United States Department of Agriculture

Renewable Resources – Forest Health

Rocky Mountain Region (R2)

Forest Insect and Disease Conditions in the Rocky Mountain Region

2004

Potential causes of noted dieback and mortality of thinleaf alder in riparian areas are: Cytospora canker, a *Phytophthora* species, bark beetles/wood borers, or a phytoplasma.

FOREST INSECT AND DISEASE CONDITIONS IN THE ROCKY MOUNTAIN REGION

2004

R2-05-09

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

ACKNOWLEDGMENTS

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

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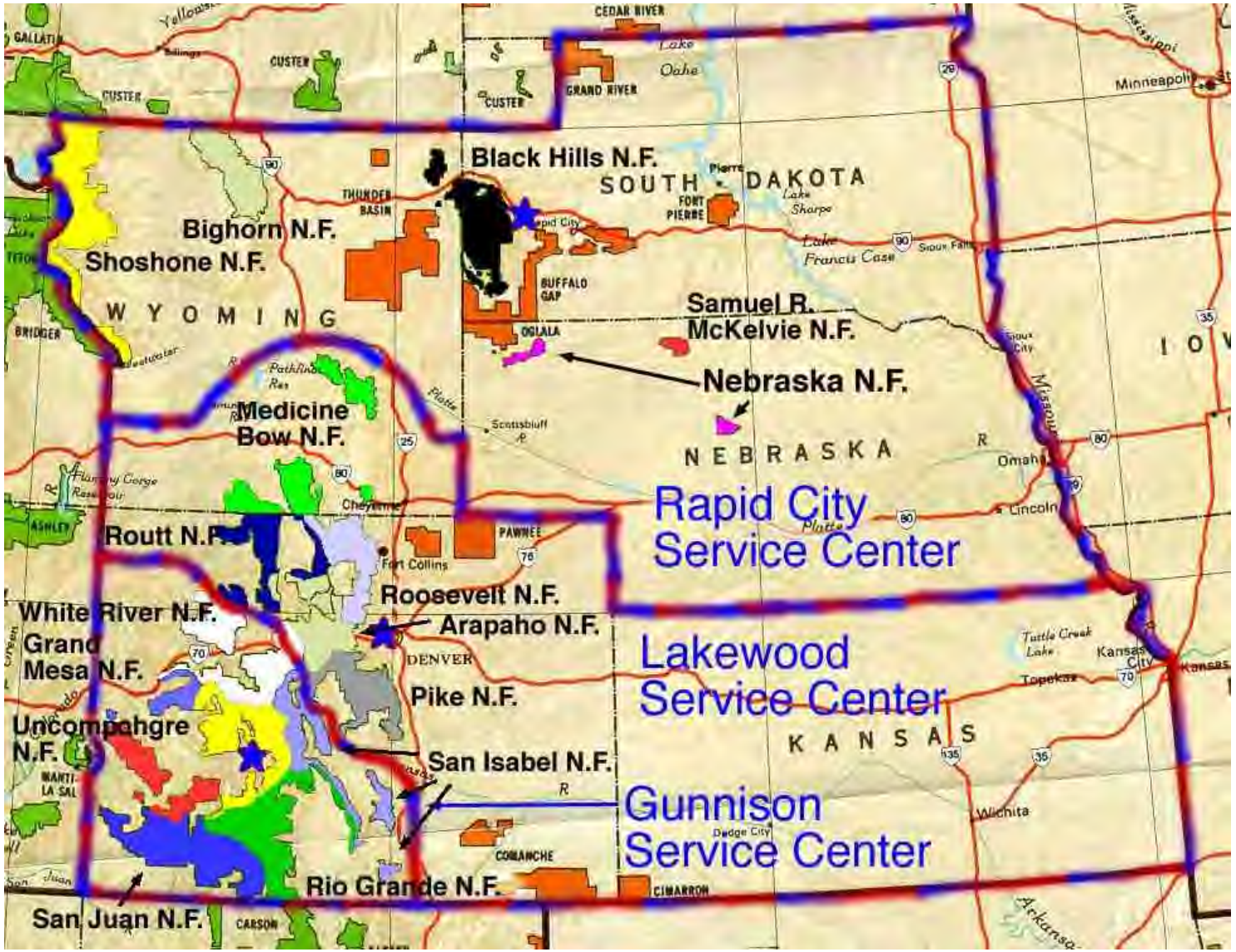
Forest Health Management (FHM) is responsible for the detection, evaluation, and suppression of insects and diseases on forested Federal lands. FHM also administers financial and technical assistance programs with the State Foresters of Colorado, Kansas, Nebraska, South Dakota, and Wyoming for insect and disease detection, evaluation, and suppression. In addition, the management of non-native forest insects/diseases and range pests are 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., Mail to: 216 N. Colorado Gunnison, CO 81230 Ph: 970/642-1199 Fax:970/642-1919	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 **Kerry Spetter** – Admin Support **Caley Gasch** – Biological Aide
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 S. Burns** – Plant Pathologist **Brian Howell** – Technician **Bernard Benton** - Computer Specialist **Meg Halford** – Student Technician **Sheryl Costello** – SCEP Entomologist
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 **Al Dymerski** – Aerial Survey Technician (started in 2005)
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 and other land management agencies.	**Frank Cross** – Group Leader **Jeri Lyn Harris -** Forest Health Monitoring Coordinator **Erik Johnson** – Aerial Survey Program Manager **Jennifer Ross** – GIS specialist **Vacant** – Aerial Survey Technician **Tom McClure** – Noxious weeds, Invasive species, Pesticide coordinator **Vacant –** Regional Entomologist

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



Status of Major Forest Damaging Agents in the Rocky Mountain Region during 2004

Most Damaging Insects

Continued high population levels of bark beetles are resulting in large-scale tree mortality among several pine species, Douglas-fir, true firs, and Engelmann spruce forests in the Rocky Mountain Region (Table1). Lodgepole, pinõn, ponderosa, and 5-needle pines are attacked and killed most often by mountain pine beetle and pine engraver beetles. Douglas-fir mortality resulted from Douglas-fir beetle, Douglas-fir engraver and pole beetles. Western balsam bark beetles and fir engraver beetles killed thousands of the region's subalpine and white firs. High-value recreation, wildlife, and timber resources are at risk to significant losses in all of these forest types.

Table 1. Overview of large bark beetle outbreaks in the Rocky Mountain Region as detected from 2004 surveys. These are estimates of the numbers of trees killed by beetles (x 1000) and the affected acres (x 1000). Some tree mortality is caused by multiple damaging agents (+).

Rocky Mountain Region Survey Totals		
Damaging Insects	**Number of Trees Killed (X 1000)**	**Number of Acres Affected (X 1000)**
Pine Engraver Beetles	4934	658
Mountain Pine Beetle	1565	549
Subalpine Fir Mortality (Western Balsam Bark Beetle +)	912	355
Douglas-fir & White Fir Engraver Beetles	498	101
Douglas-fir Beetle	204	355
Spruce Beetle	189	76
Numbers of Trees Killed and Acres Affected (X 1000)		**Counties with more than 10,000 Trees Killed by Beetles**
Colorado		
Pine Engraver Beetle	4,798/587	Archuleta, Huerfano, Summit
Mountain Pine Beetle	1,256/434	Chaffee, Grand, Gunnison, Jackson, Park, Routt, Saguache, Summit
Subalpine Fir Mortality (Western Balsam Bark Beetle +)	676/274	Gunnison, Larimer, Montrose, Ouray, Pitkin, Routt, San Miguel
Douglas-fir & White Fir Engraver Beetles	464/94	Archuleta, Custer, Fremont, Hinsdale, Huerfano, Mineral, Pueblo
Spruce Beetle	155/62	Hinsdale, Jackson, Mineral, Routt
Douglas-fir Beetle	62/41	Fremont, Saguache
Nebraska		
Pine Engraver Beetles	25/12	Thomas
South Dakota		
Mountain Pine Beetle	149/58	Custer, Lawrence, Meade, Pennington
Pine Engraver Beetles	72/45	Custer, Lawrence, Pennington, Shannon
Wyoming		
Subalpine Fir Mortality (Western Balsam Bark Beetle +)	235/81	Albany, Bighorn, Carbon, Fremont, Park, Sheridan
Mountain Pine Beetle	158/57	Albany, Carbon, Crook, Fremont, Lincoln, Park, Sheridan, Sublette
Spruce Beetle	142/70	Albany, Bighorn, Carbon, Park
Douglas-fir Beetle	34/14	Bighorn, Carbon, Fremont, Hot Springs, Park
5-Needle Pine Mortality (Mountain Pine Beetle, *Ips woodi,* White pine blister rust)	648/114	Albany, Bighorn, Fremont, Johnson, Hot Springs, Natrona, Park, Washakie

Pine engraver beetles, *Ips* spp.
Mortality to piñon, ponderosa, lodgepole, limber, and jack pines was caused by pine engraver beetles. Even Colorado blue spruce and Black Hills spruce experienced ips beetle attacks. The ips problem in each of these tree species will likely taper off when drought conditions subside.

Colorado
The extensive loss of piñon pines in the southern and western forests of Colorado continued in the state. Survey estimates from 2003 and 2004 indicate that over 6.3 million piñon pine trees have died on approximately 1.3 million acres in Colorado. The extra precipitation of 2004 greatly slowed the Ips beetle, *Ips confuses*, epidemic on the southern Front Range and extreme southwestern Colorado. In other piñon areas near Grand Junction and south of Montrose, the beetle populations were probably at their highest levels in 2004.

Ips beetles caused problems in recreation and urban settings in Colorado. *Ips pini* killed mature lodgepole pine trees in Forest Service campgrounds on the GMUG National Forest, Gunnison Ranger District. Ips-caused ponderosa pine mortality was noted in Chaffee, Conejos, Custer, Fremont, Gunnison, La Plata, Montrose, Saguache and San Miguel Counties of Colorado. Mortality of ornamental Colorado blue spruce along the Front Range of Colorado by *Ips hunteri* greatly declined in 2004 to only a few hundred trees killed. Nonetheless, this insect is still considered important due to the high value of spruce trees in urban settings.

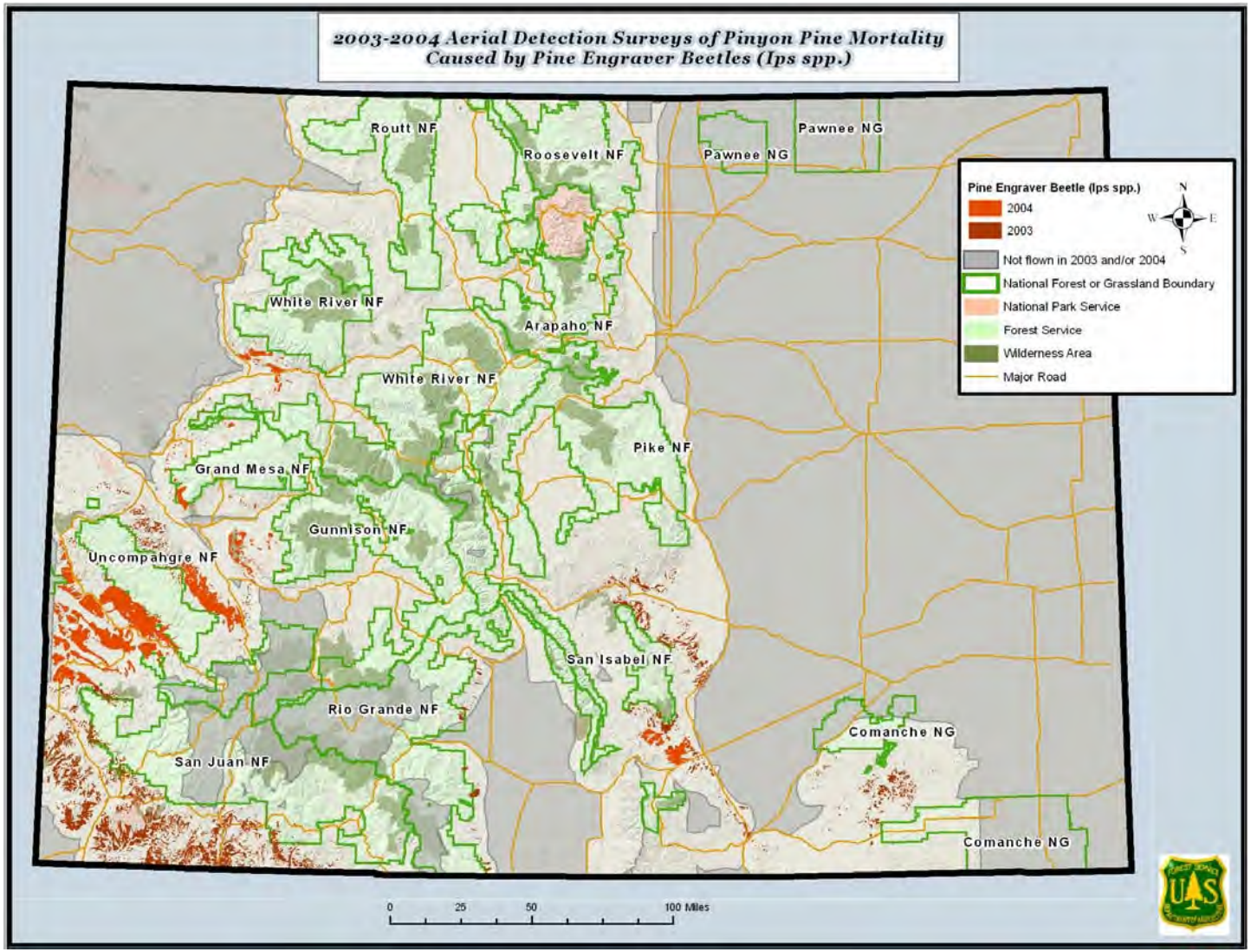
Nebraska
More than 19,000 pines were killed by ips beetles on the Nebraska National Forest, Bessey Ranger District. Tree mortality caused by these beetles affected over 10,000 acres in Thomas County.

South Dakota
Pine engraver beetle caused significant ponderosa pine mortality in the Black Hills in 2004. Ips beetle activity was concentrated in the southern Black Hills, in burned areas and around the perimeter of the forest. These recent, unprecedented levels of pine engraver beetles were a consequence of wildfires, mountain pine beetle and weather events, such as hail and snow-breakage that has resulted in a tremendous build up of dead, weakened and damaged trees. With a nearly unlimited supply of food, beetle populations increased significantly.

More activity by *Ips* spp. beetles occurred in white or Black Hills spruce, compared to activity in 2003. This, too, may be a drought-related response by opportunistic insects attacking drought-stressed trees. Tree top-kill and outright mortality were noted in several northern Black Hills locations.

Wyoming
Limber pines in the Pole Mountain Range, east of Laramie, Wyoming, were killed by *Ips woodi*. Limber pines in this area suffered from extended drought and infection with white pine blister rust disease, so they were very susceptible to ips beetle attacks.

Figure 2. Pine Engraver beetle outbreaks in Colorado during 2003 - 2004. This map shows large areas dead piñon pines killed by pine engraver beetles in southwest Colorado. Aerial Surveys were used to detect and estimate amounts of tree mortality in Colorado's forests.



Mountain pine beetle, *Dendroctonus ponderosae*

Numerous stands of lodgepole, ponderosa, limber, whitebark, and bristlecone pines in the region had outbreak and epidemic population levels of mountain pine beetle. These large beetle populations are able to respond rapidly to the large expanses of susceptible host trees.

Colorado

Mountain pine beetle activity increased in lodgepole and ponderosa pines throughout Colorado. It appears that recent warmer summers may be pushing up the reported elevation ranges for greater mortality.

High visibility lodgepole pine forests in Summit County and Grand County are experiencing expanding mountain pine beetle activity including the resort areas of Keystone and Winter Park. Lodgepole pine is also heavily attacked along the Blue River Drainage from Breckenridge north to Kremmling. The lower elevation lodgepole pine areas on the Routt National Forest, Yampa Ranger District, west of Gore Pass, also had significant expansion of mountain pine beetle activity. On the Colorado Front Range, there were notable mountain pine beetle infestations in ponderosa pine in the Poudre Canyon.

In the southern portion of the state there are two major outbreaks of mountain pine beetle that have been occurring for the past several years. In Chaffee County, mountain pine beetles have killed large numbers of ponderosa pine. This outbreak originated in the upper Arkansas River valley, but this activity has spread to the east, roughly following the course of the river, but also spreading to the Wet Mountains, the eastern slope of the Sangre de Cristo Mountains, and forested areas to the south of Cañon City. Large-scale stand treatments in association with fuels mitigation and restoration work have reduced the amount of MPB-related ponderosa pine mortality within the Westside Project area, Salida Ranger District (San Isabel NF, Chafee County).

Another major outbreak in Colorado lodgepole pine continued in the vicinity of Vail Valley along the Interstate 70 corridor. Here, mountain pine beetles have killed large numbers of lodgepole pine since 1997. Mortality was originally concentrated near the Vail Ski Area and adjacent wildland-urban interface areas, but this activity seems to be abating with stands that are less susceptible. Beetle 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 in the future. The Holy Cross Ranger District, White River National Forest, is finalizing NEPA work aimed at addressing mountain pine beetle and wildfire concerns in this area.

Mountain pine beetle activity in ponderosa pine increased at scattered locations on the southern Uncompahgre Plateau (Uncompahgre National Forest), on the Gunnison National Forest (near Sargents, CO) and across the lower elevations of the San Juan and Rio Grande National Forests. The Rio Grande National Forest had several projects aimed at reducing mountain pine beetle (and other bark beetle) impacts in ponderosa pine. These were coupled with fuels mitigation efforts in high value and wildland-urban interface settings. The San Juan NF is thinning and sanitizing ponderosa pine stands near the Chimney Rock Archeological site to address mountain pine beetle and wildfire concerns.

South Dakota

Mountain pine beetle caused extensive ponderosa pine mortality throughout the Black Hills during the past six years. Surveys detected large and expanding mountain pine beetle infestations in the Beaver Park and Deerfield areas in South Dakota. Pine mortality was widespread in the Northern Hills and Central Hills, and a number of areas with very large, concentrated beetle pockets had fused.

A multi-stand, landscape-level episode of mountain pine beetle-caused mortality is in progress and intensifying. Entire slopes appeared to be fading in unison, in some cases with just a few green survivors. Although these areas have the highest concentration of beetle-caused mortality, mountain pine beetle activity appeared to be elevated across most of the Black Hills.

Wyoming

Outbreak population levels of mountain pine beetle resulted in large-scale losses of pines near Cody, Sheridan, Lovell, Ten Sleep,

Sundance, Saratoga, and Laramie. In some areas, the beetle populations increased in Wyoming's 5-needle pines of whitebark and limber and then moved onto other pine host species of lodgepole and ponderosa.

Over 14,000 ponderosa, lodgepole, and limber pines were killed by mountain pine beetle in central Wyoming. The eastern edge of the southern Bighorn Mountains and along the Johnson County/Washakie County boundary had large areas of beetle-caused tree mortality in ponderosa pine.

Mountain pine beetle mortality in limber pine is prevalent in the southern Bighorn Mountains. Over 8,100 trees covering 1,000 acres were recorded killed. Large areas of activity were noted along the Mayoworth-Slip Road outside Mayoworth to the Hazelton Road. Other areas include the Ten Sleep Canyon, particularly the north fork of the Leigh Creek Vee.

Lodgepole pine mortality observed in the southern Bighorn Mountains was not near as numerous as limber and ponderosa pine mortality. There were a few isolated pockets of dead lodgepole pines south of Bald Hill and west of Hesse Mountain in Johnson County. Mortality in Washakie County was largely present south of Stovepipe Creek and along Childs Creek.

In the Bearlodge Mountains of Eastern Wyoming, heavy mountain pine beetle impact is seen despite a decrease in beetle activity here during in 2004.

The lower elevation lodgepole pine areas on the Medicine Bow National Forest saw significant expansion of mountain pine beetle activity in the Sierra Madre and Snowy Mountain Ranges

Subalpine fir Mortality

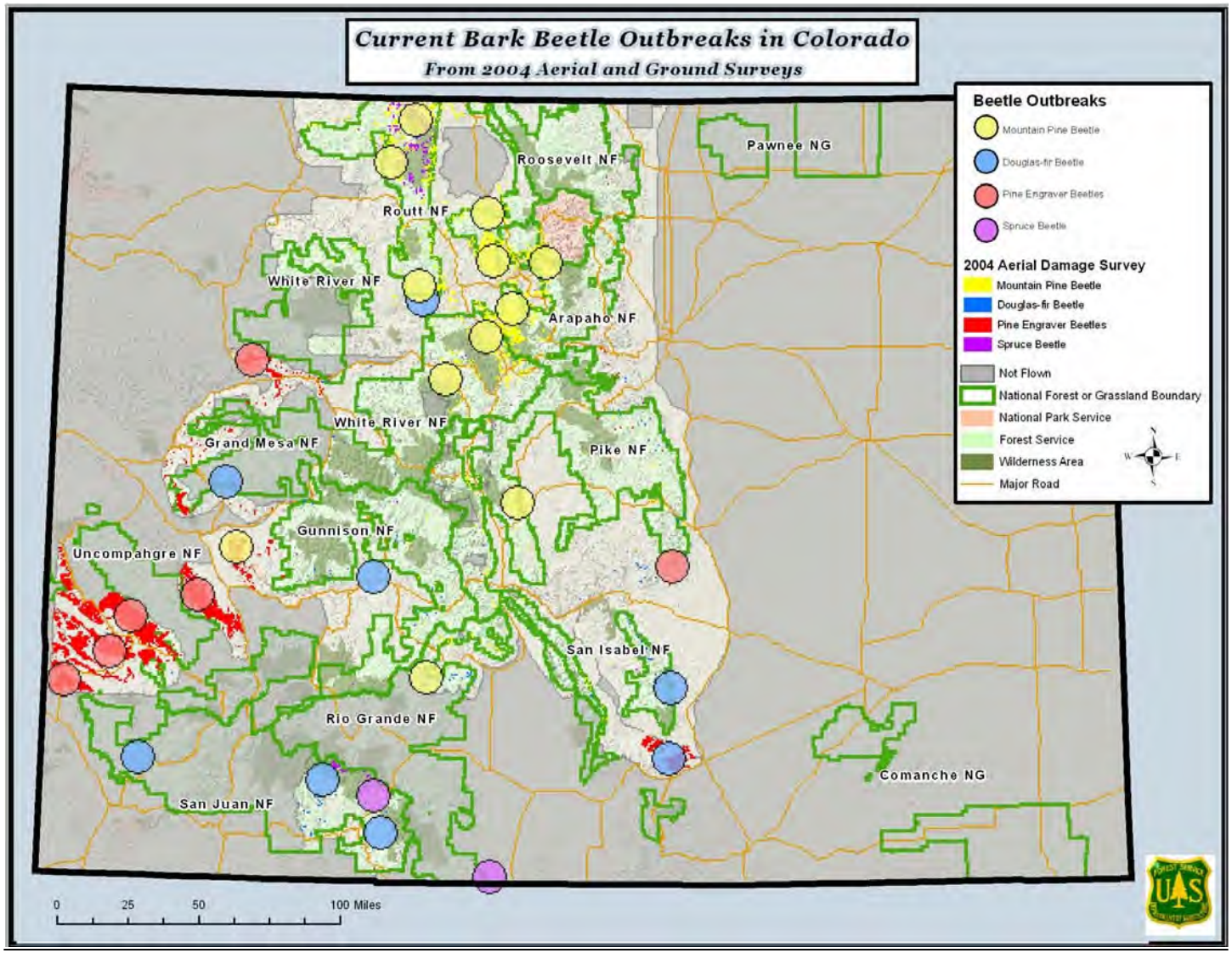
Subalpine fir trees killed by the western balsam bark beetle (*Dryocoetes confusus)* and root diseases continued to be a chronic forest health problem in the Rocky Mountain Region. Subalpine fir mortality was most often caused by the western balsam bark beetle and root rotting fungi such as *Armillaria ostoyae.* Wind-throw events in Colorado and Wyoming exacerbated these problems. In Colorado, the subalpine fir mortality occurred on 275,000 acres; in Wyoming, east of the Continental Divide, declining subalpine firs were found in 81,000 acres.

Douglas-fir & White Fir Engraver Beetles, *Scolytus* spp. *& S. ventralis*

In small diameter Douglas-firs, there were one or perhaps two species of *Scolytus* damaging the trees. These beetles function in Douglas-fir the way *Ips* does in pine and spruce. In conjunction with the Douglas-fir pole beetle, *Pseudohylesinus nebulosus*, these secondary bark beetles were responsible for the death of several thousands of small-diameter Douglas-firs throughout the host range during 2004. Douglas-fir pole beetle caused mortality of some of the largest diameter (up to 20 inches dbh) Douglas-fir trees in Mesa Verde National Park, an area that has been substantially impacted by wildfires since 1996. Douglas-fir pole beetle was found in common association with Douglas-fir beetle in the Gunnison Basin (Gunnison NF and BLM) and at various locations on the San Isabel NF south of Cañon City. The rains of 2004 should slow activity by these species in 2005, if there is adequate moisture in the Fall.

In true firs such as white fir in Colorado, *Scolytus ventralis* caused mortality in drainages through lower elevation forests between Denver and Colorado Springs and as far west as Cañon City. This beetle also killed white firs along the north slopes of the drainages of the Wet Mountains, the periphery of the San Luis Valley, north of Durango and in proximity to Pagosa Springs. Fir engraver populations increased significantly on the San Juan National Forest causing management concerns in numerous wildland-urban-interface settings.

Figure 3. Bark beetle outbreaks in Colorado during 2004. Large beetle outbreaks/epidemics killed millions of conifers throughout Colorado. Aerial Surveys detected these large areas of bark beetle caused tree mortality**.**



Douglas-fir beetle. *Dendroctonus pseudotsugae*
Douglas-fir beetle kills large diameter Douglas-firs in Colorado and Wyoming. Listed below were places with Douglas-fir beetle outbreaks/epidemics during 2004. Approximately 62,300 acres were detected in aerial surveys with tree mortality caused by Douglas-fir beetle in Colorado. In Wyoming, east of the continental divide, 70,000 acres indicated Douglas-fir beetle activity.

Colorado
Several thousand acres of Douglas-fir killed by Douglas-fir beetle were detected on private and federal lands in Douglas, Fremont, Grand, and Saguache Counties. Due to the dry conditions in Colorado, Douglas-fir beetles killed over 22,000 large trees with diameters greater than 16 inches. Other areas with increasing Douglas-fir beetle populations are in Chaffee, Custer, El Paso, Gunnison, Jefferson, Montezuma, Routt, and Teller Counties.

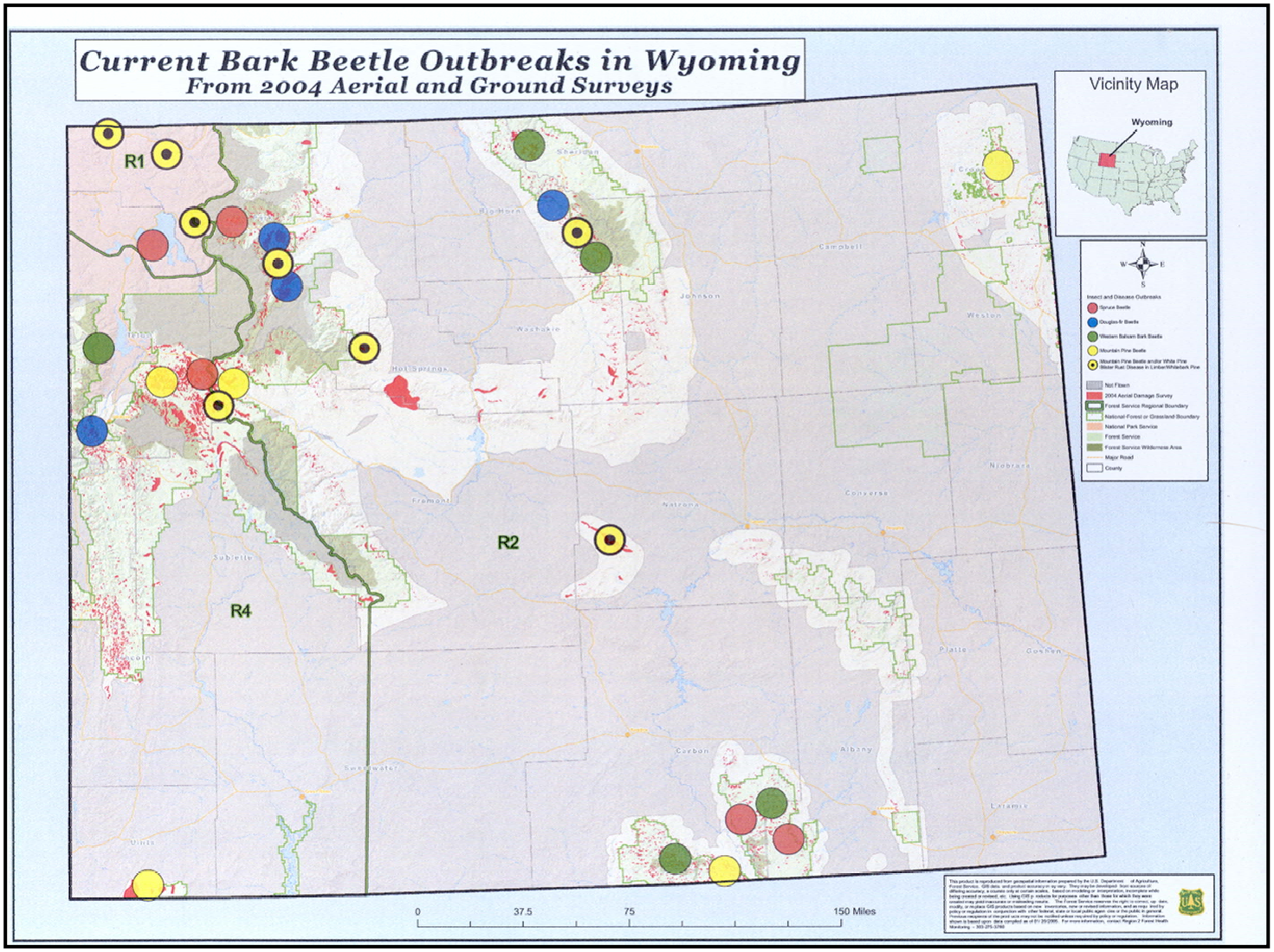
Douglas-fir beetle populations increased on the Pike-San Isabel, Grand Mesa-Uncompahgre-Gunnison, Rio Grande and San Juan National Forests as well as on surrounding lands. Some beetle activity was in direct association to prior prescribed burns and wildfires while other beetle activity had no association to fire/tree scorch. In several settings on the Rio Grande and San Juan National Forests, Douglas-fir beetle activity occurred in areas of chronic defoliation by way 170.

western spruce budworm. Throughout southern Colorado, Douglas-fir beetle activity was intermingled with that of the Douglas-fir pole beetle, *Pseudohylesinus nebulosus.*

Wyoming
Counties in Wyoming experiencing Douglas-fir beetle problems are Bighorns, Carbon, Hot Springs, Johnson, Park, and Washakie. On the western side of the Bighorn Mountains, beetle populations have increased in the Shell and Tensleep Canyon areas. Without some sort of management actions, such as sanitation and salvage harvesting, it is likely that up to 70% of the Douglas-fir trees in these canyons will be killed. (Douglas-fir beetle continued)

Douglas-fir beetle (DFB) mortality was widespread in the southern Bighorn Mountains. The North Fork of the Powder River, Horseshoe Canyon, and Packsaddle Canyon in Johnson County had a combined 446 Douglas-fir trees killed. Washakie County had over 13,300 dead Douglas-firs with large areas in Leigh Canyon, Old Maid Gulch, Stovepipe Creek, Onion Gulch, and Bear Gulch. The Kate's Basin fire in 2000 probably rendered many Douglas-firs in the Owl Creek Mountains susceptible to Douglas-fir beetle. Over 10,000 trees east of Blondy Pass in Hot Springs County were killed by Douglas-fir beetle. Many scattered small pockets of Douglas-fir beetle mortality ran along North Red Creek south of High

Figure 4. Bark beetle outbreaks in Wyoming during 2004. This map shows the large beetle outbreaks and epidemics occurring throughout Wyoming. Aerial Surveys were performed by Regions 1, 2, and 4 to detect beetle caused tree mortality in Wyoming's forests.



Spruce beetle, *Dendroctonus rufipennis*

Engelmann and blue spruce in Colorado and Wyoming forests were killed by spruce beetle. Listed below are current places with spruce beetle outbreaks/epidemics.

Colorado

Aerial survey estimates throughout Colorado for spruce tree mortality caused by spruce beetle were 155,500 trees killed on 63,000 acres. Spruce beetle was more prevalent in Colorado and still at epidemic levels in the Routt County blowdown area and adjacent Jackson County. In this 1997 big, blowdown areas on the Routt National Forest, spruce beetles were infesting a few thousand standing trees. Various species of *Ips* in spruce and other secondary bark beetles of spruce were also common.

In southern Colorado, the majority of spruce beetle activity occurred in scattered pockets of less than 100 acres, but many of these sites contained large numbers of mature spruce killed by spruce beetle. In terms of the scattered activity, there were about 30 known spruce beetle sites on the White River, Grand Mesa, Gunnison, Uncompahgre, San Juan, and Rio Grande National Forests. Salvage and sanitation efforts are planned or are underway in several of these settings. The Forest Service and Telluride Ski Resort have been successful in minimizing spruce beetle impacts to the ski area (Uncompahgre National Forest) by using aggressive sanitation and a trap tree program. Areas of significant spruce beetle expansion in 2004 include Baylor Park, White River National Forest, County Line, Rio Grande National Forest and both the Rio Grande and San Juan NF sides of Wolf Creek Pass. Substantial spruce beetle activity was noted in several Colorado Wilderness Areas, including Eagle's Nest, La Garita, South San Juan, Uncompahgre and Weminuche.

Wyoming

Spruce beetle killed thousands of Engelmann spruce in Wyoming in 2004. Approximately, 34,000 trees were killed on 14,000 acres of forest lands near Cody, Dubois, the western Bighorn Mountains, Sierra Madre and Snowy Mountain Ranges. Spruce beetle populations are increasing rapidly in the Medicine Bow Mountains near Fox Park.

Spruce beetle was observed in the southern Bighorn Mountains or the Owl Creek Mountains. There were 1,200 trees killed over a 400 acre span east of Sheep Ridge in the Owl Creek Mountains. A small area of Engelmann spruce mortality was recorded west of Old Maid Gulch in the southern Bighorn Mountains.

Most Damaging Diseases and Abiotic Agents

The most damaging disease-causing and abiotic agents in the Rocky Mountain Region are dwarf mistletoe, root rotting fungi, white pine blister rust fungus, and drought. Except for the white pine blister rust fungus, all of these agents are native and naturally occur in the region's forests. These can become a management concern in areas managed for recreation and timber production.

Dwarf mistletoes, *Arceuthobium spp.*

These host-specific, parasitic plants grow on Douglas-fir, limber pine, lodgepole pine, piñon pine, and ponderosa pine in Colorado and Wyoming.

With recent drought conditions, dwarf mistletoes cause or contribute to tree mortality in many areas of Colorado and Wyoming. *Arceuthobium vaginatum subsp. cryptopodum* impacts ponderosa pine stands throughout the Colorado Front Range and in Boulder, Clear Creek, Gilpin, Douglas, Park and El Paso Counties. Infested ponderosa pines were more vulnerable to attack from tree-killing bark beetles.

Lodgepole pine dwarf mistletoe *(A. americanum)* infects more than 50% of lodgepole pine stands in Colorado and Wyoming. In some areas there is a danger that adequate consideration of dwarf mistletoe management is not done in our haste to meet fuel-reduction targets in lodgepole pine forests at the wildland-urban interface. Projects planned solely for fuel management can lead to further intensification and damage from dwarf mistletoe, potentially exacerbating fuel problems in the future.

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

Root Diseases, caused by *Armillaria* spp*., Heterobasidion annosum, Leptographium wageneri,* and *L.terebrantis*

Armillaria root disease is the most common root disease in the region and found primarily in the mixed conifer and spruce-fir forest types. *Armillaria ostoyae* was among the key causes of subalpine fir mortality. It is a major problem in vegetation management of developed recreation sites, and important in the disturbance regimes and management of spruce-fir forests. 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, Medicine Bow, and Shoshone 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.

Annosum 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. It has allowed many piñon trees to be more susceptible to Ips beetle attacks. A closely related root disease, caused by *L. terebrantis*, inhibits regeneration by killing young ponderosa and jack pines in Nebraska plantations. Older pines are also infected, but may not be killed by this fungus.

White pine blister rust, *Cronartium ribicola*

White pine blister rust is found on whitebark and limber pines throughout Wyoming, in limber pines and Rocky Mountain bristlecone pines of Colorado, and in limber pine of the Black Hills in South Dakota. Implications of this disease on the Region's 5-needle pines may be very significant both ecologically and culturally.

Nearly 100 survey and monitoring plots were established in the Sangre de Cristo and Wet Mountains of Colorado. Infection levels varied from no infections to moderately high infections, with up to 80 percent of the trees infected in some stands.

During aerial surveys, declining limber pine stands were observed with a combination of white pine blister rust and mountain pine beetle attack. Usually, limber pines with entire crowns of fading, red needles were caused by mountain pine beetle attacks; trees with flagged, dead branches and in the upper crown were caused by white pine blister rust. This situation spanned over 17,000 acres of central Wyoming. Other surveys in Northern Wyoming found another 28,000 acres with declining limber pine. White pine blister rust is causing significant ecological impacts on the Laramie and Pole Mountain Ranges in south-central and southeastern Wyoming.

Most Damaging Abiotic Agent - Drought

Most of the Rocky Mountain Region has been experiencing forest health problems relating to drought. Forest Health specialists observed the following of some of most affected areas in the region.

Colorado

Moisture conditions improved over much of the region but there are still several drought related tree damages in the state. Extensive Gambel oak dieback set up by recent drought conditions throughout southern Colorado continued in 2004 but did not expand greatly. Some conifer stands in the Colorado Rocky Mountains were exhibiting heavy cone crops due to the drought conditions. Narrowleaf cottonwoods around the margins of the San Luis Valley continue to dieback because of drought.

A result of this drought in Colorado has been a build-up of the Gambel Oak Flatheaded Borer (*Agrilus quercicola*). Along the southern Front Range, and to a lesser extent the Durango-Cortez area, this build-up of the flatheaded borer has led to attacks and losses of ornamental oaks and other white and red oak groups. Denver and Colorado Springs have been particularly hard hit with this problem. The current thinking is that this native borer problem in ornamentals, while serious, will be short-lived.

Native aspen stands throughout Colorado show impacts from drought as evidenced by myriad diseases and insects, including cankers (especially Cytospora canker), organisms that cause decay, wood borers and beetles in dead and declining trees. The appearance of three new minor hardwood bark beetles underlines the depth of the drought's reach in that it spared few trees from vulnerability. The sighting of these new beetles could also signal the northward shift of traditionally southern species as a result of climate change.

Nebraska

In Nebraska, drought conditions in 2004 improved in eastern Nebraska but remained severe in the central and western portions of the state. Decline symptoms such as reduced growth, less foliage, and poor color were seen in many tree species, but especially in Scotch and Austrian pines in windbreaks and other plantings.

South Dakota

Colorado spruce, cottonwood, green ash, and a number of other species were affected by drought in western South Dakota during 2004. While some of the western portions of the state began experiencing drought in 2001, this condition became statewide by 2003. The drought has ended in the eastern part of the state but much of the western half of the state is still experiencing a moisture deficit. 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)

Insects / Host Trees / States	Remarks
Banded Elm Bark Beetle *Scolytus schevyrewi* **(Non-native)** American, Rock, and Siberian Elms **CO, KS, NE, SD, WY**	Banded elm bark beetle was initially discovered in the region during 2003. Overall throughout the region, incidence of this beetle in 2004 seemed much reduced from 2003. However, in Newcastle, Wyoming, 334 Siberian elms were found to be infested with this beetle and were removed in spring 2004. A recent study was done to determine if banded elm bark beetles carried the fungal pathogen of Dutch elm disease. Beetles emerging from bolts of American elm infected with Dutch elm disease were determined to carry the fungal pathogen at rates of 4-96% of emerging beetles.
Douglas-fir Pole Beetle *Pseudohylesinus nebulosus* Douglas-fir **CO**	Again in 2004, this beetle caused significant mortality to large Douglas-fir trees, especially in Mesa Verde National Park. This beetle has also been detected at high levels in the Wet Mountains, north of Durango, and in the Southern San Juan Mountains.Undoubtedly, drought conditions allowed this beetle to take advantage of large numbers of susceptible hosts. As the common name indicates, this insect most frequently attacks smaller diameter Douglas-fir, but trees in excess of 12 inches diameter were killed throughout southern Colorado. Across southern Colorado, Douglas-fir pole beetle activity was intermingled with that of the Douglas-fir beetle, *Dendroctonus pseudotsugae.*
Douglas-fir Tussock Moth, *Orgyia pseudotsugata* Douglas-fir **CO**	In Jefferson County an outbreak of Douglas-fir tussock moth occurred in Douglas-fir on private forested lands. This is the third outbreak of this insect in Douglas-fir. Historically, this insect has been more of a problem in ornamental Colorado blue spruces along the Front Range. The most notable outbreak of this insect in the general forest area along the Front Range occurred from 1993 – 1995. Unless prescribed burning or other forest management practices are implemented to reduce the expanse of Douglas-fir, we can expect to see more outbreaks of Douglas-fir tussock moth in Colorado's forests.
Flatheaded Wood Borer *Agrilus* spp*., Chrysobothris texanus* Grambel oak, English oak, Eastern redcedar **CO, KS**	Drought has led to attacks and losses of English oaks and other ornamental oaks by this wood borer in Colorado. Some mortality from this insect was associated with Cytospora canker on native and ornamental oaks in Front Range communities. A large number of eastern redcedars in western Kansas windbreaks were attacked by *Chrysobothris texanus*. Trees planted too close together, coupled with the drought conditions, made the cedars more susceptible to attack.

Gypsy Moth *Lymantria dispar* **(Non-native)** Several hardwood and conifer tree species **CO, KS, NE, SD, WY**	Thousands of traps were used for early gypsy moth detection throughout the region. Moths were found in Kansas and South Dakota during 2004. Kansas reported two moths trapped: one in a nursery in metropolitan Kansas City, and the other in a residential neighborhood in Topeka. Five gypsy moth adults were captured in five traps across South Dakota. Four of the adults were collected from traps in campgrounds and a single catch at a wholesale nursery.
Hardwood Bark Beetles *Pityophthorus juglandis, Typophloeus striatulus, Piyophthorus virilis* Several hardwood tree species **CO**	Three hardwood bark beetle species rarely seen or never recorded in Colorado were detected in 2004, probably due to both recent drought conditions and possible impacts from climate change. These species are: *P. juglandis*, a southwestern species found for the first time in Colorado in the Denver/Boulder area in ornamental black walnuts; *T. striatulus*, found in an alpine species of oak near Molas Divide; and *P. virilis*, found on sumac at the Garden of the Gods near Colorado Springs.
Lodgepole Pine Beetle *Dendroctonus murrayanae* Lodgepole pine **WY**	Lodgepole pine beetles were found infesting lodgepole pine in the Medicine Bow Mountains, near Fox Park, Wyoming.
Pine Needle Scales *Chionaspis pinifoliae* *Matsucoccus acalyptus* Scots pine, piñon pine **CO**	A serious, drought-enhanced infestation of *C. pinifoliae* on ornamental Scots pines was reported from Grand Junction. Chronic infestations of *M. acalyptus* continued among piñon pines along the southern Front Range of Colorado near Trinidad and the Upper Arkansas River Valley between Salida and Buena Vista (Chaffee County), and in the San Luis Valley (mostly Costilla County). This insect was also found on ornamental piñons around Grand Junction.
Pine Sawflies *Neodiprion fulviceps* Ponderosa pine **CO**	Much of the southern Black Forest area of the eastern plains northeast of Colorado Springs in Kiowa County experienced heavy defoliation of native ponderosa pine in 2004 by pine sawflies. Heaviest defoliation tended to be on open-grown trees or those around the edge of dense stands. An area of less than 100 acres was aerially sprayed by a private landowner in late July just as larval feeding was near complete. Mortality is not expected, as in past outbreaks in this area, and it will be monitored in summer 2005.
Pine Tip Moth *Rhyacionia* spp., *Dioryctria* spp. Austrian pine, Ponderosa pine and Scotch pine, Colorado blue spruce **KS, NE, SD**	Zimmerman pine moths continue to kill branches and entire trees in pine windbreaks, plantations, and landscape plantings in Kansas and Nebraska. In South Dakota, 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 spruces that have become infested with a *Dioryctria* spp.

Pine Tussock Moth *Dasychira grisefacta* Ponderosa pine **NE**	An area of a few hundred acres of ponderosa pine on private land near Kimball, Nebraska has been ongoing for two years now. Heavy defoliation of old needles occurred locally and control actions are contemplated by some landowners. A few small patches of mortality were observed. Bark beetle infestation of these trees was not observed, however woodborers were present to some extent. Monitoring is planned for spring/summer 2005.
Twig Beetles *Pityophthorus* spp. *Pityogenes* spp. Lodgepole pine, ponderosa pine, piñon pine **CO**	Not much is heard about "twig beetles" in ponderosa or lodgepole, although they are probably present in elevated numbers. Managers need to be aware of potential issues with bark beetles in defensible space and hazardous fuel reduction projects. Several places in Colorado were experiencing loss of "leave" trees due to these insects building up in slash piles. Numerous observations of these insects among piñon pine in southern Colorado. Heaviest infestations, noted in the Ignacio, CO area, caused tree mortality.
Western Pine Beetle *Dendroctonus brevicomis* Ponderosa Pine **CO**	This beetle has been killing 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 pine. Population levels of western pine beetle were higher in 2004 than they have been for at least 30 years.
Western Spruce Budworm *Choristoneura occidentalis* Douglas-fir, Engelmann spruce, Blue spruce, Subalpine fir, White Fir **CO, WY**	Aerial survey estimates of infested acres for 2004 were twenty thousand in Colorado and almost four thousand in Wyoming's Shoshone and Medicine Bow National Forests. The southern portion of Colorado's Uncompahgre Plateau had significant levels of western spruce budworm defoliation in Engelmann spruce and subalpine fir. Understory trees are being decimated due to several consecutive years of defoliation. Budworm activity was noted in other high elevation spruce-fir forests including developed recreation sites on the Rio Grande National Forest, below Wolf Creek Pass.
Western Tent Caterpillar *Malacosoma californicum* Aspen **CO**	Western Tent Caterpillar appears to be making a comeback in southern aspen stands. One outbreak near the Purgatory Ski Area, north of Durango, has enough egg masses to warrant monitoring in 2005. Outbreaks of significance were also noted among large aspen clones on the Dolores Ranger District, San Juan National Forest.
Zimmerman pine moths *Dioryctria* spp. Austrian pine, Ponderosa pine, Blue spruce **KS, NE, SD**	Zimmerman pine moths continue to kill branches and entire trees in pine windbreaks, plantations, and landscape plantings in Kansas and Nebraska. In South Dakota, 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 Nebraska showing almost 100% of the trees infested. In addition there have been a number of blue spruces that have become infested with a *Dioryctria* insect.

Diseases, Pathogens, Other Agents / Host Trees / States	Remarks
Comandra Blister Rust *Cronartium comandrae* Lodgepole pine, Ponderosa pine **CO, SD, WY**	Most heavily infected areas were Wind River Ranger District of the Shoshone NF, and Laramie Ranger District of the Medicine Bow NF in Wyoming. The disease is present in northern Colorado and western South Dakota, but causes no significant damage.
Cytospora Canker *Cytospora spp.* Alder, Aspen, English Oak **CO, WY**	This damaging canker disease is found throughout the region. It caused significant branch dieback in oaks in south Denver. Observers have increasingly noted scattered dieback and mortality of thinleaf alder (*Alnus incana* ssp. *tenuifolia*) in Colorado in recent years. Cytospora canker is associated with most dieback. *Valsa melanodiscus*/*Cytospora umbrina* has been most commonly found as the pathogen. A 2004 survey of alder in northern New Mexico, Colorado and southern Wyoming were studied in an Evaluation Monitoring Project.
Dutch Elm Disease *Ophiostoma ulmi* **(Non-native)** American elm **CO, KS, NE, SD, WY**	In 2004, the incidence of Dutch elm disease has dramatically increased in communities that still have American elms as a dominant street tree. The losses in 2004 were approximately four times the losses many communities experienced in 2003. Communities are having difficulties removing the high number of infested trees in a timely manner and this is probably, in part, responsible for the continuing increase in tree losses.
Pine Wilt and Pinewood Nematode *Bursaphelenchus xylophilus* Scotch, Austrian, and white pines **NE, SD**	Severe mortality linked to this nematode was found frequently throughout southeastern Nebraska, mostly affecting Scotch pine. Scotch and Austrian pines in the southern part of South Dakota showed symptoms of needle browning with the tree dying within the same growing season. These symptoms were associated with pine wilt and sampling indicated that these trees were supporting populations of the pinewood nematode. The number of trees found infected with this disease has increased dramatically during the past four years, perhaps related to the continuing drought and mild winters.
Sphaeropsis Shoot Blight and Canker *Sphaeropsis sapinea (*syn. *Diplodia sapinea)* Ponderosa and Jack pines **NE, SD**	Hail impact and an associated foliar disease were noticeable on a localized area between Pringle and the western border of Wind Cave National Park along and south of Highway 385. The disease associated with hail impact is called Sphaeropsis shoot blight and canker, caused by the fungus *Sphaeropsis sapinea*. It is likely that more areas were impacted, but not so heavily as to be visible from the air. Hail impact and the associated shoot blight disease were noticeable in localized areas of south-western South Dakota and central Nebraska. Aerial surveyors detected aver 2500 acres affected by this fungus.

Western Gall Rust *Endocronartium harknessii* Lodgepole, Ponderosa Pines **CO, NE, SD, WY**	Widespread throughout the Rocky Mountain Region. It usually occurs at low to moderate intensities. Occasionally, the disease can severely infect trees planted "off-site" and not original to the area. 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.
Frost Damage (abiotic agent) Green Ash **SD**	A late April frost occurred throughout the northeastern part of South Dakota and resulted in widespread defoliation of ash trees. In many areas almost 100 percent of the ash trees were defoliated. The trees leafed out with a second flush by the end of May.

2004 Rocky Mountain Region Aerial Detection Surveys

Over 37 million acres were aerially surveyed within the Rocky Mountain Region during the 2004 field season. Throughout most forest types, the number of trees and acres impacted by forest pests, especially tree-killing bark beetles, continued to increase. This trend of increasing beetle-caused mortality has been evident since 1996 and has been further exacerbated by the recent drought. In addition to the regular "overview" survey, "special" surveys for oak wilt in eastern Nebraska, piñon mortality in western Colorado, and limber pine mortality in central Wyoming were completed.

Because aerial surveys are non-quantitative, the following only provides a rough estimate of trees-killed for agents detectable from the air. Many of the most destructive diseases are not represented because these agents are not detectable from aerial surveys.

Aerial overview detection survey goals are to detect and describe, not to quantify or exactly locate, forest insect and tree disease impacts. Sketch mappers "capture the essence" of what they are seeing onto maps, while traveling at about 100 miles per hour approximately 1,500 feet above the terrain looking across about 1.5 miles. By timing the survey to occur during the appropriate "biological window", the observers record recent activity and minimize remapping past impacts. For the Black Hills, aerial surveys are timed to see current "faders" or new mortality due to mountain pine beetle.

Most evident during the 2004 aerial survey was the dramatic increase in lodgepole pine mortality attributed to the mountain pine beetle. The number of these pines killed by mountain pine beetle doubled from over 600,000 trees in 2003 to 1.2 million trees in 2004. Much of this new mortality is occurring in Northern Colorado from the Vail Valley northward.

Numbers of Ponderosa pines affected by both mountain pine beetle and pine engraver declined from 650,000 trees killed in 2003 to 400,000 trees killed in 2004. This one-year drop in numbers may be due to different surveyors, as the general trend from 1996 to 2003 has been increasing.

HIGHLIGHTS – BLACK HILLS NATIONAL FOREST

Ponderosa pine mortality from bark beetle activity dominated the aerial survey observations for the Black Hills in 2004 (Table 2). A high level of mountain pine beetle impact was mapped. Pine engraver activity remained at an unprecedented high level, with about half of the mapped mortality within and adjacent to areas that burned from one to five years ago. Although pine-killing bark beetles accounted for all the attributed tree mortality, a large but not estimated amount of additional mortality is expected due to very recent fires.

Table 2. Summary of aerial overview detection survey across all land ownerships on the Black Hills of South Dakota and Wyoming from flights made July 26-29, 2004. Values are rounded to three significant figures; "n.e." = not estimated.

Attributed Causal Agent	Affected Acres	Killed Trees
Mountain pine beetle, *Dendroctonus ponderosae*	68,400	161,000
Pine engraver beetle, *Ips pini*	45,900	70,800
Ips spp. in white spruce	396	824
Recent fire	12,300	n.e.
Hail damage with Sphaeropsis blight (*Sphaeropsis sapinea*)	1,370	n.e.

In addition to the mortality attributed to mountain pine beetle, the 2004 aerial survey attributed a large number of dead ponderosa pine as killed by pine engraver beetles (*Ips* species; Table 1). This level of ips activity is a consequence of the immense number of pines weakened by wildfire and weather events such as drought, hail, and snow-breakage that have occurred over the past few years. While records from the past century do mention periods of elevated ips activity, the current situation is apparently an unprecedented high level. However, some of the mortality attributed to *Ips* species may have been caused in part or entirely by mountain pine beetle and vice versa.

In contrast to mountain pine beetle, ips activity was concentrated in the southern Hills, in and around burned areas, and around the perimeter of the Hills along the hogback. Areas in and around the Grizzly Gulch and Battle Creek wildfires are exhibiting significant levels of ips activity, although it is difficult to differentiate fire-caused mortality from beetle-caused mortality. Occasionally, mountain pine beetle populations already present in an area will breed within fire-injured trees. It is likely that pine mortality from these beetle species and other causes will continue in fire-affected areas for several years.

Pines killed by the pine engraver beetle, *Ips pini*, and the mountain pine beetle, *Dendroctonus ponderosae*, can be difficult or impossible to distinguish from the air. These two bark beetles species may also attack and kill the same tree. The spatial pattern and size of attacked trees offers clues to distinguish the two species' activity. A general tendency in sketch mapping this year was to attribute mortality to pine engraver on the edges of the Hills, especially in the south, and near recent fires. This is based both on prior field observations and knowledge of the biology of the two beetle species. Ground surveys provide a more accurate estimate of which beetle species is involved, although the recent predominance of mountain pine beetle is well established.

It appeared that more activity by *Ips* spp. in white (Black Hills) spruce, *Picea glauca*, is taking place, as compared with last year. This, too, may be a drought-related response by opportunistic insects attacking drought-stressed trees. Top-kill and mortality were both noted in several northern Hills locations.

OTHER HIGHLIGHTS

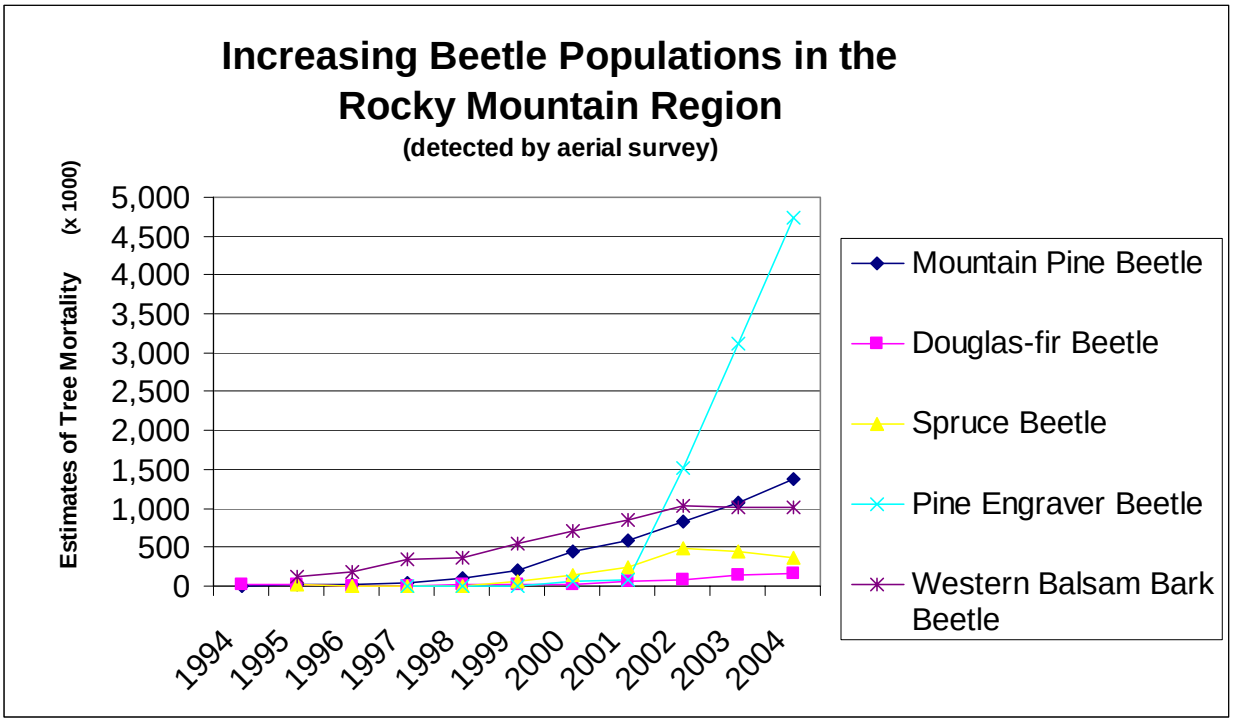
Limber and whitebark pine mortality due to mountain pine beetle, white pine blister rust, and dwarf mistletoes continues throughout most of Wyoming. Additionally, one new area of Douglas-fir tussock moth defoliation was detected in the foothills southwest of Denver, Colorado. Finally, massive piñon pine mortality attributed to the pine engraver continued throughout Southern Colorado and the Western Slope.

Spruce beetle activity was again present throughout Colorado's Park Range and Wyoming's Absaroka Mountains. New spruce beetle outbreaks were detected in the Eastern San Juan Mountains and Grand Mesa of Colorado, and in the Medicine Bow Mountains of Wyoming. Because of the difficulty in detecting this beetle's "signature", ground checking is necessary to refine aerial estimates and locations.

Numbers of Douglas-fir trees killed by the Douglas-fir beetle and white fir trees killed by fir engraver more than doubled from over 250,000 trees in 2003 to roughly 650,000 trees in 2004. Much of the mortality from these two agents is occurring concurrently in Southern Colorado. High levels of Douglas-fir mortality continues in Wyoming's Absaroka Mountains.

Ips woodi is becoming more abundant in drought-stressed limber pine. Many of these limber pines are infected with white pine blister rust on the Laramie Ranger District of the Medicine Bow National Forest. Lodgepole pine beetle, *Dendroctonus murrayanae* has been detected in lodgepole pines on the Laramie Ranger District of the Medicine Bow National Forest.

Figure 5. Running three-year averages of estimated beetle-caused tree mortality as detected from aerial survey from 1994 to 2004. Definite increases in various beetle populations around the region were observed. The amount and location of acres flown varies each year. In 2003 and 2004, special aerial detection surveys were conducted over 10 million acres of piñon in south-western Colorado to record the increased tree mortality caused by the high populations pine engraver beetles.



Aerial survey maps are available for many areas of the Rocky Mountain Region at
www.fs.fed.us/r2/resources/fhm/aerialsurvey/
The 2004 aerial survey data for the 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/2004/. 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). For additional information regarding the GIS data, please contact Erik Johnson ejohnson02@fs.fed.us 303-236-8001.

Table 3. Non-native, Invasive, Forest Pathogens and Insects in the Rocky Mountain Region

Pathogens		CO	KS	NE	SD	WY
Common Disease Name	**Scientific Name**					
Brown Spot	*Scirrhia acicola*		X			
Cercospora Blight	*Cercospora sequoia*		X	X		
Dutch Elm Disease	*Ophiostoma 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 of Insects	**Scientific Name**					
Bagworm	*Thyridoptereyx ephemeraeformis*		X	X		
Banded Elm Bark Beetle	*Scolytus schevyrewi*	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 these states, yet found infrequently during annual trapping and monitoring efforts				
Honeylocust Pod Gall Midge	*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	*Cryptorhynchus lapathi*	X			X	X
San Jose Scale	*Quadraspidiatus perniciousus*	X				
Smaller European Elm Bark Beetle	*Scolytus multistriatus*	X	X	X	X	X

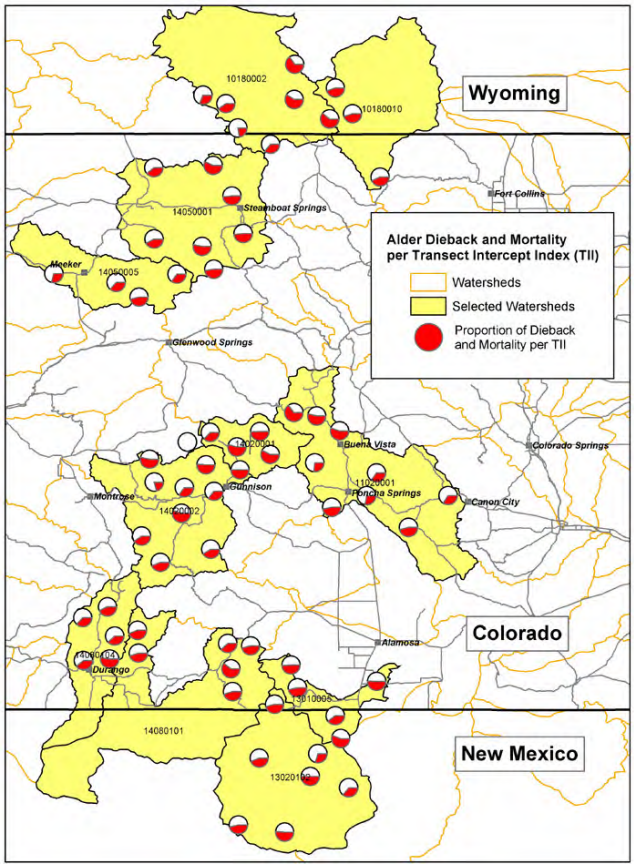
Forest Health Management Special Projects

(Project Funding by Evaluation Monitoring – EM, Special Technology Development – STDP, Pest Trend Impact Plot System – PTIPS, and Base Funding - BF)

Project Title: Alder Dieback and Mortality in the Southern Rocky Mountains - EM

Investigators and Cooperators: Jim Worrall, Barry Johnston (GMUG), Gerald Adams (Michigan State Univ.), Tom Eager, Roy Mask. **Years:** 2004 – 2007

Project Description: Poor condition of thinleaf alder (Alnus incana ssp. tenuifolia) has been noted in the Southern Rocky Mountains in recent years. To quantify the extent and severity, and gather data that may suggest a cause, we surveyed watersheds that had alder and were at least partly in Colorado.



Higher TII indicates more dead alder.

Of 6,503 standing stems (≥ 3 cm DBH) inspected, 34% were live and healthy, 29% live with dieback, and 37% were dead. Alder condition was unrelated to geographic area (Figure 6), elevation, distance to stream, and distance to road. Alder clumps with the most dieback and mortality also had low numbers of sprouts. Transects with full sun exposure had significantly poorer alder condition than transects in full shade. Cytospora canker appears to be consistently associated with dieback and mortality. Morphological and molecular studies helped identify a common, putative pathogen as *Valsa melanodiscus*. Cytospora canker is usually associated with plant stress. Other potential causes are climate dynamics, bark beetles, wood borers, alder phytoplasma, and alder Phytophthora (though preliminary isolations were negative and symptoms are not consistent). Work in 2005 will be directed toward assessing the change in alder condition over time and possible causal factors.

Figure 6. The condition of alder in transects sampled in the Southern Rocky Mountains. Transect Intercept Index, represented by the red portion of each circle, is a measure of the amount of mortality and dieback of alder in each transect.

Project Title: Monitoring white pine blister rust spread and establishment in the central Rocky Mountains – Stages 1 and 2 - EM

Investigators and Cooperators: Jeri Lyn Harris, Kelly S. Burns, 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: Stage 1 - 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.

Stage 2 – Surveys of white pine stands to determine the distributions of the rust in the Central Rocky Mountains were continued during 2003 - 2004. The extent of the southern Colorado infestation in the Mosca Pass area of the Sangre de Cristo Mountains and the Wet Mountains were delimited. Long-term survey plots in and around the Mosca Pass infestation in the Sangre de Cristo Mountains were established for monitoring distribution, rates of spread, intensity, and severity of the disease and its ecological impacts.

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

Investigators: Jim Blodgett, John Lundquist, Denise Hardesty **Years:** 2003 - 2006

Project Description: A statewide investigation of Armillaria root disease is being 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: Severity and extent of Douglas-fir beetle infestations in northern Wyoming - EM

Investigators and Cooperators: Kurt Allen and Scott Hill (Bighorn NF) **Years:** 2004 – 2006

Project Description: Forest Health Monitoring (FHM) aerial and ground detection surveys have been conducted and have indicated an increasing Douglas-fir beetle epidemic in the Bighorn Mountains of northern Wyoming. In addition, Forest Health Management has completed a biological evaluation of beetle population dynamics beginning in 2003. Although this evaluation describes changes in beetle populations and provided rough estimates of the number of trees killed, they do not appraise stand conditions and characteristics before, during or after the outbreak occurred.

Accomplishments in 2004 were the installation and data collection of 25 infested and 25 uninfested plots. Aerial photos of the project area were acquired and analyzed. Initial findings put together and used by the Bighorn National Forest for project decision making.

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

Investigators: Bob Cain, Matt Hansen, Jim Vandygriff **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 tested 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.

Comparisons were made of captures in the new design with captures in pheromone-baited funnel traps and fallen trap trees. Sixteen sites were selected from areas of various spruce beetle population levels on the Routt National Forest, Colorado, Medicine-Bow National Forest, Wyoming, and Cache and Fishlake National Forests, Utah. Each site had treatments of the new trap, fallen trap tree, and a cluster of 3 funnel traps.

Preliminary analyses indicate mixed results. During the first several weekly observations, the new trap outperformed the funnel traps by as much as 100:1 for individual replicates. This advantage waned, however, as the season progressed and seasonal totals were not significantly different among the new trap and funnel traps; trap trees caught the most beetles by a small margin. Apparently, the lure for the new trap only remains attractive for 4-6 weeks, and probably needs to be replaced at that time. In terms of spillover, the new trap and trap tree treatments had little spillover while the most of the funnel traps were associated with varying degrees of spillover. Preliminary results also suggest the possibility that the new trap works best in areas with small beetle populations.

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

Investigators and Cooperators: William Jacobi, Holly Kearns, Kelly Sullivan-Burns, Jeri Lyn Harris, Jim Hoffman, Eric Smith, Brian Geils, Anna Schoettle, Diana Tomback, Jim Blodgett.

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.

Accomplishments 2001-2004

- Collecting Meteorological Data - Meteorological stations placed at white pine sites in Colorado and Wyoming. Meteorological data were analyzed from existing database sources or the Remote Automatic Weather Stations and Colorado State Climate Center.
- Training programs were provided to inform Colorado Department of Ag. Nursery Inspectors about the signs and symptoms of white pine blister rust.
- Distribute informational posters/flyers about white pine blister rust Disease to district/forest office
- *Ribes* species identification guide for the central Rocky Mountains was developed.
- Compilation of data sets on site variables and locations of white pines in Colorado, Wyoming, and parts of Utah, New Mexico, and Idaho.
- Coordination of methods and sharing of data at the start of this project was done to standardize field research effort
- Two field crews collected data for this study on over 750 plots in SE Wyoming and Colorado. Preliminary hazard rating models for 2 areas of the Medicine Bow National Forest were developed (Jacobi and Kearns 2002).
- Collected 150 cankers from five locations in WY and CO to determine canker expansion rates to determine a measure of infection pressure.

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

Investigators and Cooperators: José Negrón, Steve Seybold, Jeff Witcosky, Bob Cain, Bernard Benton, Bill Jacobi, Ronda Koski, and Tom Harrington. **Years:** 2003 - 2006

Project Description: In 2004, we worked with Bill Jacobi and Ronda Koski (Colorado State University) and Tom Harrington (Iowa State University) to determine if *S. schevyrewi* adults emerging from Dutch elm diseased-trees carried the fungal pathogen, *Ophiostoma novo-ulmi*. Branch sections were obtained from American elms removed due to Dutch elm disease in Colorado Springs and Denver. Beetles were allowed to attack and infest the bolts. As beetles emerged, they were identified to species, crushed, and shipped to Iowa State Univ. and Colorado State Univ. Beetles were placed on a selective media and isolates of *O. novo-ulmi* obtained from 30%, 63% and 44% (CSU) and 8%, 84%, and 91% (ISU). These results indicate that *S. schevyrewi* that breed in, and emerge from, elm trees infected with Dutch elm disease can become infested with spores of this fungal pathogen.

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

Investigators and Cooperators: Jeri Lyn Harris, Tom Eager, Jim Worrall, Kelly S. Burns, Meg Halford, Jim Blodgett, Kurt Allen, Dan Long, Denise Hardesty, Judy Adams, Jim Friedly, Bill Hill

Years: Began 1991 to indefinite.

2004 Project Accomplishments: In the summer of 2004, all 14 dwarf mistletoe plots were remeasured. Three of these plots are located on the Fraser Experimental Forest in old-growth lodgepole pine. The other 11 plots are located in mixed-age ponderosa pine stands on the GMUG National Forest and the Southern Ute Indian Reservation. All plots were remarked (painted and stakes checked), global-positioning data were recorded, and all variables except tree ages were recorded. Regeneration data was also collected in four 1/300-acre subplots.
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Project Title: Modeling forest composition and structure to investigate susceptibility of lodgepole pine stands to mountain pine beetle infestations: a demonstration project - BF

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: Monitoring of wood deterioration after wildfire - BF

Investigators: Jim Worrall, Tom Eager, Roy Mask, Don Martinez, Jerry Ryszka

Cooperators: Staff from Black Hills, Shoshone, Medicine-Bow, White River, Pike, Uncompahgre, and Rio Grande National Forests **Years:** 2002 - 2007

Project Description: We have been assessing defect, decay and insect attack in trees killed in the 2002

fire season. Five tree species are included in nine fires on seven forests. We now have 3 years' data. No saprot was present in 2002 and only a trace in 2003. In 2004, Engelmann spruce had the most saprot, covering 14% of the cross section on average. Ponderosa pine had 12%, subalpine fir 7%, and other species only a trace. Wood density (specific gravity based on dry weight and volume) has not been consistent with visually detectable saprot; little loss of density has been detected over the study thus far.

Wood borer activity has varied among fires, even within a species. Overall, numbers of galleries due to cerambycids and buprestids on the sapwood surface average 1-3 per ft^2. Numbers have not increased between 2003 and 2004 in ponderosa pine, subalpine fir and Engelmann spruce, but in Douglas-fir and lodgepole pine borer numbers continued to increase in 2004. Borers tend to be most abundant at the middle and upper positions of tree boles, especially in spruce-fir. At the lower positions, bark may have been burned too much to support borer establishment in some cases.

Overall, post-fire defects that result in loss of merchantable volume (checking, saprot, borers) ranged from 13-74% of total cubic-foot volume in 2004. It was generally highest in spruce and fir, which have tended to check extensively. It is lowest in ponderosa pine in the Bucktail and Million fires, but it is much higher (64%) in ponderosa pine in the Black Hills fires, primarily due to higher amounts of saprot and checking in the Black Hills.

Recent Publications

Allen, K.K. and D.F. Long. 2003. Evaluation of the Douglas-fir beetle on the Shoshone National Forest, Wyoming. USDA For. Serv., Rocky Mountain Region, Renewable Resources. Bio. Eval. R2-04-01. 10 pp.

Allen, K.K. 2003. Evaluation of MPB activity on the Black Hills National Forest. USDA For. Serv., Rocky Mountain Region, Renewable Resources. Bio. Eval. R2-04-02. 17 pp.

Allen, K.K. 2004. Evaluation of mountain pine beetle activity in the Bugtown Gulch and Deerfield areas of the Black Hills National Forest. USDA For. Serv., Rocky Mountain region, Renewable Resources. Bio. Eval. R2-05-01. 11pp.

Blodgett, J.T., Herms, D.A., and Bonello, P. 2005. Effects of fertilization on red pine defense chemistry and resistance to *Sphaeropsis sapinea*. For. Ecol. Manage. 209:373-382.

Bonello, P. and Blodgett, J.T.2004. *Pinus nigra-Sphaeropsis sapinea* as a model pathosystem to investigate local and systemic effects of fungal infection of pines. Physiological and Molecular Plant Pathology 63:249-261.

Blodgett, J.T., Bonello, P., and Stanosz, G.R. 2003. An effective medium for isolating *Sphaeropsis sapinea* from asymptomatic pines. Forest Pathology 33:395-404.

Blodgett, J.T., and Bonello, P. 2003. The aggressiveness of *Sphaeropsis sapinea* on Austrian pine varies with isolate group and site of infection. Forest Pathology 33:15-19.

Blodgett, J.T., W.C. Schaupp, Jr., and D.F. Long. 2005. Evaluation of white pine blister rust and mountain pine beetle on limber pine in the Bighorn National Forest. USDA Forest Service, Rocky Mountain Region, For. Health Mgt., Bio. Eval. R2-05-08.

Blodgett, J.T. 2004. White pine blister rust Pest Trend Impact plots. Investigators' Annual Reports 2003. National Parks Service Rpt 28494, YCR-IAR-2004-02. p.144.

Blodgett, J.T., and K.F. Sullivan. 2004. First report of white pine blister rust on Rocky Mountain bristlecone pine. Plant Disease 88:311.

Burns, K.S. 2005. Biological evaluation of potential hazard trees in Tie City Campground. USDA Forest Service, Rocky Mountain Region, Biological Evaluation R2-05-06. 16 p.

Burns, K.S. 2005. Biological evaluation of potential hazard trees in campgrounds of the Brush Creek-Hayden Ranger District. USDA Forest Service, Rocky Mountain Region, Biological Evaluation R2-05-07. 32 p.

Cain, R.J., and Howell, B. 2005. Biological evaluation of mountain pine beetle activity on the Rock Creek analysis area of the Yampa Ranger District, Medicine Bow-Routt National Forests and Thunder Basin National Grassland, 2005. USDA Forest Service, Rocky Mountain Region, Biological Evaluation R2-05-02. 37 p.

Cain, R.J., and Howell, B. 2005. Biological evaluation of mountain pine beetle activity on the upper Fraser analysis area of the Sulphur Ranger District, Arapaho-Roosevelt National Forests and Pawnee National Grassland, 2005. USDA Forest Service, Rocky Mountain Region, Biological Evaluation R2-05-03. 37 p.

Cain, R.J., and Howell, B. 2005. Biological evaluation of mountain pine beetle activity on the Black Trout Analysis Area of the South Park Ranger District, Pike-San Isabel National Forests and Cimarron and Comanche National Grasslands, 2005. USDA Forest Service, Rocky Mountain Region, Biological Evaluation R2-05-04. 36 p.

Cain, R.J., and Howell, B. 2005. Biological evaluation of spruce beetle and mountain pine beetle activity on the French Creek Analysis Area of the Brush Creek/Hayden Ranger District, Medicine Bow-Routt National Forests and Thunder Basin National Grassland, 2005. USDA Forest Service, Rocky Mountain Region, Biological Evaluation R2-05-05. 50 p.

Eager, T. A. ; Berisford, C. W. ; Dalusky, M. J. ; Nielsen, D. G. ; Brewer, J. W. ; Hilty, S. J. ; Haack, R. A. 2004. Suitability of some southern and western pines as hosts for the pine shoot beetle, *Tomicus piniperda (Coleoptera: Scolytidae*). *Journal of economic entomology*. Vol. 97, no. 2 (2004): p. 460-467.

Harris, J.L., comp. 2004. Forest Insect and Disease Conditions in the Rocky Mountain Region, 2003. USDA For. Serv., Rocky Mountain Region, Renewable Resources. R2-04-03. 33 pp.

Howell B.E, and Mathiasen R.J. 2004. Growth Impacts of *Psittacanthus angustifolius* Kuijt on *Pinus oocarpa* Schiede in Honduras. Forest Ecology and Management 198:75-88.

Witcosky, J. February 6, 2004. *Scolytus schevyrewi* Semenov – An Asian Bark Beetle New to the United States. Pest Update. 2 pp.

Worrall, J.J., T.D. Lee and T.C. Harrington. 2005. Forest dynamics and agents that initiate and expand canopy gaps in *Picea-Abies* forests of Crawford Notch, New Hampshire, USA. Journal of Ecology 93:178-190.

Worrall, J.J., K.F. Sullivan, T.C. Harrington, and J.P. Steimel. 2004. Incidence, host relations and population structure of *Armillaria ostoyae* in Colorado campgrounds. Forest Ecol. Mgmt. 192:191-206.