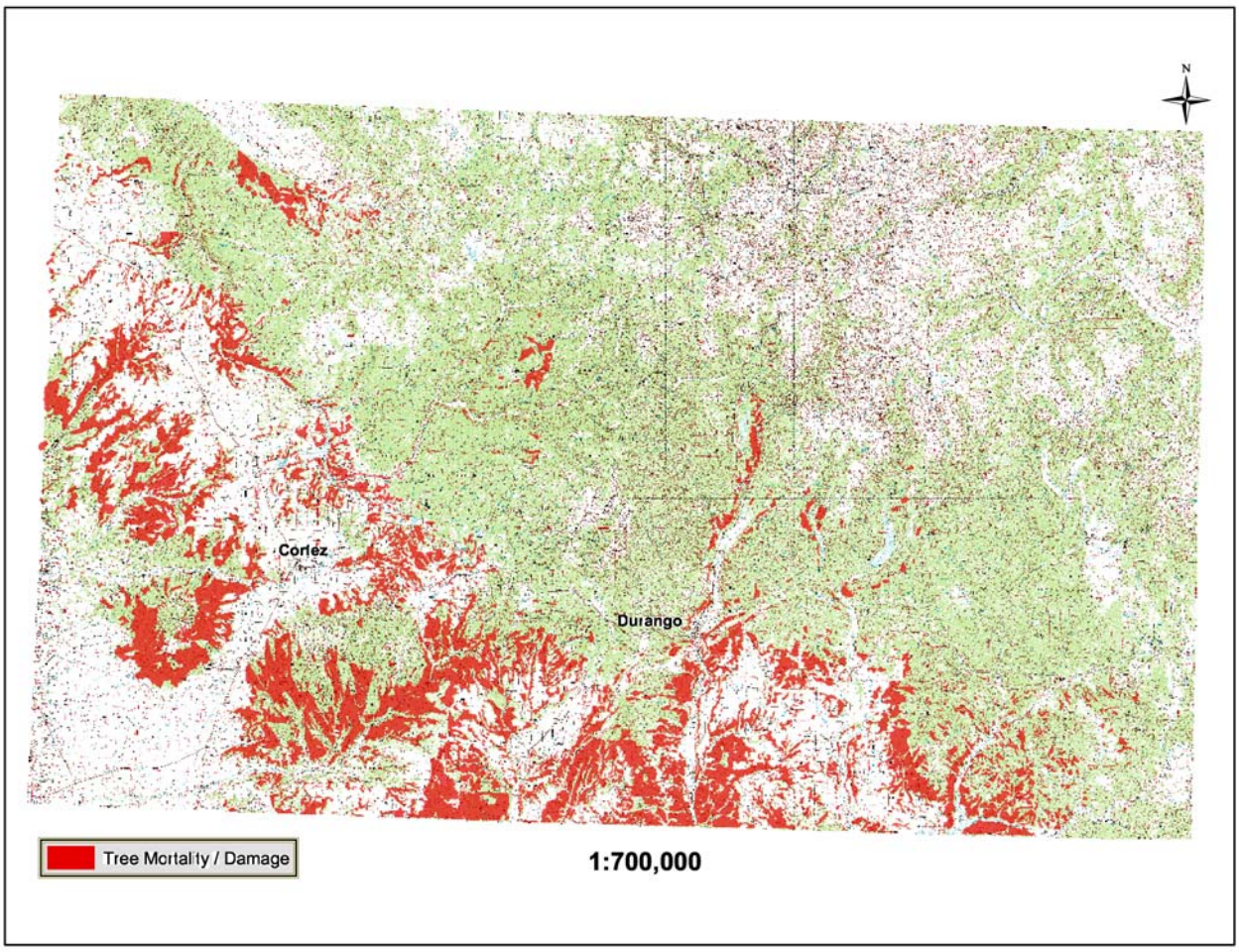
United States Department of Agriculture

Renewable Resources - Forest Health

Rocky Mountain Region

FOREST INSECT and DISEASE CONDITIONS in the ROCKY MOUNTAIN REGION

2003



Sketchmaps made by 2003 aerial surveyors observing extensive tree mortality and damages in southwest Colorado

FOREST INSECT AND DISEASE CONDITIONS IN THE ROCKY MOUNTAIN REGION

2003

R2-04-03

USDA Forest Service
Rocky Mountain Region
Renewable Resources, Forest Health Management
740 Simms Street
Golden, Colorado 80401-4720

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by
The Rocky Mountain Region Forest Health Management Staff, and State Forest Health Specialists of Colorado, Kansas, Nebraska, South Dakota, and Wyoming

Compiled by Jeri Lyn Harris

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ACKNOWLEDGMENTS

The Forest Health Management (FHM) Staff extends its appreciation to all cooperators who contributed to this report.

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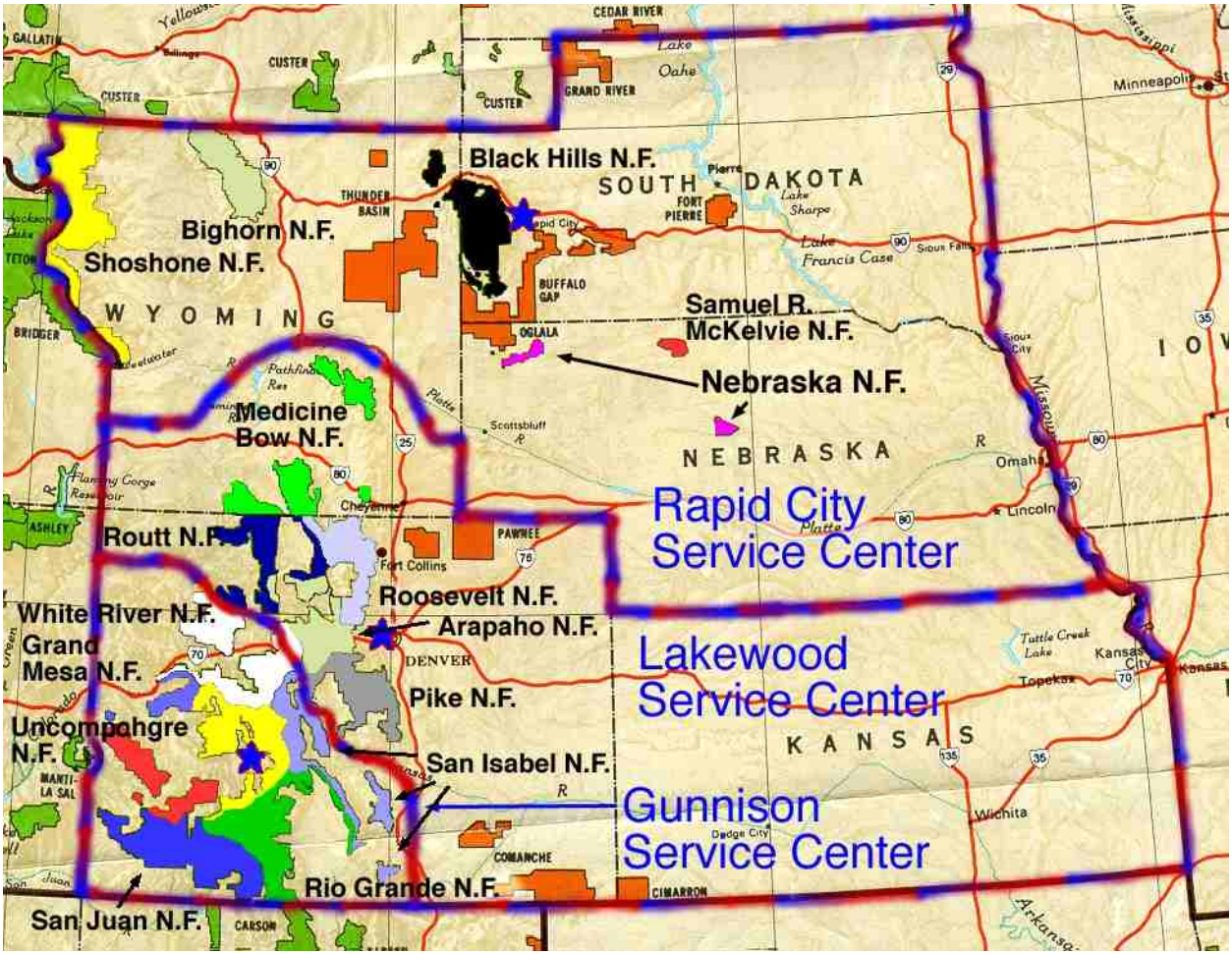
Forest Health Management (FHM) is responsible for the detection, evaluation, and suppression of insects and diseases on forested Federal lands. FHM also administers financial and technical assistance programs with the State Foresters of Colorado, Kansas, Nebraska, South Dakota, and Wyoming for insect and disease detection, evaluation, and suppression. In addition, the management of range pests and gypsy moth are a shared responsibilities with the Animal and Plant Health Inspection Service (APHIS). Close coordination and cooperation of the Federal and State agencies responsible for forest health management are necessary for effective program execution.

Three Service Centers and the Regional Office address forest health concerns for the Rocky Mountain Region (Figure1). Questions concerning operations and requests for service can be directed to the Forest Health Management (FHM) Group Leader in the Regional Office or the respective Service Center Leaders.

SERVICE CENTERS and OFFICES	SERVICE AREAS	STAFF
Gunnison Service Center (GSC) 108E. Georgia St., Gunnison, CO 81230 Ph: 970/641-4093 Fax:970/641-4514	Assistance to National Forests and cooperators in southwestern and south-central Colorado: Rio Grande, San Juan, Grand Mesa, Uncompahgre, Gunnison, White River, and San Isabel.	**Roy Mask** – Service Center Leader, Entomologist **Tom Eager** - Entomologist **Jim Worrall -** Plant Pathologist **Leanne Egeland –** Technician
Lakewood Service Center (LSC) P.O. Box 25127 Lakewood, CO 80225 Ph: 303/236/9541 Fax: 303/236-9542	Assistance to Kansas, eastern and northwestern Colorado, and southern Wyoming; National Forests: Pike, Arapaho-Roosevelt, Medicine Bow-Routt, and White River (Dillon Ranger District), Comanche and Cimarron National Grasslands.	**Jeff Witcosky** Service Center Leader, Entomologist **Bob Cain** – Entomologist **Kelly Sullivan** – Plant Pathologist **Carl Jorgensen** – Technician (2002-2003) moved to R4, FHP, Boise Field Office **Brian Howell** – Technician (2004) **Bernard Benton** - Computer Specialist **Meg Halford** – Student Technician
Rapid City Service Center (RCSC) 1730 Samco Road, Rapid City, SD 57702 Ph: 605/343-1960 Fax: 605/394-6627	Assistance to National Forests, and cooperators east of the Continental Divide in northern Wyoming, South Dakota and Nebraska: Black Hills, Bighorn, Shoshone, and Nebraska, and National Grasslands in South Dakota, Wyoming, and Nebraska.	**Kurt Allen** – Service Center Leader, Entomologist **Bill Schaupp** – Entomologist **Jim Blodgett** – Plant Pathologist **Dan Long** –Technician **Denise Hardesty** - Technician
Regional Office – Forest Health Management (FHM) 740 Simms Street, Golden, CO 80401 Ph: 303/275-5061 Fax: 303/275-5075	Assistance to the three service centers; liaison to Washington D.C. and Regional offices; coordination with state forestry agencies.	**Frank Cross** – Group Leader **Jeri Lyn Harris -** Forest Health Monitoring Coordinator **Erik Johnson** – Aerial Survey Program Manager **Tom McClure** – Noxious weeds, Invasive species, Pesticide coordinator
Regional Office – Renewable Resources	Oversight of Forest Health Management for R2.	**Marisue Hilliard –** Director **Dan Nolan** – Assistant Director

Figure 1. Service Center Zones of the Rocky Mountain Region Forest Health Management.



Status of Major Forest Health Damaging Agents in the Rocky Mountain Region during 2003

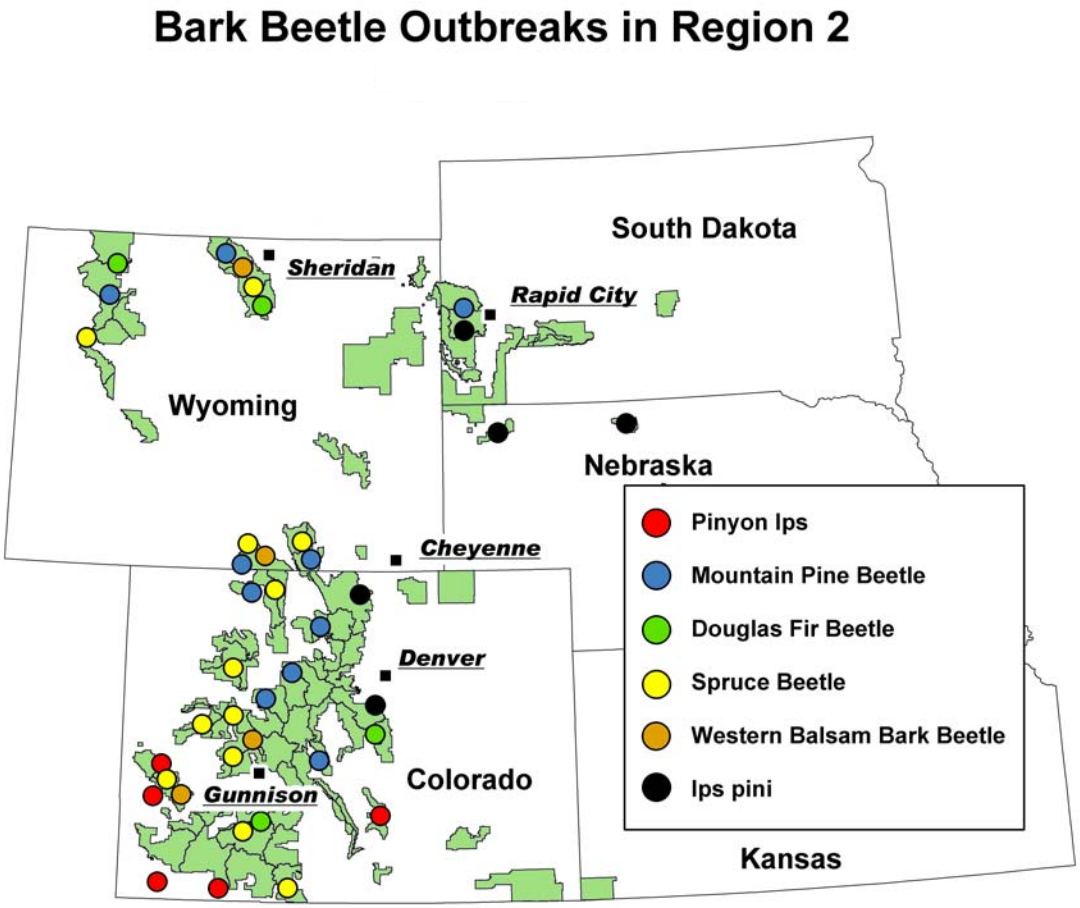
Most Damaging Insects

Continued high levels of bark beetles are resulting in large-scale losses (Table 1, Figure 2) of Engelmann spruce, Douglas-fir, ponderosa, lodgepole, and pinõn pines on forested lands in the Rocky Mountain Region. High-value recreation, wildlife, and timber resources are at risk to significant losses of spruce and pine on the Medicine Bow-Routt, White River, San Juan, Black Hills, and Shoshone National Forests.

Table 1. Overview of large bark beetle outbreaks in the Rocky Mountain Region as detected from 2003 aerial surveys. These are estimations of affected acres (in thousands) and numbers of destroyed trees (in thousands).

Rocky Mountain Region Totals		
Damaging Agents	**Number of Acres Affected (X 1000)**	**Estimated Number of Trees Killed (X 1000)**
Ips spp. Beetle	993,123	4,337.8
Subalpine Fir Mortality	535.4	1,186.3
Mountain Pine Beetle	440.3	1,015.7
Spruce Beetle	120.8	873.2
Douglas-fir Beetle	64.2	103.7
Damaging Agents	**Number of Acres Affected (X 1000)**	**Counties with more than 10,000 acres of damage**
Colorado		
Ips spp. Beetle	937.0	Archuletta, Conejos, Custer, Dolores, Fremont, Huerfano, La Plata, Larimer, Las Animas, Montezuma, Montrose, Pueblo, San Miguel
Subalpine Fir Mortality	481.8	Delta, Eagle, Garfield, Grand, Jackson, Mesa, Moffat, Pitkin, Rio Blanco, Routt
Mountain Pine Beetle	227.1	Chaffee, Eagle, Grand, Jackson, Park, Routt, Summit
Spruce Beetle	70.9	Jackson, Routt
Douglas-fir Beetle	46.6	Archuleta
Nebraska		
Ips spp. Beetle	10.3	
South Dakota		
Mountain Pine Beetle	189.7	Custer, Fall River, Lawrence, Meade Pennington
Ips spp. Beetle	45.2	Custer, Fall River, Pennington
Wyoming		
Subalpine Fir Mortality	53.6	Carbon, Fremont, Park
Spruce Beetle	49.9	Park
Mountain Pine Beetle	23.5	Carbon, Crook, Lincoln, Park, Sheridan, Sublette, Weston
Douglas-fir Beetle	17.6	Carbon, Fremont, Park

Figure 2.


Bark Beetle Outbreaks in Region 2
South Dakota
Sheridan
Rapid City
Wyoming
Nebraska
Cheyenne
Denver
Colorado
Gunnison
Kansas
Pinyon Ips
Mountain Pine Beetle
Douglas Fir Beetle
Spruce Beetle
Western Balsam Bark Beetle
Ips pini

Pine engraver beetle, Ips *spp.* Tree mortality caused by pine and spruce engraver beetles, *Ips* spp., were found in ponderosa pine, piñon pine, lodgepole pine, Jack pine, and Engelmann spruce in the Region. The *Ips* problem will likely disappear when the drought subsides.

Colorado

Perhaps the most dramatic, recent example of tree mortality in the central Rocky Mountains has been the extensive loss of piñon pine. This outbreak occurred on a huge scale, with piñon trees being killed in large numbers throughout their range (Figure 3). Several species of piñon were affected, from New Mexico to California and south into Mexico.

The mortality has been particularly intense in the southern portion of the state with many thousands of acres experiencing the loss of mature piñon. Again, the drought conditions of the past several years are the root of the situation, but fairly high tree densities and the overall even-age status of the piñon stands are contributing factors.

In the most highly affected, southern portion of the state, many stands have lost 90% of the mature piñon. The worst of this mortality occurs in the piñon stands around Durango, Cortez and Dolores. Moving further north, the mortality is more scattered with some sites of intense mortality.

Figure 3. Dead piñon pines in Southwest Colorado near Durango. These trees died due to drought and *Ips* beetle attacks. (Photo by D.Wittwer)

The future of the outbreak depends greatly upon future weather conditions. Even with weather conditions favorable to healthy piñon, it may take some time before bark beetle numbers return to a more endemic level. In any case, the slow growth of piñon stands means that many areas will not regain a mature piñon component for some time to come. Aerial survey estimates for 2003 are that 4,193,900 piñon trees have died on approximately 937,000 acres in Colorado.

Other *Ips* spp. beetles caused mortality to other pines on drought stressed sites in Colorado. In addition to the massive piñon mortality in the southern and western areas of the state, there was significant damage caused by *Ips* beetles following a spring blizzard along the east slope of the Colorado Front Range. Many broken limbs and damaged treetops from this storm created much suitable material for colonization by *Ips* beetles.

Mortality of ponderosa pine due to *Ips pini* and *Ips calligraphus* caused concern for resource managers at the Air Force Academy and Fort Carson. Ponderosa pines at lower elevations along drainages going into the grasslands were most affected. Jefferson, Boulder, Clear Creek and Gilpin Counties had higher levels of *Ips pini* on small diameter lodgepole pines. *Ips pini* was reported at high levels locally in small diameter lodgepole pine in Jefferson, Boulder, Clear Creek and Gilpin Counties.

Nebraska

Ips populations remained active in jack pine stands that were defoliated by jack pine budworm on the Bessie Ranger District of the Nebraska National Forest. In severely defoliated areas, up to 25% of the trees had *Ips* beetle attacks. Aerial survey estimated that almost 9000 pines on 3000 acres were killed here in 2003. In the Pine Ridge area, a significant level of mortality caused by *Ips* was noted, with about 12,000 pines killed on 6,500 acres. If drought conditions continue, *Ips* populations will likely remain very active.

South Dakota

Ips pini, caused significant amounts of ponderosa pine mortality in the Black Hills and the Pine Ridge Indian Reservation of South Dakota. Pine engraver beetles are typically found in dead and dying trees, as well as slash piles, but the populations were expanding and becoming a major cause of tree mortality. The population increased exponentially around the Black Hills the last four years. This recent, unprecedented level of pine engraver beetle activity is a consequence of wildfires, mountain pine beetle and weather events; weather damages by hail and snow-breakage resulted in a tremendous build up of dead, weakened, damaged tree material. With a nearly unlimited supply of food, the beetle populations increased significantly. Now that this food supply is becoming less suitable, pine engraver beetles are attracted to healthy trees and are causing significant tree mortality. Many of the areas getting hit hardest by *Ips* in the Black Hills were in the wildland-urban interface. More than 120,700 thousand ponderosa pines in 45,200 acres died from pine engraver beetles.

The state conducted several baiting programs to monitor and manage pine engraver populations. Two of the major mills in the state placed lures around their log piles to trap beetles emerging from infested logs. A golf course experiencing a high population of engraver beetles, and subsequent tree mortality, reduced the beetle populations dramatically by removal of infested trees, slash disposal and mass trapping.

Subalpine fir Mortality. Mortality caused by the western balsam bark beetle (*Dryocoetes confuses)* and root diseases continued at high levels in Colorado and Wyoming. Aerial survey estimates are that approximately 481,000 acres on Colorado contain over 1,026,000 recently killed subalpine fir trees. Estimates for central and eastern Wyoming are 160,000 trees killed on 54,000 acres (Table 2)

Colorado

Losses of subalpine fir have been significant throughout southern Colorado. In terms of management issues, the loss of subalpine fir is particularly important in recreational areas. On several ski areas, the loss of subalpine fir is a concern for managers. The widespread nature of the mortality, combined with the fact that in many cases tree death is caused by a combination of insect and fungal activity means

there are few options for managerial response. Maintaining thrifty stands with a wide range of age classes is probably the most prudent course of action to reduce long-term perturbations.

Wyoming

For over six years, there has been an outbreak of western balsam bark beetle in the northern Bighorn Mountains, causing subalpine fir decline. Much of the outbreak has been associated with blowdown events that occurred in the middle 1990's. Many stands of subalpine fir are declining on private and state properties in central Wyoming, particularly on Casper Mountain in Natrona County. Insect and disease agents continue to cause significant subalpine fir mortality on the Shoshone National Forest. Recently, over 19,000 trees were killed on the Shoshone National Forest.

Table 2. Overview of significant subalpine fir mortality (>10,000 trees per county) in the Rocky Mountain Region. These are the number of subalpine fir trees killed during 2003 as estimated from aerial detection surveys.

	Estimated Counts of Subalpine Fir Tree Mortality (in thousands)		**Estimated Counts of Subalpine Fir Tree Mortality** (in thousands)
Colorado Counties			
Delta	21.8	Moffat	55.2
Eagle	85.6	Montrose	10.0
Garfield	102.3	Pitkin	37.4
Grand	33.5	Rio Blanco	91.8
Jackson	197.3	Routt	294.7
Mesa	40.2	Summit	10.0
Wyoming Counties			
Albany	12.8	Fremont	30.3
Carbon	100.4	Natrona	13.0

Mountain pine beetle. *Dendroctonus ponderosae,* attacks lodgepole, ponderosa, limber, whitebark, and bristlecone pines in Colorado, Wyoming, and South Dakota forests. Listed below are areas experiencing mountain pine beetle outbreaks/epidemics.

Colorado

Mountain pine beetle activity increased in lodgepole pine in northern and central Colorado. In Grand County, three major outbreak areas located around Lake Granby continue to have high mortality. Mortality pockets above 10,000 feet were becoming evident and newly infested trees were noted on higher elevation sites. It appeared that recent warmer summers were pushing up the reported elevation ranges for greater mortality. High visibility areas in Summit County also had expanding mountain pine beetle activity. Lower elevation lodgepole pine areas on the Routt National Forest had significant expansion of mountain pine beetle activity especially in the Rock Creek watershed on the Yampa Ranger District.

On the Front Range, there was notable mountain pine beetle activity on the Canyon Lakes District just north of Poudre Canyon in ponderosa pine. Scattered mortality in ponderosa pine and lodgepole pine throughout the Front Range was due to a combination of this beetle and *Ips* beetles.

In the southern portion of the state there were two major outbreaks of mountain pine beetle that have been occurring for the past several years. In Chaffee County, mountain pine beetle killed large numbers of ponderosa pine. This outbreak originated in the upper Arkansas river valley, and spread to the east, roughly following the course of the river, into the Wet Mountains and the Sangre de Cristo Mountains.

Another major outbreak occurred in the vicinity of Vail Valley along the Interstate 70 corridor. Here mountain pine beetle killed large numbers of their other primary host, lodgepole pine. Mortality was originally concentrated near the Vail ski area and adjacent urban interface areas, but this activity now appears to be moving north of the Interstate with areas of increasing mortality in the Redstone Canyon/Piney Lake area. Many of these lodgepole pine stands are at fairly high risk to mountain pine beetle activity, and significant mortality is expected into the future.

There were many areas with scattered, fairly intense pockets of mountain pine beetle activity. Portions of the San Juan, Rio Grande, Gunnison, and Uncompahgre Nat'l Forests all have areas of significant mortality due to this insect. While this bark beetle activity is not on a scale represented by either the Arkansas Valley or Vail Valley outbreaks, drought conditions encourage beetle activity and cause significant epidemics.

South Dakota

Mountain pine beetle has caused intense and extensive ponderosa pine mortality throughout the Black Hills of South Dakota over the last 5 years. Results from annual aerial surveys estimate that over 1 million pines have been killed in South Dakota since 1998. The large and expanding mountain pine beetle infestation in the Beaver Park area of the northern Black Hills resulted in many stands becoming depleted of suitable host trees, while beetle populations spread to nearby areas such as Vanocker Canyon, Park Creek, and Kirk Hill. This area was the hardest hit by this beetle epidemic with more than 100,000 trees killed. Ground surveys found an overall average of 20 trees per acre killed in the Beaver Park area since 2001, nearly half being currently infested. As available host trees are killed in the Beaver Park area, then the large beetle populations expand to surrounding forest sites. The majority of the infestations were confined to national forest lands, but more private and state lands are now becoming infested.

The area around Deerfield Lake also had a large, expanding mountain pine beetle infestation. Since 2001, an average of 26 trees per acre has been killed there, with almost 70% of the trees currently infested. Additional locations where beetle populations were increasing include areas near Custer Peak, Nemo, and Bear Mountain. Continued evaluation of these outbreaks areas indicates that beetle populations were still increasing and will cause dramatic levels of future tree mortality.

As available host trees were killed in these areas, the large beetle populations expanded to surrounding forest stands. The majority of the infestations were confined to National Forest Lands, but more private lands were becoming infested as the epidemic expanded. Forest Landowners are being encouraged to thin their forests to reduce stand susceptibility. Aerial survey estimates indicated that 189,700 acres in South Dakota contained more than 270,000 trees killed by mountain pine beetle.

Wyoming

Several forest areas throughout Wyoming were experiencing large numbers of pine mortality due to increased population levels of mountain pine beetle. Ponderosa pines in the eastern foothills of the Bighorn Mountains and in Crook/Weston counties of Black Hills forests had some large pockets of tree mortality. Several areas in Crook County had large areas of beetle caused mortality including Sundance Mountain, Green Mountain, Inyan Kara Mountain, and the Missouri Buttes. The west, south, and east sides of Devils Tower also had considerable pine mortality. Work to suppress mountain pine beetle continues near Casper and on the eastern slope of the Bighorn Mountains.

Other areas of concern for mountain pine beetle increases were in the southern portions of the state. The Medicine Bow National Forest had a significant expansion of mountain pine beetle activity in the Sierra Madre Mountain Range and in the Rock Creek watershed of the Snowy Range.

Mountain pine beetle often prefers to attack Wyoming's 5-needle pines of whitebark and limber. On Carter Mountain southwest of Cody, populations of this beetle increased in whitebark and limber pines, and then switched host species, infesting adjacent lodgepole pine stands. Mountain pine beetle has killed whitebark pines throughout Yellowstone National Park. Whitebark pine mortality near Togwotee Pass was widespread and highly visible on the Shoshone National Forest.

Spruce beetle. *Dendroctonus rufipennis,* attacks Engelmann and blue spruce in Colorado and Wyoming forests. Listed below are current places with spruce beetle outbreaks/epidemics.

Colorado

Aerial survey estimates for spruce tree mortality caused by spruce beetle were 519,700 trees killed on 70,900 acres throughout Colorado. In southern Colorado, the majority of spruce beetle activity occurred in scattered pockets of less than 100 acres, but there are a number of sites where large, mature spruce have been killed over extensive areas. In terms of the scattered activity, there are about 30 known spruce beetle sites on the White River, Grand Mesa, Gunnison, Uncompahgre, San Juan, and Rio Grande National Forests.

Hundreds of thousands of spruce were killed in Routt and Jackson Counties as the spruce beetle outbreak continues to expand and intensify in the area of the Routt Divide Blowdown. Main areas affected are north of Rabbit Ears Pass to the Wyoming border on the Gore.

Wyoming

Spruce beetle killed hundreds of thousands of Engelmann spruce in Wyoming during 2003. Large pockets of spruce tree mortality were observed on the Shoshone National Forest, and in the Washakie, and Absaroka Mountain Wilderness Areas. The spruce beetle infestations started in the wilderness areas, and now have moved out to impact large areas of state, private, and federal lands.

A Wyoming State-trust section was heavily damaged by spruce beetle south of Irma Lake on Carter Mountain in Park County. Over 500,000 board-feet of Engelmann spruce were harvested due to mortality caused by this insect.

Other areas with spruce beetle mortality are the Bighorn Mountains, the Snowy Range, and Sierra Madre Mountains. In the Bighorn Mountains of north-central Wyoming, several areas near Shell Reservoir, Powder River Pass, and Bald Mountain are experiencing high levels of spruce beetle activity. Spruce beetle has expanded exponentially in the last two years on the Medicine Bow-Routt National Forests. This beetle infested many Engelmann spruce injured by 2002 fires near Colorado.

Douglas-fir beetle. *Dendroctonus pseudotsugae,* attacks Douglas-fir in Colorado and Wyoming forests. Listed below are current places with Douglas-fir beetle outbreaks/epidemics in these states.

Colorado

Douglas-fir beetle continued to kill mature trees in areas scattered throughout southern Colorado. An area north of Durango had several hundred trees killed by the beetle. In many cases, Douglas-fir beetle activity is occurring in areas of chronic defoliation by western spruce budworm.

Douglas-fir beetle was detected in fire-killed trees in the Haymen burn area of Colorado but has not yet been found in adjacent unburned Douglas-fir trees. Conditions are favorable for Douglas-fir beetle in this area. Douglas-fir beetle continues to cause some mortality in Douglas County in older burned and defoliated areas.

Wyoming

Large Douglas-fir trees and extensive damages in Wyoming forests resulted from Douglas-fir beetle activity. Douglas-fir beetle infestations frequently result from disturbance events that create large volumes of weakened Douglas-fir trees in the vicinity of susceptible stands. In 1988, extensive wildfires occurred in Yellowstone National Park and the Shoshone National Forest. Populations of Douglas-fir beetle increased in the fire-scorched trees and then moved into undamaged trees in nearby stands. This outbreak continued to expand and intensify.

The western front of the Bighorn Mountains also experienced outbreaks of Douglas-fir beetle. Populations increased in both Shell and Tensleep Canyon areas. Without sanitation and thinning, it is likely that up to 70% of the mature Douglas-fir trees in those canyons will be killed.

Most Damaging Diseases

Dwarf mistletoes are prevalent parasites in Colorado and Wyoming forests. With recent mild winter conditions and periods of drought, dwarf mistletoes contributed to mortality in many areas of the Rocky Mountain Region. This disease impacted stands throughout the Colorado Front Range, including the Red Feather Lakes area; Estes Park; the higher elevation portions of Boulder, Clear Creek and Gilpin Counties; the Jarre Canyon area of Douglas County; Park County including South Park; and the foothills west of Colorado Springs in El Paso County. Dwarf mistletoe also continued as a problem in the Black Forest northeast of Colorado Springs in ponderosa pine.

Lodgepole pine dwarf mistletoe *(Arceuthobium americanum)* infested about 50 percent of lodgepole pine stands in Colorado and Wyoming. In Wyoming, this mistletoe was common in the Green Mountain area in Fremont County where 5,000 acres (state, federal, and private properties) were adversely affected. This parasite was also widespread and a concern throughout the Bighorn, Medicine Bow, and Shoshone National Forests.

Ponderosa pine dwarf mistletoe *(A. vaginatum subsp. cryptopodum)* was widespread throughout the host type only in Colorado. Dwarf mistletoe infested approximately 20 percent of the ponderosa pine stands in Colorado's Front Range. Infested ponderosa pines were more vulnerable to attack from tree-killing bark beetles.

Limber pine dwarf mistletoe *(A. cyanocarpum)* and piñon pine dwarf mistletoe *(A. divaricatum)* commonly occur in sites with significant amounts of the host trees. The Douglas-fir dwarf mistletoe *(A. douglasii)* occurs mostly in the southern two-thirds of Colorado.

Root Diseases, caused by *Armillaria ostoyae, Heterobasidion annosum,* and *Leptographium wageneri,* and *L.terrebrantis,* occur in all major forest types in the Rocky Mountain Region.

Armillaria root disease, the most common root disease in the Region, is common in the mixed conifer and spruce-fir cover types. This root disease was among the key cause of subalpine fir mortality, which accounts for the most tree mortality in the spruce-fir cover type in the Rocky Mountain Region.

A recently completed project in selected campgrounds of southern Colorado indicated that at least 10.5% of living trees were infected in the campgrounds and even more were infected in the forest immediately outside the campgrounds. It continues as a major problem in vegetation management of developed sites, and is likely important in the disturbance regime and management of spruce-fir forests at large.

In Kansas, *Armillaria tabescens* was found in windbreak plantings with elm trees. *Armillaria ostoyae* was found in several root disease centers in the Bighorn, Black Hills, and Medicine Bow National Forests of South Dakota and Wyoming. It was not a major problem in most of these areas, but it is likely contributing to mortality.

Armillaria root disease is extensively present throughout the Black Hills of South Dakota and Wyoming with large centers of the fungus occurring in the northern portions of the Hills. The fungus occasionally kills healthy, mature ponderosa pines and white spruces, but is most often found killing seedlings and saplings in these forests. *Armillaria* root disease may weaken larger trees and make them more susceptible to bark beetle attacks.

Annosus root disease has scattered distribution within white fir in the mixed conifer covertype throughout southern Colorado. It also occurs at low incidence levels in plantings of Nebraska. In campgrounds, the disease creates hazardous conditions by increasing the probability of tree failure.

Black stain root disease (*Leptographium wageneri*), in combination with other factors, caused widespread piñon mortality in southwestern Colorado. Currently, that mortality is obscured by the outbreak of mortality caused by the bark beetle, *Ips confuses*. This area experienced unprecedented urban

development pressure that may be compounding the problem. Black stain has not been identified east of the Continental Divide in Colorado piñon forests. Also, a closely related root disease, caused by *L. terrebrantis*, inhibits regeneration by killing young pines in Nebraska plantations. Older pines are also infected, but may not be killed by this root rotting fungus.

White pine blister rust, caused by a non-native fungus, *Cronartium ribicola,* is found on whitebark and limber pines throughout Wyoming and portions of Colorado and South Dakota. Incidences of this disease on limber pine in Wyoming ranges from low amounts of 2-3% infections to as high as 100% infection on several sites (Figure 4). In 2003, isolated infestations of the disease were discovered in the Sangre de Cristo and Wet Mountains of southern Colorado on limber pine. An infected bristlecone pine (Figure 5) was also discovered in the Sangre de Cristo Mountains in the Great Sand Dunes National Monument. This discovery is very momentous in that the disease has never been reported on bristlecone pine in nature, and the implications of rust on bristlecone pine may be very significant both ecologically and culturally. .

White pine blister rust infection levels range from low to severe in whitebark and limber pine stands throughout Wyoming, however, significant rust-free areas still exist in the Sierra Madre and the Snowy Mountains in the southeast part of the state. In 2002, a study of 16 widely distributed stands across the Bighorn National Forest found white pine blister rust infection at all locations and as high as 100%. Forest Service aerial surveys show white pine blister rust, along with other damaging agents such as mountain pine beetle, dwarf mistletoe, and needle blights damaged more than 46,000 acres of white pine in northern Wyoming.

White pine blister rust caused marked decline in limber pines in the Laramie and Pole Mountain Ranges in south-central and southeastern Wyoming. White pine blister rust was discovered for the first time in the Snowy Mountains in 2002; however, the incidence in this range is still fairly low. Limber pine is a major tree species throughout southern Wyoming, often growing on harsh sites where other trees cannot grow. Extensive studies and monitoring will continue throughout Wyoming to gain a better understanding of this disease and its impacts.

White pine blister rust occurs at low to moderate infection levels in limber pine stands of northern Colorado and in isolated stands within southern Colorado. In 2004, intensive surveys of rust intensity and spread on limber pine will be initiated in these newly infected areas and the incidence of the disease on bristlecone pine will be evaluated. In 2003, data were collected on the distribution of the alternate host for white pine blister rust, *Ribes* spp. These data, along with results from over 500 plots in Wyoming and Colorado, will be used to hazard-rate limber pine stands for this disease. This work is currently underway and will be completed in the winter of 2004-2005.

White pine blister rust disease is causing decline to the few remaining stands of limber pine in the central areas of the Black Hills. Mortality of these trees was not observed, but infected trees were more susceptible to bark beetle attack.

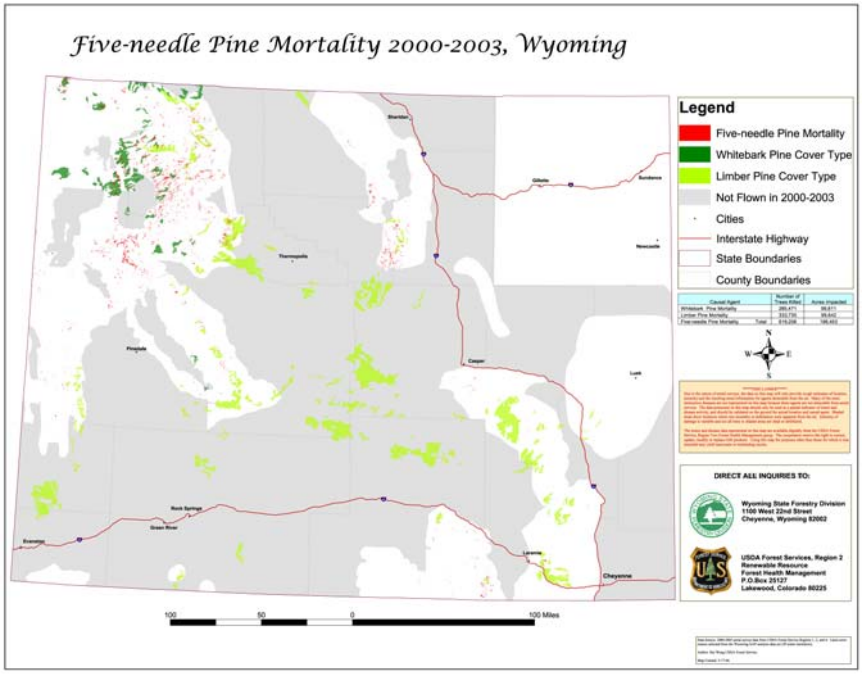


Figure 4. Aerial survey map showing places of dead/dying 5-needle (whitebark and limber) pines in Wyoming. These trees are most likely suffering from attack by various combinations of mountain pine beetles, *Ips* beetles, white pine blister rust, or dwarf mistletoe. Not shown are the isolated limber pine mortality centers in Colorado and South Dakota of the Rocky Mountain Region.

Figure 5. White pine blister rust cankers on a Rocky Mountain bristlecone pine branch in the Sangre de Cristo Mountains of Colorado. (Photo by J.L.Harris)

Most Damaging Abiotic Agent - Drought

Much of the region has suffered from drought conditions for the past several years. The drought was extreme during 2002 with many records being set in various categories of drought indices. Drought conditions were abated slightly during 2003, but tree mortality continued to occur at a high level.

Very high levels of tree mortality due to bark beetle activity have also marked this period of drought. Lack of moisture contributes to increased bark beetle activity in two ways. First, the stress induced by a drought makes host trees more vulnerable to death by the beetles. The primary defense of trees against bark beetle attack is production of resin and when moisture is unavailable to a host tree, it is unable to produce this resin for defense. Secondly, this lack of resistance in host trees allows attacking bark beetles to more easily colonize their hosts. The relative abundance of susceptible hosts allows the populations of damaging agents to increase dramatically. With large amounts of available food, bark beetles can increase their numbers and these large populations kill even more susceptible hosts. Thus, it is not surprising that large numbers of host trees can be killed in a relatively short period of time. While the extreme drought conditions of 2002 decreased during 2003, the large insect populations remained and tree mortality occurred on a large scale.

Virtually every species of conifer in all of the major forest types experienced a high degree of mortality in 2003. Overall, the distribution of the tree mortality was rather spotty, some forests suffered extensive, intense mortality, while other forested areas escaped relatively unscathed. However, if drought conditions continue, many experts predict that tree mortality will continue to increase over time. Long-term weather patterns will determine future forest conditions.

Colorado

Drought was a major damaging factor in 2003, for all of the Rocky Mountain Region states of Colorado, Kansas, Nebraska, South Dakota, and Wyoming. In addition to causing dieback and mortality, drought stress increases tree vulnerability to opportunistic diseases and insects.

In Colorado, conditions improved slightly around the state; however southwestern sites with piñon pine were extremely susceptible to attack by *Ips* bark beetle. Also areas of aspen trees were very dry and appeared to be suffering from drought stresses.
In 2003, moisture conditions improved over much of the state with the southwest corner still having severe drought conditions. Aspen and cottonwoods along ditches and riparian waterways died due to reduced stream flows. Gambel oaks were showing dieback in southern Colorado. Some conifer stands in the mountains were exhibiting stress cone crops due to the drought conditions.

Kansas and Nebraska

Severe drought conditions continued in much of the Great Plains states; all tree species in Kansas and Nebraska appeared weakened from the drought. While some of the western portions of South Dakota began experiencing drought in 2001, this condition became statewide by 2003. In addition to agro-forestry plantings, urban forests were also impacted by drought conditions. The increased environmental stress resulted in tree mortality attributed in part by colonization of borers such as ash bark beetles (*Hylesinus spp*), cottonwood borer (*Plectrodera scalator*) and Zimmerman pine moth (*Dioryctria spp*).

South Dakota

In South Dakota, spruce, cottonwood, green ash, and a number of other species were affected by drought in 2003. Colorado spruce, cottonwood, green ash, and a number of other species were affected by drought in 2003. While some of the western portions of South Dakota began experiencing drought in 2001, this condition became statewide by 2003. In addition to agro-forestry plantings, urban forests were also impacted by the drought conditions. The increased environmental stress has resulted in tree mortality attributed in part by colonization by borers such as ash bark beetles (*Hylesinus spp*), cottonwood borer (*Plectrodera scalator*) and Zimmerman pine moth (*Dioryctria spp*).

Other Damaging Forest Insects, Diseases, and Agents of Concern in Colorado (CO), Kansa (KS), Nebraska (NE), South Dakota (SD), Wyoming (WY)

Organism/Agent, Host Trees, and State	Remarks
Agrilus spp. **(Borers)** Hardwoods **CO**	In Colorado, aggressive borers of *Agrilus* spp. were observed killing drought-stressed ornamental oaks in Front Range communities south of Denver. The insect may be a native species associated with drought stressed Gambel oaks or it may be two-lined chestnut borer, a species native to eastern oaks possibly introduced on nursery stock.
Ash/Lilac Borer *Podosesia syringae* Green Ash **KS, NE, SD**	These boring pests have caused loss of green ash in shelterbelt and urban plantings. Found throughout the Great Plains in 2003. This very common pest limits the use of green ash in windbreaks to very fertile, moist sites. In South Dakota, tree mortality increased in 2003 probably due to an increase in host susceptibility because of the drought.
Bagworm *Oiketicus* spp. *Thyridopteryx* spp. Eastern redcedar, Rocky mountain juniper **KS, NE**	Bagworm occurs in many areas of Kansas and Nebraska and infests not only landscape trees but windbreaks and trees far from human habitation. At present, bagworms are not causing widespread damage. Populations are building and should be closely monitored.
Banded elm Bark Beetle *Scolytus schevyrewii*, American, Rock, and Siberian Elms **CO, KS, NE, SD, WY**	The banded elm bark beetle was first detected in Denver in an exotic bark beetle trap and has since been discovered in Colorado, Kansas, Nebraska South Dakota and Wyoming. The banded elm bark beetle is native to Korea, China, eastern Russia and other Asian countries. Adults are active from early spring until fall freeze and the insects can complete a generation in four to six weeks depending on weather conditions. Of particular concern is when the beetles are found in elms with Dutch elm disease; banded elm bark beetle might be able to vector this disease to other American elm trees. In Wyoming, this exotic bark beetle was discovered in a Siberian elm windbreak planting south of Cheyenne. Later it was found throughout Laramie County.
Cedar Bark Beetle *Phloeosinus dentatus* Eastern redcedar **SD**	The cedar bark beetle has been associated with the decline and branch mortality of eastern redcedar on approximately 50 acres of windbreak and urban plantings. Unlike past years, the population has not increased in 2003 despite the extended drought that is reducing host vitality and defenses.

Douglas-fir Pole Beetle *Pseudohylesinus nebulosus* Douglas-fir **CO**	Douglas-fir pole beetle is rarely considered a major damaging bark beetle species, but this insect killed many hundreds of mature Douglas-fir in the eastern portion of the San Juan National Forest. Undoubtedly drought conditions have allowed this beetle to take advantage of large numbers of susceptible hosts. This insect most frequently attacks smaller diameter Douglas-fir, but trees up to 12 inches DBH were killed near Pagosa Springs. This beetle was also detected at high levels during ground surveys of Wet Mountain north of Durango, in the Southern San Juan Mountains.
Douglas-fir Tussock Moth, *Orgyia pseudotsugata* Douglas-fir **CO**	There was no evidence of Douglas-fir tussock moth populations or defoliation in new or previously active areas along Colorado's Front Range.
Gypsy Moth *Lymantria dispar* (Non-native) Several hardwood and conifer tree species **CO, KS, NE, SD, WY**	This insect is monitored very year in recreational areas and near large cities. Kansas reported no catches of the moth in the state. No insect larvae or pupa were found on trees in South Dakota, nor has any defoliation in the state been attributed to this insect. There were a few moths caught in traps that were placed around the state, generally in areas near recreational sites or highway rest areas. In Wyoming, a statewide gypsy moth survey found six adult moths in Western Wyoming in 2003. All moths were submitted for DNA testing and were found to be of native North American strain. Wyoming State Forestry Division's survey of other Wyoming areas yielded no positive catches.
Jack Pine Budworm, *Choristoneura pinus* Jack pine **NE**	Defoliation by jack pine budworm has not been detected for 3 years now on the Bessie Unit. Stands that were severely defoliated recently are under attack by *Ips* beetles.
Pine Pitch Moth *Dioryctria* spp. Austrian, Ponderosa, and Scotch pines, Blue Spruce **KS,**	Infestations were found in Northwest and Southeast Kansas. Attempts to eradicate the pine pitch moth in Northwest Kansas are proving to be successful. In Southeast Kansas, the infestation is widespread and will probably not be eradicated. Zimmerman pine moth infestations are increasing. The two species most affected are Austrian and ponderosa pines, with many Austrian pine windbreaks in the southeastern part of the state showing almost 100 percent of the trees infested. In addition there have been a number of blue spruce that have become infested with a *Dioryctria* insect.
Pine sawyer *Monochamus carolinensis* Austrian, Ponderosa, Scotch Pines **KS, NE**	In Kansas, this insect occurs statewide except for the far Southwest and Northwest counties. It attacks healthy and stressed Scotch pines. This insect spreads the nematode that causes pine wilt.

Pine Tip Moth *Rhyacionia spp*. Austrian pine, Ponderosa pine and Scotch pine **KS, NE**	The trees most likely to be infested are newly planted trees and trees several years old. Older trees in excess of ten feet are less likely to be infested, however, some older and taller Scotch pine trees were found to be infested in western Kansas.
Red Turpentine Beetle *Dendroctonus valens* Jack pine, Ponderosa pine **CO, SD, WY**	Populations of red turpentine beetle have increased dramatically due to large fires. Many of the heavily fire scorched trees were infested. At this time, there has been little movement from fire scorched trees out into green trees.
Spruce Neeble Miner *Endothenia albolineana* Colorado Spruce **SD**	Colorado spruce, in agro-forestry and urban plantings of the eastern South Dakota, are increasingly damaged by this insect. The number of infested trees has increased steadily during the past five years and now the spruce needleminer is one of the most common insects reported on Colorado spruce. The insect is not responsible for tree mortality but severe infestations increase tree stress and reduce the tree's effectiveness as a screen.
Western Pine Beetle *Dendroctonus brevicomis* Ponderosa Pine **CO**	This beetle killed large ponderosa pines in several locations on the San Juan National Forest. It is most frequently found in combination ("mixed broods") with *Ips pini* (pine engraver) and *Dendroctonus adjunctus* (the round headed pine beetle); these beetles have killed several hundred large mature ponderosa pines. These bark beetles are present at higher levels in south-central and southwest Colorado.
Western Spruce Budworm *Choristoneura occidentalis* Douglas-fir, Engelmann spruce, Blue spruce, Subalpine fir, White Fir **CO, WY**	Western spruce budworm caused moderate to severe defoliation most notably in Douglas-fir (and some subalpine fir) on the lower elevations of the Snowy Range and Sierra Madre in southern Wyoming. The Colorado Front Range populations were at low levels in 2003. Isolated pockets of western spruce budworm activity were detected in north central Colorado on various landownerships. The southern portion of the Uncompahgre Plateau has seen significant levels of western spruce budworm defoliation in Engelmann spruce. In 2003 defoliation was light in the Wet and Sangre de Cristo Mountains. This area has long been subject to chronic budworm activity, but the drought seems to have reduced budworm activity.
Anthracnose *Gnomonia* spp. Green Ash and Maples **SD**	While the state has experience drought for at least the past several years, there were several weeks in the spring of 2003 with cool, moist weather. These environmental conditions are conducive to the development of anthracnose and this disease became prevalent on green ash and maples by midsummer. The disease is not resulting in tree mortality but is contributing to tree stress.
Brown Spot Needle Blight *Scirrhia acicola* *Mycosphaerella dearnessii* Scotch pine **KS, NE**	Christmas tree growers in Kansas continue to remove and destroy many heavily infected trees due to this disease. In 2003, the disease appeared to be at moderate levels.

Cercospora Blight *Cercospora sequoiae* Eastern redcedar, Rocky Mtn. juniper **KS, NE, SD**	A severe problem on Rocky Mountain juniper in eastern Kansas. It is recommended that this species not be planted in these areas. This disease continues to severely defoliate and kill junipers and redcedars in windbreaks in central and eastern Nebraska.
***Cytospora* spp. (Cankers)** Red Alder **CO**	Dieback and mortality of alder were widespread and common in riparian areas of the southern Colorado mountains. Stems with dieback almost always had *Cytosospora* cankers.
Dutch Elm Disease *Ophiostoma ulmi* **(Non-native)** American elm **CO, KS, NE, SD, WY**	Dutch elm disease can be a significant problem in riparian areas and cities throughout the Great Plains. The disease was moderate during 2003 in Kansas. In South Dakota, the incidence of Dutch elm disease increased in several communities that still have American elms as a dominant street tree. Losses in 2003 were not as high an increase as the previous two years, but still above that experienced in the mid-1990s with some communities experiencing losses higher than four or five percent. This increase may be due to the inability of communities to conduct prompt removals of the infected trees.
Oak Wilt *Ceratocystis fagacearum* Bur and red oaks **KS, NE**	Oak wilt continues to be a problem in forests along the eastern edge of Kansas. Only a few cases of oak wilt were reported in northeast Kansas. The damages occurred in woodlots and housing developments established in previous oak stands.
Pine Wilt and Pinewood Nematode *Bursaphelenchus zylophilus* Scotch, Austrian, and white pines **KS, NE, SD**	Kansas has experienced epidemic proportions of damage due to this disease the last 3-5 years. Heavy mortality linked to this nematode was found frequently throughout Kansas, mostly affecting Scotch pine. The drought exacerbated the problem and it is now moving into Austrian pine in Southeast Kansas. Numerous Scotch and Austrian pines in the southern portion of South Dakota are showing symptoms of rapid needle discoloration and decline. These symptoms are often associated with pine wilt, a disease due in part from colonization by the pinewood nematode. A survey during 2002 and 2003 found that dying Scotch pines and Austrian pines in the southwestern portion of the state were infested with the nematode. In 2003 we identified approximately 20 acres of trees in several windbreaks and communities that have died from the disease.
Russian Olive Canker *Phomopsis arnoldiae* *Tubercularia* spp*. Lasiodiplodia* spp*.* Russian olive **KS, NE, SD, WY**	This continues to be a very serious problem in the eastern half of Kansas; Russian olive is no longer recommended for use in conservation plantings.

Sphaeropsis (Diplodia) Blight *Sphaeropsis sapinea* Austrian pine, ponderosa pine, lodgepole pine **KS, NE, SD, WY**	This disease continues to be a serious problem in pine windbreaks and landscape plantings in eastern Nebraska and throughout Kansas. Kansa had moderate levels of this disease in 2003. South Dakota trees on about 300 acres of forest, urban and agro-forestry land had serious infections of diplodia tip blight. The disease is common throughout South Dakota, particularly on Austrian pine, but there has been an increase in the incidence of the disease in the Black Hills due to spring hailstorms.
Tubakia leaf spot *Tubakia dryinia* Bur Oak **NE**	Defoliation and twig dieback were common and widespread on bur oaks in eastern Nebraska.
Western Gall Rust *Endocronartium harknessii* Lodgepole, Ponderosa Pines **CO, NE, SD, WY**	In the Black Hills of South Dakota and Wyoming, this disease frequently contributes to the death of small ponderosa pines. The disease infrequently can be found elsewhere on the limbs of larger trees or causing an occasional stem canker but normally is not a severe problem. On the east side of the Continental Divide in Saguache County, lodgepole pine stands have been identified with extremely heavy infections. These are small units that were in a dense, stagnant condition and were roller-chopped to regenerate the stands in the early 1980's. The units range from less than 1 to about 35 acres and total about 270 acres. The disease is frequent in most units, with up to 98% of the trees infected. It appears that most infected trees have stem infections. Many other lodgepole stands have been roller-chopped without such results. This anomalous epidemic may have occurred because: (a) one or more years of weather conditions favorable for spore production and infection (wave years, which are infrequent) occurred soon after stand establishment; (b) inoculum was in the area in the neighboring, residual stands; and (c) the heavy slash from roller-chopping may have created a microclimate that increased the chances of spore germination and infection.
Hackberry Decline **SD**	Hackberries in urban and agro-forestry plantings are still showing symptoms of foliage yellowing and branch dieback. There has been relatively little loss in the native stands of hackberry across the state. The gradual loss of hackberry street trees, windbreaks and ornamental trees will result in a loss of diversity.

Oak Decline **NE, SD**	Dieback and mortality of native bur oak were common in eastern and northern Nebraska. Causes appeared to be changes in site conditions related to grazing and human activities. There have been numerous reports of oak decline along the extreme eastern edge of South Dakota, particularly in the northeast corner. The decline is found in native bur oak stands. The initial symptoms, leaves turning bronze at the margins, curling then dropping, are followed by tree dieback and death within a year or two. While these symptoms are characteristic of oak wilt, the causal agent, *Ceratocystis fagacearum*, has not been detected in any culturing. Further investigations will be conducted in 2004.
Chemical Damages **CO, KS**	Ice and dust-control materials utilizing magnesium chloride were increasingly applied in the mountain road systems in Colorado, with corresponding increases in tree damage throughout the state. Herbicide damage to windbreaks and other tree plantings continues to be a problem in the central portion of Kansas. Pesticide drift from crop weed control programs causes noticeable decline to agro-forestry tree plantings in parts of Kansas.
Snow Damage **CO**	Heavy spring snowstorms throughout Colorado caused broken branches of thousands of ponderosa pines and Douglas-firs in the mountains. In the towns, junipers, piñons, Colorado blue spruces, elms, and cottonwoods suffered from many broken limbs. The broken limbs provided good habitat for several bark beetles.

Non-native, Invasive, Forest Pathogens and Insects in the Rocky Mountain Region:

Common Name	Scientific Name	CO	KS	NE	SD	WY
Pathogens						
Brown Spot	*Scirrhia acicola*		X			
Cercospora Blight	*Cercospora sequoia*		X	X		
Dutch Elm Disease	*Ophiostoma (Ceratocystis) novo-ulmi*	X	X	X	X	X
Juniper Botryodiplodia	*Botryodiplodia spp.*		X	X		
Oak Wilt	*Certatocystis fagacearum*		X	X		
Pinewood Nematode	*Bursaphelenchus xylophilus*		X	X	X	
Sphaeropsis Shoot Blight	*Sphaeropsis sapinea*		X	X	X	
Thyronectria Canker	*Thyronectria austro-americana*	X	X	X		
White Pine Blister Rust	*Cronartium ribicola*	X			X	X

Common Name	Scientific Name	CO	KS	NE	SD	WY
Insects						
Bagworm	*Thyridoptereyx ephemeraeformis*		X	X		
Banded Elm Bark Beetle	*Scolytus schevyrewii*	X	X	X	X	X
Bronze Birch Borer	*Agrilus anxius*	X		X	X	X
Elm Leaf Beetle	*Pyrrhalta luteola*	X	X	X	X	X
Elm leaf Miner	*Fenusa ulmi*	X				
European Elm Scale	*Gossyparia spuria*	X	X		X	X
European Pine Sawfly	*Neodipron sertifer*		X	X	X	X
Gypsy Moth	*Lymantria dispar*	Not established in any of our states, yet found infrequently during annual trapping and monitoring efforts				
Honeylocust Pod Gall Modge	*Dadineura gleditchiae*				X	X
Jack Pine Budworm	*Choristoneura pinus*			X		
Juniper Scale	*Carulaspis juniperi*	X				
Juniper Webworm	*Dichomeris marginella*	X				
Lilac (ash) Borer	*Podesesia syringae*	X	X	X	X	X
Nantucket Pine Tip Moth	*Rhyacionia frustrana*		X	X		
Oystershell Scale	*Lepidosaphes ulmi*	X	X	X	X	X
Pine Needle Scale	*Chionaspis pinifoliae*		X	X	X	
Pine Tortoise Scale	*Toumeyella parvicornis*		X			
Poplar and Willow Borer	*Cryptorhnchus lapathi*	X			X	X
San Jose Scale	*Quadraspidiatus perniciousus*	X				
Smaller European Elm Bark Beetle	*Scolytus multistriatus*	X	X	X	X	X

2003 Rocky Mountain Region Aerial Detection Surveys

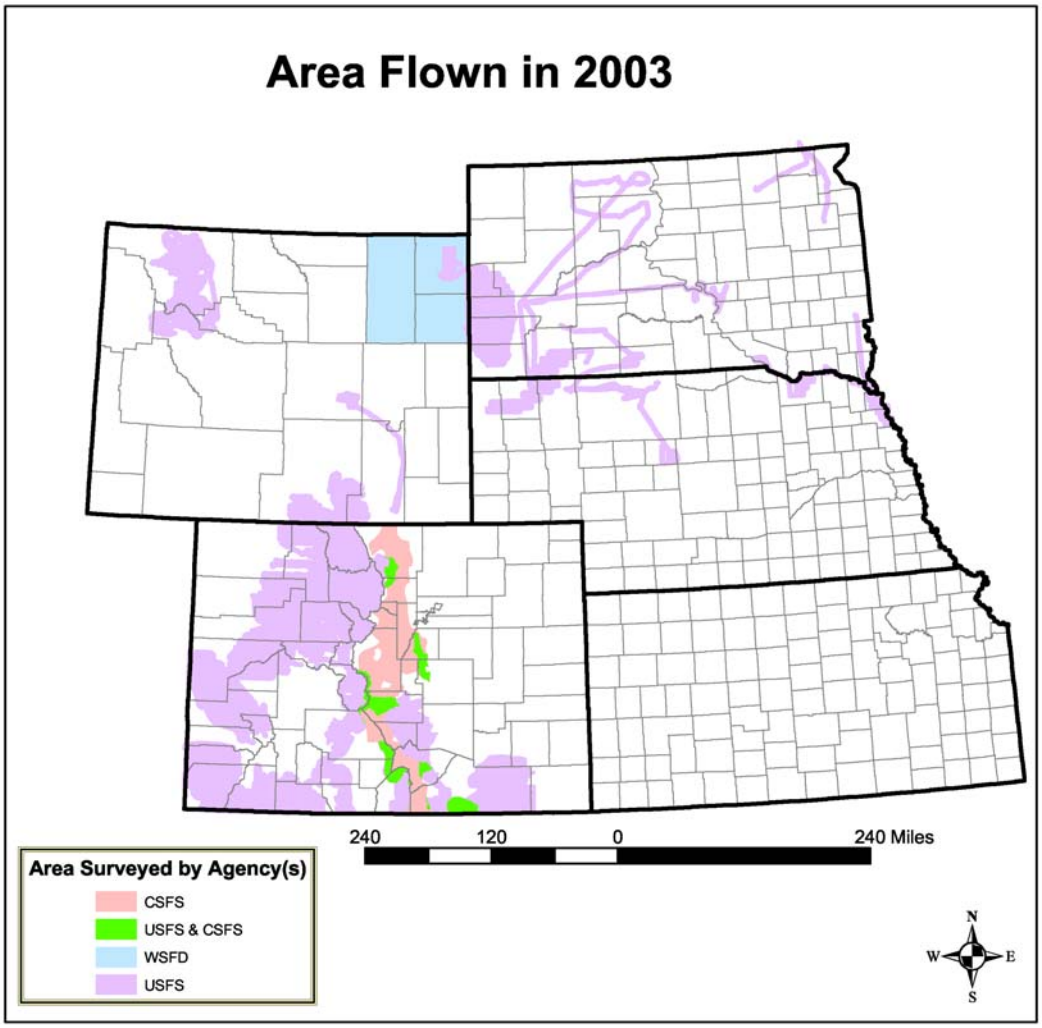
General aerial detection surveys were flown between June - October to observe forest damage and mortality caused by insects, diseases and other forest health stressors. In addition to surveying the usual Federal, State, and private lands surveyed annually, several new areas were surveyed for special projects (Figure 6). A request was made to survey some of the Great Plains riparian forests and Indian Reservation lands in Nebraska, South Dakota, and Wyoming. Also millions of acres of piñon were surveyed as R2 participated in a Forest Health Monitoring detection survey to determine the extent of piñon mortality caused by pine engraver beetles (*Ips* spp.).

R2 Forest Health Management staff (Erik Johnson, Bill Schaupp, Kelly Sullivan, Robert Cain, Daniel Long, and Leanne Egeland), state forestry cooperators (Dave Leatherman and Les Koch), and guest surveyors (Tim McConnell, Bill Ciesla, Dustin Wittwer, and Carl Jorgensen) surveyed over 43 million acres during 2003. This was approximately 175% of the acres normally surveyed in the region. Erik Johnson (R2 aerial survey program manager), Hui Wang (R2 GIS contractor), and Jeanine Paschke (WO – FHTET) processed all of the aerial survey data for maps and reports needed by several forest managers throughout the region and the country.

Due to the nature of aerial surveys, the data and maps within this document only provide rough estimates of location, intensity and trend information for agents detectable from the air. Many of the most destructive diseases are not represented because these agents are not detectable from aerial surveys. The data presented in this document should only be used as partial indicators of insect and disease activity, and should be validated on the ground for actual locations and casual agents. Shaded areas on maps show locations with tree mortality or defoliation apparent from the air. Intensity of damage is variable and not all trees in shaded areas are dead or defoliated.

Aerial Survey data of 2003 for the Rocky Mountain Region are available in digital format for use in a Geographic Information System (GIS) database. The files can be found at the following FTP address: ftp://ftp2.fs.fed.us/incoming/r2/ro/aerial_survey/2003/. Download the forest damage coverage (r203_dmg.e00) and the "flown/ not flown" coverage (r203_flown.e00). ArcView shapefiles are also available at this site. In addition to the GIS files, please open the folder entitled "meta_data" ftp://ftp2.fs.fed.us/incoming/r2/ro/aerial_survey/meta_data/ and download the two documents explaining the fields in the polygon attribute tables (PAT): the ***Aerial Survey Geographic Information System Handbook****: Sketchmaps to Digital Geographic Information* (gis_handbook.pdf), and the **PAT explanation document** (about_pat_table.xls). The ***Aerial Survey Geographic Information System Handbook****: Sketchmaps to Digital Geographic Information*, is also available at the Forest Health Technology Enterprise Team's (FHTET) Forest Health website: http://www.fs.fed.us/foresthealth/id/id_guidelines.html (bottom of page). For additional information regarding the GIS data, please contact Jeanine Paschke jpaschke@fs.fed.us 970-295-5871, or Erik Johnson ejohnson02@fs.fed.us 303-236-8001.

Figure 6. Rocky Mountain Region's 2003 aerial survey coverage by surveying agency



The following 4 maps are aerial survey sketchmaps of Colorado, Nebraska, South Dakota, and Wyoming 2003 survey flights. The most prominent damaging agents of each map are:

Figure 7 – Colorado, *Ips* Beetle;
Figure 8 – Nebraska, *Ips* Beetle;
Figure 9 – South Dakota, Mountain Pine Beetle; and
Figure 10 – Wyoming, Subalpine Fir Mortality.

Figure 7

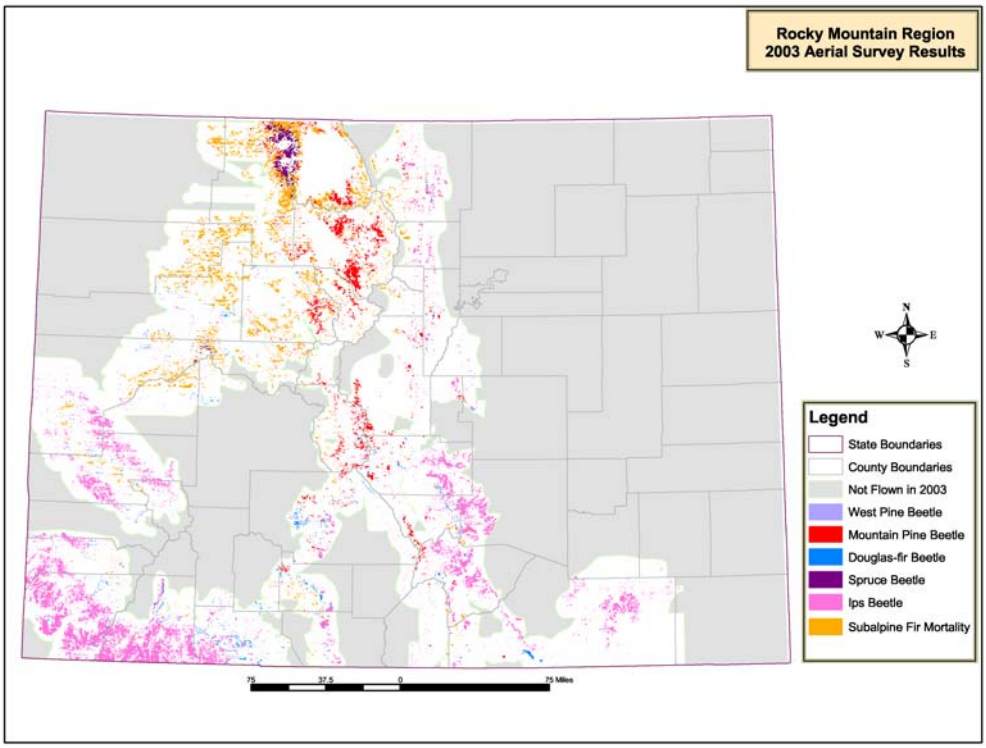


Figure 8

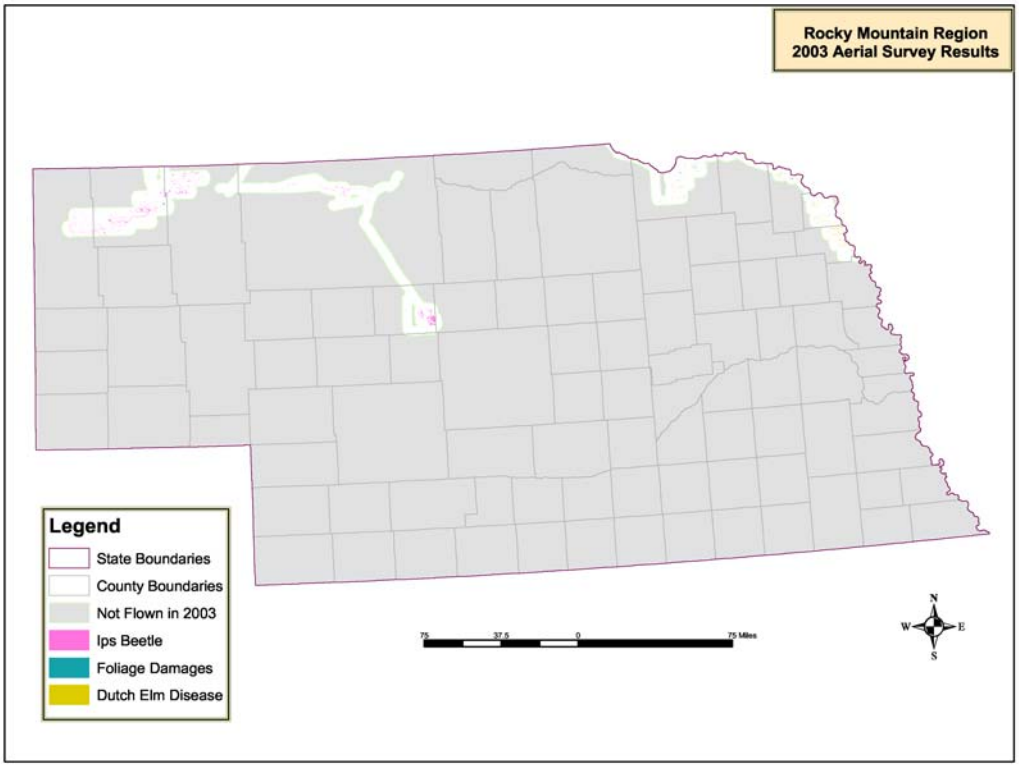


Figure 9

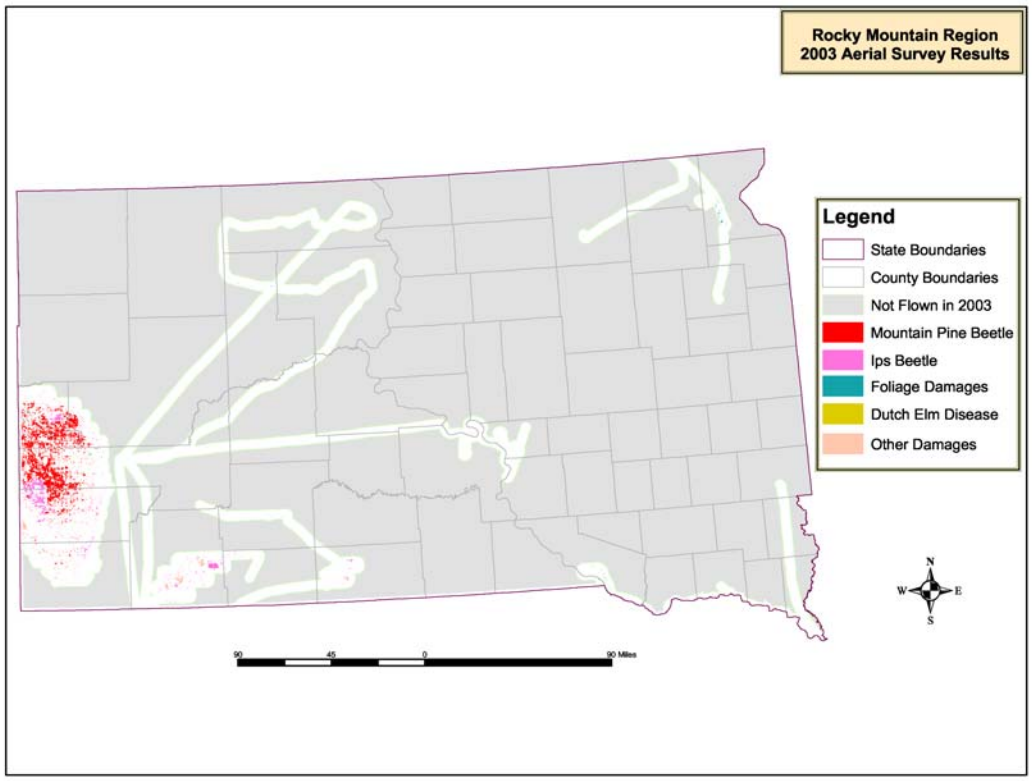
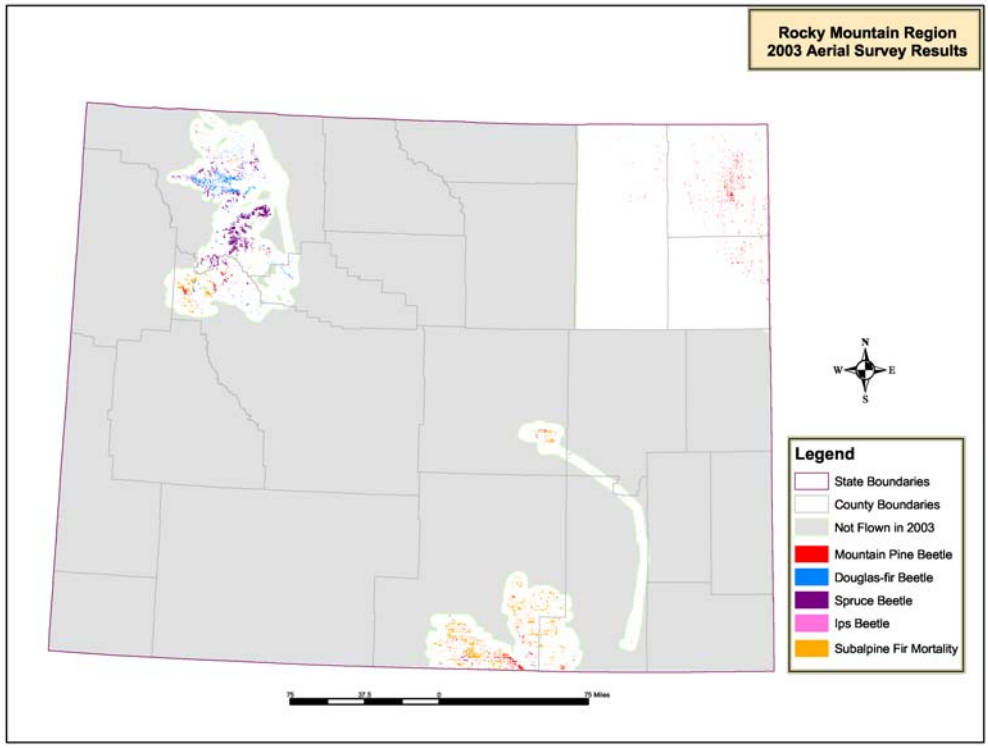


Figure 10



Forest Health Management Special Projects

Project Title: Test of insecticides as preventatives for bark beetles in South Dakota and Colorado

Investigators from Rocky Mountain Region: Kurt Allen, Tom Eager, Roy Mask, Dan Long

Cooperators: Blaine Cook and Phil Grumstrupp, Black Hills NF; Chris Fettig and Pat Shea (Retired), PSW; John Ball, SDSU; Jim Friedley, Southern Ute Tribe Forestry; David Temple, Animas Valley Tree Care; Gary Cramer, FMC; Pope and Talbot, Warne Chemical

Years: 2000-indefinite

Project Description: This project is part of a larger West-wide study to evaluate several treatments for use as a preventative spray for bark beetles. The study examines the use of these materials on mountain pine beetle (*Dendroctonus ponderosae*) in ponderosa pine (South Dakota), and on pinyon Ips (*Ips confusus*) in pinyon pine (Colorado). Field tests were undertaken to look at the effectiveness and longevity of carbaryl (Sevin) and bifenthrin (Bi-flex). Trees were sprayed at labeled and additional experimental rates to runoff on boles and branches of treatment trees and then baited to assure beetle pressure. Preliminary data indicate that both chemicals provide protection for at least one field season. The results of the 1st year of this combined West-wide study are being evaluated. Efficacy results from the 2nd year will be evaluated in 2004.

Project Title: Spruce beetle control using a naturally-baited trap

Investigators: Bob Cain, Jeff Witcosky (Lakewood Service Center) and Matt Hansen, Jim Vandygriff (Rocky Mountain Research Station)

Years: 2003 - 2004

Project Description: Legal restrictions on logging and pesticide application have diminished the options available for suppression of building spruce beetle (*Dendroctonus rufipennis* Kirby) populations. A new trap design that is environmentally benign and can potentially catch many thousands of beetles with less spillover into live trees than funnel traps with synthetic lure was tested in 2003. The new design combines the attractiveness of a trap tree with the portability of a funnel trap. The lure for the trap is a 50 cm fresh log section suspended in a vented enclosure that prevents beetle attack while allowing host volatiles to escape. Placing female spruce beetles in the log augments plume attractiveness. Attracted beetles collide with the enclosure and fall into a poisoned collecting funnel. If proven successful, the new system will be a useful option for suppressing building spruce beetle populations. Additional modifications are planned in 2004.

We propose to compare captures in the new design with captures in pheromone-baited funnel traps. To be considered a significant improvement over existing technology, the new design should catch at least twice as many beetles as the funnel trap. Also, the new trap should result in significantly less probability of spillover than that associated with pheromone-baited funnel traps.

Ten sites will be selected from areas of building spruce beetle populations on the Routt National Forest, Colorado. Each site will have treatments of the new trap and funnel trap, spaced at 100 m. Trap contents will be collected weekly and cumulative totals compared. At the end of the season, we will conduct a 100% survey of spruce within a 25 m radius of the traps to assess the occurrence of spillover onto standing, live trees.

Project Title: Modeling forest composition and structure to investigate susceptibility of lodgepole pine stands to mountain pine beetle infestations: a demonstration project

Investigators: Erik Johnson (R2 FHM), Robin Reich (CSU)

Years: 2003 - 2004

Project Description: Conventional remote sensing analytical techniques are restricted to spectral reflectance measurements at a fixed spatial resolution, such as the 30-m resolution of Landsat Enhanced Thematic Mapper (ETM+) imagery. By incorporating auxiliary information (independent variables) and re-sampling ETM+ imagery to a finer resolution, forest composition and forest structure were modeled at a 10-m spatial resolution in order to explore stand conditions favorable to mountain pine beetle infestations. Canopy closure (%), basal area (ft2/acre), diameter-at-breast-height (in), and forest type (composition) were modeled using a combination of trend surface models to describe the course-scale variability, and binary regression trees to describe the fine-scale variability. Independent variables used in the models included Landsat ETM+ bands 1 through 6, elevation, slope, aspect, and landform index. The forest structure models accounted for between 57% and 80% of the variability, while the forest composition model accounted for 97% of the variability. The final predictive surfaces created during this process will be used to evaluate the susceptibility of lodgepole pine stands to mountain pine beetle infestations. These surfaces will also be used to develop an empirical model based on regional geographic and physiological characteristics once mountain pine beetles move into the area and begin attacking trees.

Project Title: The role of wildland fire and subsequent insect attack on ponderosa pine mortality

Investigators: Kurt Allen, Dan Long

Cooperators: Joel McMillin, John Anhold and Linda Wadleigh, R-3, Ken Gibson, R-1, Carolyn Sieg and Jose Negron, RMRS, Black Hills NF, Custer, NF, Arapaho-Roosevelt NF, Coccnino NF, Kaibab NF

Years: 2000-2004

Project Description: This project will help to define the impact caused by insects when interacting with another disturbance agent, wildfire. This will allow FHP to more accurately assist land managers in predicting potential tree mortality in post-fire situations. Currently, there is little information regarding fire/insect impact in ponderosa pine ecosystems across its range in the western United States. For example, written or visual guidelines are lacking for field personnel to determine what tree will live or die relative to the amount of damage caused by fire or the probability of injured trees being killed by insects. Furthermore, the probability of fire-damaged trees providing the source of an insect outbreak that subsequently spreads to uninjured trees remains unknown. The proposed project will address this lack of adequate information by formulating models and creating visual guides and, therefore, permit land managers to make more informed decisions regarding salvaging and insect control. This information also will be useful in the development of prescriptions for prescribed burning**.** Data analysis has started and plots will be evaluated again in 2004.

Project Title: Landscape scale hazard-rating system for white pine blister rust in the central Rocky Mountains

Investigators and Cooperators: William Jacobi and Holly Kearns (Colorado State University); Kelly Sullivan, Jeri Lyn Harris, Jim Hoffman, Eric Smith (Forest Health Protection – USFS); Brian Geils and Anna Schoettle (Rocky Mountain Research Station – USFS); Diana Tomback (University of Colorado, Denver)

Years: 2001-2005

Project Description: Development for a hazard rating system to identify areas where limber pines and

bristlecone pines are threatened by white pine blister rust in Colorado continues. Using the current outbreak of this disease in southern Wyoming and northern Colorado a model system is being developed using epidemiological factors and site features. Epidemiological factors are those direct influences related to microclimate, Ribes distribution and abundance, and white pine age and size. Because information for these epidemiological factors is not available for most sites, we relate these direct factors to standard resource management data describing site and stand conditions (e.g., elevation, habitat type, current vegetation, and management history). Using these data, hazard maps for the current outbreak area in Colorado will be generated and evaluated. We will identify additional areas within the central Rockies, which could be seriously impacted by WPBR; and assess the consequences of alternative vegetation management strategies on rust impact.

Project Title: Monitoring white pine blister rust spread and establishment in the central Rocky Mountains

Investigators and Cooperators: Jeri Lyn Harris, Kelly Sullivan, Meg Halford, Jim Hoffman, John Guyon, Dave Conklin, Jim Blodgett, Eric Smith (Forest Health Protection – USFS); Maria Newcomb (Montana State University); William Jacobi and Holly Kearns (Colorado State University); Dave Johnson (retired plant pathologist)

Years: 2001-2005

Project Description: This Forest Health Monitoring (FHM) project was conducted to survey white pine stands in the central Rocky Mountains to determine the current extent and impacts of the non-native disease white pine blister rust. The project started by first analyzing FHM data and forest inventory records for locations and recorded damages to white pines in Colorado, south-eastern Idaho, southern Wyoming, eastern Utah, and northern New Mexico. Field surveys are being conducted in white pine stands of Colorado, southeastern Idaho, southern Wyoming, northern New Mexico, and eastern Utah. These surveys will allow further description of white pine stands and the distribution and severity of white pine blister rust. Additionally, we will pay close attention to the incidence of the disease on a new host, bristlecone pine.

Project Title: Pest Trend Impact Plots in the West-Rocky Mountain Region

Investigators: Jeri Lyn Harris, Tom Eager, Jim Worrall, Kelly Sullivan, Meg Halford, Kurt Allen, Dan Long, Denise Hardesty

Cooperators: Judy Adams, FHTET; Jim Friedly, BIA Southern Ute Agency; Bill Hill, Custer State Park, South Dakota, and several natural resource staff members of the Black Hills NF; White River NF; Routt NF; Roosevelt NF; Grand Mesa / Uncompahgre / Gunnison NF's; San Juan NF; Bighorn NF, and the Shoshone NF.

Years: Began 1991to present.

Project Description: Since 1991, Region 2 has been actively involved with a "Pest Trend Impact Plots in the West" project to collect long-term data for calibration of various insect and disease computer simulation models. We installed several plots to provide modeling and monitoring data for root diseases, dwarf mistletoes, stem rusts, and subalpine fir decline. During 2002-2003, stem rust data and 2001 root disease data were stored in the national FSVeg database and data analysis continues by the investigators listed above. In 2003, we re-measured the stem rust plots and the subalpine fir decline plots. We plan to remeasure the dwarf mistletoe plots in 2004.

Project Title: Monitoring of wood deterioration after wildfire

Investigators: Tom Eager, Jim Worrall, and Roy Mask

Cooperators: Don Martinez, Jerry Ryszka, and forestry staff from Black Hills, White River, Pike, Grand Mesa Uncompahgre, Gunnison, and Rio Grande National Forests

Years: 2002 - 2007

Project Description: Objectives are to measure and monitor wood deterioration following forest wildfires. Decay and stain fungi, damages by various insects, and weather checking of the wood are all evaluated.

Project Title: Distribution, Species, and Ecology of *Armillaria*-Fungi in Wyoming

Investigators: Jim Blodgett and Denise Hardesty

Years: 2003 - 2006

Project Description: A statewide investigation of *Armillaria* root disease will be conducted on federal, state, and tribal lands throughout Wyoming. This field survey is designed to examine the distribution of *Armillaria* species causing root disease in various forest types throughout Wyoming, and to explore relationships among hosts, site conditions, and *Armillaria* species. Along with providing new information about the distribution and species of *Armillaria* in Wyoming, this study will also examine relationships among the different species of *Armillaria* detected in this state and their associated soil and stand ecology. In doing this we will develop coarse-scale distribution and hazard maps for this pathogen. The spatial distribution of *Armillaria* will be compared with Forest Health Detection Monitoring data, and with annual precipitation data throughout the state. This study will provide scientific information regarding an important forest health issue, result in the diagnosis or pathogenic *Armillaria* species in Wyoming, and provide the base information for future monitoring/surveys of this important disease.

Project Title: *Scolytus schevyrewi*, a newly detected bark beetle attacking elm

Investigators and Cooperators: José Negrón, Steve Seybold, Jeff Witcosky, Bob Cain, and Bernard Benton

Years: 2003 - 2005

Project Description: During spring of 2003, a bark beetle native from Korea, China, eastern Russia and other Asian countries was trapped in Aurora, Colorado and Ogden, Utah. Since this original detection of *Scolytus schevyrewi* (Banded Elm Bark Beetle) has been found throughout R2. A cooperative study was initiated among the Rocky Mountain Research Station, Pacific Southwest Research Station and Forest Health Management in R2. Monitoring of the beetle's life cycle and evaluating its pheromone attractants continues in 2004. Banded elm bark beetles were collected from American, rock, and Siberian elms. Adults are active from early spring until fall freeze and the insects complete a generation in four to six weeks depending on weather conditions.

Recent Publications

Allen, K.K.; Schaupp, W.C.Jr.; and Long, D.F. 2002. Evaluation of mountain pine beetle activity in the Beaver Park Area of the Black Hills National Forest. USDA For. Serv., Rocky Mountain Region, Renewable Resources. R2-03-03. 14pp.

Allen, K.K.; Schaupp, W.C. Jr.; and Long, D.F. 2003. Evaluation of mountain pine beetle activity in the Deerfield Area of the Black Hills National Forest. USDA For. Serv., Rocky Mountain Region, Renewable Resources. R2-03-04. 14pp.

Cain, R.J.; Sullivan, K.F.; and Jorgensen, C.L. 2002. Biological Evaluation of mountain pine beetle activity on the Arapaho National Recreation Area (ANRA) and of dwarf mistletoe on ANRA Recreation Sites. USDA For. Serv., Rocky Mountain Region, Renewable Resources. R2-03-01. 34pp.

Cain, R.J. 2003. Biological evaluation of mountain pine beetle activity on the Green Ridge Area of Parks Ranger District, Medicine Bow-Routt National Forests, 2003. USDA For. Serv., Rocky Mountain Region, Renewable Resources. R2-03-05b. 29pp.

Harris, J.L. 2003. 1999 Road-Plot Survey of dwarf mistletoe and comandra blister rust diseases of lodgepole pine on the Bighorn National Forest. USDA For. Serv., Rocky Mountain Region, Renewable Resources. R2-03-07. 13pp.

Harris, J.L., comp. 2003. Forest Insect and Disease Conditions in the Rocky Mountain Region, 2002. USDA For. Serv., Rocky Mountain Region, Renewable Resources. R2-03-08. 42pp.

Jorgensen, C.L. 2003. Biological evaluation of spruce beetle and mountain pine beetle for the Hahns Peak/Bears Ears and Parks Ranger Districts, Medicine Bow - Routt National Forests, 2003. USDA For. Serv., Rocky Mountain Region, Renewable Resources. R2-03-05a. 19pp.

McMillin, J.D.; Long, D.F.; Harris, J.L.; and Negron, J.F. 2003. Effects of western balsam bark beetle on spruce-fir forests of north-central Wyoming. Western Journal of Applied Forestry 18(4): 259 – 266.

Schaupp, W.C. Jr.; Allen, K.K.; and Long, D.F. 2002. Evaluation of the Douglas-fir beetle along the North Fork of the Shoshone River and the Clarks Fork of the Yellowstone River, Shoshone National Forest, Wyoming. USDA For. Serv., Rocky Mountain Region, Renewable Resources. R2-03-02. 13pp.

Sullivan, K.F. 2003. Biological evaluation of insect and disease conditions in Teal Lake Campground. USDA For. Serv., Rocky Mountain Region, Renewable Resources. R2-03-06. 28pp.

Worrall, J.J.; Sullivan, K.F.; Harrington, T.C.; Steimel, J.P. 2004. Incidence, host relations and population structure of Armillaria ostoyae in Colorado campgrounds. Forest Ecology and Management (in press).