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Nevada
Division of Forestry
Department of
Conservation and
Natural Resources

Pinyon Needle Scale Damage
Pine Nut Mountains, Nevada
(Photo: Gene Phillips)

2019
Forest Pest Conditions
In Nevada

Forest Health Specialists

Forest Health Protection
USDA Forest Service
Ogden Field Office
Forest Health Protection
4746 S 1900 E
Ogden, UT 84403
Phone: 801-476-9720
FAX: 801-479-1477

Robert Cruz, Group Leader
Email: rcruz@fs.fed.us

Darren Blackford, Entomologist
Email: dblackford@fs.fed.us

Elizabeth Hebertson,
Entomologist/Pathologist
Email: lghebertson@fs.fed.us

Laura Dunning, Program Assistant
Email: ldunning@fs.fed.us

Nevada Division of Forestry
Department of Conservation and Natural Resources
State Headquarters
2478 Fairview Drive
Carson City, NV 89701
Phone: 775-684-2500

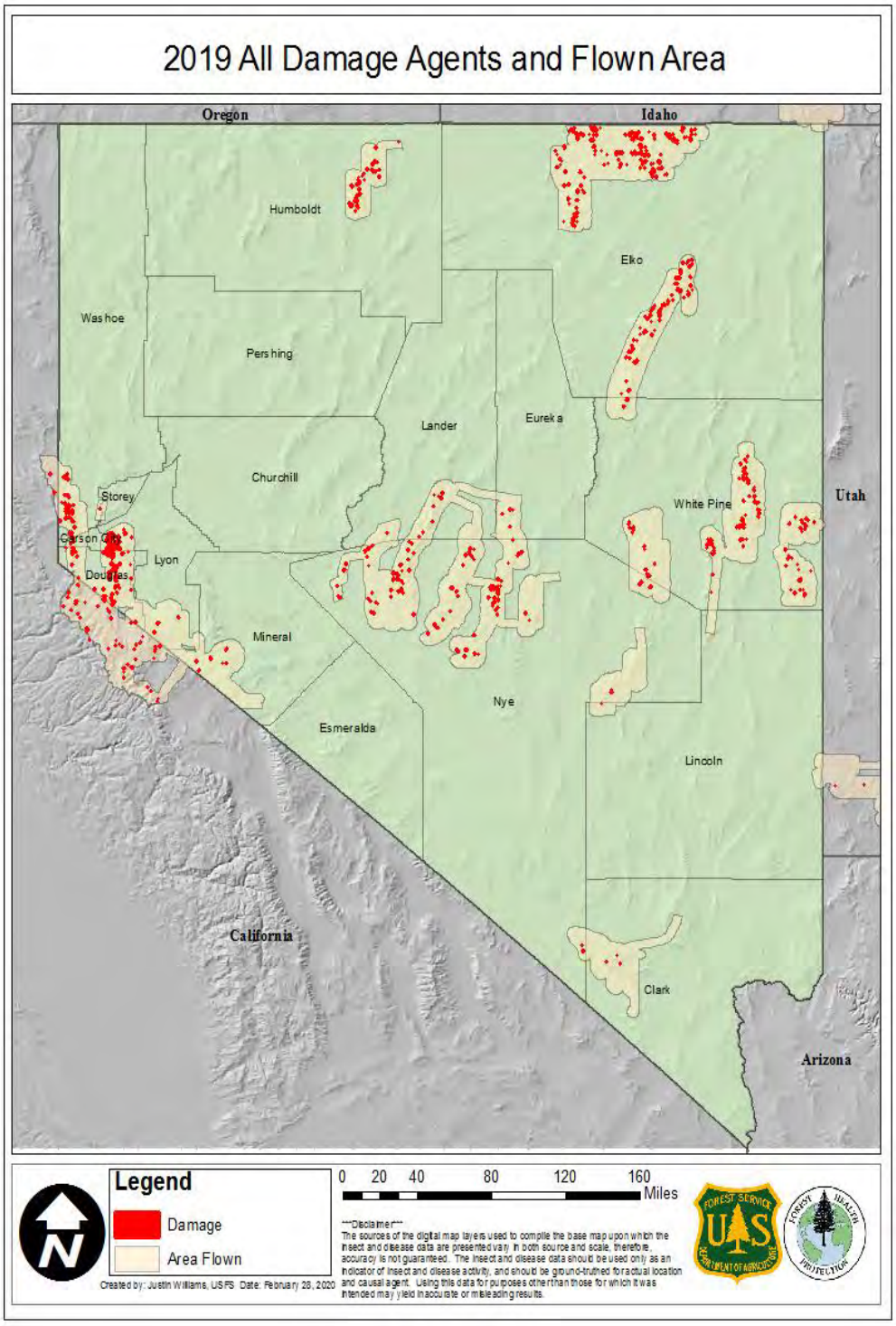
Gene Phillips
Forest Health Specialist
Email: gphillips@forestry.nv.gov
Phone: 775-849-2500 Ext.241

Ryan Shane
Resource Program Manager
Email: rshane@forestry.nv.gov
Phone: 775-684-2507

Compiled by:
Gene Phillips, Forest Health Specialist, NDF DCNR

With Contributions from:
Jeff Knight, Nevada State Entomologist
Justin Williams, Region 4, Forest Health Protection
Aaron Taveras, GIS Data Manager, NDF DCNR

March, 2020



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INTRODUCTION AND SUMMARY

To simplify discussions of forest health conditions in Nevada, this report focuses only on insects, diseases, and weather factors that impacted tree species in the State. Data collected through aerial detection surveys (ADS) conducted by the USDA Forest Service and Nevada Division of Forestry are primarily used to determine damage and mortality trends in the State from year to year. The ADS data encompasses the Humboldt-Toiyabe National Forest including portions of the Bridgeport and Carson Ranger Districts located in California. A smaller percentage of acreage was surveyed to obtain data for Great Basin National Park as well as other federal, State, and private lands (Table 1).

Table 1. Total number of acres surveyed in each of the ownership categories for the years 2012-2019.

Land Ownership/ Year	2012	2013	2014	2015	2016	2017	2018	2019
NF H-T (NV)	4,011,229	3,340095	4,429,990	4,916,969	5,329,221	5,239,810	4,778,157	5,141,140
NF H-T (CA)	582,933	685,252	595,007	625,488	570,641	575,908	590,747	600,648
BLM	1,892,996	1,013,172	1,483,353	1,597,815	2,742,127	3,168,492	2,474,465	1,942,673
Private (NV)	306,606	148,504	391,378	397,047	921,482	834,150	879,602	691,877
Private (CA within NF)	29,846	60,155	70,501	32,977	32,830	30,088	0	85,925
Great Basin NP	75,604	76,959	77,021	77,078	77,099	77,000	77,083	77,003
Other Federal*	33,228	6,466	5,124	3,719	80,120	114,275	96,863	114,755
NV State Lands	17,163	148,504	21,848	19,889	20,470	13,935	37,675	37,090
TOTAL	6,949,605	5,479,107	7,074,222	7,670,982	9,773,990	10,053,658	8,934,592	8,691,111

**Includes United States Fish and Wildlife Service, Department of Defense, Bureau of Indian Affairs, and other tribal lands*

Long term insect trend data summarizes activity detected on all surveyed ownerships in Nevada. However, the discussions of activity for individual insect and disease agents detected in 2019 are summarized by county. The total number of acres in each county and the percentage of acres surveyed during 2019 are provided in Table 2.

Table 2. Number and percentages of acres surveyed in Nevada counties in 2019.

COUNTY	COUNTY ACRES	ACRES SURVEYED	PERCENT SURVEYED
Carson City	103,569	47,899	46.2
Churchill	3,215,911	0	0.0
Clark	5,176,177	361,017	7.0
Douglas	478,351	292,010	61.0
Elko	10,979,963	1,344,235	12.2
Esmeralda	2,294,165	0	0.0
Eureka	2,663,738	311,349	11.7
Humboldt	6,219,557	203484	3.3
Lander	3,534,543	288,414	8.2
Lincoln	6,782,623	65,562	0.1
Lyon	1,310,315	296,954	22.7
Mineral	2,462,989	467,140	19.0
Nye	11,686,348	2,135,413	18.3
Pershing	3,876,864	0	0.0
Storey	167,774	59,575	35.5
Washoe	4,234,009	136,604	3.2
White Pine	5,676,727	1,253,150	22.1
Total	74,746,590	7,262,806	9.7

During the winter of 2019-2020, most of the State of Nevada experienced one of the driest winters in recorded NOAA weather history dating to 1895. There were a couple of exceptions; far northern Elko County and far southern Nevada are closer to normal or even a few areas of just above normal precipitation for the season. The Palmer Drought Stress Index (Figure 1) shows a large portion of Nevada being abnormally dry, and parts of four counties in moderate drought. Although (Figure 2) shows as precipitation being above normal, this is due to the fact Nevada is still benefitting from the excellent water year in 2019. Precipitation deficits will likely continue into the late spring and early summer of 2020 (Figure 2).

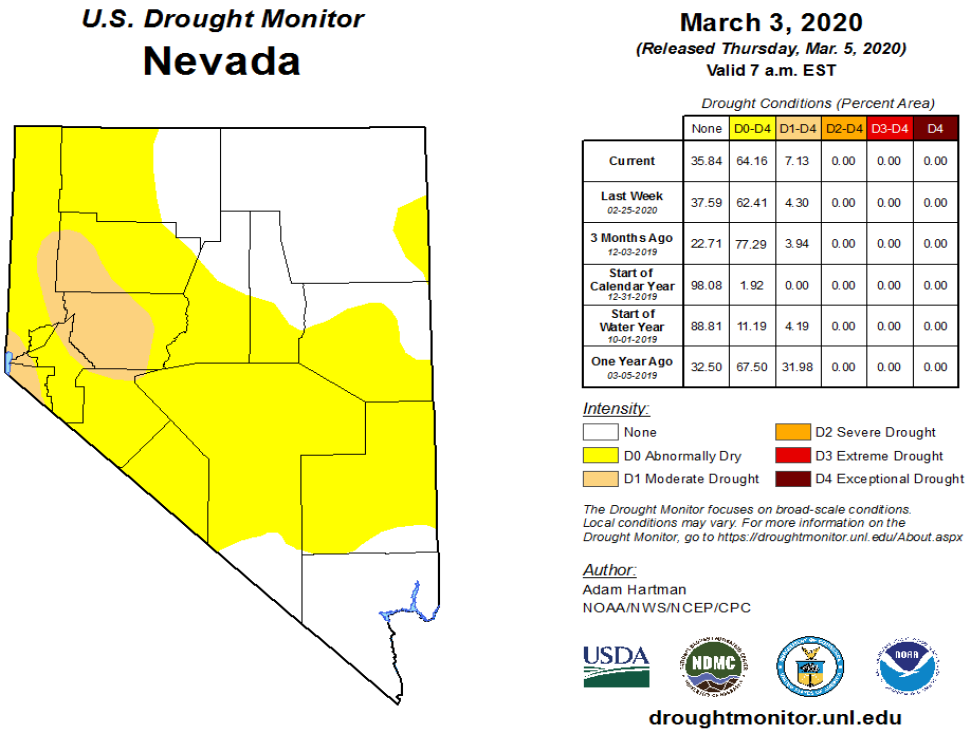

Figure 1. NV Drought Monitor Map for March 2020.

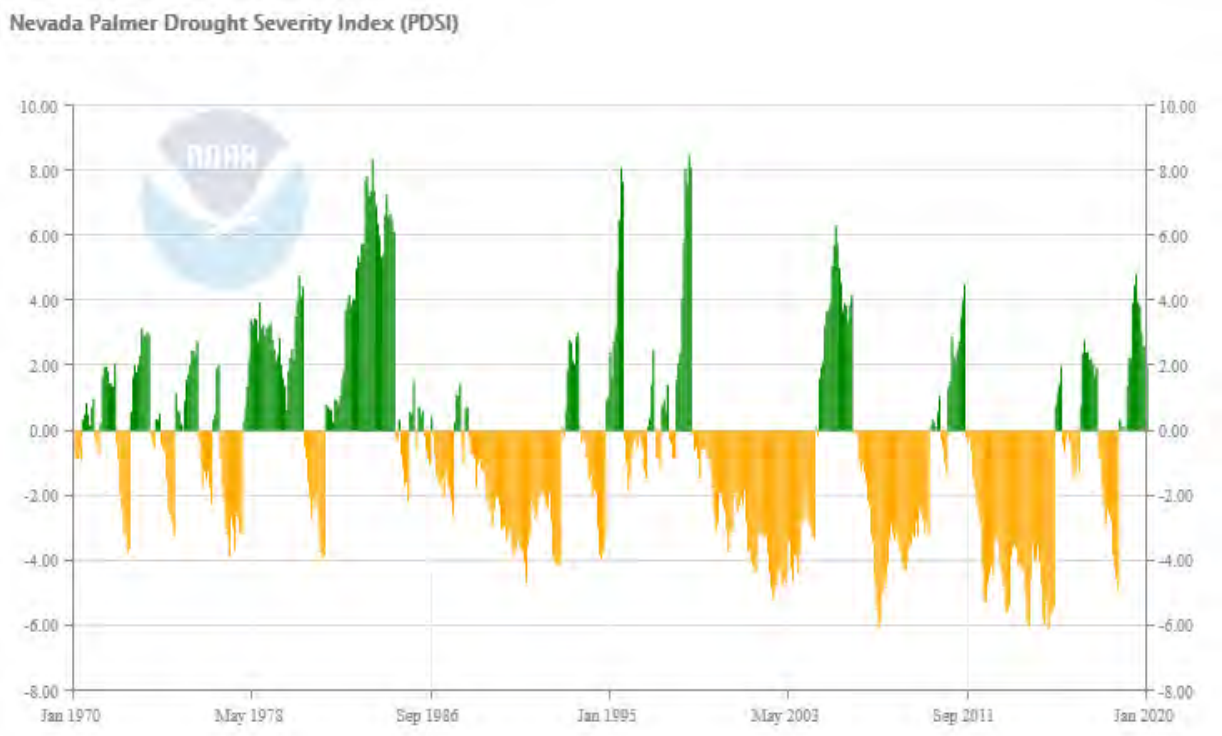

Figure 2. National Oceanic and Atmospheric Administration (NOAA) Nevada Palmer Drought Severity Index – January, Precipitation from 1970-2020 (National Climate Data Center).

In 2019, the amount of insect and disease caused mortality decreased by 33% with damage being recorded on 40,500 acres. This is can be attributed to several factors, including the natural population trends of insects, increase in predatory insect activity, and the decreases in secondary insect outbreaks, which are the outbreaks that occur once trees are stressed from initial bark beetle or disease attacks. Additionally, high precipitation amounts in the winter through the early summer in 2019 likely helped to offset tree stress and related insect infestations.

Much of the tree mortality noted in 2019 is attributed to pinyon needle scale activity. Additional acres affected were largely dominated by mountain pine beetle and fir engraver beetle, marssonina blight, followed by subalpine fir decline, white satin moth, pinyon sawfly and Douglas-fir tussock moth. Marssonina blight continues to be a problem in aspen stands, with approximately 7,750 acres of damage recorded, including tree stress and mortality statewide.

In 2019, acres damaged by defoliators decreased by 23%. Pinyon needle scale decreased in 2019 with 18,344 acres damaged, down from a total of 25,320 acres in 2018. Forest tent caterpillar, and Douglas-fir tussock moth were detected in 2019 with 526 acres and 139 acres, respectively. White satin moth infestations increased slightly, mainly in Washoe and Humboldt Counties. White satin moth was also recorded in Carson City, Douglas, and Elko Counties. A total of 2,399 acres was recorded throughout Nevada, however defoliation rates and damage decreased by 23% for the year. Subalpine fire decline was stable with approximately 1,870 acres exhibiting damage.

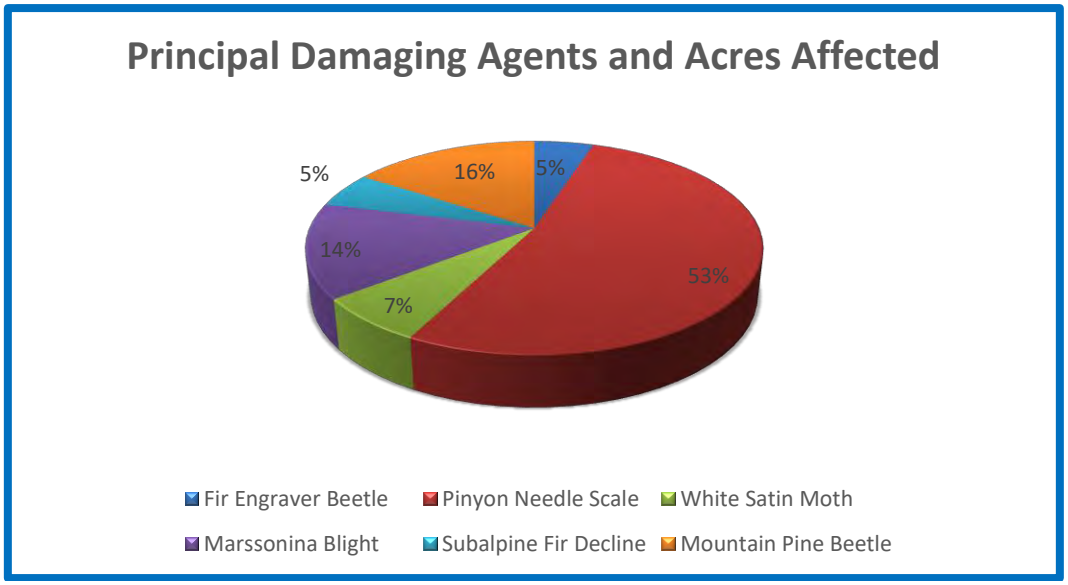

Figure 3. Graphic representation of the acres affected in Nevada by the main mortality and defoliation agents aerially mapped in 2019.

For additional information on forest insect and disease conditions and maps see:

http://foresthealth.fs.usda.gov/portal
and
http://forestry.nv.gov/forestry-resources/forest-health/

NOXIOUS WEEDS

Noxious weed species are widespread throughout Nevada. They can invade and jeopardize the sustainability of forestlands and impair their ecological functions, prevent regeneration and create hazardous fuel loads that change the fire ecology on the sites. Nevada Department of Agriculture (NDOA) monitors and oversees Nevada's weed laws. Their main website for weed status, information, contacts, is: http://agri.nv.gov/Plant/Noxious_Weeds/Noxious_Weeds_Home/. It should be noted that some of the most prevalent and impactful weedy species are not legally defined and categorized as noxious. A couple examples of these are annual grasses Cheatgrass (*Bromus tectorum*), Red brome (*Bromus rubens*), Medusahead (*Taeniatherum caput-medusae*), and Ventenata (*Ventenata dubia*).

The NDOA monitors and records noxious weed infestations throughout Nevada by recording point data and instances or occurrence. They also utilize the EDDMapS is an online mapping database where anyone with a free account can contribute to invasive species data collection. Acreages are not calculated, however the top five noxious weeds identified in order of occurrence are, Hoary cress (*Cardaria draba*), Tall whitetop (*Lepidium latifolium*), Musk thistle (*Carduus nutans*), Russian knapweed (*Acroptilon repens*), and Scotch thistle (*Onopordum acanthium*). Control efforts are generally conducted by NDOA, local Cooperative Weed Management Areas, private landowners, County Governments, Conservation Districts. The Nevada Division of Forestry (NDF) completes projects when grant funding is awarded or private landowners contract with NDF inmates crews for such activities. The map below depicts the top five weeds in occurrence statewide. A full table of weed occurrences in Nevada can be found in Appendix A.

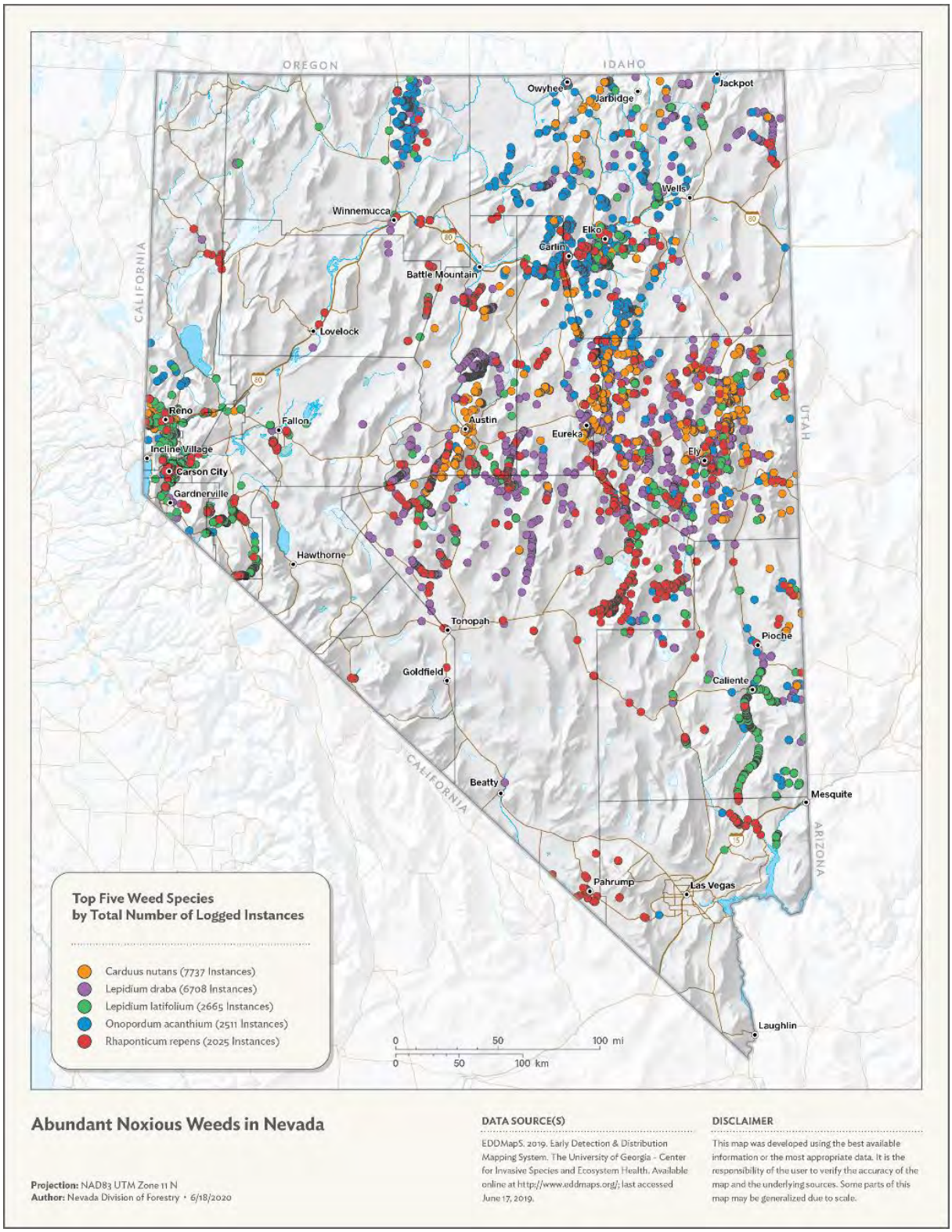

Figure 4. Top five noxious weed occurrence in Nevada

INSECTS: NATIVE DEFOLIATORS

DOUGLAS-FIR TUSSOCK MOTH

Orgyia pseudotsugata

Hosts: Douglas-fir, all true firs, spruce, and pines on occasion

Douglas-Fir Tussock Moth (DFTM) is a native defoliator of true firs, Douglas-fir and spruce. Larvae feed in spring and early summer and fist mine buds and old needles then consume new foliage as it appears. Mature larvae have brown heads and bodies with prominent ivory-colored spots. They can be an inch long when fully grown. Adults are mottled-rust brown and have a wingspan of approximately seven-eighths of an inch. Female moths lay eggs on needles in a shingle-like pattern usually in August. Larvae hatch and immediately seek a sheltered location to overwinter.

Table 5. The following is a list of the counties, acres and specific locations where western spruce budworm was detected.

County	Acres	Specific Area and Description
White Pine	139	Damage was observed within Great Basin National Park. This is a slight decrease from 2018 where 154 acres recorded. All the defoliation was found mid-slope on the northeast flank of Wheeler Peak. Damage was mainly observed on Douglas-fir and some small pockets of Engelmann spruce. It should be noted this was previously mis-diagnosed as western spruce budworm, but was verified last year, and was identified as DFTM damage.

The Douglas-fir tussock moth is a native insect capable of causing significant defoliation of subalpine fir in Nevada. Heavy defoliation can cause top kill and mortality of advanced regeneration during a single season.
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Figure 5. Douglas-fir tussock moth larvae. (Photo from http://www.bugwood.org/)

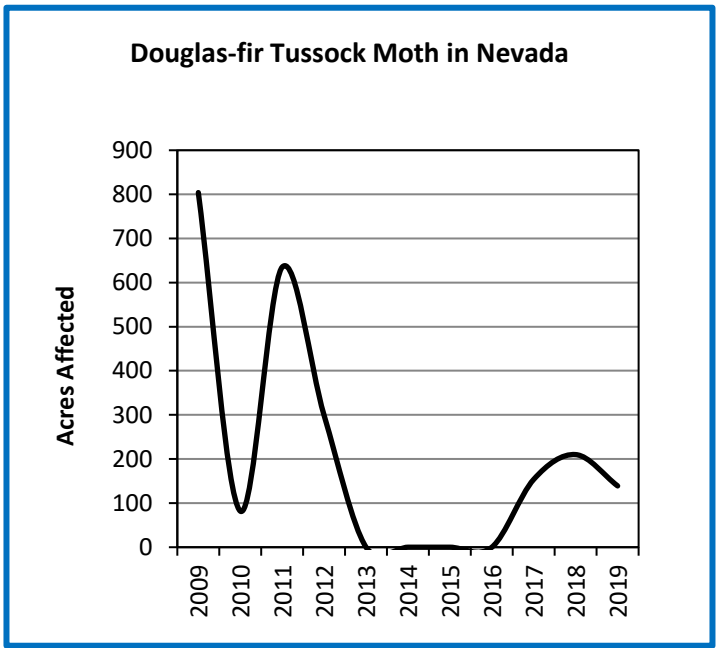


Figure 6. Acres with Douglas-fir tussock moth defoliation in Nevada from 2009-2019.

PINYON SAWFLY

Neodiprion edulicolus

Host: pinyon pine

Pinyon sawfly is a native insect capable of causing significant defoliation, but usually goes undetected because it occurs in small numbers and causes little damage. However, heavy defoliation causes reduced growth, stress, and tree mortality. Thin crowns add a ghostly, transparent appearance to the forest canopy. In some locations, sawfly outbreaks are occurring in conjunction with pinyon needle scale (*Matsucoccus acalyptus*) defoliation.

Figure 7. Sawfly damage near Dayton, Nevada.

In 2019approximately 1,157 acres were recorded in the Pine Nut Mountains and the surrounding area near Holbrook Junction. Additional local damage was noted near Gardnerville at the base of the Pine Nut Mountains and pinyon sawfly was mainly defoliating landscape yard trees. This activity will be monitored in 2020.

PINYON NEEDLE SCALE

Matsucoccus acalyptus

Host: pinyon pine

Pinyon needle scale (PNS) is a sap-sucking insect that feeds on two-year-old needles. Foliage of infested trees turns yellow then brown. Heavy defoliation causes reduced growth, stress, and tree mortality. Past outbreaks have been recorded as far back as 1959 throughout NevadaHistoric outbreaks have been noted between 1963-2011 in Nevada and southwest Utah, affecting several hundred thousand acres. In 2019 approximately 18,344 acres of damage was recorded, which was an increase compared to 25,316 acres in 2018. Much of the mapped area was also affected by a combination of secondary insects such as twig beetles (*Pityophthorus spp., Pityogenes spp.*). From the air, the damage caused by these other insects is similar in appearance to that of PNS infestation, and some areas will be dominated by one or a mixture of these insects. Consequently, differentiating damage attributed to these various causal agents can be extremely difficult, and therefore are all mapped as PNS.

Table 6. The following is a list of the counties, acres and specific locations where PNS was detected.

County	Acres	Specific Area and Description
Carson City	5,325	Low and mid elevations on the west side of the Pine Nut Range and on the far north end.
Douglas	7,107	Lower and mid elevations of the Pine Nut Range. Damage was readily evident in the Sunrise Pass area.
Lyon	3,201	Foothills of the Pine Nut Range.
Mineral	488	Lower elevations in the Excelsior Mountains.
Nye	1,731	All elevations in the Monitor and Toiyabe Ranges.
Storey	49	Throughout the Virginia Range.
Washoe	74	Lower elevation of the Virginia Range, adjacent to subdivisions.
White Pine	390	Throughout all elevations of the Egan, Duck Creek and Snake Ranges.

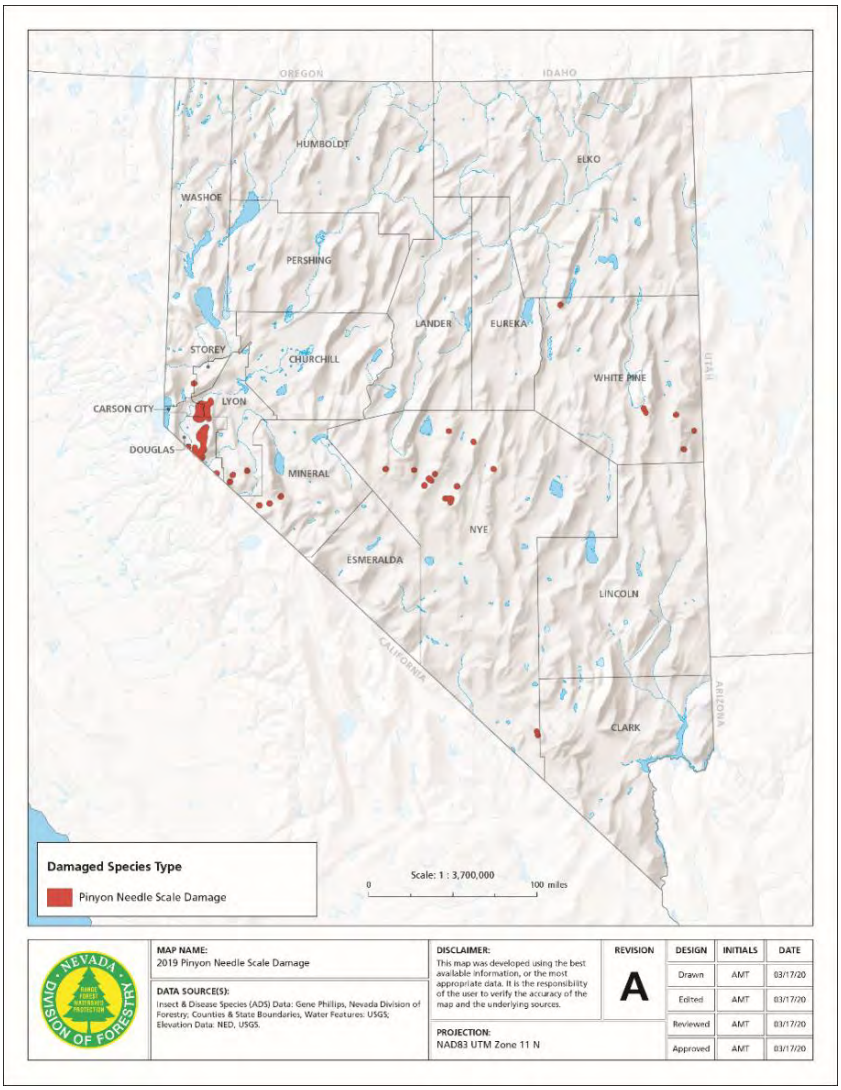


Figure 8. Pinyon needle scale damage in 2019.

FOREST TENT CATERPILLAR

Malacosoma disstria

Hosts: aspen, birch, oak, some maples, and other deciduous species

The forest tent caterpillar (FTC) is a native defoliator of aspen. Overwintering takes place as a fully developed embryo inside the eggshell. When they hatch in the spring, the larvae tend to migrate high in the tree where they feed on expanding flower and leaf buds. After bud break, larvae feed on the foliage, being most gregarious in their early life stages. The adult is a tan moth about 4 cm long with two dark brown, oblique stripes on each forewing. The caterpillar (the most often seen life stage) is mostly dark blue with wavy reddish-brown lines and distinct white, keyhole-shaped markings down the back. Larvae feed in groups without making any webbing. (Western Tent Caterpillar makes the large webs found on chokecherry and are reddish brown caterpillars). Flight and mating activities begin late afternoon through most of the night. There is one generation each year. Parasites tend to keep the outbreaks of this insect cyclic and in check over time. In 2019, FTC defoliation was recorded on 111 acres in both Eureka and White Pine Counties.

INSECTS: NATIVE BARK BEETLES

FIR ENGRAVER BEETLE

Scolytus ventralis

Hosts: true firs

Fir engraver beetle is a native bark beetle that attacks white fir, red fir, and sub-alpine fir throughout Nevada. The beetles infest stressed or weakened trees and cause top kill and mortality. Mortality events can be in cycle in 5-7 year intervals. Current surveys show population fluctuations from year to year. In 2019, mortality and damage decreased to 1,746 acres, as compared to 6,939 acres in 2018. This is a large decrease from the number of acres detected in 2018. White Pine County had the largest amount of damage recorded, which and is causing moderate damage in stands heavily dominated by true firs. Most of the damage was recorded in the Schell and White Pine Ranges as well as the Mt. Moriah Wilderness.

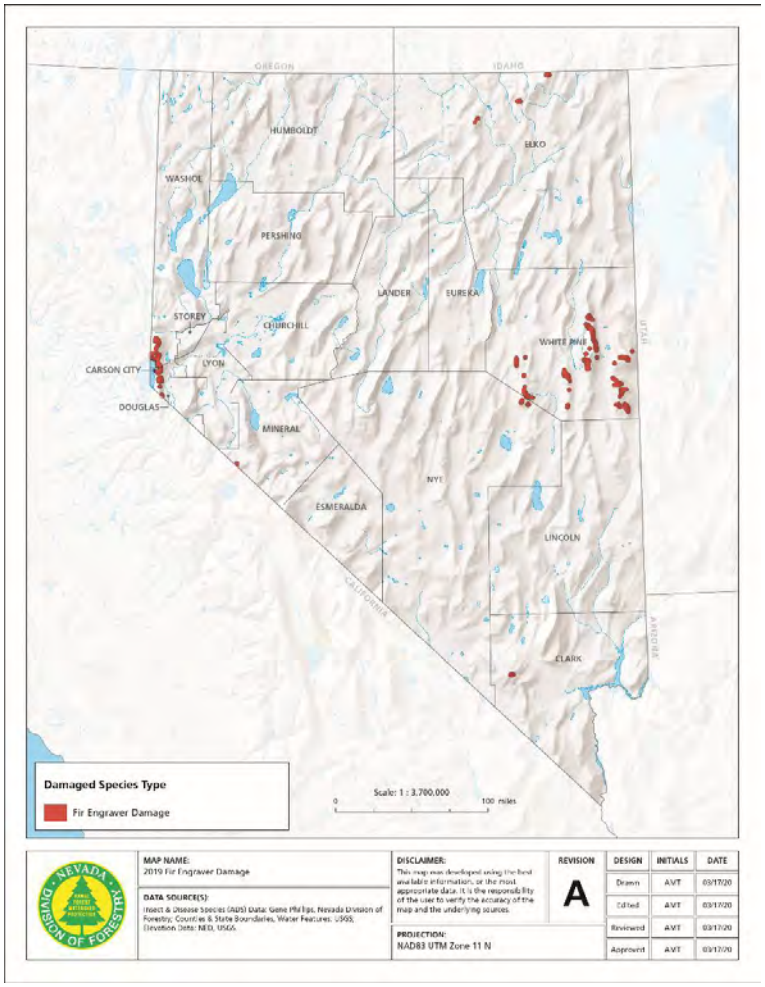


Figure 9. Fir Engraver Mortality in 2019.

Table 7. The following is a list of the counties, acres and specific locations where fir engraver beetle was detected.

County	Acres	Specific Area and Description
Carson City	2	Mortality was observed on 2 acres, all within the Carson Range.
Clark	19	Damage was located in Lee and Kyle Canyons which are north and east of Mount Charleston.
Douglas	154	Located mainly in the Carson Range.
Elko	27	Located in the Jarbidge, and Ruby Mountains.
Nye	104	Located mainly in the Grant, Hot Creek and Monitor Ranges.
Mineral	1	Damage was located in the Sweetwater Mountains.
Washoe	158	Damage is located all along the Sierra Front Range, with pockets of 5 acres or less within the Mt. Rose Wilderness Area.
White Pine	1,282	Mapped activity is found in pockets and across entire stands. These range in size from 10 to 100 acres. Stands that show continuous damage when observed do not have every true fir dying, however damage is scattered across the entire area where damage is recorded in a polygon. This was recorded mainly in the White Pine, Schell Creek, Egan, and Snake Ranges.

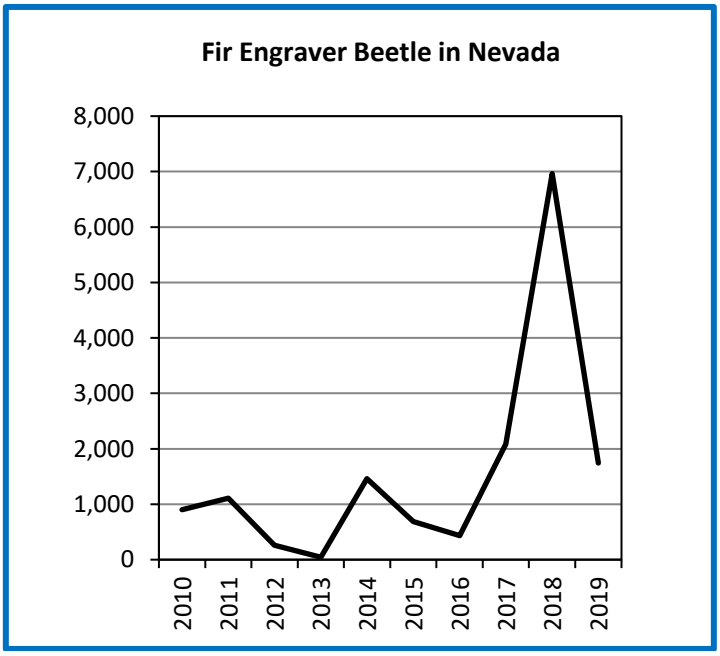


Figure 10. Fir engraver mortality in Nevada 2010-2019.

JEFFREY PINE BEETLE

Dendroctonus jeffreyi

Host: Jeffrey pine

The Jeffrey pine beetle is the most destructive bark beetle of Jeffrey pine. Endemic populations usually attack scattered, slower growing, mature and over-mature trees and trees struck by lightning. In Nevada, Jeffrey pine is naturally within the Sierra Nevada Mountains and in limited areas in the Pine Nut Mountains, and Virginia Range. Mortality decreased in 2019 to 4 acres as compared to 6 acres observed in 2018.

Figure 11. Jeffrey pine beetle-caused tree mortality in Alpine county in California along Highway 88. *(Photo: Sheri Smith)*

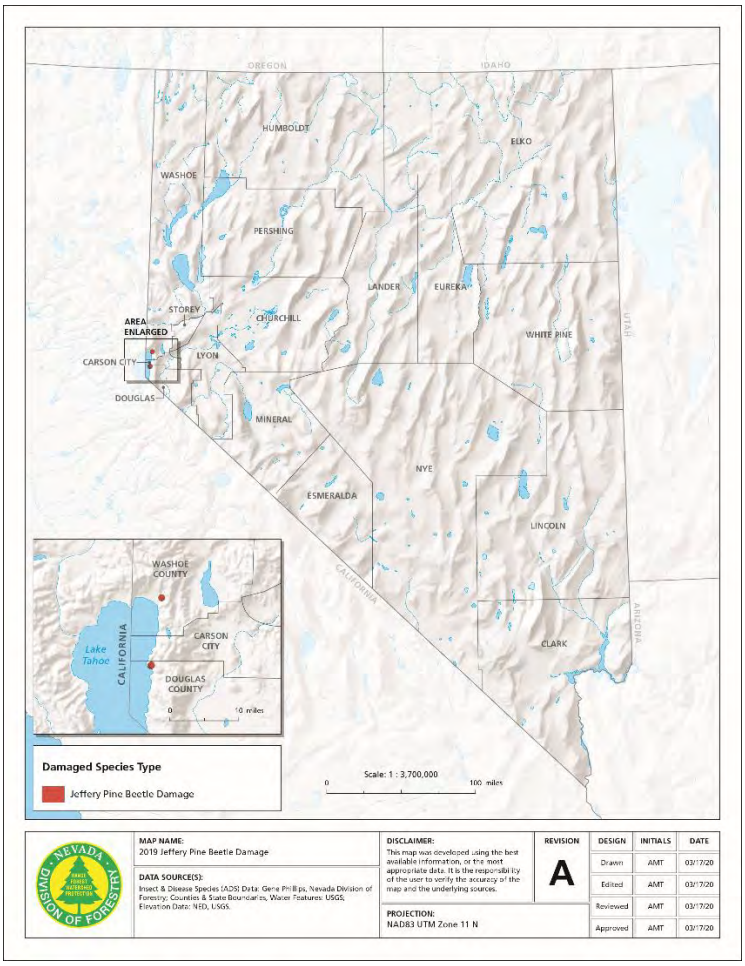


Figure 12. Jeffrey Pine Beelte in 2019

Table 8. List of Jeffrey Pine Beetle outbreak locations and acreages detected.

County	Acres	Specific Area and Description
Douglas	4	Damage was scattered and isolated within the Carson Range.

MOUNTAIN PINE BEETLE

Dendroctonus ponderosae

Hosts: whitebark, limber, lodgepole, sugar, and ponderosa pine

Mountain pine beetle (MPB) can kill thousands of trees per year during outbreak conditions and millions of trees during extended epidemics in western forests. At endemic levels, MPB favors weakened, less vigorous trees with adequate phloem thickness to complete its life cycle. During epidemics, beetles may attack smaller diameter trees down to four inches diameter at breast height. Extensive mortality may alter large forest landscapes by converting pine forest ecosystems to grass and shrub landscapes for a period of 10-20 years.

In 2019, MPB-caused tree mortality in Nevada in all tree species listed increased by approximately 100% from 2018 levels. A total of 5,499 acres mapped in 2019, as compared to 2,558 acres mapped in 2018.

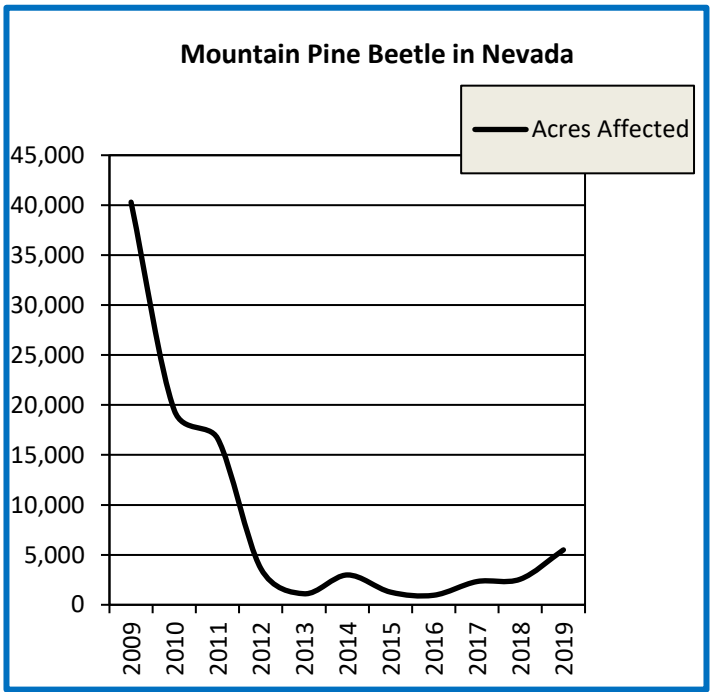


Figure 13. Whitebark, limber, western white, and lodgepole pine acres affected by mountain pine beetle in Nevada from 2009-2019.

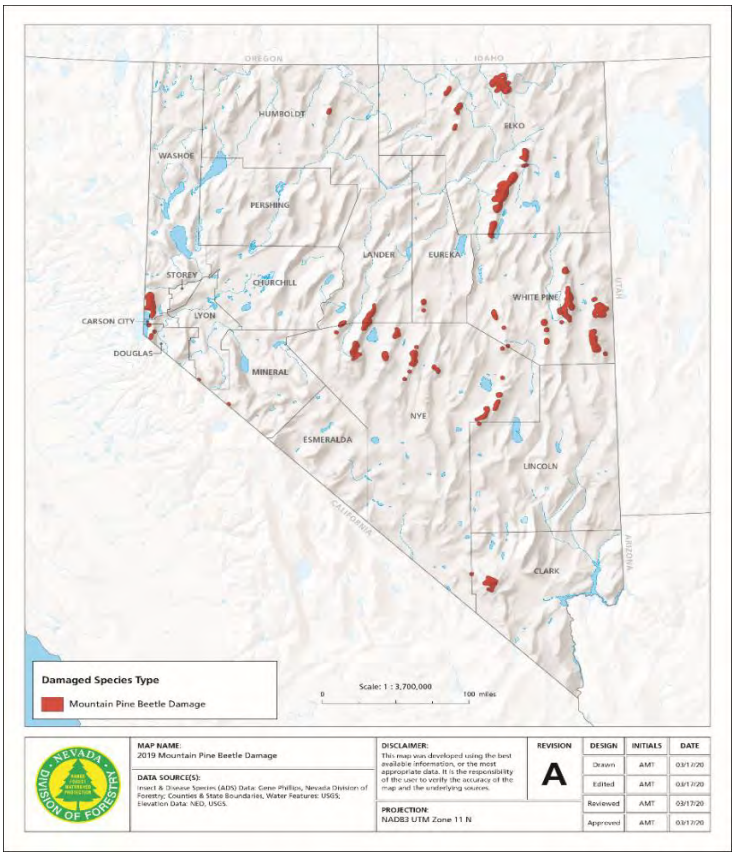


Figure 14. Mountain pine beetle caused tree mortality in 2019.

Table 9. List of Mountain Pine Beetle outbreak locations and acreages detected.

County	Acres	Specific Area and Description
Clark	31	MPB killed whitebark and limber pine trees, all within the Spring Mountain National Recreation Area.
Douglas	1	MPB killed lodgepole, limber, and western white pine, within the Carson Range in individual trees and small isolated pockets. MPB killed whitebark pine was also recorded in isolated pockets in the Sweetwater Range.
Elko	2,158	MPB killed whitebark and limber pine trees. Most of this mortality occurred in the Ruby and Jarbidge Mountain Ranges.
Lander	124	MPB killed whitebark and limber pine was recorded in the Toiyabe and Monitor Ranges, in isolated pockets as well as areas of 5-10 acres in size.
Lincoln	14	MPB killed whitebark and limber pine, all located in the Grant Range.
Mineral	1	MPB killed whitebark pine was recorded in the Sweetwater Range in isolated pockets.
Nye	594	MPB killed limber and whitebark pine trees. Damage was in the Hot Creek, Monitor, and Toiyabe Mountain Ranges. Damage in isolated pockets, up to 10 acres in size were observed.
Washoe	1,272	MPB killed lodgepole, western white, whitebark, and limber pine trees. This damage was surveyed throughout the higher elevations of the Carson Range, mostly northwest of Mount Rose. Several areas of 100 acres or more in size were recorded in this area. Mortality was recorded in ponderosa pine at lower elevations along the entire sierra front, with a larger pocket found in the Little Valley area.
White Pine	1,261	MPB killed limber and whitebark pine trees. New damage was observed in the limber pine in the Wheeler Peak area in Great Basin National Park. Damage was also recorded in the Egan and Schell Ranges, as well as the forestlands north of Current Summit and State Highway 6. Damage was observed in isolated pockets and group kill up to 5 acres in size.

WESTERN PINE BEETLE IN PONDEROSA PINE

Dendroctonus brevicomis

Western pine beetle is a native bark beetle that mainly damages ponderosa pine. It emerges in the spring as an adult beetle and attacks individual trees with heavy infestations. It also can cause damage in small groups. Attacks on individual trees are usually severe and cause tree mortality. The beetle over winters as a larva once established and completes it's life cycle in the spring.
In 2019, ponderosa pine mortality was attributed to western pine beetle in only one county within the state of Nevada. See Appendix C for trapping data.

Clark County – In 2019, there were WPB-killed ponderosa pine trees mapped on four acres in Clark County. This is a decrease in WPB damage as compared to ten acres recorded in 2018. Most of the WPB damage was observed within the Kyle Canyon corridor, along Highway 157 where salt damage is occurring from wintertime road salting. This practice is stressing the ponderosa pine within the road right-of-way. Additional damage was observed between the Kyle and Lee Canyons, scattered in pockets of one acre or less. Appendix C is a table showing the results from trapping in Kyle Canyon for various bark beetles.

PINYON ENGRAVER BEETLE / PINYON IPS

Ips confusus
Host: single leaf pinyon

Pinyon engraver beetle (PEB) is a pest in pinyon-juniper ecosystems often affecting both woodlands and valuable home landscape trees. The insect produces multiple generations each year and consequently populations can build and spread rapidly.

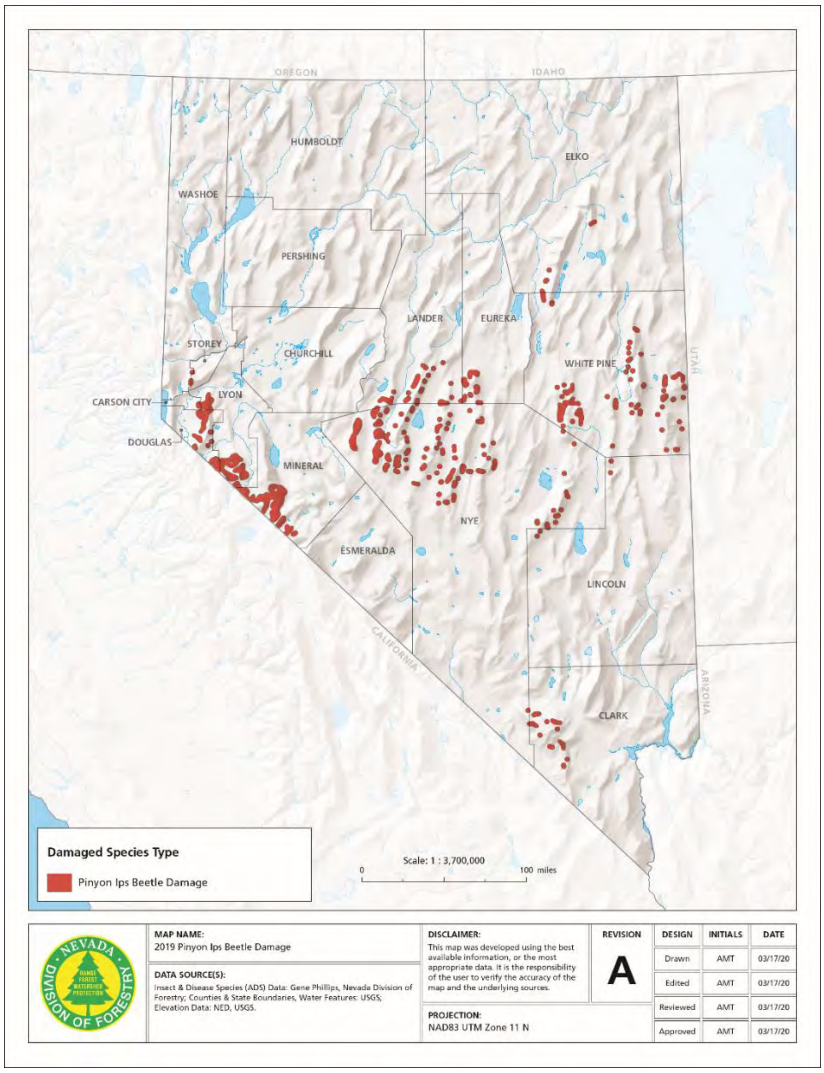


Figure 15. Tree mortality caused by the pinyon engraver beetle in 2019.

In 2019, recorded mortality decreased to 911 acres mapped as compared to 2,116 acres in 2018. This is a decrease statewide (Figure 15). In 2019, mortality was recorded in 11 counties that was caused by pinyon Ips. Nye and White Pine counties had the greatest number acres recorded in aerial surveys, and combined the damage recorded in these two counties represents 70% of the statewide total.

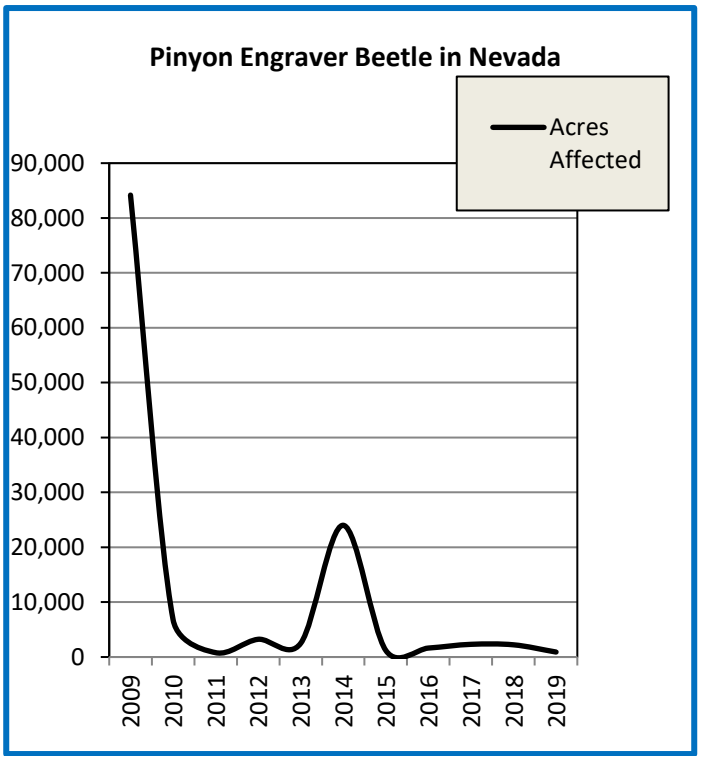


Figure 16. Pinyon pine acres affected by pinyon engraver in Nevada and from 2009-2019.

Table 12. List of Pinyon ips outbreak locations and acreages detected.

County	Acres	Specific Area and Description
Carson	6	Damage was located on the lower slopes in small pockets on the north end of the Pine Nut Mountains.
Douglas	48	Damage is located in many scattered spots throughout the Pine Nut Mountain Range and north of Holbrook Junction.
Elko	3	Scattered damage is found in isolated pockets on the south end of the Ruby Mountains, south of Shantytown.
Eureka	27	Damage is located mainly in the Monitor Range in scattered pockets.
Lander	31	Damage is found in scattered pockets in the northern Shoshone Mountains, and northern Toiyabe Range.
Lincoln	2	Scattered damage is located on the lower slopes at the south end of the Grant Range.
Lyon	44	Mortality was identified in southern ends of the Virginia Range and the Pine Nut Mountains.
Mineral	25	Mortality is primarily located in the Excelsior Mountains.
Nye	636	As compared to 1,482 acres mapped in 2018, this is a decrease from the previous year. Damage was identified in scattered pockets in the Grant, Hot Creek, Monitor, Toquima, southern Toiyabe Mountain Ranges.
Washoe	5	Damage continued to be very light where pinyon Ips-killed pinyon pine trees were mapped on the western most slopes of the Virginia Range.

White Pine	85	This is a slight decrease when compared to 2018, when 106 acres were mapped. Much of the mortality was associated with older pinyon needle scale in the eastern White Pine Range. Mortality was also observed in scattered pockets on the White Pine Range and in larger one to two-acre pockets in the Egan, and Snake Mountain Ranges.

PITCH MASS BORER

Dioryctria spp.

Hosts: Singleleaf pinyon, ponderosa pine, Jeffrey pine

In the larval stage, *Dioryctria spp*. bore into the cambium of the trunk, branches, and shoots. This borer kills lateral branches and treetops of singleleaf pinyon and Jeffrey pine. With prolonged drought, this injury has weakened pinyon trees sufficiently to allow pinyon engraver beetle to successfully attack and kill pinyon pine trees. Pitch mass borer is found throughout the state in most counties with singleleaf pinyon. The heaviest concentrations seem to occur in western Nevada where it also affects Jeffrey and ponderosa pine. Many young Jeffrey pines on the east slope of the Carson Range that reestablished after fires have been affected by this insect. Many areas across the state are damaged, but are not mapped by ADS.

Figure 17. Pitch mass borer infesting pinyon pine infected with pinyon blister rust.

INSECTS: NON-NATIVE

WHITE SATIN MOTH

Leucoma salicis (L.)

Hosts: aspen, willows, cottonwoods, and other deciduous species

The white satin moth (WSM) is a non-native defoliator of aspen in the family of tussock moths (*Lymantriidae*). WSM is native to Europe and Asia. WSM is in the same family as gypsy moth and Douglas-fir tussock moth. It was introduced into North America in British Columbia in 1920. It can be found throughout Northern Nevada. Overwintering takes place as a second-instar larvae which seek out hibernation sites on the trunk or branches of a host tree and molt after spinning silken coverings (hibernacula) which are hard to see because they are covered with bark, mosses and other detritus. When they emerge in May they feed on the young new leaves. This feeding continues until late June to early July and the larvae go through five to six more instars until they are approximately 3.5 – 4.5 cm long. The caterpillar is mostly grayish brown with a dark head and back, but what stands out is the one row of large oblong white to pale-yellow patches down the middle of the back and two yellow lines sub-dorsally. The two lateral and sub-dorsal rows of orange tubercles have tufts of long brown hairs attached. These larvae spin cocoons in the leaves to pupate into shiny black, 1.5 to 2.2 cm long pupae with tufts of yellow hair. In July and August, the adult moths emerge. The white adult moth about 2 - 4 cm long have no markings on the wings; the bodies are black and covered with white silky hairs that only allow glimpses of black beneath. See Figure 17 photos below.

Figure 18. Female White satin moth (top left); egg mass (top right); North Canyon where stands can have 100% defoliation: caterpillars (bottom right); Nevada Lake Tahoe State Park, July, 2018 (Photos-Gene Phillips)

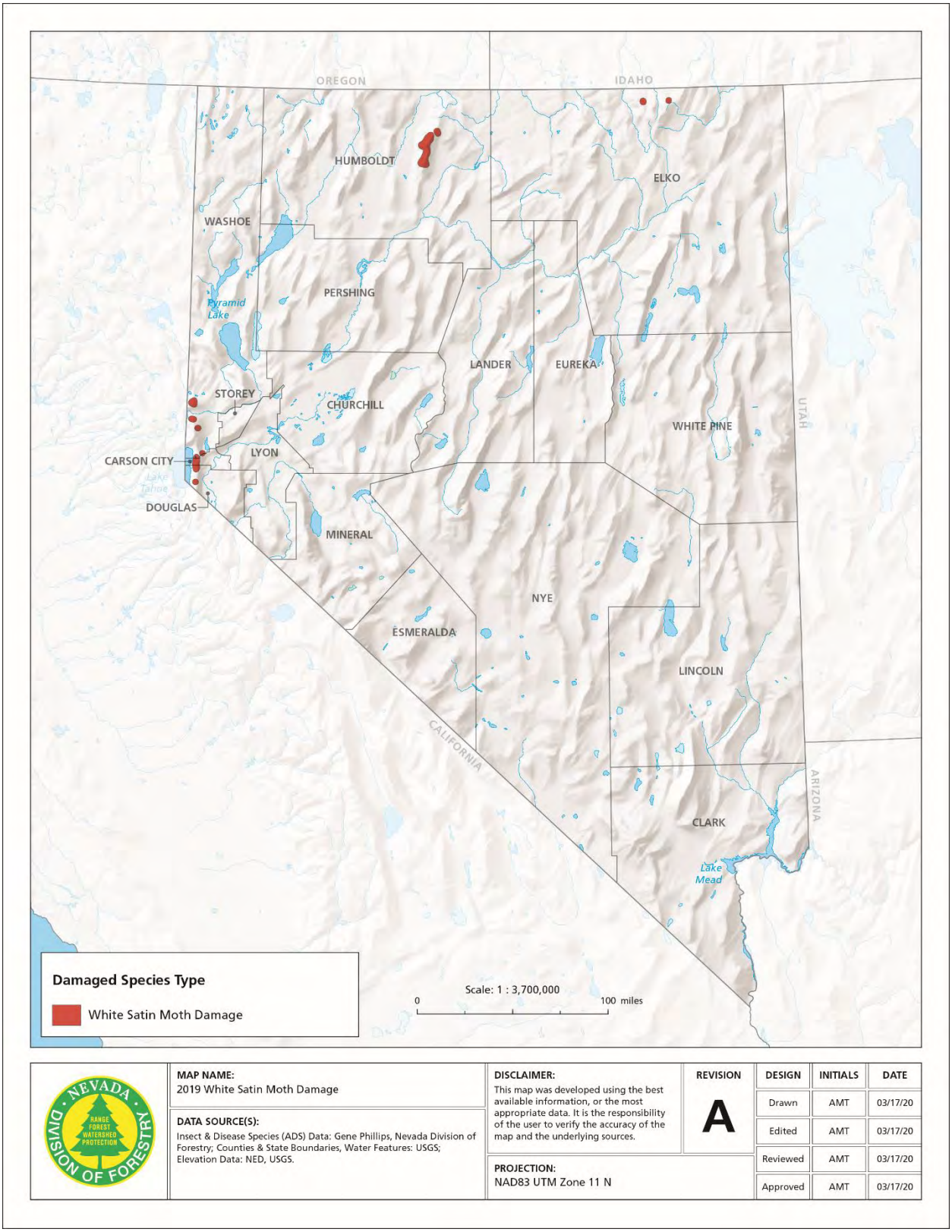


Figure 19. White Satin Moth Damage in 2019.

In 2019, continued damage was observed with an increase in acreage statewide, however there was a significant change in defoliation rates. Light to moderate defoliation was observed throughout Nevada. A total of 2,399 acres were mapped in 2019, as compared to 1,930 acres in 2018. Defoliation rates decreased to 25%-50% on infested trees. This was likely due to the long, cold and wet spring and early summer throughout the state.

In early June, areas near Spooner Summit, where one of the largest concentrations has been recorded, showed very few active caterpillars with many not even emerging. In the previous two years, caterpillars were plentiful and very active by Memorial Day. Statewide observations recorded defoliation in Carson City, Douglas, Elko, Humboldt, and Washoe Counties. Humboldt County had the majority of the damage recorded at 1,625 acres of light to moderate defoliation in the Santa Rosa Mountains. This is approximately 68% of the statewide total. The southern third of the range had large polygons of more than 100 acres each in several different drainages.

In 2019 the University of Nevada Cooperative Extension and Nevada Department of Agriculture jointly produced a. fact sheet on WSM identification and management

EUROPEAN GYPSY MOTH

Lymantria dispar

Hosts: various deciduous species

In 2019, European gypsy moth surveys were conducted by Nevada Department of Agriculture (NDOA) on a statewide basis. Trapping was conducted from May to October and resulted in no positive detection of this species. The last identified adult male was discovered in an RV park in Winnemucca in 1999.

Figure 20. Adult gypsy moths; female above; male below, Photo: USDA APHIS PPQ

Asian Gypsy Moth Survey

In 2019, Asian gypsy moth surveys were conducted by Nevada Department of Agriculture (NDOA) on a statewide basis. Trapping was conducted from May to October and resulted in no positive detection of this species.

RED PALM WEEVIL

Rhynchophorus ferrugineus

Hosts: various palm tree species

This weevil usually infests palms younger than twenty years. Adult weevils cause some damage through feeding, it is the burrowing of the larva into the heart of the palm that can cause the greatest mortality of trees. The larva will feed on the soft fibers and terminal buds, tunneling through the internal tissue of the tree for about a month. The infestation of the pest can result in yellowing and wilting of palms, that may lead to the death of the affected plant. The crown wilts first, and lower leaves will follow, due to damage to vascular tissue.

Red palm weevil (*Rhynchophorus ferrugineus*), South American weevil (*Rhynchophorus palmarum*), and Silky cane weevil (*Metamasius hemopterus*) were surveyed by the NVDOA by trapping methods outlined in Appendix C. All traps were negative for the 2019 field season.

EXOTIC WOOD BORERS

Scolytinae/Sirex Wood Wasp (*Sirex noctillo*), Asian Longhorn Beetle (*Anoplophora glabripennis*), and Emerald Ash Borer Beetle (*Agrilus planipennis*)

Hosts: Sirex Wood Wasp - mainly conifers, especially pines
Asian Long Horned Beetle – chesnut species, green and mountain ash, birch species
Emerald Ash Borer – white ash, green ash, possibly Arizona ash

All these species are non-native and can cause extensive damage to host species with high mortality rates. Emerald Ash Borer has caused major mortality in eastern and mid-west forests causing a change in both native and urban forest ecoystems, where found and major infestations develop.

The Asian Long Horned Beetle life cycle is complex. Adult females chew depressions into the bark of various hardwood tree species. They lay an egg—about the size of a rice grain—under the bark at each site. Within 2 weeks, the egg hatches, and larvae begin feeding on cambium and phloem tissues that carries nutrients and the layer responsible for new growth under the bark. After several weeks, the larva tunnels into the woody tree tissue, where it continues to feed and develop over the winter. As the larvae feed, they form tunnels or galleries in tree trunks and branches. Over the course of a year, beetle larvae develop into adults. The pupal stage lasts two to three weeks. After adult beetles emerge from the pupae, they chew their way out of the tree, leaving round exit holes approximately three-eighths of an inch in diameter. Once they have exited a tree, they feed on its leaves and bark for 10 to 14 days before mating and laying eggs.

Signs of ALB start to show about 3 to 4 years after infestation, with tree death occurring in 10 to 15 years depending on the tree's overall health and site conditions. Infested trees do not recover, nor do they regenerate.

The Sirex Wood Wasp life cycle begins when adults infest a host species. The first reaction of the host tree is due to the adult wasp and occurs after 10 to 14 days. A secretion of the wasp impairs metabolism in the shoots and needles, causing loss of water balance. The result is browning of the

needles and leaf drop. Attacked pines tend to develop thin crowns and flagging. Tip dieback begins with the needles becoming yellow and changing from green to yellowish-red, finally turning completely brown over a three- to six-month period. During this process, fungal spores germinate in the boreholes. The fungus breaks down the wood causing white rot.

In the third stage, the larva begins to bore into the wood. It eats a path, that are not visible in cross-section, because they are heavily blocked with sawdust. The exit holes are circular and very small diameter. Larval boreholes appear in the fourth stage and by this time secondary damage from other insects or disease cause additional damage with tree death occuring from two weeks to eight months.

The emerald ash borer life cycle can occur over one or two years depending on the time of year of oviposition, and the health of the tree. Eggs are deposited between bark crevices, flakes, or cracks and hatch about two weeks later. After hatching, larvae chew through the bark to the inner phloem cambium, and outer xylem where they feed and develop. Emerald ash borer has four larval stages. Larval feeding creates long serpentine galleries. Fully mature fourth stage larvae create chambers in the sapwood or outer bark where they fold into a J-shape. Once mature in the following spring, adults chew exit holes from their chamber through the bark, which leaves a characteristic D-shaped exit hole.

The Nevada Department of Agriculture conducts trapping statewide for these insects each year. If any of these were discovered in Nevada, and became established, the same pattern of damage an mortality would likely occur as in other states these pests are found. In 2019, the Nevada Department of Agriculture NDOA conducted funnel trapping for exotic wood borers in four counties. All traps were negative for the four counties.

MEDITERRANEAN PINE ENGRAVER

Orthotomicus erosus

Hosts: Pinyon pine, Aleppo Pine, Afghan Pine

This is a new non-native species identified by the Nevada Department of Agriculture (NDA) entomologist, Jeff Knight, in the fall of 2015. This species was identified in pinyon pine west of Las Vegas, in the Blue Diamond area. The Mediterranean Pine Engraver is established though out the Las Vegas area, with reports in Overton as well to the south near the state line with California. Populations at this time appear to be scattered and generally very light. The beetle does not appear to be the cause of the reported problems on pines in the area. Several specimens were submitted for identification to the NDA. The NDA is developing information on this species and its possible effects and damage to conifer species in Nevada.

STEM AND BRANCH DISEASES

DWARF MISTLETOES

Arceuthobium spp.

Hosts: Douglas-fir, pines, true firs, single-leaf pinyon, and junipers

Dwarf mistletoes (DMT) are damaging agents of coniferous trees. These parasitic plants remain the most widespread and frequently observed disease within the state. Profusely branched, dense masses of host branches called “witch’s brooms” are often observed. Dwarf mistletoe infests trees of all ages, and infection may exist in secondary growth and regeneration, as well as mature and over mature tree stands. Dwarf mistletoes spread fastest and are most problematic when an infected overstory exists over new regeneration. Severe dwarf mistletoe infestation can:

- Predispose trees to attack by insects and other diseases
- Reduce growth
- Affect the forest canopy structure
- Lower resistance to drought
- Affect production of seed

Conversely, dwarf mistletoes may be beneficial to wildlife habitat in some cases, depending on the type of wildlife habitat desired. Examples of this include providing nesting habitat for the Yellow Billed Cuckoo, and Southwest Flycatcher which are both threatened species in Nevada and the Great Basin.

Pinyon engraver beetle-caused mortality can be observed in some of the heavy dwarf mistletoe infected pinyon pine stands around the state of Nevada. Dwarf mistletoe continues to cause weakened lodgepole and ponderosa pine trees to succumb to bark beetle attacks as well.

Ponderosa and Jeffrey pines are often found heavily infected with western dwarf mistletoe (*A. campylopodum*) and then are attacked by *Ips*, flathead borers, Jeffrey pine beetle, and western pine beetle as well as other agents, especially during prolonged drought periods. Additionally, true fir trees infected with dwarf mistletoe are commonly attacked by fir engraver beetle, or experience branch dieback due to *Cytospora* canker. Limber pine dwarf mistletoe (*A. cyanocarpum*) was found infecting whitebark and limber pines on the East Humboldt and Ruby Mountains predisposing them to attack by mountain pine beetle in those areas.

When managed, forest treatments are intended to create a buffer between non-infected stands and infected stands to prevent the spread of this disease. This type of treatment can be effective, due to the primarily short range spread mechanism of dwarf mistletoes. Currently there are no observable trends that mistletoe is increasing or decreasing throughout Nevada. However, where established stands continue to be infected, causing growth loss and minor tree mortality. Mistletoe isn’t recorded so acreage of damage is unavailable, however it is found throughout the entire state various forest ecosystems.

Infected whitebark pine

Figure 21. *A. cyanocarpum* infecting whitebark pine in the Ruby Mountains.

PINYON BLISTER RUST

Cronartium occidentale

Host: singleleaf pinyon pine

This pathogen attacks and kills small trees (Figure 21) and causes branch flagging on larger trees. This disease is mainly found in a band between 6,000 and 7,000 feet of elevation in Lincoln and White Pine County. The fugus has an annual life cycle and spreads in mid-winter to infect new trees or branches of previously infected trees. Ribes species are the alternate host for the fungus.;

An informal survey of central Nevada by Forest Service pathologists and entomologists as well as BLM and Nevada State Foresters revealed that the disease is common throughout the state. Many of the rust infected trees were also attacked by pitch mass borer.

Figure 22. Single leaf pinyon pine infected with pinyon blister rust near its base.

WHITE PINE BLISTER RUST

Cronartium ribicola

Hosts: limber, bristlecone, whitebark, sugar, and western white pine

White pine blister rust (WPBR) has been observed in western and eastern Nevada on the east side of the Sierra Nevada Mountains in sugar, whitebark and western white pines. The rust has expanded its range in Nevada in recent yearsto include the Jarbidge Mountains. The fugus spreads via spores that have an alternate host on Ribes species;the life cycle is yearly where spores spread in mid-winter and infect new trees or branches of previously infected trees. Host species continue to decline in numbers and acreage with no natural resistance to the disease.

At this point in time, the only confirmed population of white pine blister rust in eastern Nevada is found in small stands of whitebark pine in the Jarbidge Mountains. There is concern that WPBR could become established in sensitive populations of Great Basin bristlecone pine. In 2010, researchers initiated an effort to collect seed from Great Basin bristlecone to include this species into breeding efforts aimed at detecting resistance to WPBR in 5 needle pines. Seed collection in from 2014 is still being tested with results pending by 2022.

Figure 23. White Pine Blister Rust in sugar Pine *(Photo: Jeff Haas)*

Aerial surveys in 2019 indicated scattered mortality throughout the Carson Range and the Lake Tahoe Basin. Approximately three acres were observed showing decline or mortality, with it being equally spread out in Carson, Douglas, and Washoe Counties.

SUDDEN OAK DEATH

Phytophthora ramorum

Hosts: coast live oak, California black oak, tanoaks, rhododendron

Sudden Oak Death (SOD), an exotic forest disease caused by the pathogen *Phytophthora ramorum*, has been killing thousands of tanoak and oaks in the coastal areas of California, but has not been observed in Nevada. The SOD pathogen is considered especially dangerous because it affects a wide variety of trees, shrubs and plants and there is no known cure. The pathogen has killed millions of tanoak and coast live oak trees along the central CA coast into Southern OR and is a concern because it also infects rhododendron, camellia and other common horticultural nursery stock. It is a water mold pathogen that produces spores and spreads easily in urban, wildland, or nursery settings. Symptoms include bleeding cankers on the tree's trunk and dieback of the foliage, in many cases leading to the death of the tree. There is currently no known cure.

However, potentially infected nursery stock was released into all 50 states from a single California nursery, prompting NDOA officials to contract with the USFS to conduct surveys. Both forest areas and areas near nurseries were surveyed but showed no SOD. SOD has not been detected for all regions surveyed to date.

Figure 24. DOD caused Trunk Canker

Figure 25. Leaf Blight from SOD

ROOT DISEASES

ANNOSUM ROOT DISEASE

Heterobasidion irregulare
Heterobasidion occidentale

Hosts: Lodgepole pine, Jeffrey pine, ponderosa pine (*H. irregulare*), spruce, true firs, and incense cedar (*H. occidentale*)

H. occidentale can be found throughout the state on true firs, but it frequently acts as butt decay or as a saprophyte on dead trees, stumps, roots, and cull logs or fallen stems. *H. irregulare* can be found in mature pine trees on the east side of the Sierras and the fungus can kill young ponderosa pine, especially in plantations on droughty soils. Symptomatic small trees can frequently be found around infected stumps with butt decay. The symptoms on larger trees include a thinning crown, decay in the root system and fruiting bodies that develop at the base of the tree or inside stumps.

Figure 26. Fruiting body on pine

ARMILLARIA ROOT DISEASE

Armillaria spp.

Hosts: All trees

Evidence of Armillaria root disease can be found throughout the state causing mortality in all species of trees. This disease also frequently functions as a weak pathogen or saprophyte. Fruiting bodies grow in clusters from the roots or at the base of the tree during moist conditions. There is a close association between root disease pockets and endemic level bark beetle populations.

Figure 27. Armillaria mushrooms, *photo: Gail Durham*

BLACK STAIN ROOT DISEASE

Ophiostoma wageneri

Hosts: pinyon pine, ponderosa pine, Jeffrey pine and Douglas-fir

Black stain root disease is a disease of several hosts. It is found mainly in pinyon pine, but it can infest both Jeffery and ponderosa pine which has been found in small areas of the eastern Carson Range. It usually kills affected trees within a few years, and it can produce groups of mortality that are several acres in size. Pockets of infected trees are preferred host for low-level populations of pinyon engraver beetles. No new pockets of black stain root disease were observed by aerial survey in 2019. The disease is generally vectored by bark beetles or woodborers, and cause infected trees thinning and chlorotic crowns, with a root disease center forming outward to the surrounding forest stand.

Figure 28. Staining at base of trunk

CANKER DISEASES

CYTOSPORA CANKER

Cytospora spp.

Host: aspen

Cytospora canker is one of the most common diseases affecting aspen and often attacks stressed trees through wounds. This fungus girdles branches by killing the cambium. Large, vigorous trees can withstand the disease with impacted health and growth rates but are rarely killed by this agent alone. Activity from this pathogen is most likely a symptom of several years of water stress or defoliation from other insects or diseases. From the air, decline due to Cytospora canker can look like defoliation by forest tent caterpillar defoliation. Heavily infected stands have been noted in the Independence Mountains and Schell Creek Range within Elko County. This has been observed mainly in mature to over-mature stands of Aspen that exceed approximately 100 years old and are found at the mid-elevation range around 6,000 feet.

Figure 29. Cytospora damage in a landscape tree & forest damage

FOLIAGE DISEASES

MARSSONINA BLIGHT

Marssonina populi

Host: Aspen

Blight and leaf spot caused by this disease have been seen in the past throughout the host type. From late April through the end of June, Nevada received heavy amounts of precipitation which caused a significant amount of blight and leaf spot by late summer.

Figure 30. Leaf spot symptoms

Approximately 4,996 acres of damage was recorded in 2019, which is a 29% decrease when compared to 7,076 acres of recorded damage in 2018. These acres were surveyed as Marssonina blight, with very little Aspen defoliation. Damage included heavy blight and leaf spot causing noticeable leaf discoloration and dieback. Since these leaf diseases are cyclical and weather dependent it is not anticipated to be a long-term problem in individual stands.

Table 13. List of Marssonina blight locations and acreages detected.

County	Acres	Specific Area and Description
Elko	4,790	Impacted areas included the Jarbidge and Ruby Mountains. It was observed throughout both ranges.
Humboldt	135	The observed damage was located mainly in the Santa Rosa Mountains just east of Orovada.
Nye	72	Observed damage was scattered throughout the southern Monitor Range.

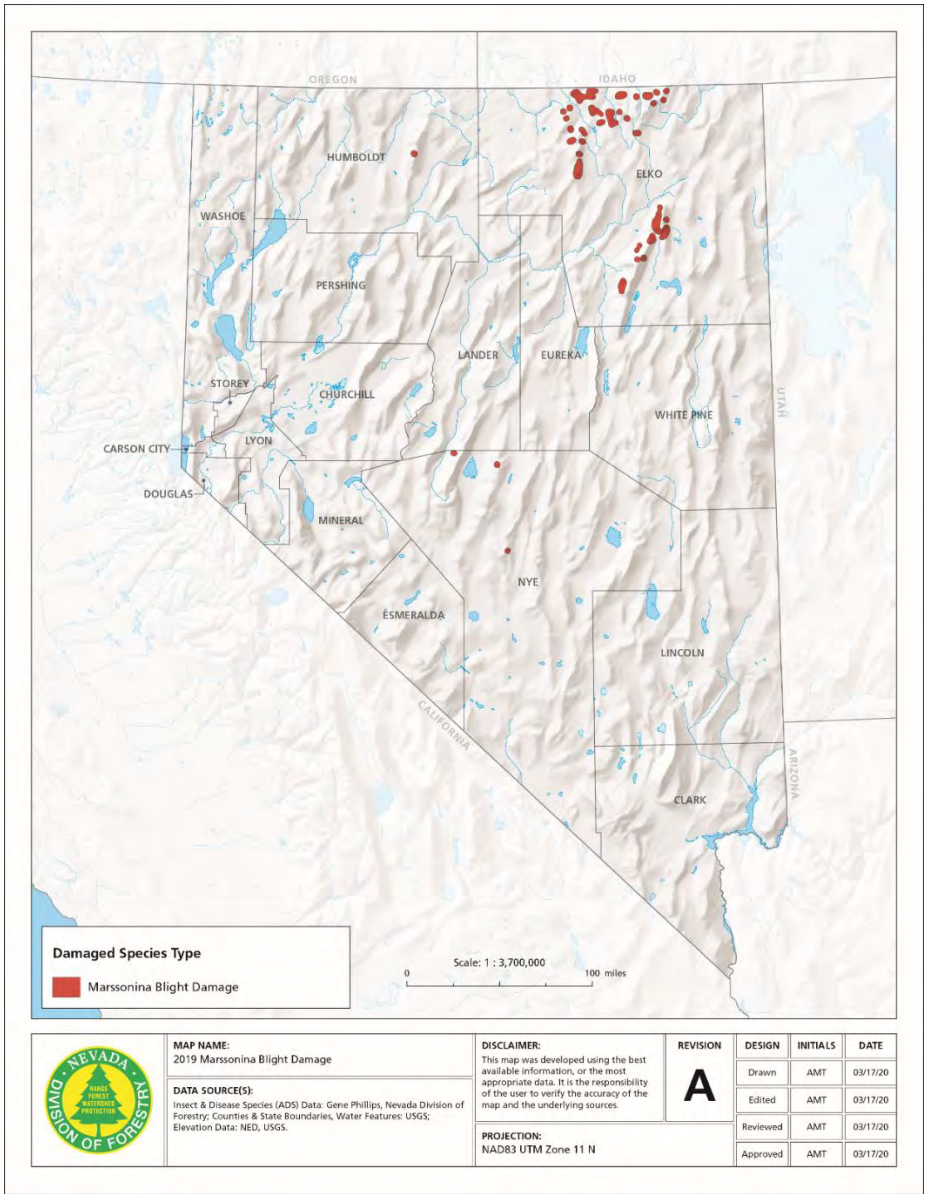


Figure 31. Marssonina Blight in 2019

DECLINES

SUBALPINE FIR DECLINE

Host: Subalpine fir

The western balsam bark beetle (WBBB) is the most significant mortality agent in a complex of forest insects and diseases causing subalpine fir decline. Endemic populations will occur in storm-damaged trees, slash, or trees of poor vigor. WBBB infestations may build to epidemic levels, where mortality can occur in groups of 100 to 10,000 trees. Annosum root disease, woodborers and several species of smaller bark beetles are also involved in this complex. Environmental stress due to drought or overcrowding may also have a role in the death of trees in this category.

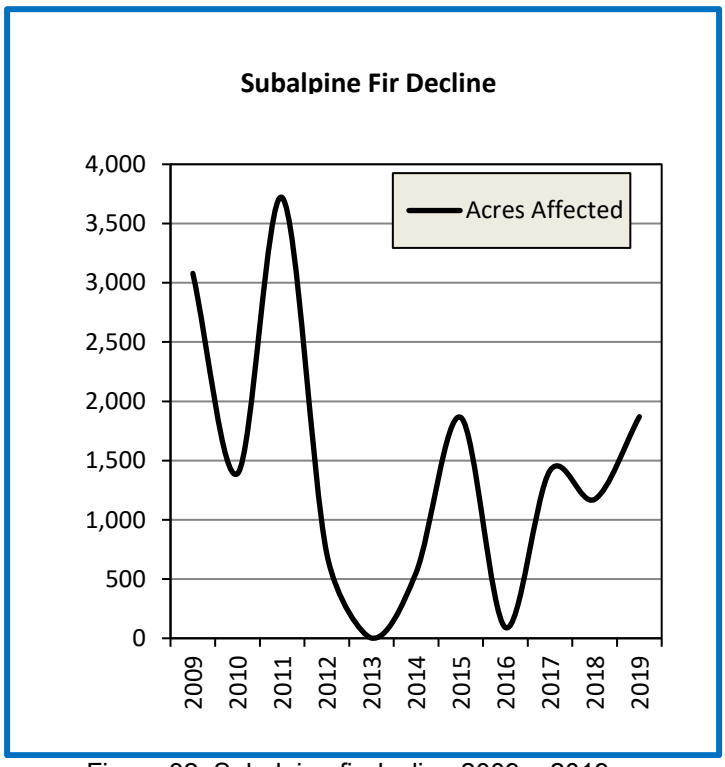


Figure 32. Subalpine fir decline 2009 – 2019.

In 2019, mortality attributed to subalpine fir mortality complex increased from very small pockets of two acres up to pockets that exceeded 50 acres. All damaged mapped in the 2019 Aerial Detection Survey is in Elko County.
Small to larger sized continuous areas were identified with some areas exceeding 50 acres. All recorded damage was in the Jarbidge Mountains and totaled approximately 1,870 acres which is an increase from the 1,147 acres observed in 2018.

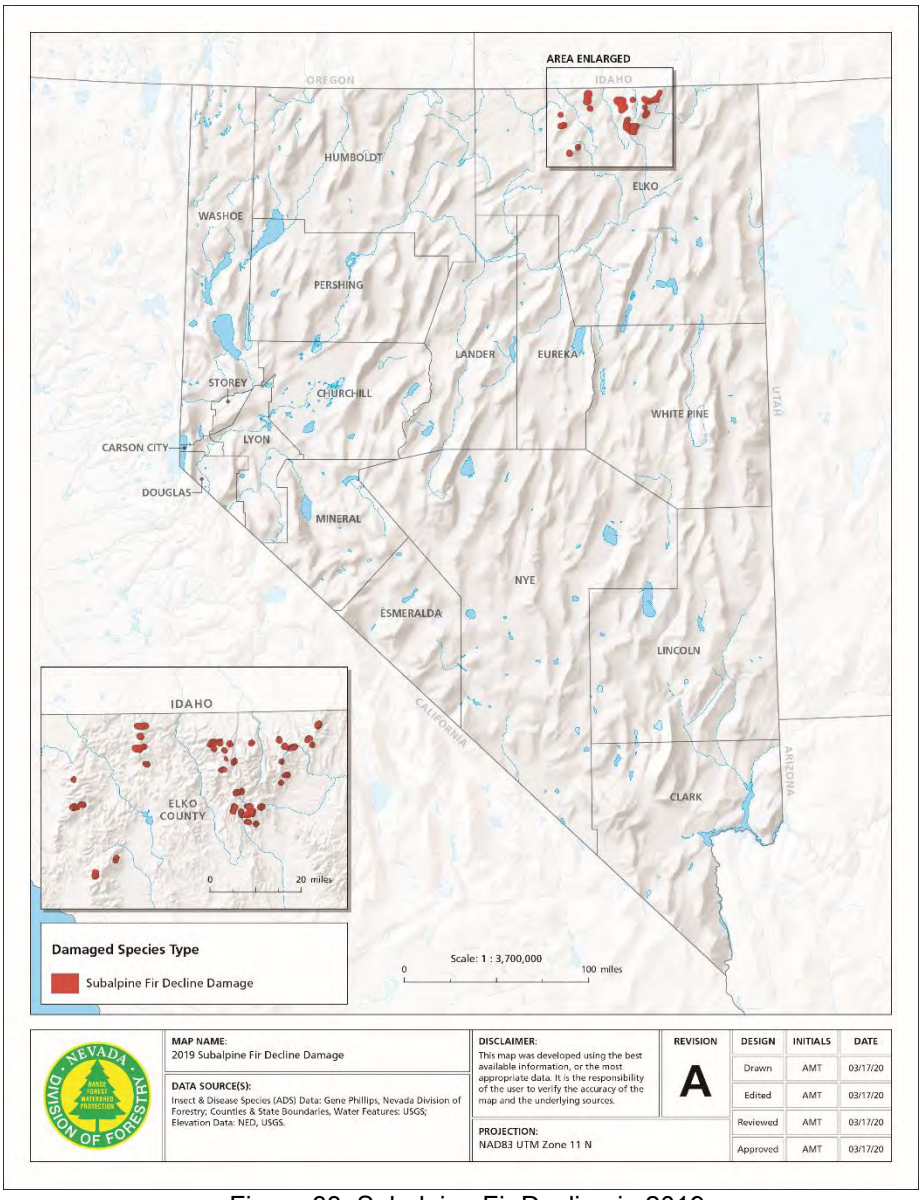


Figure 33. Subalpine Fir Decline in 2019

ASPEN DECLINE AND DIEBACK

Host: Aspen

A decrease in the amount of aspen forest acreage has been reported throughout the western U.S. for many years. The primary factors involved are succession of aspen forest to other vegetation types due to fire exclusion, and damage to regeneration by grazing animals. This phenomenon has been labeled “aspen decline” by some authors. This type of “decline” should be distinguished from the aspen dieback that has been detected in aerial survey that is caused by several agents including drought stress, insects, diseases and other stresses. This dieback can occur in aspen clones that have been impacted by fire exclusion and grazing pressure causing them to decline and die.

In 2004, Intermountain Region FHP examined what had been mapped as insect defoliator damage or Cytospora canker in several areas in north-central Nevada and discovered that several insect and disease agents were involved. Research across North America has revealed mostly canker diseases

and insect borers are causing the decline in which drought stress is the largest contributing factor to decline and dieback. In 2019, surveyors mapped 2,752 acres which is approximately a 58% decrease as compared to 2018 where 6,564 acres of damage was recorded.

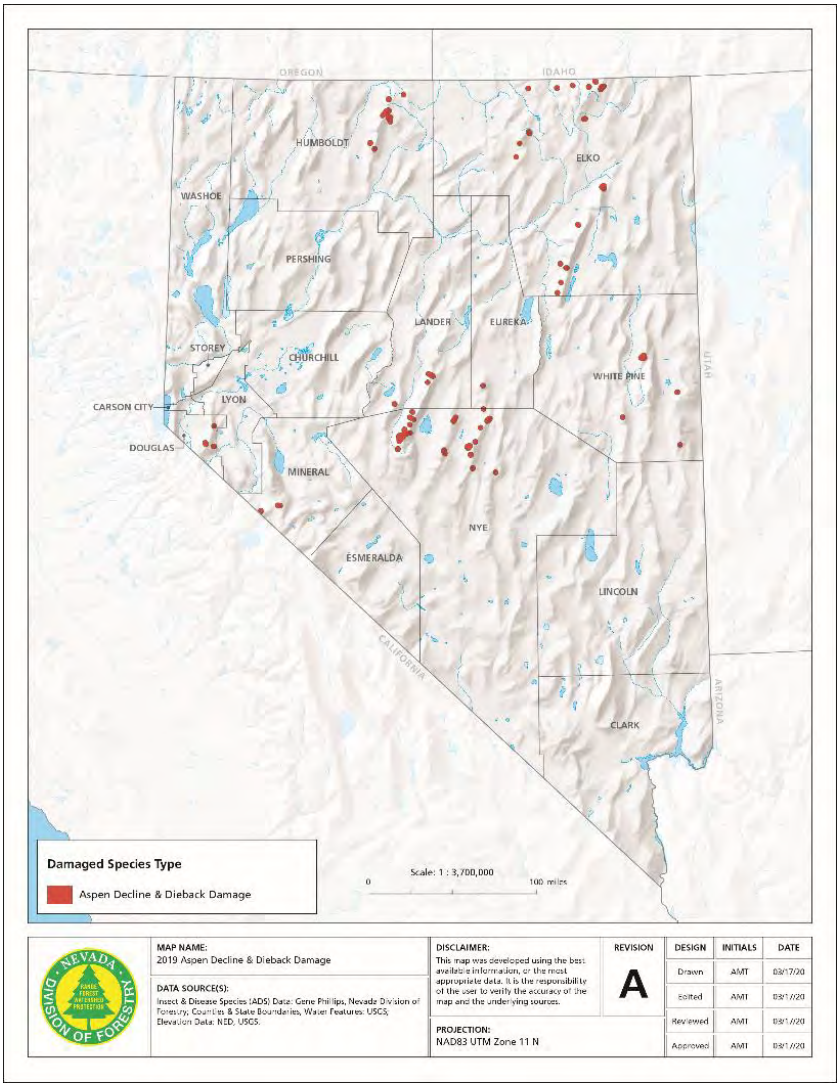


Figure 34. Aspen Decline/Dieback in 2019

Table 14. List of Aspen Decline or Dieback locations and acreages detected.

County	Acres	Specific Area and Description
Douglas	56	Observed mainly in the Carson Range
Elko	433	Located mainly in the Jarbidge and Ruby Mountains.
Eureka	14	Damage recorded in the Monitor and Hot Creek Ranges.
Humboldt	727	All of the damage being recorded in the Santa Rosa Range.
Lander	71	Scattered pockets of damage were observed in the northern Toiyabe Range, and north of Shoshone Peak.
Mineral	89	Dieback is found in scattered pockets throughout the Sweetwater Range.
Nye	1,244	Dieback is found in continuous pockets in the southern Monitor, Toiyabe, and Hot Creek Ranges
White Pine	118	Damage was recorded in the Schell Creek Range, and the Mt. Moriah Wilderness. Scattered pockets of damage were recorded.

ABIOTIC DAMAGE

WIND DAMAGE AND BLOWDOWN

Areas of concentrated, high velocity winds can cause trees to blow over. Blowdown occurs in groups or as scattered trees within the landscape. Depending on the tree species, patches of blowdown in coniferous forests can provide a food source for various bark beetles, enabling populations to build to epidemic levels. These epidemic populations may then attack and kill standing, live trees adjacent to the blowdown. No significant blowdown was mapped in Nevada in 2019.

WILDFIRE DAMAGE

Wildfires in 2019 burned fewer acres compared to the previous two years. Approximately 82,282 acres burned in 2019 compared to 1,001,966 acres in 2018. Most of the fires occurred in sagebrush ecosystems, however approximately 25% burned pinyon and juniper woodlands, and a very minor amount of mixed conifer forest, aspen stands, and riparian areas. Much of the fire damage occurred on lands managed by the Humboldt Toiyabe National Forest, and the Bureau of Land Management. One significant fire burned state land in Big Bend State Park, in Laughlin, Nevada. The park experienced a stand replacing fire on 200 acres, where salt cedar had taken over the riparian zones along the Colorado River. The park lost native stands of mesquite and cottonwoods, along with planted trees within campground areas. Restoration efforts by the Nevada Division of Forestry are ongoing and should be completed by spring of 2021.

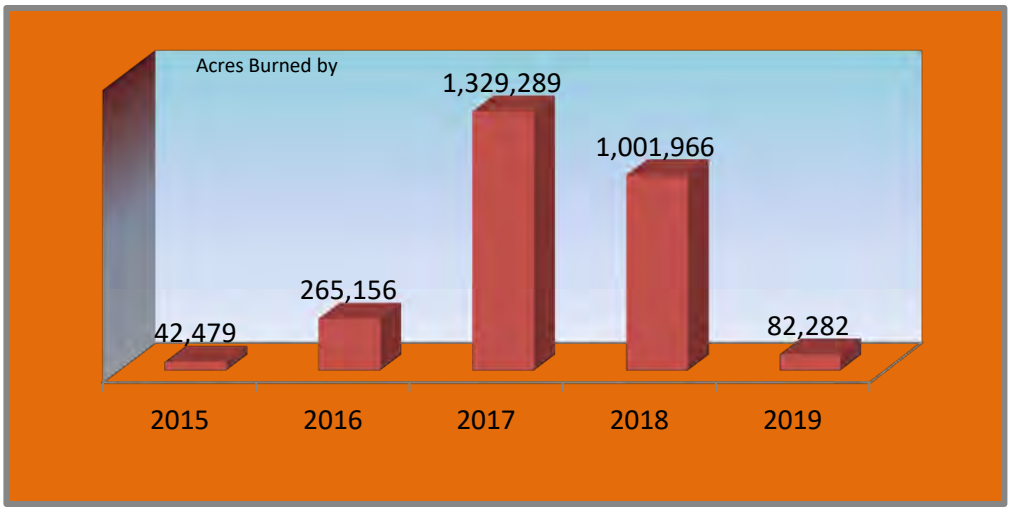


Figure 35. Wildfire damage 2015 – 2019.

APPENDIX A (NOXIOUS WEED REFERENCES)

Noxious weeds are a continuing problem for all Western states. They can colonize disturbed habitats, aggressively displacing native plant species and altering ecosystems. Several state and federal agencies have the responsibility for monitoring and controlling noxious weeds. The intention by including this information is to increase awareness of these potential problems. Table 3 at the beginning of this document is the list of plants declared noxious weeds by the State of Nevada for specific counties. The NDOA in coordination with the Nevada Department of Conservation and Natural Resources' Natural Heritage Database tracks weed populations throughout the state. For up-to-date information on Nevada Noxious Weeds and the three-tier State List go to:

http://www.invasivespecies.gov
This website is the gateway to federal and state efforts concerning invasive species. There are links to numerous invasive species databases. This website should be one of your first stops.

http://agri.nv.gov/Plant/Noxious_Weeds/Noxious_Weeds_Home/This website contains any information you need about noxious weed prevention, control and management for all land managers in the state of Nevada.

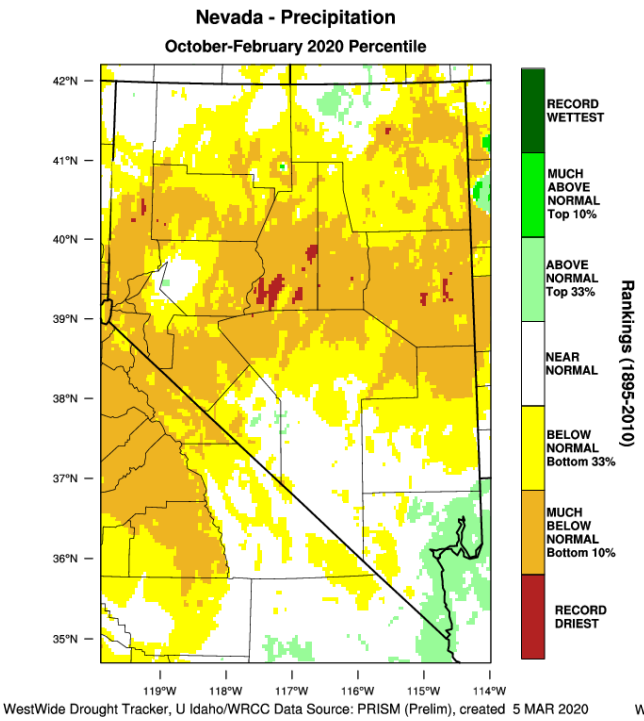
Table 4. Below is NDOA's listing of Noxious Weeds in Nevada by Category A, B or C.

Common Name	Scientific Name	Common Name	Scientific Name
Category A Weeds:		**Category B Weeds:**	
African Rue	*Peganum harmala*	Carolina Horse-nettle	*Solanum carolinense*
Austrian fieldcress	*Rorippa austriaca*	Diffuse Knapweed	*Centaurea diffusa*
Austrian peaweed	*Sphaerophysa salsula / Swainsona salsula*	Leafy spurge	*Euphorbia esula*
Black henbane	*Hyoscyamus niger*	Medusahead	*Taeniatherum caput-medusae*
Camelthorn	*Alhagi camelorum*	Musk Thistle	*Carduus nutans*
Common crupina	*Crupina vulgaris*	Russian Knapweed	*Acroptilon repens*
Dalmation Toadflax	*Linaria dalmatica*	Sahara Mustard	*Brassica tournefortii*
Dyer's woad	*Isatis tinctoria*	Scotch Thistle	*Onopordum acanthium*
Eurasian water-milfoil	*Myriophyllum spicatum*	White Horse-nettle	*Solanum elaeagnifolium*
Giant Reed	*Arundo donax*	**Category C Weeds:**	
Giant Salvinia	*Salvinia molesta*	Canada Thistle	*Cirsium arvense*
Goats rue	*Galega officinalis*	Hoary cress	*Cardaria draba*
Green Fountain grass	*Pennisetum setaceum*	Johnson grass	*Sorghum halepense*
Houndstongue	*Cynoglossum officinale*	Perennial pepperweed	*Lepidium latifolium*
Hydrilla	*Hydrilla verticillata*	Poison Hemlock	*Conium maculatum*
Iberian Starthistle	*Centaurea iberica*	Puncture vine	*Tribulus terrestris*
Klamath weed	*Hypericum perforatum*	Salt cedar (tamarisk)	*Tamarix spp*
Malta Star thistle	*Centaurea melitensis*	Water Hemlock	*Cicuta maculata*
Mayweed chamomile	*Anthemis cotula*		
Mediterranean sage	*Salvia aethiopis*		
Purple loosestrife	*Lythrum salicaria, L.virgatum and their cultivars*		
Purple Star thistle	*Centaurea calcitrapa*		
Rush skeletonweed	*Chondrilla juncea*		
Sow Thistle	*Sonchus arvensis*		
Spotted Knapweed	*Centaurea masculosa*		
Squarrose knapweed	*Centaurea virgata*		
Sulfur cinquefoil	*Potentilla recta*		
Syrian Bean Caper	*Zygophyllum fabago*		
Yellow Starthistle	*Centaurea solstiltialis*		
Yellow Toadflax	*Linaria vulgaris*		

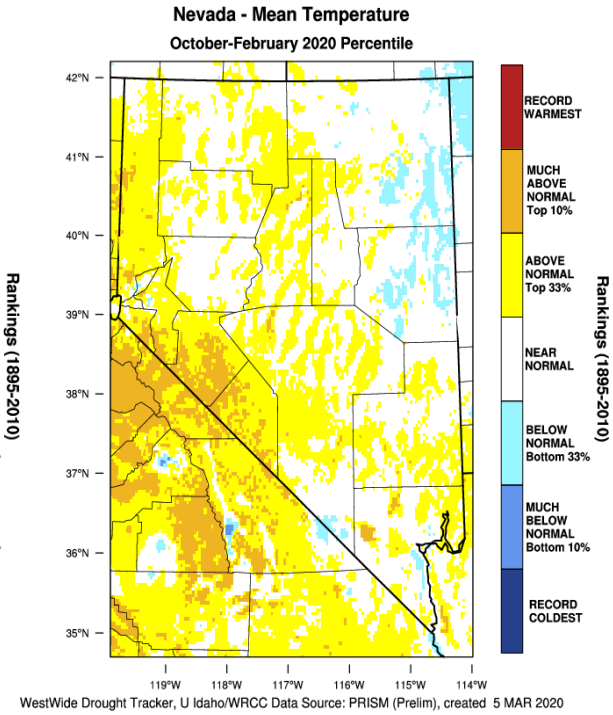
NDOA Noxious Weed Monitoring Data

SCIENTIFIC NAME	Common Name	Recorded Counts
Lepidium draba	hoary cress,	7737
Lepidium latifolium	tall whitetop	6708
Carduus nutans	musk thistle	2665
Rhaponticum repens	russian knapweed	2511
Onopordum acanthium	Scotch thistle	2085
Cirsium arvense	Canada thistle	1545
Tamarix ramosissima	Salt cedar	1511
Brassica tournefortii	Asian mustard	1261
Centaurea stoebe ssp. micranthos	Spotted knapweed	1185
Conium maculatum	Poison hemlock	873
Taeniatherum caput-medusae	medusahead	698
Hyoscyamus niger	black henbane	656
Centaurea solstitialis	Yello star-thistle	300
Centaurea melitensis	Maltese star-thistle	157
Tribulus terrestris	puncture vine	152
Linaria dalmatica	Dalmation toadflax	148
Centaurea diffusa	diffuse knapweed	133
Euphorbia esula	Leafy spurge	131
Cynoglossum officinale	Houndstongue	119
Cenchrus setaceus	Fountain grass	39
Lythrum salicaria	Purple loosestrife	28
Isatis tinctoria	Dyer's woad	27
Sonchus arvensis	Perennial sow thistle	19
Myriophyllum spicatum	Eurasian watermilfoil	18
Arundo donax	Giant reed	16
Peganum harmala	wild rue	15
Centaurea virgata	squarrose knapweed	10

APPENDIX B (PRECIPITATION & TEMPERATURE MAPS)



WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 5 MAR 2020



WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 5 MAR 2020

APPENDIX C (SURVEY METHODOLOGY, DATA COLLECTION & TRAPPING DATA)

AERIAL SURVEY METHODOLOGY

Mortality trends are described in terms of acres affected; however, not all trees on these acres are dead. Not all forested lands are surveyed, and not all the same acres are surveyed every year. Sometimes, tree mortality may be counted in the same area in consecutive years. This can lead to inflated estimates of actual tree mortality. Total acres tallied may also change between years due to increases or decreases in the total number of acres surveyed. Consequently, interpretation of ADS data should consider these sources of inconsistency.

In 2016, Forest Health Protection (FHP) changed the quantification methodology from “trees per acre” to “percent of trees affected” for polygons with insect and disease damage. Small areas are still recorded as points. A five-level classification system is used to describe damage levels. Damage is recorded as a point, polygon, or grid cell feature and one causal agent is assigned to each feature. Depending upon feature type, the intensity of the damage is recorded differently. For point data, trees affected are classified into one of 5 levels that correspond to the number of trees killed associated with each point. For a polygon or grid cell data, the percentage of trees affected within each polygon or grid cell is classified into one of 5 levels for each polygon or grid cell associated with all trees within the polygon or grid cell data as estimated by the observer.

Table 3. Five Level classification system used to describe damage levels in 2018.

Point Class	Trees Affected		Polygon or Grid Cell Class	Percent Trees Affected
1	1		1	1 to 3%
2	2 to 5		2	4 to 10%
3	6 to 15		3	11 to 20%
4	16 to 30		4	21 to 50%
5	>30		5	>50%

It should be noted that some bark beetle-killed trees are not typically symptomatic (faded foliage) until one year following the year of attack. Therefore, the numbers of acres damaged, and trees killed by bark beetles, as recorded during ADS flights, are typically a reflection of the previous year’s or earlier attacks. Levels of defoliation, however, may reflect either the activity of an insect or disease during the current year or activity since bud break.

TRAPPING DATA FOR MT. ROSE & KYLE CANYON

Trap catch counts by date and species.

Date	D. adjunctus	D. ponderosae	D. valens	Ips pini
8/5/2019	0	500+	8	0
8/19/2019	0	200+	0	0
9/4/2019	0	300+	0	0
9/24/2019	0	250	0	1
10/21/2019	0	107	0	3

Monitoring will be installed for the 2020 field season to monitor any changes in beetle populations.

Kyle Canyon trap catches summer of 2019 showing the dominance of D. brevicomis in mid-summer through early fall. This data is mainly to track secondary beetles which can indicate increased bark beetle activity.

Date	D. approximatus	D. brevicomis	D. valens	D. ponderosae
7/30/2019	12	140	12	0
8/13/2019	5	350	8	0
9/3/2019	3	>500	11	0
9/20/2019	5	40	4	0
10/3/2019	1	12	1	0
10/17/2019	24	10	0	0
10/31/2019	75	5	0	0

European gypsy moth

In all 212 funnel traps were placed in 17 counties; all traps were negative.

Red Palm Weevil

This survey used 40 bucket traps, 40 Jackson traps, and 40 blue sticky traps. The bucket traps were split with two different approved lure combinations. In all, 120 traps were placed in Clark County. All traps were negative for the season.

Asian Gypsy Moth Survey

During the 2019 season 320 traps were placed in 4 counties. Sites were selected based on host availability, use and/or risk of introduction. Traps were hung in July, serviced once and removed in Sept. for a total of 3 visits. During the service of traps, lures were replaced, if necessary, and suspect moths were collected and preserved for identification. All suspect specimens were determined as negative for target pests.

Exotic wood borer survey

This survey used EDRR style trapping methods and sites (24 traps total). The traps were place in Clark, Carson City, Douglas, and Washoe Counties. All traps were negative for the season.