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Forest Insect and Disease Conditions in the Southwestern Region, 2011

Cover photo: Ponderosa pine mortality on the Gila National Forest.

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Conditions in Brief

Weather Summary

Weather conditions played a significant role in forest health events in 2011. The winter of 2010-2011 was generally cooler and drier than normal as is typical of the La Niña weather pattern. In early February 2011, a strong and complex winter system resulted in several days of extremely adverse weather across northern and central New Mexico and Arizona, breaking record low temperatures in parts of each state and breaking a snowfall record in Flagstaff (NOAA, National Weather Service[1]).

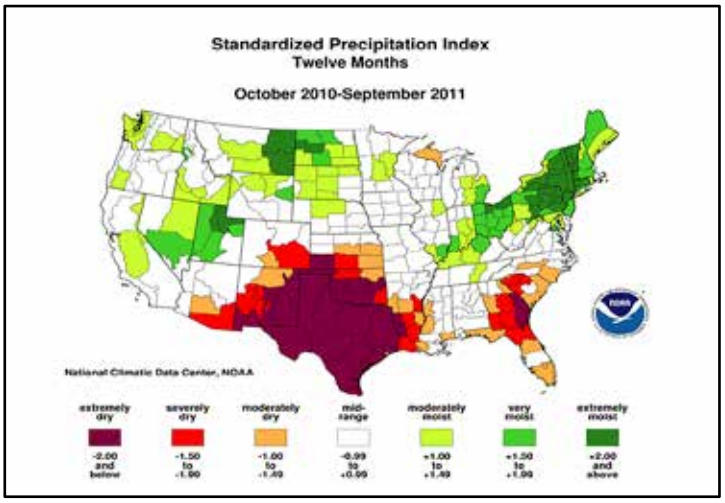

Figure 1. Standardized precipitation index for October 2010 through September 2011 (NOAA, National Climatic Data Center)[1].

Following this cold snap, heavy winds and warm temperatures made way for an exceptionally dry spring and summer across the southeastern portion of the region. The northern part of the region also experienced dry winds, but average annual temperatures were cooler than the rest of the region. Although precipitation was near normal in the northwest part of the region, the southeast portion was below normal. Early March snowpack levels were below normal for the southeast portion, and near normal for the northern mountain areas. (National Interagency Fire Center[2]).

Forest Insect and Disease Summary

The hot, dry spring and summer conditions in the southern and eastern portions of the region (see Figure 1) contributed to a record breaking fire season with large, severe events such as the Wallow, Horseshoe II, and Las Conchas fires. Insect- and disease-caused mortality also affected in these parts of the regions. Forest health aerial detection surveys were flown on 20 million forested acres of federal, state and private ownerships (Figure 2). Overall, the area with mortality rose from nearly 42,000 acres in 2010 to 178,000 acres in 2011, not including mortality due to wildfires which burned an estimated 1.3 million acres across the Southwestern Region.[3]

The majority of the forest health related mortality was mostly within the ponderosa pine and mixed conifer forest types across the southern portions of the region. The most notable affected areas are the Sacramento Mountains of the Lincoln National Forest and the Gila

[1] From NOAA, National Weather Service - http://www.srh.noaa.gov/abq/?n=climonhigh2011febsigevents
[2] From NIFC, http://gacc.nifc.gov/swcc/predictive/outlooks/seasonal/Fire_Season_Potential_and_Outlook.htm
[3] From Forest Service, http://activefiremaps.fs.fed.us/baer/download.php

National Forest in southern New Mexico where 133,750 acres were observed with some type of bark beetle-caused mortality.

Pinyon-Juniper forest types had an increase in pinyon ips activity from nearly 400 acres in 2010 to 3,300 acres in 2011 mostly in southern New Mexico. Cedar bark beetles, which were observed on only 70 acres in 2010, rose to nearly 3,000 acres in 2011, mostly in Arizona. Ponderosa pine forest types experienced the largest increase in bark beetle activity increased across the region; ponderosa pine bark beetle activity increased to more than 144,000 acres in 2011, up from 22,500 acres in 2010. Mortality in mixed conifer increased this year with Douglas-fir beetle impacted areas rising from 3,000 acres in 2010 to 5,000 acres in 2011 and fir engraver activity to 4,500 acres in 2011 up from 640 acres in 2010. Mortality in the spruce-fir forest type remained constant across the region with the exception of an increase in spruce beetle activity on the Carson National Forest, which is adjacent to a spruce beetle outbreak on the Rio Grande National Forest in Colorado. Western balsam bark beetle activity in corkbark fir continued a slow decline for the 5th year in a row after it peaked in 2007. A reason for the decrease in 2011 may be that an area on the Carson National Forest that typically has a considerable amount of western bark beetle activity was not surveyed this year.

Defoliating insects continued to be active in 2011, particularly in New Mexico. A western spruce budworm outbreak persists in the mountains of northern New Mexico. The area with defoliation by western spruce budworm escalated from 317,000 acres in 2010 to 503,000 acres in 2011. Defoliation from Douglas-fir tussock moth was not observed during aerial survey flights this year, but trap catches in New Mexico's Sandia Mountains did indicate a potential rise in the local populations there. Aspen damage increased by approximately 41,000 acres, mostly on the Carson National Forest and adjacent state and private lands. Ponderosa pine defoliation by sawflies increased in parts of northern New Mexico and Arizona, from 1,800 acres in 2010 to nearly 3,000 acres in 2011. The largest sawfly populations are in the Zuni Mountains of the Cibola National Forest. Pinyon needle scale was not mapped during aerial survey flights in 2011; the chronic nature of these infestations and their subsequent defoliation makes it extremely difficult to discern new damage from old damage.

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 had 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.

Table 1. Prominent 2011 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	2,170	200	5	30	2,405
	NM	110,170	22,070	850	8,370	141,460
True fir beetles	AZ	20	10	<5	--	40
	NM	14,870	3,010	--	1,110	18,980
Western spruce budworm	AZ	<5	3,470	40	--	3,510
	NM	342,350	26,930	70	130,930	500,270
Aspen damage	AZ	15,270	20,630	750	80	36,730
	NM	49,250	4,180	70	31,280	84,790
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 (primarily in New Mexico) and other biotic and abiotic factors causing aspen decline resulting in mortality. See text for additional information.

-- No acreage detected.

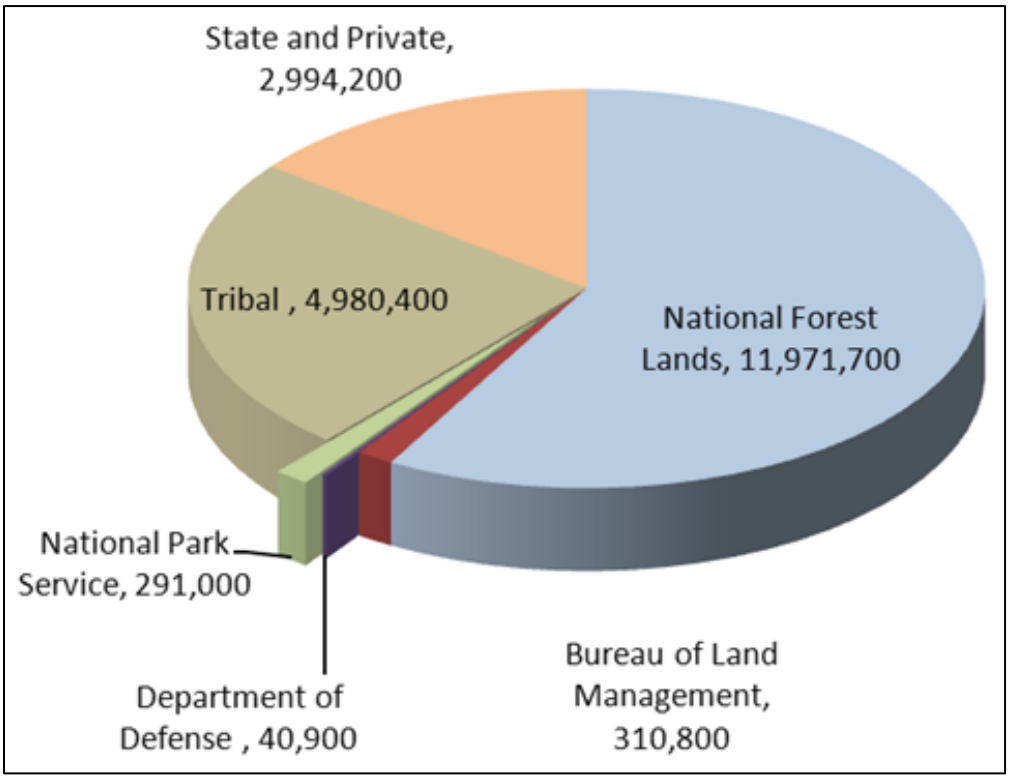

Figure 2. Aerial survey acres flown by land ownership. (20,588,900 total acres flown.

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

Owner[3]	Western pine beetle	Ips engraver	Pinyon ips	Douglas-fir beetle	Spruce beetle	Western balsam bark beetle	Fir engraver	Cedar Bark Beetles	Mortality total[2]
Apache-Sitgreaves NF	70	1,490	< 5	10			10	240	1,910
Coconino NF	50	200		20	< 5	10	< 5		600
Coronado NF	< 5	< 5	< 5	10			10	40	80
Kaibab NF	10	190		20					750
Prescott NF	10	70	< 5	10					140
Tonto NF	< 5	80		10		< 5			90
Grand Canyon NP	< 5	< 5		10					10
Canyon De Chelly NP			< 5						< 5
Saguaro NM		< 5	< 5						
Lake Mead NRA			< 5						
BLM	10	< 5	< 5						
Fort Apache Tribal	60	50	< 5	10		< 5	10	2,140	340
Hualapai Tribal	10	< 5	< 5						1,970
Navajo Tribal									10
San Carlos Tribal	20	40	< 5	< 5		< 5		120	480
Hopi Tribal			< 5						180
Indian Allotments	20	10	< 5	< 5				450	< 5
State & Private	10	20	< 5	< 5				70	
Fort Huachuca		< 5					< 5		1,070
Arizona Total	**280**	**2,160**	**20**	**90**	**< 5**	**10**	**30**	**3,060**	**6,640**
Carson National Forest	70	< 5	< 5	2,830	870	3,650	50		8,840
Cibola National Forest	2,060	10	20	40		< 5	140		2,470
Gila National Forest	47,370	25,190	1,580	< 5	< 5		< 5		58,990
Lincoln National Forest		35,430	690	30			1,050		51,250
Santa Fe National Forest	150	330	< 5	860	20	9,980	< 5		11,850
Valles Caldera NP				20					40
BLM	600	250	140						1,050
El Malpais NM	< 5								< 5
Acoma Pueblo	< 5	< 5							< 5
Isleta Pueblo	< 5								< 5
Jemez Pueblo									
Jicarilla Apache Tribal	< 5	< 5	< 5	90		20	< 5		140
Mescalero Apache Tribal		22,060	470	< 5			2,870		23,510
Navajo (NM side only)[4]	< 5	< 5		< 5				< 5	10
Picuris Pueblo	< 5			< 5					< 5
Ramah Tribal	< 5	< 5	< 5						< 5
Taos Pueblo	< 5			880	< 5	110	< 5		1,040
Zuni Pueblo	< 5		< 5						< 5
State & Private	1,110	7,260	370	250	< 5	720	390		11,360
New Mexico Total	**51,320**	**90,530**	**3,270**	**5,000**	**890**	**14,480**	**4,510**	**< 5**	**170,550**
SW REGION TOTAL	**51,600**	**92,690**	**3,290**	**5,090**	**890**	**14,490**	**4,540**	**2,940**	**177,190**

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

[2] Areas may be mapped with more than one damage agent. The totals represent the "footprint" or affected area on the ground with no multiple counting of acres. Totals include agents not shown in the table; see text for more information.

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

[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[3]	Western Spruce Budworm	Aspen Damage[5]	Sawfly - Ponderosa	Defoliation total[2]
Apache-Sitgreaves NF		6,460		6,900
Coconino NF		1,990	< 5	1,990
Coronado NF	< 5	1,350		1,520
Kaibab NF		5,470	260	5,730
Prescott NF				
Tonto NF				
Grand Canyon NP		630		630
Canyon De Chelly NP	40			150
Saguaro NM		< 5		< 5
Lake Mead NRA				
BLM				
Fort Apache Tribal	1,740	12,730		16,900
Hualapai Tribal				
Navajo Tribal				
San Carlos Tribal				
Hopi Tribal				
Indian Allotments	1,720	7,900		10,000
State & Private		80	30	100
Fort Huachuca		120		120
Arizona Total	**3,500**	**36,730**	**290**	**44,030**
Carson National Forest	169,810	41,150		175,660
Cibola National Forest	3,910	170	2,540	6,690
Gila National Forest	160	4,270		5,280
Lincoln National Forest	12,280	1,230		14,610
Santa Fe National Forest	138,250	770		139,430
Valles Caldera NP	17,940	10		17,950
Bureau of Land Management	70	< 5		70
El Malpais National Monument				
Acoma Pueblo				
Isleta Pueblo				
Jemez Pueblo	10			20
Jicarilla Apache Tribal	7,020	2,430		7,360
Mescalero Apache Tribal	3,390	610		4,000
Navajo (NM side only)[4]	730	1,010		1,640
Picuris Pueblo				
Ramah Tribal				
Taos Pueblo	15,770	60		15,830
Zuni Pueblo				
State & Private	130,930	30,190		138,850
New Mexico Total	**500,270**	**84,790**	**2,540**	**527,400**
SW REGION TOTAL	**503,770**	**121,520**	**2,830**	**571,430**

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

[2] Areas may be mapped with more than one damage agent. The totals represent the "footprint" or affected area on the ground with no multiple counting of acres. Totals include agents not shown in the table; see text for more information.

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

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

[5] Aspen damage includes a combination of insect defoliation (primarily in New Mexico) and other biotic and abiotic factors causing aspen decline resulting in mortality. See text for additional information.

Status of Major Insects

Bark Beetles

Overall bark beetle-caused tree mortality in New Mexico increased significantly in 2011. Increases were observed in most forest types. Activity was primarily in the ponderosa pine forest type on the Gila and Lincoln National Forests and Mescalero Apache Tribal lands in the southern half of the state. Tree mortality from Douglas-fir beetle, fir engraver, pinyon ips, and spruce beetles all increased this year. The observed amount of new corkbark fir mortality decreased slightly in 2011.

In contrast, bark beetle activity was low across Arizona. Marginal activity by *Ips* species in ponderosa and pinyon pines, and cedar bark beetles in the pinyon-juniper forest type was observed. The following bark beetles are grouped 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 a slight increase in pinyon ips and cedar bark beetles mortality. Pinyon ips activity went from 390 acres across the region in 2010 to 3,290 acres in 2011, mostly in New Mexico. Cedar bark beetle activity bumped up to 2,940 acres in 2011, almost exclusively in Arizona, up from 70 acres region wide in 2010. Often cedar bark beetles work in concert with a variety of wood boring beetles to cause mortality during drought events. In Arizona, woodlands in the northeast and central eastern portions of the state were impacted by drought and may have incited the increase in cedar bark beetle caused tree mortality.

Pinyon Ips

Ips confusus
Primary host: Pinyon pine

Low levels of pinyon ips caused mortality were observed in pinyon-juniper woodlands on the Prescott National Forest, Mohave and Coconino counties, and Navajo, White Mountain and San Carlos Tribal lands.

In New Mexico, a substantial increase in area affected by pinyon ips was observed during 2011 aerial detection surveys. Most of the affected area was in the southern half of the state which was especially dry during the 2010-2011 winter season.

Cedar Bark Beetle

Phloeosinus spp.
Primary host: juniper

Small groups of juniper mortality were observed during aerial survey, the mortality was caused by the cedar bark beetle in several drought affected areas of Arizona; Navajo, Hopi, San Carlos and White Mountain Apache Tribal Lands and the Apache-Sitgreaves and Coronado National Forests. In addition to juniper species being impacted, *Phloeosinus*-

caused mortality of Arizona cypress was noted during ground surveys in the Santa Rita Mountains of the Coronado National Forest.

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 7,000 feet to 9,000 feet in elevation. Bark beetles in ponderosa pine increased substantially in New Mexico, while remaining relatively stable in Arizona. Ponderosa pine mortality continues to rise with 144,300 acres mapped in 2011, up from 22,500 acres in 2010, primarily due to the lack of moisture in the spring of 2011. Pine bark beetle activity remains relatively low following the peak in activity (763,000 acres) in 2003. (Figure 3)

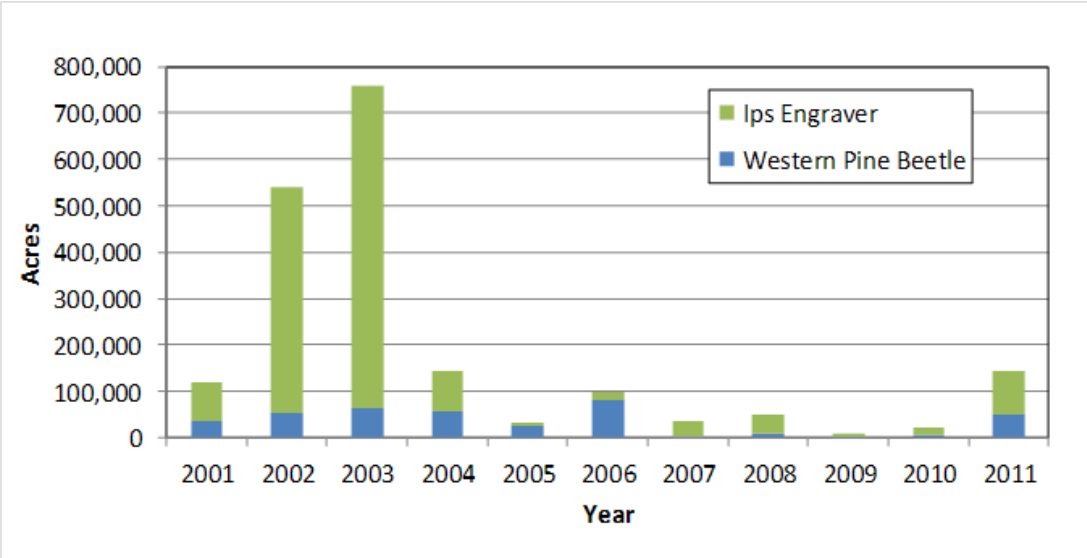

Figure 3. Western pine beetle and *Ips* engraver activity in Arizona and New Mexico, 2001-2011

Western Pine Beetle

Dendroctonus brevicomis
Primary host: Ponderosa pine

Ponderosa pine mortality caused by the western pine beetle was extremely low across Arizona in 2011. Mostly individual trees and small pockets of mortality were mapped during the 2011 aerial detection surveys. Most of the western pine beetle activity occurred in drought affected areas. Activity was observed in ponderosa pine forests across the Apache-Sitgreaves National Forests (Figure 4), White Mountain Apache, San Carlos and Navajo Nation tribal lands. On the Kaibab National Forest, activity was restricted predominantly to the Tusayan Ranger District. On the Prescott National Forest, activity was mapped in the northwestern part of the Chino Valley Ranger District and on the northeast part of Hualapai tribal lands.

In New Mexico, a significant increase in ponderosa pine mortality was observed in the southern part of the state in 2011. Extensive mortality was observed on Sacramento Mountains, both on the Lincoln National Forest and Mescalero Apache Indian Reservation, and on the Gila National Forest. The mortality in these areas is the result of the dry

conditions and subsequent insect activity. Western pine beetles are one part of a complex that is contributing to the ponderosa pine mortality. Identification by trap catches and hand collections of insects were made and identified as western pine beetle.

Figure 4. Ponderosa pine mortality caused by Ips and western pine beetle near Alpine, AZ

Ips Engraver Beetles

I. pini, I. cribicollis, I. knausi, I. lecontei, and I. calligraphus
Primary hosts: Ponderosa pine

Ips species activity in the region increased, though most activity was in New Mexico. Ponderosa pine mortality from *Ips* species and other agents was observed throughout southern New Mexico. Increased *Ips* species activity was noted in the Sacramento Mountains of the Lincoln National Forest and the Gila National Forest, particularly on southern facing slopes and areas of poor site quality. Three *Ips* species were collected from infested trees (*I. pini, I. cribicollis,* and *I. knausi*). These are part of a larger *Ips* species complex that is likely active in the area.

In Arizona, *Ips* species activity occurred in ponderosa pine forests throughout the state, especially in low elevation forests affected by drought or along forest perimeters and recently burned areas. Much of the damage was mapped on the Apache-Sitgreaves National Forests in recently burned areas. *Ips* species are also building populations in tornado damaged (down pine material) forests west and south of Flagstaff.

Mountain Pine Beetle

Dendroctonus ponderosae
Primary hosts: Ponderosa, limber, southwestern white, and bristlecone pine

In contrast to Colorado and other Rocky Mountain states, the Southwest has little mountain pine beetle activity. Occasionally, individual ponderosa pine trees have been observed with mountain pine beetle attacks or galleries in prior years, but no major recent outbreaks have occurred. Bark beetle activity in New Mexico ponderosa pine forests tends to be a combination of *Ips* species, western, and roundheaded pine beetles.

In Arizona, minor amounts of mountain pine beetle-caused tree mortality in southwestern white pine has occurred for the past few years in and adjacent to recreation sites in the Pinaleño Mountains on the Coronado National Forest. Individual tree mortality and killed groups of up to five trees were observed.

Roundheaded Pine Beetle

Dendroctonus adjunctus
Primary host: Ponderosa pine

Individual trees to small pockets of ponderosa pine mortality were found in New Mexico. It is not clear to what degree these beetles have influenced the overall mortality in the Sacramento Mountains, but they are present and 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. Endemic levels of mortality were mapped during aerial surveys and observed during site visits on the Pinaleño and Santa Catalina Mountains, Coronado National Forest.

Mixed Conifer Forest Type

Mixed conifer forests are generally found from 8,000 to 10,000 feet and composed of Douglas-fir, white fir and southwestern white pine along with pockets of aspen stands, and at lower elevations there is a ponderosa pine component. Bark beetles were also active in this forest type, overall activity increased and mortality was heaviest in the southern forests of New Mexico (Figure 5).

Region-wide, Douglas-fir beetle activity increased from 3,000 acres in 2010 to 5,000 acres in 2011. The area mapped with activity in Arizona during aerial surveys decreased substantially, while New Mexico had a substantial increase in the amount of activity. Fir engraver mortality was primarily drought driven with an increase from 640 acres mapped in 2010 to 4,500 acres in 2011.

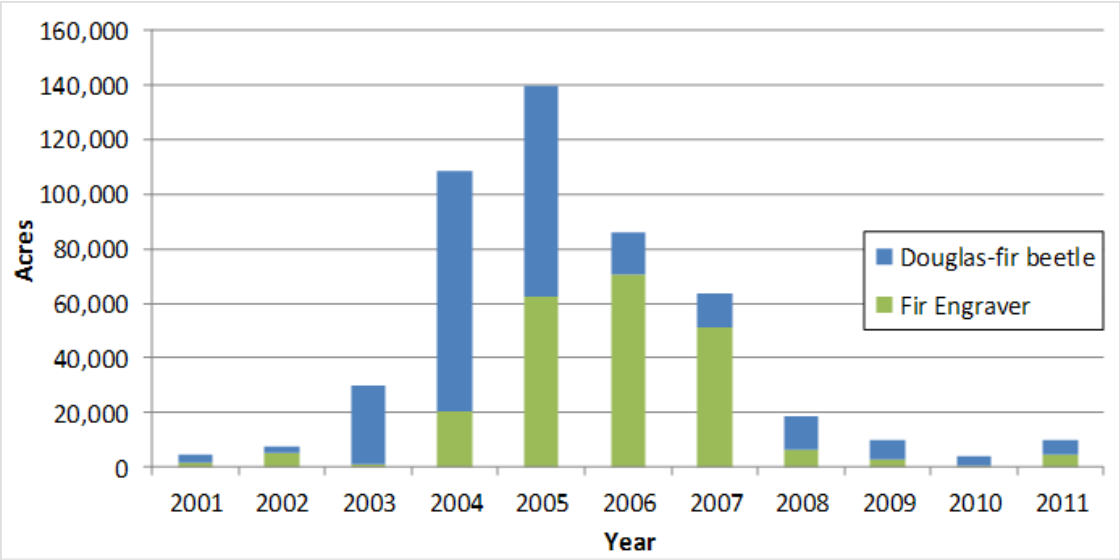

Figure 5. Mortality in mixed conifer in Arizona and New Mexico, 2001-2011

Douglas-fir Beetle

Dendroctonus pseudotsugae
Host: Douglas-fir

Figure 6. Douglas-fir beetle mortality in the Lincoln National Forest

Much of the Douglas-fir beetle-caused mortality mapped in New Mexico was in the northern part of the state on the Carson and Santa Fe National Forests. Additional mortality was also observed throughout the Sacramento Mountains of the Lincoln National Forest. Beetles were found in mature Douglas-fir trees on the Mescalero Apache Tribal lands. This is one of only a few collections recorded from this area. Along the Jemez River drainage (Cañon de San Diego) on the Santa Fe National Forest, new mortality appeared along edges of previous year's mortality pockets. In the Carson National Forest, small pockets of fading Douglas-fir trees were noted during ground surveys.

Limited Douglas-fir beetle-caused tree mortality was observed this year across Arizona. Areas with mortality include: the "sky islands" of southeastern Arizona; on the Prescott National Forest (Bradshaw and Verde Ranger Districts); on the Apache-Sitgreaves National

Forests (southwest edge of Clifton Ranger District); on White Mountain Apache, San Carlos and Navajo Nation tribal lands. Light activity also occurred on the North Kaibab Ranger District and north of Flagstaff on the Coconino National Forest. Douglas-fir beetle populations are predicted to increase in fire-injured Douglas-fir within the Wallow Fire burned area during 2012 and beyond.

Fir Engraver

Scolytus ventralis
Host: White Fir

Limited fir engraver-caused mortality of white fir was observed in Arizona including: southeast of Flagstaff on the Coconino National Forest; portions of the Coronado and Apache-Sitgreaves National Forests; and White Mountain Apache and San Carlos Tribal lands.

In New Mexico, fir engraver activity was observed during aerial surveys and numbers increased substantially from 2010. Activity was observed throughout the state, but typically only in scattered areas. The majority of the activity observed in 2011 was on the Lincoln National Forest and Mescalero Apache Tribal lands in or adjacent to areas also affected by ponderosa pine bark beetle-caused mortality.

Spruce Fir Forest Type

At about 9,000 feet elevation, mixed conifer forests transition to the spruce-fir forests. Engelmann spruce and corkbark fir are the primary trees species, but limber and bristlecone pines are also found with a smaller occurrence of aspen. Region wide, western balsam bark beetle activity was mapped on over 14,500 acres during 2011 a slight drecrease from 15,200 acres mapped in 2010. Spruce beetle was mapped across 890 acres in 2011, an increase from 180 acres on 2010 (figure 7).

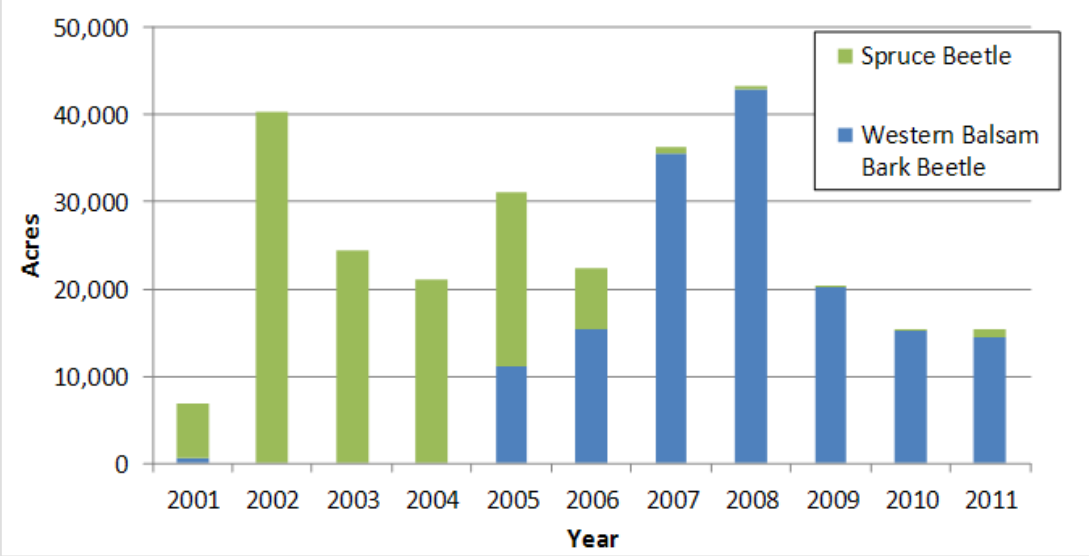

Figure 7. Spruce-fir mortality in Arizona and New Mexico, 2001-2011

Spruce Beetle

Dendroctonus rufipennis
Host: Spruce

The spruce beetle activity observed during aerial surveys was on the Carson and Santa Fe National Forests. A large outbreak of spruce beetle is occurring in the Rio Grande National Forest in Colorado, which is just north the Carson National Forest. Ground surveys found little evidence of a spruce beetle activity along the New Mexico side of the state border.

Western Balsam Bark Beetle

Dryocoetes confusus
Hosts: Subalpine/corkbark fir

Minimal western balsam bark beetle caused mortality occurred in Arizona in 2011. The activity that was observed included individual fading trees, and one group kill on the San Francisco Peaks north of Flagstaff. Other areas where beetle activity was noted included the Mogollon Rim east of Promontory Butte (Tonto National Forest) and on San Carlos Tribal lands.

In New Mexico, the activity was observed on the Carson and Santa Fe National Forests in the northern half of the state. The large majority of the activity was in the Pecos River drainage of the Pecos-Las Vegas Ranger District on the Santa Fe National Forest. The Carson National Forest had a decrease in activity, but part of decrease was due to the extent of our survey. Unfortunately, unfavorable weather conditions, budgetary constraints and aircraft scheduling conflicts, the southern end of the Camino Real Ranger District (approximately 51,000) was not surveyed. This is also the area where the majority of corkbark fir mortality occurring on the Carson National Forest was mapped last year. However, based on observations, it is believed that the amount of individual tree mortality has decreased with the exception of the Pecos River drainage.

Blue Spruce Engraver

Ips hunteri
Primary host: Blue spruce

Blue spruce engraver activity in conjunction with with root disease and dwarf mistletoe caused mortality of spruce in campgrounds on the Apache-Sitgreaves National Forests (figure 8).

Figure 8. Spruce mortality in Winn Campground, Apache-Sitgreaves NFs. Tree attacked by the spruce engraver was heavily infested with dwarf mistletoe and in some cases root disease.

Defoliators

Western Spruce Budworm

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

Western spruce budworm activity in the Southwestern Region increased substantially from approximately 318,000 acres mapped in 2010 to a little over 500,000 acres mapped in 2011 (figure 9). Western spruce budworm activity occurred primarily in New Mexico with only limited amounts in Arizona. Activity in New Mexico was widespread throughout the northern part of the state and has been a chronic situation in this area. Defoliation from the outbreak in the Sacramento Mountains in southern New Mexico continued in 2011, affecting portions of the Sacramento Ranger District of the Lincoln National Forest and the Mescalero Apache Tribal lands.

The area affected by defoliation in Arizona also increased relative to the levels observed in the 2010 and 2009 aerial surveys. Most defoliation occurred on tribal lands, particularly on the Chuska Mountains of the Navajo Nation where it has been chronic for decades and on Mount Baldy on White Mountain Apache Tribal lands. Light levels of defoliation were also detected on the Apache-Sitgreaves National Forests. Chronic budworm defoliation persists on the North Kaibab Ranger District of the Kaibab National Forest in the Dry Park area.

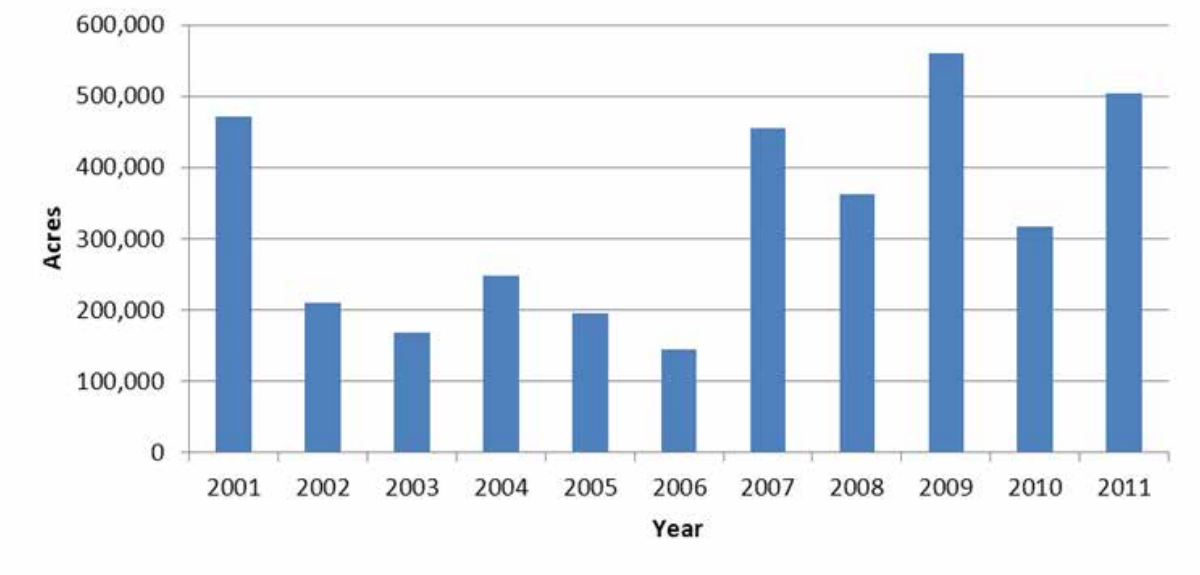

Figure 9. Western spruce budworm activity in Arizona and New Mexico, 2001-2011

Douglas-fir Tussock Moth

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

No visible defoliation from Douglas-fir tussock moth was mapped during aerial detection surveys in the Southwestern Region in 2011. The 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. In Arizona, most early warning traps had zero moths trapped this year; however, moths were trapped in low numbers on the Coronado National Forest. In New Mexico, traps were set in the Sacramento Mountains of the Lincoln National Forest, low numbers were observed. Trapping results in the Sandia Mountains continued to show an increase in the number of male moths caught. Trap catches were high enough at two locations that an egg mass and larval density sampling was warranted. Sampling was conducted in October of 2011 and April of 2012 at the Dry Camp and Tree Spring areas of the Sandia Mountains (Cibola National Forest). Both surveys revealed that populations are still at light defoliation levels. The Douglas-fir tussock moth early warning trapping results for the Southwestern Region are reported below (table 4). Traps were not placed on the Santa Clara Pueblo in 2011 due to the Las Conchas fire activity.

Table 4. 2011 Early warning trapping results for Douglas-fir tussock moth in the Southwestern Region.

Plot	Location	National Forest	Ave # of Male Moths	Comments
Baker Butte	Mogollon Rim	Coconino	[1]	
Greer	White Mountains	Apache-Sitgreaves	[1]	Wallow Fire
Alpine	White Mountains	Apache-Sitgreaves	[1]	Wallow Fire
Washington Park	Mogollon Rim	Tonto	0.2	
Icehouse	Pinal Mountain	Tonto	0	
Lower Pinal	Pinal Mountain	Tonto	0	
Reynolds Creek	Sierra Ancha Mountains	Tonto	0	
Spruce Mountain	Bradshaw Mountains	Prescott	0	
Mount Union	Bradshaw Mountains	Prescott	0	
Sunrise	White Mountains	White Mt. Apache (BIA)	0	
Marshall Gulch	Catalina Mountains	Coronado	7.25	
West Peak	Pinaleno Mountains	Coronado	9.2	
Bailey Canyon	Sacramento Mountains	Lincoln	0	
Apache CG	Sacramento Mountains	Lincoln	0	
James Ridge Lookout	Sacramento Mountains	Lincoln	0	
FS Road 5661	Sacramento Mountains	Lincoln	0	
Bluff Springs	Sacramento Mountains	Lincoln	0	
Upper Karr Canyon	Sacramento Mountains	Lincoln	0	
Cathey Vista	Sacramento Mountains	Lincoln	0	
Wills Canyon	Sacramento Mountains	Lincoln	1.2	
Apache Observatory	Sacramento Mountains	Lincoln	0	
Sunspot Road	Sacramento Mountains	Lincoln	0	
Dale Resler	Sacramento Mountains	Lincoln	0	
Tree Springs	Sandia Mountains	Cibola	24.8[2]	
Dry Camp	Sandia Mountains	Cibola	30.2[2]	
Capulin Snow Play Area	Sandia Mountains	Cibola	6.6	
Nine Mile Picnic Area	Sandia Mountains	Cibola	0.8	
Las Huertas Rd #1	Sandia Mountains	Cibola	12.4	
Las Huertas Rd #2	Sandia Mountains	Cibola	11.4	
Las Huertas Rd #3	Sandia Mountains	Cibola	18.6	

[1] Not monitored in 2011

[2] Ground sampling for larvae or egg masses in the general area of the plot on October 27-31, 2011, and April 20, 2012, no significant number of egg masses or larvae were detected.

Spruce Aphid

Elatobium abietinum
Host: Spruce

Defoliation from spruce aphid was mapped on nearly 3,000 acres in Arizona this year. Approximately 75 percent 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. Spruce aphid caused-defoliation was also mapped over 163 acres on Mount Graham in the Pinaleño Mountains.

Pine Sawflies

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

Pine sawfly defoliation increased region-wide from nearly 2,000 acres in 2010 to just less than 3,000 acres detected during the 2011 aerial detection surveys. Much of this defoliation has occurred on ponderosa pine in the Zuni Mountains of the Cibola National Forest.

In Arizona, a sawfly outbreak on the boundary of the Coconino and Kaibab National Forests near Kendrick Mountain continued to decline from about 1,200 acres mapped in 2010 to about 350 acres in 2011. In some areas the consecutive years of high defoliation has resulted in low levels of ponderosa pine mortality. Peak defoliation appears to have occurred during 2009.

The sawfly that defoliated almost 300 acres of pinyon in the City of Albuquerque's Golden Open Space area east of the Sandia Mountains has been identified as *Zadiprion rohweri*. While rearing larvae for the identification, numerous dipteran parasitoids were collected. The level of parasitism is likely contributed to the reduced number of individuals and defoliation observed in the area during 2011.

Figure 10. Pine sawfly larvae feeding on ponderosa pine

Pinyon Needle Scale

Matsucoccus acalyptus
Host: Pinyon pine

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. Pinyon needle scale was not detected in the Southwestern Region during the 2011, years of continued defoliation coupled with poor tree recovery makes it difficult discern new damage from old during aerial surveys, nearly 69,000 acres were mapped in 2010.

Pandora moth

Coloradia Pandora
Host: Ponderosa pine

Pandora moth-caused defoliation was not recorded during the past 2 years of aerial surveys, however, an increase in moth presence has been observed in the Jacob Lake area on the North Kaibab Ranger District of the Kaibab National Forest since 2008. In Arizona, Pandora moth larvae can be observed defoliating ponderosa pine in odd years with peaks of adult moths observed in even years. In 2010, light and pheromone traps were placed near Jacob Lake on the North Kaibab Ranger District. Trap catches peaked at >1,000 adult moths per night suggesting increased populations in 2011, however, only scattered, light levels of defoliation were observed, suggesting that the populations are still in the build-up phase of the outbreak.

Tiger Moth

Lophocampa ingens
Host: Pines, Douglas-fir

Figure 11. Tiger moth larvae

Although scattered reports and collections of tiger moth were made in the Southwestern Region in 2011, no widespread defoliation was mapped from the air or otherwise noticed, but the population and activity of these moths seemed to have been greater in 2011. Larvae were found on the Sandia Ranger District, Cibola National Forest (figure 11). Tiger moth tents were observed on ponderosa pine near Forest Lakes on the Apache-Sitgreaves National Forests and on pinyon near Eager, Arizona.

Aspen Defoliation and Decline

Drought related damage
Western tent caterpillar, *Malacosoma californicum*

Large aspen tortix, *Choristoneura conflictana*
Other insects and diseases

In Arizona, Marssonina blight and western tent caterpillar are contributing to aspen defoliation in the Pinaleño Mountains. The western tent caterpillar has been defoliating aspen and willows in the Santa Catalina Mountains northwest of Tucson over the past few years.

Aspen defoliation was observed throughout New Mexico in 2011. The area with aspen defoliation mapped from aerial detection surveys doubled in 2011 from 2010. The Tres Piedras and Canjilon Ranger Districts of the Carson National Forest had the largest amount of aspen defoliation. Western tent caterpillar has been the primary defoliator in this area, but large aspen tortix activity was also found in 2011.

The sudden crown dieback and mortality of aspen that began during the intense drought in 2002 is slowing. Unlike conifer trees that died quickly when attacked by bark beetles, aspen died more slowly and there was a complex of secondary insects and diseases that contributed to the mortality.

In New Mexico, the amount of new aspen decline or areas with significant additional mortality mapped during aerial surveys decreased in 2011. Most of the area with aspen decline mapped in 2011 was on the Carson National Forest.

Status of Major Disease

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 infected areas have much higher mortality rates than uninfected 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, 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 our 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: Spruces, True firs, Douglas-fir, Ponderosa pine, Aspen

Figure 12. Armillaria fruiting bodies

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* is the major armillaria species in southwestern coniferous forests, but *A. mellea* has been found in oaks, especially live oaks. One hundred and forty armillaria root disease samples were collected in various coniferous forests throughout Arizona in 2010 and 2011, in collaboration with Northern Arizona University. Rocky Mountain Research Station, Moscow, Idaho lab identified the species of armillaria using DNA sequencing. All but one of the samples were Armillaria solidipes (syn. A. ostoyae), a species known to act as both pathogen and saprophyte; the other was A. gallica, a saprophyte that only decays dead wood. 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 annosum and *H. parviporum*
Hosts: Most conifers

Figure 13. Annosus root disease

Annosus root disease is the second most common root disease in the Southwest. Based on recent genetic work, two species are now recognized in the western U.S.: *H. irregulare*, which infects ponderosa pine, and *H. occidentale* (formerly known as the "S type" of *H. irregulare*), which mostly infects true firs and spruces. In the Southwest, *H. occidentale* appears to be much more common than *H. irregulare*, with annosus root disease often observed on true firs. 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 *Inonotus dryophilus* on oak.

Stem Rusts

White Pine Blister Rust

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

No new white pine blister rust infestations were discovered in 2011. Blister rust continues to cause heavy damage to white pines in the Sacramento Mountains of southern New Mexico where it has been established for about 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. Many thousands of acres of mesic mixed conifer forest have severe blister rust infection, while more xeric sites generally have low to moderate infection. Topkill is very common in the severely infested areas.

In Arizona, white pine blister rust was first detected in 2009 in the eastern White Mountains on both the Apache-Sitgreaves National Forests and White Mountain Apache Reservation. The oldest cankers found dated around 1990. More recent waves of infection have greatly expanded the distribution and severity of this outbreak. The 2011 Wallow Fire that burned through nearly one-half million acres included 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.

Broom Rust

Melampsorella caryophyllacearum
Hosts: True firs and Chickweeds

Chrysomyxa arctostaphyli
Hosts: Spruces and kinnikinnick

Broom rusts are found at low levels throughout most of their host's 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 topkill, 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. More recently, the damage is appearing along county and city roadways as municipalities are increasing the use of de-icing salts. Additional damage from dust abatement salts was also observed in 2011, mostly in eastern 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, we observed that bark beetles (both *Ips* and *Dendroctonus* species) continued 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. Although most broken tops and windthrown trees in fully sunlit areas (i.e., middle of severely impacted tornado swaths) had already been either infested or dried out enough to make them poor host material for additional brood production by early fall, there were still windthrown trees in primarily shaded areas that had not been fully colonized and will remain suitable for brood production in early 2012.

The Humphrey's Trail on the San Francisco Peaks, Coconino National Forest was impacted by a small wind event resembling a microburst in mid-September 2011 that caused blow down and tree damage in the mixed conifer/spruce-fir type. Ground surveys did not find any bark beetle activity in the down material at that time as the disturbance event occurred after bark beetle flight should have been completed for the year.

Winter Injury

The extreme cold along with drying winds that occurred during the winter of 2010-2011 caused dieback and mortality of many junipers in the state. The damage was observed on both alligator juniper and one-seed junipers. Damage typically was limited by topography and most severe in valleys, ravines, or drainages where cold air settles. Damage has been observed throughout the state, but was especially visible during aerial surveys on the Gila and Lincoln National Forests. Nearly 23,600 acres with juniper dieback were mapped, which undoubtedly is only a portion of the affected area, as many juniper woodlands are not extensively surveyed. Some trees died while others had varying levels of branch dieback. Over the summer months, recovery was evident as some of the affected alligator juniper had epicormic and basal sprouting.

Drought

During aerial surveys over the Black Range of the Gila National Forest, many oak stands appeared to be discolored, most likely due to the extremely dry conditions.

Figure 14. Oak discoloration on the Black Range of the Gila National Forest

Discoloration commonly associated with drought was mapped on more acres in Arizona (~78,000 acres) than all of the combined acres affected by biotic and other abiotic agents, except fire during the 2011 aerial detection survey season. Drought impacted areas were generally restricted to eastern Arizona's Tribal lands; the Navajo Nation, San Carlos and White Mountain Apache Tribal lands were affected the most. All forest types were impacted except for high elevation mixed conifer stands. Riparian areas showed the most serious drought conditions. Acres impacted by drought have dramatically increased over the past 2 years. Although drought affected acres are on the rise in Arizona, only minimal bark beetle caused tree mortality was mapped in 2011. There is generally a lag time response from bark beetles to drought conditions and bark beetle-caused tree mortality does not increase until several consecutive years of drought deplete host resistance capabilities. If winter precipitation conditions continue to be low, bark beetle caused tree mortality may increase in 2012.

Other Forest Insects and Diseases

Elytroderma needle blight (*Elytroderma deformans*) 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. In 2011, about 100 acres of ponderosa pine located just south of Grand Canyon National Park, on the Tusayan Ranger District, was observed with significant elytroderma disease impacts. There were multiple elytroderma-caused witches' brooms in each infested tree.

Goldspotted oak borer (*Agrilus auroguttauts*) In 2008 oak mortality in San Diego County of the Pacific Southwest Region was linked to the goldspotted oak borer which had been affecting oaks in the area since 2002. Goldspotted oak borer is native to southern Arizona. Genetic research determined the southeastern Arizona population was the probable source for the newly established southern California population. Since then Pacific Southwest Region entomologists have been collaborating with Southwestern Region entomologists to survey the effects of goldspotted oak borer in its native range. They found that where the borer is known to occur in Arizona, larger diameter red oak species are its preferred hosts, whereas, there is no evidence of goldspotted oak borer attack or infestation on white oak species. The mean overall rates of infestation were approximately 4 percent infested and 2 percent were killed by goldspotted oak borer among large diameter live red oaks (>12.5 cm diameter at breast height) in Arizona. The infestation rate observed at one site was nearly 39 percent. Low levels of bark staining and emergence hole density were observed; and goldspotted oak borer successfully colonized individuals of *Quercus emoryi* that were as small as 14.9 cm d.b.h. and *Quercus hypoleucoides* that were 20.8 cm d.b.h. in the Arizona sites. Thus, in Arizona, goldspotted oak borer is not always playing a role in oak mortality. It is likely a secondary contributor coupled with several long- and short-term and inciting factors[4].

Fall webworm (*Hyphantria cunea*) continues to defoliate an assortment of trees throughout northern Arizona. Walnuts in the Show Low, Heber-Overgaard, 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. In New Mexico, notable webworm activity continues to be observed on riparian hardwoods and landscape trees in many areas throughout the State.

Flatheaded fir borer (*Phaenops drumondi*) Evaluation of Douglas-fir mortality on the Mescalero Apache Tribal lands and Lincoln National Forest found wood borers (Buprestidae) were the primary causal agent in the Flume Ridge area. These 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.

Lepidopteran species, of several varieties have been observed feeding on shrubs and herbaceous vegetation in New Mexico.

4 Coleman et al. 2012. Forest Ecology and Management 276: 104-117

- **Western tent caterpillars (*Malacosoma californicum*)** produced numerous tent colonies on chokecherries in early spring which were later defoliated by fall webworm near Payson, they are expected to survive. Emory oaks in the Prescott area where also colonized by tent caterpillars in early spring. In the Santa Catalina Mountains of the Coronado National Forest approximately 1,300 acres of aspen suffered light defoliation by a combination of tent caterpillars and Marssonina leaf spot. Tent caterpillars were also observed feeding for the first time on a native current in the southern part of the state.
- **Whitelined sphinx moth** larvae **(*Hyles lineata*)** were abundant along NM 117 on the eastern edge of the El Malpais National Monument in August of 2011. Larvae were observed on the road and feeding on shrubs in the area, particularly on the four-wing saltbush. Note some pictures included in photo directory.
- **Zuni tiger moth (*Arachnis zuni*)** were discovered when a large population of black caterpillars was observed along the road and in the pinyon-juniper woodlands, on the north end of the Black Range in 2011. Some caterpillars were collected and raised to adults. This species is considered to be somewhat scarce or uncommon, but appears in larger numbers at certain times. The caterpillars were observed feeding on grasses and a number of herbaceous plants, especially on four o 'clocks (*Mirabilis* spp.). No damage or feeding on juniper or pinyon trees was observed. A report by Noel McFarland in 1959 published in the Journal of the Lepidopterists' Society documented a large population east and southeast of Albuquerque in 1957.

Figure 15. Zuni Tiger moth adult and eggs

- **Spiny oakworm (*Anisota stigma*)** was observed in 2010 feeding on oaks along the eastern slopes of the Sandia Mountains. This bright and distinctive caterpillar was also reported by residents in the area (figure 16).

Figure 16. Spiny oakworm on oak

Tamarisk Leaf Beetle (Diorhabda elongate) See invasive species section.

Pinyon Spindle Gall Midge (Pinyinia edulicola) was observed on pinyon Christmas trees collected on state and private land in northern Arizona.

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 2011, approximately 14,860 acres infested by invasive plants were treated on the 11 national forests and 3 national grasslands in the Southwestern 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:

Figure 17. Buffelgrass

Terrestrial plants

- buffelgrass (Pennisetum ciliare)
- leafy spurge (*Euphorbia esula*)
- brome grasses (*Bromus* spp.)

Vertebrates

- feral hogs (*Sus scrofa*)

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*)

Among the invasive species threats identified in the OIG report, buffelgrass is probably the greatest single threat to forests and woodlands in Southwestern Region. 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 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, the tamarisk leaf beetle (TLB) (*Diorhabda elongata*) from the Mediterranean region in Europe was released as a host-specific biological control agent for saltcedar. Both adult beetles and larvae consume 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 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.). 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 cost of flycatcher habitat. To identify potential TLB impacts on the flycatcher, a collaborative effort is underway by the U.S. Geological Survey, Northern Arizona University, and the Southwest Region's Forest Health Protection (FHP) program to collect baseline data on avifauna, herpetofauna, microclimate, and plant diversity in two central Arizona watersheds prior to TLB establishment. 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 native riparian vegetation in the Chevelon Creek weed management unit in Navajo County, Arizona.

Figure 18. Typical saltcedar distribution in the Southwest United States. Photo Courtesy of Steve Dewey, Utah State, www.bugwood.org

Recent Developments in Forest Service Programs for Invasive Species and Pesticides

In 2011, the Southwestern Region's FHP program in State and Private Forestry (S&PF) provided $184,000 to both 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. 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 S&PF's grant program has been used to treat buffelgrass, starthistles, thistles, saltcedar, knapweeds, toadflaxes, and other noxious weeds within the two states.

In December 2011, new direction for invasive species management on national forests and grasslands was given when Forest Service Manual (FSM) 2900 was implemented. The previous manual direction (FSM 2080) emphasized treatment of rangeland invasive plants which has now been broadened under FSM 2900 to incorporate treatment of aquatic and terrestrial invasive species (including vertebrates, invertebrates, plants, and pathogens) in all areas of the National Forest System. The new manual direction identifies Forest Service policy, objectives, and responsibilities of managers for responding to invasive species threats.

Biological Evaluations and Technical Assistance

Arizona Zone

1. Evaluation of Insect and Disease Activity in the Plateau Facilities Project Area, North Kaibab RD; 3/23/11.
2. Update on bark beetle activity related to October tornadoes on the Coconino NF and adjacent forested lands; 6/16/11.
3. Insect and disease evaluation of Jeff Leonard silvicultural certification stand; 6/24/11.
4. Forest health conditions at Rock Crossing campground; 7/20/11.
5. Bark beetle activity associated with revegetation plan at Grand Canyon National Park; 9/20/11
6. Potential for Douglas-fir beetle activity in Wallow fire; 9/26/11
7. Russell area vegetation management project; 10/12/11.
8. Spruce Mountain forest health improvement project; 10/18/11.
9. Cherry Creek watershed forest health improvement project; 10/21/11.
10. Dry Lake Dwarf Mistletoe Suppression Proposal; 10/26/11.
11. Site visit to Moqui and Knoll Lake campgrounds; 11/7/11.

New Mexico Zone

1. Rincon Mountain Wilderness tamarisk pesticide use proposal, Coronado National Forest. 3/18/11.
2. Forest health/western bark beetle project monitoring, New Mexico State Forestry. 3/28/11.
3. Dwarf mistletoe management, Burro Analysis Area, Gila National Forest. 7/29/11.
4. Proposed forest health projects, Jicarilla Apache Indian Reservation. 8/05/11
5. Proposed forest health projects, Mescalero Apache Reservation. 8/16/11
6. Potential FY 2012 forest health project, Tres Piedras Ranger District, Carson National Forest. 8/16/11.
7. Forest health projects in the Manzano Mountains, Cibola National Forest. 8/22/11.
8. Potential FY 2012 forest health project, Camino Real Ranger District, Carson National Forest. 8/25/11.
9. Forest health projects, Picuris Pueblo. 9/2/11.

10. Potential forest health project, Sandia Ranger District, Cibola National Forest. 9/8/11

11. Potential forest health project, Laguna Project. 9/13/11.

12. Western spruce budworm project proposal, Carson & Santa Fe National Forests. 9/16/11

13. Potential FY 2012 forest health project, Espanola Ranger District, Santa Fe National Forest. 9/20/11.

14. Regional distribution of invasive plants and weeds of the national forest and grasslands in the southwestern region. 9/20/11

15. Potential FY 2012 forest health project in chaparral WUI, Santa Fe National Forest. 9/22/11.

16. Potential FY 2012 forest health project, Coyote Ranger District, Santa Fe National Forest. 9/26/11.

17. Regional cooperation with cooperative weed management areas (CWMAs). 10/7/11.

18. Potential forest health project, Jemez corridor fuelbreak, Jemez Ranger District, Santa Fe National Forest. 10/21/11

19. Pesticide use proposal for Magdalena Ranger District, Cibola National Forest and Grasslands – Use of sodium cyanide. 10/28/11.

20. Sacramento Ranger District 2011 Douglas-fir tussock moth trapping results, Lincoln National Forest. 11/1/11

21. Sandia Ranger District 2011 Douglas-fir tussock moth trapping results, Cibola National Forest. 11/1/11.

22. 2011 New Mexico gypsy moth trapping results. 11/1/11.

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Other Entomology and Pathology Activities in 2011

Bark Beetle Monitoring in Recent Tornado Affected Stands in Arizona

Figure 19. Overwintering *Ips pini* in tornado damaged pine

The National Oceanic and Atmospheric Administration and National Weather Service confirmed numerous tornados occurred during the morning of October 6, 2010, in northern Arizona. The Coconino National Forest, State Trust Lands, Camp Navajo, and various private lands were affected. Several tornados occurred approximately 10 miles west of Flagstaff traversing in south to north direction. Another significant tornado took place near Highway 87 south of Flagstaff near Clints Well. Satellite imagery and aerial surveys found approximately 5,800 acres of moderately high to severe damage across nearly 50 miles of tornado paths, plus >16,500 acres of low to moderate damage. There was an array of tree damage including windthrown trees with roots still attached to soil, trees snapped off at various heights, and partially windthrown trees that are leaning at various degrees. Engraver beetles (*Ips* species) are known to successfully colonize and produce brood in damaged and down ponderosa pine, which can lead to increased tree mortality in adjacent areas. Throughout 2011 we conducted a number of insect monitoring studies in collaboration with Richard Hofstetter (Northern Arizona University), Tom DeGomez (University of Arizona Extension), and Hannah Telle (Camp Navajo), including: 1) using traps baited with bark beetle pheromones and wood borer attractants, 2) surveying down and standing material for beetle attack densities, 3) field sampling of down material for beetle brood production, and 4) determining species composition of bark beetles, predators and associates from infested bolts. Preliminary results of these studies include: Numerous species of bark beetles (6 *Ips* and 5 *Dendroctonus* plus species from 5 other genera), predators, wood borers and associates were collected from baited traps and down material in tornado areas. Based on trap catches, *Ips* (primarily *I. pini*) populations increased significantly throughout 2011, while primary *Dendroctonus* species did not have as large of response. External evaluation of down material and stobs (the standing portion of broken trees) determined *Ips* activity was greater in smaller-sized material, and also in broken tops that were shaded compared with sunlit material. Wood borers and red turpentine beetle (*D. valens*) were more common in sunlit stobs than shaded stobs; however, the opposite pattern was observed for windthrow and broken tops. Other *Dendroctonus* species were more

common in shaded areas irrespective of damage type. Analysis of bark samples from windthrown trees found an inverse relationship between number of *I. pini* attacks and log diameter, i.e., more attacks in mid and upper sections of logs compared with the bottom section. Infested bolts were also collected from different damage types and shade conditions. *Ips pini* attacks and emergence per infested bolt were greater in shaded conditions compared to open, sunlit conditions. Similar attack densities were found in broken tops and windthrown trees, although there was slightly higher emergence from windthrown trees.

To view the poster presentation visit: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5368857.pdf

For more information, contact Joel McMillin.

Bark beetles on the Lincoln National Forest

Conifer trees throughout the Lincoln National Forest and the surrounding Sacramento Mountains are turning brown and dying. In many cases, these trees are being attacked and killed by small insects called bark beetles.

Figure 20. Ponderosa pine trees killed by bark beetles in 2011 on the Lincoln National Forest

For more than a decade, with the exception of a few years, the Sacramento Mountains have been experiencing varying levels of drought. Because of the drought, trees have become stressed and more susceptible to bark beetle injury. As trees became more stressed, bark beetles populations increased to levels that they are now able to aggressively attack and kill healthy trees.

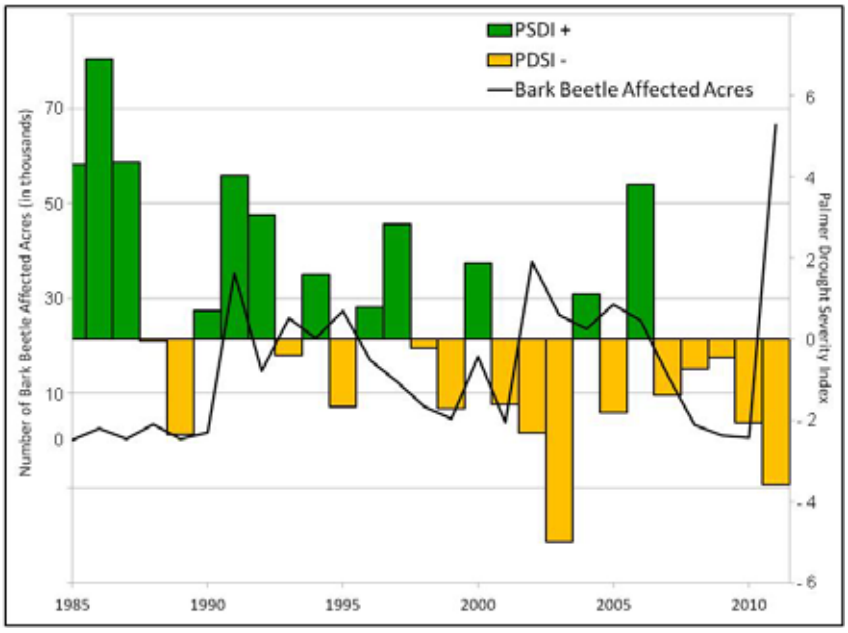


Figure 21. The Palmer Drought Severity Index with the number of bark beetle affected acres overlaid. Often, an increase in bark beetles will follow an elongated period of drought

In the Sacramento Mountains, there are many types of bark beetles. The roundheaded pine beetle, western pine beetle, and several species of engraver beetles are the

primary culprits causing mortality of the ponderosa pine. Another bark beetle, the Douglas-fir beetle, only attacks Douglas-fir, whereas the fir engraver attacks multiple species of fir. Regardless of the species of bark beetle, they attack trees in a similar way. Many of these beetles can be distinguished by the shape of the adult body and their gallery shapes.

Previous bark beetle outbreaks in the Southwest suggest bark beetle populations will continue to grow under persistent drought conditions. Some of the most affected stands of trees are those with a high density of ponderosa pine having diameters greater than 6 inches at breast height. In particular, stands that occur on ridge tops and southern facing slopes appear most affected by the drought and subsequent bark beetle-caused mortality due to drier site conditions.

For more information, contact Andrew Graves

Aspen Browse Monitoring in Arizona

Although aspen regeneration is flourishing in some parts of the Southwestern Region after the multitude of fires over the past decade, there are areas across central Arizona where rapid aspen root suckering occurred, but the sprouts are browsed by ungulates (elk, deer, cattle or sheep) and do not recruit to larger sizes. In 2011, we revisited pre-fire permanent plots in the 2010 Schultz fire area on the Coconino National Forest. Although the number of sprouts had increased tenfold after death of the overstory, to over 10,000 stems per acre, nearly 95 percent of the stems were browsed.

Aspen seedlings have also been observed taking root following several fires in Arizona, including on the Apache-Sitgreaves, Coronado, Coconino, and Kaibab National Forests. Newly germinated aspen seedlings have only a slight resemblance to the sprout form; seedling leaves are more elongated compared to the broad oval shape of normal leaves on adult trees. The most notable seedlings were established in 2001 on the Williams Ranger District, of the Kaibab National Forest, because these seedlings took root during a severe drought in elk exclosures constructed for ponderosa pine plantations, and are located in areas where aspen was absent before fire. Only two stems were found outside of fences in 2011 but were deformed by browse.

Figure 22. Aspen seedlings

For more information, contact Mary Lou Fairweather.

Pandora Moth

A project was initiated in 2010, in collaboration with Northern Arizona University, to develop technologies to better monitor, predict and quantitatively assess the risk of Pandora moth, *Coloradia pandora* Blake, outbreaks under changing climate and land use patterns that have ultimately resulted in different patterns of fire intensity at a landscape scale. This work will assist in: predicting when and where moth epidemics occur; better understanding of fire characteristics and post-fire effects on this major forest defoliator; and identify an effective sex-pheromone for monitoring Pandora moth in the Southwestern Region. The project will also investigate biological control agents including parasitoids and potential applications of nuclear polyhedrosis virus to mitigate outbreak affects.

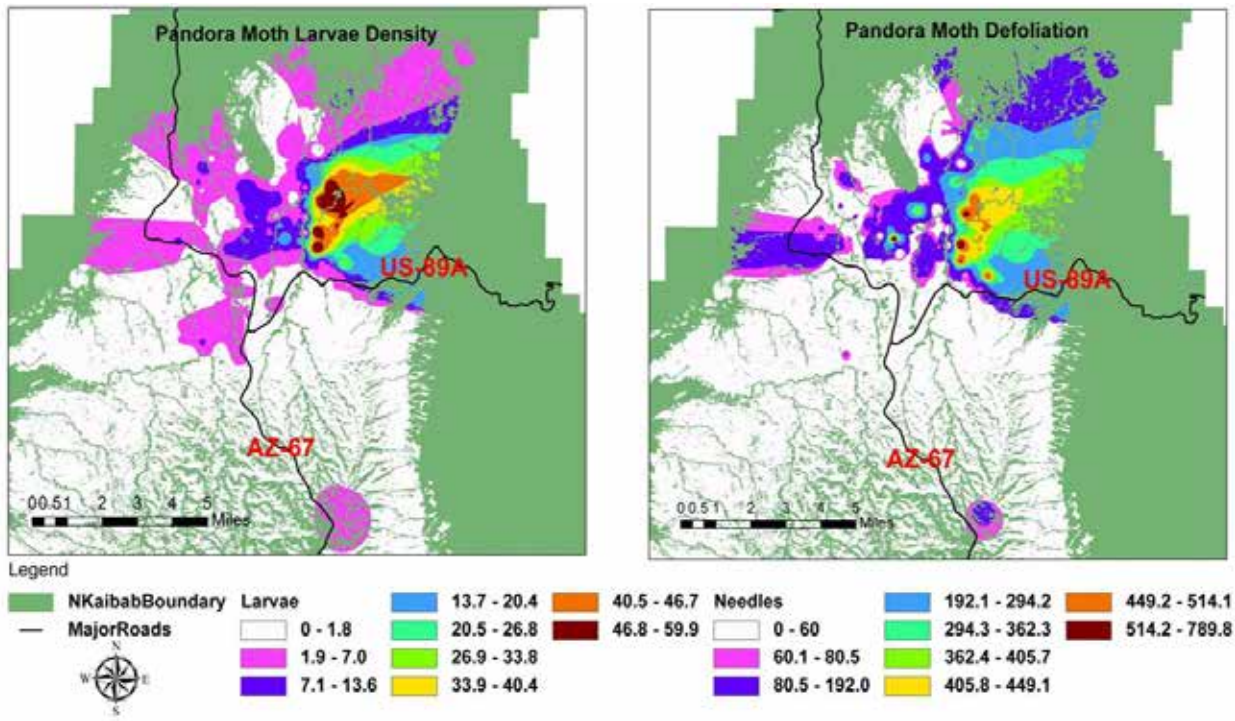


Figure 23. Larvae density (A) and defoliation severity (B) as a function of an inverse distance weighted surface using the 5 closest points. Warm colors represent higher larvae density and defoliation. Kaibab National Forest north of Grand Canyon, AZ

For more information contact Amanda Grady.

Walnut twig beetle

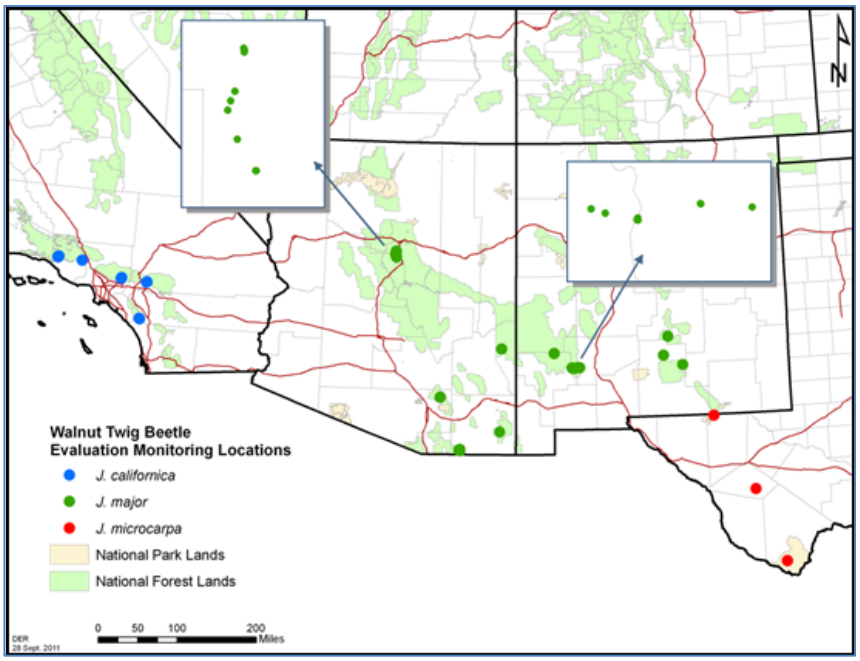


Figure 24. Walnut twig beetle evaluation monitoring locations.

The walnut twig beetle, *Pityophthorus juglandis* Blackman, is native to Arizona, California, Mexico, and New Mexico, where its original hosts were indigenous western black walnut trees (e.g., *Juglans californica* and *Juglans major*). Walnut twig beetle is associated with a newly described fungus *Geosmithia morbida*,also known as thousand cankers disease, which colonizes and kills the phloem of walnut branches and stems. When populations of walnut twig beetle are high, numerous feeding and reproductive galleries are colonized by the fungus and resulting cankers coalesce and girdle branches and stems. A monitoring effort is underway to determine the movement of this complex eastward into the expansive stands of native eastern black walnut, *Juglans nigra*, and to assess the impact of thousand cankers disease in native stands of western black walnut.

For more information, contact Andrew Graves

Hazard Tree Workshop

We conduct a workshop titled Hazard Tree Detection, Evaluation, and Management in Recreation Areas, which was launched in 1990 in order to assist Ranger District personnel with responsibilities to reduce hazard trees in developed sites. At least one training/workshop is offered annually, at a District office and alternating between New Mexico and Arizona. This has provided the opportunity for each ranger district in the Southwestern Region to send staff for training, 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 Forest Service legal responsibilities and what does and does not increase the agencies liability. Students really appreciate the question/answer period with the attorney. In 2011, the workshop was held on the Black Mesa Ranger District, Apache-Sitgreaves National Forests.

For more information, contact Mary Lou Fairweather.

Insect and Disease Workshop

Forest Health Protection staff offers training sessions on the identification, effects, and management of forest insects and diseases in the Southwest at least once a year. This 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 2011 this workshop was cancelled due to travel restrictions, but a workshop is planned for 2012.

For more information, contact the AZ or NM Zone Leader.

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.

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, conducting insect and disease aerial detection surveys and monitoring native and exotic insects in the state. Research interests include bark beetle semiochemicals, 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 condition, 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 New Mexico Cooperative Forest Health program; Region 3 representative to the STDP Insect Management Working Group; and Region 3 point-of-contact for the FHP International Activities program. Previous work experience in gypsy moth suppression, NEPA compliance, southern pine beetle management, and silviculture.

Dave Conklin **(505) 842-3288**

Forest pathologist, New Mexico Zone since 1990. Key interests: dwarf mistletoe ecology and management, including effects of fire; white pine blister rust ecology and management; other forest diseases and insects; general forest management. Work experience includes dwarf mistletoe research and monitoring, and involvement in almost 200 forest management projects on National Forest and Tribal lands.

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 & FH unit aviation officer, New Mexico Zone since September 2008. Responsibilities include aerial detection surveys, aviation safety and training coordination, and field assistance to staff. Involved with New Mexico Forestry Camp planning, 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.

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/ which includes program overviews and publications links.

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

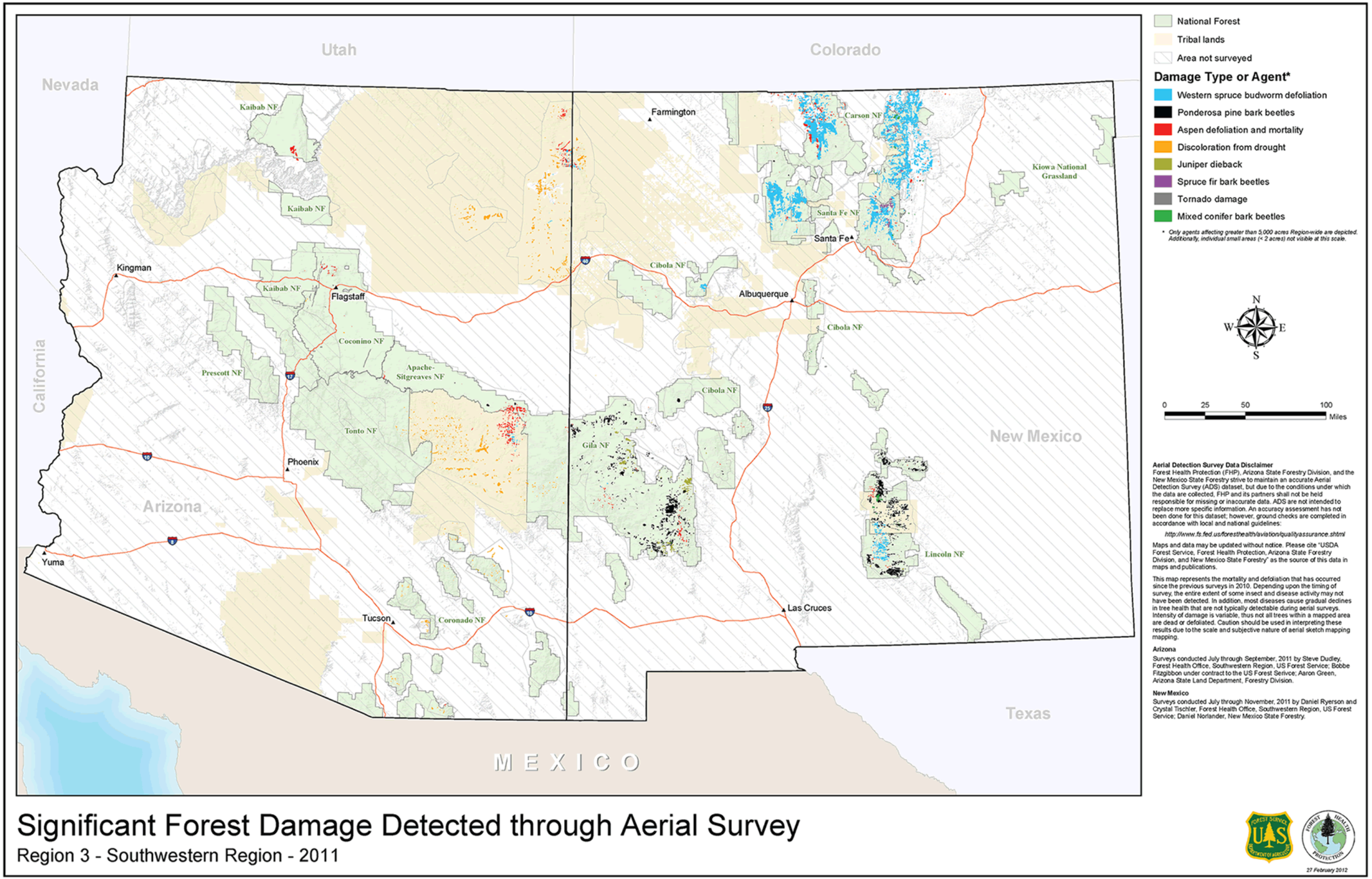
1. **Larvae and other soft-bodied insects** should be shipped in small screw-top vials or bottles containing at least 70 percent isopropyl (rubbing) alcohol. Use only enough alcohol to fully immerse the specimens; shipping regulations limit the amount to 30 ml (2 tablespoons or about 1 ounce) per vial. 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.

4. **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..

Map of Significant Forest Mortality and Defoliation Detected through Aerial Survey



Aerial Detection Survey Data Disclaimer
Forest Health Protection (FHP), Arizona State Forestry Division, and the 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 2010. 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, 2011 by Steve Dudley, 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 November, 2011 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 - 2011

27 February 2012