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Forest Insect and Disease Conditions in the Southwestern Region, 2012

Cover photo: Pinyon killed by pinyon ips adjacent to the 2011 Wallow Fire.

Forest Insect and Disease Conditions in the Southwestern Region, 2012

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Contents

List of Tables

Conditions in Brief

Weather Summary

Precipitation in 2012 continued to be below average for much of the Southwestern Region both by calendar year (figure 1) and water year (figure 2). Precipitation deficits ranged from 0 to 8 inches in most regions of both states and up to 12 inches in a few locations in northern New Mexico. According to the NOAA annual summary for the Southwestern Region:

> *"the La Niña event, which began in September 2011 and persisted through April 2012, helped push most storms north of Arizona and New Mexico. The winter was followed by an active monsoon that tended to favor the western half of Arizona, leaving eastern Arizona and most of New Mexico very dry. In New Mexico, precipitation in eastern regions has been less than 70 percent of average in the last 12 months. In the southwestern corner of the state, scant monsoon rainfall contributed to precipitation amounts of less than 50 percent of average."*
>
> *"Overall, the below-average rain and snow in Arizona and New Mexico helped sustain drought conditions, which are both widespread and intense across the region. All of the Southwest is currently experiencing at least moderate drought, with severe and extreme conditions covering the areas that have experienced the driest conditions in the last year."*
>
> *"New Mexico had a top 10 dry year. When the dry conditions of 2011 are combined with 2012, the last two years (December 2010-November 2012) in New Mexico ranked as the driest such 24-month period on record."*

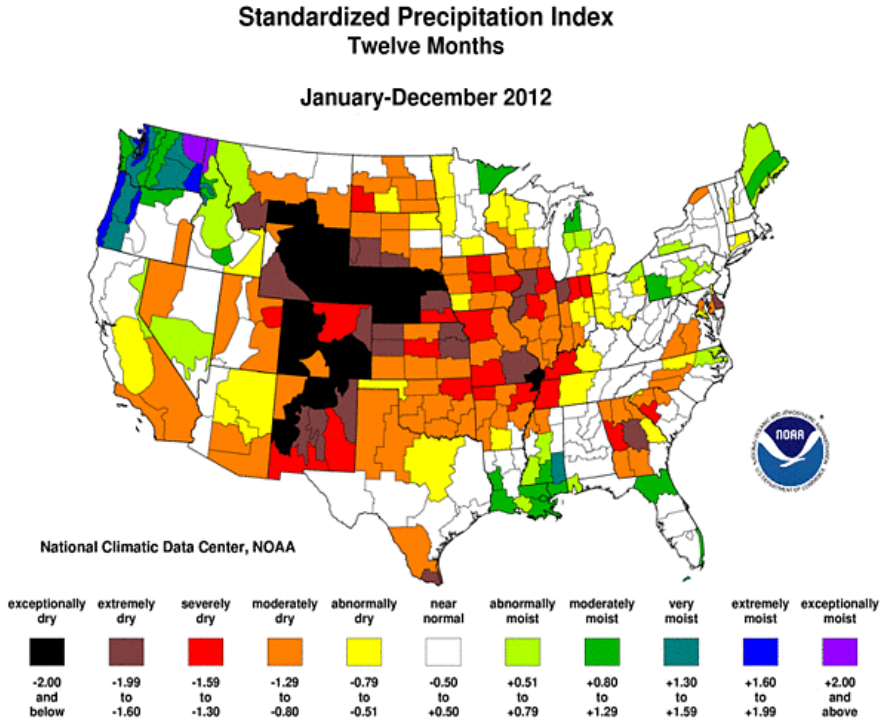


Figure 1. Standardized precipitation index for January through December 2012 (NOAA, National Climatic Data Center, http://www.ncdc.noaa.gov/).

In addition, above normal temperatures were recorded across the Southwestern Region for 2012, in particular for New Mexico.

Much of central and northern Arizona was impacted by a late season frost event. Overnight temperatures on May 26th and 27th in northern Arizona ranged from 25º F in Flagstaff to 20º F in Sunrise. As a result of these cold temperatures, branch tip mortality was observed on several hardwood and conifer species. In particular, oaks, New Mexico locust, white fir, and spruce suffered damage. While this abiotic factor will not likely cause any significant long-term damage to affected trees, the visual impact caused much alarm throughout the area in the short-term.

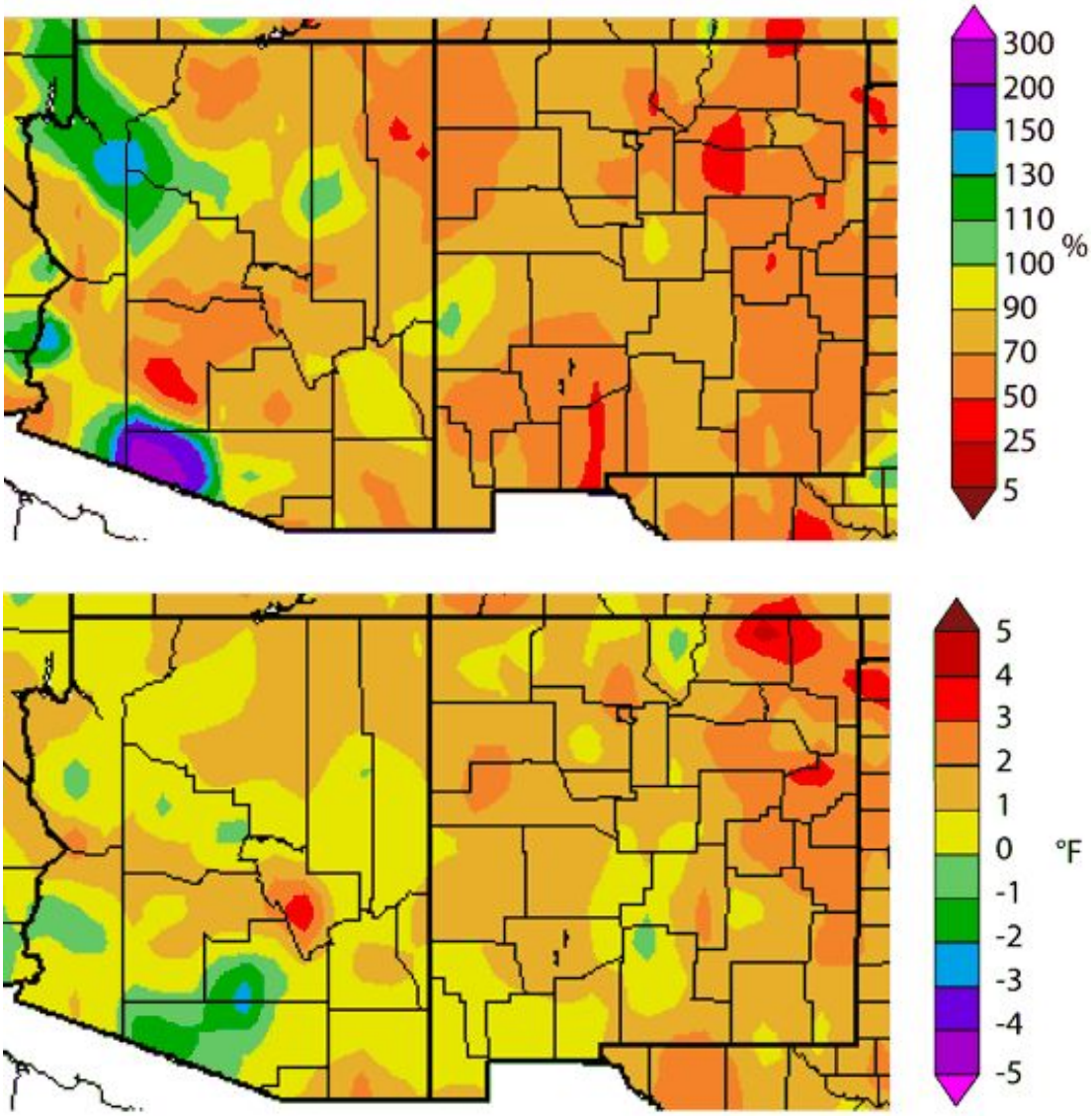


Figure 2. Water year 2012 (October 1, 2011 – September 30, 2012): percent of average precipitation (top) and departure from average temperature (bottom) (from www.climas.arizona.edu/files/climas/pdfs/periodicals/2012WaterYearInReview.pdf).

Forest Insect and Disease Summary

Forest health aerial detection surveys were flown on 20.5 million forested acres of federal, state and private ownerships in the Southwestern Region (figure 3). The continued warm and dry conditions in many areas of the region plus recent disturbance events such as recent fires and tornados led to increased insect activity in 2012. Overall, the area with tree mortality rose from nearly 178,000 acres in 2011 to 223,000 acres in 2012, not including mortality due to wildfires which burned an estimated 421,000 acres across the Southwestern Region[1]. During 2011 an additional 1.3 million acres of forest were impacted by wildfires in the region. Although aerial detection surveys do not typically record insect and disease damage within the most recent fire-impacted areas (current year and typically one year after) due to the difficulty of discriminating between fire-killed and insect or disease-killed trees, it should be noted that ground surveys during 2012 found large increases in bark beetle activity within some of these areas. For example, ground surveys on the Apache-Sitgreaves National Forests found several species of bark beetles active in partially burned stands of ponderosa pine damaged in the 2011 Wallow Fire (figure 4).

Overall, bark beetle-caused tree mortality in New Mexico increased in 2012 to more than 172,000 acres impacted based on aerial detection surveys. Across the state of New Mexico, bark beetle activity experienced rises in most forest types. The ponderosa pine forest type suffered the most bark beetle mortality with over 123,000 acres mapped across New Mexico, primarily on the Lincoln and Gila National Forests. More than 37,000 acres of mixed conifer forest type were impacted by Douglas-fir beetle and fir engraver in 2012. Mortality from pinyon ips also saw a large increase to more than 16,900 acres affected in 2012 compared with the nearly 3,300 acres in 2011. Spruce beetle activity increased slightly, having an effect on more than 2,300 acres, while corkbark fir mortality decreased by nearly half to approximately 8,100 acres.

Bark beetle activity in Arizona increased statewide from 6,400 acres with damage mapped in 2011 to 34,500 acres in 2012. Approximately 98% of bark beetle damage occurred in ponderosa pine forests with the majority of activity taking place on the Coconino and Kaibab National Forests. Much of this beetle-caused tree mortality was related to recent disturbance events such as fires and tornados.

Numerous defoliators were active throughout the Southwestern Region in 2012. Defoliation by western spruce budworm continued to affect a substantial portion of northern New Mexico, though numbers dropped slightly in 2012 with 476,000 acres recorded during aerial detection surveys. Budworm-caused defoliation also decreased in Arizona with about 1,700 acres mapped in 2012. Pine sawflies defoliated ponderosa pine in both states with a total of more than 7,500 acres being impacted in 2012. Other defoliators of conifers that caused a considerable amount of damage included the pinyon needle scale (New Mexico) and a complex of weevils (Arizona) on ponderosa pine.

Aspen damage across the Southwestern Region increased by more than 30 percent from 121,500 acres in 2011 to 180,000 acres in 2012. Damage totals included defoliation, decline and mortality of aspen. In New Mexico, aspen decline was observed on nearly 3,200 acres during 2012. Acres mapped during 2012 either had new decline or decline progressed from light to heavy. Aspen defoliation increased from 82,000 acres in 2011 to 136,000 acres in 2012. In Arizona, 1,300 acres of unspecified aspen defoliation was mapped. Most of this defoliation was probably caused by western tent caterpillar, which was particularly active on the Coronado National Forest with high

[1] From Forest Service, http://activefiremaps.fs.fed.us/baer/download.php

levels of aspen defoliation over approximately 400 acres near Safford. The large aspen tortrix caused heavy defoliation on an additional 1,400 acres on the Coconino National Forest, The number of acres of decline and mortality recorded in 2012 increased to more than 35,000 acres from the 31,000 acres reported in 2011. Most of the mapped aspen decline occurred on the North Kaibab Ranger District, the north rim of the Grand Canyon and on Navajo Nation lands.

Dwarf mistletoes are the most common and widespread pathogen in the Southwest. Over one-third of the ponderosa pine acreage and about one-half of the mixed conifer acreage has some level of infection. Ponderosa pine stands severely infested with dwarf mistletoe have higher levels of mortality than uninfested stands. Root diseases are also widely distributed across the region, and mortality from this group of diseases is found in higher elevation forests. White pine blister rust continues to cause severe damage to southwestern white pine in the Sacramento Mountains of southern New Mexico. This invasive disease also occurs in other parts of New Mexico and in the White Mountains of eastern Arizona.

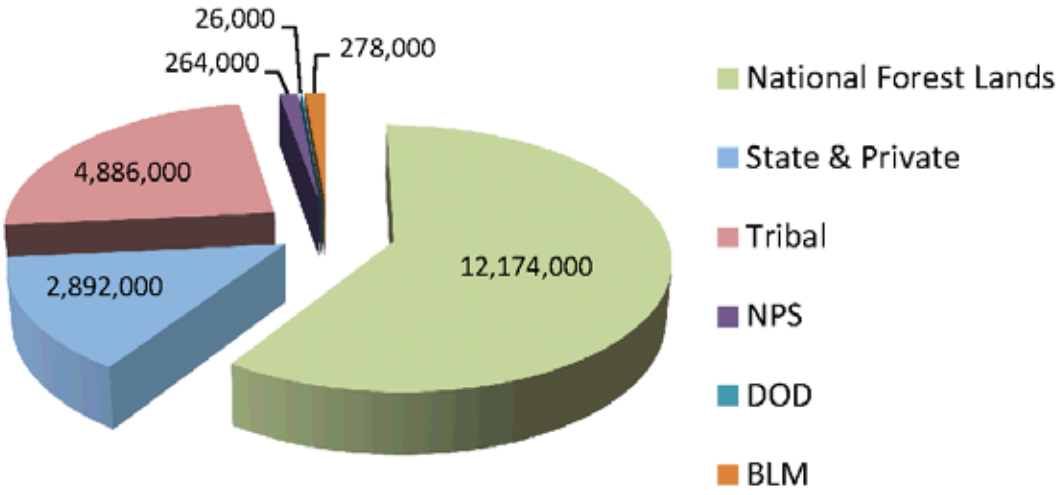


Figure 3. Aerial detection survey acres flown by land ownership (20,520,900 total acres flown).

Figure 4. Bark beetle activity in ponderosa pine following the 2011 Wallow Fire in the White Mountains of Arizona.

Table 1. Prominent 2012 forest insect and disease activity (acres) in Arizona and New Mexico*.

Agent	State	National Forest	Tribal Lands	Other Federal	State & Private	Total
Bark beetles in ponderosa pine	AZ	33,490	190	20	420	34,130
	NM	90,780	22,690	820	8,770	123,060
Douglas-fir & white fir beetles	AZ	120	80	< 5	< 5	210
	NM	22,340	12,260	10	3,220	37,820
Western spruce budworm	AZ	30	1,640	--	--	1,660
	NM	307,920	21,220	200	146,820	476,160
Aspen damage***	AZ	12,230	17,390	8,100	260	37,990
	NM	81,700	16,570	220	43,710	142,190
Root disease	AZ	219,000	**	**	**	219,000
	NM	860,000	**	**	**	860,000
Dwarf mistletoes	AZ	1,174,000	674,000	**	25,000	1,873,000
	NM	1,144,000	348,000	**	581,000	2,073,000

* Values rounded to the nearest 10; sum of individual values may differ from totals due to rounding.

** Significant activity observed/known, but acreage not determined.

*** Aspen damage includes a combination of insect defoliation and other biotic and abiotic factors causing aspen decline resulting in mortality. See text for additional information.

-- No acreage detected.

Table 2. Bark beetle incidence by site (acres) from aerial detection surveys in Arizona and New Mexico[1].

Owner[2]	Western pine beetle[3]	Ips engraver	Pinyon ips	Douglas-fir beetle	Spruce beetle	Western balsam bark beetle	Fir engraver	Cedar Bark Beetles	Bark beetles in white pine
Apache-Sitgreaves NFs	60	1,940	10	10			20	40	
Coconino NF	2,750	10,050		60		10	<5		
Coronado NF	200	20	10	10		<5	<5	10	<5
Kaibab NF	7,150	9,510	<5	20	<5	<5			
Prescott NF	10	150	<5	<5					
Tonto NF	470	1,180		<5					
Grand Canyon NP	10	<5	<5	<5					
Canyon De Chelly NP	<5		<5				<5		
Saguaro NM	<5	<5	<5				<5	<5	
Fort Huachuca		10							
Chiricahua NM		<5		<5				<5	
BLM	10	<5	<5						
Fort Apache Tribal	40	20	<5	20		<5	60		
Hualapai Tribal		<5	<5						
Navajo Tribal	50	10	<5	<5		<5	10	<5	
San Carlos Apache Tribal	50	20	<5				<5	10	
Hopi Tribal			<5					<5	
State & Private	20	400	<5	<5			<5	40	
Arizona Total	**10,620**	**23,310**	**30**	**130**	**<5**	**10**	**80**	**110**	
Carson National Forest	10	<5		2,970	850	2,780	530		
Cibola National Forest	5,290	6,050	3,790	250		40	910	130	10
Gila National Forest	41,190	8,200	2,460	180		<5	1,100	<5	10
Lincoln National Forest	20	29,610	1,340	9,130		10	6,960	60	310
Santa Fe National Forest	400	430	30	2,000	1,380	3,260	220		
Valles Caldera NP	<5			150	<5		20		
BLM	440	380	1,260	10				100	
Acoma Pueblo	10	10	150						
Isleta Pueblo	<5		<5	<5					
Jemez Pueblo	270						<5		
Jicarilla Apache Tribal	<5	<5		150	<5		20		
Laguna Pueblo	<5	<5	<5						
Mescalero Apache Tribal	70	21,980	4,150	4,050		30	7,430	80	
Navajo (NM side only)[4]	330	10	<5	<5			<5		
Picuris Pueblo	<5	<5		50			<5		
Santa Clara Tribal	<5	<5					<5		
Taos Pueblo	<5			1,390		60	90		
Zuni Pueblo	<5			<5					
State & Private	1,980	6,790	3,720	1,390	90	1,930	2,000	<5	
New Mexico Total	**50,030**	**73,470**	**16,900**	**21,730**	**2,320**	**8,130**	**19,280**	**380**	**340**
SW Region Total	**60,850**	**96,780**	**16,930**	**21,860**	**2,320**	**8,140**	**19,370**	**490**	**340**

[1] Values rounded to the nearest 10, sum of individual values may differ from totals due to rounding and multiple agents.

[2] Values based on landownership, thus any inholdings are summarized with their ownership category.

[3] Values on the Coronado NF and Saguaro NM are for roundheaded pine beetle instead western pine beetle.

[4] Activity on Navajo tribal lands in New Mexico summarized from Arizona surveys.

Table 3. Defoliation incidence by site (acres) from aerial detection surveys in Arizona and New Mexico.[1]

Owner[2]	Western spruce budworm	Aspen damage[3]	Pine sawfly - ponderosa	Pinyon needle scale	Frost / oak defoliation[4]
Apache-Sitgreaves NFs	30	2,120			2,020
Coconino NF		4,220	110		
Coronado NF		370			1,010
Kaibab NF		5,240	1,850		
Prescott NF					
Tonto NF		280			
Grand Canyon NP		7,830			
Canyon De Chelly NP				20	
Saguaro NM		20			170
Fort Huachuca					140
BLM		250			20
Fort Apache Tribal	180	7,300			12,470
Hualapai Tribal					
Navajo Tribal	1,460	10,090		540	150
San Carlos Apache Tribal					70
Hopi Tribal				240	
State & Private		260	170		390
Arizona Total	**1,660**	**37,990**	**2,120**	**800**	**16,420**
Carson National Forest	162,570	65,370			
Cibola National Forest	4,180	280	2,390	3,320	30
Gila National Forest		90		80	
Lincoln National Forest	260	240		80	1,280
Santa Fe National Forest	127,700	13,090			160
Valles Caldera NP	13,210	2,610			
BLM	200	220		20	
Acoma Pueblo					
Isleta Pueblo				30	
Jemez Pueblo					
Jicarilla Apache Tribal	6,930	12,700			1,100
Mescalero Apache Tribal	20	280			120
Navajo (NM side only)[5]	700	3,480	40		
Picuris Pueblo					
Santa Clara Pueblo		30			
Taos Pueblo	13,560	70			
Zuni Pueblo					
State & Private	146,820	43,710	2,910	410	4,970
New Mexico Total	**476,160**	**142,190**	**5,340**	**3,940**	**7,670**
SW Region Total	**477,820**	**180,180**	**7,470**	**4,740**	**24,090**

[1] Values rounded to the nearest 10, sum of individual values may differ from totals due to rounding and multiple agents.

[2] Values based on landownership, thus any inholdings are summarized with their ownership category.

[3] Aspen damage includes a combination of insect defoliation and other biotic and abiotic factors causing aspen decline and in some cases mortality. See text for additional information.

[4] Frost damage is for Arizona lands and oak defoliation is for New Mexico lands.

[5] Activity on Navajo tribal lands in New Mexico summarized from Arizona surveys.

Status of Major Insects

Bark Beetles

Bark beetles impacted more than 226,000 acres across the Southwestern Region in 2012 based on aerial detection surveys. In New Mexico, bark beetle activity increased to more than 172,000 acres impacted in 2012. Increases were observed in most forest types, but primarily in the ponderosa pine forest type on the Cibola, Gila, and Lincoln National Forests and the Mescalero Apache Tribal lands in the southern half of the state. Although Arizona had fewer acres affected than New Mexico, Arizona experienced a fourteen-fold increase in area impacted across the ponderosa pine type from 2011 levels. The amount of area affected by pinyon ips increased substantially particularly in southern New Mexico. Increases in bark beetle activity in the mixed conifer type were recorded during aerial detection surveys, partly due to better discrimination of Douglas-fir and white fir in some mixed stands. There was a notable decrease in western balsam bark beetle activity affecting corkbark fir compared with 2011.

Several species of bark beetles have continued to impact many forest types throughout the Sacramento Mountains in southern New Mexico. Drought has continued to affect overly dense forests and beetles have responded to this condition. This was observed throughout all age classes particularly on southern and western facing drier slopes. In some cases, mortality can be attributed directly to drought and wood borers, mainly in the smaller trees. Descriptions of conditions for individual bark beetle species are grouped below by forest type.

Pinyon-Juniper Forest Type

Pinyon-juniper woodlands can exist as high as 7,000 ft and tree densities can vary widely depending on individual sites. The pinyon-juniper forest type experienced an increase in pinyon ips activity in 2012, but a decrease in cedar bark beetle-caused tree mortality. Pinyon ips activity went from 3,290 acres across the region in 2011 to 16,930 acres in 2012, with almost all of it recorded in New Mexico. Cedar bark beetle activity declined to 490 acres in 2012 from 2,940 acres in 2011. Cedar bark beetles often work in concert with a variety of wood boring beetles to cause tree mortality during drought events. In Arizona, woodlands in the northeast and central eastern portions of the state were impacted by drought and may have initiated the increase in cedar bark beetle-caused tree mortality.

Pinyon Ips

Ips confusus
Host: Pinyon pine

Pinyon ips activity increased throughout the Southwestern Region. In New Mexico, a five-fold increase in area affected by pinyon ips was observed during the 2012 aerial detection surveys. Most of the impacted area was in the southern half of the state, which has been experiencing continued severe drought (figure 5).

Figure 5. Pinyon mortality in southern New Mexico.

In Arizona, only a few areas with pinyon mortality were mapped this year during aerial detection surveys; however, many dead and dying pinyon trees were seen in and around the 2011 Wallow Fire in the White Mountains. In particular, pinyon ips-caused tree mortality was noted in the vicinity of Eager and Nutrioso. Five to 30 tree pockets of pinyon mortality were observed across a few hundred acres. After the initial population build up on fire-damaged trees, more recent attacks seemed no longer dependent on susceptible fire-injured trees. Across the rest of Arizona, pinyon ips-caused tree mortality remained low.

Cedar Bark Beetle

Phloeosinus spp.
Hosts: Junipers

Primarily in southern portions of both states small groups of juniper mortality were observed during aerial detection surveys. Much of the cedar bark beetle-caused tree mortality in Arizona was observed on the Coronado National Forest; these were mainly individual trees rather than large expansive polygons. However, a large polygon of cedar bark beetle activity was noted in the southeastern area of the Clifton Ranger District on the Apache-Sitgreaves National Forests. In addition to juniper species being impacted, *Phloeosinus*-caused mortality of Arizona cypress was noted during ground surveys in the Santa Rita and Chiricahua Mountains of the Coronado National Forest. Also, planted Leyland cypress trees were being impacted by cypress bark beetles in the vicinity of Sedona, Arizona (figure 6).

In New Mexico, cedar bark beetle activity increased from less than 5 acres in 2011 to about 380 acres in 2012. Most of this activity occurred from the Cibola National Forest southward to the Sacramento Mountains. This observed damage may be partially or entirely related to the severe cold temperatures and subsequent tree damage from the winter of 2010-2011.

Figure 6. Mortality of Leyland cypress killed by cypress bark beetles near Sedona, Arizona.

Ponderosa Pine Forest Type

One of the most widely distributed forest types in the western United States, the ponderosa pine forest type in the Southwestern Region generally ranges from 6,000 feet to 9,000 feet in elevation. Ponderosa pine mortality continued to rise across the region as a whole with more than 157,000 acres mapped in 2012, up from 144,300 acres in 2011. Bark beetle activity in ponderosa in 2012 was the highest number of acres impacted since the peak in activity (763,000 acres) in 2003 (figure 7). Bark beetles in ponderosa pine decreased slightly in New Mexico, while there was a significant increase in Arizona.

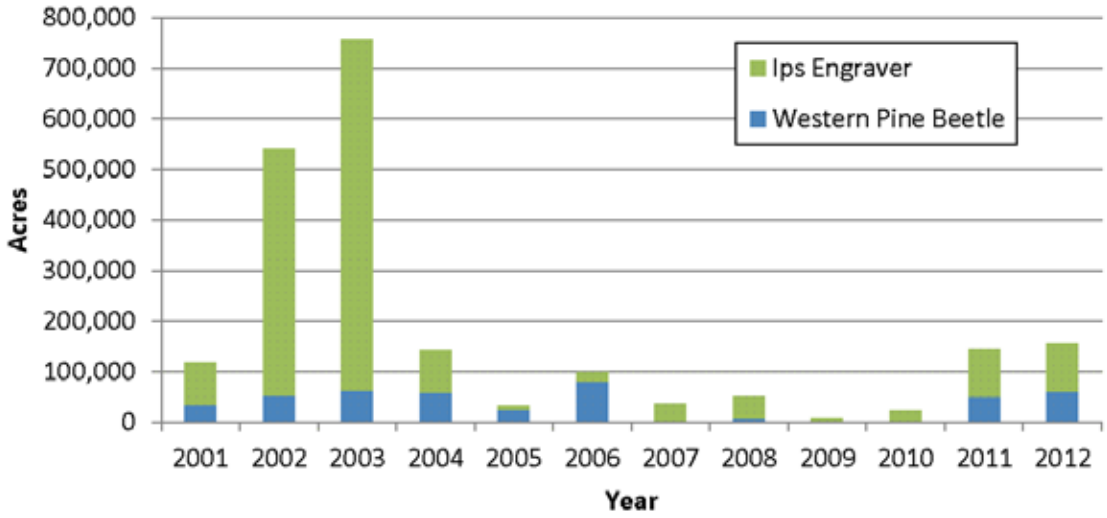


Figure 7. Western pine beetle and Ips engraver activity impacting ponderosa pine forests in Arizona and New Mexico, 2001-2012

Western Pine Beetle

Dendroctonus brevicomis
Host: Ponderosa pine

Aerial detection surveys recorded a large increase in area affected by western pine beetle during 2012 (10,600 acres) in Arizona compared to 2011 (280 acres). In addition, pockets of mortality mapped during the 2012 aerial detection surveys were larger in size compared with 2011. More than 90 percent of the activity occurred on the Coconino and Kaibab National Forests and on state and private lands and was often associated with tornado-damaged areas and fire-impacted areas (figure 8).

In New Mexico, similar levels of western pine beetle activity were recorded during the 2012 and 2011 aerial detection surveys. More than 82 percent of the activity was observed on the Gila National Forest in 2012. The extensive ponderosa pine mortality that occurred in the Sacramento Mountains has primarily been attributed to *Ips* beetles. However, western pine beetles are likely contributing to this ponderosa pine mortality as well. The ponderosa pine mortality occurring in southern New Mexico (Gila National Forest, Sacramento Mountains) was primarily the result of the dry conditions and subsequent insect activity.

Figure 8. Bark beetle-caused ponderosa pine mortality associated with previous fires on the Coconino National Forest

Ips Engraver Beetles

I. pini, I. lecontei, I. knausi, I. cribicollis, I. calligraphus
Host: Ponderosa pine

Ips species activity in the region increased slightly from 92,000 acres in 2011 to about 97,000 acres in 2012. Although the majority of activity (73,500) was recorded in New Mexico, Arizona saw a larger percent increase in area affected.

Figure 9. Bark beetle activity in drought-stressed ponderosa pine on the Lincoln National Forest.

Ips activity throughout Arizona increased ten-fold from 2011 to 2012. In particular, there were large increases on the Coconino and Kaibab National Forests. Many acres of state and private lands were impacted as well. Elevated mortality was typically associated with large-scale disturbances such as recent fires or the tornados of 2010, where damaged and downed material created a source for brood production. In areas where *Ips* activity was highest, large acreages of drought stressed trees were also recorded (7,500 acres on the Coconino National Forest).

In New Mexico, although the amount of ponderosa pine mortality attributed to engraver beetles decreased by about 18 percent, there was an increased level of ponderosa pine

mortality in 2012 throughout the state. Ponderosa pine mortality was especially evident on the Cibola, Gila, and Lincoln National Forests and adjacent lands such as the Mescalero Apache tribal lands in the Sacramento Mountains (figure 9). The bark beetle activity was the result of current drought and dense forest conditions. Bark beetle activity in ponderosa pine in New Mexico is often a combination of *Ips* engraver and western pine beetles. Both western pine beetle and *Ips* beetles were found during inspection of infested ponderosa pine trees during visits to the Gila National Forest in 2012.

Mountain Pine Beetle

Dendroctonus ponderosae
Hosts: Ponderosa, limber, southwestern white, and bristlecone pines

In contrast to Colorado and other Rocky Mountain states, the Southwest has experienced only minor mountain pine beetle activity. Occasionally, individual white pine and ponderosa pine trees have been observed with mountain pine beetle attacks in prior years, but no major outbreaks have occurred recently. In New Mexico, approximately 340 acres were mapped as having white pine affected by bark beetles. Based on ground-checking of southwestern white pines on the Lincoln National Forest, mountain pine beetle was not found, but instead a *Pityogenes* spp. was discovered. In addition, white pine on the Lincoln National Forest is often impacted by white pine blister rust.

Figure 10. Mortality of southwestern white pine caused by mountain pine beetle in the Pinaleño Mountains of Arizona.

Although only two acres of mountain pine beetle activity were mapped during the aerial surveys this year in Arizona, ground observations discovered mountain pine beetle active in white pine at different locations throughout the state. The beetle was found attacking southwestern white pine scattered throughout the 2011 Wallow Fire on the Apache-Sitgreaves National Forests in eastern Arizona. Mountain pine beetles have been impacting southwestern white pines in and adjacent to recreation sites on the Pinaleño Mountains in southeastern Arizona for the past few years (figure 10). Also, a limited number of large diameter limber pines near the base of the San Francisco Peaks outside of Flagstaff were observed to be infested with mountain pine beetle.

Roundheaded Pine Beetle

Dendroctonus adjunctus
Host: Ponderosa pine

Ponderosa pine mortality from the roundheaded pine beetle was primarily limited to the sky islands in southeastern Arizona on the Coronado National Forest. Most damage occurred in the Pinaleño, Santa Teresa, Santa Catalina and Santa Rita mountains. A few acres of mortality also occurred in Saguaro National Monument east of Tucson. Although areas affected by bark beetles within the 2011 Horseshoe II Fire in the Chiricahua Mountains were not mapped during aerial surveys, roundheaded pine beetle was observed attacking several fire-damaged ponderosa pines in the vicinity of Rustler Park. In addition, roundheaded pine beetle has been observed killing ponderosa pines north of Flagstaff near Highway 180 the past few years.

No ponderosa pine mortality was attributed to roundheaded pine beetle in New Mexico. It is not clear to what degree these beetles have influenced the overall mortality in the Sacramento Mountains, but they are part of the bark beetle community in this area and are likely contributing to these elevated levels of mortality. Roundheaded pine beetles were identified on the Pecos/Las Vegas and Jemez Ranger Districts of the Santa Fe National Forest in 2011.

Mixed Conifer Forest Type

Mixed conifer forests in the Southwestern Region are generally found from 8,000 to 10,000 ft. and primarily composed of Douglas-fir, white fir, and southwestern white pine along with pockets of aspen stands, and at lower elevations a ponderosa pine component. Overall, bark beetle (fir engraver and Douglas-fir beetle) activity increased in this forest type in both states (table 1, figure 11), particularly in the Sacramento Mountains in southern New Mexico.

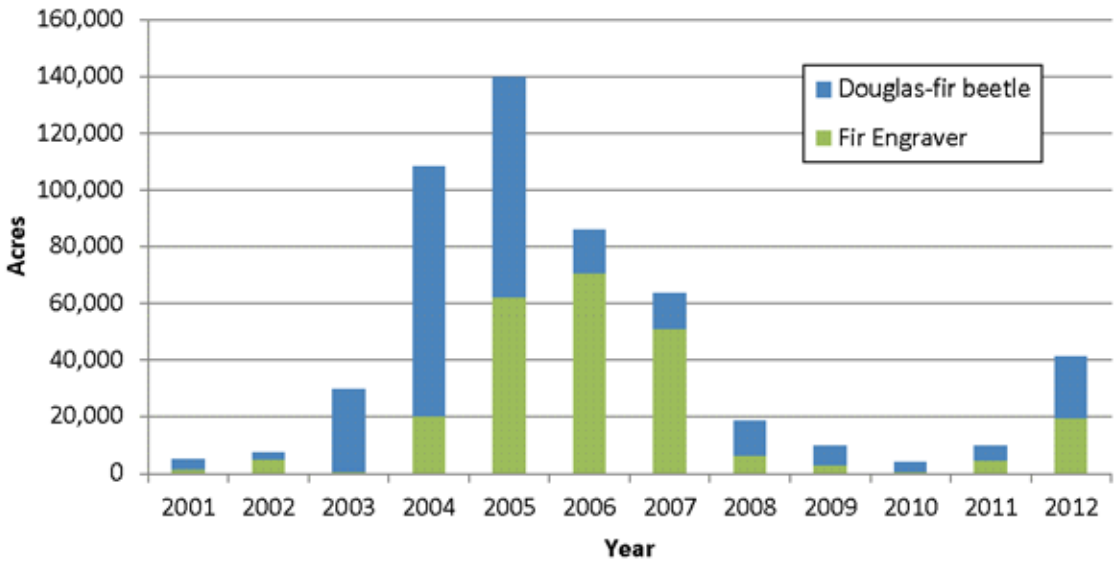


Figure 11. Mortality in mixed conifer in Arizona and New Mexico, 2001-2012. Note that Douglas-fir mortality likely includes trees killed by flatheaded fir borer in addition to Douglas-fir beetle.

Douglas-fir Beetle

Dendroctonus pseudotsugae
Host: Douglas-fir

Douglas-fir tree mortality from Douglas-fir beetle was observed throughout New Mexico during the 2012 aerial detection surveys. The affected area mapped in 2012 was four times the amount mapped in 2011. Activity was observed on the Carson and Santa Fe National Forests in the northern part of the state, but also on the Lincoln National Forest in the southern part of the state. The increase in Douglas-fir beetle-caused tree mortality in this area was partly a reflection of better delineation of Douglas-fir mortality in the mixed stands. Also, many severely drought-stressed Douglas-fir trees in the Sacramento Mountains were heavily infested with flatheaded fir borer and these buprestids likely caused or contributed to some tree mortality.

Figure 12. Douglas-fir mortality caused by Douglas-fir beetle southwest of Flagstaff, Arizona.

Although relatively few acres of Douglas-fir beetle-caused tree mortality were recorded during the 2012 aerial detection surveys in Arizona, this mortality represented a 30 percent increase from 2011. Most activity occurred on the Coconino, Kaibab, and Coronado National Forests and on Ft. Apache tribal lands. In some cases the activity was associated with recent fires. However, based on ground surveys, only limited mortality caused by Douglas-fir beetle was observed within the boundaries of the 2011 Wallow Fire on the Apache-Sitgreaves National Forests and the 2011 Horseshoe 2 Fire on the Coronado National Forest and Chiricahua National Monument. Wood boring beetles were often found attacking fire-injured trees in many areas of both fires and contributed to the mortality of trees.

Fir Engraver

Scolytus ventralis
Host: White fir

Fir mortality and fir engraver activity in the Southwest is often driven by drought conditions. The amount of tree mortality caused by fir engraver observed during aerial detection surveys in New Mexico increased significantly from what was observed in 2011. White fir mortality was observed on all of the National Forests in New Mexico, but particularly on the Lincoln National Forest. Beetles have been responding to the drought conditions in southern New Mexico along with dense, heavily stocked forest conditions. The mortality was seen throughout all age classes particularly on southern and western facing drier slopes. In some cases, mortality can be attributed directly to drought, mainly in the smaller trees.

In Arizona, the area with fir engraver activity increased slightly in 2012 compared to 2011, but overall mortality attributed to this beetle was very low. Fir engraver activity may be

underrepres ented in Arizona, however, because tree mortality within large burned areas was not mapped. Subsequent ground observations determined many fire-injured white firs were often infested with fir engraver beetles.

Spruce-Fir Forest Type

At about 9,000 ft. elevation, mixed conifer forests transition to the spruce-fir forests. Engelmann spruce and corkbark fir are the primary trees species, but blue spruce, limber and bristlecone pines are also found with a smaller occurrence of aspen. Region wide, western balsam bark beetle activity was mapped on 8,140 acres during 2012, which represents a 44 percent decrease from nearly 15,000 acres mapped in 2011. Spruce beetle was mapped across 2,320 acres in 2012, an increase from 190 acres on 2011 (figure 13).

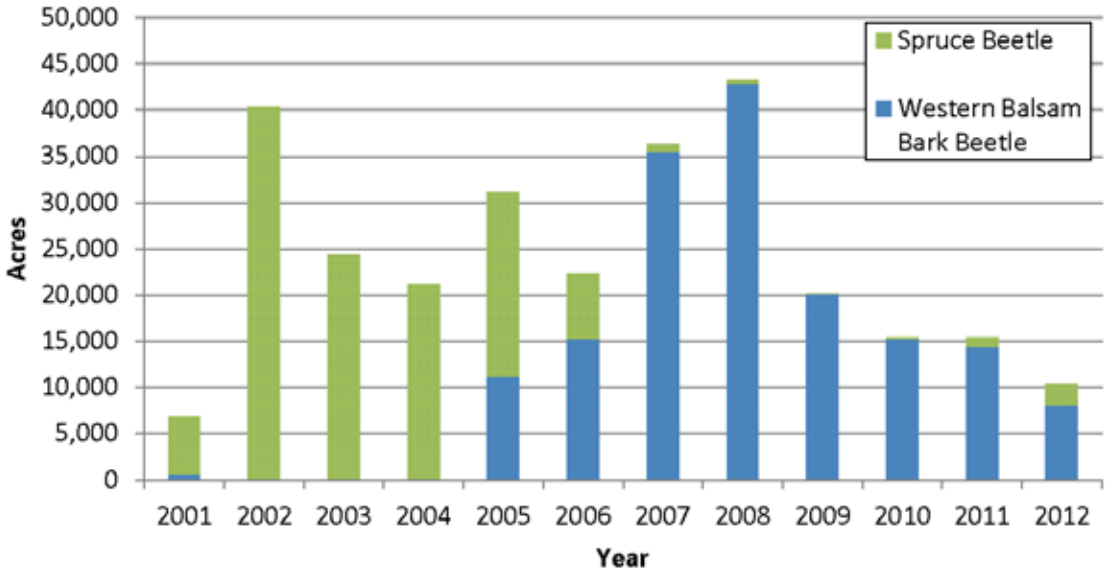


Figure 13. Spruce-fir mortality in Arizona and New Mexico, 2001-2012.

Spruce Beetle

Dendroctonus rufipennis
Host: Spruce

Spruce beetle activity remains a concern, especially with the outbreak that has been occurring adjacent to the New Mexico border along the Rio Grande National Forest in Colorado. However, only relatively minor activity was observed in the Southwest in 2012.

In New Mexico, areas with spruce beetle activity were mapped from aerial detection surveys on the Carson and Santa Fe National Forests. The largest concentration of activity was located in the Pecos Wilderness on the Santa Fe National Forest, likely the result of a large area of blowdown that occurred just over the ridge in 2007. The activity on the Carson National Forest may be related to the larger infestation currently on the Rio Grande National Forest to the north.

In Arizona, spruce beetle activity was reported on only one acre on the Kaibab National Forest during 2012 aerial detection surveys. Ground surveys during late summer of 2012 on Mt. Baldy found new and older spruce mortality. The spruce beetle activity was intermixed with frost damage and mostly recorded as frost damage with background spruce mortality during aerial surveys. In addition, based on ground surveys, spruce beetle-caused tree mortality also occurred in fire-injured trees within areas impacted by the 2011 Wallow Fire on the Apache-Sitgreaves National Forests. Some trees initially attacked by the blue spruce engraver beetle were later attacked by spruce beetle.

Western Balsam Bark Beetle

Dryocoetes confusus
Hosts: Subalpine/corkbark fir

In New Mexico, the number of acres mapped with western balsam bark beetle activity during 2012 decreased considerably from the amount mapped in 2011. Activity was primarily in high elevation areas along the Sangre de Cristo Mountain range, affecting the Carson and Santa Fe National Forests.

Only minor amounts of activity were observed in Arizona, specifically on the Flagstaff, North Kaibab, and the Safford Ranger Districts.

Blue Spruce Engraver

Ips hunteri
Host: Blue spruce

The blue spruce engraver was found infesting blue spruce and sometimes Engelmann spruce that were severely burned in the 2011 Wallow Fire. Some spruce trees initially attacked by the spruce engraver were later attacked by the spruce beetle.

Defoliators

Western Spruce Budworm

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

Western spruce budworm activity in the Southwestern Region decreased slightly from approximately 503,000 acres mapped in 2011 to about 478,000 acres mapped in 2012 (figure 14). Most of the western spruce budworm activity in the Southwest has occurred in northern New Mexico, which has a greater amount of susceptible host type.

Figure 14. Western spruce budworm defoliation of Engelmann spruce on the North Kaibab Ranger District

The outbreak in the Sacramento Mountains in southern New Mexico seems to have subsided and only a minor amount of defoliation was mapped this year on the Lincoln National Forest and Mescalero Apache Indian Reservation.

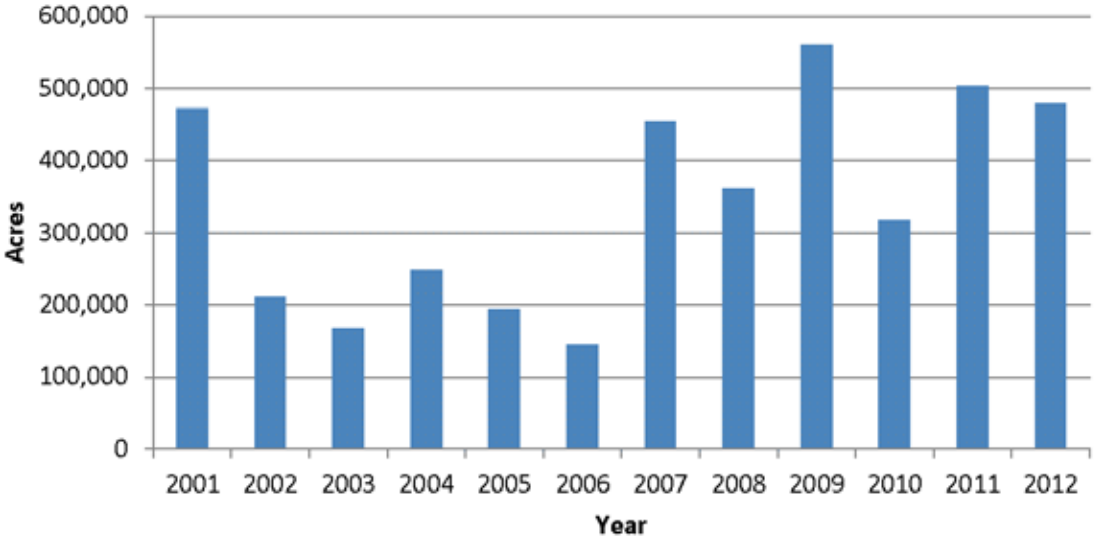


Figure 15. Western spruce budworm activity in Arizona and New Mexico, 2001-2012.

In Arizona, most western spruce budworm-caused defoliation was mapped in the Chuska Mountains on Navajo Nation tribal lands. Some defoliation was mapped on Fort Apache tribal lands, but this was a combination of frost damage, minimal defoliation from budworm, and background spruce beetle mortality. Climax stagnant spruce-fir forests on the North Kaibab Ranger District have had chronic budworm activity for years (figure 15). Top-kill to blue and Engelmann spruce was prevalent in the area.

Douglas-fir Tussock Moth

Orgyia pseudotsugata
Hosts: White fir, Douglas-fir, and spruce

Only a small amount of suspected defoliation from Douglas-fir tussock moth was mapped during the 2012 aerial detection surveys in the Southwest. No defoliation was mapped in 2011. In addition to aerial detections surveys, the Southwestern Region has participated in the Early Warning Trapping program to monitor Douglas-fir tussock moth populations since the early 1990's. The objective of the monitoring system is to identify areas with increasing Douglas-fir tussock moth populations prior to visible defoliation. Sites averaging 25 or more male moths per trap signal Douglas-fir tussock moth populations potentially capable of causing visible defoliation within 1-2 years. Trap catches in Arizona and New Mexico indicate increased activity and potential for greater defoliation in some locations during 2013 (table 4).

In Arizona, the average trap catch at West Peak in the Pinaleños (Coronado National Forest) was 49.4 moths per trap. In 2011, the average trap catch at the West Peak site was only 9.2. During the spring of 2013, egg mass surveys will be conducted to get a better idea of population

dynamics at that site. In the Pinal Mountains near Globe trap catches averaged 15 moths per trap. Other trapping locations had either zero moths or an average of less than 5 moths per trap.

In New Mexico, suspected defoliation from Douglas-fir tussock moth was mapped during aerial detection surveys on the Sacramento Ranger District of the Lincoln National Forest and a few small areas in northern New Mexico. The Sacramento Mountains in southern New Mexico had low average trap catches, but did have a slight increase in trap catches (0.5 trap average versus 0.1 in 2011). There were reports from Lincoln National Forest personnel about Douglas-fir tussock egg masses in some locations. Evaluation by the New Mexico Zone of Forest Health found numerous pupal casings at one location, but no evidence of heavy defoliation. Trap catches on the Sandia Mountains of the Cibola National Forest increased from an average of 14.9 in 2011 to 22.6 in 2012, which is just below the 25 moths per trap outbreak prediction threshold. A ground survey was conducted in the vicinity of the traps, but no significant numbers of egg masses could be located, nor was any visible defoliation observed.

Table 4. Early warning trapping results for Douglas-fir tussock moth in the Southwestern Region.

Plot	Location	Avg # of Male Moths 2011	Avg # of Male Moths 2012
Apache-Sitgreaves National Forests			
Alpine	White Mountains	*	*
Big Lake	White Mountains		0[3]
Greer	White Mountains	*	0
Hannagan Admin. Site	White Mountains		0.2[3]
Cibola National Forest			
Balsam Glade	Sandia Mountains		18
Capulin Snow Play Area	Sandia Mountains	6.6	10
Dry Camp	Sandia Mountains	30.2[2]	34
Las Huertas Rd #1	Sandia Mountains	12.4	24
Las Huertas Rd #2	Sandia Mountains	11.4	31
Las Huertas Rd #3	Sandia Mountains	18.6	34
Nine Mile Picnic Area	Sandia Mountains	0.8	1
Tree Springs	Sandia Mountains	24.8[2]	28
Coconino National Forest			
Baker Butte	Mogollon Rim	*	*
Coronado National Forest			
Cunningham	Pinaleño Mountains	*	4.8
Marshall Gulch	Catalina Mountains	7.25	9.6
West Peak	Pinaleño Mountains	9.2	49.4[4]
Lincoln National Forest			
Apache CG	Sacramento Mountains	0	0
Apache Canyon CG	Sacramento Mountains		0[3]
Apache Observatory	Sacramento Mountains	0	0
Bailey Canyon	Sacramento Mountains	0	0.7
Bluff Springs	Sacramento Mountains	0	0
Cathey Vista	Sacramento Mountains	0	0
FS Road 5661	Sacramento Mountains	0	2
FS Road 64	Sacramento Mountains		0[3]
James Ridge Lookout	Sacramento Mountains	0	1.4
Sunspot Road	Sacramento Mountains	0	*
Upper Karr Canyon	Sacramento Mountains	0	0.2
Wills Canyon	Sacramento Mountains	1.2	1
Prescott National Forest			
Mount Union	Bradshaw Mountains	0	0
Spruce Mountain	Bradshaw Mountains	0	0
Santa Clara Pueblo			
Below Site 11	Jemez Mountains	†	55
Site 12	Jemez Mountains	†	4.5
Above 4th Pond	Jemez Mountains	†	1
Cerro Toledo	Jemez Mountains	†	0
Site 16	Jemez Mountains	†	5.7
Southside	Jemez Mountains	†	3
Northwest Boundary	Jemez Mountains	†	0
Northside	Jemez Mountains	†	3.3
Tonto National Forest			
Icehouse	Pinal Mountain	0	1.8
Lower Pinal	Pinal Mountain	0	15
Reynolds Creek	Sierra Ancha Mountains	0	0
See Canyon	Mogollon Rim		0.2[3]
Washington Park	Mogollon Rim	0.2	0
White Mountain Apache Tribe (BIA)			
Sunrise	White Mountains	0	0

* Not monitored
† Not monitored due to the Las Conchas Fire
[2] Fall ground sampling for larvae or egg masses, with no significant population observed
[3] Trapping location added in 2012
[4] Egg mass sampling to occur spring of 2013.

Spruce Aphid

Elatobium abietinum
Host: Spruce

No new spruce aphid-caused defoliation was recorded from aerial surveys during 2012. Defoliation from spruce aphid was mapped on nearly 3,000 acres in Arizona in 2011. Approximately 75% of spruce aphid-caused defoliation was reported on White Mountain Apache tribal lands, concentrated around the Sunrise Ski Area. Affected acres were also mapped on the adjacent Apache-Sitgreaves National Forests and on Mount Graham in the Pinaleño Mountains.

Pine Sawflies

Neodiprion spp., *Zadiprion* spp.
Hosts: Ponderosa and pinyon pines

Pine sawfly defoliation increased region-wide from nearly 3,000 acres in 2011 to more than 7,500 acres detected during the 2012 aerial detection surveys.

Sawfly defoliation of ponderosa pine was mapped on the Gallinas and Zuni Mountains of the Cibola National Forest in 2012. This defoliation was a continuation of an event that was previously mapped in the Zuni Mountains. Most of the defoliation on the Zuni Mountains was again on Salitre Mesa area. The area on the Gallinas Mountains (Mountainair Ranger District) had previously been mapped as unknown ponderosa pine defoliation. Ground checking of the damage found sawfly evidence. Sawfly pupal cases were collected, but larvae and adults have not been identified.

Figure 16. Pine sawfly defoliation of ponderosa pine near Kendrick Mountain, Arizona.

In Arizona, a sawfly outbreak on the Coconino and Kaibab National Forests that likely began in 2008 had reduced its outbreak extent in 2011 (290 acres), but expanded again in 2012 (>2,100 acres) (figure 16). After 4+ years of consecutive defoliation, 6% of the trees that were surveyed had died from a combination of drought and consecutive years of defoliation. Defoliation was so severe that larvae were observed migrating down tree boles to feed on any green vegetation they could find, including bunch grasses. *Neodiprion fulviceps* was originally thought to be the species causing defoliation; however, based on timing of defoliation and oviposition, *N. autumnalis* may also be contributing to the outbreak. Based on ground observations, sawfly outbreaks also occurred in 2012 in the Summerhaven area on the Coronado National Forest and on San Carlos Apache tribal lands, but were not recorded during aerial surveys. The Hilltop area on San Carlos Apache lands had light to moderate defoliation of advanced regeneration to dominant ponderosa

pine-sized trees caused by *N. ventralis*. The area has had chronic sawfly activity since at least 2005.

Pinyon Needle Scale

Matsucoccus acalyptus
Host: Pinyon pine

Figure 17. Drought-induced thin crowns of pinyon pine in New Mexico.

Pinyon needle scale is a chronic defoliator of pinyon at several locations in the woodlands of Arizona and New Mexico, with intensities varying from year to year. Approximately 3,900 acres of pinyon defoliation was recorded in 2012 for New Mexico with the bulk of damage occurring on the Cibola National Forest and state and private lands. Pinyon needle scale was not mapped in the Southwestern Region during aerial surveys in 2011; however, years of chronic infestation coupled with poor tree recovery can make it difficult to discern new damage from old during aerial surveys. Additionally ongoing drought conditions contributed to thin crowns in some pinyon stands (figure 17), which are often indistinguishable from the effects of needle scale during aerial survey flights.

In Arizona, thin crowns of pinyon attributed to current pinyon needle scale activity were mapped on 800 acres across Navajo and Hopi tribal lands and at the Canyon De Chelly National Monument during 2012 aerial detection surveys. Although not recorded from aerial surveys, ground observations determined pinyon needle scale damage to woodlands occurred for several miles along Highway 60 between White River, Arizona south towards the Salt River Canyon. Additionally, several acres of pinyon needle scale-caused defoliation were observed along Forest Road 34 north of the Chevelon Work Center on the Black Mesa Ranger District, Apache-Sitgreaves National Forests. Pinyon needle scale also impacted pinyon on state and private lands in and around communities of Prescott and Payson.

Pandora moth

Coloradia pandora
Host: Ponderosa pine

Pandora moth adults have been observed flying in elevated numbers since 2008 on the Kaibab Plateau near Jacob Lake. Adults fly in even years and larvae and defoliation are observed in odd years in Arizona. In 2012 a total of 8,006 adults were trapped in light traps from late July till early September with peak flights occurring the first and second week of August. Pandora moth populations south of the Grand Canyon have historically been low, but a light trap behind the Tusayan District Office of the Kaibab National Forest trapped 1,006 adults from August 15th to the 24th, 2012. No visible defoliation has been attributed to pandora moth in Arizona.

Tiger Moth

Lophocampa ingens
Hosts: Pines and Douglas-fir

Figure 18. Tiger moth caterpillars on pinyon pine near Eager, Arizona (B. Celaya photo).

Tents and feeding by tiger moth caterpillars were conspicuous in the upper most branches of ponderosa pine during the spring of 2012 in Arizona. Damage occurred in ponderosa pine forests mainly above the Mogollon Rim from Kendrick Mountain near Flagstaff to Alpine in the White Mountains. Population increases have been noted in 1983-1984, 1989, 1995, 2006, 2011, and again in 2012. Tents were also observed in Douglas-fir at Washington Park on the Mogollon Rim. A closely related species that occurs on pinyon (*L. argentata*) was observed defoliating trees near Nutrioso and Eager in the White Mountains (figure 18). Population increases were also noted on the Kaibab National Forest in the vicinity of Juniper Ridge on the William Ranger District.

Figure 19. Discoloration of ponderosa pine needles caused by Scythropus weevils north of Flagstaff, Arizona.

Weevil

Scythropus and *Magdalis*
Host: Ponderosa pine

Large polygons of defoliation were mapped during aerial surveys in the White Mountains (660 acres), particularly near White River, Arizona and north of Flagstaff on the Coconino National Forest (720 acres). Later ground checking verified the feeding damage was consistent with *Scythropus* feeding (scraped and chewed foliage). Distal ends of needles had dried and become discolored (figure 19). No tree mortality occurred.

Mortality of shoots in the upper crown of intermediate-sized trees from *Magdalis* feeding was also present in some of these same or nearby areas. Other areas around Payson and Pinetop had similar aerial signatures, but were not ground verified and therefore were reported as unknown conifer defoliation.

Figure 20. Defoliation of aspen caused by large aspen tortrix on the San Francisco Peaks north of Flagstaff, Arizona.

Aspen Defoliation and Decline

Weather related damage
Western tent caterpillar, *Malacosoma californicum*
Large aspen tortrix, *Choristoneura conflictana*
Complex of other insects and diseases

The area with aspen damage mapped from aerial detection surveys in 2012 increased substantially compared to the amount recorded in 2011 (tables 1 and 3). Most of the defoliation in New Mexico was mapped on the Carson and Santa Fe National Forests. The concentration of activity was on the west half of the Carson on the Canjilon, El Rito, and Tres Piedras Ranger Districts. Heavy defoliation of many stands was observed as well as a large number of tents, caterpillars, and moths along highway 64, adjacent forest roads, and the Cumbres & Toltec Scenic Railroad on the northern end of the Tres Piedras Ranger District. Some large stands composed of mixed conifer and

Figure 21. Western tent caterpillars near Flagstaff, Arizona.

aspen were being affected by both western spruce budworm and aspen defoliation. Western tent caterpillar has been the primary defoliator of aspen in this area, but evidence of large aspen tortix activity was also found in 2011.

In Arizona, the area of aspen damage increased slightly in 2012 compared to 2011. Most aspen dieback and decline was noted on the Kaibab, Coconino, and Apache-Sitgreaves National Forests, Navajo and Ft. Apache tribal lands, Grand Canyon National Park, and state and private lands. Large aspen tortrix defoliated 1,430 acres on the San Francisco Peaks north of Flagstaff (figure 20). Although the damaging agent was not specified, another 1,320 acres of aspen defoliation was recorded across Arizona in 2012. Most of this defoliation was presumably due to western tent caterpillar in Arizona. Western tent caterpillar activity was especially evident on aspen in urban areas throughout northern Arizona (figure 21). In addition, tent caterpillar activity was prevalent on the Pinaleño and Santa Catalina Mountains in southeastern Arizona, particularly in the Ladybug Saddle area where aspen stands were almost completely defoliated. Tent caterpillar also defoliated chokecherry and different oak species in the vicinity of Payson and Prescott.

Figure 22. Leuschner’s tussock moth caterpillar.

Leuschner’s Tussock Moth

Orgyia leuschneri
Hosts: Box elder (primary host), alder, and sycamore

The described distribution of Leuschner’s tussock moth is limited to canyons and woodlands of southern Utah and much of Arizona and New Mexico; however, minimal information is known about the species biology or impacts. Reports of larvae, pupa and adult sightings have occurred in 2005 and 2011 along Oak Creek north of Sedona, Arizona. In 2012, defoliation of mainly box elder was detected on 55 acres near Midgley Bridge. Two generations occurred, one in June and another in August. Leuschner's tussock moth is the palest western *Orgyia* (figure 22). Cocoons and egg masses were observed on foliage, tree boles, and on rocks in and along the creek. Another population was noted in Red Rock State Park south of Sedona, but this population was not detected during aerial surveys.

Status of Major Diseases

Mistletoes

Dwarf Mistletoes

Arceuthobium spp.
Hosts: Most conifers, especially pines and Douglas-fir

There are eight species of dwarf mistletoe in the Southwest, each with a primary tree host. The three species affecting ponderosa pine, pinyon, and Douglas-fir—are found throughout most of their host's range, while the other species have more limited distributions. Dwarf mistletoes are the most widespread and damaging forest pathogens (disease-causing organisms) in the Southwest; over one-third of the ponderosa pine type, and up to one-half of the mixed conifer type, has some level of infection.

Damage from dwarf mistletoes includes growth reduction, deformity—especially the characteristic witches' brooms, and decreased longevity. Severely infested areas have much higher mortality rates than uninfested areas. Weakened trees can be killed by other damaging agents, like bark beetles or root disease. Dwarf mistletoes have an ecological role, e.g., providing bird roosting habitat and as a food source some mammals and birds. Of seemingly greater importance, dwarf mistletoe provides an indirect food source for birds that 1) feed on insects that feed on mistletoe, and 2) that feed on bark beetles that attack weakened infected trees.

True Mistletoes

Phoradendron spp.
Hosts: Junipers and various hardwoods

Several species of true mistletoe occur in the Southwest. These mistletoes are less damaging to their hosts than dwarf mistletoes, but heavy infection can reduce host longevity, especially during periods of drought. *Phoradendron juniperinum* on Utah juniper is probably the most widespread and abundant. True mistletoes are also common on oaks in southern portions of the region, and locally abundant in desert woodlands (on mesquite and palo verde) and in lower elevation riparian areas (on most hardwood species). There is also a true mistletoe species on white fir that is only found in the Santa Catalina Mountains on the Coronado National Forest in the Southwestern Region.

Root Diseases

Root diseases are fairly common in forests of the Southwest, and are often associated with mortality attributed to bark beetles. They also predispose trees to root failure, an obvious concern in campgrounds and other recreation areas. Root diseases are usually more common in mixed conifer and spruce-fir forests than in ponderosa pine forests. Like dwarf mistletoes, root diseases spread slowly, so overall incidence changes little from year to year. Root disease is often described as a "disease of the site," and can be exacerbated by certain activities.

Armillaria Root Disease

Armillaria solidipes (= *A. ostoyae*)
Hosts: Spruce, true firs, Douglas-fir, ponderosa pine, and aspen

Armillaria is the most common root disease in the Southwest, where it is estimated to account for up to 80 percent of root disease associated mortality. Although all conifer species and size classes can be infected, disease is more common in old growth mixed conifer and spruce-fir forests. *Armillaria solidipes* (syn. *A. ostoyae*) is the major armillaria species in southwestern coniferous forests, but *A. mellea* has been found in oaks, especially live oaks in southern Arizona. *A. gallica*, a saprophyte that only decays dead wood, has also been identified in mixed conifer forests. Previous surveys in mixed conifer forests on the North Kaibab Ranger District found armillaria on about 30 percent of standing live trees.

Annosus Root Disease

Heterobasidion irregulare and *H. occidentale*
Hosts: Most conifers

Annosus root disease is the second most common root disease in the Southwest, where it is found in higher elevation ponderosa pine forests and wet mixed conifer forests throughout Arizona and New Mexico. Fruiting bodies are commonly found inside stumps and, and sometimes on downed logs and upturned roots. *Heterobasidion occidentale* is common in white fir in the Southwest, but also occurs on subalpine fir and Engelmann spruce. *H. irregulare* is found in ponderosa pine, and although not common it is distributed throughout the region. Like armillaria, *Heterobasidion* is a common decayer of dead woody material as well as a pathogen.

Other Common Root Diseases

Other common root diseases in the Southwest include Schweinitzii root/butt rot, *Phaeolus schweinitzii*, often found on older Douglas-fir and occasionally ponderosa pine; Tomentosus root/butt rot, *Onnia tomentosus* (*Inonotus tomentosus*), on spruce and Douglas-fir; and Ganoderma butt rot, *Ganoderma applanatum*, found in aspen. Black Stain root disease, *Leptographium wageneri*, appears to be rare in the Southwest.

Stem Decays

Stem decays are common in older trees throughout the region. Decay represents an economic loss in terms of timber production and can increase hazard on developed sites, but decayed trees provide important cavity habitat for many wildlife species, especially birds. The most common stem decays in the Southwest include red rot, *Dichomitus squalens*, of ponderosa pine; red ring rot, *Porodaedalea pini* (*Phellinus pini*), affecting most conifers; Indian paint fungus, *Echinodontium tinctorium*, on white fir; aspen trunk rot, *Phellinus tremulae*; and *Phellinus everhartii* (figure 23) and *Inonotus dryophilus* on oak.

Figure 23. Conk of *Phellinus everhartii* on Gambel oak near Prescott, Arizona.

Stem Rusts

White Pine Blister Rust

Cronartium ribicola
Hosts: Southwestern white pine, limber pine, and *Ribes* spp.

Figure 24. White pine blister rust on southwestern white pine in the White Mountains of Arizona.

Blister rust continues to cause heavy damage to white pines in the Sacramento Mountains of southern New Mexico, where the disease has been established for nearly 40 years. Based on a set of representative monitoring plots, roughly 45 percent of the white pines in this area, which includes the Mescalero-Apache Reservation and most of the Lincoln National Forest, are infested. Blister rust was later found in the Gila National Forest, Zuni Mountains and Jemez Mountains. Many thousands of acres of mesic mixed conifer forest have severe blister rust infection, while more xeric sites generally have low to moderate infection. Top-kill is very common in the severely infested areas.

In Arizona, white pine blister rust was first detected in 2009 in the White Mountains on both the Apache-Sitgreaves National Forests and White Mountain Apache tribal lands. The oldest cankers dated to approximately 1990. More recent waves of infection have greatly expanded the distribution and severity of this outbreak. The 2011 Wallow Fire burned through rust infested areas. It is not clear what effect the fire had on the rust infestation. Future ground surveys will evaluate rust infestation in burned and unburned areas. In 2012, infected white pines and gooseberry were observed in more moderate hazard sites in the White Mountains of Arizona (figure 24).

Broom Rust

Melampsorella caryophyllacearum
Hosts: True fir and chickweed

Chrysomyxa arctostaphyli
Hosts: Spruce and kinnikinnick

Broom rusts are found at low levels throughout most of their hosts' ranges in the Southwest. High concentrations of fir broom rust occur in 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; however, infection can result in top-kill, especially in spruce. Locally, falling brooms or stem breakage at the point of infection present a hazard in developed recreation sites.

Abiotic Damage

Salt

De-icing salt use along high elevation highways has caused increasing ponderosa pine mortality over the last decade, especially in central Arizona. National Forest lands most impacted include the following forested roadways: Highway 260 near Forest Lakes; Highway 87 near Clint's Well; Interstate 40 from Flagstaff to Williams; and Highways 180 and 89A near Flagstaff. More recently, the damage is appearing along county and city roadways as municipalities are increasing the use of de-icing salts (figure 25). Additional damage from dust abatement salts was also observed in 2012, mostly in eastern Arizona.

Figure 25. Salt caused damage to aspen in Flagstaff, Arizona.

Tornado Damage

Numerous tornadoes touched down west and south of Flagstaff on October 6, 2010, affecting more than 22,000 acres on the Coconino National Forest and adjacent lands. Based on periodic visits to tornado-damaged areas, bark beetles (both *Ips* and *Dendroctonus* species) were observed to colonize storm-damaged trees throughout the warmer months of 2011. By the end of the summer, beetles had utilized most limbs and trunks of material on the ground; however, very few undamaged, standing live trees had been attacked. By early summer of 2012 small pockets of ponderosa pine mortality were noted in areas immediately adjacent to tornado swaths (figure 26). Attack rates to healthy trees were 15 to 40% higher in tornado-impacted areas compared to non-impacted areas where monitoring plots were installed.

Figure 26. Bark beetle-caused mortality of ponderosa pine following tornado damage west of Flagstaff, Arizona.

Winter Injury

Damage to alligator juniper and one-seed junipers from the extreme cold along with drying winds that occurred during the winter of 2010-2011 in New Mexico were still quite visible on the landscape in 2012 as they have maintained their red foliage. Some recovery has been observed through epicormic and basal sprouting.

Frost Injury

Figure 27. Frost damage to live oak near San Carlos, Arizona.

Hardwoods in many areas of the Arizona (Apache, Coconino, Gila and Navajo Counties) were damaged by a late frost event that occurred over Memorial Day weekend after foliage and shoots had elongated. Gambel oak and New Mexico locust was impacted from the White Mountains of eastern Arizona through most of the Mogollon Rim country in central Arizona. Impacts on lower elevation Arizona white oak/gray oak were observed on the San Carlos Apache tribal lands. Symptoms included browned and curled leaves, and branch mortality (figure 27). Mostly oaks were affected in drainages, but conifers including white fir and spruce were affected as well. On White Mountain tribal lands many acres of frost damage were originally coded as western spruce budworm until ground checking determined it was in fact frost damage mixed in with older spruce beetle mortality.

Drought

Acres impacted by drought have dramatically increased over the past two years. Drought stress was recorded on approximately 7,900 acres in Arizona in 2012. The majority of this occurred on the Coconino National Forest and state and private lands in northern Arizona. Mostly ponderosa pine forests were affected, but minor acres of Douglas-fir were affected as well. In 2011 discoloration commonly associated with drought was mapped on more acres (~78,000 ac) than all of the combined acres affected by biotic and other abiotic agents, except fire in Arizona. The Navajo Nation, San Carlos and White Mountain Apache tribal lands were the most affected. All forest types were impacted except for high elevation mixed conifer stands. Many areas affected by drought had increases in aspen decline and bark beetle activity in ponderosa pine. Riparian areas also showed serious drought-caused impacts.

Over the past couple of years in New Mexico, a variety of tree species have been impacted by abiotic factors such as drought and winter damage. In addition to juniper dieback and mortality, nearly 10,000 acres of oak showed signs of defoliation or dieback likely caused by abiotic influences. These stands throughout the Black Range on the Gila National Forest and in the Sacramento Mountains of southern New Mexico have been mapped as discolored or defoliated during aerial surveys. Stands of pinyon on the Lincoln National Forest showed signs of severe drought stress as indicated by transparent crowns.

Other Forest Insects and Diseases

Lophodermella needle cast of pines – Occurs throughout the Southwest, but typically at very low levels. Ponderosa pine is the primary host, and pinyon and southwestern white pine are occasional hosts. Yellowing and discoloration of second year needles of southwestern white pine were observed in May 2012 on the San Francisco Peaks, Coconino National (figure 28). Fruiting bodies were observed on affected needles in July, and spores were identified as *Lophodermella arcuata*.

Figure 28. Lophodermella needle cast on southwestern white pine north of Flagstaff, Arizona.

Other needle casts of conifers – White fir trees were observed being defoliated by a *Lirula* needle cast on the Prescott National Forest. Rhizosphaera needle cast of spruce was observed on 2nd year needles on the Fort Apache Reservation in June.

Goldspotted oak borer (*Agrilus auroguttatus*) **–** Based on ground surveys, large diameter Emory oaks were fading and dying due in part to drought effects combined with goldspotted oak borer activity in Madera and Gardener Canyon of the Santa Rita Mountains in southeastern Arizona. During a site visit to the Santa Rita Mountains, all fading large diameter Emory oaks encountered were currently infested with goldspotted oak borer. Oak mortality associated with goldspotted oak borer was mapped during aerial detection surveys for the first time in 2012. Three acres of evergreen oak mortality were detected in the Santa Rita Mountain Range. Additional areas may have been affected as the oak woodlands are not extensively surveyed. The activity was scattered almost exclusively within the Mount Wrightson Wilderness; specifically near Madera Canyon, Josephine Canyon and Robinson Spring. Additionally, large to mid-diameter Emory and Mexican blue oaks have been dying in Gardener Canyon and Hog Canyon for the past few years.

Flatheaded fir borer (*Phaenops drummondi*) – Evaluation of Douglas-fir mortality on the Mescalero Apache tribal lands and Lincoln National Forest in New Mexico found wood borers (Buprestidae) were the primary causal agent in the Flume Ridge area. These wood borers were occurring in severely drought-stressed trees across mid to large diameter classes. Based on gallery patterns, frass, and larval characteristics the causal agent was identified as flatheaded fir borer.

Fire-injured Douglas-fir trees in recent burned areas in Arizona (e.g., the 2011 Wallow and Horseshoe 2 Fires) were commonly infested by buprestid and cerambycid wood borers. Numerous fires over the last decade in the White Mountains have contributed to the large population of wood borers.

Southern pine beetle (*Dendroctonus frontalis*) – Low levels of Chihuahua pine mortality were observed in the Chiricahua Mountains in southeastern Arizona. Southern pine beetle brood galleries were found in these trees.

Elm leaf beetle (*Xanthogaleruca luteola*) – The central Rio Grande valley saw an increase in the amount of defoliation to many urban elm trees caused by the elm leaf beetle. This beetle has moved into the region along with the exotic elm species that were planted and have sprouted throughout much of the last century. While this small, greenish beetle can always be found at some level, the dry conditions and warm temperatures experienced over the last few years have allowed the populations and the amount of defoliation to increase.

Lepidopteran species - Several species of Lepidoptera were observed feeding on trees, shrubs and herbaceous vegetation in Arizona and New Mexico in 2012.

- **Fall webworm** (*Hyphantria cunea*) – Continues to defoliate an assortment of trees throughout northern Arizona. Walnuts and other hosts in the Show Low, Heber-Overgaard, Payson and upper Oak Creek Canyon areas have been defoliated for the past few years. Tents were also observed on Arizona sycamore, Arizona alder, walnut, chokecherry, and birch. Fall webworm was detected in August on the Santa Catalina Mountains for the first time on New Mexico locust. A larger population was found later in the area on Arizona walnuts. The insect was also found in Eagar and Star Valley feeding on a new host – lilac bush. In New Mexico, notable webworm activity continues to be observed on riparian hardwoods and landscape trees in many areas throughout the state.

- ***Dioryctria* moths –** Caused moderate to heavy shoot mortality of terminal upper leaders of pinyon across different locations in Coconino County in Arizona (figure 29).

Figure 29. Branch tip mortality caused by *Dioryctria* twig moths on the Kaibab National Forest.

- **Leafblotch miner** (Gracillariidae) **–** Was widespread again on cottonwoods in the Rio Grande River valley through Albuquerque, New Mexico. Various levels of defoliation on mature leaves were observed. Numerous parasitic wasps were observed in the blotchminer pupae samples collected.

- **Oak looper –** An unidentified oak looper was reported in the spring of 2012 to have caused defoliation of Emory oaks in Ramsey Canyon of the Huachuca Mountains in southeastern Arizona. No mortality is expected to occur.

- **Pine butterfly** (*Neophasia menapia*) **–** In Arizona, a large population of pine butterflies was observed south of Vernon. The butterflies were so numerous that they were easily caught with the bare hand. This insect has historically not caused any significant defoliation of ponderosa pines in the state and no visible defoliation has been detected.

Ponderosa pine resin midge (*Cecidomyia piniinopsis)* **–** Has been impacting ponderosa pine saplings on the Black Mesa Ranger District on the Apache-Sitgreaves National Forests in recent

years. Noticeable twig and shoot deformities are occurring in most regeneration. The Heber-Overgaard area and along Highway 260 are most affected.

Leafhopper (Cicadellidae) **–** Discoloration of walnuts from walnut leafhopper (*Dikrella readionis*) damage was common in north-central Arizona with confirmed damaged near Star Valley, Payson, Cherry and Young (figure 30). Fall webworm was also impacting the walnut in some of these areas and together the damage agents have caused branch dieback.

Figure 30. Adult walnut leafhopper in Cherry, Arizona (B. Celaya photo).

Cicadas – A large cicada emergence occurred during late spring through mid-summer in northern Arizona. Newspapers in Flagstaff made note of the nuisance to gardeners and the general public. Cicada damage via branch flagging was also noted along upper Oak Creek. Gambel oaks were affected the most.

Aphids – Giant conifer aphid (*Cinara* spp.) populations increased during 2012 and were prevalent in the Flagstaff area towards the end of the summer. In New Mexico, post-fire aspen regeneration within Santa Clara Canyon of the Santa Clara Pueblo was being affected by aphid feeding. Overall, damage was not significant.

Sycamore lace bugs (*Corythucha ciliata*) **and spider mites** (*Oligonychus* spp.) **–** A combination of sycamore lace bugs and spider mites caused leaf bronzing on sycamores in the Sedona area. The damage was detected during aerial surveys (13 acres) and then ground verified. In the spring spider mites were observed feeding on sycamores, then in late August sycamore lace bugs were observed feeding on lower leaf surfaces of foliage.

Invasive Species

Invasive Species Threats in the Southwest

Invasive species are an all-too-common threat to forests and woodlands throughout the Southwestern Region. In FY12, approximately 15,000 acres infested by invasive plants were treated on the 11 national forests and 3 national grasslands in the region. A report provided in 2011 by the Southwestern Region to the Office of Inspector General (OIG) identified the following list of invasive species as the greatest threats to terrestrial and aquatic systems on National Forest System lands:

Terrestrial plants

- buffelgrass (*Cenchrus ciliaris*)
- leafy spurge (*Euphorbia esula*)
- brome grasses (*Bromus* spp.)

Vertebrates

- feral hogs (*Sus scrofa*)

Invertebrates

- walnut twig beetle (*Pityophthorus juglandis*)

Aquatic plants

- Eurasian watermilfoil (*Myriophyllum spicatum*)

Aquatic organisms

- quagga mussels (*Dreissena rostriformis bugensis*)
- rock snot (*Didymosphenia geminata*)

Pathogens

- white pine blister rust (*Cronartium ribicola*)
- whirling disease (*Myxobolus cerebralis*)

Of the invasive species threats identified in the OIG report, buffelgrass is probably the greatest single threat to forests and woodlands in Southwestern Region (figure 31). Buffelgrass is an invasive grass species from Africa that was developed in the U.S. as a drought-tolerant forage grass. Although it was originally planted in Texas and Mexico for forage, buffelgrass now threatens the Sonoran Desert ecosystem through its expansion into southern Arizona and most of the State of Sonora in Mexico. The threat from buffelgrass comes from its ability to outcompete native desert vegetation for water, nutrients, and sunlight and also by the formation of dense buffelgrass stands that allow fires to spread across the landscape. The Sonoran Desert evolved without fire, and most of its native plants such as the iconic saguaro cactus (*Carnegiea gigantea*) are fire intolerant.

Both the Coronado and Tonto National Forests in southern Arizona have been infested by this invasive grass species. In particular, the Coronado National Forest has extensive stands of buffelgrass along the southwestern foothills of the Santa Catalina Mountains. The Coronado National Forest has engaged in a number of activities to control buffelgrass including hosting community events such as an annual Beat Back Buffelgrass Day. Buffelgrass is also a concern for

Figure 31. Images of buffelgrass, an invasive species threatening grassland ecosystems in the Southwest.

the Tonto National Forest in central Arizona with infestations occurring on four of its six ranger districts.

One of the most widely dispersed invasive species in Southwestern Region is saltcedar (*Tamarix* spp.) which commonly occurs as either a shrub or tree in thick stands along waterways. In New Mexico, saltcedar is listed as a Class C noxious weed species, which allows management decisions for the species to be determined at the local level, based on feasibility of control and level of infestation. Saltcedar can affect native riparian systems by altering stream flow (through evapo-transpiration processes) and the ecology (e.g., soil salinity and microbial activity). During the last decade, several species of the tamarisk leaf beetle (*Diorhabda* spp.) from Asia and the Mediterranean region in Europe were released as a host-specific biological control agent for saltcedar (figure 32). Both adult beetles and larvae feed on the foliage of saltcedar which can damage or kill the plant over a period of several years. Different subspecies of this beetle with specific biotic requirements for climate and day length were released in Utah and Colorado. The beetle has since migrated south into northern parts of Arizona and New Mexico from the original release states. The advancing migration of the beetle threatens some nesting habitat used by the federally listed southwestern willow flycatcher (*Empidonax traillii extimus*), which nests in saltcedar-dominated areas that have replaced the original communities of native willow species (*Salix* spp.).

Figure 32. Larva of tamarisk leaf beetle feeding on saltcedar near San Ysidro, New Mexico.

Although further releases of *Diorhabda* beetles have been suspended by the USDA Animal and Plant Health Inspection Service (APHIS), the rapid expansion of the beetle under natural conditions may remove saltcedar as a troublesome invasive species in many parts of the Southwest. However, this expansion may potentially be at the temporary cost of some flycatcher habitat in areas where invasive saltcedar dominates the vegetative community. In addition, other invasive weed species may replace the saltcedar. To identify potential *Diorhabda* impacts on the flycatcher, a multi-year collaborative effort is underway by the U.S. Geological Survey, Northern Arizona University, and the Southwestern Region's Forest Health program to collect baseline data on avifauna, herpetofauna, microclimate, and plant diversity in the Virgin, Colorado, Salt and Tonto Rivers. Northern Arizona University, Merriam-Powell Center for Environmental Research, and the

Arizona Game and Fish Department are also working together to remove saltcedar and establish common gardens to test potential negative effects of increasing temperatures on several genotypes of native riparian species collected throughout the western United States and planted in the Chevelon Creek weed management unit in Navajo County, Arizona. Grand Canyon National Park is proceeding with rigorous restoration projects along the Colorado River to remove tamarisk and restore the native riparian community while balancing the needs of recreation users on the river and restoring the ecological integrity of the riparian ecosystem. The Park has been monitoring the presence of tamarisk leaf beetle since 2009. Although tamarisk leaf beetle effects were not specifically targeted in surveys across the Southwestern Region, defoliation of tamarisk was mapped in parts of Canyon De Chelly (figures 33 & 34).

Figure 33. Tamarisk leaf beetle-caused defoliation of saltcedar in Canyon de Chelly National Monument, Arizona.

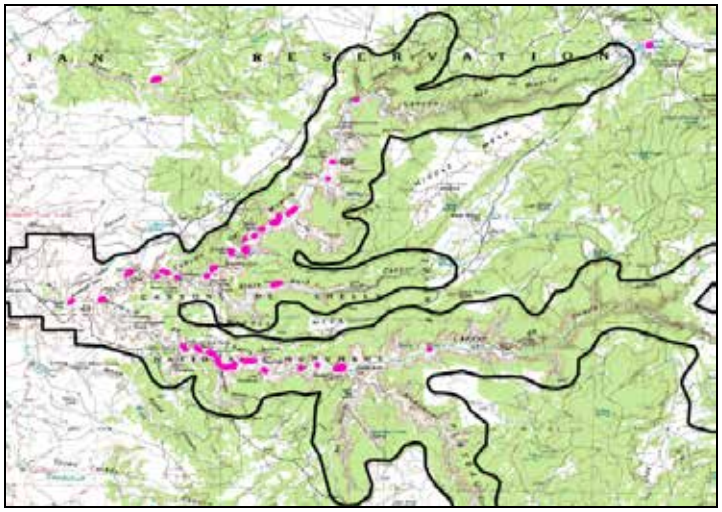


Figure 34. Areas of saltcedar defoliation caused by tamarisk leaf beetle in Canyon de Chelly National Monument, Arizona based on aerial detection surveys.

Recent Developments in Forest Service Programs for Invasive Species and Pesticides

In FY12, the Southwestern Region's Forest Health program provided a combined total of $141,000 to the states of Arizona and New Mexico as assistance for detection, treatment, and monitoring of invasive plants on state and private lands. Funding for the invasive plant program is made through a consolidated grant to the State Forester's office which is responsible for administering the program. Announcement of available funding for invasive plants under the program is made by a Request for Proposal (RFP) sent out by the State Forester. Applicants for treatment projects involving invasive plants are generally Cooperative Weed Management Areas (CWMAs) or Resource Conservation Districts (RCDs), but other organizations can qualify if they are able to treat invasive plants on a cooperative basis. Priority for funding is given to applicants with projects that propose to treat invasive plants (normally weed species on the state's noxious weed list) that threaten forests and woodlands within the state. Funding through the grant program has been used to treat buffelgrass, starthistles, thistles, saltcedar, knapweeds, toadflaxes, and other noxious weeds within the two states. Applicants should contact Bob Celaya (602-771-1415) in Arizona and Shannon Atencio (505-425-7472) in New Mexico for further information.

A new series of field guides for managing invasive and non-invasive weeds in the Southwest is now available on the region's Forest Health website at http://www.fs.usda.gov/main/r3/forest-grasslandhealth/invasivespecies. The field guides contain information for managing invasive and non-invasive weeds according to integrated weed management (IWM) principles (figure 35). The guides are intended to address management of weeds on public and private lands in the Southwestern Region and may be used by private landowners, government agencies, tribal nations, and organizations such as CWMAs.

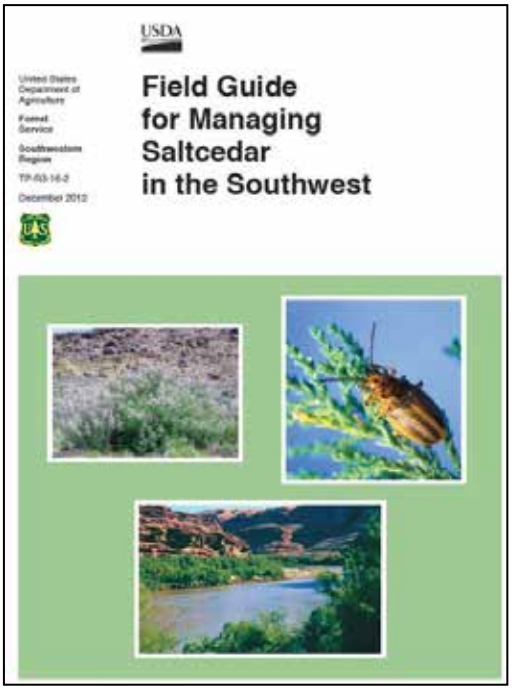


Figure 35. Cover of field guide for managing saltcedar in the Southwest.

A technical report entitled "Review and Assessment of Programs for Invasive Species Management in the Southwestern Region, 2012" was released in August of 2012. The report discusses current conditions and challenges for invasive species programs across national forests and grasslands in the Southwestern Region and includes recommendations for improving program operations. Information for the report was compiled from surveys submitted by forest staff for invasive species and pesticide use. The report may be found at http://www.fs.usda.gov/main/r3/forest-grasslandhealth/invasivespecies and is also available from Allen White, Regional Coordinator for Invasive Species and Pesticide-Use, at (505) 842-3280.

In August 2010, a spray project was conducted near Tucson, Arizona to test the effects on buffelgrass from aerial application of the herbicide glyphosate. Two rates of glyphosate were applied by helicopter on 12 sample plots. Vegetative results indicated that buffelgrass was

controlled at the higher rate of applied glyphosate (2.66 pounds acid equivalent/acre); however, small plants such as forbs, small shrubs, and grasses were also damaged by the glyphosate. Preliminary results from the aerial spray project are summarized in the report “Aerial Spraying of Herbicide to Control Buffelgrass in Southern Arizona: Efficacy, Non-Target Impacts and Application Recommendations” which may be found at: http://www.fs.usda.gov/main/r3/forest-grasslandhealth/invasivespecies.

Biological Evaluations and Technical Assistance

Arizona Zone

1. Review of silvicultural certification stand (Kristen Murphy), Coconino NF, Mogollon RD; 1/10/2012.
2. Douglas-fir Tussock Moth monitoring results for Arizona; 2/8/2012.
3. Update on bark beetle activity related to October 2010 tornados on the Coconino National Forest and adjacent lands; 2/17/2012.
4. Gypsy moth detection trapping in Arizona; 4/27/2012.
5. Bark beetle activity in Hart Prairie Fuels Reduction and Forest Health Restoration Project prescribed burns; 8/27/2012.
6. Gypsy moth detection trapping in Arizona; 9/27/2012.
7. FY13 Proposed Prevention Suppression Project - Dry Park WSB; 10/3/2012.
8. Evaluation of MCH treatments to minimize Douglas-fir beetle impacts in the Wallow Fire; 10/15/2012.
9. Cherry Creek Watershed Forest Health Improvement Project; 10/30/2012.
10. Insect and disease activity at Grand Canyon National Park; 11/2/2012.
11. Insect and disease activity in the Turkey Butte – Barney Pasture (TB-BP) Forest Health Restoration Project area; 11/13/2012.
12. Aspen regeneration monitoring following the 2010 Schultz Fire, Coconino National Forest; 11/20/2012.
13. Southwestern dwarf mistletoe in the Hilltop Project area, San Carlos Apache Tribe Forestry; 11/26/2012.

New Mexico Zone

1. Evaluation of Trees for Hazardous Defects, Coyote RD, Santa Fe NF, 2/27/12.
2. Walnut Twig Beetle Trap Monitoring, BLM, La Cueva Non-Motorized Trail System, Carlsbad, NM, 2/29/12.
3. Site visit to Rio Cebolla to observe alder dieback, Santa Fe National Forest, 3/20/12.
4. Insect/Disease Prevention/Suppression Project Proposal Field Visits, New Mexico Zone, Southwestern Region, 6/11/12.
5. FY13 Potential Forest Health Project, Mescalero IR, 8/24/12.
6. Proposed Forest Health Project, Jicarilla Apache Indian Reservation, 9/17/12.
7. Proposed FY13 Forest Health Projects, Sandia and Mountainair RD's, Cibola National Forest, 9/20/12.
8. Potential FY 2013 Forest Health Project on Jemez Pueblo, 9/21/12.

9. Proposed FY13 Forest Health Projects Smokey Bear RD, Lincoln National Forest, 10/1/12.
10. Proposed FY13 Forest Health Projects, Cuba and Jemez RDs, Santa Fe National Forest, 10/1/12.
11. Proposed FY 2013 Forest Health Projects, Española District, Santa Fe National Forest, 10/3/12.
12. Proposed FY13 Forest Health Project, Mountainair RD, Cibola National Forest, 10/11/12.
13. Sacramento RD 2012 Douglas-fir Tussock Moth Trapping Results, Lincoln National Forest, 11/5/12.
14. Sandia RD 2012 Douglas-fir Tussock Moth Trapping Results, Cibola National Forest, 11/5/12.
15. 2012 Gypsy Moth Trapping Results, 11/6/12.

Publications

Coleman, T.W., A.D. Graves, M. Hoddle, Z. Heath, Y. Chen, M.L. Flint, and S.J. Seybold. 2012. Forest stand composition and impacts associated with *Agrilus auroguttatus* Schaeffer (Coleoptera: Buprestidae) and *Agrilus coxalis* Waterhouse in oak woodlands. *Forest Ecology and Management* 276: 104-117.

Fairweather, M.L., K.S. Burns, and I.B. Lockman. 2012. Interior West forest diseases. pp. 31–40. In: (W.A. Bechtold, M.J. Bohne, B.L. Conkling, D.L. Friedman, and B.M. Tkacz, eds.) A synthesis of evaluation monitoring projects sponsored by the Forest Health Monitoring Program (1998-2007). USDA Forest Service, *Southern Research Station Gen. Tech. Rep*. SRS-159.

McMillin, J.D., A.S. Munson, J.F. Negron, and E.A. Willhite. 2012. Interior West forest insects. pp. 3–14. In: (W.A. Bechtold, M.J. Bohne, B.L. Conkling, D.L. Friedman, and B.M. Tkacz, eds.) A synthesis of evaluation monitoring projects sponsored by the Forest Health Monitoring Program (1998-2007). USDA Forest Service, *Southern Research Station Gen. Tech. Rep.* SRS-159.

Hoffman, C., J.D McMillin, C.H. Sieg, and P.Z. Fulé. 2012. Chapter 19. Influence of bark beetle-caused mortality on fuel loadings and crown fire hazard in southwestern ponderosa pine stands. pp. 241–246. In: (K.M. Potter and B.L. Conkling, eds.) *Forest Health Monitoring: 2009 National Technical Report* USDA Forest Service, GTR-SRS-167.

Seybold, S.J., T.W. Coleman, P.L. Dallara, N.L. Dart, A.D. Graves, L.A. Pederson, and S.E. Spichiger. 2012. Recent collecting reveals new state records and geographic extremes in the distribution of the walnut twig beetle, *Pityophthorus juglandis* Blackman (Coleoptera: Scolytidae), in the United States. *The Pan-Pacific Entomologist* 88: 277-280.

Zegler, T.J., M.M. Moore, M.L. Fairweather, K.B. Ireland, and P.Z. Fulé. 2012. *Populus tremuloides* mortality near the southwestern edge of its range. *Forest Ecology and Management* 282: 196–207.

Other Entomology and Pathology Activities in 2012

Aspen Browse Monitoring in Arizona

In 2012, we revisited pre-fire permanent plots in the 2010 Schultz Fire area on the Coconino National Forest. The frequency of ungulate browsed aspen regeneration (<0.1”DBH) was similar in 2009 and 2011, at 95 % and 94 %, respectively; despite the ten-fold increase in aspen stems in 2011 following fire. In 2012, browse impacts declined to 58 % utilization of all aspen stems (sucker sprouts and seedlings), with marked differences between plots, with 75 % of plots experiencing heavy browse of aspen regeneration (i.e., >65 % utilization) while others had little utilization. Plots located near Waterline Road had little utilization, likely due to heavy road construction traffic that deterred elk and deer from browsing along the roadway. However, an additional factor to the decreased utilization may be the increase in seedlings that were included in the 2012 data set. Aspen seedlings were first observed in 2011. Many seedlings may have escaped browse damage due to their short stature.

Figure 36. Abundant seed production of aspen occurred in 2012 following the Wallow Fire.

Some aspen suckers arising within the 2011 Wallow Fire burn in eastern Arizona were browsed in 2012, but quantitative surveys are needed to describe if there is an impact. Aspen seedlings were also identified in some burned areas, which was no surprise given the abundant seed production that occurred in May and June of 2012 (figure 36).

For more information, contact Mary Lou Fairweather

Pandora Moth Monitoring

Since 2010, Northern Arizona University and the Arizona Zone of Forest Health have been monitoring both adult and larval populations of the pandora moth. Thus far the population has remained in the build-up phase as indicated by the low level of naturally occurring nuclear polyhedrosis virus (NPV) and parasitoids within the monitored portion of the population. One of the major milestones of the monitoring work has been the refinement of the pandora moth lure for the Southwest. The entomology lab at the University of California, Riverside has been critical in the development of a better blend of compounds for monitoring pandora moth populations in Arizona. Another round of field testing will be required before a southwestern pandora moth lure will be available commercially. In addition to lure development, we have also documented the presence of the pandora moth on the south side of the Grand Canyon. During previous outbreaks, pandora moth impacts had only been documented north of the Grand Canyon. A light trap on the Tusayan Ranger District verified the presence of an adult population on the south side. Fewer adults were trapped on the south side than on the north. Peak flights on the south side occurred approximately two weeks later than peak flights on the north side around Jacob Lake.

For more information, contact Amanda Grady

West-wide Western Pine Beetle Bait Evaluation Trials

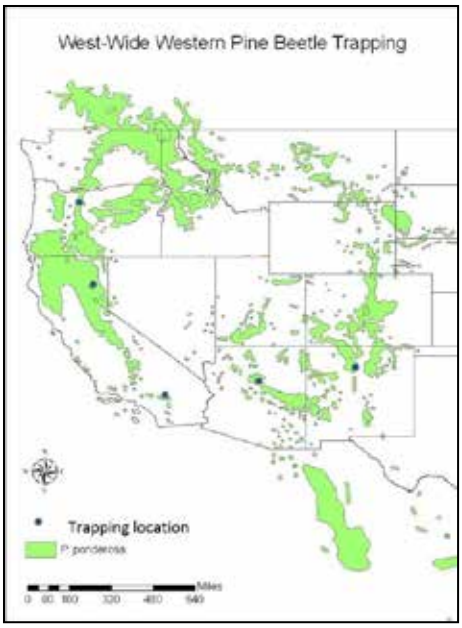


Figure 37. Sites evaluating western pine beetle lures and distribution of ponderosa pine.

In 2012, Forest Health Protection Entomologists from around the western United States evaluated western pine beetle attraction to different aggregation pheromones and host compounds. Results from earlier studies suggested that attraction could be increased in Arizona by replacing the standard host monoterpene from myrcene to alpha-pinene to match the dominant monoterpene of ponderosa pine's chemical profile. Endo-brevicomin, an aggregation pheromone produced by the southern pine beetle, was also tested to see whether western pine beetle would use the pheromone created by its sister species to locate conspecifics and to find suitable hosts. Four treatments were evaluated at 5 sites during 2012 (figure 37): 1. Exo-brevicomin + frontalin + myrcene (the standard), 2. Exo-brevicomin + frontalin + alpha-pinene, 3. Endo-brevicomin + frontalin + myrcene, and 4. Endo-brevicomin + frontalin + alpha pinene. Preliminary findings from our trap catch data supports the earlier theory that there are actually two distinct populations of the western pine beetle (an eastern and a western) throughout its range. The eastern population's distribution likely resides in Colorado, Utah, Arizona and New Mexico, while the western population's distribution occurs in California, Oregon, Idaho and British Columbia. The eastern populations respond more to lure treatment 4, while the western populations are most attracted to lure treatment 1. Earlier phylogenetic analysis of the bark beetle genus *Dendroctonus* based on mitochondrial DNA testing uncovered large genetic distances between California and Colorado populations (Kelley et al. 1999). The genetic distances between the two populations was equivalent to that observed between two fully recognized sister species of *Dendroctonus* and suggests the presence of a cryptic species. Our data supports the possibility that the eastern and western populations may have become reproductively isolated as a consequence of the geographic separation of the host varieties.

For more information, contact Amanda Grady

Monitoring Pine Sawfly Defoliation in Northern Arizona

The pine sawfly outbreak along the border of the Kaibab and Coconino National Forests near Kendrick Mountain has contracted and expanded over the past four years. This year the acreage affected increased from about 300 acres defoliated in 2011 to more than 2,000 acres defoliated in 2012. In addition to aerial detection surveys, the Arizona Zone of Forest Health has been monitoring a series of permanent plots to determine defoliation levels and the effects of consecutive years of defoliation on host tree condition. After four consecutive years of sawfly defoliation, 6 percent of the ponderosa pine within the plots had died. Seventy-five percent of the dead trees had died after two years of severe defoliation of the old and new foliage, while the remaining trees died after 3 years of severe defoliation. Thus far, bark beetles do not seem to be

influencing mortality rates within the plots; only one of the dead trees had signs of bark beetle attacks. Other recently dead and dying pines outside of the monitoring plots had symptoms of wood borers in the lower portions of the boles. Background bark beetle activity in the adjacent stands has been minimal in the past, but recent prescribed burns and small wildfires in the area may contribute to a larger source of bark beetle pressure in 2013.

For more information contact Amanda Grady

Bark Beetle Response to Fuels Reduction Treatments

The Hart Prairie Fuels Reduction and Forest Health Restoration Project area is located approximately 20 miles north of Flagstaff, Arizona on the Coconino National Forest. The total project area consists of approximately 12,775 acres. Ponderosa pine and aspen make up approximately 8,700 acres or almost 80 percent of the project area on National Forest System lands. The purpose of this project is to improve forest health, and to reduce the threat of severe wildfire in and around the Hart Prairie project area. As part of this fuels reduction and restoration effort, the Flagstaff Ranger District conducted prescribed burns in three management units between October 2011 and the middle of May 2012. No mechanical or hand treatment of overstory vegetation occurred prior to the burns; however, an October 2010 tornado had previously damaged part of the fall burn area. Forest Service personnel observed numerous fire-damaged ponderosa pine trees being attacked by bark beetles during June 2012. Monitoring plots were installed throughout a portion of the burn areas to provide the District with more detailed information on the number of trees being attacked and what bark beetles species were involved. More than 50 percent of ponderosa pine trees in the high damage category (81-100 percent total crown damage) were attacked by red turpentine beetle. Similarly, other *Dendroctonus* species and engraver beetles, ambrosia beetles and wood borers most often attacked trees in the high crown damage category. Also, more trees were attacked in areas burned in the fall than spring burn areas. Very few attacks occurred on trees sustaining less than 40 percent total crown damage. Bark beetle and other insect activity will continue to be monitored in 2013 to determine the level of beetle population increase and potential for additional tree mortality.

For more information, contact Joel McMillin

Insect and Disease Workshops

The Southwestern Region's Forest Health staff offers training sessions on forest insects and diseases in the Southwest at least once a year. This 2 to 2½-day workshop covers the biology, ecology, effects, and management of major insects and diseases affecting southwestern forest ecosystems. Emphasis is placed on the roles of these organisms as disturbance agents and their relationship to forest health. The workshop is open to Forest Service personnel, as well as other Federal, State, and Tribal resource management agencies. In 2012 this workshop was conducted in Flagstaff, Arizona. Thirty participants attended representing the

Figure 38. Field trip to discuss insect and disease identification and management in the Southwest.

four National Forests, the National Park Service, Santa Clara Pueblo and the Arizona State Forestry Division. Field trips to examine insects and diseases were conducted in pinyon-juniper woodlands and ponderosa pine, mixed conifer, aspen and spruce-fir forest types (figure 38).

In addition to the traditional insect and disease workshop, the Arizona Zone staff also conducted a forest workshop on the White Mountain and San Carlos Apache tribal lands in June 2012. More than 70 participants learned about forest insects and diseases through a combination of classroom presentations and field trips in the White Mountains (figure 39). The workshop was divided between spending time on both tribal lands and helped to facilitate discussion concerning forest health management among the foresters and land managers.

Figure 39. Participants and instructors of the 2012 forest insect and disease training on White Mountain and San Carlos tribal lands.

For more information, contact the AZ or NM Zone Leader

Hazard Tree Workshop

We conduct a workshop titled Hazard Tree Detection, Evaluation, and Management in Recreation Areas, which was launched in 1990 to assist district personnel with responsibilities to reduce hazard trees in developed sites. At least one training/workshop is offered annually. It alternates between New Mexico and Arizona to provide the opportunity for local staff to attend, without regard for training or travel costs. We discuss the Forest Service Manual direction on hazard tree identification and removal in developed sites, and an attorney with the Office of General Council provides an understanding of the agency's legal responsibilities and actions that decrease liability. In 2012, the workshop was held on the Canjilon Ranger District, Carson National Forest, NM.

For more information, contact Mary Lou Fairweather

Web Version of Insect and Disease Field Guide

A Web version of the "Field Guide to Insects and Diseases of Arizona and New Mexico Forests" is available on our Forest Health Web site: http://www.fs.usda.fed/goto/r3/foresthealth

The Web version contains all of the photographs and information of the printed guide. Access to PDFs of individual sections of the guide is available for users to print sections of the guide. Note that the guide is being updated during the spring of 2013 and will be available electronically later in 2013.

For more information, contact Mary Lou Fairweather

Forest Health Staff

Arizona Zone

John Anhold (928) 556-2073

Supervisory entomologist, Arizona Zone leader since 2000. Duties include: supervisory and managerial duties for Arizona Zone staff, oversight of Arizona Cooperative Forest Health program of the State Forester's office, Region 3 representative for the National Forest Health Monitoring program. Interest in western bark beetle technology development and transfer. Previous work experience in Region 4 working with bark beetles and coordinator for the Utah gypsy moth eradication project, and in the Northeast Area working with state cooperators regarding defoliator issues.

Steve Dudley (928) 556-2071

GIS program coordinator, Arizona Zone since 1990. Collection, processing, analysis and map production of current year forest insect and disease activity survey data remains the primary GIS task. Insect and disease detection aerial surveyor. Annual detection of mortality, defoliation and abiotic factors across Arizona.

Mary Lou Fairweather (928) 556-2075

Plant pathologist, Arizona Zone since 1989. Provides technical assistance on forest diseases to land managers. Current focus: distribution and impacts of white pine blister rust; aspen diseases and browse impacts on aspen regeneration; dwarf mistletoe ecology and management; and hazard tree identification and mitigation.

Amanda Grady (928) 556-2072

Forest entomologist, Arizona Zone arrived in October 2011 from Forest Health Protection, Pacific Southwest Region. Primary responsibilities are providing technical assistance on forest defoliators to land managers across all land ownerships, providing entomological technical assistance on all non NFS lands, conducting insect and disease aerial detection surveys and monitoring native and exotic insects in the state. Research interests include bark beetle and defoliator semiochemical work, fire and forest insect interactions and climate change effects on forest insects and restoration efforts.

Joel McMillin (928) 556-2074

Forest entomologist, Arizona Zone since 2001. Primary responsibility is providing technical assistance on bark beetle management to land managers. He serves as Southwestern Region representative to the Special Technology Development Program. Technology development interests include: short- and long-term impacts of bark beetles on forest health, bark beetle semiochemicals, stand hazard rating systems for bark beetles, fire-bark beetle interactions, single tree protection against bark beetle attack, and slash management strategies for reducing bark beetle impacts.

New Mexico Zone

Debra Allen-Reid (505) 842-3286

Supervisory entomologist, New Mexico Zone leader since 1996. Aside from zone staff supervision and unit management, duties include administrative oversight for the State of New Mexico Cooperative Forest Health program, and Region 3 point-of-contact for the FHP International Activities program. Previous work experience in defoliator aerial suppression, NEPA compliance, southern pine beetle management, and silviculture. Has worked in short-term assignments in Mexico and a long-term assignment with USAID in Haiti.

Andrew Graves (505) 842-3287

Forest entomologist, New Mexico Zone since October 2010. Primary responsibility is providing technical assistance on forest insects to federal land managers throughout the state. Additional responsibilities include managing the hazard tree program for New Mexico, and insect population monitoring. Interests include bark beetle/fungal interactions, the response of insects to drought stressed hosts, pheromones, and DNA analysis of bark beetle species.

Daniel Ryerson (505) 842-3285

Forest health and GIS specialist, New Mexico Zone since 2003. Responsibilities include GIS program for New Mexico, aerial detection surveys, data analysis, technical support, and field assistance. Involved with the national insect and disease risk map project to model future risk of forest mortality from insect and disease activity.

Crystal Tischler (505) 842-3284

Forest Health Coordinator & Forest Health unit aviation officer since September 2008. Responsibilities include aerial detection surveys, aviation safety and training coordination, and field assistance to staff. Involved with educational outreach and implementation. ICS-qualified as a Wildfire Incident GIS Specialist. Previous work experience in forest management, fuels reduction, timber sale administration and community wildfire protection planning.

Regional Staff

Allen White (505) 842-3280

Regional coordinator for invasive species and pesticide-use since 2006. Duties include coordination and management of Region 3 programs: (1) National Forest System Invasive Species, (2) State & Private Pesticide-Use, and (3) State & Private Invasive Plant Grants. Also serve as Region 3 representative for the Biological Control of Invasive Plants (BCIP) grant program managed by the Forest Health Technology Enterprise Team (FHTET). Current work in Region 3 includes production of field guides for managing invasive plants and development of methodology to control invasive buffelgrass in southern Arizona.

Visit Us Online

In an effort to better serve the Internet user, we continue to expand our online information base. The Forest Service Southwestern Region hosts a Forest Health web site at http://www.fs.usda.gov/goto/r3/foresthealth. Technical information posted on this site includes annual forest insect and disease conditions reports, literature on pest biology and management, and general information on forest health in the Southwest. Additionally, our Forest Health Protection national office maintains a web site at http://www.fs.fed.us/foresthealth/ that includes program overviews and publications links.

New forest health information web portal

http://foresthealth.fs.usda.gov/portal

The following information was copied from the Southern Region's website. "A new website is now available making insect and disease information more accessible and timely. This website brings together a wide range of complex tabular and spatial databases via 5 interfaces. The first 3 are accessible by anyone and provide access to insect and disease occurrence data in a consistent fashion with relative ease. The latter two are accessible only by forest health professionals for reporting and using data to enhance their work.

1. The **Forest Pest Conditions** page is built on the latest flex and ArcGIS 10 technology and is designed to be a companion to the annual Major Forest Insect and Disease Conditions reports. It provides:
    - A simple mapping interface through which the distribution of damaging forest insect and disease populations and their biological range can be viewed for the last five years.
    - An overview of biology, current conditions, trends, and survey methods, along with photos and web links for each forest insect and disease.
    - The ability to generate reports, maps, and download tabular information.
2. The **Data Summaries** interface provides the ability to review, query, and download tabular data for all forest insects and diseases recorded across the United States since 1997.
3. The **Insect and Disease Explorer** provides for download of a wide array of forest Insect and Disease Survey (IDS) maps depicting past, present, and potential future activity across the United States through the Insect and Disease Explorer. Other functionality includes:
    - Download IDS data in ArcGIS 9.2, 9.3, and 10 file geodatabase formats.
    - Create large format PDF maps with the quad map tool that can be printed on a plotter.
    - Query, navigate, and learn about local level forest pest activity.
4. Annual insect and disease detection and damage reports are entered in the **Pest Event Reporter** and made accessible via the Forest Pest Conditions interface.

5. The Forest Disturbance Mapper (FDM) is designed specifically for the FHP survey community to enhance their evaluation of potential forest disturbance in near real-time (16 day composites updated every 8 days) over large areas and provide critical information for survey resource allocation. The FDM web application allows the user to quickly explore and evaluate forest disturbance data and download areas for use in aerial or ground survey. Some of the main elements of the FDM are:

    - Simple interface with powerful spatial functions.
    - Download of data that can be uploaded into a digital aerial sketch mapping system.
    - Ability to upload survey data."

Appendix

Instructions for Submitting Insect and Disease Specimens for Identification

Both zone offices are equipped to receive forest insect or disease specimens submitted from the field for identification. Specimens may be shipped to the appropriate zone office as listed on the title page of this report. The following procedures for collecting and shipping specimens should be used.

Collecting

1. Adequate material should be collected

2. Adequate information should be recorded, including:
   a. location of collection
   b. when collected
   c. who collected the specimen
   d. host description (species, age, condition, etc.)
   e. area description (forest type, site conditions, etc.)
   f. unusual conditions (frost, poor drainage, etc.)

3. Personal opinion of the cause of the problem may be helpful.

Packing

1. **Larvae and other soft-bodied insects** should be shipped in small screw-top vials or bottles containing at least 70 percent isopropyl (rubbing) alcohol. Use only enough alcohol to fully immerse the specimens; shipping regulations limit the amount to 30 ml (2 tablespoons or about 1 ounce) per vial. Make sure lids are well sealed. Place all vials in a sealed plastic bag, using packing materials between vials to minimize movement. Ship in a sturdy box.

2. **Pupae and hard-bodied insects** may be shipped either in alcohol or in small boxes. Specimens should be placed between layers of tissue paper in the boxes. Pack carefully and make sure there is little movement of material within the box. Do not pack insects in cotton.

3. **Needle or foliage diseases**: Do not ship in plastic bags as condensation can become a problem. Use a paper bag or wrap in newspaper. Pack carefully and make sure there is little movement within the box.

Mushrooms and conks: Do not ship in plastic bags. Either pack and ship immediately or air-dry and pack. To pack, wrap specimens in newspaper and pack into a shipping box with more newspaper. If on wood, include some of the decayed wood.

A fillable pdf specimen label is available on our website that can be used to submit with samples for identification. (http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5207859.pdf). A screen shot of the label is shown on the next page.

R3-FS-3400-1 (2/2010)
For Federal Use Only

USDA - Forest Service

Forest Health Protection
Submission Label for Specimen Identification

Instructions: Fill out and send copy of worksheet, along with any maps, samples or specimens to the USDA Forest Service,

Forest Health Rm 228,
333 Broadway Blvd SE
Albuquerque, NM 87102
(If in New Mexico)

or

Forest Health - AZ Zone
2500 S. Pine Knoll Drive
Flagstaff, AZ 86001
(If in Arizona)

Check Enclosures:
- ☐ Appropriate Maps
- ☐ Damage Samples
- ☐ Insect Specimens

Action Requested:
- ☐ Information Only
- ☐ Identification
- ☐ Field Examination

Administrative Unit
Sub-Unit
Date of Observation
Observed by
Location of Damage (attach map)

GENERAL INFORMATION

Host
Average DBH
Size class affected: ☐ Poles ☐ Seedlings ☐ Sawtimber ☐ Saplings ☐ Overmature timber
Damaged standing stems/acre
Down stems/acre
Acres affected
GPS Coordinates:
Lat
Long
Damage to: ☐ Single trees ☐ Groups (# of) (# per)

TREE DAMAGE SYMPTOMS (Check all that apply)

Crown:	Damage to:	Tree Foliage:	Needles or leaves:	Tree Bole:	Branches:
☐ Top	☐ New Foliage	☐ Green	☐ Chewed	☐ Cracked	☐ Broken
☐ Middle	☐ Old Foliage	☐ Fading	☐ Mined	☐ Stuffed bark	☐ Swollen
☐ Lower	☐ Both	☐ Sorrel	☐ Webbed	☐ Boring dust	☐ Discolored
☐ Entire	☐ Cone or seed	☐ Red	☐ Spotted	☐ Pitch tubes	☐ Cankers
☐ Single branch or branch tips		☐ Brown	☐ Discolored	☐ Canker	☐ Mistletoe
		☐ Black	☐ Missing	☐ Conks	☐ Girdled
				☐ Woodpecker feeding	

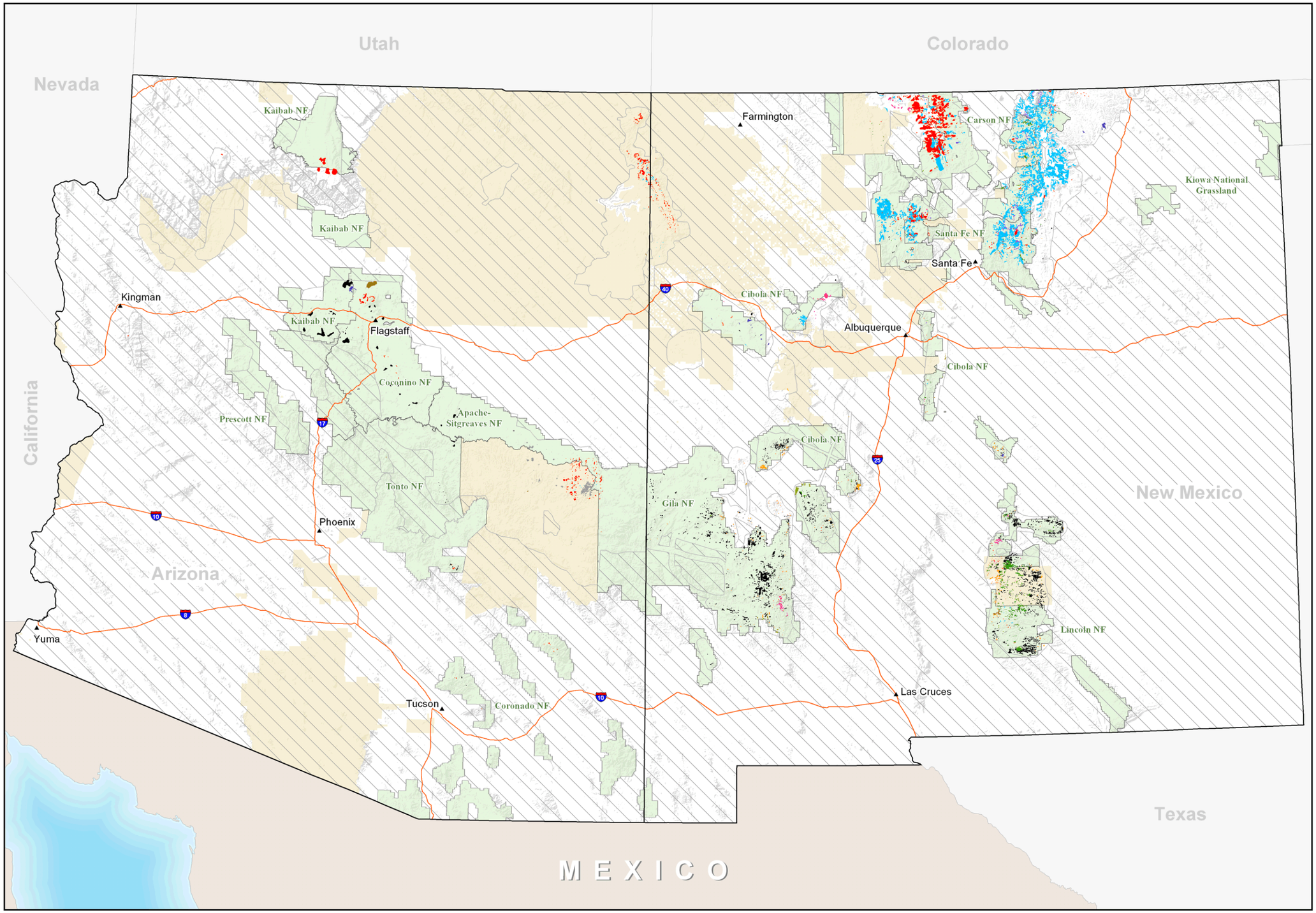
Unusual Weather Conditions:	Associated Disturbances:
☐ Wind	☐ Fire
☐ Rain	☐ Logging
☐ Hail	☐ Thinning
☐ Sleet	☐ Blowdown
☐ Snow	☐ Insects
☐ Flood	☐ Disease
☐ Drought	☐ Road construction

Remarks:

Forest Health Comments:

Received by
Date

Submit by Email | Print Form | Reset Form



National Forest
Tribal lands
Area not surveyed

Damage Type or Agent*

- Western spruce budworm
- Aspen damage
- Ponderosa pine bark beetles
- Mixed conifer bark beetles
- Frost damage
- Pinyon ips
- Spruce fir bark beetles
- Discoloration from drought
- Oak mortality
- Sawfly defoliation
- Juniper dieback

* *Only agents affecting greater than 5,000 acres Region-wide are depicted. Additionally, individual small areas (< 2 acres) not visible at this scale. Areas coded with multiple agents shown with first agent in data.*

N
W E
S

0 25 50 100
Miles

Aerial Detection Survey Data Disclaimer

Forest Health Protection (FHP), Arizona State Forestry Division, and New Mexico State Forestry strive to maintain an accurate Aerial Detection Survey (ADS) dataset, but due to the conditions under which the data are collected, FHP and its partners shall not be held responsible for missing or inaccurate data. ADS are not intended to replace more specific information. An accuracy assessment has not been done for this dataset; however, ground checks are completed in accordance with local and national guidelines:

http://www.fs.fed.us/foresthealth/aviation/qualityassurance.shtml

Maps and data may be updated without notice. Please cite "USDA Forest Service, Forest Health Protection, Arizona State Forestry Division, and New Mexico State Forestry" as the source of this data in maps and publications.

This map represents the mortality and defoliation that has occurred since the previous surveys in 2011. Depending upon the timing of survey, the entire extent of some insect and disease activity may not have been detected. In addition, most diseases cause gradual declines in tree health that are not typically detectable during aerial surveys. Intensity of damage is variable, thus not all trees within a mapped area are dead or defoliated. Caution should be used in interpreting these results due to the scale and subjective nature of aerial sketch mapping mapping.

Arizona

Surveys conducted July through September, 2012 by Steve Dudley and Amanda Grady, Forest Health Office, Southwestern Region, US Forest Service; Bobbe Fitzgibbon under contract to the US Forest Serivce; Aaron Green, Arizona State Land Department, Forestry Division.

New Mexico

Surveys conducted July through August, 2012 by Daniel Ryerson and Crystal Tischler, Forest Health Office, Southwestern Region, US Forest Service; Daniel Norlander, New Mexico State Forestry.

Significant Forest Damage Detected through Aerial Survey

Region 3 - Southwestern Region - 2012

Back cover photos: Brood galleries created by *Pityogenes* beetles on southwestern white pine (top left), broom on southwestern pine caused by *Elytroderma* fungus (middle), *Neodiprion* sawfly larvae migrating from severely defoliated ponderosa pine (bottom right), and black canker on aspen (bottom left).