Anadromous Fish Benefits	2	1,266,610	1,274,545	78	97	0	0	NM	NM	1,266,610	1,274,545
	3	(708,767)	(724,994)	69	95	(9)	(2)	NM	NM	NM	NM
	4	(23,345,615)	(23,110,093)	89	98	11	1	NM	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

Table 8-10. Cost Effectiveness Comparison for 100-year Survival Standard for Fall Chinook ($1,000s and percent)

Varied Parameter	Alternative	Low-end Nominal Range Estimate ($)	High-end Nominal Range Estimate ($)	Probability of Meeting Standard (Low) (%)	Probability of Meeting Standard (High) (%)	Probability Net of Base Case (Low) (%)	Probability Net of Base Case (High) (%)	Cost or Saving per % Increase (Low) ($)	Cost or Saving per % Increase (High) ($)	Decrease in Cost if Meets Standard (Low) ($)	Decrease in Cost if Meets Standard (High) ($)
0.0 PERCENT DISCOUNT RATE — Fall Chinook											
Implementation Costs	2	980,474	988,474	78	97	0	0	NM	NM	980,474	988,474
	3	430,102	382,102	69	95	(9)	(2)	NM	NM	NM	NM
	4	(15,803,272)	(15,885,272)	89	98	11	1	NM	NM	NM	NM
Power Costs	2	1,084,474	884,474	78	97	0	0	NM	NM	1,084,474	884,474
	3	506,102	306,102	69	95	(9)	(2)	NM	NM	NM	NM
	4	(13,594,272)	(18,094,272)	89	98	11	1	NM	NM	NM	NM
Avoided Costs	2	984,474	984,474	78	97	0	0	NM	NM	984,474	984,474
	3	406,102	406,102	69	95	(9)	(2)	NM	NM	NM	NM
	4	(16,013,272)	(15,675,272)	89	98	11	1	NM	NM	NM	NM
Transportation Costs	2	984,474	984,474	78	97	0	0	NM	NM	984,474	984,474
	3	406,102	406,102	69	95	(9)	(2)	NM	NM	NM	NM
	4	(15,508,763)	(16,179,780)	89	98	11	1	NM	NM	NM	NM
Irrigation & Water System Costs	2	984,474	984,474	78	97	0	0	NM	NM	984,474	984,474
	3	406,102	406,102	69	95	(9)	(2)	NM	NM	NM	NM
	4	(15,822,422)	(15,866,122)	89	98	11	1	NM	NM	NM	NM
Recreation Benefits	2	903,974	903,974	78	97	0	0	NM	NM	903,974	903,974
	3	338,802	338,802	69	95	(9)	(2)	NM	NM	NM	NM
	4	(21,854,341)	10,271,925	89	98	11	1	NM	NM	NM	NM
Anadromous Fish Benefits	2	958,783	975,979	78	97	0	0	NM	NM	958,783	975,979
	3	387,019	387,599	69	95	(9)	(2)	NM	NM	NM	NM
	4	(16,098,456)	(15,690,626)	89	98	11	1	NM	NM	NM	NM

Notes: Estimates for Alternatives 2, 3, and 4 are net of Alternative 1—Existing Conditions.
NM = Not meaningful

9. Cost Effectiveness

9.1 Introduction and Study Organization

The purpose of the cost effectiveness analysis is to identify the least cost method for providing various levels of output. For example, if two of the alternatives under consideration meet the NMFS jeopardy standards, then cost effectiveness analysis helps to establish the less costly alternative.

The following section reports the results of the cost effectiveness analysis. It should be noted that this analysis only deals with NED costs and benefits, as defined by the Corps. This section is divided into the following four section: discussion of biological outputs, discussion of net cost factors, cost effectiveness comparisons, and conclusions. All tables and figures presented in this section were developed as part of the DREW Cost Effectiveness Study. Sources of secondary information used by the DREW Cost Effectiveness Workgroup to develop these tables and figures are noted, as appropriate.

9.2 Discussion of Biological Outputs

There are four species of fish in the lower Snake River system that have been listed as endangered or threatened by NMFS under the Endangered Species Act, including spring/summer chinook, fall chinook, steelhead, and sockeye. The effects of the proposed alternatives in improving the chances of recovery and survival of these species are considered the “benefits” or “output” of undertaking the study alternatives. The following section reviews the development and application of the NMFS jeopardy standards.

This cost effectiveness analysis relies on model results from PATH for the biological output. Specifically, the PATH results from 1998 are used in this chapter. PATH continued to refine model outputs in 1999 and after PATH was disbanded, the Cumulative Risk Initiative (CRI) process was initiated to determine the potential biological responses to changes in the river system. The results from the 1999 PATH and the CRI model efforts were not available to be included in this appendix. However, the implications of these initiatives are discussed in Sections 9.2.1.6 and 9.2.1.7.

The PATH analysis was based upon six of seven stocks of spring/summer chinook and one stock of fall chinook, but PATH results were not extrapolated to the entire population of lower Snake River chinook. The DREW Anadromous Fish Workgroup, working in coordination with staff from NMFS and members of PATH, extrapolated the results of the PATH analysis to all lower Snake River spring/summer and fall chinook stocks and also prepared estimates for steelhead, which are believed to have a similar biological response to that of spring/summer chinook. Neither PATH nor the DREW Anadromous Fish Workgroup prepared estimates for sockeye, because there were insufficient data. The DREW Anadromous Fish Workgroup focused on harvest of the extrapolated fish runs and did not report the number of returning adults. As a result, the following cost effectiveness analysis uses the un-extrapolated estimates of wild fish prepared by PATH for spring/summer chinook, fall chinook, and steelhead. The number of spring/summer chinook, fall chinook, and steelhead projected to return under Alternatives 2, 3, and 4 are presented for years 24, 48, and 100 in Table 9-1. These estimates are presented net of Alternative 1—Existing Conditions.

9.2.1 PATH 1998 Model Results

PATH is a formal and rigorous program of formulating and testing hypotheses by using a series of model simulations to estimate both past and future trends in fish abundance for each of the selected stocks. The primary objective of PATH's modeling is to enhance the survival opportunities of the affected Evolutionary Significant Units (ESUs) by considering the probability of the stock's response to jeopardy standards, which were defined by the Biological Requirements Working Group (BRWG) and largely accepted by NMFS (Peters et al., 1999).

Table 9-1. Estimated Net Change in Spring/Summer Chinook, Fall Chinook, and Steelhead[1/2/]

Year	Alternative 2	Alternative 3	Alternative 4
Spring/Summer Chinook			
24	25,421	40,297	180,450
48	45,016	76,900	569,951
100	83,282	151,167	1,450,089
Fall Chinook			
24	–	4,829	219,592
48	–	12,007	538,809
100	–	25,940	1,234,542
Steelhead			
24	4,069	(6,468)	32,061
48	1,472	(17,838)	111,364
100	(4,265)	(44,817)	295,705
All Fish			
24	29,490	38,657	432,103
48	46,488	71,068	1,220,124
100	79,017	132,290	2,980,336

1/ Estimates are presented net of Alternative 1—Existing Conditions
2/ These estimated numbers of wild fish are cumulative.
Source: Personal communication with NMFS

9.2.1.1 Definition of Jeopardy Standards

The jeopardy standards include both survival and recovery goals as defined below:

- Survival standards (which set the threshold for survival) are based on projected probabilities that the spawning abundance will exceed a pre-defined survival threshold over a 24- or 100-year simulation period. Survival standards are met when that probability is 70 percent or greater.
- Recovery standards (which are required to consider de-listing of the species) are based on probabilities of exceeding a recovery threshold in the last 8 years of a 48-year simulation period. This standard is met when the probability is 50 percent or greater (PATH memo to IT team).

Harvest Standards

In addition to the survival and recovery standards, there may also be harvest goals, which were not considered by PATH. These thresholds may be defined as a level of recovery which, in the judgment of the tribes, will lead to significantly increased tribal harvest, and commensurate significant improvement in cultural and material well being for tribal peoples (Meyer Resources, 1999).

However, no measurable harvest goals were proposed during the course of the study. The Tribal Circumstances report prepared for this study (Meyer Resources, 1999) has reported that the harvestable goals are met under Alternative 4—Dam Breaching, but not under other alternatives under the 1998 PATH model results. It is unknown whether the harvest goals would be met for dam retention alternatives using the 1999 PATH model results (see Section 5 for more details).

9.2.1.2 Spring/Summer Chinook 1998 Model Results

Table 9-2 presents the probability of each alternative meeting the NMFS 24-year and 100-year survival standards and the 48-year recovery standards for spring/summer chinook using data from the 1998 PATH model results as reported by NMFS. This table presents the median modeling results, which are considered the most likely outcome, as well as the 25th and 75th percentile model results, which bound the median result with a range from low to high outcomes. The first line of Table 9-2 should be read to say that the lowest 25 percent of PATH results for spring/summer chinook show a probability of meeting 55 percent of the NMFS survival standards for Alternative 1, the median PATH results have a probability of meeting 67 percent of the NMFS survival standards and the highest 75 percent of PATH results for spring/summer chinook have a probability of meeting 75 percent of the NMFS survival standards.

24-year Survival Standard for Spring/Summer Chinook.

None of the median results of any of the alternatives under consideration meet the 24-year survival standards, which as discussed above, require a 70 percent probability. However, the median results of all alternatives are relatively close to the survival standard (e.g., within 1 percent to 5 percent of meeting this standard). In addition, all alternatives meet the standard under the 75th percentile model results.

48-year Recovery Standard for Spring/Summer Chinook

Alternative 4—Dam Breaching, is the only alternative under consideration that meets the 48-year recovery standards for the median model results. None of the median results for the dam retention alternatives (e.g., Alternatives 1, 2, and 3) meet the 48-year recovery standards. However, the median results of the dam retention alternatives are relatively close to meeting the standard (e.g., within 2 percent to 5 percent). In addition, the 75th percentile model results exceed the recovery standard for all alternatives.

100-year Survival Standard for Spring/Summer Chinook

All of the median results of the alternatives under consideration meet the 100-year survival standards, which as discussed above, require a 70 percent probability.

Spring/Summer Chinook Production Estimates

As shown in Table 9-1, Alternative 4—Dam Breaching would generate approximately 180,000 more spring/summer chinook than Alternative 1—Existing Conditions by year 24. Alternatives 2 and 3 are expected to generate approximately 25,000 and 40,000 more spring/summer chinook by year 24, respectively. Estimates of annual production are shown for all four alternatives in Figure 9-1.

Table 9-2. Probability of Attaining NMFS Jeopardy Standards for Spring/Summer Chinook Using Unweighted 1998 Model Results

	24-year Survival		
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1—Existing Conditions	0.67	0.55	0.75
Alternative 2—Maximum Transport of Juvenile Salmon	0.65	0.54	0.75
Alternative 3—Major System Improvements	0.66	0.55	0.75
Alternative 4—Dam Breaching	0.69	0.63	0.76
	48-year Recovery		
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1—Existing Conditions	0.48	0.31	0.65
Alternative 2—Maximum Transport of Juvenile Salmon	0.45	0.29	0.66
Alternative 3—Major System Improvements	0.46	0.31	0.67
Alternative 4—Dam Breaching	0.84	0.74	0.92
	100-year Survival		
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1—Existing Conditions	0.79	0.68	0.87
Alternative 2—Maximum Transport of Juvenile Salmon	0.78	0.65	0.87
Alternative 3—Major System Improvements	0.79	0.67	0.87
Alternative 4—Dam Breaching	0.89	0.85	0.92

Source: Personal communication from NMFS

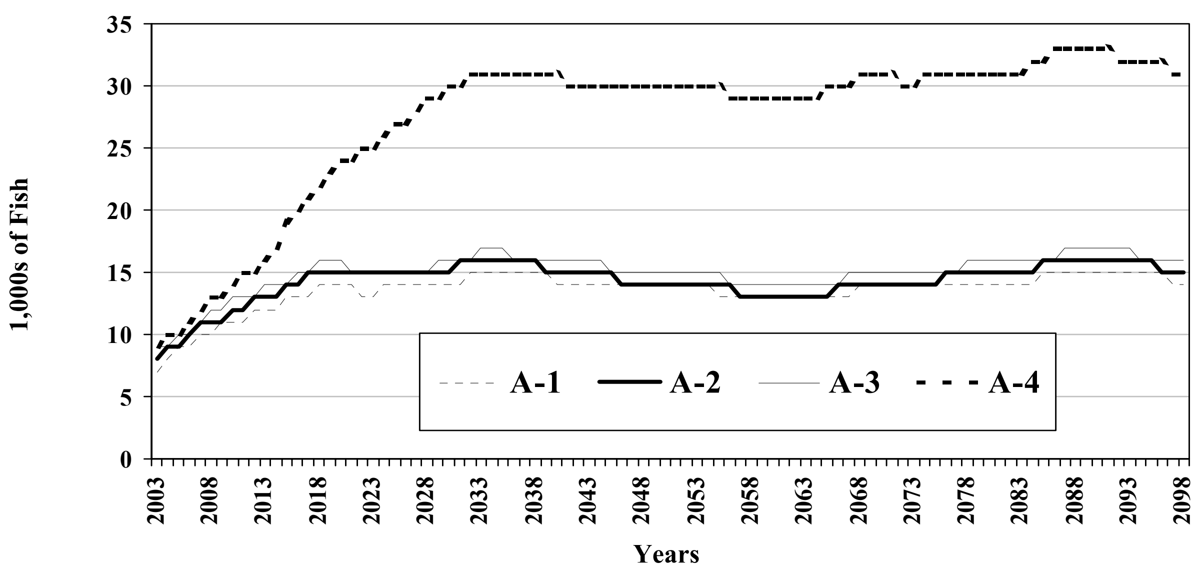

Figure 9-1. Spring/Summer Chinook Production Estimates under all Alternatives Using 1998 PATH Model Results (1,000s of fish)

9.2.1.3 Fall Chinook Model Results

Table 9-3 presents the probability of each alternative meeting the NMFS jeopardy standards for fall chinook. This table also presents the median modeling results, which are considered the most likely outcome, as well as the 25th and 75th percentile model results, which bound the median result with a range from low to high.

Table 9-3. Probability of Attaining NMFS Jeopardy Standards for Fall Chinook Using Unweighted 1998 Model Results

		24-year Survival	
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1—Existing Conditions	0.85	0.78	0.97
Alternative 2—Maximum Transport of Juvenile Salmon	0.85	0.78	0.97
Alternative 3—Major System Improvements	0.81	0.69	0.95
Alternative 4—Dam Breaching	0.93	0.89	0.98
		48-year Recovery	
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1—Existing Conditions	0.22	0.15	0.56
Alternative 2—Maximum Transport of Juvenile Salmon	0.22	0.15	0.56
Alternative 3—Major System Improvements	0.28	0.17	0.63
Alternative 4—Dam Breaching	1.00	1.00	1.00
		100-year Survival	
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1—Existing Conditions	0.83	0.71	0.98
Alternative 2—Maximum Transport of Juvenile Salmon	0.83	0.71	0.98
Alternative 3—Major System Improvements	0.78	0.64	0.95
Alternative 4—Dam Breaching	0.98	0.97	1.00

Source: Personal communication from NMFS

24-year Survival Standard for Fall Chinook

All of the median results of the alternatives under consideration meet the 24-year survival standards, which as discussed above, require a 70 percent probability.

48-year Recovery Standard for Fall Chinook

Alternative 4—Dam Breaching, is the only alternative under consideration that meets the 48-year recovery standards, using the median results from the 1998 PATH modeling process. None of the median results of the dam retention alternatives met the 48-year recovery standards under the modeling conducted in 1998, which as discussed above, require a 50 percent result. In this case, the median results of the dam retention alternatives are not close to the recovery standard (e.g., within 22 percent to 28 percent), but the 75th percentile model results for these alternatives do exceed the recovery standard.

100-year Survival Standard for Fall Chinook

All of the median results of the alternatives under consideration meet the 100-year survival standards, which as discussed above, require a 70 percent probability.

Fall Chinook Production Estimates

As shown in Table 9-1, Alternative 4—Dam Breaching would generate approximately 220,000 more fall Chinook than Alternative 1—Existing Conditions at year 24. Alternative 3—Major System Improvements is expected to generate approximately 5,000 more fall chinook by year 24. There would be no net gain in fall chinook by year 24 under Alternative 2—Maximum Transport of Juvenile Salmon. Estimates of annual production are shown for all four alternatives in Figure 9-2.

9.2.1.4 Steelhead Production Estimates

As shown in Table 9-1, Alternative 4—Dam Breaching would generate approximately 32,000 more steelhead than Alternative 1—Existing Conditions at year 24. Alternative 2—Maximum Transport of Juvenile Salmon would generate about 4,000 more steelhead than Alternative 1—Existing Conditions, while Alternative 3—Major System Improvements is expected to result in a net decrease of about 6,500 steelhead by year 24. Estimates of annual production are shown for all four alternatives in Figure 9-3.

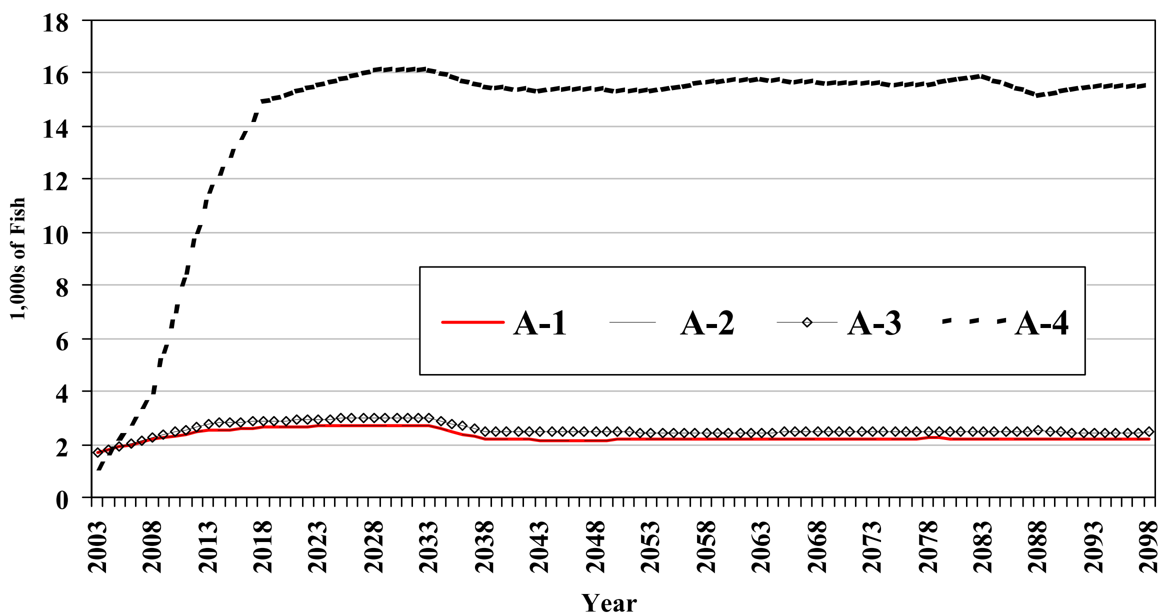

Figure 9-2. Fall Chinook Production Estimates under all Alternatives Using 1998 PATH Model Results (1,000s of fish)

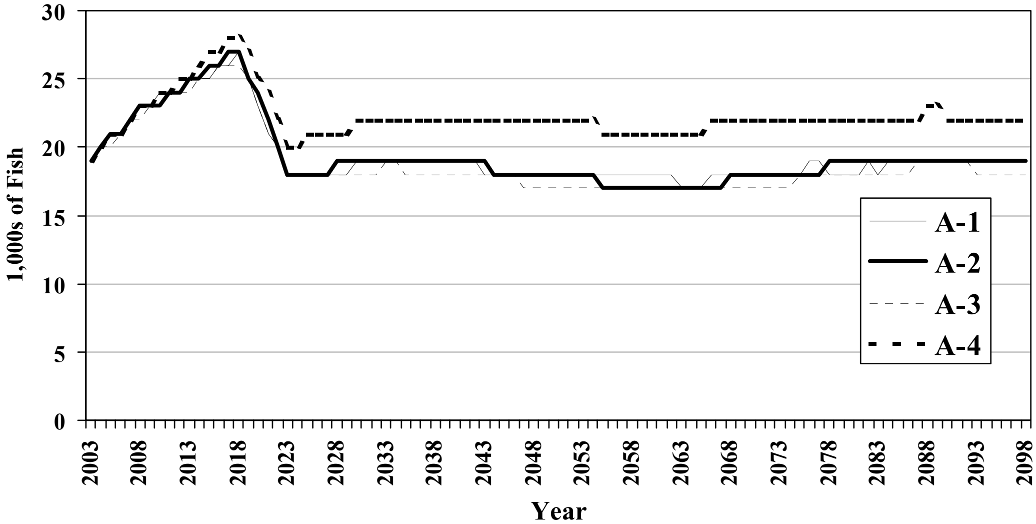

Figure 9-3. Steelhead Production Estimates under all Alternatives Using 1998 PATH Model Results (1,000s of fish)

9.2.1.5 Production Estimates for All Fish (Chinook and Steelhead)

As shown in Table 9-1, Alternative 4—Dam Breaching would generate approximately 432,000 more fish than Alternative 1—Existing Conditions at year 24. Alternatives 2 and 3 are expected to generate approximately 29,000 and 39,000 more fish by year 24, respectively. Estimates of annual production are shown for all four alternatives in Figure 9-4.

Figure 9-4. Net Increase in Fish over Base Case Conditions Using 1998 PATH Model Results (1,000s of fish)

9.2.1.6 1999 PATH Model Results

PATH modeled only wild spring/summer chinook and fall chinook. The PATH group completed their initial estimates of the expected return rates for wild adult spring/summer chinook in 1998 and for fall chinook in 1999. The Scientific Review Panel (SRP), which was tasked to review the PATH analysis methods, found inconsistencies in the results of both the fall chinook and later the spring/summer chinook analysis developed by PATH. These inconsistencies or uncertainties, that were not totally resolved by PATH, included concerns about the Differential Delayed Mortality factor (D value) that PATH attributed to smolt transport, delayed hydrosystem mortality, and such factors as the fixed assigned lower Snake River survival rate of 85 to 96 percent for Alternative 4—Dam Breaching. Adjustments made to a number of factors of concern in the original PATH analysis resulted in higher adult return predictions under Alternatives 1 through 3, which reduced the net difference between the three dam retention alternatives and Alternative 4—Dam Breaching.

According to Peters et al. (1999), the 1999 PATH model results had the following implications:

- All hydrosystem actions meet survival standards (probabilities of exceeding survival escapement thresholds are greater than 0.7), regardless of what is assumed about the estuary/ocean survival rate of transported fish.
- All dam breaching actions meet recovery standards (probabilities of exceeding recovery escapement thresholds are greater than 0.5), regardless of what is assumed about the estuary/ocean survival rate of transported fish. Alternative 4—Dam Breaching, exhibited the most robust response across those uncertainties considered to date, and produced higher recovery probabilities (as well as higher average spawning escapements) than other actions. This conclusion is sensitive to assumptions about adult upstream survival.
- For each hypothesis about relative survival of transported fish, there is a non-breaching action (actions which do not involve dam breaching) that meets the recovery standard**,** although there is no single non-breaching alternative option that meets recovery standards under all assumptions about the relative survival of transported fish. If transported fish are assumed to have high relative survival (i.e., high D), maximizing transportation will achieve recovery standards. If transported fish are assumed to have low relative survival (i.e., low D), then retaining current system configuration and allowing all smolts to migrate in-river achieves the recovery standards. Non-breaching actions are not as robust to the current level of uncertainty in relative survival of transported fish as Alternative 4—Dam Breaching.

9.2.1.7 Cumulative Risk Initiative Model Results

The adjusted PATH 1999 results were supported by the CRI modeling results. The CRI analysis, which was performed by NMFS, used the same wild fish numbers (run reconstruction data) as that used by PATH except it was restricted to the period between 1980 and 1999. This period was used, as NMFS believes this to be the most representative of the current conditions in the hydrosystem. The CRI analysis differed from that of PATH by not estimating the probability of achieving survival and recovery adult return standards, and also by estimating the chance of extinction occurring (which was not estimated by PATH). One of the main components used by CRI for estimating the chance of extinction was its estimate of population growth rate (lambda). While CRI did not specifically estimate returning numbers of fish due to Alternative 4—Dam Breaching, it did indicate that the PATH results for dam breaching and for all other alternatives were optimistic. CRI results suggest that few remaining survival improvements could be achieved from modification of the hydrosystem (i.e., Alternatives 1 to 3). However, while these results suggest that Alternative 4—Dam Breaching has a slight benefit over the other alternatives, these benefits were generally still inadequate by themselves to prevent extinction of all stocks. The CRI results suggest that the best chance of prevention of extinction would be from increasing survival and fitness in the early life history stages (egg to smolt stage) (e.g., from habitat improvements) and in increasing Columbia River estuary survival (e.g., from habitat improvements and predator control).

9.3 Discussion of Net Cost Factors

Evaluation of environmental restoration and mitigation solutions requires an evaluation of monetary effects (or factors) in four general classes. When combined, these effects form the "net cost" information for cost effectiveness analyses, described in greater detail below.

9.3.1 Definition of Net NED Costs

Net costs are defined to include all NED effects, including:

- Implementation costs for the fish-related improvements (e.g., the construction and acquisition costs, annual costs for operation, maintenance, repair, replacement, rehabilitation, and monitoring, and Federal mitigation costs). These costs are presented in Section 3.8 of this appendix.
- Avoided costs, which include operations, maintenance, repair, replacement, and rehabilitation of existing infrastructure that would be avoided under alternative conditions (e.g., existing power systems, navigation locks, and other like costs that occur under the dam retention alternatives but not under Alternative 4—Dam Breaching). These costs are also presented in Section 3.8.
- NED costs, which are any existing costs that would be incurred as a result of implementing Alternatives 2 through 4, notably:
    - additional costs to provide power by the next least costly form of power generation (see Section 3.1)
    - additional transportation costs to shift barge-transported commodities to other truck, rail and barge systems (see Section 3.3)
    - additional construction operation and maintenance (O&M) costs for irrigation and water supply systems (see Section 3.4).
- NED benefits, which are any existing benefits that would accrue as a result of implementing Alternatives 2 through 4, notably:
    - additional recreation benefits from dam breaching for anglers from enhanced fisheries and to users of a near-natural lower Snake River (see Section 3.2)
    - additional commercial fishing benefits in the river and ocean, and ocean and mainstem recreational angling benefits (see Section 3.5).

Net NED costs are defined to equal implementation costs plus avoided costs, plus NED costs less NED benefits.

9.3.2 Presentation of Annual Results (Using PATH 1998 Model Results)

Table 9-4 presents the low, most likely, and high net NED annualized costs, as defined in the previous sections. Again, all comparative estimates are net of the base case.

Under the most likely case and a 6.875 percent discount rate:

- Alternative 2—Maximum Transport of Juvenile Salmon, is $13.5 million less costly per year than the existing conditions
- Alternative 3—Major System Improvements, is $12.8 million more costly per year than the existing conditions
- Alternative 4—Dam Breaching, is $266.7 million more costly than the existing conditions annually over the 100-year study period under the most likely comparison. Alternative 4 is between $93.7 and $278.3 million more costly on an annual basis, compared with existing conditions at the 6.875 percent discount rate.

Under the most likely case and a 4.75 percent discount rate, Alternative 2 is $12.9 million less costly, Alternative 3 is $6.9 million more costly, and Alternative 4 is $231.9 million more costly than Alternative 1—Existing Conditions annually over the 100-year study period.

Under the most likely case and a 0.0 percent discount rate, Alternative 2 is $9.8 million less costly, Alternative 3 is $4.1 million less costly, and Alternative 4 is $158.4 million more costly than Alternative 1—Existing Conditions annually over the 100-year study period.

Table 9-4. Annualized Net Cost Comparison (1998 dollars) ($1,000s)

Rate	Most Likely ($)	Low ($)	High ($)
6.875 percent			
Alternative 2 less Alternative 1	13,525	13,396	10,802
Alternative 3 less Alternative 1	(12,786)	(11,630)	(17,117)
Alternative 4 less Alternative 1	(266,714)	(278,287)	(93,752)
4.75 percent			
Alternative 2 less Alternative 1	12,917	12,551	9,890
Alternative 3 less Alternative 1	(6,859)	(6,223)	(11,105)
Alternative 4 less Alternative 1	(231,923)	(250,991)	(139,483)
0.0 percent			
Alternative 2 less Alternative 1	9,845	9,743	7,995
Alternative 3 less Alternative 1	4,061	4,437	1,963
Alternative 4 less Alternative 1	(158,443)	(196,292)	79,462

Source: BST Associates using data from this appendix

9.4 Cost Effectiveness Comparisons

The following section provides a graphical and tabular comparison of the net NED costs and biological effectiveness for spring/summer chinook and fall chinook, separately, taking into account both the NMFS jeopardy standards and the estimated number of fish associated with each alternative. There are no PATH/NMFS estimates of the combined probabilities of meeting the jeopardy standards for both spring/summer and fall chinook salmon.

The cumulative costs are calculated by multiplying the annual costs by the number of years of the applied standard. As an example, Alternative 4—Dam Breaching costs $6.4 billion to administer over a 24-year period (e.g., 24 years times the annual cost of $266,714,478 equals $6,401,147,000). The total number of fish is calculated in a similar manner. As an example, Alternative 4—Dam Breaching results in 180,450 more fish during the first 24-year period than Alternative 1—Existing Conditions using PATH 1998 model results (Table 9-1).

The cost effectiveness assessment considers two different but related perspectives to determine the least costly means of meeting the NMFS jeopardy standards:

- The first evaluation considers the cost to attain an additional percentage of the jeopardy standards.
- The second evaluation considers the cost per additional fish.

9.4.1 Cost Effectiveness Assessment 1—All Costs Applied to Spring/Summer Chinook

Figures 9-5 through 9-7 and Table 9-5 present a comparison of the net NED cost and net biological effectiveness to achieve the NMFS' jeopardy standards for spring/summer chinook for the various alternatives under consideration. This cost effectiveness assessment considers the entire cost of the alternatives applied to spring/summer chinook.

9.4.1.1 24-year Survival Standard for Spring/Summer Chinook

As noted above, under the most likely (median) conditions, none of the alternatives meet the 24-year survival standard for spring/summer chinook. However, all alternatives are relatively close to the goal (e.g., within 3 percent for Alternative 1, 5 percent for Alternative 2, 4 percent for Alternative 3, and 1 percent for Alternative 4) (see Table 9-2). The cumulative costs associated with Alternative 2 are lower than those under Alternative 1, resulting in net savings relative to Alternative 1.

There is only a marginal improvement associated with selecting Alternative 4—Dam Breaching, over Alternative 1—Existing Conditions, but this occurs at a high cost. Each additional percentage of survival attained in moving from Alternative 1—Existing Conditions to Alternative 4—Dam Breaching is expected to cost approximately $3.2 billion in cumulative costs over the 24-year period. Under Alternative 4, each additional spring/summer chinook is estimated to cost $35,000 over the 24-year period, using the 1998 PATH model results (see Figure 9-5 and Table 9-5).

Table 9-5. Incremental Comparison of Net Costs ($1,000s) and Biological Effectiveness for Spring/Summer Chinook (1998 dollars)

Standard by Alternative	Cumulative Cost ($)	Percent (%)	Cost per percent ($)	Total Fish	Cost per Fish ($)
24-year Standard					
Alternative 2 less Alternative 1	324,602	(2.0)	162,301	25,421	13
Alternative 3 less Alternative 1	(306,854)	(1.0)	(306,854)	40,297	(8)
Alternative 4 less Alternative 1	(6,401,147)	2.0	(3,200,574)	180,450	(35)
48-year Standard					
Alternative 2 less Alternative 1	649,205	(3.0)	216,402	45,016	14
Alternative 3 less Alternative 1	(613,707)	(2.0)	(306,854)	76,900	(8)
Alternative 4 less Alternative 1	(12,802,295)	36.0	(355,619)	569,951	(22)
100-year Standard					
Alternative 2 less Alternative 1	1,352,510	(1.0)	1,352,510	83,282	16
Alternative 3 less Alternative 1	(1,278,556)	–	NM	151,167	(8)
Alternative 4 less Alternative 1	(26,671,448)	10.0	(2,667,145)	1,450,089	(18)

Notes:
1. This table uses 1998 PATH model results. 1999 model results are not available in the same format.
2. NM = Not meaningful.
3. Costs are presented net of Alternative 1. Figures in parentheses are costs that are greater than those incurred under Alternative 1.
4. Estimated numbers of wild fish are cumulative.

Source: BST Associates using data from this appendix, NMFS, and PATH

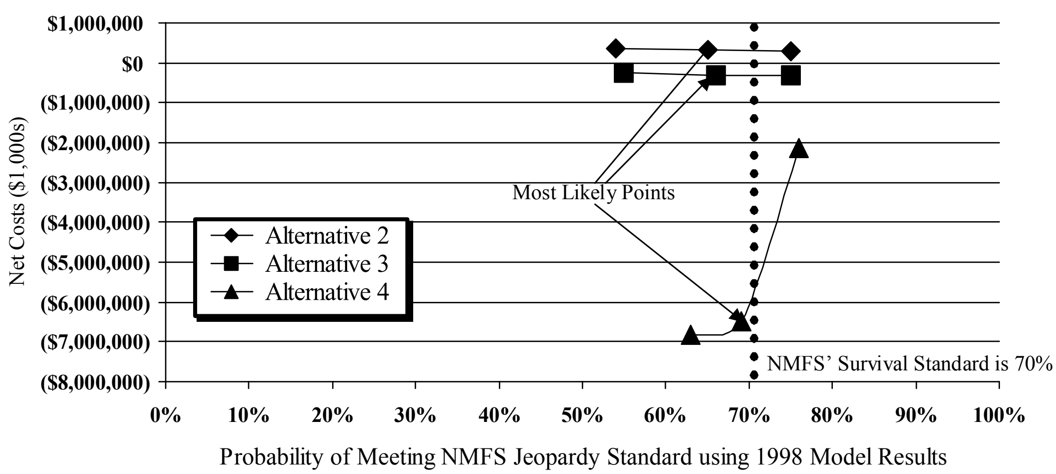

Figure 9-5. Net Cost and Biological Effectiveness Comparison for Meeting the NMFS' 24-year Survival Standards for Spring/Summer Chinook Using 1998 PATH Model Results

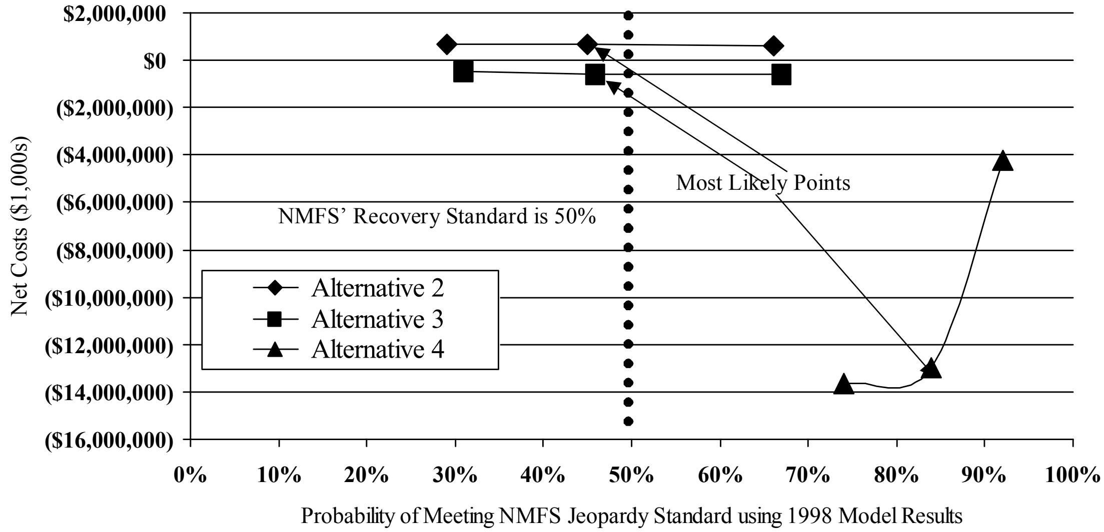

Figure 9-6. Net Cost and Biological Effectiveness Comparison for Meeting the NMFS' 48-year Recovery Standards for Spring/Summer Chinook Using 1998 PATH Model Results

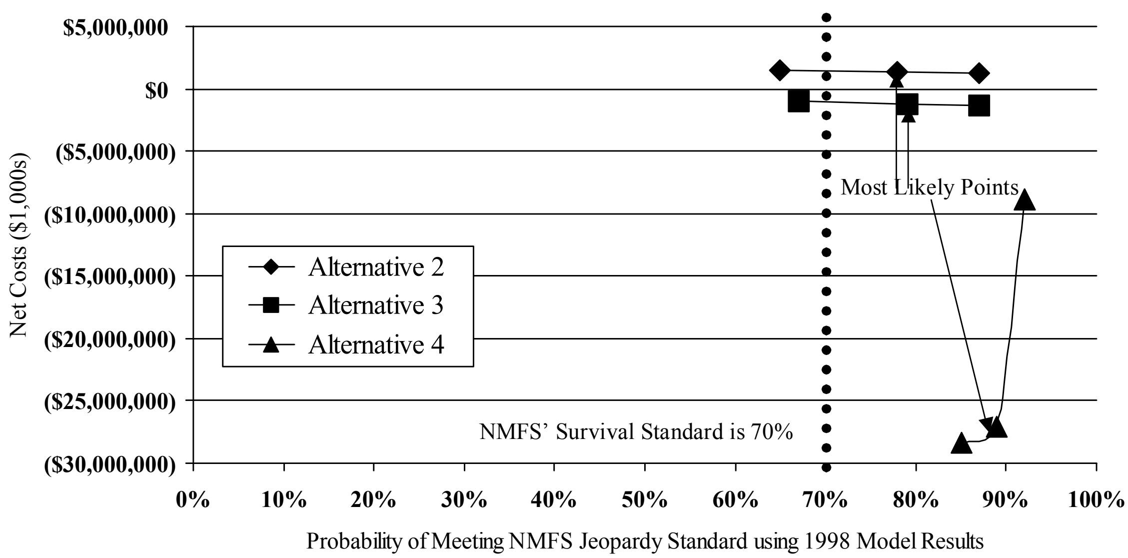

Figure 9-7. Net Cost and Biological Effectiveness Comparison for Meeting the NMFS' 100-year Survival Standards for Spring/Summer Chinook Using 1998 PATH Model Results

9.4.1.2 48-year Recovery Standard for Spring/Summer Chinook

Only Alternative 4—Dam Breaching meets the 48-year recovery standard using the 1998 PATH model results. The dam retention alternatives are relatively close to meeting the recovery standard under the median values (e.g., within 2 to 5 percent). All alternatives attain the standard under the high-end of the probability distribution (e.g., at the 75th percentile).

Each additional percentage attained from moving from Alternative 1—Existing Conditions (48 percent probability of attaining recovery) to Alternative 4—Dam Breaching (84 percent probability of recovery), is expected to cost $355.6 million over the 48-year period. Each fish attained by moving from Alternative 1—Existing Conditions, to Alternative 4—Dam Breaching is expected to cost approximately $22,000 (see Figure 9-6 and Table 9-5).

9.4.1.3 100-year Survival Standard for Spring/Summer Chinook

All alternatives meet the 100-year survival standard (see Figure 9-7 and Table 9-2).

Each additional percentage attained from moving from Alternative 1—Existing Conditions (79 percent probability of attaining recovery) to Alternative 4—Dam Breaching (89 percent probability of recovery) is expected to cost $2.7 billion over the 100-year period. Each fish attained by moving from Alternative 1—Existing Conditions to Alternative 4—Dam Breaching is expected to cost approximately $18,000 (see Figure 9-7 and Table 9-5).

9.4.2 Cost Effectiveness Assessment 2—All Costs Applied to Fall Chinook

Figures 9-8 through 9-10 and Table 9-6 present a comparison of the net cost and biological effectiveness to achieve the NMFS' jeopardy standards for fall chinook for the various alternatives under consideration. This cost effectiveness assessment considers the entire cost of the alternatives applied to fall chinook.

9.4.2.1 24-year Survival Standard for Fall Chinook

Under the most likely (median) conditions, all of the alternatives meet the 70 percent survival standard on the 24th-year. The probability of success is the same for Alternatives 1 and 2. Hence, there is no cost differential per percentage gained between these alternatives. However, Alternative 2 is $324.6 million less costly than Alternative 1.

The probability of meeting the 24-year standard is less under Alternative 3 than under Alternative 1 and also is more costly, by $306.9 million.

The 8 percent increase in probability from Alternative 1—Existing Conditions to Alternative 4—Dam Breaching would have a cumulative cost of $6,401.1 million resulting in a cost per percent of $800.1 million ($6,401.1 million/8) over the 24-year period. Each additional fish gained by dam breaching is estimated to cost $29,000 (see Figure 9-8 and Table 9-6).

9.4.2.2 48-year Recovery Standard for Fall Chinook

Only Alternative 4—Dam Breaching meets the 48-year recovery standard using the 1998 PATH model results. The dam retention alternatives are not close to meeting this recovery standard (between 22 percent to 28 percent away from the 50 percent recovery standard), using the 1998 model results (Table 9-3).

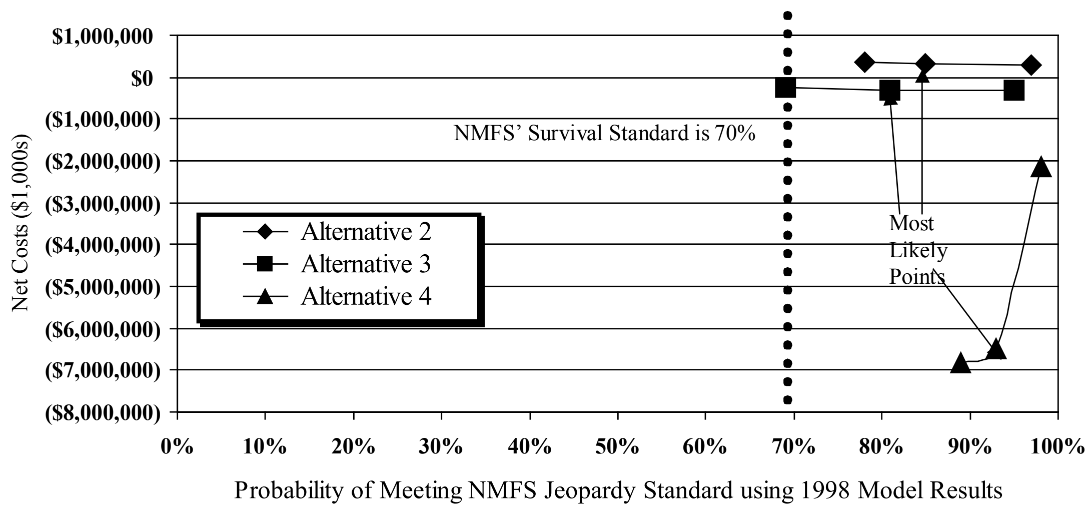

Figure 9-8. Net Cost and Biological Effectiveness Comparison for Meeting the NMFS' 24-year Survival Standards for Fall Chinook Using 1998 PATH Model Results

Table 9-6. Incremental Comparison of Net Costs ($1,000s) and Biological Effectiveness for Fall Chinook Using 1998 PATH Model Results (1998 dollars)

Standard by Alternative	Cumulative Cost ($)	Percent	Cost per percent ($)	Total Fish	Cost per Fish ($)
24-year Standard					
Alternative 2 less Alternative 1	324,602	–	–	–	–
Alternative 3 less Alternative 1	(306,854)	(4.0)	76,713	4,829	(64)
Alternative 4 less Alternative 1	(6,401,147)	8.0	(800,143)	219,592	(29)
48-year Standard					
Alternative 2 less Alternative 1	649,205	–	–	–	–
Alternative 3 less Alternative 1	(613,707)	6.0	(102,285)	12,007	(51)
Alternative 4 less Alternative 1	(12,802,295)	78.0	(164,132)	538,809	(24)
100-year Standard					
Alternative 2 less Alternative 1	1,352,510	–	–	–	–
Alternative 3 less Alternative 1	(1,278,556)	(5.0)	255,711	25,940	(49)
Alternative 4 less Alternative 1	(26,671,448)	15.0	(1,778,097)	1,234,542	(21)

Note: 1. This table uses 1998 PATH model results. The 1999 model results are not available in a similar format.
2. Costs are presented net of Alternative 1. Figures in parentheses are costs that are greater than those incurred under Alternative 1.
3. Estimated numbers of wild fish are cumulative.

Source: BST Associates using data from this appendix, NMFS, and PATH

The benefit in moving from Alternative 1—Existing Conditions to Alternative 3—Major System Improvements, is expected to cost $102.3 million with a gain of 6 percent in biological effectiveness per percent gain over the 48-year period. Each additional fish is expected to cost approximately $51,000 (see Figure 9-9 and Table 9-6).

Each additional percentage of survival attained from moving from Alternative 1—Existing Conditions (22 percent probability of attaining recovery) to Alternative 4—Dam Breaching (100 percent probability of recovery) is expected to cost $164.1 million per percent of biological effectiveness over the 48-year period. Each fish attained by moving from Alternative 1—Existing Conditions to Alternative 4—Dam Breaching is expected to cost approximately $24,000 (see Figure 9-9 and Table 9-6).

9.4.2.3 100-year Survival Standard for Fall Chinook

All alternatives meet the 100-year survival standard (see Figure 9-10 and Table 9-3).

Each additional percentage of survival attained from moving from Alternative 1—Existing Conditions to Alternative 4—Dam Breaching is expected to cost $1.8 billion over the 100-year period. Each fish attained by moving from Alternative 1—Existing Conditions to Alternative 4—Dam Breaching is expected to cost approximately $21,000 (Table 9-6).

9.4.3 Cost Effectiveness Assessment 3—Costs Applied to all Fish

A comparison of the net cost and biological effectiveness to achieve the NMFS jeopardy standards across spring/summer and fall chinook and steelhead for the various alternatives under consideration is presented in Table 9-7. This cost effectiveness assessment spreads the cost of the alternatives to all fish. As mentioned previously, there is no combined probability associated with meeting the NMFS standards across all impacted species.

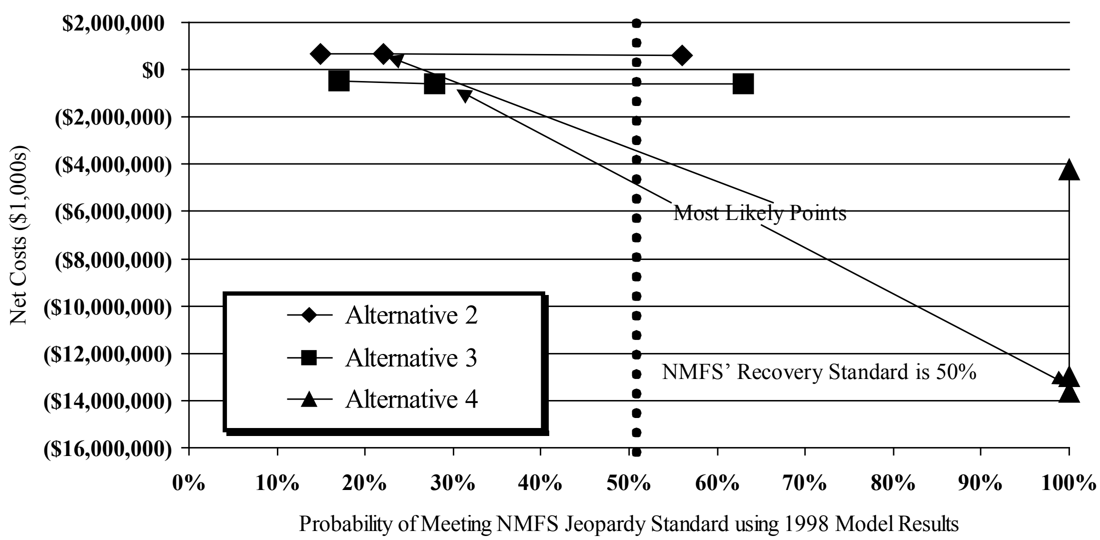

Figure 9-9. Net Cost and Biological Effectiveness Comparison for Meeting the NMFS' 48-year for Fall Chinook Using 1998 PATH Model Results

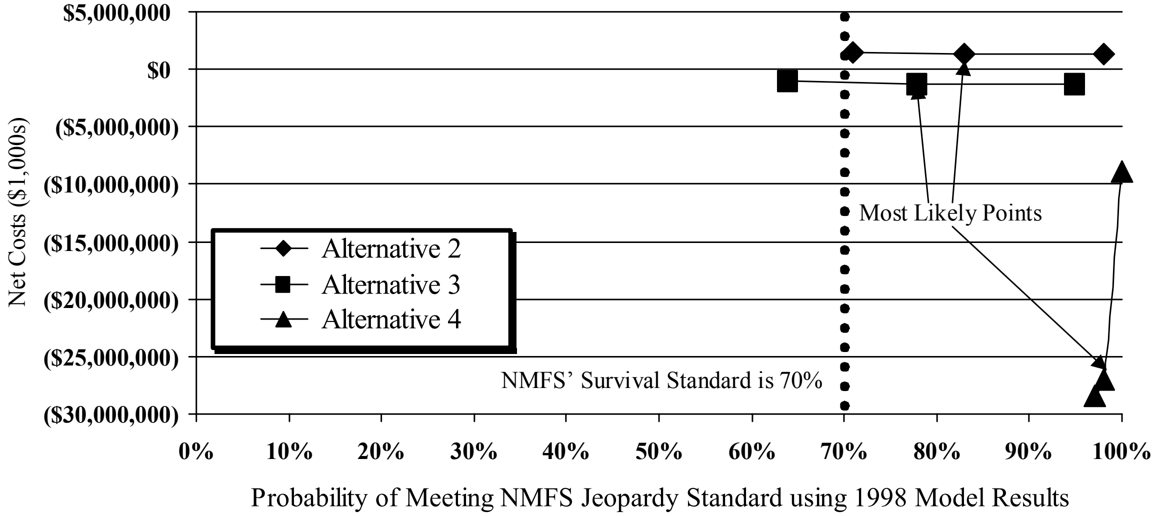

Figure 9-10. Net Cost and Biological Effectiveness Comparison for Meeting the NMFS' 100-year Survival Standards for Fall Chinook Using 1998 PATH Model Results

Table 9-7. Incremental Comparison of Net Costs ($1,000s) and Biological Effectiveness for Spring/Summer and Fall Chinook and for Steelhead Using 1998 PATH Model Results (1998 dollars)

Standard by Alternative	Cumulative Cost ($)	Total Fish	Cost per Fish ($)
24-year Standard			
Alternative 2 less Alternative 1	324,602	29,490	11
Alternative 3 less Alternative 1	(306,854)	38,657	(8)
Alternative 4 less Alternative 1	(6,401,147)	432,103	(15)
48-year Standard			
Alternative 2 less Alternative 1	649,205	46,488	14
Alternative 3 less Alternative 1	(613,707)	71,068	(9)
Alternative 4 less Alternative 1	(12,802,295)	1,220,124	(10)
100-year Standard			
Alternative 2 less Alternative 1	1,352,510	79,017	17
Alternative 3 less Alternative 1	(1,278,556)	132,290	(10)
Alternative 4 less Alternative 1	(26,671,448)	2,980,336	(9)

Note: 1. This table uses 1998 PATH model results. The 1999 model results are not available in a similar format.
2. Costs are presented net of Alternative 1. Figures in parentheses are costs that are greater than those incurred u Alternative 1.
3. Estimated numbers of wild fish are cumulative.

Source: BST Associates using data from this appendix, NMFS, and PATH

9.4.3.1 24-year Survival Standard for all Fish

Alternative 2 is estimated to generate more fish than Alternative 1 at a reduced cost. The savings from choosing this alternatives are estimated to be $11,000 per fish over the 24-year survival standard. The additional cost of moving from Alternative 1—Existing Conditions to Alternative 3—Major System Improvements is estimated to be $8,000 per fish over the 24-year period. The additional cost of moving from Alternative 1—Existing Conditions to Alternative 4—Dam Breaching is estimated to be $15,000 per fish over the 24-year period (see Table 9-7).

9.4.3.2 48-year Recovery Standard for all Fish

The savings from choosing Alternative 2—Maximum Transport of Juvenile Salmon are estimated to be $14,000 per fish over the 48-year recovery standard. The additional cost of moving from Alternative 1—Existing Conditions to Alternative 3—Major System Improvements is estimated to be $9,000 per fish over the 48-year period. The additional cost of moving from Alternative 1—Existing Conditions to Alternative 4—Dam Breaching is estimated to be $10,000 per fish over the 48-year period (see Table 9-6).

9.4.3.3 100-year Survival Standard for all Fish

The savings from choosing Alternative 2—Maximum Transport of Juvenile Salmon are estimated to be $17,000 per fish over the 100-year survival standard. The additional cost of moving from Alternative 1—Existing Conditions to Alternative 3—Major System Improvements, is estimated to be $10,000 per fish over the 100-year period. The additional cost of moving from Alternative 1—Existing Conditions to Alternative 4—Dam Breaching is estimated to be $9,000 per fish over the 100-year period (see Table 9-7).

9.5 Conclusions

9.5.1 Biological Considerations

9.5.1.1 1998 Model Results

None of the alternatives meet all of the jeopardy standards using 1998 PATH model results.

Alternative 4—Dam Breaching, comes the closest to meeting all of the jeopardy standards for both spring/summer and fall chinook (e.g., five out of six standards).

The dam retention alternatives come relatively close to meeting all of the jeopardy standards, with the exception of the 48-year recovery standard for fall chinook.

9.5.1.2 Ongoing Model Results

As discussed previously, PATH continued to refine the model in 1999, using new information on key variables related to delayed mortality (the D factor), ocean conditions, and ocean harvests, among other variables. These modifications affected model results for fall chinook, in the following ways:

- all alternatives meet the 24-year and 100-year survival standards
- all dam breaching actions meet the 48-year recovery standard

- all non-breaching actions (e.g., Alternatives 1, 2, and 3) meet the 48-year recovery standard but they are not considered as robust to the current level of uncertainty in relative survival of transported fish as is Alternative 4—Dam Breaching.

PATH was disbanded in 1999. However, the adjusted results derived from PATH's 1999 sensitivity analyses were supported by CRI modeling performed by NMFS. CRI results suggest there is little remaining survival improvements that can be achieved from modification of the hydrosystem (i.e., Alternatives 1 to 3). However, while these results suggest that Alternative 4—Dam Breaching has a slight benefit over the other alternatives, these benefits were generally still inadequate by themselves to prevent extinction of all stocks. The CRI results suggested that the best chance of prevention of extinction would be from increasing survival and fitness in the early life history stages (egg to smolt stage) (e.g., from habitat improvements) and in increasing Columbia River estuary survival (e.g., from habitat improvements, predator control). Both of these areas are outside of the hydrosystem direct control.

9.5.2 Cost Effectiveness Analysis

The following conclusions use the 1998 model results, which suggested a larger variation in output between dam retention alternatives and Alternative 4—Dam Breaching. Model results from 1999 suggest that the difference may be much narrower between these alternatives than stated in the 1998 model results. As a consequence, the cost effectiveness results based on 1998 model results may over-state the benefits from dam breaching relative to dam retention.

9.5.2.1 Cost Effectiveness Assessment 1—Costs Applied to Spring/Summer Chinook

There is little difference between the dam retention alternatives and Alternative 4—Dam Breaching with respect to meeting the NMFS jeopardy standards for spring/summer chinook. As a result, dam breaching creates little additional biological output using 1998 model results but is significantly more costly. The additional cost of choosing Alternative 4—Dam Breaching, as opposed to Alternative 1—Existing Conditions, is estimated at $18,000 to $35,000 per fish, depending on the year under consideration (e.g., the cost decreases as the number of years increases).

9.5.2.2 Cost Effectiveness Assessment 2—Costs Applied to Fall Chinook

Under the 1998 model results, the dam retention alternatives meet the 24-year and 100-year survival standards but are not close to meeting the 48-year recovery standard. The additional cost of choosing Alternative 4—Dam Breaching, as opposed to Alternative 1—Existing Conditions, is estimated at $21,000 to $29,000 per fish, depending on the year under consideration (e.g., the cost decreases as the number of years increases).

Since dam retention alternatives meet or come close to meeting the NMFS jeopardy standards for spring/summer chinook but not for fall chinook using the 1998 model results, dam breaching could be considered preferred for fall chinook but unnecessary for spring/summer chinook.

9.5.2.3 Cost Effectiveness Assessment 3—Costs Applied to all Fish

Alternative 2—Maximum Transport of Juvenile Salmon is estimated to generate more fish than Alternative 1 at a reduced cost. The savings from choosing Alternative 2 are estimated to range between $11,000 and $17,000 per fish, depending upon the number of years under consideration.

The additional cost of choosing Alternative 3—Major System Improvements is estimated to be between $8,000 and $10,000 per fish, depending upon the number of years under consideration.

The additional cost of choosing Alternative 4—Dam Breaching is estimated to be between $9,000 and $15,000 per fish, depending upon the number of years under consideration.

10. Summary of Effects

10.1 Introduction

The purpose of this section is to present a balanced display of overall benefits and costs associated with each resource area across each alternative. The summary presents both the monetary and non-monetary effects of the national and regional analyses developed for this Feasibility Report. All tables presented in this section were developed as part of this study. Sources of secondary information are noted, as appropriate.

It should be emphasized that the national and regional displays are distinct accounting stances and cannot be added or subtracted from each other. With the exception of selected monetary estimates noted by an asterisk, all estimates are presented net of Alternative 1—Existing Conditions.

10.2 National Benefits and Costs

The first section presents a comparison of national benefits and costs, including:

- biological impacts associated with each alternative
- national economic development (NED) costs
- NED benefits.

10.2.1 Biological Benefits

Table 10.1 presents a comparison of alternative results based upon data provided by NMFS and PATH using 1998 model results. None of the alternatives meet all of the jeopardy standards using 1998 PATH model results. Alternative 4—Dam Breaching, comes the closest to meeting all of the jeopardy standards for both spring/summer and fall chinook (e.g., this alternative meets five out of six standards). The dam retention alternatives come relatively close to meeting all of the jeopardy standards, with the exception of the 48-year recovery standard for fall chinook.

Table 10-1. Probability of Meeting NMFS Jeopardy Standards for Survival and Recovery Based Upon 1998 PATH Model Results (Median Values Presented)

Biological Benefits	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Spring/Summer Chinook				
Survival in 24th year (standard is 0.70)	0.67	0.65	0.66	0.69
Recovery in 48th year (standard is 0.50)	0.48	0.45	0.46	0.84
Survival in 100th year (standard is 0.70)	0.79	0.78	0.79	0.89
Fall Chinook				
Survival in 24th year (standard is 0.70)	0.85	0.85	0.81	0.93
Recovery in 48th year (standard is 0.50)	0.22	0.22	0.28	1.00
Survival in 100th year (standard is 0.50)	0.83	0.83	0.78	0.98

Source: NMFS, PATH

10.2.1.1 1999 PATH Model Results

PATH modeled only wild spring/summer chinook and fall chinook. DREW Anadromous Fish Analysts expanded PATH results to estimate total harvestable fish which included both wild and hatchery fish. The PATH analysis completed their initial estimates of the expected return rates for wild adult spring/summer chinook in 1998 and for fall chinook in 1999. The Scientific Review Panel (SRP), which was tasked to review the PATH analysis methods, found inconsistencies in the results of both the fall chinook and later the spring/summer chinook analysis developed by PATH. These inconsistencies or uncertainties, that were not totally resolved by PATH, included concerns about the differential delayed mortality factor (D value) that PATH attributed to smolt transport, delayed hydrosystem mortality, and such factors as the fixed assigned lower Snake River survival rate of 85 to 96 percent for the dam breaching alternative. Adjustments made to some of these factors, resulted in adult return predictions that were higher than those predicted in the original PATH estimates. This resulted in a reduction in the difference in predicted adult numbers between these three alternatives and Alternative 4—Dam Breaching.

According to Peters et al. (1999), the 1999 PATH model results had the following implications:

- "All hydro system actions meet survival standards (probabilities of exceeding survival escapement thresholds are greater than 0.7), regardless of what is assumed about the estuary/ocean survival rate of transported fish.
- All drawdown actions meet recovery standards (probabilities of exceeding recovery escapement thresholds are greater than 0.5) regardless of what is assumed about the estuary/ocean survival rate of transported fish. The Alternative 4—Dam Breaching, exhibited the most robust response across those uncertainties considered to date, and produced higher recovery probabilities (as well as higher average spawning escapements) than other actions. This conclusion is sensitive to assumptions about adult upstream survival.
- For each hypothesis about relative survival of transported fish, there is a non-breaching action (actions which do not involve drawdowns of dams) that meets the recovery standard, although there is no single non-breaching alternative option that meets recovery standards under all assumptions about the relative survival of transported fish. If transported fish are assumed to have high relative survival (i.e., high D), maximizing transportation will achieve recovery standards. If transported fish are assumed to have low relative survival (i.e., low D), then retaining current system configuration and allowing all smolts to migrate in-river achieves the recovery standards. Non-breaching actions are not as robust to the current level of uncertainty in relative survival of transported fish as are drawdown actions."

10.2.1.2 Cumulative Risk Initiative Model Results

The Cumulative Risk Initiative (CRI) modeling results supported the adjusted PATH 1999 results. The CRI analysis, which was performed by NMFS, used the same wild fish numbers (run reconstruction data) as that used by PATH except it was restricted to the period between 1980 and 1999. This period was used, as NMFS believes this to be the most representative of the current conditions, in the hydrosystem. The CRI analysis differed from that of PATH by not estimating the probability of achieving survival and recovery adult return standards, and also by estimating the chance of extinction occurring (which was not estimated by PATH). One of the main components used by CRI for estimating the chance of extinction was its estimate of population growth rate (lambda). While CRI did not specifically estimate returning numbers of fish due to the dam breaching alternative, it did indicate that the PATH results for dam breaching and for all other alternatives were optimistic. CRI results suggest there are few remaining survival improvements that can be achieved from modification of the hydrosystem (i.e., Alternatives 1 to 3). However, while these results suggest that Alternative 4—Dam

Breaching has a slight benefit over the other alternatives, these benefits were generally still inadequate by themselves to prevent extinction of all stocks. The CRI results suggested that the best chance of prevention of extinction would be from increasing survival and fitness in the early life history stages (egg to smolt stage) (e.g. from habitat improvements) and in increasing Columbia River estuary survival (e.g. from habitat improvements and predator control).

10.2.2 NED Costs and Benefits

The total NED costs and benefits identified in this analysis are presented in Tables 10-2, 10-3, and 10-4. These values, presented net of Alternative 1—Existing Conditions, were calculated for a 100-year period of analysis extending from 2005 to 2104. The values presented in Tables 10-2, 10-3, and 10-4 were discounted and converted into 1998 dollars.

Table 10-2. Summary—Average Annual Economic Effects (1998 dollars) ($1,000s) (6.875 percent discount rate)

Costs	Alternative 2	Alternative 3	Alternative 4
Implementation Costs	–	(22,880)	(48,790)
Power	–	–	(271,000)
Transportation	–	–	(37,813)
Water Supply	–	–	(15,424)
Avoided Costs	–	(10)	–
Total Costs	–	**(22,890)**	**(373,027)**
Benefits			
Avoided Costs	–	–	33,570
Recreation	1,405	1,437	71,255
Commercial Fishing	160	158	1,486
Implementation Costs	3,460	–	–
Power	8,500	8,500	–
Total Benefits	**13,525**	**10,095**	**106,311**
Net Benefits	**13,525**	**(12,795)**	**(266,716)**

Notes: 1. These costs and benefits, calculated for a 100-year period of study extending from 2005 to 2104, are discounted using a 6.875 percent discount rate and converted to 1998 dollars.
2. Costs and benefits are presented for Alternatives 2 through 4 net of the base case (Alternative 1).
3. A positive monetary value indicates that the alternative being evaluated has a lower cost or greater benefit than Alternative 1. A negative monetary value indicates that the evaluated alternative has a higher cost or lower benefit than Alternative 1. Positive monetary values, therefore, represent benefits, while negative values represent costs.

NED costs include the following categories:

- Implementation costs, including all project-related construction and acquisition costs, interest during construction, and operation, maintenance, repair, replacement, and rehabilitation costs. Implementation costs also include water acquisition from BOR, mitigation costs for fish and wildlife programs, and cultural resource protection (Alternatives 3 and 4)
- Cost increases associated with the shift from hydropower to more expensive forms of replacement power (Alternative 4)
- Transportation cost increases associated with the shift of barge-transported commodities to more costly truck and rail systems (Alternative 4)

- Construction/O&M costs for irrigation and water supply systems (Alternative 4)
- Costs incurred under Alternative 3—Major System Improvements that would not be incurred under Alternative 1—Existing Conditions, or under Alternatives 2 and 4.

NED costs associated with Alternative 2—Maximum Transport of Juvenile Salmon are the same as they would be under Alternative 1—Existing Conditions. NED costs associated with Alternative 3—Major System Improvements are higher than the base case by $22.9 million per year at a discount rate of 6.875 percent. The NED costs associated with Alternative 4—Dam Breaching, are estimated to be $373 million higher per year than under the base case conditions per year for 100 years, under the same discount rate (Table 10-2).

Using the 1999 NMFS/PATH results, discussed above could likely increase the biological output associated with the dam retention alternatives, will not impact net NED costs because these cost estimates are not sensitive to biological output.

NED benefits include the following categories:

- Costs incurred under Alternative 1—Existing Conditions that would be avoided under Alternative 4—Dam Breaching. These include operations, maintenance, repair, and replacement costs, as well as the costs associated with the rehabilitation of existing infrastructure
- Recreation benefits from increased fish runs and the shift to a near-natural river
- Commercial fishing benefits from increased fish runs
- Implementation benefits from a decrease in costs related to fish-related improvements that would not be incurred under Alternative 2—Maximum Transport of Juvenile Salmon (Alternative 2)
- Power benefits from increases in system hydropower generation (Alternatives 2 and 3).

Using a discount rate of 6.875 percent, NED benefits associated with Alternative 2—Maximum Transport of Juvenile Salmon, and Alternative 3—Major System Improvements are higher than under base case conditions by $13.5 million and $10.1 million per year, respectively. The NED benefits associated with Alternative 4—Dam Breaching are estimated to be $106.3 million higher per year than under the base case conditions for 100 years, under the same discount rate (Table 10-2).

Using the 1999 NMFS/PATH results discussed in Section 10.2.1, could increase the biological output associated with Alternatives 1 through 3. This would not affect the avoided costs category discussed above because this category addresses the costs of operating the existing systems, which are not sensitive to biological output (numbers of fish). Using the 1999 model results could, however, narrow the difference between Alternatives 1 through 3 and Alternative 4—Dam Breaching in those categories that are sensitive to the level of biological output. These categories include the recreation and commercial fishing categories identified above.

Table 10-3. Summary—Average Annual Economic Effects (1998 dollars) ($1,000s) (4.75 percent discount rate)

Costs	Alternative 2	Alternative 3	Alternative 4
Implementation Costs	–	(17,200)	(35,490)
Power	–	–	(267,500)
Transportation	–	–	(33,346)
Water Supply	–	–	(10,746)
Avoided Costs	–	(60)	–
Total Costs	–	**(17,260)**	**(347,082)**
Benefits			
Avoided Costs	–	–	33,890
Recreation	1,382	1,371	79,339
Commercial Fishing	176	170	1,930
Implementation Costs	2,560	–	–
Power	8,500	8,500	–
Total Benefits	**12,618**	**10,041**	**115,159**
Net Benefits	**12,618**	**(7,219)**	**(231,923)**

Notes:
1. These costs and benefits, calculated for a 100-year period of study extending from 2005 to 2104, are discounted using a 4.75 percent discount rate and converted to 1998 dollars.
2. Costs and benefits are presented for Alternatives 2 through 4 net of the base case (Alternative 1).
3. A positive monetary value indicates that the alternative being evaluated has a lower cost or greater benefit than Alternative 1. A negative monetary value indicates that the evaluated alternative has a higher cost or lower benefit than Alternative 1. Positive monetary values, therefore, represent benefits, while negative values represent costs.

Table 10-4. Summary—Average Annual Economic Effects (1998 dollars) ($1,000s) (0.0 percent discount rate)

Costs	Alternative 2	Alternative 3	Alternative 4
Implementation Costs	–	(4,930)	(8,350)
Power	–	–	(263,500)
Transportation	–	–	(25,064)
Water Supply	–	–	(2,241)
Avoided Costs	–	(1,520)	–
Total Costs	–	**(6,450)**	**(299,155)**
Benefits			
Avoided Costs	–	–	33,870
Recreation	987	809	103,573
Commercial Fishing	198	182	3,279
Implementation Costs	660	–	–
Power	8,000	8,000	–
Total Benefits	**9,845**	**8,991**	**140,722**
Net Benefits	**9,845**	**2,541**	**(158,433)**

Notes:
1. These costs and benefits, calculated for a 100-year period of study extending from 2005 to 2104, are discounted using a 0.0 percent discount rate and converted to 1998 dollars.
2. Costs and benefits are presented for Alternatives 2 through 4 net of the base case (Alternative 1).
3. A positive monetary value indicates that the alternative being evaluated has a lower cost or greater benefit than Alternative 1. A negative monetary value indicates that the evaluated alternative has a higher cost or lower benefit than Alternative 1. Positive monetary values, therefore, represent benefits, while negative values represent costs.

10.2.3 Unresolved Issues

The costs and benefits presented in the previous sections were considered in the NED analysis. The purpose of this section is to summarize the additional information that has been presented for consideration, but is not part of the NED analysis. The following areas have been identified as areas of concern, because at this time, it is unclear how these concerns will be addressed or if the costs will be implemented. Hence, the costs are not included in NED and are presented in this section as unresolved issues. If these concerns are implemented, the associated costs will increase NED costs:

- water temperature concerns
- total dissolved gas concerns
- mitigation/compensation
- passive-use values.

10.2.3.1 Discussion of Potential Water Quality Impacts

Water temperature and dissolved gas saturation levels represent two of the principal water quality concerns in the lower Snake River. To reduce water temperatures within the lower Snake River reservoirs, the Dworshak reservoir is currently operated to release 1.2 million acre-feet (MAF) of cold water during July and August each year. No other action or alternative is currently being studied to further reduce temperatures within the system. Therefore, no costs are presented.

To reduce total dissolved gas levels found at the lower Snake River reservoirs, structural modifications have been made at the dams, and additional modifications are being evaluated. The costs to reduce dissolved gas are briefly reviewed in Section 3.8.8.1. Annual costs to address total dissolved gases range from $33.6 million to $53.6 million as presented in Table 3.8-9, but these costs are not included in the implementation costs in Table 3.8-6, because it is unclear which, if any of these costs may be implemented. Therefore, these costs are not presented either in the implementation or avoided costs areas. See Appendix C for additional discussion of Water Quality Impacts.

10.2.3.2 Mitigation and Compensation

Federally required mitigation actions (for fish and wildlife programs and cultural resources) were included in implementation costs. However, it may be socially desirable to consider mitigation or compensation actions, in which losers may be "made whole." Section 13.3 identifies potential quantifiable and qualitative impacts, for which mitigation and/or compensation efforts could be considered. It is unclear which measures, if any, Congress may decide is appropriate to address. Therefore, these costs have not been identified or added to the NED analysis.

10.2.3.3 Passive Use

Section 4 discusses the concept of passive use as well as the controversy regarding how to accurately calculate the value. The average annual estimate ranges from $22.8 million to $301.5 million associated with an increase in salmon population for Alternative 4—Dam Breaching using 1998 PATH results. In addition, an average annual estimate of $420 million is presented for passive use values associated with returning the lower Snake River to the near-natural condition. Corps planning guidance does not allow passive use values to be included in NED analysis. However, since these values could be useful as a social indicator, these values are presented as additional information for the decision maker to consider.

10.3 Tribal Benefits and Costs

This section presents a summary of tribal effects. The estimated increase in tribal harvest is based upon 1998 model results. As with NED benefits, using the 1999 model results will narrow the difference between dam retention and dam breaching alternatives.

Using the 1998 PATH results, the Tribal Circumstances report states that Alternatives 1 and 2 offer limited hope of salmon recovery within a timeframe considered reasonable by the five represented tribes (Meyer Resources, 1999). The report does not address Alternative 3, but the impacts for this alternative are likely closely matched with those for Alternative 2. There would be no change in existing tribal land use under any of these alternatives.

According to the Tribal Circumstances report, Alternative 4—Dam Breaching would produce 2.4 times more tribal harvest of Snake River wild salmon and steelhead stocks compared to Alternative 1 (2.6 times more harvest than Alternative 2). At the 50-year benchmark, estimated tribal wild and hatchery harvest would increase by about 1.7 million pounds. The Tribal Circumstances report concludes that only this alternative would redirect river actions toward significant improvement of the cultural and material circumstances of the tribes.

Approximately 14,000 acres of previously inundated land would be exposed under Alternative 4. The Tribal Circumstances report states that the tribes would benefit greatly from implementation of this alternative by gaining access to lands once used for cultural, material, and spiritual purposes.

It is also important to note that improved conditions for salmon and access to land could also restore and enhance cultural, ceremonial, and other treaty-related benefits. These benefits are associated with a way of life and are recognized as important non-quantifiable benefits.

10.4 Regional Impacts

The RED account addresses regional economic impacts in terms of jobs and income resulting from the alternatives under consideration. Impacts on employment and income include direct, indirect, and induced effects. The job totals reported below are estimates of total impacts and include both full- and part-time employment.

The regional economic analysis developed for this study addresses the regional economic impacts of changes in spending projected by various DREW workgroups. These impacts, evaluated in terms of business transactions, employment, and income, were estimated using input-output models, which model the interactions among different sectors of the economy. Eight models were constructed to address the potential regional effects associated with the alternatives. Models were developed for Washington, Oregon, Idaho, and Montana, three subregions—the downriver, reservoir, and upriver subregions, and the lower Snake River study area, which consists of the three subregions. In addition, the DREW Anadromous Fish Workgroup estimated the economic impacts of changes in anadromous fish harvests. These impacts were evaluated for the Pacific Northwest states, Alaska, and British Columbia, Canada.

10.4.1 Regional Impacts Associated with Alternatives 2 and 3

Regional impacts under Alternatives 2 and 3 are expected to be relatively minor and limited to those associated with changes in implementation and avoided cost.

10.4.2 Regional Impacts Associated with Alternative 4

Construction activities resulting directly and indirectly from breaching of the four lower Snake River dams would generate increased business transactions of $2.27 billion, 20,821 temporary jobs, and an increase of $678.8 million in personal income in the lower Snake River study area.

Table 10-5 presents point estimates of the maximum number of annual temporary jobs that would be generated by resource area. Major construction projects would include replacement power facilities (7,652 jobs) and transportation-related construction (9,826 jobs). The total change presented in Table 10-5 is the sum of the maximum annual temporary increase in employment for each resource area. These increases would not, however, occur in the same year. The maximum temporary employment increase in any one year would be 14,871 jobs. In the long term, the lower Snake River study area would experience a net decrease in business transactions of $66.28 million, a loss of 1,372 jobs, and a decrease of $63.41 million in personal income (Table 10-6).

Table 10-5. Short-term Employment Effects under Alternative 4—Dam Breaching (jobs)[1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
Electric Power				
Power Plant Construction[3/]	0	0	5,572	5,572
Transmission Line Construction	0	0	2,080	2,080
Recreation				
Campground Construction	0	174	0	174
Transportation				
Rail Construction[4/]				872
Road Construction[4/]				1,972
Transportation Facilities Construction[4/]				6,982
Water Supply				
Well Modification	0	916	259	1,175
Pump Modification	844	0	0	844
Implementation				
Implementation	230	460	460	1,150
Total Change[5/]	**1,074**	**1,550**	**8,371**	**20,821**
1995 Total Employment[6/]	75,081	68,334	175,325	318,740
Change as % of 1995 Employment	1.43	2.27	4.77	6.53

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years.

2/ The lower Snake River study area is comprised of the upriver, reservoir, and downriver subregions.

3/ The DREW HIT assumed that a total of six replacement power plants would be built. The exact locations of these plants are unknown but DREW HIT assumed that three would be located in the downriver subregion, with the other three most likely located in the Puget Sound region. Construction of each power plant is estimated to generate 2,786 short-term jobs. The estimates shown in this table are the maximum number of these jobs that would be generated in any one year—5,572 in the downriver subregion, where two plants would be constructed simultaneously.

4/ These effects would occur in the lower Snake River study area but it is not known how they would be distributed among the subregions.

5/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River study area figure because some of the projected study area impacts were not distributed by subregion.

6/ These totals are the sum of the maximum annual short-term job gains for each resource area. With the exception of the implementation cost category, the jobs identified in this table would only last 1 or 2 years. The construction activities generating this projected employment would all have to take place in the same year for annual gain of 20,821 jobs. The maximum temporary employment increase in any one year would be 14,871 jobs.

Table 10-6. Long-term Subregion Employment Effects under Alternative 4—Dam Breaching (jobs)[1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
Increases in Long-term Employment				
Electric Power[3/]				
O&M Spending on Replacement Power Plants and New Transmission Lines	0	0	884	884
Recreation				
Increased Nonangler Spending	0	503	0	503
Increased Angler Spending	239	162	0	401
O&M Spending on New Campgrounds	0	26	0	26
Implementation				
Implementation	6	11	11	28
Total Increase	**245**	**702**	**895**	**1,842**
Decreases in Long-term Employment				
Water Supply				
Reduction in Irrigated Lands	0	(1,105)	(474)	(1579)
Avoided Costs				
Avoided Costs (Reductions in Corps' Spending)	(283)	(566)	(566)	(1,415)
Transportation				
Loss of Barge Transportation (Grain)[4/]	(221)	(407)	491	(137)
Reduced Cruise Ship Operations	(83)	0	0	(83)
Total Decrease	**(510)**	**(1,810)**	**(1,040)**	**(3,360)**
Net Long-term Employment Change	**(342)**	**(1,376)**	**346**	**(1,372)**
1995 Total Employment	75,081	68,334	175,325	318,740
Net Change as a % of 1995 Employment	(0.46)	(2.01)	(0.20)	(0.43)

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years.
2/ The lower Snake River study area is comprised of the upriver, reservoir, and downriver subregions.
3/ Estimates of the negative effects of electric rate increases are not available for the subregions and are excluded from this table. Rate increase effects are shown by state in Table 6-33.
4/ These figures are from Table 6-21, which summarizes the effects associated with a loss of grain farm income due to increased transport cost (Table 6-15), loss of grain-transportation-related barge revenue (Table 6-17), increased grain transportation-related railroad revenue (Table 6-19), and changes in truck transportation (Table 6-20).

Impacts would also occur throughout the Pacific Northwest, throughout a state, or in an area of a state outside a subregion. Construction activities resulting directly and indirectly from dam breaching would temporarily generate increased short-term annual business transactions of $339.6 million, 2,849 temporary jobs, and $106.6 million in personal income in Pacific Northwest areas outside the subregions. These totals represent the maximum changes that could occur in one year.

In the long term, the Pacific Northwest areas outside the subregions would experience a net decrease in business transactions of $206.8 million, a loss of 918 jobs, and decrease of $189.5 million in personal income. Annual state-level employment effects, excluding those effects modeled for the subregions (see Tables 10-4 and 10-5), are presented in Table 10-7.

Table 10-7. Annual State-level Employment Effects for Alternative 4—Dam Breaching Excluding those Effects Modeled for the Subregions (jobs)[1/2/]

	Washington	Oregon	Idaho	Montana	Total
Short-term Effects[3/]					
Power Plant Construction	2,786	0	0	0	2,786
Tidewater Rail Car Storage Construction	0	63	0	0	63
Total	**2,786**	**63**	**0**	**0**	**2,849**
Long-term Effects[4/]					
Increased Electricity Bills[5/]	(1,136)	(810)	(366)	(70)	(2,382)
O&M Spending on new Power Plants	876	0	0	0	876
Loss of Barge Transportation (Grain)	224	210	(24)	0	410
Commercial Fishing[6/]					171
Ocean Recreational Fishing[6/]					7
Total	**(36)**	**(600)**	**(390)**	**(70)**	**(918)**

1/ These impacts are not the state totals. Rather they are effects that occur throughout a state (increased electricity bills) or in areas of a state outside the subregions (the remaining categories).
2/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years.
3/ Short-term effects would be temporary. Power plant construction would occur over three one-year periods. Tidewater rail car storage construction would last for just 1 year.
4/ Long-term effects would be permanent.
5/ These estimates exclude the effects that would be associated with plant closures or business failures caused by increased electric bills.
6/ These projected increases would occur in Washington, Oregon, Idaho, Alaska, and British Columbia.

Total short- and long-term regional effects are the sum of the above subregion and state-level excluding subregion totals (Table 10-8). In the short-term, the Pacific Northwest as a whole would experience net increases of $2.6 billion in business transactions, 23,670 short-term jobs, and $785.4 million in personal income. Short-term effects would be temporary and these totals represent the maximum changes that could occur in one year. In the long-term, the Pacific Northwest as a whole would experience a net decrease in business transactions of $272.4 million, a loss of 2,290 jobs, and a net decrease of $252.9 million in personal income. These effects would be permanent.

Table 10-8. Total Regional Effects for Alternative 4—Dam Breaching-Business Transactions, Employment, and Personal Income[1/]

	Business Transactions ($ million per year)		Employment (jobs)		Personal Income ($ million per year)	
Region	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
Subregions	2,271.62	(66.28)	20,821	(1,372)	678.81	(63.41)
State-Level Effects (excluding those modeled for the subregions)	339.59	(206.08)	2,849	(918)	106.64	(189.51)
Total Regional Effects	**2,611.21**	**(272.36)**	**23,670**	**(2,290)**	**785.45**	**(252.92)**

Source: Tables 6-32 through 6-40
1/ The short-term effects presented in this table are the maximum short-term effects that could occur in 1 year. The long-term effects are, in contrast, permanent effects that are expected to occur each year. This comparison results in a relative overstatement of the short-term effects. Figure 10-1, which presents projected net annual regional employment change for the years 2001 through 2051, combines projected annual long-term effects with annual short-term effects, rather than the maximum short-term effects that could occur in 1 year.

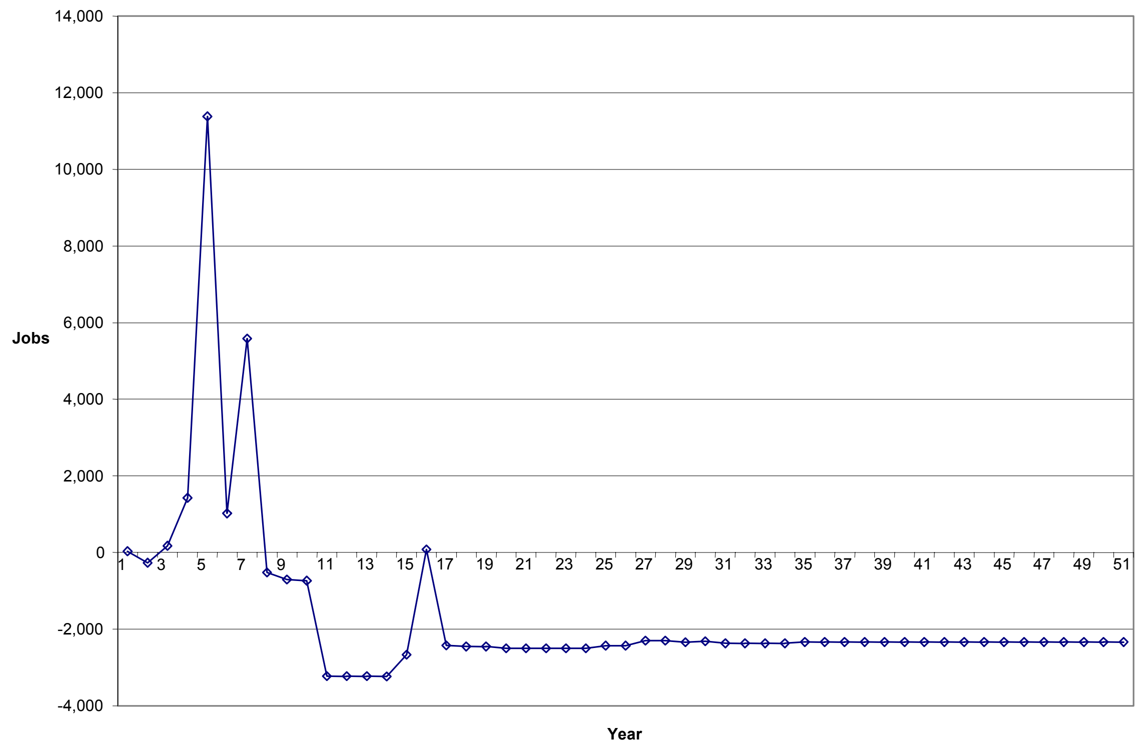

Figure 10-1. Net Annual Total Regional Employment Change (2001 to 2051)

10.5 Social Impacts

The majority of communities in the lower Snake River region are small rural towns that have low- to moderate-economic diversity. These communities primarily rely on the agricultural and wood products sectors, even though they have declined as a source of regional employment and income over the past decade.

10.5.1 Alternative 2—Maximum Transport of Juvenile Salmon and Alternative 3—Major Systems Improvements

Alternatives 2 and 3 are estimated to have little effect on the existing social and economic environment for the majority of the communities within the region. Some communities, particularly those located up river, (e.g., Lewiston, Orofino, and Riggins), could be adversely affected by lower probabilities of salmon recovery. Continued Federal oversight and uncertainty about the future of the four dams may also have negative social effects on some communities.

10.5.2 Alternative 4—Dam Breaching

Breaching the four dams would change the physical and economic environment of the lower Snake River region. Communities located upriver of the four dams (e.g., Lewiston, Orofino, and Riggins) would likely experience net employment gains as a result of expected increases in recreation and tourism associated with a free-flowing river and increased fish runs. Communities located within the six counties located adjacent to the lower Snake River reservoirs (e.g., Pomeroy, Colfax, and

Clarkston) would likely experience a net decrease in employment due to decreases in Corps employment and increased pressure on family farms caused by increased transportation, storage, and handling costs for agricultural products.

Communities located downriver of Ice Harbor Dam (e.g., Pasco, Kennewick, and Umatilla) would likely experience employment loss if farms presently irrigated from the Ice Harbor reservoir go out of business. These losses may be partially offset by expected increases in transportation- and power generation-related employment.

Communities would likely adjust to these changes over time. New individuals and businesses seeking new opportunities may replace those that have been displaced. Displaced human and capital resources may be employed in their next best use within the community. This type of adjustment does, however, take time and would vary by community. Community size has been identified as a critical factor affecting a community's ability to adapt to change, with smaller, less diverse communities tending to respond less favorably.

Many of the community level impacts may be caused by the loss of irrigated agriculture on the Ice Harbor reservoir and the increased grain transportation costs. These impacts may be minimized or partially eliminated by spending to modify existing irrigation pumps, spending to expand rail capacity in the region, or by subsidizing affected farms directly.

11. Cost Allocation

The purpose of the cost allocation analysis is to examine a range of possible cost allocation approaches that could be used to distribute the costs of the proposed alternatives. The primary purpose of allocating project costs is to identify repayment responsibility with respect to cost recovery, cost sharing, or both (as may be required). The following discussion does not recommend a preferred approach at this time. However, the cost implications of the approaches are shown using the preliminary construction costs and the unrecovered Federal investment.

The effects of assigning costs to Federal taxpayers, ratepayers, or others are not addressed in this analysis. The magnitude of costs assigned to Federal taxpayers, ratepayers, and others will affect their spending decisions. For example, additional rail capacity will likely result in new investment costs for public and private firms. A detailed analysis of which public entities and private firms would bear these costs and how they would finance these actions has not been done. Similarly, detailed analyses have not been done on the differences between retail and wholesale elasticities of demand for power. A more detailed analysis could show how changes in power costs affect spending decisions for different groups. A detailed analysis of the economic effects of costs being borne by different groups has not been completed for this study.

11.1 Purpose

From a Federal perspective, cost allocations are made to derive an equitable distribution of project costs among authorized project uses, or those proposed for authorization. Laws and regulations requiring reimbursement or cost-sharing generally specify recovery of costs incurred for the service or function. Cost allocation is, therefore, required for most Federal multipurpose projects having reimbursable purposes.

Cost allocation is an essential part of the multipurpose planning process where cost-sharing will be required. It provides information needed to determine the magnitude and share of estimated project costs that are reimbursable. This information is essential for the tests of financial feasibility and plan acceptability. During subsequent planning and construction, it provides the information required for allocating actual expenditures and ensures that cost accounts are maintained consistent with the plan formulation and allocation principles. It can also be an important component of determining financial implications and regional economic impacts.

The authorizing document for the lower Snake River projects, PL 79-14, designated the Federal Power Commission (now the Federal Energy Regulatory Commission [FERC]) as the agency responsible for defining the allocation of costs to navigation and hydropower. The final cost allocations were completed by FERC in 1965 for Ice Harbor, and 1984 for Lower Monumental, Little Goose, and Lower Granite. FERC completed the allocation studies based on data and preliminary allocations prepared by the Corps. Any new cost allocations for these projects will be coordinated with FERC.

It has been Corps policy not to request reallocation of storage and/or project costs unless a major reformulation of a project is required. Some of the alternatives identified in this Feasibility Report could require authorization by Congress. The Congressional authorization could contain directive language concerning the allocation of costs. In the absence of such directive language, the Corps administratively developed procedures would be used to allocate the project costs.

11.2 Allocating Costs

11.2.1 Assumptions

Alternative 4—Dam Breaching could affect the existing cost allocations because of the possible deletion of authorized uses (navigation and hydropower). Implementation could likely result in new cost allocations being considered for all of the dams that would be breached under this alternative (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor). A change in the existing allocations would not only affect how implementation costs are allocated, but also the existing debt on the projects. Because the economic benefits at these multi-use facilities could be significantly altered between purposes, they could be considered for new cost allocations. Table 11-1 identifies which alternatives are likely to require new cost allocations.

Table 11-1. Alternatives Requiring New Cost Allocations

Alternatives	New Cost Allocations Necessary
1—Existing Condition (Base Case)	No
2—Maximum Transportation of Juvenile Salmon	No
3—Major System Improvements	No
4—Dam Breaching	Yes

Approaches to cost allocation could be quite different depending on the alternative recommended. As long as the measures do not significantly affect the current authorized uses, the costs would be allocated to mitigation according to the existing joint-use percentages. Historically, costs for fish transportation and bypass measures have been defined as mitigation. It is assumed similar alternatives like transportation and fish bypass improvements would also be assigned to mitigation and shared according to the original joint-use percentages. Therefore, it is expected that new cost allocations would only be necessary for Alternative 4—Dam Breaching. Table 11-2 shows the construction joint-use percentages for the lower Snake River projects as established by the initial allocations.

Table 11-2. Joint-use Percentages for Construction Costs by Authorized Project Uses

Facility	% Allocated to Power	% Allocated to Navigation
Lower Monumental	94.1	5.9
Ice Harbor	78.6	21.4
Little Goose	93.3	6.7
Lower Granite	98.4	1.6
Source: Corps, Walla Walla District		

11.2.2 Methodology

Alternatives being considered for this Feasibility Report could be described as either mitigation or restoration of endangered salmon runs.

How the alternatives are characterized could change the way the costs are allocated. Mitigation measures are joint-use costs allocated based on the original firm cost allocations. Joint-use costs are assigned to those facilities that serve more than one authorized use. Currently, barging of juvenile fish and bypass measures at the projects are considered mitigation actions. Restoration measures by comparison would be allocated solely to ecosystem restoration.

The unrecovered Federal debt is comprised of investment costs allocated to power for the four lower Snake facilities (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor). Total remaining debt as of the end of 1998 was approximately $479 million for construction of the dams and $271 for the lower Snake River fish hatcheries and fish mitigation. The BPA repays this debt to the Federal government from power revenues. The four lower Snake River facilities began producing power between 1962 and 1975.

For illustrative purposes, the unrecovered Federal debt is considered part of the implementation costs and is allocated according to the requirements for mitigation or restoration for Alternative 4—Dam Breaching. At this point however, it is not clear what obligation, if any, BPA would have to repay this outstanding debt in the event the dams are breached. BPA's obligation would likely be determined based on legal opinion, congressional direction, and negotiation.

11.3 Potential Approaches to Allocating Costs for Dam Breaching

It should be recognized that when Congress provides the authorizing legislation for any of the alternatives being investigated in this Feasibility Report, it can designate what cost allocation or cost sharing approach will be used. As such, the possible alternative approaches to allocating costs are infinite. This section, however, presents two possible approaches for allocating dam breaching costs that follow the current administrative guidelines.

11.3.1 Cost Share as Mitigation

Under this option, the cost of Alternative 4—Dam Breaching would be treated as a mitigation cost. The unsubstantiated concept behind this option is that the construction and operation of the four lower Snake River dams for hydropower and navigation has resulted in declining wild salmon and steelhead stocks that represent an unmitigated loss that has accrued to the facilities. If Alternative 4—Dam Breaching is recommended for implementation as a mitigation project, it would be on the basis that it is the most effective mitigation or only effective mitigation for this loss. Therefore, the cost of achieving this mitigation would be properly assigned back to the authorized uses that necessitated the mitigation. This has been the approach for recent fish and wildlife measures at Columbia and Snake River Dams. An issue is whether costs should be allocated to authorized uses that have been eliminated.

The costs could be allocated based on existing joint use percentages. Nearly 90 percent of the cost would be allocated to hydropower and repaid to the U.S. Treasury by BPA through collections from power customers. Navigation would be allocated to 10 percent of the cost and these costs would be Federal and not recoverable. The remaining unrecovered hydropower debt on the lower Snake River dams would continue to be paid to the U.S. Treasury through collections from power customers. Any operation and maintenance (O&M) costs associated with Alternative 4—Dam Breaching (for example maintenance of the locks and remaining dam in caretaker status) could be allocated to the hydropower and navigation and shared as the O&M costs.

If one assumes that breaching of the dams is an additional or new feature for mitigation purposes, costs should be allocated as joint-use construction costs. The joint-use cost percentages would be the basis for this allocation. Tables 11-3 and 11-4 estimate how the unrecovered debt implementation and O&M costs would be allocated for Alternative 4—Dam Breaching.

Table 11-3. Mitigation—Allocated Investment Costs and Unrecovered Debt

Alternative 4—Dam Breaching Preliminary Costs – Allocated by Authorized Uses (1998 dollars) ($1,000)		
	Investment Cost	Unrecovered Debt
Hydropower	875,334	750,000
Navigation	86,572	0
Non-reimbursable Costs	6,826	0
Total	**968,732**	**750,000**

Source: Section 3.8 Implementation and Avoided Costs

Table 11-4. Mitigation—Allocated O&M Costs

Alternative 4—Dam Breaching Preliminary O&M Costs – Allocated by Authorized Uses (1998 dollars) ($1,000)	
	O&M Costs
Hydropower	4,375
Navigation	481
Total	**$4,856**

Source: Section 3.8 Implementation and Avoided Costs

11.3.2 Cost Share as Restoration

Under this option, the cost of Alternative 4—Dam Breaching would be shared as an ecosystem restoration cost and would require a non-Federal cost sharing sponsor. Remaining unrecovered hydropower debt on the lower Snake River dams would also be included as a restoration cost. Any O&M costs associated with Alternative 4—Dam Breaching (for example maintenance of the locks and remaining dam structures in caretaker status) would be financed 100 percent by a non-Federal sponsor. Section 210 of the Water Resources Development Act of 1996 established the non-Federal cost share for environmental protection and restoration as 35 percent non-Federal with O&M of the ecosystem restoration project being 100 percent non-Federal.

However, there may be precedent for 50 percent non-Federal cost sharing for ecosystem restoration activities which result in adverse impacts to purposes of an existing Federal project as in the case of the Kissimmee River Restoration and Everglades and South Florida Ecosystem. The O&M costs of the restoration remain non-Federal.

If one assumes that breaching the dams is a restoration measure, costs could be allocated solely to this purpose. Because dam breaching results in a single project purpose (ecosystem restoration), all costs should be allocated to this new project purpose. Tables 11-5 and 11-6 estimate how the unrecovered debt and implementation and O&M costs would be allocated for Alternative 4—Dam Breaching assuming restoration is the sole purpose.

Table 11-5. Restoration—Allocated Investment Costs and Unrecovered Debt

Alternative 4—Dam Breaching Preliminary Costs – Allocated to Ecosystem Restoration (1998 dollars) ($1,000)		
	Investment Cost	Unrecovered Debt
Ecosystem Restoration	968,732	750,000
Total	**968,732**	**750,000**

Source: Section 3.8 Implementation and Avoided Costs

Table 11-6. Restoration—Allocated O&M Costs

Alternative 4—Dam Breaching Preliminary O&M Costs – Allocated to Ecosystem Restoration (1998 dollars) ($1,000)	
	O&M Cost
Ecosystem Restoration	$4,856
Total	**$4,856**

Source: Section 3.8 Implementation and Avoided Costs

11.3.3 Financial Analysis

If all costs were allocated to ecosystem restoration, there would also be an issue of cost sharing. A non-Federal sponsor would need to be identified for cost sharing. A non-Federal sponsor is a legally constituted body with full authority and capability to perform the terms of its agreements and to pay damages, if necessary, in the event of failure to perform. The non-Federal share of the implementation costs and unrecovered debt would be 35 percent. The non-Federal sponsor would also be responsible for 100 percent of operation, maintenance, and replacement costs for a restoration project. Tables 11-7 and 11-8 display the cost sharing portions for the Federal and non-Federal sponsor if the action is determined to be restoration.

A more detailed discussion of potential funding options is presented in the following section, Section 12, Financial Analysis.

Table 11-7. Restoration—Unrecovered Debt and Investment Cost–Cost Sharing for the Federal and Non-Federal Sponsor

Alternative 4—Dam Breaching Preliminary Costs – Allocated to Ecosystem Restoration (1998 dollars) ($1,000)		
Sponsor	Investment Cost	Unrecovered Debt
Federal (65%)	629,676	487,500
Non-Federal (35%)	339,056	262,500
Total	**968,732**	**750,000**

Source: Section 3.8 Implementation and Avoided Costs

Table 11-8. Restoration—O&M Costs – Cost Sharing for the Federal and Non-Federal Sponsor

Alternative 4 Preliminary O&M Costs – Allocated to Ecosystem Restoration (1998 dollars) ($1,000)	
Sponsor	O&M Cost
Non-Federal (100%)	$4,856
Total	**$4,856**

Source: Section 3.8 Implementation and Avoided Costs

12. Financial Analysis

The purpose of this analysis is to describe the potential funding options for the projects being evaluated in the Lower Snake River Juvenile Salmon Migration Feasibility Study. This analysis is designed to provide information for policy makers regarding the availability of funding for the proposed alternatives within established *Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC, 1983). The following discussion is divided into three sections that address the following issues: funding requirements, potential sources of funds, and financial impacts.

12.1 Funding Requirements

The potential funding request could include three items:

- Repayment of outstanding debt
- Implementation costs to construct fish-related improvements
- Mitigation and compensation costs.

12.1.1 Repayment of Outstanding Debt

BPA is obligated to repay to the Federal Treasury all costs allocated to hydropower from the Federal dams. The capitalized costs of the project (e.g., initial construction costs, replacement costs, etc.) are repaid by BPA over a 50-year period at designated interest rates. The current debt associated with the lower Snake River locks and dams is estimated as follows:

- Amounts already included in the existing rate structure:
  - Approximately $479 million for construction of the dams, as of the end of 1998
  - Additional outstanding debt for the lower Snake River fish hatcheries and fish mitigation funds of approximately $271 million, as of the end of 1998.
- Amounts that will be included in the rate structure, upon completion:
  - Construction work in progress account will transfer to BPA as new additional debt (e.g., approximately one-half of the $271 million in construction work in progress that is occurring at the lower Snake River facilities).

As indicated, these costs are (or could be) built into the existing BPA power rates. If the lower Snake River dams are breached, it is possible that Congress, through authorizing legislation, will reduce some or all of this long-term debt or BPA ratepayers may be required to continue repayment.

12.1.2 Implementation Costs

Table 12-1 presents a summary of the costs associated with fish-related facility improvements. These implementation costs could also require payment or, alternatively, could be covered by congressional appropriation.

Table 12-1. Average Annual Implementation Costs by Study Alternative ($1,000s)

Alternative	Summary Description	Starting Year	Construction and Acquisition Costs ($)[1/]
1—Existing Conditions	Adaptive Management Strategy	2005	$15,530
2—Maximum Transport of Juvenile Salmon	Maximum Transport	2005	$12,070
3—Major System Improvements	Adaptive Management Strategy	2008	$38,410
4—Dam Breaching	Channel Bypass or Natural River Alternative	2007	$64,320

1/ These costs have been adjusted to base year 2005 using a 6.875 percent discount rate.
Source: Corps, Walla Walla District

The average annual cost to retain the dams ranges from $12.1 million to undertake Alternative 2—Maximum Transport of Juvenile Salmon to $38.4 million to undertake Alternative 3—Major System Improvements. Alternative 4—Dam Breaching is expected to cost approximately $64.3 million annually.

12.1.3 Possible Mitigation and Compensation Costs

Alternative 4—Dam Breaching would also engender other costs to replace services currently provided under existing conditions, including:

- Additional annual power costs of $271 million per year to develop alternative sources of power (e.g., includes the cost of constructing and operating combined cycle gas turbines less the cost of operating the existing system)
- Additional transportation costs of $37.8 million per year to move commodities by rail and/or to truck to more distant barge terminals in the John Day pool
- Additional costs of $15.4 million per year to supply water to irrigators and municipal/industrial users
- Additional costs to retrain workers, which have been estimated at between $45.1 million and $48.1 million
- Additional costs to mitigate 82 affected communities, which have been estimated to cost between $4.3 million and $12.9 million.

There is no requirement for the Federal government to provide compensation for these costs, but a legislative solution may be developed to provide mitigation and/or compensation.

12.2 Potential Sources of Funding

Under the dam retention strategies implementation costs would be covered by the existing cost allocation rules. However, if dam breaching were the selected alternative, there are three potential sources for funding:

- Continue with the existing cost allocation rules (under Corps fish mitigation principles)
- Seek a local sponsor who would share the costs with the Federal government for dam breaching (under Corps fish recovery principles)
- Congress authorizes the Treasury to pay all (or a part) of the cost to breach.

These issues are addressed in the following section.

12.2.1 Existing Cost Allocation Basis (Fish Mitigation)

As documented in the cost allocation analysis (Section 11), the repayment cost of existing projects is mainly allocated to power. Under existing cost allocation rules, power is currently required to pay for approximately 91 percent of the costs associated with the projects (e.g., averaged across all four lower Snake River facilities). BPA repays the Treasury for these costs. Navigation is responsible for the remaining 9 percent of costs, which is considered a Federal cost. Table 12-2 shows the joint-use percentages for construction costs by project uses.

Existing cost allocation rules would require that approximately 91 percent of the implementation costs are covered in BPA rates, with the remaining 9 percent covered by the Federal government.

Table 12-2. Joint-use Percentages for Construction Costs by Project Purposes

Projects	Percent Allocated to Power	Percent Allocated to Navigation
Lower Monumental	94.1	5.9
Ice Harbor	78.6	21.4
Little Goose	93.3	6.7
Lower Granite	98.4	1.6
Simple average across all four facilities	91.1	8.9

Source: Corps, Walla Walla District

12.2.2 Cost Sharing with a Local Sponsor (Fish Recovery)

The typical process of developing a finance plan for a Corps construction program is to develop a cost sharing agreement between a local sponsor and the Federal government.

In accordance with the Water Resources Development Act of 1986 (PL 99-662), costs for studies and projects are shared between the Federal Government and the local sponsor. A sponsor is defined as:

> *A sponsor can be a state or any other political subpart of a system or group of states; an Indian tribe; or a port authority; which has the legal and financial authority and capability to provide the cash and real estate requirements needed for a project. A sponsor can also be an interstate agency, established under two or more states with the consent of Congress under Section 15 of Article 1 of the*

> *Constitution Section 221 of the 1970 Flood Control Act defines a local sponsor for a Corps water resources project as a non-Federal interest that is "a legally constituted public body with full authority and capability to perform the terms of its agreements and to pay damages if necessary, in the event of failure to perform.*

In this study, there is no local sponsor. This feasibility report is furnished in response to the NMFS Biological Opinion for the *Reinitiation of Consultation on 1994-1998 Operation of the Federal Columbia River Power System and Juvenile Transportation Program in 1995 and Future Years.* Therefore, the source of funds to implement Alternative 4—Dam Breaching is uncertain.

12.2.3 Congressional Appropriation

Implementation of Alternative 4—Dam Breaching could be funded entirely (or partially) by direct congressional appropriation. As described in the Technical Report on Hydropower Costs and Benefits (DREW Hydropower Impact Team, 1999; Section 7.1, Page 104):

> *Congress will ultimately answer the repayment question in the legislation that would authorize the implementation of the selected alternative. The Congressional authorization could contain directive language concerning the allocation of project construction costs. For example, Congress could direct that removal of the Snake River Dams is of national interest and the taxpayers' responsibility, and BPA would not have to repay any of the construction costs.*

It is unknown at the present time whether congressional authorization would be forthcoming for all or part of the outstanding debt, implementation costs, and/or mitigation/compensation costs.

12.3 Financial Impacts

The following section addresses BPA's authorization and ability to pay for the dam breaching costs, as well as the potential impact of rate increases on BPA ratepayers.

12.3.1 BPA Funding

BPA is authorized to pay for fish and wildlife mitigation projects under the following legislation:

> Under provisions of the Northwest Power Planning and Conservation Act [PL 96-501, Section 4(h)(2)(A)], BPA is required *"to use its funding authorities to protect, mitigate, and enhance fish and wildlife to the extent such resources are affected by the hydroelectric projects of the Columbia River and its tributaries".*
>
> In addition, *"...BPA expenditures shall be in addition to, not in lieu of, other expenditures authorized to be made by other entities under other agreements or provisions of the law. Other fisheries efforts outside this Act, for example, are expected to continue and to be funded separately."*
>
> Under provisions of the Northwest Power Planning and Conservation Act (PL 96-501), *"the Bonneville Power Administration is self-financed. Pursuant to the Federal Columbia River Transmission Act, BPA must meet all its costs, including the cost of the Federal investment in the Columbia River system, from its power sale revenues. General tax revenues are not used to support BPA programs."*

However, there are limitations on how much of the additional fish and wildlife mitigation costs BPA can accommodate. Five Federal agencies involved in salmon and other fish and wildlife restoration activities in the Columbia River Basin established a Memorandum of Agreement (MOA) concerning BPA fish and wildlife costs for Fiscal Years 1996 through 2001. The MOA followed an agreement made between NMFS, members of the Pacific Northwest congressional delegation, and the Clinton Administration, to establish an upper limit on BPA costs for Columbia Basin fish and wildlife, at an average of $435 million per year through the 6-year period. This MOA was undertaken due to concern over BPA's financial position and its ability to fund future fish and wildlife programs in a deregulated power market. However, there is uncertainty about what will happen after the agreement runs out. This problem has been exacerbated by the current high rates for energy and the shortages felt throughout the region.

The Technical Report on Hydropower Costs and Benefits further describes the limits of BPA's abilities to raise rates in the presence of increasing costs:

> *In a restructured, competitive, wholesale power market, BPA can no longer automatically recover higher costs by raising its rates. This is because the utilities that buy power from BPA have alternative supplies of electricity available at prices set by the wholesale electricity market. If BPA's prices are below the market price, it may be able to recover increased costs until its prices reach the market price. However, consumers of BPA power are no longer required to bear the financial impacts of increased hydroelectric costs if less expensive electricity is available in the market. In this case, the financial impacts will be more difficult to determine. Initially, the cost would appear as BPA losses, but those losses would have to be covered by someone such as taxpayers or users of the still-regulated transmission system.* (DREW Hydropower Impact Team, 1999; Section 7.1, page 104)

The Northwest Power Planning Council recently evaluated BPA's potential financial conditions under a wide range of future electricity market conditions and possible fish and wildlife mitigation scenarios, including all of the alternatives being considered in this study. The analysis concluded:

> *Under a wide range of conditions, Bonneville (BPA) demonstrates significant value to customers even if called upon to bear relatively large additional fish and wildlife mitigation costs. Only under combinations of persistent low market conditions and increased fish and wildlife costs and/or operational impacts does Bonneville experience significant negative net revenues for extended periods. Those results are extremely sensitive to small changes in Bonneville's costs or market prices. This underscores the importance of Bonneville's cost management efforts. Financial risk management mechanisms like reserves can mitigate the negative net revenues in some conditions. In other conditions, however, the mitigating effect of the assumed reserves and/or further cost reductions is insufficient. In these cases, Bonneville would need larger reserves; some sort of contingent cost recovery mechanism or may have to look to other [sources] of funding. It is also possible that the schedules for implementation of the various fish and wildlife mitigation scenarios used in this analysis will not be met. The biological and economic effects of changes in the schedule for implementation of fish and wildlife measures should be evaluated.* (Source: Analysis of the Bonneville Power Administration's Potential Future Costs and Revenues, June 5, 1998, Executive Summary, Page 9.)

13. Compensatory Actions

The purpose of this section is to describe and document the potential mitigation and/or compensatory actions that could be undertaken to alleviate the impacts associated with the study alternatives under consideration. There are two types of potential mitigation and/or compensation actions that are addressed in the following discussion:

- Federal mitigation actions, which are included in implementation costs:
  - fish and wildlife programs
  - cultural resources.
- Potential mitigation or compensation actions:
  - mitigation activities which may be economically viable and socially desirable—if the combined cost of the mitigation plan and resulting reduced impacts are less than the initial impacts, the plan meets the requirements of being "reasonable and prudent" in an economic sense
  - compensation activities, which may be socially desirable, include areas where losers may be "made whole" by compensating them for losses.

The Corps process for determining NED impacts accounts for the most efficient (or least cost) way of accommodating changes in water budget use from the national perspective. In most cases, the national estimate of impacts documents the potential net increase in costs (or benefits) but does not provide a means to compensate or mitigate for the losses. In addition, there may be significant regional costs that are not taken into account in the national impact estimates.

The decision to fund mitigation and compensation plans is ultimately a congressional decision. The goal of this section is to identify a menu of mitigation and compensation efforts for decisionmakers by documenting quantifiable NED impacts and qualitative regional impacts that may be considered to mitigate and/or compensate losses. The following sections provide a description of Federal mitigation costs and other potential mitigation/compensation costs.

The primary purpose of the economic appendix is to evaluate the costs associated with the four alternatives. Earlier PATH biological output (e.g., 1998 model results) suggested that Alternative 4—Dam Breaching was the only alternative that satisfied most of the NMFS jeopardy standards, especially the 48-year recovery standard for fall chinook. However, the PATH 1999 model results indicate that the dam retention alternatives also meet the NMFS jeopardy standards. As a result, the mitigation and compensation actions suggested below may not be needed. They are, however, documented in this chapter to illustrate what actions may be considered, if dam breaching were the selected alternative.

13.1 Description of Federal Mitigation Costs

Federal mitigation efforts include fish and wildlife mitigation and cultural resources protection efforts that may be required under Alternative 4—Dam Breaching. Dam retention alternatives

(Alternatives 1, 2, and 3) do not require new mitigation. However, previous mitigation projects, put in place when the dams were constructed, would remain under all alternatives.

13.1.1 Fish and Wildlife Mitigation

Fish and wildlife mitigation is estimated to cost $20.7 million per year over the 100-year study life for Alternative 4—Dam Breaching. This estimate is presented in year 2005 dollars and is discounted using a 6.875 percent discount rate (see Table 13-1). Mitigation for fish and wildlife impacts related to the Dam Breaching alternative would include the following:

- Structure modifications—such as maintaining road access to existing habitat management units (HMUs), and modifications to fish hatcheries, among other items
- Vegetation restoration—such as seeding the exposed banks of the river with grass, propagation of plants and willows, and noxious weed control, among other items
- Maintenance of existing habitat management units—primarily developing alternative water sources or modifying systems for existing HMUs
- Monitoring of ongoing work to see how fish and wildlife species and vegetation are developing—efforts include conducting a seasonal bird census, nesting surveys, and habitat evaluation monitoring, among other items.

13.1.2 Cultural Resources Protection

Cultural resources protection would involve preserving and protecting cultural sites (e.g., burial grounds and other culturally significant sites) after the dams were breached. The cost to protect cultural resources includes protecting sites (e.g., preparing seed beds and undertaking bank stabilization as needed on a site-by-site basis). Cultural resources protection is expected to cost $4.9 million per year over the 100-year study period. This estimate is presented in year 1998 dollars and discounted using a 6.875 percent discount rate (see Table 13-1).

Table 13-1. Federal Mitigation Annual Costs for Alternative 4—Dam Breaching (1998 dollars) ($1,000)

Component	Cost ($)
Fish and Wildlife Mitigation Costs	$20,772
Cultural Resources Mitigation Costs	$4,924
Total	**$25,696**

Note: Average annual amounts based upon 6.875 percent discount rate.
Source: Corps, Walla Walla District

13.2 Description of Other Potential Mitigation/Compensation Costs

Other potential mitigation/compensation activities are defined to include:

- Mitigation activities, which may be economically viable and socially desirable (e.g., areas where impacts could be diminished or mitigated)

- Compensation activities, which may be socially desirable (e.g., areas where losers may be compensated for losses or "made whole" by compensating them for losses).

The following section describes both the potential quantifiable and qualitative impacts, for which mitigation and/or compensation efforts could be considered.

13.2.1 Implementation Costs

The cost of implementing the study alternatives ranges dramatically across each alternative. Under Alternative 3—Major System Improvements, implementation costs are expected to increase by approximately $22.9 million per year, compared with Alternative 1—Existing Conditions). Under Alternative 4—Dam Breaching, implementation costs are expected to increase by approximately $8.4 to $48.8 million per year, depending on the discount rate (see Table 13-2).

There is currently no method to pay these implementation costs, which could be integrated into a mitigation/compensation strategy.

Table 13-2. Summary of Annual Net NED Impacts (1998 dollars) ($1,000)

Discount Rate	Implementation Costs ($)	Power[1/] Costs ($)	Transportation Costs ($)	Irrigation/Water Systems Costs ($)	Total Impacts ($)
6.875%					
Alternative 2	$3,460	$8,500	$0	$0	**$11,960**
Alternative 3	($22,880)	$8,500	$0	$0	**($14,380)**
Alternative 4	($48,790)	($237,430)	($37,813)	($15,424)	**($339,457)**
4.75%					
Alternative 2	$2,560	$8,500	$0	$0	**$11,060**
Alternative 3	($17,200)	$8,500	$0	$0	**($8,700)**
Alternative 4	($35,490)	($233,610)	($33,346)	($10,746)	**($313,192)**
0.0%					
Alternative 2	$660	$8,000	$0	$0	**$8,660**
Alternative 3	($4,930)	$8,000	$0	$0	**$3,070**
Alternative 4	($8,350)	($229,640)	($25,064)	($2,241)	**($265,295)**

1/ Equals increased alternative power costs less avoided costs (e.g., turbine rehabilitation and other costs for the dam retention alternatives).
Note: Numbers in parenthesis represent direct costs, numbers without parenthesis represent direct benefits.
Source: Corps, Walla Walla District and various DREW Workgroups

13.2.2 Power Mitigation/Compensation Actions

The overall cost of producing power (e.g., including system transmission reliability and ancillary services costs) is expected to decrease slightly under dam retention alternatives (Alternatives 2 and 3) as compared with Alternative 1—Existing Conditions. Under Alternative 4—Dam Breaching, the net cost of alternative power is expected to increase by approximately $229.6 to $237.4 million per year over the 100-year study period, depending on the discount rate (Table 13-2).

The economic impacts of power rate increases are expected to be widely distributed in varying degrees amongst the electric ratepayers throughout the Western Systems Coordinating Council

(WSCC) region, which consists of all or part of the 14 western states and British Columbia, Canada. The Pacific Northwest region is, however, likely to be the most impacted sub-region based on the regional system production costs. It is expected that the power rate impacts to each individual electric ratepayer could fall within a wide range of possibilities.

No possible mitigation measures were identified in the hydropower analysis. To mitigate for the increased power system costs, an alternative way of meeting power demands (loads) would need to be identified. The hydropower analysis, however, identified the most cost-effective way to meet power loads with each of the alternatives. Any possible mitigation plan would be more costly and hence would not mitigate the impacts, but only change them to some other mix of power resources.

Subsidizing each ratepayer an amount equivalent to the impact could compensate the economic effects of potential power rate increases. This could come from the nation's taxpayers to the regional ratepayers, which would require congressional authorization. This compensation would constitute a transfer of the economic effects from one region of the country to the entire country.

13.2.3 Transportation Mitigation/Compensation Actions

The loss of barge transportation under Alternative 4—Dam Breaching would likely lead to an increased use of other more costly cargo transportation systems. This would entail longer truck travel to more distant barge terminals or a shift to rail transportation services. The net NED costs incurred by cargo shippers are expected to be approximately $25.1 to $37.8 million per year for the 100-year study period, as shown in Table 13-2, depending on the discount rate.

The magnitude of the NED costs does not take into account a potential rate adjustment by railroad carriers in response to the loss of competition from the barge lines. However, a study conducted for the Corps by Translog Associates (1999) found that rail rates in the long distance market are determined by factors other than truck-barge competition and that dam breaching would have no effect on rail rates in that market. In the local market, railroads were expected to limit rate increases to the amount of the increase in the combined truck/barge rate that would occur with dam breaching.

In addition, other components of the barge industry transportation system could experience losses in income from:

- commercial barge companies—foregone revenue and idle capacity
- selected grain elevators—loss of revenue, idle capacity
- selected port districts—loss of revenue, idle capacity
- state and local governments—additional road and highway maintenance costs and possible loss of tax revenues.

There is no current means to mitigate or compensate for these potential NED costs, wealth transfers, and losses among other components of the barge industry transportation system.

13.2.4 Irrigation and Municipal/Industrial Water Supply Mitigation/ Compensation Actions

The NED costs for irrigation and water systems have been estimated at $15.4 million per year at a discount rate of 6.875 percent. This measure of impact assumes that:

- the value of the farmland would be reduced due to the loss of irrigation
- municipal and industrial pump stations would need to be improved
- privately owned wells would need to be replaced.

There is no current means to mitigate or compensate for these potential NED costs. If congressionally authorized and funded, potential mitigation/compensation efforts could include:

- payment for required improvements
- potential purchase of farm land.

13.2.5 Social Mitigation/Compensation Actions

The long-term employment losses across the Pacific Northwest could be approximately 5,596 jobs as a result of implementation of Alternative 4—Dam Breaching (see Section 6). Approximately 3,306 long-term jobs could be gained under Alternative 4. Approximately 3,200 of these job losses could result in dislocated or displaced workers. Overall adverse community-level social impacts include:

- decreases in net farm income and increased financial pressure on dryland farmers throughout the region
- increases in consolidation of family farms and a decrease in rural farm population
- decreases in county property tax base in 20 regional counties
- increases in dislocated workers from Ice Harbor irrigated agricultural lands and loss of source of local school revenue
- shifts in the economic base of communities and changed potential for future growth.

Many of these significant community-level and employment impacts are caused by the increased costs of grain transportation and by the loss of irrigated agriculture on the Ice Harbor reservoir that would occur under Alternative 4—Dam Breaching. These impacts could be minimized in part by modification of the irrigation pumps and direct upgrades to expand rail capacity in the region and/or a direct subsidy to the farms currently shipping on the lower Snake River, as discussed in the previous section.

In the absence of direct mitigation to impacted parties for increased transportation costs, loss of irrigation water, and other impacts discussed above, employment losses could be addressed by providing targeted job retraining and education credits, at an estimated cost of between $45.1 million and $48.1 million.

Potential mitigation for 82 affected communities has been estimated at between $4.3 million and $12.9 million, based on previous Federal and state mitigation expenditures used to address the impacts of free trade, old growth forest conservation, and dislocated workers. Community-level impacts could be addressed by providing block grants to affected communities in the region for economic diversification activities. For example, to mitigate farm communities most affected by the loss of river transportation, economic development programs could be used to create more local value-added products and decrease the dependency on the export of unprocessed grains to foreign markets.

Under Alternative 2—Maximum Transport of Juvenile Salmon, the lower probability and higher degree of risk associated with anadromous fish recovery may lead to negative economic and social impacts to sport fishing-dependent communities. These communities may lose an important component of their economic base and may need assistance to transition to another non-fishery-dependent job base.

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15. Glossary

Adverse Water Conditions: Water conditions limiting the production of hydroelectric power, either because of low water supply or reduced gross head or both. Also sometimes called critical water conditions.

Automatic Generation Control (AGC): Small, but frequent changes in generation necessary to regulate and transmit energy at 60 cycles per second.

Average Megawatt (aMW): The amount of megawatts averaged over a specified time period.

Average Water Conditions: Precipitation and runoff conditions which provide water for hydroelectric power development approximating the average amount and distribution available over a long time period, usually the period of record.

Avoided Costs: Costs required under the base condition (Alternative 1 – Existing Conditions) that would not be required under Alternatives 2 through 4.

Base Condition: The assumed future conditions from which all alternatives are compared against.

Benefit-Transfer: Economic technique used to transfer existing studies, value estimates, and willingness to pay functions, to new policy contexts, sites, and affected populations.

Business Sales: Estimated gross receipts received by a business with the exception of those businesses in the trade sector where it is the margin or the value added by that business.

Capability: The maximum load which a generator, turbine, transmission circuit, apparatus, station, or system can supply under specified conditions for a given time interval, without exceeding approved limits of temperature and stress.

Capacity: The load for which a generator, turbine, transformer, transmission circuit, apparatus, station or system is rated. Capacity is also used synonymously with capability. For definitions pertinent to the capacity of a reservoir to store water, see Reservoir Storage Capacity.

> **Dependable Capacity:** The load-carrying ability of a station or system under adverse conditions for the time interval and period specified when related to the characteristics of the load to be supplied. The dependable capacity of a system includes net firm power purchases.
>
> **Hydraulic Capacity:** The maximum flow which a hydroelectric plant can utilize for energy.
>
> **Installed Capacity:** The sum of the capacities in a powerplant or power system, as shown by the nameplate ratings of similar kinds of apparatus, such as generating units, turbines, or other equipment.
>
> **Overload Capacity:** The maximum load that a generating unit or other device can carry for a specified period of time under specified conditions when operating beyond its normal rating but within the limits of the manufacturer's guarantee, or, in the case of expiration of the guarantee, within safe limits as determined by the owner.

Peaking Capacity: The maximum peak load that can be supplied by a generating unit, powerplant, or power system in a stated time period. It may be the maximum instantaneous load or the maximum average load over a designated interval of time. Sometimes called peaking capability.

Sustained Peaking Capacity: Capacity that is supported by a sufficient amount of energy to permit it to be fully usable in meeting system loads.

Capacity Value: That portion of the at-site or at-market value of electric power which is assigned to capacity.

Combined Cycle Plant (CC): An electric power plant consisting of a series of combustion turbines with heat extractors on their exhausts.

Combustion Turbine Plant (CT): An electric power plant consisting of natural gas or distillate oil-fired jet engines connected to a generator.

Consumer Surplus: Economic value received above the price actually paid.

Cost Effectiveness Analysis: Identification of the least cost method for providing various levels of output.

Critical Period: The multiple-month period when the limitation of hydroelectric power supply due to the shortage of available water is most critical with respect to system load requirements, as determined from an analysis of the historical streamflow record. The reservoir begins the critical period full; the available storage is fully drafted at one point during the period; and the critical period ends when the storage has completely refilled.

Demand: The rate at which electric energy is delivered to or by a system, part of a system, or piece of equipment, usually expressed in kilowatts or megawatts, for a particular instant or averaged over a designated period of time.

Demand Curve: Identifies quantities of a good or service that will be consumed at different prices.

Drawdown: The distance that the water surface elevation of a storage reservoir is lowered from a given or starting elevation as a result of the withdrawal of water to meet some project purpose (i.e., power generation, creating flood control space, irrigation demand, etc.).

Drawdown Regional Economic Workgroup (DREW): The interagency group developed to estimate the economic and social effects associated with alternatives being studied in the Lower Snake Juvenile Mitigation Feasibility Study.

Duration Curve: A curve of quantities plotted in descending sequential order of magnitude against time intervals for a specified period. The coordinates may be absolute quantities or percentages.

Energy: That which does or is capable of doing work. It is measured in terms of the work it is capable of doing; electric energy is usually measured in kilowatt-hours.

Average Annual Energy: The average amount of energy generated by a hydroelectric project or system over the period of record.

Firm Energy: Electric energy which is intended to have assured availability to the customer to meet any or all agreed upon portion of his load requirements.

Nonfirm Energy: Electric energy having limited or no assured availability.

Off-peak Energy: Electric energy supplied during periods of relatively low system demands.

On-peak Energy: Electric energy supplied during periods of relatively high system demands.

Pumping Energy: The energy required to pump water from the lower reservoir to the upper reservoir of a pumped-storage project.

Secondary Energy: All hydroelectric energy other than primary energy. Secondary energy is generally marketed as non-firm energy.

Environmental Quality (EQ) Account: An accounting stance established by the 1983 U.S. Water Resources Council guidelines. This account is used to display and integrate qualitative information on the effects of the proposed alternatives on significant resources and attributes of the human environment.

Exports: Electric power which is transferred from a given power system to another (usually adjacent) power system. Export power must be included in the given power system's loads.

Forebay: The impoundment immediately above a dam or hydroelectric plant intake structure. The term is applicable to all types of hydroelectric developments (i.e., storage, run-of-river and pumped-storage).

Fossil-Fuel Plant: An electric power plant utilizing fossil fuels (coal, lignite, oil, or natural gas) as its source of energy.

Generating Unit: A single power-producing unit, comprised of a turbine, generator, and related equipment.

Generation: The act or process of producing electric energy from other forms of energy; also, the amount of electric energy so produced.

Generator: The electrical equipment in power systems that converts mechanical energy to electrical energy.

Gigawatt: One million kilowatts.

Head Loss: Reduction in generating head due to friction in the water passage to the turbine: includes trashrack, intake, and penstock friction losses.

Heat Rate: A measure of generating station thermal efficiency, generally expressed as BTUs per net kilowatt-hour. It is computed by dividing the total BTU content of the fuel burned (or of heat released from a nuclear reactor) by the resulting net kilowatt-hours generated.

Hydropower Impact Team (HIT): The study team consisting of up to 20 members from Federal and State agencies, Tribes, Northwest Power Planning Council, and several environmental and industry interest groups.

Hydro Simulation Program (Hydrosim or HYDSIM)): A hydro-regulation model used by BPA.

Hydro System Seasonal Regulation Program (HYSSR): A hydro-regulation model used by the Corps of Engineers.

IMpact analysis for PLANning (IMPLAN): Input-Output model used to estimate effects of changes in direct benefits and costs on regional economies.

Imports: Electric power which is transferred into a power system from another (usually adjacent) power system. Import power is usually considered to be a generating resource.

Inflow: The rate of water flow into a reservoir or forebay during a specified period.

Input-Output Modeling: A regional economic analysis technique that models the sales flows among industries and government agencies based on historical purchase patterns for each industry and for consumers. This techniques is used to estimate the effects of changes in direct benefits and costs on regional economies.

Intertie: An electrical connection between two utility systems permitting the flow of power in either direction at different times between the two systems.

Kilowatt (kW): The electric unit of power, which equals 1,000 watts or 1.341 horsepower.

Kilowatt-hour (kWh): The basic unit of electric energy. It equals one kilowatt of power applied for one hour of time.

Line Loss: Energy loss and power loss on a transmission or distribution line.

Load: The amount of electric power delivered at a given point.

> **Intermediate Load:** That portion of the load between the base load and the peaking portion of the load.
>
> **Interruptible Load:** Electric power load which may be curtailed at the supplier's discretion, or in accordance with a contractual agreement.
>
> **Peak Load:** The maximum load in a stated period of time. The peaking portion of the load is that portion of the load that occurs for less than eight hours per day.

Mechanical Availability: The ratio of the number of days in total period minus days out of service due to maintenance and forced outages, to the number of days in the total period.

National Economic Development (NED) Account: The economic account that displays changes in the economic value of the national output of goods and services. The general measurement standard for the value of goods and services is defined as the willingness of users to pay for each increment of output associated with a proposed alternative.

Net Present Value (NPV): The adjustment of a stream of investments to a common point in time.

Nuclear Power Plant: An electric generating station utilizing the energy from a nuclear reactor as the source of power.

Other Social Effects (OSE) Account: An accounting stance established by the 1983 U.S. Water Resources Council guidelines. This account addresses potential effects from perspectives that are relevant to the evaluation process but are not reflected in the NED, RED, or OSE accounts.

Categories typically addressed as part of this account include community impacts; life, health, and safety factors; displacement; and long-term productivity.

Outage: The period during which a generating unit, transmission line, or other facility is out of service.

> **Forced Outage:** The shutting down of a generating unit, transmission line, or other facility for emergency reasons.
>
> **Maintenance Outage:** The removal of a generating unit for required maintenance at any time between scheduled outages.
>
> **Scheduled (Planned) Outage:** The shutdown of a generating unit, transmission line, or other facility for inspection or maintenance in accordance with an advance schedule.

Passive Use Value: The value that individuals place on the mere existence of something. Passive use values are the benefit received from simply knowing that the resource exists even if no use is made of it. Also known as existence value.

Period of Record: The historical period for which streamflow records exist.

Personal Income: The income received by all individuals in the economy from all sources. Made up of wages and salaries, proprietors income, rental income, dividends, personal interest income, and the difference between transfer payments (payouts) and personal contributions for social insurance.

Plant Factor: The ratio of the average load on the plant for the period of time considered to the aggregate rating of all the generating equipment installed in the plant.

Pondage: Reservoir storage capacity of limited magnitude, that provides only daily or weekly regulation of streamflow.

Power: The time rate of transferring energy. Electrical power is measured in kilowatts. The term is also used in the electric power industry to mean inclusively both capacity (power) and energy.

> **Continuous Power:** Hydroelectric power available from a plant on a continuous basis under the most adverse hydraulic conditions contemplated. Same as prime power.
>
> **Firm Power:** Power intended to have assured availability to the customer to meet all or any agreed upon portion of his load requirements.
>
> **Interruptible Power:** Power made available under agreements which permit curtailment or cessation of delivery by the supplier.
>
> **Nonfirm Power:** Power which does not have assured availability to the customer to meet his load requirements.
>
> **Prime Power:** Same as continuous power.
>
> **Seasonal Power:** Power generated or made available to customers only during certain seasons of the year.

Power Benefits: The monetary benefits associated with the output of a hydroelectric plant.

Power Plant (POWERPLANT): A generating station where prime movers (such as turbines), electric generators, and auxiliary equipment for producing electric energy are located.

Pumped-Storage Hydroelectric Plant: A hydroelectric power plant that generates electric energy for peak load use by utilizing water pumped into a storage reservoir, usually during off-peak periods**:** The two major types of pumped-storage hydroelectric plants are pump-back and off-stream pumped-storage plants.

Pump-Turbine (Reversible Turbine): A hydraulic turbine, normally installed in a pumped-storage plant, which can be used alternately as a pump and prime mover (turbine).

Ramp Rate: The maximum allowable rate of change in output from a powerplant. The ramp rate is established to prevent undesirable effects due to rapid changes in loading or (in the case of hydroelectric plants) discharge.

Regional Economic Development (RED) Account: The economic account that addresses change in the distribution of regional economic activity. Effects are addressed in terms of changes to regional business sales, employment, and income.

Reserve: The additional capacity of a power system that is used to cover contingencies, including maintenance, forced outages, and abnormal loads.

> **Cold Reserve:** Thermal generating capacity available for service but not maintained at operating temperature.
>
> **Hot Reserve:** Thermal generating capacity maintained at a temperature and condition which will permit it to be placed into service promptly.
>
> **Spinning Reserve:** Generating capacity connected to the bus and ready to take load. It also includes capacity available in generating units which are operating at less than their capability.
>
> **Standby Reserve:** Reserve capacity which can be placed on-line in a matter of minutes. Includes hot reserve capacity, combustion turbines, and most idle hydroelectric capacity.
>
> **System Required Reserve:** The system reserve capacity needed as standby to insure an adequate standard of service.

Rule Curve: A curve or family of curves indicating how a reservoir is to be operated under specific conditions to obtain best or predetermined results. Rule curves can be designated to regulate storage for flood control, hydropower production, and other operating objectives, as well as combinations of objectives.

Runner: The rotating part of a turbine.

Run-of-River Plant: A hydroelectric power plant utilizing pondage or the flow of the stream as it occurs.

Spill: The discharge of water through gates, spillways, or conduits which bypasses the turbines of a hydroelectric plant.

Station Use: Energy power used in a generating plant as necessary in the production of electricity. It includes energy consumed for plant light, power, and auxiliaries regardless of whether such energy is produced at the plant or comes from another source.

Storage Plant: A hydroelectric plant associated with a reservoir having power storage.

Storage Project: A project with a reservoir of sufficient size to permit carryover from the high-flow season to the low-flow season, and thus to develop a firm flow substantially more than the minimum natural flow. A storage project may have its own powerplant or may be used only for increasing generation at some downstream plant.

Streamflow: The rate at which water passes a given point in a stream, usually expressed in cubic feet per second (cfs).

> **Natural Streamflow:** Streamflow at a given point of an uncontrolled stream, or regulated streamflow which has been adjusted to eliminate the effects of reservoir storage or upstream diversions.
>
> **Regulated Streamflow:** The controlled rate of flow at a given point during a specified period resulting from reservoir operation.

Supply Curve: Identifies quantities of a good or service that firms will produce at different prices.

Surface Bypass Collector (SBC): A type of fish bypass facility.

Tailrace: The channel or canal that carries water away from a dam. Also sometimes called afterbay.

Tailwater Elevation: The elevation of the water surface downstream from a dam or hydroelectric plant.

Thermal Plant: An electric power plant which derives its energy from a heat source, such as combustion, geothermal water or steam, or nuclear fission. Includes fossil-fuel and nuclear steam plants and combustion turbine and combined cycle plants.

Transmission: The transporting or conveying of electric energy in bulk to a convenient point at which it is subdivided for delivery to the distribution system. Also used as a generic term to indicate the conveying of electric energy over any or all of the paths from source to point of use.

Travel Cost Method (TCM): A technique that uses the actual number of trips taken by an individual as the quantity variable and the visitor's travel cost as the price variable to identify a demand curve for recreation.

U.S. Water Resources Council (WRC) (1983) Guidelines: The Economic and Environmental Principles and Guidelines for Water and related Land Resources Implementation Studies developed by the U.S. Water Resources Council (1983). The analysis presented in this appendix is based on these guidelines.

Watt: The basic electrical unit of power or rate of doing work. The rate of energy transfer equivalent to one ampere flowing under a pressure of one volt at unity power factor. One horsepower is equivalent to approximately 746 watts.

Western Systems Coordinating Council (WSCC): One of nine regional energy reliability councils that were formed due to a national concern regarding the reliability of interconnected bulk power systems. The WSCC comprises all or part of the 14 Western States and British Columbia, Canada.

Wheeling: The transfer of power and energy from one utility over the transmission system of a second utility for delivery to a third utility, or to a load of the first utility.

Willingness to Pay (WTP): The expressed amount an individual would pay for something. For goods sold in a market, the WTP is the amount actually paid to obtain the good plus an additional amount that an individual would have been willing to pay for the chosen quantity of the good. For non-market goods, WTP is the expressed amount an individual would pay.