FOREST INSECT and DISEASE CONDITIONS in the ROCKY MOUNTAIN REGION

2002

Aerial view of ponderosa pine mortality caused by mountain pine beetle in the Beaver Park Area of the Black Hills National Forest in South Dakota.

United States
Department of
Agriculture

Renewable
Resources
Forest Health

Rocky
Mountain
Region

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USDA Forest Service
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Renewable Resources, Forest Health Management
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by
The Rocky Mountain Region Forest Health Management Staff

Compiled by Jeri Lyn Harris

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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. 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.

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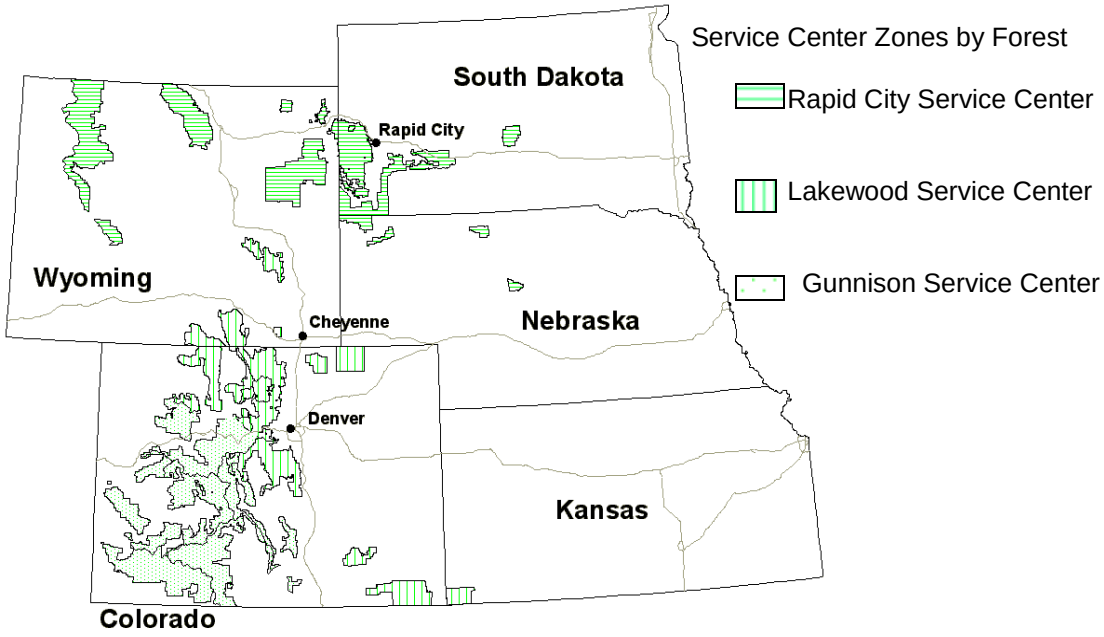
Regional Office – Renewable Resources	Oversight of Forest Health Management for R2.	**Marisue Hilliard –** Director **Dan Nolan** – Assistant Director

Rocky Mountain Region
Forest Health Management Zones



Bug-n-Crud Group – (standing- left-right) Bernard Benton, Dan Nolan, Dan Long, James Blodgett, Jeff Whitcosky, Kelly Sullivan, Bob Cain, Jeri Lyn Harris, Carl Jorgensen, Roy Mask, Kurt Allen, and Tom Eager. (kneeling – left-right) Bill Schaupp, Frank Cross, and Jim Worrall.
(not available for picture) Erik Johnson, Meg Halford, Matt Cahir, and Tom McClure.

Status of Major Forest Health Damaging Agents in the Rocky Mountain Region during 2002

Most Damaging Insects

In Colorado, South Dakota and Wyoming, there are several bark beetle outbreaks and some of these have reached epidemic levels. Table 1 and maps (Fig. 1a and 1b) show aerial detection survey estimates of trees killed by the various beetles and other damaging agents.

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

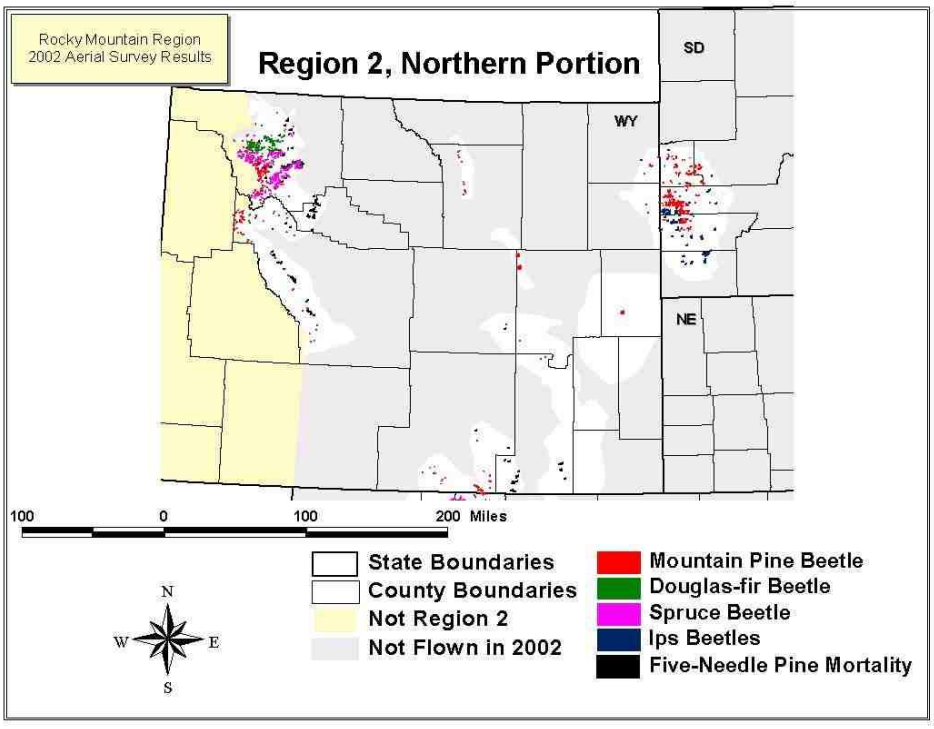
Mountain pine beetle outbreaks have reached epidemic proportions near Lake Granby Area (Grand County) and in the Upper Arkansas Valley (Chaffee County). There are numerous places where beetle populations are dramatically increasing in Eagle, Jackson, Saguche, Custer, and Park Counties.

Pine mortality due to mountain pine beetle on the Pike National Forest is low at this time with only 7000 trees recently killed. However, on the San Isabel National Forest, over 82,000 pines have died due to the activities of this insect. Mountain pine beetle populations are increasing on the Routt National Forest with over 15,000 pines dead.

Table 1. Overview of large beetle outbreaks in the Rocky Mountain Region as detected from 2002 aerial surveys. These are the estimated numbers (in thousands) of trees killed during 2002; approximately 18.2 million acres of the Rocky Mountain Region were surveyed aerially.

	Mountain Pine Beetle	***Ips* Beetle**	**Spruce Beetle**	**Douglas-fir Beetle**
Colorado Counties				
Chaffee	67.3			
Custer	13.6			
Eagle	23.2			
Grand	136.1			
Jackson	19.5		30.1	
Park	10.5			
Routt			177.2	
Saguache	15.6			
South Dakota Counties				
Custer	14.5	14.1		
Fall River		11.4		
Lawrence	26.1			
Meade	18.3			
Pennington	104.8	13.4		
Wyoming Counties				
Carbon	17.0			
Park	84.8		108.9	89.2

Figure 1a. Northern portion of the Rocky Mountain Region showing aerial survey results of 2002. Agents commonly contributing to five-needle pine mortality are mountain pine beetle, *Ips* beetle, dwarf mistletoe disease, or white pine blister rust disease.



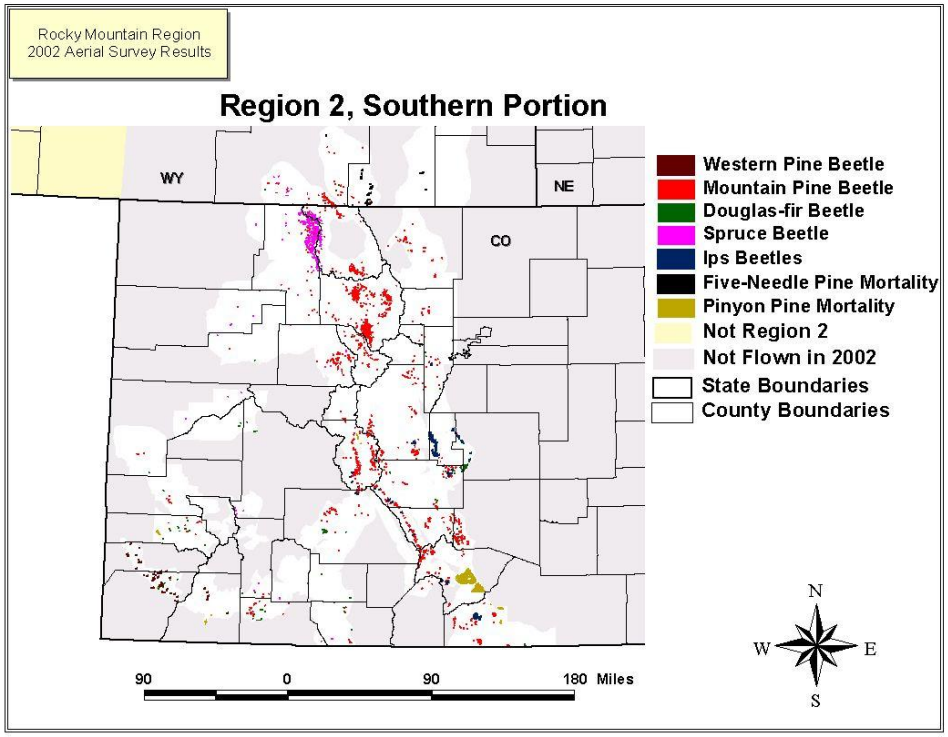


Figure 1b. Southern portion of the Rocky Mountain Region showing aerial survey results of 2002. Pinyon pine mortality is most likely caused from *Ips* spp. beetles attacking drought-stressed trees. Agents commonly contributing to five-needle pine mortality are mountain pine beetle, *Ips* beetle, dwarf mistletoe disease, or white pine blister rust disease.

Wyoming
Shoshone National Forest experienced thousands of whitebark pines and limber pines dying due to activities of this beetle. Mountain pine beetle, along with some forest diseases, are playing a significant role in limber pine and whitebark pine decline on more than 58,000 acres of white pines in western Wyoming.

This beetle species is also causing considerable damage in ponderosa pine in the lower foothills along the eastern flank of the Bighorn Mountains from Johnson County north into Sheridan County on state, private, and federal lands. With populations in this area of the Bighorns increasing, tree mortality caused by this beetle will be highly visible in 2003.

Small pockets of dead lodgepole and ponderosa pines, recently killed by mountain pine beetle, were characteristic in the Laramie Mountain, Sierra Madre, and Snowy Mountain Ranges of south-central and south-eastern Wyoming. Many of these pockets contained over 150 dead trees.

Mountain pine beetle continues to infest large areas of the Wyoming side of the Black Hills. Crook and Weston Counties contained infestations with over 15,000 trees killed in this area. Populations in this area increased from 2001 to 2002 with pockets of 20-50 dead ponderosa pines common in northeastern Wyoming.

South Dakota
Mountain pine beetle has caused intense and extensive ponderosa pine mortality throughout the Black Hills of South Dakota over the last 3 years. Aerial surveys detected a large and expanding mountain pine beetle infestation in the Beaver Park area of the northern Black Hills. Ground surveys found an lverall average of 37 trees per acre killed since 2000, about half being currently infested. The area south of Deerfield Lake also has a large and expanding mountain pine beetle infestation. Since 2000, an average of 24 trees per acre have been killed there, with over 60^ currently infested. Continued evaluation of these outbreaks areas indicates that beetle populations are still increasing and will cause dramatic levels of future tree mortality.

As more and more available host trees are killed in the outbreak areas, the large beetle populations expand to surrounding forest sites. The majority of the infestations are located on National Forest lands, although more private and state lands are now becoming infested. In 2002, mountain pine beetle affected approximately 15,000 acres of private forestland in addition to lands within the Black Hills National Forest. Private lands adjacent to the National Forest are beginning to suffer considerable mortality and forest landowners are thinning. Anitation, salvage, and thinning activities are ongoing on private and public lands, including suppression in areas along the private/public land interface. These practices are intended to mitigate beetle impacts and also reduce the fire hazard and negative impacts on water quality.

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

Colorado
Weather conditions in 2002 throughout Colorado were highly conducive to increases in spruce beetle. Mild winters and warm dry summers have created a situation that has allowed these populations to significantly increase. Spruce beetle activity in Conejos County, CO increased dramatically in the Grouse Creek area. A later than usual flight period, resulted in close to a thousand standing spruce being infested. This area was due to be salvaged logged this summer and this additional mortality was designated for removal.

A similar situation occurred on the Twister sale site near Creede, CO. This location was salvaged logged in 2000 -2001 and it was hoped that the great majority of spruce beetles were removed. However, field surveys conducted in the summer of 2002 found close to 1,000 newly infested trees. This additional mortality has been marked and offered for salvage sale in the season of 2003.

Spruce beetle surveys were conducted for the past several years on the Grand Mesa National Forest. In 2001, there was a great deal of concern over increasing populations of the beetle attacking standing, green spruce. Salvage logging operations have been conducted to remove these infested trees and a significant amount of blowdown has significantly reduced the number of infested standing trees. Although long-term trends in spruce beetle populations are largely driven by climatic conditions, it is hoped that continued salvage will reduce the potential for a large-scale outbreak.

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.

Nearby in the Flat Tops of Rio Blanco, Garfield, and Moffat counties, CO, numbers of spruce beetle-killed trees are increasing. Spruce beetle caused mortality from aerial survey estimates about 3,500 spruce trees destroyed.

Aerial surveys also detected dying spruce in the Eagle's Nest Wilderness Area, on the Uncompahgre Plateau, and in the southern San Juan Mountains.

Preventive spraying may be necessary to protect live, high-value trees on private and public lands in the near future in areas with active spruce beetle populations.

Wyoming

Spruce beetle attacked hundreds of thousands of Engelmann spruce in Wyoming in 2002. In the Bighorn Mountains of north-central Wyoming, the Shell Reservoir and Ten Sleep Canyon areas are experiencing epidemic levels of spruce beetle. Following small blowdown events in 1997-1999 in south-central Wyoming, spruce beetle populations are increasing in the Sierra Madre and Snowy Mountain Ranges of the Medicine Bow National Forest. Several large spruce beetle infestations were detected along stream bottoms in the Sierra Madre mountain range.

Large pockets of spruce tree mortality caused by this beetle were observed in Yellowstone National Park east of Yellowstone Lake and in the Teton and Absaroka Mountain Wilderness Areas in western Wyoming. These infestations started in the wilderness areas and National Park, and now have moved out to impact large areas of state, BLM and other National Forest lands. Spruce beetle populations also increased in the Wind River Range, partly in conjunction with fires that occurred in the area over the past few years.

***Ips* -** Problems with 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

The amount of tree mortality due to *Ips* continues to skyrocket, in combination with dwarf mistletoe infection and drought. It is very difficult to distinguish faders resulting from the impact of various *Dendroctonus* bark beetles. In particular, this increased *Ips* – dwarf mistletoe – drought mortality greatly complicates aerial surveys. Such "complex-caused" mortality is particularly evident in southern and southwestern Colorado.

Major piñon mortality is occurring in the southwest corner of the state around Mancos in Montezuma County. Usually the primary organism in these trees is piñon Ips (*Ips confusus*). In some trees, signs of blackstain root disease are found, but this situation appears to be mostly due to drought and *Ips*. piñon mortality in the southwestern part of the state now extends from Pagosa Springs west to the Four Corners area and north to Norwood. Surveys indicate that close to a million trees and roughly 50% of the piñon forests are dead. No doubt much of the green material is also infested and not yet discolored. Other major areas of piñon *Ips* mortality occur in the southern Front Range and extending from Pueblo south to

Trinidad. "Interior" hotspots of piñon *Ips* mortality continue in the San Luis Valley near Crestone, and on the east flanks of the Uncompahgre Plateau south of Montrose. Current mortality totals at least 5000 trees.

The 2002 fire situation greatly increased public willingness and demand for mitigation work and we are seeing *Ips* responding to the great amounts of greenwood cutting at these sites. Greater than normal incidence of *Ips* beetles in lodgepole has been reported from a number of locations near Fraser, Monarch Pass, and Boulder County.

Ips hunteri attacks on urban Colorado blue spruce increased in 2002 in the Greeley, Denver, and Colorado Springs areas. About 40 large Colorado blue spruce were removed because of *I. hunteri* in Fort Collins. A total of 295 trees have been infested in the City of Denver, with neighboring suburbs such as Wheat Ridge and Aurora reporting similar, serious losses. Colorado Springs and Greeley have also lost over a hundred large spruce trees to this beetle. If the drought continues, this *Ips* problem could become a major epidemic because spruce is one of the first species affected by water shortages.

South Dakota

The pine engraver, *Ips pini*, is another bark beetle causing significant amounts of ponderosa pine mortality in the Black Hills. Pine engraver populations built up in storm and fire damaged areas and then increased exponentially around the Black Hills for the last 3 years, no doubt aided by drought conditions.

Many of the areas getting hit hardest by *Ips* in the Black Hills are in the wildland-urban interface. In 2002, the pine engraver affected approximately 25,000 acres of private and urban forest lands. The population has been increasing in recent years due to the increase in suitable host material, trees that have been injured or killed by fire and severe snow and hail storms.

The recent, unprecedented levels of *Ips* activity is a consequence of wildfires and weather events, such as hail and snow-breakage. *Ips* beetles breed in this weakened and damaged tree material. With a nearly unlimited supply of food, the *Ips* beetle populations increased significantly. Now that this food supply is becoming less suitable, *Ips* have exited it and are killing standing trees.

Nebraska

Ips populations moved into jack pine stands that had been defoliated by jack pine budworm on the Halsey unit of the Nebraska National Forest. In severely defoliated areas, up to 25% of the trees had *Ips* attacks. In the Pine Ridge area, there was light and scattered mortality caused by *Ips*. If drought conditions continue, *Ips* populations will likely increase.

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 activity was low along the Front Range of Colorado and in the areas of the previous outbreaks associated with the 1996 Buffalo Creek wildfire and the 1993-1995 Douglas-fir tussock moth defoliation. Forest Health workers anticipate increases of Douglas-fir beetle activity in 2003 in many areas of the Arapaho-Roosevelt, Pike-San Isabel, San Juan, and White River National Forests from the 2002 wildfires that burned in Douglas-fir forest type.

Wyoming

Douglas-fir beetle is causing extensive damage in Wyoming forests. Douglas-fir beetle infestations frequently result from disturbance events that create large volumes of weakened Douglas-fir trees near 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. Subsequent generations of the beetles moved from these injured trees to undamaged trees in nearby forest stands. In 2002, beetle activity from this ongoing epidemic was focused in the North Fork of the Shoshone River drainage west of ody, resulting in at least 80,000 newly faded trees.

Significant Douglas-fir mortality is occurring throughout river corridors in western Wyoming. There was an increase in Douglas-fir beetle activity during 2002 with over 11,000 trees killed along the Snake River and Greys River on the Bridger-Teton National Forest. Significant mortality is also occurring throughout the North and South Forks of the Shoshone River. Impacts are being felt as trees die in campgrounds and around summer cabins and resorts and these scenic corridors are impacted. There is also a growing concern over fire hazard with the accumulation of dead trees in these areas. Douglas-fir beetle is also on the increase on the southern end of the Shoshone National Forest near Dubois. In all of these areas, the beetle populations are expected to rise and cause even more mortality in the coming year. Suppression and control efforts to minimize impacts to these high value recreation areas are ongoing on both the Shoshone and Bridger-Teton National Forests. Significant success in protecting high-value areas has been achieved using the antiaggregant pheromone MCH on the Shoshone National Forest.

The west and east fronts of the Bighorn Mountains are experiencing outbreaks of Douglas-fir beetle. On the west side populations have significantly increased in both Shell and Tensleep Canyons. Addictional beetle-caused tree mortality is expected in these areas in 2003.

Most Damaging Diseases

Dwarf mistletoes, *Arceuthobium* spp., occur in Colorado and Wyoming on logepole pine, ponderosa pine, limber and whitebark pines, piñon pine and Douglas-fir.

With recent mild winter conditions and a periods of drought, these parasitic plants are contributing to mortality in many areas of the Rocky Mountain Region. Colorado areas of the 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 all have high incidences of this disease. Dwarf mistletoe is also a continuing problem in the Black Forest northeast of Colorado Springs in ponderosa pine.

Lodgepole pine dwarf mistletoe *(A. americanum)* infests about 50% of lodgepole pine stands in CO and WY. In Wyoming, this mistletoe is common in the Green Mountain area in Fremont County where 5,000 acres (state, federal, and private properties) are adversely affected. This parasite is widespread and a concern throughout the Bighorn, Medicine Bow, and Shoshone National Forests.

Ponderosa pine dwarf mistletoe *(A. vaginatum subsp. cryptopodum)* is widespread throughout the host type only in Colorado. Dwarf mistletoe infests approximately 20 percent of the ponderosa pine stands in Colorado's Front Range. Infested ponderosa pines are 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 Colorado, Nebraska, South Dakota, and Wyoming.

Armillaria root disease, the most common root disease in the Region, was evident in the mixed conifer and spruce-fir cover types. This root disease was among the key cause of subalpine fir decline, which accounts for the most tree mortality in the spruce-fir cover type in the Rocky Mountain Region. Armillaria incidence in developed recreation sites in Colorado resulted in tree failures and numerous tree removal projects. An early-season wind event on the Grand Mesa blew down a large root disease center in a campground. The adjacent sites were closed because of the disease following a hazard tree inspection two years earlier. Although no acreage figures were available, Armillaria is building up in northeast Wyoming (Crook and Weston counties).

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, 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. The disease, and other damaging agents, causes decline to limber pine stands in South Dakota and northern Colorado (Figure 2).

White pine blister rust infection levels range from low to severe in whitebark and limber pine stands throughout Wyoming forests. 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 disease, 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, Pole, and Snowy Mountain Ranges in south central and southeastern Wyoming. Limber pine is a major tree species throughout this area, often growing on harsh sites where no other tree vegetation can grow. Extensive studies and monitoring are ongoing in all of these white pines sites to better understand this disease and its impact in Wyoming.

White pine blister rust occurs at low infection levels in limber pine stands of northern Colorado. Its intensity and spread on the limber pine is being closely monitored. Bristlecone pines, which are not yet infected, were also evaluated because this tree species can also be a host for this fungus. Efforts are underway to collect data on white pines in Colorado, on the distribution of *Ribes* plants, the alternate host for blister rust, and use this data to hazard-rate limber pine stands for this disease.

This 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.

Western gall rust, caused by the fungus *Peridermium harknessii.* This disease is widely distributed but not generally common or severe on lodgepole and ponderosa pines throughout the Rocky Mountain Region.

In the Black Hills of South Dakota and Wyoming, it 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.

Northwest of Saguache in Colorado, on the east side of the Divide, some lodgepole pine stands have been identified with extremely heavy infection. These are small units that had been 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.

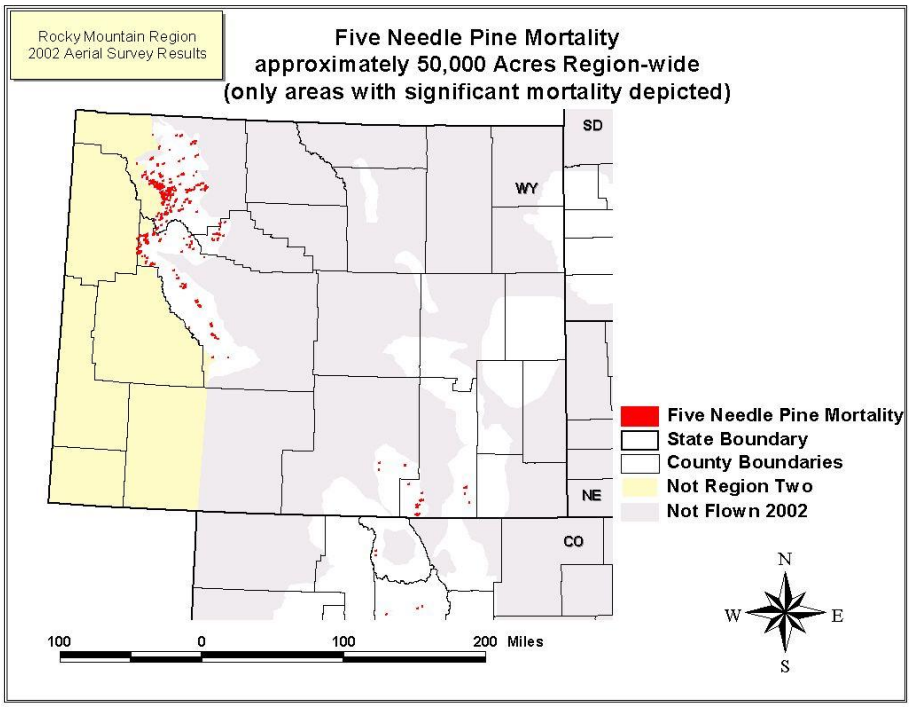


Figure 2. Map showing places of dead/dying 5-needle (white) pines. These trees are most likely suffering from attack by various combinations of mountain pine beetles, Ips beetles, white pine blister rust disease, or dwarf mistletoe disease.

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.

Most Damaging Abiotic Agents and Declines

Weather Damages:

Drought was a major damaging factor in 2002, continuing into 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.

Currently, Colorado reservoirs are filled to only 40% of normal levels. Plantings in urban area of Colorado blue spruce, lindens, and maples seemed to be very susceptible to drought. If needed, water conservation measures in 2003 may lead to additional urban tree problems. Forest health specialists

report seeing a “halo” effect caused by drought in aspen stands surrounded by meadows, where the trees on the edge of the aspen clone show the moisture stress first.

In South Dakota, approximately 200,000 acres of windbreak trees with spruce, cottonwood, green ash, and ponderosa pine were all affected by drought in 2002. While some of the western portions of the state began experiencing drought in 2001, this condition became almost statewide by 2002. In addition to agro-forestry plantings, urban forests were also impacted by the drought conditions. The increased environmental stress has resulted in an increase in successful colonization by borers. While some of the western portions of the state began showing signs drought stress in 2001, this condition became almost statewide by 2002. In addition to agro-forestry plantings, urban forests were also impacted by the drought conditions. The increased environmental stress has resulted in an increase in successful colonization by borers and bark beetles.

Frost damage during May and June in Colorado resulted in foliage loss for many deciduous and conifer trees. Aspen, fir and spruce throughout Colorado showed damaged buds or lack of foliation, Gambel oak in southern Colorado showed significant shoot dieback caused by freezing. The loss of new coniferous growth may setback defoliating insects dependant on new growth such as western spruce budworm.

Chemical Damages: Ice and dust-control materials utilizing magnesium chloride are being increasingly applied in the mountain road systems in Colorado, with corresponding increases in tree damage throughout the state. The Air Force Academy near Colorado Springs reports moving 150 trees damaged/killed by salts on their land. Serious problems reported from other areas include Aspen and the Black Forest.
On the west side of the Cottonwood Pass, for several miles along Gunnison County road 209, heavy mortality of lodgepole pine was observed in 2002, mostly on the downhill side of the road. MgCl2 has been used for dust abatement on this road for years, but only in small portions of the road. Beginning in 2000 or 2001 the entire road was treated. Treatment is once per year, soon after opening the road in the spring, and the roadbed is bladed before application to increase retention of the solution. The road is closed during winter. It appears undeniably that trees growing immediately near these roads (particularly the downhill side) are being adversely affected. Symptoms include foliage tip burn (that becomes accumulatively worse on older needles) and branch/top dieback. Both would appear to be consistent with toxic salt accumulations.
Herbicide damage to windbreaks and other tree plantings are a serious problem in Nebraska. Pesticide drift from crop weed control programs causes noticeable decline to agro-forestry tree plantings in parts of Kansas.

Animal Damage: Related to drought in the forests of Colorado, there has been a reduced amount of food present for wildlife. More animal damages to trees were observed, particularly porcupine feeding on ponderosa pine phloem in the Black Forest area. Fox squirrel damages to cottonwoods and other deciduous trees in the riparian forests and tree browsing by deer were more apparent. Black bears were reported in foothills residential backyards feeding on tree fruits and other non-traditional food sources in lieu of natural food shortages in the mountains. Excessive elk feeding on aspen bark was noted in Larimer County.

Subalpine fir decline:
Subalpine fir decline, caused by the western balsam bark beetle *Dryocoetes confuses,* and root rotting fungi such as *Armillaria ostoyae,* has been a serious forest health concern of forest managers working with subalpine fir sites in Wyoming and Colorado (Table 2, Fig. 3).

For over five 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. There is concern for the persistence of tree cover at harsh

sites due to this significant episode of fir mortality. Many stands of subalpine fir are declining on private and state properties in central Wyoming, particularly on Casper Mountain in Natrona County.

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 2002 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	14.5	Mesa	38.3
Eagle	37.6	Moffat	35.1
Garfield	108.1	Pitkin	22.6
Grand	33.5	Rio Blanco	170.1
Gunnison	45.8	Routt	224.0
Huerfano	17.6	San Miguel	14.2
Jackson	79.5	Summit	22.5
Wyoming Counties			
Albany	11.8	Fremont	44.1
Carbon	51.1	Park	16.6

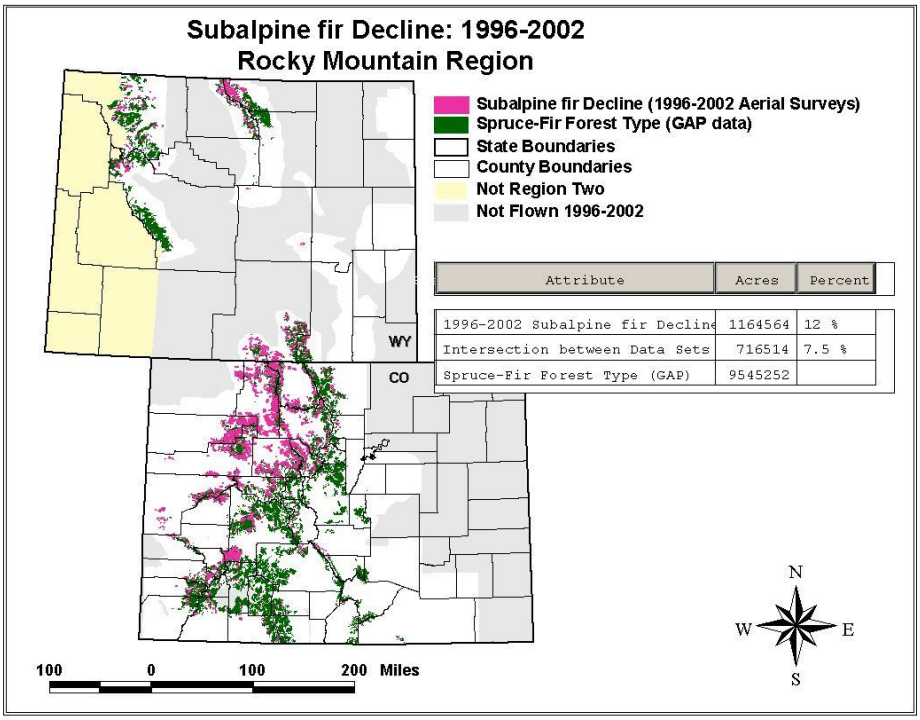


Figure 3 – Map depicting the distribution of subalpine fir mortality detected from aerial surveys 1996 through 2002 in R2. More than 10% of the spruce-subalpine fir forest type (over one million acres) in the Region are experiencing various levels of mortality.

Other Damaging Forest Insects and Diseases of Concern in CO, KS, NE, SD & WY	
Organism, Host, and Location	**Remarks**
Ash/lilac borer *Podosesia syringae* Green Ash **KS, NE, SD**	These phloem/wood-boring insects have caused loss of green ash in shelterbelts and other plantings on private lands in the Great Plains states. This is consistently a problem for young ash in urban and rural plantings throughout Nebraska.
Bagworm *Oiketicus* spp. *Thyridopteryx* spp. Eastern redcedar, Rocky mountain juniper **KS, NE**	Bagworm populations continued to be higher than normal in some areas in eastern Nebraska. Populations fluctuated around Kansas, but were heavy in north-central portions of the state.
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 200 acres of windbreak and urban plantings. The population is on the increase, most likely due to the extended drought that is reducing host vitality and defenses. The loss of cedars is a concern in windbreaks as there are only a few evergreens that tolerate the growing conditions in the northern Great Plains.
Elm leaf beetle *Xanthogaleruca luteola* American elm, Siberian elm **CO, KS, NE, SD**	Damage by this insect was moderate to locally severe in eastern CO.
European pine sawfly *Neodiprion sertifer* Scotch pine **KS, NE, SD**	Reports of damage were quite common from Christmas tree growers in eastern Nebraska and in north-central Kansas.
Fall webworm *Hyphantria cunea* Cottonwood, Walnut, Hickory, Mulberry **CO, KS, SD, WY**	This year saw moderate activity of this insect in Kansas.
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. Fortunately, almost all detection and delimitation traps were empty in 2002, despite a few catches in the region in 2000-2001. Four moths were caught in SD and one in Yellowstone National Park in 2002.
Jack pine budworm, *Choristoneura pinus* Jack pine **NE**	Populations of jack pine budworm have declined on the forest. Stands that were severely defoliated are now being attacked by Ips beetles.
Pine needle scale *Chionaspis pinifolia* Austrian pine, ponderosa pine, Scotch pine **KS**	Damage increased to an overall moderate level in Christmas tree plantations in Kansas.
Piñon Needle Scale *Matsucoccus acalyptus* piñon pine **CO**	Affecting piñons and causing problems in areas near Nathrop, Buena Vista, Aguilar, and Trinidad in 2002.

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.
Western Spruce Budworm *Choristoneura occidentalis* Douglas-fir, Engelmann spruce, Blue spruce, Subalpine fir, White Fir **CO, WY**	The southern portion of the Uncompahgre Plateau has seen significant levels of western spruce budworm defoliation in Engelmann spruce. In 2002 defoliation was light in the Wet and Sangre de Cristo Mountains. There was heavy defoliation in Larimer Countay near Cherokee Park. Acreages of Douglas-fir with light and moderate defoliation are increasing in the Front Range of El Paso and Douglas Counties.
Yellownecked caterpillar *Datana ministra* Oaks, Basswood, Elm, Fragrant sumac, Maple **KS, NE**	Populations were higher than normal and occasionally caused substantial defoliation in Nebraska
Ash yellows Caused by phytoplasmas Green ash, white ash **CO, KS, NE, SD, WY**	Large-diameter green ash in Grand Junction, the Denver area and other urban centers were declining in 2000. Biotic causes are difficult to assign to this, although the ash yellows phytoplasma could be involved.
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 2002, the disease appeared to be at moderate levels.
Cedar apple rust *Gymnosporangium juniperi-virginiana* Apple species (*Amelanchier* spp.), Eastern redcedar, Rocky Mtn. juniper, Utah juniper **CO, KS, NE, SD, WY**	A serious economic pest in some fruit orchards. Moderate to heavy infection reported this last year.
Cercospora blight of juniper *Cercospora sequoiae* Eastern redcedar, Rocky Mtn. juniper **KS, NE, SD**	A severe problem on Rocky Mtn. 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 NE.
Comandra blister rust *Cronartium comandrae* Lodgepole pine, Ponderosa pine **CO, SD, WY**	This disease continues as one of the most common and destructive diseases of hard pines in northern Colorado, western South Dakota and Wyoming, but is of concern in only a few areas.
Dothistroma needle blight *Dothistroma spp.* *Mycosphaerella pini* Austrian, ponderosa, limber pines **KS, NE, WY**	Damage was reported as light to heavy in the eastern half of Kansas and timely pesticide applications are needed to control the disease.

Dutch Elm Disease *Ophiostoma ulmi* **(Non-native)** American elm **CO, KS, NE, SD, WY**	Dutch elm disease occurs in low to moderate numbers in the Great Plains and continues to be a problem in riparian areas and cities throughout the state. Colorado Springs and the Air Force Academy reported and removed several elms during 2002. In 2002, Dutch elm disease increased in a number of South Dakota communities that still have significant elm populations. Losses in the last two years have been three to four times higher than that experienced in previous years, about a total of 100 acres of street and park trees across the state. Due to the inability of communities to conduct prompt removals of the infected trees there will be an increase in root-graft infections for 2003.
Needle casts *Lophodermella concolor* *L. montivaga* *L. cerina* *Rhabdocline pseudotsugae* *Davisomycella ponderosae* Lodgepole pine, ponderosa pine, Douglas-fir **CO, WY**	The epidemic of ponderosa pine needlecast has caused increasingly severe spring discoloration and defoliation on the San Juan National Forest for the past 3-4 years appears to be over. Little or no discoloration was observed in spring 2002. Analysis of weather records and literature suggests that in the early stages of the epidemic, up to and including 1999, the pathogen, *Davisomycella ponderosa*, heavily infected new foliage in association with weather conditions favorable for infection. Following infection, the disease is latent for one to several years. Subsequent dry, warm growing seasons probably permitted the pathogen to kill foliage earlier than it otherwise might have. The disease has left many trees in a weakened condition with a reduced complement of foliage. Mortality observed in 2002 may be due to a combination of the effects of drought and the needlecast. Western pine beetle has been detected in needle-cast affected areas.
Oak wilt *Ceratocystis fagacearum* Bur and red oaks **KS, NE**	Oak wilt continues to cause mortality in forests along the eastern edge of the Great Plains states. Only a few cases of oak wilt were reported in northeast Kansas. Damage occurred in oak stands in which woodlots and housing developments were established.
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 pines in south east Kansas. The incidence of pine wilt was high in 2002 in NE. Heavy mortality linked to nematode was found frequently throught southeastern Nebraska, mostly on Scotch Pine. The nematode has been extracted from ponderosa pines near Fort Meade,SD, but is most commonly found in windbreaks of Scotch pine and Austrian pine. In 2002 in South Dakota, 10 acres of trees in several windbreaks that died from the disease were identified. A survey of plantings to determine the extent of the disease in South Dakota is being completed.
Russian Olive canker *Phomopsis arnoldiae* *Tubercularia* spp*. Lasiodiplodia* spp*.* Russian olive **KS, NE, SD, WY**	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**	In 2002, in parts of South Dakota, there were trees on 400 acres of forestland, urban land and agroforestry land that had serious infections of diplodia blight. The disease is particularly common on Austrian pine, but there has been an increase in the incidence of the disease in the Black Hills due to spring hail storms. This disease continues to be a serious problem in pine windbreaks and landscape plantings in eastern Nebraska and throughout Kansas.

Hackberry Decline **SD**	Approximately 200 acres of hackberry in urban and agro-forestry plantings have been affected by hackberry decline in 2002. 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 as there are few substitutes for this tree species.
Piñon pine decline **CO**	Piñon pines in Colorado were greatly impacted by decline. Affected areas include native piñon stands and many areas of planted ornamentals. The Buena Vista area is well known for its "decline". Other areas of widespread mortality of this species include the southeastern plains east of Walsenburg (Piñon Canyon and Kim areas, in particular), the west side of the Sangre de Cristo Mountains near Crestone, Canon City area, south of Montrose, the Mesa Verde area, and areas northwest of Paradox. The widespread nature of piñon decline is likely related to the drought conditions of the West.

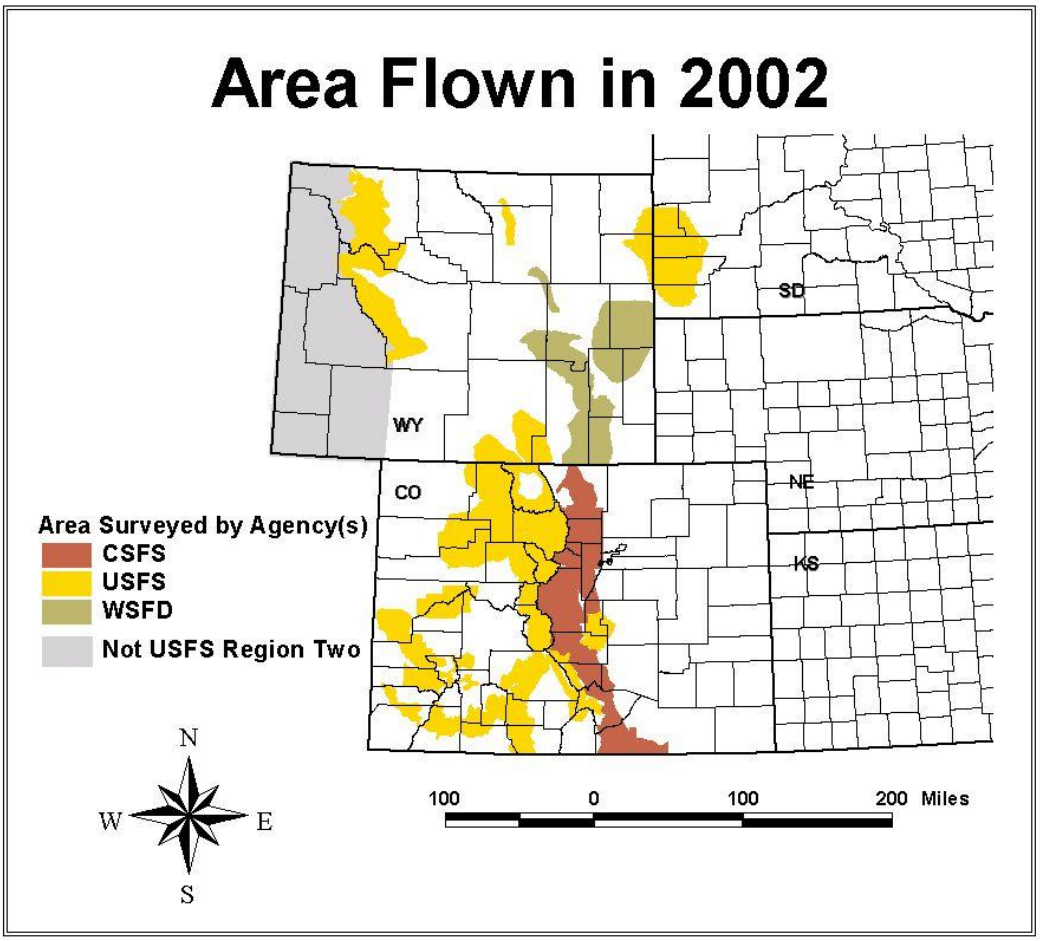
2002 Rocky Mountain Region Aerial Survey

General aerial detection surveys of damage and mortality in forest stands due to insects, diseases and other forest health stressors in the Rocky Mountain Region were flown between early July and into November of 2002 by Erik Johnson, Tim McConnell, Kelly Sullivan, Daniel Long, Carl Jorgensen (United States Department of Agriculture Forest Service), Les Koch (Wyoming State Forestry Division), Dave Leatherman (Colorado State Forest Service) and William Ciesla (Forest Health Management International). Approximately 18.2 million acres were surveyed within the Rocky Mountain Region in 2002 (Figure 4). Most of the areas known to have significant forest pest activity in 2002 were included in this survey.

Due to the nature of aerial surveys, the data and maps within this document will 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 a partial indicator of insect and disease activity, and should be validated on the ground for actual location and casual agent. 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 2002 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/2002/. Download the forest damage coverage (r202_dmg.e00) and the "flown/ not flown" coverage (r202_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 4. Rocky Mountain Region's 2002 aerial survey coverage by surveying agency.



Forest Health Management Special Regional Projects

Project Title: Test of carbaryl and permethrin as preventatives for mountain pine beetle in South Dakota and Colorado

Investigators: Kurt Allen, Tom Eager, Roy Mask, Joel McMillin , Dan Long

Cooperators: Blaine Cook and Phil Grumstrupp, Black Hills NF, Chris Fettig, Pat Shea, PSW (Retired), John Ball, SDSU, Pope and Talbot, Warne Chemical

Years: 2000-2001

Project Description: Field tests were undertaken to look at the effectiveness and longevity of carbaryl and permethrin as preventative sprays against the mountain pine beetle in South Dakota and Colorado. Trees were sprayed at labeled rates to runoff and then baited to assure beetle pressure. Preliminary data indicate that both chemicals provide protection for one year, and perhaps a second year with carbaryl.

Project Title: Development of a Monitoring and Management Tool for the Central Rocky Mountain Populations of Mountain Pine Beetle, *Dendroctonus ponderosae*

Investigators: Kurt Allen, Tom Eager

Cooperators: Steve Munson, R-4, Steve Seybold, University of Minnesota, Darrell Ross, Oregon State University

Years: 2001 - 2004

Project Description: Through laboratory and field studies we propose to substantially improve our ability to detect and manage populations of the mountain pine beetle in stands of ponderosa and lodgepole pine in the Rocky Mountains. Through an already established collaborative network at three locations with previously constructed rearing facilities (Ogden, UT; Gunnison CO; & Rapid City, SD), mountain pine beetles will be reared, population-specific blends of semiochemicals will be determined, and field responses will be assayed. Trap catch data will be matched with succeeding aerial mapping data to establish an early warning tool to forecast population trends in this region of the US. An improved mountain pine beetle attractant will also be used to bait trap trees for suppression treatments. Management guidelines utilizing the geographically specific monitoring and tree-baiting tool will be developed and published for widespread use by land managers throughout the central Rocky Mountain area.

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. We propose 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. 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. Plume attractiveness is augmented by placing female spruce beetles in the log. 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.

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: Western balsam bark beetle use of spruce-fir blowdown in Wyoming

Investigators: Kurt Allen, Joel McMillin , Dan Long

Cooperators: Chris Thomas, Bighorn NF, Jeff Hogenson, Shoshone NF, Jose Negron, RMRS

Years: 2001-2002

Project Description: Western balsam bark beetle (*Dryocoetes confusus* Swaine) attacks subalpine fir throughout western North America. Tree blowdown is known to trigger outbreaks of certain bark beetles but has not been examined for western balsam bark beetle. This is despite observational studies having found outbreaks of this beetle adjacent to areas of tree blowdown. Objectives of this 2001-2002 study were to determine if western balsam bark beetle successfully attacks and produces brood in downed fir and determine its life history in blowdown. Study sites were chosen in mixed conifer stands on the Bighorn and Shoshone National Forests in Wyoming. Several trees were felled on both forests in July 2001; ½ were baited with beetle pheromone *exo*-brevicomin. In September, trees were sampled for the number of brood by life stage at various locations on the tree bole. These methods were repeated in 2002 for the sample trees. Western balsam bark beetle attacked and brood had developed in the felled trees. The 2 most common life stages found in 2001 were larvae and eggs, in 2002 the most common life stages were larvae and new adults. Pheromones did not increase the number of brood in felled trees. More brood were found in the mid bole section of the tree than at DBH or in the crown. Based on the preliminary data, we conclude that western balsam bark beetle takes advantage of storm events that create downed host material. This suggests that prompt management of downed material is needed to reduce the likelihood of subsequent western balsam bark beetle outbreaks.

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: 2000-2002

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**.**

Project Summary: Multiple ½ acre transects were installed on five national forests across 4 states (Black Hills National Forest in South Dakota, Custer NF in Montana, Arapaho-Roosevelt NF in Colorado, Kaibab & Coconino NF's in Arizona). Approximately 1,500 ponderosa pine trees were assessed at each site for fire damage and insect presence across varying fire intensities. In addition to quantifying the amount of damage to the crown and bole of trees and insect presence, trees were categorized by diameter, height, dwarf mistletoe infection (Arizona only) and fire-intensity rating of aboveground soil. Approximately the same number of trees were assessed for status and insect presence in undamaged stands adjacent to the fire-impacted lands.

To determine the relationship between exterior fire damage and the damage to the cambium, 200+ additional trees per fires in Montana, South Dakota, and Arizona were assessed for scorch intensities and cambium health by removing 1-inch phloem plugs from the base of each tree on the four Cardinal directions. These same measurements were conducted in Colorado.

All burn plots were re-evaluated in 2002 to determine additional mortality and causes of mortality. The unburned plots were monitored for movement of insects from fire-injured trees to uninjured trees. A second set of plots was put in the Black Hills NF in an area that burned in 2001 (Rogers Shack). These plots will be monitored in the future along with the other plots.

Preliminary findings: 1) Insect activity was considerable at the Black Hills NF, South Dakota, and Kaibab & Coconino NF, Arizona, fire sites. Both primary (*Ips*, western pine beetle, turpentine beetle) and secondary (wood borers) insects were detected in fire-damaged trees, 2) Additional tree mortality caused by insects and delayed fire effects is being observed and quantified within the fire study areas. At the Arizona site, there was approximately 5% additional mortality between 2001 and 2002.

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: 2001-2004

Project Description: We are developing a hazard rating system to identify areas where limber pines and bristlecone pines are threatened by white pine blister rust in Colorado. 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 will 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, we will generate and evaluate hazard maps for the current outbreak area. We will identify additional areas within the central Rockies, which could be seriously impacted by WPBR; and we will assess the consequences of alternative vegetation management strategies on rust impact.

Project Title: Monitoring white pine blister rust disease 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: 2001-2004

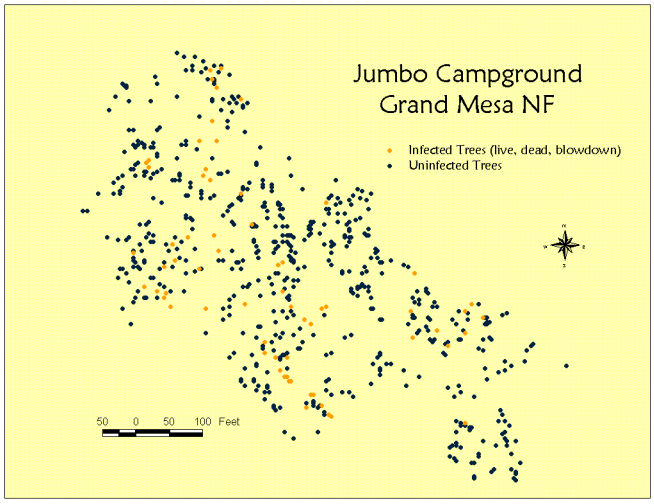
Project Description: This Forest Health Monitoring (FHM) project was conducted to evaluate several sites with declining white pine trees possibly due to white pine blister rust disease in the central Rocky Mountains. The project started by first analyzing FHM data and forest inventory records for locations 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 pines sites of Colorado, south-eastern Idaho, southern Wyoming, northern New Mexico, and eastern Utah. We have collected several databases on forest cover types and white pines in the central Rocky Mountain States. Our recent surveys will allow further description of white pine sites and the distribution and severities of white pine blister rust disease.

Project Title: Epidemiology of Armillaria Root Disease in Campgrounds

Investigators: Jim Worrall, Kelly Sullivan, Tom Harrington (Iowa State Univ.)

Years: 2000 - present

Project Description: The goal of this project is to better understand how Armillaria root disease spreads in campgrounds of the central Rocky Mountains. In 2000 we intensively surveyed three campgrounds for Armillaria. Infected trees and stumps were mapped, data on trees and symptoms were recorded, and samples were collected. From over 500 samples, 370 isolates were purified. A subset will be identified to species by restriction digests of amplified IGS sequences, and somatic incompatibility and DNA fingerprinting will determine clonal identity of isolates. Based on the pattern of genet structure and other information, managers will be informed of mode of spread, factors that may influence infection, and any modified management recommendations.



Results of sampling and mapping Armillaria in one of the campgrounds that were intensively surveyed. Of the live trees in the campground, 10% had advanced infection by the root disease.

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

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

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 "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 mistletoe, stem rust diseases, and subalpine fir decline. During 2002-2003, stem rust disease and 2001 root disease data were stored in the national FSVeg database. In 2003, we plan to re-measure the stem rust disease plots and the subalpine fir decline plots.

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, GMUG, 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: Aerial Detection and Survey training for Brazilian foresters

Investigators: Erik Johnson and William Ciesla

Cooperators: Jim Ellenwood, Erich Gomes Schaitza, Y. M. Malheiros de Olivera, M. A. Doetzer Rosot, and Joel Penteado

Years: 2001 - 2003

Project Description: Aerial Survey is being introduced to Brazil via a USDA Forest Service/EMBRAPA technical exchange program primarily for assessment of damage caused by European wood wasp, *Sirex noctilio*. Steps are being taken to introduce and implement aerial sketchmapping in Brazil that includes demonstration flights, a feasibility study, production of maps showing pine plantations based on classification and visual interpretation of Landsat 7 ETM data, observer training/ mentoring, and implementing operational flights.

Publications 2002

Allen, K.K. and Long, D.F. 2001. Evaluation of mountain pine beetle activitiy on the Black Hills National Forest. USDA For. Serv., Renewable Resources, RM Region. Bio. Eval. R2-02-02. 29p.

Allen, K.K. and Long, D.F. 2002. Evaluation of Douglas-fir beetle along the North Fork of the Shoshone River, Shoshone National Forest, Wyoming. USDA For. Serv., Renewable Resources, RM Region. Bio. Eval. R2-02-03. 8p.

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., Renewable Resources, RM Region. Bio. Eval. R2-03-03. 14p.

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., Renewable Resources, RM Region. Bio. Eval. R2-03-04. 14p.

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. 2002. USDA For. Serv., Renewable Resources, RM Region. Bio. Eval. R2-03-01. 34p.

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., Renewable Resources, RM Region. Bio. Eval. R2-03-05b. 29p.

Harris, J.L.; Mask, R.; and Witcosky, J. 2002. Forest insect and disease conditions in the Rocky Mountain Region, 2000-2001. USDA For. Serv., Renewable Resources, RM Region. Annual Cond. R2-02-10. 42p.

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., Renewable Resources, RM Region. Bio. Eval. R2-03-07. 13p.

Johnson, E. 2002. 2001 Aerial Detection Survey of the Rocky Mountain Region. USDA For. Serv., Renewable Resources, RM Region. Pest Det. R2-02-09. 20p.

Jorgensen, C.L. 2002. Biological Evaluation of the spruce beetle and mountain pine beetle for the Brush Creek-Hayden Ranger District, Medicine Bow-Routt National Forests 2000 and 2001. USDA For. Serv., Renewable Resources, RM Region. Bio. Eval. R2-02-07. 27p.

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., Renewable Resources, RM Region. Bio. Eval. R2-03-05a. 19 p.

McMillin, J.D.; Allen, K.K.; and Long, D.F. 2001. Evaluation of Western balsam bark beetle flight periodicity on the Bighorn National Forest, Wyoming. USDA For. Serv., Renewable Resources, RM Region. Bio. Eval. R2-02-01. 14p.

Schaupp, W.C. Jr.; Jorgensen, C.L.; Cadenhead, A.J. 2002. Bark beetle evaluation – 2000 and 2001, Hahns Peak/Bears Ears and Parks Ranger Districts, Medicine Bow – Routt National Forest, Colorado. USDA For. Serv., Renewable Resources, RM Region. Bio. Eval. R2-02-04. 49p.

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., Renewable Resources, RM Region. Bio. Eval. R2-03-02. 13p.

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

Worrall, J. and Sullivan, K. 2002. Discoloration of ponderosa pine on the San Juan National Forest, 1999-2001. USDA For. Serv., Renewable Resources, RM Region. Bio. Eval. R2-02-06. 20p.

Service Trip Reports

Gunnison Service Center

GSC-02-01 Spruce beetle monitoring, Twister Area, RGNF
GSC-02-02 Spruce beetle activity, Sawmill Mountain Area, WRNF
GSC-02-03 Bark beetle incidence, Conejos Peak RD, RGNF
GSC-02-04 Meadowlake CG, Rifle RD, WRNF
GSC-02-05 Piñon and ponderosa mortality on private lands, Norwood and Ridgeway, Co
GSC-02-06 Southern Ute Reservation site visits

Lakewood Service Center

LSC-02-01 Integrated pest management projects on the South Park Ranger District
LSC-02-02 Pest management concerns for campgrounds in the Hayman Fire Area
LSC-02-03 Service trip to the United States Air Force Academy
LSC-02-04 Spruce beetle outbreak in the Silver Lake Campground
LSC-03-01 Forest insect problems at the Monument Fire Center
LSC-03-02 White pine blister rust survey of Canyon Lakes Ranger District
LSC-03-03 Service trip of Dillon Reservoir Campgrounds and the Frisco Nordic Center Project Area
LSC-03-04 Spruce beetle management recommendation for Silver Lake Campground 2003
LSC-03-05 Decay of living conifers in spruce-fir forests of the Central Rocky Mountains
LSC-03-06 Insect and disease monitoring reports for the Medicine Bow and Routt National Forests

Rapid City Service Center

RCSC-02-01 FHM Aerial Survey (Black Hills NF, 2001)
RCSC-02-02 FHM Aerial Detection Survey (Bighorn NF, 2001)

RCSC-02-03	FHM Aerial Detection Survey (Shoshone NF, 2001)
RCSC-02-04	Flight periodicity of western balsam bark beetle in the Shoshone National Forest.
RCSC-02-05	Mountain pine beetle on the Bighorn National Forest
RCSC-02-06	Marking guidelines for tree removal in sales (Black Hills NF)
RCSC-02-07	Insect activity in the Battle Creek fire (Black Hills NF)
RCSC-03-01	Insect Conditions on the Wind River and Washakie Ranger Districts (Shoshone NF)
RCSC-03-02	Mountain Pine Beetle Conditions on the East Face of the Forest (Bighorn NF)
RCSC-03-03	Sick pines in the Nebraska National Forest, Bessey Ranger District
RCSC-03-04	FHM Aerial Survey (Black Hills NF, 2002)
RCSC-03-05	FHM Aerial Detection Survey, Exemption Area and Fort Meade (BLM, SD)