Forest Health Conditions in Arizona - 2022

Arizona Department of Forestry and Fire Management

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

Over 15,000,000 acres surveyed by air	Over 400,000 acres with observed bark beetle caused mortality	Over 195,000 acres with observed drought damage

Assembled by Aly McAlexander, with technical support from Wolfgang Grunberg

Table of Contents

Introduction

Arizona has an incredibly diverse landscape. From the lower Sonoran desert scrub and pinyon-juniper woodland to the high elevation spruce-fir forests.

Forests cover approximately 27% of the state, which is over 19 million acres. These forests are comprised of 37 species of coniferous and hardwood trees. The majority of forestland is located above the Mogollon Rim. Juniper (*Juniperus* spp.) and pinyon juniper (*Pinus edulis-Juniperus* spp.) woodlands are the most abundant forest types 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.

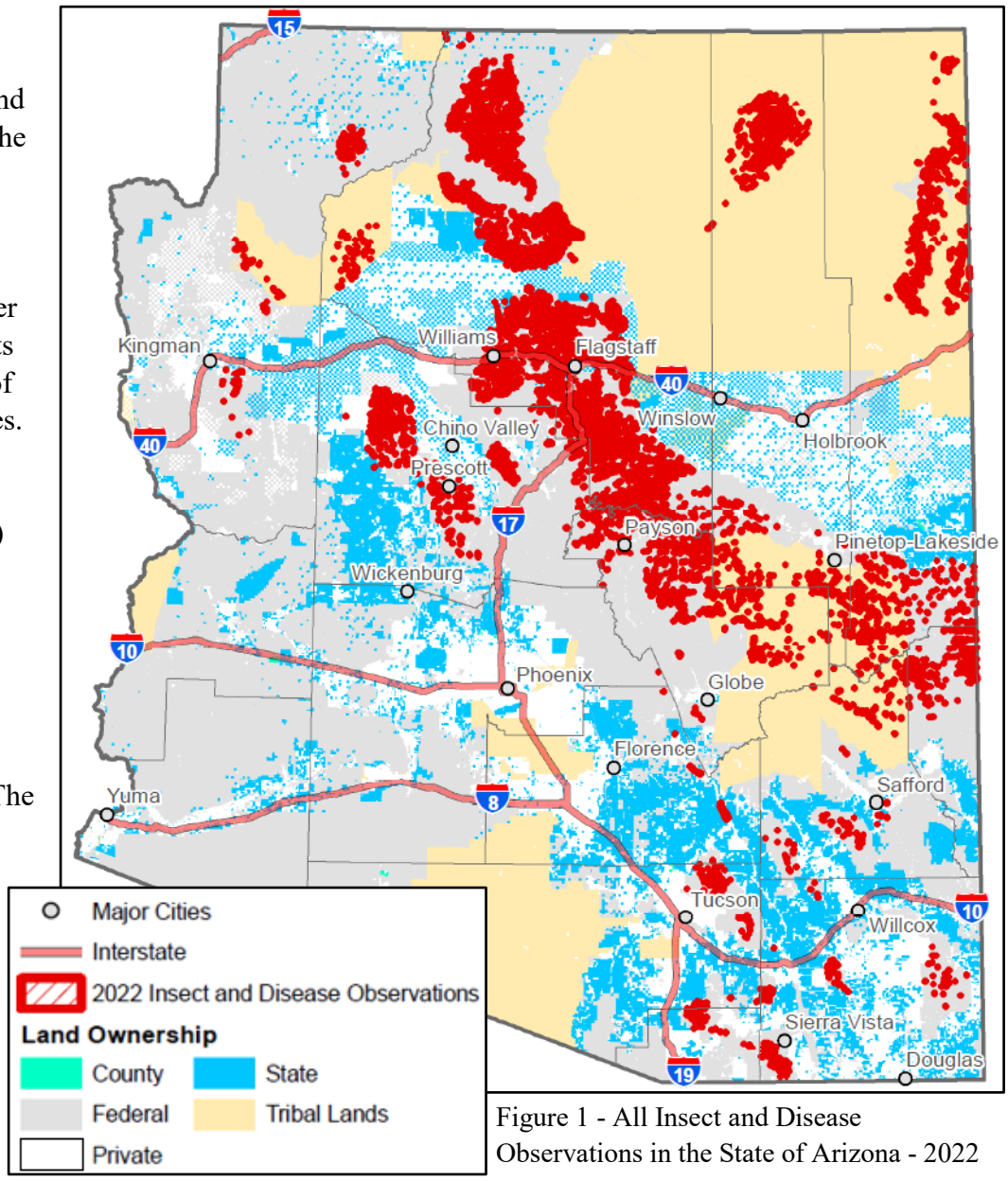

Figure 1 - All Insect and Disease Observations in the State of Arizona - 2022

Urban areas include forests that are typically composed of a mix of native and introduced tree species that require various management techniques. Nearly 90% of Arizona's residents live in an urban forest, which provide numerous environmental, economic and social benefits.

With such a broad diversity of forests comes a diverse group of insects and diseases; from native and non-native pine engraver beetles to introduced fungal pathogens such as white pine blister rust. This report includes information on the insects and diseases having significant impacts on Arizona's forested landscapes.

Photo: (From left to right) Marianne Davenport, Entomologist, USDA Forest Service; Aly McAlexander, Forest Health Program Manager, DFFM, 2022

Aerial Survey Summary

Annually, the Department of Forestry and Fire Management (DFFM) partners with the USDA Forest Service, Forest Health Protection (FHP) team, to survey millions of acres with forest and woodland resources from the air; this is called an Aerial Detection Survey (ADS). The ADS provides land managers and the public with information about landscape-level forest and woodland health conditions. This conditions report summarizes the 2022 ADS program and discusses current forest and woodland health issues in Arizona.

In the summer of 2022, during the ADS season, over 15,000,000 acres were flown to identify dead, dying, and declining trees (Figure 2). The aerial surveys cover National Forest lands (54% of the area surveyed), tribal lands (29% of the area surveyed), private lands (9% of the area surveyed), state lands (6% of the area surveyed), and county lands (less than 1% of the area surveyed) (Table 1).

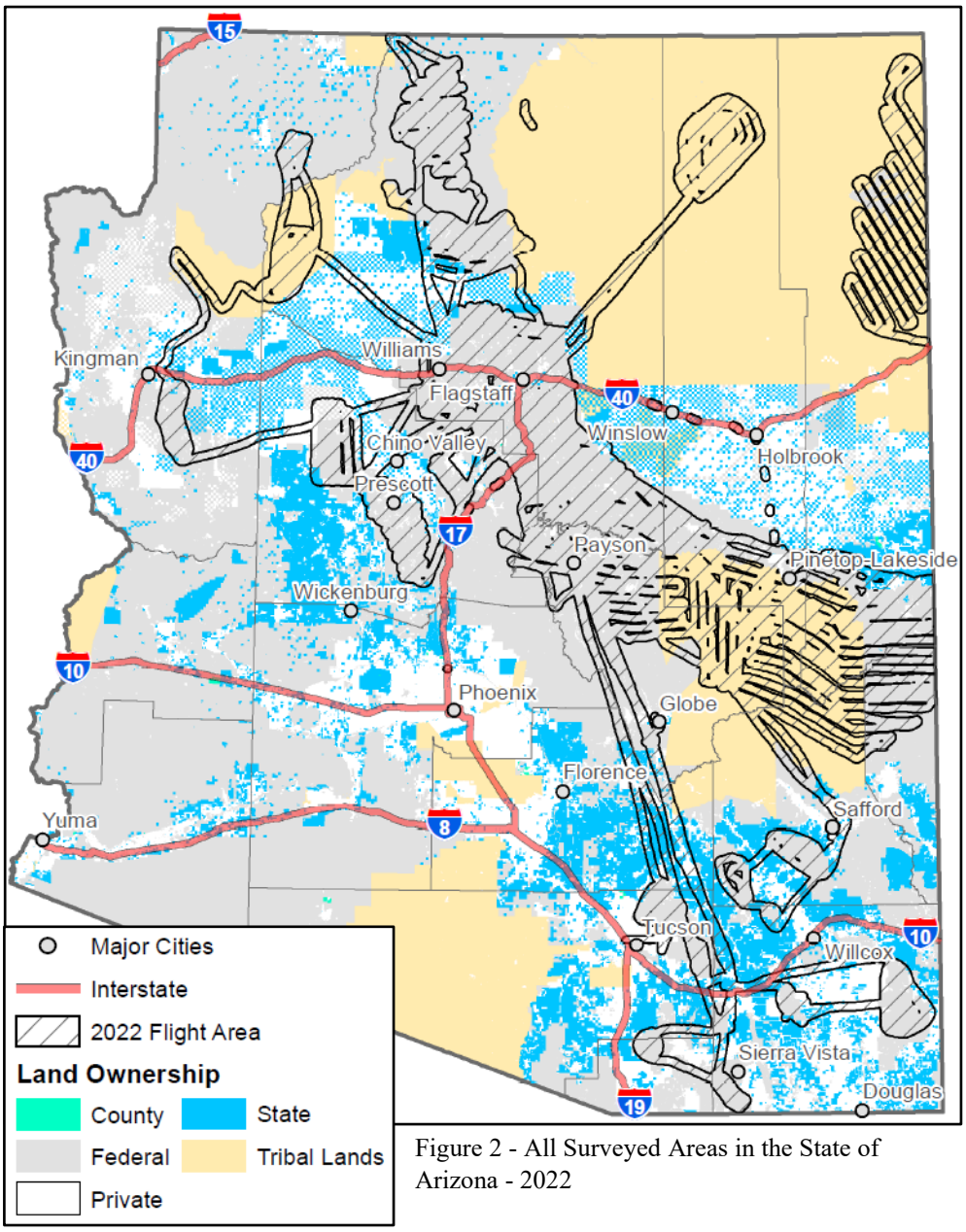

Figure 2 - All Surveyed Areas in the State of Arizona - 2022

Throughout the ADS season, as well as after, the USDA Forest Service, DFFM forest health specialists, and District staff verify ADS data by conducting ground surveys and providing landowners with technical assistance.

Arizona 2022 ADS: Approximate Surveyed Area by Land Ownership

Land Ownership*	GIS Acres	%
County	1,242.1	0.01%
Federal	8,224,653.7	54.47%
Private	1,445,296.1	9.57%
State	927,827.0	6.14%
Tribal Lands	4,501,432.8	29.81%
Grand Total	**15,100,451.7**	**100.00%**

* 2022 BLM Surface Management Agency data

Table 1. Surveyed Area by Land Ownership for the State of Arizona - 2022

Climatic Overview

Relevance

It is important to understand the climatic conditions occurring throughout our state, as precipitation and temperature are two of the biggest environmental factors influencing forest health. When trees are drought stressed from a lack of precipitation, and stressed from increased average temperatures, they become increasingly susceptible to infection and infestation from diseases and insects. In addition, densely packed forest stands increase competition for these resources between trees. Furthermore, prolonged drought stress, which is drought lasting longer than 6 months, can lead to decreased overall tree health and increased likelihood of tree death.

Tree tissues produce and collect more ethanol and terpenes when they are stressed. Many insects, in particular bark beetles, can detect these chemicals. Thus, stressed trees are releasing more ethanol and terpenes into the atmosphere, attracting bark beetles to their location, and rousing their attacks. The connection between stress and increased susceptibility to insects and diseases underscores the importance of understanding the type and severity of stress.

Review of Arizona's Drought Conditions

Between January and March, 2022 long term drought conditions appeared to improve in portions of central and southern Arizona. Small areas in Navajo, Coconino, and Mohave counties were still experiencing Exceptional drought levels (D4), which is the highest and most severe level of drought according to the Drought Monitor. Extreme drought levels (D3) were still present in La Paz, Mohave, Coconino, Navajo, Apache and Greenlee counties; while severe drought (D2) conditions persisted in Yuma and Maricopa counties (Figure 3). La Niña conditions lingered, but there was a shift at this time that the likelihood of the 2022 monsoon season could be wetter than average for southeast portions of the state.

Exceptional (D4) and Extreme (D3) drought conditions continued in parts of La Paz, Mohave, Coconino, Navajo and Apache counties from April to June, 2022. Severe (D2) drought conditions were persisting in Yuma and Maricopa counties (Figure 3). Abnormally Dry (D0) and Moderate (D1) drought levels were observed in portions of central and southern Arizona; this was a result of the brief wet periods within these areas. La Niña conditions continue to persist over the Pacific Ocean; if this weather pattern could materialize it would mean drier than normal weather during the 2022-2023 fall and winter.

August and September were productive months for precipitation throughout Arizona; most of the state received average or above-average precipitation (100-400%). Because of this moisture, short-term drought significantly improved in August 2022, leaving 76% of the state in Abnormally Dry (D0) or Moderate (D1) drought levels. All Exceptional (D4) drought levels were gone from the state, and only 3% of the state, in Mohave County, had a small area of Extreme (D3) drought (Figure 3). La Niña conditions still persisted into September, suggesting below-normal precipitation during the winter (Figure 3).

Arizona was much cooler than normal in November. Most of the state (53%) was experiencing Abnormally Dry (D0) conditions; Moderate (D1) drought conditions persisted over 36% of the state, and Severe (D2) drought conditions only covered 11% of the state (Figure 3). By the end of November, into December La Niña conditions would continue into early 2023.

Overall Arizona received much needed precipitation during our Monsoon season, but the La Niña conditions continued to persist, suggesting a drier than normal fall and winter leading into 2023. The timing of when our

forests receive their moisture, and the form they receive that precipitation in, all impacts the health and vigor of Arizona's forests.

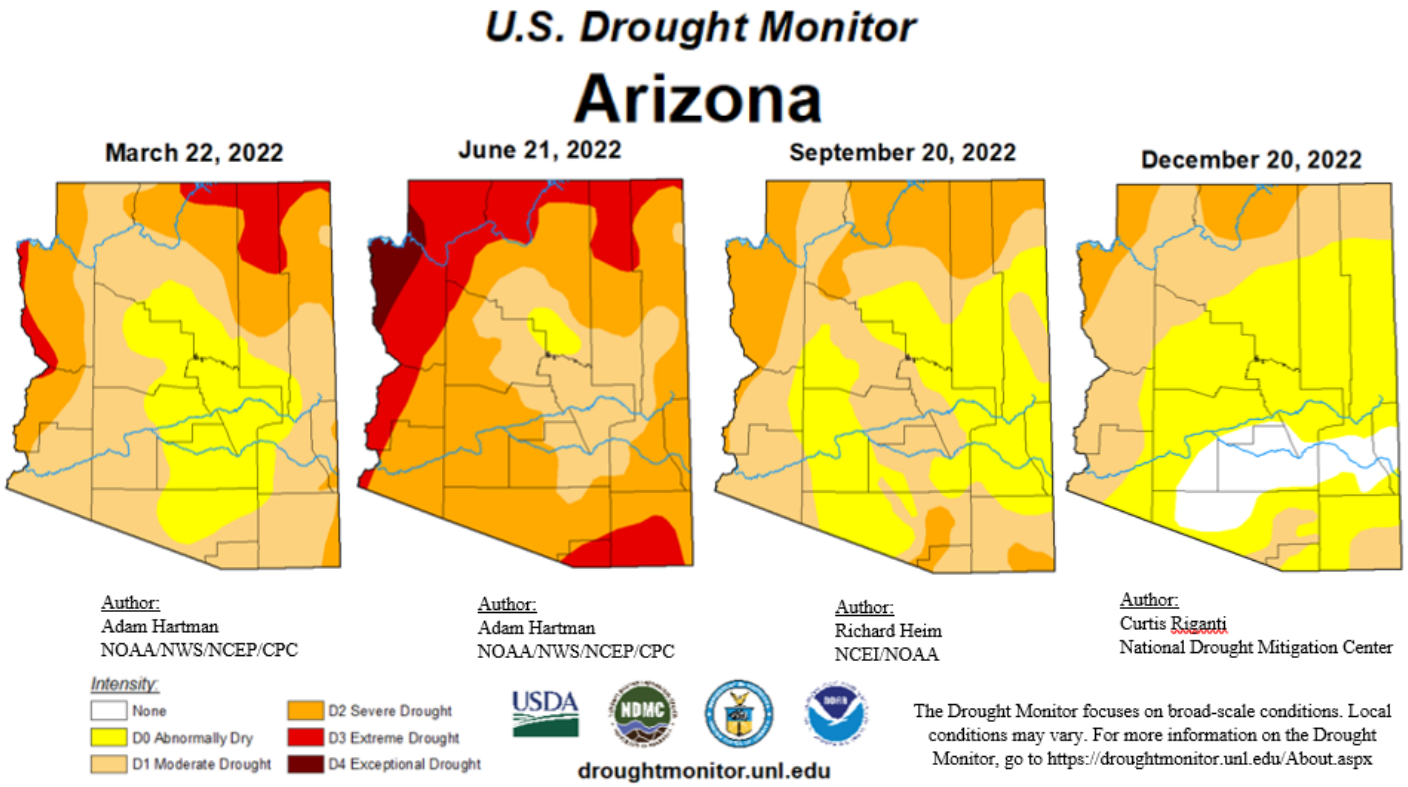

Figure 3 – U.S. Drought monitor maps of Arizona in March, June, September, and December, 2022; obtained from droughtmonitor.unl.edu

Statewide Highlights

Bark Beetle Update

When we compare the acres with bark beetle caused tree mortality throughout Arizona, between 2021 and 2022, we see a small decrease in areas with mortality caused by bark beetles. Figure 4 shows all bark beetle mortality observations from 2022; this damage is spread throughout the state, occurring mostly on federal and tribal lands (Table 1). During the summer of 2021 over 528,000 acres with bark beetle caused mortality were observed; in the summer of 2022 that number declined to just over 440,000 acres (Table 2), this is a 23% decrease in bark beetle caused mortality statewide.

Arizona 2022 - Estimated Acres with Observed Insect Damage by Land Ownership					
Disease Causal Agent	**Federal**	**Private**	**State**	**Tribal Lands**	**Grand Total**
Bark Beetles	286,166.3	6,828.8	5,558.2	104,130.4	**402,683.7**
Defoliators	8,335.9	3,928.5	1,109.4	2,635.1	**16,008.9**
Sap Feeders	14,927.8	1,616.5	241.7	7,549.1	**24,335.0**
Twig Beetles	1,918.3	30.8		633.3	**2,582.3**
Wood Borers	703.3	0.3	0.3	54.2	**758.0**
Grand Total	**312,051.6**	**12,404.8**	**6,909.5**	**115,002.1**	**446,368.0**

Table 2. Estimated Acres with Observed Insect Damage by Land Ownership for the State of Arizona - 2022

Bark beetle damage will be broken down by District, with detail provided on each bark beetle. One type of bark beetle mortality identified in every district is observed "Unknown Bark Beetle" damage, which represents all ponderosa pine bark beetles. As there are more than a dozen bark beetles that attack and kill ponderosa pine trees in Arizona, there is often more than one species within a single tree; thus, ponderosa pine mortality is represented by the "Unknown Bark Beetle" type within our ADS data.

In the Southeast (A3S) and Central Districts (A4S) this "Unknown Bark Beetle" category also includes the Southern pine beetle (*Dendroctonus frontalis)* and Mexican Pine Beetle (*Dendroctonus mexicanus)* as they attack Chihuahua and apache pines that are found in this part of Arizona.

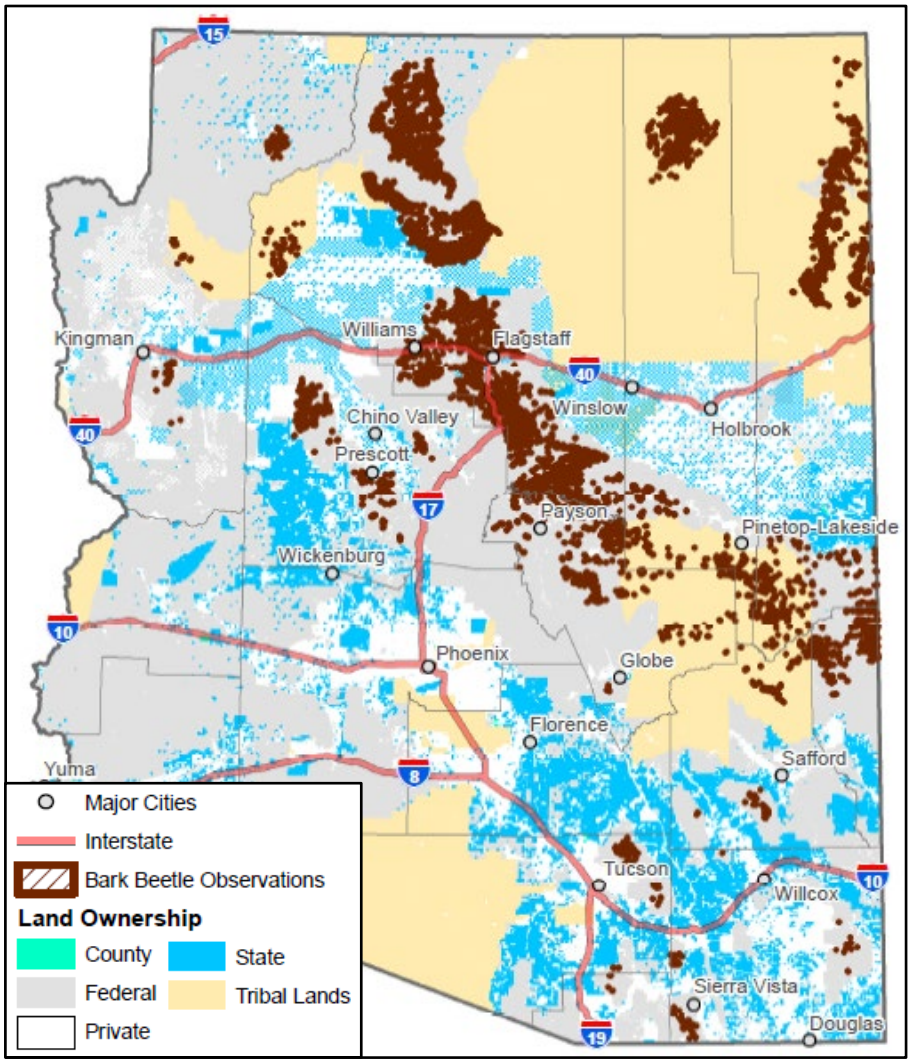

Figure 4 – All Bark Beetle Observations within Arizona - 2022

Cedar and Cypress Bark beetle (*Phloeosinus* spp.) damage was observed in several Arizona Districts in the summer of 2022. These bark beetles attack Arizona cypress and juniper trees. They do not typically cause extensive mortality; they are often found attacking portions of weakened, dying or recently felled trees. All reported acres of cedar and cypress bark beetle mortality were observed on the ground by forestry professionals.

Twig Beetle (*Pityophthorus* spp., *Pityogenes* spp., and/or *Pityoborus secundus*) damage was observed in four of Arizona's five districts. Twig beetles attack and kill the small limbs and branches of weakened and stressed pines and other conifers. These beetles are typically considered secondary insects as they often only kill trees that were previously weakened or stressed. If conditions are favorable, twig beetles could develop large populations and attack and kill small trees. These beetles are hard to identify, thus similarly to the "Unknown Bark Beetle" damage type they are all represented by the "Twig Beetle" damage type within the ADS data.


Photo: Light Ponderosa pine BB mortality, Kaibab NF, 2022

Invasive Insect Update

Tamarisk leaf beetles (*Diorhabda* spp.) were identified in the 1990's as a potential bio-control for the invasive tamarisk plant (*Tamarix* spp.), also known as salt cedar. Salt cedar was introduced into the southwest in the 1800s; thus, it had centuries to become established and begin taking over native habitat. For example, one to two cottonwoods can grow per acre along the river beds in Arizona, but three to four thousand salt cedar plants can attempt to grow on a single acre.

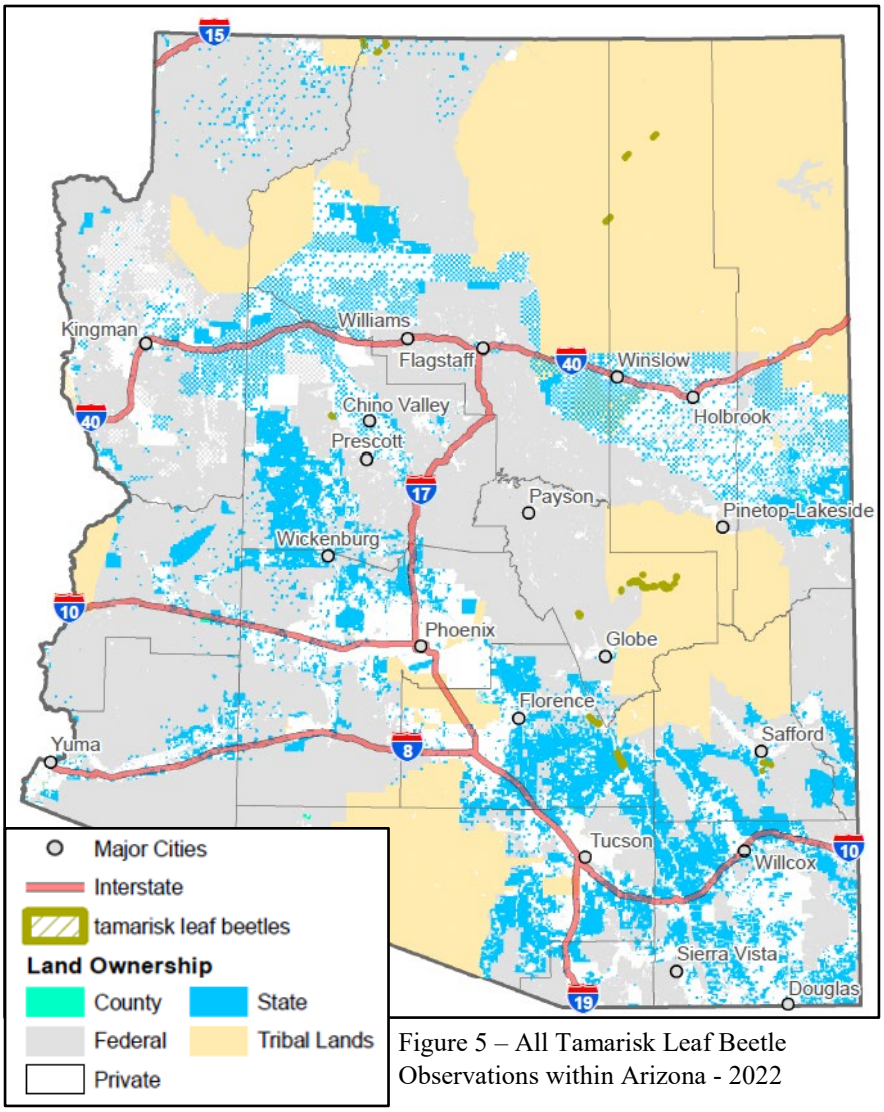

Figure 5 – All Tamarisk Leaf Beetle Observations within Arizona - 2022

Tamarisk leaf beetles were released in hopes it would help abate the salt cedar invasion, and allow native plants to move back into their native habitat. However, as salt cedar became established, and native riparian habitat declined, the endangered Southwestern Willow Flycatcher began using salt cedar for its nesting grounds. The extent of control that the beetle will exert on tamarisk and the affect that will have on Southwestern Willow Flycatcher habitat is unknown. Tamarisk leaf beetles were not expected to persist below the Arizona-Utah border; however, they have been consistently moving south along the Colorado River, and into the rivers and riparian areas of Arizona.

Several Arizona Districts did have observed salt cedar defoliation from Tamarisk leaf beetle (Figure 5), this data will be discussed per District. It is worth mentioning that the acres observed with tamarisk leaf beetle damage are areas that are not typically flown. Thus, these acres were captured only because our flight path took us over or near these riparian areas. It is reasonable to assume damage from

Photo: Credit, Camden Bruner, Wildlife Biologist USDA Forest Service, Tamarisk leaf beetle defoliation in the Tonto NF, 2022

these insects is on additional acres throughout Arizona that were not flown during the ADS season, therefore the acres reported here are not representative of the entire State.

Noninfectious Disorders (Abiotic Damage)

The symptoms of abiotic disorders can resemble those of some insects and diseases, making it more difficult to determine the cause. Abiotic disorders and damages can become entry points for pathogens, while also increasing the tree's overall stress, making it more susceptible to other insect and disease infestation. In this report abiotic damage falls into 3 categories: Drought, Human Activities, or Unknown. Drought refers to a water deficit that develops when there is a lack in precipitation or changes to a watering schedule. When the water loss exceeds the rate of water absorption from the soil, chronic injury within the plant host can occur. This injury is expressed through symptoms such as a lack in growth, wilting, discoloration of the foliage, and premature leaf drop. In the Southwest, winter drought is particularly harmful to forests and can render large areas more susceptible to bark beetles and wildfire. The progression of decline in the tree will typically begin from the top down and from the outside in; the roots are usually the last part of the tree to die. The symptoms associated with chronic drought stress and drought damage can look very similar to root disease symptoms.

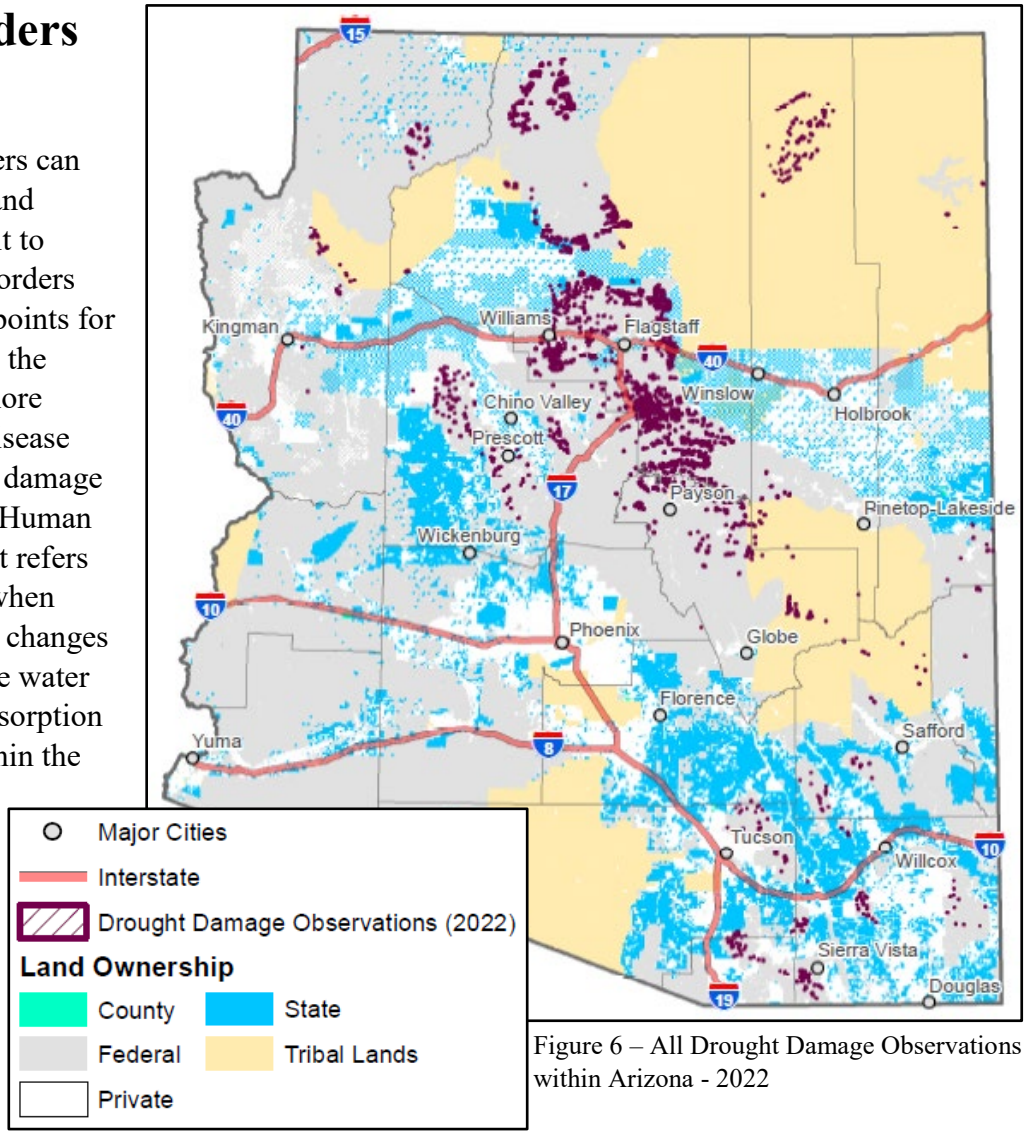

Figure 6 – All Drought Damage Observations within Arizona - 2022

Forestry professionals began noticing large areas of juniper-pinyon dieback in northern Arizona, near Flagstaff and Williams in the late spring, early summer of 2022. Ground-truthing confirmed the pinyon-juniper woodland dieback was due to drought. Figure 6 shows the majority of drought observations were above the Mogollon Rim, in pinyon-juniper woodlands, and some ponderosa pine stands.

Human Activities is another group of noninfectious disorders dedicated to observed salt and deicer damage along roadways. The uptake of salt by roots is a common issue where sodium chloride, calcium chloride, and magnesium chloride are applied to de-ice highways in the winter or for dust abatement on dirt roads in the spring/summer/fall. The salt leached off the roads in heavy rains goes into drainages where trees will capture the water, resulting in damage and even mortality. Often the symptoms associated with salt damage look

insignificant, and appear as tip burn. Mortality can often occur when magnesium chloride or calcium chloride is applied right before heavy rainstorms.

Unknown abiotic damage is a catch-all group for damage we could not identify from the air and were unable to confirm on the ground. The majority of this unknown damage are areas identified for having a general discoloration to their crowns. Many areas that were checked on the ground that had this aerial signature of crown discoloration, appeared to be suffering from drought stress. The Unknown category also includes defoliation, general mortality or dieback, and occasionally branch flagging that was not able to be verified by ground-truthing.

Photo: Pinyon pine mortality from drought, Coconino NF, 2022

Disease Identification during Aerial Detection Surveys

Many of the signs and symptoms associated with tree diseases can be difficult to identify from the air, as the aerial signatures can look very similar to insect activity. For this reason, USDA Forest Service and Arizona DFFM forestry professionals ground truth, and verify that the damage observed from the air is the same agent that is causing the damage on the ground. Due to the complexities with identifying diseases from the air, there were not many acres with observed disease damage. The majority of observed disease damage is found on the ground by forestry professionals working in the field.

Arizona's Five Districts

The Arizona Department of Forestry and Fire Management divides the state into five (5) distinct Districts (Appendix I). Each District shares similar forest and woodland health issues while experiencing a varying degree of tree damage from insects and disease. Each District will be reviewed individually to more accurately show which insects and diseases are impacting the state, and where their damage can be found throughout the state.

It is important to note that the acreages for each District may look inflated due to the fact that some acres are counted twice because more than one damage causal agent was found on those acres.

Northern District (A1S) Update – 2022

Status of Insects

The Northern District (A1S) is composed of the Kaibab National Forest, Coconino National Forest, Grand Canyon National Park, and Navajo, Hualapai, Havasupai, and Kaibab Reservations; these areas are surrounded by scattered county, state, and military reservation lands (Appendix I).

Figure 7 is a map showing all insect and disease observations within the Northern District. The majority of insect observations occurred on Federal Lands (Table 3). In total, more than 254,000 acres were observed with bark beetle mortality, over 6,500 acres with observed defoliator damage, over 800 acres with sap feeding insect damage, and just over 400 acres with wood boring insect damage.

The bark beetle mortality that was observed was cause by more than 9 different bark beetles; this damage was observed on more than 254,000 acres within the Northern District (Table 4).

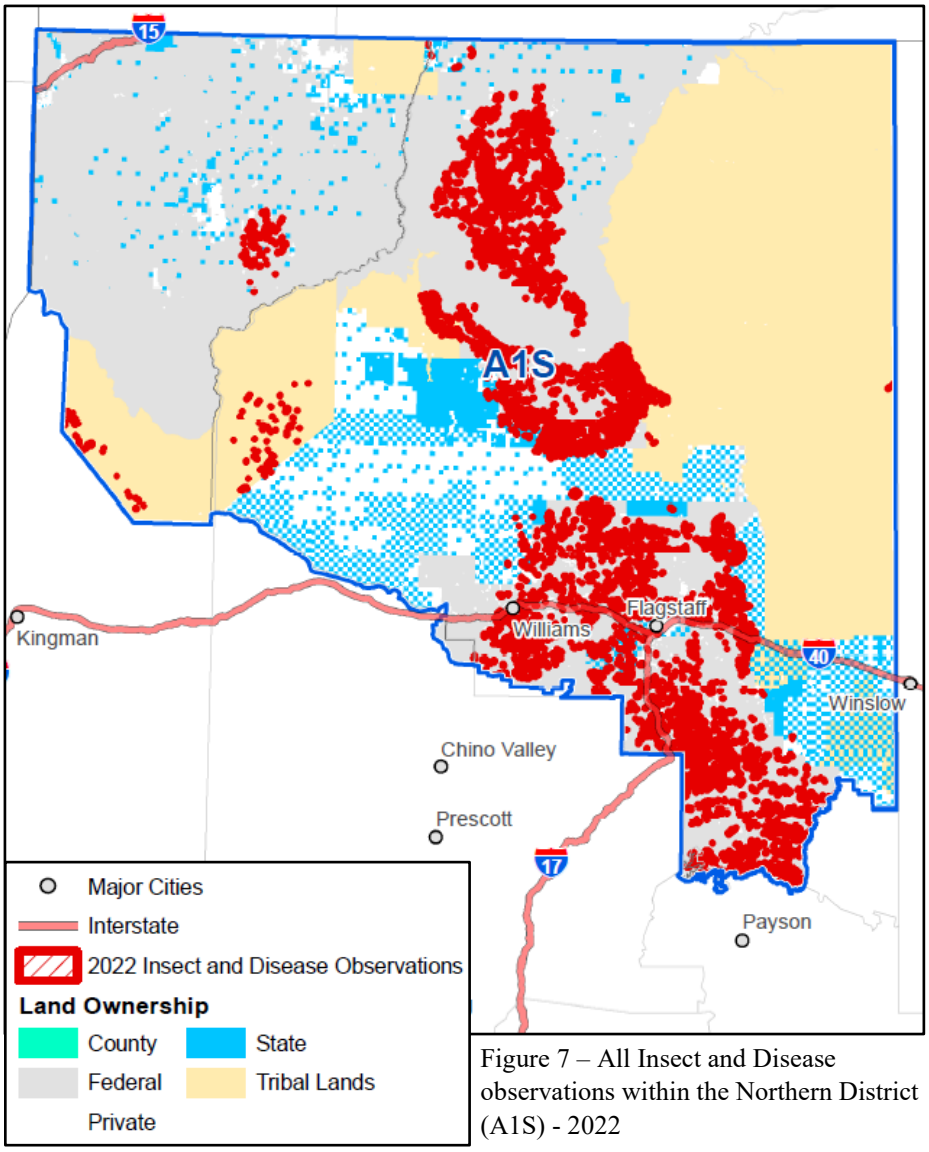

Figure 7 – All Insect and Disease observations within the Northern District (A1S) - 2022

Of the more than 8 different types of bark beetles observed causing mortality within the Northern District, the Cedar and Cypress bark beetles (*Phloeosinus* spp.) caused the least amount of damage with only one acre with observed mortality. This observed single acre suggests the data was collected on the ground by a forestry professional.

A1S - Estimated Acres with Observed Insect Damage by Land Ownership					
Insect Agent	**Federal**	**Private**	**State**	**Tribal Lands**	**Grand Total**
Bark Beetles	233,916.2	4,897.3	5,501.5	9,910.3	**254,225.3**
Defoliators	6,101.9	210.9	44.2	153.0	**6,510.0**
Sap Feeders	827.2			36.0	**863.2**
Wood Borers	380.0			54.2	**434.3**
Grand Total	**241,225.3**	**5,108.2**	**5,545.8**	**10,153.5**	**262,032.8**

Table 3. Estimated acres with Observed Insect Damage by Land Ownership for the Northern District (A1S) - 2022

Douglas-fir beetle (*Dendroctonus pseudotsugae*), Spruce beetle (*Dendroctonus rufipennis*), Twig beetles (refer back to the introduction for clarification of what genus these beetles belong to) and Western Balsam bark beetles (*Dryocoetes confusus*) accounted for just over 9,600 acres with bark beetle caused tree mortality (Table 4).

Fir engraver (*Scolytus ventralis*) beetles caused over 31,000 acres with observed mortality (Table 4); this is a 628% increase in mortality from last year, when just over 4,200 acres were observed with fir engraver mortality in 2021.

Pinyon ips (*Ips confusus*) caused over 91,000 acres with observed mortality (Table 4). This mortality of pinyon pines was observed in the lower elevation woodlands of the Northern District (A1S).

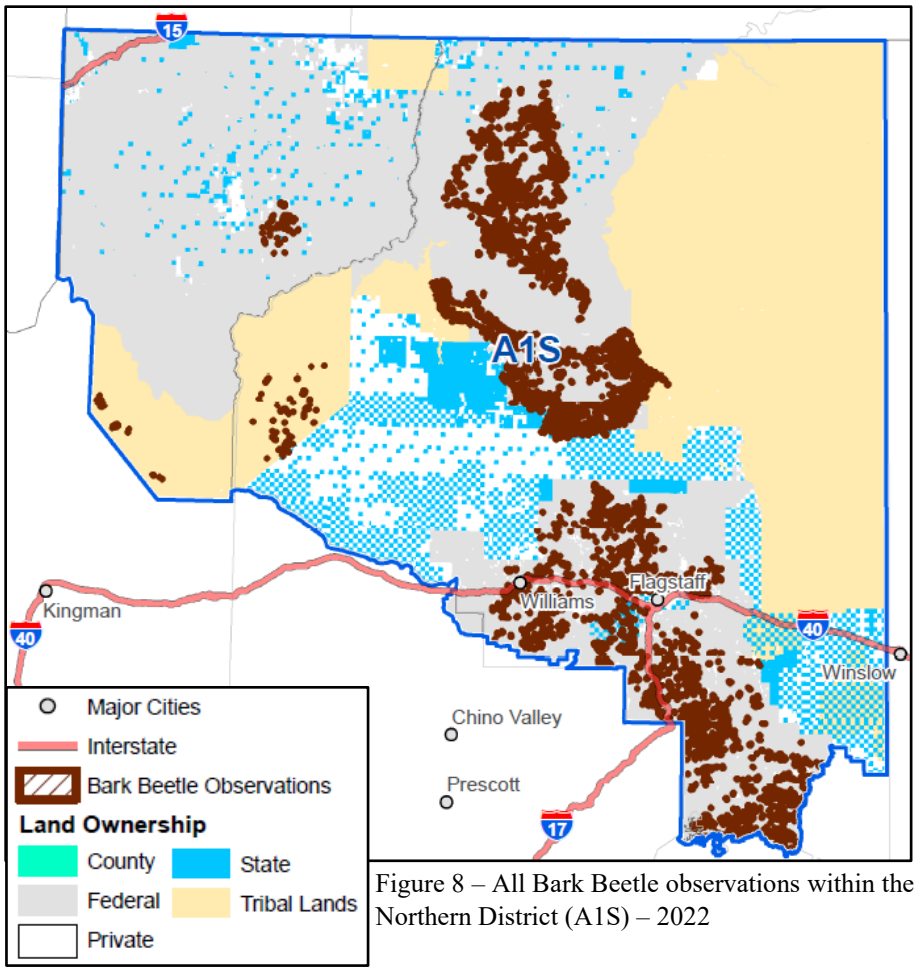

Figure 8 – All Bark Beetle observations within the Northern District (A1S) – 2022

Lastly, the Unknown Bark Beetle category includes over 121,000 acres with observed mortality (Table 4). This category of unknown bark beetles includes all the bark beetles that attack ponderosa pines: *Ips pini*, *Ips lecontei, Ips calligraphus, Ips integer, Ips latidens, Ips woodi, Ips hoppingi, Ips knousi, Ips fonanseai, Dendroctonus barberi, Dentroctonus ponderosae, Dendroctonus adjunctus, Dendroctonus valens,* and *Dendroctonus approximates.* It is important to note this is a 52% decrease in ponderosa pine mortality from the Unknown Bark Beetle category; over 253,000 acres were observed last year with Unknown Bark Beetle caused mortality in the Northern District (A1S).

A1S - Estimated Acres with Observed Bark Beetle Damage by Land Ownership					
Bark Beetles	**Federal**	**Private**	**State**	**Tribal Lands**	**Grand Total**
Cedar & Cypress bark beetles	0.6	0.4			**1.0**
Douglas-fir beetle	1,491.2				**1,491.2**
Fir engraver	31,190.5	38.1			**31,228.6**
Pinyon ips	74,914.6	3,740.1	4,399.4	8,708.3	**91,762.5**
Spruce beetle	282.3				**282.3**
Twig beetles	1,538.4	12.9			**1,551.3**
Unknown bark beetle	118,170.3	1,105.7	1,102.1	1,202.1	**121,580.1**
Western Balsam bark beetle	6,328.4				**6,328.4**
Grand Total	**233,916.2**	**4,897.3**	**5,501.5**	**9,910.3**	**254,225.3**

Table 4. Estimated acres with Observed Bark Beetle Damage by Land Ownership for the Northern District (A1S) - 2022

The Northern District had other insect damage caused by wood borers which was observed on over 400 acres (Table 5); this damage was attributed to roundheaded borers (Cerambycidae spp.) which primarily attack weakened, dying, or dead trees.

A1S - Estimated Acres with Observed Insect Damage by Land Ownership			
Insect Agent	**Federal**	**Tribal Lands**	**Grand Total**
Roundheaded borer	380.0	54.2	**434.3**

Table 5. Estimated acres with Observed Roundheaded Borer Damage by Land Ownership for the Northern District (A1S) - 2022

Additional insect damage was observed in the Northern District (A1S) that fell into one of two categories: sap feeders or defoliators. The majority of sap feeding or sap sucking insects fall into the orders Hemiptera and Homoptera; they are small in size and directly injure the host tree by sucking its food and water supply, producing necrotic spots in the host tissue, and indirectly injuring the tree by introducing plant diseases into the host.

Photo: Mixed conifer BB mortality (Fir engraver and Douglas-fir), Kaibab NF, 2022

Pinyon needle scale (*Matsucoccus acalyptus)* is a sap sucking insect that attacks pinyon pines. Pinyon needle scale can cause needles to yellow and drop early. Repeated attacks can cause reduced growth and stunted needles; in severe outbreaks small trees may be killed, but larger trees can become more susceptible to bark beetle attacks. This year just over 800 acres with pinyon needle scale damage was observed in the Northern District (Table 6); this is a 91% decrease from last year's pinyon needle scale damage in the Northern District (A1S) when over 10,000 acres were observed with damage.

A1S - Estimated Acres with Observed Insect Damage by Land Ownership			
Insect Agent	**Federal**	**Tribal Lands**	**Grand Total**
Douglas-fir Tussock moth	7.2		**7.2**
Pinyon needle scale	827.2	36.0	**863.2**
Unknown defoliator	4,556.0		**4,556.0**
Western Spruce budworm	1,513.5		**1,513.5**
Grand Total	**6,896.7**	**36.0**	**6,932.7**

Table 6. Estimated acres with Observed Insect Damage by Land Ownership for the Northern District (A1S) - 2022

Photo: Pinyon needle scale, Coconino NF, 2022

Defoliating insects damage trees by eating their leaves/needles; by removing their photosynthetic tissue, the host trees becomes increasingly susceptible to attacks from other insects and pathogens. If the defoliation is severe enough, it can lead to the death of the host tree.

Western Spruce budworm (*Choristoneura occidentalis)* attacks Douglas-fir, true firs, and spruce trees. Defoliation by the western spruce budworm can cause growth loss, with repeated heavy defoliation leading to an extreme decrease in growth and even

tree deformity. Top kill can also occur in severe defoliation, which can lead to whole tree mortality. This year over 1,500 acres with western spruce budworm were observed within the Northern District of Arizona (Table 6).

Douglas-fir Tussock Moth (*Orgyia pseudotsugae*) damage was observed in the Northern District this year. Douglas-fir Tussock Moth attacks Douglas-fir, white fir, and spruce trees. If outbreaks are severe enough they can cause significant mortality of both overstory and understory trees within 1-2 years. Top-kill can occur in minor outbreaks; Doug-fir bark beetles are attracted to these stressed trees and cause epidemics in tussock moth defoliated landscapes. This year just over 7 acres were observed north of Payson with Douglas-fir Tussock Moth defoliation; these 7 acres consisted of federal lands in the southeast corner of the district (Figure 9).

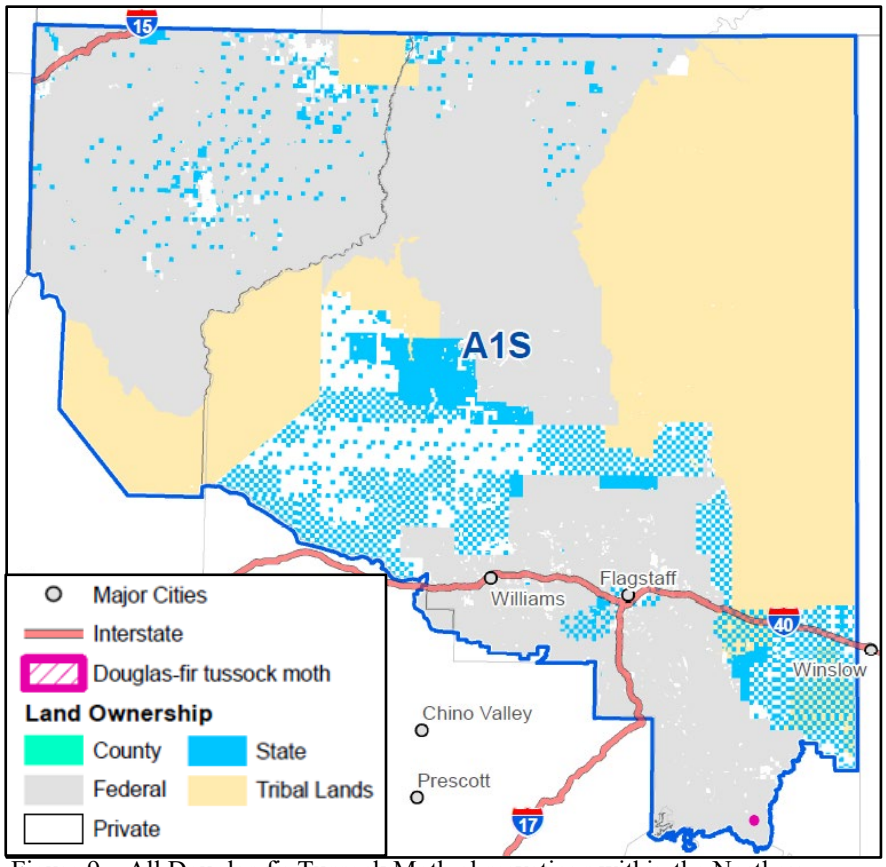

Figure 9 – All Douglas-fir Tussock Moth observations within the Northern District (A1S) – 2022

Lastly, there is a group of defoliators identified as "Unknown Defoliator". This is a catch-all name for defoliation seen from the air that cannot be identified as a specific insect or disease-causing agent. The majority of "Unknown Defoliator" damage occurs in aspen or other deciduous tree stands. Only some of these locations are able to be reached on the ground by forestry professionals, thus there are still locations that are not double checked and are left as "Unknown Defoliation". This year, over 4,500 acres with observed "Unknown Defoliator" damage were mapped within the Northern District (Table 6).


Photo: Unknown defoliation of Ponderosa Pine in a mixed conifer stand in the north rim of Grand Canyon National Park, 2022

Aerial surveyors identified a large area in the north rim of the Grand Canyon National Park that consisted of this unknown defoliation (Photo:

Unknown defoliation of Ponderosa Pine). Upon further investigation through ground-truthing, not a single insect or disease could be identified as causing this defoliation. Due to the severity of the defoliation, it suggests more than one insect and or disease caused this damage.

Status of Invasive Insects

This year several locations were observed in riparian areas where severe defoliation of salt cedar from tamarisk leaf beetle had occurred. In the Northern District, just over 400 acres were observed having defoliation damage from the tamarisk leaf beetle (Table 7).

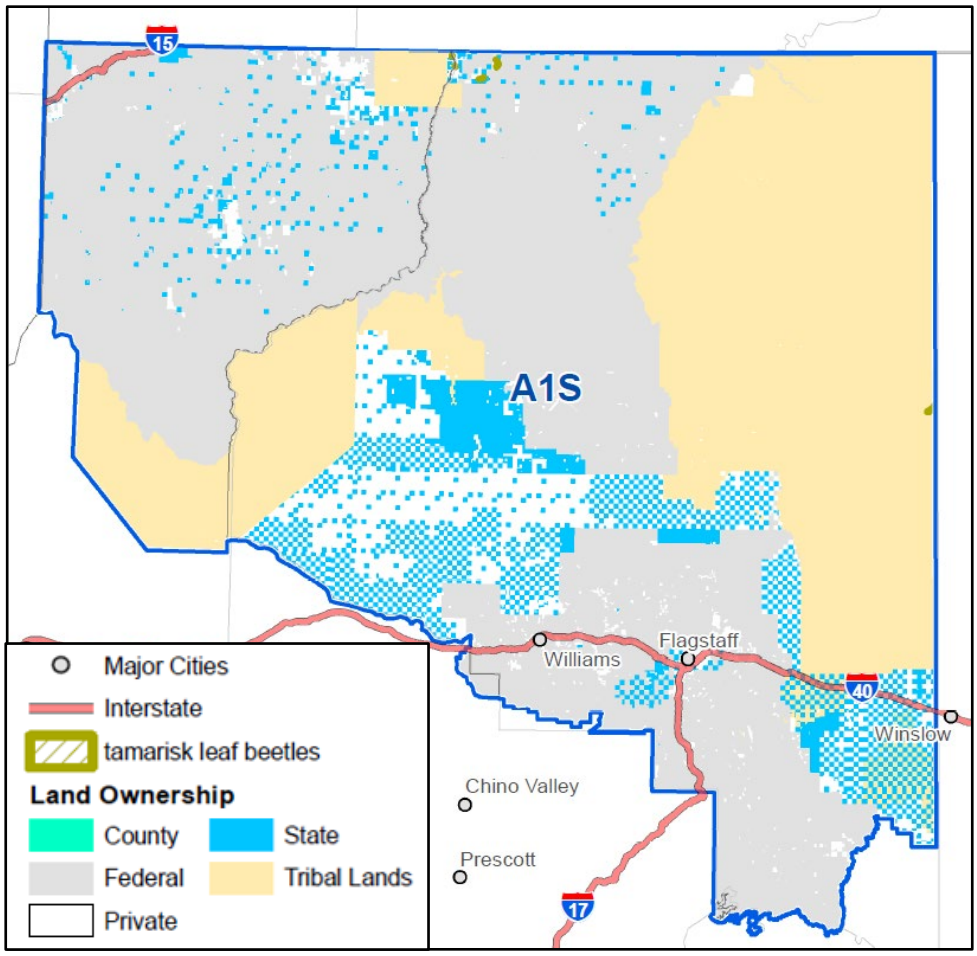

Figure 10 – All Tamarisk Leaf beetle observations within the Northern District (A1S) – 2022

The majority of this damage was observed on private and tribal lands (Figure 10); with over 200 acres of observed tamarisk defoliation on private lands and over 150 acres on tribal lands. The remaining 70 acres of observed tamarisk defoliation was on federal and state lands (Table 7).

A1S - Estimated Acres of Observed Invasive Insect Damage by Land Ownership					
Insect Agent	**Federal**	**Private**	**State**	**Tribal Lands**	**Grand Total**
Tamarisk leaf beetles	25.3	210.9	44.2	153.0	**433.3**

Table 7. Estimated acres with Observed Invasive Insect Damage by Land Ownership for the Northern District (A1S) - 2022

Status of Unknown and Non Infectious Disorders

This year over 152,000 acres with observed drought damage were identified (Table 8). Most of these observed acres were on federal lands and within pinyon-juniper woodlands (Figure 11).

There was just over 400 acres with observed salt or deicer damage, all of which is found along roadways mostly on federal lands (Table 8).

A1S - Estimated Acres with Abiotic and Unknown Tree Damage by Land Ownership					
Disease Causal Agent	**Federal**	**Private**	**State**	**Tribal Lands**	**Grand Total**
Drought	132,169.4	8,757.7	6,709.7	4,496.6	**152,133.4**
Unknown	2,342.0	163.9		179.5	**2,685.4**
Road Salt or Deicers	316.4	66.2	31.6		**414.2**
Grand Total	**134,827.7**	**8,987.8**	**6,741.3**	**4,676.1**	**155,233.0**

Table 8. Estimated acres with Observed Abiotic and Unknown Damage by Land Ownership for the Northern District (A1S) - 2022

Of the 2,600 acres with unknown damage, over 1,100 acres were observed with unknown defoliation damage (Table 8); this damage was either categorized as heavy defoliation (> 2/3 of foliage) or light defoliation (< 1/3 of foliage). There was 855 acres with observed unknown dieback, just over 6 acres with unknown discoloration, and nearly 650 acres with unknown mortality (Table 9).

A1S - Estimated Acres with Unknown Tree Damage by Land Ownership				
Unknown Damage Type	**Federal**	**Private**	**Tribal Lands**	**Grand Total**
Defoliation - Heavy	516.4	37.1	101.6	**655.1**
Defoliation - Light	521.8			**521.8**
Dieback	761.7	15.4	77.9	**855.0**
Discoloration		6.6		**6.6**
Mortality	542.1	104.8		**646.8**
Grand Total	**2342.0**	**163.9**	**179.5**	**2685.4**

Table 9. Estimated acres with Unknown Damage by Land Ownership for the Northern District (A1S) - 2022

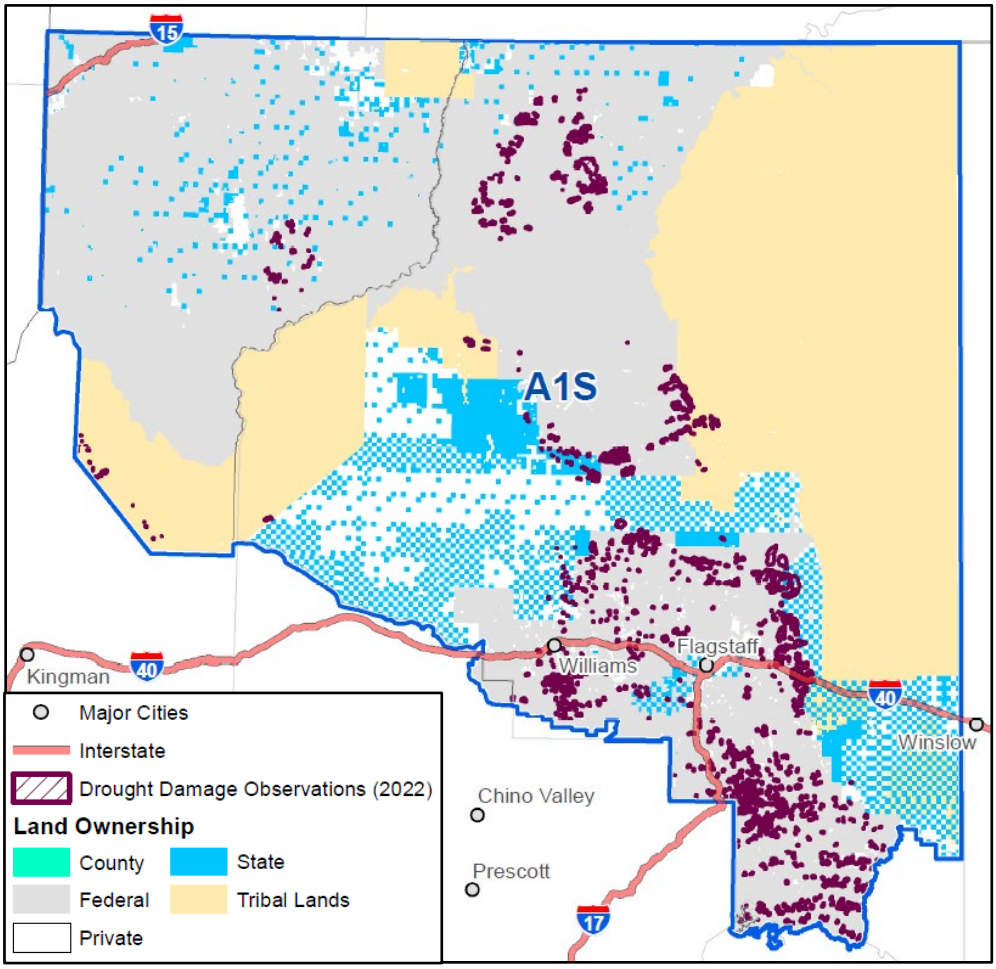

Figure 11 – All drought observations within the Northern District (A1S) – 2022

Photo: Drought dieback, juniper-pinyon woodlands Coconino NF, 2022

Northeast District (A2S) Update – 2022

Status of Insects

The Northeast District is composed of Navajo, Apache, Fort Apache, and Hopi reservation lands, as well as the Apache-Sitgreaves National Forest; these lands are surrounded by scattered county and state lands (Appendix I).

Figure 12 is a map showing all insect and disease observations within the Northeast District (A2S). The majority of insect observations occurred on tribal lands. In total, more than 113,000 acres with bark beetle mortality were observed, over 3,000 acres with defoliator damage, over 6,700 acres with sap feeding damage, and less than half an acre of wood borer damage was observed (Table 10).

There were more than 8 different types of bark beetles observed causing mortality within the Northeast District; this damage was observed on more than 113,000 acres (Table 10).

Of the 8 different types of bark beetles observed causing mortality within the Northeast District the Cedar and Cypress bark beetles (*Phloeosinus* spp.) caused the least amount of damage with only half of one acre with observed mortality (Table 11). The small size of this damage area suggests the data was collected on the ground by a forestry professional.

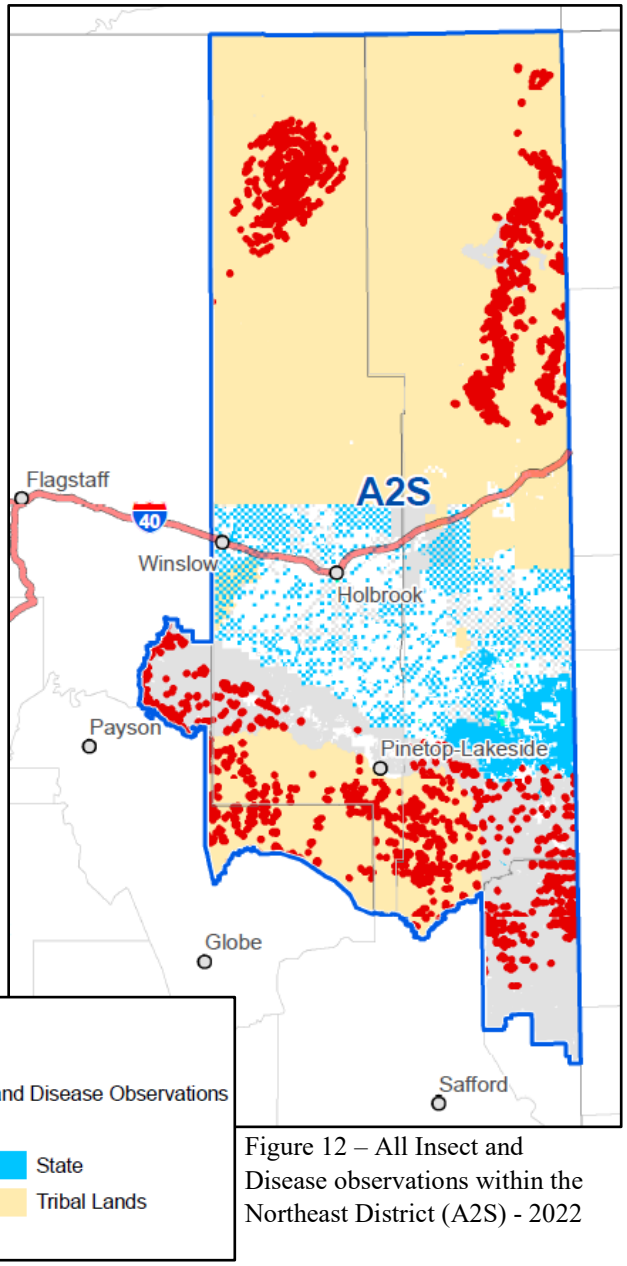

Figure 12 – All Insect and Disease observations within the Northeast District (A2S) - 2022

Douglas-fir beetle (*Dendroctonus pseudotsugae*), Spruce beetle (*Dendroctonus rufipennis*), Fir engraver (*Scolytus ventralis*), Twig beetles (refer back to the introduction for clarification of what genus these beetles belong to) and Western Balsam bark beetles (*Dryocoetes confusus*) accounted for over 10,700 acres with bark beetle caused tree mortality (Table 11).

Pinyon ips (*Ips confusus*) caused over 71,000 acres with observed mortality (Table 11). The observed mortality of Pinyon pines was a 383% increase from last year, when over 14,000 acres were observed with Pinyon ips mortality; this damage occurred in the lower elevation pinyon-juniper woodlands of the Northeast District (A2S).

A2S - Estimated Acres with Observed Insect Damage by Land Ownership					
Insect Agent	**Federal**	**Private**	**State**	**Tribal Lands**	**Grand Total**
Bark Beetles	23,049.6	80.7	19.8	90,255.9	**113,406.0**
Defoliators	959.1	14.3		2,099.0	**3,072.4**
Sap Feeders	71.4			6,668.2	**6,739.6**
Wood Borers			0.3		**0.3**
Grand Total	**24,080.1**	**95.0**	**20.0**	**99,023.1**	**123,218.2**

Table 10. Estimated acres with Observed Insect Damage by Land Ownership for the Northeast District (A2S) - 2022

Lastly, the Unknown Bark Beetle category includes nearly 31,000 acres with observed mortality (Table 11). This category of unknown bark beetles includes all the bark beetles that attack ponderosa pines: *Ips pini*, *Ips lecontei, Ips calligraphus, Ips integer, Ips latidens, Ips woodi, Ips hoppingi, Ips knousi, Ips fonanseai, Dendroctonus barberi, Dentroctonus ponderosae, Dendroctonus adjunctus, Dendroctonus valens,* and *Dendroctonus approximates*. As more than one species often contributes to the decline and death of ponderosa pines, we lump all ponderosa bark beetles into this one category "Unknown Bark Beetles". It is worth mentioning this is a 59% decrease in ponderosa pine mortality from the Unknown Bark Beetle category; over 77,000 acres were observed last year with Unknown Bark Beetle caused mortality in the Northeast District (A2S).

A2S - Estimated Acres with Observed Bark Beetle Damage by Land Ownership					
Disease Causal Agent	**Federal**	**Private**	**State**	**Tribal Lands**	**Grand Total**
Cedar & Cypress bark beetles				0.5	**0.5**
Douglas-fir beetle	48.4			657.0	**705.4**
Fir engraver	2,029.7			6,199.7	**8,229.4**
Pinyon ips	5,954.2	19.8	14.9	65,680.2	**71,669.2**
Spruce beetle	18.7			26.3	**45.0**
Twig beetles	256.0			633.0	**889.0**
Unknown bark beetle	14,655.0	60.9	4.8	16,238.1	**30,958.7**
Western Balsam bark beetle	87.6			821.2	**908.8**
Grand Total	**23,049.6**	**80.7**	**19.8**	**90,255.9**	**113,406.0**

Table 11. Estimated acres with Observed Bark Beetle Damage by Land Ownership for the Northeast District (A2S) - 2022

Photo: Fir engraver and Douglas-fir beetle mortality, Tonto NF, 2022

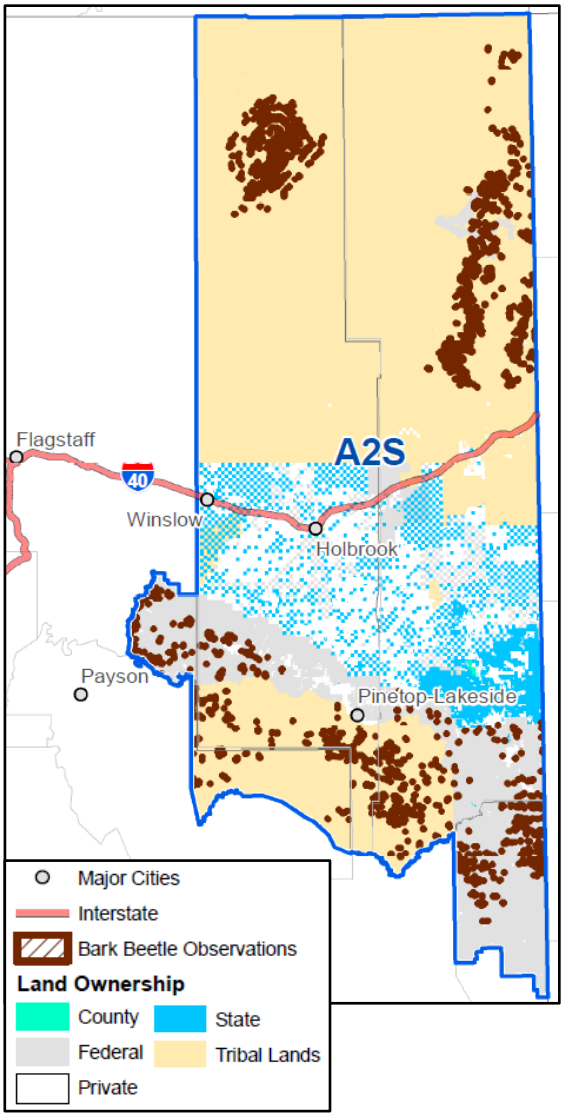

Figure 13 – All Insect and Disease observations within the Northeast District (A2S) - 2022

The Northeast District had other insect damage caused by wood borers which was observed on less than one acre (Table 12). This damage was attributed to roundheaded borers (Cerambycidae spp.) which primarily attack weakened, dying, or dead trees; this location was identified on the ground by forestry professionals, which is why the size of the damage area is small.

A2S - Estimated Acres with Observed Insect Damage by Land Ownership		
Insect Agent	**State**	**Grand Total**
Roundheaded borer	0.3	**0.3**

Table 12. Estimated acres with Observed Wood Borer Damage by Land Ownership for the Northeast District (A2S) - 2022

Additional insect damage was observed in the Northeast District (A2S) that fell into one of two categories: sap feeders or defoliators. The majority of sap feeding or sap sucking insects fall into the orders Hemiptera and Homoptera.

A2S - Estimated Acres with Observed Insect Damage by Land Ownership				
Insect Agent	**Federal**	**Private**	**Tribal Lands**	**Grand Total**
Pinyon needle scale	71.4		6,654.0	**6,725.4**
Spruce aphid			14.2	**14.2**
Unknown defoliator	946.2	14.3	1,294.1	**2,254.7**
Western Spruce budworm			69.0	**69.0**
Grand Total	**1,017.6**	**14.3**	**8,031.4**	**9,063.3**

Table 13. Estimated acres with Observed Insect Damage by Land Ownership for the Northeast District (A2S) - 2022

Pinyon needle scale (*Matsucoccus acalyptus)* is a sap sucking insect that attacks pinyon pines and can cause needles to yellow and drop early. Repeated attacks can cause reduced growth and stunted needles. Severe outbreaks may kill small trees while larger trees can become more susceptible to bark beetle attacks. This year over 6,700 acres with pinyon needle scale damage was observed in the Northeast District (Table 13); this is a 78% increase from last year's pinyon needle scale damage in the Northeast District (A2S) when over 3,700 acres were observed with damage.

Photo: Grey discoloration and thinning crowns from Pinyon needle scale, Tonto NF, 2022

Spruce aphid (*Elatobium abietinum*) has been affecting high elevation spruce forests in the southwest for just a few decades; this insect is a sap feeder, causing early leaf/needle drop, yellowing of foliage, and reduced growth. The aerial signature for this insect is hard to see, and thus it is mostly identified on the ground by forestry professionals. This year during the aerial survey 69 acres with spruce aphid damage were observed on the Northeast District (Table 13).

Defoliating insects damage trees by eating their leaves/needles; by removing their photosynthetic tissue, the host trees becomes increasingly susceptible to attacks from other insects and pathogens. If the defoliation is severe enough, it can lead to the death of the host tree.

Western Spruce budworm (*Choristoneura occidentalis)* attacks Douglas-fir, true firs, and spruce trees. This year only 69 acres with western spruce budworm were observed within the Northeast District (Table 13).

The "Unknown Defoliator" group is a catch-all name for defoliation as seen from the air that cannot be identified as a specific insect or disease-causing agent. The majority of "Unknown Defoliator" damage occurs in aspen or other deciduous tree stands. Only some of these locations are able to be reached on the ground by forestry professionals, thus there are still locations that are not double checked and are left as "Unknown Defoliation". This year, over 2,200 acres with observed "Unknown Defoliator" damage were mapped within the Northeast District (Table 13).

Status of Invasive Insects

This year several locations were observed in riparian areas where severe defoliation of salt cedar from tamarisk leaf beetle had occurred (Figure 14). In the Northeast District (A2S), over 700 acres were observed having defoliation damage from the tamarisk leaf beetle (Table 14).

The observed damage was only on federal and tribal lands (Table 14). This damage was mostly found in the northern end of the Northeast District, as well as at the southern end (Figure 14).

Photo: Tamarisk leaf beetle defoliation, Fort Apache Reservation, 2022

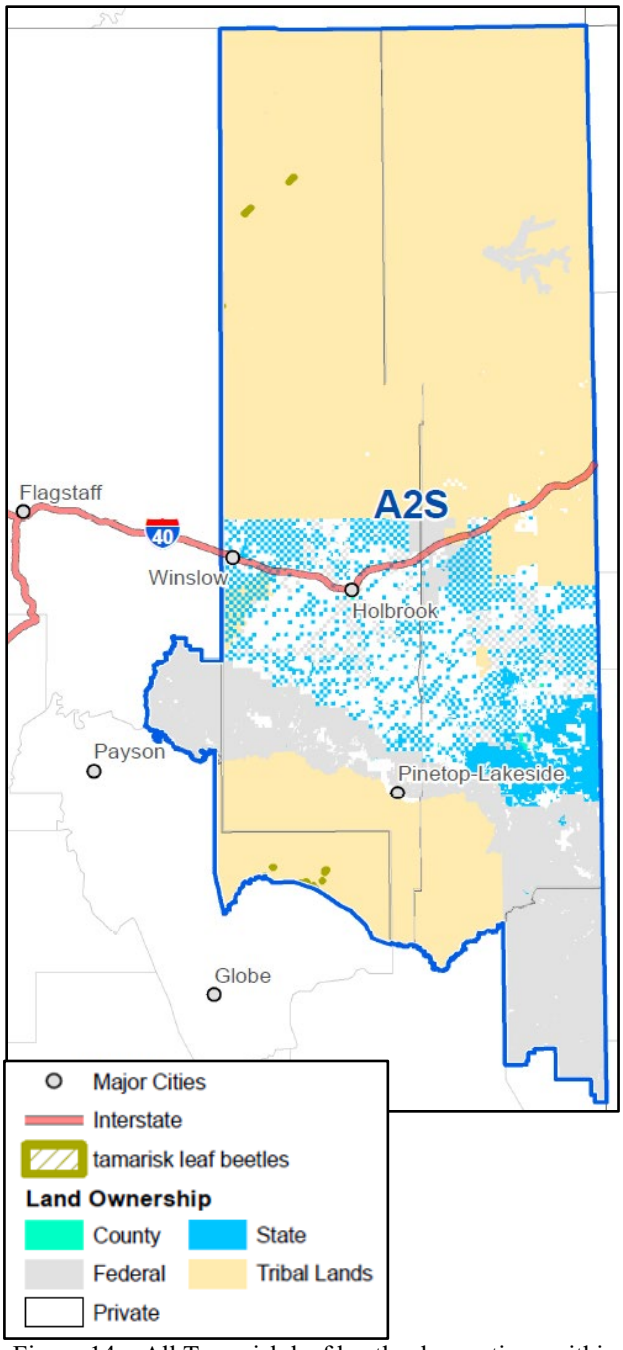

Figure 14 – All Tamarisk leaf beetle observations within the Northeast District (A2S) - 2022

A2S - Estimated Acres with Observed Invasive Insect Damage by Land Ownership			
Disease Causal Agent	**Federal**	**Tribal Lands**	**Grand Total**
Tamarisk leaf beetles	12.8	735.9	**748.7**

Table 14. Estimated acres with Observed Invasive Insect Damage by Land Ownership for the Northeast District (A2S) - 2022

Status of Diseases

This year, within the Northeast District (A2S), 116 acres of disease damage were identified on federal and private lands (Table 15). These diseases are difficult to identify from the air, therefore these locations were mapped on the ground by forestry professionals.

Sycamore anthracnose is a foliar disease that infests Arizona sycamore; this damage was observed on over 115 acres (Table 15). The symptoms include twig and stem cankers, shoot blight following cold snaps in the spring, and leaf blight from direct infection of leaves. This disease is ubiquitous with Arizona sycamore. These observed acres with Sycamore anthracnose were identified on the ground by forestry professionals.

In Arizona, white pine blister rust is a fungal disease that has only been found on Southwestern white pines, although limber pines and bristlecone pines are also susceptible. This nonnative disease is most common in wetter, mixed conifer sites that are higher in elevation. The observed half an acre with white pine blister rust (Table 15) was identified on the ground by forestry professionals.

A2S - Estimated Acres with Observed Disease Damage by Land Ownership			
Disease Causal Agent	**Federal**	**Private**	**Grand Total**
Sycamore anthracnose	44.5	71.2	**115.6**
White Pine blister rust	0.5		**0.5**
Grand Total	**45.0**	**71.2**	**116.1**

Table 15. Estimated acres with Observed Disease Damage by Land Ownership for the Northeast District (A2S) - 2022

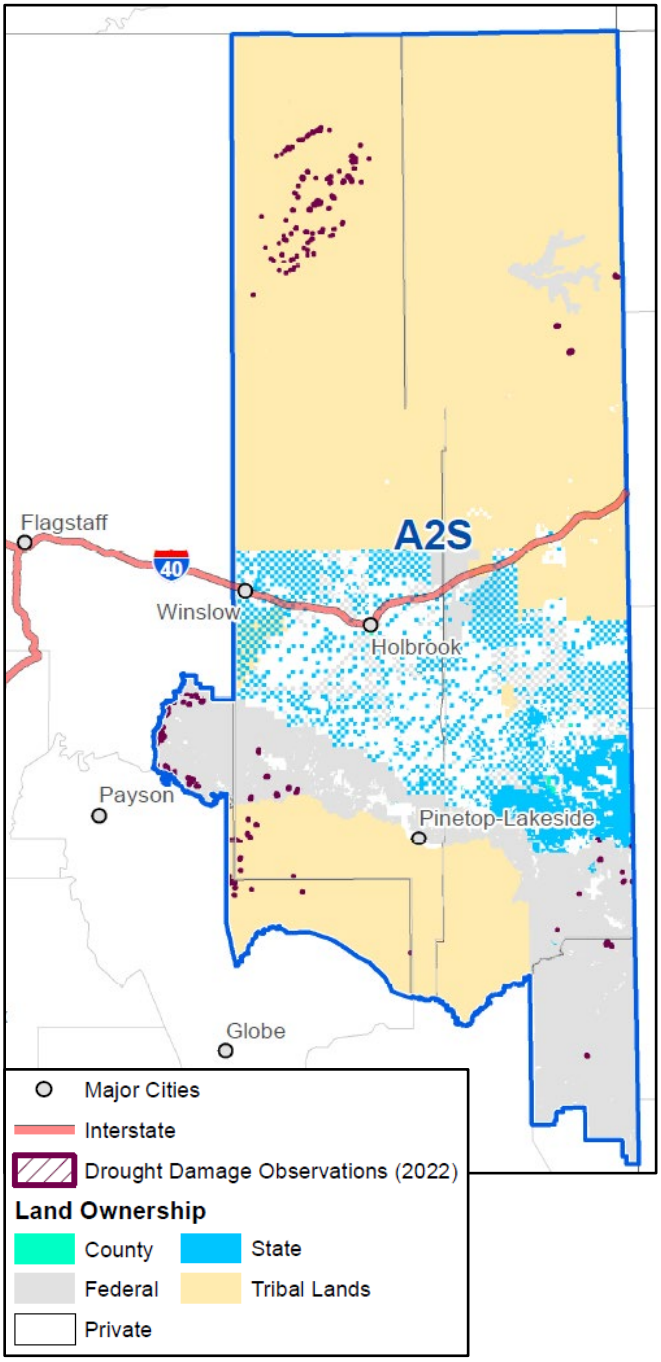

Figure 15 – All Drought observations within the Northeast District (A2S) - 2022

Status of Unknown and Non Infectious Disorders

This year over 11,000 acres with observed drought damage were identified (Table 16). Most of these observed acres were on federal and tribal lands within pinyon-juniper woodlands (Figure 15).

There was just over 40 acres with observed salt or deicer damage, all of which is found along roadways mostly on federal lands (Table 16).

A2S - Estimated Acres with Abiotic and Unknown Tree Damage by Land Ownership					
Disease Causal Agent	**Federal**	**Private**	**State**	**Tribal Lands**	**Grand Total**
Drought	5,891.2	14.3	4.4	5,438.5	**11,348.5**
Road Salt or Deicers	45.5	1.1			**46.6**
Unknown	439.1	37.6	39.8	804.1	**1,320.6**
Grand Total	**6,375.8**	**52.9**	**44.2**	**6,242.7**	**12,715.7**

Table 16. Estimated acres with Abiotic and Unknown Damage by Land Ownership for the Northeast District (A2S) - 2022

Of the 1,300 acres with unknown damage, over 122 acres were observed with unknown defoliation damage (Table 17); this damage was either categorized as heavy defoliation (> 2/3 of foliage) or light defoliation (< 1/3 of foliage). There were 180 acres with observed unknown dieback, over 260 acres with unknown discoloration, and nearly 750 acres with unknown mortality (Table 17). These acres were not able to be surveyed on the ground, thus they remain as an unknown damage type.

A2S - Estimated Acres with Unknown Tree Damage by Land Ownership					
Unknown Damage Type	**Federal**	**Private**	**State**	**Tribal Lands**	**Grand Total**
Defoliation - Heavy	16.7			42.6	**59.3**
Defoliation - Light	62.7				**62.7**
Dieback	56.8	37.6	39.8	47.7	**181.3**
Discoloration	207.4			60.0	**267.4**
Mortality	95.5			653.9	**749.4**
Grand Total	**439.1**	**37.6**	**39.8**	**804.1**	**1320.1**

Table 17. Estimated acres with Unknown Damage by Land Ownership for the Northeast District (A2S) - 2022

Southeast District (A3S) Update – 2022

Status of Insects

The Southeast District is composed of the Ak-Chin, Tohono O' Odham, and San Xavier reservation lands, as well as the Coronado National Forest Sky Islands, the Cabeza Prieta National Wildlife Refuge, Organ Pipe Cactus National Monument, Saguaro National Park, and Chiricahua National Monument. These areas are surrounded by scattered county and state lands, with some military reservation lands as well (Appendix I).

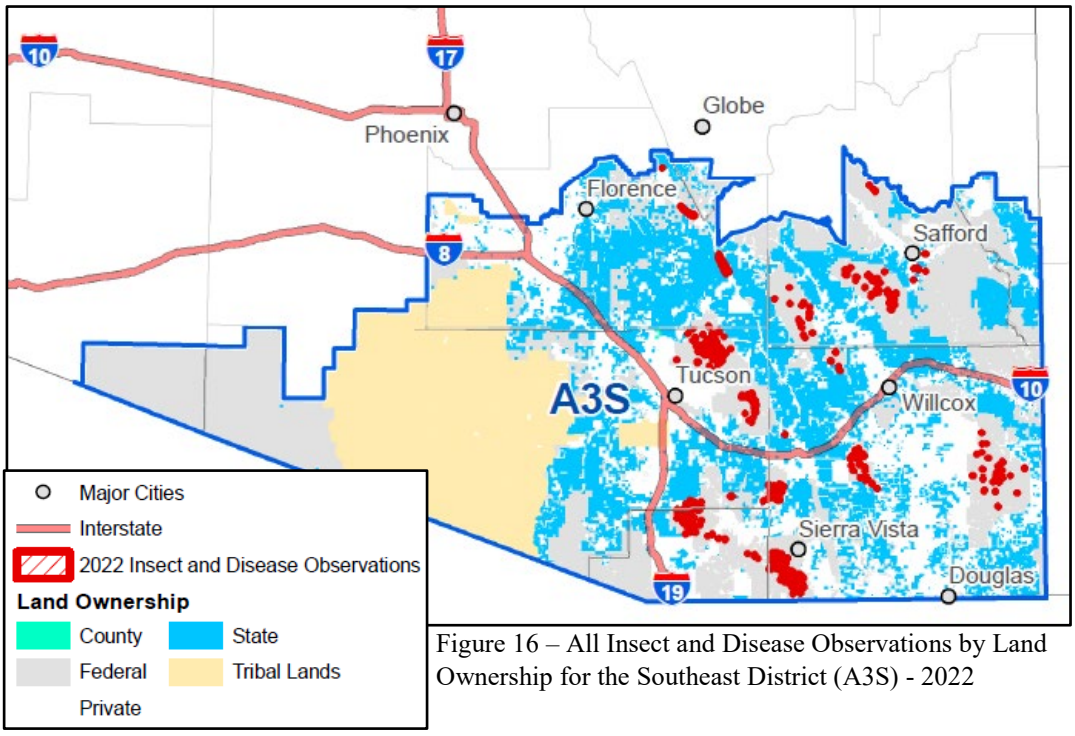

Figure 16 – All Insect and Disease Observations by Land Ownership for the Southeast District (A3S) - 2022

Figure 16 is a map showing all insect and disease observations within the Southeast District (A3S). The majority of insect observations occurred on federal and private lands (Table 18).

A3S - Estimated Acres with Observed Insect Damage by Land Ownership				
Insect Agent	**Federal**	**Private**	**State**	**Grand Total**
Bark Beetles	3,667.2	1.4	0.1	**3,668.7**
Defoliators	869.7	3,668.8	1,065.2	**5,603.6**
Wood Borers	323.3	0.25		**323.5**
Grand Total	**4,860.1**	**3,670.4**	**1,065.3**	**9,595.8**

Table 18. Estimated acres with Observed Insect Damage by Land Ownership for the Southeast District (A3S) - 2022

The bark beetle mortality observed throughout the Southeast District was caused by more than 6 different types of bark beetles, causing more than 3,600 acres with mortality (Table 18).

Of the 6 different types of bark beetles observed causing mortality, the group of "Unknown Bark Beetles" caused the most damage with just over 2,000 acres with observed mortality (Table 19). As previously mentioned, the category of unknown bark beetles includes all the bark beetles that attack ponderosa pines. As more than one species often contributes to the decline and death of ponderosa pines, we lump all ponderosa bark beetles into this one category "Unknown Bark Beetles". In the Southeast District (A3S) the "Unknown Bark Beetle" category also includes the Southern pine beetle (*Dendroctonus frontalis)* and Mexican Pine Beetle (*Dendroctonus mexicanus)* as they attack Chihuahua and apache pines that are found in this part of Arizona.

A3S - Estimated Acres with Observed Bark Beetle Damage by Land Ownership				
Disease Causal Agent	**Federal**	**Private**	**State**	**Grand Total**
Cedar & Cypress bark beetles	32.0			**32.0**
Douglas-fir beetle	114.5			**114.5**
Fir engraver	830.5			**830.5**
Pinyon ips	652.9			**652.9**
Unknown bark beetle	2,010.6	1.4	0.1	**2,012.1**
Western Balsam bark beetle	26.7			**26.7**
Grand Total	**3,667.2**	**1.4**	**0.1**	**3,668.7**

Table 19. Estimated acres with Observed Bark Beetle Damage by Land Ownership for the Southeast District (A3S) - 2022

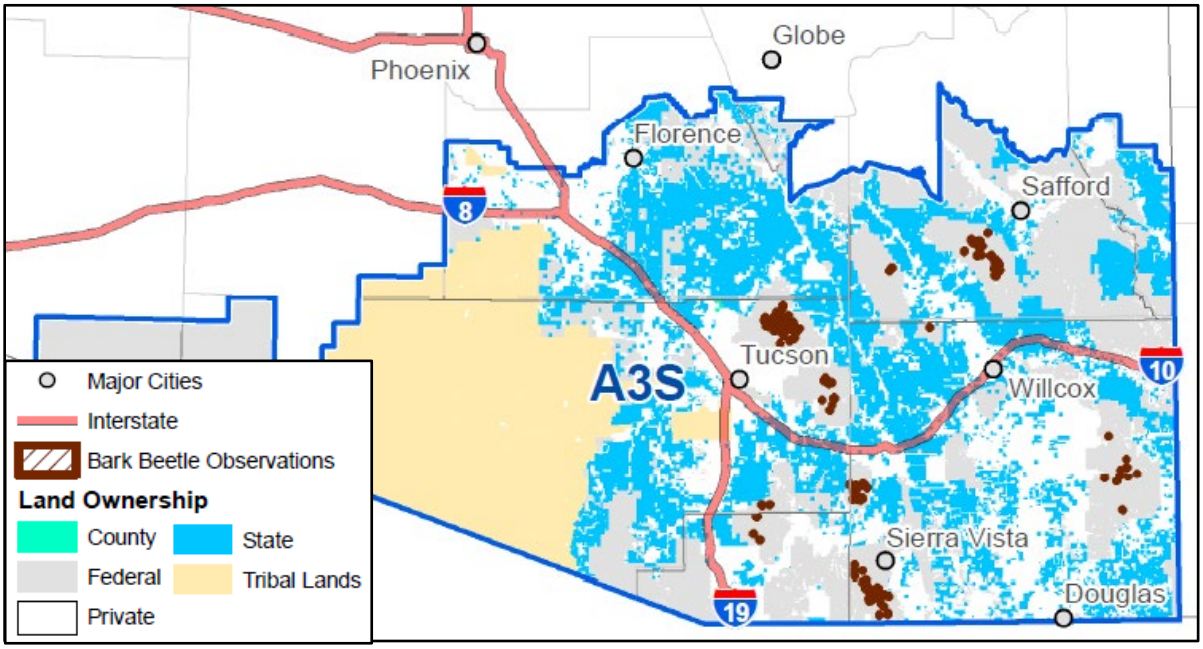

Figure 17 – All Bark Beetle Observations by Land Ownership for the Southeast District (A3S) - 2022

Photo: Credit, Amanda Grady, Entomologist, USDA Forest Service, Light Ponderosa pine bark beetle mortality, Coronado NF, 2022

Douglas-fir beetle (*Dendroctonus pseudotsugae*), Fir engraver (*Scolytus ventralis*), and Western Balsam bark beetle (*Dryocoetes confusus*) damage accounted for over 900 acres with bark beetle caused tree mortality in the high elevation, mixed conifer forests of the Coconino National Forest.

Pinyon ips (*Ips confusus*) and Cedar and Cypress bark beetle (*Phloeosinus* spp.) mortality was observed on over 600 acres; this damage was observed in the lower elevation woodlands on federal lands (Table 19).

Photo: Pinyon ips mortality, Coronado NF, 2022

Most woodborer damage observed through the 2022 ADS season was caused by nonnative species and will be discussed in more detail in the Invasive Insect Update section of this report. However, the woodborer causing damage in the Southeast District is the native Goldspotted Oak Borer (*Agrilus auroguttatus*). This year just over 300 acres with Goldspotted Oak Borer (GSOB) damage was observed in the Southeast District (Table 20). Larval feeding by GSOB causes the most extensive damage on oaks. As the larvae feed, water and nutrient uptake is disrupted, leading to eventual tree death.

A3S - Estimated Acres with Observed Insect Damage by Land Ownership			
Disease Causal Agent	**Federal**	**Private**	**Grand Total**
Goldspotted Oak borer	323.3	0.3	**323.5**

Table 20. Estimated acres with Observed Goldspotted Oak Borer Damage by Land Ownership for the Southeast District (A3S) - 2022

Photo: Goldspotted oak borer mortality, Coronado NF, 2022

Additional insect damage was observed in the Southeast District (A3S); this damage was identified as defoliator damage. Defoliating insects damage trees by eating their leaves/needles, leaving the trees susceptible to attacks from other insects and pathogens.

Douglas-fir Tussock Moth (*Orgyia pseudotsugae*) damage was observed in the Southeast District this year (Figure 18). Douglas-fir Tussock Moth attacks Douglas-fir, white fir, and spruce trees. If outbreaks are severe enough they can cause significant mortality of both overstory and understory trees within 1-2 years. Top-kill can occur in minor outbreaks; Doug-fir bark beetles

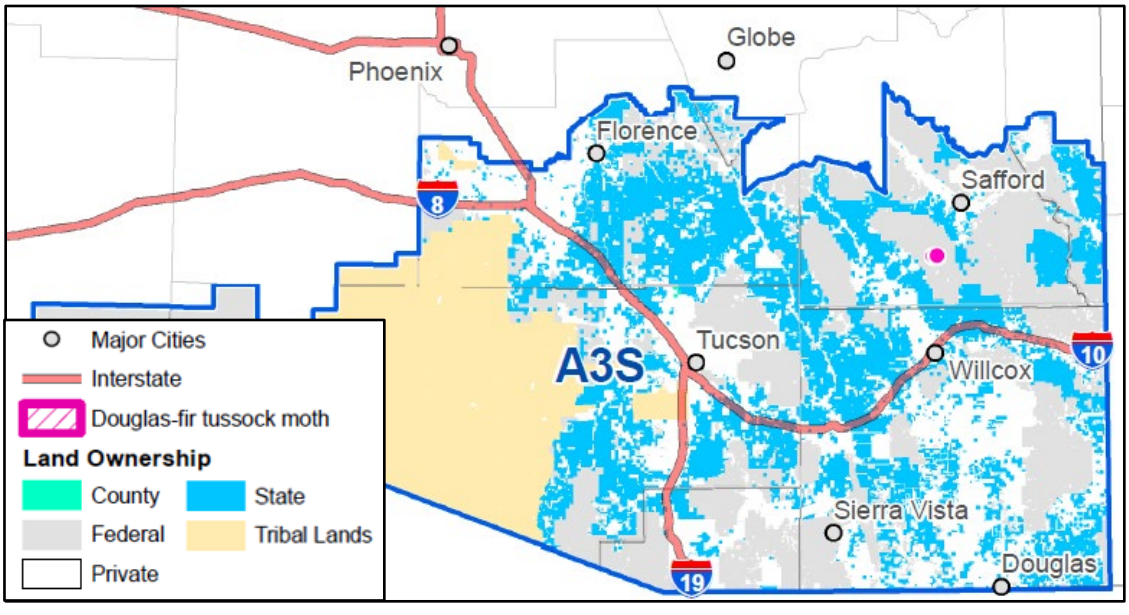

Figure 18 – All Douglas-fir Tussock Moth observations within the Southeast District (A3S) – 2022

A3S - Estimated Acres with Observed Insect Damage by Land Ownership	
Insect Agent	**Federal**
Douglas-fir Tussock moth	170.6
Unknown defoliator	648.0
Grand Total	**818.6**

Table 21. Estimated acres with Observed Defoliator Damage by Land Ownership for the Southeast District (A3S) - 2022

Photo: Douglas-fir tussock moth defoliation, Mt Graham, Coronado NF, 2022

Photo: Douglas-fir tussock moth egg masses, Mt Graham, Coronado NF, 2022

are attracted to these stressed trees and cause epidemics in tussock moth defoliated landscapes. This year 170 acres were observed on Mt Graham with Douglas-fir Tussock Moth defoliation (Appendix II and Appendix III); these 170 acres were all on federal lands (Table 21).

Lastly, there is a group of defoliators identified as "Unknown Defoliator". This is a catch-all name for defoliation as seen from the air that cannot be identified as a specific insect or disease-causing agent. Not all of these locations are able to be reached on the ground by forestry professionals, thus there are still locations that are not double checked and are left as "Unknown Defoliation". This year, over 600 acres with observed "Unknown Defoliator" damage were mapped within the Southeast District (Table 21).

Status of Invasive Insects

This year several locations were observed in riparian areas where severe defoliation of salt cedar from tamarisk leaf beetle had occurred. In the Southeast District (A3S), over 4,700 acres were observed having defoliation damage from the tamarisk leaf beetle (Table 22).

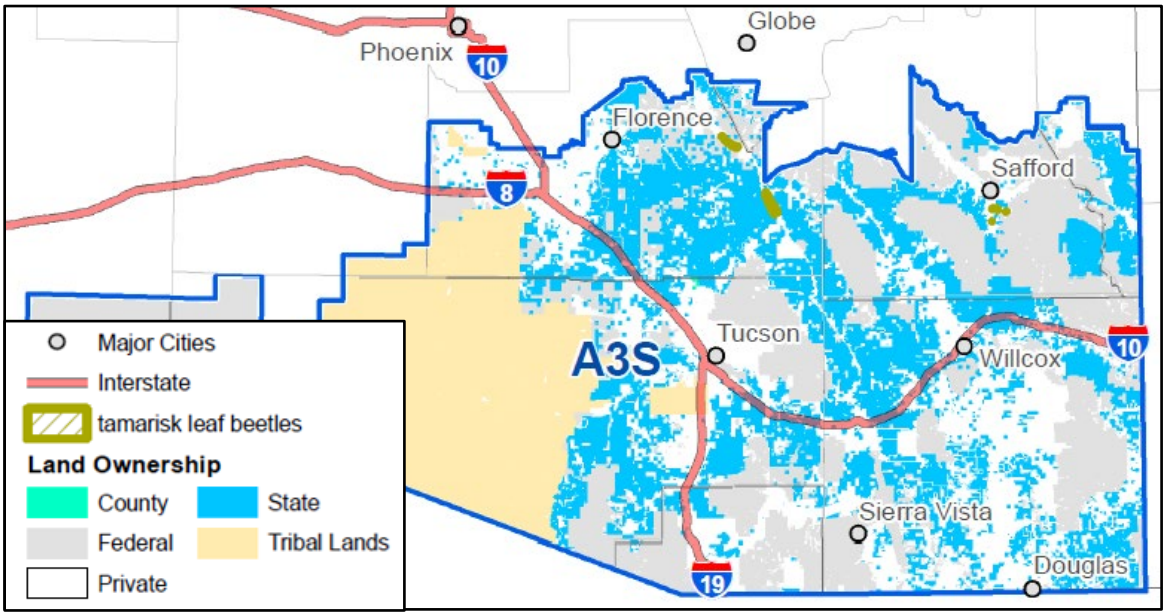

Figure 19 – All Tamarisk Leaf beetle observations within the Southeast District (A3S) –

The observed damage was on federal, private, and state lands (Table 22). This damage was observed in the northern end of the Southeast District (Figure 19).

A3S - Estimated Acres with Observed Invasive Insect Damage by Land				
Disease Causal Agent	**Federal**	**Private**	**State**	**Grand Total**
Tamarisk leaf beetles	51.1	3,668.8	1,065.2	**4,785.0**

Table 22. Estimated acres with Observed Invasive Insect Damage by Land Ownership for the Southeast District (A3S) - 2022

Status of Diseases

This year, within the Southeast District (A3S), 70 acres of disease damage were identified on federal lands (Table 23). These diseases are difficult to identify from the air, therefore these locations were observed and mapped on the ground by forestry professionals.

A3S - Estimated Acres with Observed Disease Damage by Land Ownership		
Disease Causal Agent	**Federal**	**Grand Total**
Unknown canker	70.1	**70.1**

Table 23. Estimated acres with Observed Disease Damage by Land Ownership for the Southeast District (A3S) - 2022

Photo: Coatimundi in a riparian area in the Dragoon Mountains, Coronado NF, 2022

The 70 acres of observed "unknown canker" damage was in fact damage caused by the fungus *Biscogniauxia mediterranea.* This fungus was first found on Emory oak (*Quercus emoryi*) in Arizona, in the Southeast District (A3S) in 2019 (Appendix V). It was labeled as "unknown canker" in our data this year because we do not have this specific disease listed in our aerial detection survey disease causal agent list.

Status of Unknown and Non Infectious Disorders

This year over 6,000 acres with observed drought damage were identified in the Southeast District (Table 24). The majority of these acres were on federal lands, spread throughout the eastern half of the District, within pinyon-juniper woodlands (Figure 20).

A3S - Estimated Acres with Abiotic and Unknown Tree Damage by Land				
Disease Causal Agent	**Federal**	**Private**	**State**	**Grand Total**
Drought	5,817.0	188.7	20.5	**6,026.2**
Unknown	66.0	44.5	0.1	**110.6**
Grand Total	**5,883.0**	**233.2**	**20.6**	**6,136.8**

Table 24. Estimated acres with Observed Abiotic and Unknown Damage by Land Ownership for the Southeast District (A3S) - 2022

Lastly, there were just over 100 acres with unknown damage (Table 24), identified as unknown dieback during the aerial detection surveys (Table 25). These areas were not able to be confirmed on the ground, thus their damage causal agent remains as unknown damage.

A3S - Estimated Acres with Unknown Tree Damage by Land Ownership				
Disease Causal Agent	**Federal**	**Private**	**State**	**Grand Total**
Dieback	66.0	44.5	0.1	**110.6**

Table 25. Estimated acres with Unknown Damage by Land Ownership for the Southeast District (A3S) - 2022

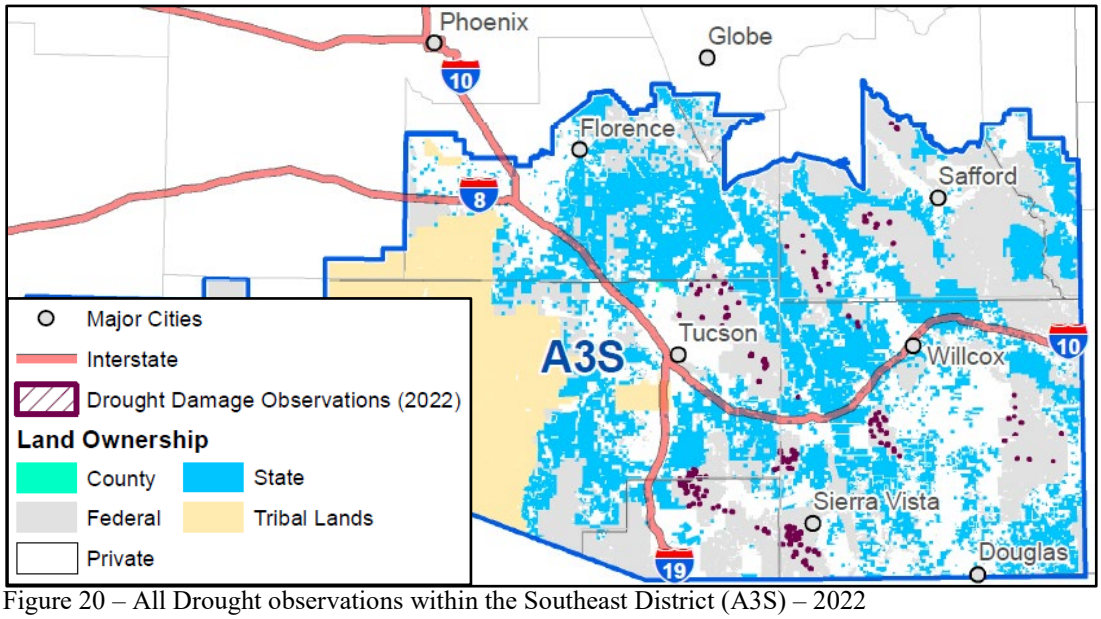

Figure 20 – All Drought observations within the Southeast District (A3S) – 2022

Central District (A4S) Update – 2022

Status of Insects

The Central District is composed of the Tonto National Forest, San Carlos, Gila River, Salt River, and Fort Howell Reservation lands, and the Kofa National Wildlife Refuge; these areas are surrounded by scattered county and state lands, with some military reservation lands as well (Appendix I).

Figure 21 is a map showing all insect and disease observations within the Central District. The majority of insect observations occurred on federal lands. Just over 20,000 acres with bark beetle mortality were observed, over 600 acres with observed defoliator damage, and more than 8,800 acres with sap feeder damage were observed throughout Arizona's Central District (Table 26).

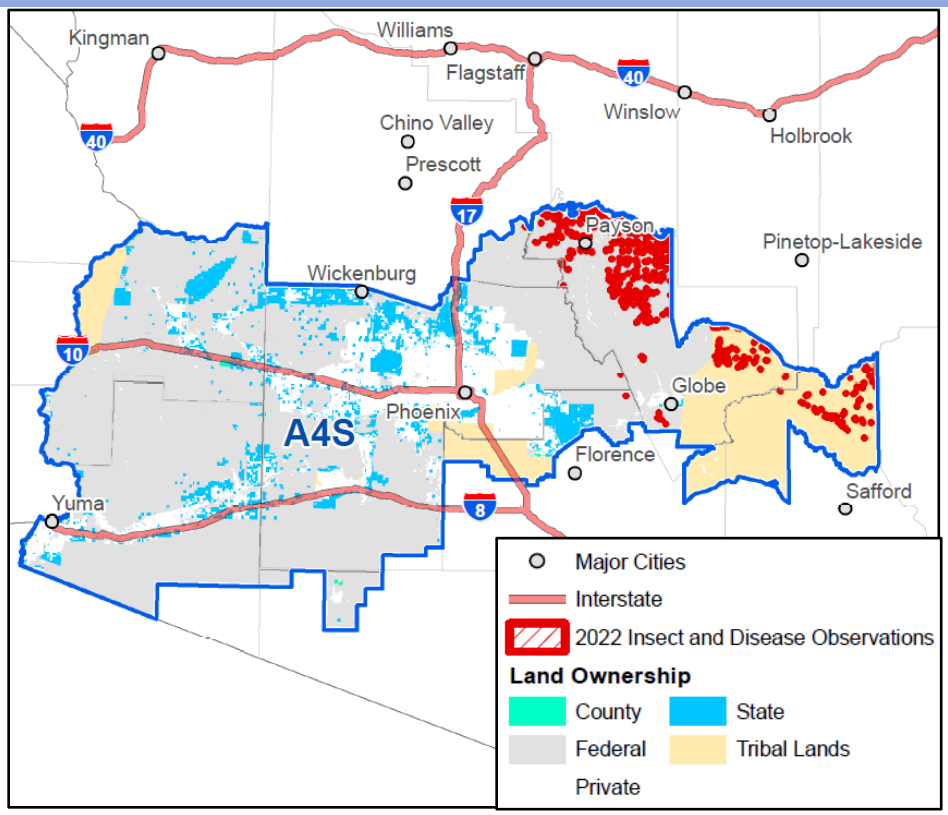

Figure 21 – All Insect and Disease Observations within the Central District (A4S) –

A4S - Estimated Acres with Observed Insect Damage by Land Ownership					
Insect Agent	**Federal**	**Private**	**State**	**Tribal Lands**	**Grand Total**
Bark Beetles	16,378.1	68.4		3,964.2	**20,410.7**
Defoliators	305.6			383.1	**688.7**
Sap Feeders	7,613.4	303.2	43.3	844.8	**8,804.7**
Grand Total	**24,297.1**	**371.6**	**43.3**	**5,192.2**	**29,904.2**

Table 26. Estimated acres with Observed Insect Damage by Land Ownership for the Central District (A4S) - 2022

The bark beetle mortality observed throughout the Central District was caused by more than 6 different types of bark beetles. These bark beetles caused more than 20,000 acres with mortality (Table 26). The majority of this bark beetle caused mortality occurred on federal lands in the northeastern part of the District (Figure 21)

Of the more than 6 different bark beetles observed causing mortality, the group of "Unknown Bark Beetles" caused the most mortality with over 16,000 acres with observed mortality (Table 27). As previously mentioned, this category of unknown bark beetles includes all the bark beetles that attack

Photo: Fir engraver mortality, Tonto NF, 2022

ponderosa pines. As more than one species often contributes to the decline and death of ponderosa pines, we lump all ponderosa bark beetles into this one category "Unknown Bark Beetles". In the Central District (A4S) this "Unknown Bark Beetle" category also includes the Southern pine beetle (*Dendroctonus frontalis)* and Mexican Pine Beetle (*Dendroctonus mexicanus)* as they attack Chihuahua and Apache pines that can be found in this part of Arizona.

A4S - Estimated Acres with Observed Bark Beetle Damage by Land Ownership				
Bark Beetles	**Federal**	**Private**	**Tribal Lands**	**Grand Total**
Douglas-fir beetle	71.9			**71.9**
Fir engraver	1,758.0	14.7	68.6	**1,841.3**
Pinyon ips	2,014.7	10.5	91.7	**2,116.8**
Twig beetles	123.7	17.8	0.3	**141.8**
Unknown bark beetle	12,398.4	25.4	3,803.6	**16,227.4**
Western Balsam bark beetle	11.5			**11.5**
Grand Total	**16,378.1**	**68.4**	**3,964.2**	**20,410.7**

Table 27. Estimated acres with Observed Bark Beetle Damage by Land Ownership for the Central District (A4S) - 2022

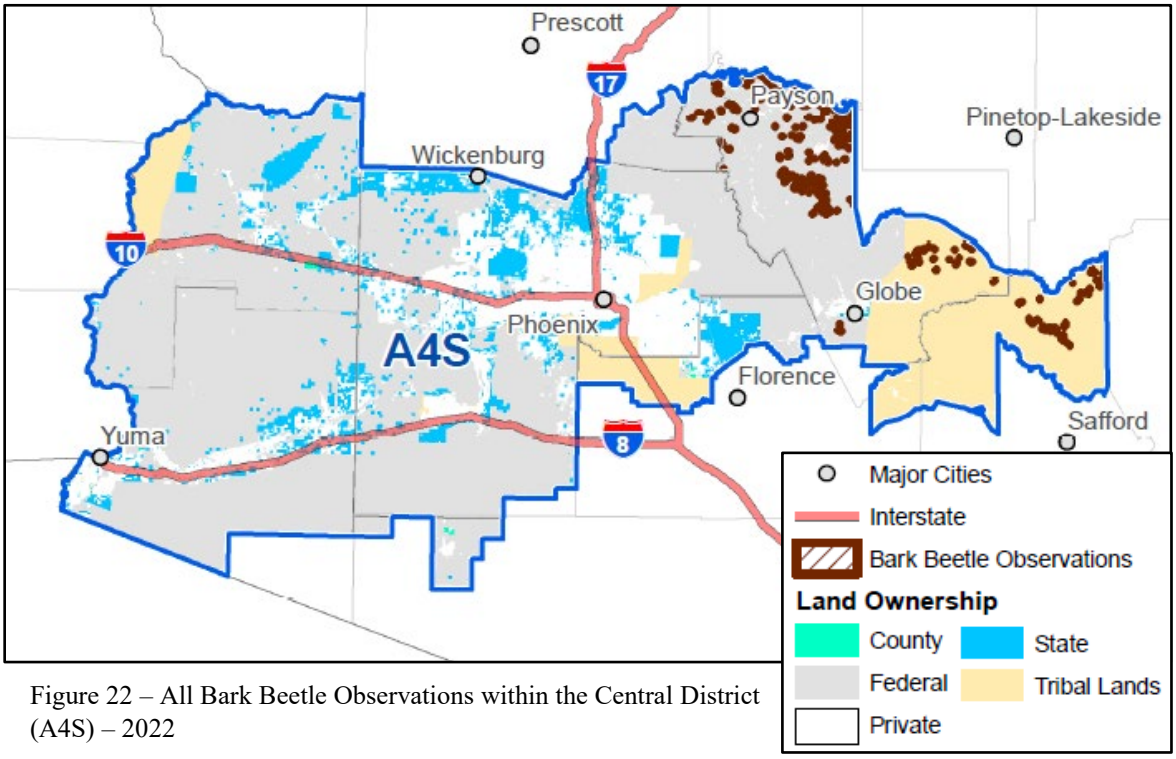

Figure 22 – All Bark Beetle Observations within the Central District (A4S) – 2022

Douglas-fir beetle (*Dendroctonus pseudotsugae*), Fir engraver (*Scolytus ventralis*), Twig beetles (refer back to the introduction for clarification of what genus these beetles belong to) and Western Balsam bark beetles (*Dryocoetes confusus*) accounted for just over 2,000 acres with bark beetle caused tree mortality (Table 27).

Pinyon ips (*Ips confusus*) mortality was observed on more than 2,100 acres; damage was mostly observed in the lower elevation woodlands on federal lands (Table 27).

Additional insect damage was observed in the Central District (A4S); this damage was identified as defoliator or sap feeder damage. Defoliating insects damage trees by eating their leaves/needles; by removing their photosynthetic tissue, the host trees becomes increasingly

Photo: Light ponderosa pine bark beetle mortality, Tonto NF, 2022

susceptible to attacks from other insects and pathogens. If the defoliation is severe enough, it can lead to the death of the host tree.

A4S - Estimated Acres with Observed Insect Damage by Land Ownership					
Insect Agent	**Federal**	**Private**	**State**	**Tribal Lands**	**Grand Total**
Douglas-fir Tussock moth	28.4				**28.4**
Pinyon needle scale	7,613.4	303.2	43.3	844.8	**8,804.7**

Table 28. Estimated acres with Observed Insect Damage by Land Ownership for the Central District (A4S) - 2022

Douglas-fir Tussock Moth (*Orgyia pseudotsugae*) defoliation was observed in the Central District this year south of Globe (Figure 23), with just over 28 acres of observed damage (Table 28). Douglas-fir Tussock Moth attacks Douglas-fir, white fir, and spruce trees. If outbreaks are severe enough they can cause significant mortality of both overstory and understory trees within 1-2 years. These 28 acres with Douglas-fir Tussock Moth defoliation (Appendix II and Appendix III) were all on federal lands (Table 28).

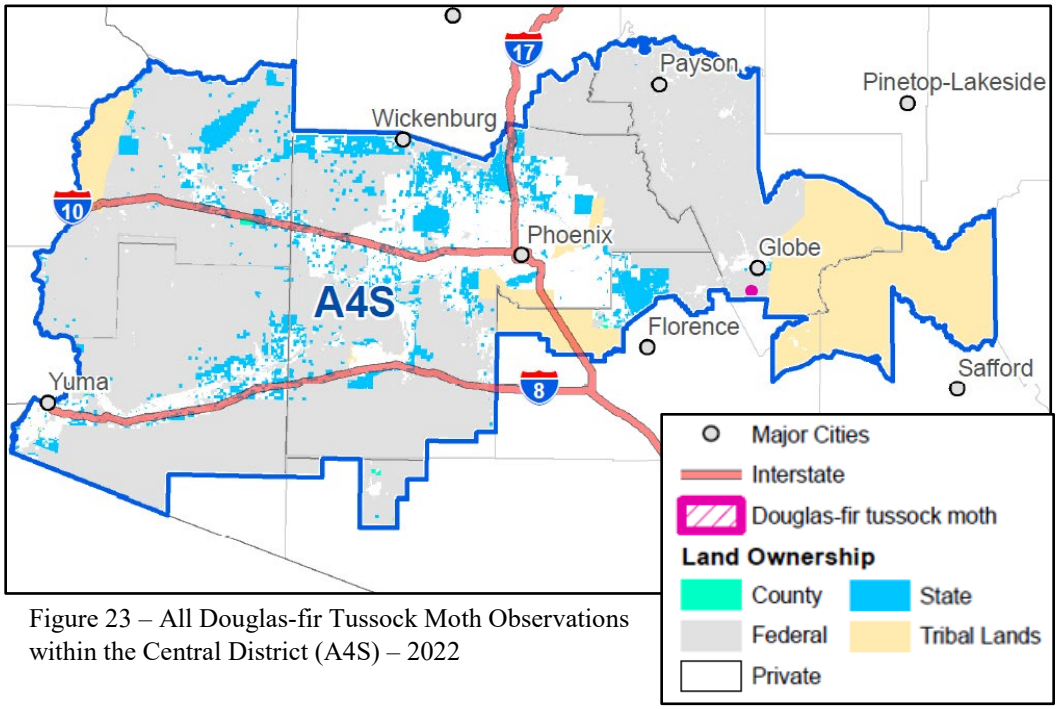

Figure 23 – All Douglas-fir Tussock Moth Observations within the Central District (A4S) – 2022

Sap feeding or sap sucking insects are small in size and directly injure the host tree by sucking its food and water supply, producing necrotic spots in the host tissue, and indirectly injuring the tree by introducing plant diseases into the host.

Photo: Douglas-fir tussock moth cocoon, Tonto NF, 2022

Pinyon needle scale (*Matsucoccus acalyptus)* is a sap sucking insect that attacks pinyon pines. Pinyon needle scale can cause needles to yellow and drop early. Repeated attacks can cause reduced growth, and stunted needles. Severe outbreaks may kill small trees, while larger trees can become more susceptible to bark beetle attacks. This year over 8,800 acres with pinyon needle scale damage was observed in the Central District (Table 28).

Status of Invasive Insects

Just over 600 acres were observed with tamarisk leaf beetle damage in the Central District (Table 29). More than 300 acres with salt cedar defoliation were observed within San Carlos tribal lands, in the north western edge of the reservation (Figure 24). The remaining 250 plus acres in the Central District (A3S) with salt cedar defoliation were on federal lands, Northwest of Globe, AZ (Figure 24).

A4S - Estimated Acres with Observed Invasive Insect Damage by Land Ownership			
Insect Agent	**Federal**	**Tribal Lands**	**Grand Total**
Tamarisk leaf beetles	277.2	383.1	**660.3**

Table 29. Estimated acres with Observed Invasive Insect Damage by Land Ownership for the Central District (A4S) - 2022

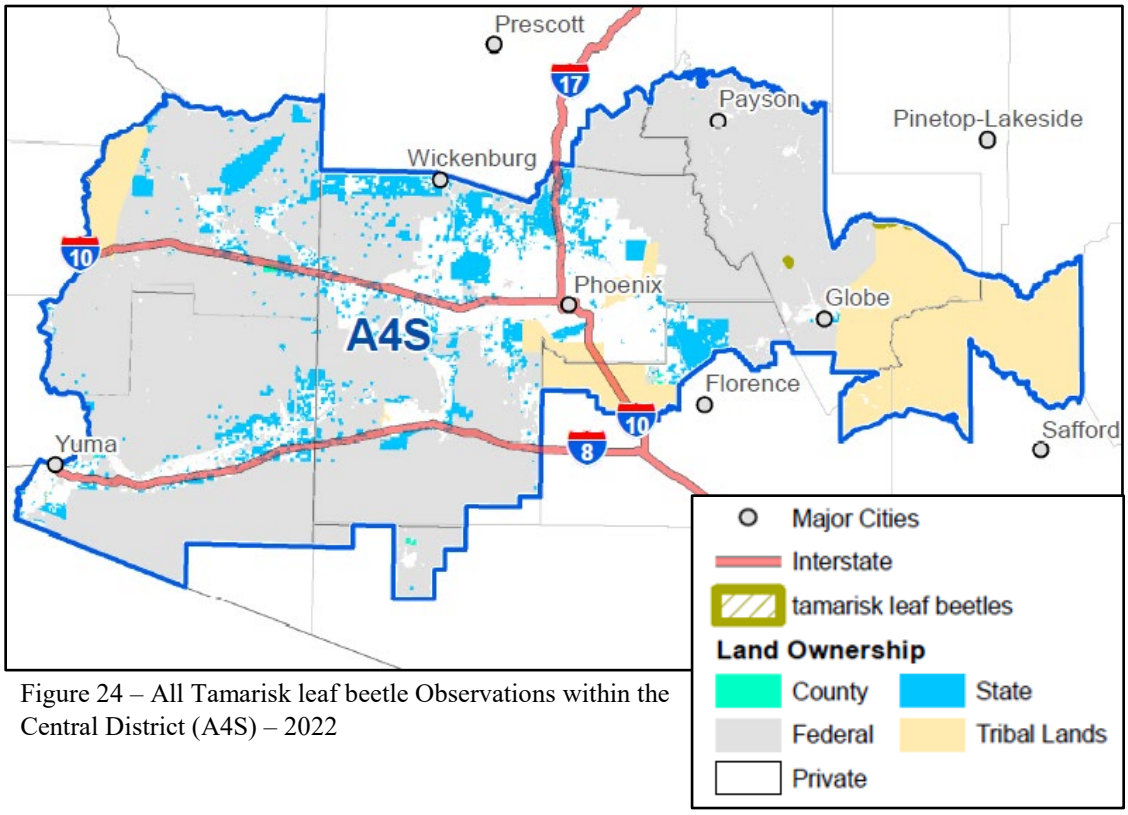

Figure 24 – All Tamarisk leaf beetle Observations within the Central District (A4S) – 2022

Status of Unknown and Non Infectious Disorders

This year more than 16,000 acres were observed with drought damage in the Central District (Table 30). This damage was observed along the eastern edge of the District (Figure 25) and most of these acres were on federal lands (Table 30). There were only 24 acres with observed salt damage on federal and private lands (Table 30).

Lastly, there were just over 180 acres with observed unknown damage (Table 30). Of these 180 acres of unknown damage, just

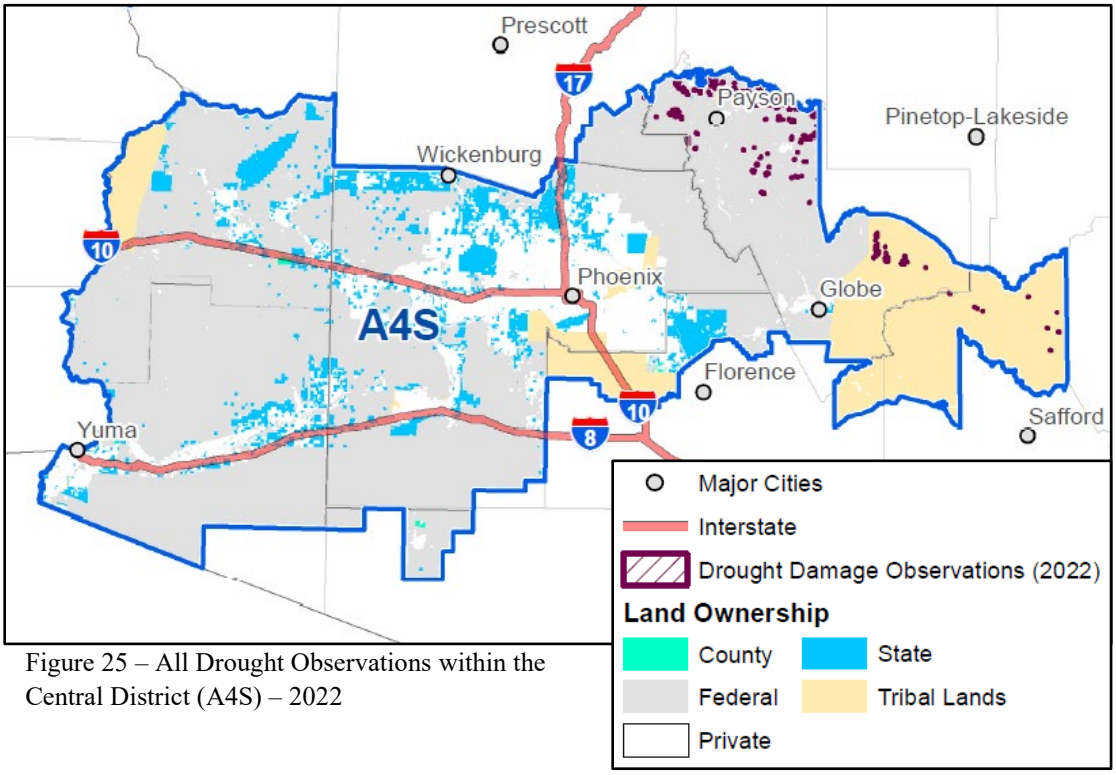

Figure 25 – All Drought Observations within the Central District (A4S) – 2022

over 133 acres were observed with unknown defoliation damage, (Table 31); this damage was either categorized as heavy defoliation (> 2/3 of foliage) or light defoliation (< 1/3 of foliage). The remaining 47 plus acres of unknown damage were identified as unknown dieback (Table 31). These areas were not able to be confirmed on the ground, thus their damage causal agent remains as unknown damage.

A4S - Estimated Acres with Abiotic and Unknown Tree Damage by Land Ownership				
Disease Causal Agent	**Federal**	**Private**	**Tribal Lands**	**Grand Total**
Drought	13,384.3	127.2	2,746.0	**16,257.4**
Road Salt or Deicers	23.1	1.0		**24.1**
Unknown	119.1	32.8	29.3	**181.2**
Grand Total	**13,526.5**	**161.0**	**2,775.3**	**16,462.7**

Table 30 Estimated acres with Abiotic and Unknown Damage by Land Ownership for the Central District (A4S) - 2022

A4S - Estimated Acres with Unknown Tree Damage by Land Ownership				
Disease Causal Agent	**Federal**	**Private**	**Tribal Lands**	**Grand Total**
Defoliation - Heavy	15.9	20.5		**36.4**
Defoliation - Light	97.5			**97.5**
Dieback	5.7	12.3	29.3	**47.3**
Grand Total	**119.1**	**32.8**	**29.3**	**181.2**

Table 31. Estimated acres with Unknown Tree Damage by Land Ownership for the Central District (A4S) - 2022

Photo: Ponderosa pine discoloration along roadway from salt, de-icer, near the Tonto NF, 2022

Northwest District (A5S) Update – 2022

Status of Insects

The Northwest District is composed of the Prescott National Forest, Lake Mead National Recreation Area, Fort Mohave Reservation, and the Havasu National Wildlife Refuge; these areas are surrounded by scattered county and state lands, with some military reservation lands as well (Appendix I).

Figure 26 is a map showing all insect and disease observations within the Northwest District (A5S). The majority of insect observations occurred on federal lands, with over 10,000 acres with observed bark

A5S - Estimated Acres with Observed Insect Damage by Land Ownership				
Insect Agent	**Federal**	**Private**	**State**	**Grand Total**
Bark Beetles	9,155.2	1,780.9	36.8	**10,973.0**
Defoliators	99.7	34.6		**134.3**
Sap Feeders	6,415.8	1,313.3	198.4	**7,927.5**
Grand Total	**15,670.7**	**3,128.9**	**235.1**	**19,034.7**

Table 32. Estimated acres with Observed Insect Damage by Land Ownership for the Northwest District (A5S) - 2022

Photo: Light, Ponderosa pine bark beetle mortality, Mingus Mountains, Prescott NF, 2022

beetle mortality, over 100 acres with observed defoliator damage, and nearly 8,000 acres of observed sap feeder damage, occurring throughout Arizona's Northwest District (Table 32).

The bark beetle mortality observed throughout the Northwest District was caused by more than 5 different types of bark beetles that affected more than 10,000 acres with mortality (Table 33). The majority of this bark beetle caused mortality occurred on federal lands (Figure 27). This mortality was a 73% decrease from 2021, when over 40,000 acres were observed with bark beetle caused mortality.

Of the more than 5 different types of bark beetles observed causing mortality the group of "Unknown Bark Beetles" caused the most damage with over 8,000 acres with observed mortality (Table 32). As previously mentioned, this category of unknown bark beetles includes all the bark beetles that attack ponderosa pines. As more than one species often contributes to the decline and death of ponderosa pines, we lump all ponderosa bark beetles into this one category "Unknown Bark Beetles".

Douglas-fir beetle (*Dendroctonus pseudotsugae*), Fir engraver (*Scolytus ventralis*), and Twig beetles (refer back to the introduction for clarification of what genus these beetles belong to) damage accounted for nearly 850 acres with bark beetle caused tree mortality in the higher elevation, mixed conifer forests of the Prescott National Forest (Table 32).

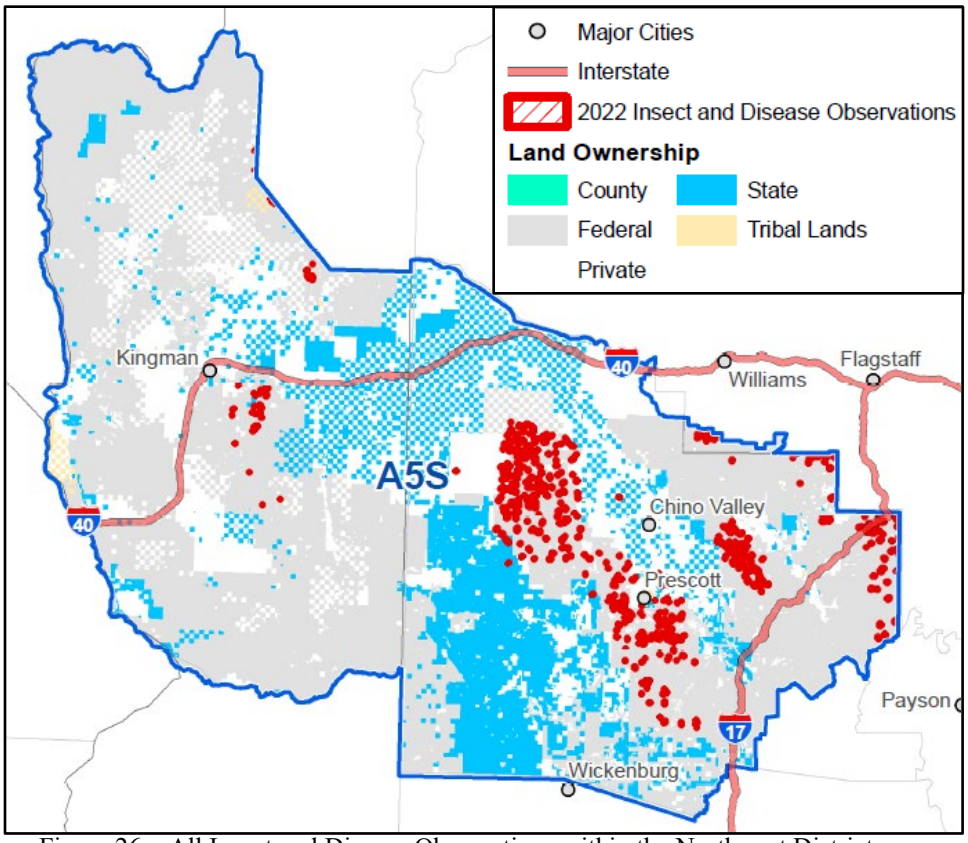

Figure 26 – All Insect and Disease Observations within the Northwest District (A5S) – 2022

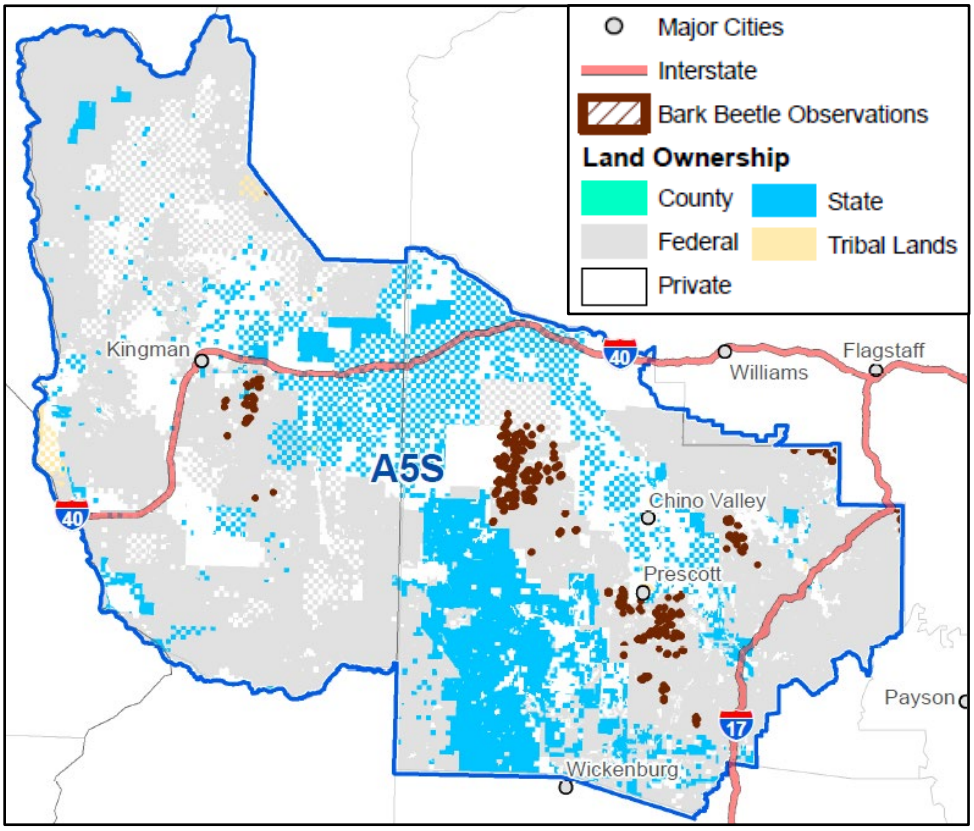

Figure 27 – All Bark Beetle Observations within the Northwest District (A5S) – 2022

Pinyon ips (*Ips confusus*) mortality was also observed on nearly 1,900 acres; this damage was observed in the lower elevation woodlands of federal, private, and state lands (Table 32).

A5S - Estimated Acres with Observed Bark Beetle Damage by Land Ownership					
Bark Beetles	**County**	**Federal**	**Private**	**State**	**Grand Total**
Douglas-fir beetle		44.8	0.5		**45.2**
Fir engraver		657.5	142.2		**799.7**
Pinyon ips		1,313.0	144.9	0.5	**1,458.4**
Twig beetles		0.3			**0.3**
Unknown bark beetle		7,139.8	1,493.4	36.3	**8,669.4**
Grand Total	**0.2**	**25,652.2**	**5,136.1**	**329.5**	**31,118.1**

Table 33. Estimated acres with Observed Bark Beetle Damage by Land Ownership for the Northwest District (A5S) - 2022

Photo: Pinyon Ips mortality, Prescott NF, 2022

Photo: Pitch tubes on Ponderosa pine from bark beetle activity, Prescott NF, 2022

Additional insect damage was observed in the Northwest District (A5S); this damage was identified as sap feeder damage (Table 32). Sap feeding or sap sucking insects are small in size and directly injure the host tree by sucking its food and water supply, producing necrotic spots in the host tissue, and indirectly injuring the tree by introducing plant diseases into the host.

Pinyon needle scale (*Matsucoccus acalyptus)* is a sap sucking insect that attacks pinyon pines. Pinyon needle scale can cause needles to yellow and drop early. Repeated attacks can cause reduced growth, and stunted needles. Severe outbreaks may kill small trees, while larger trees can become more susceptible to bark beetle attacks. This year nearly 8,000 acres with pinyon needle scale damage was observed in the Northwest District (Table 34).

A5S - Estimated Acres with Observed Insect Damage by Land Ownership				
Insect Agent	**Federal**	**Private**	**State**	**Grand Total**
Pinyon needle scale	6,415.8	1,313.3	198.4	**7,927.5**

Table 34. Estimated acres with Observed Insect Damage by Land Ownership for the Northwest District (A5S) - 2022

Status of Invasive Insects

This year a small area of salt cedar defoliation was observed on federal and private lands, west of Chino Valley (Figure 28). This accounted for over 130 acres that were observed with tamarisk leaf beetle defoliation of salt cedar (Table 35).

A5S - Estimated Acres with Observed Invasive Insect Damage by Land Ownership			
Insect Agent	**Federal**	**Private**	**Grand Total**
Tamarisk leaf beetles	99.7	34.6	**134.3**

Table 35. Estimated acres with Observed Invasive Insect Damage by Land Ownership for the Northwest District (A5S) - 2022

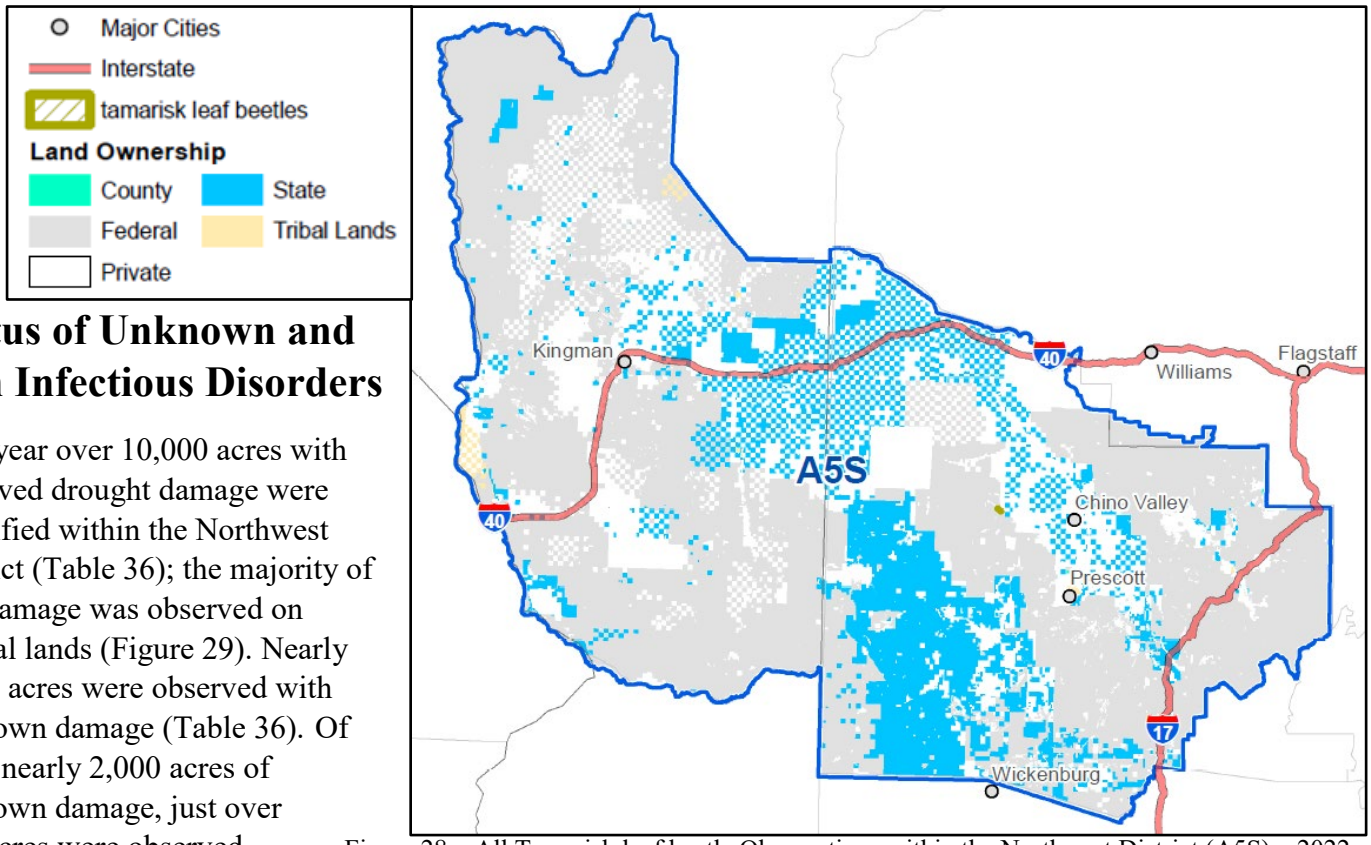

Figure 28 – All Tamarisk leaf beetle Observations within the Northwest District (A5S) – 2022

Status of Unknown and Non Infectious Disorders

This year over 10,000 acres with observed drought damage were identified within the Northwest District (Table 36); the majority of this damage was observed on federal lands (Figure 29). Nearly 2,000 acres were observed with unknown damage (Table 36). Of these nearly 2,000 acres of unknown damage, just over 600 acres were observed with unknown defoliation damage (Table 36); this damage was either categorized as heavy defoliation (> 2/3 of foliage) or light defoliation (< 1/3 of foliage). There was over 900 acres of observed unknown dieback, and over 300 acres of observed unknown discoloration (Table 37). These areas were not able to be confirmed on the ground, thus their damage causal agent remains as unknown damage.

A5S - Estimated Acres with Abiotic and Unknown Tree Damage by Land Ownership					
Disease Causal Agent	**County**	**Federal**	**Private**	**State**	**Grand Total**
Unknown		1,287.8	628.9	27.7	**1,944.4**
Drought	0.2	8,693.7	1,378.3	66.7	**10,138.9**
Grand Total	**0.2**	**9,981.5**	**2,007.2**	**94.4**	**12,083.4**

Table 36. Estimated acres with Observed Abiotic and Unknown Damage by Land Ownership for the Northwest District (A5S) - 2022

A5S - Estimated Acres with Unknown Tree Damage by Land Ownership				
Disease Causal Agent	**Federal**	**Private**	**State**	**Grand Total**
Defoliation - Heavy	503.3	55.2		**558.4**
Defoliation - Light		60.5	27.7	**88.2**
Dieback	763.3	221.5		**984.8**
Discoloration	21.2	291.7		**312.9**
Grand Total	**1287.8**	**628.9**	**27.7**	**1944.4**

Table 37. Estimated acres with Observed Unknown Damage by Land Ownership for the Northwest District (A5S) - 2022

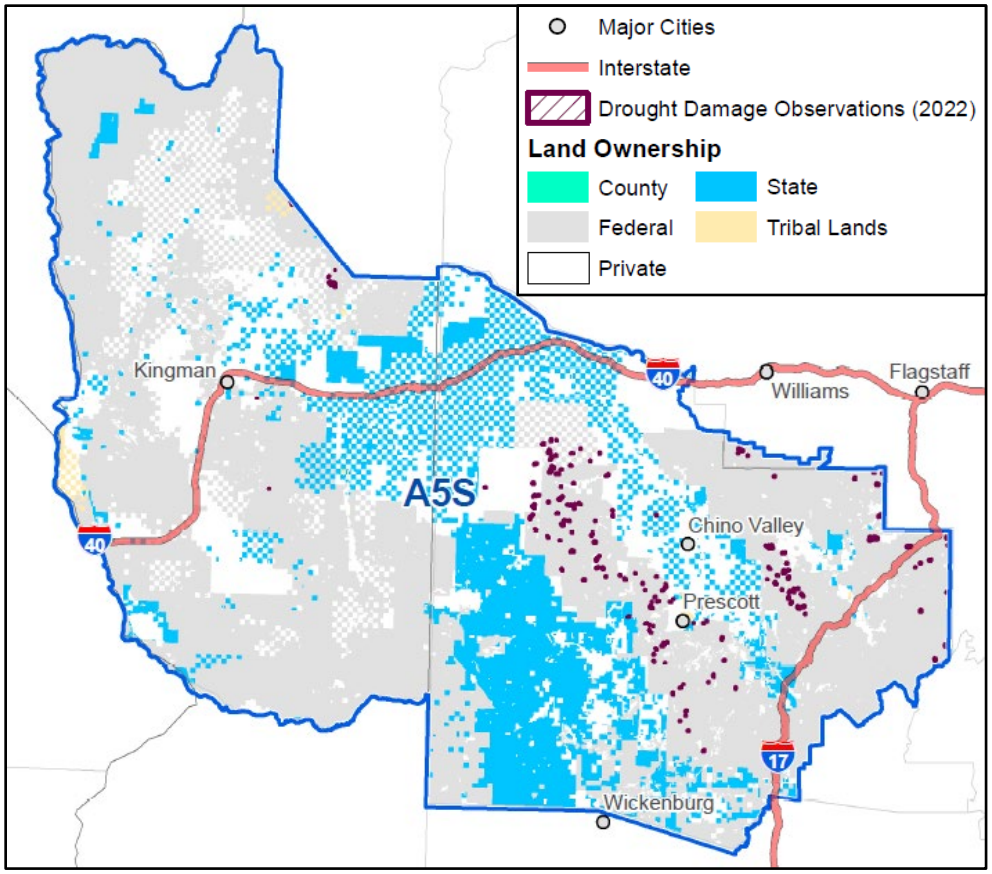

Figure 29 – All Drought Observations within the Northwest District (A5S) – 2022

Photo: Light, juniper dieback due to drought, Prescott NF, 2022

Status of Urban Forests

Mediterranean Pine Engraver

Photo: Credit, Chris Baptista, Entomology Program Manager, Environmental and Plant Services Division, AZDA

The Mediterranean pine engraver (*Orthotomicus erosus*), or MPE, was first discovered in the Central Valley of California in 2004. Since its introduction, this non-native bark beetle has steadily spread to Nevada and Arizona. As of 2022, they have not been found in New Mexico.

In 2018, the DFFM began monitoring for the presence of MPE, to determine if it had become established in the Phoenix Metro area. By 2019, the DFFM created a monitoring protocol for an MPE Monitoring Program; MPE traps were then placed throughout the Phoenix metropolitan area. When this program began in 2019, 16 traps were placed around the Phoenix Metro area for a period of 20 weeks in the summer. In 2020 a total of 30 traps were placed throughout the Phoenix Metro area and monitored for 20 weeks throughout the summer. In 2021, 30 traps were placed in the Phoenix Metro, and an additional 10 traps were placed in Tucson, AZ. These 40 traps in the Phoenix metro and city of Tucson were left out for 24 weeks, from April to September. In its final year (2022), the 30 traps were spread out even further around the Phoenix metro. The data collected from these four years of trapping will help the DFFM determine if the beetles' lifecycle is different in Arizona than its native habitat (i.e. if the beetles are actively flying and reproducing during the relatively mild fall and winter). Trap samples were collected every week, frozen, and later processed and counted. Since monitoring began in 2018, over 355,000 MPE beetles have been collected from the Phoenix Metropolitan area (Figure 30).

It is important to mention that this beetle is known to have a large host range, in both urban and wildland forest types. At this point, MPE has only been found in urban forests. But due to its large host range, this invasive insect poses the risk of infesting wildland forests, underscoring the importance of continued monitoring and research regarding management options.

The Arizona Department of Forestry and Fire Management's public facing dashboard on the Mediterranean Pine Engraver in the Phoenix metro can be found at the following link:

https://dffm.maps.arcgis.com/apps/MapSeries/index.html?appid=4cb0e4f828d44b158aa37006880d664e

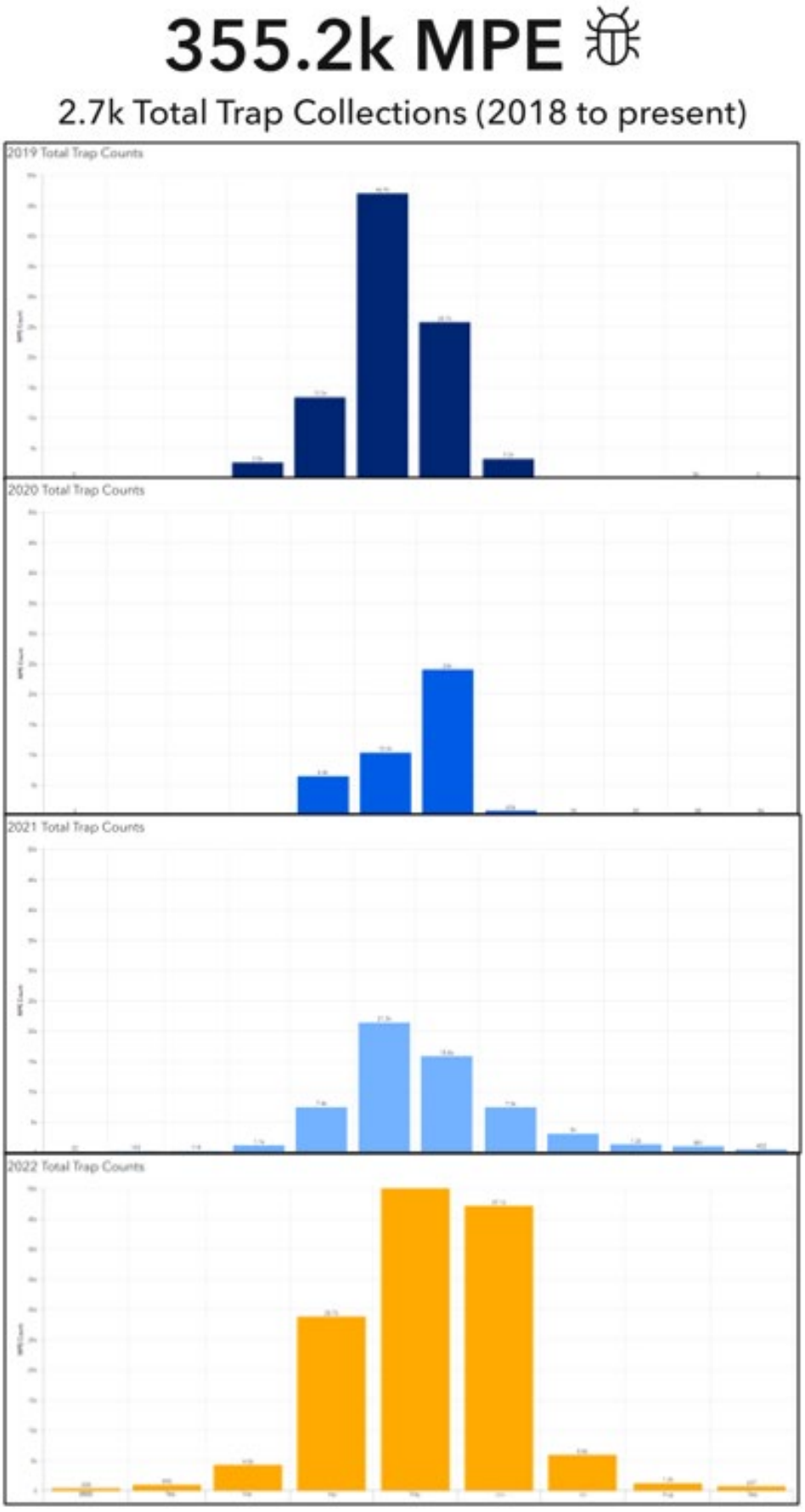

Figure 30 – Total Trap Counts of Phoenix Metro Mediterranean Pine Engraver Traps for the Last Four Years

General 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 500
Phoenix, Arizona 85007
602-771-1400
Website: dffm.az.gov
Forest Health Website: dffm.az.gov/forestry-community-forestry/forest-health

The Forest Health Team

Assistant State Forester for Forestry Programs: John Richardson, jrichardson@dffm.az.gov, 602-771-1420

Specialized Forestry Program Administrator: Cori Dolan, cdolan@dffm.az.gov, 520-262-5519

GIS & Data Supervisor: Wolfgang Grunberg, wgrunberg@dffm.az.gov, 602-399-1886

Forest Health Program Manager: Aly McAlexander, amcalexander@dffm.az.gov, 602-290-9644

Urban & Community Forestry Program Manager: LoriAnne Barnett-Warren, lbarnett@dffm.az.gov, 602-399-9447

Invasive Plant Program Coordinator: William Sommers, wsommers@dffm.az.gov, 602-771-1405

Conservation Education Coordinator: Megan Lasley, mlasley@dffm.az.gov, 602-206-9830

Forest Health Technician: Viridiana Quinonez Nevarez, vquinonez@dffm.az.gov, 480-349-7585

Photo Credits

All aerial photos of observed insect, diesease, and noninfectious disorders without a photo credit were taken by Aly McAlexander; any additional photos without credit were either taken by Aly McAlexander or other Department of Forestry and Fire Management employees.

The State of Arizona Forest Health Program is made possible with assistance from the USDA Forest Service.

Photo: Turkey tail mushroom, Mt Graham, Coronado NF, 2022

Published: January 31, 2023

Appendix I: AZ DFFM Districts

WARNING: DO NOT TOUCH

DOUGLAS-FIR TUSSOCK MOTH CATERPILLARS

Portions of mixed conifer forests are experiencing a **Douglas-fir tussock moth outbreak along the Mount Graham, Swift Trail Scenic Drive** from Turkey Flat recreation area up to Ladybug Saddle. Affected trees have brown to red foliage that may be concentrated in tree tops and the exterior of the crown (shown below). Douglas-fir tussock moth is a native insect that commonly reaches outbreak populations. Outbreaks can last for two to four years. Crown dieback and tree mortality may follow when Douglas-fir tussock moth caterpillars eat most of the needles. These defoliated trees also become more susceptible to bark beetle attacks.

Prefers to feed on: White fir and Douglas-fir in the Southwestern Region.

Life cycle: One generation a year; the insect overwinters in an egg mass; caterpillars hatch from eggs at bud break and feed on needles throughout the early to mid-summer; adult male moths fly from late-summer to early fall in the Southwest.

Tussockosis: Caterpillars of Douglas-fir tussock moth (shown above) are very hairy. The hairs on the caterpillars as well as their egg masses and cocoons may cause allergic reactions to some people and pets, called "tussockosis." Itching is the most common complaint, but adverse health effects can include rashes with welts or blisters (shown below), watery eyes, runny nose, cough and, less commonly, shortness of breath, wheezing, and chest tightness. Recreaters should avoid groups of severely defoliated trees infested with Douglas-fir tussock moth caterpillars.

Scan the QR Code for more information on Douglas-fir tussock moth

Questions or comments: Email Amanda Grady, Forest Entomologist,
amanda.grady@usda.gov
928-556-2072

Coronado National Forest, Region 3

Forest Service News Release

Contact Title: Starr Farrell
(520) 282-0436
starr.farrell@usda.gov
www.fs.usda.gov/coronado

Douglas-fir Tussock Moth Outbreak

Mount Graham, Safford Ranger District

Tucson, Ariz., (July 18, 2022) – A sudden and severe defoliation (damage or loss of needles) event was reported in the Safford Ranger District, Coronado Nation Forest on Mount Graham in late June of 2022. Forest Service entomologists with the Arizona Zone, Forest Health Protection program confirmed the agent responsible for the damage is a native insect, the Douglas-fir tussock moth, *Orgyia pseudotsugae*. The outbreak is concentrated in lower mixed conifer forests along State Route 366, Swift Trail Scenic Highway, from Turkey Flat recreation and residential area up to Ladybug Saddle.

Symptoms of the damage include defoliation caused by feeding caterpillars and needle discoloration from healthy green foliage to a brownish-red hue as the partially consumed vegetation begins to dry. Damage is highly visible along the scenic highway and in several recreation areas including along the Turkey Flat Trail. Trees with light to moderate defoliation often survive a single defoliation event. However, branch dieback and tree mortality may occur when caterpillars eat more than 80% of the needles. These defoliated trees also become less vigorous and more susceptible to bark beetle attacks.

As the outbreak begins, the damage is concentrated on new foliage and thus most apparent in treetops and in the outer branches. As they grow, caterpillars consume new and old needles from early to mid-summer. Damage symptoms will worsen as caterpillars mature and consume more vegetation. From mid to late summer the caterpillars construct cocoons generally on the underside of host vegetation or on branches, tree trunks, and even on patio furniture during outbreaks. Adults emerge from cocoons and mate during the fall. After mating, the flightless female will lay an egg mass on top of the cocoon from which she emerged. Egg masses will overwinter and hatch the following spring as new vegetation emerges from host trees. One generation occurs per year and outbreaks may continue for three to four years. Natural enemies including a virus generally reduce populations once they become abundant. Suppression efforts may be needed in high-use recreation areas to reduce the population and impacts to vegetation or critical habitat.

In addition to impacts on tree health, we anticipate high numbers of caterpillars to occur in these areas potentially posing a health and safety hazard to visitors due to contact with the urticating or irritating hairs of the caterpillars leading to tussockosis.

Older caterpillars are about 1 inch long and are covered in long hairs with noticeable tufts of hairs behind the head, along the body, and at the rear. People and animals can develop an itchy rash or other allergic reactions from exposure to the irritating hairs, called “tussockosis.” Itching is the most common complaint, but adverse health effects can include rashes with welts or blisters, watery eyes, runny nose, cough, and less commonly, shortness of breath, wheezing, and chest tightness. People should avoid areas with heavily defoliated trees, caterpillars, cocoons, and egg masses. Workers in these areas should wear long sleeves to reduce contact with caterpillars. It is also recommended to wash hands and any exposed skin with soap and water, change clothing and take a cool shower after being exposed to areas with heavy infestation.

Forest Health Protection will continue to monitor the extent and severity of the damage and the insect populations during 2022. Fall assessments will inform the need for further management.

If there are additional questions or concerns, about damage occurring on the Coronado National Forest please contact Amanda Grady, Forest Entomologist at amanda.grady@usda.gov, or Joel McMillin, Arizona Zone Leader for Forest Health Protection at Joel.McMillin@usda.gov.

Private landowners and affected residences should contact Aly McAlexander, Forest Health Specialist with the Arizona Department of Forestry and Fire Management at amcalexander@dffm.az.gov

For any additional questions feel free to contact the Coronado National Forest at Mailroom_R3_Coronado@usda.gov. For the most current updates about the Coronado National Forest, please follow us on Facebook at https://www.facebook.com/CoronadoNF and Twitter at https://twitter.com/CoronadoNF.

#####

USDA is an equal opportunity provider, employer, and lender.

Arizona Forest Health Alert

Oystershell Scale Crawlers Emerging in Northern and Central Arizona

May 2022

Oystershell scale (OSS) (*Lepidosaphes ulmi*) crawlers, which are newly emerged scales, are the only mobile life stage of OSS. Crawlers will begin to hatch in late May to early June in northern and central Arizona. Most crawlers emerge over a 2-3 week period in late May to early June but may continue to emerge throughout the summer and into the fall.

This crawler stage is when OSS are most vulnerable to treatments that can reduce population sizes and impacts. That is why homeowners should begin monitoring for crawler emergence by Memorial Day weekend, as this is the best time for homeowners with infested trees to most efficiently treat the pest.

Why do we care?

Populations of OSS have increased across northern and central Arizona, leading to greater impacts in both urban and wildland settings. OSS damage host trees by inserting their piercing mouth-parts into the bark to suck fluids from the tree. This can lead to bark cracking, branch mortality or whole tree death if the infestation is severe. OSS damage may also weaken host plants, making them more susceptible to other insects or pathogens. Although aspen appears to be the preferred host of OSS, this insect may also affect poplars, willow, ash, lilac, and other tree and shrub species with thin bark. This is a persistent insect that will continue to infest the same hosts, and potentially nearby hosts, year after year.

Signs of activity

Up close, the scale resembles the shell of an oyster (Fig. 1). From a distance, large groups of scales may appear as dark or gray patches against the white trunk of an aspen (Fig. 2). Newly emerged OSS crawlers can be difficult to identify; they look like tiny yellow-orange specks on the tree trunk and branch surfaces (Fig. 3). As crawlers hatch and emerge from beneath the old mother scale they will crawl up the tree trunk in search of a new feeding spot or can be wind-blown to a nearby host. Once they settle and begin to feed, the armored scale or shell begins to harden. After the outer shell hardens the scale is protected and less susceptible to treatments including the use of pesticides.

What to look for

Photo by Colorado State University Extension

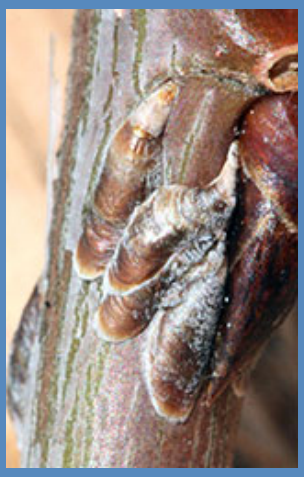

Fig. 1 Adult OSS.

Fig. 2 and Fig. 3 Photos by the USDA Forest Service

Fig. 2 Severely infested aspen (right) next to an unaffected aspen (left).

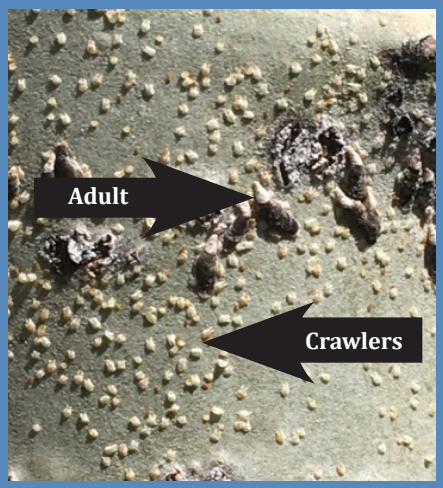

Fig. 3 Close up of adult scales among many tiny yellowish-white crawlers.

What else could it be?

There are other scales that occur on aspen, but none that will look similar to OSS. However, there are non-insect agents that cause damage which can resemble OSS damage, namely cankers. A variety of fungal pathogens cause canker formation on aspen which may result in sunken and/or roughened bark. From a distance, cankers may appear as darkened patches that may be confused with OSS. Two common aspen cankers that might be confused with OSS are Cytospora canker (*Cytospora spp.*) (Figure 4) and hypoxylon (*Entoleuca mammatum*) (Figure 5). It is important to positively identify OSS as the causal agent before implementing any management strategies.

Photos by the USDA Forest Service

Fig. 4 Orange fruiting bodies emerging from pimple-like structures caused by *Cytospora* spp.

Fig. 5 White and black stromata of *E. mammatum*. Note the dark, roughen bark caused by the pathogen.

Fig. 6 Physical removal of scales. Photo courtesy of Colorado State University Extension.

What can you do?

A variety of treatments are recommended for OSS mitigation. The most benign treatments include **physical removal** of OSS adults and crawlers (Figure 6); even a strong jet of water from a garden hose may be used to displace and kill the fragile crawlers. Summer season **horticultural oils**, when applied to coincide with the egg hatch/crawler period can effectively be used to help control OSS. Winter season, or dormant season horticultural oils can kill many of the overwintering eggs of OSS and can therefore be a useful management option. **Pyriproxifen** is an insect growth regulator that is particularly effective against OSS, but is only sold for use by commercial applicators. **Dinotefuran** is a water soluble, systemic insecticide that is effective against OSS. Dinoterfuran can be applied as a soil drench or as a spray on the tree trunk, where it is absorbed into the plant and subsequently translocated within the tree. Dinotefuran remains active for one to two years.

Old scales will remain on the bark after treatments. Remove scales from an infested area to monitor emergence the following year to determine if additional treatments are needed. For more information on treatment methods see the Colorado State University Extension, Oystershell Scale Fact Sheet No. 5.513 (https://extension.colostate.edu/topic-areas/insects/oystershell-scale-5-513/).

Lastly, proper tree maintenance of your aspen will also help minimize OSS impacts. By using proper pruning techniques, pruning in the dormant season, and adequate watering will help to reduce stress of host trees and minimize impacts of OSS.

LET US KNOW!

This USDA Forest Service Oystershell Scale Survey helps track the spread of OSS in the West. If you have spotted OSS, particularly in an urban environment, please fill out this survey to let us know. To submit a report, visit the app store to download the Survey123 app, then scan this QR Code through the app.

For further information about this insect or other forest health concerns, contact Aly McAlexander, Forest Health Specialist, at (602) 771-1415 or amcalexander@dffm.az.gov.

Funding provided by the USDA Forest Service.

Disease Note

Diseases Caused by Fungi and Fungus-Like Organisms

First Report of *Biscogniauxia mediterranea* on *Quercus emoryi* in Southern Arizona

S. A. Wright,[1] B. M. Lalande,[1,2] N. Wilhelmi,[3] and J. E. Stewart[1,†]

[1] Department of Agricultural Biology, Colorado State University, Fort Collins, CO
[2] United States Forest Service, Forest Health Protection Region 2, Gunnison, CO
[3] United States Forest Service, Forest Health Protection Region 3, Flagstaff, AZ

Funding: Funding was provided by Colorado State University, Department of Agricultural Biology (Undergraduate Research Fellowship) and U.S. Forest Service, Forest Health Protection, Region 3: Emerging Pest Program. Plant Dis. 106:1305, 2022; published online as https://doi.org/10.1094/PDIS-09-21-1933-PDN. Accepted for publication 28 September 2021.

In 2019, a decline of *Quercus emoryi* (Emory oak) was observed on the Coronado National Forest located in southeastern Arizona. Symptoms associated with oak mortality included crown dieback and large cankers revealing charcoal-like stromal growth. Trunks and root collars showed girdling, and many affected trees also displayed evidence of gold-spotted oak borer activity. Initial surveys in stands identified clusters of severe infections. Samples with black perithecia and stromal tissue were collected from symptomatic hosts. Morphological characterization of the fungus was completed on fresh perithecial tissue. Stromata were pulvinate and black, showing embedded perithecial bumps, with ostioles visible from the surface of the stroma. Asci were short stipitate and cylindrical with visible oil drops, 6.6 to 9.4 (mean: 8.8) by 139.8 to 179.9 µm (mean: 166.4). Ascospores were smooth ovoid, brown to dark brown, with narrowed and round ends, 6.9 to 9.1 (mean: 7.7) by 13.8 to 25.9 µm (mean: 16.5). Colonies grown on half-strength potato dextrose agar (1/2 PDA) (Korhonen and Hintikka 1980) at 25°C for 14 days were whitish-gray when viewed from the top, and darkened embedded spheres were visible from the bottom. Single-spored cultures were isolated by dissecting the hymenium and placing in distilled water. The suspension was streaked onto 1/2 PDA plates and incubated for 12 h, and pure cultures were grown on 1/2 PDA. DNA was isolated from a mycelial scrape and extracted using a 10% Chelex solution (Safaee et al. 2017). The internal transcribed spacer (ITS) region was amplified with the ITS1/ITS4 primer pair (White et al. 1990) and PCR products were sequenced at Eurofins Scientific (Louisville, KY). Isolates (BSS1, BSS2, BSS3, and BSS4) were compared with other *Biscogniauxia mediterranea* sequences in the NCBI database (MG098274 and EF026134) and had 100% sequence identity. Pathogenicity assays were conducted using 8-year-old Emory oak trees in a greenhouse. The oak trees were drought stressed and watered at 50% pot capacity for 2 months prior to inoculation. Each tree received approximately 2,400 ml of water every 2 weeks for the remainder of the experiment. Eight trees were wounded three times with a 5-mm corer. A 5-mm plug of mycelium of isolate BSS2 was used to inoculate wounds. Four trees were used as controls and inoculated with 1/2 PDA plugs. Wounded and inoculated areas were assessed after 3 months. All eight trees exhibited dark necrotic tissue in the vascular cambium and lesions ranged from 11.4 to 25.8 mm in length and were 3.9 to 13.3 mm wide. The controls exhibited no fungal sign, lesions, or necrotic tissues. The pathogen *B. mediterranea* was recovered from 13 of the 24 total inoculations and its identity was confirmed with ITS sequencing. Mortality and dieback caused by *Biscogniauxia* spp. are commonly associated with drought-stressed trees, with increasingly hot and dry conditions routinely noted as inciting factors (Desprez-Loustau et al. 2006). Emory oak is among the dominant tree species in much of the Madrean oak woodlands of the southwestern United States and Mexico and provides vital ecological and cultural services. As southwestern states continue to experience hotter and drier conditions, it is likely Emory oak will become increasingly susceptible to dieback and mortality due to this *Biscogniauxia* sp. (Souther et al. 2021).

References:

Desprez-Loustau, M., et al. 2006. Ann. For. Sci. 63:597.
Korhonen, K., and Hintikka, V. 1980. Karstenia 20:19.
Safaee, D., et al. 2017. Mycol. Iran. 4:121.
Souther, S., et al. 2021. For. Ecol. Manage. 483:118900.
White, T. J., et al. 1990. Page 315 in: PCR Protocols: A Guide to Methods and Applications. Academic Press, San Diego, CA.

The author(s) declare no conflict of interest.

e-Xtra

Keywords: fungi, tree fruits, forest, disease management, pathogen detection

† indicates the corresponding author.
J. E. Stewart: Jane.Stewart@colostate.edu