United States
Department of
Agriculture

Forest
Service

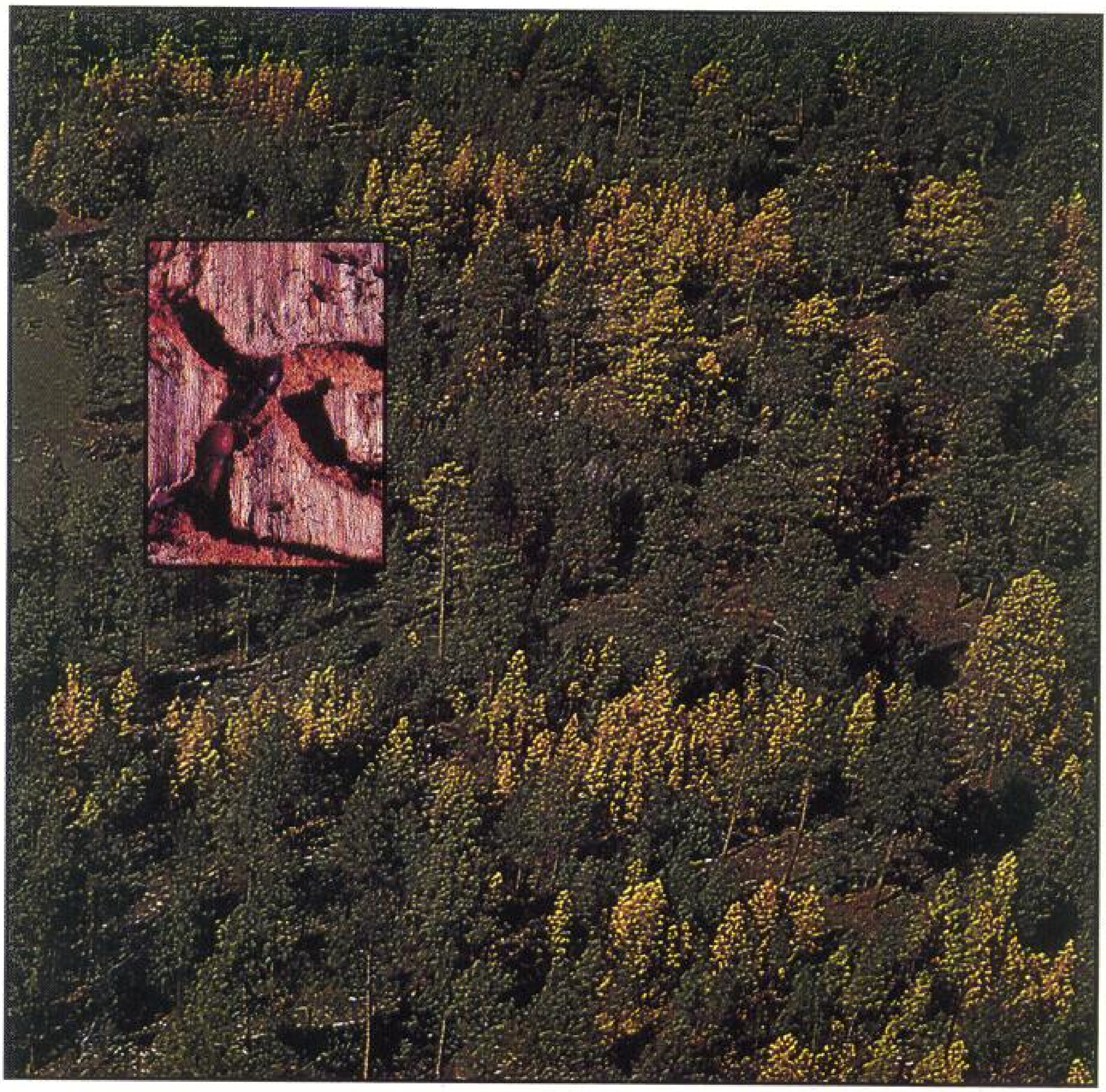
**Southwestern
Region**

R-3 91-8

Integrated Pest Management Guide

Arizona Five-Spined Ips, *Ips lecontei* Swaine, and Pine Engraver, *Ips pini* (Say), in Ponderosa Pine

By Douglas L. Parker



Introduction

The Arizona five-spined ips, *Ips lecontei* Swaine, and the pine engraver, *Ips pini* (Say), are common and destructive bark beetles that attack pole-size ponderosa pines in Arizona and New Mexico. The Arizona five-spined ips is mostly a pest in low elevation ponderosa pine forests below the Mogollon Rim in central and southern Arizona (Furniss and Carolin 1977). It also occurs in southwestern New Mexico. The pine engraver is more widely distributed in the Southwest and causes the heaviest tree losses in higher elevation forests in the northern portions of both states.

The most damaging *Ips* outbreaks result from several natural and forest management practices that weaken and damage trees or create slash. Beetles attack fresh slash and weakened trees, a population buildup occurs, and live trees are attacked and killed if no new slash is available. Thousands of pole-size trees can be killed during severe outbreaks. Tree mortality in management areas can significantly decrease timber production and increase management costs. Tree losses in high-use recreation areas, near homes and cabins, and in communities will cause increased public concern as more people recreate and live in ponderosa pine forests.

Ips-caused tree mortality can be prevented if forest managers understand the reproductive capacity of these beetles, integrate pest management techniques into the Integrated Resource Management (IRM) process, and implement appropriate techniques on a timely basis. When prevention is not feasible, suppression measures may be needed.

This guide summarizes technical information in publications, observations of pest management specialists, and unpublished tree loss data on these insects. This guide presents the most important facts about these beetles and their management, and serves as a reference tool to forest managers.

Life History and Habits

Generally, *I. lecontei* completes three generations a year (Fig. 1). Adult beetles, which wintered under the bark of infested material, emerge when warm weather arrives in the spring and search for favorable hosts. They prefer to attack fresh slash, but live trees can be attacked and killed when large numbers of beetles are present. Adults bore through the outer bark, construct galleries, and lay eggs in the soft inner bark. Eggs usually hatch within seven days and larvae feed upon the inner bark for about four weeks before they pupate. Adults develop from the pupae in a week and emerge by boring out through the bark. They fly to a suitable host tree and start the second generation. Due to warmer temperatures in July, the second generation completes development within 30 days, less than half the time required to complete the first generation. Another flight occurs and the third generation begins in mid-August, taking about the same time to develop as the first generation (80 days). Beetles in this generation usually remain under the bark and do not fly until the following spring. At lower elevations on warm sites, third generation adults may fly in the fall and begin a fourth generation.

Little is known of the life history of the pine engraver in the Southwest. It probably completes three generations each year, similar to the *I. lecontei*, but could have two generations at high elevations and four generations in low elevation ponderosa pine stands. Its habits are similar to

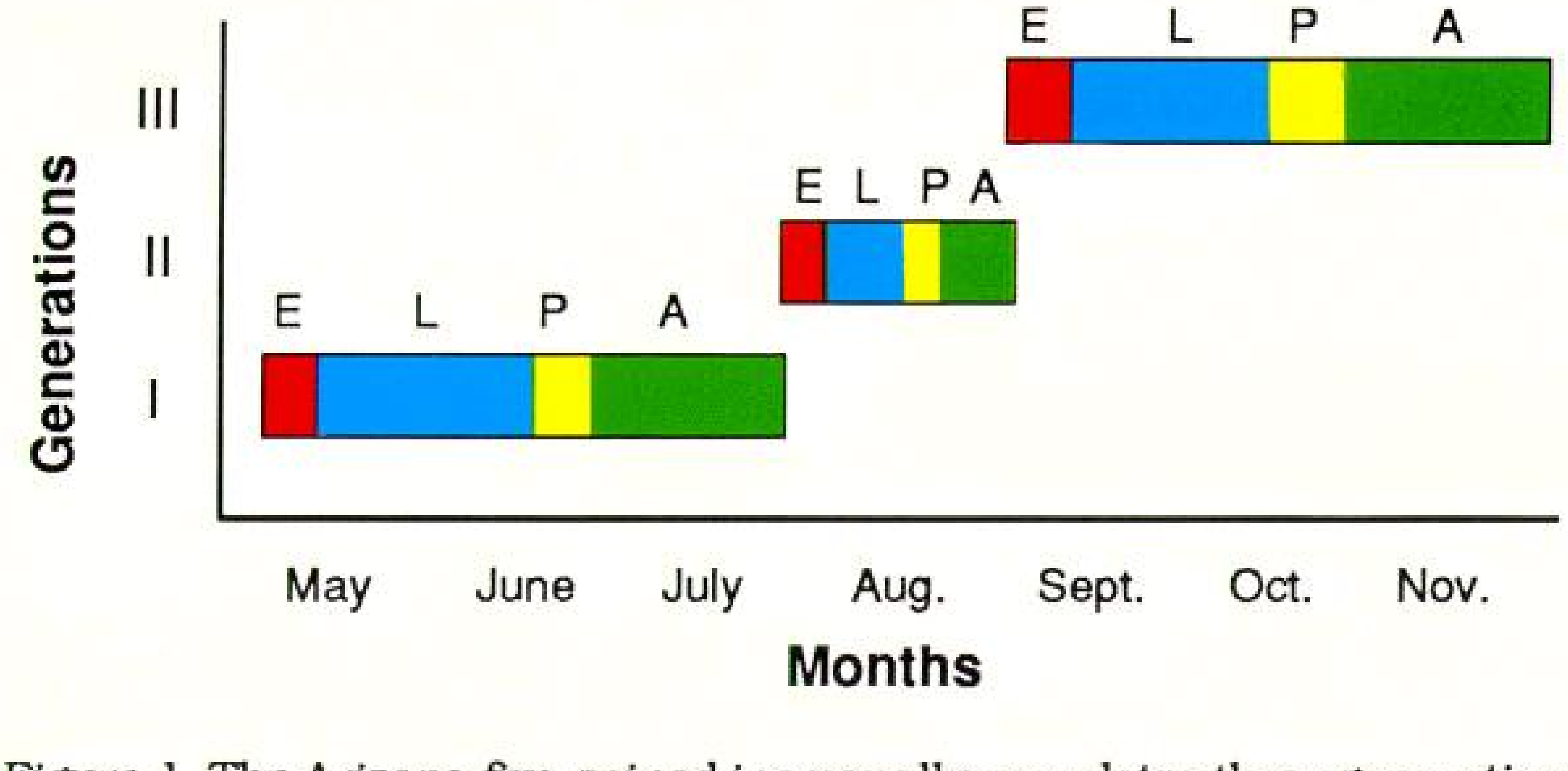


Figure 1. The Arizona five-spined ips usually completes three generations each year (Ostmark, 1966). For ease of understanding, this graph shows distinct periods for each generation, but generations actually overlap. Beetles go through four stages of development: egg (E), larva (L), pupa (P), and adult (A).

the Arizona five-spined ips, although this species is not as aggressive a tree killer. The pine engraver appears to be more common in the mid- to upper-elevational limits of ponderosa pine forests.

Drought, pathogens, wildfires, and severe weather that weaken and damage trees favor outbreaks; however, most outbreaks in the Southwest appear to be caused by slash or weakened trees created during forest management projects (Fig. 2). Typically, beetles attack green slash or weakened trees, a population buildup occurs, and beetles emerge from the slash to attack and kill live trees in or near management areas. The most damaging outbreaks occur when fresh slash and weakened trees are periodically present in an area for two or more years, permitting a massive beetle population buildup. When these conditions exist, and no additional fresh slash is available, beetles attack and kill live trees (Fig. 3). Live, healthy trees are not good habitat for beetle brood production; so, populations decline in the next generation. However, high population levels may continue if live trees are stressed by drought or other factors.

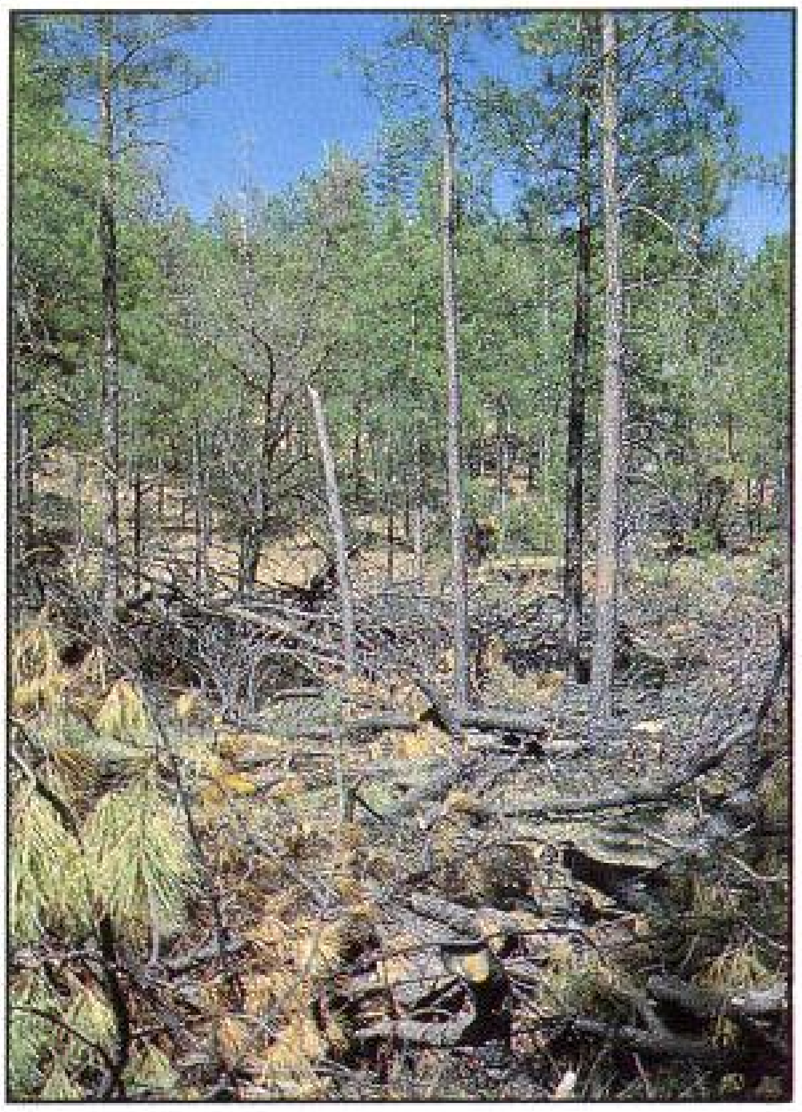


Figure 2. Ponderosa pine slash favors outbreaks.

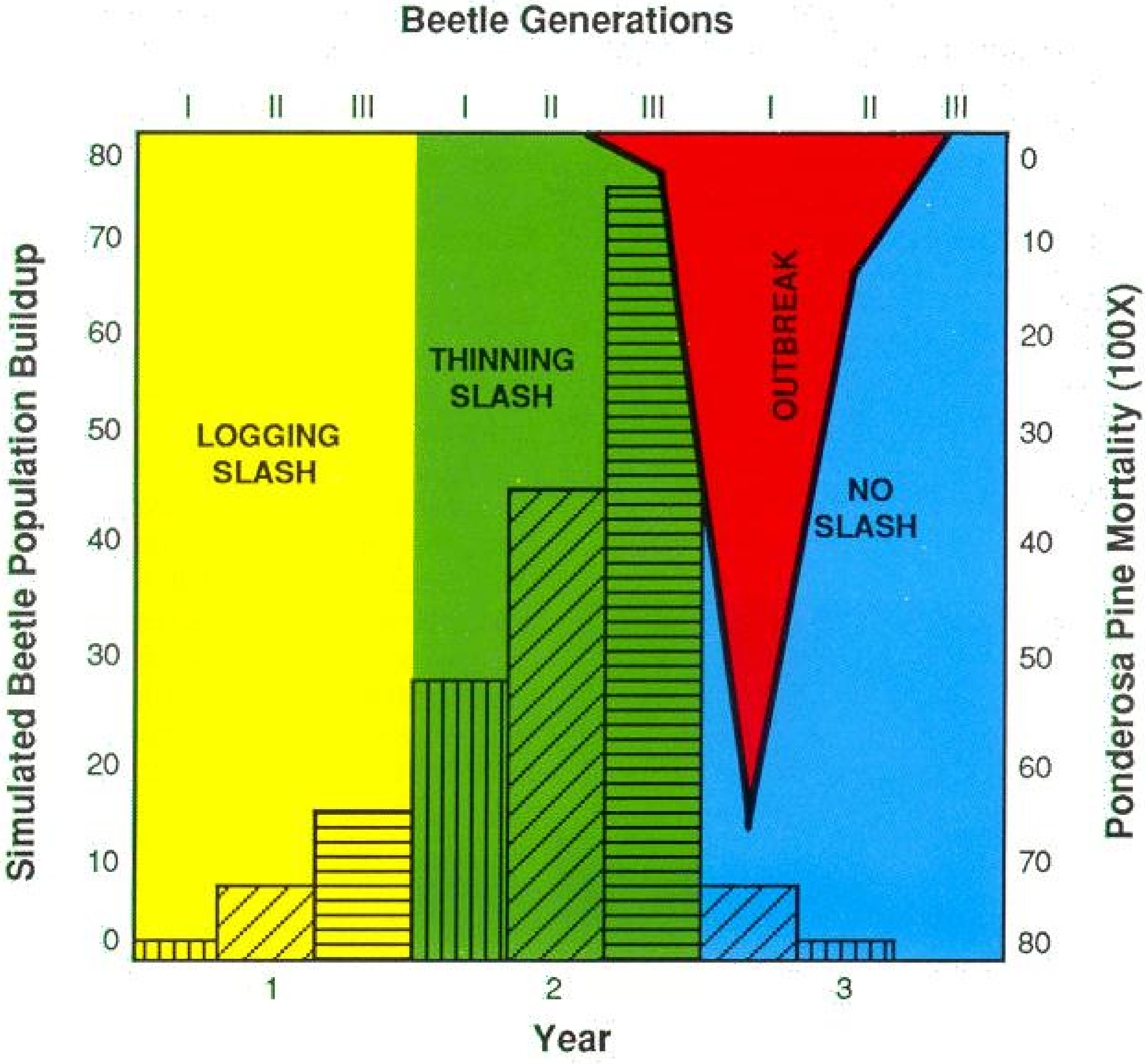


Figure 3. Simulated above is beetle population buildup over a 2-year period and the ensuing outbreak in live trees. Fresh ponderosa pine slash was continuously available in years 1 and 2, the beetle population increased to a high level at the end of the second year, a damaging outbreak occurred in year 3, and the beetle population collapsed after live trees were infested.

Evidences of Infestation

Boring Dust

When beetles bore through the outer bark and build galleries in the inner bark, they produce a fine-grained, tan to reddish brown dust. This dust, or frass, is pushed out through the entrance hole and collects in bark crevices and at the base of standing trees (Fig. 4). Rarely, small pitch tubes (globules of pitch) appear on the trunk of infested trees.

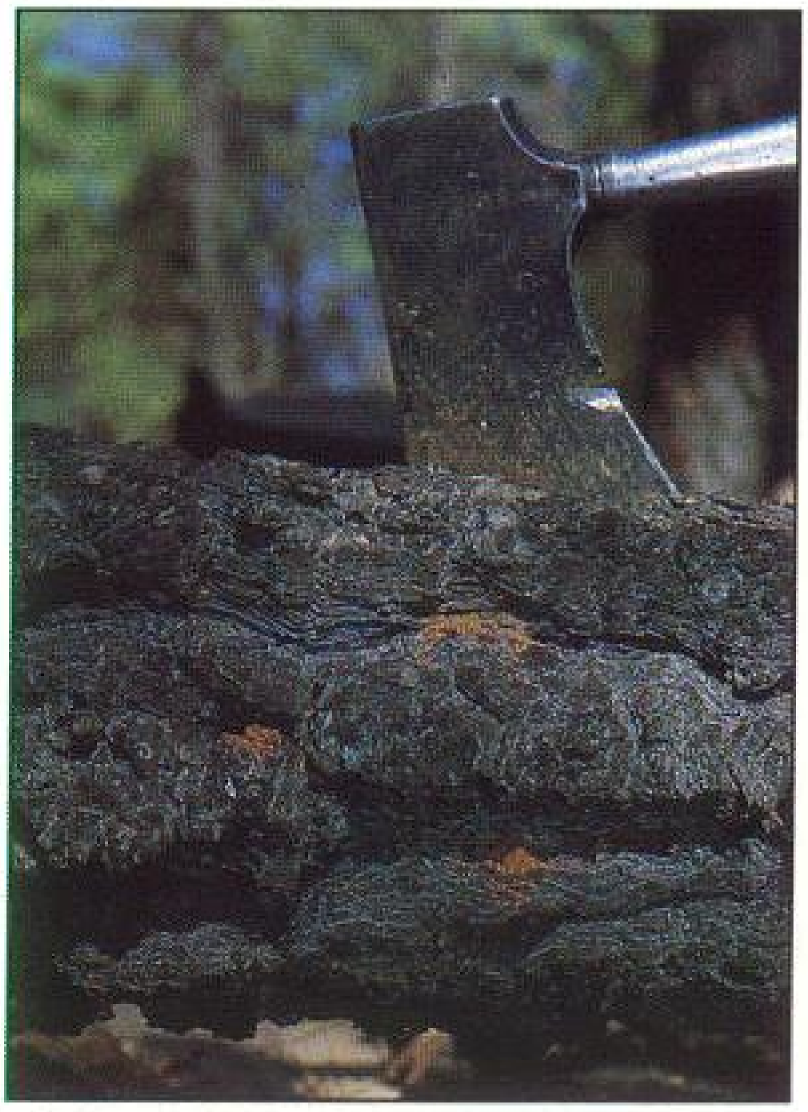


Figure 4. Boring dust produced by beetles on slash (top) and standing tree (bottom).

Gallery Pattern

Both of these bark beetles are polygamous species. One to five females can join each male, but three is most common (Massey and Parker 1981 and Livingston 1979). The male beetle bores through the outer bark, forms a nuptial chamber in the inner bark, and is joined by the females. Each fertilized female then constructs her own egg gallery leading from the nuptial chamber. With three females, the gallery has a characteristic Y-shaped pattern (Fig. 5).

Figure 5. A typical Arizona five-spined ips gallery pattern consists of three egg galleries in a y-shaped pattern radiating from a nuptial chamber.

Figure 6. *I. pine* (Say) mature larva (left), a pupa (center), and an adult (right).

Stages of the Insect

Ips beetles go through four life stages:

Eggs: Eggs are oval, glossy-white, and barely visible to the naked eye (0.5 mm to 1.0 mm long). They are laid in niches on each side of egg galleries.

Larvae: Larvae are white, legless grubs, with light-brown head capsules (Fig. 6). Larvae go through three instars (Ostmark 1966). Small larvae feed in groups for a short time after hatching, then feed individually, each making a separate tunnel as they develop into medium size and then large larvae. Mature larvae are about 6 mm long and they construct circular cells in the inner bark and transform into pupae.

Pupae: Pupae are white, about 5 mm long, and have many adult characteristics, such as antennae and wing covers. Pupae gradually darken as they change into adults (Fig. 6).

Adults: Beetles are light brown at first, but darken as they mature and eventually become black. *I. lecontei* adults are about a half centimeter long and have five small spines on each side of the declivity (cavity) on their posterior. *I. pini* adults are slightly smaller and have four spines on each side of the declivity.

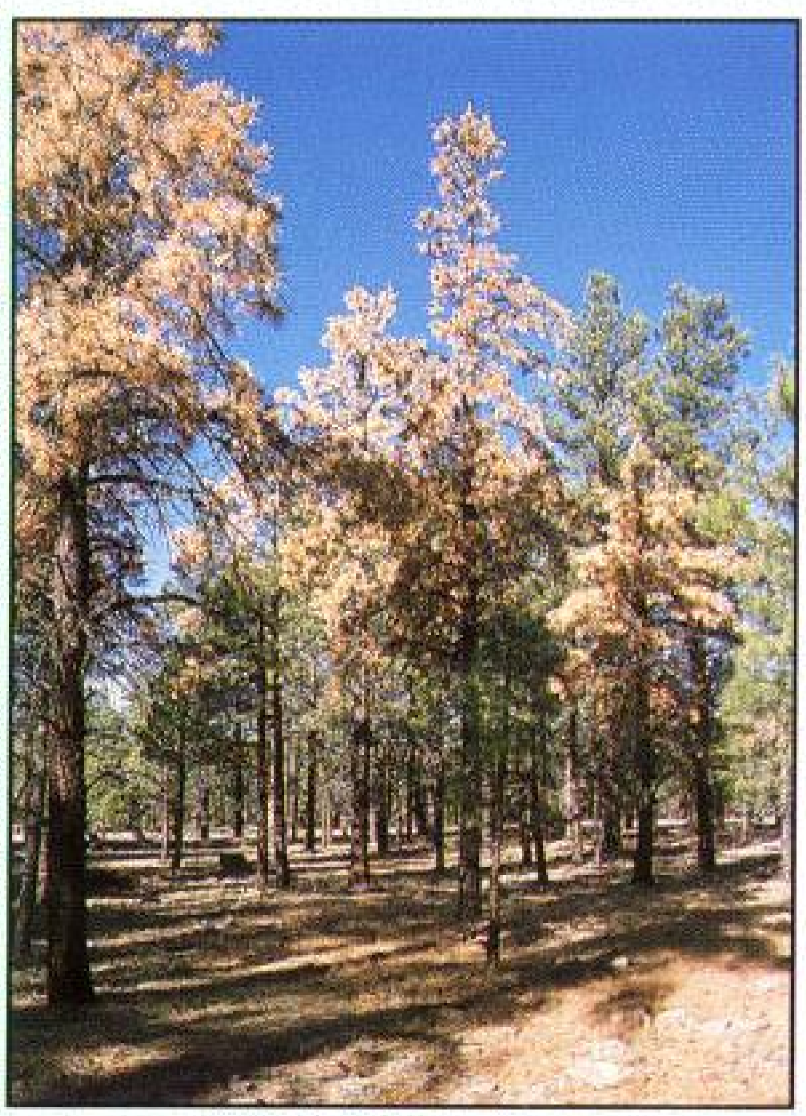


Figure 7. Faded trees killed by the Arizona five-spined ips.

Fading Trees

Within a month after trees have been attacked in the spring, needles in the upper crowns of trees turn a light straw color. Fading continues until all the foliage of the tree becomes yellowish brown (Fig. 7). Sometimes, only the upper portions of a tree are infested and killed (Fig. 8), but these trees usually die within one to two years as a result of

Figure 8. Tree top-killed by engraver beetles.

additional beetle attacks, introduction of blue-stain fungi that clog the water conducting tissue in trees, and invasion of other bark beetles and borers. Trees attacked in late summer or in the fall often do not fade until the following spring.

Effects of Infestation

The amount of tree-killing varies considerably during outbreaks. Sometimes, only a few groups of standing trees are attacked and killed, but populations of apparently similar proportions can kill thousands of trees on other occasions. Factors that influence the amount of tree-killing are not well understood, and most cannot be assessed, but severe outbreaks generally occur after beetle populations increase in slash for two or more years.

Results of a survey conducted on the San Carlos Indian Reservation in central Arizona show the level of tree mortality that can occur during a typical Arizona five-spined ips outbreak. The infestation occurred in an almost pure ponderosa pine forest where logging and thinning slash had been created for two years. The outbreak was first detected when forest workers noticed groups of pole-size trees fading from green to yellow. A few weeks later, 65 groups of dead trees were detected on about 7,000 acres, ranging in size from an estimated 30 to 300 trees.

The survey of 14 infestation centers within the outbreak area revealed that the Arizona five-spined ips seriously depleted stands in all infestation centers. Overall, 2,129 trees were killed on 12.1 acres (Table 1). The average loss was 176 trees per acre. Depletion of stands in sampled areas varied from 80 to 99 percent of all trees three inches in diameter at breast height (DBH) and larger, and the average loss was 91 percent. Seventy-nine percent of the dead trees were less than nine inches DBH (Table 2). Sawtimber trees were also killed by *I. lecontei* in association with other *Ips* species, and red turpentine beetle (*Dendroctonus valens* LeConte), and the western pine beetle (*Dendroctonus brevicomis* LeConte).

Few trees three inches in diameter and larger survived the beetle outbreak within infestation centers (Fig. 9). The number of live trees remaining averaged 17.4 trees per acre (Table 1). Tree survival averaged nine percent.

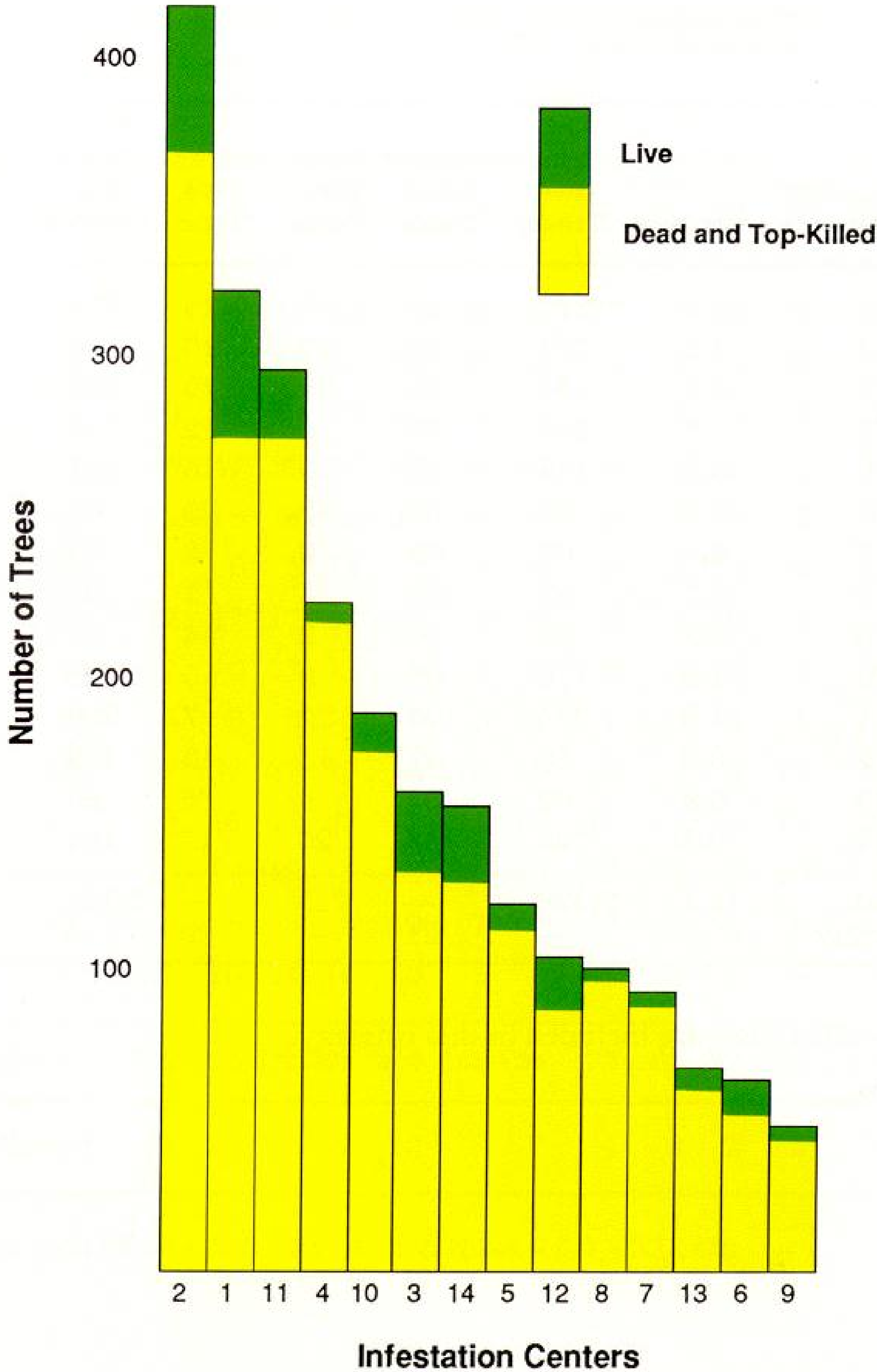


Figure 9. Number of live trees and dead and top-killed trees are shown for the 14 infestation centers sampled.

Table 1. Beetle-killed and live trees in 14 selected infestation centers, Arizona, 1978.

Infestation Center	Acreage	Total Dead Trees[1]	Percent Dead Trees	Total Live Trees	Percent Live Tree	Total Trees Per Center
1	2.9	274	85	47	15	321
2	1.5	374	90	40	10	414
3	0.3	134	85	24	15	158
4	0.8	219	98	4	2	223
5	0.2	115	95	6	5	121
6	0.2	52	80	13	20	65
7	0.4	90	98	2	2	92
8	0.7	97	99	1	1	98
9	0.2	45	96	2	4	47
10	1.9	176	95	9	5	185
11	1.5	274	93	22	7	296
12	0.3	89	87	13	13	102
13	0.9	62	94	4	6	66
14	0.3	128	83	26	17	154
Total	12.1	2,129	—	213	—	2,342
Average	—	—	91	—	9	—

[1] Top-killed trees are included in this category.

Table 2. Beetle-killed and top-killed trees by one inch diameter classes.

Infestation Center	Diameter[1] of Dead and Top-killed Trees											Total Trees
	3	4	5	6	7	8	9	10	11	12	13	
1	17	38	42	42	20	30	25	17	15	9	19	274
2	66	73	72	53	32	27	24	8	6	1	12	374
3	29	32	20	23	16	4	4	3	0	1	2	134
4	46	47	32	31	22	15	10	3	4	2	7	219
5	41	16	14	12	10	10	4	3	3	0	2	115
6	1	0	5	14	7	8	5	7	2	1	2	52
7	12	17	17	12	10	9	6	3	3	0	1	90
8	17	16	13	11	8	5	9	8	4	2	4	97
9	5	6	5	6	5	3	4	1	5	4	1	45
10	33	27	27	16	14	16	16	9	3	2	13	176
11	43	46	43	33	29	17	16	11	12	9	15	274
12	15	13	13	6	4	9	3	7	4	5	10	89
13	5	5	5	7	9	7	7	7	3	1	6	62
14	32	16	14	10	20	5	6	8	3	5	9	128
Total	362	352	322	276	206	165	139	95	67	42	103	2,129
Percent	17	16	15	13	10	8	7	4	3	2	5	100

[1] 3 inch class = 3.1 - 4.0; 4 inch class = 4.1 - 5.0; etc.

Integrated Pest Management

Beetle-caused tree losses can be substantially reduced through use of one or more prevention and suppression techniques. To be effective, forest managers must be familiar with all suitable techniques, consider their use when planning programs, and use them when appropriate. Prevention is the recommended approach because the techniques are more effective, economical, environmentally acceptable, and compatible with forest management methods. It is not always possible, however, to avoid conditions that favor outbreaks, whether they are natural or man-caused, and suppression occasionally must be considered. Suppression should be considered as a high-risk decision and implemented only as a last resort.

Prevention

The number and combination of prevention methods needed in a management area must be evaluated in relation to outbreak risk. At a minimum, slash should not be created for more than one year in ponderosa pine stands growing at the lower elevational range of the species on the Prescott, Coconino, Tonto, and Apache-Sitgreaves National Forests, San Carlos and Ft. Apache Indian Reservations, and nearby lands of State and private ownership, Arizona; and the Gila National Forest and nearby State and private lands in New Mexico. *I. lecontei* is an aggressive tree killer in these areas. Preventive techniques are especially recommended for use in areas where the potential for outbreaks appears to be high due to the prevalence of southwestern dwarf mistletoe, *Arceuthobium vaginatum* supsp. *cryptopodum* (Engelm.) Hawks. and Weins, a disease that weakens trees and favors beetle buildups. Strict prevention measures are needed in high elevation ponderosa pine stands in the northern portions of the Region subject to *I. pini* during droughty periods. Conversely, extra preventive efforts are not recommended in areas where trees are relatively vigorous or where outbreaks rarely occur. A brief discussion of prevention methods follows:

1. Utilization. Harvesting most ponderosa pine trees to a four inch (10.2 cm) top will prevent beetle population increases. Few beetles are produced in debris below four inches in diameter outside bark (DOB) because of the limited amount of food in the inner bark.

2. Timing of Management Programs. Beetle population increases can be minimized by cutting during specific seasons. Trees cut from July to December dry out during the fall and winter and are unfavorable for beetle habitat. The best time to cut trees is in mid to late summer because this permits trees to dry for as long as possible. Also, live trees may be less susceptible during this period. Inner bark of green trees cut from January to May usually remains moist and enhances beetle population increases.

3. Avoiding Programs that Create Slash for More than One Year. The chances of causing an outbreak can be greatly reduced by avoiding the practice of creating slash and weakening trees in a management unit for more than a year. A beetle population will remain relatively low if projects are conducted every other year. A buffer of over two miles between management areas appears to prevent mass movement of beetles from one area to another, although data are unavailable to support this assumption.

4. Slash Disposal. Means of destroying green slash — burning, chipping, burying, etc. — will reduce potential of a beetle buildup.

5. Residual Insecticide Sprays. Valuable trees at recreation and residential sites can be treated with a protective residual spray. Susceptible trees can be protected by treating the trunk and large branches with a two-percent carbaryl (Sevin) suspension. Attacking beetles will be killed as they try to chew through the treated bark. However, once beetles have already entered a tree it is too late to try a preventive spray. Since new, improved insecticides and treatment techniques may be developed, it is always wise to consult a forest pest management specialist before planning a preventive spray project.

Suppression

Beetle populations can be suppressed if infested slash is treated before beetles emerge and attack live trees. The decision to conduct a costly suppression program is risky because there is no reliable way to determine if beetles will attack live trees in a management unit, fly elsewhere to attack trees, or decline without killing any trees. Also, infestations in slash must be found just after initial attack to allow time to complete administrative procedures needed for funding and to carry out treatment. Too often, infestations go undetected by forest workers until live trees begin to fade. Once this occurs, it is too late to limit tree losses. Forest workers must know how to detect an infestation and promptly report new outbreaks. Surveillance work sheets and kits can be used to report outbreaks, but a direct request for assistance is also appropriate. Methods of suppression follow:

1. Covering Infested Slash with Clear Plastic. Beetle broods in infested slash (four inches DOB and larger) can be killed by piling bolts in forest openings, covering piles with clear plastic, and securely anchoring the plastic to the ground (Fig. 10). The plastic covering functions like a greenhouse and temperatures reach a level high enough to kill beetle broods (Buffam and Lucht 1968). This approach should not be used if beetles have emerged.

2. Slash Disposal. Burning, chipping, debarking, or burying infested slash will kill beetle broods.

3. Removal of Infested Slash. Infested slash can be removed two or more miles from ponderosa pine forests to prevent the loss of valuable trees because of emerging beetles. The public should not be encouraged to collect infested slash for firewood. Valuable ornamental trees can be killed by beetles emerging from slash.

4. Use of Insecticides. Lindane products are registered for bark beetle suppression. Suppression can be achieved by applying the insecticide to infested slash (four inches DOB and larger).

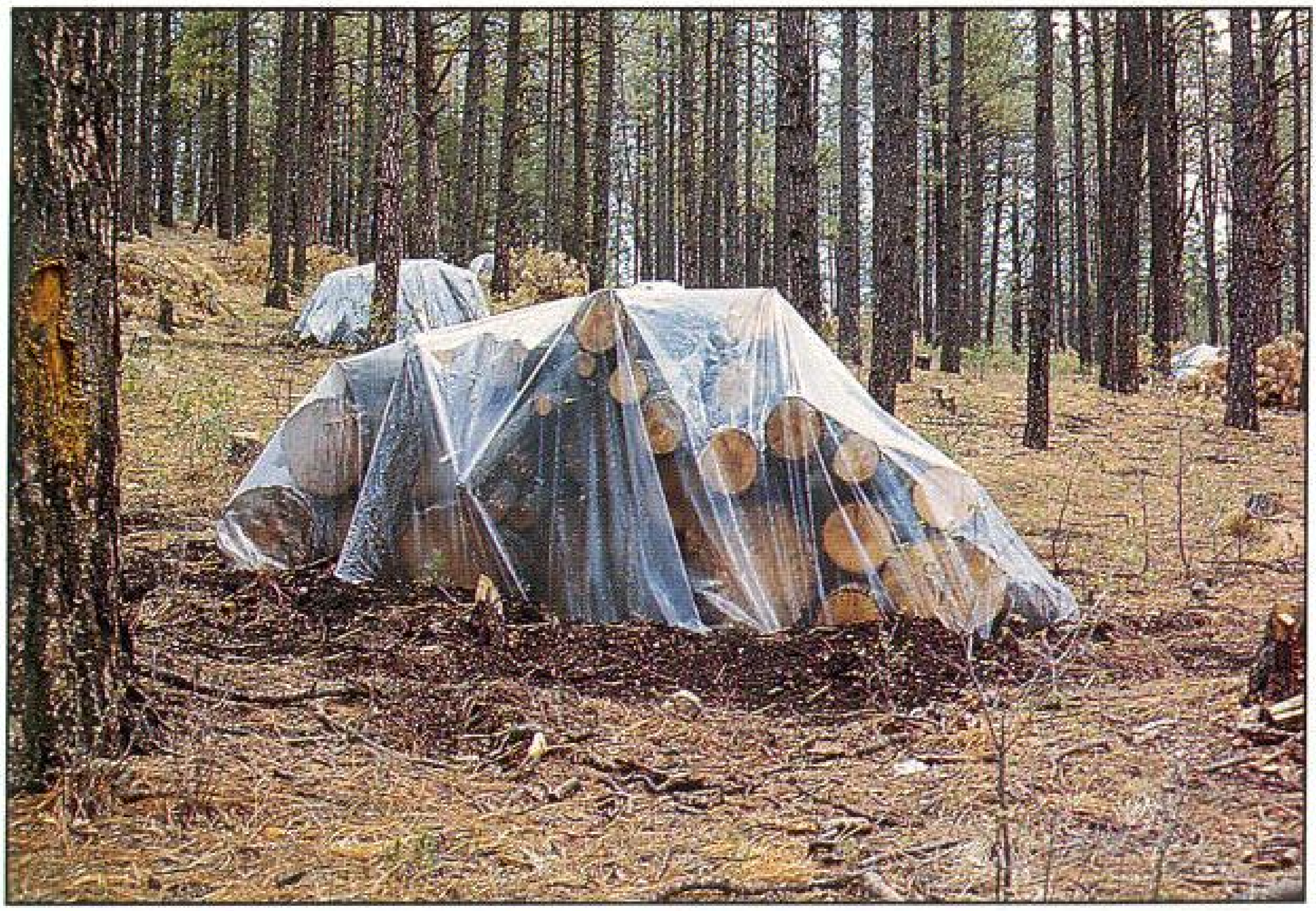


Figure 10. Covering slash with clear plastic will kill beetle broods.

Summary

To reduce tree losses caused by *Ips* beetles, close coordination between the forest manager and pest management specialists is essential. Forest managers must realize that outbreaks can significantly affect immediate and long-term forest management objectives and take the necessary steps to prevent tree losses. The pest management specialist's role is to advise the forest manager. The forest manager uses this information, in addition to inputs from other specialists, to determine management programs and directions. Forest pest management assistance can be obtained from the following organizations:

Federal and Indian Lands

Arizona

USDA Forest Service
Forest Pest Management
2323 E. Greenlaw Lane
Flagstaff, AZ 86004
Telephone: (602) 556-7357
FTS: 765-7357

New Mexico

USDA Forest Service
Forest Pest Management
517 Gold Avenue, SW
Albuquerque, NM 87102
Telephone: (505) 842-3190
FTS: 476-3190

State and Private Lands

Arizona

Arizona State Land Department
Division of Forestry
1616 West Adams, Rm. 100
Phoenix, AZ 85007
Telephone: (602) 542-2517

New Mexico

NMSU Extension Forest
Entomologist
EMNRD Forestry Division
P.O. Box 1948
Santa Fe, NM 87504
Telephone: (505) 827-5833

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