United States Department of Agriculture

Forest Insect and Disease Conditions in the Rocky Mountain Region, 2021

Forest Service
Rocky Mountain Region
Forest Health
R2–RO–22-01
January 2022

Disclaimers for Aerial survey data, GIS, and Maps

Due to the nature of aerial surveys, these data will only provide rough estimates of the location, intensity, and the resulting trend information for agents detectable from the air. Many of the most destructive diseases are not represented in the data because these agents are not detectable from aerial surveys. The maps and data presented should only be used as a partial indicator of insect and disease activity and should be validated on the ground for actual location and causal agent. The insect and disease data are available digitally from the USDA Forest Service, Region Two Forest Health Protection group. The cooperators reserve the right to correct, update, modify, or replace GIS products. Using these data for purposes other than those for which they were intended may yield inaccurate or misleading results.

The information shown is based upon data compiled as of October 2021.

Cover photo: Oh Be Joyful Recreation Area, Gunnison NF and BLM, Colorado. Photo by Suzanne Marchetti, USDA Forest Service.

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Conditions in Brief

2021 Weather Summary for the Rocky Mountain Region

In 2021, the Rocky Mountain Region, Region 2, experienced varying amounts of precipitation. During winter and early spring, some areas in the eastern portion of the region such as eastern Colorado and Nebraska received average to above-average rainfall. Other areas of the Region remained very dry. Spring also brought significant weather events such as tornados to South Dakota, which caused damage to forests in the Black Hills.

The Region experienced dry and drought conditions during the summer, which persisted into the fall (Fig. 1). Several record temperatures were set in Colorado during the summer of 2021. In June, when monsoonal moisture arrived, it caused flash flooding, especially in areas impacted by recent wildfires. Denver received its first measurable snow for the season on December 10, 2021, the latest first snow in 87 years.

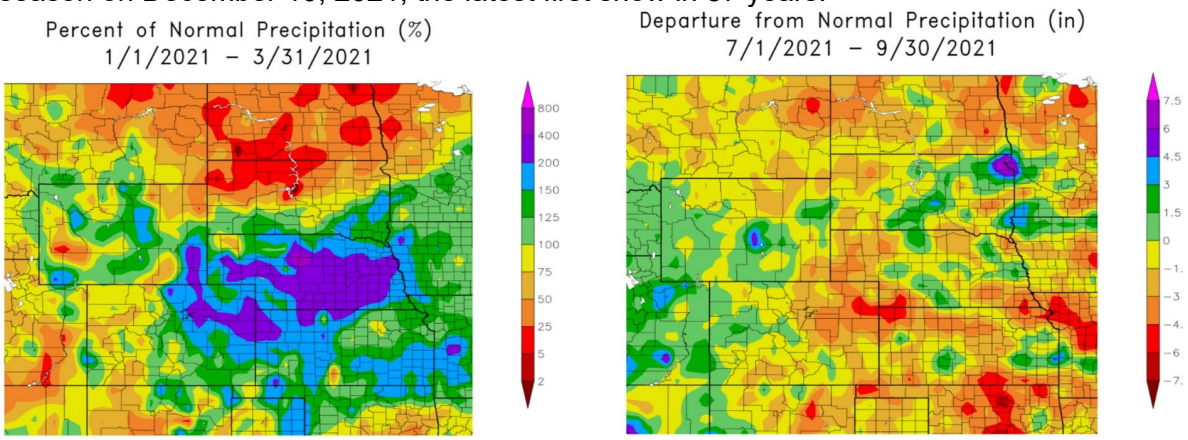

Figure 1. Percent of normal precipitation (left) and departure from normal precipitation (inches; right) for Region 2. Source: High Plains Regional Climate Center.

Aerial Survey Summary

The Rocky Mountain Region encompasses over 22 million acres of national forests and grasslands across Colorado, Kansas, Nebraska, South Dakota, and Wyoming. The mission of the USDA Forest Service is to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations. Each year during the summer and early fall, employees from the Forest Health Protection Program (FHP) and state partners conduct aerial surveys to map forest insect and disease activity across the Region. Aerial surveys provide an annual snapshot of forest health conditions over large areas more efficiently and economically than other methods. To conduct the survey, observers in small aircraft record areas of activity using a digital aerial sketch mapping system that incorporates a tablet computer, geographic information systems, and global positioning system technology. Aircraft used for these flights are typically small high-wing planes such as the Quest Kodiak 100 and Cessna T206. Aircraft fly in either a grid pattern over relatively flat terrain or following the contours of mountainous terrain or divided landscapes. The USDA Forest Service partners with Colorado State Forest Service, Wyoming State Forestry Division, and Kansas Forest Service to conduct the annual survey.

Every summer, the goal is to survey all forested lands above the pinyon-juniper forest type, which is approximately 44 million acres. Not all areas within the five-state Region were

surveyed with aircraft, which makes yearly comparisons misleading. In 2020, the aerial survey flight plan was disrupted by a global pandemic, which resulted in only half of the planned area being surveyed, 23 million acres. In 2021, less restrictive COVID-19 restrictions allowed for a complete survey, over 100% or 47 million acres (Fig.2).

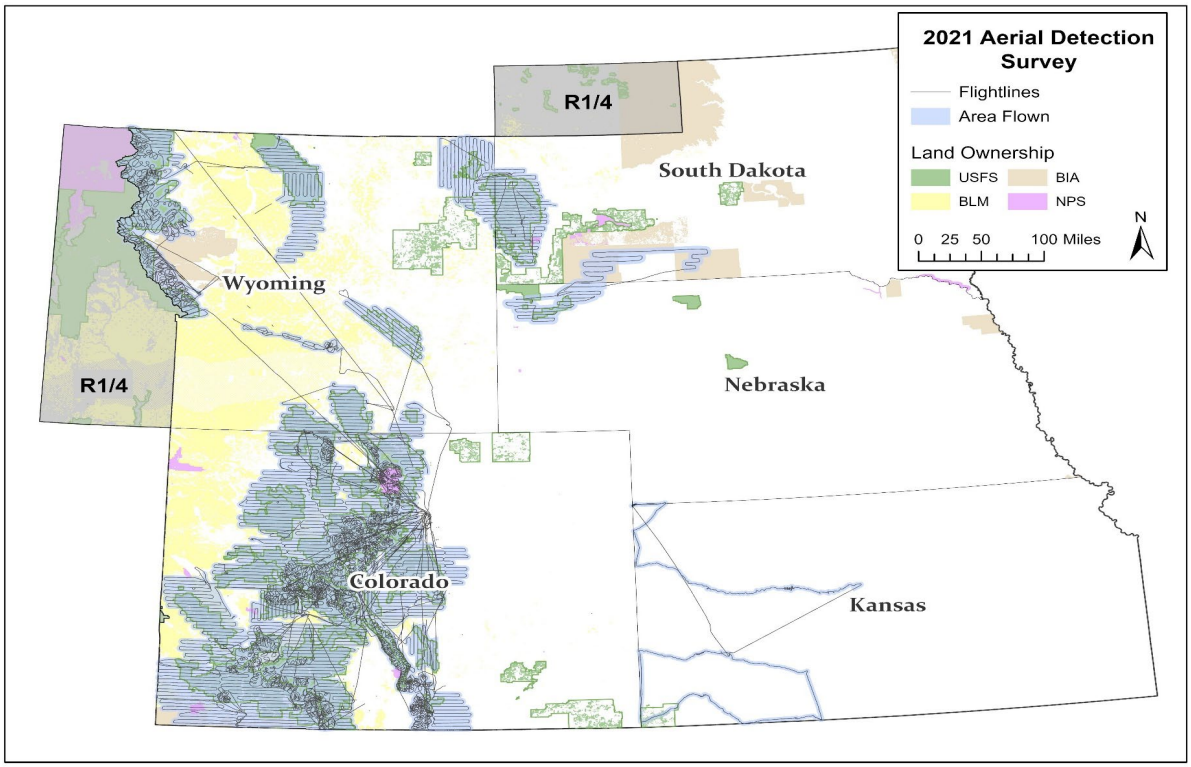

Figure 2. Flown areas and flight lines from the 2021 aerial detection survey. Map by Marianne Davenport, USDA Forest Service.

Bark Beetle Summary

New tree mortality was attributed to these primary bark beetles: spruce beetle, western balsam bark beetle, and ponderosa pine beetle complex, including roundheaded, western, and mountain pine beetles. Heavy western spruce budworm defoliation and drought contributed to continued Douglas-fir beetle activity in the Region.

Forest Health Protection specialists monitor areas for spruce beetle and western balsam bark beetle activity where avalanches occurred recently; insect trap monitoring does not show increasing spruce beetle populations and down material is not heavily infested. Monitoring for spruce beetle and mountain pine beetle populations is also occurring in southwestern Colorado on the San Isabel and Gunnison National Forests. Aerial survey numbers reported in Tables 1 and 2 indicate acres with varying intensities of fading trees that were mapped in 2021.

Table 1. Bark beetle[1] activity by state in acres from aerial detection surveys in 2021 in Region 2.

State	Spruce Beetle		Mountain Pine Beetle		Douglas-fir Beetle		Western Balsam Bark Beetle	
Year	**2019**	**2021**	**2019**	**2021**	**2019**	**2021**	**2019**	**2021**
Colorado	89,000	53,000	720	1,500	7,400	8,000	23,000	29,000
Kansas	0	0	0	0	0	0	0	0
Nebraska	0	0	0	0	0	0	0	0
South Dakota	0	0	8	0	0	0	0	0
Wyoming[2]	4,300	15,000	50	140	40	710	5,700	11,000
Region 2 Total[3]	**93,300**	**68,000**	**778**	**1,640**	**7,440**	**8,710**	**28,700**	**40,000**

[1]Only major bark beetle and mortality agents shown. Agents detected with lesser activity may not be represented in the table.
[2]Includes only the Region 2 portion of Wyoming.
[3]Sum of individual values may differ from totals due to rounding and multiple agents occurring in the same location.

Table 2. Bark beetle[1] activity by National Forest (NF) in acres from aerial detection surveys in 2021.

National Forest[2]	Spruce Beetle	Mountain Pine Beetle	Douglas-fir Beetle	Western Balsam Bark Beetle	Bark Beetle complex in Ponderosa Pine
Arapaho and Roosevelt NF	970	30	30	4,400	0
Bighorn NF	440	40	1	20	0
Black Hills NF	0	0	0	0	0
Grand Mesa, Uncompahgre, and Gunnison NF	14,000	760	1,900	4,300	1,900
Medicine Bow and Routt NF	560	50	470	6,400	0
Nebraska NF	0	0	0	0	0
Pike and San Isabel NF	19,000	410	980	980	0
Rio Grande NF	490	60	690	80	0
San Juan NF	4,800	0	460	100	4,500
Shoshone NF	14,000	40	130	180	0
White River NF	110	10	1,600	6,800	0

[1]Only major bark beetle and mortality agents are shown. Agents detected with lesser activity may not be represented in the table.
[2]Values based on proclamation boundaries, thus any inholdings are summarized with the Forest boundary.

Defoliation and Abiotic Injury Summary

Defoliation can be caused by insects, diseases, and abiotic events, including the non-living parts of an ecosystem such as weather, light, and water. Due to lighting conditions and smoke, the causal agents of tree defoliation can be difficult to distinguish when conducting aerial surveys. Specific abiotic events such as avalanches and windthrow, the uprooting and overthrowing of a tree caused by the wind, can cause local catastrophic damage. Visible defoliation detected from aerial surveys in 2021 are listed in Tables 3 and 4.

Tree stress caused by multiple years of defoliation can directly lead to tree mortality or predispose trees to bark beetle attack. Windthrow events were widespread between the 2020 summer aerial survey and the 2021 aerial survey. Areas of windthrown trees may warrant ground monitoring for bark beetle activity depending on the species, the size of the impacted trees, and the adjacent stands. Notable windthrow events were observed on the

Medicine Bow-Routt, Arapaho-Roosevelt, Black Hills, Grand Mesa, Uncompahgre, and Gunnison National Forests in 2021

Table 3. Major defoliators, diseases, and abiotic[1] activity by state in acres from partial aerial detection surveys in 2021.

State	Aspen Defoliation and Discoloration[2]	Western Spruce Budworm	Windthrow
Colorado	14,000	147,000	3,400
Nebraska	0	0	0
Kansas	0	0	0
South Dakota	30	0	0
Wyoming[3]	723	35,000	50
Region 2 Total[4]	**15,000**	**182,000**	**3,500**

[1]Only major defoliators, diseases, and abiotic agents are shown. Agents detected with lesser activity may not be represented.
[2]Aspen defoliation and discoloration includes damage primarily by Marssonina leaf spot, western tent caterpillar, and large aspen tortrix.
[3]Includes only the Region 2 portion of Wyoming.
[4]Sum of individual values may differ from totals due to rounding and multiple agents occurring in the same location.

Table 4. Major defoliators, diseases, and abiotic[1] activity by National Forest (NF) in acres from partial aerial detection surveys in 2021[2].

National Forest[3]	Aspen Defoliation and Discoloration[4]	Western Spruce Budworm	Windthrow[5]
Arapaho and Roosevelt NF	6	10	1,500
Bighorn NF	0	2,000	0
Black Hills NF	30	0	0
Grand Mesa, Uncompahgre, and Gunnison NF	2,800	12,000	1,100
Medicine Bow and Routt NF	2,700	830	740
Nebraska NF	0	0	0
Pike and San Isabel NF	1,200	26,000	0
Rio Grande NF	3,400	4,800	0
San Juan NF	1,100	4,400	0
Shoshone NF	20	22,000	0
White River NF	200	30	50

[1]Only major defoliators, diseases, and abiotic agents are shown. Agents detected with lesser activity may not be represented in the table.
[2]Sum of individual values may differ from totals due to rounding and multiple agents occurring in the same location.
[3]Values based on proclamation boundaries, thus any inholdings are summarized with the Forest boundary.
[4]Aspen defoliation and discoloration includes damage primarily by Marssonina leaf spot, western tent caterpillar, and large aspen tortrix.
[5]A special windthrow survey was conducted on the Medicine Bow-Routt and Arapaho-Roosevelt NFs in the fall of 2020, and the resulting mapped acres are represented here along with acres mapped in 2021.

Disease Summary

Most tree diseases, such as cankers, dwarf mistletoes, root diseases, and rusts, are persistent and prevalent in the Region, but aerial detection surveys cannot adequately characterize damage. Foliage diseases usually have a detectable aerial signature, but they occur irregularly, increasing when weather conditions are favorable. The return of seasonal monsoon conditions in southern Colorado increased some foliar diseases in aspen. Elsewhere in the Region, the incidence and severity of some leaf blights and needle casts decreased in 2021 due to dry weather conditions. Recently, aerial surveys and subsequent ground observation confirmed Diplodia shoot blight and Comandra blister rust.
These and other diseases are discussed in the “Status of Major Diseases” chapter.

Status of Major Bark Beetles

Spruce Beetle

Dendroctonus rufipennis
Hosts: spruce

Spruce beetle populations continue to expand where there are suitable hosts in Region 2. Many large areas with ongoing activity have minimal mature spruce remaining.

In Wyoming, the Shoshone National Forest continues to experience elevated levels of spruce beetle-caused mortality on the Wind River District, south of Togwotee Pass on the Intermountain Region border, even as hosts are becoming depleted. Many stands have no live spruce larger than 10 inches in diameter. Small groups of spruce beetle-infested trees are scattered in the northern Bighorn Mountains in the Burgess Junction area (Fig. 3). Currently, the population does not appear to be expanding rapidly. In total, aerial surveys mapped spruce mortality on 15,000 acres in the Region 2 portion of Wyoming (Fig. 4).

Widespread spruce beetle activity was observed in Colorado, with 53,000 acres mapped this year (Fig. 4-5). New spruce mortality from spruce beetle is occurring on both sides of the Continental Divide in and around the Rocky Mountain National Park. Ground observation shows extensive mortality in the Endo Valley area of Rocky Mountain National Park and continued spruce beetle activity. On Mount Evans and Guanella Pass, spruce beetle populations continue to expand from windthrow.

The largest areas of spruce beetle activity continue in southern Colorado (Fig. 6). There are declining populations due to host depletion on the Wet Mountains. This year, low-intensity activity was detected on the north side of the West Elks south of Aspen. The Sawatch Range population continues to move north, impacting new areas around Cottonwood and Cumberland passes. Areas of spruce beetle activity around Silverton/Red Mountain Pass are becoming more apparent from the air and ground.

Figure 3. Spruce beetle galery (left) and infested trees (right) on the Shoshone NF. Photos by Kurt Allen, USDA Forest Service.

Figure 4. Spruce beetle activity as observed from the 2021 aerial detection survey. Map by Marianne Davenport, USDA Forest Service.

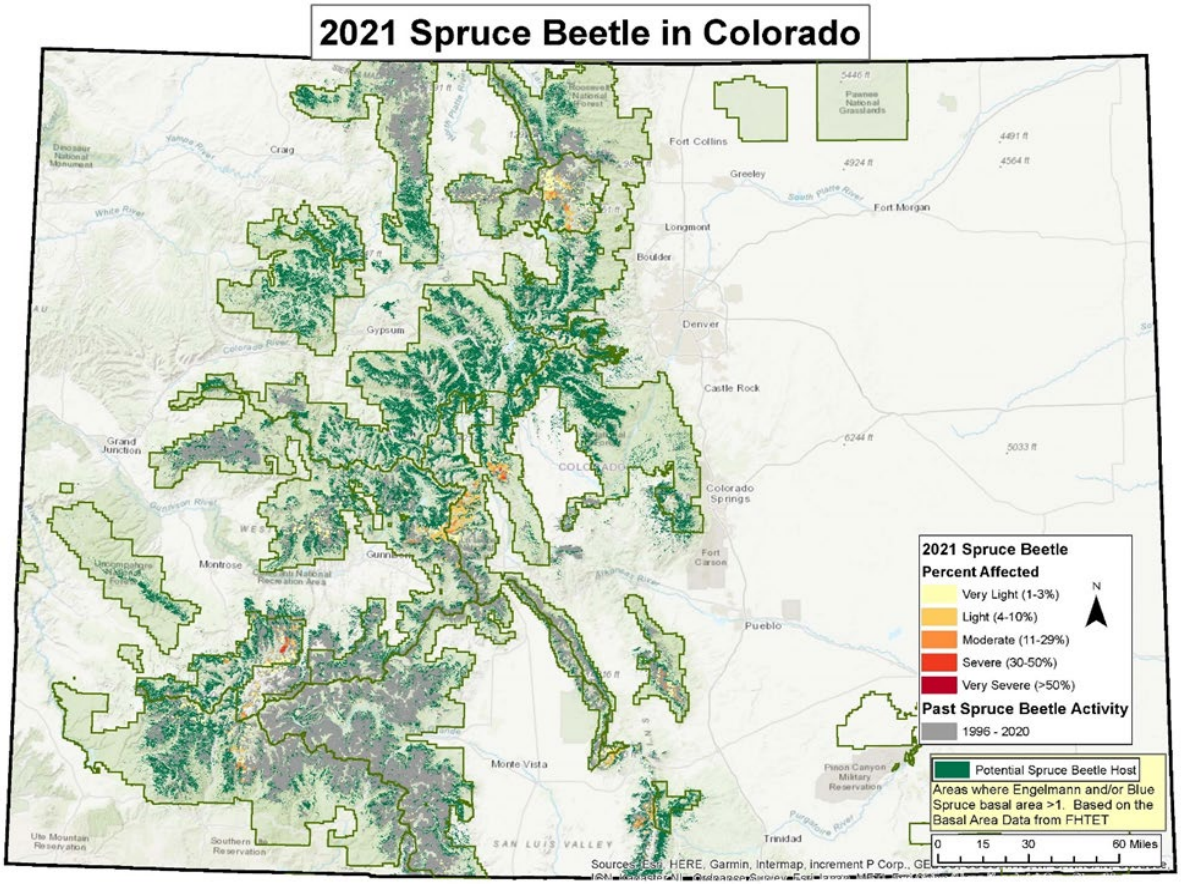

Figure 5. Spruce beetle affected areas in Colorado vary in intensity. Map by Jennifer Ross, USDA Forest Service.

Figure 6. Englemann spruce fading and standing dead from spruce beetle attack on the San Isabel NF. Photo by Justin Backsen, USDA Forest Service.

Mountain Pine Beetle

Dendroctonus ponderosae

Hosts: ponderosa, lodgepole, limber, whitebark, and bristlecone pine

Region 2 has several increasing mountain pine beetle activity areas, primarily in southern Colorado. Most notable is an expanding outbreak on the Gunnison Ranger District. The area is on the edge of approximately 300,000 acres of mature lodgepole pine that was unaffected by the mountain pine beetle epidemic in the 2000s (Fig. 7). Favorable conditions have allowed mountain pine beetle populations to expand beyond treatment areas in the Taylor Basin, and newly infested areas have been observed in the Crested Butte area.

Another mountain pine beetle population was detected north of Trout Creek Pass, east of Buena Vista, on about 200 acres in ponderosa pine. Mountain pine beetle activity was mixed with western pine beetle in ground surveys on the Uncompahgre Plateau. On the Dolores Ranger District, roundheaded pine beetle and western pine beetle continue to cause extensive ponderosa pine mortality. The mountain pine beetle is a minor component of the bark beetle complex impacting trees there.

The mountain pine beetle is at endemic levels across Wyoming and South Dakota, with mortality reduced to individual ponderosa and five-needle pines infrequently occurring across the landscapes.

The response from the Forest Service and landowners in the area has been rapid with funding from multiple sources for sanitation and thinning (Fig. 8). Forest Health Protection , National Forest Service, Colorado State Forest Service and the National Forest Foundation are working together for rapid response.

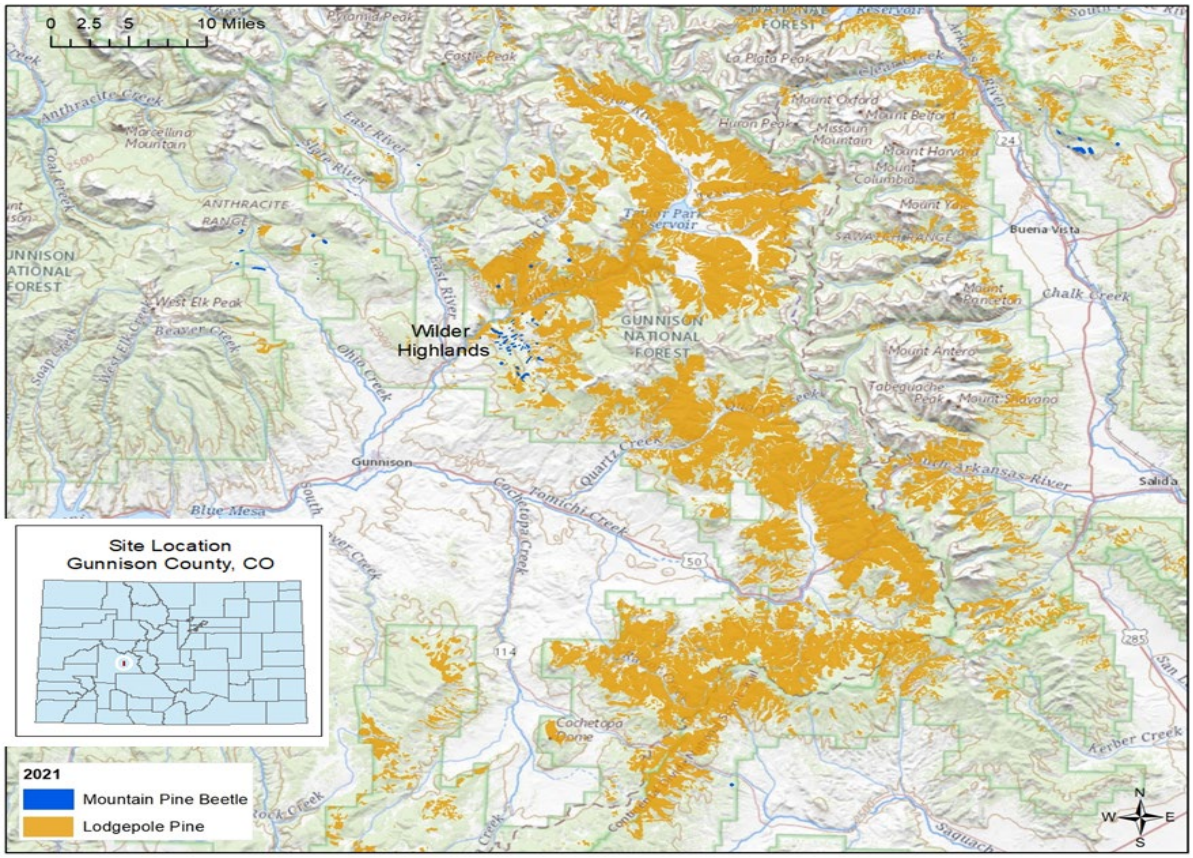

Figure 7. Mountain pine beetle survey of the Wilder-Gunnison Highland outbreak area and nearby susceptible lodgepole pine forests. Map by Suzanne Marchetti, USDA Forest Service.

Figure 8. Mountain pine beetle-killed lodgepole pine salvage treatment on the Gunnison Ranger District. Photo by Suzanne Marchetti, USDA Forest Service.

Lodgepole Pine Beetle

Dendroctonus murryannae
Host: lodgepole pine

Aerial survey detected a pocket of lodgepole pine mortality in the Bighorn NF. Ground observation identified the causal agent to be lodgepole pine beetle (Fig. 9 and 10). This is an elusive beetle in Region 2, and it has been found in small pockets and scattered trees that were dying in a few locations in the Bighorn Mountains the past few years. It is not an insect of concern and is an infrequently encountered bark beetle in the Region. Identification was confirmed by USFS FHP National Entomologist, Bob Rabaglia.

Figure 9. Lodgepole pine beetle caused mortality in the Bighorn NF (left). Lodgepole pine beetle larvae (right). Photos by Kurt Allen, USDA Forest Service.

Figure 10. Pitch tubes low on the tree trunk (left). Galleries of lodgepole pine beetles extending down into large roots (right). Photos by Kurt Allen, USDA Forest Service.

Roundheaded and Western Pine Beetle Complex in Ponderosa Pine

Roundheaded pine beetle, *Dendroctonus adjunctus*
Western pine beetle, *Dendroctonus brevicomis*
Mountain pine beetle, *Dendroctonus ponderosae*
Host: ponderosa pine

An epidemic of primarily roundheaded pine beetle (RHPB) mixed with western pine beetle, some mountain pine beetles, and engraver beetles continues to expand on the Dolores Ranger District of the San Juan National Forest (Fig. 11). Populations are expanding across “the glade” area and are moving north through the ponderosa forest type (Fig. 12 and 13), verified by ground surveys conducted in November 2021. RHPB was also confirmed this year on the Norwood Ranger District near Lone Cone on the Uncompahgre National Forest, confirming the expansion north from the original outbreak areas. Forest Health Protection contributed funding to support the removal of infested trees and thinning efforts in this timber management area on the San Juan National Forest.

Figure 11. Roundheaded pine beetle-killed ponderosa pine trees (left) and fresh pitch tubes due to roundheaded pine beetle attack on the Dolores Ranger District (right). Photos by Amy Lockner and Brad Lalande, respectively, USDA Forest Service.

Figure 12. Roundheaded and western pine beetle caused tree mortality in southwest Colorado on the Dolores Ranger District. Photo by Justin Backsen, USDA Forest Service.

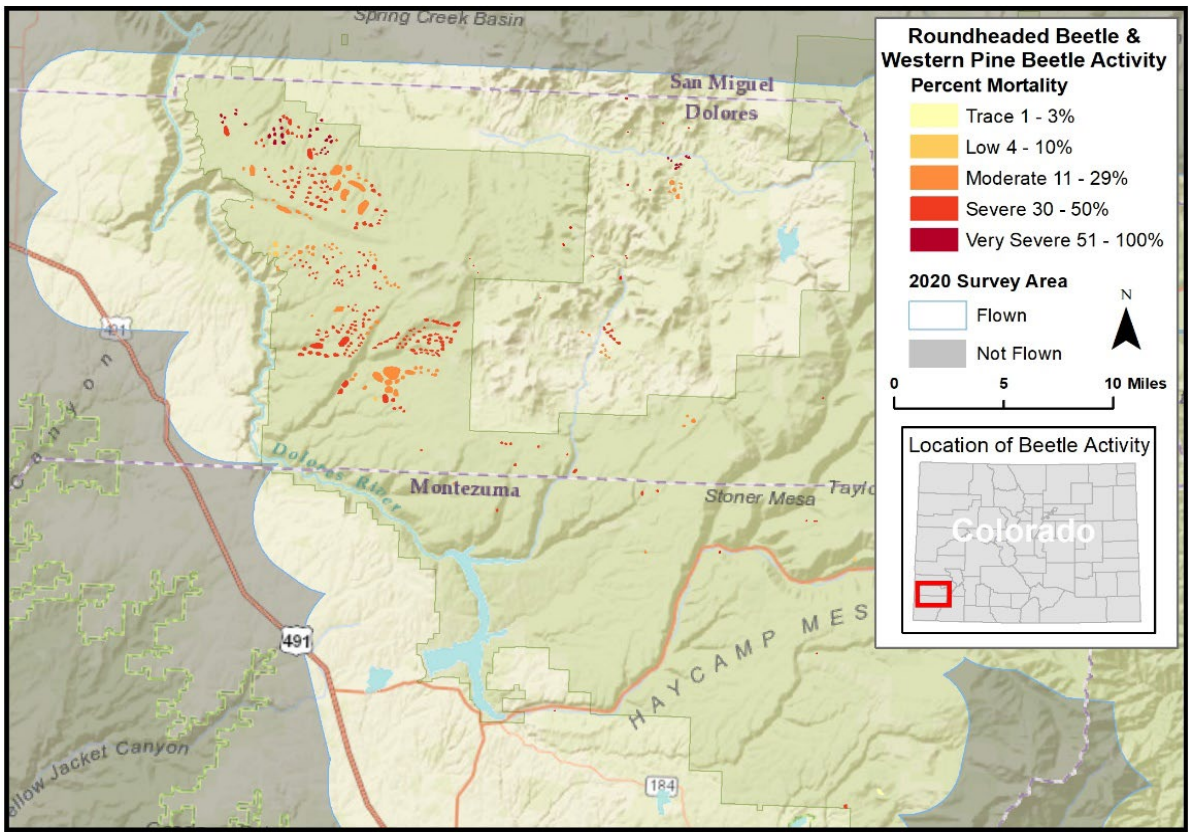

Figure 13. Roundheaded and western pine beetle activity in southwestern Colorado as observed from the 2020 aerial detection survey. Map by Jennifer Ross, USDA Forest Service.

Douglas-fir Beetle

Dendroctonus pseudotsugae
Host: Douglas-fir

Douglas-fir beetle is scattered and widespread in Wyoming and Colorado and is favored by prevailing drought conditions and years of heavy western spruce budworm in both states (Fig. 14-16). Aerial surveys recorded 8,000 acres in Colorado and 700 in Wyoming. In the Clarks Fork area on the northern Shoshone National Forest, the lack of foliage from western spruce budworm prevented aerial surveyors from identifying the total damage from Douglas-fir beetles. Ground observations indicate that Douglas-fir beetle populations are increasing in this area and in the southern Bighorn Mountains. New pockets of Douglas-fir beetle activity continue to increase on the White River National Forest. An anti-aggregation pheromone, MCH (3-methylcyclohex-2-en-1-one), is being used consistently on Douglas-fir in developed recreation sites in southern Colorado.

Figure 14. Douglas-fir beetle-killed trees and western spruce budworm-defoliated trees, Bighorn NF. Photo by Kurt Allen, USDA Forest Service.

Figure 15. Douglas-fir beetle galleries on Douglas fir Shoshone NF (left) and Douglas-fir beetle killed trees near Creede, Colorado (right). Photos by Kurt Allen and Amy Lockner, USDA Forest Service.

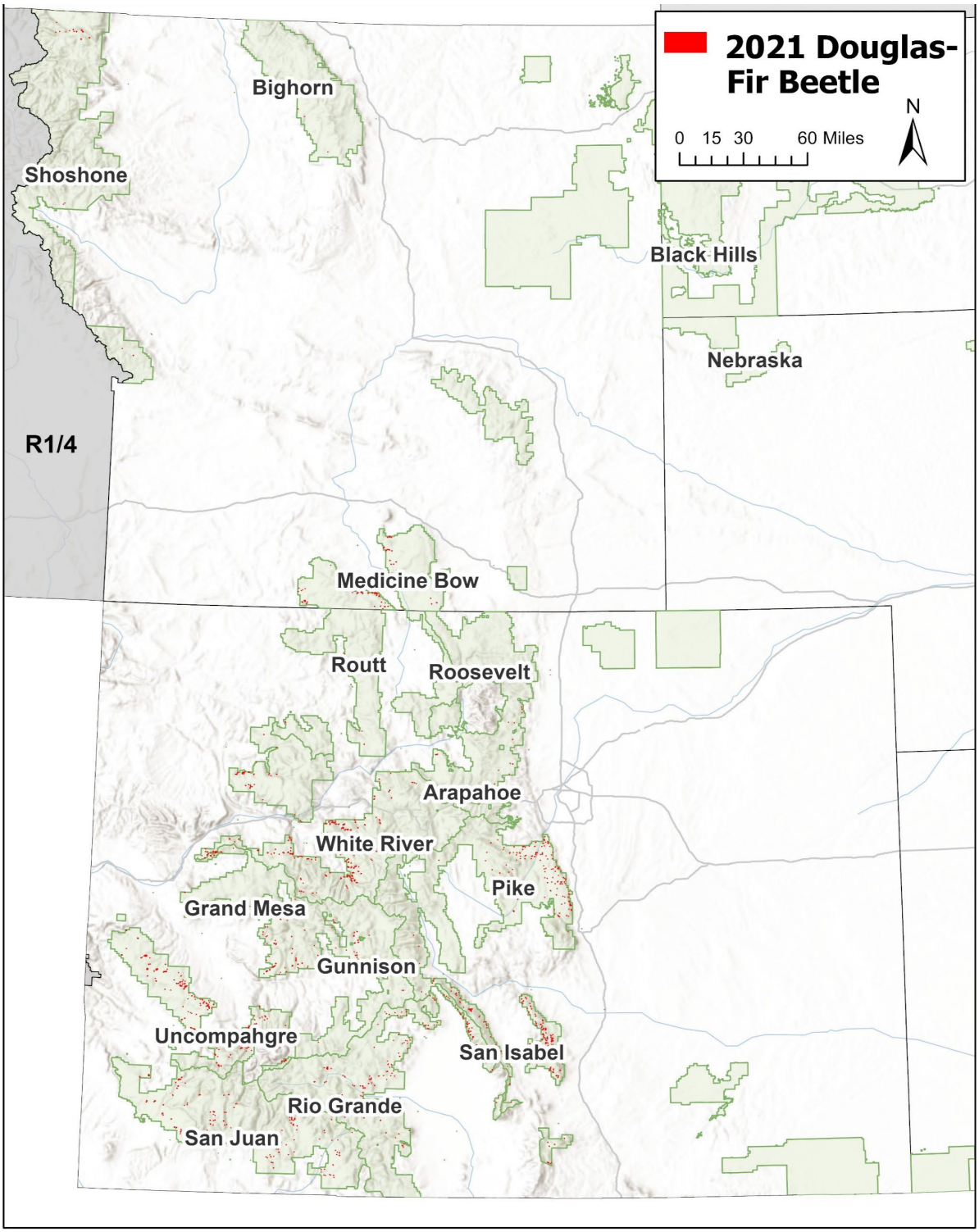

Figure 16. Scattered Douglas-fir beetle-caused tree mortality in Wyoming and Colorado is increasing in intensity with drought and stress from western spruce budworm defoliation. Map by Marianne Davenport, USDA Forest Service.

Fir Engraver

Scolytus ventralis
Host: white fir

Fir engraver continues to kill trees in southern Colorado and is favored by drought stress and heavy defoliation by western spruce budworm (Fig 17). Aerial surveys detected 2,200 impacted acres in 2021. It was documented in ground observations on the Rio Grande NF, where thick white fir regeneration is being reduced and stands thinned to control budworm outbreaks. Vallecito reservoir also has a noticeable population. The area around Ouray on the Gunnison NF is especially notable as cumulative fir engraver caused mortality, combined with annosus root disease, is directing forest management to more resilient species.

Figure 17. White fir mortality caused by fir engraver beetles (left) and horizontal egg and vertical larval galleries of fir engraver beetle in the inner bark of white fir (right). Photos by Amy Lockner, USDA Forest Service.

Engraver Beetles and Twig Beetles in Pines

Ips spp., *Pityophthorus* spp., and others
Hosts: ponderosa, lodgepole, limber, and pinyon pine

Extremely dry conditions in 2018, 2020, and again in 2021 have been favorable to engraver beetles and twig beetles in all pine types.

Pinyon ips (Fig. 18) is increasing in southern and western Colorado, most notably in the Four Corners region and on the Uncompahgre Plateau. Special aerial surveys conducted in 2021 over southwest Colorado reported nearly 18,000 acres of pinyon pine mortality and drought-related juniper mortality (Fig. 19).

Pine engraver beetles, which includes a complex of multiple *Ips* species, have all been active in the Black Hills and Nebraska NF in ponderosa pine (Fig. 20-21). Trees of all sizes

are being killed, sometimes in larger groups. Fading pockets of trees have attracted a lot of attention since 2020.

Figure 18. Pinyon ips mass attack on pinyon on the Rio Grande NF (left) and pinyon ips from Uncompahgre Plateau (right). Photos by John Nelson, USDA Forest Service.

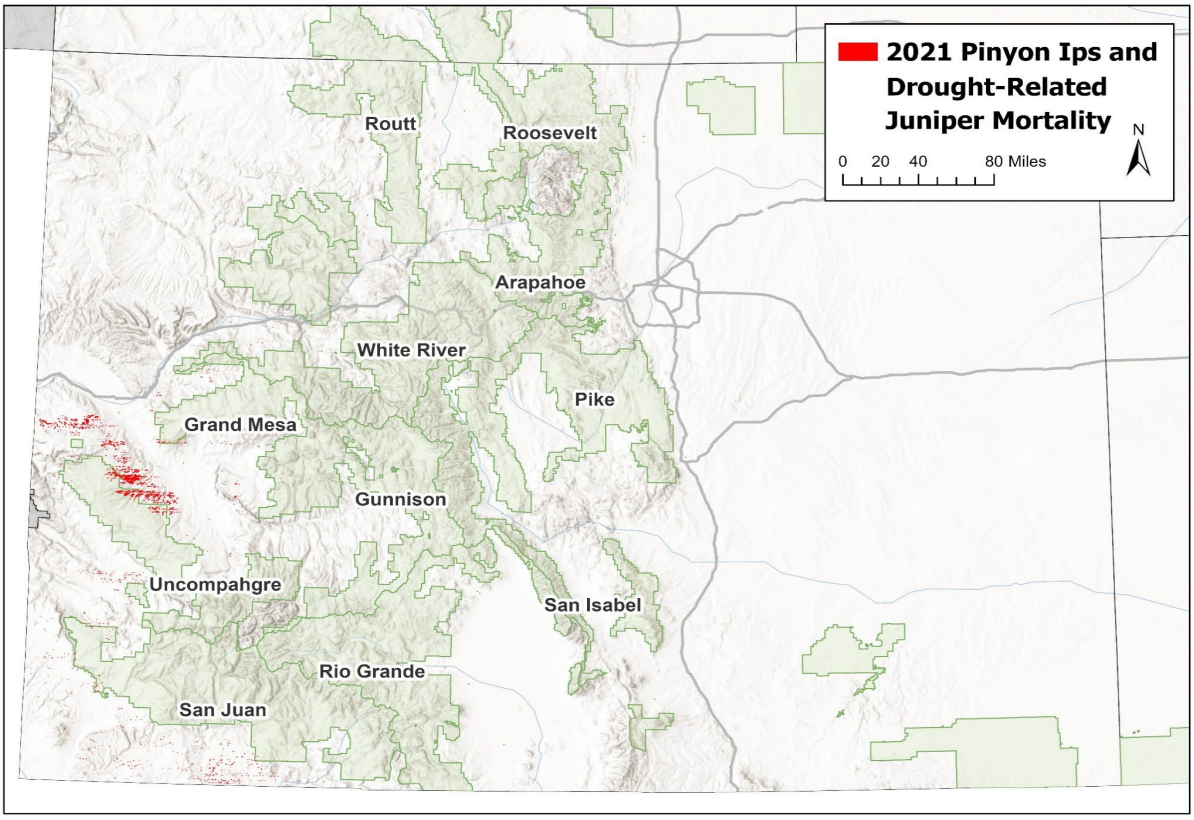

Figure 19. Pinyon Ips and drought-related juniper mortality observed by special aerial surveys in southwest Colorado. Map by Marianne Davenport, USDA Forest Service.

Figure 20. *Ips* caused mortality on the Nebrask NF (left) and the Black Hills NF (right). Photo by Kurt Allen, USDA Forest Service.

Figure 21. *Ips* adult (left), pitch tube caused by *Ips calligraphus* (middle), and galleries and larvae of *Ips* spp. (right). Photos by Kurt Allen, USDA Forest Service.

Western Balsam Bark Beetle

Dryocoetes confusus
Host: subalpine fir

Western Balsam Bark Beetle (Fact Sheet). In Colorado, subalpine fir is dying in large pockets, especially in areas where the species is adjacent to high elevation sagebrush parks (Fig. 22-23); trees in these areas are susceptible to drought and are less likely to overcome beetle attacks. The Grand Mesa, Uncompahgre, and Gunnison (GMUG) National Forests have experienced a noticeable increase in mortality, especially on the Uncompahgre Plateau and the West Elk Mountains. High-intensity mortality has warranted verification by ground observations of the host tree species due to the unusual intensity. In spruce-depleted areas on the Rio Grande National Forest, subalpine and corkbark firs are generally healthy with less competition from spruce due to prior spruce beetle-caused mortality.

In Wyoming, subalpine fir mortality caused by western bark beetle was light and scattered. However, ground surveys indicate what appears to be an increasing amount of beetle activity in the northern Bighorn Mountains (Fig. 24).

Figure 22. Radiating galleries of western balsam bark beetle on subalpine fir. Photos by Rebecca Stokes and Suzanne Marchetti, USDA Forest Service.

Figure 23. Subalpine fir mortality caused by western balsam bark beetle on the Roosevelt NF (left) and Gunnison NF (right). Photos by Justin Backsen and Suzanne Marchetti, USDA Forest Service.

Figure 24. Western balsam bark beetle activity in subalpine fir as observed from the 2021 aerial detection survey. Map by Marianne Davenport, USDA Forest Service.

Red Turpentine Beetle

Dendroctonus valens

Host: any pine species and occasionally Douglas-fir

No observations were reported in the Region of red turpentine beetles. Prevailing drought conditions and abundant fire injured trees are favorable for increased populations of this beetle; however, it is not a primary killer of healthy trees.

Status of Major Defoliators

Western Spruce Budworm

Choristoneura freemani
Hosts: true firs, Douglas-fir, and spruce

Aerial surveys detected 92,000 acres of western spruce budworm in Colorado and 39,000 acres in Wyoming (Fig. 25-26). Aerial surveys may underestimate tree mortality due to western spruce budworm in areas near wildfires as smoke can obscure defoliation from the air.

In Wyoming, spruce budworm defoliation continues across almost all Douglas-fir stands on the Shoshone, Bighorn, and Medicine Bow National Forests. In many areas, heavy defoliation on trees of all sizes has occurred for multiple years leading to unhealthy trees and causing tree mortality. Light budworm defoliation has been observed in Engelmann spruce and subalpine fir. Many areas with the heaviest defoliation are experiencing increased Douglas-fir beetle activity as the beetles take advantage of trees weakened by western spruce budworm.

In Colorado, budworm activity intensified and expanded into areas that have not been seen in many years. In the San Juan and Gunnison National Forests, including Taylor Mesa and Kebler Pass, ground observations recorded heavy budworm damage in spruce/fir stands.

Aspen Defoliating Insects

Large aspen tortrix, *Choristoneura conflictana*
Western tent caterpillar, *Malacosoma californicum*
Host: aspen

Aspen defoliation/foliar damage caused by a combination of defoliators and other biotic and abiotic agents was observed over 15,000 acres in the Region, primarily in Colorado. The most notable insect defoliation events are caused by large aspen tortrix larvae and western tent caterpillars (Fig. 27). Aspen leaf diseases and abiotic defoliators are discussed in the “Status of Major Diseases” section. These agents produce similar aerial signatures and must be verified by ground observations to identify the specific damage-causing agents in a particular stand. Aspen trees typically survive defoliation events; however, repeated defoliation over several years can result in mortality.

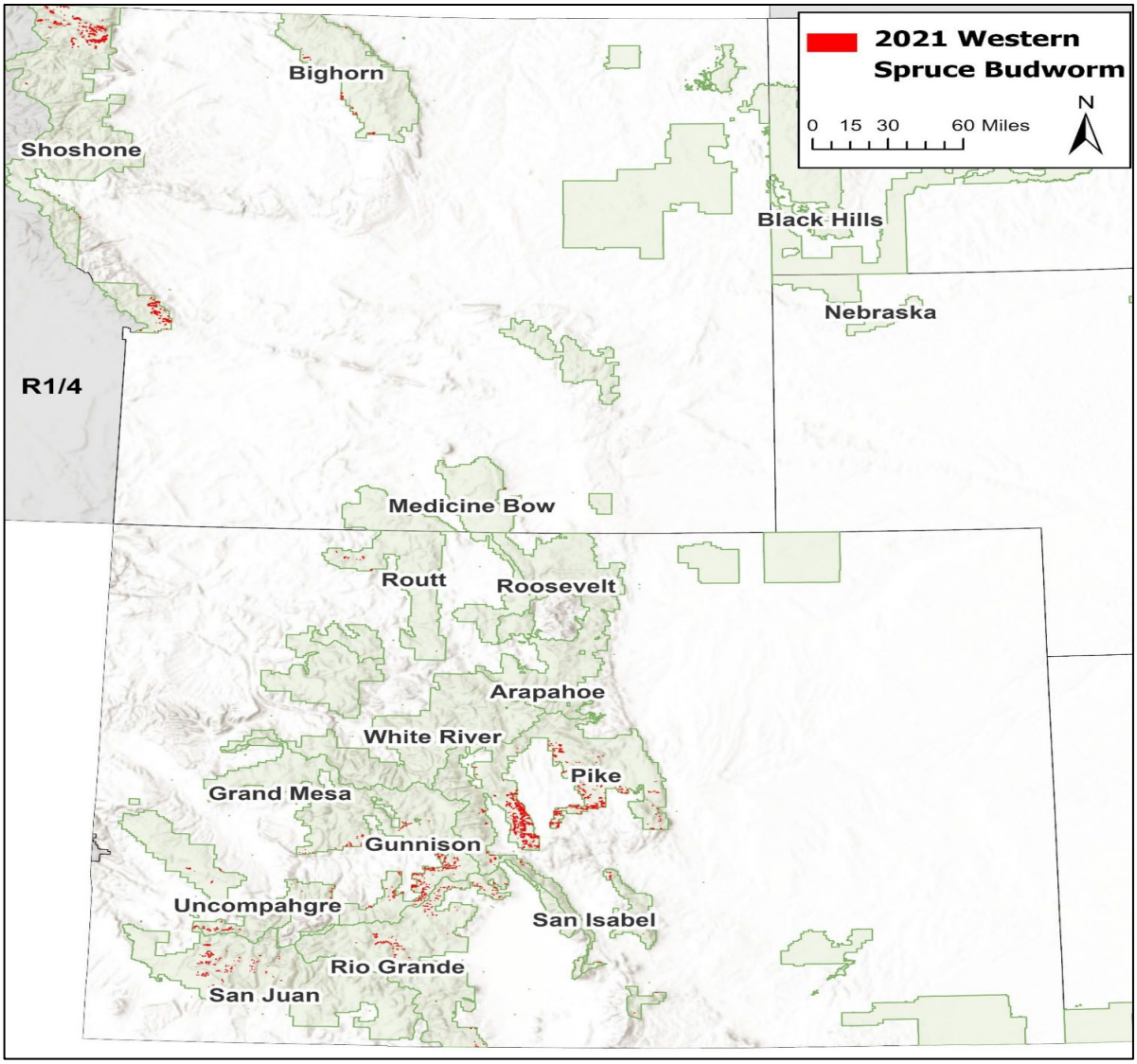

Figure 25. Western spruce budworm activity as observed from the 2021 aerial detection survey. Map by Marianne Davenport, USDA Forest Service.

Figure 26. Western spruce budworm larvae in southern Colorado (left) and feeding damage (middle and right) on the Shoshone NF. Photos by Suzanne Marchetti and Kurt Allen, respectively, USDA Forest Service.

Figure 27. Western tent caterpillars on chokecherry trees in Gunnison NF. Photo by Suzanne Marchetti, USDA Forest Service.

Pandora Moth

Coloradia pandora

Host: ponderosa pine

Although pandora moths are one of the largest defoloitors of ponderosa pine, they are not often observed in the Region. However, one moth was photgraphed in late May in Custer, South Dakota in 2021 (Fig. 28).

Figure 28. Pandora Moth in the Black Hills. Photo by Matt Daily, USDA Forest Service.

Pine Tussock Moth

Dasychira grisefacta (Dyar)
Host: ponderosa pine

This insect, which feeds on pine needles, is typically present at low levels and unnoticed during aerial surveys. However, outbreaks in the Region have been previously recorded in western Nebraska. In 2021, a pine tussock moth outbreak was observed on private lands in the western Black Hills region in northeast Wyoming on ponderosa pine (Fig. 29).

Figure 29. Pine tussock moth (left) and defoliated ponderosa pines northeastern Wyoming in 2021 (right). Photo by Harrison Brookes, Wyoming Forestry Division.

Aspen Blotchminer

Phyllonorycter tremuloidiella
Hosts: primarily aspen

Aspen blotchminer is a moth larva that feeds between the surfaces of aspen leaves causing noticeable injury and darkening to individual leaves (Fig. 30). 2021 is the first year this insect has been documented causing widespread damage. Damage is generally not extensive but was identified as aspen discoloration by aerial surveyors on the Gunnison National Forest, and subsequently verified by ground observations on Independence Pass and Kenosha Pass in 2021.

Figure 30. Aspen blotchminer larva emerging from gallery (left). Late stage darkening of gallery pockets (right). Photo by Suzanne Marchetti, USDA Forest Service.

Pine Aphids

Pineus spp., *Cinara* spp.

Hosts: ponderosa pine and other conifers

High levels of aphids and scale insects were found on ponderosa pine in scattered areas of the Black Hills Mountains, most notably near the experimental forest (Fig. 31). Infestations were so intense that the trees appeared wet and the ground cover was saturated with honeydew secreted from the insects.

Figure 31. Aphid infestations on ponderosa pine in the Black Hills (both). Photos by Kurt Allen, USDA Forest Service.

Status of Major Diseases

Dwarf Mistletoes

Arceuthobium spp.
Hosts: pines and Douglas-fir

Dwarf mistletoes (Fig. 32) are parasitic plants that cause widespread disease in coniferous forests of the Region. Dwarf mistletoe infections cause branch deformity, also known as witches' brooms, stunted growth, thinning crowns, and premature mortality. Stress induced by severe infection often leads to bark beetle or root disease-related mortality. Fire regimes play a direct role in the incidence and severity of dwarf mistletoes. Fire exclusion leads to extensive spread.

Figure 32. Southwestern dwarf mistletoe plants (left) and a heavily infected Douglas-fir with large witches' brooms on the Rio Grande NF (right). Photos by Brad Lalande, USDA Forest Service.

Large wildfires of 2020 reduced the overall inoculum of dwarf mistletoe in the Region, yet it continues to persist in Colorado and Wyoming. Treatments were conducted on the Bighorn (150 acres), GMUG (70 acres), Medicine Bow-Routt (200 acres), and Shoshone (150 acres) National Forests to reduce dwarf mistletoe impacts. Continued management of dwarf mistletoe, in conjunction with bark beetle management, will increase the health of future forests.

A dwarf mistletoe management guide is available for the region (*Dwarf Mistletoes: Ecology and Management in the Rocky Mountain Region*). Please see our website.

Root Diseases

Root diseases caused by pathogenic fungi are ubiquitous in all tree species throughout the Region. *Armillaria* spp. causes the most damage in the mixed conifer forest type in the Region. While other root disease pathogens, such as *Heterobasidion* spp. (white fir in Colorado and pine in Nebraska), *Onnia tomentosa* (spruce-fir and pines), and *Phaeolus schweinitzii* (Douglas-fir) occasionally occur throughout the Region, particularly in southwest Colorado. Ganoderma root disease is prevalent in aspen and can be especially problematic in developed recreation areas due to green tree failures. Root diseases are difficult to identify (without fruiting bodies) and manage, as they persist in the soil for decades as saprophytes and symptoms are often obscure.

Armillaria Root Disease

Armillaria spp., primarily *A. solidipes* (*A. ostoyae*), *A sinapina,* and *A. gallica*
Hosts: almost all tree species in the Region are susceptible

Armillaria spp. are the most common root pathogens and occur on every tree species in the Region. Signs of the pathogen include mycelial fans under the bark and root-like rhizomorphs (vegetative underground growth) (Fig. 33), zone lines in wood, and occasionally clustered honey mushrooms at the base of trees. Infected host trees may have crown dieback/thinning, resin at the base of the tree, and extensive decay in the tree's roots and base.

In 2021, a multiregional (Northern, Rocky Mountain, and Intermountain Regions) group conducted subalpine fir mortality surveys in Colorado, Wyoming, and Montana to determine the presence of pathogens associated with subalpine fir. The surveys identified Armillaria spp. on both live and dead subalpine fir, with rhizomorphs (on live and dead trees) and mycelial fans (mostly on dead trees or dead tissue) observed.

In 78 riparian areas of Nebraska, North Dakota, and South Dakota, *A. gallica* was the only species identified; it was found to cause root disease 69% of the time and rot at the base of the tree 18% of the time in 10 different live hardwood tree species. In the Nebraska National Forest, including mostly non-riparian areas, *A. gallica* was also the only *Armillaria* species identified and was found causing both root disease and rot at the base of the tree of hardwood tree species (Fig. 33). These surveys suggest *A. gallica* is a common root pathogen of hardwood trees in these states with a much wider host and geographic range than previously known.

Figure 33. Armillaria mycelial fans in an Engelmann spruce root (left). Rhizomorphs found on white fir in conjunction with Heterobasidion root disease (middle). Extensive butt rot caused by *Armillaria gallica* in green ash (right). Photos by Brad Lalande (left/middle) and Jim Blodgett (right), USDA Forest Service.

Comandra Blister Rust

Cronartium comandrae
Hosts: lodgepole and ponderosa pine
Alternate host: bastard toadflax and northern comandra

Comandra blister rust is one of the more important diseases of lodgepole pine in the Region. It causes stem deformities, growth reduction, and cankers that girdle branches or stems, resulting in top-kill (spiked tops), flagging (branch death), or tree mortality. The rust affects the tree's form and growth rate and lowers lumber quality. On large trees, stem cankers usually result in the non-merchantability of infected logs. Infected seedlings and young trees are frequently killed.

This fungal rust disease is especially severe in Wyoming and northern Colorado affecting lodgepole and to a lesser degree ponderosa pine. The disease enters its host through needles and initially spreads down branches, causing branch flagging. During a 2021 survey in Wyoming, many branch cankers were observed, indicating many recent infections. This disease will eventually spread into stems, where it causes top kill and tree mortality. The perennial stem cankers with concentric ridges of resinous sapwood and dead cambium tend to be yellow-colored due to heavy resin flow (Fig. 34). Signs include light yellow to orange pustules (aecia) of spores (aeciospores) produced at canker margins.

Figure 34. Comandra blister rust causing top kill (left) with a closer view of the stem on the same tree (middle), and the rust sporulating on a young stem (right). Photos by Jim Blodgett, USDA Forest Service.

White Pine Blister Rust

Cronartium ribicola
Hosts: limber, whitebark, and Rocky Mountain bristlecone pine
Alternate hosts: currants and gooseberries (*Ribes* spp.), and species of *Pedicularis* and *Castilleja*

White pine blister rust (WPBR), caused by the exotic, invasive fungus *Cronartium ribicola*, continues to spread and intensify in the Region (Fig. 35). Favorable weather conditions over the past decade have allowed for continued expansion of the disease into previously unimpacted sites. New outbreaks have been reported in Boulder, Larimer, Alamosa, Huerfano, Costilla, and Saguache counties in Colorado and Albany and Carbon counties in Wyoming. Branch flagging, top kill, and mortality of some seedlings and saplings are occurring. In areas where the disease is well-established, such as the Medicine Bow, Bighorn, Shoshone, and Black Hills National Forests, WPBR is killing and damaging trees in almost all stands of five-needle pines in the Region.

The combined impacts of WPBR, bark beetles and climate change threaten white pines, including all host pine trees. Limber pine is listed as a “species of local concern” on the Black Hills National Forest, “species of management concern” in Rocky Mountain National Park, and a “US Bureau of Land Management sensitive species” in Wyoming. In December 2020, US Fish and Wildlife Service proposed listing whitebark pine on the Shoshone National Forest and Wind River Indian Reservation in the Region as threatened under the Endangered Species Act. The Species Status Assessment Report concluded that the primary stressor affecting the conservation status of whitebark pine is WPBR. If listed, protections for whitebark pine will be increased, and conservation strategies will be promoted.

A recent survey of 106 permanent plots extending from central Montana to southern Colorado found about 30 percent of live limber pines greater than 4.5 feet tall were infected with rust. However, large portions of the white pine distribution in the Region have not been challenged by rust, particularly in Colorado (Fig. 36). Region 2 Forest Health Protection

employees collaborate with Colorado State University and National Park Service partners and other USDA Forest Service employees and scientists from across the country to develop, promote, and implement proactive management strategies to protect, conserve, and restore these important species.

Figure 35. Aecia rupturing through the bark of a limber pine sapling (left). Typical crown symptoms of WPBR include flagging (branch death) and top kill (right). Photos by Kelly Burns, USDA Forest Service.

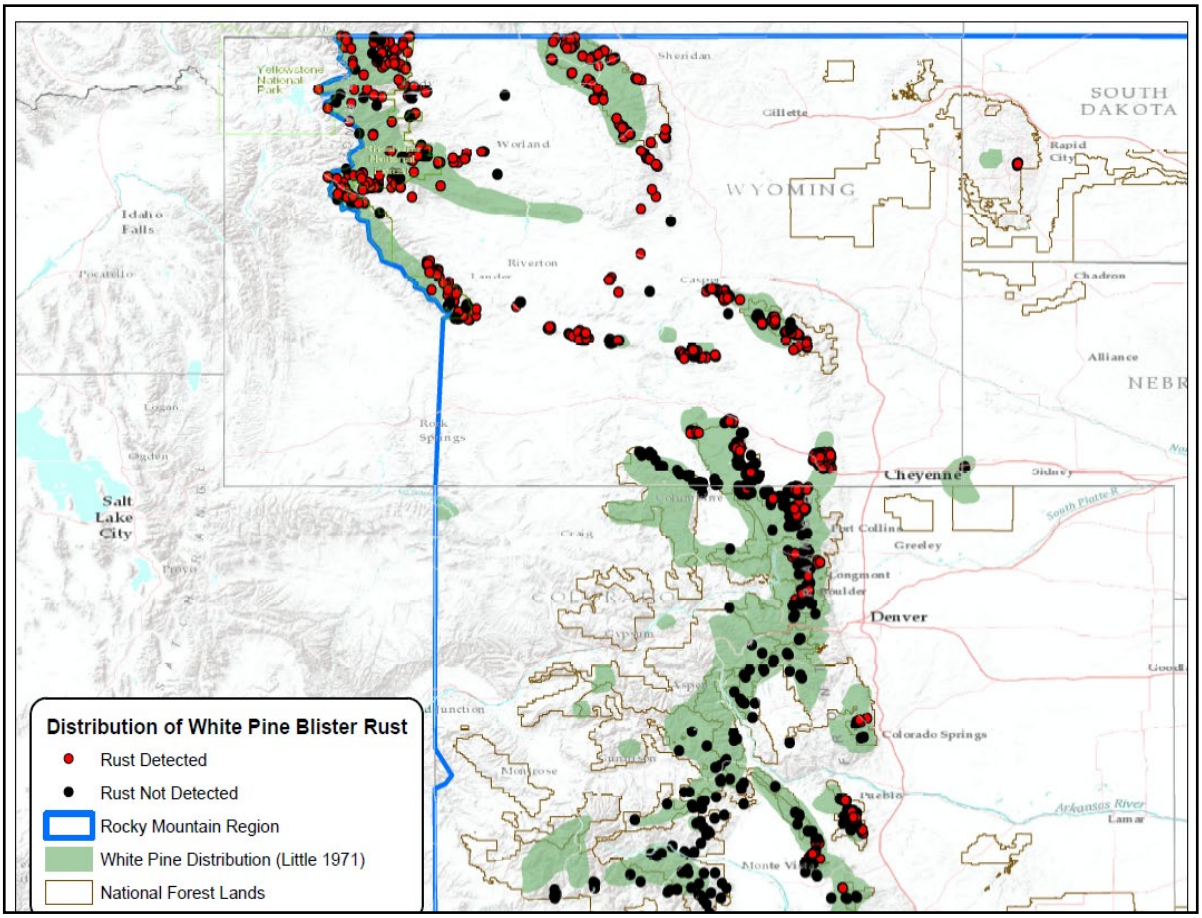

Figure 36. Current distribution of WPBR in Region 2 based on ground observations, including site visits, permanent/temporary plots, and transects.

Spruce Broom Rust

Chrysomyxa arctostaphyli

Hosts: mostly Engelmann and Colorado blue spruce

Alternate hosts: bearberry or kinnikinnick; manzanitas are occasional alternate hosts

Spruce broom rust was frequently observed sporulating in Colorado and Wyoming in 2021 (Fig. 37). This could indicate a "wave year" with more brooms in the next few years. This disease causes a dense proliferation of branches (witches' brooms) in infected trees. Brooms often lead to cankers and deformations, dead tops and branches, broken tops and branches, growth loss, top-kill, and tree mortality. Rust brooms are especially damaging when they occur near the stem (Fig. 37). Rust brooms can serve as infection courts for decay fungi, resulting in stem breakage, creating hazards in developed recreation areas.

Figure 37. Spruce broom rust sporulating on Engelmann spruce with orange aecia (left and center), and an older broom in the main stem (right). Photos by Jim Blodgett, USDA Forest Service.

Western Gall Rust

Peridermium harknessii
Hosts: lodgepole and ponderosa pine

Symptoms of western gall rust are round to pear-shaped swellings or galls on branches or stems. Flared target-like cankers, called “hip” cankers (Fig. 38) are common in lodgepole and ponderosa pine in some areas of the Region. Orange pustules (aecia) with yellow-orange spores (aeciospores) form in bark cracks on galls or at the edges of the hip cankers (Fig. 38). Stem cankers can greatly reduce merchantable volume.

Mass infections occur in “wave years” when conditions are favorable. This disease was frequently found sporulating in 2021 in Colorado, South Dakota, and Wyoming. This may indicate that 2021 will be another “wave year” for western gall rust.

Figure 38. Western gall rust causing extensive deformation of a lodgepole pine stem (left), with the fungal pathogen sporulating on the canker edges (middle and right). Photos by Jim Blodgett, USDA Forest Service.

Diplodia Shoot Blight and Canker Disease

Diplodia sapinea
Hosts: pines and other conifers

This disease causes shoot blights and cankers in pines and some other conifers. The fungal pathogen affects seedlings to mature trees, and damage can be severe. Symptoms range from dead needles, new-shoot branch mortality, extensive branch and top death, to tree mortality. New infections often result in short, light brown, wilting needles that fade to gray and remain attached to stems. Needles and stems are often stunted or crooked (Fig. 39).

Diplodia was recently identified in Wyoming and is a persistent disease issue in Kansas, Nebraska, and South Dakota. In 2021, ADS identified: 150 acres in Wyoming, mainly in

Crook County, 2,500 acres in Nebraska mostly in the Nebraska NF, and 130 acres in South Dakota mostly in the Black Hills NF. However, only heavy infections are easily identified during ADS. In a 2021 ground survey of the Nebraska NF, this disease caused extensive damage to some trees with adjacent trees, although symptomatic, showing less crown damage (Fig. 39). The pathogen was confirmed in a laboratory from branch segments of symptomatic trees from all stands surveyed.

Figure 39. Diplodia shoot blight and canker disease in a branch (note drooping needles; left), scattered Diplodia crown symptoms in ponderosa pine (middle), and heavy branch mortality in a tree (right). Photos by Jim Blodgett (left and middle) and Kurt Allen (right), USDA Forest Service.

Common Aspen Diseases

Aspen in parts of the Region have succumbed to insects and diseases, as well as environmental conditions over the last two decades. Fortunately, aspen is regenerating abundantly following large fires that have occurred in some portions of the Region such as on the Laramie District of the Medicine Bow-Routt National Forest. In 2021, aerial detection surveys mapped nearly 16,000 acres of aspen crown dieback and defoliation, primarily on the GMUG, Medicine Bow-Routt, Pike and San Isabel, Rio Grande, and San Juan National Forests. Ground surveys identified a variety of agents contributing to the observed damage, including cytospora canker (*Cytospora* spp.), sooty bark canker (*Encoelia pruinosa*), aspen trunk rot (*Phellinus tremulae*), foliar diseases, wood borers, and bark beetles (Fig. 40). On the Routt National Forest and likely in other impacted areas, secondary pathogens and insects are likely taking advantage of trees weakened by prolonged drought.

The return of seasonal monsoon conditions in southern Colorado resulted in an increase in some foliar diseases in aspen. Most notably, an ink spot (*Ciborinia whetzelii*) was confirmed in an isolated pocket within the San Isabel National Forest, causing extensive foliage discoloration on all age classes (Fig. 41). Marssonina leaf blight (*Marssonina* spp.) was still not prevalent, even with favorable environmental conditions in southwest Colorado.

Figure 40. The three most common diseases found on aspen in Region 2. Fruiting bodies (pycnidia) of cytospora canker with orange tendrils (left), concentric rings of sooty bark canker forming “barber pole” under the bark of a dead aspen (center), and lower surface view of large hoof-shaped conk of *Phellinus tremulae* causing internal stem decay (right). Photos by Brad Lalande, USDA Forest Service.

Figure 41. Progression of ink spot found on aspen leaves in the San Isabel NF. The disease will initially form a reddish-brown expanding blotch pattern, eventually turning to black sclerotic masses that drop to the forest floor (left). Browning leaves characteristics of foliar damage caused by ink spot (right). Photos by Brad Lalande, USDA Forest Service.

Dothistroma or Red-Band Needle-Blight

Mycosphaerella pini
Hosts: pines

Needle-blights cause conifer needles to turn brown and sometimes shed needles prematurely, usually with older needles being lost first. Dothistroma needle-blight is a common and damaging diseases of pine species in Wyoming and South Dakota. However, symptoms are sporadic.

A foliage disease was causing scattered needle chlorosis and necrosis in the Bighorn NF in 2021. Several acres were affected and symptoms were attributed to Dothistroma needle-blight. On many trees, only the current years’ needles were present, and in some cases,

those were being killed by the disease. The disease was affecting trees from seedling stage to maturity (Fig. 42). This disease was also observed in 2020 in different areas of the forest including along Crazy Woman Road.

Figure 42. Symptoms of needle-blight disease in lodgepole pine trees (left), a sapling (middle), and needles (right) from the Bighorn NF. Photos by Jim Blodgett, USDA Forest Service.

Ponderosa Pine Dieback and Mortality

Dieback and mortality of ponderosa pine are increasing in Colorado and Wyoming. The damage became obvious and widespread from the Colorado-Wyoming border area south to Colorado Springs in 2020. ADS mapped some damage (~150 ac.) in 2020 and 2021, but the signature was difficult to pick up from the air. Typical symptoms include flagging, resinosis, and sometimes mortality (Fig. 43). News outlets reported the damage was the result of unusual weather events in 2019-20. Persistent drought is likely exacerbating impacts. A 2021 survey of impacted stands on the Douglas Ranger District of the Medicine Bow National Forest found some secondary insects, such as twig beetles and wood borers, associated with the damage. Currently, it is unclear if any pathogens are involved. Isolations were performed from symptomatic branches and results are pending.

Figure 43. Typical crown symptoms include flagging (branch death) and sometimes mortality (left and right). A heavily impacted stand on the Douglas Ranger District, Medicine Bow NF (right). Photos by Kelly Burns, USDA Forest Service.

Abiotic Damage

Downed Trees from Avalanches and Wind

Depending on the tree species and the size of trees broken or uprooted, avalanches or windthrow can create potential habitat for damaging beetles. Spruce beetle, Douglas-fir beetle, and western balsam bark beetle are attracted to downed trees. When ample suitable host material exists in a stand, increased populations of beetles can flourish, and their numbers may reach epidemic proportions where they can mass-infest and kill healthy, green standing trees in nearby stands Mountain pine beetle is not attracted to downed trees, so the risk of bark beetle outbreaks occurs less often where downed trees are present in lodgepole or ponderosa pine stands. Other beetles, such as engraver beetles, also attack downed trees and can compete with potentially more serious bark beetles for space beneath the bark. In areas where avalanches are frequent, trees tend to be smaller and present less risk. In new blowdown events (Fig. 44) there may be larger diameter trees taken down, creating beetle habitat.Weather conditions, stand age, and composition all influence the potential for bark beetles to move into downed trees and eventually adjacent trees.

Extensive areas of windthrow in September 2020 across western Colorado and Wyoming occurred in lodgepole pine, spruce-fir, and aspen. Aerial Survey mapped 3,400 acres in Colorado and 50 acres in Wyoming and South Dakota. Forests are working with Forest Health Protection to prioritize treatment efforts to minimize potential bark beetle problems.

Figure 44. Windthrown lodgepole, aspen, spruce, and fir near Tin Cup, Gunnison NF, Colorado. Photo by Brian Howell, USDA Forest Service.

FHP Project Funding: Making a Difference on Federal Lands

Regional FHP personnel work with the National Forest Service and other federal agencies in Region 2 to develop and fund projects. In 2021, eight National Forests used Forest Health Protection funding to help manage insect and disease problems on federal lands. In addition, the Washington Office funded projects on Rocky Mountain National Park, Black Canyon of the Gunnison National Park, and Bureau of Land Management Buffalo Field Office lands in the southern Bighorn Mountains.

The Bighorn NF used FHP funds to thin advanced regeneration in the Canyon Creek Timber Sale area, removing dwarf mistletoe and Comandra rust infected lodgepole pine and retaining healthy Engelmann spruce, subalpine fir, and lodgepole pine on about 150 acres.

The Black Hills NF mixed FHP funds with trust funds to mechanically and manually precommercial thin overstocked ponderosa pine stands on the Northern Hills Ranger District. This project also supports fuels targets while improving forest resilience to bark beetles and timber growth. Forest Health Protection funded about 90 acres of the 481-acre project.

The Grand Mesa Uncompahgre and Gunnison NF (GMUG) used FHP funds for dwarf mistletoe, root disease, bark beetle, and windthrow sanitation across multiple districts in forest management areas and developed recreation sites. They also used MCH to protect high value Douglas-fir from Douglas-fir beetle on selected developed sites and cooperatively in a wildland interface area adjacent to the Lawson Hill subdivision. Forest heath work on the Telluride Ski Area complemented a GMUG Good Neighbor Agreement for thinning work. Funds were used for aspen restoration on Grand Mesa. FHP funds and surveys also supported mountain pine beetle sanitation efforts in the Wilder-Gunnison Highlands cooperative response project. This partnership with the National Forest Foundation and Colorado State Forest Service has been highlighted nationally and regionally as an excellent example of shared stewardship.

The Medicine Bow-Routt NF used FHP funds to clean up windthrown trees on the Turpin Spruce Blowdown project and did thinning work to encourage growth of aspen and herbaceous cover on Pole Mountain on the Laramie Ranger district. The Yampa Ranger District continued sanitation of dwarf mistletoe left after timber sales salvaged following a mountain pine beetle epidemics.

The Rio Grande NF used FHP funding to complete 300 acres of mastication within the Trough Project Area. The project included mastication of western spruce budworm host species, primarily Douglas-fir, that have been chronically impacted. Host species within the area exhibit dead tops, fading needles, needle cast, and other signs of severe infestation. The project improved forest health and wildlife habitat, reduced the multistory stand structure, and shifted species composition toward ponderosa pine and aspen (Fig. 45).

Figure 45. Trough mastication and thinning treatment to reduce western spruce budworm habitat. Photo by Kirby Self, USDA Forest Service.

The Pike-San Isabel NF used FHP funds for thinning and sanitation projects on the Pikes Peak, Salida and San Carlos Ranger Districts, and for bark beetle preventive spray projects on developed sites on the Pikes Peak and San Carlos Ranger Districts.

The San Juan NF used FHP funds to contract for thinning and removal of roundheaded pine beetle-infested pines on 120 acres on the Luggan project area in Glade Canyon, and to thin and hand pile 44 acres at the Junction Creek Campground and Trailhead. MCH provided by the FHP Gunnison Service Center was used to protect Doulas-fir trees at the Treasure Falls Trailhead and Vallecito Creek Campground.

The Shoshone NF used FHP funds to remove dwarf mistletoe and *Comandra* rust infested trees on about 165 acres in previously thinned lodgepole pine stands. FHP funds were also used to thin for bark beetle resilience in Douglas-fir stands defoliated by western spruce budworm along the Clarks Fork.

FHP Programs and Information for Managing Invasive Species

The most notable invasive forest pest of our native trees in the Region is the Eurasian disease white pine blister rust, which is expanding its range in five-needle pines.

Many more invasive tree insect and disease pests affect nonnative trees in our urban and planted landscapes. Some are devastating urban tree pests such as emerald ash borer, walnut twig beetle, and Dutch elm disease. On our NFS lands, invasive plants are a serious threat to our rangelands and native plant communities. State and Private Forestry-FHP does not fund invasive plant treatments on NFS lands.

Invasive Plant Grants to States

FHP provides limited grant funding to state agencies for assistance with local management of invasive plants on state and private forest lands to reduce the spread of priority weeds on all forest lands. By maintaining some flexibility in the program, states can put these dollars where they can really make a project or program successful. Even small grants to the local weed boards can make a big difference. Each state handles the funds differently to support treatments and leverage state and county funding for weed programs. Our state agency partners for the invasives plants program are Colorado Department of Agriculture, Wyoming Department of Agriculture, South Dakota Department of Agriculture-Resources, Conservation and Forestry Division, Nebraska Forest Service, and Kansas Forest Service.

Other Entomology and Pathology Activities

FHP Trainings

Hybrid FHP hazard tree trainings were conducted in which participants attended a virtual classroom and an in-person field session to reduce exposure to COVID-19. Gunnison, Medicine Bow-Routt, Uncompahgre, and White River NFs participated in Hazard Tree Management trainings, with additional assistance given to Region 1 & 4 in Yellowstone National Park. All traditional Insect and Disease trainings were canceled for 2021. Both Hazard Tree Management and Insect and Disease trainings are tentatively scheduled for 2022. For more information regarding regional trainings please visit our website.

Hazard Tree Success Story

While preparing for the field portion of our Hazard Tree Management trainings, we visited Yeoman Park Campground on the White River NF. This campground is operated and maintained by the Forest Service and consists of 24 campsites of which a portion are within dense, mature spruce-fir forests. The forest identified a live Engelmann spruce that failed due to extensive internal decay (Fig. 46) and several other trees with severe defects. This prompted the Eagle Holy Cross Ranger District to close the campground for the foreseeable future to perform a full hazard tree evaluation. The campground evaluation was completed in about 2 weeks with assistance from timber and recreation staff, as well as local high school students. Large diameter, mature Engelmann spruce are prone to internal decay as they age, which increased the complexity to mitigate hazards at the site. Therefore, the campground will remain closed until all hazard trees can be mitigated. We appreciate the hard work by the Eagle-Holy Cross Ranger District to ensure the health and safety of all who recreate in NFS lands.

Figure 46. Engelmann spruce with extensive internal decay (left). Internal brown rot inside of failed Engelmann spruce following removal (right). Photos by Brad Lalande, USDA Forest Service.

Hazard Tree Management Program and Updates

Revisions were made to the *Guide to Hazard Tree Management* (herein updated to *Hazard Tree Management* Technical Report R2-73) and to the *Hazard Tree Management Training Supplement*. The supplement is for training purposes in conjunction with the *Hazard Tree Management* Technical Report, *Field Guide to Diseases and Insects of Rocky Mountain Region*, *Hazard Tree Evaluation Survey123 and ArcGIS Online Guide*, and the *Tree Failure Form Guide.* The supplement is also included the Region 2 *Hazard Tree Evaluation Form* and *How to Prune Trees* guidelines. All Hazard Tree Management information were updated and are available on our website.

Limber Pine Planting on the Black Hills NF

In South Dakota, limber pine, a Black Hills NF species of local concern, occurs in isolated areas scattered over a small geographic area of about 2 square miles in the Black Elk Wilderness of the forest and adjacent Custer State Park. Recently, many of these pines were killed by mountain pine beetle and white pine blister rust. An integrated management plan has been implemented in the forest including planting 2-year-old limber pine seedlings. Four hundred and fifty-five seedlings from local seed were planted in the spring of 2017, 2018, and 2021 at seven areas with the help of several volunteers (Fig. 47). Seedling survival has been better than expected (97%) and we are seeing good exponential growth (average 2.4 inches/yr).

Figure 47. One of seven limber pine planting sites in the Black Hills NF (left), example of the great limber pine growth (middle), and some of the helpful volunteers (right). Photos by Jim Blodgett, USDA Forest Service.

Special Forest Health Protection Projects

Evaluation Monitoring (EM)

Sentinel walnuts: monitoring decline and change in western Kansas walnuts for early detection of thousand cankers disease. EM-IW-20-01. Ryan Armbrust and Jim Kruse.

Special Technology Development Program (STDP)

FHP Project to advance and utilize acoustic technologies to detect wood-infesting insects. STDP-R2-20-01. Richard Hofstetter and Sky Stephens.

DNA-based identification and characterization of forest root disease pathogens in western USA. STDP-R2-18-01. Ned Klopfenstein, Jane Stewart, Mee-Sook Kim, and James Blodgett.

Developing molecular tools to identify emerging conifer foliage pathogens. STDP-R2-17-03. Jane Stewart, Suzanne Marchetti, and Kelly Burns.

Biocontrol of Invasive Forest Pests (BCIFP)

Enhancing Canada thistle biocontrol: development of accurate and cost-effective tools to identify Canada thistle rust in plant tissue and soil. BCIFP-R2-20-01. Andrew Norton.

Performance curves to optimize mass rearing and field release of introduction biological control for Russian knapweed. BCIFP-R2-20-02. Paul Ode.

Pesticide Impact Assessment Program (PIAP)

Fostering community forest resilience in the Great Plains. PIAP-R2-21-01. John Ball.

Publications

2021 Biological Evaluations and Service Trips

Gunnison Service Center

GSC-21-01, Crane Timber Sale Insect and Disease Evaluation: Grand Valley and Paonia Ranger Districts: Gunnison, Grand Mesa, and Uncompahgre NFs – Lalande, Schotzko, Lockner, Marchetti

GSC-21-02, Mountain Pine Beetle Activity in Lodgepole Pine: Wilder, Gunnison Highlands, and Gunnison NFs - Lockner, Schotzko, Lalande, Marchetti

GSC-21-03, Bayfield Ranger District (San Juan National Forest) Campground Insect and Disease Assessments – Lalande, Lockner

GSC-21-04, Biological Evaluation of Mountain Pine Beetle in Lodgepole Pine: Wilder, Gunnison Highlands, and Gunnison NF – Lockner, Schotzko, Lalande, Marchetti

GSC-21-05, Insect and Disease Assessment Associated with Grand Mesa Blowdown Event (Grand Valley and Paonia Ranger Districts), Gunnison, Grand Mesa, and Uncompahgre NF – Lalande, Lockner, Schotzko

GSC-21-06, Recent Blowdown in Previously Treated Areas on Taylor/Stoner Mesa, Dolores Ranger District, San Juan NF – Lockner, Lalande

GSC-21-07, Western Spruce Budworm Surveys on the Taylor Mesa of the Dolores Ranger District, San Juan NF – Schotzko, Lockner, Lalande

GSC-21-08, Lower Hermosa 416 Fire and Saul's Creek Insect and Disease Assessment, Bayfield Ranger District, San Juan NF – Lalande, Lockner

GSC-21-10, Hazard Trees at One Mile Campground, Gunnison RD, Grand Mesa, Uncompahgre, and Gunnison (GMUG) NFs – Lalande

Lakewood Service Center

LSC-21-01, Tree Mortality Assessment on Clear Creek County Parcel R161239 – Stephens, Burns

LSC-21-02, Spruce Beetle Management Recommendations and Risk Table Decision Guide – Stephens, Stokes

LSC-21-03, Assessment of MCH Deployment for Douglas-fir Beetle Management at Kelsey Campground, South Platte Ranger District, Pike NF – Stephens

LSC-21-04, Accomplishments in Spruce Beetle Management: Guanella Pass Campground, Arapaho-Roosevelt NF – Stephens

LSC-21-05, Site Assessment on the U.S. Air Force Academy – Stokes

LSC-21-07, Spruce blowdown assessment for Hahns Peak Bears Ears RD – Stokes

LSC-21-08, Spruce blowdown assessment for Sulphur RD – Stokes

LSC-21-09, Forest Health assessment for Rocky Mountain National Park – Stokes

LSC-21-10, Evaluation of Recent Green Tree Failures in Springdale CG, PPRD, PSICC – Burns

LSC-21-11, Limber Pine Conservation Program in Rocky Mountain National Park FY21 – Burns

LSC-21-12, Site Assessment on the U.S. Air Force Academy – Stokes

LSC-22-01, Evaluation of Declining Aspen Stands in Steamboat Srpings, HPBE RD, RNF – Burns, Kruse, Lalande, Stokes

LSC-22-02, Site Assessment of Aspen Ski Area – Stokes

LSC-22-03, Fox Park Dwarf Mistletoe Projects – Burns

Rapid City Service Center

RCSC-21-01, Conditions in White Spruce Stands in the PAR Project Area – Allen, Schotzko, Blodgett

RCSC-21-2, Pine Engraver Beetle Activity on the Black Hills NF – Allen, Schotzko

RCSC-21-3, Needle-Blight Disease on Lodgepole Pine in the Bighorn NF – Blodgett, Allen

RCSC-21-4, Spruce Beetle Activity on the Bighorn NF – Allen, Schotzko, Blodgett

RCSC-21-5, Western Spruce Budworm Activity in the Sinks Canyon Area, Shoshone NF – Schotzko, Allen, Blodgett

RCSC-21-6, Pine Engraver Beetle Activity in Tornado Damaged Areas on the Black Hills NF – Allen, Schotzko
RCSC-21-7, Pine Engraver Beetle Activity at Mt Rushmore National Memorial – Allen, Schotzko

Other Reports and Peer-Reviewed Publications

Alveshere, B. C., McMurtrey, S., Bennett, P., Kim, M. S., Hanna, J. W., Klopfenstein, N. B., Blodgett, J. T.. and LeBoldus, J. M. 2020. Phylogeography and host range of *Armillaria gallica* in riparian forests of the northern Great Plains, USA. For. Pathology. 51:e12663.

Blodgett, J. T., Smith, D. R., and Stanosz, G. R. 2021. First report of Diplodia shoot blight and canker disease caused by *Diplodia sapinea* on ponderosa pine in WY, U.S.A. Plant Dis. 105:3289.

Blodgett, J. T., Burns, K. S., and Lalande, B. M. 2021. Hazard Tree Management. USDA Forest Service, Rocky Mountain Region, Forest Health Protection, Tech. Rpt. R2-73.

Blodgett, J. T., Burns, K. S., and Lalande, B. M. 2021. Hazard Tree Evaluation Survey123 and ArcGIS Online Guide. USDA Forest Service, Rocky Mountain Region, Forest Health Protection, Tech. Rpt. R2-71-Version 2.

Stewart, J. E., Kim, M. S., Lalande, B. M., and Klopfenstein, N. B. 2021. Pathobiome and microbial communities associated with forest tree root diseases. In F.O. Asiegbu & A. Kovalchuk. (1st Ed.). Forest Microbiology Tree Microbiome: Phyllosphere, Endosphere, and Rhizosphere. Pg. 277-292. Elsevier.

Wright, S. A., Lalande, B. M., Wilhemi, N., and Stewart, J.E. 2021. First report of *Biscogniauxia mediterranea* on *Quercus emoryi* in southern Arizona. Plant Dis. 2021 Oct 13. doi: 10.1094/PDIS-09-21-1933-PDN.

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Rapid City Service Center
Kurt Allen – Service Center Leader
James Blodgett – Plant Pathologist/Forest Health Monitoring Program Coordinator (acting)
Kendra Schotzko – Entomologist
Vacant – Forestry Technician

State Partners

Colorado State Forest Service – Dan West, Forest Entomologist
Kansas Forest Service – Ryan Armbrust, Forest Health Coordinator
Nebraska Forest Service – Laurie Stepanek, Forest Health Specialist
South Dakota Resource Conservation and Forestry Division – Anthony Seidl, Forest Health Program Coordinator
Wyoming State Forestry Division – Harrison Brookes, Forest Health Program Manager

Report from the Forest Health Protection Staff
Rocky Mountain Region, Forest Health Protection's Web page.