



Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Southwestern Region | PR-R3-16-24 | May 2025

Forest Health Conditions in Arizona & New Mexico 2024



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Cover photo: Aerial photo of the Hermit Peak/Calf Canyon Fire in 2024. Older direct fire mortality is visible as well as newer post-fire and bark beetle driven tree mortality.

Forest Health Conditions in Arizona and New Mexico – 2024
Southwestern Region
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Introduction

This Document summarizes aerial and ground-based observations of forest damage caused by insects, diseases, and abiotic events across the Southwestern Region in 2024. These data are collected annually by the Forest Health Protection (FHP) team, the Arizona Department of Forestry and Fire Management, and the New Mexico Energy, Minerals, and Natural Resources Department. The information is provided to internal and external partners and is accessible to the public. Information is provided to track annual trends and to help guide land management decisions. The report also helps to fulfill a congressional mandate (The Cooperative Forest Assistance Act of 1978, as amended) that requires survey, monitoring and annual reporting of the health of forests in the U.S. Forest Health Protection staff is available to answer questions and contact information can be found at the end of this document. Please visit the FHP website for additional information and other publications: <https://www.fs.usda.gov/main/r3/forest-grasslandhealth>.

Weather Conditions in Brief

Drought

Over the last 24 years, the southwestern U.S. has experienced multiple extended drought periods with recovery periods that are relatively short (Figure 1). Early 2024 was wetter than normal and, while most of the region was still under some level of drought, extreme drought conditions were confined to southern New Mexico by the spring of 2024 (Figure 2, left). Fall was unusually warm, and drought conditions worsened (Figure 2, right). The hot and dry conditions continued through the end of 2024.

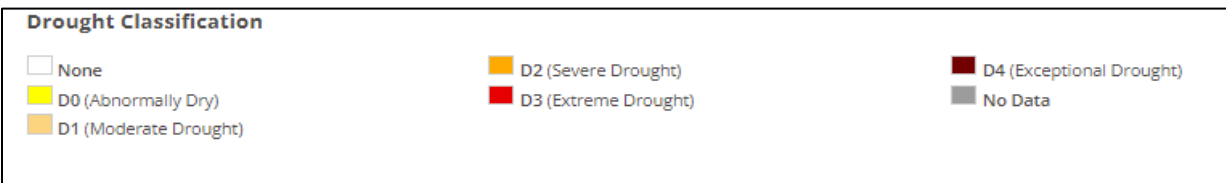
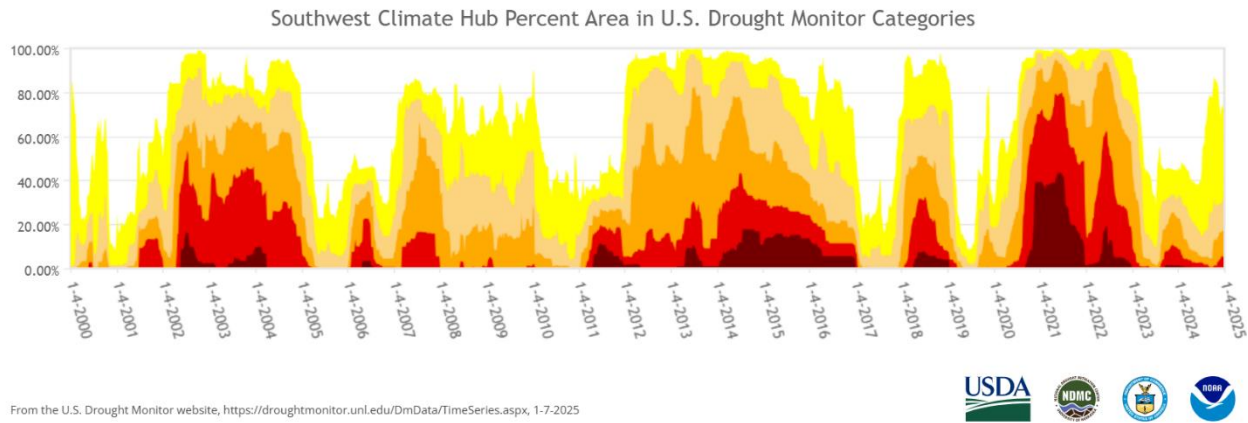


Figure 1: Percent of the southwestern U.S. in various drought monitor categories from 2000-2024. Source: <https://droughtmonitor.unl.edu/DmData/TimeSeries.aspx>

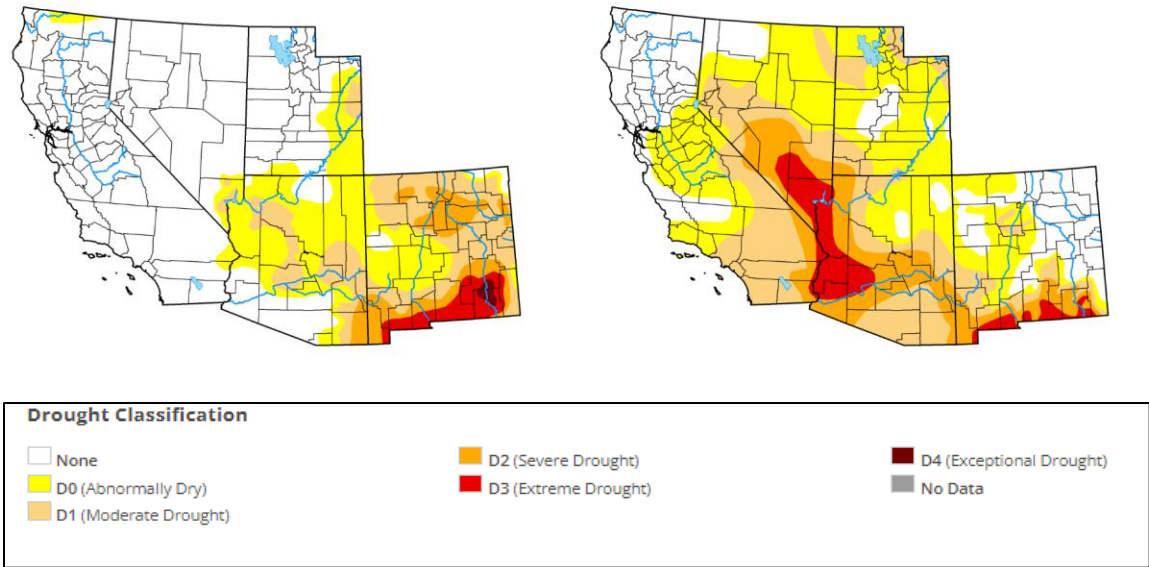


Figure 2: U.S. Drought Monitor comparison map of the southwestern U.S. between March 26, 2024 (left) and October 1, 2024 (right). Source: <https://droughtmonitor.unl.edu/Maps/CompareTwoWeeks.aspx>

Temperatures

Temperatures for the Southwest in 2024 were generally above average, with parts of New Mexico and Arizona having record warmest years (Figure 3).

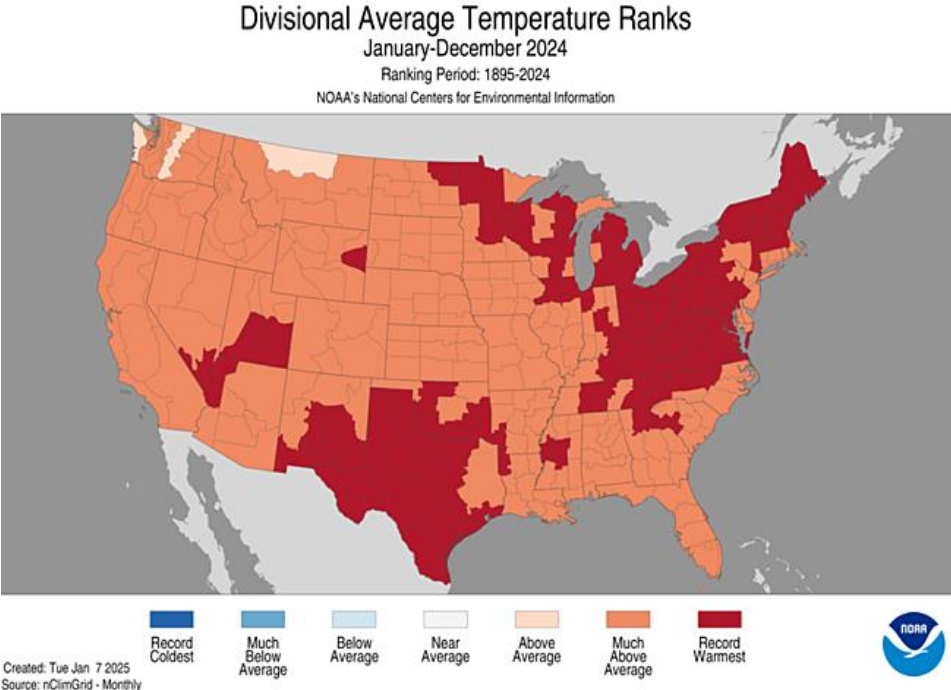


Figure 3: Average temperature ranks for the contiguous U.S. for January – December 2024. Source: <https://www.ncei.noaa.gov/access/monitoring/us-maps/>

Regional Forest Insect and Disease Summary

Aerial Survey Summary

In 2024, aerial detection surveys (ADS) covered approximately 22 million acres of the Southwestern Region (Table 1, Figure 4). Aerial surveys primarily covered national forest (NF) land (56% of area surveyed), followed by tribal (22%), state and private (17%), and other federal lands (5%). Ground-based monitoring data also contributed to the insect and disease data in 2024.

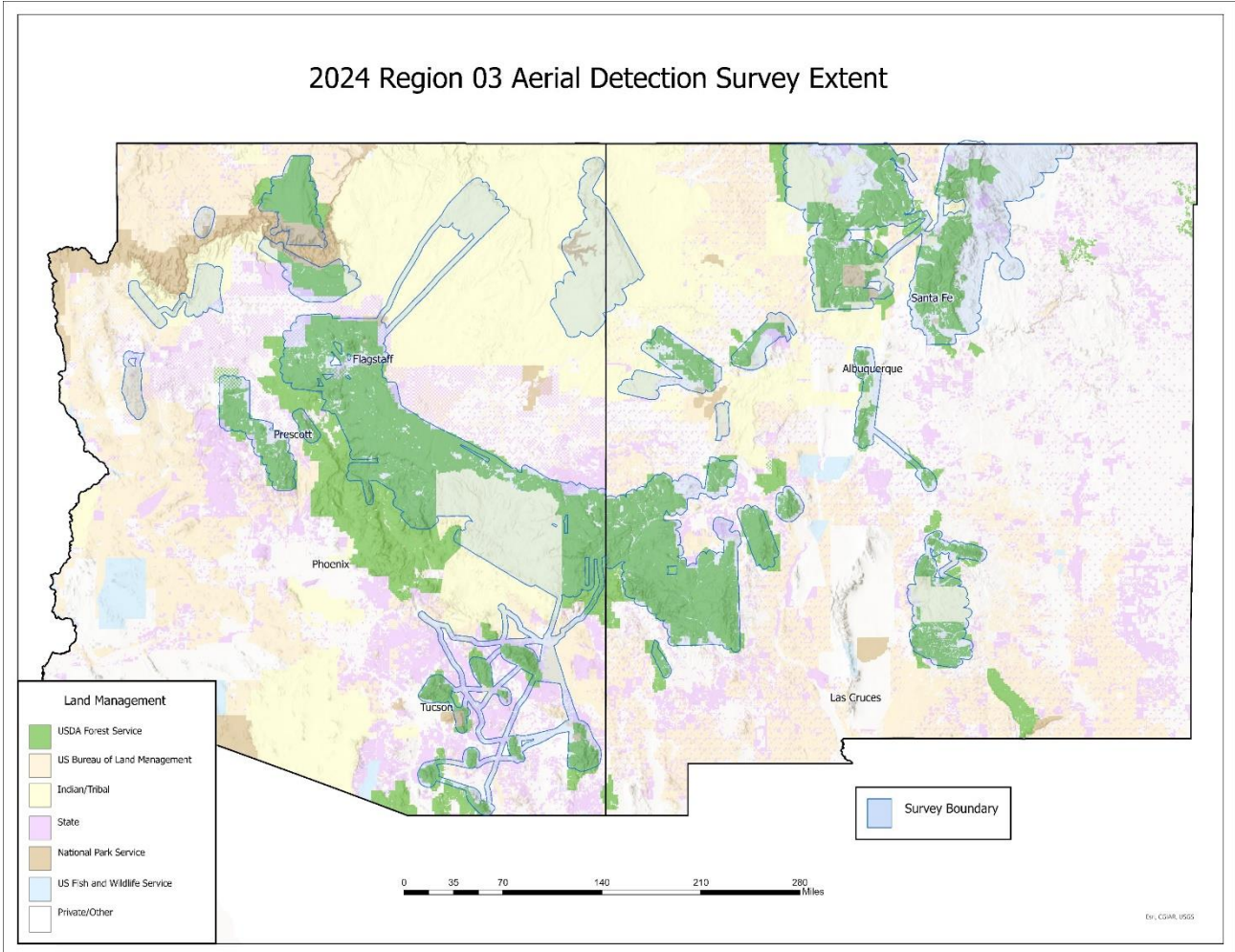


Figure 4. Areas of the Southwestern Region surveyed during 2024 aerial detection survey flights.

Table 1. Aerial detection survey acres flown in 2024 in the Southwestern Region.¹

Owner	State	Forested ²	Riparian ²	Woodland ²	Total ²
National Forest Lands	AZ	3,042,500	98,600	2,783,000	5,924,100
Bureau of Land Management	AZ	21,400	8,100	101,700	131,300
Department of Defense	AZ	18,600	400	22,200	41,200
National Park Service	AZ	136,000	1,300	189,800	327,000
Tribal	AZ	1,369,000	12,300	2,165,300	3,546,700
State and Private	AZ	188,600	79,000	425,000	692,700
Arizona Total		4,776,200	199,600	5,687,100	10,662,900
National Forest Lands	NM	4,263,200	111,500	2,206,400	6,581,100
Bureau of Land Management	NM	34,600	1,800	192,500	228,900
Bureau of Reclamation	NM	1,600		*	1,600
Department of Defense	NM		*	500	500
Department of Energy	NM	3,600	200	6,000	9,800
National Park Service	NM	83,600	17,200	17,000	117,700
Tribal	NM	863,300	4,500	530,700	1,398,400
State and Private	NM	1,924,200	98,800	1,172,600	3,195,600
New Mexico Total		7,174,000	234,000	4,125,600	11,533,600
Grand Total		11,950,200	433,600	9,812,700	22,196,600

*Indicates less than 50 acres of land ownership and vegetation type surveyed.

¹ Values rounded to the nearest hundred, sum of individual numbers may differ from totals due to rounding.

² Vegetation type is based on USFS R3 Ecological Response Unit data,

Bark Beetle Summary

Tree mortality attributed to bark beetles was mapped on 102,286 acres in 2024, an increase from the 50,140 acres mapped in 2023 (Table 2). This acreage is still relatively low compared to the 700,000+ acres mapped in 2022 and 2021. Regionwide, the complex of bark beetle species causing mortality of ponderosa pine contributed to the most acres with mortality for any forest type. Acres with ponderosa pine mortality increased across the region from 15,369 acres in 2023 to 61,967 acres in 2024. Douglas-fir mortality attributed to Douglas-fir beetle was the second most prevalent with 14,772 acres, the majority of which was detected in northern New Mexico. Spruce beetle-caused mortality was the third highest acreage in the region with 10,016 acres mapped with mortality. Overall bark beetle activity across the region remained at relatively low levels for 2024.

In Arizona, ponderosa pine bark beetles were the most prevalent mortality agent mapped for the fourth year in a row, with 29,022 acres with damage mapped, an increase from the 9,157 acres mapped in 2023. Fir engraver activity in Arizona was mapped at 2,305 acres with activity and accounted for the second highest acreage mapped but was down from 4,439 acres mapped in 2023. Douglas-fir beetle activity was also down in 2024 with 636 acres mapped relative to 2,441 acres with activity mapped in 2023. Western balsam bark beetle-caused mortality declined from 476 acres mapped in 2023 to 262 acres mapped in 2024. In 2024, Arizona had 109 acres with bark beetle-related pinyon pine mortality, down from the 411 acres mapped in 2023. Spruce beetle levels in Arizona remained low with 35 acres mapped in 2024 and 181 acres mapped in 2023.

Ponderosa pine bark beetles were the most active mortality agent in New Mexico in 2024, with 32,945 acres with activity mapped, an increase from the 6,213 acres mapped in 2023. Much of this activity was correlated with past forest fires, including the Hermit Peak/Calf Canyon Complex (Figure 5). Douglas-fir beetle activity was the second most common mortality agent detected with 14,136 acres mapped, an

increase over the 7,414 acres mapped in 2023. Spruce beetle was the third most impactful bark beetle with 9,981 acres mapped, down from 12,477 acres in 2023. Fir engraver activity in New Mexico increased slightly with 5,374 acres mapped in 2024 and 4,480 acres in 2023. Like Arizona, pinyon ips activity was low, with only 963 acres mapped in 2024, down from 1,937 acres in 2023. Western balsam bark beetle damage in New Mexico remained low but did increase from 41 acres mapped in 2023 to 292 acres mapped in 2024.



Figure 5: Mortality of ponderosa pine and white fir (upper right of photograph) from post-fire insect activity (woodborers and bark beetles) is prevalent throughout the Hermit Peak / Calf Canyon Fire scar in New Mexico. Yellow-orange trees are recent mortality.

Table 2. Bark beetle¹ incidence (acres) by ownership from aerial detection surveys in 2024 in Arizona and New Mexico².

Owner ³	Pine bark beetles ⁴	Pinyon ips	Douglas-fir beetle	Fir engraver	Spruce beetle	Western balsam bark beetle
Apache-Sitgreaves National Forests	8,636	50	11	232	0	4
Coconino National Forest	2,161	2	29	8	0	1
Coronado National Forest	115	0		4		0
Kaibab National Forest	3,757	15	336	1,454	26	173
Prescott National Forest	1,539	6	1	12		
Tonto National Forest	1,356	1		37		
Bureau of Land Management	242	0		3		
Department of Defense	9					
Canyon De Chelly National Monument	2					
Grand Canyon National Park	472	2	128	294	1	53
Saguaro National Monument	7					
Sunset Crater National Monument	1					
Walnut Canyon National Monument	1					
Havasupai Tribal		1				
Hopi Tribal		2				
Hualapai Tribal	12	3				
Navajo Tribal	984	13	37	1		1
San Carlos Tribal	4,898	3		1		
White Mtn Apache Tribal	4,666	1	93	260	8	29
Other Tribal	1					
State and Private	288	12	1			
Arizona Total	29,148	109	636	2,305	35	262
Carson National Forest	1,181	4	3,422	448	5,240	85
Cibola National Forest	5,456	19	178	1,510		12
Gila National Forest	6,486	29	515	6		
Lincoln National Forest	2,774	743	49	124	0	182
Santa Fe National Forest	5,986	2	7,248	1,278	4,648	7
Bureau of Land Management	94	9	61			
Department of Energy						
Bandelier National Monument	1		0			
El Malpais National Monument	173					
Valles Caldera National Preserve	2		54		1	
Acoma Pueblo	64	1				
Isleta Pueblo	355	4	1			
Jemez Pueblo	155		0			
Jicarilla Apache Tribal	79	1	522	60		
Laguna Pueblo	13		0			
Mescalero Apache Tribal	302	9	34	33	1	0
Navajo Nation	8	2	8	3		1
Picuris Pueblo	347	0	6			
Santa Clara Pueblo	0					
Taos Pueblo		0	7	0		
Zia Pueblo	1					
Zuni Pueblo	2					
Cochiti Pueblo						
State & Private	9,467	141	2,029	1,913	92	6
New Mexico Total	32,945	963	14,136	5,374	9,981	292
Grand Total	62,093	1,072	14,772	7,679	10,016	554

¹Only major bark beetle and mortality agents shown. Agents detected with lesser activity may not be represented in the table.

²Values rounded to the nearest 10, 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.

³Values based on landownership, thus any inholdings are summarized with their ownership category.

⁴Ponderosa pine bark beetle attributed mortality may include acreage from similar hosts such as Apache, Arizona, and Chihuahua pines...

Defoliation and Sap Sucker Damage Summary

Defoliation was the most common damage type mapped regionwide in 2024. Defoliation from insects and diseases (including agents not included in Table 3) increased across the region from 277,295 acres in 2023 to 365,386 acres in 2024 (Table 3). As in previous years, most of the acres with defoliation were detected in New Mexico (89%) and attributed to western spruce budworm (77% of total defoliation acreage in New Mexico). Western spruce budworm damage increased from 199,002 acres detected in 2023 to 248,869 acres in 2024, with the majority (all but the 46 acres mapped on the Kaibab NF in AZ) mapped in New Mexico. Pinyon needle scale, a native sap sucking insect, affected the second highest number of acres with defoliation in 2024 with a total of 44,581 acres mapped regionwide, an increase from the 32,330 acres mapped in 2023. More pinyon needle scale damage was recorded in Arizona (64%) than in New Mexico. Aspen damage had the third highest number of acres mapped in the region with 28,002 acres mapped in 2024, up from 15,737 acres in 2023. Aspen damage recorded during aerial surveys includes defoliation and mortality. Aspen damage in 2024 was recorded predominantly in New Mexico (79%).

In Arizona, pinyon needle scale damage was the most prevalent defoliating agent, and observable damage was mapped on 28,338 acres in 2024, only slightly above the 23,813 acres mapped in 2023. Acres mapped with tamarisk leaf beetle-caused defoliation decreased, with 7,464 acres observed in 2024 and 12,023 acres 2023. Aspen damage mapped from the air in 2024 was observed on 5,778 acres, down from 7,603 acres in 2023. Branch and tip dieback (flagging) was mapped on 1,341 acres of ponderosa pine, 82% of which was on White Mountain Apache Tribal Lands, where 632 acres were attributed to Prescott scale (a native sap sucker) and 469 acres were attributed to twig beetles.

In New Mexico, the most prevalent defoliator was western spruce budworm, which caused damage on 248,823 acres, up from 199,002 acres in 2023. Douglas-fir tussock moth acreage was the second highest mapped defoliator damage and increased substantially in New Mexico with 2,642 acres mapped in 2023 and 18,082 acres mapped in 2024. Most of this damage was mapped on the Santa Fe NF (Figure 6), although the Carson and the Cibola NFs also each had over 2,000 acres mapped with damage. Aspen damage also increased in New Mexico with 22,224 acres mapped in 2024 and 8,134 acres mapped in 2023. Pinyon needle scale almost doubled in 2024 with 16,243 acres mapped, up from 8,518 acres in 2023. Ponderosa pine defoliation attributed to pine needleminer was mapped on 13,781 acres in 2024, up from 11,381 acres in 2023. Mapped acres with oak defoliation in New Mexico in 2024 were slightly up with 3,201 acres mapped compared to 2,555 acres in 2023. Defoliation in ponderosa pine was also mapped from sawflies (7,074 acres) and pine needle scale (879 acres).



Figure 6: Douglas-fir tussock moth damage on Mesa Alta, Coyote RD, Santa Fe NF, New Mexico.

Table 3. Defoliation¹ and aspen damage incidence (acres) by ownership from aerial detection surveys in 2024 in Arizona and New Mexico².

Owner ³	Western spruce budworm	Aspen damage	Needle miner ponderosa	Sawfly ponderosa	Pinyon needle scale	Tamarisk leaf beetle	Douglas-fir tussock moth	Scale insects ponderosa ⁵	Oak Defoliation
Apache-Sitgreaves National Forests		1370			455			44	
Coconino National Forest		87			507				
Coronado National Forest		26							
Kaibab National Forest	46	1,259			46				
Prescott National Forest					1,580				78
Tonto National Forest					5,859				
Bureau of Land Management		11				441			
Canyon De Chelly National Monument						17			
Grand Canyon National Park		63							
Havasupai Tribal									
Hopi Tribal						81			
Hualapai Tribal					270				
Navajo Tribal		1,206			4,518	326			23
San Carlos Tribal					5,410	330			
White Mtn Apache Tribal		1746			8,398	6		632	
Other Tribal					385	90			
State & Private		10			910	6,173			
Arizona Total	46	5,778			28,338	7,464		676	101
Carson National Forest	106,634	1,625	9,329				2,749		2,016
Cibola National Forest	3,539	1,206	145	5,469	258		2,291	879	335
Gila National Forest		635		232	6,089				
Lincoln National Forest	666	158		95	4,218				88
Santa Fe National Forest	37,220	12,271	138	469	448		10,991		699
Bureau of Land Management	8				226	49	0		
Valles Caldera National Preserve	2,893	128							
Jemez Pueblo	110								
Jicarilla Apache Tribal	4,188	180							39
Laguna Pueblo		6				31			
Mescalero Apache Tribal	275				1,464				
Navajo Nation		1526							
Picuris Pueblo		49							
Santa Clara Pueblo	84								
Taos Pueblo	5,571	210							
State & Private	87,635	4,230	4,169	808	3,539	103	2,050		24
New Mexico Total	248,823	22,224	13,781	7,074	16,243	182	18,082	879	3,201
Grand Total	248,869	28,002	13,781	7,074	44,581	7,647	18,082	1,655	3,302

¹Only major defoliator agents shown. Less commonly detected agents or those detected with lesser activity may not be represented in the table.

²Values rounded to the nearest 10, 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.

³Values based on landownership, thus any inholdings are summarized with their ownership category.

⁴Aspen damage includes a combination of insect defoliation and other biotic and abiotic factors causing aspen decline, dieback, and in some cases mortality.

⁵Ponderosa scale insects includes damage from both Prescott needle scale in AZ and pine needle scale in NM.

Disease Summary

Dwarf mistletoe is the most common and widespread pathogen in the Southwest. Because aerial detection surveys do not allow for identification of dwarf mistletoe infestations and yearly ground estimates are limited, the overall estimated acreage affected does not change from year to year. Current estimates (Arizona 1,873,000 acres and New Mexico 2,073,000 acres across all ownerships) are based on historical records, which indicate that over one-third of the ponderosa pine acreage and about one-half of the mixed conifer acreage have some level of infection. Recent roadside surveys showed similar affected area in ponderosa pine compared with these historical records.

Root diseases are also widely distributed across the region (219,000 acres and 860,000 acres across all ownerships for Arizona and New Mexico, respectively) but poorly documented. The most prominent root diseases in the region are caused by *Armillaria* spp. and *Heterobasidion occidentale*, and these diseases often interact with bark beetles, drought, and other tree stressors to cause tree mortality. Foliar diseases generally occur sporadically based on environmental conditions but can be a chronic issue in areas conducive to infection.

White pine blister rust, a disease caused by the introduced fungus *Cronartium ribicola*, continues to injure and kill southwestern white and limber pine in the Southwest. Tree mortality from this disease is most prevalent on the Sacramento Mountains of southern New Mexico, but the disease can now be found in many parts of the Southwest, including eastern Arizona and parts of northern New Mexico.

Abiotic Summary

Although abnormally dry conditions and moderate to extreme drought continued to occur across the Southwestern Region in 2024, damage associated with these dry conditions generally continued to decline (Table 4). Limited impacts were still documented from woodlands to high elevation forests in both Arizona and New Mexico. Drought-induced discoloration of all conifer species (though primarily ponderosa pine) was mapped on 15,120 acres regionwide in 2024, down from 25,046 acres in 2023. Drought-induced dieback in juniper had largely declined in the region with only 158 acres mapped in Arizona in 2023, but this increased in 2024 to 805 acres in Arizona and 398 acres in New Mexico. The damage was primarily occurring on and around the Coronado and Gila NFs, further south than this damage had previously been observed. Red belt winter injury was again observed in northern New Mexico on the Valle Vidal unit of Carson NF where 1,005 acres were mapped in 2024 in the vicinity of the 1,185 acres impacted in 2023. Hail damage was mapped on 211 acres across the region, localized on New Mexico State Game & Fish Lands. Salt damage of ponderosa pine along roadways was mapped on about 50 acres in Arizona and 47 acres in New Mexico in 2024, down from 406 acres mapped across the Southwestern Region in 2023.

Table 4. Abiotic damage¹ incidence (acres) by ownership from aerial detection surveys in 2024 in Arizona and New Mexico².

Owner ³	Juniper drought dieback	Oak crown dieback	Ponderosa branch flagging ⁴	Ponderosa drought discolor	All spp. drought discolor
Apache-Sitgreaves National Forests			87	1,501	650
Coconino National Forest	65		107	2,616	1,265
Coronado National Forest	666				438
Kaibab National Forest			1		
Prescott National Forest				76	320
Tonto National Forest				29	13
Bureau of Reclamation					
Canyon De Chelly National Monument					
Grand Canyon National Park					
Saguaro National Park					227
Wupatki National Monument	1				
Hopi Tribal					
Hualapai Tribal					5
Kaibab Tribal					
Navajo Tribal					
San Carlos Tribal					
White Mtn Apache Tribal			469	630	551
Other Tribal					
State & Private	74			45	165
Arizona Total	805		665	4,898	3,634
Carson National Forest			1,345		1,698
Cibola National Forest	28			96	154
Gila National Forest	129				623
Lincoln National Forest				194	127
Santa Fe National Forest				125	
Bandelier National Monument					
El Malpais National Monument					
Valles Caldera National Preserve					
Acoma Pueblo					
Isleta Pueblo					
Jemez Pueblo					
Jicarilla Apache Tribal					
Laguna Pueblo					
Mescalero Apache Tribal					
Navajo Nation				120	258
Picuris Pueblo					
Ramah Tribal					
Santa Clara Pueblo					
Taos Pueblo					1
Zuni Pueblo					
State & Private	241	284	36	1,848	1,453
New Mexico Total	398	284	1,381	2,383	4,310
Grand Total	1,203	284	2,046	7,281	7,944

¹Only major abiotic damage shown, less commonly detected damage may not be reported in the table.

²Values rounded to the nearest acre, 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

³Values based on landownership, thus any inholdings are summarized with their ownership category.

⁴Ponderosa branch flagging includes acres with damage caused by twig beetles and general branch flagging.

Status of Major Insects

Bark Beetles

The overall total acreage with tree mortality attributed to bark beetles increased slightly across the region in 2024 for beetle species tracked by aerial survey (Table 2). Most of the bark beetle damage for the region was mapped on Forest Service lands (66%).

Pinyon-Juniper Woodlands

In 2024, 9,812,700 acres of woodlands were surveyed. Acres with bark beetle-attributed mortality in pinyon-juniper woodlands remained very low (Figure 7).

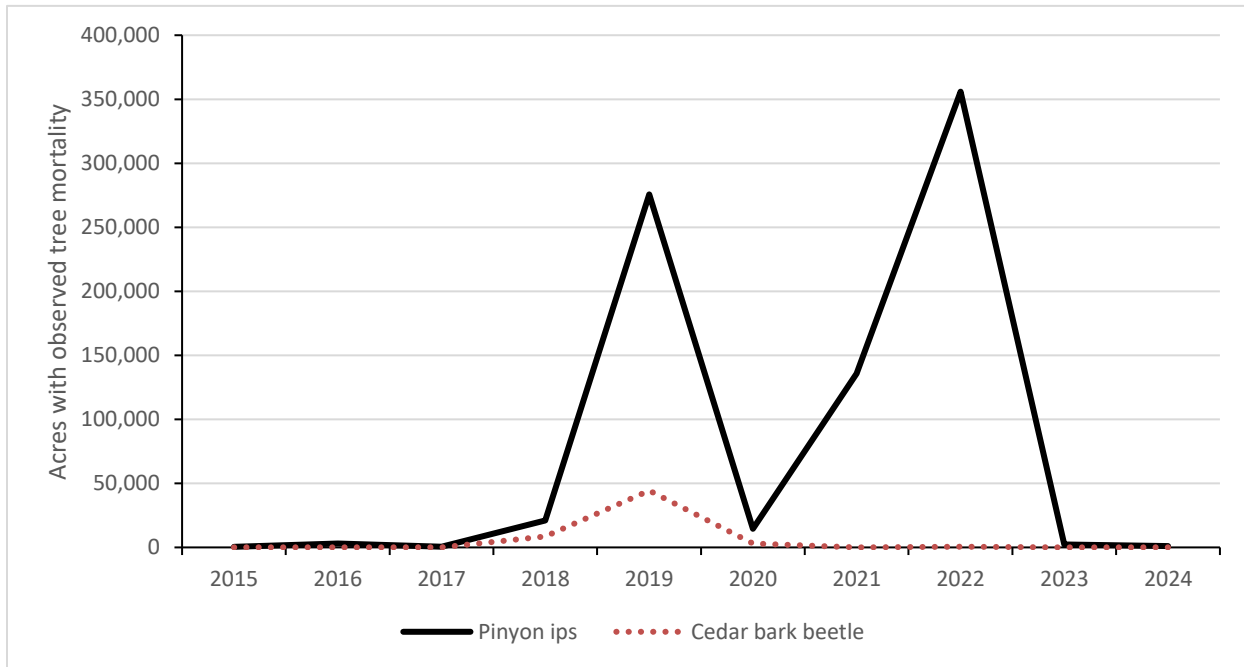


Figure 7: Pinyon-juniper mortality associated with pinyon ips and cedar bark beetles in the Southwestern Region over the last ten years.

Pinyon Ips

Ips confusus

Host: Pinyon pine

Acres with pinyon mortality decreased from 2,350 acres in 2023 to 1,072 acres in 2024 (Table 2, Figure 7). Similar to 2023, most of the mortality was observed in New Mexico (963 acres; 90%). This was a decrease from the 1,937 acres mapped in the previous year. The damage in New Mexico occurred primarily on the Lincoln NF (743 acres) and private lands (136 acres) with scattered mortality on other ownerships. In Arizona, the 109 acres reported in 2024 was a decrease from 411 acres mapped in 2023. The Apache-Sitgreaves NFs accounted for the greatest proportion of pinyon mortality (50 acres; 46%) in Arizona with scattered mortality on other ownerships.

Cedar Bark Beetles

Phloeosinus spp.

Host: Junipers and Arizona cypress

Juniper mortality has historically been linked to cedar bark beetle activity in the Southwest, and ground surveys in 2022 found many dead alligator junipers with evidence of attack. However, in recent years, many junipers had dieback with the lower branches of the trees often remaining green, and, other than in alligator juniper, evidence of bark beetle activity was scarce. During 2021-2023 most of the fading juniper were thus mapped as dieback rather than mortality, as described in the Abiotic section of this document under “drought”. In 2023, no acres of mortality attributed to cedar bark beetles were mapped in the region, and in 2024 only 10 acres were mapped (Figure 7) with Arizona accounting for eight acres and New Mexico for two acres.

Juniper Twig Pruner

Styloxus bicolor

Host: Junipers

The juniper twig pruner is a native longhorn beetle that causes tip dieback, particularly during droughts. In Arizona, damage caused by this agent was detected in 2023 on 1,245 acres, primarily on White Mountain Apache Tribal Lands. No damage was mapped in New Mexico in 2023. In 2024, no damage was mapped from this insect in either New Mexico or Arizona.

Ponderosa Pine Forest Type

In the Southwestern Region, ponderosa pines are attacked by a diverse complex of bark beetles, most commonly in the *Ips* and *Dendroctonus* genera. These beetles overlap geographically, and it is quite common to find several species co-occurring within the same tree.

Ponderosa pine mortality increased throughout most of the region, with 61,967 acres mapped in 2024 and 15,369 acres mapped in 2023 (Figure 8). The damage occurred relatively equally in Arizona (29,022 acres, 47%) and New Mexico (32,945 acres, 53%). This was an increase for both states from 9,157 acres and 6,213 acres in Arizona and New Mexico, respectively, in 2023.

In Arizona, most of the mortality (30%; 8,636 acres) was recorded on the Apache-Sitgreaves NFs, but San Carlos Apache and White Mountain Apache Tribal Lands both had over 4,500 acres as well (Table 2). Most of the ponderosa pine mortality in Arizona was scattered, but some larger polygons were mapped on most NF lands. Many of the larger mortality areas were associated with previous wildfire activity such as the Mangum Fire on the Kaibab NF, the Crooks Fire on the Prescott NF, and the Rafael Fire on the Coconino NF.

Most of the mortality in New Mexico was located on state and private lands (9,467 acres, 29%) followed by the Gila NF (6,486 acres, 20%), Santa Fe NF (5,986 acres, 18%), and Cibola NF (5,456 acres, 17%). In New Mexico, post-fire bark beetle related tree mortality is occurring throughout the Hermit Peak/Calf Canyon Fire scar on the Santa Fe NF and the Black Fire scar on the Gila NF (Figure 9).

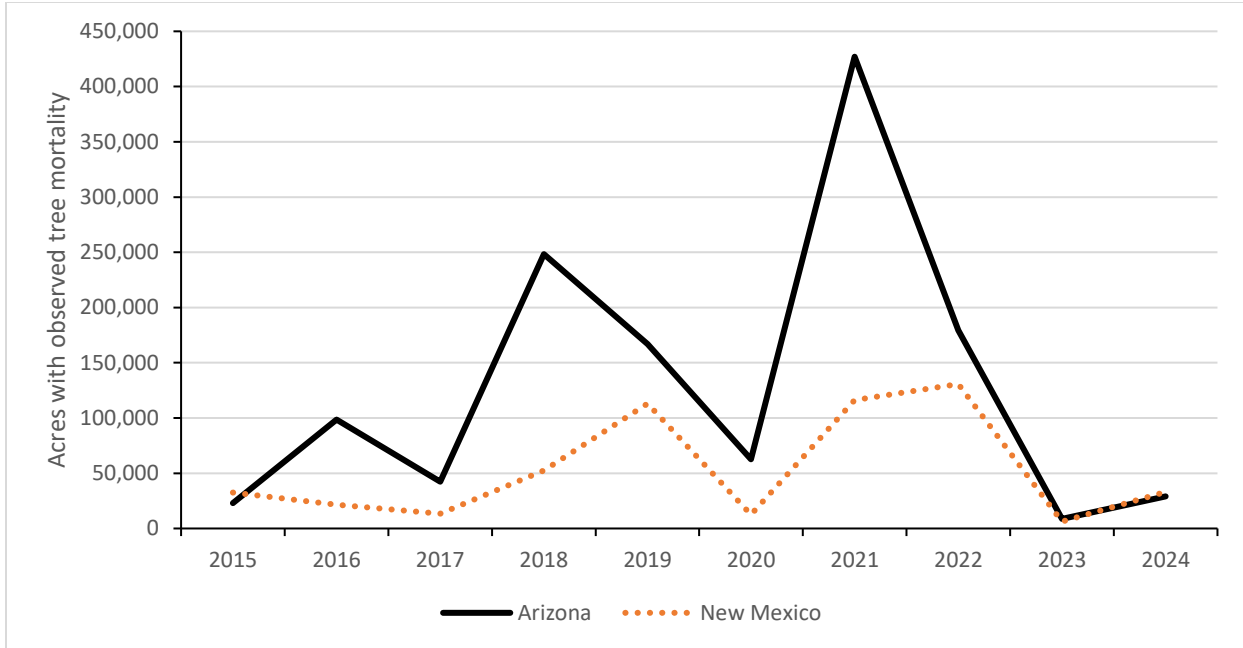


Figure 8: Ponderosa pine mortality attributed to bark beetles in the Southwestern Region over the last ten years.

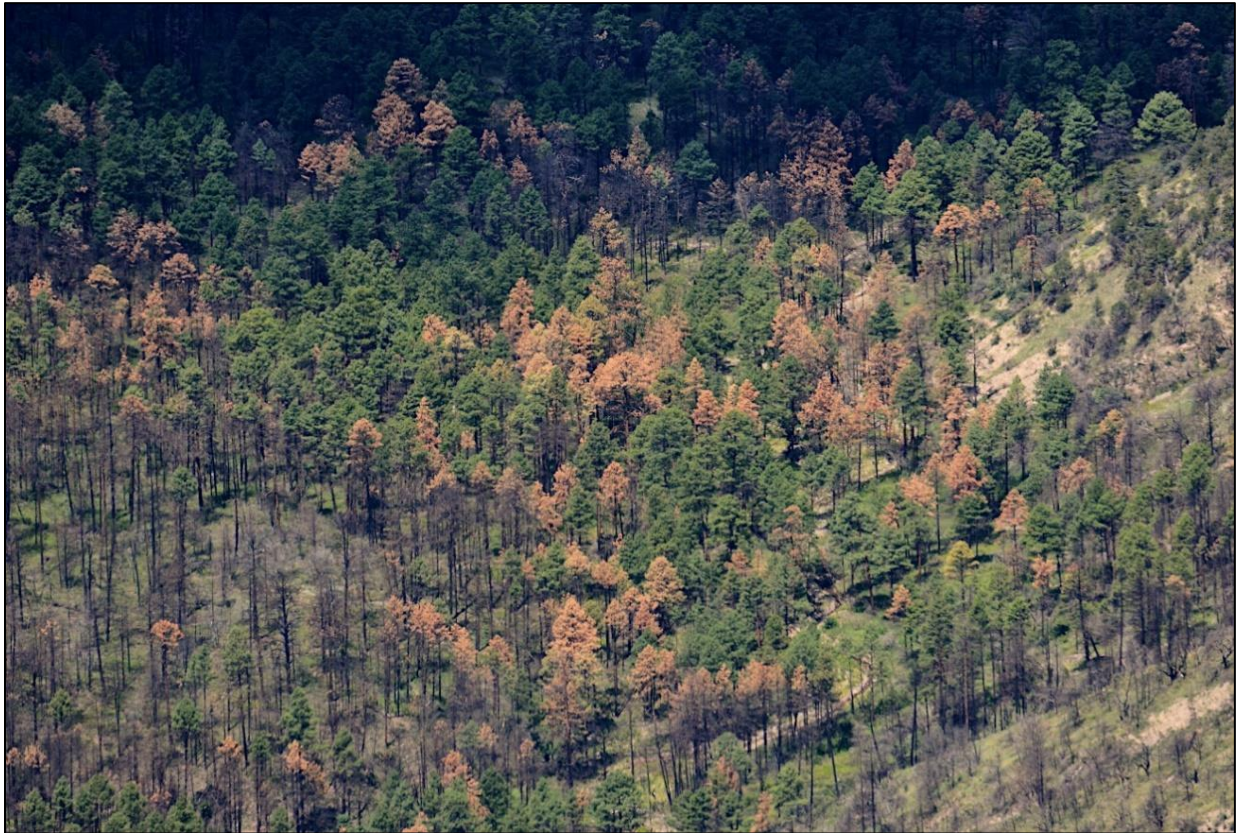


Figure 9: Mortality of ponderosa pine from post-fire stress and insect activity (typically a combination of bark beetles and woodborers) in the Black Fire footprint in New Mexico.

Mixed Conifer Forest Type

Mortality in mixed conifer forests from bark beetles, primarily consisting of Douglas-fir beetle on Douglas-fir and fir engraver on white fir, increased slightly throughout the Southwestern Region. Douglas-fir and white fir mortality in 2023 was mapped on 18,774 acres. In 2024, mortality increased, with 22,348 acres mapped (Figure 10).

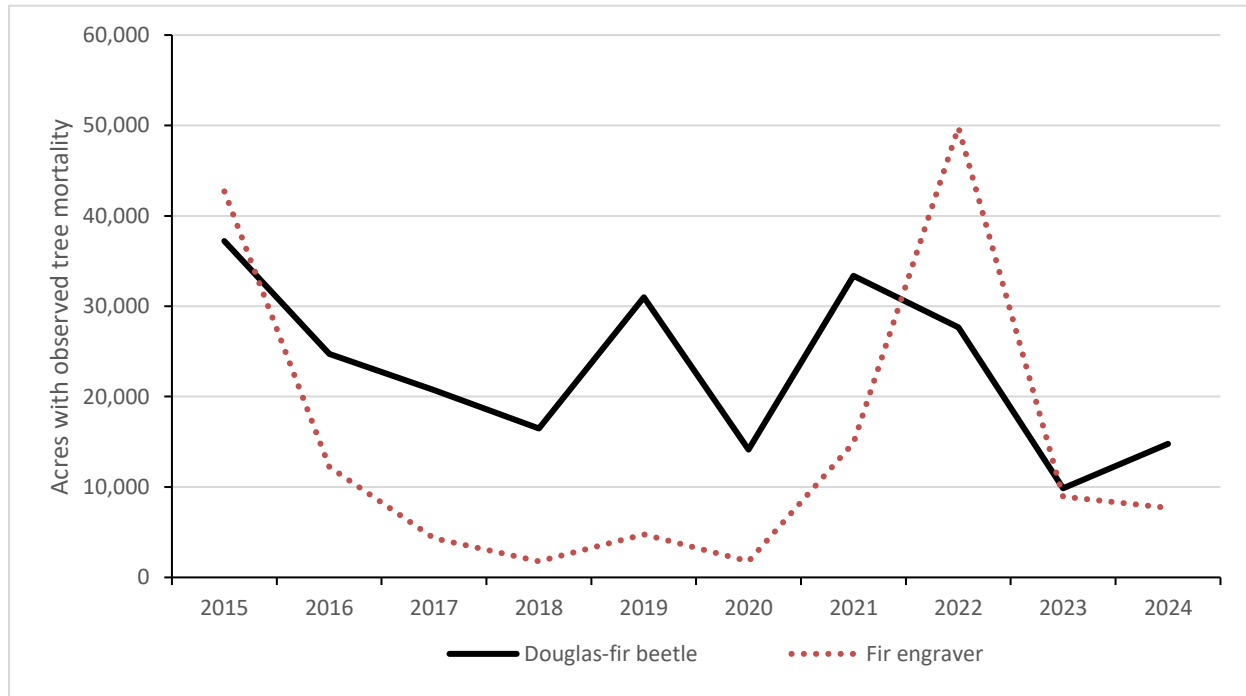


Figure 10: Mixed conifer mortality associated with Douglas-fir beetle and fir engraver in the Southwestern Region over the last ten years.

Douglas-fir Beetle

Dendroctonus pseudotsugae

Host: Douglas-fir

Douglas-fir beetle activity is most common in dense stands of mature Douglas-fir. At endemic levels, this beetle species will target stressed trees such as those injured by fire, infected by dwarf mistletoe or root disease, or trees experiencing severe defoliation or drought stress. Generally, Douglas-fir beetle will only affect small pockets or individual trees, but infestations may grow to larger outbreaks during periods of suitable climate and widespread susceptible host trees. In 2024, Douglas-fir mortality from Douglas-fir beetle increased across the region from 9,855 acres in 2023 to 14,772 acres (Figure 10). New Mexico accounted for 96% (14,136 acres) of the total Douglas-fir beetle activity. This was almost double the acreage recorded in 2023 (7,414 acres). About half of the New Mexico acreage was recorded on the Santa Fe NF (7,248 acres) (Table 2). The damage is being observed even outside of fire-affected areas on the Pecos/Las Vegas and Jemez Ranger Districts (RDs) (Figure 11). Acres with Douglas-fir mortality attributed to Douglas-fir beetle in Arizona in 2024 decreased. In 2023 2,441 acres were observed while in 2024 only 636 acres were observed. Similar to 2023, the majority of damage (336 acres) for Arizona occurred north of the Grand Canyon on the Kaibab NF and in Grand Canyon National Park.



Figure 11: Douglas-fir beetle mortality in the Pecos Wilderness, New Mexico.

Fir Engraver

Scolytus ventralis

Hosts: White fir, corkbark fir

Fir engraver-caused mortality is often linked to root disease and drought-stressed trees growing in dense stands on warm, dry sites in the Southwest. Fir mortality may be more prevalent on drier south- and west-facing slopes.

White fir mortality attributed to fir engraver continued to decrease in the region, with total acres mapped declining from 8,919 acres in 2023 to 7,679 acres in 2024 (Figure 10). New Mexico accounted for the majority of the white fir mortality with 5,374 acres, a slight increase over the 4,480 acres recorded in 2023. The bulk of the mortality in New Mexico was distributed among the Cibola NF (1,510 acres, 34%), Santa Fe NF (1,278 acres, 29%), and private lands (1,764 acres, 39%). In Arizona, 2,305 acres were mapped with mortality, a decrease from the 4,439 acres mapped in 2023. The majority of fir engraver activity occurred on the Kaibab NF (1,454 acres, 63%). White fir mortality in Arizona mainly consisted of individual or small pockets, but some larger polygons were mapped on the North Kaibab RD and were associated with wildfire activity.

Spruce-fir Forest Type

At around 9,000' elevation, mixed conifer forests start to transition to spruce-fir forests. Engelmann spruce and corkbark fir are the primary tree species, but blue spruce, southwestern white and limber pines, Rocky Mountain bristlecone pine, and aspen may also be present.

Spruce Beetle

Dendroctonus rufipennis

Host: Spruce

Spruce mortality attributed to spruce beetle continued to decrease across the Southwestern Region from 12,658 acres in 2023 and 10,016 acres mapped in 2024 (Figure 12). Spruce beetle activity in Arizona was once again very low in 2024 with only 35 acres mapped, mainly on the Kaibab NF (26 acres). This was down from the 181 acres mapped in 2023. New Mexico accounted for more than 99% of bark beetle-caused spruce mortality regionwide with 9,981 acres. This was a decline from the 12,477 acres reported for New Mexico in 2023. Within New Mexico, most of the spruce mortality was mapped on the Carson (5,240 acres, 52%) and Santa Fe NFs (4,648 acres, 47%). On the Santa Fe NF, the Pecos watershed has experienced many years of spruce beetle activity which has had a dramatic effect on these high elevation forest systems.

Spruce Engraver Beetles

Ips spp.

Host: Spruce

Spruce *ips* activity, totaling ten acres, was also mapped in the White Mountains and mostly recorded as single scattered spruce on White Mountain Apache Tribal Lands during site visits.

Western Balsam Bark Beetle

Dryocoetes confusus

Hosts: Corkbark fir

This bark beetle commonly interacts with root diseases caused by *Armillaria* spp. or *Heterobasidion occidentale* to kill trees. The interaction of bark beetles and root disease is common in many forests throughout the West. Signs of infection by *Armillaria* spp. can consistently be found on dead corkbark fir trees in many spruce-fir forests across the Southwestern Region. Fir engraver can also cause corkbark fir mortality and is indistinguishable from mortality caused by western balsam bark beetle during aerial surveys.

Corkbark fir mortality attributed to western balsam bark beetle increased slightly regionwide from 517 acres in 2023 to 554 acres in 2024 (Figure 12). The damage attributed to western balsam bark beetle occurred relatively equally between states with Arizona reporting 262 acres and New Mexico with 292 acres. In Arizona, mortality decreased from 476 acres reported last year with the majority of corkbark fir damage occurring on the Kaibab NF (173 acres). In New Mexico, the acreage affected by western balsam bark beetle increased from 41 acres mapped in 2023 to 292 acres in 2024. Most of the area affected was located on the Carson (85 acres) and Lincoln (182 acres) NFs.

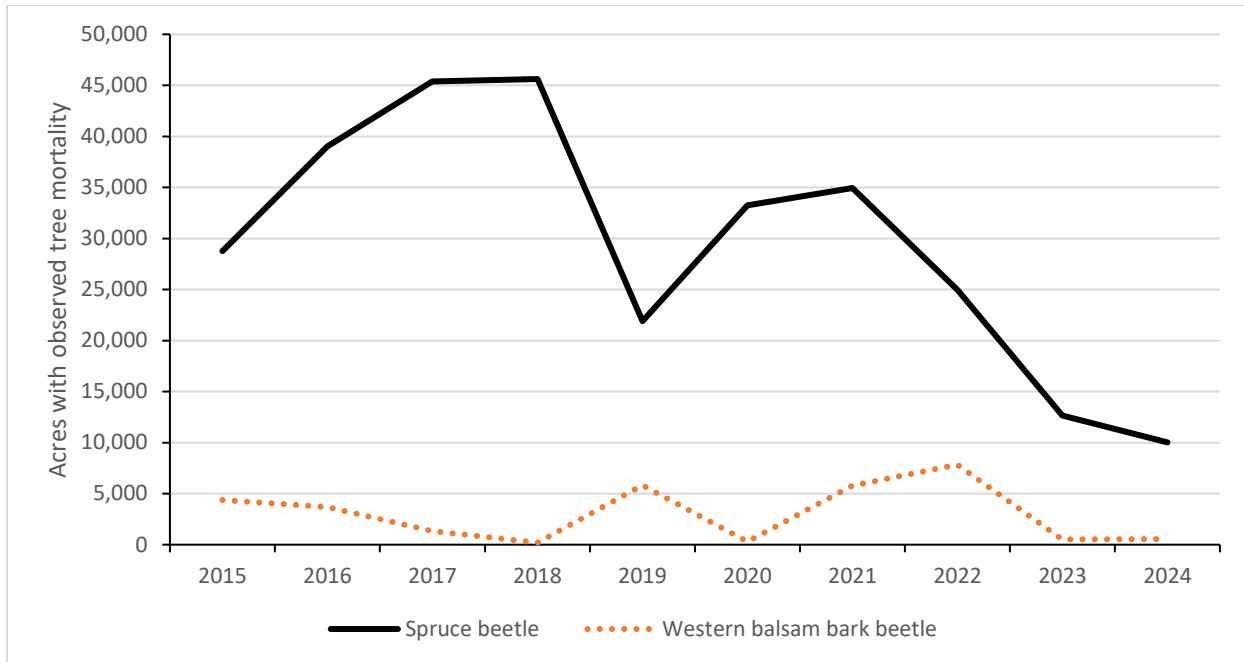


Figure 12: Tree mortality in spruce-fir forests attributed to spruce beetle and western balsam bark beetle in the Southwestern Region over the last ten years.

Defoliators

Defoliation damage ranges from removal of foliage to crown discoloration, dieback, branch flagging, and premature needle drop due to desiccation or tissue necrosis. Defoliation may be caused by insects, diseases, or abiotic events. Acres observed with damage from biotic agents (including less prominent agents not included in Table 3) increased regionwide from 277,295 acres in 2023 to 366,062 acres in 2024 (Table 3). Western spruce budworm continues to cause the most acreage of defoliation compared to other agents in the region. The most prominent defoliators for each state were western spruce budworm and pinyon needle scale for New Mexico and Arizona, respectively.

Pinyon-Juniper Woodlands

Pinyon Needle Scale

Matsucoccus acalyptus

Host: Pinyon pine

Pinyon needle scale infestations are persistent in many pinyon-juniper woodlands throughout the region, and repeated defoliation caused by this insect can cause reduced growth and stunted needles. In severe outbreaks, small trees may be killed. While chronic in many places, the amount of visible defoliation varies from year-to-year. Depending upon the severity of the defoliation and timing of ground visits and survey flights, this damage can be quite difficult to detect from the air and thus accuracy may vary from year to year.

Acres with damage attributed to pinyon needle scale increased from 32,330 acres in 2023 to 44,581 acres in 2024 regionwide (Table 3). Most of the damage (28,338 acres, 64%) was detected in Arizona, similar to the 23,813 acres mapped in the state in 2023. Pinyon needle scale damage accounted for over 70% of Arizona's total acres with defoliation, and the damage was mapped across the state. Pinyon

needle scale continues its chronic activity on the Prescott NF (1,580 acres) (Figure 13), particularly on the Chino Valley RD (944 acres). In addition, widespread activity was detected on the northern portion of the Tonto NF (5,859 acres) and on Navajo (4,518 acres), San Carlos Apache (5,410 acres), and White Mountain Apache (8,398 acres) Tribal Lands.

New Mexico saw a substantial increase in acres impacted by pinyon needle scale with 16,243 acres mapped in 2024, up from 8,518 acres in 2023. The majority of the damage in New Mexico was mapped on Gila (6,089 acres) and Lincoln (4,218 acres) NFs. Much of the damage on the Lincoln is occurring on the eastern slopes of the Sacramento Mountains.



Figure 13: Pinyon-juniper woodland with pinyon needle scale on the Bradshaw RD, Prescott National Forest.

Ponderosa Pine Forest Type

Pine Needle Scale

Chionaspis pinifoliae

Host: Most pines, spruce, Douglas-fir

In 2024, 879 acres of pine needle scale defoliation were recorded on the Cibola NF. As with other scale insects, pine needle scale is a sap sucking insect, and feeding from this insect causes needles to yellow and eventually drop. Heavy infestations over several years can kill young trees and severely weaken larger trees, predisposing them to attack by other pests.

Pine Sawflies

Neodiprion and *Zadiprion* spp.

Host: Ponderosa pine

Pine sawfly defoliation in ponderosa pine increased substantially in 2024 with 7,074 acres mapped with damage, up from 858 acres mapped in 2023. For the third year in a row, all acres were mapped in New Mexico. The majority (5,469 acres, 77%) of this damage occurred on the Cibola NFs centered on the Zuni Mountains and Gallinas Mountains (Figure 14). Smaller amounts of damage were mapped on the Gila, Lincoln, and Santa Fe NFs, as well as on state and private lands.



Figure 14: Photos of a new pine sawfly outbreak on the Zuni Mountains, Cibola NF, New Mexico. Landscape scale photograph of the defoliation on the left and closeup of affected ponderosa pines is on the right.

Pine Needleminer

Coleotechnites ponderosae

Host: Ponderosa pine

Ponderosa pine needleminer activity increased from 11,381 acres in 2023 to 13,781 acres in 2024. As in 2022 and 2023, all of the damage was reported in New Mexico where it was documented mostly on the Carson NF (9,329 acres, 68%) and state and private lands (4,169 acres, 30%).

Prescott Scale

Matsucoccus vexillorum

Host: Ponderosa pine

Branch flagging in ponderosa pine attributed to Prescott scale dropped from 3,909 acres in 2023 to 676 acres in 2024. All of this damage was recorded in Arizona, predominantly on White Mountain Apache Tribal Lands (632 acres, 93%) with the remainder mapped on the adjacent Apache-Sitgreaves NFs (44 acres, 7%). Prescott scale is a native sap sucking scale insect that causes branch flagging in early summer but rarely causes tree mortality.

Mixed Conifer Forest Type

Aspen Defoliation, Dieback, and Mortality

Western tent caterpillar, *Malacosoma californicum*

Large aspen tortrix, *Choristoneura conflictana*

Oystershell scale, *Lepidosaphes ulmi*

Black leaf spot, *Drepanopeziza populi*

Complex of drought and other insects and diseases

In the Southwestern Region, aspen mortality, dieback, and defoliation are monitored through a combination of aerial and ground surveys. Aspen damage increased regionwide to 28,002 acres in 2024 from 15,737 acres in 2023. New Mexico had more damage (22,224 acres, 79%) than Arizona (5,778 acres, 21%). Most of the damage across the region was mapped as defoliation (21,454 acres) with more acreage (17,581 acres) in New Mexico than in Arizona (3,873 acres) (Table 3). Similarly, more mortality was mapped in New Mexico (5,130 acres) than in Arizona (2,021 acres).

The number of acres with aspen damage increased in New Mexico from 8,134 acres mapped in 2023. Damage mapped as mortality increased from the 1,239 acres mapped in 2023 as did acreage mapped as defoliation (7,008 acres in 2023). In 2024, the defoliation in New Mexico was primarily mapped on the Santa Fe NF (10,964 acres). Western tent caterpillar is often the primary defoliating agent; however, large aspen tortrix has also historically contributed to the defoliation.

In Arizona, the overall number of acres mapped with aspen damage increased from the 8,334 acres mapped in 2023. Both defoliation and mortality increased from 4,524 acres and 3,810 acres in 2023 for defoliation and mortality, respectively. Ongoing ground surveys and a network of permanent monitoring plots are used in Arizona to evaluate impacts from agents that are not easily detected by aerial surveys including invasive oystershell scale, other native insects and diseases, and ungulate browse.

Aspen Bark Beetle

Trypophloeus populi

Host: Aspen

Aspen bark beetle activity was noted in Arizona during 2024. Unlike bark beetles in conifers, this species is not mapped by aerial survey. There are many drivers of aspen mortality, and it is not possible to distinguish agents from the air. Aspen bark beetles, mainly *Trypophloeus populi*, attacked individual mid- to large-diameter aspen trees in high elevation forests in Arizona on the San Francisco Peaks, Coconino NF and near Greens Peak and Big Lake on the Apache-Sitgreaves NFs. The species is known to cause damage in stressed aspen.

Willow Scale

Diaspidiotus gigas

Host: Aspen and willow spp.

Willow scale is an invasive, sap-sucking scale insect from Europe. Scales are small and often inconspicuous and can go unnoticed. Damage often results in a bubbling or pitting effect on the main bole that is noticeable from a distance. Willow scale has been noted on urban aspen around Flagstaff and was observed causing aspen mortality at Fort Tuthill, Luke Air Force Base, Recreation Area in 2024.

Willow scale has also become established in the forest setting within aspen enclosures on the Coconino NF where it is contributing to aspen mortality.

Douglas-fir Tussock Moth

Orgyia pseudotsugata

Hosts: True firs, Douglas-fir, and spruce

Douglas-fir tussock moth (DFTM) activity increased dramatically in the region from 2,642 acres mapped in 2023 to 18,082 acres in 2024 with several different outbreaks occurring across New Mexico. Severe outbreaks can cause heavy defoliation and significant mortality quickly in both Douglas-fir and white fir. In 2023 and 2024, DFTM damage for the Region was only mapped in New Mexico. Most of the damage in 2023 was mapped on the Cibola NF (2,201 acres, 83%). In 2024, the Cibola NF had a similar amount of acres impacted (2,291 acres), and the outbreak that was first observed in 2022 on the Manzano Mountains, Mountainair RD is winding down, leaving large areas of mortality. The Santa Fe NF had 10,991 acres of damage mapped in 2024. Activity was on the Coyote RD along the southern boundary of the Chama River Canyon Wilderness and on the north edge of the San Pedro Parks Wilderness (Figure 15). Douglas-fir tussock moth damage was also mapped on the Carson NF (2,749 acres) and state and private lands (2,050 acres) in 2024.

In addition to mapping damage with ADS, regular monitoring of DFTM populations using a pheromone-based trapping system started in the Southwestern Region in 1992 and continues in both states to this day. In Arizona trapping results at the Knoll Lake Recreation Area, Coconino NF suggest populations are increasing and may require additional monitoring in 2025. In New Mexico, male moth and egg mass surveys on the Santa Fe NF indicate that the defoliation activity will continue into 2025. Jemez Pueblo Tribal Lands are also experiencing a DFTM outbreak. Male moth trapping and egg mass surveys will be added to the area in 2025. Preliminary assessments made during site visits indicate that this DFTM outbreak will likely continue in 2025.



Figure 15: Douglas-fir tussock moth-caused defoliation (reddish-grey trees) on the Coyote RD, Santa Fe NF.

Western Spruce Budworm

Choristoneura freemani

Hosts: True firs, Douglas-fir, and spruce

Western spruce budworm activity increased across the Southwestern Region from 199,002 acres mapped in 2023 to 248,869 acres in 2024 (Table 3, Figure 16). Matching with the historical pattern, the damage was mapped primarily in New Mexico (248,823 acres, 99%).

In Arizona, few acres are impacted by western spruce budworm given the lack of contiguous host type in the state. In 2024, aerial observers detected 46 acres with defoliation in Arizona, all on the North Kaibab RD, Kaibab NF. No acres of damage were reported in 2023.

Most western spruce budworm-caused defoliation occurred in the northern part of New Mexico, particularly on the Carson NF (106,634 acres). Defoliation has been observed in mixed conifer and spruce-fir stands in this area for the past four decades. Douglas-fir has been the preferred host, although white fir and Engelmann spruce are also commonly defoliated. Twig dieback, top-kill, and tree mortality have resulted from the chronic defoliation, and understory regeneration has been significantly affected in some stands.

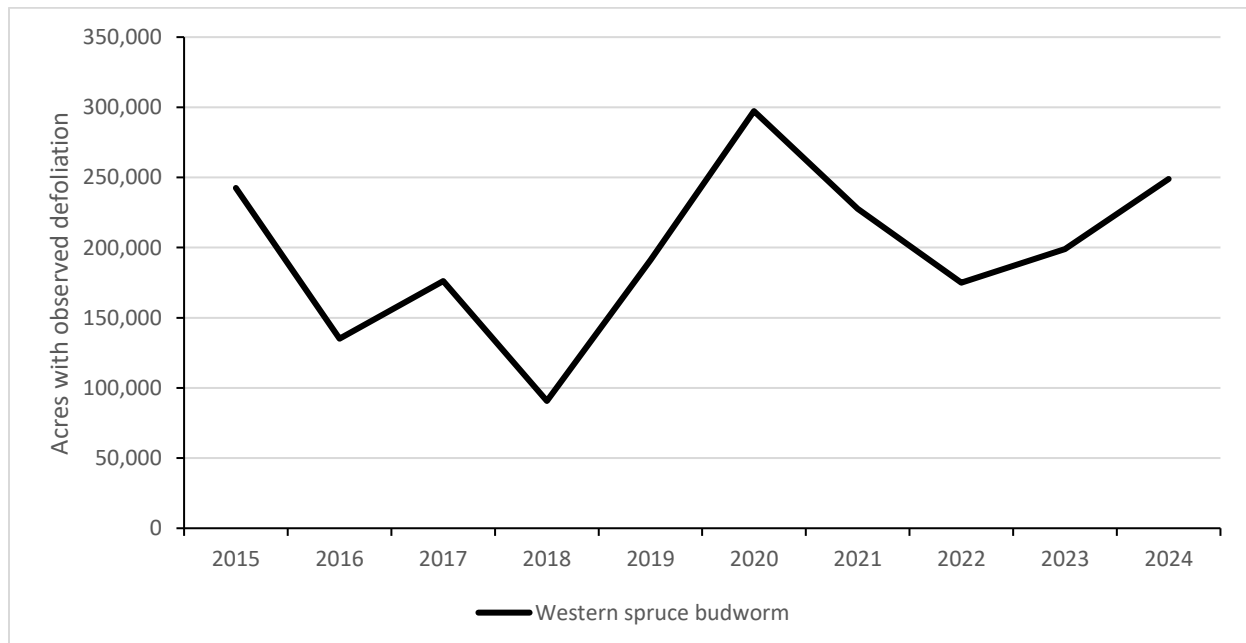


Figure 16: Defoliation attributed to western spruce budworm in the Southwestern Region for the last ten years.

Spruce-fir Forest Type

Spruce Aphid

Elatobium abietinum

Hosts: primarily Engelmann and occasionally blue spruce

Spruce aphid is an exotic, invasive insect with periodic outbreaks that can cause significant damage and mortality of Engelmann spruce. Spruce aphid damage has been minimal in the last four years (Figure 17) and mapped exclusively in Arizona. In 2023, 60 acres with damage was mapped on White Mountain

Apache Tribal Lands (81%) and neighboring Apache-Sitgreaves NFs. In 2024, only seven acres were mapped with damage, all in Arizona on White Mountain Apache Tribal Lands.

The most recent spruce aphid activity observed in New Mexico was reported at Ski Apache on the Lincoln NF during the winter of 2018-2019. At that time, ground visits identified feeding damage and live aphids.

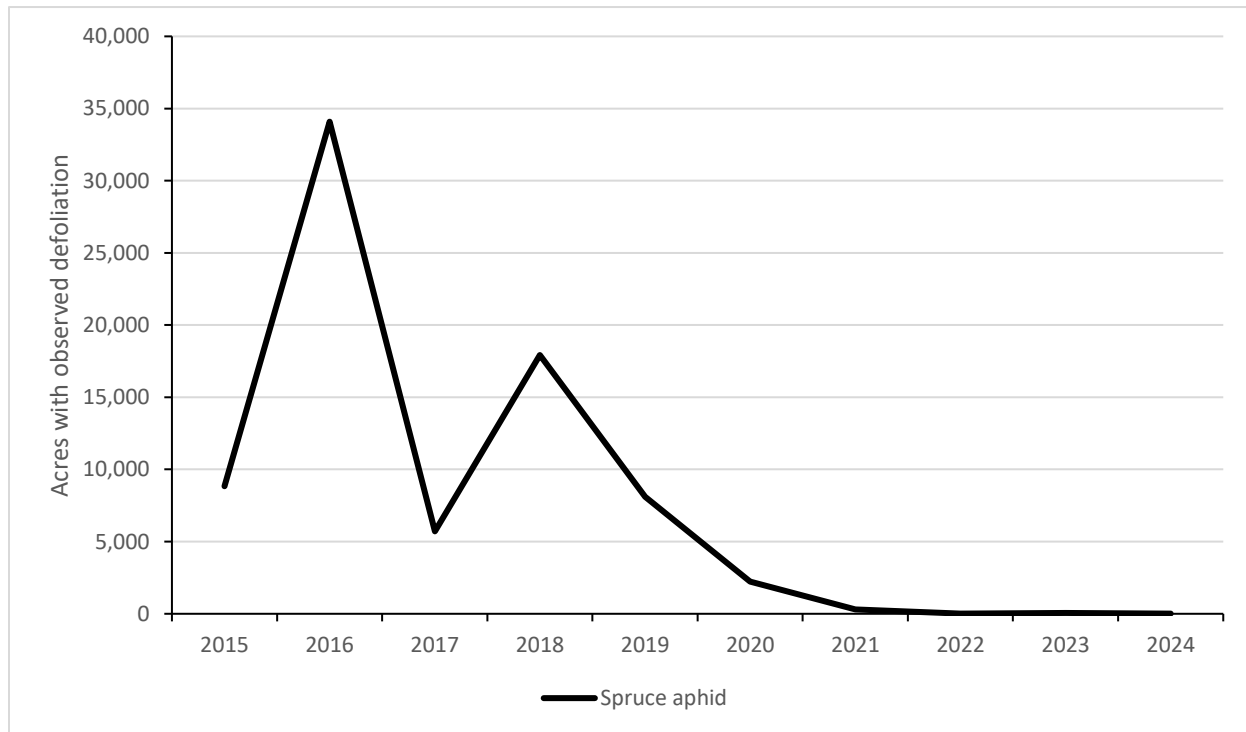


Figure 17: Defoliation attributed to spruce aphid in the Southwestern Region over the last 10 years.

Bud and Shoot Insects

Injury to buds and shoots may be caused by caterpillars, weevils, bark beetles, midges, aphids, or scale insects. Most of these insects are only problematic in replanted areas that occur on harsh or marginal sites following disturbance.

Pine Tip Moths

Rhyacionia spp.

Host: Ponderosa pine

Pine tip moths prefer expansive areas with young pine seedlings to infest. Seedlings are less susceptible to tip moth damage once they reach a height of six feet. Tip moth larval feeding will damage terminal and lateral shoots resulting in reduced height growth, stagnation in the susceptible size class, and deformities including forking and multiple leaders.

In 2024, severe pine tip moth damage on the Apache-Sitgreaves NFs was documented on the Black Mesa RD near Heber-Overgaard.



Figure 18: Pine tip moth pupae in bud of ponderosa.

Several reforestation projects within the Rodeo-Chedeski Fire footprint were affected. Most 15-20 year-old seedlings at the site are three to five feet tall due to repeated tip moth infestation and harsh growing conditions. Overwintering pupae were collected from infested buds and shoots in October 2024 (Figure 18). It is suspected they are Nantucket pine tip moth. Nantucket pine tip moth, a non-native insect from the southeastern U.S., became established in Arizona and New Mexico in the 1970s and 80s.

Miscellaneous Insects

Goldspotted Oak Borer

Agrilus auroguttatus

Hosts: Emory oak, silverleaf oak

Typically, goldspotted oak borer is a secondary pest in drought-affected oaks stands. Dieback, discoloration, defoliation, and mortality of oaks have been mapped at low levels across much of the host type for the last few years (Tables 3 & 4), but damage is hard to separate by host type and damage agent from the air. Ground surveys indicate the pathogens *Biscogniauxia mediterranea* and another undescribed *Biscogniauxia* spp. play an important role in the decline of many Emory and silverleaf oak stands and it is impossible to differentiate the two agents during aerial surveys.

Tamarisk leaf beetle

Diorhabda spp.

Host: Saltcedar

One of the most widely distributed invasive species in the Southwestern Region is saltcedar (*Tamarix* spp.), which occurs as a shrub or tree along many waterways and riparian areas. In 2001, several species of the tamarisk leaf beetle (*Diorhabda* spp.) from central Eurasia were released in western states as a host-specific biocontrol agent (Figure 19). Adult tamarisk leaf beetle and larvae both consume saltcedar foliage, which can damage or kill the plant over several years. Feeding by the beetle causes saltcedar leaves to dry out and turn brown while remaining on the stem; thus, crown discoloration is commonly seen in affected saltcedar stands. Defoliation of saltcedar caused by tamarisk leaf beetle is often documented from the air during aerial detection surveys and while ferrying between survey areas. The number of acres with tamarisk leaf beetle-caused damage is likely underestimated in the region as riparian surveys are limited. However, special surveys to document extent of tamarisk leaf beetle-caused defoliation were conducted along portions of the San Pedro and Gila Rivers in southeastern Arizona in 2023 and 2024 at the request of Arizona Department of Forestry and Fire Management to support priorities around invasive species management. In 2024, 7,464 acres with defoliation were mapped whereas in 2023 defoliation was detected on 12,023 acres. Most of the acres detected continue to be mapped on state and private lands in Arizona (Table 2).



Figure 19: Tamarisk leaf beetle. USDA Forest Service photo by Camden Bruner.

Twig and Cone Beetles

Pityophthorus, *Conophthorus*, and *Pityogenes* spp.

Hosts: multiple hosts

In 2024, a total of 2,046 acres with branch flagging on ponderosa pine attributed to twig beetles were mapped. Of this total, 665 acres were mapped in Arizona, primarily on White Mountain Apache Tribal Lands (469 acres, 71%), and 1,381 acres were mapped in New Mexico. In New Mexico, the damage was primarily mapped on the Carson NF (1,345 acres, 97%). In ponderosa pine, the damage from twig beetle can appear very similar to damage from Prescott scale and drought dieback. Ground surveys are necessary to distinguish among the agents.

In 2024, 2,149 acres of cone beetle damage on bristlecone pine were observed. This damage was mapped exclusively in New Mexico on the Carson NF (420 acres) and private lands (1,730 acres) (Figure 20). The larvae bore into developing cones and into the twig itself. While not a large amount of acreage is affected compared to other insect and disease activity, the continued damage on this high-elevation pine species warrants attention. Each year new areas of bristlecone pine on the Carson NF are observed with this damage, and ground checks reveal repeated annual damage, though it has not resulted in total tree mortality yet.



Figure 20: Branch flagging and damage to bristlecone pine from cone beetles. This example from the Chacon area in New Mexico shows the cumulative damage affecting these trees as seen in the gray portions of the bristlecone pine crowns.

Status of Major Diseases

Mistletoes

Dwarf Mistletoes

Arceuthobium spp.

Hosts: Conifers

Dwarf mistletoes are among the most widespread and damaging forest pathogens (disease-causing organisms) in the Southwestern Region with over one-third of the ponderosa pine type and up to one-half of the mixed conifer type having some level of infection. Damage to host trees from dwarf mistletoe infection includes growth reduction, deformity (especially the characteristic witches' brooms), and decreased longevity (Figure 21). Severely infested areas have higher tree mortality rates than uninfected areas. Weakened trees can be killed by other damaging agents such as bark beetles. Dwarf mistletoes have an ecological role, as they provide bird roosting habitat and an occasional food source for some mammals and birds. There are eight species of dwarf mistletoe in the region, each with a primary tree host. The species that primarily affect ponderosa pine, pinyon pine, and Douglas-fir are the most common and are found throughout most of their respective host ranges, while the other species have more limited distributions (Figure 22).



Figure 21. Some important dwarf mistletoe species in the Southwestern Region: *Arceuthobium divaricatum* witches' broom on pinyon pine (top-left), *A. vaginatum* subsp. *cryptopodum* witches' broom on ponderosa pine (top-right), *A. douglasii* witches' broom on Douglas-fir (bottom-right), and *A. apachecum* witches' brooms on a southwestern white pine (bottom-left) and associated aerial shoots (insets).

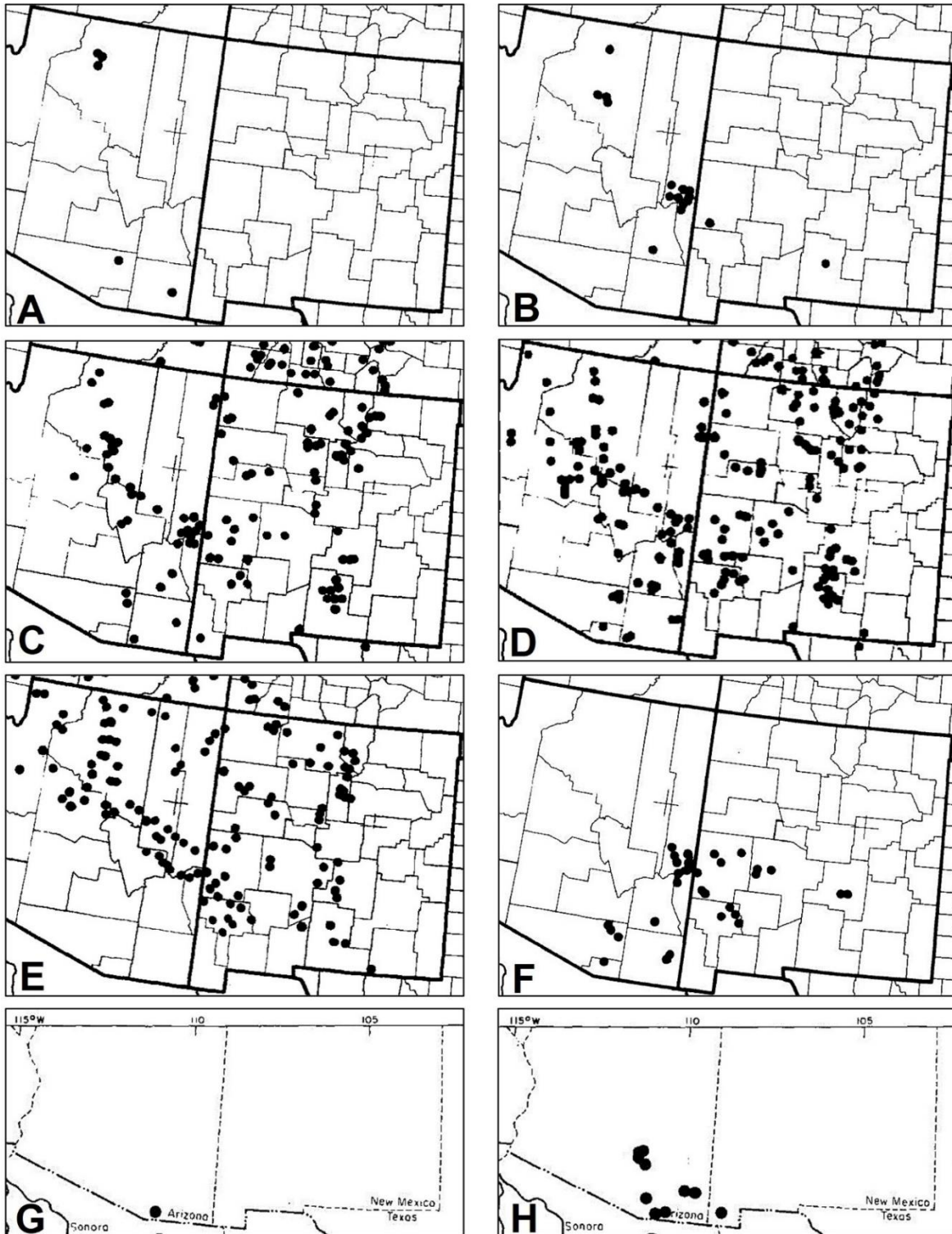


Figure 22. Distributions of dwarf mistletoe species in the Southwestern Region principally infecting white fir (A, *Arceuthobium abietinum* f. sp. *concoloris*), spruce (B, *A. macrocarpum*), Douglas-fir (C, *A. douglasii*), ponderosa pine (D, *A. vaginatum* subsp. *cryptopodum*), pinyon pine (E, *A. divaricatum*), white pines (F, *A. apachecum* and G, *A. blumeri*), and Chihuahua pine (H, *A. gillii*). Maps adapted from Hawksworth and Wiens (1996).

True Mistletoes

Phoradendron spp.

Hosts: Junipers, Arizona cypress, white fir, and various hardwoods

Eight species of true mistletoe occur in the Southwestern Region. These mistletoes are less damaging to their hosts than dwarf mistletoes, but heavy infestations can reduce host longevity during periods of drought. The leafless *Phoradendron juniperinum* on junipers is probably the most widespread and abundant species. Big leaf mistletoe (*P. macrophyllum*) is ubiquitous throughout many riparian areas in the region where it infects most riparian hardwood species (excluding oaks). Southwestern oak mistletoe (*P. coryae*) is common on oaks in lower elevations and in southern portions of the region. Desert mistletoe (*P. californicum*), another leafless species, can be abundant on mesquite and palo verde in desert woodlands. There is one true mistletoe known to infect white fir (*P. pauciflorum*), which is limited to southern Arizona. *Phoradendron densum* is also common in Arizona cypress around Sedona.

Root Diseases

Root diseases are common in forests of the Southwestern Region. They can predispose trees to root failure, a concern in campgrounds and other developed recreation areas. In the Southwest, root diseases affect a wide range of hosts but are most common in mixed conifer and spruce-fir forests. Root diseases spread slowly, so overall extent changes little from year to year. Root disease is often described as a “disease of the site”, as these pathogens can persist in the soil as saprophytes on stumps and large roots for decades after host trees are removed or killed by fire.

Armillaria Root Disease

Armillaria spp.

Hosts: Spruce, true firs, Douglas-fir, white fir, ponderosa and pinyon pines, oaks, and occasionally aspen

Armillaria root rot is the most common root disease in the Southwest, where it is estimated to account for up to 80% of all root disease-associated mortality. Although all conifer species and size classes can be infected, root disease is more common in old growth mixed conifer and spruce-fir forests. *Armillaria solidipes* (= *A. ostoyae*) is the major *Armillaria* species in southwestern coniferous forests. Although most common on true firs, Engelmann spruce, and Douglas-fir, it is increasingly observed on southwestern white pine and ponderosa pine in many areas including the San Francisco Peaks on the Flagstaff RD, Coconino NF and the Alpine RD, Apache-Sitgreaves NFs. A large pocket of infection was observed in 2023 on ponderosa pine on the North Kaibab RD, Kaibab NF, where disease appears to be particularly severe and widespread on all host species. Previous surveys in mixed conifer forests on the North Kaibab RD, Kaibab NF found *Armillaria* on about 30% of standing live trees. *Armillaria gallica* has been observed on the Mogollon Rim RD, Coconino NF infecting Douglas-fir and is likely more widespread, though information on the species distribution is lacking. *Armillaria mellea* has been observed in southern Arizona in oak woodlands.

Heterobasidion Root Disease (Formerly Annosus Root Disease)

Heterobasidion irregulare and *H. occidentale*

Hosts: Ponderosa pine (*H. irregulare*), true firs and Engelmann spruce (*H. occidentale*)

Heterobasidion root disease is the second most common root disease in the Southwest, where it is found in higher elevation ponderosa pine and mixed conifer forests throughout Arizona and New

Mexico. Fruiting bodies are commonly found inside hollow stumps and sometimes on downed logs and upturned roots. *Heterobasidion occidentale* is common in white fir in the Southwest but also occurs on corkbark fir and Engelmann spruce. *Heterobasidion irregulare* affects ponderosa pine and is found throughout the region but does not commonly cause disease in the Southwest. Like *Armillaria* spp., *Heterobasidion* spp. are known as saprophytes or nutrient recyclers of dead woody material as well as pathogens and may persist on a site even in the absence of live hosts.

Other Common Root Diseases

Other common root diseases in the Southwest include Schweinitzii root and butt rot, caused by the fungus *Phaeolus schweinitzii*, which is often found on older Douglas-fir and occasionally on ponderosa pine, southwestern white pine, white fir, and spruce. Tomentosus root disease, caused by *Onnia tomentosa*, is found on spruce and Douglas-fir and can be a major hazard tree consideration where it occurs in developed recreation sites. Black stain root disease, caused by *Leptographium* spp., appears to be rare in the Southwest but has been reported in pinyon pine in northern New Mexico and Douglas-fir on Mescalero Apache Tribal Lands. Infections by another less aggressive species of *Leptographium* have also been observed recently in pinyon pine in New Mexico. *Ganoderma applanatum* is the primary root disease pathogen affecting aspen in the Southwest. The disease causes crown dieback, windthrow, and mortality, especially in older aspen stands (though aspen of all ages are affected). Aspen stands on mesic sites seem to have higher incidence of disease compared to drier sites. Infection is particularly widespread on the Carson NF in New Mexico. Other species of *Ganoderma* affect many hardwood species, including Fremont cottonwood, Emory and silverleaf oak, Arizona sycamore, and netleaf hackberry. Infection may lead to gradual decline, and the presence of a fruiting body indicates high potential for failure.

Stem Decays

Stem decays are common in older trees throughout the Southwestern Region. Decay represents an economic loss in terms of timber production and can increase hazards on developed sites, but decayed trees also provide important cavity habitat for many wildlife species, especially birds. One of the most common stem decays causing brown rot in the Southwest is red belt fungus, *Fomitopsis schrenkii*, which affects conifers and sometimes aspen. Prominent stem decays causing white rots in the region include red rot, *Dichomitus squalens*, of ponderosa and pinyon pines; red ring rot, *Porodaedalea pini*, affecting most conifers; paint fungus, *Echinodontium tinctorium*, on true fir and occasionally Douglas-fir or spruce; false tinder conk, *Phellinus tremulae*, on aspen; pouch fungus, *Cryptoporus volvatus*, a sap rot found on bark beetle-killed conifers; *Phellinus everhartii*, *Inonotus dryophilus*, and *I. andersonii* on oaks; *I. munzii* on cottonwoods; and *Sanghuangporus weirianus* on Arizona walnut.

Stem Rusts

White Pine Blister Rust

Cronartium ribicola

Hosts: Southwestern white, limber, and Rocky Mountain bristlecone pines (aecial stage); *Ribes*, *Castilleja*, and *Pedicularis* spp. (telial stage)

White pine blister rust, caused by *Cronartium ribicola*, is the only known exotic invasive forest disease in the Southwestern Region, where thousands of acres of mesic mixed conifer forest have severe infection (more xeric sites generally have low to moderate infection). Top kill is very common in severely affected

areas. Although Rocky Mountain bristlecone pine is susceptible, white pine blister rust has not yet affected this species within the Southwestern Region.

In New Mexico, white pine blister rust continues to cause heavy damage to southwestern white pines on the Sacramento Mountains, where the disease has likely been established for over 50 years (Figure 23). Based on a set of representative monitoring plots, roughly 45% of the white pines in this area, which includes Mescalero Apache Tribal Lands and most of the Lincoln NF, are infected. White pine blister rust also occurs on the Gila, Cibola, and Santa Fe NFs of New Mexico. In 2022, white pine blister rust infection on the Black Range of the Gila NF was confirmed, and the disease is now found on most mountain ranges in central and southern New Mexico.

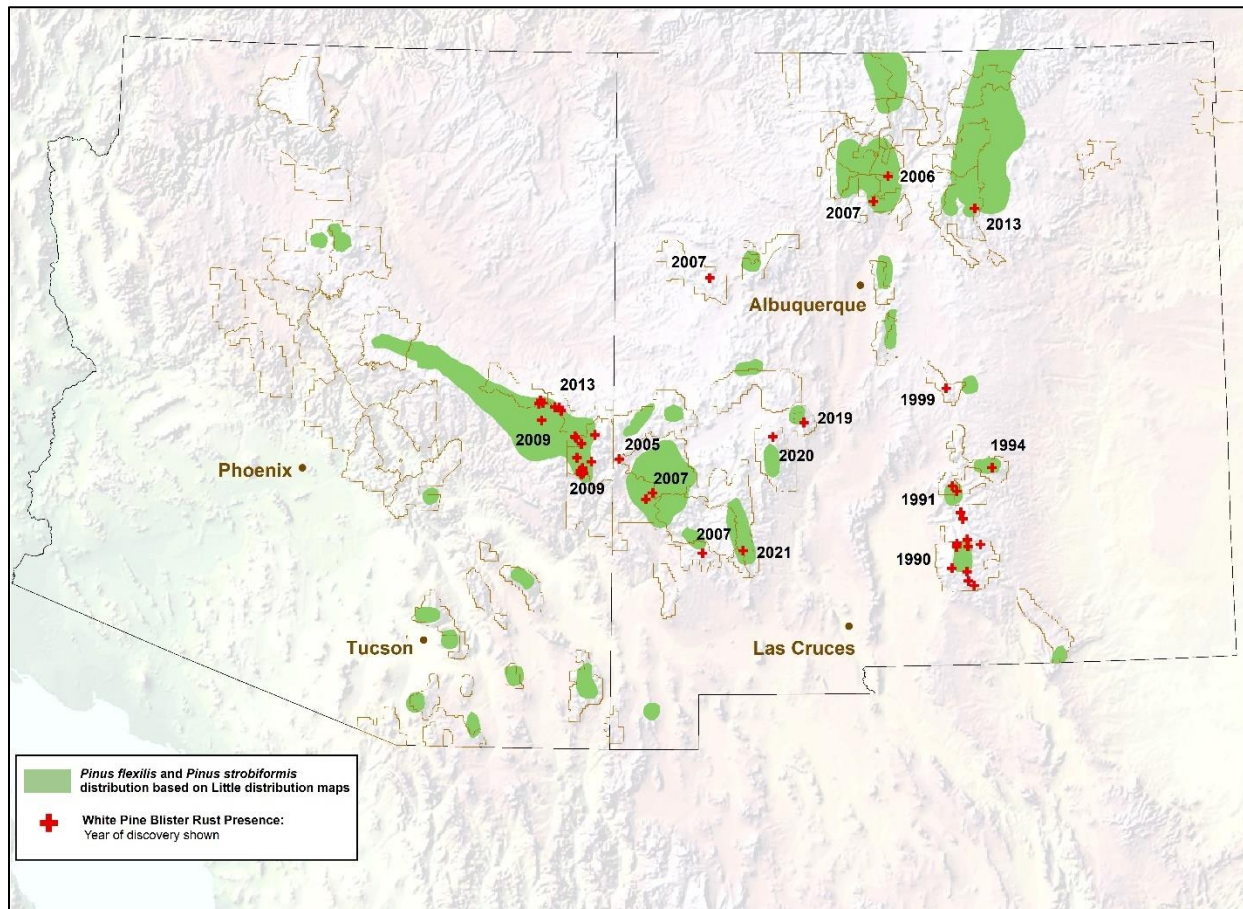


Figure 23. Distribution of known white pine blister rust infection centers within the Southwestern Region and the year in which they were discovered. USDA Forest Service image.

In Arizona, white pine blister rust was first detected in 2009 on White Mountain Apache Tribal Lands and neighboring Apache-Sitgreaves NFs, which are still the only land management units known to be affected in this state (Figure 23). Age estimation of older cankers suggests the white pine blister rust pathogen may have been present for 20 years at that point but at undetectable levels. Since 2009, the pathogen has continued to expand into new areas, including into more moderate hazard sites throughout most of the White Mountains. However, white pine blister rust is still absent throughout most of the host type in Arizona.

Information on white pine blister rust projects in the Southwestern Region can be found in the “Other Entomology and Pathology Activities in 2024” section.

Broom Rusts

Melampsorella caryophyllacearum

Hosts: True firs (aecial stage) and chickweed (telial stage)

Chrysomyxa arctostaphyli

Hosts: Spruce (aecial stage) and bearberry (telial stage)

These two species of broom rust pathogens occur at relatively low frequency on their respective hosts in the Southwestern Region. However, higher infestations of fir broom rust occur on the Sandia and Manzano Mountains of central New Mexico and a few other locations. Damage from this easily recognized disease has not been well quantified, but infection can result in top-kill, especially in spruce. Falling brooms or stem breakage when infections occur on the bole may present a hazard in developed recreation sites.

Limb Rust and Western Gall Rust

Cronartium arizonicum and *Endocronartium harknessii*

Hosts: Ponderosa pine (aecial stage) and *Castilleja* spp. (telial stage, *C. arizonicum* only)

There are two stem rust diseases on ponderosa pine in the Southwestern Region. The most frequently observed is *Cronartium arizonicum*, the cause of limb rust. Limb rust is common in portions of Arizona and can be quite damaging to individual trees. Incidence in New Mexico is infrequent, but it has been found on Jicarilla Apache Tribal Lands. The fungus causes orange-colored pustules on dying branches with progressive upward and downward branch mortality, generally initiating from the center of the crown. Waves of new infection are initiated by environmental conditions conducive to the disease and may occur at intervals of several years.

Western gall rust, caused by *Endocronartium harknessii*, deforms but seldom kills older trees. Infection typically causes growth of large galls on infected branches. Occasionally, during wave infection years, this pathogen has caused mortality in seedlings and saplings. The pathogen that causes this rust disease does not have an alternate host, and infection proceeds from pine to pine. This disease is uncommon in the Southwestern Region.

Gymnosporangium Rusts

Gymnosporangium spp.

Hosts: junipers and Arizona cypress (telial stage) and Rosaceae / Hydrangeaceae (aecial stage)

Eight *Gymnosporangium* species occur in the Southwestern Region on various juniper hosts, and one species occurs on Arizona cypress. Dramatic deformities can be caused on these telial hosts, including witches' brooms, branch galls, branch knots, and stem swellings (Figure 24). Telia are produced on these deformities and can be bright orange, gelatinous, and very showy (as with *G. speciosum*) or more subtle, like the small brown pads produced on leaf scales by *G. kernianum*. Damage to telial hosts is minimal beyond these deformities. Defoliation can occur in heavily infected alternate hosts, and *Gymnosporangium* spp. can be agricultural pests of orchard crops in some cases.



Figure 24. Various *Gymnosporangium* species producing telia within witches' brooms (left), from galls (top-right), and from stem swellings (bottom-right) on juniper hosts; these rust fungi typically alternate on members of the Rosaceae (top-right inset) or Hydrangeaceae.

Canker Diseases

Canker diseases are commonly associated with damaged or stressed trees. Disturbances which may inflict mechanical damage to trees or stressors such as drought can increase the incidence of canker diseases. These pathogens are often involved in aspen mortality and dieback due to the soft living tissue of the bark, which makes aspen extremely susceptible to wounding and subsequent infection. Sooty bark canker, caused by *Encoelia pruinosa*, is the most lethal canker of aspen, while Cytospora canker, caused by *Cytospora* spp., is the most common.

Cytospora umbrina causes alder heat canker, a disease associated with high temperatures. This disease has been increasingly observed affecting Arizona alder (*Alnus oblongifolia*) in association with dieback and mortality. Damage and mortality related to this pathogen have been observed in Oak Creek Canyon on Red Rock RD, Coconino NF as well as along Tonto Creek and the East Verde River on the Payson RD,

Tonto NF. Alder heat canker has been associated with dieback and mortality of alder species in Alaska, Colorado, and New Mexico but has not been formally documented in Arizona affecting Arizona alder. Forest Health Protection and partners at the University of Arizona are currently working to formally document *C. umbrina* as a pathogen of Arizona alder.

Pathogens in the genus *Biscogniauxia* cause cankers resulting in dieback and mortality on many different hardwood species, particularly in the *Quercus* genus. These pathogens are associated with hot, dry conditions and tend to cause disease when trees are water stressed. In Arizona, *Biscogniauxia* spp. were first observed causing dieback and mortality of Emory and silverleaf oaks in 2018 (Figure 25). These pathogens have now been observed on the Nogales, Douglas, and Safford RDs, Coronado NF; Bradshaw RD, Prescott NF; and Pleasant Valley RD, Tonto NF. In 2024, *Biscogniauxia* spp. were observed for the first time on the Red Rock RD, Coconino NF. These pathogens were observed on dead oaks on the Silver City and Reserve RDs, Gila NF in 2022, representing the first observations in New Mexico. The most severe dieback and mortality associated with these pathogens continues to be observed in Madera Canyon in the Santa Rita Mountains and along Turkey Creek in the Chiricahua Mountains of southeastern Arizona. Mortality is distributed across size classes and is most severe in the silverleaf oaks. Thus far, two species have been identified: *B. mediterranea* and an undescribed *Biscogniauxia* species. Work is ongoing with partners at Northern Arizona University to better understand the biology, distribution, and impacts of these emerging pathogens. More information on this project can be found in the “Other Entomology and Pathology Activities in 2024” section.

Diplodia sapinea was observed for the first time causing tip dieback on ponderosa pine in the town of Payson, AZ and the surrounding Payson RD, Tonto NF. Symptoms of infection included foliage discoloration as well as branch and tip dieback. Severity of infection was variable, ranging from full crowns to scattered branches displaying dieback symptoms (Figure 26). Symptomatic branches were collected and sent to the Stewart Lab at Colorado State University to assess agents involved. *Diplodia sapinea* was isolated from most of the symptomatic branches collected. This may represent the first observation of *D. sapinea* causing disease on ponderosa pine in AZ.

Foliar Diseases

Foliar diseases in the Southwest may occur in conifers (needle casts) or hardwoods. Fungal species causing these diseases may overwinter in old leaf litter from the previous year or in previously infected



Figure 25. Canker caused by *Biscogniauxia* spp. Fruiting bodies are dark black or light grey. As fruiting bodies emerge from the canker bark is pushed off to reveal the flat grey or black fruiting bodies.



Figure 26. Tip dieback associated with *Diplodia sapinea* infection observed on the Payson RD, Tonto NF.

foliage that has not been cast. Outbreaks are sporadic and highly dependent on favorable weather conditions, generally coinciding with above average moisture in the spring and/or early summer. In conifers, symptoms may be similar to winter injury or salt damage, but the presence of fruiting bodies on needles can allow for confirmation of needle cast disease. Fruiting bodies are typically black in color but can be tan or brown. Foliar diseases in hardwoods are most often observed in aspen, cottonwood, willow, and sycamore. Heavy infections may cause defoliation, particularly in the lower crowns where humidity tends to be higher. Although occasional outbreaks can appear quite dramatic, foliar diseases rarely cause long-term damage in the region.

In New Mexico, no major damage by foliar pathogens was observed via aerial survey in 2024. Pinyon pine with needle cast symptoms were observed around the Coyote District Office (Santa Fe NF) during a ground survey in early spring, and the fungus *Heterotruncatella spartii* was morphologically identified from affected needle samples. In Arizona, chronic white pine needle cast caused by *Lophodermella arcuata* has been observed impacting southwestern white pine on the San Francisco Peaks and is particularly severe at higher elevations where conditions are more conducive to this pathogen. In addition, sycamore anthracnose (caused by *Apiognomonia veneta*) continues to affect riparian areas throughout Arizona. This foliar disease is particularly noticeable in Oak Creek Canyon and Wet Beaver Creek near Sedona where the infection appears to be a chronic issue.

Abiotic Damage

Salt

De-icing salt use has contributed to chronic ponderosa pine damage along highways in the Southwestern Region. Approximately 97 acres with salt damage were mapped across the region in 2024, decreasing from 406 acres in 2023. Arizona and New Mexico each accounted for about half of this damage. Damage has typically been observed along major corridors, including county and city roadways, as states, counties, and municipalities continue use of de-icing salts. Application of dust abatement salt is also associated with damage to ponderosa pine along dirt roads in rural housing areas. Damage may be more widespread than observed during aerial surveys, as it is typically more obvious when viewed from the ground.

Red Belt Winter Injury

Late season winter injury can inflict significant damage to affected trees. Red belt is a landscape-scale winter injury event that occurs with the sudden appearance of warm, dry winds producing a temperature inversion. A relatively thin layer of warm air arrives that cannot mix downward and continues to contact side slopes. Trees exposed to unseasonably warm air by day receive seasonably cold air at night. This alteration of warm and cold air exposure, along with the frozen condition of the soil, results in desiccation injury because daytime transpiration removes moisture from the needles more rapidly than roots in frozen soil can replace it.

A new red belt winter injury event occurred across 1,185 acres of the Valle Vidal Unit of the Questa RD, Carson NF between The Rock Wall and Beatty Lakes during the winter of 2022-2023. Ponderosa pine was the primary host damaged, but other conifer species in the area were also affected. Continued damage affecting about 914 acres was observed in this same area during 2024 Aerial Detection Survey flights. As severely impacted areas may experience higher mortality in future years, continued monitoring will occur. Red belt and other winter injury events may become more common with milder winters.

Drought

Drought-induced damage across the Southwestern Region continued in 2024. Evidence of acute drought stress was observed to some extent in all tree species but was again particularly notable in ponderosa pine (Table 4). Juniper crown dieback across Arizona also increased to 805 acres mapped in 2024 from 158 acres in 2023, but the majority of this damage (82.7%) occurred on the Coronado NF after previously being widespread in northern Arizona. In New Mexico, juniper dieback was mapped on 398 acres in 2024, an increase from only two acres in 2023. Most of this damage was located on private lands (60.6%) and on the Gila NF (32.4%).

Drought-stressed ponderosa pine exhibited slight yellowing of needles and some premature needle loss. Symptoms were most evident on dry ridges and upper slopes. Arizona accounted for most of the drought stress mapped in ponderosa pine with 4,898 acres in 2024, up from 3,906 acres in 2023 (Table 4). Most of this damage was mapped on the Coconino (53.4%) and Apache-Sitgreaves NFs (30.6%) and on White Mountain Apache Tribal Lands (12.9%). Drought-stressed ponderosa pine was mapped across 2,383 acres in New Mexico in 2024, down from 16,531 acres in 2023, with most of this damage mapped on state and private lands (77.5%). Drought stress affecting all other species, which may also include ponderosa pine, increased across the region from 4,538 acres in 2023 to 7,940 acres in 2024. Much of this damage was concentrated on the Carson NF (21.7%), private lands in New Mexico (18.5%), and the Coconino NF (16.0%). Delayed, late season damage associated with drought stress can be high, and normal ADS flights may underestimate damage in years of acute drought. Drought stress may increase susceptibility to insects and diseases which do not affect vigorous trees. Drought may also act as a principal mortality agent.

Hail

Hail damage was observed on 211 acres of New Mexico State Game and Fish lands in 2024.

Invasive Species

Each year invasive species and diseases bring new and expanding challenges for documentation, monitoring, and treatment. An invasive species is a non-native organism whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health.

Table 5 shows some of the major invasive species and diseases that pose the greatest threats to terrestrial and aquatic ecosystems on forests and grasslands in the Southwestern Region. Many other invasive or exotic species (e.g., introduced fish species) also can seriously impact native species. Table 6 shows some of the common invasive plant species in the Southwestern Region. Further information on invasive species associated with forests and grasslands in the Southwestern Region may be found at <http://www.fs.usda.gov/main/r3/forest-grasslandhealth/invasivespecies>.

Table 5. Major invasive species and diseases threatening forests and grasslands in Arizona and in New Mexico.

Type	Common name, Species	Impacts
Pathogens	Chronic wasting disease, prion-based Chytrid fungus, <i>Batrachochytrium dendrobatidis</i> Whirling disease, <i>Myxobolus cerebralis</i> White pine blister rust, <i>Cronartium ribicola</i>	Deer and elk Amphibians Salmonid fish species Five-needle pines
Terrestrial Plants	Buffelgrass, <i>Cenchrus ciliaris</i> Cheatgrass, <i>Bromus tectorum</i> Giant cane, <i>Arundo donax</i> Musk thistle, <i>Carduus nutans</i> Yellow bluestem, <i>Bothriochloa ischaemum</i>	Desert plant communities Grasslands and shrublands Waterways Grasslands and shrublands Grasslands and shrublands
Invertebrates	Northern crayfish, <i>Orconectes virilis</i> Spruce aphid, <i>Elatobium abietum</i> Oystershell scale, <i>Lepidosaphes ulmi</i> Quagga mussel, <i>Dreissena rostriformis bugensis</i>	Aquatic plants and animals Engelmann and blue spruce Aspen and other hardwoods Streams, rivers, and lakes
Vertebrates	American bullfrog, <i>Lithobates catesbeiana</i> Feral hog, <i>Sus scrofa</i>	Aquatic animals Plant communities and small animals

Table 6: Common Invasive Plant Species in the Southwestern Region**Annual Grasses**

Cheatgrass	<i>Bromus tectorum</i>
Red brome	<i>Bromus madritensis</i>

Perennial Grasses

Buffelgrass	<i>Pennisetum ciliare</i>
Fountain grass	<i>Cenchrus setaceus</i>
Yellow bluestem grass	<i>Bothriochloa ischaemum</i>

Annual and Perennial Forbs

Sahara mustard	<i>Brassica tournefortii</i>
London rocket	<i>Sisymbrium irio</i>
Stinknet	<i>Oncosiphon pilulifer</i>
Russian thistle	<i>Salsola tragus</i>
Dalmation toadflax	<i>Linaria dalmatica</i>
Diffuse knapweed	<i>Centaurea diffusa</i>
Bull thistle	<i>Cirsium vulgare</i>
Scotch thistle	<i>Onopordum acanthium</i>

Woody Perennials

Giant reed	<i>Arundo donax</i>
African sumac	<i>Searsia lancea</i>
Saltcedar	<i>Tamarix ramosissima</i>
Siberian elm	<i>Ulmus pumila</i>
Russian olive	<i>Elaeagnus angustifolia</i>

*This is not an exhaustive list.

Highlight of Species

Stinknet

Oncosiphon piluliferum

Many invasive species are a threat to ecosystems worldwide but this past year in the Southwest, stinknet (*Oncosiphon piluliferum*) has become even more of a serious threat (Figure 27). There have been wide advances of stinknet in Arizona. Stinknet is also called globe chamomile. While it is a recent introduction (the first herbarium record was in spring 1997, and its first publication in Landrum et al 2005), it has aggressively spread. In 2005, Landrum describes that stinknet was discovered at 12 locations during spring surveys. By 2019 it had spread so much that it gained public notice. In some areas it has already produced a monoculture in desert, riparian, and shrub ecosystems. The impacts to desert communities are the most concerning due to the impacts to annual and young perennial seedlings. Stinknet outcompetes native seedlings. It also increases fire risk because the lifespan is short and once the plants die, the plant skeleton and leaf litter can easily ignite and spread fire.

There are updated maps, documentation on new sites, treatment and research. For example, University of Arizona has been doing research and outreach. They host the following website:

<https://extension.arizona.edu/topics/stinknet>. There is also an interactive website showing the change in stinknet over the years. It has gained momentum and continues to expand each year.

<https://experience.arcgis.com/experience/bad4ea0507d94502a3c116e3bc8c4df4/>

One documented case of stinknet was found in New Mexico near Lordsburg this past year. It has been treated. There is a high likelihood that stinknet will spread further into New Mexico.



Figure 27. Stinknet growth stages – Top left: Small rosette, Top right: Small bolting plant, Bottom left: Full Bloom, Bottom right: Landscape covered in dead stinknet. Source: Comprehensive Land Managers Guide to Managers, Southwest Vegetation Management Association.

Feral Swine

Sus scrofa

Feral swine have been in North America since the 1500s and are generally also called wild pigs, wild boars, wild hogs, and razorbacks (Figure 28). They are descended from released pigs first brought to the United States by Europeans as a food source. Feral hog can carry up to 70 zoonotic diseases transmittable to livestock and humans. Attacks to humans are very rare and are often when the animal is cornered or under threat.

Feral swine are also an increasing problem in the Southwest. As seen in the maps (Figure 29), there can be a spread from the west in California and the east from Texas. There are several challenges from feral swine. One is the rapid rate of reproduction. There can be two litters per year with 4 to 10 piglets. The other is destruction to native vegetation and crops. This causes both ecological and economic loss. They root in the soil causing destruction to soil, seedlings, and mature shrubs and trees; they eat seeds, acorns, wildlife including nests, crops, and cattle; and cause general property damage. Feral swine are not the same as the native javelinas or collared peccaries (*Dicotyles tajacu*), which are smaller and a native mammal that does not cause damage.



Figure 28: Feral swine with young.

Control of feral swine depends on an individual population and its food sources. The options fall into two categories, lethal and non-lethal. In most cases, lethal is the preferred option to reduce population sizes. The most effective method is trapping followed by euthanasia. The options are cage trapping, bait, hunting including night shooting, toxicants, fencing, and harassment.

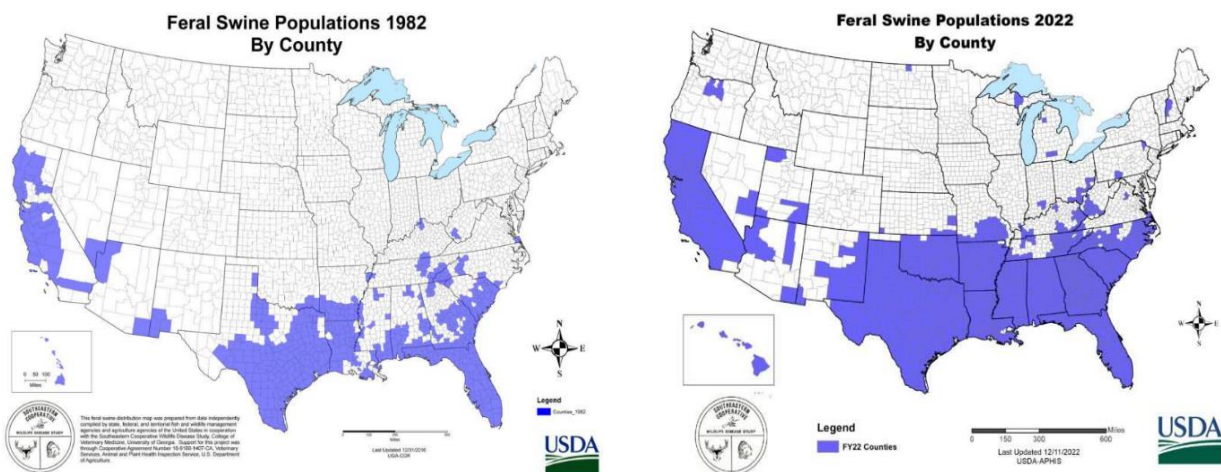


Figure 29: Population maps for feral swine.

Newly emerging species with limited populations:

Mediterranean House Gecko

Hemidactylus turcicus

This species currently has limited population range in Arizona and New Mexico (Figure 30). It's unclear if this species will cause ecological or economic damage. The one obvious conflict is the food source and niche habitat are the same for native species. This species should be monitored for changes in distribution and behavior.



Figure 30: Mediterranean house gecko. Photo by Wendy VanDyk Evans.

Aoudad or Barbary Sheep

Ammotragus lervia

Barbary sheep have spread into New Mexico from Texas (Figure 31 & 32). While small in numbers, there is the possibility of conflicts with native desert bighorn sheep (*Ovis canadensis nelsoni*). Both species compete for the same resources. They should be monitored for further spread.



Figure 31: Barbary sheep.

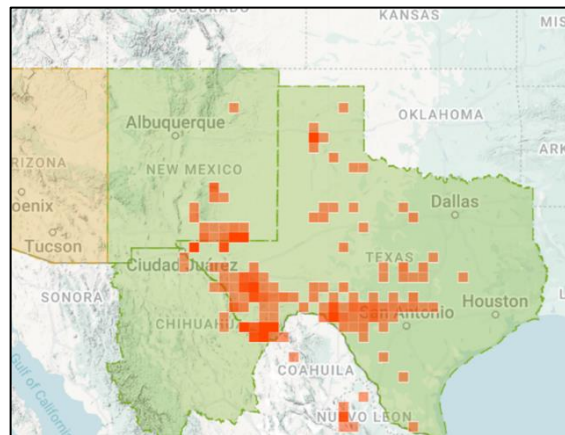


Figure 32: Map of aoudad populations.

Other Entomology and Pathology Activities in 2024

Forest Health Regional Training

The FHP staff provides annual training opportunities to resource managers on insect and disease identification, effects, and management as well as hazard tree identification and mitigation. In 2024, the classroom portion of these regional trainings were held virtually. Presentations were well attended and given live via Microsoft Teams. Trainings included participants from numerous forests, tribes, and National Park Service units. Presentations were recorded and made available to internal and external partners. Follow-up field training days occurred in New Mexico on the Wilderness RD of Gila NF and in Arizona on the Apache-Sitgreaves NFs, White Mountain Apache Tribal Lands, and at Grand Canyon National Park.

Nursery Pathogen Monitoring

In 2024, FHP worked with Grace Ganter and Dr. Jane Stewart of Colorado State University (CSU) to establish a plantation at New Mexico State University's John T. Harrington Forestry Research Center (JTHFRC) for monitoring nursery pathogens after outplanting (Figure 33). Seedlings were grown at two nurseries with 250 ponderosa pine (*Pinus ponderosa*) and 250 southwestern white pine (*P. strobiformis*) grown at each nursery. Seed was sourced from Santa Fe NF (SFNF), as the planting occurred on lands impacted by the Hermit Peak/Calf Canyon Fire (HPCC). Initial sampling at both nurseries occurred in April 2024. The seedlings were planted with assistance from FHP, SFNF, CSU, and JTHFRC staff in October 2024 in a fenced enclosure within a ponderosa pine stand that burned in HPCC. All fire-killed snags and remaining live trees were cut within the site and in a buffer around the fence to reduce hazard tree impacts and homogenize conditions on the site. Seedlings were sampled again for fungal pathogens at the time of planting. Additional sampling will take place in April and October 2025, six- and 12-months post-planting, respectively. Objectives are to look for soilborne pathogens like *Fusarium* spp. and monitor for changes in fungal communities associated with nursery stock (i.e., do the pathogens from the nursery persist or is there a shift to the native fungal communities in the soils where planting occurs). This project will help to improve survival of planted trees in imminent, widespread post-fire plantings. *For more information, contact Gregory Reynolds.*



Figure 33. Colorado State University and FHP personnel planting pine seedlings (left, center) and taking soil samples (right) to monitor nursery pathogens over time following planting in burned areas.

White Pine Blister Rust Genetic Resistance

In 2024, FHP continued work to sustain white pines in the face of the introduced pathogen *Cronartium ribicola*, the causal agent of white pine blister rust (WPBR). This work is being conducted in collaboration with Dr. Kristen Waring of Northern Arizona University, Dr. Owen Burney of New Mexico State University, Dr. Richard Sniezko of the Dorena Genetic Resource Center (DGRC), and others. Seed has been collected from parent trees across the range of southwestern white pine to grow and test for resistance to WPBR and assess adaptive traits.

Progeny are inoculated with *C. ribicola* at DGRC in Cottage Grove,

OR to evaluate resistance. A small percentage (around 5%) of trees have shown resistance in these trials with locations of parent trees distributed across much of the region. Progeny from these inoculations that showed resistance are being grafted into an orchard at Tyrell Seed Orchard to conserve this resistant genetic material. Cone collections for future resistance testing occurred in 2024 on the Lincoln and Carson NFs. Two regional field trials have been established in cooperation with the Mescalero Apache Tribe (2017) in New Mexico and the Apache-Sitgreaves NFs (2018) in Arizona. These are long-term, fenced test sites that will be used to evaluate the durability of various disease resistance mechanisms observed at DRGC. Additional plantings were established in 2024 at Trestle Depot Recreation Area on the Lincoln NF and at Big Lake Recreation Area on the Apache-Sitgreaves NFs (Figure 34).



Figure 34. Southwestern white pine planting following root disease suppression and hazard tree mitigation project on Apache Trout Campground, Apache-Sitgreaves NFs.

In addition, FHP has collected scion from parent trees throughout the region over the last several years which have shown some level of resistance to WPBR, either via major gene or quantitative resistance, with collection from one tree occurring in 2024. Overall, WPBR-resistant scion has been collected from the Lincoln NF and Mescalero Apache Tribal Lands in southern New Mexico, the Zuni Mountains (Cibola NF) of northern New Mexico, and the White Mountains of Arizona (Apache-Sitgreaves NFs). Scion material is grafted into a seed orchard in Mora, NM and will be used to provide disease resistant seed for future reforestation efforts. *For more information, contact Gregory Reynolds or Nicholas Wilhelmi.*

First Report of *Cytospora umbrina* Causing Disease on Arizona Alder in Arizona

In 2024, FHP staff completed the process to formally document *Cytospora umbrina* as a disease-causing agent of Arizona alder. To complete this process, 12 trees in Oak Creek Canyon were inoculated with isolates of *C. umbrina* which had been collected from symptomatic alder in the same area. Three

branches were inoculated on each of the 12 test trees; one branch per isolate and one control branch which was inoculated with sterile agar. Following inoculations, trees were observed for development of disease symptoms, namely necrosis and subsequent canker formation. One month following inoculation, most branches inoculated with pathogen isolates displayed necrosis and canker formation, while control branches showed no canker growth or further necrosis beyond the inoculation site (Figure 35). Callus tissue formed around the inoculation wounds associated with the control, while little to no callus tissue was observed on branches inoculated with pathogen isolates (Figure 35). After four months, all inoculated branches were removed and sent to Dr. Alex Hu at the University of Arizona to complete the pathogen isolation and genetic sequencing necessary to publish the first report. *Cytospora umbrina* was isolated from 83% of inoculated branches with canker formation and was not isolated from any of the control branches. The first report will likely be published in the spring/summer of 2025, providing an important addition to knowledge of the mortality agents associated with Arizona alder. *For more information, contact Nicholas Wilhelmi.*

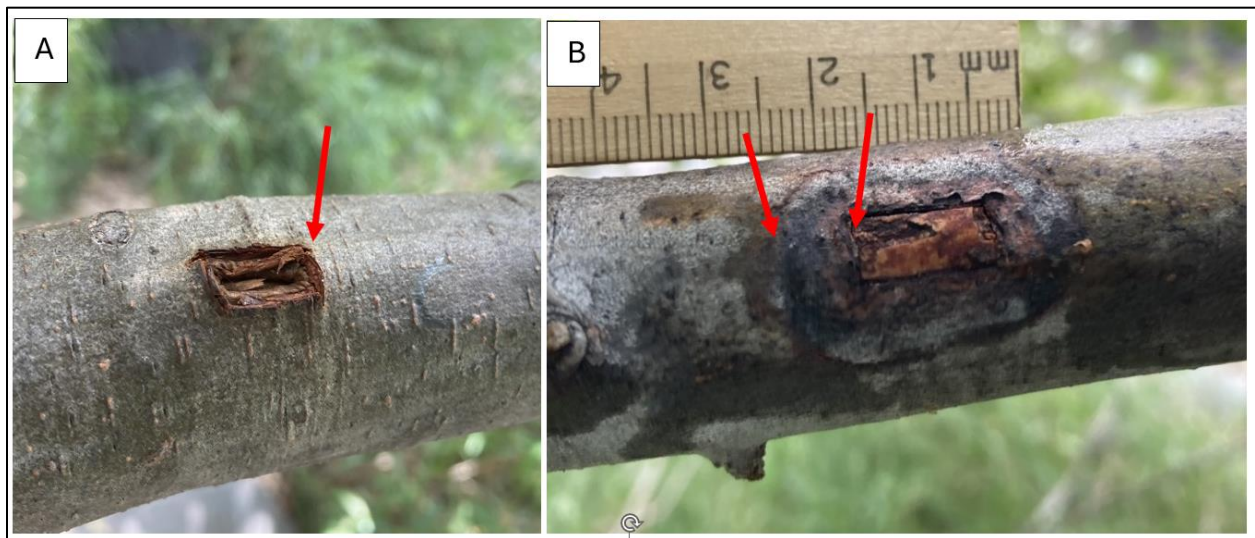


Figure 35. Rectangular inoculation sites on alder branches: control inoculation site exhibiting no canker growth and the formation of callus tissue (A), and inoculation with an isolate of the pathogen exhibiting necrosis related to canker growth and no callus tissue formation (B). Red arrows point to inoculation site border (A) and canker margin (B).

Assessing Potential for Spruce Beetle Outbreak Following Spruce Aphid Defoliation

In 2020, Arizona Zone FHP entomologists, in collaboration with scientists from Rocky Mountain Research Station in Flagstaff, AZ; Logan, UT; and Bozeman, MT and faculty at Northern Arizona University, received funding from Evaluation Monitoring (EM) to assess the impact of spruce aphid defoliation on the performance of spruce beetles. The study consisted of an individual tree study to monitor how well beetles perform in spruce with different levels of aphid-caused defoliation and a network of plots stratified by defoliation levels as determined by aerial surveys. For the individual tree study, 30 trees with a range of defoliation severities were baited with a pheromone lure to incite spruce beetle attacks. These trees were monitored over the summer. Spruce beetle success was evaluated by examining each tree for the presence of successful galleries, larvae, or pupae. Defense characteristics; in the form of

terpene concentration, resin volume, and resin ducts; were also analyzed for each tree. Tree mortality 18 months after baiting was higher for trees with high defoliation than trees with medium defoliation or low defoliation but was attributed to defoliation and root rot more than bark beetles. Mean resin duct density over 2021-22 was about two-fold greater for trees with medium or high defoliation compared with low defoliation. Phloem concentration of total terpenes and each of 34 constituent terpenes was similar among defoliation classes. Five months after baiting, an average of 67% of pitch tubes had beetle galleries, but this percentage did not differ over defoliation classes. The percentage of pitch tubes with larvae was lower than for galleries and differed among defoliation classes. Larvae were completely absent in trees with low defoliation, scarce in trees with moderate defoliation (6%), and most common in trees with high defoliation (20%). Results of this study suggest that spruce beetle under endemic conditions do not gain a reproductive advantage from trees defoliated by spruce aphid, and beetle outbreaks likely do not initiate from aphid defoliation events. For the plot level data, we completed data collection in the summer of 2022, and analysis of these data are in progress. *For more information, contact Monica Gaylord.*

Anti-aggregant Pheromones to Reduce Ips Beetle Attacks on Ponderosa Pine

Arizona Zone entomologists, Joel McMillin and Monica Gaylord, teamed up with researchers Chris Fettig and Jackson Audley, from the Pacific Southwest Research Station, to test the efficacy of an anti-aggregant pheromone in preventing bark beetle attacks on ponderosa pine outside of Flagstaff, Arizona. In May of 2023, the team identified 75 small diameter (8-12 inch at breast height) ponderosa pine in an old plantation approximately 10 miles north of Flagstaff. These 75 trees were baited with the attractant lure for pine engraver (*Ips pini*). Two different doses of anti-aggregant (verbenone in the form of SPLAT verb) were than applied to 50 of the trees; 25 receiving a low dose (70 grams) and 25 receiving the double dose (140 grams). The trees were monitored over the summer and a final check was done in October of 2023 to assess the number of successful attacks. Due to generally low beetle populations, only 8 trees total were attacked. In 2024, we repeated the same experiment, and once again experienced low beetle pressure. We are planning on repeating the experiment again in 2025 with hopes of better results. *For more information, contact Monica Gaylord.*

Developing Integrated Pest Management Strategies for Aspen Infested with Invasive Oystershell Scale

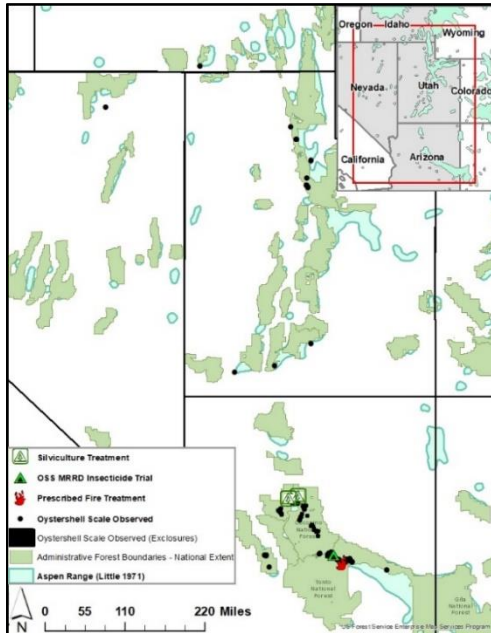


Figure 36: Map of OSS occurrence in forested ecosystems across the western US, and location of silviculture, fire, and pesticide treatments in Arizona.

In 2024, major strides were made towards building an integrated pest management (IPM) program to manage aspen infested with invasive oystershell scale (OSS) in the western U.S. A team of agency and academic partners received a total of \$308,000 (2023-2026) from USDA National Institute of Food & Agriculture Crop Protection and Pest Management Program to fund a proposal titled “IPM for oystershell scale, an invasive pest of aspen forests and urban trees”. Main objectives include research and monitoring of OSS phenology in Arizona and Utah, monitoring efficacy of treatments (silviculture and pesticide) to mitigate OSS-infested aspen, expand extent monitoring beyond Arizona, and create outreach materials and recommendations for land/resource managers. These main objectives are major gaps in research and monitoring required to develop an IPM program for OSS. An extensive aspen plot network of nearly 300 plots across Arizona in native stands and plots within treated exclosures were leveraged. Partners on the Coconino, Kaibab, and Apache-Sitgreaves NFs have implemented silviculture and prescribed fire treatments that are being monitored before and after treatments (Figure 36).



Figure 37: Basal bark application of Dinotefuran on oystershell scale infested aspen, Mogollon Rim RD, Coconino NF, AZ.

In 2024, a pesticide efficacy study was implemented using a systemic pesticide with the active ingredient Dinotefuran. It was applied as a basal bark treatment on 14 aspen trees on the Mogollon Rim RD, Coconino NF (Figure 37). Partners at Northern Arizona University (NAU) continue to monitor target (OSS phenology and mortality) and non-target impacts on treated and untreated trees compared to baseline data collected in 2023. Partners at the University of Georgia and NAU are also evaluating movement and persistence of the pesticide in aspen trees, soil, and nearest water sources before and after treatments.

Other major accomplishments in 2024 include the professional development of new graduate students and publication of two peer reviewed manuscripts on aspen health and invasive OSS. *For more information contact Amanda Grady.*

Using Survey123 to Monitor Extent and Severity of Oystershell Scale on All Lands

The USDA Forest Service and partners have documented rapid and widespread OSS impacts, predominantly on NF lands in Arizona from 2017 to the present. However, it has been realized that OSS is not only an emergent issue in the Southwestern Region, nor does it only affect aspen on NFS lands. In support of broad survey and detection monitoring for invasive oystershell scale, FHP has worked with the Southwestern Region’s Geospatial program to create a new Survey123 application (app) called the “Oystershell Scale Survey Form”. This app was developed to be used broadly by natural resource managers including state and other federal partners, interested aspen stakeholders such as in academia and other organizations, and by the public. To use the survey, one must download the Survey123 application and then search the downloaded surveys for “Oystershell Scale Survey Form”. Once the form is downloaded, users can contribute data to the nationwide and all lands database. The app can be downloaded, and data will contribute to the FHP database as OSS is encountered. The QR code below can be used to download the Oystershell Scale Survey Form if Survey123 has been downloaded on your device. *For more information contact Amanda Grady.*

Oystershell Scale Survey Form



Biological Evaluations and Technical Assistance

Arizona Zone

- Gaylord, M.L. 2024. Biological evaluation for Connell Gulch watershed improvement project, Chino Ranger District, Prescott National Forest. AZ-FHP-2024-03.
- Gaylord, M.L. 2024. Pine mortality evaluation for Christopher Creek, Payson Ranger District, Tonto National Forest, Arizona. AZ-FHP-2024-06.
- Gaylord, M.L. 2024. Post-treatment evaluation of Bear Canyon bark beetle suppression project, Santa Catalina Ranger District, Coronado National Forest, Arizona. AZ-FHP-2024-08.
- Gaylord, M.L., and N. Wilhelmi. 2024. Biological evaluation for Connell Gulch and Nine Road watershed improvement projects, Chino Ranger District, Prescott National Forest. AZ-FHP-2024-04.
- Gaylord, M.L., A. Grady, and N. Wilhelmi. 2024. Biological evaluation of forest health conditions at Sunset Crater Volcano National Monument. AZ-FHP-2024-01.
- Grady, A.M. 2024. Pine tip moth damage in ponderosa pine plantations near Heber-Overgaard, Black Mesa Ranger District, Apache-Sitgreaves National Forests. AZ-FHP-24-11.
- Wilhelmi, N. 2024. Update on assessment of oak dieback and mortality on the Mogollon Rim Ranger District, Coconino National Forest, Arizona. AZ-FHP-2024-02.
- Wilhelmi, N. 2024. Tree assessment in Crescent Moon Picnic Area, Red Rock Ranger District, Coconino National Forest, Arizona. AZ-FHP-2024-07.
- Wilhelmi, N. 2024. Biological evaluation for Woody '05 mastication project, Coconino National Forest, Arizona. AZ-FHP-2024-10.
- Wilhelmi, N., M. Gaylord, A. Grady, and J. McMillin. 2024. Biological evaluation of forest health conditions at Fort Tuthill Recreation area. AZ-FHP-2024-05.

New Mexico Zone

- Reynolds, G.J. 2024. Closeout of four successful dwarf mistletoe suppression projects on the Mescalero Apache Reservation (FY2018-FY2021). USDA Forest Service, Southwestern Region, NM-FHP-24-08.
- Reynolds, G.J. 2024. Closeout of FY 2020 Dwarf Mistletoe Suppression project on Jicarilla Apache Tribal Lands. USDA Forest Service, Southwestern Region, NM-FHP-24-10.
- Reynolds, G.J. 2024. Evaluation of a proposed FY 2025 dwarf mistletoe suppression project on Santa Clara Pueblo Tribal Lands. USDA Forest Service, Southwestern Region, NM-FHP-24-09.
- Reynolds, G.J. 2024. Evaluation of forest health issues in the Rojocito project area on Camino Real Ranger District, Carson National Forest. USDA Forest Service, Southwestern Region, NM-FHP-24-03.
- Reynolds, G.J. 2024. Evaluation of hazard tree issues in Red Canyon Campground on Mountainair Ranger District, Cibola National Forest. USDA Forest Service, Southwestern Region, NM-FHP-24-01.
- Reynolds, G.J. 2024. Forest health assessment for Capulin Volcano National Monument. USDA Forest Service, Southwestern Region, NM-FHP-24-06.
- Reynolds, G.J. and Souder, S.K. 2024. Evaluation of forest health issues in Coyote Ranger District, Santa Fe National Forest. USDA Forest Service, Southwestern Region, NM-FHP-24-02.
- Souder, S.K. 2024. Observation of defoliation by Douglas-fir tussock moth on Jemez Pueblo Tribal Lands. USDA Forest Service, Southwestern Region, NM-FHP-24-07.
- Souder, S.K. 2024. Observation of defoliation by Douglas-fir tussock moth on Sandia Mountains, Cibola National Forest. USDA Forest Service, Southwestern Region, NM-FHP-24-04.

Peer-reviewed Publications

Crouch, C.D, Grady, A.M., Wilhelmi, N.P., Hofstetter, R.W., Moore, M.M, and K.M. Waring. 2024. Extent impacts and drivers of oystershell scale invasions in aspen ecosystems. *NeoBiota* 95:1-33.

<https://neobiota.pensoft.net/article/121748/>

Crouch, C.D., Wilhelmi, N.P., Rogers, P.C., Moore, M.M. and K.M. Waring. 2024. Sustainability and drivers of *Populus tremuloides* regeneration and recruitment near the southwestern edge of its range.

Forestry. <https://doi.org/10.1093/forestry/cpae018>

Crouch, C.D., Hofstetter, R.W., Grady, A.M., Edwards, N.N.S, and K.M. Waring. 2024. Oystershell scale (Hemiptera: Diaspididae) Phenology, intensification, and spread on aspen in Arizona, USA.

Environmental entomology. 53:293-304. <https://doi.org/10.1093/ee/nvae006>

Forest Health Staff

Arizona Zone

Joel McMillin

(928) 556-2073

Joel has been the Zone Leader and Supervisory Entomologist for the Arizona Zone since May 2019. His primary duties include supervisory and managerial responsibilities for the Arizona Zone staff and providing oversight of Arizona Cooperative Forest Health program of the State Forester's office. Interests include quantifying impacts of forest insects, bark beetle semiochemicals, stand hazard rating systems for bark beetles and fire-insect interactions. Joel previously served as Group Leader/Supervisory Entomologist with Boise Field Office in the Intermountain Region and Entomologist with the Arizona Zone.

Monica Gaylord

(928) 556-2074

Monica has been a forest entomologist with the Arizona Zone since July 2014. Her primary responsibility is providing technical assistance on bark beetle management to land managers. Previously she was assistant research professor at Northern Arizona University. Forest Health interests include how drought and restoration treatments impact tree susceptibility to southwestern pine bark beetles, fire-bark beetle interactions, and single tree protection against bark beetle attacks.

Amanda Grady

(928) 556-2072

Amanda has been a forest entomologist with the Arizona Zone since October 2011, previously with the Pacific Southwest Region. Primary responsibilities include providing technical assistance on forest insect management to federal land managers, forest health monitoring related to defoliating and sap sucking insects and conducting aerial detection surveys. Special interests include integrated pest management development for emergent invasive insects in Arizona.

Nicholas Wilhelmi

(928) 556-2075

Nicholas has been a plant pathologist with the Arizona Zone since January 2017. Primary responsibilities include providing forest disease technical assistance to federal and tribal land managers and hazard tree identification/mitigation training for the Arizona Zone. Current interests include conservation of genetic resistance to white pine blister rust in five needle pines, emerging drought driven pathogens, and aspen monitoring.

New Mexico Zone

Andrew Graves

(505) 842-3287

Andrew has been the Zone Leader for the New Mexico Zone since October 2020. His primary duties include supervisory and managerial responsibilities for the New Mexico Zone staff. Interests include bark beetle/fungal interactions, the response of insects to drought stressed hosts, pheromones, and DNA analysis of bark beetle species and their hosts. Andrew previously served as a forest entomologist with the New Mexico Zone since October 2010.

Gregory J. Reynolds

(505) 842-3288

Greg has been a plant pathologist with the New Mexico Zone since January 2017. His primary responsibilities are providing forest disease technical assistance to federal and tribal land managers and managing the hazard tree program for the zone. His current focus is on nursery pathogens (e.g. *Fusarium* spp.), preservation of genetic resistance to white pine blister rust in five-needle pines, and dwarf mistletoe epidemiology. Greg previously served as a plant pathologist (identifier) with the Animal and Plant Health Inspection Service in New Jersey.

Steven Souder

(505) 842-3286

Steve has been an entomologist with the New Mexico Zone since October 2020. His primary responsibility is providing technical assistance on forest insect management to NFs, tribal lands, and other federal land managers in New Mexico. Steve previously worked on fruit fly research with the Agricultural Research Service in Hawaii for over a decade.

Regional Staff

Crystal Tischler

(505) 842-3284

Crystal has been the regional aerial survey program manager since September 2022. Crystal previously served as forest health coordinator with the NM office since September 2008. Responsibilities include managing the aerial detection survey program for the region and providing UAS capability to the FHP staff. Her previous work experience is in forest management, fuels reduction, timber sale administration, and community wildfire protection planning.

Zach Hall

(505) 842-3284

Zach has been a regional survey technician since November 2022. His primary responsibilities include supporting the regional aerial survey, geospatial, and remote sensing programs. He has previously worked as an aircraft sensor operator and as a biologist with the National Park Service.

Janet Nickerman

(626) 353-8439

Invasive Plant Program Manager and Pesticide Use Coordinator since June 2023 and previously served as Acting Regional Invasive Species Program Manager and Pesticide Use Coordinator from August 2022 through February 2023. Primary responsibilities include providing oversight of pesticide use in the region and guiding the invasive species program for NFs and in collaboration with State, Private, Tribal and other federal partners in the Southwest.

Appendix: Species Index

Table 7. Common and scientific names for forest insects and diseases* frequently encountered in the Southwestern Region.

Insects		Diseases	
Cedar bark beetles	<i>Phloeosinus</i> spp.	Armillaria or shoestring root rot	<i>Armillaria</i> spp.
Cone beetles	<i>Conophthorus</i> spp.	Biscogniauxia canker of oak	<i>Biscogniauxia</i> spp., including <i>B. mediterranea</i>
Douglas-fir beetle	<i>Dendroctonus pseudotsugae</i>	Black canker	<i>Ceratocystis fimbriata</i>
Douglas-fir tussock moth	<i>Orgyia pseudotsugae</i>	Black leaf spot	<i>Drepanopeziza populi</i>
Fall webworm	<i>Hyphantria cunea</i>	Comandra blister rust	<i>Cronartium comandrae</i>
Fir engraver	<i>Scolytus ventralis</i>	Cytospora canker	<i>Cytospora chrysosperma</i>
Flatheaded wood borers	<i>Buprestidae</i>	Dwarf mistletoe	<i>Arceuthobium</i> spp.
Janet's looper	<i>Nepytia janetae</i>	Elytroderma needle cast	<i>Elytroderma deformans</i>
Juniper twig pruner	<i>Styloxus bicolor</i>	False tinder conk	<i>Phellinus tremulae</i>
Large aspen tortrix	<i>Choristoneura conflictana</i>	Fir broom rust	<i>Melampsorella caryophyllacearum</i>
Mountain pine beetle	<i>Dendroctonus ponderosa</i>	Ganoderma root rot	<i>Ganoderma applanatum</i>
New Mexico fir looper	<i>Galenara consimilis</i>	Gymnosporangium rust	<i>Gymnosporangium</i> spp.
Oystershell scale	<i>Lepidosaphes ulmi</i>	Heterobasidion root rot	<i>Heterobasidion irregulare</i> , <i>H. occidentale</i>
Pandora moth	<i>Coloradia pandora</i>	Hypoxylon canker	<i>Entoleuca mammata</i>
Pine coneworm	<i>Dioryctria auranticella</i>	Indian paint fungus	<i>Echinodontium tinctorium</i>
Pine engravers	<i>Ips</i> spp.	Ink spot leaf blight	<i>Ciborinia whetzellii</i>
Pine needle scale	<i>Chionaspis pinifoliae</i>	Limb rust	<i>Cronartium arizonicum</i>
Pine sawflies	<i>Neodiprion</i> spp., <i>Zadiprion</i> spp.	Lophodermella needle cast	<i>Lophodermella</i> spp.
Pine-feeding needleminers	<i>Coleotechnites</i> spp.	Melampsora rust	<i>Melampsora</i> spp.
Pine tip moths	<i>Rhyacionia</i> spp.	Pinyon needle rust	<i>Coleosporium jonesii</i>
Pinyon ips	<i>Ips confusus</i>	Red band needle blight	<i>Dothistroma septosporum</i>
Pinyon needle scale	<i>Matsucoccus acalyptus</i>	Red belt fungus	<i>Fomitopsis schrenkii</i>
Ponderosa pine seedworm	<i>Cydia piperana</i>	Red ring rot	<i>Porodaedalea pini</i>
Red turpentine beetle	<i>Dendroctonus valens</i>	Red rot	<i>Dichomitus squalens</i>
Roundheaded pine beetle	<i>Dendroctonus adjunctus</i>	Rhabdocline needle cast	<i>Rhabdocline</i> spp.
Roundheaded wood borers	<i>Cerambycide</i>	Schweinitzii root and butt rot	<i>Phaeolus schweinitzii</i>
Spruce aphid	<i>Elatobium abietum</i>	Sooty bark canker	<i>Encoelia pruinosa</i>
Spruce beetle	<i>Dendroctonus rufipennis</i>	Spruce broom rust	<i>Chrysomyxa arctostaphyli</i>
Tiger moth	<i>Lophocampa ingens</i>	Sycamore anthracnose	<i>Apiognomonina veneta</i>
Twig beetles	<i>Pityophthorus</i> spp., <i>Pityogenes</i> spp., <i>Pityoborus secundus</i>	Tomentosus root rot	<i>Onnia tomentosa</i>
Western balsam bark beetle	<i>Dryocoetes confusus</i>	True fir needle cast	<i>Lirula abietis-concoloris</i>
Southwestern pine beetle	<i>Dendroctonus barberi</i>	True mistletoe	<i>Phoradendron</i> spp.
Western shoot borer	<i>Eucosma sonomana</i>	Western gall rust	<i>Endocronartium harknessii</i>
Western spruce budworm	<i>Choristoneura fremmanni</i>	White pine blister rust	<i>Cronartium ribicola</i>
Western tent caterpillar	<i>Malacosoma californicum</i>		
Willow scale	<i>Diaspidiotus gigas</i>		

*Pathogen scientific names are updated routinely and may not match the regional field guide