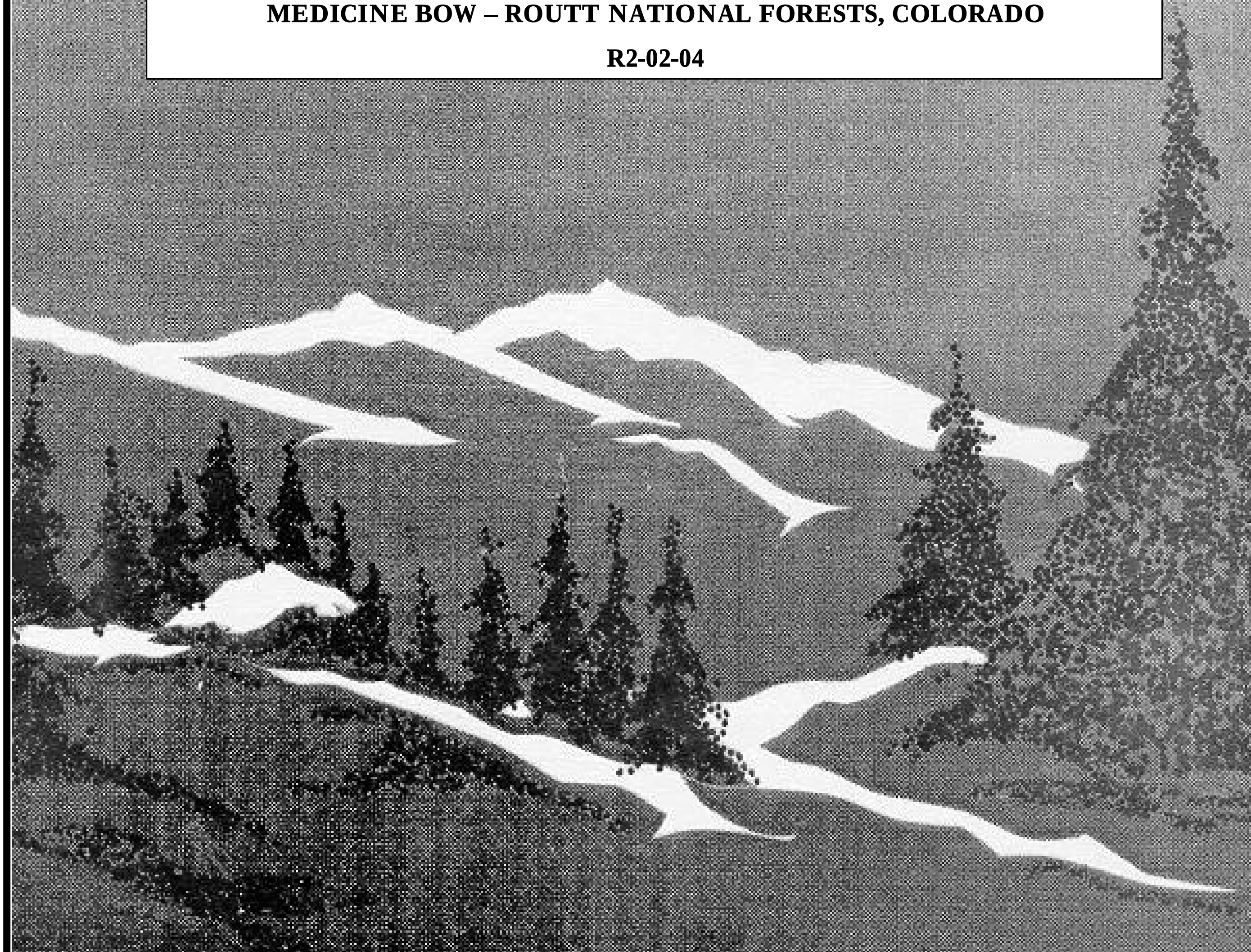
Forest Health Management

BARK BEETLE EVALUATION – 2000 and 2001

HAHNS PEAK/BEARS EARS and PARKS RANGER DISTRICTS,

MEDICINE BOW – ROUTT NATIONAL FORESTS, COLORADO

R2-02-04



USDA United States Department of Agriculture

Renewable Resources
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Forest Service
Rocky Mountain Region
Denver, Colorado

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Biological Evaluation R2-02-04

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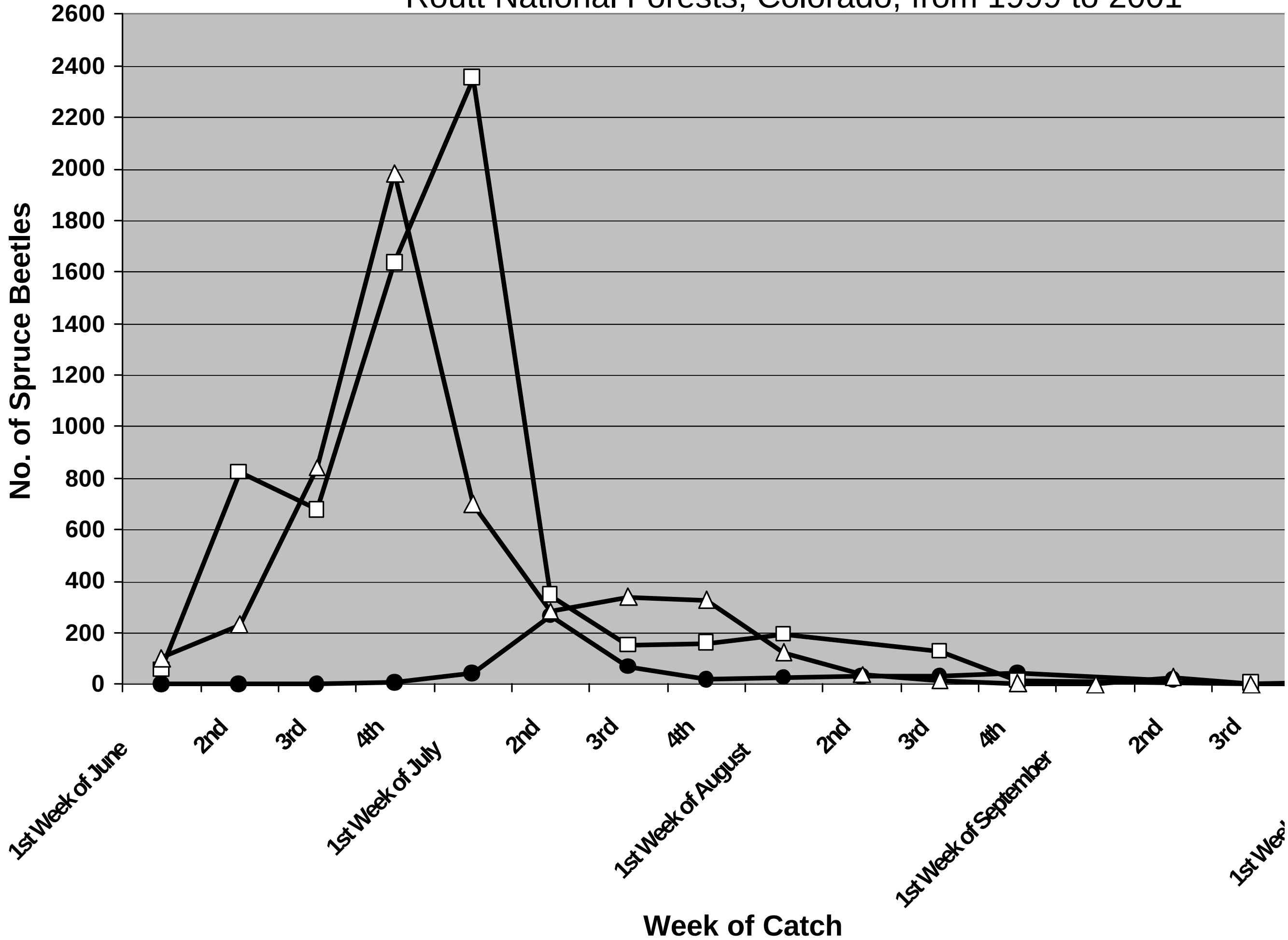

Figure 1. Combined weekly spruce beetle captures in 16-funnel Lindgren ph traps placed two per location at 9 (in 1999) or 10 locations on the Medicin Routt National Forests, Colorado, from 1999 to 2001

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SUMMARY

This is the third in a series of biological evaluations necessitated by a 1997 windstorm on the Medicine Bow - Routt National Forest and surrounding areas in southern Wyoming and northern Colorado. The October 1997 windstorm is known as the Routt Divide Blowdown. The mapped portion of the Routt Divide Blowdown is approximately 13,000 acres, although the total extent of windthrow is larger. Most of this blowdown occurred on the Hahns Peak/Bears Ears Ranger District in the spruce/fir forest. Previous biological evaluations covered conditions in 1998 (Schaupp et al. 1999) and in 1999 (Schaupp and Frank 2000). This biological evaluation covers the conditions in 2000 and 2001.

Survey and monitoring of bark beetle activity on the two Ranger Districts has occurred each year since the Routt Divide Blowdown and was continued in 2000 and 2001. Survey and monitoring techniques include aerial survey, pheromone trapping, extent surveys, brood sampling, and general reconnaissance.

The spruce beetle situation has changed significantly the past two years. In 2000 and 2001, spruce beetle populations relocated from blowdown into standing green trees. This has resulted in a large amount of spruce mortality at far higher levels than those observed since at least 1994. Small areas of standing spruce mortality increased in size and intensity, growing into small outbreaks. Localized spruce beetle outbreaks grew significantly as well. The magnitude of spruce beetle population increase within windthrow was greater than expected, as measured by the huge increase in killed trees once the spruce beetles moved from windthrow into standing trees. These spruce beetle outbreaks in standing trees are numerous and have been detected in many areas on the Hahns/Peak Bears Ears Ranger District and in several areas on the Parks Ranger District. Outbreaks range in size from groups of infested trees within a stand to entire stands containing thousands or possibly tens of thousands of infested trees.

A large-scale spruce beetle outbreak has begun in the analysis area because two necessary conditions have been met --- susceptible forest conditions and lots of spruce beetles. The triggering event that has allowed spruce beetle populations to enlarge and take advantage of this susceptible condition was the Routt Divide Blowdown. Continued windthrow and the presence of diseased and damaged trees provide additional host material for spruce beetle populations to increase.

Based on what we know about spruce beetle, the scale of the current outbreak could cover one or more mountain ranges and result in widespread and intense spruce mortality and associated impacts. Large spruce beetle outbreaks are ongoing in Utah and Wyoming and spruce beetle populations are rising in many areas on the central and southern western slope of Colorado. Vast portions of the central Rocky Mountains are characterized by forest conditions that are susceptible to spruce beetle outbreaks.

An assessment of the mountain pine beetle situation has been incorporated into this biological evaluation. Mountain pine beetle populations are currently at moderate to low levels within the analysis area. Suppression of the MPB population on the Steamboat Springs Ski Area has been successful so far and continues. However, adjacent to the analysis area, increasing mountain pine beetle populations are causing significant pine mortality. Many locations within the analysis area are susceptible to mortality from mountain pine beetle. It is only a matter of time before these areas are affected.

Management efforts can locally mitigate bark beetle impacts to varying degrees, but stopping landscape-level bark beetle epidemics once they have begun is almost impossible. Small outbreaks can be controlled if proper suppression and prevention activities are initiated before these epidemics reach multi-stand proportions.

Preparation of an environmental impact statement is near completion and suppression actions are well underway. The recommendations from the first and second biological evaluations (Schaupp et al. 1999, Schaupp and Frank 2000) have been implemented. This evaluation describes action alternatives to mitigate increasing spruce and mountain pine beetle impacts and makes additional recommendations based on conditions and progress to date.

ACKNOWLEDGMENTS

Thanks and praise are due the many employees from the Hahns Peak/Bears Ears Ranger District on Routt National Forest, the Forest Health Management group, and the Steamboat Ski and Resort Corporation who worked on this project, whether in the forest or the office. This continues to be a collaborative effort involving many people. Special commendation is made to Lee Pederson, former Biological Technician at the Lakewood Service Center. Efforts by members and associates of the Bark Beetle Information Task Force to "spread the word" are not only greatly appreciated, but are an important part of what needs to be done.

INTRODUCTION

Several major episodes of windthrow on the Medicine Bow - Routt National Forests in 1996 and 1997 have resulted in an unusually large acreage of blowdown, predominantly in the spruce/fir forest cover type. On October 25, 1997, winds estimated to be in excess of 120 miles per hour uprooted a large number of trees on the Medicine Bow - Routt National Forests. Approximately 13,000 acres of blowdown have been mapped in Colorado, primarily on the west side of the Continental Divide. This wind event was named the Routt Divide Blowdown. The extent of the blowdown was presented by Schaupp et al. (1999). Additional blowdown has been documented on other National Forests and other lands in Colorado and southern Wyoming in 1998 and 1999, primarily on the Gore, Snowy and Sierra Madre mountain ranges. The total acreage affected is larger than that which has been mapped. Each year since 1997, relatively small amounts of additional windthrow have occurred in these mountains, although to a much reduced extent.

This biological evaluation is the third in a series covering the third and fourth years following the Routt Divide Blowdown. The population increase of the spruce beetle, *Dendroctonus rufipennis* [Kirby] (Order Coleoptera; Family Scolytidae), was described by Schaupp and Frank (2000). The area potentially affected by growth and continued expansion of current spruce beetle populations includes several major drainages and mountain ranges of southern Wyoming and Colorado.

This biological evaluation discusses spruce beetle and mountain pine beetle, *Dendroctonus ponderosae* Hopkins (Order Coleoptera; Family Scolytidae), populations on the Gore and Parks mountain ranges. Most of the affected land is publicly owned and is administered by the Hahns Peak/Bears Ears and Parks Ranger Districts, Medicine Bow - Routt National Forests. This evaluation concerns lands included in the analysis area of the Bark Beetle Analysis Draft Environmental Impact Statement (DEIS), Medicine Bow - Routt National Forests, Hahns Peak/Bears Ears Ranger District, Routt County, Colorado (USDAFS 2001).

This extensive blowdown has triggered a rapid population increase of spruce beetle in fallen spruce trees. There was considerable risk that beetles emerging from windthrown spruce would infest standing, healthy spruce once the windthrown trees became unsuitable for colonization. Spruce beetle populations have moved from blowdown to infest standing trees.

In addition, mountain pine beetle populations are in outbreak status in several areas adjacent to the assessment area. Mountain pine beetle populations are rising within the assessment area.

The focus of this Biological Evaluation is fourfold, as follows:

1. Describe the current status of ongoing bark beetle epidemics within the evaluation area. This includes both the spruce beetle and the mountain pine beetle.
2. Discuss the susceptibility of forested stands for continued infestation by these bark beetles and describe the potential for growth or decline of beetle populations and associated tree mortality.
3. Describe the actions taken to mitigate the effects of the bark beetles and discuss the effectiveness of these actions.
4. Make recommendations for future treatments.

THE SPRUCE BEETLE

The spruce beetle is the principal natural agent that can create landscape level disturbances in the spruce forests of western North America (Holsten et al. 1999). Sporadic spruce beetle outbreaks have killed extensive areas in parts of western North America, including Alaska, western Canada, Colorado, Idaho, Montana, and Utah (Holsten et al. 1999). Such outbreaks commonly develop in windthrown timber. Spruce beetle populations can increase dramatically within windthrow, from which they emerge to attack and kill standing, living spruce. Like fire and wind, the spruce beetle is a natural, though destructive, means for recycling old forests and for making way for new forests (Furniss and Carolin 1977).

The spruce beetle is the principal forest insect of concern in the blowdown areas. Normally, this native beetle is present in small numbers in weakened, diseased or wind thrown spruce, large pieces of logging slash, and fresh stumps. Individual or small, scattered groups of standing trees may be killed, creating snags and gaps in the forest canopy. Natural enemies, weather, competition, host tree resistance and other factors combine to keep beetle populations at low levels, but disturbances in susceptible spruce/fir stands can trigger the development of spruce beetle outbreaks.

Stand conditions are highly susceptible to spruce beetle outbreaks when the following conditions exist: basal area > 150 square feet per acre; average diameter at breast height > 16 inches for all live spruce; proportion of spruce in the canopy > 65%; and physiographic location in a well-drained site in a creek bottom (Schmid and Frye 1976)

THE MOUNTAIN PINE BEETLE

The mountain pine beetle (MPB) is a bark beetle species that has many similarities with the co-generic spruce beetle --- it is a native species that feeds on the inner bark of mature coniferous trees, often killing them. Natural enemies, weather, competition, host tree resistance and other factors combine to keep beetle populations at low levels such that tree mortality is usually barely evident. Relative population size naturally fluctuates between two modes, called low or "endemic" and outbreak or "epidemic"; outbreak populations periodically arise, causing widespread and intense tree mortality that alters the forest ecosystem (Amman et al. 1989).

Outbreaks of MPB frequently develop in lodgepole pine stands that contain well-distributed, large diameter trees (Amman et al. 1989). Highly susceptible stands of lodgepole pine are those with the following characteristics: average diameter at breast height > 8 inches; average age > 80 years; and a suitable climate for beetle development based on a low elevation-latitude combination (Amman et al. 1977; Schmid and Amman 1992 and references therein), roughly meaning elevations at or below 8,500 feet in Colorado.

Unlike the spruce beetle, MPB population outbreaks are not triggered by obvious disturbances such as windthrow. The development of outbreak populations of MPB is not well understood. Suffice to say that as stand susceptibility to MPB increases with time, the effectiveness of natural control decreases and outbreaks develop (Furniss and Carolin 1977). MPB outbreaks are more frequent for a given stand and area, as compared with spruce beetle. This reflects the differing characteristics of their host tree species, such as successional status and longevity. The mountain pine beetle ranks first in destructiveness among the bark beetles of the West (Furniss and Carolin 1977).

THE CONTEXT OF THE BARK BEETLE SITUATION

The word "*Dendroctonus*" translates from Latin as "tree killer". Like nearly all species in the genus *Dendroctonus*, the spruce and mountain pine beetle infests and kills mature trees. As our western forests grow older and increasingly show the effects of fire suppression and other forest management practices subsequent to Euro-American colonization, larger and more contiguous landscapes in the Rocky Mountain area have become simultaneously susceptible to bark beetle outbreaks (Samman and Logan 2000). Susceptible forests await only a trigger creating many beetles under favorable weather conditions before a bark beetle outbreak develops.

There have been a number of blowdown events in Colorado and Wyoming in the past few years. Recent history of spruce beetle outbreaks and their relationship to windthrow was discussed in a prior evaluation in this series (Schaupp and Frank 2000). And this history did not include two current and large spruce beetle outbreaks in the northern Shoshone National Forest, which extends into the Northern and Intermountain Regions, and in northern Bighorn National Forest (Johnson 2001).

These recent spruce beetle episodes underscore the fact that much of the spruce/fir forest in the Rocky Mountain Region is mature to very old (USDA Forest Service 1987). The susceptible mature forest areas, not all directly associated with the blowdown areas, are increasingly vulnerable to a disturbance. As time passes since the last large-scale disturbance event in the spruce/fir forest, it becomes increasingly near to the moment when a new disturbance will recycle the old forest to a young forest.

The context of each recent blowdown event in Colorado and Wyoming is that they are occurring at a time and in places when and where many areas are susceptible to large-scale spruce beetle outbreaks (Map 1). For Map 1, stand susceptibility was interpolated from remotely acquired GAP data (Scott et al. 1993) that does not include the specific variables listed above in connections with highly susceptible stands (Schmid and Frye 1976). Using surrogate variables, stand susceptibility was based upon the following conditions: cover type of spruce/fir; large or very large tree size class; and canopy cover percentage greater than zero. This is presented to indicate both where outbreak populations of spruce beetle may develop and, once developed, where such population would thrive should they disperse. The Medicine Bow - Routt National Forests staff have conducted a more detailed analysis at a smaller scale using both calculated and interpolated susceptibility ratings for both spruce beetle and mountain pine beetle to assist in predicting the potential extent of future bark beetle activity. Even though central and southern Colorado is not depicted, Map 1 shows that the area potentially affected by spruce beetle is quite large.

Spruce beetle-caused disturbances triggered by blowdown since 1997 in northern Colorado and southern Wyoming will likely result in the regeneration of mature forests into younger-aged forests. These beetle-caused disturbances may shift tree species composition, depending on the extent and intensity of mortality. Many other impacts result from large tree-killing bark beetle outbreaks in addition to the creation of large numbers of dead trees in a short time span (Schmid and Amman 1992).

Similarly, widespread tree mortality resulting from MPB outbreaks has many impacts in addition to the creation of large numbers of dead trees in a short time span (Schmid and Amman 1992). Similar to the situation with spruce beetle, a large amount of land in the analysis area and generally across Colorado and Wyoming has lodgepole pine stands that are moderately to highly susceptible to MPB.

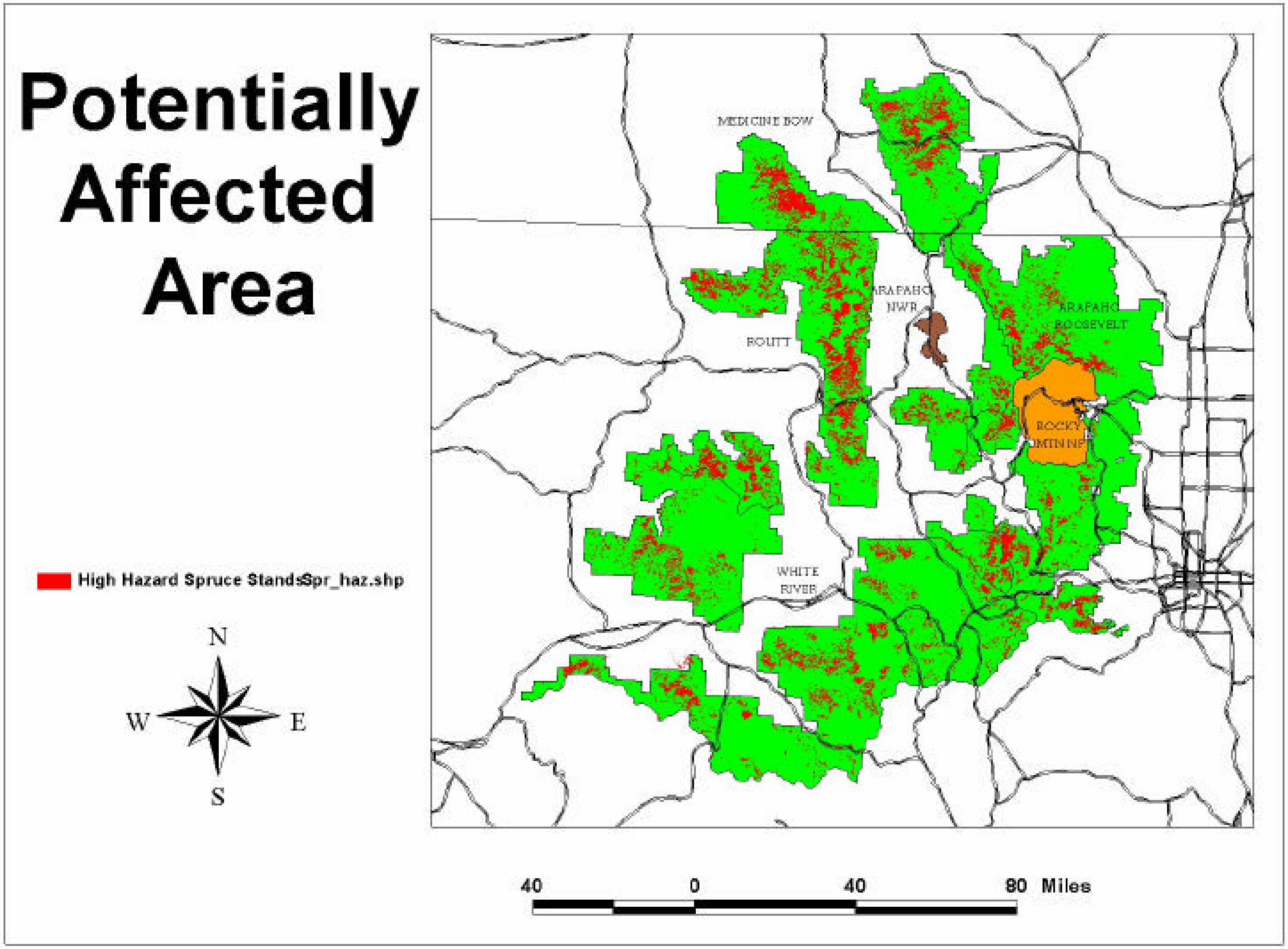
Age by area distribution of lodgepole pine stands across the Rocky Mountain Region and in the Medicine Bow - Routt National Forests is heavily skewed towards ages in excess of 80 years (USDA Forest Service 1987). Most of these stands have average diameters in excess of 8 inches and many are in suitable climatic areas for MPB outbreaks. It is not surprising that the total number of pines killed by MPB in Colorado has about doubled each year since 1995 and continues to increase (Johnson 2002). Large MPB outbreaks are in progress near the analysis area of this biological evaluation, including lodgepole pine in southern North Park, and the southern Rabbit Ears Range of Colorado, the edges of the upper Platte River Valley in Wyoming south of Encampment, and the Independence Mountain area along the Colorado-Wyoming border in northern North Park. The context of current widespread susceptibility and recent MPB behavior is that there is a lot of pine forest that is becoming more extensively and intensely affected by outbreaks. While not yet occurring within the analysis area, it is a matter of when, not if, large MPB outbreaks will take place there.

THE PURPOSE AND SCOPE OF MONITORING AND EVALUATION ACTIONS

All of the monitoring and evaluation actions by Forest Health Management (FHM) attempt to determine bark beetle population locations and trends in the analysis area. This requires sampling portions of the resident beetle populations and inventorying spruce/fir and pine stands for beetle activity. When sampling, the need for accurate, intensive information about any one area may conflict with the need for approximate, extensive information about many areas. The timely allocation of finite resources and sampling effort must strike a balance between these needs. Fortunately, there are sampling plans and protocols for spruce and mountain pine beetles that have been developed by the research community. However, few such protocols and plans have been statistically validated in the field following their development, and some such protocols and plans are too intensive or time-consuming to use over large areas.

For this evaluation, the size of the affected area is too vast to sample with significant precision such that statistically valid inferences are possible with high levels of confidence. This conflict of needs --- precision versus extent --- is not unique to the Routt Divide Blowdown situation and is applicable to the other blowdown areas.

Map 1. Location of spruce/fir forest susceptible to spruce beetle-caused mortality in southern Wyoming and northern Colorado



In most instances, we need to know a little bit about a lot of places and in a few instances, we need to know a lot about a few places --- this is a balancing act, choosing which type of information over what area is needed and using the best methods to obtain the needed information. The FHM group has learned that sufficiently accurate information and predictions can be made by following established protocols and by using sampling plans that strike a balance between these conflicting needs. The purpose of the evaluation is to give the land manager the best possible information covering the largest possible area as soon as possible. This document provides necessary information, in an evaluation rather than as a research study, to serve as a basis for decisions.

METHODS

MONITORING ACTIONS

Several actions have been taken by FHM to monitor and evaluate spruce and mountain pine beetle populations on these Ranger Districts. These actions include the following: aerial survey to detect recent tree mortality and blowdown; deploying spruce beetle pheromone traps to monitor spruce beetle flight; conducting general reconnaissance and an "extent survey" to determine the spatial distribution of bark beetle-attacked trees across blowdown and on land important to recreation and timber production; and conducting spruce beetle brood sampling to determine the density and predominant life stages of spruce beetle present in select areas.

Additional details and background information regarding methods are available in two prior biological evaluations prepared by Schaupp et al. (1999) and Schaupp and Frank (2000).

AERIAL SURVEY

Aerial surveys were conducted from fixed wing, single engine aircraft flying at about 1,500 feet above the ground at approximately 100 miles per hour in 2000 and 2001. Missions were flown during the "biological window" for bark beetles, the time of year that conifer foliage that is fading as a result of bark beetle colonization can best be detected. When the observer(s) detected recent tree mortality, the number of dead trees and probable cause(s) of death were coded and the affected area sketched onto 1:100,000 scale US Geological Survey 30 X 60 minute maps. Similarly, new windthrow areas were detected and estimated as polygons sketched onto the maps. Note that foliage on pines and spruces fades the summer following initial beetle colonization. Additional changes on spruces may be detected the second summer following colonization.

Erik Johnson (Aerial Survey Program Manager, FHM), assisted by Willis C. Schaupp, Jr. and Lee Pederson, surveyed the entire Routt National Forest and environs, including the Gore and Park Range(s), the Medicine Bow Mountains, and the northern portion of the Flat Tops, late July 2000 and 2001. They also conducted an aerial survey of the Sierra Madre and Medicine Bow mountain ranges, including the Medicine Bow National Forest and environs, in mid July 2000 and 2001.

Aerial survey provides general detection information quickly over an extensive area at low cost. It provides trend and approximate location information, which is intended to induce site visits on the ground in areas of concern.

PHEROMONE TRAPPING

The spruce beetle flight period was monitored using 16-funnel Lindgren traps baited with a chemical attractant, which was a commercially available two-component synthetic version of the spruce beetle aggregation pheromone. Deployment was accomplished according to the technical bulletins and advice provided by the manufacturer of both the traps and chemical lures.

Two traps were placed at each of 12 locations within the analysis area. The Mad Creek location was discontinued after two years. Although a few beetles were caught there, that location is too distant from sizeable areas of spruce/fir cover type to be worth the effort. The Iron Lopez Timber Sale pheromone trap location was added in 2000 and continued in 2001, in response to the recommendation that areas of timber harvest or salvage be monitored with traps (Schaupp et al. 1999).

In 2000, traps were deployed during May and June, snow and mud permitting. In 2001, all traps with lures were placed in the field by the end of April using snowmobiles and snowshoes. For both years, traps were checked weekly from late May through mid-August, thereafter checked every two weeks. The traps were checked for the last time on October 24, 2000, and the week of October 19, 2001.

Trap capture data establish the presence of attacking spruce beetles in an area and identifies the timing of such attacks.

GENERAL RECONNAISSANCE

Given the large analysis area to be covered, as much field information as possible was needed to determine where bark beetle activity was occurring. This was particularly important for spruce beetle populations, which were expected to move out of the blowdown as it dried-out and begin to attack standing trees in 2000 and 2001.

In order to maximize reporting from as much of the analysis area as possible, the entire staff of the Medicine Bow – Routt National Forests was invited to participate in general reconnaissance in 2000 and 2001. Each year, training was made available to all permanent and temporary staff engaged in field activity. Specific data forms were developed to allow reporting of bark beetles activity. A "beetle kit" was widely distributed, containing identification and collection information and materials that allowed anyone to report field information on bark beetle activity. Submission of the forms was voluntary, but strongly encouraged.

EXTENT SURVEY

Establishing the presence or absence of beetle populations across an area while estimating their general activity level was accomplished through extent surveys. Extent surveys were done for spruce beetle in both wind thrown and standing spruces and for mountain pine beetle in standing pines. The surveys were conducted from June through November, although most of the work was completed in August and September. FHM and Medicine Bow-Routt National Forests staff conducted the extent surveys. The Medicine Bow-Routt National Forests staff was trained during 2000 and 2001 by FHM staff to help accomplish these surveys. Data were recorded on sheets specifically designed for the project.

Surveying Spruce Blowdown

Results from 1998 and 1999 showed that spruce beetle populations were found within windthrow at most survey locations following the Routt Divide Blowdown (Schaupp et al. 1999; Schaupp and Frank 2000). By 2000, much of the Routt Divide Blowdown had become too dry to attract and support new generations of spruce beetles. Therefore, extent survey of blowdown was not conducted in 2000 and 2001. Surveyors were alert to the presence of fresh blowdown and reported it. Survey activity was redirected to standing spruce trees.

Surveying Spruce/Fir and Lodgepole Pine Stands

Surveying consisted of "gridding" through the stands and looking for boring dust or woodpecker activity that would indicate the presence of spruce or mountain pine beetles. If a tree was suspected of being infested with spruce beetles, the surveyor would chop into the stem of the tree with a hatchet to examine the phloem or inner bark for beetle presence. Beetle presence was indicated by finding spruce beetle eggs, larvae, pupae or adults. The data recorded were the tree species, DBH (diameter at breast height), any spruce beetle life stages, pitch tubes presence, presence of boring dust, needle condition, infestation level, and colonization status. Needle condition was recorded as green, fading, or brown. Infestation level was identified as low, high, or pitched out. Colonization was determined if the surveyor thought that the tree was going to produce a viable spruce beetle brood. Woodpecker activity was also indicated on the data sheet. If the surveyor thought that the tree was infested during the current summer, the tree was recorded as "newly hit"; if the surveyor thought the tree was infested the previous year or some time prior to the current season the tree was recorded as an "old hit". An "old hit" was also indicated if there were horizontal larval galleries found under the bark, but no spruce beetle life stages were seen. If the surveyor thought the tree successful defended itself by pitching out the spruce beetles, the tree was identified as a "pitch out." A low infestation level was determined by the surveyor if there were few beetles found or if no beetles were found, but spruce beetle activity was present. The surveyor determined a high infestation level if there was significant damage to the phloem and there were many spruce beetle adults or larvae present and/or if there was lots of pitch tubes and frass surrounding the tree. The presence of *Ips* was also noted.

Beetle-colonized spruce trees were designated with a tree tag, tree marking paint, and flagging for removal by the suppression crew. In addition, the infested trees' position was recorded with Global Positioning System equipment.

In 2000, spruce/fir and lodgepole pine stands and areas on the Steamboat Springs Ski Area and in and around the all campgrounds and trailheads on the Hahns Peak/Bears Ears Ranger District, Medicine Bow - Routt National Forests, were surveyed. In 2001, spruce/fir and lodgepole pine stands and areas in the Steamboat Ski Area, Lester Mountain Timber Sale Area, Buffalo Pass corridor, Rabbit Ears Pass corridor, picnic areas, campgrounds and trailheads on portions of the Parks Ranger District within the Park Mountain Range and on the Hahns Peak/Bears Ears District, Medicine Bow - Routt National Forests were surveyed.

BROOD SAMPLING

Brood sampling of spruce beetle populations in standing trees was conducted following the methods described by Knight (1960a). One 6 by 6 inch bark sample was cut from the north and south sides of the sample tree trunk at 4 – 7 foot height. Each bark section was carefully removed with a chisel or hatchet. Cheesecloth ground covers placed at the base of the sample tree were used to collect and prevent the loss of insects as the sample was removed. Samples were processed in the field. Because several layers of beetle brood could be present, samples were searched destructively. Data collected include the number of spruce beetles by life stage and associated organisms such as *Ips* beetles and natural enemies. The DBH was recorded for each sample tree.

Brood sampling in standing spruce was conducted in September 2000 on the Steamboat Springs Ski Area, primarily to determine the predominant life stage of the beetle population. The life stage of the beetle population relates to the timing of direct control activities (Appendix 1). Deep and persistent snow in the spring and early summer mean survey and direct control actions cannot be completed before adult spruce beetle emergence has begun. Therefore, infested trees containing mostly adult spruce beetles in the early fall are candidates for immediate treatment, because they will yield attacking beetles early the following summer before control efforts can be implemented. It was assumed that infested trees containing mostly immature spruce beetles in the early fall were a less urgent hazard that could to be treated the following summer. This is because the spruce beetle life cycle is typically completed in two years (Schmid and Frye 1977) and adult spruce beetles must spend one winter within their brood tree before being able to reproduce.

RESULTS

AERIAL SURVEY

Spruce beetle

During the 2000 aerial survey of the analysis area, only 24 trees within six polygons were mapped as recent mortality of standing trees due to spruce beetle (Table 1 and Map 2). This total represents all standing spruce trees seen by the surveyors that displayed characteristic symptoms of crown fading, needle loss, and grouped spatial pattern that indicate recent spruce beetle-caused mortality.

It is most likely that these beetle-killed standing trees had been successfully attacked and colonized during the summer of 1999 and then had faded the following summer in 2000. It is probable that some standing trees colonized during the summer of 1999 went undetected during the 2000 aerial survey. A reasonable conclusion, nevertheless, is that the signs of spruce beetle activity were so rare in the 2000 aerial survey that little mortality had occurred in standing spruce by the end of the summer in 1999.

Ground survey information from 1999 supports this conclusion, because few attacks on standing trees were found despite an extensive search for them in portions of the affected area (Schaupp and Frank 2000). In 1999, therefore, the spruce beetle population remained primarily within the blowdown. As was expected, spruce beetles emerged from the blowdown in 2000 and attacked both wind thrown and standing trees. It was these “standing hits” from 2000 that faded and were detected by the aerial survey flight of 2001.

The aerial survey of 2001, compared with that of 2000, detected a large increase in spruce mortality due to spruce beetle (Table 1 and Map 3). In 2001, recent mortality of standing spruce was clearly evident in many places in the northern portion of the analysis area. Nearly 12,000 fading trees were mapped during the aerial survey. As compared with 2000, this change was so great that one of the survey crew went to the field to ground check some areas while the aerial survey was underway. Observations confirmed spruce beetle infested standing trees at several locations. Fieldwork conducted throughout the summer verified that the spruce beetle population was primarily located within standing trees. In some locations, nearly all spruces over 8 inches in diameter across entire stands were attacked ---- many of these locations had been detected and sketched onto the 2001 aerial survey map.

The aerial survey tally for 2001 is an underestimate. This is due to two factors. First, some faded trees were not detected. This is because the visual “signature” of spruce killed by spruce beetle is among the most subtle and easily missed signs of bark beetle activity in western forests. Second, fading continued to occur after the survey was completed. Although the proportion of trees fading after the aerial survey is unknown, increased fading was very noticeable at locations visited frequently during the summer. One such accessible and highly visible area is along the south side of the Middle Fork of the Elk River near Slavonia Trailhead --- thousands of trees faded on the alluvial plain and rising canyon wall to the south. This can be seen extending for about 2 miles upstream and east of the bridge on Forest Service Road 443 crossing the Middle Fork of the Elk River. At this and other locations, the fading in the forest was obvious and striking, occurring across groups of stands.

Table 1. Annual Aerial Survey for Bark Beetle Activity, 2000 and 2001

Table 1. Results of bark beetle aerial detection surveys within the biological evaluation analysis area on the Hahns Peak/Bears Ears and Parks Ranger Districts of the Medicine Bow - Routt National Forests, Colorado, for the years 2000 and 2001. *

Bark Beetle	Dead Trees – 2000	Dead Trees - 2001	Acres - 2000	Acres - 2001
Spruce beetle	24	11,695	22	4,034
Mountain pine beetle	366	778	336	556

* The numbers presented are estimates based on observations sketched onto maps during survey flights and are therefore approximate.

It is known that some locations with large, dense concentrations of beetle-infested, green, standing spruce attacked in the summer of 2000 were mapped showing few faded trees or were not mapped at all. In these stands there was a mix of infested tree status --- those that faded after the 2001 survey and those trees that had been attacked during 2001. This latter group of trees infested in 2001 will not fade until the summer of 2002. Ground survey and reconnaissance found many such stands located along and near to the North, Middle, and South Forks of the Elk River and on the upper slopes of Floyd Peak. A significant increase in the number of faders is expected to be evident in the 2002 aerial survey at these locations and possibly other locations within the analysis area.

The increase in spruce beetle activity in standing trees is evident when Maps 2 and 3 are compared. While each symbol on the maps represents a different number of beetle-killed trees, a cluster of many similar symbols is an indication of an outbreak population. The large concentration of spruce beetle symbols or incidences in the northeastern portion of the analysis area (Map 3) is coincident with the location of windthrow mapped from the Routt Divide Blowdown in 1997 (Schaupp and Frank 2000). As is evident from Maps 2 and 3, much of the spruce beetle activity in standing trees is within the Mt. Zirkel Wilderness boundary. Over 63% of the mapped blowdown was within the Mt. Zirkel Wilderness boundary (Schaupp et al. 1999).

Mountain pine beetle

Although Maps 2 and 3 show many points of pine mortality due to mountain pine beetle, this amounts to few total trees on a small acreage compared with the spruce beetle situation (Table 1). Most mapped infested areas are single trees or small groups of trees. The mountain pine beetle was at low to moderate levels within the analysis area in 2000 and 2001 as determined by aerial survey, which detects attacked pines the year following infestation.

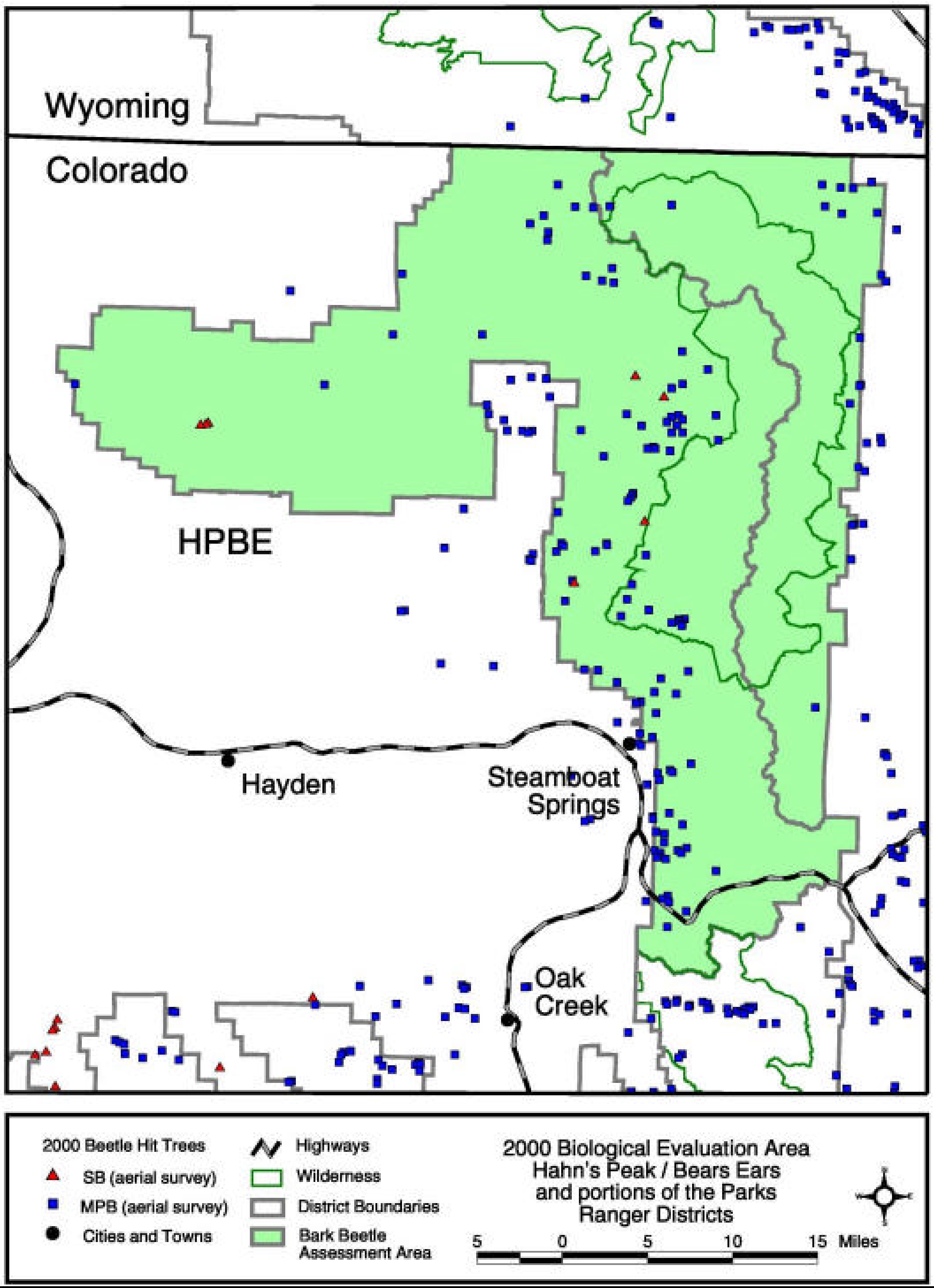
However, the number of detected MPB-killed trees did roughly double from 2000 to 2001. This annual doubling mirrors a trend evident across Colorado generally since 1995 (Johnson 2001 and 2002). Should this rate continue, it will not be long before the number of pines killed by MPB will be very large.

The only MPB outbreak known within the analysis area was on the Steamboat Springs Ski Area prior to the initiation of direct control measures. Few faded pines were mapped on the Ski Area in 2001, although some green MPB-infested trees, attacked in 2001, remain to be treated in 2002. It may be that the reduction in faded trees from 2000 to 2001 on private land along east side of the Yampa Valley is also due to direct control activity.

Based on aerial survey, other areas of concern at present within the analysis area include in and near Hahns Peak Village, along the Elk River corridor east of Clark, in the northwest corner of the analysis area, and along the western edge of North Park.

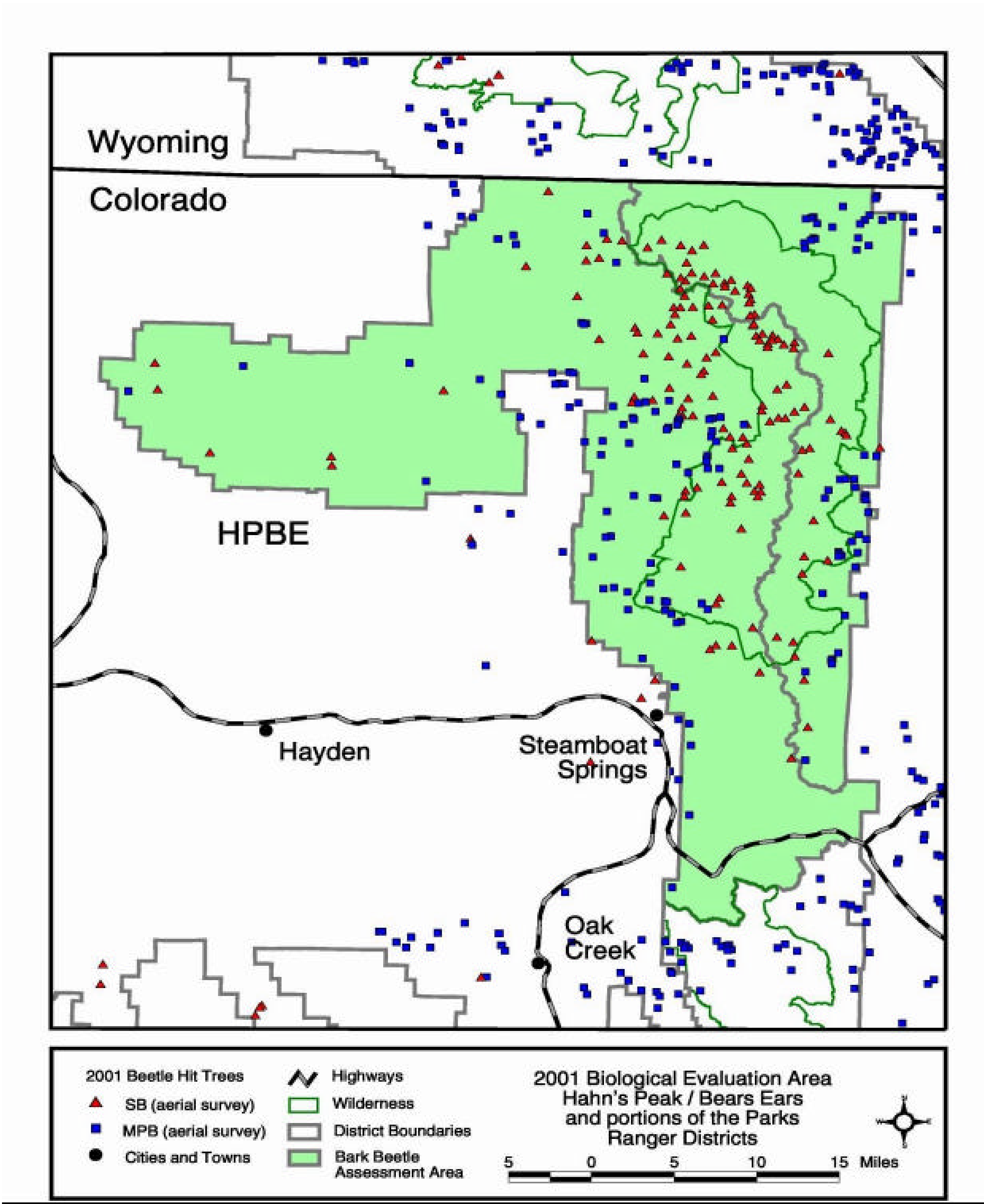
Map 2. AERIAL SURVEY OF BARK BEETLE ACTIVITY IN 2000

Map 2. Spatial distribution of bark beetle-killed trees in 2000, as determined by aerial sketch map survey. "SB (aerial survey)" = location of one or more spruce beetle killed ("hit") trees; "MPB (aerial survey)" = location of one or more mountain pine beetle killed ("hit") trees; "HPBE" = Hahns Peak/Bears Ears Ranger District; HPBE boundary with Parks Ranger District is the Continental Divide, shown as a gray line.



MAP 3. AERIAL SURVEY OF BARK BEETLE ACTIVITY IN 2001

Map 3. Spatial distribution of bark beetle-killed trees in 2001, as determined by aerial sketch map survey. "SB (aerial survey)" = location of one or more spruce beetle killed trees; "MPB (aerial survey)" = location of one or more mountain pine beetle killed trees; "HPBE" = Hahns Peak/Bears Ears Ranger District; HPBE boundary with Parks Ranger District is the Continental Divide, shown as a gray line.



PHEROMONE TRAPPING

Results were obtained from 11 trapping locations in 2000. Logistical problems precluded results from the Buffalo Pass location that year.

Results were obtained from 11 trapping locations in 2001. In 2001, the Floyd Peak pheromone trap location was given over to a research project investigating the relationship between pheromone trap catch and spruce mortality. The project is lead by Jose Negron, research entomologist with the USDA Forest Service's Rocky Mountain Research Station. Staff from the Rocky Mountain Region, FHM, and Medicine Bow - Routt National Forests are assisting with the project. Similar work is being conducted in Utah.

The total annual spruce beetles pheromone trap catch increased about ten-fold from 1999 to 2000 and dropped only slightly from 2000 to 2001 (Table 2). The total annual catch was 2 spruce beetles in 1998 (Schaupp et al. 1999), followed by 548 in 1999 (Schaupp and Frank 2000), then 6,549 in 2000, and finally 5,022 in 2001. Although the relationship between pheromone trap catch and spruce mortality has not been established, the large increase in total annual trap catch after 1999 parallels the timing of greatly increased spruce beetle activity as determined by the number and density of attacked standing trees seen in field observations.

In 2000, the first spruce beetles were caught during the first week of June. In 2001, the first spruce beetle capture was made on May 31, when 10 beetles were caught at the Reed Creek location. These dates are one month earlier than the first catch in 1999. Perhaps snow remains longer on windthrow compared to standing trees, so that the spruce beetle flight threshold temperature is first attained on a later date in windthrow versus standing trees. This could explain why the first spruce beetle captures were earlier in 2000 and 2001 and later in 1999 when the majority of the beetles were in blowdown. Besides the effect of being in blowdown, the initiation of spruce beetle flight was likely influenced by weather conditions each year.

In 2000 and 2001, the peak of spruce beetle catch was distinct, sharp, and early in the summer (Fig. 1). Peak catch occurred during the first week of July in 2000 and during the last week of June in 2001. This is similar to 1999, when peak catch was during the first week of July, due almost entirely to activity at Floyd Peak (Schaupp and Frank 2000).

Most, but not all of the catch occurred early in the summer. Fifty percent of the overall catch had been made by the fourth week of June in 2000 and 2001 and seventy-five percent had been caught by the first week of July (Fig. 2). The cumulative percentage catch over time shows that the beetle flight was later in 1999 compared to the trap catches in 2000 and 2001 (Fig. 2).

Approximately twenty-five percent of the combined total weekly beetle catch was made between the second week of July and the end of the season (Fig 2). This is consistent with prior descriptions of the attack period, which may be from May to early August depending upon the attainment of the flight temperature threshold (Schmid and Frye 1977).

Although the traps were highly variable within each year, the trend for 2000 and 2001 was similar among the traps (Fig. 3 and 4). Additional data from 2002 and later will clarify the spruce beetle attack period on the Routt. Given that the spruce beetle population was located in the blowdown in 1999 and that, in 1999, ten times fewer beetles were caught as compared with 2000 and 2001, it will be better to rely on the data from 2000 and 2001 for predicting spruce beetle activity on the Routt.

Beetles were caught over a longer time period than the six to eight week time span that was expected. The captured beetles could be attacking adults seeking to start a brood, parent adults that had reemerged to attack again and start another brood, or recently matured adults seeking hibernation sites for the winter. Later in the summer spruce beetles may be attracted to aggregation pheromone that may intensify some outbreaks. Ground searches for newly attacked trees conducted in late summer may be completed before all spruce beetle attacks have occurred. After surveying the trees in a stand, more trees may be attacked before the field season if over. Also trees that successfully "pitched out" beetles at the beginning of the attack period may have succumbed to the beetle attacks and are infested by summer's end.

Surveys conducted later in the summer or early fall are more accurate than surveys conducted earlier in the season. When seeking to locate beetle-attacked trees, proper timing is important. Field reconnaissance and extent surveys are most accurate if they occur well after the beetle attack period has ended. However, starting such activities as soon as possible during the summer is necessary when many areas need to be examined. Surveys conducted later eventually risk not being completed due to inclement weather. Prioritizing activities by the degree of certainty required from field information is recommended. Pheromone trap catch results can be used to determine when ground surveys should begin. This approach must be tempered by incorporating the relative importance of specific survey results. This starts with the assumption that spruce beetles caught in pheromone traps are attacking beetles, caught while flying about seeking hosts and aggregating towards host trees already under attack. By displaying the annual beetle trap catch in terms of the percentage of the total reached by a given week in the summer, called the "cumulative percentage per week", we can better understand the timing within the spruce beetle attack period (Fig. 2).

Table 2. Annual Pheromone Trap Captures of Spruce Beetle by Location from 1999 to 2001

Table 2. Spruce beetle captures in 16-funnel Lindgren pheromone traps using a two-component lure on the Medicine Bow - Routt National Forests, Colorado, from 1999 to 2001. The data are combined from two traps per location. Unless noted, locations are on the Hahns Peak/Bears Ears Ranger District.

Location of Pheromone Trap	Elevation (in feet)	Total Spruce Beetles Caught in 1999	Total Spruce Beetles Caught in 2000	Total Spruce Beetles Caught in 2001
Walton Creek Campground	9,560	3	169	302
Mt. Werner (Ski Area)	10,320	23	114	414
Sawmill Timber Sale (Parks RD)	9,240	0	202	443
Buffalo Pass	9,840	**	**	7
Floyd Peak	9,320	304	978	**
Reed Creek ++	8,640	11	62	42
3-Island Trail Head	8,440	58	67	261
Seedhouse Campground	8,040	60	293	101
Lost Dog	8,880	14	130	255
Iron Lopez Timber Sale	8,800	**	322	1,441
Bears Ears	9,720	55	4,035	2,160
Sawmill Campground	9,960	17	177	39
ANNUAL TOTAL		545	6,549	5,022

* RD = Ranger District
** No data
++ Location called "Floyd Peak" in 1998

Figure 1. Weekly Spruce Beetle Captures 1999-2001

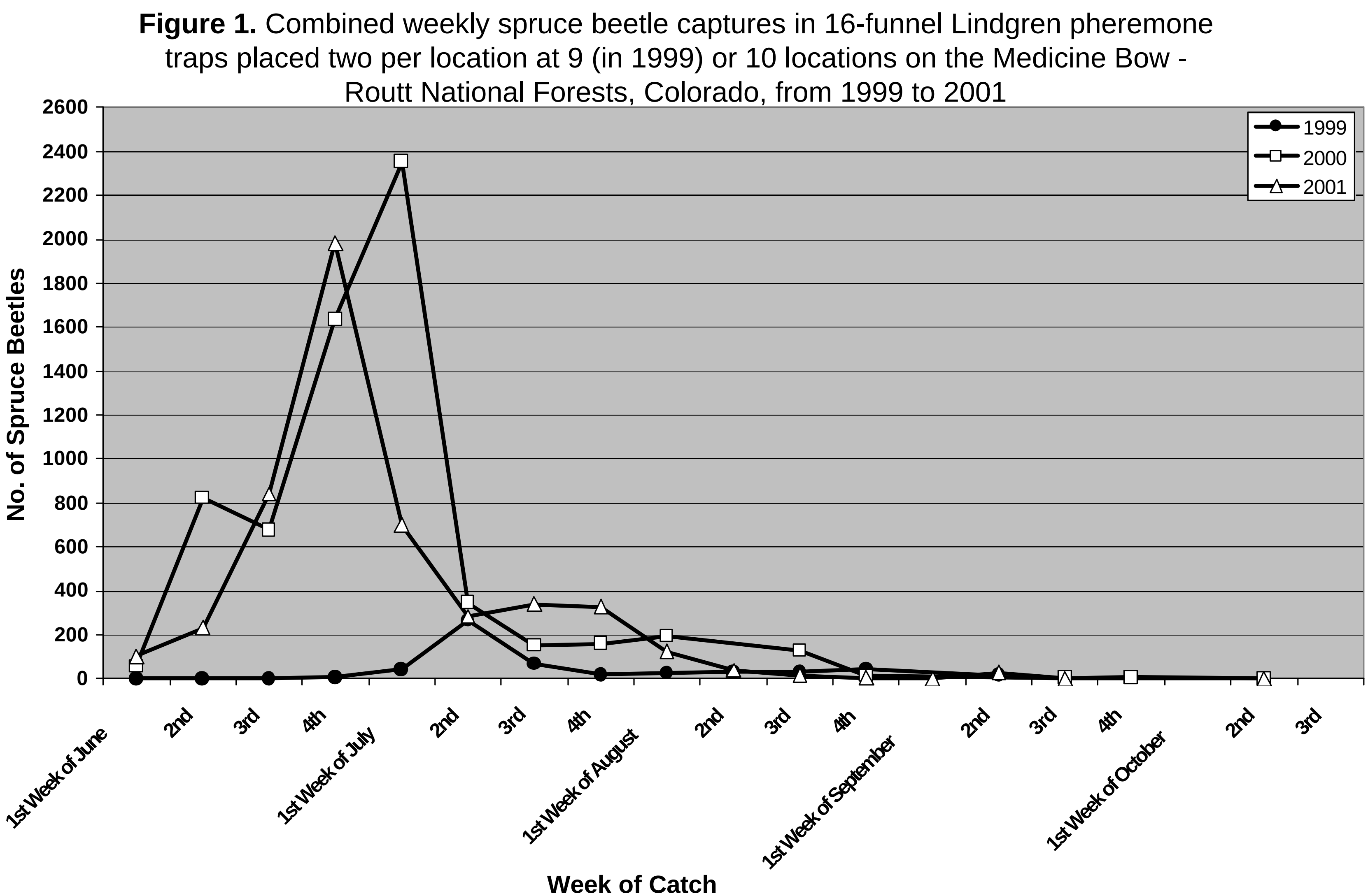


Figure 2. Cumulative percentage of annual spruce beetle pheromone trap catch by week

Figure 2. Cumulative percentage of total annual spruce beetle pheromone trap catch attained per week from 1999 - 2001 on the Hahns Peak/Bears Ears and Parks Ranger Districts, Medicine Bow - Routt National Forests, Colorado

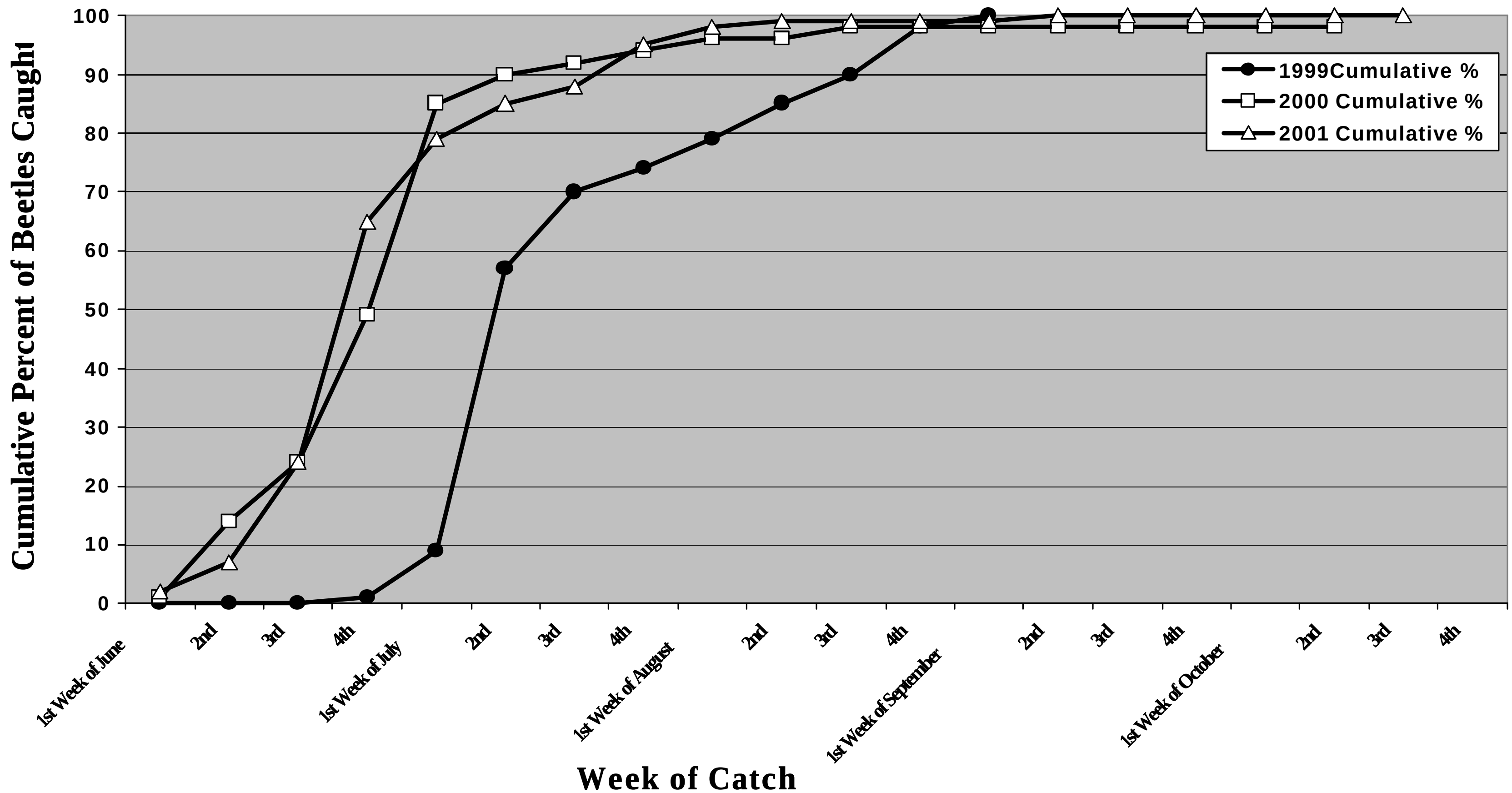


Fig. 3. Combined weekly spruce beetle catch in 16-funnel Lindren pheremone traps placed two per location on the Hahns Peak/ Bears Ears Ranger District, Medicine Bow - Routt National Forests, Colorado, in 2000

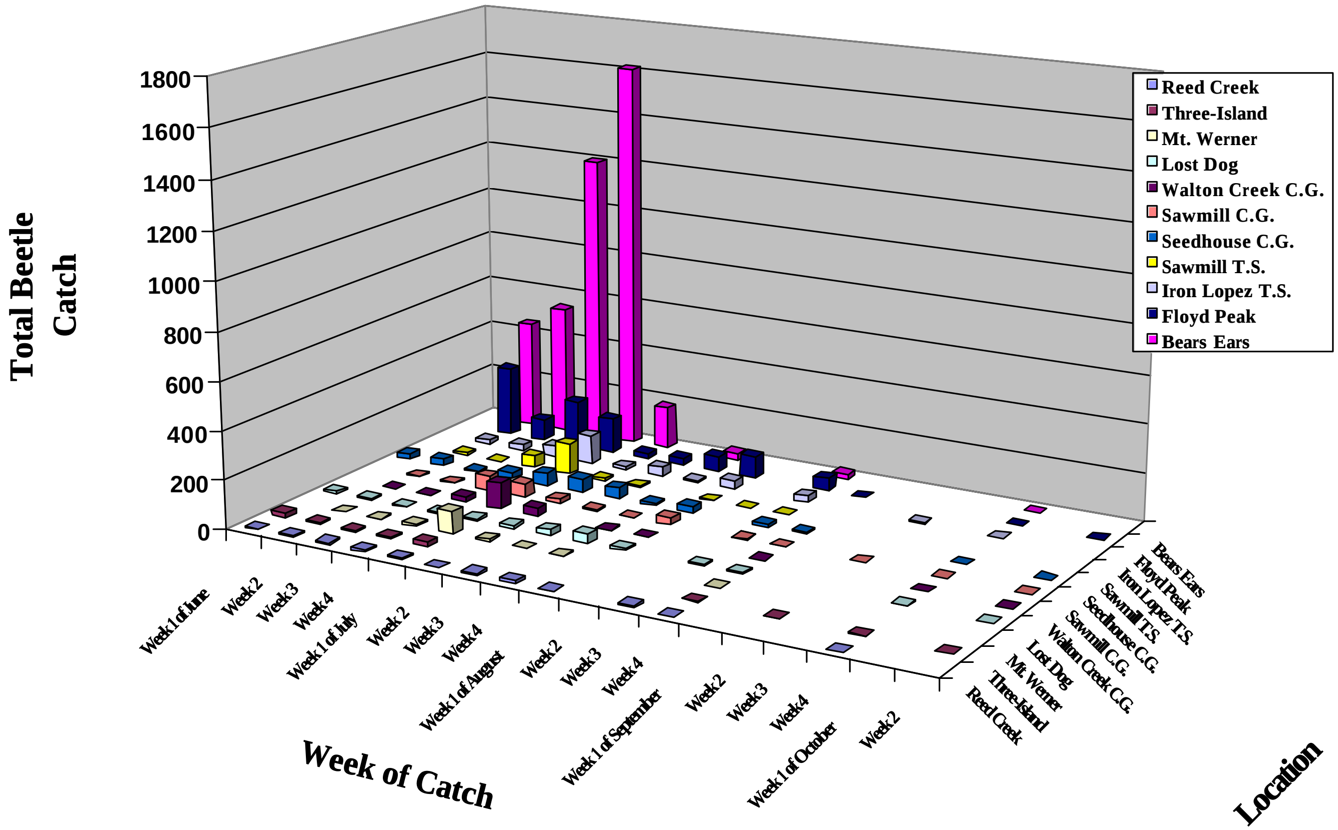
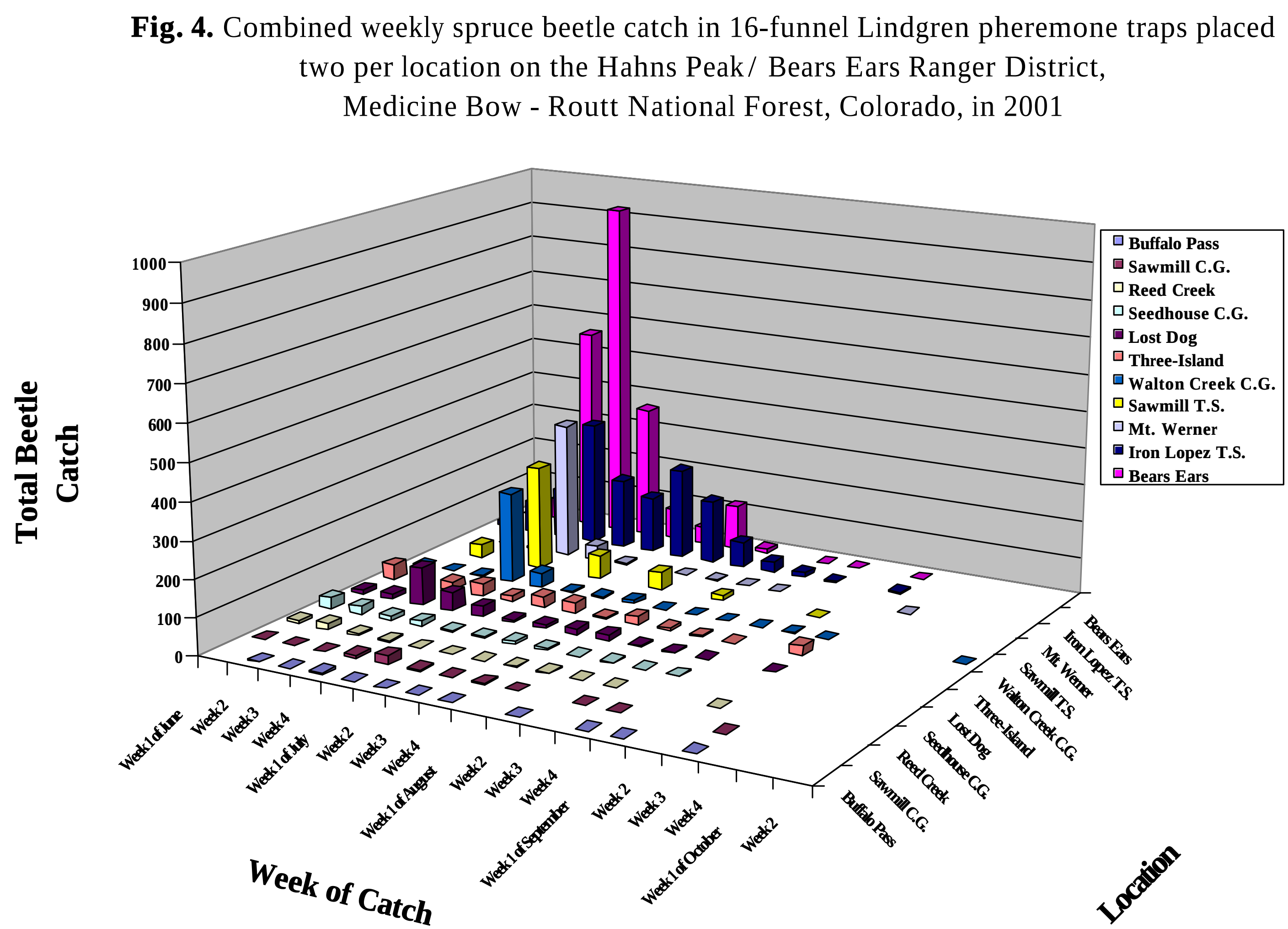


Figure 4. Weekly Spruce Beetle Captures – 2001



GENERAL RECONNAISSANCE AND EXTENT SURVEY

Standing trees infested with beetles were found throughout the assessment area in 2000 (Map 4). The vast majority of these infested trees were spruce. This widespread distribution of attacks on standing spruce trees had been expected, given that spruce beetle populations were found within windthrow at most survey locations following the Routt Divide Blowdown (Schaupp et al. 1999; Schaupp and Frank 2000). Contrary to expectations, however, number of attacks detected in 2000 was very large. It was clear that the predicted exodus of spruce beetle populations from blowdown into standing spruce trees began in 2000.

The type and distribution of trees attacked by these spruce beetle populations seemed to differ based on proximity to the largest concentrations of blowdown. Infested trees south of Buffalo Pass, most distant from the largest concentrations of blowdown, were usually weaker hosts. For example, attacked standing spruce trees on the Steamboat Springs Ski Area usually had some detectable stressor, such as being suppressed, partially windthrown or infected by Armillaria root rot. Infested trees were scattered about singly or in small groups, generally not concentrated along streams, and were on poorer quality sites. Consequently, such trees were in the lower range of diameter and height for suitable hosts and would not be expected to produce a large number of spruce beetles following colonization. Many of the attacked trees had evidence of successful resistance to colonization, as shown by the presence of pitch tubes, resin-soaked egg galleries, and the absence of developing brood. Still other attacked trees had too few attacks to become colonized and were classified as “pitch outs” by the surveyors.

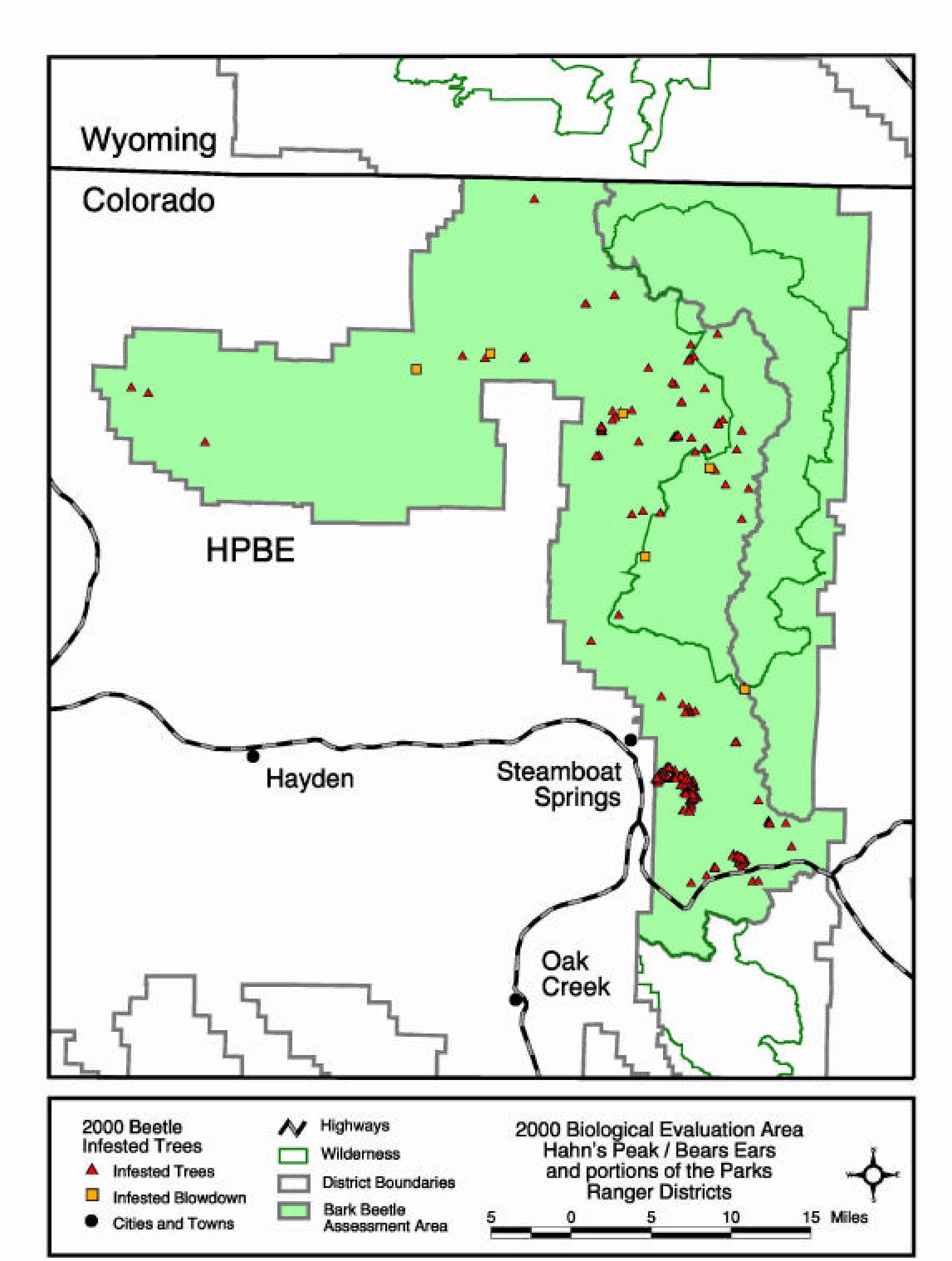
By contrast, most spruce trees > 12 inch DBH, healthy or weak, were attacked and are expected to die along the Elk River east of Clark. The pattern of infested trees differed from the Steamboat Ski Area as follows: occurred in large groups, sometimes covering entire stands; began along and concentrated down water courses; included large diameter spruces in an area. Beetles are expected to spread from the Elk River corridor to spruce stands elsewhere. This scenario does not take into account the spruce beetles already developing in other areas of the assessment area. The aerial survey already begins to indicate the trend of the spruce beetle epidemic (Table 1). The aerial survey result and the extent survey results from 2000 caused a change in focus for the 2001 survey activity.

The main objective in 2000 was to determine where standing infested trees were located in the assessment area. Forest Service staff surveyed many parts of the forest and found standing infested spruce trees almost everywhere they surveyed. Also additional blowdown areas were found infested with spruce beetle in 2000 (Map 4). These blowdown areas are outside the concentrated portions of the Routt Divide blowdown described in a previous Biological Evaluation (Schaupp et al. 1999). Other small blowdown areas are probably scattered throughout the assessment area that are not documented, and are prime habitat for spruce beetle population buildup.

The areas that received intense surveying found more infested trees in 2000 than areas that were not surveyed as thoroughly. More trees were found in these areas, as indicated by stacked triangles on Map 4. Areas that received more intense surveying include the Steamboat Ski Area, Campgrounds, Lester Mountain Timber Sale, Buffalo Pass scenic corridor and Rabbit Ears Pass scenic corridor. This does not mean that the bark beetle infestation was more intense in these areas as compared with other areas. However, the areas not surveyed as intensely may have a higher infestation levels than indicated by the map. The conclusion from the 2000 extent surveys is that there are standing infested spruce and lodgepole over the entire forest.

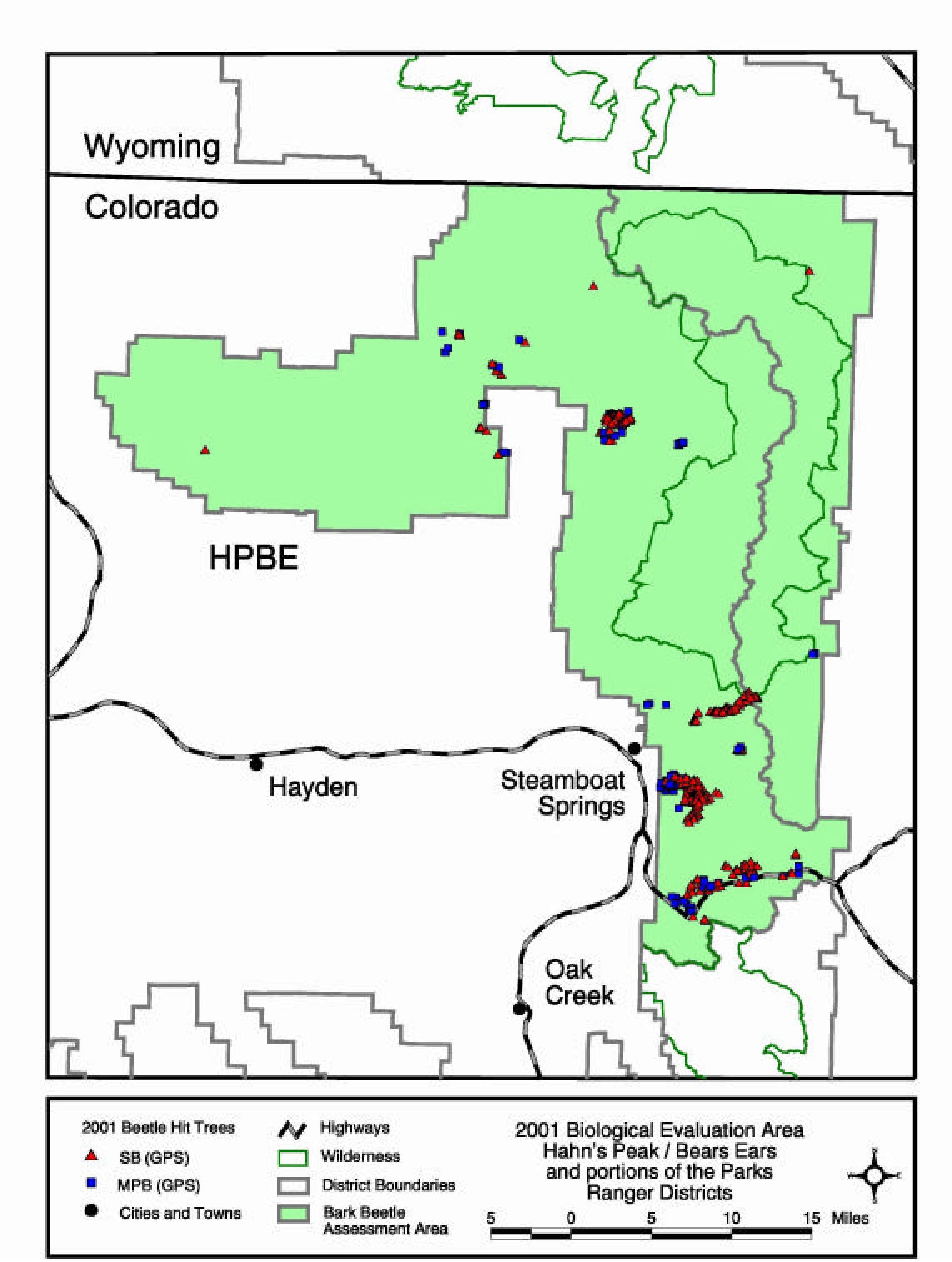
Map 4. Spruce Beetle Extent Survey Locations – 2000

Map 4. Location of documented bark beetle infested trees, as determined by the extent survey. Infested trees include either an spruce beetle infested spruce tree or a mountain pine beetle infested lodgepole pine. The majority of standing infested trees are spruce. Infested blowdown were discovered in 2000. Each triangle can represent from 1 to 20 infested trees.



MAP 5. LOCATION AND RESULT OF EXTENT SURVEY IN 2001

Map 5. Location of documented bark beetle infested trees in areas of human interest in the assessment area, as determined by the extent survey. Infested trees include either an spruce beetle infested spruce tree or a mountain pine beetle infested lodgepole pine. Each symbol can represent from 1 to 20 infested trees



A major change in focus happened from 2000 to 2001 and is In 2000, the objective was to find where there were infested standing trees, whereas in 2001, areas of human interest were the targets of intense surveying for mountain pine beetle and spruce beetle activity. The objective in 2001 was to determine the infestation levels on the high value areas. The high value areas include the Steamboat Ski Area, all campgrounds in the assessment area, Rabbit Ears scenic corridor, Buffalo Pass scenic corridor, Lester Mountain Timber Sale Area, Iron Lopez Timber Sale, and the areas designated as urban interface. This focus change is reflected in the results of the 2001 extent surveys (Map 5). A summary of each area can be found in the 2001 Accomplishments, later in this document. From 2000, the lesson learned was that the beetles were everywhere, and in 2001 areas of interest need to be protected concentrating resources on these areas. This change was motivated by the analyses and conclusions from the DEIS of analysis area (USDAFS 2001).

Brood Sampling

Larvae were the predominant spruce beetle life stage found during the brood sampling of standing trees in 2000 (Table 3). There was one egg found at the Dark Forest location. Pupae and adults were found at all locations at lower densities than larvae. The immature stage of the spruce beetle brood would suggest that most or all of the sampled trees were initially attacked earlier in the summer of 2000. The presence of adults, however, means that either some of the brood was completing development in one year or that the trees were attacked to some degree in the summer of 1999.

Based upon the relatively high density of adults at the Morningside Egress location, it was recommended that infested trees in this area be treated immediately. It was further suggested that infested trees in the Tomahawk and Dark Forest locations be treated because they contained the most spruce beetles. The Morningside Park and Pioneer Ridge locations had the lowest densities of spruce beetles and were considered a much lower priority for treatment.

Table 3. Spruce Beetle Brood Density in Standing Trees in 2000

Table 3. Average spruce beetle brood density per square foot of bark surface by life stage taken from standing trees during mid-September 2000 on the Steamboat Springs Ski Area, Medicine Bow – Routt National Forests, Colorado. Two 6 X 6 inch samples were taken at 4 - 7 foot height from the north and south sides of each tree.

Location on Ski Area	Trees Sampled	Average brood per square foot (± standard error of the mean)				
		Eggs	Larvae	Pupae	Adults	Total
Dark Forest	10	0.2 ± 0.2	85.8 ± 23.9	19.0 ± 9.1	3.4 ± 2.6	108.4 ± 28.5
Morningside: Egress	4	0 ± 0	222.0 ± 46.5	69.0 ± 22.3	26.0 ± 17.8	317.0 ± 47.0
Morningside: Park	3	0 ± 0	60.7 ± 23.3	4.0 ± 2.7	2.7 ± 1.7	67.3 ± 25.6
Pioneer Ridge	3	0 ± 0	2.7 ± 2.7	3.3 ± 2.6	5.3 ± 4.0	11.3 ± 9.2
Tomahawk	5	0 ± 0	239.6 ± 46.3	10.8 ± 8.7	1.2 ± 0.9	252.6 ± 46.2
ALL LOCATIONS	25	0.1 ± 0.1	125.4 ± 19.1	21.7 ± 6.1	6.7 ± 3.2	153.8 ± 21.8

Knight (1960a) found no consistent relationship between brood density and subsequent outbreak status during the summer of initial attack. He concluded that sampling late larvae and adults the second summer was the best time to determine if a population was increasing, decreasing or static (Knight 1960b). Because these samples were taken during the summer of initial attack, it is difficult to determine what the population will do. Winter mortality will have major impacts on the populations. If the majority of populations sampled have a two-year life cycle, then the majority of the sampled population had not been subjected to winter and the mortality associated with the winter. There is too much uncertainty to make a statement about the spruce beetle population on the Ski Area based on our samples. However, given large blowdown area, and the substantial increase in dead spruce trees from the aerial surveys in 2000 and 2001, it is safe to assume the spruce beetle population is growing exponentially over the analysis area, and will affect the Ski Area.

Based on our brood sampling, the decision to not aggressively treat all infested trees was unwise. Large variations meant that some untreated trees could have produced many beetles. This may explain why so many infested trees were found on the Ski Area in 2001.

From the 2001 extent survey of the Ski Area, the Dark Forest had an outbreak where over 375 infested trees were identified. This was well over half of all the infested trees found on the Ski Area. The rest of the infested trees were scattered across the Ski Area in small clumps of less than 5 trees per clump. Because of its location, the Dark Forest may have favorable conditions for the spruce beetle that may have attributed to finding so many infested trees compared to the rest of the Ski Area.

ACCOMPLISHMENT SUMMARY FOR THE ANALYSIS AREA FOR CALENDAR YEAR 2000

Detection or Identification of Individual Outbreaks and Suppression Treatments

- Aerial surveys were conducted across the entire forest.
- On the ground searches were conducted over several thousand acres highly susceptible areas, including the entire Steamboat Ski Area.
- These on the ground surveys identified over 100 outbreaks on the Hahns Peak/Bears Ears Ranger District.
- Six weeks of direct suppression in high-value areas with high beetle populations.
- Peeled or piled for burning 2,411 infested trees.
- Over 9000 person-hours in the field.
- 84 people were directly involved with fieldwork.
- Another 16 people helped with logistics, support, food, housing, purchasing, personnel, etc.

An agreement was entered into with the Northern Cheyenne Tribe. This agreement brought us 20 highly qualified fire fighters under an arrangement that is new to the Forest Service and new to the Tribe. This has been very successful and is encouragement for future projects.

Long Term Planning

An environmental analysis has been completed, and the DEIS is ready for release, for an assessment area of about 700,000 acres of National Forest System Lands. The action alternatives describe varying degrees of suppression, protection, prevention and monitoring in both spruce-fir and lodgepole pine cover types over a period of years. It is nearly certain that the forest will be subjected to bark beetle epidemics resulting in vast acreages of tree mortality. The Forest does not propose to stop the epidemic. This does not appear to be feasible. Rather, the alternatives are designed to protect high-value areas from the effects of beetle outbreaks. Each alternative suggests a level at which control and protection would be discontinued so that we do not find ourselves continuing to fight a losing battle. Continuous monitoring and evaluation are important elements of each alternative.

Community Involvement

We collaborated with local communities extensively in 2000.

In 1999, we established the Bark Beetle Information Task Force, comprised of members from the Colorado State Forest Service, city and county governments, county extension service, Chamber of Commerce, the Steamboat Ski Area and the USDA Forest Service. During 2000 the Task Force met 20 times and continued community educational efforts by producing widely aired public service announcements, participating in media interviews, and producing a newspaper insert titled "Blowdown, Beetles and Your Backyard," which was distributed throughout northwest Colorado and southeastern Wyoming.

- Local and regional newspapers covered the situation with 37 articles.
- 4,700+ people attended interpretive programs in the summer of 2000.
- We prepared 13 news releases regarding the bark beetle situation and our response to it.
- 27 Public service announcements were aired.
- The staff made 35 appearances to local government and civic groups to keep these groups up to date on the situation.
- In cooperation with the Colorado State Forest Service and the Bark Beetle Information Task Force we sent mailings to approximately 5,000 potentially affected homeowners to give them information on how to protect their property.
- Updated congressional staffers several times during the year.
- Conducted several field trips attended by local governments, local and regional media and Congressional staffers, industry representatives and local fire departments.
- Collaborated with several school districts to provide field trips and class projects regarding the beetle epidemic.

ACCOMPLISHMENT SUMMARY FOR THE ANALYSIS AREA FOR CALENDAR YEAR 2001

Survey, Suppression and Preventative Spraying

Entire Routt National Forest

Aerial surveys were conducted across the entire forest.

Steamboat Ski Area

The spruce/fir stands on the Ski Area and those within ¼ mile of the Ski Area were inventoried for spruce beetle infested trees. Approximately 633 trees were identified as being infested, 385 of these were identified in one stand. Fifteen of the spruce trees were located on terrain too steep for safe removal, so these trees were peeled by hand up to height of eight feet and were left standing for wildlife habitat. All other trees were cut down and the bark peeled off the bole, killing the beetles.

The lodgepole pine stands on the Ski Area were inventoried and 54 infested lodgepole trees were identified.

Campgrounds

All the campgrounds located in the Routt National Forest within and north of Highway 40 were surveyed for bark beetle infestation in Colorado. Forty-six infested trees were treated by cutting and peeling. There were over 60 trees within ¼ mile of Summit Lake campground that were infested with spruce beetle, but only 5 trees within the campsites were removed, the others were near or in the Mt. Zirkel Wilderness. In the Seedhouse Campground, 100 spruce trees and 96 lodgepole pine trees were treated with a preventative pesticide, Carbaryl.

Lester Mountain Timber Sale Area (Coulton Creek)

Over 800 trees were identified as beetle infested in the ongoing Lester Mountain Timber Sale. The majority of these trees were located in one stand. The approximately 600 trees within the sale area boundary were added to the timber sale. The remaining 200+ trees were cut down and the bark peeled off by Forest Service crews. The trees cut down by Forest Service crews were peeled up the bole until no more beetles were found. The remainder of the tree was flagged and left as trap trees to be peeled after infestation of spruce beetle in 2002.

Iron Lopez Timber Sale (West of Hahn's Peak Lake)

Cutting units within the Iron Lopez timber sale were inventoried at the suggestion of the timber sale administrator. Few spruce beetle infested trees were found in the cutting units. Over 50 beetle-infested trees were found within the sale boundary, but outside of designated cutting units. Most of the infested trees were located along the creek drainages within the sale area. No suppression efforts were done in the Iron Lopez Timber Sale.

Scenic Corridors

The spruce/fir stands along the Rabbit Ears Pass and Buffalo Pass Corridors were inventoried. Crews identified 203 beetle-infested spruce trees and 41 beetle-infested lodgepole trees along Rabbit Ears Pass and 208 beetle-infested spruce trees along Buffalo Pass. 78 trees were treated as high as the beetle were located and the rest of the trees were left as a trap tree. Suppression crews were started on the west side of Buffalo Pass and began working "uphill" until they were forced out by snow. About 20 trap trees on Rabbit Ears Pass and about 15 trap trees on Buffalo pass were peeled in the fall of 2001. These numbers are not exact, because there was apparent windthrow near where the trap trees were located. Suppression crews also peeled these as if they were trap trees.

Urban Interface

Except for the stands along the Seedhouse Road corridor urban interface, all spruce/fir and lodgepole stands within areas designated as urban interface were surveyed for spruce beetle- and mountain pine beetle-infested trees. Few infested trees were found in the urban interface areas surveyed.

Long Term Planning

The DEIS was released for scoping, for an assessment area of about 700,000 acres of National Forest System Lands. Public comments and questions were received from the scoping efforts. In 2001, the Task Force expanded its mission to include education about the role of fire in the ecosystem, fire prevention for homeowners, and fuel reduction projects in wildland urban interface areas. During 2001 the Bark Beetle Task Force met 11 times and continued community educational efforts by producing widely aired public service announcements, and participating in media interviews.

Community Involvement

We collaborated with local communities and the Bark Beetle Task Force extensively in 2001.

- Washington Office Congressional Forest Health Tour was attended by 42 people. Congressional staffers were updated information several times during the year.
- Local and regional newspapers covered the situation with 41 articles discussing beetles, beetle management and/or beetles relation to fire.
- 3400+ people attended interpretive programs in the summer of 2001.
- A series of public service announcements were aired in the spring of 2001, informing citizens that there is a beetle epidemic and they should check trees on their private land and seek a tree-specialist for professional advice.
- Forest Service staff made 16 appearances to local government and civic groups to keep these groups up to date on the situation.
- In cooperation Bark Beetle Information Task Force, we sent mailings to 350 homeowners in areas identified on a map where there are known beetle infestations.

- 67 comment letters were received in response to scoping.
- Conducted several field trips attended by local governments, local and regional media and Congressional staffers, industry representatives and local fire departments.
- Collaborated with several school districts to provide field trips and class projects regarding the beetle epidemic.

DISCUSSION

EPIDEMIC STATUS IN STANDING TREES

As predicted from the 1999 Biological evaluation (Schaupp et al. 2000), the spruce beetle activity has increased dramatically in 2000 and even more in 2001, compared to levels found in 1999 on the Hahns Peak/Bears Ears Ranger District. The spruce beetles have left the windthrow and are now attacking and killing standing spruce trees. The spruce beetle population is presently at epidemic status. The aerial survey has shown a geometric increase in infested trees, but the aerial survey does not pick up all of the currently infested spruce. It takes at least a year after the tree is dead before fading is noticeable and even then the dead needles fall off, making the infested trees difficult to spot from the air. The aerial survey is a good indicator as to broad scope, but fails to identify all infested areas or the exact number of infested trees. The aerial survey does indicate dramatically more spruce trees were killed in 2001 than the previous years. This increase is expected to continue for the next several years. Ground surveying in 2000 and 2001 confirmed what was indicated by the aerial survey that the spruce beetles had moved from the blowdown patches into standing trees and from those standing trees to other standing trees, killing the trees as the go. Efforts to locate beetle populations in areas of high value and remove them quickly are now the priority.

CHANGES IN PROCEDURES

There was a major shift in priorities as far as surveying and dealing with population outbreaks in 2001. In 2000, the main purpose of the inventory crew was to figure out where the beetles were, so that the suppression crews could start eliminating infested trees. In 2001, the main focus was to sanitize high value areas, knowing that the spruce beetle population was building. The high value areas identified in the DEIS in the analysis area on the Medicine Bow - Routt National Forests are as follows: the Steamboat Ski Area, 12 campgrounds, current timber sale areas, scenic corridors, urban interface areas.

On the Steamboat Ski Area in 2000, 150 infested spruce trees were identified. The number of infested trees found on the Steamboat Ski area in 2001 exploded to over 600. After the brood surveys in 2000, the recommendation was to treat some of the infested trees on the Ski Area, but not necessarily all of them, because of resource constraints. The assumption was that these beetles completed their life cycle in 2 years and could be treated in 2001 without these beetles infesting more trees. Also the conclusions drawn from the brood sampling in 2000 may have been misleading, because the sample size was not large enough and the great variation between sample trees was not given due consideration. The recommendation in 2000 may have been a mistake, because of the increase of infested trees on the Ski Area. Of the explanations for the increase, two are most plausible. The first explanation is the beetles in the infested trees that were not treated in 2000 produced a pheromone plume during the summer of 2001. The pheromone plume then attracted beetles that immigrated from other infestations on the forest including untreated blowdown. The weakness of this explanation is that there should have been more immigrant beetles and more infest trees, given all the beetles coming out of the blowdown. The second explanation is that the beetles may have completed their life cycle in one year, instead of the expected two years. If this was the case, the suppression effort in 2000 would have left a reservoir of spruce beetles to infest more spruce trees in 2001. Regardless of whether the beetles immigrated from other areas or matured in one year or a combination of both explanations, the lesson learned is to treat all known infested trees in high value areas.

By treating all known infested trees in an area, it should reduce the pheromone plume and reservoir of beetles to help prevent future infestations or intensifying the current infestation. However, this will not reduce the areas or trees susceptibility to the spruce beetle.

INITIATION OF PREVENTATIVE SPRAYING

One of the primary concerns is to protect individual high value trees from infestation. Examples would be campground trees and those trees that provide screening and wind protection in high traffic areas on the Ski Area. In response to rising beetle populations, preventative spraying was initiated in the fall of 2001 to protect such trees. Trees selected for preventative spray treatment were originally to be around the radio towers of Mt. Werner on the Steamboat Ski Area, Dumont Campground, Summit Lake Campground, and Seedhouse Campground. Only trees in the Seedhouse Campground were treated with Carbaryl. The other sites could not be protected because of snow cover. Application of this substance within 50 feet of snow would be in contrary to the procedures detailed in the DEIS. In 2002, the spraying program should expand to include all these areas as well as other areas determined by the Forest Service staff laid out in the EIS. These areas include campgrounds, scenic corridors, around buildings for screening, and so forth. For best protection, trees within these areas should be treated with a preventative pesticide before the end of May, when the beginning of the beetle flight is expected in 2002. If these trees are not protected in 2002, they will likely be attacked by the spruce beetle and will die in the next couple of years.

EFFORTS ARE WORKING

There was a dramatic step forward for the MPB direct suppression efforts from 2000 to 2001 on the Steamboat Ski Area. In 2000, ground surveying identified approximately 150 infested lodgepole pine trees, whereas in 2001, 56 infested trees were identified by the ground survey crew. Although the suppression efforts may not be the only cause of the decrease in MPB infested trees, it likely played an important role in reducing the number of MPB infested trees. Direct suppression efforts for MPB are expected to continue in 2002 and should involve fewer infested pines.

AREA MANAGEMENT OBJECTIVES

When considering preventative insecticide treatment, it is important to prioritize areas by management objective. Certain trees in campgrounds, parking areas or other recreation areas may be important enough to protect, because they provide shade or screening to the public. Along the scenic corridors, some trees may warrant preventative pesticide protection while other trees may not. For example, conifer trees that screen buildings from the public's view may have a higher priority than individual trees along the highway. Urban interface areas where the forest meets residential areas will be of major concern, because of the high value of ornamental trees. The US Forest Service will not be able to stop the outbreaks from happening but may be able to protect some areas or trees of human interest.

POTENTIAL RISKS OF ADJACENT FORESTED LANDS

Although this Biological Evaluation concentrates on the Hahn's Peak/Bears Ears District of the Routt National Forest, bark beetle outbreaks also are being observed in other parts of the central Rocky Mountains. Recent blowdown events and susceptible forests in Wyoming and other parts of Colorado are facilitating bark beetle outbreaks in those regions, especially in the Brush/Creek Hayden District of the Medicine Bow National Forest adjacent to the assessment area. The bark beetle epidemics have the potential and are expected to reach landscape scale and kill most of the older mature spruce over the west slope of the Rocky Mountain region. In the 1940's this drama played out in the Flat Tops Wilderness before a rare extremely cold temperature episode stopped the epidemic. Consequently, this is same area is not highly susceptible to spruce beetle mortality now (Map 1). It has taken fifty years before another large disturbance, the Routt Divide Blowdown, initiated a new beetle epidemic. The spruce forest was susceptible to spruce beetle outbreaks in the late 1940's and is probably more susceptible now, some fifty years later. The US Forest Service will not be able to stop spruce beetle or mountain pine beetle pandemics once they are in progress. However, the US Forest Service may be able to protect high value areas or individual trees from being killed by the bark beetles in the short term.

RECOMMENDATIONS

There are short-term and long-term management strategies for treating bark beetle populations. Many of the management tactics are short-term, such as trap trees, pheromone traps, direct suppression and preventative spraying. These tactics address the symptom of the problem --- too many beetles in one place at one time. However, the long-term management strategies for bark beetles should produce stands that are not susceptible to bark beetles where epidemics and associated impacts are undesirable. A long-term goal of reducing susceptibility to bark beetles involves creating a mosaic of age classes and stand conditions across entire landscapes. There are many variations to the silvicultural treatments that are discussed in Appendix 1 for the spruce beetle and Appendix 2 for the mountain pine beetle. Without substantial interference, the forest regenerates and grows again into a susceptible condition. Because landscape-level beetle epidemics are infrequent, the opportunity exists to modify stand and landscape conditions in areas where these large beetle-caused disturbances conflict with management objectives. The analysis area, though large, is not unique with respect to bark beetle epidemics or susceptible stand conditions. It is recommended that the Medicine Bow - Routt National Forests undertake an integrated overview of the bark beetle situation as it exists now, consider desired future conditions, and do so in a way that considers all susceptible forested lands. By showing leadership in this area, the US Forest Service may be able to achieve integrated approach across all forested lands. Certainly the Hahns Peak/Bears Ears and Parks Ranger Districts will not be the only ones affected by bark beetles in the near future.

Some adjustments can be made to the short-term management tools to maximize their effectiveness in areas of concern. One option in many areas is to begin using lethal trap trees in and around areas of known beetle populations. During the ground surveys, the crews reported the trap trees from the previous winter, had only spruce beetles along the bottom edge of them. The rest of a trap tree was infested with an *Ips* beetle, making that part of the tree unsuitable for spruce beetles. The *Ips* beetle pheromone signals to the spruce beetle that it is "not welcome here". The recommendation is to begin using lethal trap trees, which will prevent the *Ips* infestation and kill any incoming spruce beetles. This will be more efficient in killing spruce beetles.

Trapping beetles with pheromone needs to be continued across the forest to monitor the spruce beetle activity for as long as there is an epidemic. Besides monitoring the attach period and flight, trapping beetles in a this fashion can be used to help reduce a population. Aggressive trapping efforts in an area are a possibility, to reduce local outbreak impacts on the forest (Bentz and Munson 2000). An aggressive trapping program in some areas of the analysis area may produce desired results.

Pheromone trapping will help determine when surveying and suppression can begin, which is expected to be in early July. Additional years of data will give a better indication of how long the beetle attack period is and when it typically begins. After the ground surveying is completed for an area, suppression treatment of all known infested trees or beetle habitat should be done as soon as possible. This should reduce the pheromone plume produced by the beetles that attracts other beetles to the area. Reducing the pheromone attraction should be a major concern in high value areas because it will reduce the number of beetles immigrating to that area.

Preventative spraying of areas in the high value areas, especially along the Elk River and on the Ski Area, will be necessary to keep trees from being attacked and killed. Preventative spraying of trees that provide screening or wind protection need to be done before the expected beetle flight period in July, 2002. Other areas of consideration are the scenic corridors. If these trees are not protected they will be lost to the spruce beetle outbreak.

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APPENDIX 1 ACTION ALTERNATIVES AGAINST SPRUCE BEETLE

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MANAGEMENT STRATEGIES

Forest managers can develop various strategies to avoid or reduce resource losses to spruce beetles. Before developing a strategy, the forest manager must evaluate the resource values and economics of management actions for each stand in light of management objectives. The beetle population level must also be considered, because population levels will determine the priority of management actions and the type of strategy to be invoked. Landscape considerations are important, because both stand susceptibility and beetle population levels in adjacent and nearby stands will influence bark beetle caused tree mortality in stands under consideration.

The primary strategy should be silvicultural treatments of potentially susceptible stands in order to maintain their health with a moderate growth rate. These silvicultural strategies should be implemented well in advance of an epidemic. The first step in this strategy is to risk-rate spruce stands, which will indicate the most susceptible stands and areas where susceptible stands are concentrated. The stands can then be treated with harvesting directed at the most susceptible stands and areas. Infested logging residuals seldom become a significant contributor to spruce beetle populations if stump height is kept below 18 inches (45 cm) and cull logs and tops are limbed, cut into short lengths, and left unshaded, unpiled, and exposed to sunlight. Silvicultural treatments have greater long-term effectiveness, because these treatments modify stand conditions.

The primary strategy assumes, in general, beetle populations are not immediately threatening resource values. If beetle populations are threatening, then strategies involving suppression are more appropriate. Suppression methods including silvicultural, physical and chemical measures are available to forest managers for reducing spruce beetle populations. Some methods are suitable only for populations in windthrown host material; other methods are better suited for infestations in standing trees. Most suppression methods are short-term responses to existing beetle populations and, therefore, correct only the immediate situation (Holsten et al. 1999).

A long-term goal of reducing susceptibility to spruce beetle involves creating a mosaic of age classes and stand conditions across entire landscapes. Without substantial interference, each major spruce beetle epidemic sets the stage for the epidemic to be repeated, as the forest regenerates and grows again into a susceptible condition. Because landscape-level spruce beetle epidemics are infrequent, the opportunity exists to modify landscape conditions in areas where these large beetle-caused disturbances conflict with management objectives. In this way, major spruce beetle epidemics may not necessarily be repeated in the distant future.

TREATMENT OPTIONS

SILVICULTURAL TREATMENT

Silvicultural practices and priorities can be developed if clear and well-defined management objectives exist. In determining treatment or cutting unit priorities, spruce beetle susceptibility should be integrated with all the other treatment objectives to best attain management goals and objectives. Three stand ratings, utilizing the potential outbreak rating or risk, provide guides that should be used in determining overall stand treatment priorities.

1. High. Susceptibility to attack and damage is a primary concern in reaching or maintaining management objectives where the potential spruce beetle risk is high or medium. This concern may be addressed by evaluation of probable spruce beetle population trends, possible impacts, and so forth, conducted by pest management specialists. In the event of an outbreak, a majority of spruce in the larger diameter classes (> 12 inches DBH) will be killed.
2. Medium. Susceptibility to attack and damage is a concern in attaining management objectives, but is definitely less than in high rated stands. The degree of concern will depend upon management objectives for the area and how a potential spruce beetle outbreak might affect them.
3. Low. Susceptibility to attack and damage by spruce beetle is not a concern.

An important consideration in any silvicultural treatment is wounding of residual trees. Great care must be exercised in any mechanical entry to avoid wounding. Especially with sub-alpine fir and, to a lesser degree, spruce species, as wounds provide entry courts for decay and root disease fungi. Not only can the pathogens lead to tree mortality, it is likely that there is an interaction between spruce beetle and infected trees, rendering them more susceptible to beetle attack.

Cutting Methods in Susceptible Stands

Once a spruce beetle infestation reaches epidemic proportions in susceptible stands, chances for control are greatly reduced. Hence vegetation management strategies aimed at preventing the accumulation of numerous high-risk stands and other high-risk beetle situations are the preferred management approach.

Intermediate Cutting Methods

A. Sanitation/Salvage. During an outbreak, beetle infested, dead, and highly vulnerable large diameter spruce are removed in an effort to maximize utilization of attacked material. Salvage of significant blowdown material within 1 to 2 years, particularly when it occurs in and adjacent to highly susceptible stands, is recommended where it meets overall management objectives.

B. Presalvage. With the imminent threat of an outbreak, large diameter, slow growing spruce are removed from highly susceptible stands. Presalvage is the removal of merchantable trees in anticipation of losses likely to occur before definitive regeneration cuts (Smith 1986). In some situations, presalvage may achieve the same results as a shelterwood cut.

C. Precommercial thinning. Thinning young stands to regulate stocking and species composition may be appropriate when commensurate with other stand objectives.

D. Commercial thinning. Thinning at 20 or 30 year intervals will improve stand vigor. While thinned stands have higher average diameter, benefits from improved vigor likely outweigh risks associated with having larger diameter trees. Thinning pine stands susceptible to mountain pine beetle indicates that the habitat modification provided by thinning is an important contributor to reduced stand susceptibility. Spacing between trees is the critical factor in this, rather than just reducing tree density. It is likely that habitat modification in thinned spruce stands would play a similar role of reducing stand susceptibility to spruce beetle. However, windthrow is a significant concern when increasing inter-tree spacing. A long term goal of thinning more appropriate to spruce/fir stands may be to create a mosaic of age classes rather than trying to maintain a single age class.

Even-aged Regeneration Cutting Methods

A. Clearcutting. This method effectively eliminates bark beetle risk on treated acres for a considerable period of time. However, if faced with large acreages of unmanaged, highly susceptible stands, clearcut regeneration techniques will require decades to achieve a level of management where beetle risk is diminished.

Where locations have a mix of low, medium, and high-risk stands, clearcutting the high risk stands over one or two decades may diminish the overall beetle risk. Regeneration needs will significantly affect the location and degree to which this method is employed.

B. Shelterwood. This method has advantages over clearcutting when an objective is to reduce beetle susceptibility within a location in a minimum of time. For a given sale quantity, shelterwood cuts would require treatment of more acres than clearcutting. Shelterwood prescriptions should provide opportunities to remove trees at high risk to bark beetle, such as damaged trees, trees already infested, or poor vigor dominants and codominants. Where more than the recommended basal area to be removed is in high risk trees, a decision of whether to accept the risk of spruce beetle attacks or to accept the risk of windthrow by removing additional susceptible trees will have to be addressed (Alexander 1986). Two or three entries may be required to meet the desired condition (Alexander 1986).

Uneven Aged Regeneration Cutting Methods

In situations where stands are clearly irregular in structure, maintaining the irregular stand structure is desirable, and the risk to spruce is apparent and undesirable, selection or group selection cutting methods are applicable. Selection regeneration methods may have advantages in managing spruce beetle susceptible stands in these situations by allowing regulation of stocking, basal area, and controlling diameter distribution while maintaining stand characteristics valuable to management objectives.

No specific information or guidelines are available on the implementation of uneven-aged cutting methods in spruce beetle susceptible stands. Multiple entries may be required to achieve the desired stocking and diameter distribution. However, where visual quality is important, suggested stand structure objectives could be a growing stock level of 100 to 120 sq. ft. of basal area on most sites, a maximum tree diameter of 24 inches, and a diameter distribution approaching a Q of 1.3 to 2.0 (Alexander and Edminster 1977). Where lowered susceptibility to spruce beetle is needed, fewer large diameter trees are desirable, so that an average stand diameter less than or equal to 12-14 inches for spruce is suggested. As with commercial thinning, the improved stand vigor and modified habitat conditions which would result from cutting in uneven aged stands is predicted to lower stand susceptibility to spruce beetle attack and tree killing.

Minimizing Spruce Beetle Build-up in Logging Slash and Debris

The following guidelines can be utilized to minimize spruce beetle population increases in logging slash and debris:

A. Cut trees as low to the ground as possible, preferable stump height of no more than 12 inches.

B. Cull logs and larger diameter slash material can be used to "trap" beetles to further reduce populations and lessen the risk of attack to standing trees, if this material is left in the cutting unit and then removed or treated after beetle flight. This trap material must be removed prior to the next beetle flight. If they are not removed, beetles produced in this material will increase the chance of attacks to surrounding standing spruce (Schmid 1977). Utilize C-Provisions, R0-C-6.46, R0-C6.47, R0-CT-6.46, and R0-CT-6.47 as deemed necessary.

CULTURAL TREATMENT

Trap Tree Method

Trap trees are green trees with a diameter greater than 18 inches DBH that are felled, preferably before the spring beetle flight (Holsten et al. 1999). Trap trees should be left in their "natural state" with no limbing being done, because the limbs shade the bole and make the trees more attractive to spruce beetles. Trap trees are used to attract and decoy emerging beetles away from living, standing green spruce trees. Traditional trap tree usage is more effective for absorbing beetles than baiting standing green trees for the following reasons: 1) beetles prefer downed material over standing green trees; 2) beetles infest a greater percentage of the bole; and 3) the mean attack density is greater. Once the trap tree is infested with beetles, it must be treated by milling, burning, solar heating, or insecticidal application (Schmid and Frye 1977).

Trap tree treatment considerations to be aware of are as follows: 1) beetles are effectively attracted up to one-quarter mile from the felled tree, becoming less effective with an increase in distance; 2) trees felled in the shade are preferred over those felled in the sun (Nagel et al. 1957); and 3) trap trees, by attracting beetles, may lead to attacks on standing spruce adjacent to them. Unbucked trees provide more shade, increasing beetle suitability and reducing both fungal development and competition from *Ips* species, because branches provide increased shade and serve to hold the bole above ground. By keeping the bole off the ground, more of the shaded underside is available for colonization. The number of trap trees felled is relative to the attacking beetle population and the size of the felled host. A trap tree may absorb 10 times the number of beetles a standing tree will absorb (Schmid and Frye 1977). Nagel et al. (1957) recommends one trap tree for every four to five infested standing trees. Schmid and Frye (1977) include a table for more precise estimates of the number of trap trees to be felled based on the current infestation level.

Sanitation of Infested Trees

This treatment strategy does not differ in principle from silvicultural treatments where trees currently infested by spruce beetle are removed or treated to kill the beetles within them. In practice, this treatment differs from silvicultural treatments in that fewer trees are removed and mechanical means may or may not be used. Prompt identification and treatment of infested trees before the inhabiting beetles emerge will remove a local source of contagion. It can afford a degree of protection to nearby susceptible trees and stands. Consideration must be given to the relative susceptibility of the adjoining landscape and the local "beetle pressure." Where both are at a high level, sanitation of a few infested individual trees is not likely to have a positive benefit due to immigration of beetles and because the number of trees removed may not alter susceptible stand conditions.

CHEMICAL

Lethal Trap Tree Method

Lethal trap trees, a modification of the traditional trap tree method, are another effective option to attract, hold and eliminate beetles from the forest (Frye and Wygant 1971, Buffam 1971, Buffam et al. 1973, Lister et al. 1976). Lethal trap trees eliminate the need to remove infested material from the forest and can be especially useful in areas where removal of material is prohibitive. Prior to felling, the trap tree is injected with a silvicide, making it a lethal trap tree. Currently, no silvicides are registered for use in the United States.

A variation of the lethal trap tree method is to apply an insecticide to the felled trees so that attacking beetles are killed as they attempt to bore into the treated tree. Currently, several insecticides are registered and available for this use in the United States.

Insecticides Preventing Infestation

Insecticides can be applied to the boles of uninfested trees to kill attacking beetles and protect high value trees. Application of these insecticides will not kill larvae or adults already present in the phloem. These insecticides work directly on the attacking adults attempting to bore into the tree and therefore need to be applied prior to the tree being attacked by spruce beetles. Only insecticides labeled for this use can be applied. Pruning the lower branches from the base of the tree prior to spraying should increase the effectiveness of the application and create warm, unfavorable conditions to the spruce beetle.

Pheromones

Pheromones, or message bearing chemicals, are emitted by the spruce beetle and serve to coordinate and regulate their attack behavior. Synthetic versions of these chemicals are available that either attract or repel spruce beetles. Synthetic pheromone production and pheromone dissemination methods need to be improved to take full advantage of pheromone technology. In addition, variation in results of operational synthetic pheromone use indicate that we do not fully understand regional variations in the chemical components of spruce beetle pheromones and the role(s) played by host volatiles. A summary discussion of operational and potential spruce beetle pheromone uses with literature citations was provided by Skillen et al. (1997). Operational uses of spruce beetle pheromones at present include trap out and attack disruption. However, results are inconsistent.

The trap out tactic uses attractant pheromones to lure spruce beetles into traps or trap trees and thereby reduce beetle populations to a more acceptable level. This would work best in isolated, lower level beetle populations where immigration would not erase the impact of trapping. Treatment trials using this have shown that the synthetic attractant pheromones do not compete well with natural attractant pheromones and may have varying attractiveness, as currently formulated, in every region of the spruce beetle range. However, the trap-out tactic has been successful on isolated populations in Utah as part of an integrated strategy employing several tactics (Bentz and Munson 2000).

In general, the use of attractant pheromones does not constitute a treatment tactic on its own, but is employed to augment silvicultural treatments or trap tree methods. For example, to retain or bring beetles into an area scheduled for a regeneration cut, one could place tree baits in the stand to be treated. Similarly, one can place tree baits containing attractant pheromone on trap trees or lethal trap trees to render them more attractive. It must be stressed that spillover attacks on trees adjacent to those baited is a common occurrence. Failure to treat baited and adjacent attacked trees in a timely manner can lead to exceptionally high tree mortality.

Deploying the spruce beetles' repellent pheromone prior to the attack period might reduce tree mortality from spruce beetle. The natural repellent pheromone or anti-aggregant pheromone of the spruce beetle is MCH or 3,2-MCH (3-methyl - 2-cyclohexen - 1-one). As colonization of a tree proceeds, the amount of MCH released into the air increases. Apparently, a certain threshold of MCH signals to other beetles that the tree is fully occupied and no longer suitable for colonization. Beetles searching for host material are thus repelled by such trees and search elsewhere for suitable material.

MCH has been used successfully to disrupt attack and colonization by spruce beetle in host trees and shown to reduce the attraction of spruce beetles on infested logs. In addition, MCH has recently been shown to be effective in preventing attack by Douglas-fir beetle (*Dendroctonus pseudotsugae*) on small, valuable stands of Douglas-fir. However, equivocal results in recent trials in Utah suggest that operational use of MCH against spruce beetle cannot be universally successful in all areas or.

A potential use of MCH would be to deploy MCH in an area in an attempt to disrupt attack and colonization there, causing dispersal of beetles. This would be done with methods similar to those used against Douglas-fir beetle. It may be that this tactic is only successful at lower beetle population levels and that effectiveness ceases above some population threshold. Another potential use of MCH would be deploying it to "push" spruce beetles from a stand or area needing protection while at the same time "pulling" them into a nearby stand or area scheduled for regeneration harvest with attractant pheromones. Neither of these tactics has been successfully demonstrated against spruce beetle as yet.

One inhibition to the development of operational MCH use has recently been eliminated. The USDA Forest Service under the authority of the US Environmental Protection Agency currently registers MCH for use in the United States. Not all States, however, have reviewed this recent development and given their approval against the Douglas-fir and spruce beetles.

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APPENDIX 2 ACTION ALTERNATIVES AGAINST MOUNTAIN PINE BEETLE

by W. C. Schaupp, Jr.

MANAGEMENT STRATEGIES

Several actions are available to reduce pine mortality which results from attack by mountain pine beetle (MPB), *Dendroctonus ponderosae* Hopkins (Order Coleoptera; Family Scolytidae). Indirect action can be taken toward the habitat and host trees required by MPB, while direct action can be taken against the MPB population itself. These pest management actions may focus upon reducing the number of susceptible pines and the overall susceptibility of stand conditions to MPB, upon eliminating infested trees and the MPB population directly or upon preventing new attacks. Indirect action addresses the "cause" of MPB outbreaks, which is the presence of susceptible pine stands, while direct action addresses the "symptom" of MPB outbreaks, which is too many beetles in one place at one time. Currently, there is no way to suppress a large-scale MPB epidemic once it has begun, although this is a theoretical possibility given unlimited funding and effort. Prevention should be emphasized where MPB impacts are undesirable. Altering stand conditions to be less favorable to MPB population increase and less susceptible to mortality from MPB is the only long-term "cure". Once undesirable MPB-caused mortality has begun, the intent of forest management should be to reduce adverse impacts to affected areas and minimize spread of the problem to adjacent stands. The decision to take a particular action(s) should be based on management objectives, economic factors, MPB population status and trends, stand conditions, location, resource values at risk, and other relevant issues. Consideration of MPB in the context of overall land management is important, for focusing on MPB alone may amplify other problems, such as dwarf mistletoe infestation. A combination of several of the following action alternatives may be useful in most situations.

ALTERNATIVE 1: DO NOTHING

Accept pine tree mortality and associated impacts caused by MPB as a natural phenomenon. MPB is a native insect that has been active for thousands of years. It is one of the most important biotic causes of pine mortality in conifer forests across the West. MPB populations increase or decrease without direct human influence. Epidemics of MPB have many ramifications in addition to the creation of dead pine trees. These impacts vary depending upon the extent, intensity, and duration of the MPB epidemic.

<u>Where to use</u> - Use where other alternative actions are not desired, cannot be implemented or will not be effective. One example would be designated wilderness areas.

<u>Advantages</u> - No mechanical site disturbance or introduction of foreign materials into the environment will occur. Understory vegetation will prosper. From extensive and intense MPB epidemics, water yield and possibly annual stream flow will increase. Tree regeneration may be facilitated by increased sunlight reaching the forest floor. Changes in vegetation and cover may be advantageous to certain wildlife species, particularly those which utilize dead trees. Successional trends may be affected advantageously. Public sentiment might be positively impacted by the decision to "let nature take it's course". Resources might be redirected toward areas where MPB impacts are undesirable, reducing future susceptibility to MPB, rather than "chasing beetles" where they are currently causing mortality.

<u>Disadvantages</u> - The "do nothing" alternative means human activity will not change the forest's resistance to MPB population increase and spread. Therefore, where MPB populations are increasing, doing nothing allows MPB populations to continue to increase and spread to additional trees and sites. Dead trees can

become safety hazards over time as they rot and fall. Timber values are reduced or lost. From extensive and intense MPB epidemics, the following may occur: visual quality adversely affected by large numbers of dead and dying trees; travel restricted within affected stands by the eventual presence of fallen trees; fire hazard increased during the period when red, dry needles are present on recently killed pines; and, after killed trees have dropped their needles and rot and fall to the ground, more severe fires that are harder to manage. Loss of tree cover might lead to erosion or landslide once the tree roots have rotted. Tree regeneration may be inhibited due to loss of seed-bearing pines, the shading and covering effect of dead and fallen trees, and a lack of seedbed preparation. Changes in vegetation and cover may not be advantageous to certain wildlife species. Successional trends may be affected disadvantageously. Public sentiment may be negatively impacted, even in situations where an MPB epidemic can not be stopped by direct action.

ALTERNATIVE 2: SILVICULTURAL TREATMENT

Actions which promote tree vigor and wide spacing are the primary means to reduce or prevent the impact of MPB epidemics. The best long-term tactic to minimize losses to MPB is partially cut susceptible stands or harvest and subsequently replace susceptible stands. Removal of individual pines of low vigor and poor health will lessen the chance that MPB may get started in an area. Highly hazardous conditions for MPB in lodgepole pine stands are those at lower elevation-latitudes where average tree diameter exceeds 8 inches and average tree age exceeds 80 years; highly hazardous conditions for MPB in ponderosa pine stands are those where average tree diameter is equal to or greater than 8 inches and basal area is greater than or equal to 120 square feet. Therefore, partial cutting that reduces stands to 60 - 80 square feet of basal area or less and average tree diameter to below 8 inches affords the greatest protection. When partially cutting (thinning) susceptible stands, care must be taken to avoid leaving dense pockets of mature pines, because these areas can serve as foci for MPB attack. Cutting trees already killed by MPB is called "salvage harvesting" and is discussed under Alternative 3.

Where to use - This is a preventive treatment that addresses long-term tree and stand health. It should be incorporated into land management activity wherever MPB impacts are considered undesirable or are to be minimized. It is particularly important where timber values are the highest priority.

Advantages - Silvicultural treatment reduces the susceptibility of trees and stands to MPB attack and has been shown to limit pine mortality from MPB in stands. While this does not guarantee immunity from MPB infestation, it promotes tree and stand health and creates conditions known to be less favorable to MPB. Cutting green trees prior to MPB infestation maximizes economic return from timber resources, because MPB-killed trees are usually less valuable. If applied on a landscape scale, silvicultural treatments could result in a mosaic of susceptibility to MPB, which theoretically might inhibit the development of large-scale MPB epidemics by increasing MPB mortality as they seek new stands to infest. Landscape disturbance and renewal is inevitable in pine forests. MPB epidemics and stand replacing fires tend to create vegetation patterns that are very different from the results of most silvicultural treatments. Silvicultural treatment offers the opportunity to create vegetation patterns and stand conditions that may be more consistent with land management objectives than the results of an MPB epidemic and/or stand replacing fire. To rephrase this last sentence more directly and simply, `Who will select the trees that will die --- the forest manager or the beetles and fires ?'

Disadvantages - This action is not suitable for areas where tree cutting is undesirable, unaffordable or not allowed. Examples of such areas are wilderness, steep slopes, and areas where the visual quality of cut areas would be lower than that of dead trees. It is not possible in areas with no loggers and/or ready market for wood products.

ALTERNATIVE 3: SANITATION AND SALVAGE HARVESTING

Sanitation harvesting is a treatment applied to currently infested pine stands. Green trees with immature MPB developing under the bark are cut and either removed to an area at least one mile from other, susceptible pines or processed at a mill prior to MPB emergence. This makes it impossible for the MPB living within the infested trees to mature, emerge, and attack uninfested pines. Because MPB emergence can begin as early as mid-July; sanitation must be completed prior to MPB emergence to be effective. Salvage harvesting is cutting pines already killed by MPB from which the beetles have departed. This so frequently occurs in conjunction with sanitation that the tactics are combined under this alternative, although salvage harvesting does not affect the MPB population directly. The removal of currently infested and recently killed pines in a stand can serve as a starting point for a silvicultural treatment (see Alternative 2), as it will reduce the basal area and tree diameter in the infested patches.

<u>Where to use</u> - Use in stands that are currently under attack where reduction of the MPB population and recovery of timber resource values is desirable and where timber harvesting activity is acceptable. Especially appropriate are infested stands in proximity to uninfested, susceptible stands of high value where mortality from MPB would threaten land management objectives. Employ concurrently with silvicultural treatment in stands where the MPB population has not yet reached serious epidemic levels.

<u>Advantages</u> - MPB populations can be significantly reduced in localized areas and in stands by removing most or all infested trees prior to the emergence of the next generation of beetles. Sanitation provides a degree of protection to surrounding, uninfested trees and stands by removing a nearby source of attacking beetles. Timber volume is recovered that would otherwise be lost. The fire hazard which would result from the presence of dead pines holding dry, red needles is lowered. By limiting the creation of dead trees that will eventually rot and fall to the ground, the potential for severe fires that are harder to manage is lessened. The visual impact of dead and dying trees is reduced. The subsequent hazard from falling trees is lowered. Pine regeneration will be encouraged by both the site disturbance and the reduction in shade.

<u>Disadvantages</u> - There is little time for implementation, because infested trees must be removed by mid-July in the year following attack by MPB. Sanitation/salvage harvesting has not been demonstrated to suppress MPB populations on a scale larger than the individual stand, though this may occur in some cases. It should not be considered an efficacious control tactic across large landscapes or during severe MPB epidemics where MPB immigration into treated stands is likely. Sanitation/salvage harvesting undertaken without additional considerations for stand health and survival can lead to residual conditions that have other significant problems, such as increased spread and intensification of dwarf mistletoe. Individual infested trees must be identified and, in erring on the side of caution, trees which were unsuccessfully attacked that might otherwise survive will be targeted for cutting. Application may remove tree cover in spots or at densities that may be considered aesthetically unacceptable. Adverse site and soil disturbance is possible. Local mills and markets can be swamped by a sudden glut of wood.

ALTERNATIVE 4: INFESTED TREE TREATMENT

Cut and individually treat infested pines prior to the maturation and emergence of MPB, which can begin as early as mid-July. Any action that kills most or all of the MPB within infested trees prior to MPB emergence falls under this direct control action alternative. **The following examples do not work in all situations and are not all supported by rigorous research results.** Examples of infested tree treatment techniques are as follows: (1) Cut and burn on site; (2) Cut and bury at least 6 inches deep on site; (3) Cut and chip; (4) Cut and remove the bark from infested portions of logs before the immature MPB transform to adult beetles; (5) Cut and expose to direct sunlight such that the trunk surface receives sufficient heat to kill the beetles under the bark, rotating the trunk to ensure complete exposure; (6) Cut and cover with thick clear plastic such that the trunk surface receives sufficient heat to kill the beetles under the bark; (7) Cut and treat infested logs with an approved, registered insecticide in accordance with label directions [NOTE: Currently, only a few formulations of lindane, usually labelled as some brand of `borer spray', remain available to treat infested logs; it is increasingly difficult to locate such formulations of lindane in Colorado; and it is expected that, once current stockpiles are depleted, the manufacturer(s) will not produce additional supplies and the manufacturer(s) will not attempt to reregister these formulations of lindane with the United States Environmental Protection Agency for use by private citizens after their current registration expires]. It is important to check any treatment near the end of June. If excessive MPB survival is noted, option (7), chemical treatment, could still be performed to prevent MPB emergence. Infested tree treatment differs from sanitation harvesting (Alternative 3) only because it is usually applied on a smaller scale and is often not conducted in conjunction with salvage harvesting.

Where to use - This alternative is most appropriate for treating small spots in areas of great concern, such as those adjacent to residences and within developed recreation sites. It may also be appropriate in unroaded areas, on slopes too steep to harvest with conventional methods, in areas where the disturbance from conventional harvest activity is unacceptable, and in areas where there is no possibility of sanitation/salvage harvesting due to insufficient volume, no bids or other reasons.

Advantages - Much of the immature MPB population can be eliminated from the treated area. As a result, infested tree treatment provides a degree of protection to surrounding, uninfested trees and stands by removing a nearby source of attacking beetles. This temporary protection period can be used to advantage if silvicultural treatment is then implemented. The potential for site and soil disturbance is less than that of Alternative 3. The fire ignition hazard from the presence of dead pines holding dry, red needles is lowered. The visual impact of dead and dying trees is reduced. The subsequent hazard from falling trees is lowered. Pine regeneration may be encouraged by the reduction in shade. Firewood may be recovered from this treatment.

Disadvantages - There is little time for implementation, because infested trees must be removed by mid-July to August in the year following attack by MPB. Although a degree of protection is provided by this treatment, it is an action that kills beetles; the issue of mitigating the susceptible forest condition that lead to an MPB infestation is not addressed. Individual tree treatment is not a stand treatment and does not address any considerations for improving stand health. Individual tree treatment is unlikely to be implemented at a sufficiently large scale to be an effective control tactic across large landscapes or during severe MPB epidemics where MPB immigration into treated areas is likely. Infested trees must be individually identified and, in erring on the side of caution, trees which were unsuccessfully attacked that might otherwise survive may be targeted for treatment. Because it can be difficult to locate and treat absolutely all infested trees in an area, additional follow-up treatments may be needed in subsequent years. Infested trees may be moved inadvertently as firewood prior to MPB emergence, possibly spreading the infestation. The cost of pesticides can be significant. Potential environmental hazards exist from improper use, storage or disposal of chemicals and chemically treated wood.

ALTERNATIVE 5: PROTECTION OF HIGH VALUE TREES

Prior to the attack period of MPB, which can begin as early as mid-July, the stems of living, green, uninfested trees which are of high value are sprayed with an approved, labelled insecticide that repels and/or kills attacking MPB and prevents infestation.

Where to use - This action is appropriate around private homes and in and around campgrounds and developed recreation sites when there is a threat due to active MPB populations in the vicinity. Trees must be of high value to justify the expense of spraying. Because specialized equipment may be required, trees must be relatively accessible. This action is not effective for trees which have already been infested by MPB.

Advantages - Controlled experiments and operational experiences have established this action as very effective in protecting individual pines from infestation. Specific formulations of carbaryl and permethrin are currently labelled for this use. Protection using carbaryl has been demonstrated to last from 10 - 18 months, meaning that a late spring application may afford two years of protection.

Disadvantages - Carbaryl and permethrin are toxic to insects other than MPB. Insecticide applied as protection does not effectively reduce the beetle population or address the cause of the outbreak. It does not guarantee absolute protection, especially if the application is not thorough and complete. It can be very expensive, especially if large areas require treatment, and is not likely to be employed over large areas for that reason. Potential environmental hazards exist from improper use, storage or disposal of chemicals and chemically treated wood. At the outset of MPB outbreaks, there may be a shortage of qualified applicators. Many citizens have concerns about environmental contamination and safety.