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Forest Insect and Disease Conditions in the Rocky Mountain Region, 2020

Forest Service

Rocky Mountain Region

Forest Health
R2–RO–21-01
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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 2020.

Cover photo: Spruce beetle caused tree mortality on Monarch Pass, Colorado. Photo by Suzanne Marchetti, USDA Forest Service.

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Conditions in Brief

2020 Weather Summary for the Rocky Mountain Region

In 2020, the Rocky Mountain Region (Region 2 or R2) experienced average precipitation during the winter and spring, followed by a severe drought across the Region in the summer and fall. These drought conditions, combined with above-average temperatures, (Fig. 1) resulted in a destructive fire season. Colorado and Wyoming experienced several large fires that burned for months. In fact, the three largest fires in recorded Colorado history all occurred in 2020.

The Region experienced other severe weather phenomena throughout the year, which impacted forest health. Instances of late-spring frosts were documented, which damaged budding trees. There were also several notable instances of wind and hail damage in the Region. The Black Hills National Forest experienced hail and tornado events in the spring and in early July. The Medicine Bow-Routt and Arapaho Roosevelt National Forests recorded damage from a rare derecho wind event which formed on June 6th, causing damage across Colorado, Wyoming, western Nebraska and the Dakotas. Wind gusts over 110 mph were recorded near Winter Park, CO. Uncommonly high winds were also observed over the Rockies from Montana into the Four-Corners September 8-10, causing localized damage in forests throughout the area.

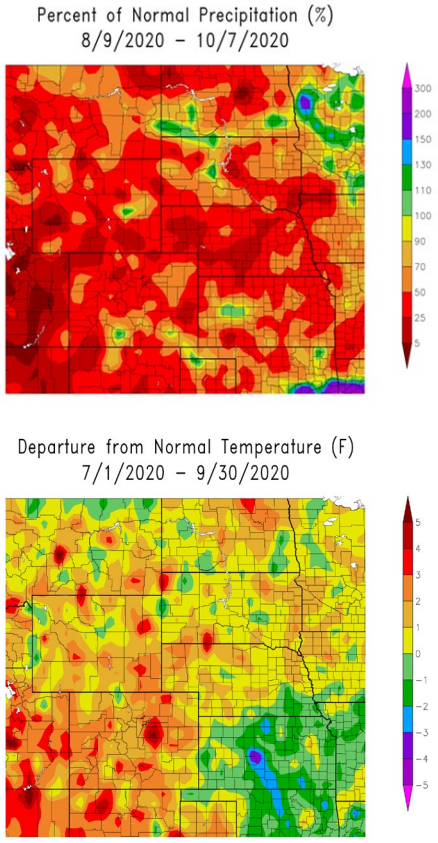

Figure 1. Departure from normal temperature (F; above) precipitation (%; below) for Region 2. Source: High Plains Regional Climate Center.

Aerial Survey Summary

Each year during the summer and early fall, Forest Health Protection (FHP) and its state partners conduct aerial surveys to map forest insect and disease activity in the Rocky Mountain 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 sketchmapping 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 the terrain in mountainous or deeply dissected landscapes. The US Forest Service partners with state cooperating agencies to conduct the annual survey.

In 2020, the aerial survey plan was disrupted by a global pandemic caused by the COVID-19 coronavirus. In a normal year, the goal is to survey all forested lands above the pinyon-juniper forest type, which is about 44 million acres. To reduce possible exposure to the virus, extra precautions were taken, which limited the 2020 survey. All surveys were conducted out of the local airport in Broomfield, CO and personnel were divided into compartmentalized teams. The aerial survey team worked closely with service center personnel and other cooperators to prioritize the areas that were surveyed. The Region was divided into low, medium and high priority areas to direct survey efforts. The aerial survey team covered nearly all the high and medium priority areas and some of the low priority areas, totaling approximately 23 million acres (Fig. 2). Not all of the areas within the region were flown in 2020 therefore comparing the number of acres impacted by insect and disease agents between years is misleading.

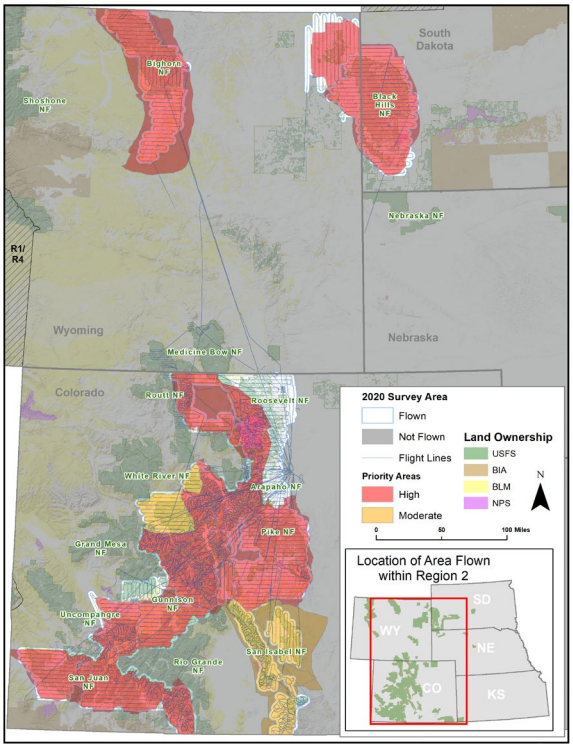

Figure 2. Priority areas and flight lines from the 2020 aerial detection survey.

Bark Beetle Summary

Across the Region, total acres mapped with new tree mortality attributed to bark beetles generally declined in those areas flown both in 2019 and 2020, but large epidemics of spruce beetle and roundheaded/western pine beetles in Colorado continue to expand. Aerial survey numbers reported in Tables 1 and 2 indicate acres with varying intensities of fading trees that were mapped in 2020**.**

Table 1. Bark beetle[1] activity by state (acres) from partial aerial detection surveys in 2020 in Region 2[2].

State	Spruce Beetle	Mountain Pine Beetle	Douglas-fir Beetle	Western Balsam Bark Beetle	Roundheaded/ western pine beetles
Colorado	62,000	290	2,900	7,500	3,000
Nebraska					
Kansas					
South Dakota		1			
Wyoming[3]	410	190	30	460	
Region 2 Total	**62,000**	**490**	**2,900**	**8,000**	**3,000**

[1]Only major bark beetle and mortality agents 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; a blank cell indicates no damage was observed.
[3]Includes only the Region 2 portion of Wyoming.

Table 2. Bark beetle[1] activity by National Forest (acres) listed by area flown from partial aerial detection surveys in 2020[2].

National Forest (NF)[3]	Percent of Forest Flown	Spruce Beetle	Mountain Pine Beetle	Douglas-fir Beetle	Western Balsam Bark Beetle	Roundheaded pine beetle
Bighorn NF	>95%	410	160	30	430	
Black Hills NF	>95%		10			
Pike NF	>95%	6,200	80	320	400	
Roosevelt NF	>95%	1,500	30	6	780	
San Isabel NF	>95%	20,000	40	420	430	
Arapaho NF	49%	1,500	4		230	
Gunnison NF	71%	4,000	40	310	200	
Rio Grande NF	27%	540	40	40		
Routt NF	38%	100			620	
San Juan NF	88%	5,100		90	100	2,900
Uncompahgre NF	32%	6,400		10	70	
White River NF	63%	160		820	3,500	
Grand Mesa NF	0%					
Medicine Bow NF	0%					
Nebraska NF	0%					
Shoshone NF	0%					

[1]Only major bark beetle and mortality 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; a blank cell indicates no damage was observed.
[3]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. Causal agents can be difficult to differentiate when conducting aerial surveys. Abiotic events such as avalanches and windthrow can cause locally catastrophic damage. Tree stress caused by multiple years of defoliation can lead to tree mortality directly or predispose trees to bark beetle attack. Visible defoliation detected from partial aerial surveys in 2020 are listed in Tables 3 and 4. Windthrow events were widespread in 2020. Areas of windthrown trees may warrant ground monitoring for bark beetle activity depending on the species and size of impacted trees as well as trees in adjacent stands. Notable windthrow events were observed on the Medicine Bow-Routt, Arapaho-Roosevelt, Black Hills, the Grand Mesa, Uncompahgre and Gunnison National Forests in 2020.

Table 3. Major defoliators, diseases and abiotic [1] activity by state (acres) from partial aerial detection surveys in 2020[2].

State	Aspen Defoliation and Discoloration[3]	Western Spruce Budworm	Windthrow
Colorado	15,000	128,000	1,500
Nebraska			
Kansas			
South Dakota	200		
Wyoming[4]	180	15,000	1,300
Region 2 Total	**15,000**	**144,000**	

[1]Only major defoliators, diseases and abiotic agents are shown. Agents detected with lesser activity may not be represented.
[2]Sum of individual values may differ from totals due to rounding and multiple agents occurring in the same location; a blank cell indicates no damage was observed.
[3]Aspen defoliation and discoloration includes damage primarily by marssonina leaf spot, western tent caterpillar and large aspen tortrix.
[4]Includes only the Region 2 portion of Wyoming.

Table 4. Major defoliators, diseases and abiotic[1] activity by National Forest (acres) from partial aerial detection surveys in 2020[2].

National Forest (NF)	Percent of Forest Flown	Aspen Defoliation and Discoloration[4]	Western Spruce Budworm	Windthrow[5]
Bighorn NF	>95%	90	5,900	
Black Hills NF	>95%	250		6,600
Pike NF	>95%	1,900	17,000	20
Roosevelt NF	>95%	10	1,300	
San Isabel NF	>95%	1,900	21,000	
Arapaho NF	49%	420		1,400
Gunnison NF	71%	1,900	16,000	
Rio Grande NF	27%	600	930	
Routt NF	38%	50		40
San Juan NF	88%	4,100	15,000	
Uncompahgre NF	32%	320	2,300	
White River NF	63%	370	220	
Grand Mesa NF	0%			
Medicine Bow NF	0%			310
Nebraska NF	0%			
Shoshone NF	0%			

[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; a blank cell indicates no damage was observed.

[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.

Disease Summary

Most tree diseases, such as dwarf mistletoes, cankers, stem rusts and root diseases, are persistent and widespread in the Region, but damage cannot be characterized adequately by aerial detection surveys. Widespread foliage diseases usually have a detectable aerial signature, but they occur sporadically, increasing when weather conditions are conducive. Recently, aerial surveyors detected Diplodia shoot blight and Comandra blister rust that subsequently were ground-truthed. The incidence and severity of some leaf blights and needle casts decreased in 2020 due to extremely dry weather conditions.

Status of Major Bark Beetles

Spruce Beetle

Dendroctonus rufipennis
Host: Spruce

Spruce beetle epidemics are still expanding where larger diameter spruce trees are available (Fig. 3). Many large areas with ongoing activity are experiencing continued large spruce mortality.

In Wyoming, the Shoshone National Forest has spruce beetle activity on the Wind River District, mostly in the Union Pass and Brent Creek areas. The Bighorn National Forest also has some light spruce beetle activity in the northern Bighorns, from about Burgess Junction to Porcupine Work Center (Fig. 4); these populations appear to be building and expanding.

In Colorado, there is still activity in and around Rocky Mountain National Park. On Mt. Evans and Guanella Pass, spruce beetles continue to become more detectable near blowdown areas. The largest expanses of activity continue to be in southern Colorado with notable expansion and increased intensity in the Wet Mountains. New activity was also observed on the north side of the Elk Mountains, south of Aspen.

Dying spruce trees fade slowly and spruce beetle mortality can be difficult to detect from the air, particularly when lighting conditions are poor due to weather or smoke from forest fires. Acres of mortality throughout the Region may have been underestimated in 2020 as a result.

Lakewood Service Center is monitoring some 2018 and 2019 avalanche runs for spruce beetle and western bark beetle. The 2020 windthrow will provide additional habitat for building spruce beetle populations. National Forests have been actively removing spruce beetle-affected and windthrown trees in the suitable timber base.

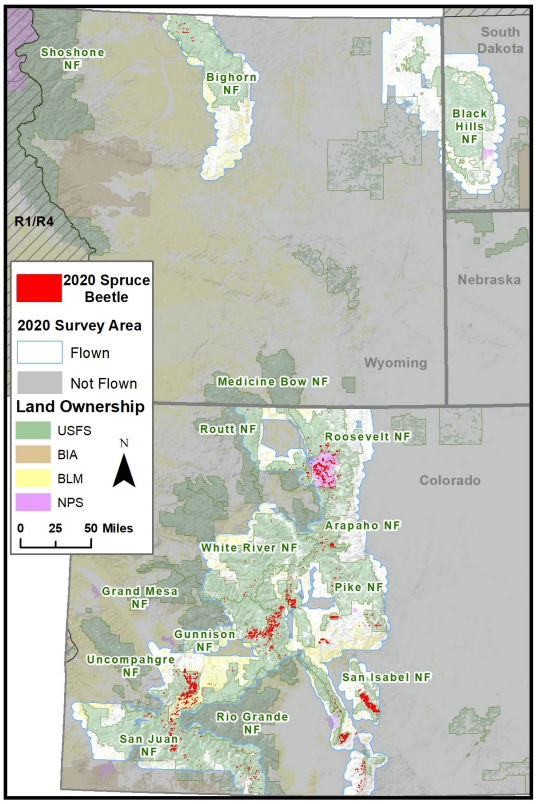

Figure 3. Spruce beetle activity in Colorado and Wyoming (R2) as observed from the 2020 aerial detection survey.

Figure 4. Spruce beetle outbreak observed on the Gunnison National Forest (left) and spruce beetle-infested tree on the Bighorn National Forest (right). Photos by Justin Backsen and Kurt Allen, respectively, USDA Forest Service.

Mountain Pine Beetle

Dendroctonus ponderosae
Hosts: Ponderosa pine, lodgepole pine, limber pine, whitebark pine, bristlecone pine

Mountain pine beetle (Fig. 5) activity has returned to endemic levels in much of the Region as the most recent large outbreaks have subsided. A notable exception is a mountain pine beetle outbreak that is expanding in the Wilder-Gunnison Highland communities and surrounding Gunnison National Forest, located in Taylor Canyon of the Gunnison Ranger District (Figs. 6-8). Ground surveys indicate a growing population. Drought stress is reducing tree defenses and contributing to conditions favorable to increasing beetle populations.

Figure 5. Mountain pine beetle and one of its predators, a clerid beetle larva, in an infested lodgepole pine in the Taylor Canyon area of the Gunnison National Forest, Colorado. Photo by Suzanne Marchetti, USDA Forest Service.

This outbreak threatens one of the largest remaining mature lodgepole pine forests in Colorado unaffected by the mountain pine beetle epidemic in the 2000s. Removing currently infested trees and thinning to combat expanding beetle populations is a priority for the Gunnison National Forest and the surrounding community. A rapid response team that includes personnel from FHP, National Forest System, Colorado State Forest Service and the National Forest Foundation is working together to respond to the Wilder-Gunnison Highland outbreak (Fig. 6). The team's efforts resulted in a total of 260 acres treated by removing infested trees and thinning within a year of FHP reporting the outbreak. End-of-year FHP funds from the Washington Office and the Regional Office helped support the effort. Plans are underway for additional treaments in 2021.

Figure 6. Blue stained logs harvested in the Wilder–Gunnison Highland mountain pine beetle project on the Gunnison Ranger District and adjacent private lands. Photo by Suzanne Marchetti, USDA Forest Service.

Ground surveys on the Dolores Ranger District on the San Juan National Forest also show that mountain pine beetle is an active component of a complex of bark beetles in ponderosa pine.Mountain pine beetle is not the primary tree mortality agent in this area but it is mixed with the more abundant roundheaded pine beetle and western pine beetle.

Figure 7. Mountain pine beetle-killed lodgepole pine in the Taylor Basin of the Gunnison Ranger District. Photo by Amy Lockner, USDA Forest Service.

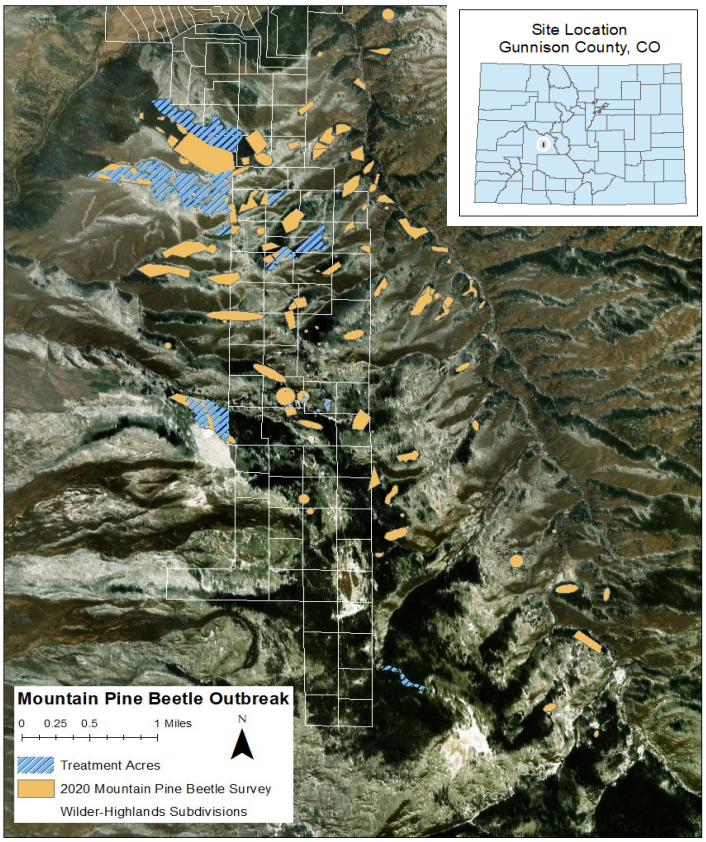

Figure 8. Mountain pine beetle ground survey map of The Wilder-Gunnison Highland outbreak area. Surveyed stands have light to moderate infestations.

Roundheaded Pine Beetle 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

The northern range of the roundheaded pine beetle extends into southern Colorado where it occurs with the western pine beetle and mountain pine beetle in ponderosa pine. An outbreak of roundheaded pine beetle and, to a lesser extent, western pine beetle on the San Juan National Forest has continued to expand since 2011 (Fig. 9). While roundheaded pine beetle (Fig. 10) outbreaks are typically shorter in duration in southwestern forests, this outbreak has continued to increase in intensity with abundant pine hosts available. In 2020, aerial detection surveys recorded over 3,000 acres on the Dolores Ranger District with varying intensity of beetle-caused tree mortality (Fig. 11). The area affected is within the San Juan National Forest suitable timber base and provides a valuable resource for local mills. Ground surveys on the Dolores Ranger District were completed after the beetle flights in the fall. Surveys indicate that populations are continuing to expand. FHP Gunnison Service Center entomologists have been working in partnership with the Colorado State Forest Service to learn more about the behavior of this beetle complex in southwestern Colorado.

Figure 9. Roundheaded and western pine beetle caused tree mortality in southwest Colorado on the Dolores Ranger District. Photo by Justin Backsen, USDA Forest Service.

Figure 10. 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.

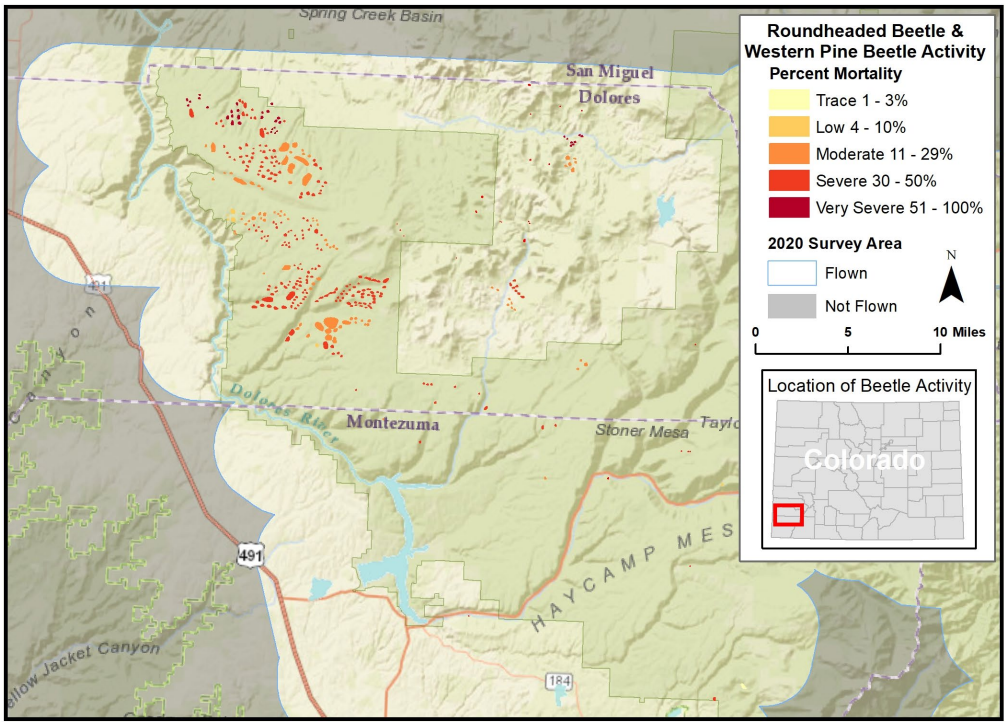

Figure 11. Roundheaded and western pine beetle activity in southwestern Colorado as observed from the 2020 aerial detection survey.

Douglas-fir Beetle

Dendroctonus pseudotsugae
Host: Douglas-fir

The Douglas-fir beetle is active across the Region. Current drought conditions and years of heavy western spruce budworm defoliation favor outbreak development (Figs. 12 and 13). Aerial surveys detected 2,900 acres with Douglas-fir beetle activity in areas flown. Defoliation in northern Wyoming on the Northern Shoshonee National Forest's Clarks Fork is so severe that the Douglas-fir beetle may be a secondary cause of the mortality. Large 2020 fires will also create scorch and weakened tree habitat for the Douglas-fir beetle. In 2020, FHP entomologists supported efforts to protect high-value Douglas-fir trees on developed sites in Colorado by using the beetles' own anti-aggregation pheromone, Methylcyclohexenone (MCH). A synthesized formulation of MCH is distributed in high value susceptible stands to confuse the beetles. MCH treatments, proven to be an effective alternative to chemical insecticides, can be used by homeowners as well as forest land managers.

Figure 12. Douglas-fir beetle-killed trees and western spruce budworm-defoliated trees on the Puma Hills, Pike National Forest. Photo by Justin Backsen USDA Forest Service.

Figure 13. Signs of Douglas-fir beetle attack. Pitch streaming (left), boring dust in bark (center) and fading crowns (right). Photos by Sky Stephens, USDA Forest Service.

Fir Engraver

Scolytus ventralis
Host: White fir

Acres affected by fir engraver on white fir (Fig. 14) continue to decrease in southern Colorado from a high outbreak year in 2015 with approximately 19,000 acres affected. Outbreaks of fir engraver beetle are often associated with localized drought conditions and may occur in areas where white fir has matured on sites more favorable to ponderosa pine. Stands defoliated by western spruce budworm are also highly susceptible to fir engraver.

Figure 14. Fir engraver beetle galleries are unique and run horizontally. Photo by Amy Lockner, USDA Forest Service.

Engraver Beetles and Twig Beetles in Pines

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

Engraver beetles are most active in drought-stressed trees. Extremely dry conditions in 2018 and 2020 have been favorable to these beetles, and damage may increase in 2021 if drought conditions persist. Pinyon *Ips* activity has caused concern at the Colorado National Monument in western Colorado (Fig. 15). An engraver beetle pheromone trapping project was conducted to protect trees near slash piles and decked wood on the Uncompahgre Plateau (Fig. 16). Pine engravers and twig beetles killed lodgepole pine along the highly traveled I-70 corridor near Idaho Springs, CO (Fig. 17). In fall, patches of trees attacked by *Ips calligraphus* began to fade near Hill City, SD and Mt. Rushmore in the Black Hills (Fig. 18).

Figure 15. Fading pinyon pine foliage on a tree killed by pinyon *Ips* in Colorado National Monument in 2020. Photo by Suzanne Marchetti, USDA Forest Service.

Figure 16. Pinyon *Ips* trap catch (left) near slash piles and decked wood in treated stands along Horsefly Trail (right) on the Uncompahgre National Forest. Photo by Suzanne Marchetti, USDA Forest Service.

Figure 17. Declining lodgepole along I-70 Corridor from *Ips* and twig beetles (left). Galleries characteristic of *Ips* and twig beetles present in lodgepole (right). Photos by Kelly Burns and Sky Stephens, respectively, USDA Forest Service.

Figure 18. Trees killed by a combination of *Ips calligraphus* and *grandicollis* engraver beetles fading near Mt. Rushmore in fall of 2020. Photo by Kurt Allen USDA Forest Service

Western Balsam Bark Beetle

Dryocoetes confusus
Hosts: Subalpine fir

Western balsam bark beetle activity was detected on 8,000 acres of subalpine fir (Fig. 19) in Colorado and Wyoming. These infestations are generally widespread, but kill fewer trees per acre than other bark beetles currently active in the state (Fig. 20). The beetles leave a distinctive star-shaped gallery pattern beneath the bark (Fig. 21). Western balsam bark beetle activity is often associated with root disease in high elevation forests. Where western balsam bark beetle occurs in spruce beetle-affected stands, overall stand mortality is increased. In 2020, FHP Lakewood Service Center entomologists began monitoring subalpine fir broken or uprooted in 2019 avalanche runs to determine if populations in these downed trees will move to adjacent stands.

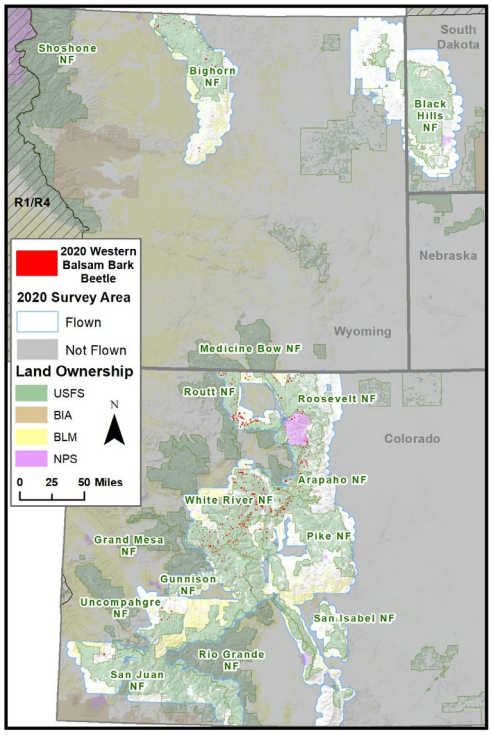

Figure 19. Western balsam bark beetle activity in subalpine fir as observed from the 2020 aerial detection survey.

Figure 20. Subalpine fir mortality caused by western balsam bark beetle on the Gunnison National Forest. Photo by Amy Lockner, USDA Forest Service.

Figure 21. Star-shaped galleries of western balsam bark beetle on subalpine fir. Photo by Brad Lalande, USDA Forest Service.

Red Turpentine Beetle

Dendroctonus valens
Host: Any pine species and occasionally Douglas-fir

Red turpentine beetles are commonly found on the base of stressed trees (Fig. 22). Trees scorched in 2020 forest fires will be susceptible to attack by turpentine beetles. These beetles are rarely primary tree killers and are typically associated with other beetles (especially after fire). The adult beetles are generally red and large and almost always found around the base of the tree. The larvae feed gregariously and are found under unusually large pitch tubes.

Figure 22. Red turpentine beetle and eggs and adults in a gregarious gallery (left). Large pitch tubes from red turpentine beetles at the base of a girdled ponderosa pine (right). Photos by Kurt Allen, USDA Forest Service.

Status of Major Defoliators

Western Spruce Budworm

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

Budworm activity continued at high levels on the Shoshone, Bighorn, Pike, San Isabel, Gunnison, San Juan, Rio Grande, Routt and Uncompahgre National Forests and adjoining lands (Fig. 23). In Wyoming, western spruce budworm is active throughout the range of Douglas-fir at varying levels. Many areas have experienced defoliation at epidemic levels for multiple years causing mortality and predisposing trees to Douglas-fir beetle attack.

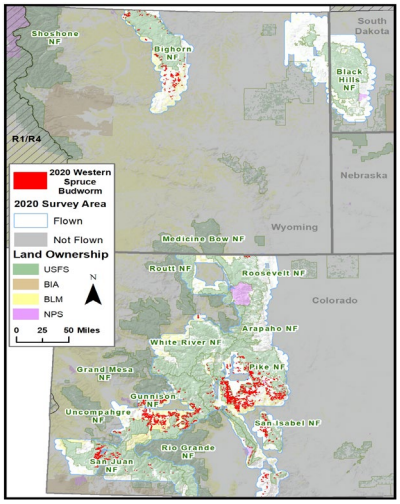

Figure 23. Western spruce budworm activity mapped by aerial surveys conducted in 2020.

Ground observation in higher elevation spruce and subalpine forest types also documented some defoliation in the northern Shoshone and Routt National Forests. In Colorado, budworm activity intensified and expanded into areas where it has not been seen in many years. Limited aerial surveys detected 128,000 acres with defoliation (Fig. 23).

Western spruce budworm feeds on the new needles of white fir, Douglas-fir and less notably on spruce and subalpine fir (Fig. 24). Drying needles webbed to twigs impart a brown cast to infested trees (Fig. 25). Managing stands by thinning and favoring non-host tree species when possible can increase mortality of dispersing budworm larvae.

Figure 24. Western spruce budworm larvae and defoliation (left) on the Shoshone National Forest and eclosed eggmass remaining on white fir needle in Southern Colorado. Photos by Kurt Allen and Amy Lockner, respectively, USDA Forest Service.

Figure 25. Brown cast to western spruce budworm-defoliated trees and tree mortality. Photos by Justin Backsen (left) Suzanne Marchetti (right), USDA Forest Service.

Aspen Defoliation

Large aspen tortrix, *Choristoneura conflictana*
Western tent caterpillar, *Malacosoma californicum*
Marssonina leaf spot, *Marsonina brunnea* and/or *M. populi*
Abiotic damage agents

Aspen defoliation/foliar damage caused by a combination of defoliators and other biotic and abiotic causal agents was observed over 15,000 acres, primarily in Colorado. Aspen defoliation can be caused by the large aspen tortrix, western tent caterpillar, Marssonina leaf spot and/or abiotic damage caused by such events as late spring frosts or high winds. All of these produce similar aerial signatures and must be ground-checked to verify the specific damage-causing agents in a particular stand. Aspen typically survives defoliation events; however, repeated defoliation over several years can cause mortality. On the Gunnison National Forest, trees that refoliated after a tortrix outbreak suffered leaf scorch from extreme drought (Fig. 26).

Figure 26. Large aspen tortrix defoliation in Southern Colorado (left) and leaf scorch in aspen that had refoliated after tortrix outbreak. Photos by Suzanne Marchetti, USDA Forest Service.

Other Insects

Gambel Oak Looper

Lambdina Punctata
Host: Gambel oak

Gambel oak looper was reported for a second year on the Crown Recreation Area on BLM land in Pitkin County. Gambel oak loopers are active in July and August (Fig. 27). Gambel oak is resilient to this late-season defoliation. This insect is one of several oak defoliators that can contribute to Gambel oak defoliation.

Figure 27. Gambel oak loopers skeletonize oak leaves. Photo by Cary Green, USDA Forest Service.

Oystershell Scale

Lepidosaphes ulmi
Hosts: Primarily aspen

Oytershell scales can be common on many hardwood species in more urban areas, but can cause damage to aspen and other poplars in forest settings (Fig. 28). Heavy damage has been observed on aspen in the Black Hills. In recent years oystershell scale has killed aspen in Arizona and shows signs of becoming a more serious pest in forest settings.

Figure 28. Heavy oystershell scale population on aspen in the Black Hills National Forest. Photo by Kurt Allen, USDA Forest Service.

Pinyon Needle Scale

Matsucoccus acalyptus
Hosts: Pinyon pine

Pinyon needle scale can be a locally common and persistent insect that feeds on one-year-old needles of pinyon pine. An outbreak was documented near and around Elephant Rock Campground on the San Isabel National Forest (Fig. 29).

Figure 29. Pinyon needle scale at Elephant Rock Campground. Photo by Amy Lockner, USDA Forest Service.

Pinyon Pitch Mass Borer

Dioryctria ponderosae
Host: Pinyon pine, ponderosa pine

Pinyon pitch mass borer is common on Colorado pinyon pines. The tiny moth is rarely noticed, but larval feeding causes large pitch masses on branches on trunks (Fig. 30). Damage on ponderosa pine is less noticeable. Pinyon pitch mass borer was noted on a site visit to Colorado National Monument.

Figure 30. Pitch mass on pinyon pine in Colorado National Monument. Photo by Suzanne Marchetti, USDA Forest Service.

Status of Major Diseases

Parasitic plants

Dwarf Mistletoes

Arceuthobium spp.
Hosts: Pines and Douglas-fir

Dwarf mistletoes (Fig. 31) 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 31. Southwestern dwarf mistletoe plants (left) and a heavily infected lodgepole pine with large witches' brooms (right). Photos by Brad Lalande, USDA Forest Service.

Five species of Arceuthobium occur in the Region, each with a specific set of susceptible hosts. Pines and Douglas-fir are commonly infected throughout much of their range, while spruces and true firs are only very rarely, hosts in the Region. Dwarf mistletoes provide ecological benefits to insects, birds and mammals, as brooms, shoots and fruits can be used for shelter and food.

This disease continues to intensify in Colorado and Wyoming. Dwarf mistletoe is not present in Nebraska or South Dakota. In 2020, the Gunnison Ranger District completed 71 acres of treatments southeast of Gunnison to reduce lodgepole pine dwarf mistletoe. Lodgepole pine infected with *A. americanum* in conjunction with extensive drought in the Gunnison National Forest, likely contributed to a recent mountain pine beetle outbreak.

The increased prevalence of bark beetle and dwarf mistletoes provides an opportunity for land managers to utilize various management techniques to combat both agents. The Shoshone National Forest used FHP funding in 2020 to continue removing dwarf mistletoe-infested lodgepole pine within treatments following mountain pine beetle epidemics. Similarly, the San

Juan National Forest used funding to thin and sanitize 140 acres of dwarf mistletoe-infected ponderosa pine, in combination with roundheaded pine beetle management.

The 2020 fire season had some of the largest wildfires ever recorded in the Region. Stand replacing fires, even scorching of lower branches and surface fires, assist in regulating dwarf mistletoe spread by providing natural barriers and reducing prevalence with stands. A dwarf mistletoe management guide is available for the Region (Dwarf Mistletoes: Ecology and Management in the Rocky Mountain Region).

True Mistletoe

Phoradendron juniperinum
Host: Junipers

Juniper mistletoe is the only true mistletoe that occurs within the Region. True mistletoes are considered hemiparasites as they receive water and nutrients but minimal carbon from their hosts, as they can photosynthesize to produce their own food. Unlike other true mistletoes, juniper mistletoe has reduced leaves, looking more like dwarf mistletoe. Juniper mistletoe is found at low rates in the pinyon-juniper woodlands of southwestern Colorado and can infect all juniper species that occur there. Impacts are generally minor as they are less aggressive than dwarf mistletoes. In combination with persistent drought in southwest Colorado, juniper mistletoe increases water stress, as the plant continues to transpire, while the host attempts to conserve the limited available water. Although detrimental to their host, true mistletoe is heavily used as food by wildlife.

Root Diseases

Root diseases, caused by pathogenic fungi, occur on all tree species throughout the Region. *Armillaria* spp. and *Heterobasidion* spp. are the most common pathogens causing serious root diseases in conifers. *Ganoderma* spp. is the most common root disease in aspen stands. It can also be found in other hardwood species in Kansas, Nebraska and South Dakota. Additionally, root disease pathogens occur and create hazards in recreation areas. Root diseases are difficult to manage since many species persist in the soil as saprophytes, degrading dead tissue to survive.

Armillaria Root Disease

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

Armillaria root disease is the Region's most common root pathogen and can occur on every tree species in the Region depending on the pathogenicity of the Armillaria species. Signs of the pathogen include mycelial fans under the bark, zone lines, melanized root-like rhizomorphs and occasionally clustered honey-mushrooms at the base of trees (Fig. 32). Infected hosts may have crown dieback/thinning, basal resinosis and extensive decay of the tree's roots and butt.

In 2020, many *Armillaria* spp. infected stands were identified following an extreme derecho wind event. The high winds caused failures to occur from southwest Colorado into the Dakotas, devastating many recreation areas and campgrounds. On the Grand Mesa, Gunnison and Uncompahgre National Forests, campgrounds had to be temporarily closed to remove downed wood after the storm. Concessionaires and Forest Service staff were inundated with cleaning up

tree failures for the majority of the summer and fall seasons. Residual trees were evaluated for symptoms indicative of *Armillaria* spp.

A recent study highlighting subalpine fir in Colorado forests, indicated that Armillaria root disease was associated with increased mortality in conjunction with drought and western balsam bark beetle. Additionally, *A. gallica* was recently identified as the main species in riparian areas within Nebraska, North and South Dakota and Wyoming. It was found to frequently cause root disease, infecting various hardwood tree species.

Figure 32. Armillaria mycelial fans in a hardwood tree root cambium and bark. Dense mycelial fan and zone lines on ponderosa pine stem. Photos by Jim Blodgett (left) and Brad Lalande (right), USDA Forest Service.

Heterobasidion Root Disease

Heterobasidion irregulare (H. annosum s.s.*)*
Hosts: Ponderosa pine and eastern redcedar

H. occidentale (H. parviporum)
Hosts: White fir and occasionally subalpine fir, Engelmann and blue spruce within the distribution of white fir

Heterobasidion irregulare is a pine specialist and has only been found in ponderosa pine and eastern redcedar on the Bessey Ranger District of the Nebraska National Forest. Currently, *H. irregulare* has not been detected in Colorado, Wyoming, or South Dakota.

Heterobasidion occidentale has been found only in mixed conifer forests within the range of white fir in southern Colorado (Fig. 33). The disease is most prevalent on white fir and occasionally neighboring Engelmann spruce. Subalpine fir, Douglas-fir and blue spruce, within white fir's range, are susceptible but *H. occidentale* has not been detected on those species in the Region to date.

Heterobasidion root disease can be managed where necessary. Freshly cut stumps are highly susceptible to aerial spores, if they are not treated immediately after silvicultural treatments. Extensive root-to-root contact assists in the spread of the disease. Extreme caution should be taken in Heterobasidion root disease centers to limit the spread. Infection is difficult to confirm in live trees as fruiting bodies or conks are generally found within the stump, but root failure and

butt rot is common. Sounding the tree near the base may determine infection and the extent of internal decay.

In 2020, foresters on the Grand Mesa, Uncompahgre, Gunnison and Rio Grande National Forests managed areas with extensive Heterobasidion root disease by spraying newly cut stumps with a borax solution and converting cover type away from white fir, including planting limber pine ~50% survival and Douglas-fir ~25% survival in high-value campgrounds.

Figure 33. *Heterobasidion occidentale* rot in a tree stump (left). Conk pulled from roots of *H. occidentale* infected white fir (right). Photos by Brad Lalande, USDA Forest Service.

Rusts

Many of the rust diseases in the Region initially infect needles, but then grow into branches and eventually stems. Stem rusts are among the most damaging diseases in the Region. Damage includes spreading cankers that can cause extensive deformities, top kill and mortality. Stem rusts create hazards by deforming stems, directly weakening stems and/or killing the bark allowing for the entry of stem decay fungi. This eventually results in stem breakage.

Comandra Blister Rust

Cronartium comandrae
Hosts: Lodgepole pine and ponderosa pine
Alternate host: Bastard toadflax and northern comandra

Comandra blister rust (CBR) is an important disease in the Region. It can be quite damaging to lodgepole pine and is less common in ponderosa pine. The pathogen, *Cronartium comandrae*, requires an alternate host to complete its life cycle. Disease impacts include extensive stem deformities, growth reduction, top-kill and tree mortality (Fig. 34). Heavily impacted stands can have high timber volume losses. This disease is most damaging in Wyoming and areas of northern Colorado. Numerous small scattered CBR polygons, detected during aerial survey as fading lodgepole pine trees, were noted in the northern Bighorn National Forest in 2020.

Figure 34. Fading lodgepole pine tree with a Comandra blister rust stem canker (left) and a close up of the very resinous canker (right). Photos by Jim Blodgett, USDA Forest Service.

White Pine Blister Rust

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

The exotic, invasive fungal disease, white pine blister rust (WPBR), continues to spread and intensify in the Region. Infected limber pines were confirmed during field surveys in several new locations including the Snowy Range Ski Area and Corner Mountain Trailhead on the Medicine Bow National Forest; near treeline above Rainbow Curve and in Ute Meadows in Rocky Mountain National Park; and near the Mountain Research Station and Fourth of July Trailhead on the Roosevelt National Forest. Branch flagging, top kill and some mortality of seedlings and/or saplings (Fig. 35) is occurring in each of these areas.

In 2020, permanent plots that date back to the 1980s were revisited on the Bighorn, Black Hills, Medicine Bow and Shoshone National Forests. WPBR continues to intensify in all previously sampled areas.

The combined impacts of WPBR, bark beetles and climate change threaten white pines in the Region. Limber pine is listed as a “species of local concern” on the Black Hills National Forest, a “species of management concern” in Rocky Mountain National Park and a “BLM sensitive species” in Wyoming. In December 2020, US Fish and Wildlife Service proposed listing whitebark pine, which occurs on the Shoshone National Forest and Wind River Indian Reservation, as

threatened under the Endangered Species Act. As a threatened species, protections for whitebark pine will be increased and conservation strategies will be promoted.

FHP is actively collaborating with RMRS, CSU, NPS and other USFS Regions to develop, promote and implement proactive management strategies to protect, conserve and restore these important species.

Figure 35. A new white pine blister rust canker with swollen fascicles, an early symptom of the disease that is common in limber pine (left). Small, orange droplets or spermogonia form within cankers and are visible throughout summer (right). Photos by Kelly Burns, USDA Forest Service.

Broom Rusts

Fir broom rust, *Melampsorella caryophyllacearum*
Hosts: White fir and subalpine firs
Alternate host: Chickweeds

Spruce broom rust, *Chrysomyxa arctostaphyli*
Hosts: Engelmann spruce and Colorado blue spruce
Alternate hosts: Bearberry or kinnikinnick, manzanitas are occasional alternate hosts

There are two broom rust species in the Region, specific to true fir and spruce. To persist in an area their associated alternate host must be present. Initial infections occur in the needles, but they can spread to the stem causing stem cankers, top-kill and tree mortality (Fig. 36). Stem breakage is common at cankers which can also result in tree mortality. These diseases can affect a large percentage of the trees in a stand resulting in significant growth loss. Extensive broom rust-infected trees are predisposed to other diseases or insects and create hazards in recreation areas.

Figure 36. Broom rust infection on subalpine fir (left) and a swollen, dead fir stem killed by fir broom rust (right). Photos by Jim Blodgett, USDA Forest Service.

Western Gall Rust

Endocronartium harknessii
Hosts: Lodgepole pine and ponderosa pine

Western gall rust is a common disease of pines that occurs throughout the Region. The causal fungus, *Endocronartium harknessii*, does not require an alternate host to complete its life cycle but spreads directly from pine to pine. Symptoms include branch galls, stem cankers often referred to as hip cankers, reduced growth and branch death (Fig. 37). Yellow-orange fruiting bodies may be visible on branch galls and on the margins of stem cankers in the spring and early summer. Trees of all ages are impacted, but mortality is rare in mature trees. Hip cankers may lead to severe growth deformities that are prone to decay and failure. Infections tend to occur during wave years, when environmental conditions are conducive to spread and infection.

This disease continues to be a problem in ponderosa pine in South Dakota and both ponderosa and lodgepole pine in Colorado and Wyoming.

Figure 37. Stem cankers caused by western gall rust in lodgepole pine. Fruiting bodies are sometimes visible along canker margins in the spring and summer (left). Hip cankers can severely deform stems increasing susceptibility to failure (left and right). Photos by Kelly Burns, USDA Forest Service.

Mistletoe Rust

Peridermium bethelii
Hosts: Lodgepole pine infected with dwarf mistletoe (*Arceuthobium americanum*)

Mistletoe rust has been observed in many western states including Colorado and Wyoming. While the rust is not usually common, there may be pockets of increased infections, where as many as 15% of *A. americanum* infections are associated with the rust. Although this species is similar to *C. comandrae*, the rust is only found in conjunction with *A. americanum* swellings or in close proximity to the mistletoe plants (Fig. 38). The rust may girdle branches causing dieback, depending on the severity and may rarely kill trees when associated with a bole infection, subsequently killing the mistletoe as well. In 2020, FHP identified *P. bethelii* within Taylor Canyon, near Gunnison, CO, extending over Cumberland Pass to Gold Creek Campground. It has also been observed in Falls Campground on the Shoshone National Forest. Most likely there are endemic populations throughout the range of lodgepole pine dwarf mistletoe in Colorado and Wyoming.

Figure 38. Lodgepole pine infected with both dwarf mistletoe and mistletoe rust. Aecia of mistletoe rust in swelling caused by dwarf mistletoe (left). Mistletoe rust on main stem of dwarf mistletoe-infected lodgepole pine (right). Photos by Brad Lalande, USDA Forest Service.

Shoot Blight and Canker Diseases

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 conifer species in the Region. 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 kill, to tree mortality (Fig. 39). 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.

Diplodia is common and damaging in South Dakota and Nebraska. Symptoms are often discovered during aerial detection surveys. This disease is frequently associated with hail damage. Several hundreds of acres of trees were heavily impacted on the Nebraska National Forest in 2020. High mortality is expected in those areas. Stress from root dieback caused by abnormally wet conditions was suggested as a contributing factor in Nebraska. Root diseases and *Ips* beetles have been associated with Diplodia mortality in Nebraska and South Dakota in the past.

Figure 39. Landscape photo with scattered dead branches to the left and dying crowns to the right (left); and a closeup of drooping dead needles, a common symptom of Diplodia (right). Photo by Jim Blodgett, USDA Forest Service.

In 2019, Diplodia shoot blight and canker disease was confirmed for the first time in Wyoming. Isolates were collected from ponderosa pine and seedings were inoculated in a greenhouse to determine aggressiveness (Fig. 40).

Figure 40. From left-to-right: Diplodia shoot blight symptoms at 5 days; shoot blight and canker symptoms at 4 weeks, 2 photos inoculated with different isolates, and a control at 4 weeks. Far-left photo by Bailey Maca and others by Jim Blodgett, USDA Forest Service.

Common Damage Agents in Aspen

Aspen is susceptible to a variety of diseases that are common and damaging throughout the Region. Aspen monitoring projects on the Gunnison (2020), Bighorn, Black Hills, and Shoshone (since 2008) National Forests identified that the three most damaging diseases are sooty-bark canker, cytospora canker and aspen trunk rot.

Canker Diseases of Aspen

Cytospora canker*, Cytospora* spp.
Black canker*, Ceratocystis populicola*
Sooty bark canker, *Encoelia pruinosa*
Host: Quaking aspen

The three diseases stated above are the most common stem cankers found on aspen in the Rocky Mountain Region (Fig. 41). On the Gunnison National Forest, Cytospora canker was found on 5% of live trees and 38% of recently dead aspen; sooty-bark was only found on 1% of live trees, yet 15% on dead trees; and black canker was found on 4% and 8% of live and dead aspen, respectively. *Cytospora* spp. was found on live trees in conjunction with insect-related damages caused by poplar borers and aspen bark beetles, causing small cankers that will most likely heal in the future. Although sooty-bark was found less than cytospora canker, it is considered the number one killer of aspen in the Rocky Mountains. The target cankers caused by black canker do not kill the tree directly, but predispose the stem to failure, resulting in early mortality. The extreme winds encountered in 2020 may have assisted in breakage where black canker weakened stems.

Figure 41. Sooty-bark canker, note the barber pole and sooty appearance on the upper stem (left), cytospora canker with orange discolored margin on main stem (center) and black canker with flared callous tissue causing target canker (right) are the most common canker diseases in aspen. Photos by Jim Blodgett (left), Brad Lalande (center/right), USDA Forest Service.

Stem Decay of Aspen

Aspen Trunk Rot*, Phellinus tremulae*
Host: Quaking aspen

Aspen trunk rot causes internal stem decay, which results in tree failure and degrades much of the merchantable qualities. On the Gunnison National Forest, 7% of all trees surveyed had aspen trunk rot, which was the most prevalent disease on all plots. The disease is identified by hoof-shaped fruiting bodies (Fig. 42) that originate at branch stubs on the main stem with 8 to 12 feet of internal decay above and below each conk. Prior to fruiting bodies becoming visible at 3-5 years post infection, internal decay is present within the stem. This is a common disease throughout the Region and causes significant hazards in campgrounds and recreation areas.

Figure 42. Fruiting body of aspen trunk rot indicating internal decay within stem. This tree was flagged for removal in a campground. Photo by Brad Lalande, USDA Forest Service.

Foliar Damages of Aspen

Marssonina Leaf Blight

Marssonina brunnea and/or *Marssonina populi*
Host: Quaking aspen

Marssonina leaf blight (Fig. 43) was less common in Colorado, Wyoming and South Dakota in 2020 than in 2019 due to drier than normal spring conditions suppressing the development and spread of the disease. While conditions were not conducive for the disease, some areas in southwest Colorado had extensive Marssonina leaf blight that was visible during the 2020 aerial surveys. Initial symptoms include tiny blisters or brown lesions often with yellow margins on leaves. Severe outbreaks cause brown lesions to coalesce into large brown leaf spots and premature defoliation. Disease resistance varies with clones, therefore planting or managing for resistant clones is the most effective management technique. Although this pathogen rarely kills trees on its own, affected trees may be more susceptible to other damage agents and growth reduction can be significant.

Figure 43. Aspen leaves infected with Marssonina leaf blight (left). The disease leads to leaf discoloration and pre-mature defoliation (right). Photos by Jim Blodgett, USDA Forest Service.

Conifer Foliage Diseases

Foliage diseases of conifers are common in the Region, but they are difficult to identify macroscopically and therefore greatly understudied. Native conifer foliar pathogens have become invasive emerging pathogens in some areas of North America raising concerns that more severe and sustained epidemics may occur as climates warm. FHP is collaborating with Colorado State University to develop molecular tools to identify the important needle pathogens in the Region. These tools will greatly enhance our ability to track the distribution and severity of these diseases in the future.

Lophodermella Needle Cast

Lophodermella montivaga and *L. concolor*
Host: Lodgepole pine

Lophodermella needle cast is one of the most common foliar diseases of lodgepole pine in the Region. The incidence and severity of the disease tends to increase in the year following a wet spring. Most stands remain unaffected during outbreaks, but impacts can be locally severe. Symptoms include needle discoloration, stunting and death (Fig. 44). Growth loss and mortality of younger trees may occur following successive years of infection. Outbreaks of Lophodermella needle cast have been reported on the Gunnison, White River and San Isabel National Forests since 2008. Disease incidence has decreased over the past two years due to extremely dry conditions.

Figure 44. Sapling severely infected by *L. concolor* only retaining current-year needles (left) and close-up of *L. montivaga* fruiting bodies on infected two-year-old needles. Photos by Suzanne Marchetti (left) and Kelly Burns (right), USDA Forest Service.

Bifusella Needle Cast

Bifusella linearis and *B. saccata*
Host: Limber pine

Bifusella needle cast is widespread on limber pine in Colorado and Wyoming, but impacts are usually not severe. Typical symptoms include needle discoloration, death and premature shedding. The disease can be identified by the shiny black, elongated fruiting bodies that are produced on two- to three-year old needles (Fig. 45). *Bifusella linearis* appears to be the primary causal pathogen in the Region.

Figure 45. Close-up of *Bifusella linearis* fruiting bodies on infected limber pine needles in Rocky Mountain National Park (left) and a symptomatic limber pine near Guanella Pass, Arapaho National Forest. Photos by Kelly Burns (left) and S. Sky Stephens (right), USDA Forest Service.

Ponderosa Pine Dieback and Mortality

Unknown Cause
Host: Ponderosa pine

Dieback and mortality of ponderosa pine is increasing in the Region. Damage became obvious and widespread in the Colorado Front Range and southern Wyoming in 2020. Aerial Detection Surveys mapped some damage (150 ac.) in 2020, but the signature was difficult to pick up from the air. Typical symptoms include flagging, resinosis and sometimes mortality (Fig. 46). News outlets reported the damage was the result of unusual weather events in 2019 and 2020; however, Drs. Ned Tisserat and Jane Stewart (CSU) isolated *Diplodia* spp. from a symptomatic branch collected from northern Colorado.

Figure 46. Dieback and mortality of ponderosa pine was widespread in Colorado and Wyoming in 2020 but specific causes are currently unknown. Photo by Marianne Davenport, USDA Forest Service.

Abiotic Damage

Downed Trees from Avalanches and Wind

Avalanches or windthrow can create habitat for damaging beetles, bepending on the tree species and the size of trees broken and uprooted. Spruce beetle, Douglas-fir beetle and western balsam bark beetle are all attracted to downed trees, and could potentially build up populations in their respective hosts, Engelmann spruce, Douglas-fir or subalpine fir. Beetle populations built up in downed trees can move to adjacent standing host trees. Mountain pine beetle is not attracted to downed trees so the risk of bark beetle outbreaks is less where downed trees occur in lodgepole or ponderosa pine stands. The risk from bark beetles increases with the increasing size of host trees toppled and increasing abundance of standing host trees in adjacent 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. 47) there may be larger diameter trees taken down, creating habitat. Weather conditions, stand age and composition all influence the potential for bark beetles to move into downed trees and eventually adjacent trees.

Figure 47. Windthrown spruce and fir near Rollins Pass, Arapaho National Forest, Colorado. Photo by Brian Howell, USDA Forest Service.

Nursery Damage Agents in the Region

The Charles E. Bessey Nursery in the Nebraska National Forest provides quality seedlings and services for reforestation, restoration, and conservation projects in Region 2 and the Great Plains states. Several conifer and hardwood species are grown at the nursery in both the field and in greenhouses (Fig. 48). Therefore, various damage agents occur at the nursery.

The main conifers grown most years in the greenhouse include ponderosa and lodgepole pines, Douglas-fir, and Engelmann spruce. In the field, the main conifer species include Colorado blue, Norway, and Black Hills spruce; Scotch, Jack, southwestern white, ponderosa, and Austrian pines; eastern red cedar; and Rocky Mt. juniper. The biggest disease issue is Phomopsis blight in the junipers, with minor Fusarium and Diplodia issues. All diseases are well controlled with proper watering and fungicides as needed. Aphids cause minor issues in both the field and greenhouses. Tip moth is an occasional issue in pines in the field.

Over 40 hardwood species were grown in 2020, though several other hardwood species have been grown over the years. The main disease issues are rusts of various species and black stem in native cottonwood. As in conifers, aphids are the most common insect problem. Other insect issues include various species of leaf-feeding beetles. These diseases and insects are controlled as needed.

Weeds need to be managed around both conifer and hardwood crops. The main issue in the field is Mare's tail or horseweed (*Erigeron canadensis*); managed with herbicides, plowing, and weeding. The main mammal problem is deer, which is managed with fencing.

Figure 48. Trees and shrubs are grown both in the field (left) and in greenhouses (right) at Charles E. Bessey Nursery. Photos by Richard Gilbert, left and Jim Blodgett, right, USDA Forest Service.

2020 FHP Project Funding: Making a Difference on National Forests and other Federal Lands.

Limited funding is available from both the Washington Office of the USDA Forest Service and Rocky Mountain Regional Office of the USDA Forest Service to assist with project implementation to prevent or suppress forest insect and disease problems. Regional FHP personnel work with National Forests and other federal agencies in the Rocky Mountain Region to develop proposals for funding. In 2020, eight National Forests used FHP funding to help manage insect and disease problems.

The Black Hills National Forest used FHP funds to complete 202 acres of precommercial thinning on the Northern Hills Ranger District and 42 acres on the Mystic Ranger District. These projects help support fuels targets while improving forest resilience to bark beetles and enhancing timber growth. Treated areas were overstocked with dense regeneration and/or sapling and pole size with some stands showing gall rust and high risk for mountain pine beetle infestation.

The Grand Mesa Uncompahgre and Gunnison National Forests used FHP funds for preventive spraying of healthy trees and removal of spruce beetle-infested trees at the Alpine Guard Station and Big Blue Campground; dwarf mistletoe reduction on 71 acres on the Gunnison Ranger District; deploying MCH to protect high value Douglas-fir from Douglas-fir beetle on over 700 acres in developed sites; monitoring and mitigation of Annosus root rot and removal of fir engraver-infested trees on 34 acres in Amphitheater and Angel Creek Developed sites; a trap tree project with the Telluride Ski Area; *Ips* beetle trapping near slash piles and decked wood on the Uncompahgre Plateau; and work on the Wilder-Gunnison Highlands mountain pine beetle response. The Wilder-Gunnison Highlands partnership agreement with the National Forest Foundation and Colorado State Forest Service have received significant late funding from the Washington Office and Regional Office.

The Medicine Bow-Routt National Forests used FHP funds to thin and masticate

approximately 101 acres on the Pole Mountain Vegetation Project and to begin clean-up of windthrown trees on Elk Mountain.

FHP funds allowed the Rio Grande National Forest to complete additional sale prep on 1,400 acres in the fall of 2019 and to treat 123 acres on South Springs (Fig. 49) and Whiskey Bottle mastication projects.

Figure 49. South Springs mastication on the Rio Grande National Forest. Photo by Kirby Self, USDA Forest Service.

The Arapaho-Roosevelt National Forest used FHP funds in Guanella Pass Campground to remove spruce beetle-infested trees. The Forest, in collaboration with the Lakewood Service Center, also used FHP funds to deploy and evaluate deploying anti-aggregation pheromone-kairomone combination (MCH + green leaf volatiles (AKB)) to protect standing spruce (Fig. 50).

The Pike-San Isabel National Forests used FHP funds to complete marking and cruising work on the Marshall Pass Timber Sale associated with the Marshall Pass Vegetation Management project on the Salida Ranger District. The Forests also used FHP funds to cruise additional volume associated with Morel Salvage Sale, part of the Greenhorn Environmental Assessment on the San Carlos Ranger District.

Figure 50. MCH and AKB pouches on spruce tree. Photo by Marianne Davenport, USDA Forest Service.

Funds were also used to protect trees from spruce beetle in four campgrounds on the San Carlos and Salida Ranger Districts. End-of-year Washington Office FHP funds were added to the South Arkansas Stewardship Agreement to treat 28 acres associated with the Monarch Pass Vegetation Management project on the Salida Ranger District. This agreement is with the Arkansas River Watershed Collaborative and utilizes cut-to-length harvest systems that can work on steep terrain. This project involves removal of trees that are infested with or that have been killed by spruce beetle (Fig. 51).

Figure 51. Spruce beetle sanitation and salvage on Monarch Pass. Photo by Justin Anderson, USDA Forest Service

The San Juan National Forest used FHP funds to contract for thinning and removal of roundheaded pine beetle-infested pines on 140 acres within the Lone Pine assessment area. Treatments included thinning trees on 70 acres at the Junction Creek Campground and Trailhead near Durango, and deploying MCH to protect Douglas-fir at Treasure Falls Trailhead and Vallecito Creek Campground.

The Shoshone National Forest used FHP funds to remove dwarf mistletoe and *Comandra* rust from infested trees in previously thinned lodgepole pine stands. FHP funds were also used to thin for bark beetle resistance in Douglas-fir stands defoliated by western spruce budworm.

Two other Federal Agencies received 2020 FHP funds from the Washington Office. Rocky Mountain National Park received funds for limber pine protection and bark beetle suppression and the BLM Field Office in Buffalo, Wyoming received funds for thinning Douglas-fir in areas with ongoing heavy western spruce budworm defoliation.

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 National Forest System lands, invasive plants are a serious threat to our rangelands and native plant communities. State and Private Forestry-FHP does not have funding for invasive plant treatments on National Forest System 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

All FHP trainings were canceled in 2020 due to a global pandemic caused by COVID-19. Canceled trainings included three Hazard Tree Management and two Forest Insect and Disease Identification and Management trainings. In a typical year, FHP personnel also contribute to various continuing education programs, certification trainings, new employee orientation trainings, workshops, conferences and more. For more information regarding Regional trainings please visit the Region 2 FHP training website.

Hazard Tree Management Program and Updates

Various new and updated Hazard Tree Management products were completed in 2020. Those include a new *Tree Failure e-Form* and associated *Tree Failure Form Guide*. Revisions were made to the *Hazard Tree Evaluation Survey123 and ArcGIS Online Guide, Hazard Tree Database User's Guide* and *Trimble Hazard Tree Evaluation Guide*. All Hazard Tree Management Training PowerPoints were updated as was the Region's Hazard Tree Web pages. FHP provided virtual talks, on-site hazard tree survey training and assistance with hazard tree surveys in 2020. More information is available on the Region 2 FHP hazard tree website.

Limber Pine Planting on the Black Hills National Forest

As part of the Limber Pine Restoration Project, limber pine seedlings grown from local seed, were planted in 2017 and 2018 at in the Norbeck Wildlife Preserve, Black Hills National Forest. Limber pine is a *Species of Local Concern* in South Dakota, with less than 100 mature trees growing naturally in the state. It occurs in isolated-areas scattered over the Black Hills National Forest and Custer State Park. Many of the native trees were recently killed by mountain pine beetle and white pine blister rust. Most seedlings are growing well, averaging about seven centimeters of height growth per year (Fig. 52) over the first four years. Approximately 200 additional limber pines will be planted in 2021.

Figure 52. A five-year-old limber pine at the Norbeck Wildlife Preserve planting site in the Black Hills National Forest. From left-to-right: photo of a limber pine with a Vexar tube, same tree with tube removed, measuring 2-year growth, and measuring 5-year growth. Photos by Jim Blodgett, USDA Forest Service.

Evaluation Monitoring, Research andTechnology Development Projects

Evaluation Monitoring Projects

Health & abundance of limber pine in southern Colorado & northern New Mexico – Kristy Duran (Adams State University) and Kelly Burns

Effects of spruce beetle (*Dendroctonus rufipennis*) outbreaks on Rocky Mountain spruce-fir stand characteristics -- Donna Shorrock, Amy Chambers and Jim Kruse

Defense traits and resistance to mountain pine beetle – Barbara Bentz (RMRS) and Sky Stephens

Special Technology Development Program (STDP) grants in 2020 (new and continuing)

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.

Publications

2020 Biological Evaluations and Service Trips

Gunnison Service Center

GSC-20-01, Forest Health Assessment at the Black Canyon of the Gunnison National Park - Carlin, Lockner, Marchetti
GSC-20-02, Mountain Pine Beetle Activity in Lodgepole Pine at the Wilder Highlands Area, Gunnison National Forest - Carlin, Lockner, Marchetti, Allen
GSC-20-03, Stump Treatments for Heterobasidion (Annosus) Root Disease in the Rio Grande National Forest - Lalande, Marchetti
GSC-20-04, Aspen Mortality Increases in Curecanti National Recreation Area - Marchetti
GSC-20-05, Pinyon Needle Scale on the San Isabel National Forest - Lockner
GSC-20-06, Tree Failure and Risk Assessment in Cobbett Campground, Grand Valley RD, Grand Mesa, Uncompahgre and Gunnison (GMUG) National Forests - Lalande, Fairweather
GSC-20-07, Hazard Tree Assessments in Norwood RD Campgrounds, Grand Mesa, Uncompahgre and Gunnison (GMUG) National Forests - Lalande

Lakewood Service Center

LSC-20-01, Spruce Beetle Management, Crags Campground, Pike National Forest - Stephens
LSC-20-02, MCH Deployment at Kelsey Campground, South Platte Ranger District, Pike National Forest - Stephens.
LSC-20-03, Spruce Beetle Management: Guanella Pass Campground, Arapaho-Roosevelt National Forest - Stephens
LSC-120-04, Tree Decline Assessment on Several Arapaho-Roosevelt National Forest Recreation Sites - Stephens
LSC-20-05, Air Force Academy- Site Assessment - Stokes
LSC-20-06, Spruce Blowdown Assessment on the Brush Creek Hayden RD, Medicine Bow National Forest - Stephens/Stokes
LSC-20-07, Ants at Lone Rock Campground SPRD, Pike National Forest - Stephens

LSC-20-08, Forest Health Assessment of the Roach Project Area, Canyon Lakes Ranger District, Arapaho-Roosevelt National Forest - Burns
LSC-20-09, Limber Pine Health Assessment on the Clear Creek Ranger District, Arapaho-Roosevelt National Forest - Burns, Stephens, Stokes, Davenport
LSC-21-01, Tree Mortality Assessment on Clear Creek County Parcel R161239 - Stephens and Burns
LSC-21-02, Spruce Beetle Management Recommendations and Risk Table Decision Guide - Stephens and Stokes
LSC-21-03, Assessment of MCH Deployment for Douglas-fir Beetle Management at Kelsey Campground, South Platte Ranger District, Pike National Forest - Stephens
LSC-21-04, Accomplishments in Spruce Beetle Management: Guanella Pass Campground, Arapaho-Roosevelt National Forest - Stephens

Rapid City Service Center

RCSC-20-01, Limber Pine Planting in the Black Hills National Forest (2019 Update) - Blodgett
RCSC-20-02, Black Elk Limber Pine: 2019 - Blodgett
RCSC-20-03, First Report of *Diplodia* in Wyoming - Blodgett
RCSC-20-04, Estimated Tree Mortality Caused by the Mountain Pine Beetle During the 1997-2015 Epidemic on the Black Hills National Forest - Allen, Schotzko, Dymerski
RCSC-20-05, Spruce Beetle Activity on the Bighorn National Forest - Allen, Schotzko, Dymerski
RCSC-20-06, Aspen Health on National Forests in the Northern Rocky Mountain Region (2008/2009 to 2019) - Blodgett, Schotzko, Allen, Dymerski
RCSC-20-07, Aggressiveness of *Diplodia* isolates from Wyoming - Blodgett
RCSC-20-08, Defoliation by Western Spruce Budworm in the Shoshone National Forest, Wyoming - Allen, Schotzko, Dymerski
RCSC-20-09, Limber Pine Planting in the Black Hills National Forest (2020 Update) - Blodgett
RCSC-20-10, Western Spruce Budworm Activity in the Tensleep Canyon Area, Bighorn National Forest - Allen, Schotzko, Dymerski
RCSC-20-11, Western Spruce Budworm Activity in the Sinks Canyon Area, Shoshone National Forest - Allen, Schotzko, Dymerski

Other Reports & Peer-Reviewed Publications

Alexander, K., Truslove, M., Davis, R., Stephens, S., and Zentz, R. 2019. A collaborative approach to preparing for and reacting to emerald ash borer: a case study from Colorado. Forestry: An International Journal of Forest Research. 93, 239–253, doi:10.1093/forestry/cpz070

Anonymous. 2020. Hazard Tree Database User's Guide. USDA Forest Service, Rocky Mountain Region, Forest Health Protection.

Anonymous. 2020. Trimble Hazard Tree Evaluation Guide. USDA Forest Service, Rocky Mountain Region, Forest Health Protection.

Blodgett, J. T., Burns, K. S. and Lalande, B. M. 2020. Hazard Tree Evaluation Survey123 and ArcGIS Online Guide. USDA Forest Service, Rocky Mountain Region, Forest Health Protection, Tech. Rpt. R2-71.

Blodgett, J. T., Burns, K. S. and Lalande, B. M. 2020. Tree Failure Form Guide. USDA Forest Service, Rocky Mountain Region, Forest Health Protection, Tech. Rpt. R2-72.

Lalande, B. M., Hughes, K., Jacobi, W. R., Tinkham, W. T., Reich, R. M. and Stewart, J.E. 2020. Subalpine fir decline in Colorado is associated with stand density, warming climates and interactions among fungal diseases and the western balsam bark beetle. For. Ecol. Manage. 466. doi:10.1016/j.foreco.2020.118133.Regional Reports

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Wyoming State Forestry Division -- Harrison Brookes, Forest Health Program Manager

Online Resources

For more information on forest health-related topics please visit the following websites:

- The Region 2 FHP homepage
- Field Guide to Diseases & Insects of the Rocky Mountain Region
- Aerial Detection Survey Maps (see link on page for current year's draft data)
- Trainings offered by Region 2 FHP Personnel
- Hazard Tree information and further resources