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MONTANA FOREST INSECT AND DISEASE CONDITIONS AND PROGRAM HIGHLIGHTS

2002

Montana
Department of
Natural Resources
and Conservation

Forestry Division

Western false hemlock looper larva

Western spruce budworm adult and pupae

MONTANA

Forest Insect and Disease Conditions and Program Highlights - 2002

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INTRODUCTION

This report summarizes the major forest insect and disease conditions in Montana during 2002 and was jointly prepared by the Montana Department of Natural Resources and Conservation, Forestry Division and USDA Forest Service (FS), Forest Health Protection (FHP), State and Private Forestry, Northern Region. Information for the report was derived from ground and aerial surveys within Reporting Areas across parts of Montana. A Reporting Area (RA) includes all federal, state, and private land ownerships within a particular geographic boundary (Figure 1).

SUMMARY OF CONDITIONS

Bark Beetles

As we completed our fourth consecutive year of unusually dry conditions, we saw most bark beetle populations continue to expand. Mountain pine beetle-caused mortality was recorded on more acres than at any time in the past 15 years; Douglas-fir beetle-infested acres decreased in most areas, and has finally begun declining from all-time recorded highs; grand fir mortality attributable to fir engraver has never before been recorded on so many acres; and western balsam bark beetle-killed subalpine fir was mapped on considerably more acres than in the past several years. Now, as we begin 2003, it appears that we are entering into a fifth year of near-drought conditions. Without some type of major shift in weather patterns, we anticipate most beetle infestations will continue to increase in both extent and intensity through the coming field season.

Defoliators

In 2001 aerial surveyors mapped 1,300 acres of western spruce budworm east of the Continental Divide in the Helena Reporting Area. In 2002 aerial surveyors mapped 54,444 acres of defoliation by budworm in the Beaverhead, Deerlodge, Helena, and Gallatin Reporting Areas east of the Continental Divide (Figure 7). There was a significant increase in number of moths caught at several trapping sites. If the weather conditions remain within the normal range or are warmer and drier during 2003, we can expect budworm populations to increase across Montana. Defoliation by both western hemlock looper (338 acres) and false hemlock looper (3,424 acres) were observed. The false hemlock looper defoliated Douglas-fir on the Flathead Indian Reservation, east of Libby, north side of Flathead Lake, and along the Clark Fork River between Rock Creek and Beavertail Hill. Western hemlock looper defoliated subalpine fir in three areas of western Montana. Defoliation of lodgepole pine (2,948 acres) was reported on the Gallatin N.F. Either the sugar pine tortrix or pine needle sheath miner caused the defoliation. Extremely heavy defoliation of Douglas-fir by Douglas-fir tussock moth occurred on approximately 200 acres of private land in the vicinity of Loon Lake, northwest of Polson in 2002. No gypsy moths were caught in the state of Montana in 2002.

Root Diseases

Mortality and growth losses from root disease continue to be high throughout the state. Root disease-caused mortality is more common west of the Continental Divide, although large patches can be found east of the Divide. The effect of the fires of 2000 on root diseases is one of opportunity. The tree species that are best adapted to low intensity, high frequency fires, are those species that are also root disease-tolerant, such as western larch and ponderosa pine. In the root diseased areas that burned, there is the opportunity to reduce the effects from root disease by planting these species or encouraging the natural regeneration of these species.

Dwarf Mistletoes

Dwarf mistletoes continue to cause losses of approximately 33 million cubic feet annually. Douglas-fir, western larch and lodgepole pine are the tree species most severely affected. Fire greatly influences the distribution of dwarf mistletoes across the landscape. In general, any fire event that kills infected trees will reduce the population of dwarf mistletoe, at least in the short term. Large, complete burns will greatly reduce dwarf mistletoe populations across the landscape and may even eliminate small, localized populations. Small, patchy burns will temporarily reduce the amount of mistletoe, but infected residuals provide a ready source of dwarf mistletoe seeds for the infection of the new regeneration.

White Pine Blister Rust

White pine blister rust continues to be present throughout the range of five-needle pines in the state. Rust severity is highest in the northwestern part of the state where the disease continues to cause extensive mortality in western white pine. The effects of blister rust on whitebark pine ecosystems took longer to appear than in western white pine forest type, but it is apparently proving to be equally devastating.

Limber Pine Decline

Limber pine decline and mortality appear to be continuing across scattered locations in central and eastern Montana. Permanent plots to monitor the decline were established in 1996 at various locations near Stanford, Monarch, Clyde Park, and Dewey. Data was collected in 1999, 2000, and 2002.

ANNUAL AERIAL SURVEY

The annual aerial detection survey in Montana was conducted from June 24 until September 26, 2002. The survey covered approximately 23.7 million acres of mixed ownership forestlands, excluding most wilderness areas (Figure 2). Yellowstone NP is included in this acreage. Four FHP sketch mappers, using three different airplanes, conducted the 2002 aerial survey.

Much of the data summarized in this report is a product of the aerial survey, as well as ground surveys and biological evaluations. Along with the data summaries, aerial survey maps are available from the Missoula FHP Field Office, in both paper and digitized GIS format.

The annual aerial detection survey is an overview survey designed to cover large areas in relatively short periods. Aerially detected signatures include tree mortality, defoliation and windthrow. If forest disturbance activities are low, secondary disturbances such as diseases, needle casts, high-water damage and previous fire damage are sketch mapped. The intent of the survey is to cover each area once a year during which time the observer sketch maps as many disturbances and damage as possible. The survey is conducted using single-engine, high-wing airplanes, flying at speeds of approximately 90 to 130 mph, at an average altitude of approximately 1,000 to 2,000 feet above ground level.

The aerial survey data are estimates made from airplanes and though not as many areas were ground checked, as we would like, enough were checked to lend confidence to the areas for which we only have aerial survey data. Together, aerial and ground surveys provide information relative to bark-beetle-caused mortality, as well as other damage agents pertinent to land managers charged with the responsibility of maintaining forest health.

INSECTS

Abbreviations

The following abbreviations are used for beetles and their hosts throughout the bark beetle section:

Beetles	DFB	=	Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopkins
	ESB	=	Spruce beetle, D. *rufipennis* (Kirby)
	IPS	=	Pine engraver, *Ips pini* (Say)
	MPB	=	Mountain pine beetle, *D. ponderosae* Hopkins
	WPB	=	Western pine beetle, *D. brevicomis* LeConte
	FE	=	Fir engraver, *Scolytus ventralis* LeConte
	WBBB	=	Western balsam bark beetle, *Dryocoetes confuses* Swaine
	RTB	=	Red turpentine beetle, *D. valens* LeConte
Hosts	LPP	=	Lodgepole pine
	PP	=	Ponderosa pine
	WWP	=	Western white pine
	WBP	=	Whitebark pine
	DF	=	Douglas-fir
	GF	=	Grand fir
	SAF	=	Subalpine fir
	ES	=	Engelmann spruce
Other	NF	=	National Forest
	RD	=	Ranger District
	IR	=	Indian Reservation
	BLM	=	Bureau of Land Management

Reporting Area summaries follow. For each, bark beetle effects on their respective hosts are noted. To the extent possible, we have indicated areas affected, an estimate of impacts, and beetle population trends. Though reporting areas are typically designated by names of National Forests, Indian Reservations, or National Parks; there may be within those reporting areas, lands of various ownerships—federal, state and private.

BARK BEETLE CONDITIONS BY REPORTING AREA IN BRIEF

Mountain Pine Beetle (MPB). The infested area increased markedly in many parts of Montana—especially on the Lolo, Deerlodge and Flathead reporting areas (Tables 4 and 5, and Figure 3). Acres on which beetle-caused mortality was recorded—in all species and on all ownerships—more than doubled, to slightly more than 261,300 acres in 2002. That is the highest total infested area in the Montana since 1988. Populations are still expanding in many areas, with high numbers of new attacks found in most areas surveyed. In 2001, acres infested totaled but 111,600.

Douglas-fir Beetle (DFB). Populations continued to decline in most parts of Montana, although beetle-killed trees were still quite noticeable in many areas (Table 3, Figure 4). Few areas were surveyed in which new attacks were found. In western Montana, infested stands on the Flathead and Kootenai reporting areas showed generally declining populations. In many areas, beetle-killed trees were still noticeable; but in few did we find higher numbers of new attacks in 2002 than in 2001. Stands surveyed in and around areas affected by the 2000 fires on parts of the Bitterroot and Helena reporting areas showed still-high populations and increased new attacks in 2002. However, stand conditions in many of those areas suggest populations may soon begin to decline. Similar surveys conducted on the Flathead and Beaverhead reporting areas indicated populations were not as high in those areas. Generally, static populations were observed on the Lolo reporting area.

The infested area totaled 60,200 acres in 2002, compared to 82,300 acres in 2001. With the large number of acres of Douglas-fir older than 100 years that exist in Montana and so long as weather remains conducive to beetle survival and expansion, the threat will exist for DFB populations to rebound.

Fir Engraver (FE). Grand fir stands, in which FE-caused mortality was recorded, exhibited the most dramatic increases in 2002 (Table 6, Figure 5). Most stands in which grand fir was a significant component in parts of western Montana showed some level of infestation. The total infested area exceeded 8,900 acres in 2002. Last year 1,000 infested acres were recorded. We believe the dramatic increases in FE-caused mortality were drought related; and without a return to more normal precipitation, beetle-caused mortality may continue at unusually high levels.

Western Balsam Bark Beetle (WBBB). The number of acres on which subalpine fir mortality, attributed to WBBB, were recorded increased markedly in 2002 (Table 6, Figure 6). Not all infested areas were flown, but ones surveyed—on the Bitterroot, Gallatin, and Beaverhead reporting areas—totaled more than 112,000 acres. We had recorded 27,600 acres in 2001. That upward trend is expected to continue.

Others:

Pine engraver beetle (IPS) populations, and associated tree mortality increased in ponderosa pine stands in some parts of eastern Montana. While not at the level of outbreak as other beetles, engraver beetle-affected acres increased to just over 500 acres. Spruce beetle (ESB) populations remained at nearly endemic levels throughout the Montana, with the exception of a widely scattered outbreak recorded east of Yellowstone Lake in Yellowstone National Park. There, more than 6,000 acres were lightly infested. Western pine beetle (WPB)-caused mortality, still relatively low, increased to just over 740 acres in second-growth ponderosa pine stands in western Montana. Those increases were likely attributed to continuing abnormally dry conditions.

The following tables, and area summaries included throughout this report, show estimates of infested areas and amounts of associated mortality; as gathered through annual aerial detection surveys. Some have been augmented by ground surveys; but time, access, and available personnel limit those. These combined survey methods, then, provide information on extent and intensity of bark beetle infestations.

BARK BEETLE CONDITIONS BY REPORTING AREA

Beaverhead Reporting Area

Dillon RD. Most bark beetle-caused mortality on the District was observed in SAF stands, where WBBB appeared to be one of the more prevalent of the mortality-causing agents in those stands. Groups of faders, ranging from 5 to 300 trees each, were mapped throughout the Beaverhead Mountain Range, from Gold Stone Pass on the north to Tex Creek on the south. Largest concentrations were mapped near Lake Canyon and Dad Creek Lakes. Total infested area on the District was about 2,400 acres; on which an estimated 4,300 subalpine fir were killed.

In other parts of the District, widely scattered small groups of DFB-killed DF—totaling less than 300 acres; and MPB-killed LPP—just over 700 acres, were noted. They were of considerably less impact than the outbreak of WBBB.

Wise River RD. WBBB remained the single most important agent of mortality in SAF stands on the District. Small and scattered groups of faders were recorded in the Anaconda Range, from Oreamnos Lake, eastward to Tenmile Lakes. Throughout the Pioneer Mountains, however, much larger and more extensive groups were mapped. Largest groups were located near Foolhen and Shaw Mountains, southward to Stewart Mountain. Infested areas totaled an estimated 1,400 acres on which 2,400 trees were killed.

Mountain pine beetle killed LPP were found scattered in very small groups throughout the Pioneers, with one large group being recorded in upper Pattengail Creek drainage, north of Bobcat Mountain; and a few smaller groups in the East Pioneers, near Kelly Reservoir and Silver King Mine. The area infested by MPB was estimated at 650 acres. Douglas-fir beetle caused mortality was noted in very small and widely scattered groups totaling less than 80 acres.

Wisdom RD. As in other parts of the Forest, WBBB is the most significant mortality-causing agent on the District. Subalpine fir stands throughout the Beaverhead Mountain Range, along the Montana/Idaho border are infested to greater or lesser extents. Notable concentrations were mapped in the Ruby Creek drainage, west of Wisdom; and in the Beaver Creek and Thompson Creek drainages in the Anaconda Range to the north. In total, on the District, 3,600 subalpine fir were killed on 2,700 acres.

Other small and widely scattered bark beetle-caused mortality (DFB and MPB) was of little importance. Mortality attributed to each totaled 160 DF, 16 PP, and 55 LPP.

Madison RD. Subalpine fir mortality, attributed to WBBB, reached extremely high levels throughout the District in 2002. While some stands were more heavily infested than others, it appeared there were few SAF stands on the District not affected to some extent. Relatively small groups—up to 100 trees each—were reported in the Tobacco Root Mountains to the north. To the south, throughout the Gravelly Range, extremely large groups of faders—covering as much several thousand acres each, and averaging an estimated 3-5 trees per acre—were mapped.

Largest concentrations of WBBB-killed trees were noted southwest of Ennis in Morgan Gulch, Cherry Creek drainage, near Wolverine Basin, close to Freezeout, Divide, and Cascade Mountains, in the upper Coal Creek drainage, and to the west near Stonehouse Mountain and Antone Peak. Lesser, but significant amounts of WBBB-caused mortality were recorded in the Ruby Range and the Blacktail Mountains. Total affected area on the District was estimated at 25,500 acres on which 54,000 trees were killed.

Elsewhere, there were lesser amounts of DFB-killed DF, and MPB-killed WBP scattered throughout the reporting area. DFB-caused mortality was especially noticeable in the West Fork Madison River drainage, and totaled about 3,900 trees on 1,600 acres. Mountain pine beetle-killed WBP were prevalent, and significant, near and to the west of Sawtooth Mountain. An estimated 28,000 WBP were killed on 11,600 acres. Smaller amounts of LPP (on 870 acres) and PP (on 480 acres), killed by MPB, were also noted on the District.

To the south, in the Centennial Range, on lands administered mostly by BLM, large amounts of SAF, killed by WBBB, were found. In that same general area, significant amounts of WBP and LPP have also been infested by MPB. Largest groups of SAF faders were noted in Curry, Humphry, and Shambow Creek drainages and totaled almost 47,000 trees on 14,000 acres; while most MPB-caused mortality was to the west of there, from Curry Creek west to West Fork Corral Creek. A total of 48,000 WBP and 36,000 LPP were killed on a combined 15,500 acres.

Aerial survey estimated totals for the reporting area, on lands of all ownerships, showed nearly 3,500 acres infested by DFB; 45,600 acres infested by MPB (all hosts); and almost 68,000 acres infested by WBBB. Approximately 304,000 trees were killed by bark beetles throughout the area in 2001—and recorded as faders in 2002.

Bitterroot Reporting Area

Stevensville RD:

Widely scattered and small groups of DFB-killed DF were noted in the Bitterroot Mountains, west of Stevensville. In lower elevation stands, along the eastern slopes of the Bitterroots, small and very scattered groups of PP, killed by MPB and/or WPB were observed. Several groups of LPP, killed by MPB, were mapped in McCalla Creek drainage, west of Stevensville.

In the Sapphire Mountains, to the east of the Bitterroot Valley, many small groups of beetle-killed trees were generally scattered throughout the reporting area. Most numerous were groups of DFB-killed DF, but also quite numerous were groups of SAF, killed by WBBB. Also prevalent, especially near Skalkaho Mountain, were groups of PP, killed by MPB. Likewise, many PP have been killed by MPB in the Sleeping Child and Little Sleeping Child drainages.

District totals showed almost 200 acres of DFB-infested DF; nearly 400 acres infested by MPB—most in PP stands; and more than 200 acres affected by WBBB. Those were about the same levels found in 2001.

Darby RD:

Widely scattered groups of PP, killed by MPB and WPB, were observed in low-elevation stands on the east slopes of the Bitterroot Mountains. Beetle-killed groups were especially noticeable south of Lake Como. In that same general area, widely scattered and small groups of LPP, killed by MPB were mapped. Also in that area, many DF have been affected by fire or DFB, or both.

In summary, almost 350 acres exhibited some level of DFB-caused mortality; and 550 acres of MPB-killed trees—almost equally distributed between PP and LPP stands. Other bark beetle-caused damage was noticeable, but less prevalent.

Sula RD:

Many groups of DF, killed by DFB and varying in size from a few to as many as 150 trees each, were noted throughout several tributaries of East Fork Bitterroot River, from Sula east to the Forest boundary. East of the Bitterroot River, in Warm Springs Creek drainage, observers noted many groups of DFB-caused mortality. Total area infested by DFB on the District exceeded 900 acres.

In that area, numerous groups of LPP, killed by MPB were also recorded. Those totaled more than 350 acres; with another 70 acres showing PP killed by MPB. At higher elevations, SAF stands generally contained small groups of WBBB-killed trees; totaling only about 30 acres.

West Fork RD:

Extreme amounts of DFB-killed—and fire-affected—DF were mapped throughout the reporting area. Largest groups were noted in the upper portions of West Fork Bitterroot River drainage—specifically in the Deer Creek, Salt Creek, and Hughes Creek drainages. Numerous large groups were also observed west of Nez Perce Pass, in the Frank Church-River of No Return Wilderness; however, much of that wilderness area was not flown. Groups of beetle-killed trees are generally smaller and less wide-spread than in 2001, but quite extensive, nevertheless. District totals showed nearly 10,000 acres still infested. In addition, several hundred acres were observed on which MPB had killed LPP or PP; and about 200 acres showed comparatively small amounts of WBBB-killed SAF.

Throughout the Bitterroot reporting area, in areas affected by fires of 2000, it was difficult for the aerial observer to distinguish between DF affected by fire and those infested by DFB. Ground surveys indicated beetles had infested many fire-damaged trees. Surveys conducted in fire-affected and adjacent stands in 2002, on more than 50 variable-radius plots, showed an average of 27 new attacks per acre in 2002, compared to 6 in 2001. Many of those surveys, however, suggest beetle populations may soon begin to decline.

Reporting area totals for 2002 showed more than 11,700 acres infested by DFB, on which about 25,000 DF were killed. Slightly more than 1,000 acres of LPP and 1,300 acres of PP contained MPB-caused mortality. Much of the latter was recorded on the Sula State Forest. Just over 500 acres of SAF stands were infested by WBBB. Morality attributed to other bark beetles was less noticeable.

Custer Reporting Area

Beartooth RD. Large groups of WBBB-killed SAF were recorded in the Pryor Mountains near Tony Island Spring; smaller groups near Teeples Spring. Total mortality attributed to WBBB in that area was 1,500 trees on 660 acres. WBBB attributed to SAF mortality on about 1,000 acres of various ownerships.

Elsewhere, MPB-caused mortality was noted in PP stands at several widely scattered locations. The most significant amounts were mapped in Lost Water Creek drainage, in Burnt Timber Canyon, and along Tiller Ridge. Infested stands were also noted on lands administered by BLM, to the southeast of lands under FS jurisdiction. Total infested area was about 375 acres on FS land and another 650 on BLM.

Sioux RD. District not flown in 2002. In 2001, MPB-infested PP stands had been noted in Chalk Buttes, Ekalaka Hills, and the Long Pines. Additional beetle-caused mortality was observed in the East and West Short Pine Hills, North and South Cave Hills, and Slim Buttes. There was some indication those populations were building. A total of 870 acres, averaging mortality of less than a tree per acre, was recorded in 2001.

Ashland RD. District not flown in 2002. Small and widely scattered groups of MPB-killed PP had been recorded on about 450 acres in 2001. Much of that was in the Otter Creek and Tongue River drainages, or in stands affected by the Stag Fire of 2000.

Deerlodge Reporting Area

Butte RD. Very large groups of LPP, killed by MPB, were mapped to the north, south, east, and west of Butte in 2002. The largest groups, and the most damaging amount of MPB-caused mortality, were recorded to the southeast, in the Basin Creek and Thompson Park areas. There, fader groups extended to several thousand acres each, and averaged as high as an estimated 30 beetle-killed trees per acre. Ground surveys conducted there showed the infestation in that area is still increasing, with more than 20 trees per acre infested in 2002.

To the east, along East Ridge, the very noticeable outbreak continued, as did ones near Delmoe Lake, north of Homestake Pass. To the north of Butte, in Hail Columbia Gulch, Sheep Gulch, Browns Gulch, and Telegraph Gulch, outbreaks continued to build.

To the west and southwest, near Fleecer Mountain, and along east-facing slopes of Fleecer Ridge increasing amounts of MPB-killed LPP were mapped. District-wide, more than 83,000 LPP were killed on nearly 12,000 acres. That represented a tenfold increase in infested area in 1 year.

Douglas-fir beetle-killed DF was noted in small and widely scattered amounts throughout the DF type and totaled less than 30 acres, with an average of one tree per acre killed.

Jefferson RD. Mountain pine beetle-infested LPP stands were mapped east of Delmoe Lake, and extending east of Whitetail Reservoir into the upper portions of Whitetail Creek. Infestations there were not as extensive as those to the west, but appear to be still increasing. In total, almost 3,000 acres were infested on the District.

South of Boulder, in the vicinity of Bull Mountain, small and widely scattered groups of DFB-killed DF were noted. Those totaled about 125 acres. In the northern portion of the Tobacco Root Mountains, several groups of SAF, killed by WBBB and totaling 225 acres, were mapped near Mill Canyon, Beall Lake, Smelter Mountain and Lava Mountain. In that area, small and scattered groups of DFB-killed DF, and MPB-killed WBP were also found.

Deer Lodge RD. Mountain pine beetle-caused mortality in LPP stands is increasing east of Deer Lodge, in the Baggs Creek and Cottonwood Creek drainages. Small and, as yet, widely scattered groups of MPB-killed LPP were observed in many LPP stands throughout the reporting area. Those outbreaks, totaling about 2,000 acres, appeared to be increasing.

Large groups of MPB-killed LPP were also noted between Jones Mountain and Douglas Mountain, west of Deer Lodge. Those, likewise, will probably expand in 2003.

Pintler RD. Large and rapidly expanding groups of LPP, killed by MPB, were mapped in Boulder Creek and Smart Creek drainages, north of Philipsburg. Building MPB populations were found in many mature LPP stands on the District, but especially noticeable were concentrations noted in Upper Willow Creek drainage. Other groups were mapped near the confluence of Stony Creek and Rock Creek. District totals were 4,400 acres of MPB-caused mortality in LPP stands, 120 in PP stands, and another 350 in WBP stands.

In upper Stony Creek drainage, and northward into Harvey Creek drainage, may small and widely scattered groups DFB-killed DF were seen. In several high-elevation SAF stands, notably upper Stony Creek, Rock Creek, and Lutz Creek, WBBB-caused mortality was prominent. Mortality in those stands totaled almost 1,600 acres. In a few lower-elevation PP stands, north towards the Clark Fork River, MPB had killed several groups of trees. There, stands on predominantly State and private land, the infested area totaled more than 550 acres.

For the Reporting Area, MPB-infested stands were found on more than 27,000 acres—most in LPP stands on FS-administered lands. DFB infested another 2,400 acres and WBBB about 2,200 acres.

Flathead Reporting Area

Swan Lake RD. Unusually high amounts of GF, killed by FE, were mapped throughout mixed-conifer stands on the District. While FE was the direct cause of mortality, we surmise beetles were exploiting large numbers of drought-weakened trees that have become increasingly available over the last few years. A large polygon, covering several thousand acres, and averaging an estimated one FE-killed GF per acre, was mapped just east of Echo Lake.

Elsewhere, and southward through the Swan Valley, most stands that contained GF were affected to a greater or lesser extent. DF stands in that same general area were also impacted severely by DFB. Although infested groups were typically not large, they were very generally scattered throughout the DF type. The largest group, of 2000 trees, was mapped in the South Fork Lost Creek drainage, a few miles south of Swan Lake.

Significant amounts of MPB-killed LPP were also widely scattered throughout LPP stands, both east and west of Swan Valley. There were also important amounts of WBP mortality, attributed to MPB, in some locations—the most notable being a large fader group mapped above Swan Lake, near the mouth of Sixmile Creek. Many high-elevation SAF stands in that area also contained trees killed by WBBB—generally scattered throughout the type.

On the "Island Unit," west of Flathead Lake, MPB-killed LPP and FE-infested GF increased significantly in 2002. One group of beetle-killed LPP, north of Forrey Creek, contained an estimated 3000 trees. Many small groups of LPP, killed by MPB, DF killed by DFB, and SAF killed by WBBB were mapped throughout the Blacktail Mountain area. Lower elevation PP stands were adversely affected by MPB throughout the Unit as well.

District-wide, nearly 3,300 acres showed some level of FE-caused mortality on both FS and private land. An additional 1,700 acres were impacted by DFB, and MPB killed various of its host on 3,200 acres on lands of all ownerships.

Spotted Bear RD. Mountain pine beetle-caused mortality expanded significantly in LPP stands along the South Fork Flathead River, south and east of Spotted Bear. One polygon between Addition Creek and Jungle Creek—about 2500 acres, contained an estimated 50,000 beetle-killed trees. Other groups nearby totaled 15,000; 10,000; and several of 3,000 trees each. Most LPP stands along tributaries of the South Fork, south of the Ranger Station, have been affected to some extent. Ground-collected data in that area showed an average of nearly 35 trees per acre killed in 2002. That was a general increase over the level of a year ago. In total, almost 14,000 acres showed MPB infestations, compared with just under 12,000 acres in 2001.

Other areas of increasing populations were mapped along Spotted Bear River—especially in the vicinity of Big Bill Mountain. In DF stands in the Spotted Bear River drainage, DFB-killed trees were common, but in mostly small and widely scattered groups. Those were especially prevalent in the vicinity of Pivot Mountain and Blue Lakes. Elsewhere in the District, MPB- and DFB-caused mortality was scattered. Total DFB-affected stands on the District covered slightly more than 625 acres.

Hungry Horse/Glacier View RD. Both MPB and DFB activity increased throughout the District in 2002. MPB-caused mortality was common in both LPP and WWP stands on both sides of Hungry Horse Reservoir, from Hungry Horse and Martin City, south to the District boundary. Building populations of MPB were mapped in the upper portions of Middle Fork Flathead River, especially along and near Patrol Ridge. Numerous other groups of MPB-caused faders were mapped along the Middle Fork from Nimrod, north to Tunnel Creek. MPB killed about 5,000 LPP, more than 340 WWP, and another 30 WBP on a combined 2,800 acres.

Douglas-fir beetle-caused mortality was observed in higher concentrations on the Coram Experimental Forest, other sites just south and east of Hungry Horse and Martin City, and along the Reservoir, south to Dudley Creek. Nearly 1,000 acres were affected. At higher elevations, considerable amounts of WBBB-caused mortality were noted in SAF stands—of particular note near Clayton, Margaret, and Three Eagles Lakes. In those areas, more than 600 acres were infested.

On Glacier View RD, especially in upper-elevation stands of SAF above Coal Creek and Hay Creek, many groups of WBBB-killed trees—some of several hundred acres in size, were noted. More than 1,400 acres were impacted. To the south, in tributaries of North Fork Flathead River, DFB-, MPB-, and FE-caused mortality was widely scattered. In the area of the Moose Fire (of 2001), in tributaries of Big Creek, DFB populations were found in varying amounts, some at levels causing management concerns. Mountain pine beetle affected stands on about 85 acres and DFB on almost 50 more.

Tally Lake RD. Many large groups of FE-killed GF were observed on Stillwater SF, north of Whitefish Lake, within this reporting area. Throughout mixed conifer stands on the District itself, many groups of beetle-killed trees, of several species, were observed. Around Tally Lake, numerous groups of DFB-killed DF were mapped. Some groups contained as many as 500 trees each. In that same general area, MPB populations were found to be building in LPP stands. From there, south to Highway 2 west of Kalispell, LPP stands infested by MPB were prevalent.

Throughout the Logan Creek drainage, many lower-elevation DF stands have been seriously impacted by DFB; while upper-elevation ones showed significant amounts of WBBB-caused mortality. Mortality attributed to WBBB was especially heavy in stands near Sheppard Mountain and in upper portions of Good Creek, Bowen Creek, and Robertson Creek drainages. Fir engraver-caused mortality was also noted in many stands dominated by GF. In general, bark beetle-caused mortality recorded during aerial surveys (trees killed by beetles in 2001) increased throughout the reporting area.

On District and adjacent lands, nearly 2,000 acres showed some level of DFB-caused mortality, about 500 acres showed MPB-killed trees, about 600 acres of FE-related activity, and more than 2,900 acres of WBBB-infested SAF.

Throughout the reporting area, on lands of all ownerships, more than 21,600 acres have been infested by MPB; 8,100 acres by FE; 7,100 acres by DFB; and 5,400 acres by WBBB. In all, slightly less than 160,000 bark beetle-killed trees were recorded in 2002.

Gallatin Reporting Area

Big Timber RD. Douglas-fir beetle-caused mortality in the lower Boulder River drainage, south of Big Timber increased somewhat over that reported in 2001. Beetle-killed groups from Froze to Death Creek, south to Clear Creek, were generally of from 5 to 30 trees each; however, one 80-tree group was mapped south of Miller Creek. From Clear Creek, south to the East Fork Boulder River, groups were larger—most from 30 to 50 trees each, although 2 of 80 trees each were observed in that area. On private and FS lands, approximately 850 acres have been infested.

In the upper part of the drainage, from Elk Creek nearly to Boulder Pass, several groups of WBBB-killed SAF were found. One group was estimated to contain 350 trees. In that area, about 400 acres of SAF stands have been affected. A few small groups DFB- and WBBB-caused mortality were noted on the east slopes of the Crazy Mountains. Most of the rest of the District was not flown.

Livingston RD. Scattered, small groups of DFB-killed DF were once again mapped in the Mill Creek drainage. Although lessening, DFB populations have existed in that area of the District for more than 10 years. Those infestations covered less than 200 acres, total.

Widely scattered MPB-killed LPP (one 200-tree group was noted near Ibex Mountain), DFB-infested DF, and SAF affected by WBBB were mapped on the west side of the Crazy Mountains. SAF-infested stands totaled about 1,300 acres. The remainder of the District was not flown.

Gardiner RD. A few groups of DFB-killed DF, most containing from 30 to 50 trees each, were mapped in the Bear Creek drainage, northeast of Gardiner. In a few higher elevation stands, SAF had been killed by WBBB.

A small outbreak of DFB was also noted in Cedar Creek and Slide Creek drainages, east of the Yellowstone River, north of Gardiner. White pine blister rust was reported as the damaging agent in WBP stands at several locations on the District. Secondary bark beetles may also be affecting those trees.

Throughout the District, about 525 acres of DFB-infested stands were noted. Another

650 acres were found to contain noticeable amounts of WBBB-caused mortality.

Bozeman RD. The most prevalent bark beetle condition noted on the District was widely scattered, but occasionally large, groups of WBBB-killed SAF totaling about 620 acres. The largest groups in the Gallatin Range were mapped in the Rock Creek drainage; however, fader groups were noted throughout. Also of note throughout the District were widely scattered, small groups of DF, killed by DFB that totaled approximately 70 acres.

Likewise in the northern part of the District, in the Bridger Mountains, widely scattered and mostly small groups DFB- and WBBB-killed trees noted in DF and SAF stands, respectively. Heaviest concentrations of the latter were noted in the upper portions of Stone and Jackson Creek drainages.

Hebgen Lake RD. Douglas-fir beetle-killed DF were still very noticeable both north and south of Hebgen Lake, but the infested area appeared to be generally less than recorded in the last few years. Fader groups were generally in the 10- to 50-tree range. Total infested area was about 700 acres.

Northward, from Hebgen Lake, throughout the Madison Range, SAF stands were once again heavily infested by WBBB. Very large groups were mapped within the Snowslide Creek, Sage Creek, Little Sage Creek, and Wapiti Creek drainages. Elsewhere, though widely scattered throughout the SAF type, groups were generally smaller. Although not all SAF stands were flown, nearly 12,000 acres were observed with some degree of beetle-infested stands. A few small groups of LPP, killed by MPB, were observed at a few locations.

For the portion of the Reporting Area flown, nearly 2,400 acres of DFB-infested stands were observed. Another 150 acres of MPB-infested LPP, and almost 15,000 acres on which WBBB-killed SAF was found were mapped.

Helena Reporting Area

Townsend RD. Extensive stands of white bark and limber pines, affected by blister rust, were recorded in the Big Belt Mountains, east of Canyon Ferry Lake. MPB and secondary bark beetles have also infested many of those stands. Small groups of DFB-, WBBB-, and MPB-killed trees were also mapped in a widely scattered pattern throughout the reporting area. District-wide, DFB-infested trees were observed on about 260 acres and MPB-killed LPP on another 125 acres.

Helena RD. Significant amounts of MPB-killed PP were mapped south and east of Helena. The most numerous and largest groups were recorded in the Prickly Pear Creek drainage—especially Lump Gulch, near Blue Bird Flats, Sheep Mountain, and Strawberry Butte.

Additional large groups were observed northeast of Helena, in Smith River drainage, near the boundary between Helena and Lewis & Clark NFs. Smaller, more widely scattered groups of PP, killed by MPB, were noted throughout the PP type. Throughout the District, beetle-killed PP were noted on 2,500 acres. Several groups DF, killed by DFB, some as large as 50 trees observed in Crow Creek drainage, near the old Eagle Creek Ranger Station. Total DFB-infested area was about 110 acres.

Lincoln RD. Douglas-fir beetle-caused mortality in DF stands was much reduced from only a few years ago, but remnant beetle populations continued to kill trees at a few scattered locations. Several groups, one as big as 200 trees, were recorded in the Arastra Creek drainage, northwest of Lincoln. Elsewhere, groups were small and widely scattered throughout the District.

Total affected area was approximately 750 acres.

Mountain pine beetle-caused mortality in some low-elevation PP stands was also observed. Most were small groups, well scattered throughout the type; however, larger groups were recorded on private land, just to the east of the Forest boundary in South Fork Dearborn River, Wolf Creek, and several nearby drainages. Those outbreaks covered several hundred acres. WBBB has contributed to mortality in SAF stands in a few isolated locations. Minor amounts of LPP, killed by MPB, were also noted in a few stands.

Throughout the Helena reporting area, in the areas affected by fires of 2000, it was difficult for the aerial observer to distinguish between DF affected by fire and those infested by DFB.

Area-wide survey estimates for bark beetle-caused mortality totaled: DFB 1,200 acres; MPB 4,100 acres; and WBBB about 100 acres.

Kootenai Reporting Area

Rexford RD. Small groups of DFB-killed DF were found in a widely scattered pattern on both the east and west sides of Lake Koocanusa. Notable concentrations to the west were found in the Big Creek drainage; while to the east, most were found in the Pinkham Creek drainage. Total affected area was about 980 acres.

Also noticeable were groups of SAF, killed by WBBB, near Purcell Summit, Lawrence Mountain and Inch Mountain. That mortality totaled nearly 930 acres. Other beetle-caused mortality was more widely scattered, and small groups.

Fortine RD. Douglas-fir beetle-caused mortality, in DF stands, remained a significant concern on the District. The most severely affected stands were located in the Galton Range, south of the US/Canada border; and along Gibralter Ridge, south to Grave Creek. Other infested stands were mapped along Patrick Ridge, from Deep Creek to Stryker, and generally throughout Sunday Creek and its tributaries. Douglas-fir beetle-caused mortality totaled nearly 2,300 acres on FS and private land.

Subalpine fir mortality, caused by WBBB, was also prevalent at many locations on the District. One of the largest groups on the Forest, covering more than a thousand acres and containing an estimated 1,000 beetle-killed trees, was mapped east of Skillet Mountain. Total for the District was more than 3,000 acres.

Three Rivers RD. Douglas-fir beetle continued to be the most significant mortality-causing agent throughout DF stands on the District. Most DF and other mixed-conifer stands were very generally infested by DFB from the southern end of Bull Lake, northward to Seventeenmile Creek, in the Yaak River drainage. The largest groups and most heavily infested areas were mapped near Bull Lake, in the Callahan Creek, O'Brien Creek, and Pine Creek drainages; however, it appeared that most DF stands were affected to a greater or lesser extent. Total affected area was nearly 5,000 acres; down from about 7,500 acres in 2001.

In the northern part of the Yaak drainage, combinations of MPB and blister rust are very seriously affecting WWP stands. Large-diameter and older trees are more impacted by MPB, whereas blister rust was affecting stands of all ages. Mountain pine beetgle-killed WWP was especially noticeable in Red Top Creek, Meadow Creek, Hellroaring Creek, and Pete Creek drainages, and totaled about 400 acres. A few groups of MPB-killed LPP were noted throughout the Yaak drainage, with the largest groups found in the vicinity of Newton Mountain. Those outbreaks accounted for about 7,000 dead trees on 770 acres. Douglas-fir beetle-caused mortality was very widely scattered throughout the upper Yaak. Most fader groups were small.

Libby RD. Very widespread and significant amounts of DFB- and MPB-caused mortality in mixed-conifer stands were reported throughout the District. Beetle-killed groups were especially noticeable south of Libby in Libby Creek, Swamp Creek, and Fisher River drainages. While groups of beetle-killed trees were fairly evenly distributed through the respective forest types, DFB-caused mortality was more prevalent from Miller Creek north to the Kootenai River, west of Libby Creek; and from the Fisher River drainage north to the Kootenai on east and north of Highway 2, as far east as Pleasant Valley.

Several additional groups of DF, killed by DFB, were mapped near Grub Mountain and Lemonade Lake. Significant numbers of DFB-killed trees were also observed in the Wolf Creek and Dunn Creek drainages. DFB infested nearly 9,300 acres on the District.

While a few MPB-killed groups of LPP were noted from about Tepee Creek, north along Fisher River, they were much more noticeable south of Fisher River, towards the District boundary. Other groups of MPB-killed LPP were mapped west of Island Lake. Totals for the District were more than 4,700 trees killed on about 2,800 acres.

North and east of Libby, significant groups of DFB-killed DF were noted between Alexander Creek and Aqueduct Creek drainages, and throughout the Quartz Creek drainage. Groups of LPP, killed by MPB, were becoming more numerous north of Libby as well. Other groups of beetle-killed trees, attributable to several bark beetle species, including MPB (in LPP, PP, and WWP), DFB, WPB, and WBBB were widely distributed in fairly small, but numerous groups throughout the reporting area. WBBB infested about 750 acres.

Cabinet RD. Numerous, but relatively small groups of MPB-killed LPP, and DFB-killed DF, were mapped at various locations throughout the Vermillion River drainage. Mountain pine beetle-caused damage was more prevalent in the lower portion of the drainage, while DFB was more common in the upper. Several small groups LPP, killed by MPB, were found in the Swamp Creek drainage; DFB-caused mortality was more common from there, westward to the Bull River. In some mixed-species stands, MPB-killed WWP was noticeable. In total, MPB killed host trees on about 350 acres of LPP type and another 170 acres of WWP.

Douglas-fir beetle-infested DF stands very prevalent south of the Clark Fork River, from Little Beaver Creek, northwestward to Elk Creek. The most heavily infested areas were in Beaver Creek and White Pine Creek drainages. District-wide about 2,370 acres were infested. Widely scattered small groups of MPB-killed LPP, PP, and WWP; plus noticeable amounts of SAF, killed by WBBB, were found at several locations.

Total mortality attributed to bark beetles on the reporting area was 33,000 DF killed by DFB on 21,200 acres; 250 GF killed by FE on 130 acres; 17,200 trees killed by MPB on 7,000 acres; and 3,800 SAF killed by WBBB on 4,800 acres.

Lewis & Clark Reporting Area

Rocky Mountain RD. District not flown in 2001 or 2002.

Judith RD. Small and widely scattered groups of beetle-killed trees were mapped in the Highwood Mountains this year. Most were DFB-killed DF; however, isolated groups of LPP and PP, killed by MPB, were also noted. No significant concentrations were recorded, rather a generally light infestation throughout the reporting area. Total beetle-killed trees were 230 DF on 160 acres and 170 PP on 180 acres.

A similar scattered pattern to DFB-caused mortality was also observed in the Judith RD portion of the Big Snowy Mountains. There, root diseases appear to be especially prevalent and likely contribute to the significant amounts of beetle-caused mortality, although about 130 acres had SAF mortality attributed to WBBB.

Musselshell RD. Very widely scattered and small groups of DFB-killed DF were mapped throughout the Big and Little Snowy Mountains. Notable concentrations were recorded near North Horsethief and Horsethief Canyons; and in the Willow Creek drainage, north and east of Posey Spring. Most was on non-FS land and totaled about 270 acres. An occasional group of WBBB-killed SAF was also reported. Also on the District, about 350 PP were killed on 320 acres.

Kings Hill RD. Several large groups of MPB-infested PP were recorded—the largest of which covered nearly 1,000 acres and contained an estimated 4,000 trees. That group was located in the Tenderfoot Creek drainage, a few miles west of Mount Vesuvius.

In that same general area, other smaller groups of MPB-killed PP were noted as well. Totals for the District were about 4,300 PP killed on just over 1,000 acres. Small and widely scattered groups DFB-killed DF also mapped throughout the District.

Area-wide mortality attributed to bark beetles totaled almost 600 DF on 460 acres; 5,600 pines on 2,100 acres; and 320 SAF on 165 acres.

Lolo Reporting Area

Missoula RD. Although not infested to the extent other stands on the Forest have been, LPP stands throughout the western portion of the District were generally found to contain smaller and more widely scattered groups of MPB-killed trees. Many DF stands, particularly in the Lolo Creek drainage, showed continuing DFB-caused mortality. Few groups were larger than about 30 trees, but they were fairly generally scattered throughout DF types. Stands in the Rattlesnake Creek drainage were similarly affected.

Douglas-fir stands in Rock Creek drainage, on the other hand, showed still high amounts of DFB-caused mortality. Many large groups of faders, some up to 500 trees, were mapped from about Cinnamon Bear Point to the confluence of Rock Creek and Clark Fork River. The most significant amount of DFB-caused mortality was recorded in the Rock Creek drainage and totaled about 12,000 trees on 5,600 acres. In upper Rock Creek drainage—from about Pawnee Gulch to Squaw Rock—MPB-caused mortality in LPP stands became more noticeable. Bark beetle-killed trees elsewhere on the District were generally light and scattered.

District totals included 1,200 acres of MPB-killed trees in addition to the more than 5,600 acres of DFB-infested stands.

Ninemile RD. While some of the LPP stands in the immediate vicinity of Siegel Pass showed decreasing amounts of MPB-caused mortality in 2002, many other stands throughout the District had markedly increased amounts of faded trees. Very large groups of beetle-killed trees were mapped from Stark Mountain, northwestward along the Ninemile Divide to Ninemile Peak. Large groups of dead LPP were also recorded near Josephine Peak, and in the Mill Creek drainage, to the east.

Elsewhere, large amounts of MPB-killed LPP and PP were recorded throughout the District. LPP and DF stands in the Fish Creek and Petty Creek drainages showed significant amounts of beetle-caused mortality; however, in those areas, it was generally smaller groups and more widely scattered. It appeared that most LPP stands, with any significant component of susceptible-size trees, anywhere on the District, were being affected by MPB. Total infested LPP stands on the District covered nearly 24,000 acres on lands of all ownerships. DFB-caused mortality was found on but 365 acres.

Plains/Thompson Falls RD. Remarkable increases in the amount of MPB-killed LPP were recorded in many stands throughout this reporting area and the adjacent Superior RD in 2002. These were trees that were killed in 2001; however, ground surveys showed populations are still increasing in many areas.

The largest polygons along the Divide between the two Districts were recorded near Brooks Mountain, Knox Pass, and Mount Bushnell. Southeast of Thompson Falls, in LPP stands in the Cherry Creek drainage, very large groups of MPB-killed LPP were mapped near Eddy Mountain and Sacajawea Peak. More generally, LPP stands throughout the Coeur d'Alene Mountains from the confluence of the Flathead and Clark Fork Rivers, westward to the Montana/Idaho border were affected to some extent.

North of the Clark Fork River, MPB populations also heavily impacted LPP stands within the Thompson River drainage. The largest groups in that area were recorded near Cube Iron Mountain, Big Hole Peak, and in the West Fork Fishtrap Creek drainage.

Still other LPP stands west of Siegel Pass towards Keystone Peak and north to Siegel Mountain, exhibited large groups of beetle-killed trees. More than 100,000 beetle-killed LPP were recorded in that area alone.

Near Marmot Peak, and in other parts of upper Fish Trap Creek, stands of WWP have been seriously affected by a combination of blister rust and MPB. Elsewhere, MPB populations have killed significant amounts of LPP and PP in Thompson Creek and Little Thompson Creek drainages.

Widely scattered, in mostly small groups—but still important total amounts, DFB-caused mortality was observed throughout DF stands on the District. In noticeable, but considerably lesser amounts, MPB has killed WBP in some stands, and WBBB has contributed to the death of SAF.

Totals for the District and adjacent State and private lands showed MPB-killed trees on almost 35,000 acres; about 2,300 acres infested by DFB; 340 acres with WBBB-caused mortality; and over 400 acres infested by WPB.

Seeley Lake RD. Mountain pine beetle-caused mortality became more noticeable in LPP stands south of Seeley Lake, in the vicinity of Clearwater Lake, near Florence Lake. MPB-killed WBP, as well as damage caused by blister rust, was noted in several stands near Morrell Mountain. Total for the District was about 250 acres of LPP-infested stands and another 720 acres of WBP with significant amounts of MPB-killed trees.

Elsewhere on the District, DFB-killed trees were somewhat lightly scattered through the DF type—more noticeable in Cottonwood Creek drainage and totaling 430 acres; and WBBB-caused mortality was observed on about 50 acres in a few high-elevation SAF stands. Minor amounts of MPB-killed PP were also noted on the District, but a few larger groups were seen near Woodward.

Superior RD. Large groups of MPB-killed LPP—some totaling hundreds of thousands of trees—were mapped on the District near Van Ness Point, Mount Baldy, and Blacktail Mountain southeast of St. Regis; near Moon Peak and Up Up Mountain, west of St. Regis; and very generally scattered throughout the Twelvemile Creek drainage. The largest polygons in that general area were recorded near Brooks Mountain, Knox Pass, and Mount Bushnell—on the Divide between Superior and Plains/Thompson Falls RDs. Very large groups were also mapped near Greenwood Hill and Camels Hump Lookout. District-wide more than 47,200 acres were infested.

Significant amounts of MPB-caused mortality were recorded in PP stands east of Superior, from Eddy Creek northwest to Sloway Gulch. Acres with significant amounts of PP mortality totaled more than 2,300. At least some of that mortality is thought to be drought related. Ground surveys showed still-increasing populations in many areas. In some, host depletion has resulted in population declines; however, in a few areas surveyed, 2002 attacks averaged more than 120 per acre.

Throughout the Reporting Area—the most heavily impacted in the State—MPB killed more than 922,000 LPP on 108,000 acres; 7,000 PP on 4,200 acres; 500 WBP on 760 acres; and 340 WWP on 176 acres. Though nearly insignificant by comparison, DFB killed about 21,500 DF on 9,600 acres; WPB killed 260 PP on 275 acres; and WBBB accounted for 1,350 dead SAF on 730 acres.

Garnet Mountains (BLM): Mostly small and widely scattered groups of bark beetle-killed trees were mapped throughout the Area. No significant outbreaks were recorded; however, the total number of groups of dead trees was notable. A few miles east of Bonner, MPB-killed groups of LPP were noted—some as large as 50 trees each. Along the Blackfoot corridor, to the east, MPB- and WPB-killed PP were numerous. Near Lost Horse Mountain, a developing MPB outbreak in LPP was observed. In the upper portion of Elk Creek, several small groups of DFB-killed DF were recorded. Further to the east, in McElwain Creek drainage, MPB-infested LPP stands were noticeable. In a few higher-elevation SAF stands, WBBB damage was apparent.

In total, about 540 DF were killed on 110 acres; MPB killed approximately 650 LPP and 620 PP on a combined 530 acres; 50 WPB-killed PP were recorded on 70 acres; and 40 dead SAF on 10 acres was attributed to WBBB.

INDIAN RESERVATIONS

Blackfeet IR

The Blackfeet IR was not flown in 2001 or 2002.

Crow IR

Widely scattered, but mostly small groups of MPB-caused mortality, were recorded in PP stands in drainages the on eastern slopes of the Wolf Mountains, east of Lodge Grass. Heaviest concentrations were mapped in Kid Creek drainage, south of Sioux Pass; and to the north in Cache Creek, Corral Creek, and Thompson Creek drainages. Total infested area on the Reservation (including the Pryor Mountains) was 1,025 acres, on which an estimated 2,000 PP were killed.

Widely scattered, generally small groups of PP, killed by MPB, were found in the Pryor Mountains. Some groups of limber pine and LPP, also killed by MPB, were reported. Those totaled about 70 and 40 acres, respectively. The largest concentrations of beetle-killed PP were found in Pryor Creek and East Pryor Creek drainages, as well as near West Pryor Mountain. At some higher elevations, WBBB had killed about 2,450 SAF on approximately 970 acres.

Flathead IR

Significant increases in the amount of LPP, killed by MPB, on the Reservation were noted in 2002. Many more groups of beetle-killed trees were mapped in the southwestern and southeastern portions of the Reservation. The largest groups to the west were observed in Magpie Creek, Revais Creek, and Hewolf Creek drainages; to the east, in the Dry Creek and Pistol Creek drainages, and near McDonald Lake.

In the northeast, MPB-caused mortality increased markedly from Hellroaring Creek, north to the Reservation boundary. Elsewhere, MPB activity in both LPP and PP stands was very generally scattered throughout the respective host types. Larger groups of LPP faders were noted south of Rainbow Lake, and significant amounts of PP mortality were observed in the Revais Creek drainage and near Saddle Mountain.

In the interior of the Reservation, important amounts of MPB-caused mortality were found in PP stands near Sonyok Mountain, and northward into the Salish Mountains, west of Loon Lake; on Wild Horse Island; and near Black Lake.

Scattered throughout mixed conifer stands were noticeable amounts of mortality attributed to DFB, FE, and WPB. Some SAF stands in the upper Jocko River drainage experienced mortality caused by WBBB.

Total beetle-infested areas on the Reservation included 2,600 DF killed on 1,700 acres; 460 GF killed by FE on 300 acres; 80 PP killed by WPB on 80 acres; another 7,900 PP killed by MPB on 3,725 acres; and about 20 PP killed by IPS on a few acres. Western balsam bark beetle-caused mortality accounted for 420 dead SAF on 110 acres. By far, the most significant damage was done by MPB in LPP stands, where 126,000 trees were killed on nearly 17,000 acres.

Fort Belknap IR

Very widely scattered and generally small groups of MPB-killed PP were mapped across the Reservation. Groups ranged in size from 1-90 trees, with concentrations noted near Thornhill Butte, Landusky, in the Little Rocky Mountains, and within Beaver Creek drainage. A few small and isolated groups of LPP, killed by MPB, were also observed near Mission Ridge. About 1,000 PP were killed on just over 500 acres. Another 25 LPP were killed on about 10 acres.

Northern Cheyenne IR

Very widely scattered and small groups of PP, killed by IPS and MPB, were noted throughout the forested areas of the Reservation. Heaviest concentrations of MPB-killed trees were mapped in Trail Creek and Skunk Creek drainages, south of Busby; but there were noticeable groups of IPS-killed trees there, as well.

In the eastern part of the Reservation, south and east of Lame Deer; larger and less widely scattered groups of IPS-killed PP were noted. Area affected by IPS totaled 445 acres, on which about 1,060 trees were killed. MPB killed another 1,300 PP on 720 acres.

Rocky Boys IR

Widely scattered, but mostly small groups of PP, killed by MPB, were mapped throughout the forested area of the Reservation flown in 2002. Largest groups were observed in the Eagle Creek and Sandy Creek drainages, with the largest groups—of up to 200 trees each—being observed near the head of Green Creek, the confluence of Muddy Creek and Sandy Creek, and near Black Mountain. Several smaller groups were noted south of Centennial Mountain. Although in recent years LPP stands have been affected by MPB, and management efforts have been implemented to reduce their effects; no damage attributable to MPB was recorded in LPP stands during aerial surveys.

Nearly 1,700 beetle-killed PP were mapped on about 860 acres.

Glacier NP

Most of the Park was not flown again in 2002; however, along the southern boundary, almost 100 acres of LPP stands were noted to contain MPB-killed trees. In that same area it was determined that about 50 DF have been killed, on 15 acres, by DFB.

Yellowstone NP

Numerous large groups of WBBB-caused mortality were mapped in SAF stands throughout the Gallatin Range, in northwest portion of the Park. Largest groups were noted near Little Quadrant Mountain and Sepulcher Mountain. In that same general area, several large groups of WBP, killed by MPB, were also recorded. In the north central part of Park, from the Gardiner River east to Buffalo Plateau, numerous but small groups of DFB-killed DF were observed. Elsewhere in the northern portion of the Park, numerous, small groups of WBP and LPP, killed by MPB, were widely scattered. A few larger groups of the former were noted near Mount Washburn and Amethyst Mountain.

The most significant groups of beetle-killed trees in the Park were the large groups of ES, killed by ESB, in Columbine and Rocky Creek drainages, east of Yellowstone Lake. In the southeastern portion of the Park, large groups of WBP, killed by MPB; and SAF, killed by WBBB were observed. The largest groups of the former were on the Two Ocean Plateau.

Throughout the rest of the Park, widely scattered and mostly small groups of SAF, LPP and WBP faders were mapped. More significant amounts of SAF mortality, attributed to WBBB, were noted along Big Game Ridge and in the upper Snake River drainage, east of the Park's south entrance.

Beetle-killed totals for the Park included 3,500 DF—attributed to DFB; 3,700 ES on 6,050 acres killed by ESB; 680 LPP on 610 acres killed by MPB; 11,500 WBP killed by MPB on 11,800 acres; and finally, 11,100 SAF were killed by WBBB on 14,120 acres.

DEFOLIATORS

Western Spruce Budworm

The majority of defoliation of conifers in the Northern Region was caused by the western spruce budworm (*Choristoneura occidentalis* Freeman). Aerial surveyors mapped 52,444 acres of western spruce budworm defoliation in Montana. On the Beaverhead reporting area, our aerial survey detected 23,500 acres of DF defoliated by western spruce budworm. Light to heavy defoliation was recorded near Melrose and also in the Tobacco Root Mountains. We also recorded 4,441 acres of defoliation from western spruce budworm on the Deerlodge reporting area. with heavy defoliation recorded in the High Ore drainage near Basin. Defoliation from budworm was also recorded both north and south of Helena on 4,567 acres and 19,934 acres of defoliation was recorded on Elkhorn Ridge on the Gallatin reporting area. We noted some defoliation on the Lewis and Clark NF during ground surveys.

There was a significant increase in number of moths caught in pheromone traps at several trapping sites on the Deerlodge National Forest and a slight increase in moths caught at several other trapping sites. Even a slight increase suggests that the populations across Montana are beginning to increase. There was little to no budworm activity between 1992 and 2000. We are also beginning to record moderate to high levels of defoliation from ground surveys in localized areas on forests east of the Divide. Some tree mortality resulting from heavy defoliation appears to have occurred in pole and sapling size trees over the last 2 years.

If weather conditions remain within the normal range or are warmer and drier during 2003, we can expect budworm populations to increase across Montana. We expect to see moderate to high populations and associated defoliation on parts of the Helena, Beaverhead, Deerlodge and Gallatin reporting areas. We also expect to begin to see scattered defoliation on forests west of the Divide.

During 2003, we will remeasure the budworm permanent plots that were installed in the early 1990s. The installation of these plots followed the budworm outbreak in the 1980s. We will remeasure tree heights, diameters and mortality on all plots. Most historic budworm areas are represented by the series of permanent plots. We hope that the information from the permanent plots can be useful in suppression or prevention projects. There are suppression techniques, such as spraying a biological insecticide, that are very effective in protecting foliage throughout a budworm outbreak. In Montana, budworm outbreaks can last as long as 10 years or even longer. Suppressing budworm populations might be appropriate if the objective of the land manager is to protect certain values such as wildlife habitat or visuals. There is a budworm extension that can be linked to FVS to predict tree defoliation and mortality.

The model has not been used in Region 1. The information from the permanent plots can be used to validate and calibrate the budworm extension.

Douglas-fir Tussock Moth

Extremely heavy defoliation of DF by DFTM occurred on approximately 200

acres of private land in the vicinity of Loon Lake, Northwest of Polson in 2002.

Monitoring of DFTM population levels by means of pheromone-baited sticky traps to catch adult males has been done in western Montana since 1979. Traps have been placed at 33 permanent plots. The nearest plot to the 2002 defoliated area was near Jette Lake, a few miles to the southwest. In 2002, trap catches at this plot averaged 72.6 moths per trap, a substantial increase from 2001 levels of 50.0 moths per trap. Trap catches at most of the other plot locations also increased in 2002 over the 2001 levels (Table 1).

Plot locations where the most moths were caught and numbers of moths were: Jette Lake (72.6), Pistol Creek (62.2), Big Arm (30.0), Rocky Point (30.0), Kerr Dam (27.4), Pattee Canyon (20.6) and Blue Mountain (18.0). Because of the high trap catches, lower crown larval samples are planned for Jette Lake, Pistol Creek, Big Arm, Rocky Point and Kerr Dam in June of 2003.

Table 1. Douglas-fir tussock moth trap catches western Montana 1994-2002

Average number of male moths per trap

Plot	Location	1994	1995	1996	1997	1998	1999	2000	2001	2002
Albert Creek	14N, 21W, S16	0.0	0.0	0.0	0.0	0.0	0.4	1.2	3.2	2.6
Arlee	16N, 20W, S1	0.0	0.0	0.0	0.0	0.0	1.6	0.8	4.6	7.0
Big Arm	24N, 21W, S36	0.2	0.0	0.2	0.0	0.0	0.0	0.8	13.0	30.0
Big Fork	27N, 19W, S36	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.4	0.0
Blue Mountain	13N, 20W, S34	0.0	0.0	0.0	0.0	0.6	1.2	0.4	10.8	18.0
Butler Creek	16N, 23W, S24	0.0	0.0	0.2	0.0	0.0	0.4	2.8	8.4	9.6
Clear Creek	19N, 24W, S26	0.0	0.0	0.0	0.0	0.0	0.4	*	0.6	1.2
Corral Creek	15N, 22W, S36	0.0	0.0	0.0	0.4	0.0	0.6	0.8	1.0	2.4
Ferndale	27N, 19W, S32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4
Fish Creek	14N, 24W, S6	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.4	0.0
Foys Lake	28N, 22W, S36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.6
Frenchtown F	14N, 21W, S10	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.8	0.4
Frenchtown J	14N, 21W, S22	0.0	0.0	0.0	0.0	0.0	0.2	1.6	2.4	6.8
Frenchtown T	14N, 21W, S23	0.0	0.0	0.0	0.0	0.4	0.0	1.4	4.8	12.8
Jette Lake	23N, 21W, S2	0.0	0.0	0.8	0.0	0.4	2.0	6.0	50.0	72.6
Kerr Dam	22N, 21W, S13	0.0	0.0	0.0	0.0	0.2	0.4	8.6	22.8	27.4
Lake Mary Ronan	25N, 22W, S23	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Lakeside	26N, 20W, S6	0.0	0.0	0.0	0.0	0.2	0.0	2.2	0.6	0.0
Lolo Creek	11N, 20W, S6	0.0	0.0	0.0	0.2	0.0	0.0	1.0	2.6	0.2
Pattee Canyon	12N, 19W, S12	0.0	0.0	0.0	0.0	0.2	0.0	1.2	8.6	20.6

Table 1--continued

Plot	Location	1994	1995	1996	1997	1998	1999	2000	2001	2002
Petty Creek	14N, 22W, S19	0.0	0.0	0.0	0.2	0.0	0.8	9.8	7.6	4.6
Pistol Creek	18N, 20W, S35	0.4	0.0	0.4	0.4	1.2	63.6	13.8	55.8	62.2
Polson-Big Creek	22N, 19W, S21	0.0	0.0	0.0	0.0	0.0	0.6	0.2	3.4	5.2
Polson-Hell Roaring	22N, 19W, S33	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.8	0.4
Polson-Lost Lake	22N, 19W, S17	0.0	0.0	0.0	0.0	0.2	0.2	3.4	4.6	3.4
Revais Creek	17N, 22W, S4	0.0	0.0	0.0	0.0	0.0	0.8	1.6	1.6	2.2
Rocky Point	23N, 20W, S4	0.0	0.0	0.0	0.2	0.0	0.6	1.4	21.6	30.0
St. Mary Lake	18N, 19W, S35	0.0	0.0	0.0	0.2	0.0	0.0	1.0	4.4	0.8
Skidoo Bay	23N, 19W, S2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	6.0
Smith Camp	25N, 20W, S8	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.2
Somers # 1	27N, 21W, S27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0
Somers # 2	27N, 20W, S26	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.6	1.0
Worden Creek	12N, 20W, S21	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	1.2

Gypsy Moth

Cooperative detection monitoring for the gypsy moth in Montana with the Animal and Plant Health Inspection Service (APHIS), Montana Department of Agriculture, and Montana Department of Natural Resources and Conservation (DNRC) continued in 2002. A network of over 1,600 strategically located pheromone-baited traps was placed throughout the state. No gypsy moths were caught in the state of Montana in 2002.

The trapping program will continue as usual in Montana next year.

Other Defoliators

Aerial survey also detected defoliation from western false hemlock looper (*Nepytia freemani* Munroe) on Douglas-fir (3,423 acres) in western Montana and western hemlock looper (*Lambdina fiscellaria*) on subalpine fir (338 acres) in three areas in western Montana.

Defoliation from western false hemlock looper was recorded on 1,529 acres on the Kootenai National Forest approximately 15 miles east of Libby on both sides of Hwy 37. This may be the first time it has been reported to cause a significant amount of defoliation on the Kootenai National Forest. Other areas of defoliation (262 acres) included several miles along the Clark Fork River between Rock Creek and Beavertail Hill and up the Rock Creek drainage. A large area of defoliation from western false hemlock looper was also recorded on the north side of Flathead Lake near Somers extending west to Niarada-Hot Springs and a smaller spot on the northeast side of the lake near Bigfork. The number of acres defoliated in the Flathead Lake area increased between 2001(626 acres) and 2002 (1451 acres). Another area (182 acres) on the southern portion of the Flathead Indian Reservation near Ravalli, Montana was reported for the first time this year. Total number of acres defoliated by the western false hemlock looper in Montana was 3,423.

Defoliation of lodgepole pine was reported on 2,949 acres on the Gallatin NF in 2002. Either the sugar pine tortrix or pine needle sheath miner caused the defoliation.

DISEASES

Root Diseases

Root diseases are the most significant disease agents of mortality and growth loss in Montana, mostly west of the Continental Divide. Because root diseases are diseases of the site, we see very little changes occurring from one year to the next. The most significant root diseases in Montana are Armillaria root disease (*Armillaria ostoyae* (Romagn.) Herink), laminated root disease (*Phellinus weirii* (Murr.) Gilb.), annosum root disease (*Heterobasidion annosum (*Fr.) Bref.), and brown cubical root and butt decay (*Phaeolus schweintizii* (Fr.) Pat.). The most susceptible tree species in Montana is DF, with GF and SAF taking a close second. The most tolerant species are WL, pines and western redcedar, with the remaining species falling somewhere along the gradient between susceptible and tolerant. Although root diseases cause significant amounts of mortality and growth loss, they are also a major agent influencing both structure and species composition across landscapes. Root diseases have greatly influenced succession of vegetation in our forests. This is especially evident in the absence of natural fire cycles. On sites where there is a mixed species component with root disease tolerant serals, root diseases tend to prolong the seral stage on those sites. Root diseases slowly thin out the more root disease-susceptible species (Douglas-fir and true firs), and favor the root disease-tolerant serals.

On GF/SAF climax habitats, with a DF forest type, low levels of root disease will actually push the stand towards climax faster than in the absence of root disease. This is due to the greater susceptibility of DF to root diseases. Although grand fir and subalpine fir are fairly susceptible to root diseases, they are measurably more tolerant than DF. Root disease on western redcedar/western hemlock climax sites will also push stands towards climax by weeding out the more root disease susceptible seral species on these sites (DF and GF).

On sites with a root disease susceptible forest type and climax habitat, very high levels of root disease will maintain an early stand development. Root disease patches experience wave after wave of mortality as trees become large enough for their root systems to contact the inoculum on the site. Trees are unable to grow to a very large size before being killed by root disease.

Mortality from Douglas-fir bark beetle (DFB) continues to be high in various spots in Montana, which has raised some issues regarding management for DFB beetle in root diseased areas. DF infected with root disease often harbors endemic levels of DFB which likely aids in the rise of the DFB populations during an outbreak.

Annosum root disease of PP is less evident than the above root diseases, but very important in local areas. It has been found causing mortality in ponderosa pine plantations in various locations on the Darby RD, Bitterroot National Forest, private lands west of Kalispell, and continues to be a significant agent on the Flathead Indian Reservation.

White Pine Blister Rust

White pine blister rust is an introduced pathogen of white pine (WP), present in western North America since the early 1900's. Blister rust spread quickly throughout the natural range of western white pine (WWP) in the northwest United States with devastating impact. By the mid-1960's initial control efforts, such as Ribes removal and chemical control had been abandoned. Harvest of white pine was accelerated because managers thought that little would survive.

A tree breeding program, in place since the early 1950's, has utilized low levels of naturally occurring rust resistance in WWP to produce rust-resistant planting stock. This stock has been used operationally for approximately the last 15 years, and is the basis for restoration of WWP. Rust-resistant WWP is utilized, among other places, on the Kootenai, Lolo, and Flathead NFs, and the Stillwater and Swan State Forests in western Montana. Initial predictions for performance of the rust-resistant white pine were that 65% or more of the trees would remain canker-free in the long-term. However, monitoring studies in operational plantations in Idaho have shown that infection levels of the rust-resistant stock are highly variable by site, ranging from zero to 95%+ infection levels.

In order to address this and other issues involving the performance and management of rust-resistant WWP, a 3-day conference of geneticists, pathologists, silviculturists, and ecologists was held in October 2002, in Coeur d'Alene, ID. As a follow-up to that conference, 2-day workshops will be offered in 2003 to update forest managers on the latest information regarding performance and management of rust-resistant WWP in the Inland Empire. A 1-day workshop titled "Pruning for White Pine Blister Rust", is also offered each summer through University of Idaho Forestry Extension.

In addition to WWP, blister rust infects other species of five-needle pines such as whitebark (WPB) and limber pine (LP). The effects of blister rust on whitebark pine ecosystems took longer to appear than in the WWP forest type, but apparently have the ability to be equally devastating. Areas in and around Glacier National Park are experiencing losses of more than 90% of the WBP. Surveys in western Montana have found 42% of the WBP killed and 89% of the remaining trees infected by blister rust. Statewide surveys by Forest Inventory and Analysis (FIA) have found 16% of the plots with WBP have blister rust present. The combined effects of blister rust and mountain pine beetle have killed extensive areas of WBP, raising concerns about the viability of this ecosystem and the resultant effects on dependent species such as grizzly bear and Clark's nutcracker. There is currently an effort underway to compile various surveys on the status of WBP and blister rust in the western United States. A restoration program using natural resistance is underway for WBP.

Dwarf Mistletoes

Dwarf mistletoes (DFMT) (*Arceuthobium* spp.) are parasitic plants that extract water and nutrients from living conifer trees. The DFMTs are native components of western coniferous forests, having co-evolved with their hosts for millions of years. The different DFMTs are generally host specific. In Montana, LPP and larch DFMT occur throughout the range of their respective hosts while Douglas-fir DFMT occurs only in the range of its host west of the Continental Divide.

Because DFMTs are obligate parasites, ecological forces that have patterned the development of the host tree species have also played roles in influencing the distribution of DFMTs across the landscape. Fire is one of those influential ecological forces. In general, any fire event that kills host trees will reduce the population of DFMTs, at least in the short term. The larger and more continuous the fire disturbance, the greater the reduction in DFMT populations at the landscape level. Large, complete burns will greatly reduce DFMT populations across the landscape and may even eliminate small, localized populations. Small, "patchy" burns will temporarily reduce portions of DFMT populations, but infected residuals provide a ready source of DFMT seeds for the infection of the newly developing regeneration.

Human influences, including fire suppression and logging, have also had effects on DFMT population dynamics. Partial cutting, which created multi-storied stands, and fire suppression may have served to increase the severity of DFMTs relative to the "pre-settlement" condition. Conversely, DFMTs may have been reduced in certain age classes, habitat types, elevation zones or topographic positions that have been intensively managed. Fire suppression and cutting practices that have encouraged shifts in species compositions could have either increased or decreased the disease severity depending on what species of trees and DFMTs occurred on any given site.

The parasitic activity of dwarf mistletoes causes reduced tree diameter and height growth, decreased cone and seed production, direct tree mortality, or predisposition to other pathogens and insects. Lodgepole pine dwarf mistletoe causes an average growth loss of 10.5 ft^3/acre/year and larch and Douglas-fir dwarf mistletoes cause average growth losses of 20 ft^3/acre/year in areas where they occur in Montana. On the other hand, witches' brooms and tree mortality may result in greater structural diversity and increased animal habitat. Dwarf mistletoe flowers, shoots and fruit are food for insects, birds and mammals. Witches' brooms may be used for hiding, thermal cover, and nesting sites by birds and other mammals. In the long term, heavily infested stands of the host trees can begin to decline, resulting in a successional shift toward other tree species.

In 2002, dwarf mistletoe suppression activities were proposed on more than 850 National Forest acres in Montana. Infected western larch and Douglas-fir seed trees were girdled and infected regeneration slashed on 11 acres in the Lolo NF. On the Kootenai NF, infected overstory trees were girdled in 24 acres of infested western larch.

Heartwood Stem Decays

The main function of heartwood in live trees is to give individual trees vertical stability. The decay of heartwood weakens this vertical stability, making trees more susceptible to stem breakage. Stem breakage can lead to mortality and subsequent formation of small-scale canopy gaps. The main successional functions of heartwood stem decays are to move stands from a mature closed canopy to a more open canopy and to perpetuate an open canopy.

Stem decays are important in the creation of wildlife habitat in living trees. Although primary cavity nesters are capable of excavating in sound wood, they selectively excavate in trees and snags with heartwood decay. Most primary cavity nesters do not reuse their holes from one year to the next. The previous year's holes are then used by a multitude of secondary cavity nesters, which are very dependent on already-created holes for successful reproduction. Thus, cavity-nesting habitat (i.e., heartwood decay) is necessary for the successful reproduction of a number of animal species.

Heartwood decay fungi are also necessary for the formation of hollow trees, which are also important habitat for a number of animal species. Hollow trees are created when decay fungi invade the heartwood of a living tree. The decay may progress to the point that the cylinder of decayed heartwood eventually detaches from the sapwood and slumps down, leaving a hollow chamber. The only way to obtain a hollow dead tree or log is to start with a living tree hollowed out by decay.

Foliage Diseases

Most fungi-causing foliage diseases are confined to the needles and leaves, a few attack buds, and some invade young twigs. Foliage diseases are generally more severe in the lower canopy on seedlings, saplings, and small poles than on larger trees. Most of the fungi affect either foliage of the current season or older foliage, but rarely both; it is unusual for all the foliage in either category to be involved. The fungi vary in pathogenicity from year to year according to climatic conditions; heavy infection over a period of years is exceptional. Some trees in a stand are severely infected, but others escape with little or no infection, apparently because of individual resistance. Foliage diseases rarely cause mortality, but they do cause a reduction in growth. Foliar disease activity was generally light throughout Montana in 2002.

Elytroderma needle blight

Elytroderma needle blight (*Elytroderma deformans* (Weir) Darker) is the most damaging foliage disease on ponderosa pine in Montana. The fungus infects and kills needles, but it also invades twigs, and causes localized brooms. Spores of the fungus mature in late summer and fall and are dispersed when the needles are wet. The fungus can live from year to year in invaded bark, so the disease can be perpetuated without conditions favorable for either spore production or infection of new needles.

Localized areas of heavy infection from Elytroderma needle blight were again seen across western Montana in 2002. Elytroderma has been heavy in several locations in Montana for a number of years: Jette Lake area north of Polson, Bitterroot Valley south of Missoula, and the Rock Creek drainage east of Missoula.

Sphaeropsis (Diplodia) shoot blight and canker

Sphaeropsis shoot blight and canker (also known as Diplodia shoot blight) is caused by the fungal pathogen *Sphaeropsis sapinea* (Fr:Fr) Dyko & Sutton in Sutton. The disease is seen mainly on ponderosa pine (*Pinus ponderosa*) in Montana, but other species can be affected. Damage occurs on current year's growth in spring as evidenced by shoot dieback, needle stunting, and needle discoloration. Needles turn a straw-like color, then red as the shoot dies and dries out. Resin droplets often exude from the base of infected needles. Cones are infected by the fungus and act as a source of inoculum each spring as spores are spread to new growth by rain-splash. Severity of infections on PP varies. In the most susceptible trees, nearly all current-year shoots can be infected, and chronic infections can result in non-vigorous crowns and occasional top-kill. In less susceptible trees only scattered shoots are affected, while some PP appear to be resistant and without visible infections. Patterns of infection within a tree's crown vary as well; there may be numerous dead shoots on one side of a tree and few if any on the other.

Observations also suggest that ponderosa pine along river bottoms and major drainages may have heavier levels of infection, perhaps due to airflow patterns or other environmental conditions.

Western gall rust and Sphaeropsis shoot blight

Casually attributing shoot dieback on ponderosa pine to Sphaeropsis shoot blight may lead to an incomplete or incorrect diagnosis. Informal surveys show that western gall rust infections are commonly present towards the ends of branches with shoot dieback, although there is no reason that western gall rust and Sphaeropsis shoot blight cannot be present on the same branch. In fact, even small amounts of water stress increase infection by *Sphaeropsis sapinea*, and western gall rust infections may be causing the stress in portions of the branch distal to even small rust galls. Combined damage from Sphaeropsis shoot blight and western gall rust continues to cause noticeable dieback of PP shoots. Low levels of damage can currently be seen throughout western Montana. Moderate to severe damage occurs in certain locations.

Declines

Limber Pine Decline and Mortality

In their 1998 FHP report "Limber Pine Mortality on the Lewis and Clark National Forest, Montana," Taylor and Sturdevant reported early findings from a study designed to identify the cause(s) of decline and mortality of limber pine in central Montana. They determined that most of the mortality seen from 1995 through 1998 on four transects in the Lewis and Clark National Forest was associated with defoliation by the needle pathogen *Dothistroma septospora* (Doroguine) Morelet. Even though 41% of the study trees were reportedly infected with the white pine blister rust pathogen *Cronartium ribicola* Fisch, Taylor and Sturdevant believed the rust-caused mortality was low.

The transects were visited three times (1999, 2000, and 2002) since the first report was printed. Data in the forthcoming report "Update on Limber Pine Decline and Mortality on the Lewis and Clark National Forest, Montana" support Taylor and Sturdevant's assertion that much of the mortality is associated with high levels of *D. septospora* and white pine blister rust has caused only minimal mortality on the transects since the study began.

When 90% or more of a tree's needles were affected by *D. septospora*, subsequent mortality increased considerably over trees less affected by the foliar pathogen. Mortality was greater yet for trees that had 90% or more of their needles affected by *D. septospora* for two consecutive years.

Transects on south-facing slopes had more defoliation associated with *D. septospora*, and greater subsequent mortality, than the west-and northwest-facing transects from 1999 through 2002. This suggests that the trees on the south-facing slopes may have been predisposed to defoliation by hot, dry conditions on the south-facing slopes or by other site conditions.

Weather data shows higher than average precipitation in June, July, and August during some years prior to heavy defoliation. The increased precipitation may have contributed to dissemination, germination, and infection rates of *D. septospora* in limber pine. Later weather data shows less than average annual precipitation prior to increased mortality seen on the south-facing transects in 2001 and 2002. Inadequate soil moisture may have contributed to the decline of the previously heavily defoliated trees.

Although mortality has increased on the two south-facing transects in 2001 and 2002, retention of 2 or more years of needles and declining rates of defoliation, suggest the *D. septospora* infections may be waning on the transects. However, since much remains unknown about the biology of this pathogen in limber pine, we cannot reliably predict the future affects this pathogen will have on these stands.

The study shows that the white pine blister rust rating system does not work well for rating severity of blister rust on LP. However, the data collected strongly supports the conclusion that *C. ribicola* was a minor factor in the overall mortality on transects from 1999 through 2002.

Drought

Montana has been experiencing a drought for the past 3 years. Foliage discoloration, reduced growth, top dieback, branch dieback, and overall decline were seen on various tree species across the state.

Hazard Tree Management in Recreation Sites

Forest Health Protection has increased its efforts to provide technical assistance to land managers in hazard tree management in recreational areas. A form is available to help managers evaluate trees and assure proper documentation of an on-going hazard tree management program. Forest Health Protection provides assistance and training in use of the form and other aspects of hazard tree management, including comprehensive vegetation management.

A national database has been developed to identify the most common factors associated with tree failures. Forest Health Protection will be taking on a greater role in 2003 to facilitate the use of this database in Montana. If this database is adequately supported and successful in the information gained, educational materials will be developed to help resource managers in decision-making related to hazard trees.

Anyone requesting training or other assistance with hazard tree management should contact Marcus Jackson (406-329-3282) or Blakey Lockman (406-329-3189).

Nursery Diseases

During 2002, the most severe problems on forest tree seedlings at nurseries in Montana were caused by late spring frosts. Damage was extensive on many bare root species that had started to grow in the early spring. Overnight temperatures in the lower 20s occurred and many seedlings were either killed or extensively damaged. In some cases, entire crops were damaged so extensively that no shippable seedlings were forthcoming. Growers commonly try to reduce spring frost damage by irrigation, but the record low temperatures experienced were too extreme to be ameliorated with irrigation.

Usually, the most important diseases of conifer seedlings in Montana are incited by several species of *Fusarium*. *Fusarium* species can cause important diseases on both bareroot and container-grown seedlings. The most important diseases caused by *Fusarium* spp. are damping-off of young germinants and root diseases of older seedlings. During 2002, unusually severe disease was caused by *Fusarium* on container-grown ponderosa pine seedlings at one Montana nursery. Damage was limited to stems, with pathogens attacking seedlings at the base of needle fasicle sheaths. Top blight and culling of many container-grown seedlings was the result.

Other important root pathogens include *Cylindrocarpon* spp., *Pythium* spp. and *Phytophthora* spp. *Cylindrocarpon* spp. are primarily pathogens of container-grown WWP seedlings; *Pythium* and *Phytophthora* spp. usually damage many different conifer hosts in bareroot nurseries.

Botrytis cinerea is an important foliar pathogen, which is especially damaging in container nurseries. Western larch and ES are especially susceptible. Other important pathogens of conifer seedlings include *Sphaeropsis sapinea, Sirococcus conigenus* and *Phoma eupyrena*, all causing tip dieback diseases on *Pinus* spp. Most tip dieback diseases occur at endemic levels each year; occasionally disease outbreaks occur because of prolonged cool, wet conditions during the spring and early summer.

Efforts to develop alternatives to pre-plant soil fumigation with methyl bromide/chloropicrin for production of bareroot seedlings were successful at some nurseries but not at others. Several nurseries have successfully produced high-quality seedlings without pre-plant soil fumigation for many years. Practices including crop rotation and fallowing supplemented by application of particular organic amendments have been helpful in reducing the need for chemical soil fumigation. Incorporating green manure crops (particularly *Brassica* spp.) to maintain soil organic matter, improve soil tilth and reduce disease severity have not generally been successful. In addition, incorporating a biological control agent (*Trichoderma harzianum*) has produced mixed results in bare root nurseries. A large trial involving several container nurseries will be conducted during 2003 to determine if this biocontrol agent (commercially available as T-22 Root Shield®) is effective against root pathogenic fungi under greenhouse conditions.

Tests are continuing in conjunction with the Missoula Technology & Development Center to evaluate several treatments designed to reduce levels of pathogenic fungi within styroblock containers that are reused to grow several crops of conifer seedlings. Dry heat and radio frequency waves show promise as alternatives to submersion in hot water and chemical sterilization treatments.

Tree Improvement Plantation Diseases

Tree improvement plantations in Montana are often damaged by foliage diseases that can adversely affect their utility. The most damaging diseases are caused by *Lophodermella concolor* on lodgepole pine, *Meria laricis* on western larch and *Rhabdocline pseudotsugae* and *Phaeocryptopus gaumannii* on Douglas-fir. The most important impact of these diseases is reduced tree growth. Direct disease control with pesticides is often necessary to ameliorate disease effects because of the importance of growth in selecting individual trees for tree improvement.

SPECIAL PROJECTS

1. Changes in Fire-Killed Western Larch

Research concerning changes in fire-killed western larch is limited. This 10-year study, with multiple size classes, will provide more information than previous studies about losses in timber and fuel wood values. Biologists have shown interest in wildlife use of deteriorating fire-killed larch. Others may find this study useful in projecting down woody fuels on burned larch sites.

The study includes four size classes (8-11.9 inches d.b.h, 12-15.9 inches d.b.h, 16-19.9 inches d.b.h, and 20+ inches d.b.h) spread over five locations within the boundaries of the 2001 Moose Fire. Ten trees in each size class will be randomly selected and dissected 1, 2, 3, 5, 7, and 10 years after the fire. Cracks, woodborers, wood stain, decay and other factors will be measured after the trees are cut down. Twenty trees in each size class will be left uncut as “longevity snags” to continue monitoring conk development and snag longevity.

The study plots were established in June 2002 and the initial dissection data were collected in October 2002. Data are currently being analyzed. One year after the fire, most of the defect in the fire-killed trees appears to be from heartwood decay and shakes that were present prior to the fire. Minor losses from woodborers were noted. Very little wood stain was present. The first year report will be available in spring 2003.

2. Measuring the Effect of Management on DFB Populations

A multi-year study was begun to measure the effects of management activities on DFB populations, and particularly ones existing in fire-affected areas. Beetle-infested stands on the Bitterroot, Helena, and Beaverhead NFs; as well as BLM-administered land near Boulder, were assessed for beetle presence and status prior to implementation of management efforts. Those efforts included salvage of infested and threatened trees, use of trap trees or baited funnel traps, and the use of the DFB anti-aggregant, MCH. Data was then collected following implementation of management and subsequent beetle flights.

Although not all proposed and scheduled activities have been carried out, in areas where salvage logging was conducted, and other areas where funnel traps were used, beetle-caused mortality was markedly reduced. In areas where MCH was used to protect threatened trees or stands, treatments were deemed successful. In almost none of the treated areas was new beetle-caused mortality observed.

3. Testing Efficacy of Verbenone Pouch in Reducing MPB-Caused Mortality in LPP

A project was conducted in LPP stands on the Butte RD to help determine the efficacy of the verbenone pouch in protecting trees from MPB attack. In a randomly assigned treatment (by block) test, we treated three 1-acre plots in each of 6 blocks. Treatments consisted of 0, 20, or 40 pouches per acre. Pouches were stapled to individual trees in a grid pattern (approximately one-half chain apart at 40/acre; about three-fourths chain apart at 20/acre). Stands were treated in late June and evaluated in early October. Treatment results, not as good as experienced in a similar test in 2001, showed significant differences in treatment effects between verbenone treatments and controls, but not between treatments. Results are shown in the following tables:

0 Pouches/Acre (Control)

Plot	Trees/Acre (≥5”dbh)	LPP/Acre (≥5”dbh)	Avg.d.b.h. LPP	Trtmnt (Verb/Acre)	Mass Attacks	Strip Attacks	Pitch-outs	% Mass Attacks
2	272	263	8.7	0	29	8	5	11.3
4	251	221	7.6	0	7	0	1	3.2
8	282	118	8.8	0	6	1	0	5.1
12	249	162	10.1	0	34	11	7	21.0
15	301	165	9.4	0	31	8	5	18.8
17	336	250	8.8	0	51	5	12	20.4
Avg.	*298*	*196*	*8.9*	-	*26*	*5*	*5*	*13.3*

20 Pouches/Acre

3	393	372	7.6	20	7	0	3	1.9
6	233	229	9.0	20	21	9	18	9.2
9	371	364	8.2	20	2	3	1	0.6
10	252	230	10.2	20	40	1	8	17.4
14	327	321	9.3	20	12	3	5	3.7
16	332	325	8.4	20	0	0	1	0
Avg.	*318*	*306*	*8.8*	-	*14*	*3*	*5*	*4.6*

40 Pouches/Acre

1	282	266	8.4	40	4	2	3	1.5
5	303	246	9.2	40	18	2	13	7.3
7	286	282	8.2	40	1	1	2	0.3
11	184	163	10.6	40	25	4	6	15.3
13	398	397	8.4	40	4	1	2	1.0
18	183	129	9.5	40	9	2	2	7.0
Avg.	*273*	*247*	*9.1*	-	*10*	*2*	*5*	*4.0*

4. DFB Surveys in Areas Affected by Fire in 2000

A specially funded crew surveyed 332 stands in 13 areas affected by fire in 2000, on 7 NFs. Survey results showed virtually all surveyed stands had continuing DFB populations. Most new attacks were confined to fire-damaged trees, but in at least some, totally green trees had been infested. While existing beetle populations are unusually high, and in virtual "epidemic" status for most areas surveyed; additional stand data collected in those areas suggest beetle populations may decline in 2003. That prognostication is dependent on both management activities in those areas and weather patterns developing over the next year or two.

The following table summarizes those results (from Bulaon, 2003, FHP Report 03-2):

Summary of Douglas-fir beetle-caused mortality in surveyed fires ending October 2002–does not include older or unknown mortalities. Values are estimated trees per acre over 11 inches d.b.h.

Fire name	Fire damaged non-attacked	Fire damaged 2001 attacks	Fire damaged 2002 attacks	Total live basal area (ft^1/acre) 2002*	Anticipated DF mortality trend
Mussigbrod	26.3	1.17	17.50	38.8 (48%)	Decreasing
Blodgett-Trailhead	68.0	0	52.46	50 (56%)	Decreasing
Crooked	14.2	15.62	16.11	36.7 (32%)	Decreasing
Elizabeth	12.7	11.03	15.45	50 (32%)	Decreasing
Cave Gulch	18.8	4.34	19.24	66.2 (44%)	Decreasing
Maudlow-Toston	35.2	2.64	46.80	45 (42%)	Decreasing
Cliff Point	15.9	11.64	33.37	33.7 (26%)	Decreasing
Lydia Mountain	25.3	3.11	44.15	58.8 (35%)	Decreasing
Stone Hill	32.9	3.56	19.78	70 (58%)	Decreasing
Flat Creek	27.1	3.52	30.22	34.8 (45%)	Decreasing
Landowner	29.4	12.49	38.27	57.8 (37%)	Decreasing
Ninemile	27.8	4.63	17.59	49.9 (56%)	Decreasing
Burnt Flats	17.1	5.76	9.83	87.6 (52%)	Decreasing

5. Annosum Survey

Region 1 Forest Health Protection routinely recommends treating ponderosa pine stumps to prevent the introduction of *Heterobasidion annosum* (Fr.)Bref., causal agent of annosum root disease. Spores of the agent need to be present in order for new infections to become established. Incidence of the fungus will give us a better handle on the risks involved with not treating stumps. A project was initiated in 2002 to determine the incidence of p-type *Heterobasidion annosum* in Region 1. A survey was completed for the Lolo NF and surveys are planned for the Bitterroot and Flathead NFs in 2003. The stands selected for surveying are ponderosa pine forest type, with large stumps old enough for fruiting bodies to have had a chance to form, and regeneration old enough to have made contact with infected stump roots. A query was developed to incorporate all these criteria.

TSMRS stand data from the Lolo, Flathead, and Bitterroot NFs were queried for stands that met the following criteria: ponderosa pine forest type, mature harvesting 30+ years ago OR mature harvesting 20-30 years ago, and 30+ acres in size.

Stand selection came from two stratum; 30+ year-old mature harvesting activity, and 20- to 30-year-old mature harvesting activity. Ten percent of each stratum was randomly selected for surveying. The survey involves systematically searching the old stumps for *H. annosum* fruiting bodies (conks). When conks are found, data is taken on the stump, including the diameter and GPS coordinate. Data is also taken on any symptomatic and/or dead trees in close proximity to the stump.

The survey was completed on the Lolo NF in 2002. We searched 40 stands from the query and found positive *H. annosum* in 8 stands. These infected stands appear to be well distributed throughout the search area. An FHP report is forthcoming and will include the location of the positive *H. annosum* as well as the location of all the searched stands.

6. Evaluating Releases of *Cyphocleonus achates* as Potential Insectary Sites in Montana

Cyphocleonus achates is currently the most promising introduced biological control agent of spotted knapweed, *Centaurea maculosa*. The large root-feeding weevil mines the center of the knapweed taproot often stunting growth and reproduction and can even cause plant mortality. Hundreds of releases, usually between 50 to 200 weevils, have been introduced across most of the knapweed range in Montana and in surrounding states.

The primary objective of this project was to identify sites, where weevils had been previously released, to make future collections of weevils for redistribution. Nineteen sites were determined to have collectable populations of this weevil and will be reevaluated before collections are made in 2003. Weevils collected from insectary sites will be redistributed to sites that were burned and have mature knapweed plants or into other high priority areas identified by county or forest weed cooperators. We also verified the establishment of *C. achates*, collected information on site characteristics that might influence establishment, and impact data at most of the sites.

At five additional sites, weevil corrals were constructed similar to those at the Western Agricultural Research station. However, we did not transplant, clip or irrigate plants instead only used existing field knapweed populations. Therefore, we do not expect to produce high numbers of weevils such as the Western Agricultural Center produces. We also compared the efficacy of collecting weevils from corrals versus sweeping near corrals. However, the real comparison will be in 2003 once the weevils have had a chance to reproduce in the corrals. An FHP report will be produced this spring with more details on weevil establishment, site characteristics and impact.

COMMON AND SCIENTIFIC NAMES

Pathogens

Annosum root disease	*Heterobasidion annosum* (Fr.:Fr.) Bref.	Primary hosts: DF, GF, PP, SAF
Armillaria root disease	*Armillaria ostoyae* (Romagn.) Herink	DF, GF, SAF, sapling pines
Brown cubical butt rot	*Phaeolus schweinitzii* (Fr.:Fr.) Pat.	DF
Dothistroma needle cast	*Dothistroma septospora* (Doroguine) Morelet	LP, PP, WWP, LPP, WPB
Dwarf mistletoes	*Arceuthobium* spp.	PP, LP, DF, WL
Brown Stringy rot	*Echinodontium tinctorium* (Ell. & Ev.) Ell. & Ev.	GF, WH
Elytroderma needle cast	*Elytroderma deformans* (Weir) Darker	PP
Fusarium root rot	*Fusarium oxysporum* Schlechtend.:Fr.	DF (Nursery)
Grey mold	*Botrytis cinerea* Pers. ex Fr.	WL (Nursery)
Laminated root rot	*Phellinus weirii* (Murrill) R.L. Gilbertson.	DF, GF, WH, SAF
Sirococcus tip blight	*Sirococcus conigenus* (DC.) P. Cannon & Minter	WWP (Nursery)
Sphaeropsis shoot blight	*Sphaeropsis sapinea* (Fr.:Fr.) Dyko & Sutton in Sutton	PP
Western gall rust	*Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka	LPP, PP
White pine blister rust	*Cronartium ribicola* J.C. Fisch.	WWP, WBP, LP

Insects

Douglas-fir beetle	*Dendroctonus pseudotusugae* Hopkins	DF
Douglas-fir tussock moth	*Orygia pseudotsugata (*McDunnough*)*	DF, TF, ES
Gypsy moth	*Lymantria dispar (*Linaeus*)*	Most hardwoods
Mountain pine beetle	*Dendroctonus ponderosa* Hopkins	All pines
Pine engraver beetle	*Ips pini* (Say)	PP, LPP
Spruce beetle	*Dendroctonus rufipennis* Swaine	ES
Western balsam bark beetle	*Dryocoetes confuses* Swaine	SAF
Western spruce budworm	*Choristoneura occidentalis* Freeman	DF, TF, ES, WI
Western pine beetle	*Dendroctonus brevicomis* LeConte	PP
Fir engraver beetle	*Scolytis ventralis* LeConte	GF, SAF
Hemlock looper	*Lambdina fiscellaria lugubrosa* (Hulst)	DF
False hemlock looper	*Nepytia canosaria* (Walker)	DF

DF = Douglas-fir; GF = Grand fir; TF = True fir; SAF = Subalpine fir; PP = Ponderosa pine; LP = Limber pine: LPP = Lodgepole pine; WWP = Western white pine; ES = Engelmann spruce; WH = Western hemlock; WL = Western larch; WBP = Whitebark pine

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Table 2. Acres of host type infested by bark beetles, 1996-2001

	1996	1997	1998	1999	2000[1]	2001
DFB[2]	4,353	3,995	8,310	38,259	34,401	82,273
ESB	1,267	1,502	1,995	830	213	637
IPS	19	513	698	214	11	17
WPB	1,181	857	1,318	1,324	368	670
FE	401	615	523	134	159	1,047
WBBB	4,4673	30,088	59,248	43,472	28,010	27,622
MPB	27,503	34,187	39,198	77,347	40,758	111,626
Total	79,397	71,757	111,290	161,580	103,920	223,892

[1]Not all areas were flown in 2000 due to fires.

[2]DFB=Douglas-fir beetle; ESB= Engelmann spruce beetle; IPS=Pine engraver; WPB=Western pine beetle; FE=Fir engraver; WBBB=Western balsam bark beetle; MPB=Mountain pine beetle

Table 3. Douglas-fir beetle-infested acres and new dead trees in Montana, all ownerships, from 1999 through 2002

Reporting Area	1999		2000		2001		2002	
	Acres	Trees	Acres	Trees	Acres	Trees	Acres	Trees
Beaverhead	★	★	772	1,716	★	★	3,463	6,073
Bitterroot	1,163	4,619	★	★	11,414	21,649	11,755	24,676
Custer	0	0	★	★	14	50	0*	0*
Deerlodge	825	1,858	★	★	217	530	2,405	3,563
Flathead	4,237	15,891	6,329	14,199	14,909	22,813	7,164	16,924
Gallatin	1,234	2,896	1,244*	3,600*	2,231	3,214	2,374	4,293
Helena	584	1,037	273*	740*	1,521	2,262	1,204	2,103
Kootenai	19,858	59,902	15,352	42,677	32,051	61,132	17,589	24,411
Lewis & Clark	373	621	★	★	377	761	457*	576
Lolo	9,495	32,890	9,660	28,296	9,660	28,296	9,659	21,484
Garnets	417	1,333	★	★	415	1,166	111	541
Flathead IR	164	547	771	2,258	1,427	2,960	1,691	2,598
Crow IR	★	★	★	★	4	18	0	0
Glacier NP	57*	146*	★	★	★	★	15*	49*
Yellowstone NP	★	★	★	★	★	★	2,315	3,523
Other	33	50	★	★	433	2,139		
TOTAL	38,440	121,790	34,401	93,486	82,274	155,820	60,202	118,441

★ = Not surveyed. Yellowstone includes both MT and WY

*Only partially surveyed

Table 4. Acres of mountain-pine-beetle-caused mortality on State and private lands in Montana from 1999 through 2002

	1999				2000				2001				2002			
Reporting Area	LPP[1]	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP
Beaverhead	★	★	★	★	35	6	12	0	★	★	★	★	1,149	135	1,131	0
Bitterroot	0	822	0	0	★	★	★	★	837	0	0	0	45	519	0	0
Custer	0	33	0	0	★	★	★	★	0	108	0	0	2*	8*	0*	0*
Deerlodge	47	26	0	0	★	★	★	★	347	0	0	0	4,380	563	32	0
Flathead	57	90	12	13	81	46	0	107	362	80	13	41	2,062	185	39	76
Gallatin	69	6	118	0	0*	0*	4*	0*	15	2	0	0	19	0	0	0
Helena	119	449	12	0	2*	94*	20*	0*	28	1,526	0	0	103	2,394	0	0
Kootenai	15	117	0	63	14	25	0	14	28	58	0	79	2,315	81	0	74
Lewis & Clark	122	827	5	0	★	★	★	★	47	2,238	2	0	6*	592*	0*	0*
Lolo	1,819	368	3	7	992	172	0	2	4,170	459	8	0	7,333	1,131	44	27
Garnets	20	1,325	0	0	★	★	★	★	22	204	0	0	134	296	0	0
Crow IR	0	664	0	0	★	★	★	★	68	390	0	0	0	557	0	0
Fort Belknap IR	0	113	311	0	★	★	★	★	0	138	0	0	0	82	0	0
No. Cheyenne IR	0	4	0	0	★	★	★	★	0	4	0	0	0	16	0	0
Rocky Boys IR	6	336	0	0	★	★	★	★	0	24	0	0	0	399	0	0
Flathead IR	72	0	0	0	135	624	28	0	481	466	0	0	915	839	0	0
Other	0	0	0	0	0	0	0	2	0	28	0	0	0	0	0	0
Total	2,346	5,240	461	83	1,259	967	64	125	6,405	5,725	23	120	18,416	7,797	1,246	177

[1]LPP = Lodgepole pine; PP = ponderosa pine; WBP = whitebark pine; WWP = western white pine

Table 5. Acres of mountain-pine-beetle-caused mortality on all Federal ownership in Montana, from 1999 through 2002

	1999				2000				2001				2002			
Reporting Area	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP
Beaverhead	★	★	★	★	641	46	169	0	★	★	★	★	11,150	2,736	29,132	0
Bitterroot	34	978	10	0	★	★	★	★	146	555	2	0	1,028	836	6	0
Custer	0	416	0	0	★	★	★	★	0	1,158	0	0	36*	1,017*	0*	0*
Deerlodge	203	31	6	0	★	★	★	★	976	2	2	0	21,212	246	388	36
Flathead	3,936	75	28	64	4,639	100	42	447	13,052	92	767	130	17,986	435	429	412
Gallatin	133	0	7,684	0	6*	0*	14*	0*	12*	0*	0*	0*	128	0	0	0
Helena	294	232	30	0	8*	8*	2*	0*	88	590	0	0	271	1,499	0	0
Kootenai	83	252	4	834	190	98	0	199	978	95	4	727	2,965	603	2	898
Lewis & Clark	451	724	571	0	★	★	★	★	509	4,126	0	0	10*	1,483*	0*	0*
Lolo	45,558	1,234	61	102	27,217	1,436	10	56	64,745	1,371	210	41	100,475	3,068	718	149
Crow IR	0	732	0	0	★	★	★	★	116	748	0	0	35	776	21	0
Fort Belknap IR	60	753	0	0	★	★	★	★	0	0	0	0	8	428	0	0
Flathead IR	2,005	825	2	0	1,467	1,810	0	0	5,354	1,873	0	0	16,025	2,887	6	0
No. Cheyenne IR	0	582	0	0	★	★	★	★	0	290	0	0	0	703	0	0
Rocky Boys IR	30	174	0	0	★	★	★	★	2	22	0	0	0	465	0	0
BLM (Garnets)	10	16	0	0	★	★	★	★	502	2	0	0	26	232	0	0
Glacier NP	0*	0*	0*	0*	6*	0*	0*	12	★	★	★	★	91*	0*	0*	0*
Yellowstone NP	★	★	★	★	★	★	★	★	★	★	★	★	606	20	11,814	0
Total	2,346	5,240	461	83	34,174	3,498	237	714	86,480	10,924	976	898	172,050	17,434	42,516	1,495

Table 6. Bark-beetle-infested acres (other than mountain pine beetle and Douglas-fir beetle) in Montana, all ownerships, 1999-2002

Reporting Area	Engelmann Spruce Beetle				Pine Engraver Beetle				Western Pine Beetle				Fir Engraver Beetle				Western Balsam Bark Beetle			
	1999	2000	2001	2002	1999	2000	2001	2002	1999	2000	2001	2002	1999	2000	2001	2002	1999	2000	2001	2002
Beaverhead	★	6	★	42	★	0	★	14	★	0	★	0	★	0	★	10	★	18,698	★	67,669
Bitterroot	12	★	27	4	6	★	0	0	134	★	63	95	0	★	34	6	119	★	814	515
Custer	0	★	0	0*	12	★	0	0*	0	★	0	0*	0	★	0	0*	0	★	630	972
Deerlodge	2	★	0	22	74	★	0	2	0	★	2	0	0	★	0	32	291	★	4	2,187
Flathead	304	118	71	93	0	2	0	0	43	64	61	57	79	56	605	8,126	0	3,407	6,800	5,377
Gallatin	244	53*	287	0	0	0*	0	0	0	0*	2	0	0	0*	0	0	37,588	3,123*	9,700	14,896
Helena	22	0*	2	2	2	0*	0	0	2	36*	79	0	0	0*	0	0	89	78*	1,328	93
Kootenai	82	8	170	10	14	2	0	0	103	66	156	164	6	26	207	132	718	1,978	2,440	5,120
Lewis & Clark	45	★	8	0*	0	★	2	0*	0	★	0	0*	0	★	16	0*	2,671	★	3,940	164*
Lolo	40	14	30	8	22	0	13	3	893	190	205	275	31	22	95	295	1,019	300	1,677	728
Garnets	0	★	0	0	0	★	0	0	91	★	38	69	2	★	0	0	26	★	43	10
Flathead IR	0	2	42	0	8	7	2	4	59	10	26	79	16	55	90	302	38	72	204	113
No. Cheyenne IR	4	★	0	0	74	★	0	441	0	★	0	0	0	★	0	0	0	★	0	0
Fort Belknap IR	0	★	0	0	0	★	0	0	0	★	0	0	0	★	0	0	0	★	0	0
Rocky Boys IR	0	★	0	0	0	★	0	0	0	★	0	0	0	★	0	0	0	★	0	0
Crow IR	0	★	0	0	0	★	0	0	0	★	0	0	0	★	0	0	0	★	20	60
Glacier NP	37	★	★	0*	0	★	★	0*	0	★	★	0*	0	★	★	0*	8	★	★	0*
Yellowstone NP	★	★	★	6,049	★	★	★	32	★	★	★	0	★	★	★	21	★	★	★	14,120
Total	792	201	637	6,230	212	11	17	496	1,325	366	671	739	134	159	1,047	8,924	42,567	27,565	27,600	112,024

★ = Not surveyed * = Partially surveyed Yellowstone includes both MT and WY

Figure 1. Reporting Area (RA) boundaries in Montana includes all federal, state, and private land ownerships.

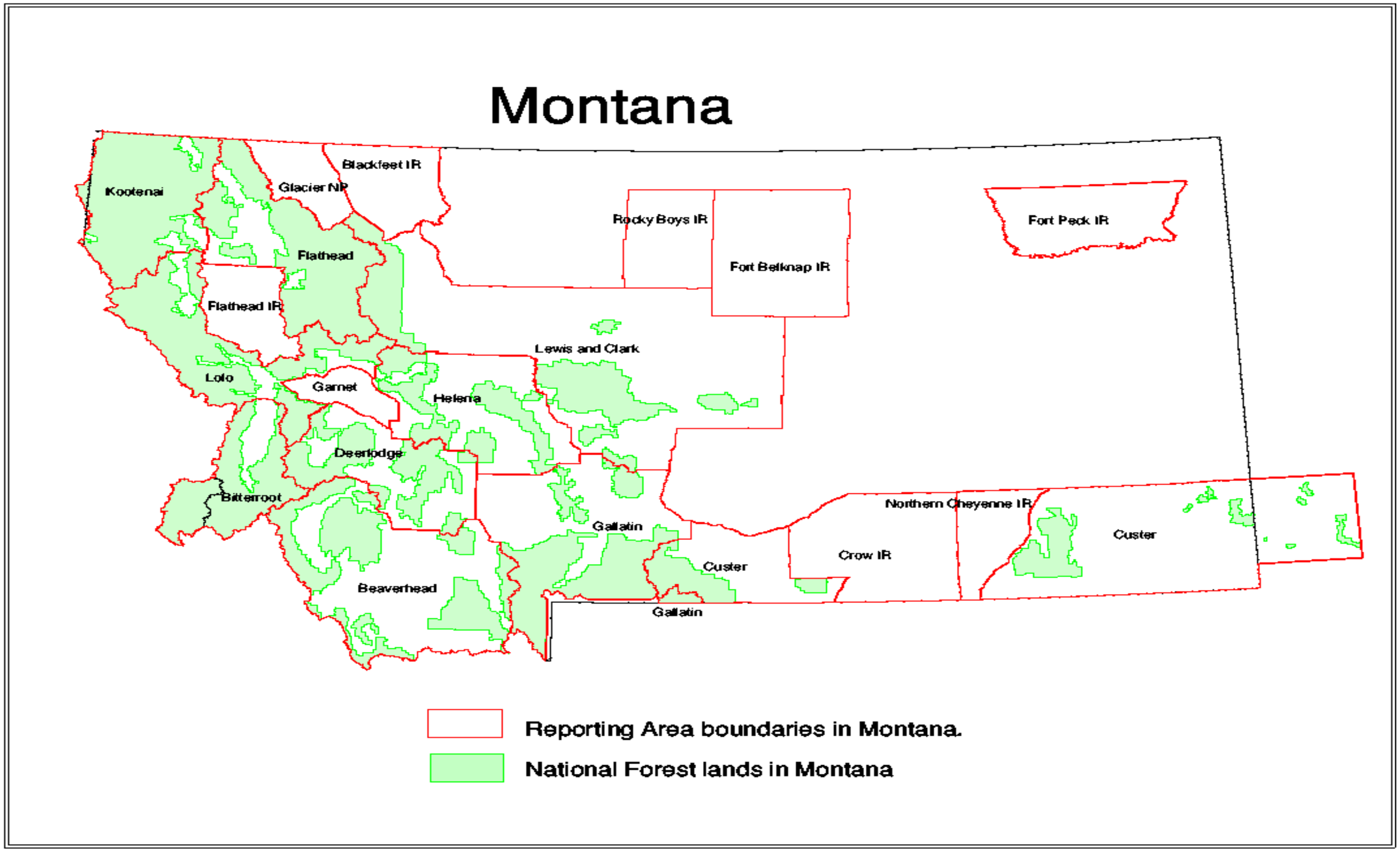

Figure 2. Area surveyed during the Forest Health Protection aerial detection survey in Montana, 2002.

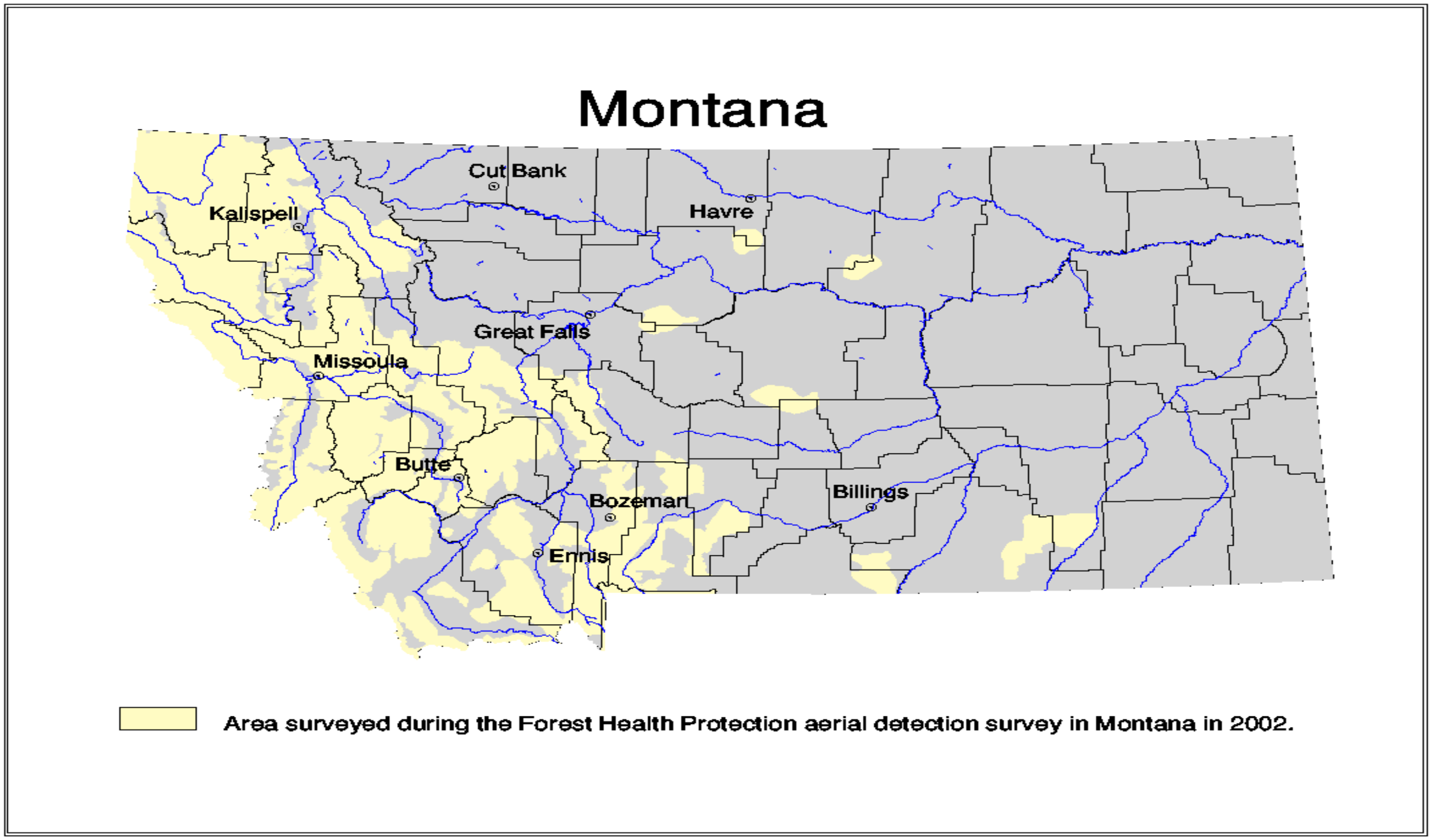

Figure 3. Mountain pine beetle infestations in Montana, 2002.

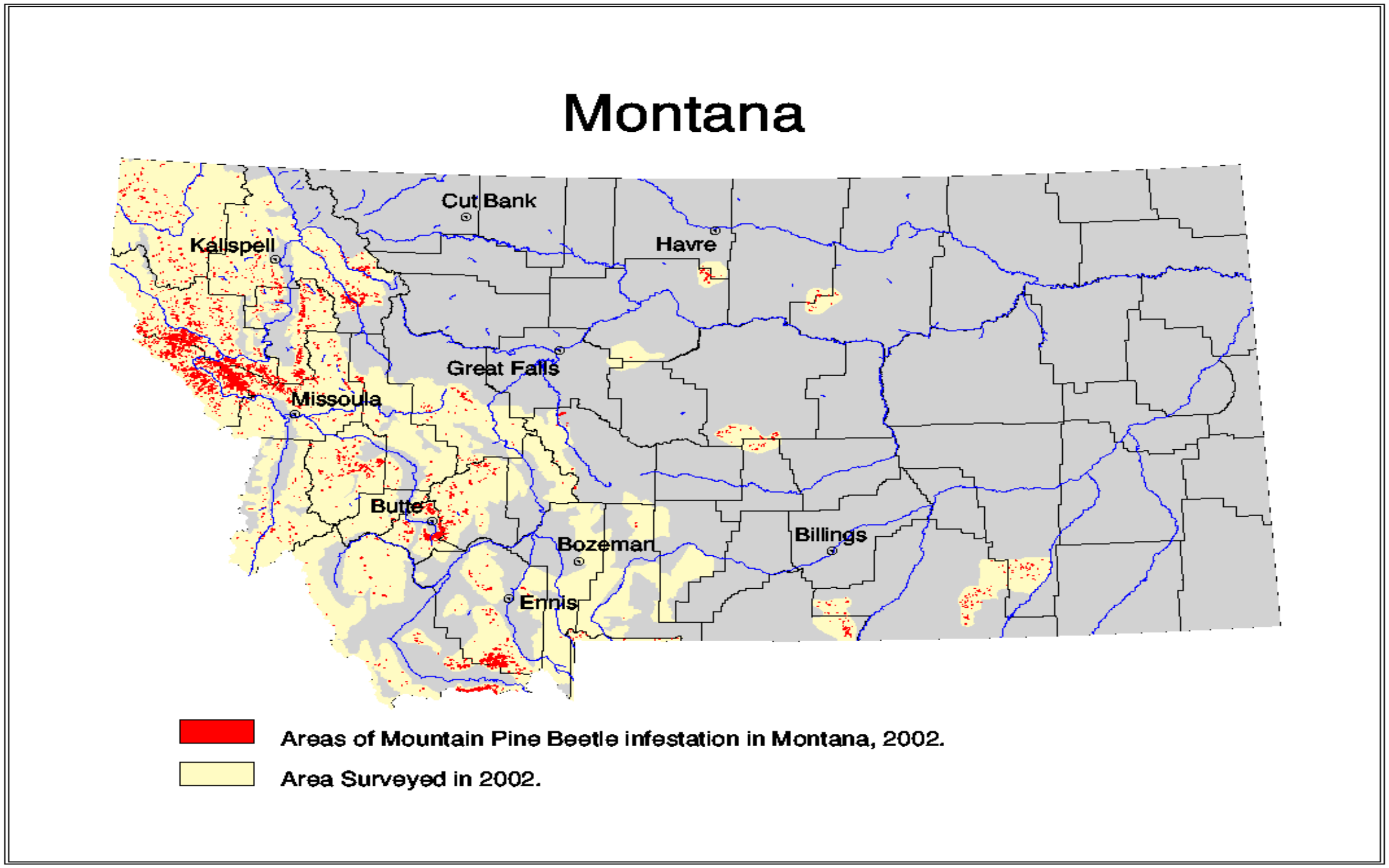

Figure 4. Douglas-fir beetle infestation in Montana, 2002.

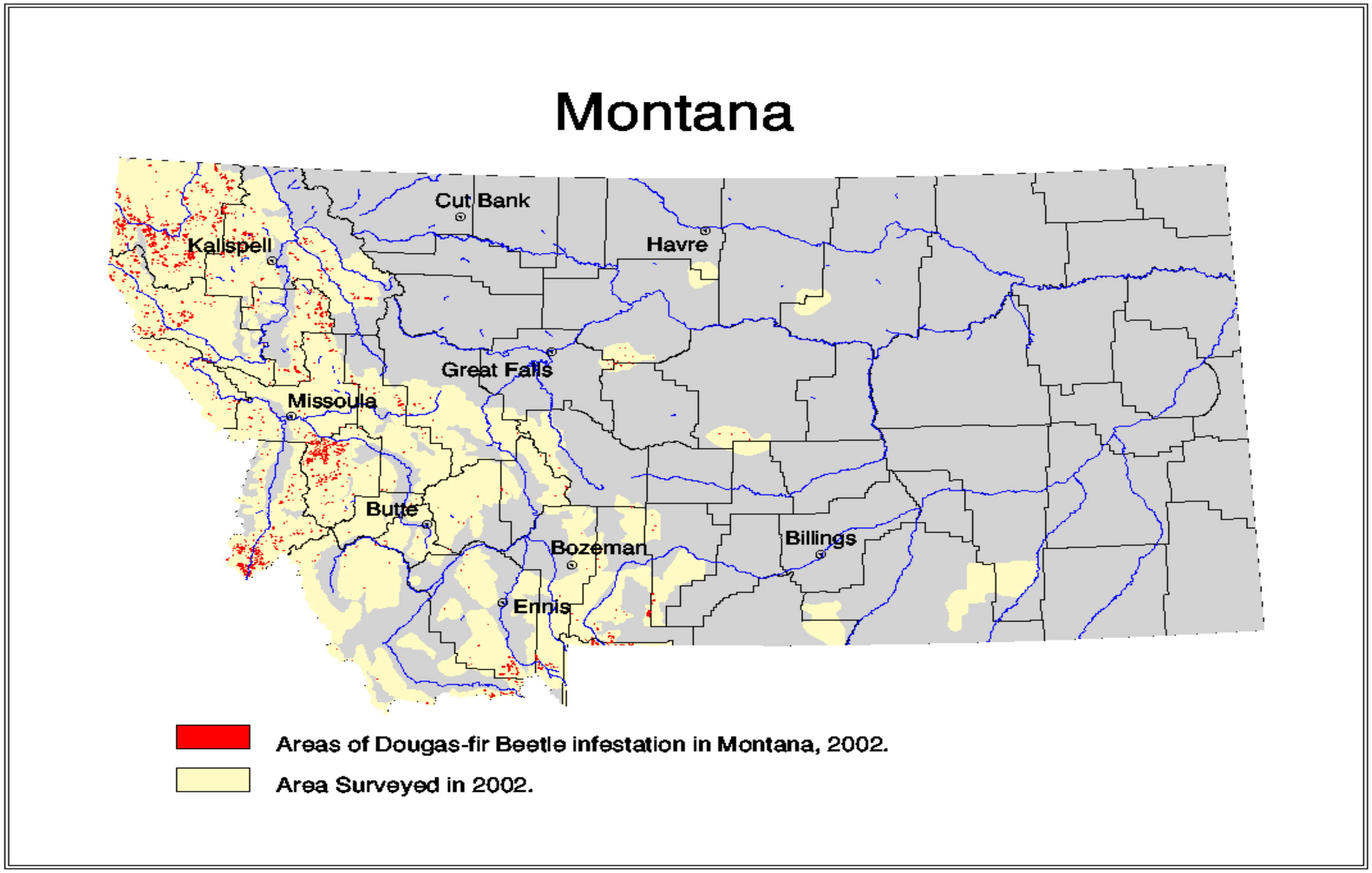

Figure 5. Fir engraver infestation in Montana, 2002.

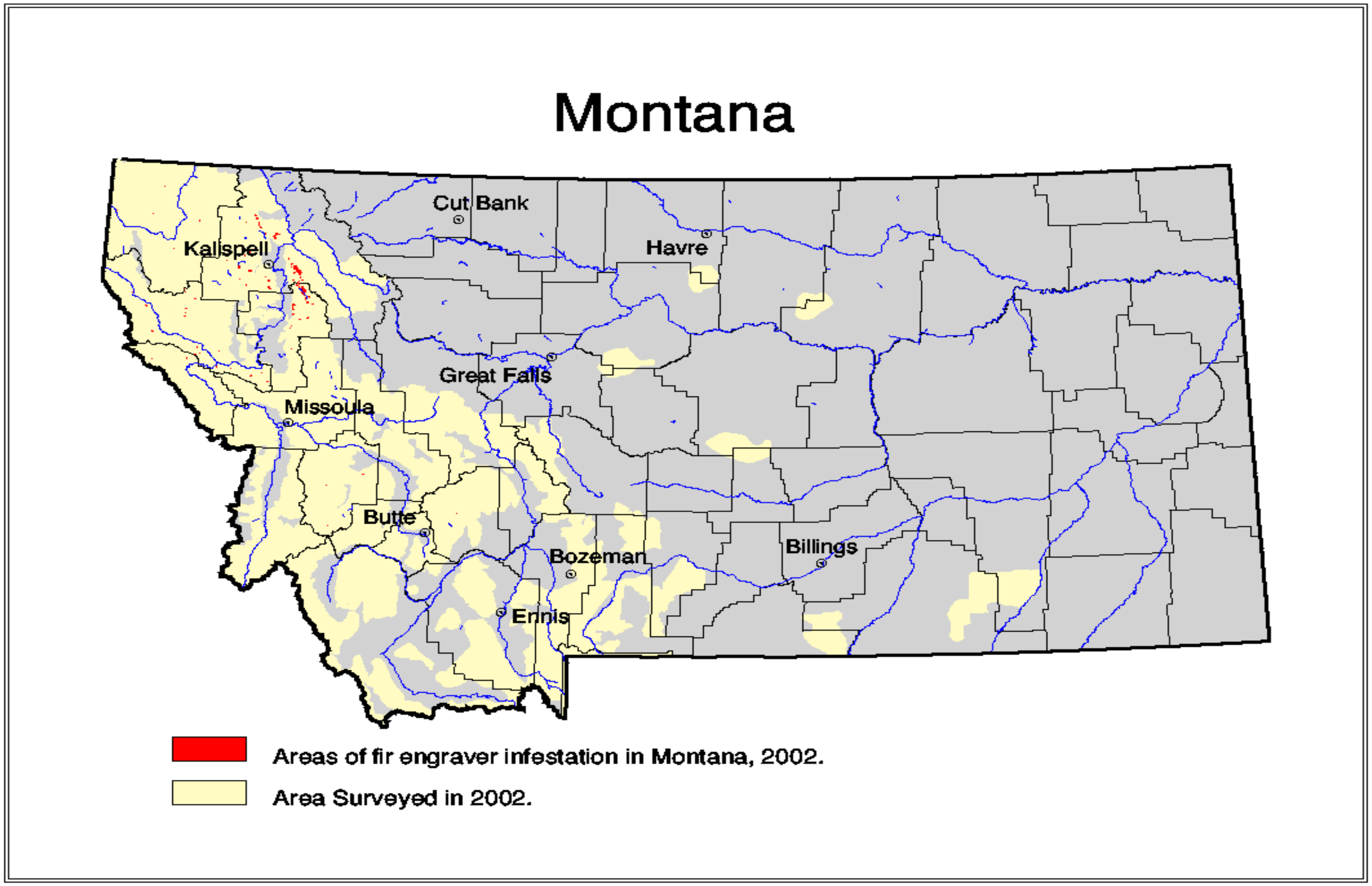

Figure 6. Western balsam bark beetle infestation in Montana, 2002.

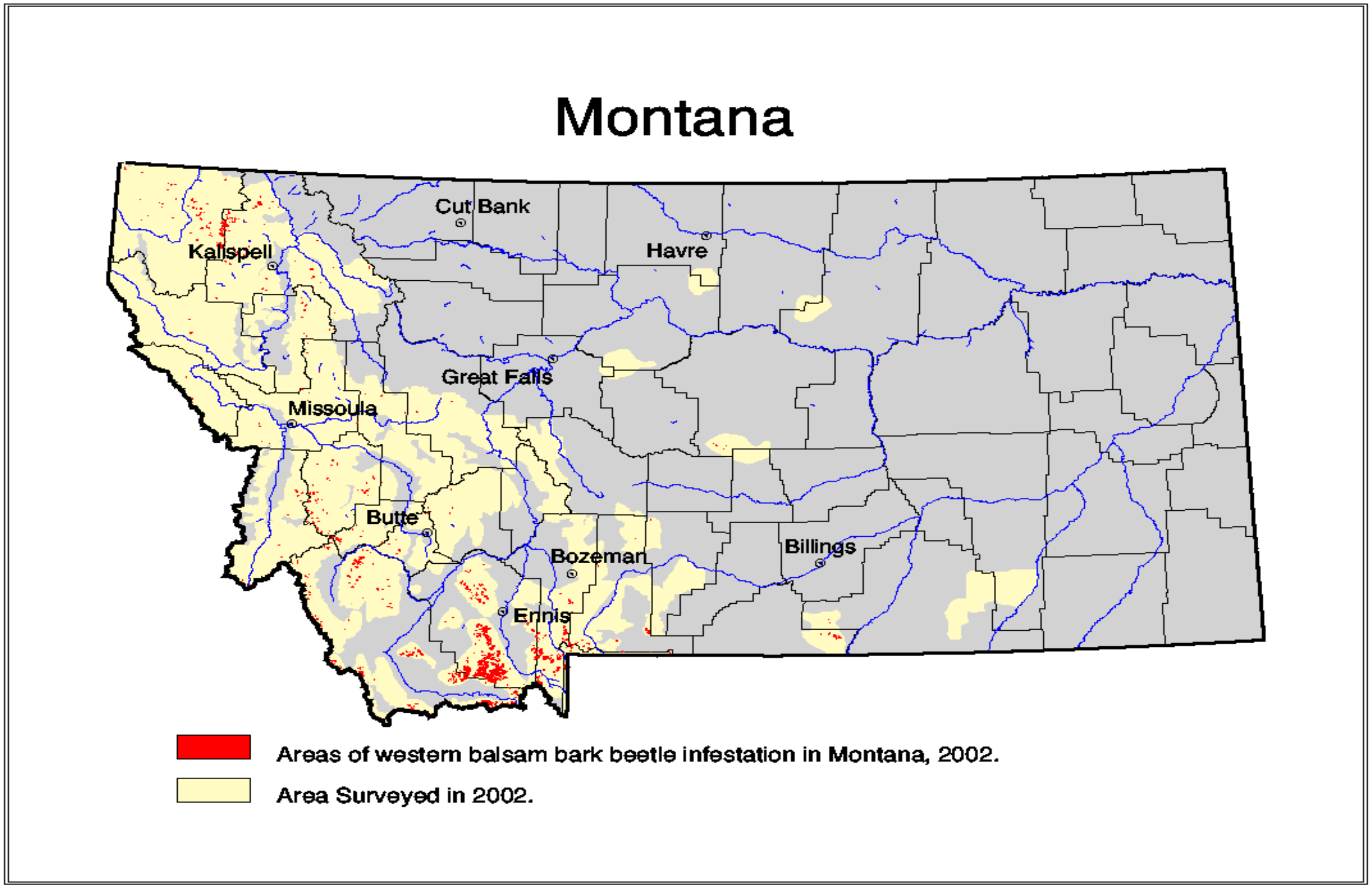

Figure 7. Western spruce budworm infestation in Montana, 2002