



# ARIZONA FOREST HEALTH CONDITIONS 2018

**A publication by the Forest Health Program of the Arizona  
Department of Forestry and Fire Management**

Arizona is a state with incredible landscape diversity that ranges from the lower Sonoran Desert scrub and pinyon-juniper woodland to the high elevation spruce-fir forests.

Forests cover roughly 27% of the state and occupy 19.4 million acres. These forests are comprised of 37 species of coniferous and hardwood trees. The majority of forestland is located above the Mogollon Rim with distinct forested areas scattered throughout the rest of the state. Juniper (*Juniperus* spp.) and pinyon juniper (*Pinus edulis-Juniperus* spp.) woodlands are the most abundant forest type in Arizona, occupying approximately 14.8 million acres, or 20.3% of the state. The rarest and most significant in ecological terms is riparian forest, which occupies less than one-half of 1% of Arizona's land.

In urban areas, we experience urban forests that are typically composed

**15 million acres  
surveyed by air**

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**276,000 acres of tree  
damage from bark  
beetles**

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**513% increase in  
bark beetle activity**

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**300% increase in trees  
damaged from 2017**

of a mix of native and introduced tree species that require various management techniques. These urban forests are inhabited by almost 90% of Arizona's residents and provide numerous environmental, economic and social benefits. With such a broad diversity of forests comes a similarly diverse group of insects and diseases that impact forest and woodland health, such as pine engraver beetles, pine sawflies, spruce aphid, pinyon needle scale, sycamore anthracnose, and white pine blister rust.

Annually, the Department of Forestry and Fire Management (DFFM) partners with the USDA Forest Service to survey millions of acres of forest and woodland resources from the air. The Aerial Detection Survey (ADS) provides land managers and the public with information about landscape-level forest and woodland health conditions (Fig. 1). In 2018, the ADS occurred over 15 million acres to detect dead and/or dying trees. During the year, DFFM forest health specialists and district staff verify ADS data, conduct ground surveys, and provide landowner technical assistance. This conditions report summarizes the ADS and discusses forest and woodland health issues in Arizona.

## Overview

The most significant event detected in 2018 was the dramatic increase of bark beetle-caused tree mortality, where a total of 275,933 acres were affected. This was a 513% increase from 2017 with most of this damage occurring in ponderosa pine forests (247,737 acres). Very little precipitation fell in Arizona from August 2017 to June 2018, resulting in a majority of the state being in extreme or exceptional drought by the end of spring (Fig. 2). These conditions had a profound effect on forested environments. Forest trees are dependent on adequate soil moisture in the spring for the production of their defensive chemicals and structures to protect them from harmful insects and diseases. Under these drought conditions, most trees were in a state of extreme stress and highly vulnerable to bark beetles, especially in areas that were experiencing exceptional drought. Most bark beetle populations were at low, endemic levels in 2017 with 45,003 acres affected. By the end of spring 2018, bark beetle populations were rapidly increasing, resulting in wide spread tree mortality, especially in marginal habitat such as the transition zones where ponderosa pine stands begin to mix with pinyon and juniper (Fig. 3). In 2018, 18,409 bark beetle-affected acres of pinyon pine were recorded, a 3,141% increase over the previous year. Acres of juniper that were affected by bark beetles, which is not typically seen, was 8,379 acres. The dramatic increase of bark beetle

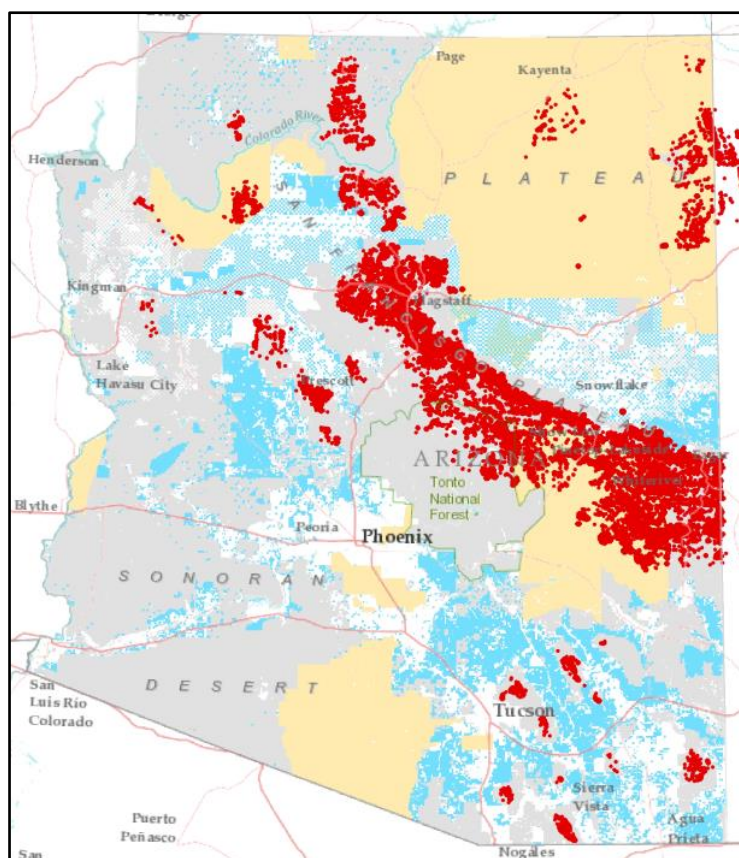


Figure 1. Arizona 2018 Aerial Detection Survey Insect and Disease Locations



populations in these transition zones was mainly due to the drought in combination with the fact that most bark beetle species responsible for the mortality in these regions have up to three generations per year. Outside of the transition zones, tree mortality from bark beetles was sporadic, consisting of individual or small groups of trees. In higher elevations, bark beetle populations declined. Fir engraver activity in white fir fell 87% to 63 acres, Douglas-fir beetle in Douglas-fir fell 37% to 317 acres, and western balsam bark beetle in corkbark fir fell 63% to 46 acres. Aspen mortality from sudden aspen decline fell 26% to 171 acres. Tree damage from defoliators and sap feeders continued to decline by 9% to 31,421 acres. While spruce aphid activity continues to be an issue in the Mt. Baldy and Greens Peak areas and populations are expanding in the San Francisco Peaks, pinyon needle scale damage remains about the same. The greatest decline in defoliation occurred on the North Rim of the Grand Canyon, where the Pandora moth is in the pupa stage of its two-year life cycle and does not feed. There was a significant population of alder flea beetle detected in Oak Creek Canyon that affected 237 acres of alder, but the trees are expected to fully recover next spring.

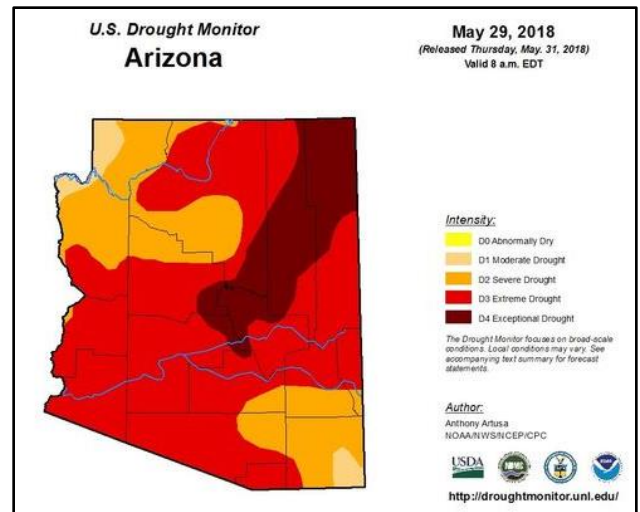


Figure 2. Extent of drought: May 29, 2018



Figure 3. Ponderosa pine mortality in the transition zone. Photo Credit: Daniel DePinte



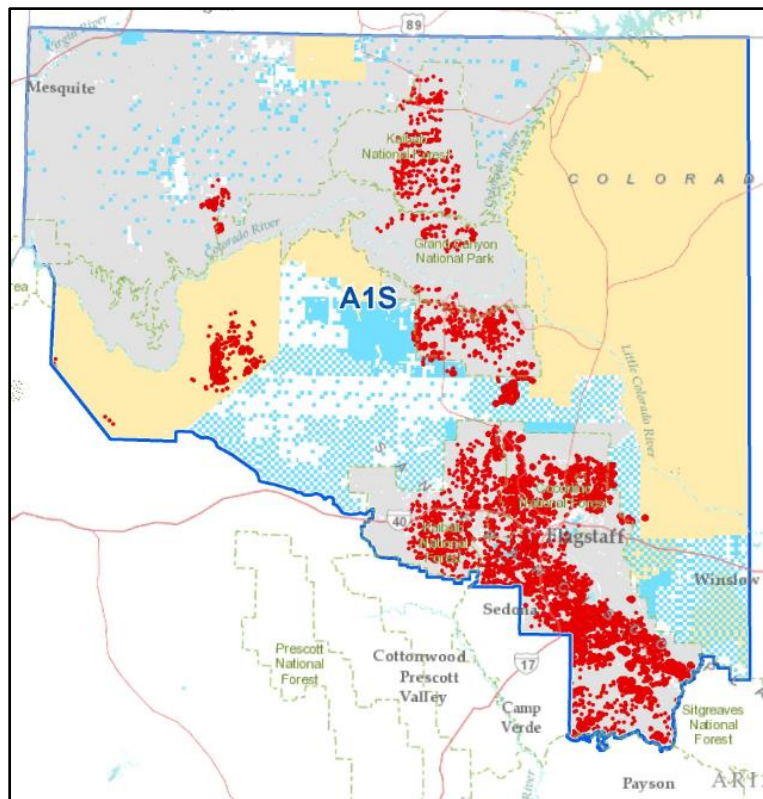
Arizona Department of Forestry and Fire Management has 5 distinct districts. Each district shares similar forest and woodland health issues while experiencing a varying degree of tree damage from insects and disease.

## Northern District (A1S)

There was a total of 68,210 acres of forest trees impacted by insects and disease in 2018 in the Northern District, which is an increase of 51% over the previous year. Most of this increase was due to significant bark beetle activity. Trees affected by bark beetles increased 185% to 56,907 acres, primarily in ponderosa pine forests. Pandora moth defoliation decreased by 20,000 acres, reflecting the 2-year life cycle of this insect which is currently in its pupa stage. Drought-related damage increased in the pinyon and oak woodlands with a 2,181% increase.

*Table 1. Northern District (A1S) 2018 Estimated Acres of Observed Tree Damage by Land Ownership (Acres)*

Damage Causing Agent	Federal	Indian Lands	Private and Local	State	Grand Total
Abiotic Agents		7,984.7			<b>7,984.7</b>
Bark Beetles	46,603.7	476.7	5,302.7	4,524.3	<b>56,907.3</b>
Declines	82.1		40.7	4.1	<b>126.9</b>
Defoliators	2,203.8	0.7	67.2		<b>2,271.8</b>
Human Activities (road salt or deicers)	15.4		1.2		<b>16.6</b>
Sap Feeders		902.6			<b>902.6</b>
<b>Grand Total</b>	<b>48,905.0</b>	<b>9,364.7</b>	<b>5,411.9</b>	<b>4,528.3</b>	<b>68,209.9</b>



*Photo Credit: Daniel DePinte*



*Figure 4. Location of Insect and Disease Activity in the Northern District.*

# Northeast District (A2S)

There was a 476% increase of insect and disease impacts to trees in the Northeast District in 2018 compared to the previous year. In total, 188,461 acres are affected, primarily due to significant increases of bark beetle and spruce aphid activity. Bark beetle-caused mortality increased 593%, mostly in ponderosa pine forests. Sap-feeding insect activity increased 356% to 26,954 acres affected, which is mostly due to spruce aphid activity.

Table 2. Northeast District 2018 Estimated Acres of Observed Tree Damage by Land Ownership (Acres)

Damage Causing Agent	Federal	Indian Lands	Private and Local	State	Grand Total
Abiotic Agents		25.9			25.9
Bark Beetles	92,834.0	55,313.9	8,950.6	1,138.7	158,237.2
Declines	15.2	28.4			43.6
Defoliators	660.7	631.9			1,292.6
Foliage and Shoot Diseases		1,679.1	108.6		1,787.7
Human Activities (road salt or deicers)		0.2			0.2
Sap Feeders	6,456.7	20,486.5	10.3		26,953.5
Unknown	20.9	86.2	13.4		120.5
<b>Grand Total</b>	<b>99,987.4</b>	<b>78,252.3</b>	<b>9,082.9</b>	<b>1,138.7</b>	<b>188,461.3</b>

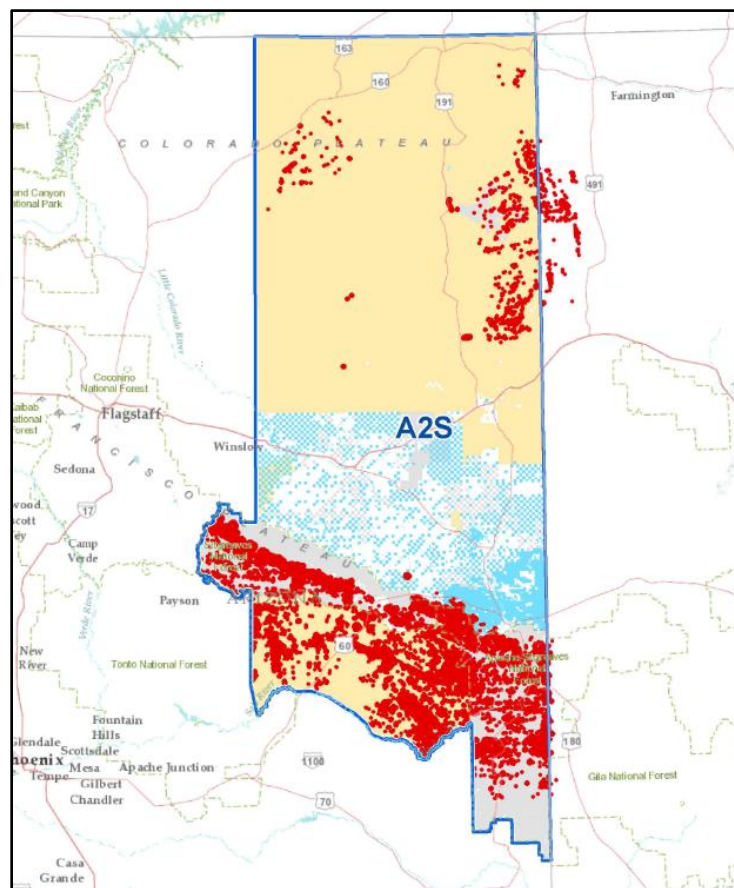


Figure 5. Location of Insect and Disease Activity in the Northeast District.



Photo Credit: Daniel DePinte





# Southeast District (A3S)

There was a 2,096% increase in insect and disease impacts to trees in the Southeast District in 2018 compared to the previous year, primarily due to an increase of bark beetle activity in ponderosa pine. In the greater Tucson area, bark beetle collections were similar in 2018 as compared to 2017. Trapping of beetles is occurring in numerous parks throughout Tucson and will continue to be monitored through 2019 by DFFM and the University of Arizona Department of Entomology. Between January and June 2018, total trap catch equaled 2,679 beetles, of which all were *Ips calligraphus*.

Table 3. Southeast District 2017 Estimated Acres of Observed Tree Damage by Land Ownership

Damage Causing Agent	Federal	Indian Lands	Private and Local	State	Grand Total
Abiotic Agents	3,921.4		22.2		3,943.6
Bark Beetles	3,785.2		1.0	36.5	3,822.8
Defoliators	0.5		0.2		0.7
Unknown	7.1				7.1
Wood Borers	0.7				0.7
<b>Grand Total</b>	<b>7,715.0</b>	<b>-</b>	<b>23.5</b>	<b>36.5</b>	<b>7,775.0</b>

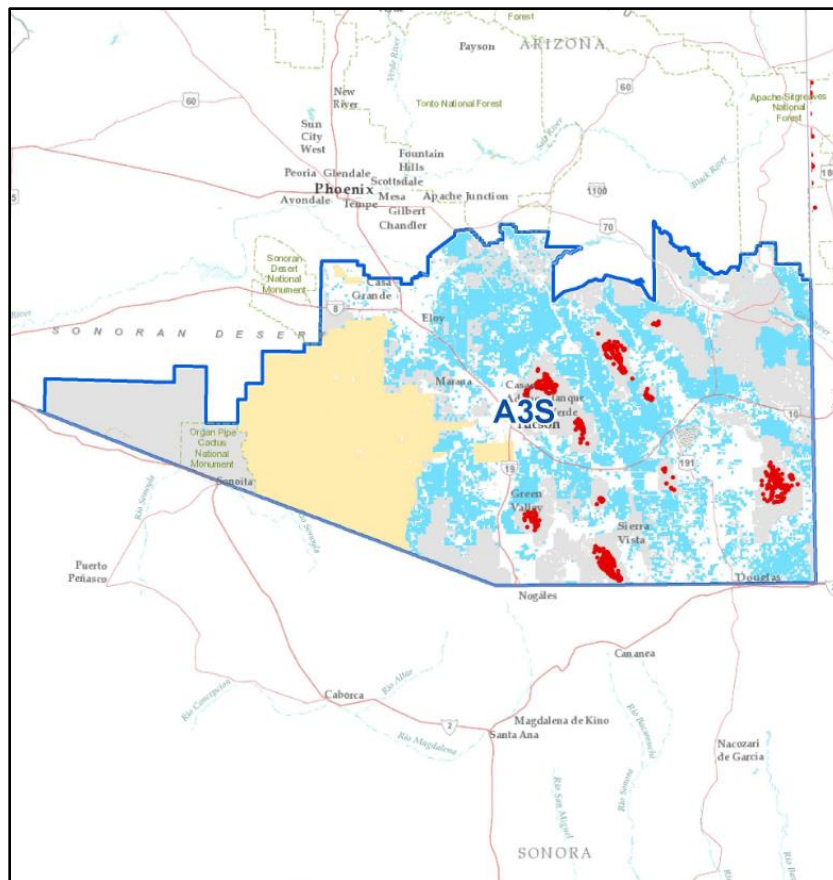


Photo Credit: Bob Celaya



Figure 6. Location of Insect and Disease Activity in the Southeast District.

## Central District (A4S)

There was a 3,797% increase in insect and disease impacts to trees in the Central District in 2018 with 51,867 acres being affected. Most of the impacts were caused by bark beetles, primarily in ponderosa pine forests. Aleppo pine blight occurred at unprecedented levels in the Phoenix metropolitan area in early January 2018. Most affected trees have recovered and a monitoring project has been established to track the blight should it reappear in early 2019.

*Table 4. Central District Estimated Acres of Observed Tree Damage by Land Ownership*

Damage Causing Agent	Federal	Indian Lands	Private and Local	State	Grand Total
Abiotic Agents	37.7				37.7
Bark Beetles	20,081.1	31,270.6	179.5		51,531.2
Unknown	88.4	209.4	0.2		298.0
<b>Grand Total</b>	<b>20,207.2</b>	<b>31,480.0</b>	<b>179.7</b>	<b>-</b>	<b>51,866.9</b>

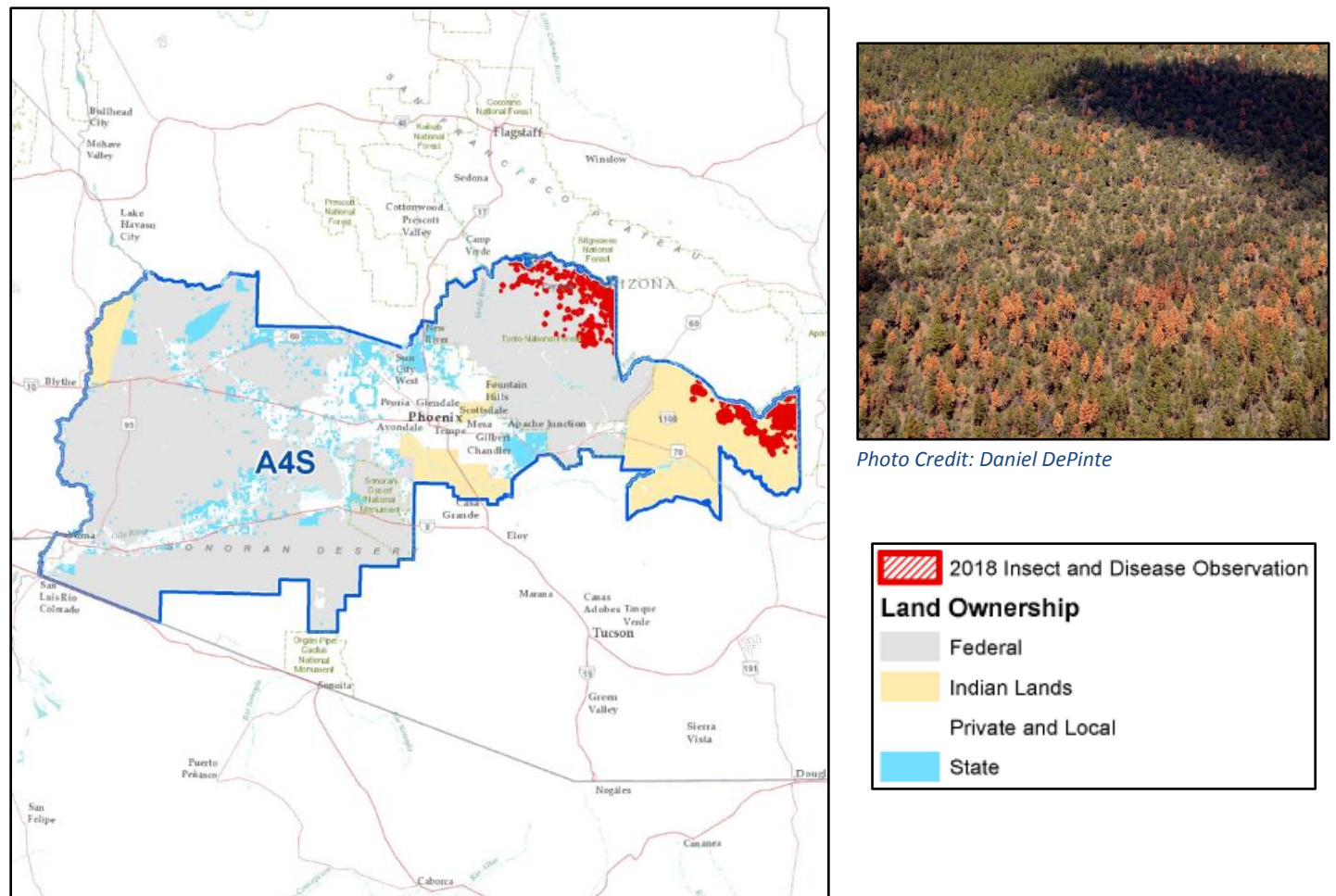


Figure 7. Location of Insect and Disease Activity in the Central District



# Northwest District (A5S)

There was a 427% increase in insect and disease impacts to trees in the Northwest District in 2018 compared to the previous year. Most of the increase was due to higher levels of bark beetle activity in ponderosa pine forests. A new infestation of western pine beetle was identified in the Hualapai Mountains after initial aerial detection flights. This infestation is not included in the total acreage and impacts may be greater than reported.

Table 5. Northwest District Estimated Acres of Observed Tree Damage by Land Ownership

Damage Causing Agent	Federal	Indian Lands	Private and Local	State	Grand Total
Bark Beetles	4,152.1		1,223.9	59.0	5,435.1
Unknown	4.1		0.2		4.4
Wood Borers	0.1			0.1	0.2
<b>Grand Total</b>	<b>4,156.4</b>	<b>-</b>	<b>1,224.2</b>	<b>59.1</b>	<b>5,439.7</b>

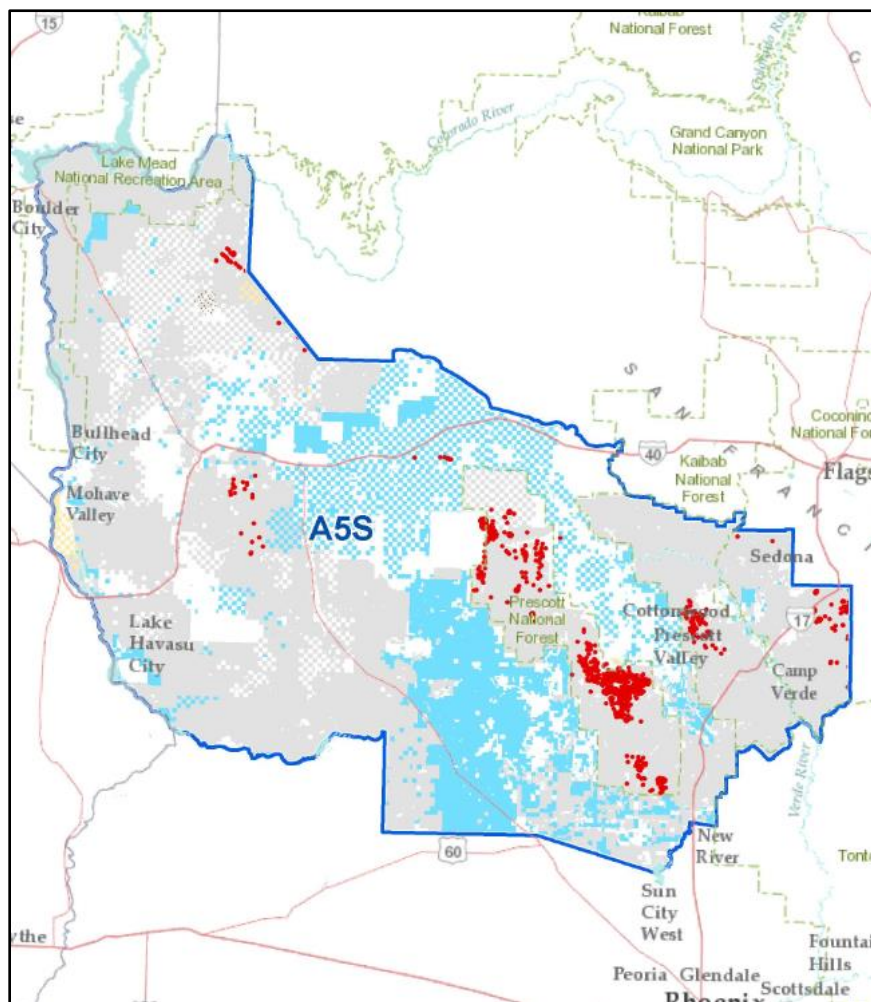


Figure 8. Location of Insect and Disease Activity in the Northwest District

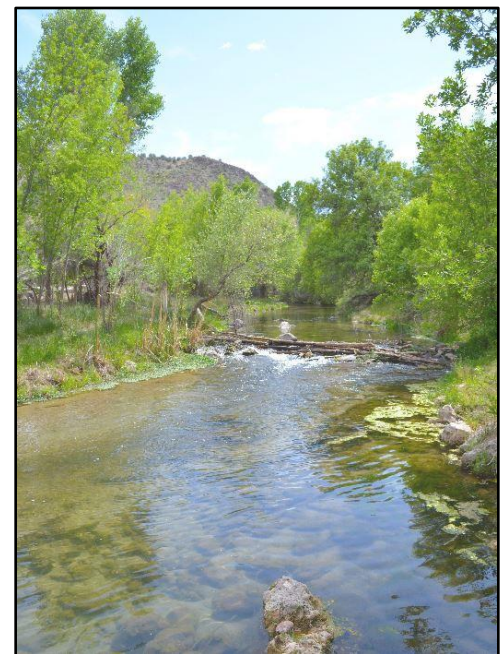


Photo Credit: John Richardson





# Statewide Insect and Disease Update

## By Damage Causing Agent

### Bark Beetles

In Arizona, there are several bark beetle species that cause ponderosa pine mortality, therefore they are grouped in this report as the ponderosa pine bark beetle complex. The main species that attack ponderosa pine in Arizona are western pine beetle (*Dendroctonus brevicomis*), roundheaded pine beetle (*D. adjunctus*), Arizona five-spined Ips (*Ips lecontei*), and the pine engraver (*I. pini*). The Mexican pine beetle (*D. approximates*), southern pine beetle (*D. frontalis*), six-spined Ips (*I. calligraphus*), and (*I. kanusi*) also contribute to ponderosa pine mortality, but are less abundant. There were 247,737 acres of ponderosa pine damage attributed to bark beetles in 2018, with the majority occurring along the eastern portion of the Mogollon Rim and lower elevations within the Fort Apache and San Carlos Reservations.

### Western Pine Beetle

The western pine beetle is found throughout the range of ponderosa pine, its principle host, except in the Black Hills of South Dakota. Outbreaks of this beetle can cause extensive tree mortality. In the southern Sierra Nevada of California during a recent outbreak in 2015-16, 100% mortality of some stands were observed (Fig. 9). These beetles typically emerge from infested trees around the middle of April and can have up to 3 generations per year. They prefer mature ponderosa pine except during periods of outbreak where trees as small as 6 inches in diameter at breast height (dbh) are attacked. They typically prefer the lower and mid-bole of the tree, and are often found in association with Ips beetles (which attack the upper bole) as well as the red turpentine beetle (*D. valens*) (which attack the trunk near the ground). During the ADS flight of the Hualapai Mountains in western Arizona in mid-July, very little individual tree mortality was observed, but by the end of August several pockets of 6 to 12 western pine beetle-infested ponderosa pines were reported by Hualapai County park employees and verified by DFFM personnel.



Figure 9. Western pine beetle-caused tree mortality in California in 2016. Photo Credit: USFS

### Roundheaded Pine Beetle

The roundheaded pine beetle is found only in the southwestern range of ponderosa pine and produces just one generation per year. What is unique about this beetle is that it emerges in mid-fall in search of a new host. The female initiates the attack and will construct a vertical gallery that is somewhat sinuous, which makes it easy to identify (Fig. 10).



Figure 10. Roundheaded pine beetle galleries. Photo Credit: USFS

## Ips spp.

There are several species of Ips beetles that attack ponderosa pine in Arizona, but the two that cause the most mortality are the Arizona five-spined Ips and the pine engraver. These two bark beetles are very similar in behavior, except that the Arizona five-spined Ips is found only in Arizona and New Mexico, while the pine engraver is found throughout the range of ponderosa pine and also uses other pine species as hosts. The male Ips beetle initiates the attack and creates a nuptial chamber where it mates with typically 3 or 4 females (Fig. 11). Like the western pine beetle, Ips beetles can have 3 generations per year and have the capacity to cause widespread mortality during periods of drought.



Figure 11. *Ips calligraphus* galleries. Photo Credit: Bob Celaya



Figure 12. Pinyon Ips mortality. Photo Credit: Bob Celaya

## Pinyon Ips

Pinyon pine had the greatest increase in bark beetle damage in 2018 with 18,409 acres affected, an increase of 3,141%. The pinyon Ips biology is similar to those that attack ponderosa pine, with the exception that adult pinyon Ips spend the fall and winter feeding at the base of the tree. Like other Ips species, pinyon Ips can have up to 3 generations per year, therefore populations can exponentially increase during periods of extreme drought (Fig. 12).

## Cedar Bark Beetle

The cedar bark beetle, in association with drought, affected 8,378 acres of juniper in 2018. The hosts for cedar bark beetle (*Phloeosinus* spp.) are juniper species and Arizona cypress (*Cupressus arizonica*). Typically, these bark beetles are uncommon and rarely found except during periods of extreme and exceptional drought when they can cause widespread mortality as was mentioned in the Forest Service Region 3 Forest Conditions Report during the drought of 2002-2003.



Figure 13. Cedar bark beetle galleries near Prescott, AZ. Photo Credit: Steve McKelvey.



## Other Bark Beetles

Bark beetle activity in upper elevation tree species declined this year even though winter precipitation was far below normal. Fir engraver activity in white fir declined 88% to 63 acres affected. Douglas-fir beetle activity in Douglas-firs declined 37% to 317 acres affected, while western balsam bark beetle activity in corkbark fir declined 63% to 46 acres affected.

## Defoliators

Acres defoliated declined 665% with only 3,565 acres affected. The dramatic reduction was a result of the Pandora moth being in the pupa stage (Fig. 14) of its two-year life cycle. Adults will emerge from the forest floor litter in spring 2019 to lay eggs on ponderosa pine and start the feeding stage again. In 2018, defoliated acres were mostly due to the Douglas-fir tussock moth (1,017 acres) and western spruce budworm (1,132 acres) feeding on white fir, Engelmann spruce, and Douglas-fir. The alder flea beetle affected alder in Oak Creek Canyon (237 acres), and several species of moth defoliated aspen (686 acres).



Figure 14. Pandora moth pupae. Photo Credit: USFS



Figure 15. Spruce aphid activity on Greens Peak. Photo Credit: Daniel DePinte

## Sap Feeders

Spruce aphid activity on Engelmann and blue spruce increased 378% to 26,880 acres affected, mostly in Mt. Baldy, Greens Peak (Fig. 15) and the San Francisco Peaks. Pinyon needle scale activity on pinyon pine decreased 36% to 976 acres affected.

# Forest Health in Urban Areas

The Aleppo pine blight returned to the Phoenix metropolitan area in early January at unprecedented levels. This blight has been occurring sporadically throughout the Southwest for many decades. While there has been much speculation, no definitive cause has been identified. DFFM personnel in cooperation with USDA Forest Service Forest Health Protection personnel collected and sent several samples to UC Davis, Colorado State, and USDA Forest Service laboratories for analysis (Fig. 16). Fungal and nematode test results were negative, but a pine feeding mite (*Oligonychus milleri*) was identified by a USDA Forest Service mite specialist. A monitoring program has been developed in cooperation with local municipalities in the Phoenix metropolitan area to further aid in the identification of the cause (Fig. 17). An invasive bark beetle, the Mediterranean pine engraver (*Orthotomicus erosus*), was discovered in the Central Valley of California in 2004 and has been since spreading into other regions. Monitoring traps were established in the Phoenix metropolitan area to determine if the bark beetle was present (Fig. 18) with two of five trap locations having positive results. The extent of damage caused by this beetle has yet to be determined. In Tucson, bark beetle activity by *Ips calligraphus* is still prevalent. Seven trap locations have been established throughout the city with Udall and Reid Park experiencing the greatest numbers of beetles. Trapping and monitoring will continue throughout 2019.



Figure 16. Sampling Aleppo pine blight in the Phoenix metropolitan area.  
Photo Credit: John Richardson



Figure 17. DFFM Forest Health staff discuss Aleppo pine blight with 11 different municipalities in the Phoenix metropolitan area. Photo Credit: Jon Orona



Figure 18. 1 of 5 trap locations for the MPE in May 2018. Photo Credit: John Richardson



# Flight Information

Table 6. Estimated Flight Area by Forest Type

Forest Type	Arizona (ac)	Flight Area (ac)	Covered by Flight (%)
Forest	5,847,239	4,922,856	84.2%
PJ Woodland	10,205,097	5,158,258	50.5%
Woodland	3,233,490	656,692	20.4%
Other	53,656,586	4,758,531	8.9%
<b>Total Area</b>	<b>72,932,412</b>	<b>15,496,337</b>	<b>21.2%</b>

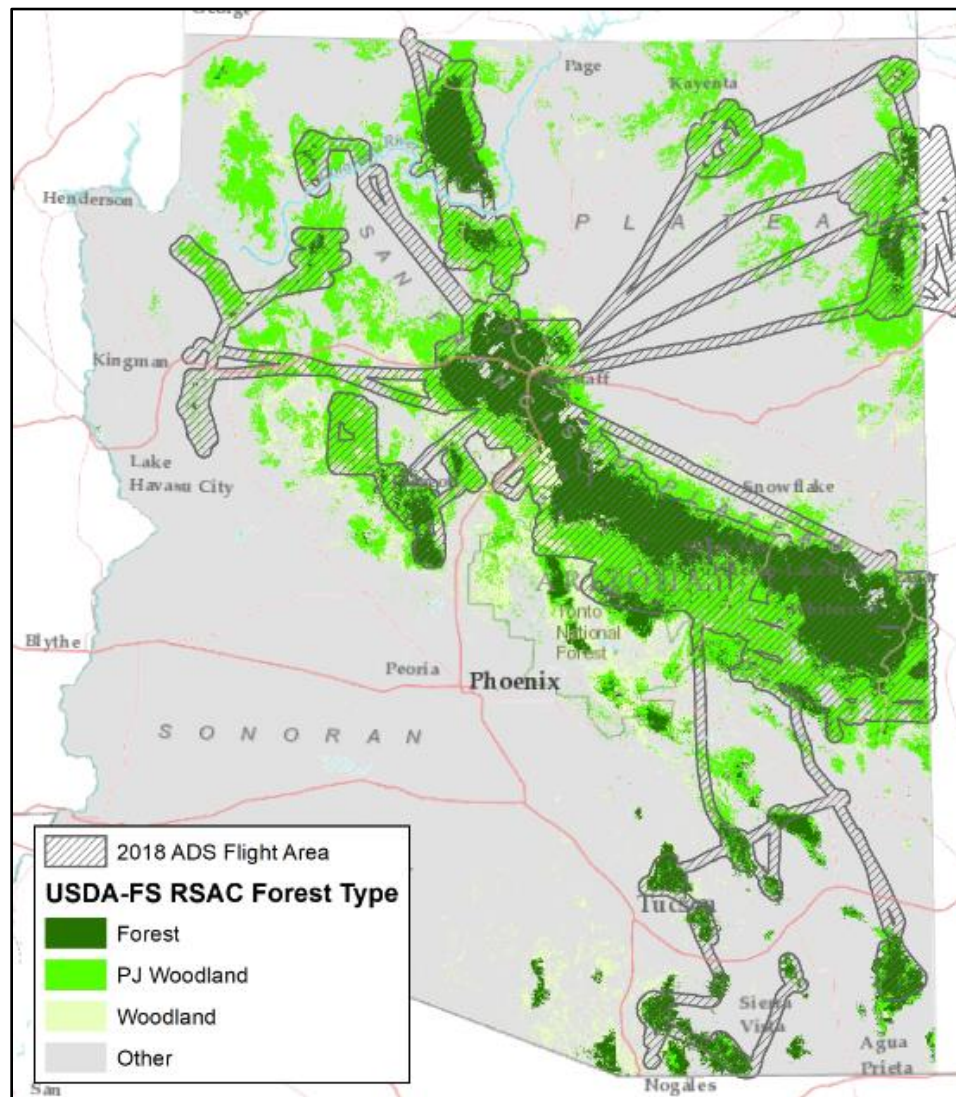
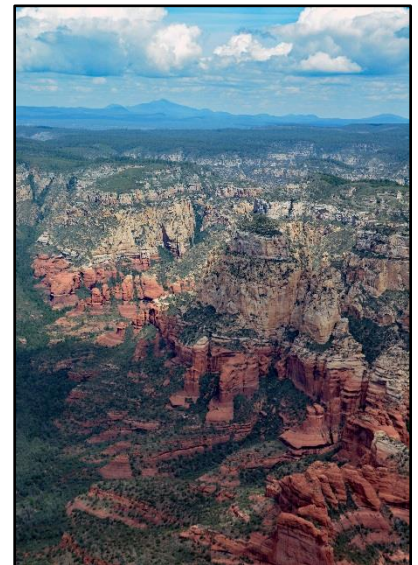


Figure 19. 2018 Aerial Detection Survey Flight Area



# Contact Information

The DFFM Forest Health Program is a statewide program that is based in Phoenix, AZ.

Office of the State Forester  
1110 West Washington St., Suite 100  
Phoenix, Arizona 85007  
602-771-1400

Website: [dffm.az.gov](http://dffm.az.gov)

Forest Health Website: [dffm.az.gov/forestry-community-forestry/forest-health](http://dffm.az.gov/forestry-community-forestry/forest-health)

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## The Forest Health Team

**Program Manager:** John Richardson, [JRichardson@dffm.az.gov](mailto:JRichardson@dffm.az.gov), 602-771-1420  
**Forest Health Specialist:** Steve McKelvey, [SMcKelvey@dffm.az.gov](mailto:SMcKelvey@dffm.az.gov), 602-771-1415  
**Project Coordinator:** Wolfgang Grunberg, [WGrunberg@dffm.az.gov](mailto:WGrunberg@dffm.az.gov), 602-399-1886  
**Conservation Education Coordinator:** Cori Dolan, [Cdolan@dffm.az.gov](mailto:Cdolan@dffm.az.gov), 520-262-5519  
**Urban Forestry Specialist:** Jon Orona, [JOrona@dffm.az.gov](mailto:JOrona@dffm.az.gov), 602-771-1407

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*Photo Credit: Bob Celaya*



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