Southern Pine Beetle Control Plan

A. Henry

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Combined Forest Pest
Research and
Development Program

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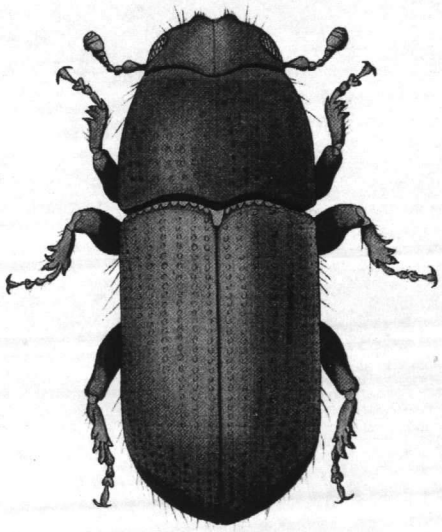
Southern Pine
Beetle Handbook

An Aerial Observer's Guide to Recognizing and Reporting Southern Pine Beetle Spots



Contents

In 1974 the U.S. Department of Agriculture initiated the Combined Forest Pest Research and Development Program, an interagency effort that concentrated on the Douglas-fir tussock moth in the West, on the southern pine beetle in the South, and on the gypsy moth in the Northeast. The work reported in this publication was funded in whole or in part by the Program. This manual is one in a series on the southern pine beetle.

An Aerial Observer's Guide To Recognizing and Reporting Southern Pine Beetle Spots

by Ronald F. Billings and Coleman Doggett [1]

Introduction

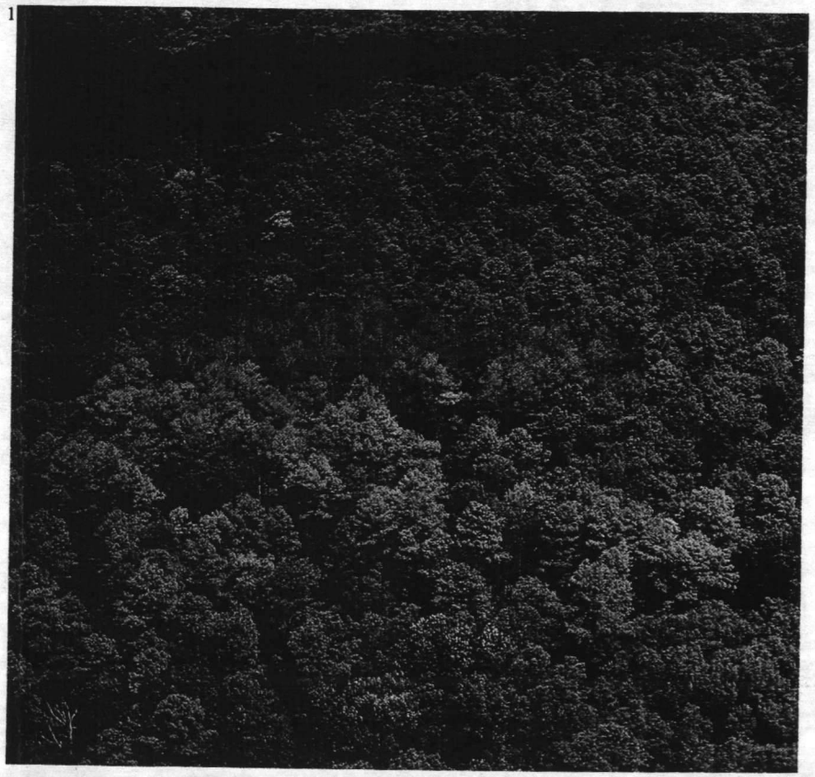
Early detection of new infestations is the first step in controlling the southern pine beetle (SPB) and in reducing timber losses. Over large forested areas, periodic aerial surveys are the most practical observation method. Aerial observers plot suspected beetle spots—pine trees with discolored foliage—onto maps or aerial photographs. Ground crews then check these areas to see if SPB caused the damage and to determine if control is needed. The problem is, during beetle outbreaks, so many suspected SPB spots are reported that ground crews cannot check them promptly. This hampers control operations.

This handbook is designed to help foresters and technicians become efficient aerial observers. It has two sections. First, we describe what SPB spots look like from the air in summer—the season when most new infestations are observed—and explain how to distinguish them from areas with trees dead or dying from other causes. The discussion includes guidelines for assigning a ground check priority to each reported spot. Then, based on seasonal habits of the beetle and on seasonal changes in the appearance of infestations, we describe symptoms that you should look for in fall, winter, and spring.

[1] Principal Entomologist, Texas Forest Service, Lufkin, and Pest Control Forester, North Carolina Division of Forest Resources,

Guidelines for Summer Aerial Surveys

Beetle Behavior in Summer



During summer, SPB broods develop rapidly. Within 4-6 weeks after a tree is attacked, the new brood of adult beetles emerges, even though tree foliage may still be green. Because of this delay in foliage fade, many spots may already be "inactive" (abandoned by SPB) before ground check crews can check them. Inactive spots do not require control.

Certain SPB spots, however, expand in summer as adult beetles emerge from brood trees and attack pines at the spot's edge. Continuous spot growth is most common when beetle populations are high. From the air, the expanding spot appears as a group of red- and yellow-crowned trees (fig. 1), and ground crews checking these spots often find beetles in adjacent green trees. Not all spots expand after detection, but those which do—unless controlled—may cause large timber losses.

Figure 1.—Typical expanding SPB spot in summer.

Recognizing SPB Spots

When new spots first become visible, they may have only light-green or yellow-crowned trees (fig. 2) and not display other stages of foliage fade. This is particularly true in late spring and early summer. But by midsummer the typical expanding SPB spot has dead or dying pines in various stages of discoloration (fig. 1). The different foliage colors trace the beetle's spread through the forest. After 8-12 weeks, beetle-killed trees at the spot's origin drop their needles. Next to these bare trees are red-crowned ones, most of them no longer containing beetles. Then come yellow-crowned pines that have been more recently killed. Newly attacked trees on the margin of the spot will have green crowns, and from the air you will not be able to distinguish these from unattacked trees.

Figure 2.—New SPB spot with

Evaluating Potential Spot Expansion

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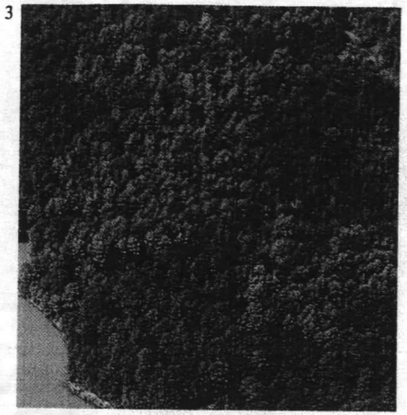

The major purpose of SPB control programs during the summer months is to reduce timber losses by locating and treating expanding infestations. Spots which are no longer expanding are soon abandoned by the beetles and have little need for control. To assist ground crews, you need to distinguish SPB spots showing visible symptoms of expansion from other spots likely to become inactive.

But how can you tell from the air if a spot will expand? Yellow crowns are the most useful clue. An expanding spot will have at least some yellow crowns. Rapidly expanding spots contain as many yellow-crowned trees as red ones. The location of the yellow-crowned trees within the spot marks the path of its spread, which may be in one direction (see fig. 1), or in several (fig. 3). When a spot becomes inactive, it will no longer have such trees (fig. 4). For control purposes, you do not need to report spots without yellow crowns.

Figure 3.—SPB spot expanding

During SPB outbreaks, spots may range in size from one to several hundred trees. As a general rule, the larger a SPB spot appears from the air, the more likely it is to grow. You can greatly aid control operations by reporting only spots with a total of five or more red- and yellow-crowned trees. Spots with fewer than five trees are not likely to expand and will often become inactive during the summer (fig. 5). This minimum will also eliminate recording many small *Ips* and black turpentine beetle spots, which are less prone to cause economic losses. True, you may overlook a few expanding SPB spots by using this practice, but these will be recorded later if they exceed five trees in size. During severe beetle outbreaks, forest managers may make the minimum reporting size larger than five trees if workloads of ground check crews become too great.

You should estimate the size of each spot reported. Two methods exist for such estimates: one, recording total number of dead and dying trees, which is indicative of the amount of salvageable timber; or two, noting only the number of red- and yellow-crowned trees, but not those having lost most or all of their foliage. This second method provides a better measure of trees that still contain beetles. Before selecting one method over the other, check the survey policy of your organization. And be sure that ground crews know which estimating system you use.

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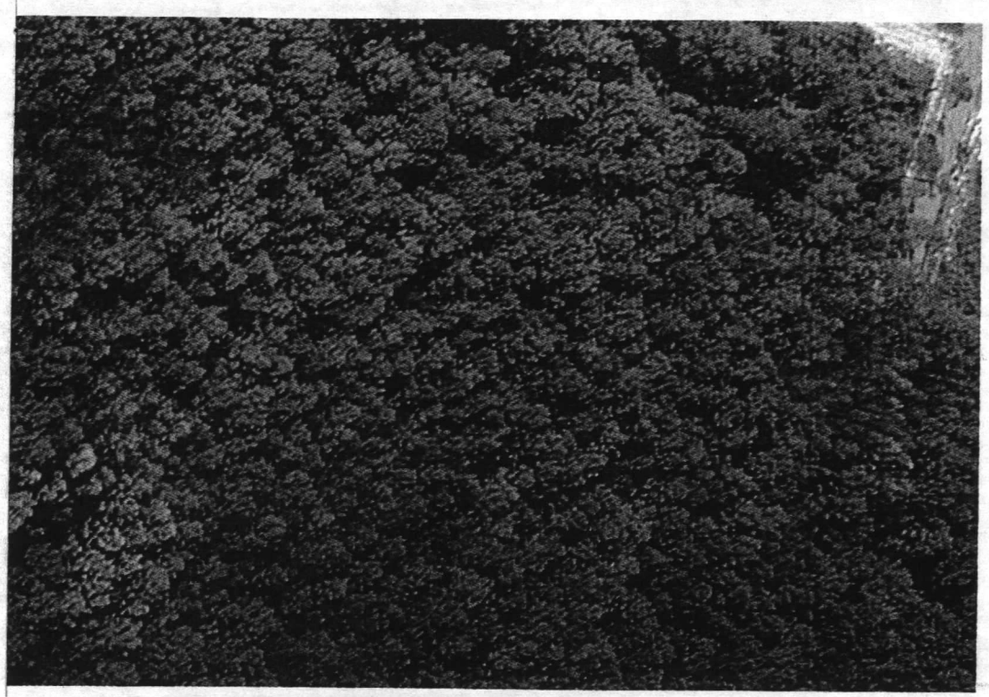

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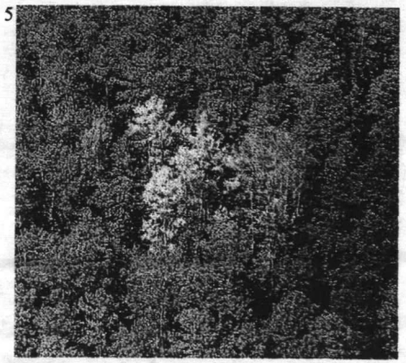

Figure 4.—At left, expanding spot; at right, nonexpanding spot.

Figure 5.—Small spot with low beetle activity.

Determining Ground Check Priorities

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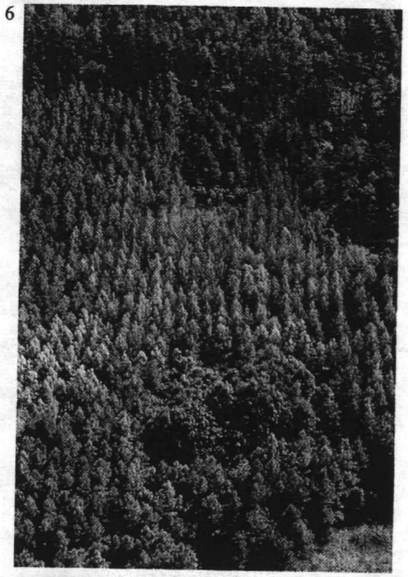

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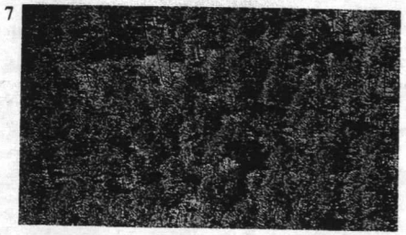

Figure 6.—High priority spot in plantation (North Carolina Forest Service).

Figure 7.—Low priority spot in sparse pine stand.

If spots are numerous, assign a priority for ground checking to each SPB spot reported. List at the time of observation both the estimate of spot size and the ground check priority next to each spot location on your map or photo. Ground crews will then know which spots to check immediately and which ones they may visit as time permits. For your own reference or to aid new observers, prepare a priority table for your survey area. On it, list conditions to look for in evaluating spots from the air. Table 1 is an example of a priority table for aerial observers.

Experience has shown that SPB infestations in mature sawtimber stands (see fig. 1) or dense pine plantations (fig. 6) are most apt to spread unless controlled. You should assign these spots a higher ground check priority than SPB spots in sparse pine stands (fig. 7) or in areas containing more hardwoods than pines.

Many forest managers prefer commercial salvage of infested pines for beetle control. But the spot must be accessible and have enough timber volume to justify salvage efforts. A logger can afford to build roads when a large volume of timber is involved; a small volume may be worth salvaging only if it is near an existing road. If salvage is the only means of control used in your area, you should give a low ground check priority to small, inaccessible spots.

The land use objective may also influence the priority you assign a spot. A SPB spot in a residential or recreational area (see fig. 3), for example, may require immediate action. But a spot in a wilderness area or in a remote, noncommercial forest may well be given a low ground check priority.

Upon completion of each detection flight, give ground crews a list of the spots requiring ground checking. For each spot, include plotted position, estimate of spot size, and ground check priority. Ground crews then have all the information they need to systematically handle large numbers of spots.

Table 1—*Example of a table for setting ground check priorities from the air, May through October. Choose the spot classification which best describes the spot.*

Priority for ground check	*Spot classification*
Priority 1 (high)	More yellow- than red-crowned trees
	In dense natural pine stand or in area with past history of SPB outbreaks
	Easy access or high salvageable volume
	In plantation or other high value area
	Threat to cross property lines and affect high value stands
Priority 2 (breakout)	Yellow-crowned trees in spot previously reported controlled or inactive
Priority 3 (medium)	More red-crowned than yellow-crowned trees
	Poor access or moderate salvageable volume
Priority 4 (low)	Few yellow-crowned trees
	Infested pines surrounded by hardwoods or open land
	Difficult to locate on ground because of small size or inaccessibility
	In unmerchantable timber or with low salvageable volume

Followup Aerial Surveys

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To aid beetle control programs, you should make periodic aerial surveys every 4–6 weeks. During midsummer surveys, it is helpful to revisit SPB spots recorded on earlier flights but not yet ground checked or controlled. Remember, because of rapid foliage changes in warm weather, the same spot may look different from the air several weeks after detection. Many spots that first appeared active may by August or September no longer contain yellow-crowned trees. After a followup survey, you may safely assume that such spots have stopped expanding, and give them a low priority for ground checking and control. If all the infested trees in a spot have lost their foliage, the spot can be declared inactive (fig. 8). In winter, however, bare-crowned trees may contain beetle brood and only by ground checking can you verify that SPB spots are inactive.

Some spots that appeared small at first may have grown large by the time of the following flight. If so, you should update their size and ground check

Figure 8.—An inactive SPB

Updating Flight Maps

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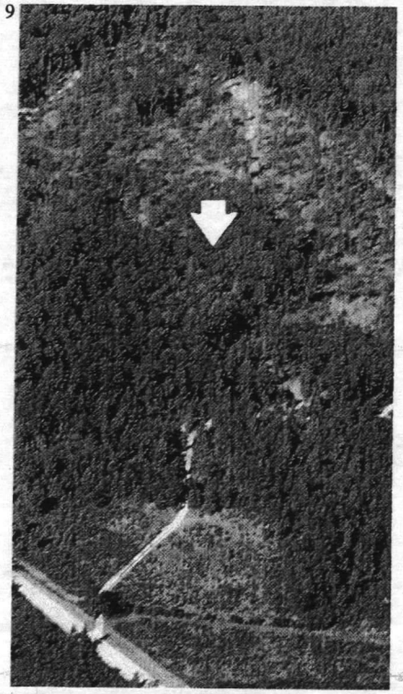

To keep current on SPB spots in your area, you must frequently update flight maps. Use the same set of maps or photos for all aerial surveys in a given year. This reduces the chance that a spot will go unreported or be reported more than once. Before each flight, note on your aerial map SPB spots reported by ground crews as inactive or controlled. The notation prepares you for spotting breakouts.

A suggested system for recording spots and updating SPB flight maps is given in table 2. To use this system, draw a small circle around each new spot on your map. Use a different colored pencil for each survey flight. As new information comes in, alter the circle to indicate the current status of each spot.

you can aid ground crews by sketching the infestation boundaries on a map or aerial photograph.

Finally, during midsummer flights, inspect recently controlled spots for signs of renewed beetle activity (breakouts). A breakout appears as a group of red- and yellow-crowned trees at the edge of the controlled area (fig. 9). Report all breakouts.

Figure 9.—Breakout following

Distinguishing SPB Spots from Other Tree Problems

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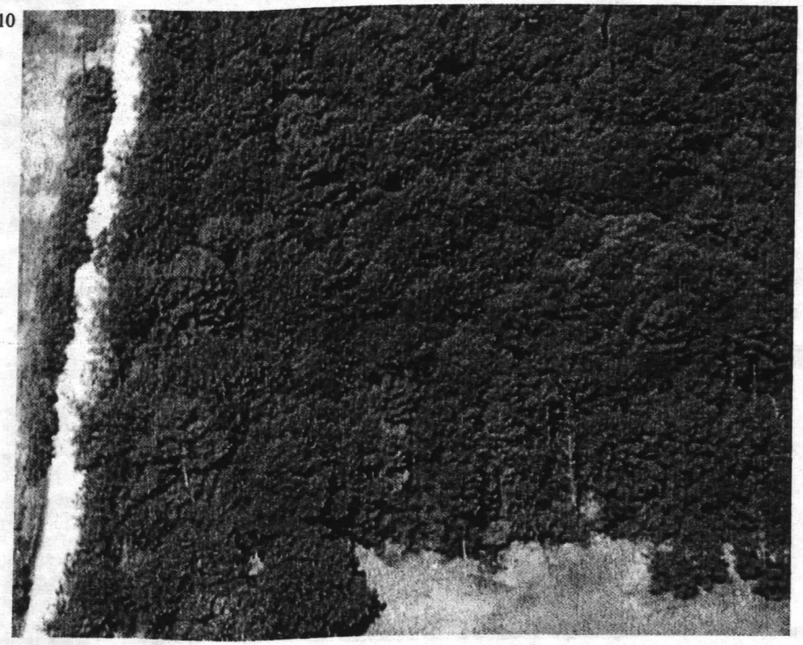
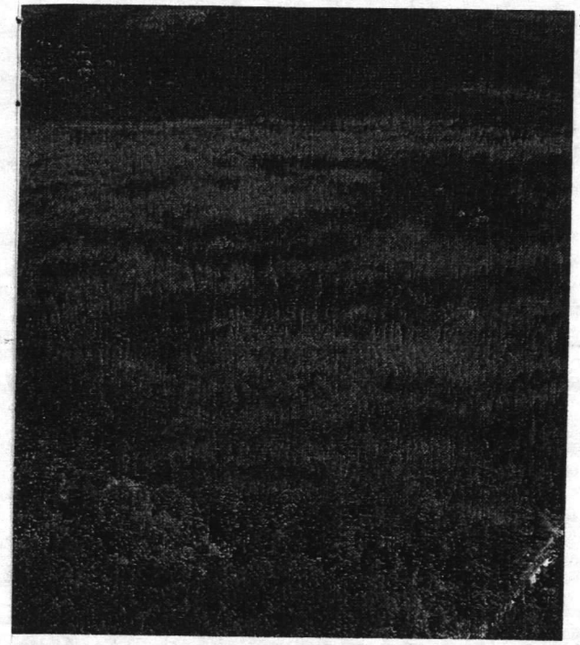


Groups of dead pines with only red crowns are commonly seen during SPB surveys (fig. 10). They may indicate SPB spots that are inactive or no longer expanding. But the red crowns may have been caused by lightning, fire, herbicides, or bark beetles other than the SPB. With close observation, you can learn to recognize damage by these other causes and avoid reporting it as SPB damage.

Figure 10.—Dead pines with

Fire



Trees killed by recent fires appear as red or brown patches, with crowns all the same color (fig. 11). Light fires sometimes scorch trees without killing them, which leaves the lower crown red and the upper crown green. Scorched earth beneath trees and fire-control lines also signal recent fire occurrence.

Figure 11.—Brown patches sig-

Foliage Diseases

11 Pines suffering from diseases, especially pine "needle cast," may show symptoms similar to those of SPB-killed trees. Pond pine along the Atlantic Coastal Plain is frequently infected with needle-cast fungi, as are loblolly and slash pines. Common from February through June and again in September and October, needle cast primarily hinders spring and early fall aerial surveys. Moderately affected trees have greener upper crowns than lower crowns. When the spring growth flush begins, green terminal shoots appear on trees with needle cast; no green shoots come out on SPB-killed trees once they turn red.

Herbicides

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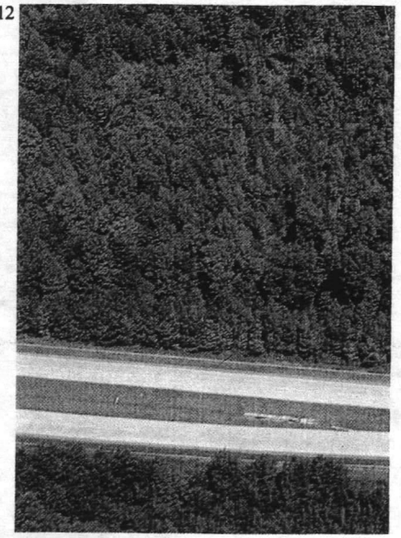

Uniform strips of yellow- or red-crowned trees along powerlines, pipelines, roads, and railroad tracks (fig. 12) are most often an indication of herbicide application and not of SPB infestations. Sprays applied to agricultural crops often drift onto adjacent stands of trees, causing foliage discoloration. When herbicide damage occurs in mixed pine-hardwood stands, hardwoods are affected along with pines. In timber stand improvement operations, only hardwoods are affected.

Figure 12.—Herbicide-damaged trees along highway right-of-way (North Carolina Forest Service).

Other Bark Beetles

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Single, widely scattered yellow- or red-crowned trees observed during summer surveys generally indicate lightning strikes or attacks by bark beetles other than SPB. Black turpentine beetles typically kill single pines. Most *Ips* infestations are small and scattered, often containing only red-topped pines (fig. 13), unlike varicolored SPB spots. *Ips* attacks occur primarily during extended droughts or adjacent to recently logged areas or in storm-damaged stands. In case of large infestations, ground checking is the only way to determine whether *Ips* or SPB is responsible.

Figure 13.—Scattered pines in-

Checklist for Summer Aerial Surveys

For detecting and reporting SPB spots from May through October, follow these guidelines:

- Decide if the observed trees show symptoms of recent SPB attack. Look for a group of dead and dying pines with at least some yellow crowns.
- For suspected SPB spots, determine if the number of yellow- and red-crowned trees exceeds the minimum reportable size.
- Plot the locations of all reportable spots as accurately as possible on a map or photo. Use landmarks such as clearings, road intersections, pipelines, and lakes.
- Estimate and record either the total number of affected trees (bare + red + yellow) or the number of recently infested trees (red + yellow).
- Assign a ground check priority to the spot, based on a priority table (table 1). Record this information on the map or photo.
- Report all information promptly to ground check crews.

Table 2.—*Suggested symbols to use on SPB flight maps*

Source of information	*Symbol* [1]	*Description*
Initial aerial survey	20/1 ⊙	New spot with 20 trees and priority 1 for ground check (color indicates date of flight)
Ground check information	15/3 ●	Spot found to be inactive upon ground check (use to update flight maps prior to next flight)
Control information	50/1 ⊗	Spot controlled since last flight (use to update flight maps prior to next flight)
Followup flight	20/4 ⊖	Previously seen spot that appears to be inactive from air with bare trees or red crowns or both, but no yellow crowns
Followup flight	100/1 ⊗ B.O./20	Controlled spot that is observed from air to have a breakout with 20 active trees
Followup flight	~~10/4~~ ⊙ 100/1	Previously seen spot updated from 10 to 100 active trees and priority 4 to priority 1

[1] Some organizations prefer to use a

spot's location may not be accurately

Guidelines for Fall, Winter, and Spring Aerial Surveys

Fall Surveys

In the fall, when hardwood leaves change color, it is difficult to detect new SPB spots in mixed pine-hardwood forests. The yellow or red foliage of cypress trees in the fall also may be mistaken for beetle-infested pines. As a result, survey flights are usually discontinued until hardwoods have completely dropped their leaves.

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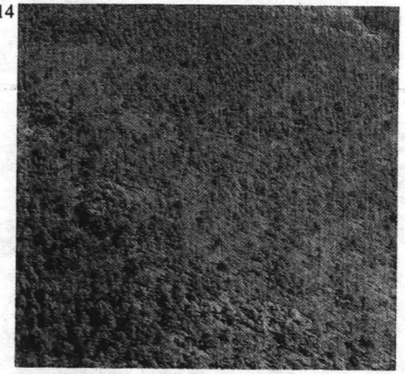

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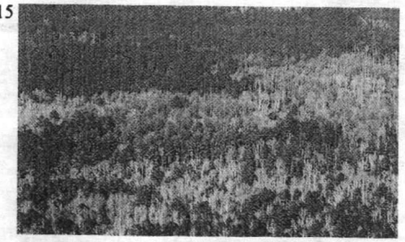

Figure 14.—Winter spots in Virginia (Virginia Division of Forestry).

Figure 15.—Winter SPB spot in Texas.

Winter Surveys

The purpose of winter surveys is to locate overwintering SPB populations so that control can be applied before beetles disperse in the spring. Ground check priorities during winter surveys can be based on just two factors: number of affected trees and accessibility for control. Remember, SPB broods develop more slowly during the winter, often remaining within trees until after the foliage drops. Red crowns in a SPB spot during the winter, unlike those in summer, indicate that beetle broods are present.

The effectiveness of winter surveys for SPB varies among different geographic regions. Their activity restricted by cold temperatures, beetles in the Piedmont and Atlantic Coast States tend to remain throughout the winter in the same multiple-tree spots they occupied during the late fall. These spots become detectable when aerial surveys are resumed in December or January (fig. 14).

In the Gulf Coast, however, beetles in the fall often leave large spots to infest single trees scattered throughout the forest, and, in mild winters, may continue to infest new trees. Pines infested in winter maintain green crowns for 2–4 months, thus escaping observation during aerial surveys. In winter, even multiple-tree spots started in the fall are easy to overlook on the Gulf Coast because the foliage color of infested trees does not change dramatically. Between December and April, infestations seldom show the yellow crowns that clearly mark SPB spots in summer. At normal survey altitudes (1000–2000 ft), you may be able to see only the larger groups of bare and red-crowned trees (fig. 15). Most of the red-topped pines still contain SPB. But much of the beetle population in winter and early spring occurs in scattered single trees which elude detection. By flying slowly with a helicopter at low altitudes (100–500 ft), you have a better chance of seeing beetle-infested pines in winter along the Gulf Coast. At these low altitudes you may see off-color crowns of beetle-infested pines (fig. 16) that at higher altitudes would not be distinguishable from uninfested trees. Also, trees killed by SPB often have bark stripped by woodpeckers, which leaves them with highly visible white boles. Although effective, surveys by helicopter are costly and generally applicable only to high value stands.

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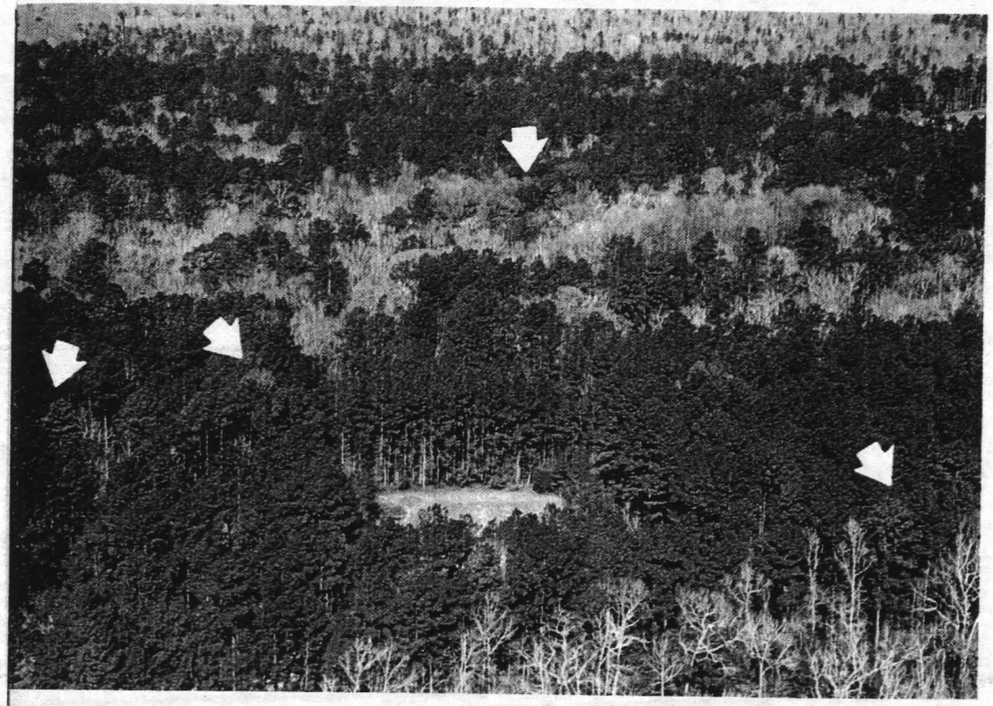

Figure 16.—Helicopter view of

Regional Differences

Spring Surveys

Trees killed by beetles in late winter on the Gulf Coast can be seen during March and April. Even though early emerging beetles may kill large numbers of trees, new spots in spring seldom persist or expand. Temperatures in the spring are still too cool for continuous spot growth. This results in many scattered, short-lived spots in which groups of infested trees show the same foliage color.

Locating new SPB spots in early spring is difficult in mixed pine-hardwood stands: new foliage on hardwood trees makes them resemble SPB-killed pines with fading foliage. As conditions improve for long distance dispersal, however, beetles leave scattered brood trees to concentrate in expanding spots. These multiple-tree spots become easily seen by early summer in the Gulf Coast or by midsummer or later in the remainder of the South.

Because of these seasonal limitations, SPB observation surveys along the Gulf Coast are most effective from May to October. For States along the Atlantic Coast and in the Piedmont region, SPB surveys are practical during midwinter as well as throughout the summer.

The procedures discussed in this handbook were developed primarily from information gathered on the Gulf Coast where SPB may be active throughout the year. Some of the recommendations may require modifications for effective use in other areas of the beetle's range, where there are fewer SPB generations per year and forest conditions are different. If questions arise, check with a Federal or State forest pest control specialist, who can tell you which, if any, of the recommendations are not applicable to your survey area.

Acknowledgment

Guidelines for recognizing and reporting SPB spots during aerial surveys are derived from research and operational experience of the Texas Forest Service and the North Carolina Division of Forest Resources. The authors gratefully acknowledge the contributions provided by other State and Federal forest pest control specialists throughout the South in the preparation of this handbook. The photographs were provided by the Forest Pest Control Section of the Texas Forest Service, unless otherwise noted.

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Report No. 80-1-17
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BIOLOGICAL EVALUATION OF SOUTHERN PINE BEETLE INFESTATIONS ON CAMP LEJEUNE MARINE CORPS BASE, NORTH CAROLINA

by

Patrick J. Barry
Supervisory Entomologist

ABSTRACT

Aerial surveys and ground checks of 87,000 acres consisting of 42,000 acres of susceptible host show an estimated 162 multiple tree southern pine beetle spots on Camp Lejeune. An estimated 423.2 MBF are currently infested with a potential for an additional 1,270 MBF loss without a control project. A large red cockaded woodpecker population will require special protection during a control project.

INTRODUCTION

On February 22, 1980, the U. S. Forest Service Aerial Survey Team (State and Private Forestry, Doraville, Georgia) in cooperation with the Camp Lejeune Forestry Department conducted a 100 percent southern pine beetle aerial survey of the base (Carothers, 1980). Areas of dead and dying pine were marked on a base map and used as reference for ground checking the week of March 3rd. Sixteen of these spots were randomly selected for ground checking proportionate to spot size class distribution.

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At each spot, the number and volume of infested trees were recorded to project total infested volume throughout the base. The aerial survey can only provide for recording red and fading trees. The number of green infested trees were recorded in ground sampled spots, to supply a correction factor for projecting total numbers of infested trees from the aerial survey data.

RESULTS

Table 1 shows results of the aerial survey after application of the correction factor (2.047). The base is heavily infested with 3.86 spots per 1,000 acres of susceptible forest type. The 162 infestations contain an estimated 2,383 currently infested trees comprising an estimated 423.2 MBF of timber. Figure 1 shows areas of heaviest southern pine beetle activity. It is noteworthy that Camp Lejeune supports a large population of red cockaded woodpeckers. This endangered species nests in old growth southern pines and was found proximal to or within some southern pine beetle infestations. Figure 2 shows the location of these woodpecker nesting sites. This information was provided by the Camp Lejeune Base Forestry Department.

Table 1.--Number of southern pine beetle spots and infested trees by spot size class (corrected aerial survey data), Camp Lejeune Marine Corps Base, 1980.

	- - - - - Spot Size - - - - -					
	1-10	11-25	26-50	51-100	100+	TOTAL
No. spots	135	0	8	18	1	162
No. trees	346	0	307	1,576	154	2,383

DISCUSSION AND RECOMMENDATIONS

The aerial survey and ground examinations of infestations on the military base show that the current outbreak is in its initial stages. At this time, the infestations are in stressed and weak trees. Some of the stressed trees were man-

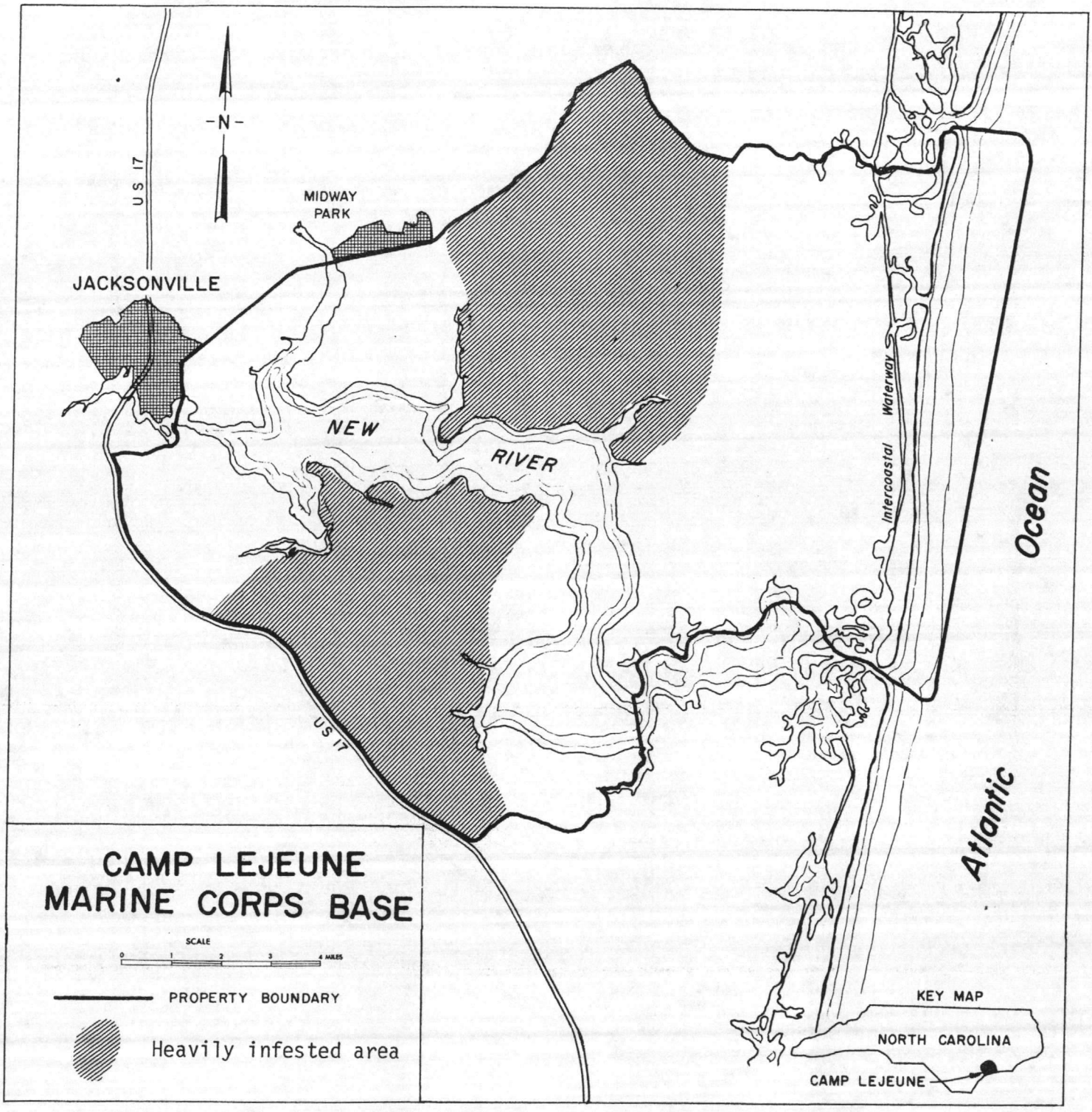


Figure 1.--Location of heaviest southern pine beetle activity.

Figure 2.--Location of 22 red cockaded woodpecker colonies.

caused such as, those wounded by climbing spikes used in climbing trees to install communication wire, those in bivouac areas that had been chopped on with axes and hatchets, and those with soil compaction due to continuous foot and vehicle traffic. Certain areas seem to be used repeatedly. Trees were girdled by communication wire where the wire was wrapped around them a number of times and then tied off tightly. Mechanical damage from vehicles and equipment is also a source of stress caused by the scarring and debarking of trees. Numerous stressed trees were found around wet areas and pocosins. This stress is due to either too much water or not enough. This particular problem could have been caused by the drought we had in 1978. If conditions stay ideal for the southern pine beetle, tremendous losses of pine timber could be sustained on the base.

Based on traditional spot growth data for the area, as much as 1,270 MBF could be lost within the next year, if infestations on the base are not controlled. The total loss could be as much as 1,693 MBF (currently infested 423 MBF - the projected 1,270 MBF). Based on individual situations, any of several suppression techniques may be used.

CURRENT SUPPRESSION PROCEDURES

1. Removal of Infested Trees by Commercial Sale or Administrative Use. When infested trees of merchantable size are accessible, they should be removed by commercial sale or administrative use procedures. Logging of the infested material should begin immediately. Contract time limits should insure rapid removal.

   When practical, and if host type is present, a 40- to 70-foot buffer strip should be marked and cut adjacent to and ahead of the most recently infested trees. This practice is effective in reducing the possibility of "breakouts." When only a small volume of infested merchantable material occurs in a spot, noninfested trees surrounding the spot may be marked to provide an operable cut.

   The order of priority of removing beetle-infested timber from a spot should be as follows:

   -- Trees in the buffer zone at the head(s) of the spot - if not removed within 2 weeks of marking, another visit and talley must be made in order to insure removal of all infested trees and an adequate buffer strip.

   -- Trees with fresh attacks and having young broods (usually the green, recently infested trees).

   -- Trees having nearly developed broods (usually the red and fading trees).

   Remove infested trees from Marine Corps Base, Camp Lejeune lands by commercial sale or administrative use procedures in accordance with guidelines and procedures set forth in FSM 2400 through 2490.

2. Piling and Burning. Unmerchantable or inaccessible southern pine beetle infestations can be suppressed by cutting, piling, and thoroughly burning the bark of infested trees. The entire bark surface must be thoroughly burned to insure effective control. The order of priority for cutting, piling, and burning infested trees, particularly the large spots, is the same as paragraph (1) under "Removal of Infested Trees by Commercial Sale or Administrative Use." Cutting a buffer strip is not recommended. To reduce the possibility of "breakouts," every effort should be made to locate and treat all green infested trees during the piling and burning operation.

3. Chemical Control. The chemical formulation recommended for southern pine beetle control is a ½ percent lindane spray with water as the carrier. This may be formulated from a 20 percent lindane emulsifiable concentrate at the rate of 11 pints of concentrate in enough water to make 55 gallons of spray. (Ratio of one part 20 percent lindane EC to 39 parts water.)

Dursban® (chlorpyrifos) is also registered for southern pine beetle control. It is available as a liquid containing 4 pounds of insecticide per gallon of concentrate. The spray is prepared by mixing 2 2/3 fluid ounces of concentrate with water to make 1 gallon or 2.1 gallons of concentrate in 100 gallons of water. Dursban® is to be applied only by or under the supervision of a certified pest control operator or other trained personnel responsible for insect control programs.

Cut, limb, and buck all infested trees into workable lengths. Spray the infested bark surface to the point of runoff. A compressed air sprayer (3-gallon capacity or equivalent) is an ideal applicator. Infested logs must be turned two or three times to insure complete treatment of infested bark. Low pressure sprayers may be used to treat large accessible infestations.

The order of priority for cutting and spraying infested trees in large spots is the same as paragraph (1) under "Removal of Infested Trees by Commercial Sale or Administrative Use." Cutting a buffer strip is not recommended. To reduce the possibility of "breakouts," every effort should be made to locate and treat all green infested trees during the chemical control operation.

Never spray trees from which southern pine beetle brood has emerged. Natural enemies of the southern pine beetle in these trees can then complete their development.

Instructions for minimizing the adverse effects of mixing, transporting and storing pesticides, applying pesticides and disposing of pesticide containers and excess chemicals are outlined in U. S. Marine Corps regulations.

4. Cut-and-leave. This control tactic reduced losses from spot growth and proliferation during the summer months. Cut-and-leave is designed to disrupt spot growth in small to medium-sized spots (40 active trees) by dispersing emerging beeltes. These spots can be salvaged when markets or weather permit. Trees are still suitable for sale months after felling.

The following procedure is to be followed when using cut-and-leave:

(1) Identify all active trees within the spot.

(2) Fell all active trees within the spot.

(3) Fell a horseshoe-shaped buffer of green, uninfested trees around the most recently attacked trees at the head of the spot and leave them lying on the ground with crowns pointed toward the center of the spot. The buffer should be as wide as the average height of the trees in the stand.

Cut-and-leave treatments should only be applied during the summer months between June and October. Spots with 10 or more infested trees should be treated first. As time permits, spots with less than 10 infested trees should also be treated if they contain trees with fresh attacks. In these smaller infestations where a specific head is not distinguishable, an adequate buffer strip (equivalent to the average height of the stand) and all infested and green uninfested trees within the spot should be felled.

Reexamination of Treated Areas. Reexamine areas where infested trees were removed by commercial sales, piled and burned, or chemically treated or cut and left within 2 or 3 weeks after treatment to check for additional infested trees. If additional trees are found, treat them.

In any area where infested trees are cut for chemical control, piling and burning, cut-and-leave or removed through commercial sales and administrative use procedures, stumps adjacent to living pine trees should be treated to control or prevent the root rot Fomes annosus.

Stands that have been previously thinned or have had a history of F. annosus infection, stumps should be treated with the competing fungus, Peniophora gigantea.

Stands that have no history of F. annosus and have never been thinned, the stumps should be treated with borax.

Southern pine beetle infested tree stumps cut during the period of May through August, and below 34° N. latitude do not have to be treated with either of the above materials. This is because few spores are formed during this period and high temperatures often kill spores that are produced. However, routine summer thinning in areas of southern pine beetle buildup is not recommended.

RED COCKADED WOODPECKER CONSIDERATIONS

1. Within colonies and buffer zones, each infested tree will be inspected individually and decisions made as to control measures for that tree; buffers of noninfested trees will not be treated.

2. Active cavity trees will not be cut or sprayed.

3. Dead or apparently live cavity trees from which beetles have emerged will not be cut.

4. Inactive cavities (dead, enlarged by other species, etc.) will not be cut unless a minimum of four cavity trees (active and inactive) per colony remain to provide shelter for a breeding pair of birds and up to two helpers for the interim period necessary for excavation of new replacement cavities.

5. Spraying with presently approved pesticides (Lindane - a chlorinated hydrocarbon, Dursban - an organophosphate) will not be conducted within colonies and buffers--trees cut within these areas will be removed.

6. Cutting of buffers around the head of infestations in contiguous habitat is acceptable unless doing so would separate the colony completely from suitable foraging territory (doughnutting or isolating colonies). In this case, the Camp Lejeune Wildlife Manager should determine if a buffer should be cut and, if so, the modifications of the buffer that should be made considering:

   a. the likelihood of preventing the infestation from entering colony sites by cutting or not cutting the buffer,

   b. the distance from the colony to suitable foraging territory if a buffer is cut (short distances would be crossed by the bird without undue impact), and

   c. the probability of the infestation destroying all or a significant portion of the foraging territory if the buffer is cut versus not cut.

These guidelines were developed by the U. S. Fish and Wildlife Service, Asheville, N.C. and Forest Insect and Disease Management, Asheville, N.C.

PREVENTIVE MEASURES

The preceeding represents only short-term, immediate control strategies. Preventive measures must be taken to help ward off further southern pine beetle infestations in noninfested stands. Some of the more significant preventive measures include:

1. Preventing or minimizing littleleaf disease, a condition which predisposes these weakened trees to beetle attack. Depending on severity of infection, diseased trees may be removed during normal thinnings, on a 6-year cutting cycle or as soon as merchantable. In high-hazard areas or in replanting known littleleaf sites, use loblolly pine or a more resistant tree species, as opposed to shortleaf pine.

2. Harvesting mature and overmature stands. Such stands are vulnerable to beetle attack and should be harvested as soon as possible.

3. Thinning stagnated stands. Overstocked stands are low in vigor and are more likely to be attacked. They should be thinned to a point that trees again show thrift and vigor.

4. Minimizing impact of natural disturbances which causes stand stress. These factors include ice, wind, hail, and animal damage, flooding, erosion, poor soil fertility, etc. Corrective measures include removal of individually damaged trees, wholesale salvage, improving drainage, fertilization, etc.

5. Minimizing or eliminating man-caused disturbances. Logging, pipeline, sewerline, and powerline construction, and other construction activities require use of heavy equipment which causes tree skinning and soil compaction and significantly weakens trees. Efforts to minimize the damaging consequences of these activities can significantly reduce the possibility of their leading to southern pine beetle problems.

PRECAUTIONARY PESTICIDE USE STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key--out of reach of children and animals--away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you used for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary landfill dump, or crush and bury them in a level isolated place.

NOTE: Some states have restrictions on the use of certain pesticides. Check your state and local regulations. Also, because registration of pesticides are under constant review by the U. S. Department of Agriculture, consult your county agricultural agent or state extension specialist to be sure the intended use is still registered.

LITERATURE CITED

Carothers, William A. 1980. Aerial detection survey of southern pine beetle activity, Department of the Navy, Camp Lejeune Military Reservation, North Carolina. USDA - Forest Service, Southeastern Area, S&PF, FIDM, Rep. No. 80-3-9.

Ray

PROJECT CONTROL PLAN

Southern Pine Beetle

US Marine Corps - Marine Corps Base
Camp Lejeune, North Carolina

Prepared by: Peter E. Black — Assistant Base Forester — 6-13-80 Date

Reviewed by: Kenneth C. Harrison — Base Forester — 6-13-80 Date

Recommended by: Julian L. Wooten — Division Director — 6-13-80 Date

Approved by: T. R. Bailey — Base Maintenance Officer — 6-13-80 Date

PROJECT CONTROL PLAN

Southern Pine Beetle - US Marine Corps Base, Camp Lejeune, North Carolina

1. Southern Pine Beetle

Southern pine beetle, Dendroctonus frontalis zimmerman, is the most destructive pine beetle in the South. The beetle can kill trees singly or in groups of trees covering many acres. Multiple generations during the growing season provide the means for a rapid population buildup to epidemic levels.

Southern Pine Beetle (SPB) mortality can be reduced through use of integrated suppression and disruptive tactics as recommended by Forest Insect and Disease Management, State and Private Forestry, United States Forest Service. All suppression decisions to reduce losses caused by the southern pine beetle are made by the land manager. He must make decisions using information provided in the 1) biological evaluation, 2) cost/benefit statement, and 3) the environmental impact statement and environmental analysis report.

To be effective, the suppression effort requires that all high and medium priority infestations be treated regardless of location or size. Spot treatment priorities are to be determined by using current spot rating schemes. Control projects impact timber markers, sales administrators, and clerks to a great extent. Therefore, manpower needs should be planned in advance.

Suppression activities are in two phases: operational surveys and treatment.

a. Operational Surveys - Aerial survey data enable land managers to effectively plan ground operations. In cases where work forces are limited, timely operational surveys are used to direct ground activities into those areas where needs are greatest, i.e., active infestations with 10 or more

fading trees located in overmature densely-stocked stands that are particularly susceptible to further SPB losses. Infestations with less than 10 fading trees can be ground checked as time permits.

1. Aerial Phase - Make operational aerial surveys over the area of infestations at 3 to 4 week intervals. Conduct these surveys on predetermined flight lines in either an east-west or north-south direction at 1 mile intervals. Flight lines are to be established at one-half mile intervals over the outbreak area; fly alternate lines on subsequent operational surveys. Two observers, one on each side of the aircraft, should map the location and estimate the size of all groups of 10 or more red and fading pines within one-half mile of the aircraft. This will give 100 percent coverage of the area being surveyed. Optimum detection of southern pine beetle infestations is obtained by flying at a height of 1,000 feet above the ground at an air speed of 90 to 120 miles per hour.

2. Ground Phase - Infestations with 10 or more fading trees observed from the air will be ground checked on a priority basis as soon after the flight as possible. Priorities for ground checking are to be established on the basis of spot size and location. The largest spots observed from the air with the greatest number of fading trees will be checked first. The following grading system will be used to set ground checking priorities:

25+ fading trees present - high

10-25 fading trees present - medium

less than 10 fading trees present - low

All high and medium priority spots should be ground checked first. Forest personnel ground checking beetle activity must be able to identify SPB infested trees with live beetle broods present in the spot. When active infestations are encountered, an estimate of the number of fresh attacks and the total number infested trees should be recorded. This information

should then be used to set priorities so that the largest spot or spots in high value stands are treated first. The following system will be used to set treatment priorities:

No. of Active Trees	Rank
> 50	4
21 - 50	2
11 - 20	1
1 - 10	0
Pine basal area at active head	
> - 120	2
80 - 120	1
< 80	0
Fresh attacks	
Present	3
Absent	0
Stand Class	
Sawtimber (9")	1
Pulp (9")	0
High 7 10	
Medium 4 6	
Low 0 3	

All high and medium priority spots will be treated first. Ground crews should always be on the alert for southern pine beetle infestations not detected from the air.

b. Assign Treatment. Spot treatment will be based on treatment priority, time of year, and spot location.

1. High priority spots will be marked and treated first. Salvage-sale will be the preferred treatment. All high priority spots will be marked for salvage until marked spots exceed operator capability and the backlog will create a delay of 3 weeks or more. The excess high priority spots will be treated as follows:

October-May --chemicals only. Any spot size up to 40 infested trees. If spot is more than 40 infested trees, spot to be salvaged controlled as soon as conditions permit.

June-September --cut-and-leave, if spot is less than 40 infested trees. If spot is less than 40 infested trees, spot to be salvage controlled the following month.

2. Medium priority spots will be marked for salvage after all high priority spots have been marked. When marked spots exceed operator capability, and the backlog will create a treatment delay of 3 weeks or more:

Excess medium priority spots will be treated the same as for high priority spots.

3. Low priority spots are not assigned a treatment. Research shows these spots have a high probability of going inactive. If they grow, they would then be assigned a higher priority for treatment the next month.

c. Treatment - Suppression should be a year-round effort. Although major suppression efforts primarily occur from late spring through fall, winter treatment of southern pine beetle infestations is also important because brood densities tend to be higher and are concentrated in fewer trees for a longer period of time. Prompt suppression of actively infested trees during the winter months will decrease the number of beetles dispersing into adjacent stands during the spring months.

Suppression is achieved using one or a combination of the methods listed below. Salvage removal of infested trees are salvaged and removed from the immediate area and some return is realized. Where salvage is not a viable

spot disruption tactic because of inaccessability, (lack of roads, seasonal constraints, etc.) alternative control methods selected should also:

--minimize adverse environmental effects, and

--maximize control effectiveness.

1. Removal of infested trees by commercial sale or administrative use. When infested trees of merchantable size are accessible, they should be removed by commercial or administrative procedures. Logging of the infested merchantable material should begin immediately. Contract time limits should insure rapid removal.

In spots with one or several areas with fresh attack (more than 10 green infested trees), and if additional host type is present and exceeds a basal area of 120 square feet per acre, a buffer strip the length of the average stand height will be marked and cut adjacent to and ahead of the most recently infested trees. This practice is effective in reducing the possibility of "breakouts." In small infestations, (i.e., less than 10 infested trees), the size of the buffer strip, if necessary, will be determined by the land manager.

The order of priority for removing beetle infested timber from a spot in the Coastal Plan will be as follows:

--Trees in the buffer zone at the head(s) of the spot - if not removed within 2 weeks of marking, another visit and talley must be made in order to ensure removal of all infested trees and an adequate buffer strip.

--Trees with fresh attacks and having young broods (usually the green, recently infested trees).

--Trees having nearly developed broods (usually the red and fading trees).

Remove infested trees from Camp Lejeune lands by commercial sale or administrative procedure in accordance with guidelines and procedures set forth in FSM 2400 through 2490.

The following southern pine beetle suppression strategies --cut-and-leave, and pile-and-burn-- are to be used when salvage removal of infested trees is not a viable suppression tactic. For example, when infested trees are of nonmerchantable size or because infested trees of merchantable size are inaccessible, or in highly sensitive areas such as recreation areas, hiking areas or picnic areas.

2. Cut-and-leave - This control tactic reduces losses from spot growth and proliferation during the summer months. Cut-and-leave is designed to disrupt spot growth in small to medium-size spots (less than 40 active trees) by dispersing emerging beetles. These spots can be salvaged when markets or weather permit. Trees are still suitable for sale months after felling.

The following procedure is to be followed when cut-and-leave is applied:

(1) Identify all active trees within the spot.

(2) Fell all active trees toward the center of the spot.

(3) Fell a horseshoe-shaped buffer of green, uninfested trees around the most recently attacked trees at the head of the spot and leave them lying on the ground with crowns pointed towards the center of the spot. The buffer should be as wide as the average height of the trees in the stand.

Cut-and-leave treatments should only be applied during the summer months between June-October. Spots with 10 or more fresh attacks should be treated first. As time permits, spots with less than 10 actively infested trees should also be treated if they contain trees with recent fresh attacks. In these smaller infestations where a specific head is not distinguishable, an adequate buffer strip (equivalent to the average height of the stand) and all infested and green uninfested trees within the spot should be felled.

3. Chemical Control - Chemical concentrations recommended for SPB control are a one-half percent Lindane or a one percent Chlorpyrifos and carrier mixture. The carrier may be water or number 2 fuel oil. The correct carrier to use is specified on the pesticide container label. The proper concentration may be obtained from a 20 percent lindane emulsifiable concentrate at a rate of 11 pints of concentrate in enough water to make 55 gallons of spray (ratio of one part 20 percent lindane EC to 39 parts water).

The proper concentration of Chlorpyrifos may be obtained from a 44 percent liquid concentrate by mixing 2 2/3 fluid ounces of concentrate with water to make a total of 1 gallon of mixture (equivalent to 2.1 gallons in 100 gallons of water).

Dursban 4E is the Dow Chemical Company trade name for chlorpypifos.

Cut, limb and, when necessary, buck all infested trees into workable lengths. Spray the infested bark surface to the point of runoff. The entire bark surface must be treated to insure adequate control, turning the logs as needed. Low pressure sprays may be used to treat large, accessible infestations, particularly in the winter months when many of the infestations are inaccessible to logging machinery. A hydraulic sprayer is recommended.

The priority for cutting and spraying infested trees in large spots is as follows:

1. Trees having nearly developed broods (usually the red and fading trees).

2. Trees having young broods and fresh attacks (green infested trees).

Do not cut a buffer strip. To reduce the possibility of "breakouts" every effort should be made to locate and treat all green infested trees during the chemical control operation. Look for fresh pitch tubes at 10-15' level.

Never spray trees from which southern pine beetle brood has emerged. Natural enemies of the southern pine beetle in these trees can then complete their development.

Instructions for minimizing the adverse effects of mixing, transporting, and storing pesticides, applying pesticides and disposing of pesticide containers and excess chemicals are outlined in Section 8.3 of the Forest Service Health and Safety Code and FSM 2145.4. Detailed safety procedures should be outlined in the project suppression plan.

4. Pile and Burning - Unmerchantable or inaccessible southern pine beetle infestation can be suppressed by cutting, piling and thoroughly burning the bark of infested trees. The entire bark surface must be thoroguhly burned to insure effective control. The order of priority for cutting, piling and burning infested trees, particularly in large spots, is the same as paragraph (3) under Chemical Control. Do not cut a buffer strip. To reduce the possibility of "breakouts" every effort should be made to locate and treat all green infested trees during the piling and burning operation.

Control Crew Organization

A project leader will be assigned to head up the base-wide control work. His responsibilities will be as follows:

1. Responsible to the base forester for all control work
2. Maintain offical files
3. Make operational flights
4. Assign spots for the evaluator to locate and check
5. Make control crew assignments
6. Spot check control work
7. Enforce safety rules and regulations
8. Ensure control spots are checked for reinfestation approximately three weeks after control

9. Prepare and distribute copy of latest copy of presuppression flight map to base forester.

Control Organization

1. Manpower

One spot evaluator, scout, sales inspector

- - - Make periodicoperational flights

- - - Locate and evaluate spots

- - - Assign priority to known spots and number spots for record keeping

- - - Re-check spots after salvage to detect breakout

- - - Show spots for marking and sale to marking crew and sales inspector.

- - - Determine boundary on all medium and high priority spots.

One sales inspector

- - - Inspect logging on all salvage sales

- - - Inform project leader as to what spots have been harvested

- - - Inform porject leader as to the progress and quality of all salvage sales.

One three-man crew, which includes straw boss

Who is responsible for maintaining adequate supplies of materials for a cut-and-leave system of management and materials and supplies for marking of SPB infested timber for salvage sale.

One four-man crew, which includes straw boss

Who is responsible for maintaining adequate supplies of materials for marking SPB infested timber for salvage sale.

2. Transportation

2 4x4 pickups

1 4x4 (6) passenger pickup

3. Equipment

A. Spot Evaluator

1. Hatchet
2. 10 Factor Prism
3. Clinometer
4. Diameter Tape
5. Flagging
6. Notebook
7. Maps

B. Three Man Crew

2 chainsaws

1 5 gallon can of chainsaw gas

1 gallon can chain oil

2 pairs of chainsaw chaps

3 pairs of gloves

3 sets of hearing protection

2 cant hooks

2 axes

2 wedges

1 portable drinking water can with cups

1 file for saws and axes

3 timber marking guns

1 case timber marking paint

3 diameter tapes

3 clinometers

C. Four man Crew

1 portable drinking water can with cups

5 timber marking guns

C. (continued)

2 diameter tapes

5 clinometers

Timing

During the winter or inactive period, operational flights should be made as needed.

Safety Precautions

Lindane and chlorphyrifos are poisonous and will be applied only by licensed applicators from Insect Vector Control. They will observe the following:

Safety Precautions for this project by NREA Division

1. Keep insecticide off the skin and away from the eyes and nose. Use protective equipment. In case of contact, wash immediately with soap and water.
2. Wear elbow length, neophrene gloves when spraying and especially when mixing the insecticide.
3. Wash carefully with soap and warm water immediately after mixing or applying the spray and before eating.
4. Clothes should be changed daily. Launder these clothes separately from other clothing and keep hands out of the laundry water.
5. Observe manufacturer's recommendations on the label and become familiar with antidotes.
6. Store all chemicals in original container and be sure all containers are properly marked.
7. Avoid breathing pesticide vapor or spray mists.
8. Do not apply insecticide to wet bark.
9. Keep pesticide out of ponds, lakes and streams.
10. Do not apply in any way not specified on the labels or for any use.

11. Release pressure slowly when opening spray-can covers.

12. Do not stand opposite a treater while the tree is being sprayed.

13. Follow instruction for dispersal, protective devices, storage and transportation as specified in Marine Corps Order P11000.8A.

14. Handle chain saws with care. Keep moving chain away from body. Always be alert when felling and cutting up trees.

15. Observe all safety regulations as specified in Marine Corps Order P11000.8A.

Post Suppression Evaluation

A post suppression evaluation will be written annually. Data will be recorded during each presuppression flight on breakouts of individual spots salvaged and reported in the presuppression flight narrative report. The Forestry Branch, Natural Resources and Environmental Affairs Division will participate in the Southern Pine Beetle Information System (SPBIS). They will provide FI&DM, State and Private Forestry, SA with completed forms SA 3400-4 and SA 3400-5. This data will be stored in the SPBIS computer program and accessed each year to provide data for the annual Post Suppression Evaluation Report.

Records and Reports

A. Field Reports - The Foreman for each crew will keep a record of the following information for each spot using the SPBTS form provided by FI&DM, State and Private Forestry (Form SA 3400-4).

1. Exact location

2. Number of infested trees and date area was checked

3. Number of trees treated and date treated (to be posted on record daily).

4. Size of spot (acres)

5. Volume of salvage, by products.

6. Effectiveness of treatment, date checked and if any followup work is needed. This record should be made at the time the final sale compliance check is made on a spot.

B. Monthly Report - Submit Form SA 3400-5 to the USDA-Forest Service, Southeastern Area, State and Private Forestry, Resource Protection Unit, Forest Insect and Disease Management Group, Box 5895, Asheville, North Carolina 28803, by the 8th of each month. A copy of the presuppression flight maps showing the location of any new beetle spots should accompany the SA 3400-5 sent to the State and Private Office in Asheville. If no work for the reporting month, a negative report is required.

C. Narrative Report - After each aerial survey, write a brief narrative report of survey results and send a copy to the Forest Insect and Disease Management Group as in B above. Individual spot breakout information recorded during each presuppression flight will also be reported in this narrative.

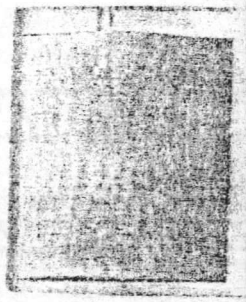
Planned Assistance

FI&DM will make a minimum of two technical assistance trips to project forests during the active control season (May - September). Further assistance can be obtained by phoning or writing Forest Insect and Disease Management, Box 5895, Asheville, North Carolina 28803, phone FTS 672-0625.

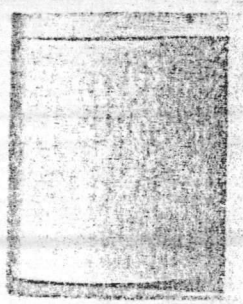
A Field Guide for Ground Checking Southern Pine Beetle Spots

by
Ronald F. Billings and
Herbert A. Pase III[1]

Introduction

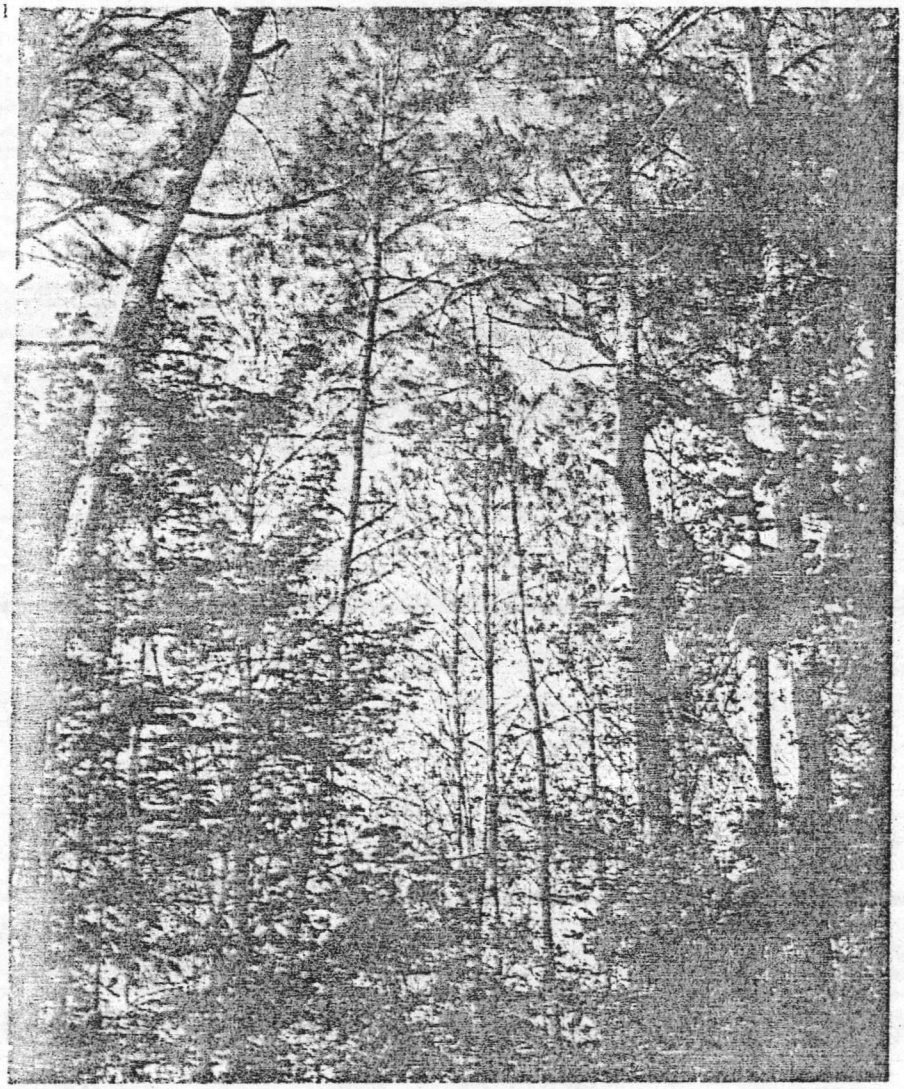


The job of locating and controlling the southern pine beetle (SPB) takes the teamwork of three separate field operations—aerial survey, ground check, and direct control. Aerial surveys locate many areas with dead or dying pines believed to harbor SPB. Some are active beetle spots; others are not. Only by checking from the ground can we be sure. So, on the basis of tree symptoms visible from the air, aerial survey crews assign each spot a high, medium, or low priority for ground checking. Ground check crews then visit newly detected spots, giving first attention to high priority areas. Your responsibility, as a member of the ground check crew, is to see firsthand the extent of beetle activity in each spot and to determine if further tree killing is likely to occur. This handbook shows how to recognize various stages of SPB attack, how to decide if control is needed, and how to mark buffer strips for control crews.



[1] Respectively, principal entomologist and entomologist II, Forest Pest Control Section, Texas Forest Service, Lufkin, Texas.

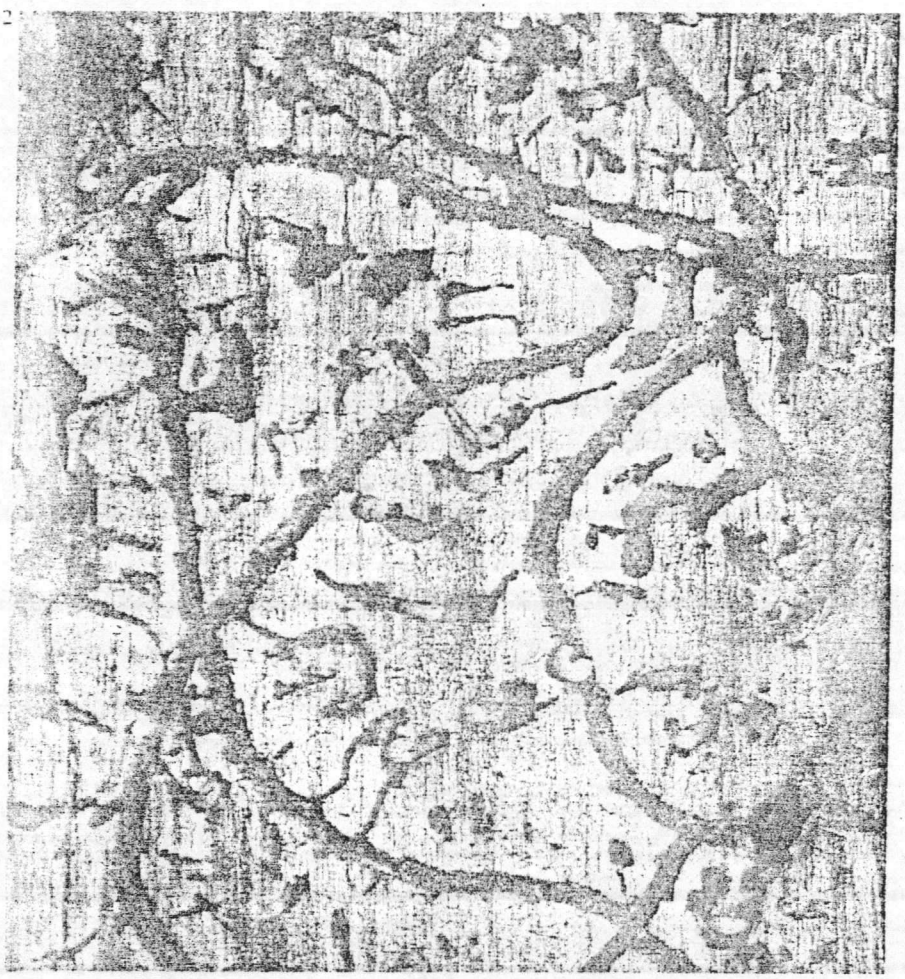
Locating SPB Spots from Ground Level



To find newly detected spots, use a map and compass, if necessary, to arrive at the general area indicated by the aerial survey team. Once there, look for a group of yellow- or red-topped pines (fig. 1). Spots that cannot be found after a reasonable search should be rechecked during the next aerial survey flight. The aerial crew may be able to correct errors in plotting or to pinpoint landmarks guiding you to the spot.

Figure 1.—Red-topped pines indicative of SPB spot.

How to Identify SPB Attacks



Like any living thing, pines may die from a variety of causes. But how can you tell if they were killed by SPB? The best way is to remove sections of bark from trees with fading (yellow) foliage or from trees with bark just starting to loosen. Look for the winding, S-shaped tunnels or galleries made only by SPB adults (fig. 2). SPB galleries are filled with a sawdustlike material (frass) left behind by feeding adult beetles.

In pines just coming under attack, galleries are not yet present. The first symptom of SPB in this case will usually be pitch tubes in bark crevices. These glossy masses of resin mark where the adult beetles bore into the trunk of a tree. SPB pitch tubes are soft and pink when fresh, becoming hard and white or yellow with age

Figure 2.—Galleries of SPB adults together with white larvae.

Other Bark Beetles

(fig. 3). But remember, pitch tubes—alone—are not reliable indicators of SPB attack because other bark beetles also leave them.

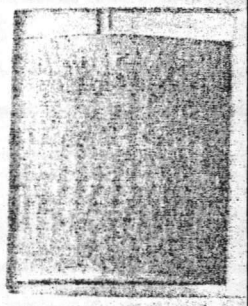
For a couple of weeks after attack, you may find SPB adults within the S-shaped galleries where they lay eggs. The SPB itself is surprisingly small, considering the amount of damage it can do. The adult beetle measures only 1/8 of an inch long and is black or dark brown. Because of their small size, you may have difficulty recognizing SPB adults among the many other bark-inhabiting insects. Again, the S-shaped galleries provide telltale evidence that SPB killed the tree, even when the beetles themselves are no longer present.

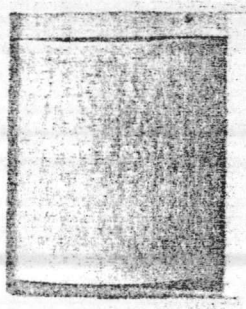
The southern pine beetle is not the only destructive bark beetle in the South. Other beetles, including *Ips* beetles and the black turpentine beetle (BTB), also kill pines, but usually in small, scattered outbreaks not requiring control. This means that you must be able to tell the difference between SPB attacks and those of other bark beetles. Identification can be difficult because the various beetles are similar in many ways.

Yet there are unmistakable differences. For instance, the black turpentine beetle is about ¼ of an inch long, which makes it much larger than the southern pine beetle. Also, the BTB normally limits its attacks to the lower 10 feet of the trunk, while the SPB attacks at almost any height on the tree. Pitch tubes of the BTB usually are reddish and much larger than those of the SPB (fig. 4). The black turpentine beetle's galleries follow no distinct pattern.

Differences between SPB and *Ips* beetles are less obvious because the insects are similar in size. Adult galleries provide the best clue for recognizing *Ips* attacks. They are long, straight tunnels often joining to form a Y or H shape. *Ips* galleries usually are not packed with frass (fig. 5). Keep in mind that *Ips* and black turpentine beetles may occur in the same tree as the southern pine beetle.

Figure 3.—Pitch tubes of SPB.





Seasonal Variation in Attack Symptoms

Figure 4.—Pitch tubes of black turpentine beetle.
Figure 5.—Galleries of the adult *Ips* beetle.

The time it takes SPB to grow from eggs to adults varies seasonally, as does the time it takes for symptoms of beetle attack to appear in infested pines. Judging the presence or absence of SPB and the stage of development during the winter months can be a difficult task. Foliage on trees attacked in cold months may remain green for long periods, although such trees quickly lose their needles once foliage discoloration begins. Because the beetle needs 2–4 months to mature during cold months, some winter-killed pines with bare crowns may still contain SPB. Also, the insects in winter often reattack the top and base of a tree already containing developing broods. This leaves different beetle life stages at different heights in the same tree. Because of these difficulties, no attempt has been made to categorize infested spots for the winter months.

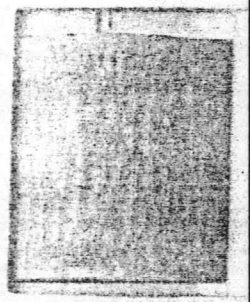
Stages of Beetle Attack During the Summer

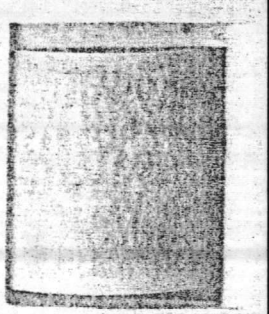
SPB attack sequence and developmental time are more predictable from May to October, and the appearance of beetle-killed pines changes with a distinct pattern. On the basis of these facts, three categories for beetle-infested pines have been established, reflecting various stages of attack. The number of trees in each stage of attack—and where the trees are located in a spot—is the key to whether a SPB spot is likely to spread in warm weather. It is essential, then, that you learn to recognize these three stages to correctly determine the need for control.

Stage 1—Pines With Fresh Attacks

When SPB bore into a tree, they produce chemicals attracting other beetles to the tree. This sets off a chain reaction. The attractants usually bring together more than enough beetles to kill the pine, and excess beetles spread to nearby trees. They, too, give off the attractant, which calls in still more SPB. The infestation grows. Because only freshly attacked trees are sources of attractant, it is important to identify their number and location. Only then can you determine if the spot is likely to spread. The following characteristics identify trees with fresh attacks:

- *Foliage* . . . appears normal (green).
- *Pitch tubes* . . . are soft and white or light pink and usually sticky to the touch (fig. 6). SPB normally attack first at heights of 10–20 feet above ground. So, if there are no pitch tubes visible at eye level, look higher on the trunk. In severely stressed pines, pitch tubes may not appear. Instead, reddish boring dust appears in bark crevices, on the leaves of shrubs, and in spider webs at the base of the tree (fig. 7).





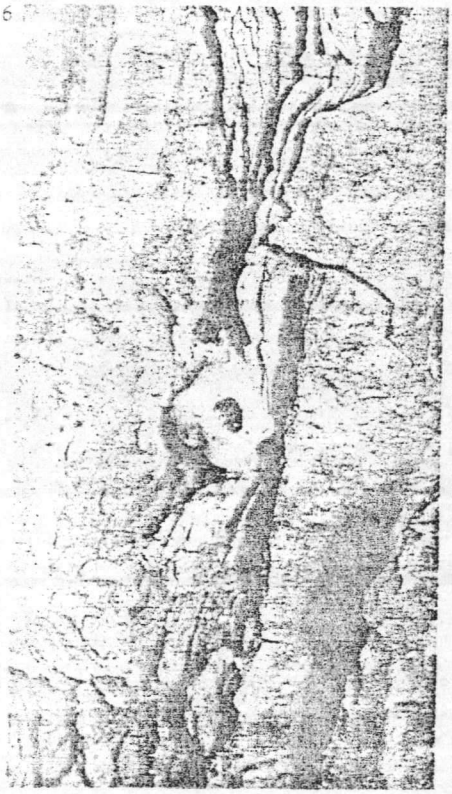
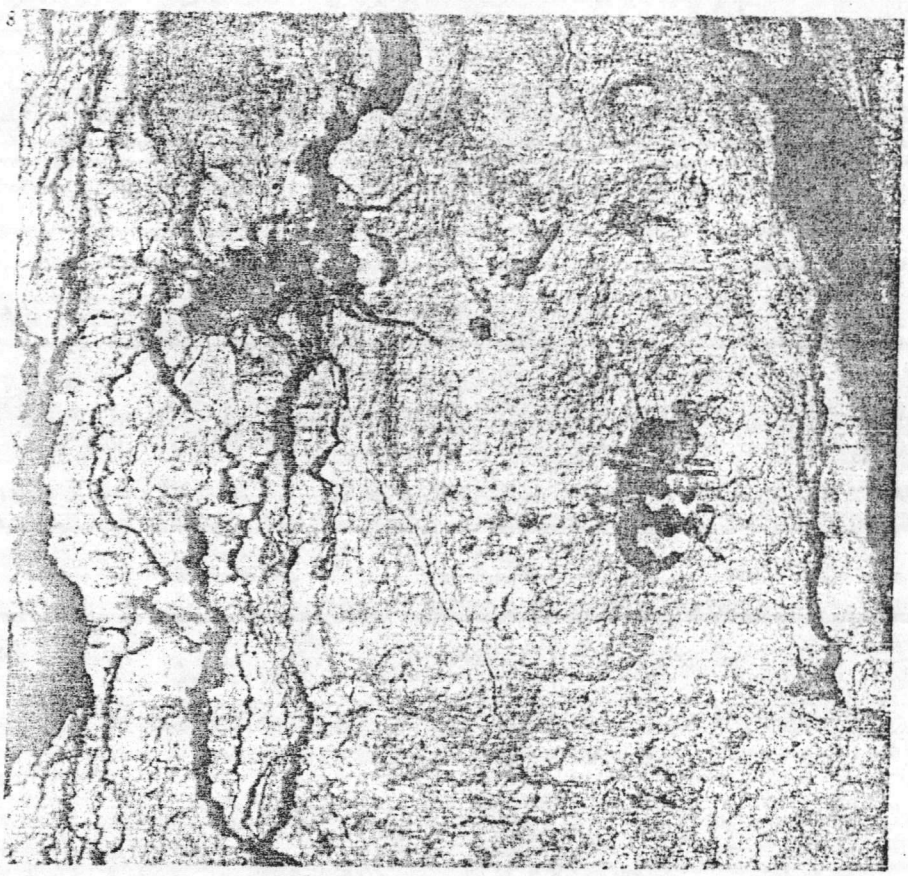


Figure 6.—Fresh pitch tube and SPB adult on stage 1 tree.

Figure 7.—Boring dust in spider webs at base of stage 1 tree.



• *Checkered beetles (clerids)* . . . may be seen crawling about on the trunks of freshly attacked pines (fig. 8). They are common predators of SPB and respond to SPB attractant.

• *Bark* . . . remains tight and hard to remove.

• *Color of wood surface* . . . is white like that of unattacked trees, except close to new adult galleries, where it is brown (fig. 9).

Figure 8.—Adult checkered beetles on stage 1 tree.

Figure 9.—White-colored wood of stage 1 tree with SPB adult gallery.

Stage 2—Pines With Developing SPB Broods

Soon after adult beetles have overcome a tree, they stop producing attractant. Eggs hatch, and small, white SPB larvae start feeding in inner bark mines, which are mixed among the S-shaped adult galleries (fig. 2). As larvae develop, they move into the outer bark, where they eventually change into white pupae and then into brown or black adults. It is important to realize that the beetle has these various forms. To see the later beetle stages, carefully shave away outer layers of bark with an axe or machete (fig. 10). Other features of trees with developing brood are:

- *Foliage* . . . is green on most trees containing larvae, but may fade to yellow or turn red before the new

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Figure 10.—Shaved bark with SPB larvae and pupae in outer bark of stage 2 trees.

Figure 11.—Ambrosia beetle dust at base of stage 2 tree.

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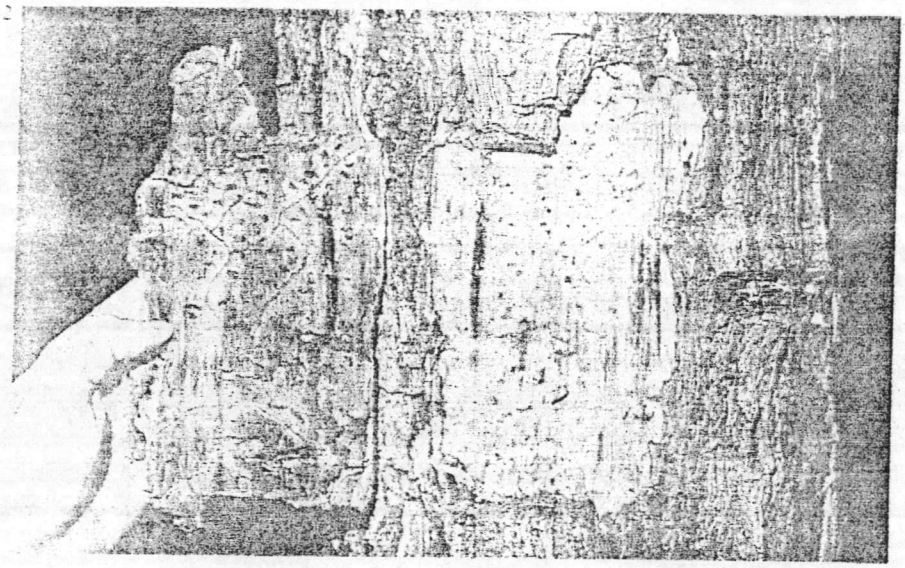

generation of beetles emerges from the tree. Foliage color varies greatly by season and among individual trees, so it is not always a good indicator for this stage.

- *Pitch tubes* . . . are white and hardened, resembling popcorn (fig. 3).
- *Exit holes* . . . may appear at this stage and mark where parent beetles have left the tree. They are round holes about the size of a pencil lead.
- *Ambrosia beetle dust* . . . is white and begins to appear in small to moderate amounts around the base of the tree (fig. 11). It is not present in stage 1 trees.
- *Bark* . . . is loose and easy to peel away from the trunk.
- *Color of wood surface* . . . is light brown (fig. 12). It may shade into dark brown with blue or black sections infested by staining fungi.
- *Checkered beetle larvae* . . . show up in SPB galleries in the bark. The larvae are pink or reddish and about ½ inch long (fig. 13).

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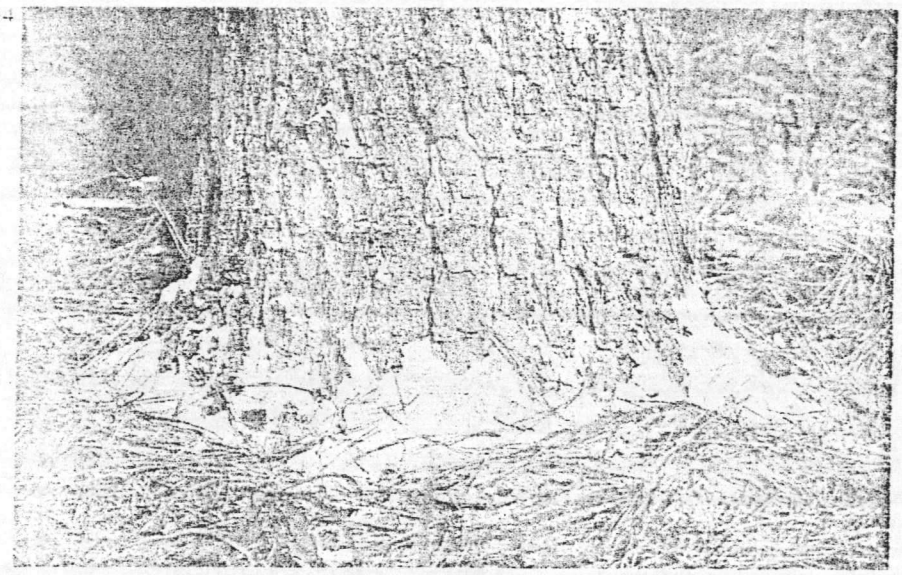
Figure 12.—Brown wood associated with bark beetle mining in stage 2 tree.

Figure 13.—Checkered beetle larvae in inner bark of stage 2 tree.

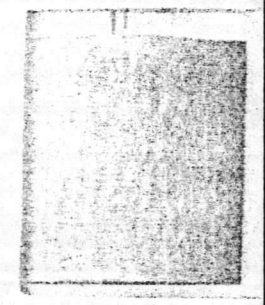
Stage 3—Pines Killed and Vacated by SPB



After maturing in the bark, new adult beetles bore their way out and fly off to attack another pine. A tree is termed "inactive" when no SPB of any stage can be found in it. Other features of inactive trees include:

- *Foliage* . . . of most trees is red and needles may have started dropping.
- *Ambrosia beetle dust* . . . is abundant at the base of the tree and is now off white or cream colored (fig. 14).
- *Pitch tubes* . . . are hard and yellow, crumbling easily in your fingers (fig. 15).
- *Exit holes* . . . are numerous (fig. 15).
- *Bark* . . . is very loose and easily removed.
- *Color of wood surface* . . . is dark brown to black with SPB galleries often obscured by the coarse, fibrous borings of sawyer beetle larvae (fig. 16).
- *Checkered beetle larvae or pupae* . . . are purple and occur in pockets within the outer bark shortly after the SPB brood leaves.

Figure 14.—Ambrosia beetle dust at base of stage 3 tree.



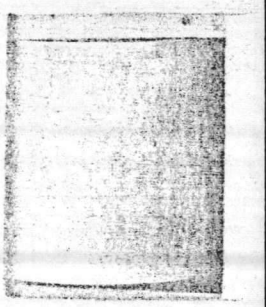


Figure 15.—SPB pitch tubes and exit holes through bark of stage 3 tree.

Figure 16.—Wood discoloration caused by insect and fungal activity in stage 3 tree.

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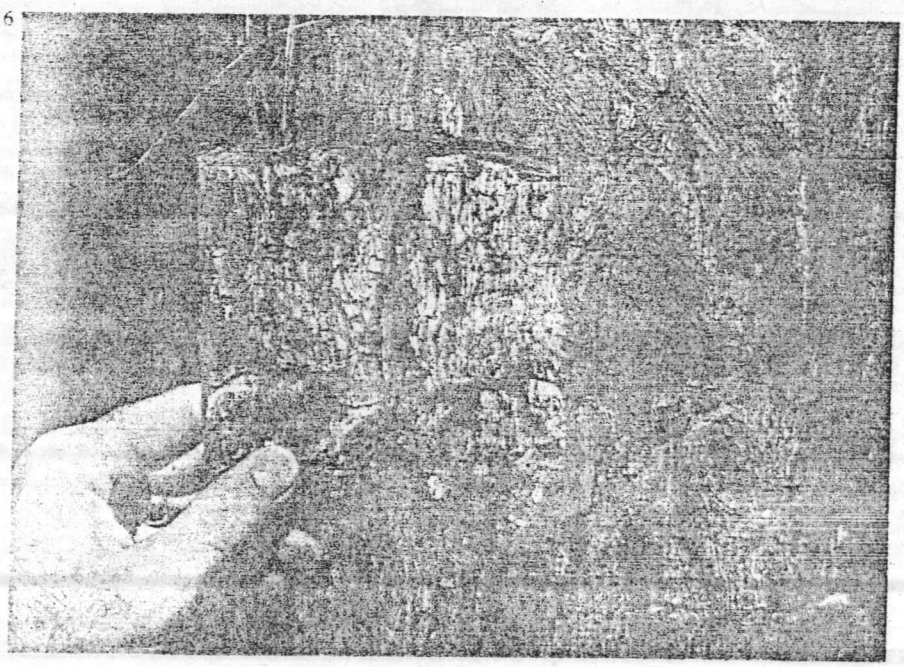

Collecting Spot Expansion Data

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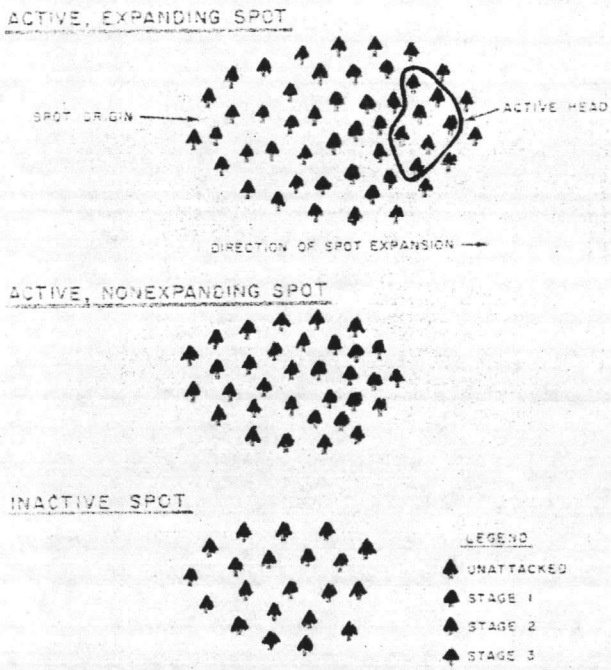


Figure 17.—Three kinds of SPB spots.

Is the new spot you have located a threat to grow larger? It may well be. The southern pine beetle can readily spread if it has three conditions: Attractants from stage 1 trees, continuous emergence of attacking adult beetles from stage 1 and stage 2 trees, and pines to attack (fig. 17). During the summer, spots with no stage 1 trees are not likely to expand because attractants are no longer present. And spots with only stage 3 trees—since beetles have already left—need no control at all. The following steps, to be used between May and October, explain how to collect information for use in the control priority guide:

1—Walk completely around the spot and look for stage 1 trees, which indicate the area of most recent beetle activity. Areas with stage 1 pines are called "active heads". Check to see if the spot is expanding in more than one direction. Large spots can have more than one active head.

2—Determine the number of stage 1 and 2 trees. For large spots that have more than 50 trees, it is not necessary to examine each tree. Just walk the boundaries and estimate the number of these trees in the spot.

3—From a location about 20 feet in front of the active head or heads, determine the pine basal area (a measure of stand density) in square feet per acre. A 10-factor prism is useful for this purpose.

4—Note whether most trees in the spot are pulpwood (less than 9 inches in diameter) or sawtimber size (more than 9 inches in diameter).

5—Using the Control Priority Guide from the next section of this handbook, determine the control priority for the spot.

6—Flag a trail back to the nearest road or landmark for the control crew.

Using the Control Priority Guide

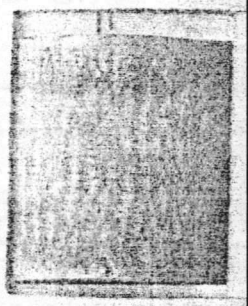
To assign a control priority using information gathered at the spot, turn to table 1 (see page 18). Four keys to spot growth (A, B, C, and D) appear in the left-hand column. For each of these, select from the middle column the classification matching your spot. Select from the right-hand column the risk-rating points for that classification. For Key A, for example, if your spot classification is "present," your risk-rating choice would be 30 points. Take one number for each key and add them together. This gives you the total risk-rating points for your spot.

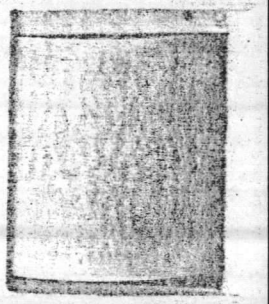
If the total of risk rating points is 70 or greater, the spot is assigned a high priority for control. Risk totals between 40 and 60 indicate a medium priority for control, and totals of 30 or less signal a low control priority.

A Word on Control Priorities

Effective control requires prompt removal of the buffer strip and stage 1 trees. For large spots, this should be done first, then you can remove the other infested trees in the spot. Salvaging stage 3 trees is not critical to control, but can be done later.

Decisions on controlling SPB spots depend not only on the control priority, but also on the availability of crews and equipment, access to the spot, and market value of beetle-killed pine. If possible, high priority spots should be controlled promptly or they will spread, while medium priority spots can be handled as time permits. A low priority spot may need no control. Since it is uncertain what will happen in medium or low priority spots, you should recheck them every 4–6 weeks until they are controlled or become inactive. During major SPB outbreaks, aerial surveys are the most practical way to monitor uncontrolled spots after the first ground check.





The Buffer Strip

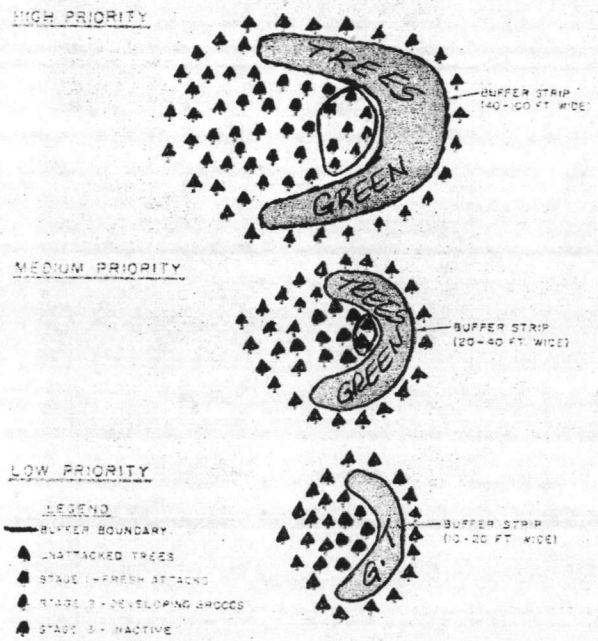


Figure 18.—Location of buffer strips.

No matter which means of control is used, success hinges upon treating all stage 1 trees. The best insurance is to cut a buffer strip of uninfested pines around the active head of a spreading spot. This tactic interrupts the beetles' flow of attractants and stops their advance. The buffer strip also provides a margin of error, just in case attacked pines were initially overlooked or the spot has expanded since then.

A buffer strip 10–40 feet wide is enough for medium and low priority spots and for high priority spots with fewer than 30 trees. But a buffer strip 40–100 feet wide is needed for large high priority spots (fig. 18). As a rule of thumb, the number of trees in the buffer strip should not be more than the combined number of stage 1 and stage 2 pines in the spot being treated. The buffer strip should enclose all stage 1 and stage 2 trees and be widest in the direction that the spot is expanding.

If control is planned within 2 weeks after the ground check, mark the buffer strip at the time of the first ground check. If control is not planned this soon, wait until just before the control date to mark the buffer strip or carefully recheck its boundaries before treatment. Otherwise, the spot may enlarge beyond the buffer zone before the control starts.

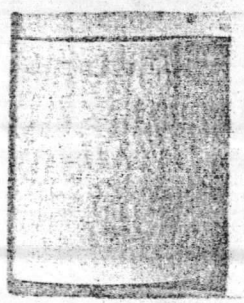
Checklist

- Verify that trees were killed by SPB.
- See if any stage 1 trees are present.
- Mark and count all stage 1 and stage 2 trees.
- Measure basal area of pine about 20 feet in front of the active head or heads.
- Note whether the stand contains mainly pulpwood or sawtimber.
- Using table 1, determine the control priority.
- If control is to be applied promptly, mark the buffer strip of uninfested pines around the active head.
- Flag a route back to the nearest road or landmark.
- Report ground check information promptly.

Table 1.—*Guide to southern pine beetle spot growth and control priorities (May through October)*

Key to spot growth	*Your spot's classification*	*Risk-rating points*
A. Stage 1 trees	absent	0
	present	30
B. Stage 1 and 2 trees	1–10	0
	11–20	10
	21–50	20
	more than 50	40
C. Pine basal area (ft^2/acre) (or stand density) at active head or heads	less than 80 (low density)	0
	80–120 (medium density)	10
	more than 120 (high density)	20
D. Stand class by average d.b.h. (in inches)	pulpwood (9 in or less)	0
	sawtimber (more than 9 in)	10
	Total [1]	

[1] If total is 70–100 control priority is High. If total is 40–60 control priority is Medium. If total is 0–30 control priority is Low.



Glossary

southern pine beetle—*Dendroctonus frontalis,* a bark beetle identified by the S-shaped galleries it makes beneath the bark of attacked pines.

spot—A group of dead or dying trees infested by the southern pine beetle.

spot growth—The natural expansion of untreated spots as additional live trees on the outer edge of a spot become infested.

stage 1 pine—Infested pine showing symptoms of fresh attacks by SPB.

stage 2 pine—Infested pine with developing broods (larvae, pupae, or new adults) of SPB.

stage 3 pine—Pine killed by SPB from which all broods have emerged.

active spot—SPB infestation in which one or more of the attacked trees contain beetles or brood.

inactive spot—SPB infestation in which the beetles in all of the attacked trees have completed development and emerged.

active head of spot—That portion of a SPB spot containing beetles in the process of attacking live trees.

buffer strip—A group of live uninfested pines, adjacent to the most recently infested trees in a spot, that is felled to assure effective control.

Ips beetles—A group of related pine-killing beetles that can be distinguished from SPB by the unfilled Y- or H-shaped galleries made by attacking parent beetles.

black turpentine beetle—*Dendroctonus terebrans,* a large bark beetle commonly found attacking the lower trunks of pines, producing large reddish pitch tubes.

Acknowledgments

The guidelines for setting control priorities on SPB spots resulted from research conducted by the Texas Forest Service (TFS). The photographs were provided by the TFS Forest Pest Control Section.

The authors appreciate the manuscript reviews and other assistance given by State pest management specialists throughout the South and by Forest Insect and Disease Management, State and Private Forestry, Southeastern Area, Forest Service, U.S. Department of Agriculture.

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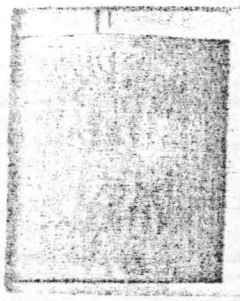

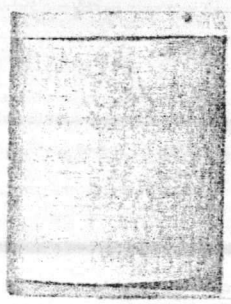

United States
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Combined Forest Pest
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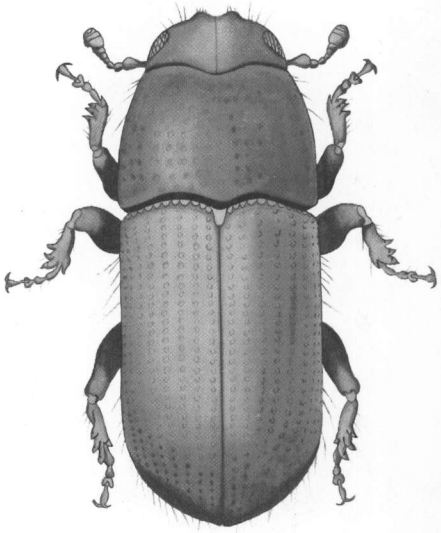
Development Program

Agriculture Handbook
No. 560

Southern Pine
Beetle Handbook

An Aerial Observer's Guide to Recognizing and Reporting Southern Pine Beetle Spots



Contents

In 1974 the U.S. Department of Agriculture initiated the Combined Forest Pest Research and Development Program, an interagency effort that concentrated on the Douglas-fir tussock moth in the West, on the southern pine beetle in the South, and on the gypsy moth in the Northeast. The work reported in this publication was funded in whole or in part by the Program. This manual is one in a series on the southern pine beetle.

An Aerial Observer's Guide To Recognizing and Reporting Southern Pine Beetle Spots

by Ronald F. Billings
and Coleman Doggett [1]

Introduction

Early detection of new infestations is the first step in controlling the southern pine beetle (SPB) and in reducing timber losses. Over large forested areas, periodic aerial surveys are the most practical observation method. Aerial observers plot suspected beetle spots—pine trees with discolored foliage—onto maps or aerial photographs. Ground crews then check these areas to see if SPB caused the damage and to determine if control is needed. The problem is, during beetle outbreaks, so many suspected SPB spots are reported that ground crews cannot check them promptly. This hampers control operations.

This handbook is designed to help foresters and technicians become efficient aerial observers. It has two sections. First, we describe what SPB spots look like from the air in summer—the season when most new infestations are observed—and explain how to distinguish them from areas with trees dead or dying from other causes. The discussion includes guidelines for assigning a ground check priority to each reported spot. Then, based on seasonal habits of the beetle and on seasonal changes in the appearance of infestations, we describe symptoms that you should look for in fall, winter, and spring.

[1] Principal Entomologist, Texas Forest Service, Lufkin, and Pest Control Forester, North Carolina Division of Forest Resources, Raleigh.

Beetle Behavior in Summer

During summer, SPB broods develop rapidly. Within 4-6 weeks after a tree is attacked, the new brood of adult beetles emerges, even though tree foliage may still be green. Because of this delay in foliage fade, many spots may already be "inactive" (abandoned by SPB) before ground check crews can check them. Inactive spots do not require control.

Certain SPB spots, however, expand in summer as adult beetles emerge from brood trees and attack pines at the spot's edge. Continuous spot growth is most common when beetle populations are high. From the air, the expanding spot appears as a group of red- and yellow-crowned trees (fig. 1), and ground crews checking these spots often find beetles in adjacent green trees. Not all spots expand after detection, but those which do—unless controlled—may cause large timber losses.

Figure 1.—Typical expanding SPB spot in summer.

2

When new spots first become visible, they may have only light-green or yellow-crowned trees (fig. 2) and not display other stages of foliage fade. This is particularly true in late spring and early summer. But by midsummer the typical expanding SPB spot has dead or dying pines in various stages of discoloration (fig. 1). The different foliage colors trace the beetle's spread through the forest. After 8-12 weeks, beetle-killed trees at the spot's origin drop their needles. Next to these bare trees are red-crowned ones, most of them no longer containing beetles. Then come yellow-crowned pines that have been more recently killed. Newly attacked trees on the margin of the spot will have green crowns, and from the air you will not be able to distinguish these from unattacked trees.

Figure 2.—New SPB spot with mainly yellow crowns.

Evaluating Potential Spot Expansion

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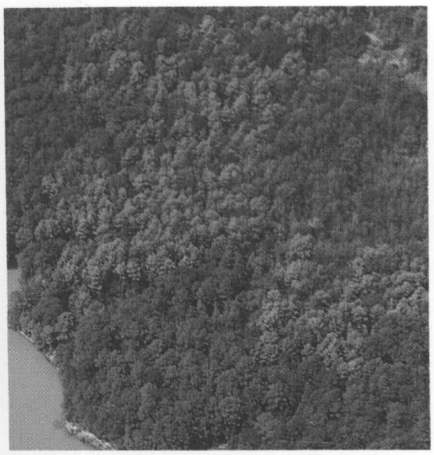

The major purpose of SPB control programs during the summer months is to reduce timber losses by locating and treating expanding infestations. Spots which are no longer expanding are soon abandoned by the beetles and have little need for control. To assist ground crews, you need to distinguish SPB spots showing visible symptoms of expansion from other spots likely to become inactive.

But how can you tell from the air if a spot will expand? Yellow crowns are the most useful clue. An expanding spot will have at least some yellow crowns. Rapidly expanding spots contain as many yellow-crowned trees as red ones. The location of the yellow-crowned trees within the spot marks the path of its spread, which may be in one direction (see fig. 1), or in several (fig. 3). When a spot becomes inactive, it will no longer have such trees (fig. 4). For control purposes, you do not need to report spots without yellow crowns.

Figure 3.—SPB spot expanding in several directions.

During SPB outbreaks, spots may range in size from one to several hundred trees. As a general rule, the larger a SPB spot appears from the air, the more likely it is to grow. You can greatly aid control operations by reporting only spots with a total of five or more red- and yellow-crowned trees. Spots with fewer than five trees are not likely to expand and will often become inactive during the summer (fig. 5). This minimum will also eliminate recording many small *Ips* and black turpentine beetle spots, which are less prone to cause economic losses. True, you may overlook a few expanding SPB spots by using this practice, but these will be recorded later if they exceed five trees in size. During severe beetle outbreaks, forest managers may make the minimum reporting size larger than five trees if workloads of ground check crews become too great.

You should estimate the size of each spot reported. Two methods exist for such estimates: one, recording total number of dead and dying trees, which is indicative of the amount of salvageable timber; or two, noting only the number of red- and yellow-crowned trees, but not those having lost most or all of their foliage. This second method provides a better measure of trees that still contain beetles. Before selecting one method over the other, check the survey policy of your organization. And be sure that ground crews know which estimating system you use.

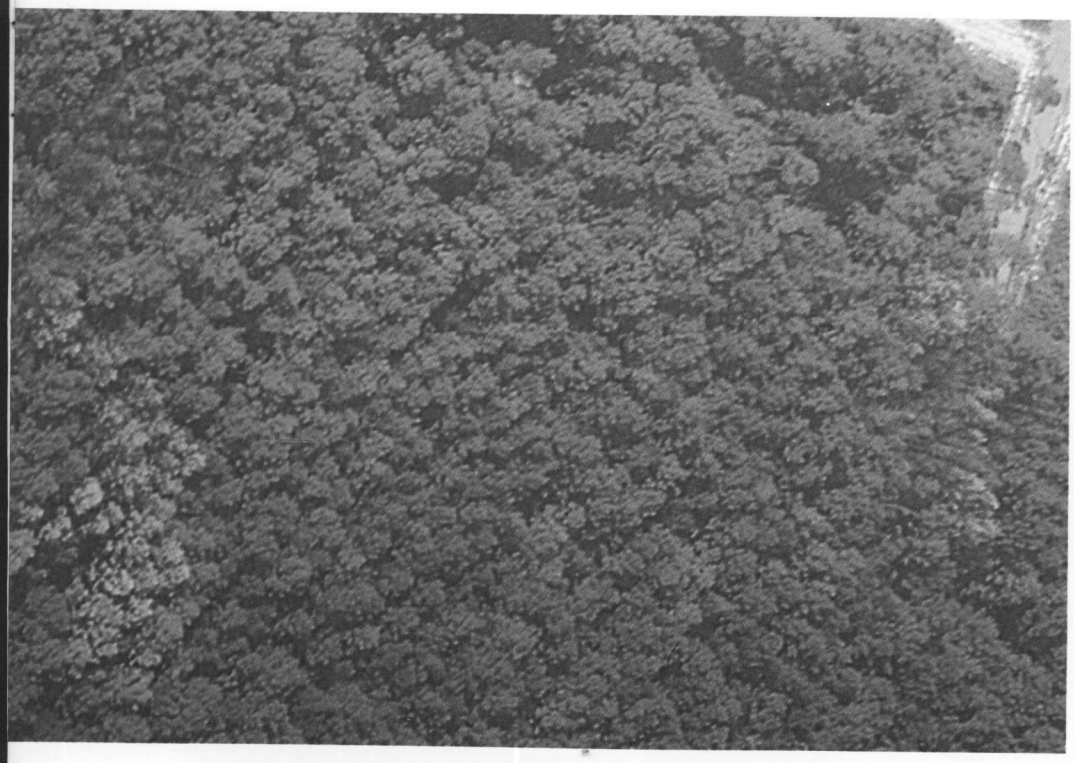

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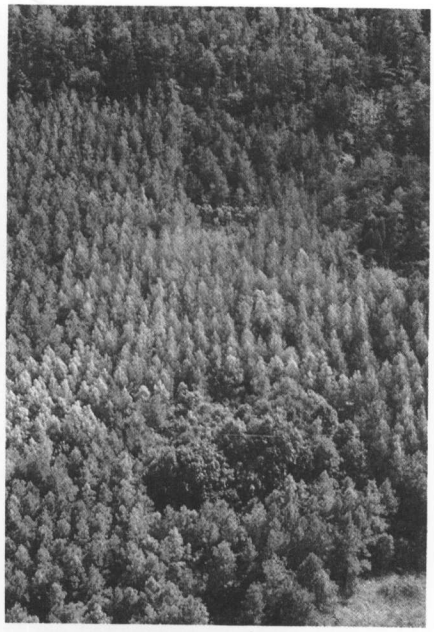
Figure 4.—At left, expanding spot; at right, nonexpanding spot.

Figure 5.—Small spot with low beetle activity.

Determining Ground Check Priorities

6



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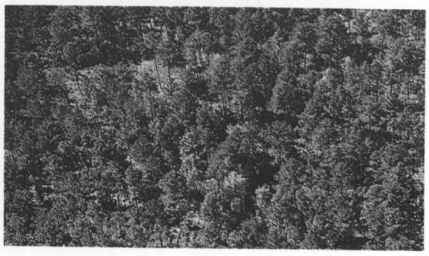


Figure 6.—High priority spot in plantation (North Carolina Forest Service).

Figure 7.—Low priority spot in sparse pine stand.

If spots are numerous, assign a priority for ground checking to each SPB spot reported. List at the time of observation both the estimate of spot size and the ground check priority next to each spot location on your map or photo. Ground crews will then know which spots to check immediately and which ones they may visit as time permits. For your own reference or to aid new observers, prepare a priority table for your survey area. On it, list conditions to look for in evaluating spots from the air. Table 1 is an example of a priority table for aerial observers.

Experience has shown that SPB infestations in mature sawtimber stands (see fig. 1) or dense pine plantations (fig. 6) are most apt to spread unless controlled. You should assign these spots a higher ground check priority than SPB spots in sparse pine stands (fig. 7) or in areas containing more hardwoods than pines.

Many forest managers prefer commercial salvage of infested pines for beetle control. But the spot must be accessible and have enough timber volume to justify salvage efforts. A logger can afford to build roads when a large volume of timber is involved; a small volume may be worth salvaging only if it is near an existing road. If salvage is the only means of control used in your area, you should give a low ground check priority to small, inaccessible spots.

The land use objective may also influence the priority you assign a spot. A SPB spot in a residential or recreational area (see fig. 3), for example, may require immediate action. But a spot in a wilderness area or in a remote, noncommercial forest may well be given a low ground check priority.

Upon completion of each detection flight, give ground crews a list of the spots requiring ground checking. For each spot, include plotted position, estimate of spot size, and ground check priority. Ground crews then have all the information they need to systematically handle large numbers of spots.

Table 1—*Example of a table for setting ground check priorities from the air, May through October. Choose the spot classification which best describes the spot.*

Priority for ground check	*Spot classification*
Priority 1 (high)	More yellow- than red-crowned trees In dense natural pine stand or in area with past history of SPB outbreaks Easy access or high salvageable volume In plantation or other high value area Threat to cross property lines and affect high value stands
Priority 2 (breakout)	Yellow-crowned trees in spot previously reported controlled or inactive
Priority 3 (medium)	More red-crowned than yellow-crowned trees Poor access or moderate salvageable volume
Priority 4 (low)	Few yellow-crowned trees Infested pines surrounded by hardwoods or open land Difficult to locate on ground because of small size or inaccessibility In unmerchantable timber or with low salvageable volume

Followup Aerial Surveys

8

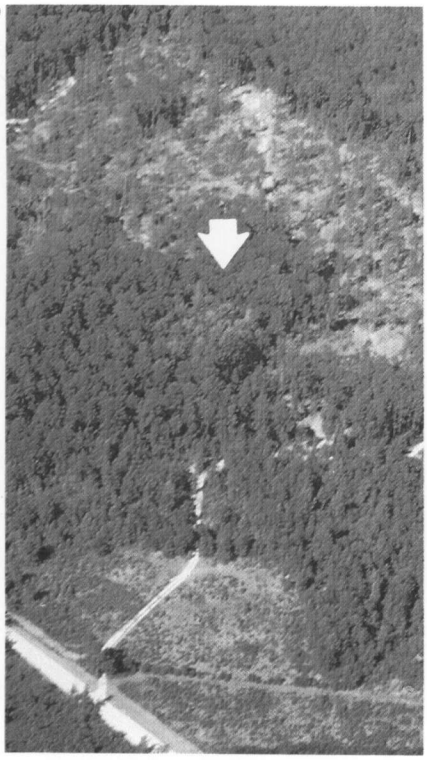
To aid beetle control programs, you should make periodic aerial surveys every 4-6 weeks. During midsummer surveys, it is helpful to revisit SPB spots recorded on earlier flights but not yet ground checked or controlled. Remember, because of rapid foliage changes in warm weather, the same spot may look different from the air several weeks after detection. Many spots that first appeared active may by August or September no longer contain yellow-crowned trees. After a followup survey, you may safely assume that such spots have stopped expanding, and give them a low priority for ground checking and control. If all the infested trees in a spot have lost their foliage, the spot can be declared inactive (fig. 8). In winter, however, bare-crowned trees may contain beetle brood and only by ground checking can you verify that SPB spots are inactive.

Figure 8.—An inactive SPB spot.

Some spots that appeared small at first may have grown large by the time of the following flight. If so, you should update their size and ground check priority. For very large infestations,

Updating Flight Maps

9



you can aid ground crews by sketching the infestation boundaries on a map or aerial photograph.

Finally, during midsummer flights, inspect recently controlled spots for signs of renewed beetle activity (breakouts). A breakout appears as a group of red- and yellow-crowned trees at the edge of the controlled area (fig. 9). Report all breakouts.

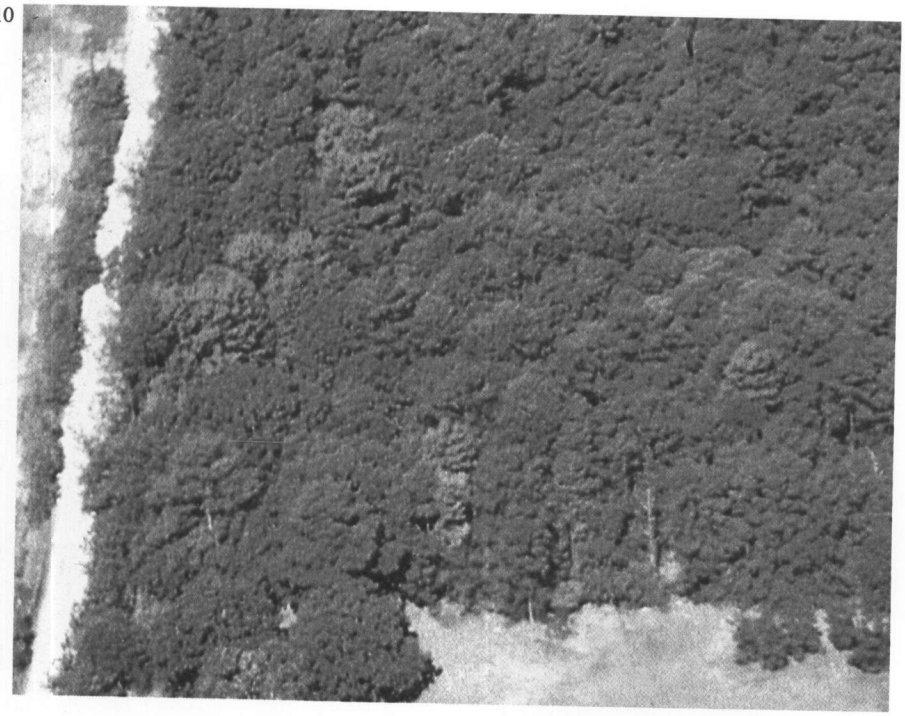
Figure 9.—Breakout following salvage control.

To keep current on SPB spots in your area, you must frequently update flight maps. Use the same set of maps or photos for all aerial surveys in a given year. This reduces the chance that a spot will go unreported or be reported more than once. Before each flight, note on your aerial map SPB spots reported by ground crews as inactive or controlled. The notation prepares you for spotting breakouts.

A suggested system for recording spots and updating SPB flight maps is given in table 2. To use this system, draw a small circle around each new spot on your map. Use a different colored pencil for each survey flight. As new information comes in, alter the circle to indicate the current status of each spot.

Distinguishing SPB Spots from Other Tree Problems

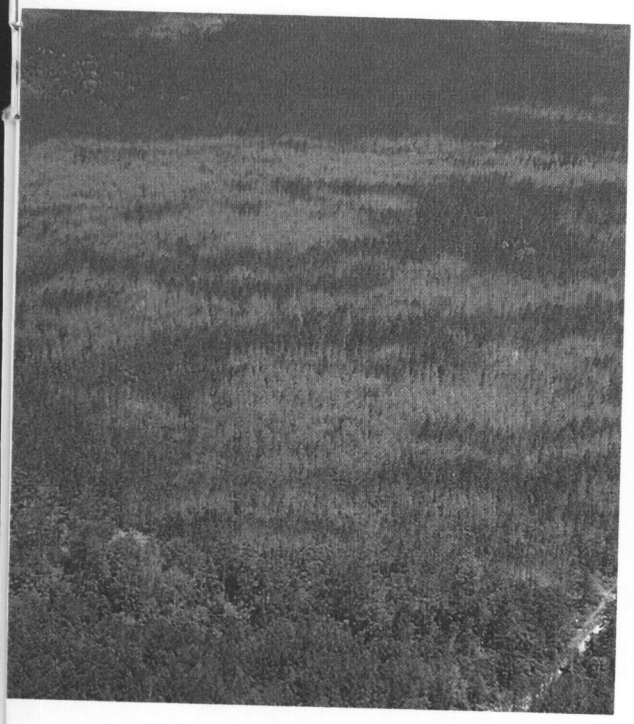
10



Groups of dead pines with only red crowns are commonly seen during SPB surveys (fig. 10). They may indicate SPB spots that are inactive or no longer expanding. But the red crowns may have been caused by lightning, fire, herbicides, or bark beetles other than the SPB. With close observation, you can learn to recognize damage by these other causes and avoid reporting it as SPB damage.

Figure 10.—Dead pines with only red crowns.

Fire



Trees killed by recent fires appear as red or brown patches, with crowns all the same color (fig. 11). Light fires sometimes scorch trees without killing them, which leaves the lower crown red and the upper crown green. Scorched earth beneath trees and fire-control lines also signal recent fire occurrence.

Figure 11.—Brown patches signaling recent fire.

Foliage Diseases

11 Pines suffering from diseases, especially pine "needle cast," may show symptoms similar to those of SPB-killed trees. Pond pine along the Atlantic Coastal Plain is frequently infected with needle-cast fungi, as are loblolly and slash pines. Common from February through June and again in September and October, needle cast primarily hinders spring and early fall aerial surveys. Moderately affected trees have greener upper crowns than lower crowns. When the spring growth flush begins, green terminal shoots appear on trees with needle cast; no green shoots come out on SPB-killed trees once they turn red.

Herbicides

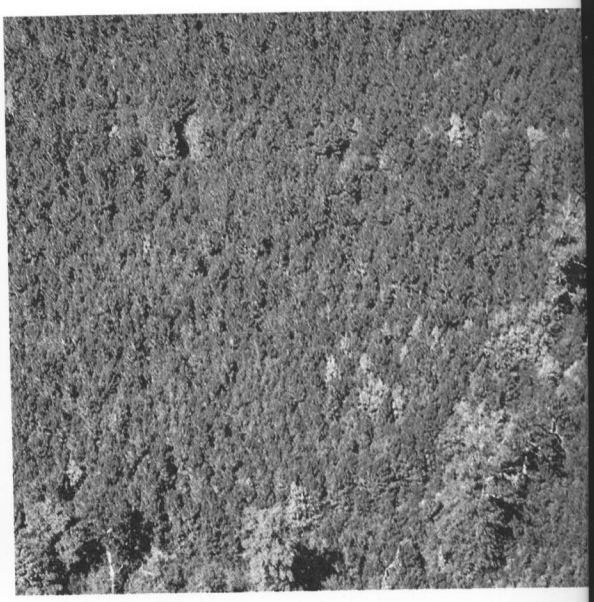
12

Uniform strips of yellow- or red-crowned trees along powerlines, pipelines, roads, and railroad tracks (fig. 12) are most often an indication of herbicide application and not of SPB infestations. Sprays applied to agricultural crops often drift onto adjacent stands of trees, causing foliage discoloration. When herbicide damage occurs in mixed pine-hardwood stands, hardwoods are affected along with pines. In timber stand improvement operations, only hardwoods are affected.

Figure 12.—Herbicide-damaged trees along highway right-of-way (North Carolina Forest Service).

Other Bark Beetles

13



Single, widely scattered yellow- or red-crowned trees observed during summer surveys generally indicate lightning strikes or attacks by bark beetles other than SPB. Black turpentine beetles typically kill single pines. Most *Ips* infestations are small and scattered, often containing only red-topped pines (fig. 13), unlike varicolored SPB spots. *Ips* attacks occur primarily during extended droughts or adjacent to recently logged areas or in storm-damaged stands. In case of large infestations, ground checking is the only way to determine whether *Ips* or SPB is responsible.

Figure 13.—Scattered pines infested by *Ips* beetles.

Checklist for Summer Aerial Surveys

For detecting and reporting SPB spots from May through October, follow these guidelines:

- Decide if the observed trees show symptoms of recent SPB attack. Look for a group of dead and dying pines with at least some yellow crowns.
- For suspected SPB spots, determine if the number of yellow- and red-crowned trees exceeds the minimum reportable size.
- Plot the locations of all reportable spots as accurately as possible on a map or photo. Use landmarks such as clearings, road intersections, pipelines, and lakes.
- Estimate and record either the total number of affected trees (bare + red + yellow) or the number of recently infested trees (red + yellow).
- Assign a ground check priority to the spot, based on a priority table (table 1). Record this information on the map or photo.
- Report all information promptly to ground check crews.

Table 2.—*Suggested symbols to use on SPB flight maps*

Source of information	*Symbol* [1]	*Description*
Initial aerial survey	20/1 ⊙	New spot with 20 trees and priority 1 for ground check (color indicates date of flight)
Ground check information	15/3 ●	Spot found to be inactive upon ground check (use to update flight maps prior to next flight)
Control information	50/1 ⊗	Spot controlled since last flight (use to update flight maps prior to next flight)
Followup flight	20/4 ⊖	Previously seen spot that appears to be inactive from air with bare trees or red crowns or both, but no yellow crowns
Followup flight	100/1 ⊗ B.O./20	Controlled spot that is observed from air to have a breakout with 20 active trees
Followup flight	~~10/4~~ ⊙ 100/1	Previously seen spot updated from 10 to 100 active trees and priority 4 to priority 1

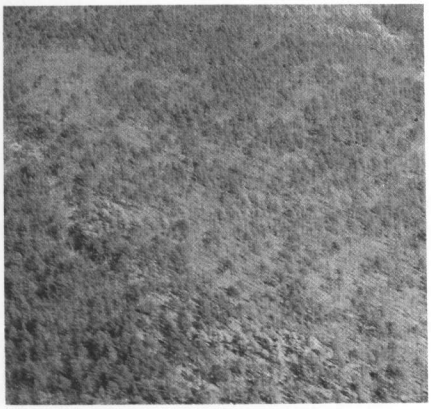
[1] Some organizations prefer to use a square symbol □ to indicate that a spot's location may not be accurately plotted.

Guidelines for Fall, Winter, and Spring Aerial Surveys

Fall Surveys

In the fall, when hardwood leaves change color, it is difficult to detect new SPB spots in mixed pine-hardwood forests. The yellow or red foliage of cypress trees in the fall also may be mistaken for beetle-infested pines. As a result, survey flights are usually discontinued until hardwoods have completely dropped their leaves.

14



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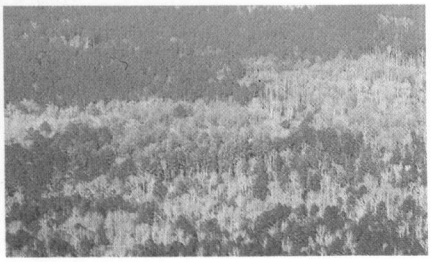

Figure 14.—Winter spots in Virginia (Virginia Division of Forestry).

Figure 15.—Winter SPB spot in Texas.

Winter Surveys

The purpose of winter surveys is to locate overwintering SPB populations so that control can be applied before beetles disperse in the spring. Ground check priorities during winter surveys can be based on just two factors: number of affected trees and accessibility for control. Remember, SPB broods develop more slowly during the winter, often remaining within trees until after the foliage drops. Red crowns in a SPB spot during the winter, unlike those in summer, indicate that beetle broods are present.

The effectiveness of winter surveys for SPB varies among different geographic regions. Their activity restricted by cold temperatures, beetles in the Piedmont and Atlantic Coast States tend to remain throughout the winter in the same multiple-tree spots they occupied during the late fall. These spots become detectable when aerial surveys are resumed in December or January (fig. 14).

In the Gulf Coast, however, beetles in the fall often leave large spots to infest single trees scattered throughout the forest, and, in mild winters, may continue to infest new trees. Pines infested in winter maintain green crowns for 2–4 months, thus escaping observation during aerial surveys. In winter, even multiple-tree spots started in the fall are easy to overlook on the Gulf Coast because the foliage color of infested trees does not change dramatically. Between December and April, infestations seldom show the yellow crowns

that clearly mark SPB spots in summer. At normal survey altitudes (1000–2000 ft), you may be able to see only the larger groups of bare and red-crowned trees (fig. 15). Most of the red-topped pines still contain SPB. But much of the beetle population in winter and early spring occurs in scattered single trees which elude detection. By flying slowly with a helicopter at low altitudes (100–500 ft), you have a better chance of seeing beetle-infested pines in winter along the Gulf Coast. At these low altitudes you may see off-color crowns of beetle-infested pines (fig. 16) that at higher altitudes would not be distinguishable from uninfested trees. Also, trees killed by SPB often have bark stripped by woodpeckers, which leaves them with highly visible white boles. Although effective, surveys by helicopter are costly and generally applicable only to high value stands.

Figure 16.—Helicopter view of scattered infested pines in winter.

Spring Surveys

Trees killed by beetles in late winter on the Gulf Coast can be seen during March and April. Even though early emerging beetles may kill large numbers of trees, new spots in spring seldom persist or expand. Temperatures in the spring are still too cool for continuous spot growth. This results in many scattered, short-lived spots in which groups of infested trees show the same foliage color.

Locating new SPB spots in early spring is difficult in mixed pine-hardwood stands: new foliage on hardwood trees makes them resemble SPB-killed pines with fading foliage. As conditions improve for long distance dispersal, however, beetles leave scattered brood trees to concentrate in expanding spots. These multiple-tree spots become easily seen by early summer in the Gulf Coast or by midsummer or later in the remainder of the South.

Because of these seasonal limitations, SPB observation surveys along the Gulf Coast are most effective from May to October. For States along the Atlantic Coast and in the Piedmont region, SPB surveys are practical during midwinter as well as throughout the summer.

The procedures discussed in this handbook were developed primarily from information gathered on the Gulf Coast where SPB may be active throughout the year. Some of the recommendations may require modifications for effective use in other areas of the beetle's range, where there are fewer SPB generations per year and forest conditions are different. If questions arise, check with a Federal or State forest pest control specialist, who can tell you which, if any, of the recommendations are not applicable to your survey area.

Acknowledgment

Guidelines for recognizing and reporting SPB spots during aerial surveys are derived from research and operational experience of the Texas Forest Service and the North Carolina Division of Forest Resources. The authors gratefully acknowledge the contributions provided by other State and Federal forest pest control specialists throughout the South in the preparation of this handbook. The photographs were provided by the Forest Pest Control Section of the Texas Forest Service, unless otherwise noted.

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PROJECT CONTROL PLAN

Southern Pine Beetle

US Marine Corps - Marine Corps Base
Camp Lejeune, North Carolina

Prepared by:	Peter E. Black Assistant Base Forester	6-13-80 Date
Reviewed by:	Kenneth C. Harrison Base Forester	6-13-80 Date
Recommended by:	Dillon L. Wooten Division Director	6-13-80 Date
Approved by:	T. R. Bailey Base Maintenance Officer	6-13-80 Date

PROJECT CONTROL PLAN

Southern Pine Beetle - US Marine Corps Base, Camp Lejeune, North Carolina

1. Southern Pine Beetle

Southern pine beetle, Dendroctonus frontalis zimmerman, is the most destructive pine beetle in the South. The beetle can kill trees singly or in groups of trees covering many acres. Multiple generations during the growing season provide the means for a rapid population buildup to epidemic levels.

Southern Pine Beetle (SPB) mortality can be reduced through use of integrated suppression and disruptive tactics as recommended by Forest Insect and Disease Management, State and Private Forestry, United States Forest Service. All suppression decisions to reduce losses caused by the southern pine beetle are made by the land manager. He must make decisions using information provided in the 1) biological evaluation, 2) cost/benefit statement, and 3) the environmental impact statement and environmental analysis report.

To be effective, the suppression effort requires that all high and medium priority infestations be treated regardless of location or size. Spot treatment priorities are to be determined by using current spot rating schemes. Control projects impact timber markers, sales administrators, and clerks to a great extent. Therefore, manpower needs should be planned in advance.

Suppression activities are in two phases: operational surveys and treatment.

a. Operational Surveys - Aerial survey data enable land managers to effectively plan ground operations. In cases where work forces are limited, timely operational surveys are used to direct ground activities into those areas where needs are greatest, i.e., active infestations with 10 or more

fading trees located in overmature densely-stocked stands that are particularly susceptible to further SPB losses. Infestations with less than 10 fading trees can be ground checked as time permits.

1. Aerial Phase - Make operational aerial surveys over the area of infestations at 3 to 4 week intervals. Conduct these surveys on predetermined flight lines in either an east-west or north-south direction at 1 mile intervals. Flight lines are to be established at one-half mile intervals over the outbreak area; fly alternate lines on subsequent operational surveys. Two observers, one on each side of the aircraft, should map the location and estimate the size of all groups of 10 or more red and fading pines within one-half mile of the aircraft. This will give 100 percent coverage of the area being surveyed. Optimum detection of southern pine beetle infestations is obtained by flying at a height of 1,000 feet above the ground at an air speed of 90 to 120 miles per hour.

2. Ground Phase - Infestations with 10 or more fading trees observed from the air will be ground checked on a priority basis as soon after the flight as possible. Priorities for ground checking are to be established on the basis of spot size and location. The largest spots observed from the air with the greatest number of fading trees will be checked first. The following grading system will be used to set ground checking priorities:

25+ fading trees present - high

10-25 fading trees present - medium

less than 10 fading trees present - low

All high and medium priority spots should be ground checked first. Forest personnel ground checking beetle activity must be able to identify SPB infested trees with live beetle broods present in the spot. When active infestations are encountered, an estimate of the number of fresh attacks and the total number infested trees should be recorded. This information

should then be used to set priorities so that the largest spot or spots in high value stands are treated first. The following system will be used to set treatment priorities:

No. of Active Trees	Rank
> 50	4
21 - 50	2
11 - 20	1
1 - 10	0
Pine basal area at active head	
> - 120	2
80 - 120	1
< 80	0
Fresh attacks	
Present	3
Absent	0
Stand Class	
Sawtimber (9")	1
Pulp (9")	0
High 7 10	
Medium 4 6	
Low 0 3	

All high and medium priority spots will be treated first. Ground crews should always be on the alert for southern pine beetle infestations not detected from the air.

b. Assign Treatment. Spot treatment will be based on treatment priority, time of year, and spot location.

1. High priority spots will be marked and treated first. Salvage-sale will be the preferred treatment. All high priority spots will be marked for salvage until marked spots exceed operator capability and the backlog will create a delay of 3 weeks or more. The excess high priority spots will be treated as follows:

October-May --chemicals only. Any spot size up to 40 infested trees. If spot is more than 40 infested trees, spot to be salvaged controlled as soon as conditions permit.

June-September --cut-and-leave, if spot is less than 40 infested trees. If spot is less than 40 infested trees, spot to be salvage controlled the following month.

2. Medium priority spots will be marked for salvage after all high priority spots have been marked. When marked spots exceed operator capability, and the backlog will create a treatment delay of 3 weeks or more:

Excess medium priority spots will be treated the same as for high priority spots.

3. Low priority spots are not assigned a treatment. Research shows these spots have a high probability of going inactive. If they grow, they would then be assigned a higher priority for treatment the next month.

c. Treatment - Suppression should be a year-round effort. Although major suppression efforts primarily occur from late spring through fall, winter treatment of southern pine beetle infestations is also important because brood densities tend to be higher and are concentrated in fewer trees for a longer period of time. Prompt suppression of actively infested trees during the winter months will decrease the number of beetles dispersing into adjacent stands during the spring months.

Suppression is achieved using one or a combination of the methods listed below. Salvage removal of infested trees are salvaged and removed from the immediate area and some return is realized. Where salvage is not a viable

spot disruption tactic because of inaccessability, (lack of roads, seasonal constraints, etc.) alternative control methods selected should also:

--minimize adverse environmental effects, and

--maximize control effectiveness.

1. Removal of infested trees by commercial sale or administrative use. When infested trees of merchantable size are accessible, they should be removed by commercial or administrative procedures. Logging of the infested merchantable material should begin immediately. Contract time limits should insure rapid removal.

In spots with one or several areas with fresh attack (more than 10 green infested trees), and if additional host type is present and exceeds a basal area of 120 square feet per acre, a buffer strip the length of the average stand height will be marked and cut adjacent to and ahead of the most recently infested trees. This practice is effective in reducing the possibility of "breakouts." In small infestations, (i.e., less than 10 infested trees), the size of the buffer strip, if necessary, will be determined by the land manager.

The order of priority for removing beetle infested timber from a spot in the Coastal Plan will be as follows:

--Trees in the buffer zone at the head(s) of the spot - if not removed within 2 weeks of marking, another visit and talley must be made in order to ensure removal of all infested trees and an adequate buffer strip.

--Trees with fresh attacks and having young broods (usually the green, recently infested trees).

--Trees having nearly developed broods (usually the red and fading trees).

Remove infested trees from Camp Lejeune lands by commercial sale or administrative procedure in accordance with guidelines and procedures set forth in FSM 2400 through 2490.

The following southern pine beetle suppression strategies --cut-and-leave, and pile-and-burn-- are to be used when salvage removal of infested trees is not a viable suppression tactic. For example, when infested trees are of nonmerchantable size or because infested trees of merchantable size are inaccessible, or in highly sensitive areas such as recreation areas, hiking areas or picnic areas.

2. Cut-and-leave - This control tactic reduces losses from spot growth and proliferation during the summer months. Cut-and-leave is designed to disrupt spot growth in small to medium-size spots (less than 40 active trees) by dispersing emerging beetles. These spots can be salvaged when markets or weather permit. Trees are still suitable for sale months after felling.

The following procedure is to be followed when cut-and-leave is applied:

(1) Identify all active trees within the spot.

(2) Fell all active trees toward the center of the spot.

(3) Fell a horseshoe-shaped buffer of green, uninfested trees around the most recently attacked trees at the head of the spot and leave them lying on the ground with crowns pointed towards the center of the spot. The buffer should be as wide as the average height of the trees in the stand.

Cut-and-leave treatments should only be applied during the summer months between June-October. Spots with 10 or more fresh attacks should be treated first. As time permits, spots with less than 10 actively infested trees should also be treated if they contain trees with recent fresh attacks. In these smaller infestations where a specific head is not distinguishable, an adequate buffer strip (equivalent to the average height of the stand) and all infested and green uninfested trees within the spot should be felled.

3. Chemical Control - Chemical concentrations recommended for SPB control are a one-half percent Lindane or a one percent Chlorpyrifos and carrier mixture. The carrier may be water or number 2 fuel oil. The correct carrier to use is specified on the pesticide container label. The proper concentration may be obtained from a 20 percent lindane emulsifiable concentrate at a rate of 11 pints of concentrate in enough water to make 55 gallons of spray (ratio of one part 20 percent lindane EC to 39 parts water).

The proper concentration of Chlorpyrifos may be obtained from a 44 percent liquid concentrate by mixing 2 2/3 fluid ounces of concentrate with water to make a total of 1 gallon of mixture (equivalent to 2.1 gallons in 100 gallons of water).

Dursban 4E is the Dow Chemical Company trade name for chlorpypifos.

Cut, limb and, when necessary, buck all infested trees into workable lengths. Spray the infested bark surface to the point of runoff. The entire bark surface must be treated to insure adequate control, turning the logs as needed. Low pressure sprays may be used to treat large, accessible infestations, particularly in the winter months when many of the infestations are inaccessible to logging machinery. A hydraulic sprayer is recommended.

The priority for cutting and spraying infested trees in large spots is as follows:

1. Trees having nearly developed broods (usually the red and fading trees).

2. Trees having young broods and fresh attacks (green infested trees).

Do not cut a buffer strip. To reduce the possibility of "breakouts" every effort should be made to locate and treat all green infested trees during the chemical control operation. Look for fresh pitch tubes at 10-15' level.

Never spray trees from which southern pine beetle brood has emerged. Natural enemies of the southern pine beetle in these trees can then complete their development.

Instructions for minimizing the adverse effects of mixing, transporting, and storing pesticides, applying pesticides and disposing of pesticide containers and excess chemicals are outlined in Section 8.3 of the Forest Service Health and Safety Code and FSM 2145.4. Detailed safety procedures should be outlined in the project suppression plan.

4. Pile and Burning - Unmerchantable or inaccessible southern pine beetle infestation can be suppressed by cutting, piling and thoroughly burning the bark of infested trees. The entire bark surface must be thoroguhly burned to insure effective control. The order of priority for cutting, piling and burning infested trees, particularly in large spots, is the same as paragraph (3) under Chemical Control. Do not cut a buffer strip. To reduce the possibility of "breakouts" every effort should be made to locate and treat all green infested trees during the piling and burning operation.

Control Crew Organization

A project leader will be assigned to head up the base-wide control work. His responsibilities will be as follows:

1. Responsible to the base forester for all control work
2. Maintain offical files
3. Make operational flights
4. Assign spots for the evaluator to locate and check
5. Make control crew assignments
6. Spot check control work
7. Enforce safety rules and regulations
8. Ensure control spots are checked for reinfestation approximately three weeks after control

9. Prepare and distribute copy of latest copy of presuppression flight map to base forester.

Control Organization

1. Manpower

One spot evaluator, scout, sales inspector

- - - Make periodicoperational flights

- - - Locate and evaluate spots

- - - Assign priority to known spots and number spots for record keeping

- - - Re-check spots after salvage to detect breakout

- - - Show spots for marking and sale to marking crew and sales inspector.

- - - Determine boundary on all medium and high priority spots.

One sales inspector

- - - Inspect logging on all salvage sales

- - - Inform project leader as to what spots have been harvested

- - - Inform porject leader as to the progress and quality of all salvage sales.

One three-man crew, which includes straw boss

Who is responsible for maintaining adequate supplies of materials for a cut-and-leave system of management and materials and supplies for marking of SPB infested timber for salvage sale.

One four-man crew, which includes straw boss

Who is responsible for maintaining adequate supplies of materials for marking SPB infested timber for salvage sale.

2. Transportation

2 4x4 pickups

1 4x4 (6) passenger pickup

3. Equipment

A. Spot Evaluator

1. Hatchet
2. 10 Factor Prism
3. Clinometer
4. Diameter Tape
5. Flagging
6. Notebook
7. Maps

B. Three Man Crew

2 chainsaws

1 5 gallon can of chainsaw gas

1 gallon can chain oil

2 pairs of chainsaw chaps

3 pairs of gloves

3 sets of hearing protection

2 cant hooks

2 axes

2 wedges

1 portable drinking water can with cups

1 file for saws and axes

3 timber marking guns

1 case timber marking paint

3 diameter tapes

3 clinometers

C. Four man Crew

1 portable drinking water can with cups

5 timber marking guns

C. (continued)

2 diameter tapes

5 clinometers

Timing

During the winter or inactive period, operational flights should be made as needed.

Safety Precautions

Lindane and chlorphyrifos are poisonous and will be applied only by licensed applicators from Insect Vector Control. They will observe the following:

Safety Precautions for this project by NREA Division

1. Keep insecticide off the skin and away from the eyes and nose. Use protective equipment. In case of contact, wash immediately with soap and water.
2. Wear elbow length, neophrene gloves when spraying and especially when mixing the insecticide.
3. Wash carefully with soap and warm water immediately after mixing or applying the spray and before eating.
4. Clothes should be changed daily. Launder these clothes separately from other clothing and keep hands out of the laundry water.
5. Observe manufacturer's recommendations on the label and become familiar with antidotes.
6. Store all chemicals in original container and be sure all containers are properly marked.
7. Avoid breathing pesticide vapor or spray mists.
8. Do not apply insecticide to wet bark.
9. Keep pesticide out of ponds, lakes and streams.
10. Do not apply in any way not specified on the labels or for any use.

11. Release pressure slowly when opening spray-can covers.

12. Do not stand opposite a treater while the tree is being sprayed.

13. Follow instruction for dispersal, protective devices, storage and transportation as specified in Marine Corps Order P11000.8A.

14. Handle chain saws with care. Keep moving chain away from body. Always be alert when felling and cutting up trees.

15. Observe all safety regulations as specified in Marine Corps Order P11000.8A.

Post Suppression Evaluation

A post suppression evaluation will be written annually. Data will be recorded during each presuppression flight on breakouts of individual spots salvaged and reported in the presuppression flight narrative report. The Forestry Branch, Natural Resources and Environmental Affairs Division will participate in the Southern Pine Beetle Information System (SPBIS). They will provide FI&DM, State and Private Forestry, SA with completed forms SA 3400-4 and SA 3400-5. This data will be stored in the SPBIS computer program and accessed each year to provide data for the annual Post Suppression Evaluation Report.

Records and Reports

A. Field Reports - The Foreman for each crew will keep a record of the following information for each spot using the SPBTS form provided by FI&DM, State and Private Forestry (Form SA 3400-4).

1. Exact location

2. Number of infested trees and date area was checked

3. Number of trees treated and date treated (to be posted on record daily).

4. Size of spot (acres)

5. Volume of salvage, by products.

6. Effectiveness of treatment, date checked and if any followup work is needed. This record should be made at the time the final sale compliance check is made on a spot.

B. Monthly Report - Submit Form SA 3400-5 to the USDA-Forest Service, Southeastern Area, State and Private Forestry, Resource Protection Unit, Forest Insect and Disease Management Group, Box 5895, Asheville, North Carolina 28803, by the 8th of each month. A copy of the presuppression flight maps showing the location of any new beetle spots should accompany the SA 3400-5 sent to the State and Private Office in Asheville. If no work for the reporting month, a negative report is required.

C. Narrative Report - After each aerial survey, write a brief narrative report of survey results and send a copy to the Forest Insect and Disease Management Group as in B above. Individual spot breakout information recorded during each presuppression flight will also be reported in this narrative.

Planned Assistance

FI&DM will make a minimum of two technical assistance trips to project forests during the active control season (May - September). Further assistance can be obtained by phoning or writing Forest Insect and Disease Management, Box 5895, Asheville, North Carolina 28803, phone FTS 672-0625.

Forest Insect & Disease Management

Report No. 80-1-17
June 1980

BIOLOGICAL EVALUATION OF SOUTHERN PINE BEETLE INFESTATIONS ON CAMP LEJEUNE MARINE CORPS BASE, NORTH CAROLINA

by

Patrick J. Barry
Supervisory Entomologist

ABSTRACT

Aerial surveys and ground checks of 87,000 acres consisting of 42,000 acres of susceptible host show an estimated 162 multiple tree southern pine beetle spots on Camp Lejeune. An estimated 423.2 MBF are currently infested with a potential for an additional 1,270 MBF loss without a control project. A large red cockaded woodpecker population will require special protection during a control project.

INTRODUCTION

On February 22, 1980, the U. S. Forest Service Aerial Survey Team (State and Private Forestry, Doraville, Georgia) in cooperation with the Camp Lejeune Forestry Department conducted a 100 percent southern pine beetle aerial survey of the base (Carothers, 1980). Areas of dead and dying pine were marked on a base map and used as reference for ground checking the week of March 3rd. Sixteen of these spots were randomly selected for ground checking proportionate to spot size class distribution.

SOUTHEASTERN AREA, STATE & PRIVATE FORESTRY
USDA FOREST SERVICE, ATLANTA, GA 30309

At each spot, the number and volume of infested trees were recorded to project total infested volume throughout the base. The aerial survey can only provide for recording red and fading trees. The number of green infested trees were recorded in ground sampled spots, to supply a correction factor for projecting total numbers of infested trees from the aerial survey data.

RESULTS

Table 1 shows results of the aerial survey after application of the correction factor (2.047). The base is heavily infested with 3.86 spots per 1,000 acres of susceptible forest type. The 162 infestations contain an estimated 2,383 currently infested trees comprising an estimated 423.2 MBF of timber. Figure 1 shows areas of heaviest southern pine beetle activity. It is noteworthy that Camp Lejeune supports a large population of red cockaded woodpeckers. This endangered species nests in old growth southern pines and was found proximal to or within some southern pine beetle infestations. Figure 2 shows the location of these woodpecker nesting sites. This information was provided by the Camp Lejeune Base Forestry Department.

Table 1.--Number of southern pine beetle spots and infested trees by spot size class (corrected aerial survey data), Camp Lejeune Marine Corps Base, 1980.

	- - - - - Spot Size - - - - -					
	1-10	11-25	26-50	51-100	100+	TOTAL
No. spots	135	0	8	18	1	162
No. trees	346	0	307	1,576	154	2,383

DISCUSSION AND RECOMMENDATIONS

The aerial survey and ground examinations of infestations on the military base show that the current outbreak is in its initial stages. At this time, the infestations are in stressed and weak trees. Some of the stressed trees were man-

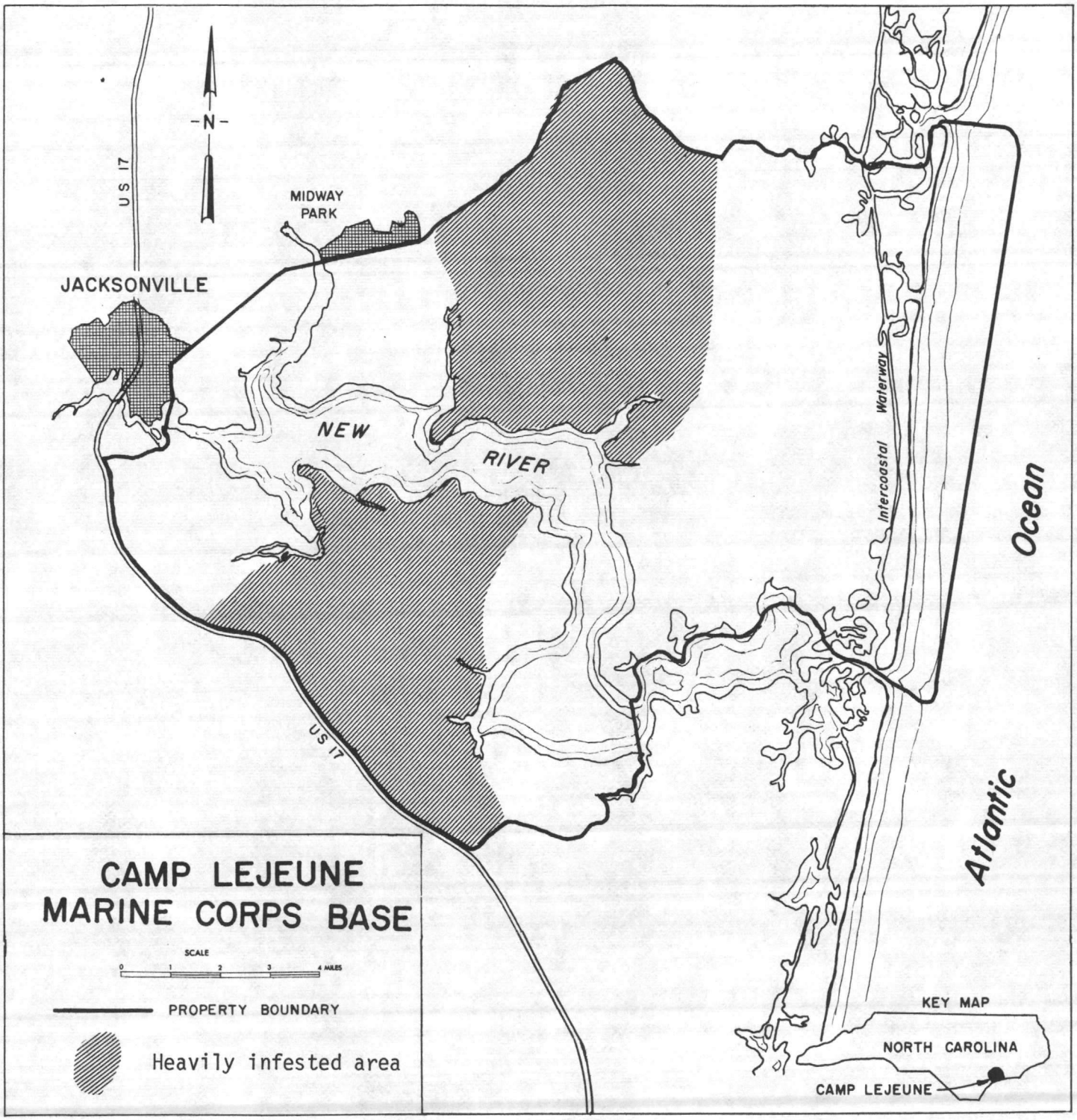


Figure 1.--Location of heaviest southern pine beetle activity.

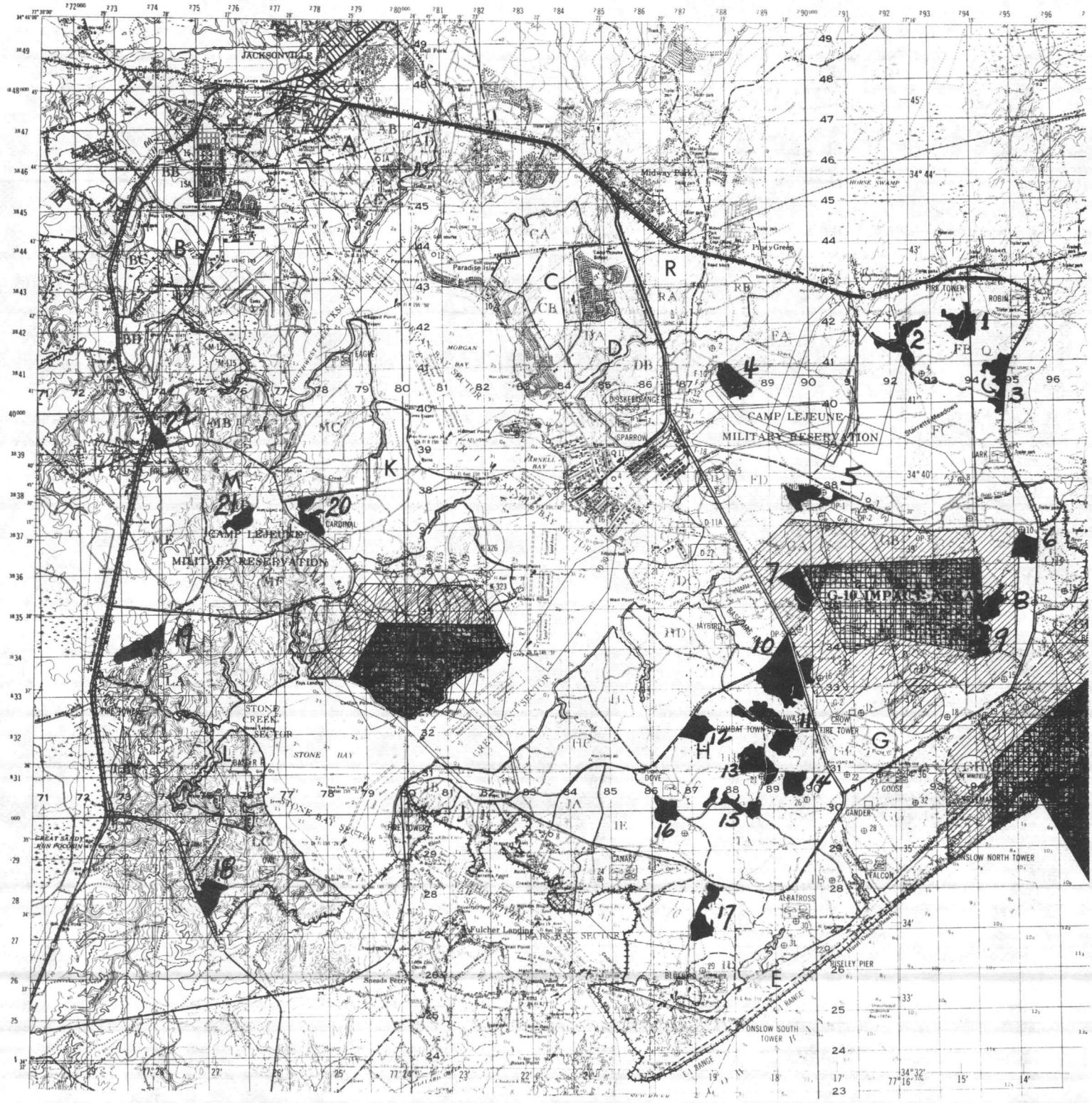


Figure 2.--Location of 22 red cockaded woodpecker colonies.

caused such as, those wounded by climbing spikes used in climbing trees to install communication wire, those in bivouac areas that had been chopped on with axes and hatchets, and those with soil compaction due to continuous foot and vehicle traffic. Certain areas seem to be used repeatedly. Trees were girdled by communication wire where the wire was wrapped around them a number of times and then tied off tightly. Mechanical damage from vehicles and equipment is also a source of stress caused by the scarring and debarking of trees. Numerous stressed trees were found around wet areas and pocosins. This stress is due to either too much water or not enough. This particular problem could have been caused by the drought we had in 1978. If conditions stay ideal for the southern pine beetle, tremendous losses of pine timber could be sustained on the base.

Based on traditional spot growth data for the area, as much as 1,270 MBF could be lost within the next year, if infestations on the base are not controlled. The total loss could be as much as 1,693 MBF (currently infested 423 MBF - the projected 1,270 MBF). Based on individual situations, any of several suppression techniques may be used.

CURRENT SUPPRESSION PROCEDURES

1. Removal of Infested Trees by Commercial Sale or Administrative Use. When infested trees of merchantable size are accessible, they should be removed by commercial sale or administrative use procedures. Logging of the infested material should begin immediately. Contract time limits should insure rapid removal.

   When practical, and if host type is present, a 40- to 70-foot buffer strip should be marked and cut adjacent to and ahead of the most recently infested trees. This practice is effective in reducing the possibility of "breakouts." When only a small volume of infested merchantable material occurs in a spot, noninfested trees surrounding the spot may be marked to provide an operable cut.

   The order of priority of removing beetle-infested timber from a spot should be as follows:

   -- Trees in the buffer zone at the head(s) of the spot - if not removed within 2 weeks of marking, another visit and talley must be made in order to insure removal of all infested trees and an adequate buffer strip.

   -- Trees with fresh attacks and having young broods (usually the green, recently infested trees).

   -- Trees having nearly developed broods (usually the red and fading trees).

   Remove infested trees from Marine Corps Base, Camp Lejeune lands by commercial sale or administrative use procedures in accordance with guidelines and procedures set forth in FSM 2400 through 2490.

2. Piling and Burning. Unmerchantable or inaccessible southern pine beetle infestations can be suppressed by cutting, piling, and thoroughly burning the bark of infested trees. The entire bark surface must be thoroughly burned to insure effective control. The order of priority for cutting, piling, and burning infested trees, particularly the large spots, is the same as paragraph (1) under "Removal of Infested Trees by Commercial Sale or Administrative Use." Cutting a buffer strip is not recommended. To reduce the possibility of "breakouts," every effort should be made to locate and treat all green infested trees during the piling and burning operation.

3. Chemical Control. The chemical formulation recommended for southern pine beetle control is a ½ percent lindane spray with water as the carrier. This may be formulated from a 20 percent lindane emulsifiable concentrate at the rate of 11 pints of concentrate in enough water to make 55 gallons of spray. (Ratio of one part 20 percent lindane EC to 39 parts water.)

   Dursban® (chlorpyrifos) is also registered for southern pine beetle control. It is available as a liquid containing 4 pounds of insecticide per gallon of concentrate. The spray is prepared by mixing 2 2/3 fluid ounces of concentrate with water to make 1 gallon or 2.1 gallons of concentrate in 100 gallons of water. Dursban® is to be applied only by or under the supervision of a certified pest control operator or other trained personnel responsible for insect control programs.

   Cut, limb, and buck all infested trees into workable lengths. Spray the infested bark surface to the point of runoff. A compressed air sprayer (3-gallon capacity or equivalent) is an ideal applicator. Infested logs must be turned two or three times to insure complete treatment of infested bark. Low pressure sprayers may be used to treat large accessible infestations.

   The order of priority for cutting and spraying infested trees in large spots is the same as paragraph (1) under "Removal of Infested Trees by Commercial Sale or Administrative Use." Cutting a buffer strip is not recommended. To reduce the possibility of "breakouts," every effort should be made to locate and treat all green infested trees during the chemical control operation.

   Never spray trees from which southern pine beetle brood has emerged. Natural enemies of the southern pine beetle in these trees can then complete their development.

   Instructions for minimizing the adverse effects of mixing, transporting and storing pesticides, applying pesticides and disposing of pesticide containers and excess chemicals are outlined in U. S. Marine Corps regulations.

4. Cut-and-leave. This control tactic reduced losses from spot growth and proliferation during the summer months. Cut-and-leave is designed to disrupt spot growth in small to medium-sized spots (40 active trees) by dispersing emerging beeltes. These spots can be salvaged when markets or weather permit. Trees are still suitable for sale months after felling.

The following procedure is to be followed when using cut-and-leave:

(1) Identify all active trees within the spot.

(2) Fell all active trees within the spot.

(3) Fell a horseshoe-shaped buffer of green, uninfested trees around the most recently attacked trees at the head of the spot and leave them lying on the ground with crowns pointed toward the center of the spot. The buffer should be as wide as the average height of the trees in the stand.

Cut-and-leave treatments should only be applied during the summer months between June and October. Spots with 10 or more infested trees should be treated first. As time permits, spots with less than 10 infested trees should also be treated if they contain trees with fresh attacks. In these smaller infestations where a specific head is not distinguishable, an adequate buffer strip (equivalent to the average height of the stand) and all infested and green uninfested trees within the spot should be felled.

Reexamination of Treated Areas. Reexamine areas where infested trees were removed by commercial sales, piled and burned, or chemically treated or cut and left within 2 or 3 weeks after treatment to check for additional infested trees. If additional trees are found, treat them.

In any area where infested trees are cut for chemical control, piling and burning, cut-and-leave or removed through commercial sales and administrative use procedures, stumps adjacent to living pine trees should be treated to control or prevent the root rot Fomes annosus.

Stands that have been previously thinned or have had a history of F. annosus infection, stumps should be treated with the competing fungus, Peniophora gigantea.

Stands that have no history of F. annosus and have never been thinned, the stumps should be treated with borax.

Southern pine beetle infested tree stumps cut during the period of May through August, and below 34° N. latitude do not have to be treated with either of the above materials. This is because few spores are formed during this period and high temperatures often kill spores that are produced. However, routine summer thinning in areas of southern pine beetle buildup is not recommended.

RED COCKADED WOODPECKER CONSIDERATIONS

1. Within colonies and buffer zones, each infested tree will be inspected individually and decisions made as to control measures for that tree; buffers of noninfested trees will not be treated.

2. Active cavity trees will not be cut or sprayed.

3. Dead or apparently live cavity trees from which beetles have emerged will not be cut.

4. Inactive cavities (dead, enlarged by other species, etc.) will not be cut unless a minimum of four cavity trees (active and inactive) per colony remain to provide shelter for a breeding pair of birds and up to two helpers for the interim period necessary for excavation of new replacement cavities.

5. Spraying with presently approved pesticides (Lindane - a chlorinated hydrocarbon, Dursban - an organophosphate) will not be conducted within colonies and buffers--trees cut within these areas will be removed.

6. Cutting of buffers around the head of infestations in contiguous habitat is acceptable unless doing so would separate the colony completely from suitable foraging territory (doughnutting or isolating colonies). In this case, the Camp Lejeune Wildlife Manager should determine if a buffer should be cut and, if so, the modifications of the buffer that should be made considering:

   a. the likelihood of preventing the infestation from entering colony sites by cutting or not cutting the buffer,

   b. the distance from the colony to suitable foraging territory if a buffer is cut (short distances would be crossed by the bird without undue impact), and

   c. the probability of the infestation destroying all or a significant portion of the foraging territory if the buffer is cut versus not cut.

These guidelines were developed by the U. S. Fish and Wildlife Service, Asheville, N.C. and Forest Insect and Disease Management, Asheville, N.C.

PREVENTIVE MEASURES

The preceeding represents only short-term, immediate control strategies. Preventive measures must be taken to help ward off further southern pine beetle infestations in noninfested stands. Some of the more significant preventive measures include:

1. Preventing or minimizing littleleaf disease, a condition which predisposes these weakened trees to beetle attack. Depending on severity of infection, diseased trees may be removed during normal thinnings, on a 6-year cutting cycle or as soon as merchantable. In high-hazard areas or in replanting known littleleaf sites, use loblolly pine or a more resistant tree species, as opposed to shortleaf pine.

2. Harvesting mature and overmature stands. Such stands are vulnerable to beetle attack and should be harvested as soon as possible.

3. Thinning stagnated stands. Overstocked stands are low in vigor and are more likely to be attacked. They should be thinned to a point that trees again show thrift and vigor.

4. Minimizing impact of natural disturbances which causes stand stress. These factors include ice, wind, hail, and animal damage, flooding, erosion, poor soil fertility, etc. Corrective measures include removal of individually damaged trees, wholesale salvage, improving drainage, fertilization, etc.

5. Minimizing or eliminating man-caused disturbances. Logging, pipeline, sewerline, and powerline construction, and other construction activities require use of heavy equipment which causes tree skinning and soil compaction and significantly weakens trees. Efforts to minimize the damaging consequences of these activities can significantly reduce the possibility of their leading to southern pine beetle problems.

PRECAUTIONARY PESTICIDE USE STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key--out of reach of children and animals--away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you used for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary landfill dump, or crush and bury them in a level isolated place.

NOTE: Some states have restrictions on the use of certain pesticides. Check your state and local regulations. Also, because registration of pesticides are under constant review by the U. S. Department of Agriculture, consult your county agricultural agent or state extension specialist to be sure the intended use is still registered.

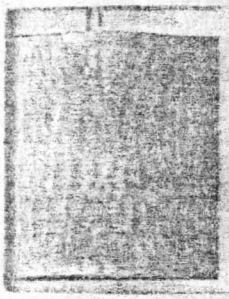
LITERATURE CITED

Carothers, William A. 1980. Aerial detection survey of southern pine beetle activity, Department of the Navy, Camp Lejeune Military Reservation, North Carolina. USDA - Forest Service, Southeastern Area, S&PF, FIDM, Rep. No. 80-3-9.

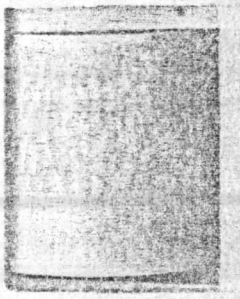
A Field Guide for Ground Checking Southern Pine Beetle Spots

by
Ronald F. Billings and
Herbert A. Pase III[1]

Introduction

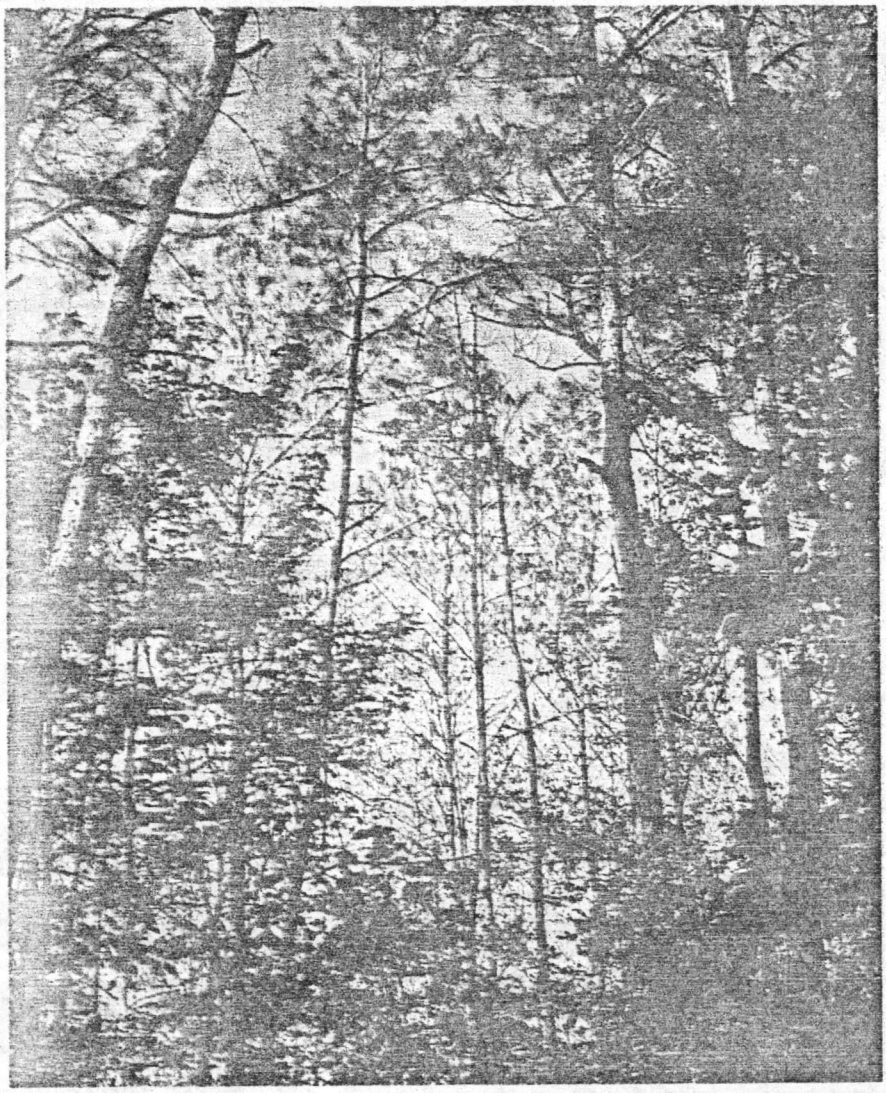


The job of locating and controlling the southern pine beetle (SPB) takes the teamwork of three separate field operations—aerial survey, ground check, and direct control. Aerial surveys locate many areas with dead or dying pines believed to harbor SPB. Some are active beetle spots; others are not. Only by checking from the ground can we be sure. So, on the basis of tree symptoms visible from the air, aerial survey crews assign each spot a high, medium, or low priority for ground checking. Ground check crews then visit newly detected spots, giving first attention to high priority areas. Your responsibility, as a member of the ground check crew, is to see firsthand the extent of beetle activity in each spot and to determine if further tree killing is likely to occur. This handbook shows how to recognize various stages of SPB attack, how to decide if control is needed, and how to mark buffer strips for control crews.



[1] Respectively, principal entomologist and entomologist II, Forest Pest Control Section, Texas Forest Service, Lufkin, Texas.

Locating SPB Spots from Ground Level



To find newly detected spots, use a map and compass, if necessary, to arrive at the general area indicated by the aerial survey team. Once there, look for a group of yellow- or red-topped pines (fig. 1). Spots that cannot be found after a reasonable search should be rechecked during the next aerial survey flight. The aerial crew may be able to correct errors in plotting or to pinpoint landmarks guiding you to the spot.

Figure 1.—Red-topped pines indicative of SPB spot.

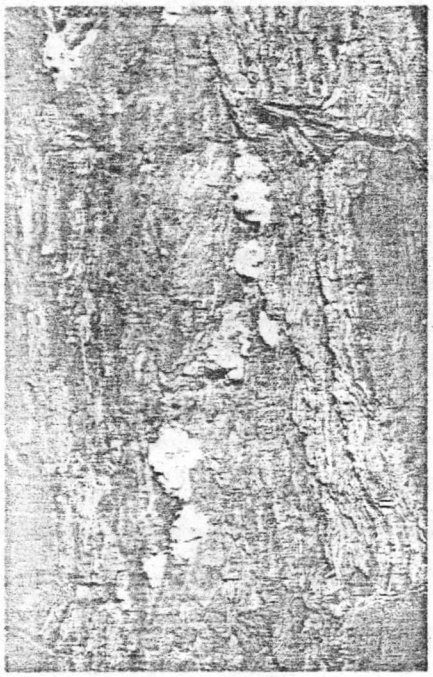
How to Identify SPB Attacks

Like any living thing, pines may die from a variety of causes. But how can you tell if they were killed by SPB? The best way is to remove sections of bark from trees with fading (yellow) foliage or from trees with bark just starting to loosen. Look for the winding, S-shaped tunnels or galleries made only by SPB adults (fig. 2). SPB galleries are filled with a sawdustlike material (frass) left behind by feeding adult beetles.

In pines just coming under attack, galleries are not yet present. The first symptom of SPB in this case will usually be pitch tubes in bark crevices. These glossy masses of resin mark where the adult beetles bore into the trunk of a tree. SPB pitch tubes are soft and pink when fresh, becoming hard and white or yellow with age

Figure 2.—Galleries of SPB adults together with white larvae.

Other Bark Beetles



(fig. 3). But remember, pitch tubes—alone—are not reliable indicators of SPB attack because other bark beetles also leave them.

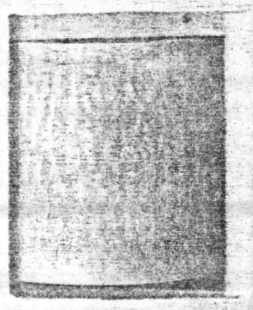
For a couple of weeks after attack, you may find SPB adults within the S-shaped galleries where they lay eggs. The SPB itself is surprisingly small, considering the amount of damage it can do. The adult beetle measures only 1/8 of an inch long and is black or dark brown. Because of their small size, you may have difficulty recognizing SPB adults among the many other bark-inhabiting insects. Again, the S-shaped galleries provide telltale evidence that SPB killed the tree, even when the beetles themselves are no longer present.

The southern pine beetle is not the only destructive bark beetle in the South. Other beetles, including *Ips* beetles and the black turpentine beetle (BTB), also kill pines, but usually in small, scattered outbreaks not requiring control. This means that you must be able to tell the difference between SPB attacks and those of other bark beetles. Identification can be difficult because the various beetles are similar in many ways.

Yet there are unmistakable differences. For instance, the black turpentine beetle is about ¼ of an inch long, which makes it much larger than the southern pine beetle. Also, the BTB normally limits its attacks to the lower 10 feet of the trunk, while the SPB attacks at almost any height on the tree. Pitch tubes of the BTB usually are reddish and much larger than those of the SPB (fig. 4). The black turpentine beetle's galleries follow no distinct pattern.

Differences between SPB and *Ips* beetles are less obvious because the insects are similar in size. Adult galleries provide the best clue for recognizing *Ips* attacks. They are long, straight tunnels often joining to form a Y or H shape. *Ips* galleries usually are not packed with frass (fig. 5). Keep in mind that *Ips* and black turpentine beetles may occur in the same tree as the southern pine beetle.

Figure 3.—Pitch tubes of SPB.



Seasonal Variation in Attack Symptoms

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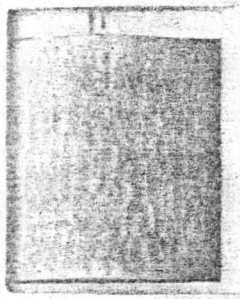
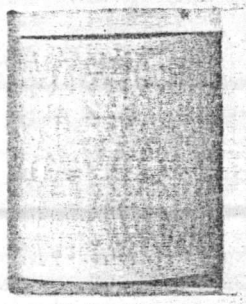
Figure 4.—Pitch tubes of black turpentine beetle.
Figure 5.—Galleries of the adult *Ips* beetle.

The time it takes SPB to grow from eggs to adults varies seasonally, as does the time it takes for symptoms of beetle attack to appear in infested pines. Judging the presence or absence of SPB and the stage of development during the winter months can be a difficult task. Foliage on trees attacked in cold months may remain green for long periods, although such trees quickly lose their needles once foliage discoloration begins. Because the beetle needs 2–4 months to mature during cold months, some winter-killed pines with bare crowns may still contain SPB. Also, the insects in winter often reattack the top and base of a tree already containing developing broods. This leaves different beetle life stages at different heights in the same tree. Because of these difficulties, no attempt has been made to categorize infested spots for the winter months.





Stages of Beetle Attack During the Summer

SPB attack sequence and developmental time are more predictable from May to October, and the appearance of beetle-killed pines changes with a distinct pattern. On the basis of these facts, three categories for beetle-infested pines have been established, reflecting various stages of attack. The number of trees in each stage of attack—and where the trees are located in a spot—is the key to whether a SPB spot is likely to spread in warm weather. It is essential, then, that you learn to recognize these three stages to correctly determine the need for control.

Stage 1—Pines With Fresh Attacks

When SPB bore into a tree, they produce chemicals attracting other beetles to the tree. This sets off a chain reaction. The attractants usually bring together more than enough beetles to kill the pine, and excess beetles spread to nearby trees. They, too, give off the attractant, which calls in still more SPB. The infestation grows. Because only freshly attacked trees are sources of attractant, it is important to identify their number and location. Only then can you determine if the spot is likely to spread. The following characteristics identify trees with fresh attacks:

- *Foliage* . . . appears normal (green).
- *Pitch tubes* . . . are soft and white or light pink and usually sticky to the touch (fig. 6). SPB normally attack first at heights of 10–20 feet above ground. So, if there are no pitch tubes visible at eye level, look higher on the trunk. In severely stressed pines, pitch tubes may not appear. Instead, reddish boring dust appears in bark crevices, on the leaves of shrubs, and in spider webs at the base of the tree (fig. 7).

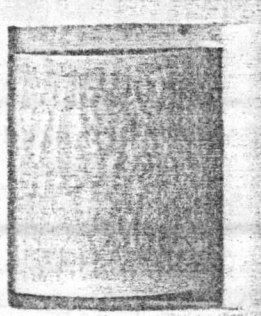


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Figure 6.—Fresh pitch tube and SPB adult on stage 1 tree.

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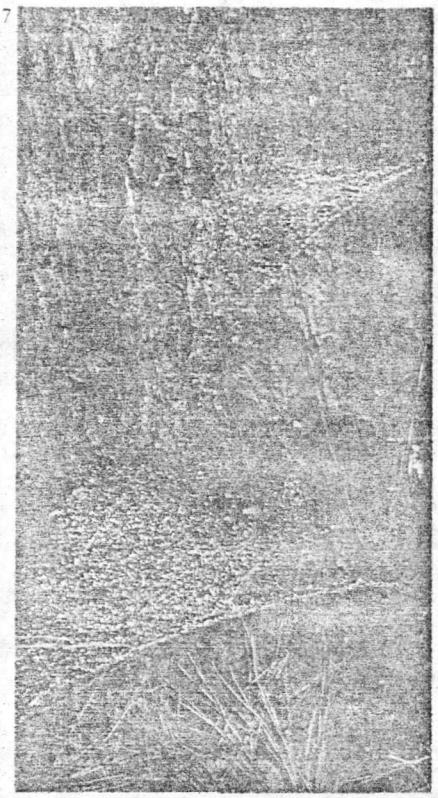
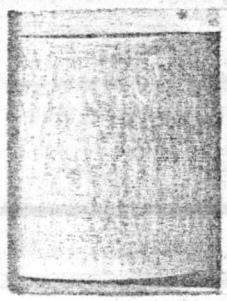


Figure 7.—Boring dust in spider webs at base of stage 1 tree.



• *Checkered beetles (clerids)* . . . may be seen crawling about on the trunks of freshly attacked pines (fig. 8). They are common predators of SPB and respond to SPB attractant.

• *Bark* . . . remains tight and hard to remove.

• *Color of wood surface* . . . is white like that of unattacked trees, except close to new adult galleries, where it is brown (fig. 9).

Figure 8.—Adult checkered beetles on stage 1 tree.

Figure 9.—White-colored wood of stage 1 tree with SPB adult gallery.

Stage 2—Pines With Developing SPB Broods

Soon after adult beetles have overcome a tree, they stop producing attractant. Eggs hatch, and small, white SPB larvae start feeding in inner bark mines, which are mixed among the S-shaped adult galleries (fig. 2). As larvae develop, they move into the outer bark, where they eventually change into white pupae and then into brown or black adults. It is important to realize that the beetle has these various forms. To see the later beetle stages, carefully shave away outer layers of bark with an axe or machete (fig. 10). Other features of trees with developing brood are:

- *Foliage* . . . is green on most trees containing larvae, but may fade to yellow or turn red before the new

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Figure 10.—Shaved bark with SPB larvae and pupae in outer bark of stage 2 trees.

Figure 11.—Ambrosia beetle dust at base of stage 2 tree.

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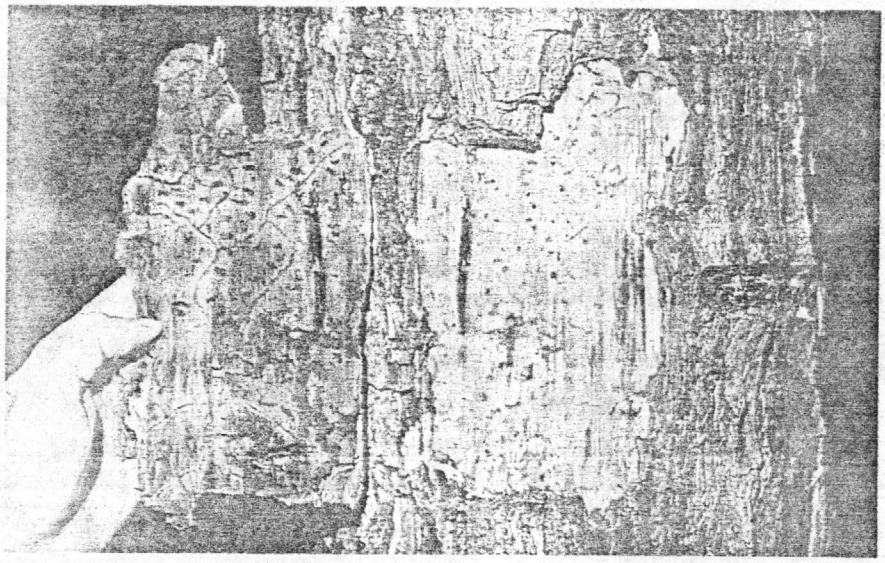

generation of beetles emerges from the tree. Foliage color varies greatly by season and among individual trees, so it is not always a good indicator for this stage.

- *Pitch tubes* . . . are white and hardened, resembling popcorn (fig. 3).
- *Exit holes* . . . may appear at this stage and mark where parent beetles have left the tree. They are round holes about the size of a pencil lead.
- *Ambrosia beetle dust* . . . is white and begins to appear in small to moderate amounts around the base of the tree (fig. 11). It is not present in stage 1 trees.
- *Bark* . . . is loose and easy to peel away from the trunk.
- *Color of wood surface* . . . is light brown (fig. 12). It may shade into dark brown with blue or black sections infested by staining fungi.
- *Checkered beetle larvae* . . . show up in SPB galleries in the bark. The larvae are pink or reddish and about ½ inch long (fig. 13).

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Figure 12.—Brown wood associated with bark beetle mining in stage 2 tree.

Figure 13.—Checkered beetle larvae in inner bark of stage 2 tree.

Stage 3—Pines Killed and Vacated by SPB

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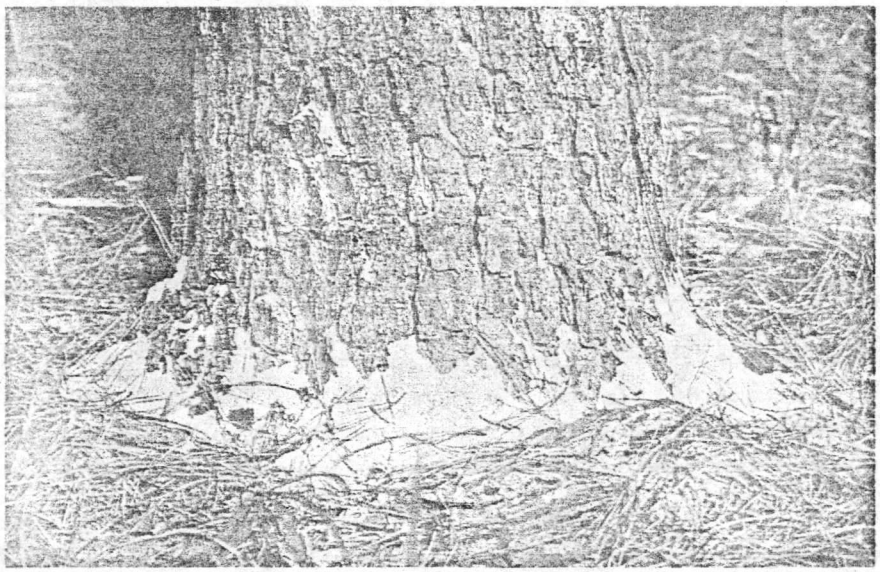
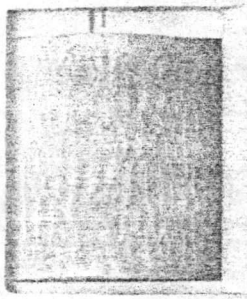


After maturing in the bark, new adult beetles bore their way out and fly off to attack another pine. A tree is termed "inactive" when no SPB of any stage can be found in it. Other features of inactive trees include:

- *Foliage* . . . of most trees is red and needles may have started dropping.
- *Ambrosia beetle dust* . . . is abundant at the base of the tree and is now off white or cream colored (fig. 14).
- *Pitch tubes* . . . are hard and yellow, crumbling easily in your fingers (fig. 15).
- *Exit holes* . . . are numerous (fig. 15).
- *Bark* . . . is very loose and easily removed.
- *Color of wood surface* . . . is dark brown to black with SPB galleries often obscured by the coarse, fibrous borings of sawyer beetle larvae (fig. 16).
- *Checkered beetle larvae or pupae* . . . are purple and occur in pockets within the outer bark shortly after the SPB brood leaves.

Figure 14.—Ambrosia beetle dust at base of stage 3 tree.



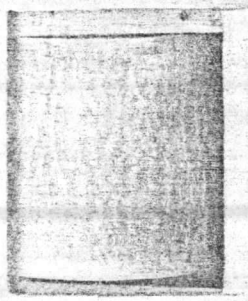


Figure 15.—SPB pitch tubes and exit holes through bark of stage 3 tree.

Figure 16.—Wood discoloration caused by insect and fungal activity in stage 3 tree.

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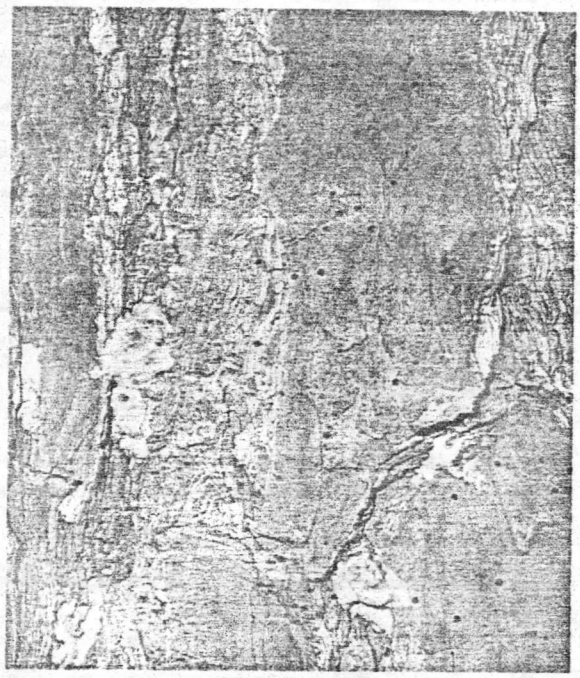

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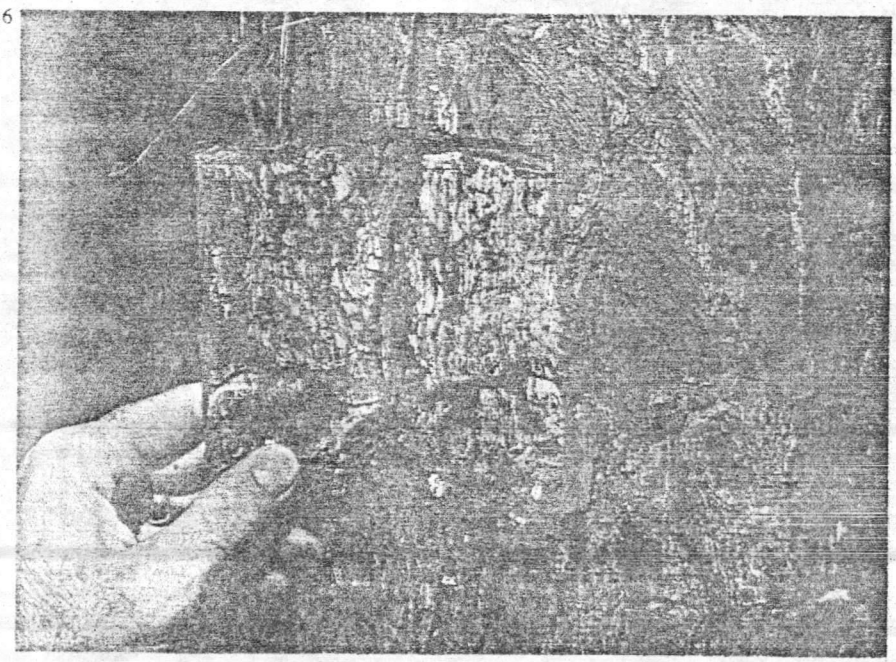

Collecting Spot Expansion Data

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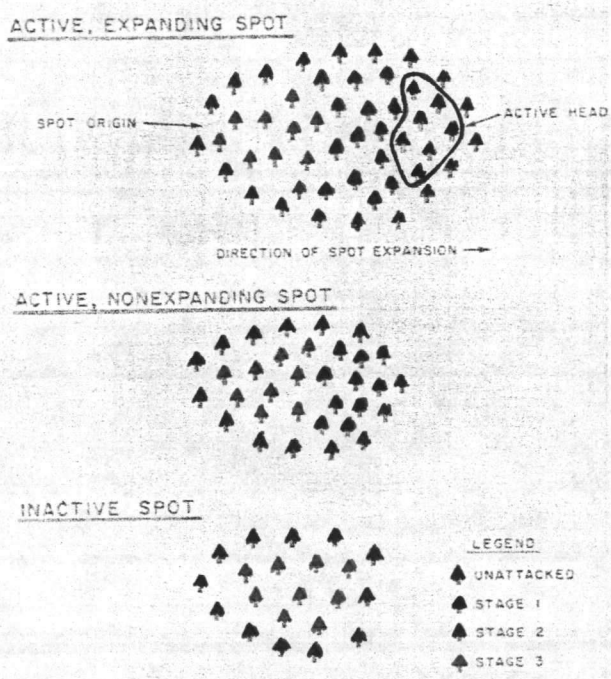


Figure 17.—Three kinds of SPB spots.

Is the new spot you have located a threat to grow larger? It may well be. The southern pine beetle can readily spread if it has three conditions: Attractants from stage 1 trees, continuous emergence of attacking adult beetles from stage 1 and stage 2 trees, and pines to attack (fig. 17). During the summer, spots with no stage 1 trees are not likely to expand because attractants are no longer present. And spots with only stage 3 trees—since beetles have already left—need no control at all. The following steps, to be used between May and October, explain how to collect information for use in the control priority guide:

1—Walk completely around the spot and look for stage 1 trees, which indicate the area of most recent beetle activity. Areas with stage 1 pines are called "active heads". Check to see if the spot is expanding in more than one direction. Large spots can have more than one active head.

2—Determine the number of stage 1 and 2 trees. For large spots that have more than 50 trees, it is not necessary to examine each tree. Just walk the boundaries and estimate the number of these trees in the spot.

3—From a location about 20 feet in front of the active head or heads, determine the pine basal area (a measure of stand density) in square feet per acre. A 10-factor prism is useful for this purpose.

4—Note whether most trees in the spot are pulpwood (less than 9 inches in diameter) or sawtimber size (more than 9 inches in diameter).

5—Using the Control Priority Guide from the next section of this handbook, determine the control priority for the spot.

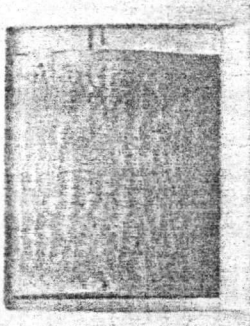
6—Flag a trail back to the nearest road or landmark for the control crew.

Using the Control Priority Guide

To assign a control priority using information gathered at the spot, turn to table 1 (see page 18). Four keys to spot growth (A, B, C, and D) appear in the left-hand column. For each of these, select from the middle column the classification matching your spot. Select from the right-hand column the risk-rating points for that classification. For Key A, for example, if your spot classification is "present," your risk-rating choice would be 30 points. Take one number for each key and add them together. This gives you the total risk-rating points for your spot.

If the total of risk rating points is 70 or greater, the spot is assigned a high priority for control. Risk totals between 40 and 60 indicate a medium priority for control, and totals of 30 or less signal a low control priority.

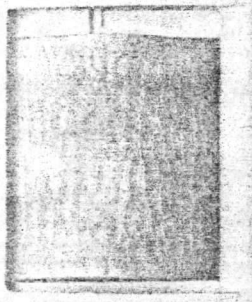
A Word on Control Priorities



Effective control requires prompt removal of the buffer strip and stage 1 trees. For large spots, this should be done first, then you can remove the other infested trees in the spot. Salvaging stage 3 trees is not critical to control, but can be done later.

Decisions on controlling SPB spots depend not only on the control priority, but also on the availability of crews and equipment, access to the spot, and market value of beetle-killed pine. If possible, high priority spots should be controlled promptly or they will spread, while medium priority spots can be handled as time permits. A low priority spot may need no control. Since it is uncertain what will happen in medium or low priority spots, you should recheck them every 4–6 weeks until they are controlled or become inactive. During major SPB outbreaks, aerial surveys are the most practical way to monitor uncontrolled spots after the first ground check.

The Buffer Strip



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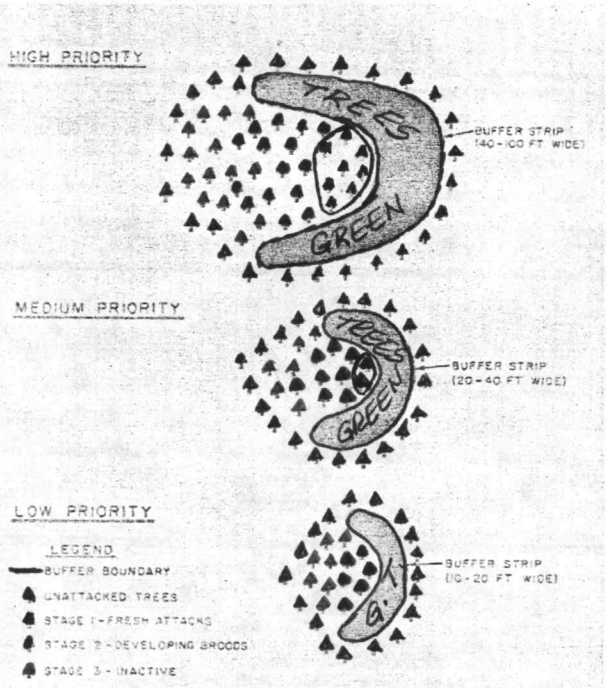
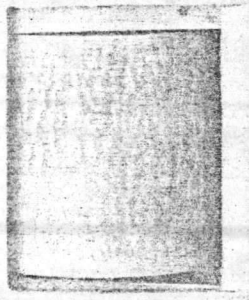


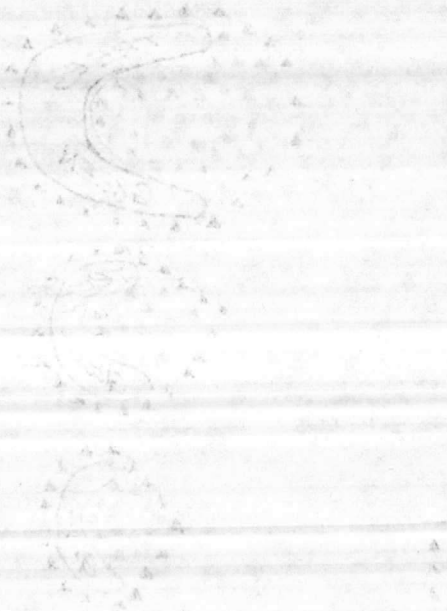
Figure 18.—Location of buffer strips.

No matter which means of control is used, success hinges upon treating all stage 1 trees. The best insurance is to cut a buffer strip of uninfested pines around the active head of a spreading spot. This tactic interrupts the beetles' flow of attractants and stops their advance. The buffer strip also provides a margin of error, just in case attacked pines were initially overlooked or the spot has expanded since then.

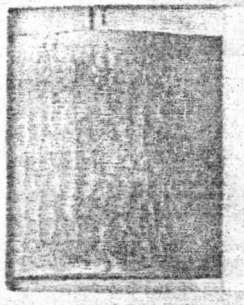
A buffer strip 10–40 feet wide is enough for medium and low priority spots and for high priority spots with fewer than 30 trees. But a buffer strip 40–100 feet wide is needed for large high priority spots (fig. 18). As a rule of thumb, the number of trees in the buffer strip should not be more than the combined number of stage 1 and stage 2 pines in the spot being treated. The buffer strip should enclose all stage 1 and stage 2 trees and be widest in the direction that the spot is expanding.

If control is planned within 2 weeks after the ground check, mark the buffer strip at the time of the first ground check. If control is not planned this soon, wait until just before the control date to mark the buffer strip or carefully recheck its boundaries before treatment. Otherwise, the spot may enlarge beyond the buffer zone before the control starts.





Checklist

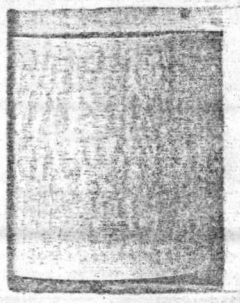


- Verify that trees were killed by SPB.
- See if any stage 1 trees are present.
- Mark and count all stage 1 and stage 2 trees.
- Measure basal area of pine about 20 feet in front of the active head or heads.
- Note whether the stand contains mainly pulpwood or sawtimber.
- Using table 1, determine the control priority.
- If control is to be applied promptly, mark the buffer strip of uninfested pines around the active head.
- Flag a route back to the nearest road or landmark.
- Report ground check information promptly.

Table 1.—*Guide to southern pine beetle spot growth and control priorities (May through October)*

Key to spot growth	*Your spot's classification*	*Risk-rating points*
A. Stage 1 trees	absent	0
	present	30
B. Stage 1 and 2 trees	1–10	0
	11–20	10
	21–50	20
	more than 50	40
C. Pine basal area (ft^2/acre) (or stand density) at active head or heads	less than 80 (low density)	0
	80–120 (medium density)	10
	more than 120 (high density)	20
D. Stand class by average d.b.h. (in inches)	pulpwood (9 in or less)	0
	sawtimber (more than 9 in)	10
	Total [1]	

[1] If total is 70–100 control priority is High. If total is 40–60 control priority is Medium. If total is 0–30 control priority is Low.



Glossary

southern pine beetle—*Dendroctonus frontalis,* a bark beetle identified by the S-shaped galleries it makes beneath the bark of attacked pines.

spot—A group of dead or dying trees infested by the southern pine beetle.

spot growth—The natural expansion of untreated spots as additional live trees on the outer edge of a spot become infested.

stage 1 pine—Infested pine showing symptoms of fresh attacks by SPB.

stage 2 pine—Infested pine with developing broods (larvae, pupae, or new adults) of SPB.

stage 3 pine—Pine killed by SPB from which all broods have emerged.

active spot—SPB infestation in which one or more of the attacked trees contain beetles or brood.

inactive spot—SPB infestation in which the beetles in all of the attacked trees have completed development and emerged.

active head of spot—That portion of a SPB spot containing beetles in the process of attacking live trees.

buffer strip—A group of live uninfested pines, adjacent to the most recently infested trees in a spot, that is felled to assure effective control.

Ips beetles—A group of related pine-killing beetles that can be distinguished from SPB by the unfilled Y- or H-shaped galleries made by attacking parent beetles.

black turpentine beetle—*Dendroctonus terebrans,* a large bark beetle commonly found attacking the lower trunks of pines, producing large reddish pitch tubes.

Acknowledgments

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