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Forest Insect and Disease Conditions and Program Highlights 1994

Report 95-2

MONTANA DEPARTMENT OF STATE LANDS

Montana Department of State Lands Forestry Division

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INTRODUCTION

This report summarizes the major insect and disease conditions in Montana during 1994 and was jointly prepared by Insect and Disease Management, Forest and Rangeland Management, Northern Region, USDA Forest Service and the Montana Department of State Lands. Information for this report was derived from ground and aerial surveys conducted throughout Montana, except for national parks and most national forest wilderness areas.

SUMMARY OF CONDITIONS

With some exceptions, there was a continued decline in number of acres infested by bark beetles in 1994. That is, in part, a reflection of the unusually cool and wet summer of 1993. For some species--mountain pine beetle in lodgepole pine being a good example--the decline in infested area is due to depletion of susceptible hosts, through either beetle depredations or management activities. Because summer 1994 was warmer and drier than normal, we may expect a resurgence of bark beetle activity in some areas in 1995. Notable is the likelihood of increasing populations of Douglas-fir beetle, western pine beetle, and engraver beetles. Fading, which occurred in low-elevation ponderosa pine stands well into the fall, suggests that on drier sites increases in beetle populations have already occurred. Whether or not that trend continues will be determined in large part by moisture received for the remainder of this winter and the coming spring. Subalpine fir mortality caused by western balsam bark beetles, although down from 1993, continues high.

Western spruce budworm caused defoliation in Douglas-fir and true fir in the Northern Region during 1993 dropped to its lowest level since Region-wide recordkeeping began in 1948. This decline continued in 1994, even though weather conditions were favorable for defoliators. Aerial surveys during the summer of 1994 detected 2,350 acres of visible defoliation, compared to 1,595,724 acres in 1991. Pheromone-baited traps used to monitor the adult male flight were also way down in 1993. No moths were caught over large areas where budworm populations had been moderate to high for many years. Pheromone trap counts in Montana were from zero to low in 1994.

Only three Douglas-fir tussock moths were trapped around the State in 1994. No visible defoliation was observed or is expected in 1995.

Lodgepole needle miner defoliation was observed again west of Red Lodge.

Incidence of root disease remains high throughout the State, though most of the root disease-caused tree mortality occurs west of the Continental Divide. Past management practices, such as selective harvesting and fire suppression, have increased the proportion of root disease-susceptible species in a number of habitat types around the State.

Annosus root disease continues to be very damaging in ponderosa pine stands in western Montana, and has been prevalent in areas where trees have been selectively harvested. It has also been found causing mortality in Douglas-fir and may be one of the causal agents in the ongoing occurence of subalpine fir high mortality. Schweinitzii butt rot continues to be common on Douglas-fir throughout its range. Armillaria root disease contiues to be damaging in many stands, especially those with large portions of Douglas-fir and true firs.

Dwarf mistletoes persist on over 2.5 million acres, resulting in an annual loss of approximately 33 million cubic feet. Tree species most affected in Montana are lodgepole pine, Douglas-fir and western larch.

White pine blister rust has persisted throughout the range of western white pine and whitebark pine, and has prevented the management of wild-type western white pine on moderate- to high-hazard sites. It also continues to cause mortality in whitebark pine stands, as well as limiting the production of cones.

Diplodia blight continues to cause damage to ponderosa pine, especially in western Montana to off-site planted ponderosa pine. Elytroderma needle cast was dramatically visible again in western Montana. Lodgepole pine needle cast has persisted along the Bitterroot Divide for the past 3 to 4 years. Needle cast in limber pine was observed around the northern portion of the Little Belt Mountains in central Montana. Rhabdocline needle cast in Douglas-fir was mapped in for the first time in several years in the south portion of the Tobacco Root Mountains.

THE ANNUAL AERIAL SURVEY

If the summer of 1993 was the summer of clouds and rain, then the summer of 1994 was the summer of fire and smoke. Both sets of environmental conditions presented challenges to accomplish the annual aerial survey. Survey flights began July 5 and ended September 16. August forest fires hampered survey flights because of poor visibility causing the survey to continue to mid-September. Most forested lands in Montana, except wilderness and national parks, were surveyed by Insect and Disease Management personnel in approximately 268 hours for the purpose of monitoring new forest disturbances, including effects of insects and diseases, wind throw, winter damage, and high water. These effects were observed and sketch mapped to provide most of the data summarized in this report. In 1994, approximately 20.5 million acres were surveyed from the air in Montana.

Areas not flown in 1994 include the Crow and Northern Cheyenne Indian Reservations, the Rocky Mountain Division of the Lewis and Clark National Forest (NF), the Ashland and Sioux Divisions of the Custer National Forest, the Tendoy Mountains of the Beaverhead NF, the Ruby Range and the Judith Mountains.

Because of the hot, dry summer, increased Ips and western pine beetle activity were observed in drier-site ponderosa pine stands, along the lower Clark Fork corridor. A special aerial survey was conducted on November 22 to sketch map tree mortality that was not visible during the regular aerial survey earlier in the year. Data from that survey will be included in the 1995 Montana Conditions Report.

INSECTS

BARK BEETLES

Douglas-fir Beetle (DFB)

In Montana, a considerable increase in infested area was noted Statewide--up from 4,940 acres in 1993 to 7,194 in 1994. Estimated tree mortality also increased, from just over 7,000 trees last year to more than 12,600 this year. Significant increases were mapped on the Flathead NF. Numerous 20- to 100-tree groups were noted in the Spotted Bear River drainage, northeast of Spotted Bear (Spotted Bear Ranger District [RD]) and on the Coram Experimental Forest (Hungry Horse RD). Elsewhere on the Forest, scattered, smaller groups were seen on the Glacier View, Tally Lake, and Swan Lake RDs. Ground data collected at several selected stands on the Hungry Horse and Spotted Bear RDs showed generally declining trends. Beetle populations are not expected to increase unless weather remains warmer and drier than normal.

On the Helena NF, new groups of fading Douglas-firs were found south of Canyon Ferry and west of Townsend (Townsend RD) and northwest of Holter Lake (Helena RD). The infestation on the Lincoln RD, north and west of Lincoln continued, but at a less-intensive rate than in the last 2-3 years. Ground-collected data indicated beetle populations are declining in most areas on the Forest.

A population-reduction strategy, using pheromone-baited funnel traps around trees which had been baited the previous year, was employed successfully on the Lincoln RD. Many emerging beetles were trapped, but follow-up surveys showed no trees attacked in the treatment areas in 1994. Baited trees and traps were removed later in the summer.

Slight increases were observed on the Gallatin NF in some areas, but the major infestation which has occurred in the Mill Creek drainage (Livingston RD) declined due to aggressive salvage and judicious use of pheromone tree baits. Beetle populations still exist in the Sixmile Creek drainage and other stands on the east side of the Yellowstone River. Infested trees were also mapped on the Bozeman RD and in the Boulder River drainage (Big Timber RD). Data gathered at several areas on the Forest showed a decidedly declining trend when comparing developing brood to numbers of beetles attacking trees in 1994.

Recently infested stands were noted on the Kootenai NF, principally in the vicinity of Pinkham Falls (Rexford RD). Two of three infested groups surveyed in that area showed increasing beetle populations. Additional trees likely will be killed for the next year or two. Other fader groups were observed in the Purcell Mountains and along Fisher River (Libby RD) and around Bull Lake (Three Rivers RD). Small and widely scattered groups were noted elsewhere throughout the Forest.

Many other reporting areas showed some level of infestation, though most was scattered and of a more static nature. Groups of beetle-killed trees were seen in the area around Seeley Lake and near Missoula on the Lolo NF; in the East Fork Bitterroot River drainage (Bitterroot NF); in the Beartooth and Pryor Mountains on the Custer NF, where ground surveys showed static population trends; in the Garnet Mountains, Bureau of Land Management (BLM) land; and near Mission Reservoir (Flathead Indian Reservation [IR]).

In 1994, we cooperated in a project to assess the effectiveness of MCH (DFB anti-aggregative pheromone) in protecting standing Douglas-fir from attack by DFB. Our portion of the project, a multi-Region effort, was conducted on the Lincoln RD. Preliminary results were encouraging. We also became involved in another multi-Region project to develop a hazard rating system for DFB. Still in the data-collection phase, the project will continue in 1995.

Figure 1--Douglas-fir beetle infestation acres in Montana, 1989-1994.

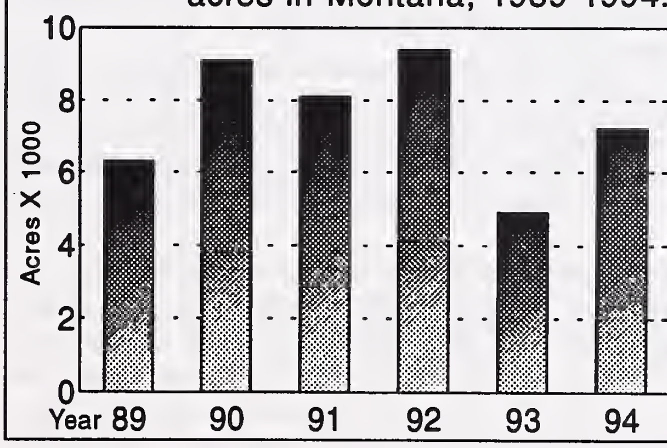


Table 1--Douglas-fir beetle-infested acres in Montana, all ownerships, from 1992 through 1994.

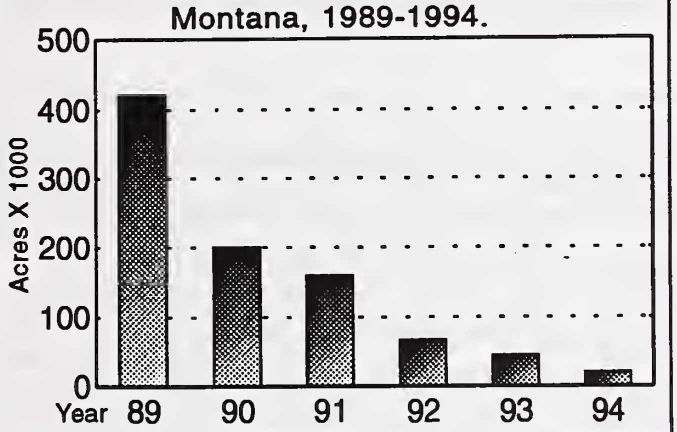
	------ 1992 ------			------ 1993 ------			------ 1994 ------		
Reporting Area	Acres	Trees	Vol. (MBF)[1]	Acres	Trees	Vol. (MBF)	Acres	Trees	Vol. (MBF)
Beaverhead NF	1,395	1,607	321.4	311	190	38.0	47	51	10.2
Bitterroot NF	1,770	2,947	884.1	201	467	140.1	166	351	105.3
Custer NF	2	20	4.0	562	711	45.2	672	793	158.6
Deerlodge NF	165	176	35.2	12	15	3.0	32	32	6.4
Flathead NF	770	774	232.2	510	907	272.1	1,629	3,869	1,160.7
Gallatin NF	1,183	1,210	242.0	1,034	1,182	871.0	1,182	1,164	232.8
Helena NF	35	114	22.8	503	1,104	220.8	996	1,354	270.8
Kootenai NF	472	616	184.8	589	1,155	346.5	1,272	2,547	764.1
Lewis & Clark NF	-	-	-	46	67	108.8	14	20	4.0
Lolo NF	1,775	2,475	742.5	606	1,051	315.3	624	1,221	366.3
Swan River SF	111	155	46.5	16	53	15.9	145	372	111.6
Stillwater SF							10	9	2.7
Thompson River SF	57	146	43.8	0	0	0	28	78	23.4
Flathead IR	80	153	45.9	156	295	88.5	166	438	131.4
Garnets	236	327	98.1	44	92	27.6	123	201	60.3
Crow IR				29	63	12.6	*	*	*
Glacier NP				214	483	144.9	*	*	*
Yellowstone NP				114	235	47.0	*	*	*
Other Areas				2	5	1.0	88	103	20.6
Total	**8,051**	**10,720**	**2,903.3**	**5,288**	**8,856**	**2,065.3**	**7,194**	**12,603**	**3,429.2**

* Not flown.
[1] (MBF) = 1,000 Board Feet

Mountain Pine Beetle (MPB)

MPB populations continued their decline in most host species. The 1994 total, for all species and on all ownerships, at 19,195 acres, is the lowest figure recorded in the state in the past quarter-century. It is less than half the nearly 43,500 acres recorded in 1993. An estimated 56,000 trees were killed--1,700 western white pine (WWP), 5,500 ponderosa pine (PP), 48,500 lodgepole pine (LPP), and 465 white bark pine (WBP).

Figure 2--Mountain pine beetle infestation acres (all pine species) in Montana, 1989-1994.



Western White Pine. In Montana's WWP stands, 1,706 acres were infested--a reduction from 2,000 acres last year. Much of it was on the Kootenai NF, in the Pete Creek, Spread Creek and North Fork Meadow Creek drainages, all tributaries of the Yaak River; and in the North and South Callahan Creeks, south of Troy (Three Rivers RD). Others were scattered on the Cabinet RD.

The next most seriously affected reporting area was the Flathead NF. Of the 379 acres recorded on the Forest, compared to 843 in 1993, most were along both sides of Hungry Horse Reservoir; but concentrated somewhat in the Peters and Deadhorse Creek drainages. Several groups were observed in the North Fork Flathead River drainage (Glacier View RD), and in adjacent areas on the Stillwater SF, across the Whitefish Divide. Others were noted in the southeast corner of Glacier National Park (NP), along the Middle Fork Flathead River.

Ponderosa Pine. Infested PP stands, equalled approximately one-third of the 11,924 acres infested in 1993 recorded in 1994, down to 3,723 acres. About half was on the Lolo NF and adjacent state and private lands. Much of it was mapped in stands along I-90, both west and east of Missoula, and in the lower Rattlesnake drainage (Missoula RD). Faders were also found scattered throughout the PP type on the Ninemile and Plains/Thompson Falls RDs. An ongoing infestation on the Ninemile RD is in the vicinity of Blue Ridge.

Scattered groups of beetle-killed trees were found in the Bitterroot River drainage south of Lolo; in the southern and western portions of the Flathead IR; throughout the Garnet Mountains (BLM); the Little Rocky Mountains (Fort Belnap IR); and in the Big and Little Snowies south of Lewistown. None are considered to be major infestations.

Lodgepole Pine. LPP stands infested in 1994 were less than half those infested in 1993. Total affected acres were reduced from 29,352 to 13,053. The most significant infestations continue to be on the Lolo NF where 7,904 acres are still in outbreak conditions. Most of that is on the Plains/Thompson Falls RD (6,342 acres) and is located north and east of Plains in Hinchwood Creek, McGinnis Creek, and Little Thompson River drainages; along the Flathead IR Divide; and south of Plains near Combest Peak on the Plains/Superior divide. On the Superior RD (897 acres), the outbreak is concentrated near the divide with Plains RD and in Tamarack Creek drainage. A small amount was located in the upper Ninemile Creek drainage, Ninemile RD. Ground-collected data on the Lolo NF showed an average of 20 trees attacked in 1994--compared to 18 in those same areas in 1993.

Flathead NF had 1,578 acres infested. Over half of those (904 acres) were on the Swan Lake RD, on Crane Mountain--roughly from Mauzey Creek south to Gunderson Creek. Spotted Bear RD had 317 acres infested and Hungry Horse RD had 100 acres--both those outbreaks being scattered along Hungry Horse Reservoir and near Spotted Bear. Data collected from 25 selected plots averaged four newly attacked trees in 1994; 22 in 1993.

The once massive outbreak on the Kootenai NF, which covered more than 400,000 acres, has been reduced to 1,298 acres. Much of that is near Newton Mountain, along the South Fork Yaak River, or elsewhere along tributaries of the Yaak River (Three Rivers RD). Data from 30 ground plots averaged 10 trees per acre attacked in 1994; nine in 1993. Most new attacks were observed near Newton Mountain, however. Four of six plot areas showed no new attacks at all.

Deerlodge NF had 357 acres affected, mostly on the Philipsburg RD, while the Helena NF showed 134 acres impacted along Prickly Pear Creek south of Helena. On the Gallatin NF, 213 infested acres were scattered throughout the Gallatin and Hyalite Canyons (Bozeman RD), and Lewis & Clark NF had trees killed on 298 acres, primarily on the Judith RD. An additional 447 acres were observed scattered in the northeast and western parts of the Flathead IR.

Whitebark Pine. There were significant increases in infested WBP stands--from 163 to 713 acres, and an increase in beetle-killed trees from an estimated 109 in 1993 to 465 in 1994. A majority of those, covering 470 acres, were observed on the Gallatin NF (Hebgen Lake RD). Other infestations were small and scattered. There is renewed interest in causes of whitebark pine mortality throughout its range because of its importance in high-elevation ecosystems.

Table 2--Acres of mountain pine beetle-caused mortality on Federal and Indian Reservation lands in Montana from 1992 through 1994.

	-------- 1992 --------				-------- 1993 --------				-------- 1994 --------			
Area	LPP[1]	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP
Beaverhead NF	2,041	6	138	-	201	2	42	0	47	0	85	-
Bitterroot NF	6	62	-	-	18	345	0	0	4	214	0	0
Custer NF	-	40	2	-	203	173	30	-	87	0	30	-
Deerlodge NF	168	-	-	-	52	12	0	0	256	0	0	0
Flathead NF	4,129	28	80	2,624	2,546	115	32	271	1,375	96	47	330
Gallatin NF	275	-	160	-	2,019	2	67	0	164	2	320	-
Helena NF	290	36	44	-	232	78	10	0	94	76	16	0
Kootenai NF	31,616	782	48	533	4,817	473	0	590	1,244	109	6	974
Lewis & Clark	212	153	149	-	431	78	15	0	208	279	15	0
Lolo NF	15,929	80	2	54	15,268	998	0	71	7,438	677	40	88
Total NF	**54,666**	**1,187**	**623**	**3,211**	**25,787**	**2,275**	**151**	**933**	**10,917**	**1,461**	**559**	**1,392**
Crow IR	*	*	*	*	4	80	-	-	*	*	*	*
Fort Belknap IR	76	129	-	-	*	*	*	*	2	22	0	0
Flathead IR	380	1,128	-	-	658	7,229	0	0	447	466	0	0
N. Cheyenne IR	*	*	*	*	0	56	0	-	*	*	*	*
Rocky Boy's IR	61	26	-	-	*	*	*	*	0	14	0	0
Total IR	**517**	**1,283**	**-**	**-**	**662**	**7,365**	**0**	**0**	449	502	0	0
BLM	299	20	54	4	135	56	6	0	102	82	118	0
Glacier NP					40	0	0	66	*	*	*	*
Yellowstone NP					2	0	0	0	*	*	*	*
Total Federal (Non-FS)	**816**	**1,303**	**54**	**4**	**839**	**56**	**6**	**66**	**551**	**584**	**118**	**0**
Total	**55,482**	**2,490**	**677**	**3,215**	**26,626**	**2,331**	**157**	**699**	**11,468**	**2,045**	**677**	**1,392**

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

* Not flown.

[2] NF = National Forest

[3] IR = Indian Reservation

Table 3--Acres of mountain pine beetle-caused mortality on state and private lands in Montana from 1992 through 1994.

	1992				1993				1994			
Area	LPP[1]	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP
Beaverhead NF	127	-	2	-	35	0	-	0	9	0	0	0
Bitterroot NF	2	68	-	-	8	306	-	0	0	269	0	0
Custer NF		2	18	-	4	19	-	0	0	2	0	0
Deerlodge NF	88	2	-	-	122	12	-	0	99	33	2	0
Flathead NF	121	94	-	60	190	504	0	573	191	36	0	49
Gallatin NF	-	2	26	-	485	10	4	0	49	0	32	0
Helena NF	84	78	4	-	100	186	2	0	34	132	2	0
Kootenai NF	540	64	-	20	75	70	-	60	53	20	0	70
Lewis & Clark NF	8	24	45	-	26	294	-	0	2	337	0	0
Lolo NF	749	170	2	-	253	548	-	2	463	508	0	2
Stillwater SF	48	2	10	261	6	0	-	358	4	2	0	59
Swan River SF	2	-	-	26	56	0	-	8	0	2	0	14
Thompson River	279	70	-	-	163	45	-	0	618	137	0	0
Garnets	18	132	-	-	40	0	-	0	6	174	0	0
Other									57	26	0	120
Total	**2,066**	**708**	**107**	**393**	**2,726**	**1,994**	**6**	**1,001**	**1,585**	**1,678**	**36**	**314**

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

Areas of mountain pine beetle infestations in Montana (all host species), 1994.

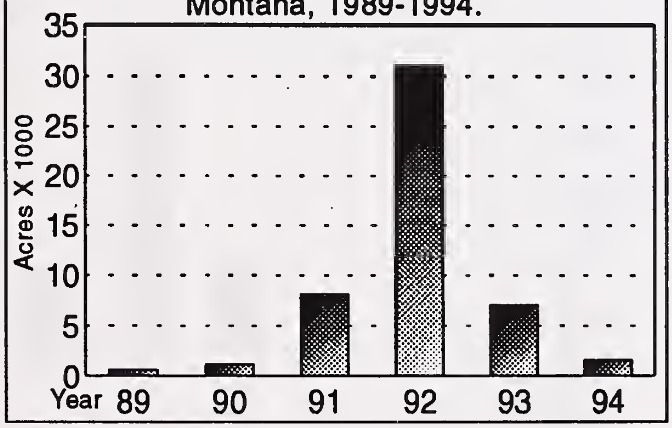
Pine Engraver (IPS)

IPS-killed ponderosa pines were noted on only 247 acres in 1994--an increase from 52 in 1993. We know that figure will increase significantly in 1995. A late-season aerial observation flight was conducted along the Clark Fork River, from Alberton to Superior. Several thousand affected acres, and nearly 5,000 dead trees were recorded. Those will appear as part of the 1995 aerial survey totals, but were observed and evaluated in late 1994 because of earlier-than-normal fading. Approximately two-thirds of the trees we looked at had been killed by engraver beetles. Others were infested by WPB, MPB, RTB, or combinations of several beetles.

An ongoing project to assess the ability of combinations of semiochemicals in protecting ponderosa pine slash from attack by spring-flying beetles will continue in 1995. Results from the test conducted in 1994 were encouraging and will serve as a basis for the 1995 trials.

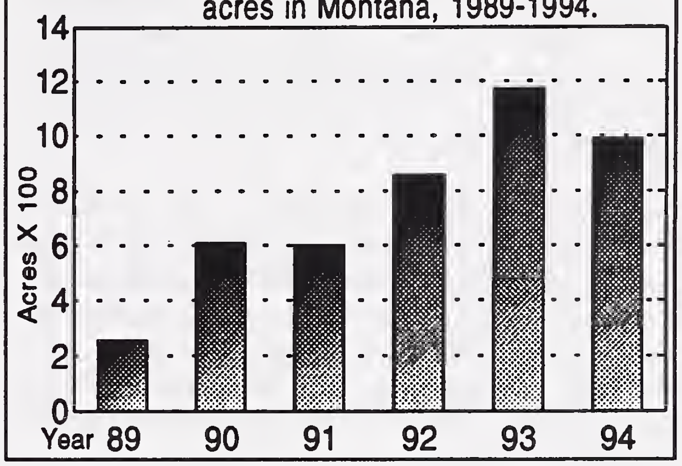
Lodgepole pine stands were less affected in 1994, state-wide. Only 1,304 affected acres were mapped, about one-sixth the 7,015 acres recorded in 1993. More than 90 percent of those were observed on the Gallatin (Big Timber RD and adjacent private land) and Lewis & Clark NFs.

Figure 3--Pine engraver beetle (Ips) infestation acres (LPP&PP) in Montana, 1989-1994.



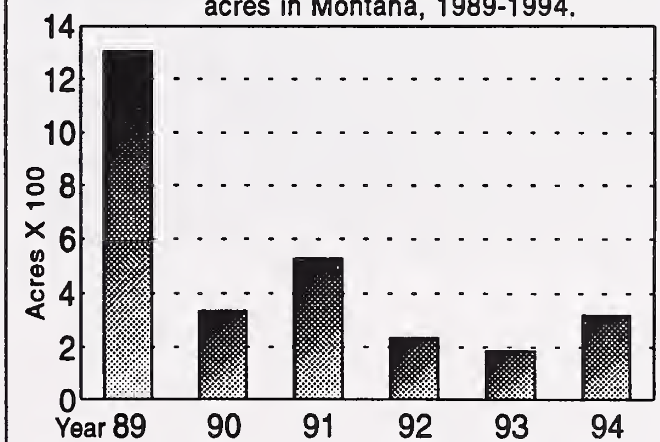
Western Pine Beetle (WPB). Ponderosa pine stands infested by WPB also declined in western Montana in 1994--but not as significant a decline as occurred in other parts of the Region. Where 1,170 acres had been infested in 1993, 985 acres showed some level of tree killing attributed to WPB in 1994. Most was observed as scattered groups on the Bitterroot and Lolo NFs--principally along I-90, both east and west of Missoula--and in the Garnet Mountains reporting area.

Figure 4--Western pine beetle infestation acres in Montana, 1989-1994.



Fir Engraver (FE). FE-infested stands increased somewhat in the state, up from 187 acres to 318. Only 324 trees were estimated to have been killed--barely one per acre. Most affected stands were mapped on the Lolo NF. The Missoula RD, with 86 acres, had the highest total of any reporting area. Though some grand fir stands exist in western Montana, FE is not as significant a pest as it is in northern Idaho.

Figure 5--Fir engraver beetle infestation acres in Montana, 1989-1994.



Western Balsam Bark Beetle (WBBB). Subalpine fir stands infested by WBBB declined by nearly a third in Montana, down from 58,184 to 39,292 acres, statewide. The Gallatin NF had the most expansive infested area--19,749 acres. Most were in stands in the Madison Range, north and south of Hebgen Lake (Hebgen Lake RD); in the Gallatin Range, south from Bozeman to Yellowstone NP, and in other portions of the Madison Range to the west (Bozeman RD). Near Jardine and Cooke City, SAF stands were impacted on the Gardiner RD.

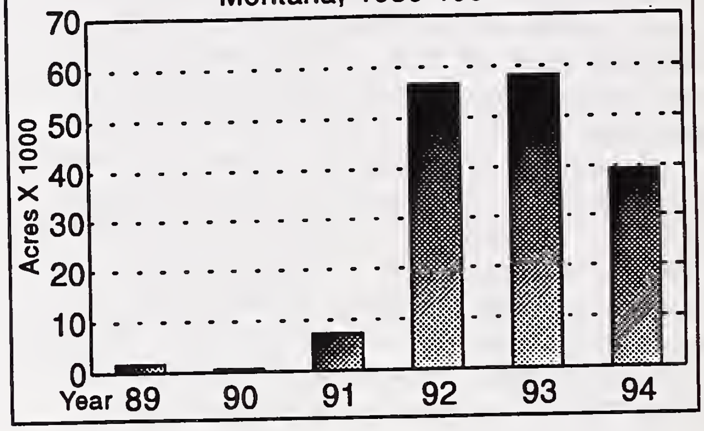
Next most seriously affected was the Beaverhead NF, with 17,447 infested acres in the Gravelly and Tobacco Root Mountain ranges (Sheridan and Madison RDs) and in the Beaverhead and Anaconda Ranges (Wisdom RD).

Lesser amounts were recorded on Lewis & Clark NF, 842 acres mostly south of Kings Hill Pass (Kings Hill RD); and Custer NF, 369 acres on the Beartooth RD, west of Red Lodge and in the Pryor Mountains. On the Lolo NF, 206 acres were infested--much of it in the Fish Trap area and other parts of the Thompson River drainage (Plains/Thompson Falls RD).

On the Flathead NF, 194 acres--scattered throughout higher elevations above the North Fork Flathead River (Glacier View RD) were infested. The Helena NF, had 183 acres in the Little Belt Mountains northeast of White Sulphur Springs (Townsend RD) affected; as did the Deerlodge NF, where the total was 177 acres, mostly scattered through the Flint Creek Range (Phillipsburg RD). Though not all BLM land in the Centennial Mountains was flown, significant infestations remain in that part of the state near the Continental Divide.

In 1994, as in 1993, we used pheromone-baited traps to help determine seasonal flight periodicity of WBBB in Montana. Traps were installed on the Sula RD, Bitterroot NF in June. Collections were made weekly, and traps removed in early October. Preliminary counts showed peak beetle flight occurred in early to mid-August in 1993 and late-June in 1994. The test will be conducted for a third year in 1995.

Figure 3--Western Balsam Bark Beetle infestation acres (SAF) in Montana, 1989-1994.



Engelmann Spruce Beetle (ESB)

ESB populations remained at virtual endemic levels in 1994. On 157 acres, only 148 trees were reported killed. Amounting to less than one tree per acre, a somewhat arbitrary epidemic "threshold," the level of mortality declined from that experienced in 1993 when 362 trees were estimated to have been killed on 526 acres. Most of the few, small and scattered groups recorded were observed on the Flathead (Spotted Bear RD), Gallatin Big Timber RD), and Lewis & Clark (Judith RD) NFs.

Figure 7--Engelmann spruce beetle infestation acres in Montana, 1989-1994.

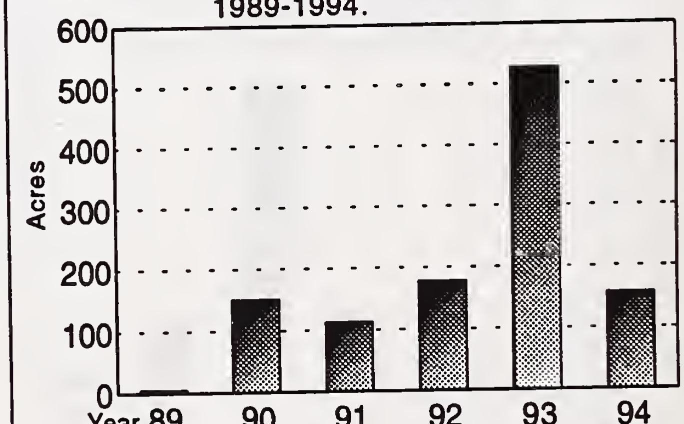


Table 4--Bark beetle-infested acres (other than mountain pine beetle and Douglas-fir beetle) in Montana, all ownerships, 1992-1994.

	Engelmann Spruce Beetle			Pine Engraver Beetle			Western Pine Beetle			Fir Engraver Beetle			Western Balsam Bark Beetle **		
Reporting Area	1992	1993	1994	1992	1993	1994	1992	1993	1994	1992	1993	1994	1992	1993	1994
Beaverhead NF	0	7	0	376	0	57	0	6	-	23	0	0	3,463	22,543	17,447
Bitterroot NF	0	0	0	16	0	0	90	144	196	6	0	2	53	10	42
Custer NF	0	0	14	39	2,169	0	0	0	-	0	0	0	6	70	369
Deerlodge NF	55	2	0	1,895	0	0	4	2	0	20	0	6	534	242	177
Flathead NF	35	20	40	0	0	0	16	42	32	90	20	58	341	173	194
Gallatin NF	0	0	38	2,943	27,936	831	0	12	-	0	24	0	1,998	32,454	19,749
Helena NF	2	29	8	0	0	0	114	126	-	0	0	0	200	254	183
Kootenai NF	15	4	0	2	0	2	20	2	56	12	26	38	48	38	56
Lewis & Clark	0	109	41	1,402	871	185	0	76	-	0	96	150	106	553	842
Lolo NF	2	4	6	0	0	57	98	0	417	182	0	0	479	174	206
Garnets	0	0	0	0	0	0	26	50	0	0	0	0	12	27	4
Flathead IR	2	0	2	127	2	0	222	88	176	149	22	36	61	24	20
N. Cheyenne IR	0	*	*	1,295	*	*	0	*	*	0	*	*	0	*	*
Stillwater SF	4	0	0	0	0	0	0	0	0	6	0	14	0	10	0
Swan River SF	0	0	0	0	0	0	0	0	0	6	0	6	0	0	0
Thompson R. S	0	2	0	0	6	2	16	0	12	34	0	4	2	22	2

* Not flown

** Mortality in subalpine fir

DEFOLIATORS

Western Spruce Budworm

Current Status

Western spruce budworm caused defoliation in Douglas-fir and true fir in the Northern Region, during 1993, dropped to its lowest level since Region-wide record keeping began in 1948. This decline continued in 1994, even though weather conditions were favorable for defoliators. Aerial surveys during the summer of 1994 detected 2,350 acres of visible defoliation, compared to 1,595,724 acres in 1991. Forests with defoliation include the Deerlodge and Gallatin. Pheromone-baited traps used to monitor the adult male flight were also way down in 1993. No moths were caught over large areas where budworm populations had been moderate to high for many years. Pheromone trap counts in Montana were from zero to low in 1994.

Outlook for 1995

Budworm populations are not expected to fully recover soon. Even if weather patterns remain near normal, it could take several years before large-scale visible defoliation occurs again.

Figure 8--Western spruce budworm defoliation acres in Montana, 1989-1994.

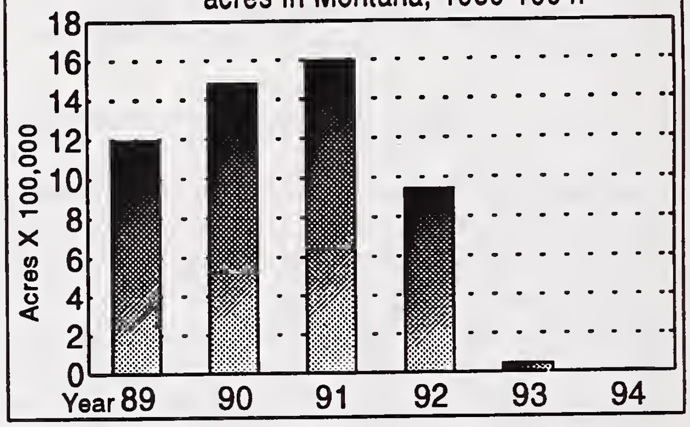


Table 5--Acres of western spruce budworm defoliation visible from the air in Montana, 1991 through 1994.

	All Ownerships				1994 Acres by Ownership				
Reporting Area	1991	1992	1993	1994	IR	NFS	BLM	State	Private
Beaverhead NF	26,725	39,914	1,734	0	0	0	0	0	0
Bitterroot NF	276,085	8,560	1,091	0	0	0	0	0	0
Custer NF	8,782	0	0	0	0	0	0	0	0
Deerlodge NF	356,065	282,067	8,349	1,948	0	995	374	0	579
Flathead IR	55	67	0	0	0	0	0	0	0
Gallatin NF	30,932	6,321	5,810	404	0	390	0	0	14
Garnets	165,828	14,514	1,163	0	0	0	0	0	0
Helena NF	331,489	415,182	22,356	0	0	0	0	0	0
Lewis & Clark NF	210,039	145,826	1,217	0	0	0	0	0	0
Lolo NF	189,569	28,869	2,558	0	0	0	0	0	0
TOTAL	**1,595,724**	**941,320**	**44,279**	**2,352**	**0**	**1,385**	**374**	**0**	**593**

Douglas-fir Tussock Moth

Three adult male moths were caught in 1994 using pheromone-baited detection traps. Two moths were caught at Pistol Creek, south of St Ignatius, and one moth was caught near Big Arm on the southwest side of Flathead Lake. Although no moths were caught in 1993, this increase does not indicate an upward trend.

Lodgepole Needleminer

Defoliation was observed for the second year in a row west of Red Lodge in lodgepole pine stands, including state, private and Custer NF lands, totalling approximately 560 acres. Outbreaks are relatively uncommon in Montana. This small moth has a 2-year life cycle and causes damage to its host only after a long-sustained outbreak of several generations.

Gypsy Moth

Early detection efforts for the European and Asian gypsy moth did not detect gypsy moth in Montana this year. A total of 1,326 pheromone traps were deployed throughout the State by USDA Forest Service, Animal and Plant Health Inspection Service (APHIS), Montana Department of Agriculture, and the Montana Department of State Lands.

While Montana was moth free in 1994, moths were caught in neighboring states. Eight moths were trapped in the Black Hills of South Dakota (a total of 11 in the state), 3 moths were trapped in Wyoming, and 3 moths were trapped in Idaho. The State of Washington caught over 100 European gypsy moths, and six Asian/European gypsy moth hybrids were trapped near Fort Lewis. As neighboring states continue to detect gypsy moths and Asian/European hybrids are introduced into the Region, the importance of detection trapping continues to increase. Thanks to those who participate in this annual program, we are able to assess the threat that the Asian and European gypsy moths pose to Montana's natural resources.

Pre-Commercial Thinning / Tip Moth Permanent Plot Work

In 1993, a study to examine pre-commercial thinning as a means to reduce tip moth impact was initiated on the Ashland District of the Custer NF. Thirty plots were established in three areas; 5 plots each in thinned and unthinned stands.

In 1994, 10 of the 30 plots were remeasured.

Results from this study will not be complete for a number of years. Early indications show that ponderosa pine trees in thinned plantations are infested at the same or higher levels than trees in unthinned plantations, but they grow faster and have fewer structural deformities.

Pine Tussock Moth Defoliation Impact Plots

Elevated populations of the pine tussock moth (*Dasychira grisefacta* (Dyer)) were detected on the Ashland and Sioux RDs, Custer NF in 1991 and 1992, but defoliation was not detected until 1993 when 600 acres were affected on the Sioux RD. The population on the Ashland RD collapsed (apparently due to virus) in 1993 before defoliation occurred.

Pine tussock moth defoliation was not limited to the Sioux RD in 1993. Approximately 500 acres were defoliated in South Dakota in 1992, with some resulting mortality. In 1993, the South Dakota population collapsed, but 4,800 acres were defoliated in Wyoming and 2,100 acres were defoliated in Nebraska.

While the defoliation on the Sioux RD was mostly light (10-25 percent foliage gone), with some moderate (26-75 percent foliage gone) areas, heavy defoliation occurred in some other areas (most noteably Wyoming). The infrequent occurrence of this pest lead forest entomologists from the affected states to establish permanent plots to track the activity of this insect across the Region.

In late October of 1993, six plots were established, three in a lightly defoliated area and three in a moderately defoliated area. In late October, it was difficult to determine the extent of defoliation as rains and wind had dislodged a number of the masticated and dead needles. Not one tree appeared moderately defoliated in October, but had the survey been conducted in August (when defoliation was most evident) it is likely that a number of trees would have been categorized as moderately defoliated.

While establishing plots, abundant evidence of high populations of pine tussock moth was found (old pupal cases, hatched egg masses, and numerous overwintering larvae on the boles of the trees). Based on our observations in the woods and the fact that there was plenty of foliage left for larvae to feed upon, 1994 defoliation would have been expected to be at higher levels than 1993.

In August of 1994, defoliation was not visually detectable. Walk-through surveys of the area defoliated in 1993 did not indicate the presence of pine tussock moth. After 45 minutes of scanning foliage for any signs of the pine tussock moth, only one cadaver of a virused late instar larvae, 5 empty pupal cases, three of which appeared to have been parasitized, and a few masticated needle stubs attached to the twig were found.

According to Bill Schaupp, USDA Forest Service forest entomologist, from the Rapid City Service Center, working with the Wyoming pine tussock moth outbreak, the Wyoming population had likewise disappeared. There is no obvious reason for the population collapse. The majority of larvae apparently did not survive the winter.

Because the population of pine tussock moths remained elevated for such a brief period of time, and because there was relatively light defoliation on the Sioux RD in 1993, few long-term impacts from this insect are anticipated.

Bill Schaupp will be compiling data from all areas in the Great Plains affected by the pine tussock moth from 1991-1994. While the Sioux RD did not experience tree mortality from this insect, areas in South Dakota and Wyoming did indicating that this insect may have the potential to cause tree mortality in the future. He feels in areas that sustained mortality, the defoliation related density reduction and nutrient flush provided by insect frass and body parts may actually be beneficial to the long-term growth and development of the stands.

DISEASES

NURSERY - TREE IMPROVEMENT DISEASES

NEW AND UNUSUAL DISEASES

1. Extensive root infection by species of *Cylindrocarpon* (primarily *C. destructans*) was found on Douglas-fir, Noble fir, and western white pine container-grown seedlings at a private nursery in Pablo.

2. *Botrytis cinerea* was common on roots and foliage of lodgepole pine seedlings removed from cold storage to be planted on the Ninemile RD, Lolo NF. Disease levels were higher than normally encountered.

3. Bareroot Douglas-fir seedlings to be planted on the Bozeman RD, Gallatin NF, were extensively colonized by the mycorrhizal symbiont *Thelephora terrestris*. Fungal colonization started from root systems, but vegetative portions of the fungus were common on stem and foliar tissues.

4. *Botrytis cinerea* was found at unusually high levels on container-grown western larch seedlings which had been removed from greenhouses after production at the State's nursery Missoula. Tip dieback of lodgepole pine caused by *Phoma* spp. also was common at the nursery.

5. Bareroot lilac seedlings were infected with *Colletotrichum gloeosporioides* at the state nursery in Missoula.

COMMON, RECURRING DISEASES

1. The most common and damaging diseases of conifer seedlings in Idaho and Montana nurseries continued to be root diseases caused by *Fusarium* spp. These fungi caused damping-off and root diseases on many different conifer hosts in bareroot and container nurseries. The most common soil-borne pathogen in bareroot nurseries was *F. oxysporum*, although several other species were commonly isolated from infested soil and roots of diseased seedlings. The major pathogen in container nurseries was *F. proliferatum*, although *F. oxysporum* and several other fusaria also occurred at high levels in some nurseries. *Fusarium* diseases in nurseries were often very difficult to control. Although all conifer species were susceptible, most damage occurred on Douglas-fir, western larch, western white pine, and Engelmann spruce.

2. *Cylindrocarpon destructans* continued to cause severe losses to western white pine and whitebark pine seedlings at several nurseries. Although damage to other conifer species occurred, root decay of five-needle pines was most serious. Most efforts to reduce amounts of root decay have been unsuccessful.

3. *Botrytis cinerea* continued to cause damage to container-grown western larch and Engelmann spruce seedlings at several nurseries. Western red cedar has also been shown to be very susceptible to this pathogen. Conifer seedlings stored for prolonged periods of time may become severely damaged by *B. cinerea*, particularly if storage temperatures are maintained above freezing.

4. Tip dieback caused by *Sirococcus strobilinus*, *Sphaeropsis sapinea*, and *Phoma eupyrena* commonly occurred at low levels at most bareroot nurseries. Ponderosa and lodgepole pine were the two most affected species.

5. Pythium root disease usually occurred at low levels at most bareroot nurseries. The most important causal organism was *P. ultimum*. Damage can be reduced by improving water drainage in soil.

NURSERY DISEASE PROJECTS

1. Alternatives to chemical soil fumigation for control of soil-borne diseases in bareroot nurseries: This multi-regional project was initiated in 1993 in response to the proposed banning of methyl bromide as a soil fumigant by the year 2001. Treatments were established in the two Forest Service nurseries in Idaho (Coeur d'Alene and Lucky Peak - Boise) to evaluate efficacy of certain organic amendments and fallowing to control soil-borne pathogens. Plots were sown with conifers in the spring of 1994 and data taken on disease incidence and first-year seedling performance. Tests will continue through the 1995 growing season and treatments are scheduled to be repeated within additional portions of the nurseries sown in 1995. Preliminary results indicated that some treatments seem more efficaceous than others, although definitive conclusions cannot be made until tests are concluded.

Another portion of this project deals with genetic studies to ascertain pathogenic characteristics of the common soil-borne pathogen, *Fusarium oxysporum*. New molecular biology techniques (polymerase chain reaction, restriction fragment length polymorphisms), vegetation compatibility testing, isozyme analysis, and pathogenicity testing are being applied to define characteristics of pathogenic behavior by this important pathogen. The major goal of the work is to devise rapid techniques for differentiating pathogenic strains of the fungus in order to predict disease intensity from standard soil and seedling sampling. This work is being conducted in cooperation with the University of British Columbia and Oregon State University.

2. Epidemiology of *Cylindrocarpon* spp. on container-grown seedlings: several investigations were continued to characterize fungal species involved in disease, assess pathogenicity, and formulate procedures to reduce losses. An evaluation to investigate fate of *Cylindrocarpon* spp. on outplanted white pine seedlings and their role on seedling performance was conducted in cooperation with the University of Idaho and Potlatch Corporation.

3. Pathogenic potential of *Fusarium* spp. on conifer seedlings: techniques to evaluate potential of *Fusarium* isolates to elicit disease on young conifer germinants are used to quickly screen isolates. Soil isolates of *F. oxysporum* showed wide variation of virulence, whereas isolates of *F. proliferatum* were usually similar in their high virulence in these tests. Pathogenic behavior information was supplemented with recent genetic work indicating low genetic variability in tested isolates of *F. proliferatum*. This genetic work is being conducted in cooperation with the University of British Columbia.

4. Biological control of nursery root diseases are being investigated. Commerically available materials are tested for their efficacy in control of soil-borne pathogens. Thus far, no efficaceous preparations have been found, but efforts will continue in this area. Of particular interest is evaluation of seed dressing organisms that may confer resistance to commonly encountered root pathogens.

1994 SPECIAL PROJECTS

FOREST HEALTH ANALYSIS

Insects and pathogens are important disturbance agents which bring change to forests. The impact of natural disturbances such as insects and pathogens must be integrated into forest planning in order to responsibly develop management strategies. The goal of Insect and Disease Management's (I&D) forest health analysis is to develop efficient, sound, and well-documented data sets and analytical methods to perform landscape level analysis of insect and pathogen roles in forest succession. The analytical methods we are developing will allow managers to more easily incorporate insect and pathogen effects in project analysis.

I&D efforts are aimed at describing how insects and pathogens affect successional patterns and disturbances, describing and comparing current and historic insect and pathogen activity, and predicting future successional trends which reflect the role of insects and pathogens.

The methodology being developed involves a combination of data management, spatial and non-spatial data analysis, and modeling. A team of Northern Region entomologists and pathologists have defined key sets of functions that describe the most important ways in which insects and pathogens affect forest succession. Forest conditions that favor the occurrence of these functions were also defined. A data array of insect and pathogen indices was built for subcompartment stands from a 1974 sample of subcompartments representing 6 national forests in northern Idaho and western Montana. The 1974 data and indices are being compared against stand data from the 1930's for the same land units. Through this comparison we will have an indication as to what extent insects and pathogens are responsible for change in successional stages on stands between the 1930's and 1974. This data will be used to calibrate existing landscape and tree growth simulation models, so that those models can be used to predict future landscape changes.

An effort is underway to package all these steps into a fully automated system, so that future analyses to predict successional changes can be done more quickly. These analyses are expected to occur at scales as great as the one used in this project and at the district level. To date, analysis has involved use of the Oracle Data Base Management System, the Arc/Info Geographic Information System, the ArcView2 data display tool, and the Forest Vegetation Simulator. The goal is to use these or similar tools to create a system that will be available for widespread use on the project 615 platform.

EVALUATION OF THE FLIGHT PERIOD OF THE WESTERN BALSAM BARK BEETLE

Once again, pheromone-baited Lindgren funnel traps were placed in the Trout Creek drainage of the Bonners Ferry RD, Idaho Panhandle NFs, and on the Bitterroot NF to monitor the flight period of the western balsam bark beetle. Trap catches were much lower this year than in 1993. At Trout Creek, beetles were caught from June 17 through September 23. Peak trap catches occurred on June 25 and July 1. The cool, wet summer of 1993 may have caused a decline in the population reflected in the 1994 trap catches. The summer of 1994 was unusually hot and dry. Because we have monitored the western balsam bark beetle flight period during two summers of abnormal weather, the traps will be monitored once again in 1995.

WHITEBARK PINE CONE AND SEED INSECT SURVEY

A survey of insects affecting whitebark pine cones and seeds was initiated in 1994. A total of 32 whitebark pine sites were visited. Of these, 24 had trees that we could potentially climb and collect cones but only three sites had second-year cones to collect. Cones at these sites were collected and examined for insect damage. Cones collected by St. Maries RD personnel at one other site were also examined for insect damage. External evidence (frass or boring dust) and/or larvae of a coneworm, Dioryctria sp., were found in a high percentage of the cones examined.

Table 6--Whitebark pine cone collection sites.

Location	*# cones examined*	*% with coneworm damage*
Gisborne Mtn.	296	67
Schweitzer	50	48
Big Mtn.	7	100
Freezeout Ridge	201	75

NEW PROJECT: WILDLIFE TREE RECRUITMENT USING STEM DECAYS

Wildlife biologists have been recruiting wildlife trees for years using techniques such as topping trees using a chainsaw or explosives, girdiing, and herbicides. All of these methods seek to provide the correct fungal decay conditions required for suitable nesting habitat. These methods are rarely successful and have some serious drawbacks. Topping trees is dangerous and relatively expensive. Limited research shows girdling and herbicides may be ineffective for creating cavity habitat because trees are often killed using these methods and thus tend to fall down before they become suitable for cavity excavation. Trees killed using any of these methods are often vulnerable to removal by firewood cutters long before they can be used by cavity excavators.

Stem decay inoculation is an inexpensive, effective, and safer method of creating conditions suitable for cavity excavation in live trees. The potential longevity of cavity habitat in live trees is greater than that in created snags because live trees are less prone to natural falldown or removal for firewood. Inoculation utilizes the natural process of heartwood stem decay to create habitat suitable for cavity excavation, and is thus more compatible with Ecosystem Management principles than other methods.

A project has been established on the Bitterroot NF for the recruitment of wildlife trees. Two locally collected stem decay organisms, *Phellinus pini* and *Fomitopsis officianalis*, were used to inoculate 45 ponderosa pine, 17 western larch, and 23 Douglas-fir. The site is in a low-elevation ponderosa pine forest where past harvesting has left a second-growth forest nearly void of wildlife trees and potential wildlife trees. Such areas are optimal sites for inoculating trees with native stem decays. The trees were inoculated in November 1994 and will be monitored annually for evidence of woodpecker use (presence of nest cavities, chips or foraging activity in the bark or wood), decline or mortality, and evidence of fungal fruiting structures.

The cones have been placed in rearing cages and any adults that emerge will be identified to species. Other, less conspicuous, insects may also be discovered through rearing and dissection. This was a poor cone crop year and insect infestations may be abnormally high due to the few cones available for colonization. However, our preliminary survey showed that insects are infesting whitebark pine and may have a high impact on viable seed. This project will continue for the next few years to get a damage assessment of cone crops of various sizes and determine impact.

WESTERN SPRUCE BUDWORM LONG-TERM IMPACT PLOTS.

The objectives of this project are to (1) validate/calibrate the Forest Vegetation Simulator (FVS)-linked budworm population dynamics and damage model, (2) validate the Carlson and Wulf hazard rating model, and (3) examine the effects of budworm over time on ecosystem structure and function. Validation of the Carlson and Wulf hazard rating system is completed and we are currently working on a publication describing our findings.

In 1994, current defoliation and population estimates were measured on all permanent plots across the Northern Region. Additional plots were established on the Beaverhead, Bitterroot, Deerlodge, Helena, Lewis and Clark, and Nez Perce NFs.

To date, impact plots have been established in stands on all Forests across the Northern Region with a history of low, moderate or heavy defoliation budworm defoliation (Table 1).

In addition, long-term impact plots have been established in timber sales across the Northern Region (Table 2). Plots were established in cut units and adjacent uncut units. Over the next few years, long-term impact plots will be established in additional timber sales representing other types of harvests and on other Forests. Plots were also established in two wilderness areas in the Region (Table 2). These plots represent no management activity except for possible fire suppression.

Table 7--Permanent Plots in Timber Sales and Wilderness Areas

Forest	District	Stand ID	Defoliation History *	Year Established
Beaverhead	Wise River	204-03-008	L	1994
Beaverhead	Wise River	204-03-052	L	1994
Beaverhead	Wise River	237-01-025	H	1994
Beaverhead	Wise River	347-01-026	H	1994
Bitterroot	Sula***	399-99-999**	L	1994
Helena	Helena***	299-99-999**	M	1994
Lewis & Clark	Musselshell	632-02-048	L	1994
Lewis & Clark	Musselshell	632-02-018	L	1994
Nez Perce	Salmon River	199-99-999**	L	1994
Nez Perce	Salmon River	199-99-998	L	1994

* L = 1-3 years; M = 4-6 years; H = 7 or more years of defoliation prior to plot establishment.
** Permanent plots not within established district timber stands.
*** Wilderness areas.

Table 8--Permanent Plot Summary

Forest	District	Stand ID	Defoliation History *	Year Established
Beaverhead	Wise River	205-01-012	H	1992
Beaverhead	Wise River	204-03-049	H	1992
Bitterroot	Darby	245-05-059	L	1992
Bitterroot	Darby	265-04-127	M	1992
Bitterroot	Stevensville	199-99-012**	L	1991
Bitterroot	Sula	302-05-001	M	1993
Clearwater	Palouse	299-99-002**	L	1992
Clearwater	Palouse	299-99-001**	L	1992
Clearwater	Palouse	299-99-044**	L	1992
Clearwater	Palouse	299-99-410**	L	1992
Deerlodge	Butte	141-02-803	H	1993
Deerlodge	Jefferson	222-06-001	M	1993
Deerlodge	Jefferson	227-05-014	L	1994
Helena	Helena	321-02-012	L	1993
Helena	Townsend	115-06-064	H	1993
Helena	Townsend	112-02-066	M	1993
Lewis & Clark	Musselshell	631-07-012	H	1992
Lewis & Clark	Kings Hill	702-05-006	L	1992
Lewis & Clark	Kings Hill	708-01-046	L	1994
Lolo	Missoula	371-07-021	M	1992
Lolo	Seeley Lake	631-02-015	M	1992
Lolo	Seeley Lake	629-02-032	M	1992
Nez Perce	Salmon River	399-99-015**	L	1991
Nez Perce	Salmon River	399-99-009**	L	1991
Nez Perce	Salmon River	115-01-033	M	1994

* L = 1-3 years; M = 4-6 years; H = 7 or more years of defoliation prior to plot establishment.
** Permanent plots not within established district timber stands.

APPENDIX

Insect and Disease Management

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COMMON AND SCIENTIFIC NAMES

Diseases

Annosus root disease	*Heterobasidion annosum* (FR.) Bref.	Primary hosts: DF, GF, PP, SAF
Armillaria root disease	*Armillaria ostoyae* (Romagn.) Herink	DF, GF, SAF, sapling pines
Atropellis canker	*Atropellis piniphila* (Weir) Lohn. and Cash	LPP
Brown cubical butt rot	*Phaeolus schweinitzii* (Fr.) Pat.	DF
Comandra rust	*Cronartium comandrae* Peck.	LPP, PP
Diplodia blight	*Sphaeroposis sapinea* (Fr.) Dyko.	PP
Dutch elm disease	*Ceratocystis ulmi* (Buism.)	American elm
Dwarf mistletoes	*Arceuthobium* spp.	LPP, DF, WL
Brown stringy rot	*Echinodontium tinctorium*	GF, WH
Elytroderma needle cast	*Elytroderma deformans* (Weir) Darker	PP
Fusarium root rot	*Fusarium oxysporum* Schlect.	DF (Nursery)
Grey mold	*Botrytis cinerea* Pers. ex Fr.	WL (Nursery)
Larch needle blight	*Hypodermella laricis* Tub.	WL
Larch needle cast	*Meria laricis* Vuill.	WL
Laminated root rot	*Phellinus weirii* (Murr.) Gilb.	DF, GF, WH, SAF
Lodgepole pine needle cast	*Lophodermella concolor* (Dear.) Dark	LPP
Pini rot	*Phellinus pini* (Thore:Fr.) Pilet.	DF, WL, ES, All pines
Sirococcus tip blight	*Sirococcus strobilinus* Preuss	WWP (Nursery)
Swiss needle cast	*Phaeoeryptopus gaeumannii* (Rohde)	DF
Western gall rust	*Endocronartium harknessii* (Moore) Hirat.	LPP, PP
White pine blister rust	*Cronaritum ribicola* Fisch.	WWP, WBP
Rhabdocline needle cast	*Rhabdocline pseudotsugae* Syd.	DF

Insects

Douglas-fir beetle	*Dendroctonus pseudotsuga* Hopkins	DF
Douglas-fir tussock moth	*Orygia pseudotsugata* (McDunnough)	DF, TF, ES
Gypsy moth	*Lymantria dispar* (Linnaeus)	Most hardwoods
Mountain pine beetle	*Dendroctonus ponderosae* Hopkins	All pines
Pine engraver beetle	*Ips pini* (Say)	PP, LPP
Spruce beetle	*Dendroctonus rufipennis* (Kirby)	ES
Western balsam bark beetle	*Dryocoetes confusus* 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
Lodgepole terminal weevil	*Pissodes terminalis* Hopping	LPP
Balsam woolly adelgid	*Adelges piceae* (Ratzeburg)	SAF, GF
Pine tussock moth	*Dasychira plagiata*	PP
Sawflies	*Neodiprion autumnalis*	PP
Tip moth	*Rhyacionia species*	PP

DF = Douglas-fir; GF = Grand fir; TF = True fir; SAF = Subaline fir; PP = Ponderosa pine; LPP = Lodgepole pine; WWP = Western white pine; ES = Engelmann spruce; WH = Western hemlock; WL = Western larch; MH = Most hardwoods; WRC = Western redcedar; WBP = Whitebark pine

RECENT PUBLICATIONS

Dumroese, R. K., R. L. James, and D. L. Wenny. 1993. *Fusarium* root infection of container-grown Douglas-fir: effect on survival and growth of outplanted seedlings and persistence of the pathogen. New Forests 7:143-149.

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