2018 ALASKA REGION HIGHLIGHTS

"Our revamped website has a menu of new webpages for the most common and important forest damage agents in Alaska."

Digital Media

Alaska Forest Health Protection has been working hard to increase timely stakeholder access to forest health information and resources. Our revamped website has a menu of new webpages for the most common and important forest damage agents in Alaska: https://www.fs.usda.gov/main/r10/forest-grasslandhealth. Additionally, an interagency spruce beetle website was developed as a one-stop shop for spruce beetle information in Alaska to provide resources to homeowners and land managers: https://www.alaskasprucebeetle.org. We have also started posting forest health information on social media through the Chugach National Forest (https://www.facebook.com/ChugachNF/) and Tongass National Forest (https://www.facebook.com/TongassNF/) Facebook pages, and on the Alaska Region Twitter feed (https://twitter.com/AKForestService, #alaskaforesthealth). Lastly, we've created Story Maps (an ESRI product) as a new, interactive way to learn about Forest Health Highlights in Alaska, with maps of our ground and aerial survey data that users can explore and manipulate. These Story Maps are linked on our website, and available here: Alaska Forest Health 2017 (https://arcg.is/jqWGj) and Alaska Forest Health 2018 (https://arcg.is/jXrSj).

Aerial Survey

In 2018, aerial surveyors mapped 1.14 million acres of forest damage from insects, diseases, declines and abiotic agents on 28 million acres (Map 1, page 5; Map 2, page 6) (Table 1, page 7; (Table 2), page 8). The number of acres surveyed in 2018 increased slightly (1.5%) compared to 2017, but the total recorded damage increased by 35% from the previous year.

Diseases

Aspen running canker is the most damaging disease of aspen in Alaska, and can be found throughout most of the boreal forest. Disease incidence within stands is significantly greater north of the Alaska Range, with the highest levels of disease in the Tanana-Kuskokwim Lowlands. Canker is more prevalent on smaller diameter trees, particularly within older stands, wherein nearly all the smaller trees have been killed by canker. However, large diameter trees are also susceptible when disease pressure from the smaller tree cohort is great enough (Figure 1).

Figure 1. An older aspen (~12 inch diameter at breast height) near Nenana that had no leaves. The thick bark of older trees makes it challenging to find and expose the canker margin. We stripped away the bark to reveal greenish-white healthy tissue on the left and the dead lesion on the right.

The outbreak of hemlock canker disease that killed western hemlock trees and lower tree crowns across Prince of Wales Island 2012-2016 and elsewhere in Southeast Alaska since 2014 continues to wind down. We have used several techniques to identify the causal fungus, yielding a short list of potential pathogens. Field inoculation trials were implemented in 2018, with more than 500 hemlock saplings tested with 12 fungal isolates (results expected next year).

Dothistroma needle blight (Figure 2) has caused increased localized damage to shore pine in Southeast Alaska since 2010. The recent prolonged outbreak near Gustavus killed almost 60% of shore pine trees in monitoring plots in severely affected forests. This year, heavy damage was also aerially mapped on central Prince of Wales Island. Outbreaks of this native pathogen are triggered by warm, wet conditions. If higher temperatures coincide with precipitation, disease impacts could become considerably more pronounced into the future.

Figure 2. Orange banding symptoms and black fungal fruiting structures of *Dothistroma septosporum* on shore pine needles.

Noninfectious Disorders & Declines

Less than 18,000 acres of active yellow-cedar decline were mapped in 2018, down from 47,500 acres in 2017 and the lowest reported acreage in many years. Although the colder, snowier weather of 2017/18 promoted cedar health, the significant decrease in mapped acreage largely stemmed from a more conservative mapping effort. Forests affected by decline events in 2015 and 2016 remain symptomatic, since tree death often occurs gradually over many years.

Yellow-cedar decline in young-growth stands is an emerging issue that we began tracking closely after the first affected stands were detected in 2013. Decline has now been confirmed in 33 stands on Zarembo, Wrangell, Mitkof and Prince of Wales Islands. In 2018, permanent plots were installed in the five most severely affected stands to assess decline impacts. Many yellow-cedars were symptomatic (Figure 3) and showed signs of recent secondary bark beetle attack; mortality rates were low but are expected to rise.

Figure 3. A yellow-cedar crop tree on Wrangell Island with branch dieback and discolored foliage, symptoms of freezing injury to fine roots (yellow-cedar decline).

Invasive Plants

An array of groups are cooperating to treat Elodea infestations around Alaska, including Chugach National Forest, Alaska Division of Agriculture, US Fish and Wildlife Service, Alaska Department of Fish and Game, as well as several Soil and Water Conservation Districts. To date, treatments using the herbicide fluridone have been highly effective in controlling the invasive aquatic plant. In 2018, however, the goal of eradicating Elodea from the state was challenged by several new detections.

A new infestation of spotted knapweed was detected alongside railroad tracks south of Anchorage in 2018. Members of the Anchorage Cooperative Weed Management Area organized a weed pull to remove the flowering plants and prevent them from going to seed. The Alaska Railroad will consider chemical control of the remaining immature knapweed plants next year. Little spotted knapweed occurs in Alaska, so eradication is possible with vigilant detection and treatment.

R10 FHP has joined forces with the Copper River Watershed Project to manage Alaska's Invasive Plant Mini-Grant program. This program supplies funds to non-federal organizations targeting invasive terrestrial plants that are ranked at 60 or higher in the Alaska invasive plant ranking system. With funding from the mini-grant program, organizations are able to do outreach about invasive plants in their local communities, survey new areas, and manually or chemically treat infestations. Eight projects were funded in 2018, with seven of them in close proximity to either the Tongass or Chugach National Forests. This work is crucial for preventing or limiting the spread of invasive plants to neighboring National Forest lands.

Insects

The spruce beetle outbreak continues in Alaska. Over 900,000 acres have been impacted over the last three years. Beetle mortality is centered in the Matanuska-Susitna River drainages, but is also occurring on the northwestern Kenai Peninsula. The multi-agency Alaska Spruce Beetle Working Group was formed in 2018 with representatives from Alaska Division of Forestry, University of Alaska Fairbanks Cooperative Extension Service, and Forest Health Protection. Several projects are underway in cooperation with partners, including a spruce beetle-resistance screening study, a systemic insecticide trial (Figure 4), and an individual tree protection study using anti-aggregation pheromones.

Hemlock sawfly populations rose to outbreak levels in Southeast Alaska in 2018. Over 48,000 acres of western hemlock defoliation were observed on Admiralty, Mitkof, Wrangell, Etolin, Prince of Wales, Revillagigedo, Gravina and Annette Islands and the Cleveland Peninsula. The warm, dry summer facilitated the outbreak by limiting the fungi that infect larvae and keep populations in check. Pupal cases collected in collaboration with partners across the Tongass National Forest had a low parasitism rate, indicating that the outbreak is likely to continue, especially if we experience another dry summer in 2019.

Over the last several decades multiple species of leaf mining insects have increased in frequency and intensity in Alaskan forests. Aspen leaf miner damage was recorded on almost 240,000 acres, the majority of which was concentrated in the Interior. About 14,000 acres were mapped in the Copper River Valley. Birch leaf miner activity was recorded on over 100,000 acres including areas further removed from the population centers and roadways where it has typically been observed during past surveys.

Figure 4. Jason Moan from AK Division of Forestry injects a white spruce with an insecticide to test whether it will protect the tree from attack by spruce beetle. Photo Credit: Don Grosman, Arborject Inc.

Map 1. Alaska aerial detection survey, 2018.

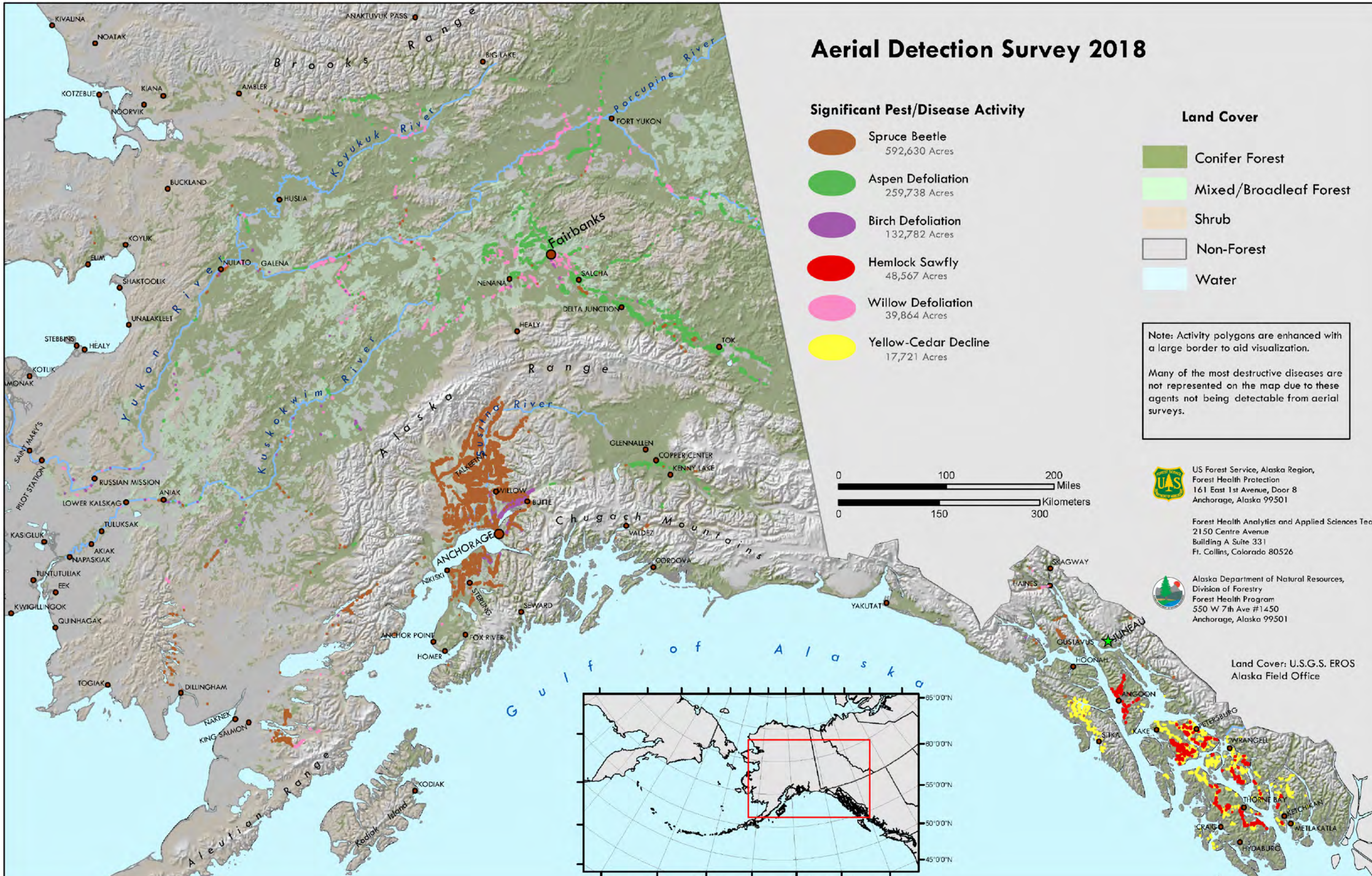

Table 1. Forest insect and disease activity detected during aerial surveys in Alaska in 2018 by land ownership and agent. All values are in acres[1].

Category	AGENT	Total Acres	National Forest	Native	Other Federal	State & Private
Forest Diseases	Dothistroma needle blight	3,605	1,607	46	273	1,679
	Alder dieback	3,206	164	321	429	2,292
	Spruce needle rust	304	0	97	0	206
	Spruce broom rust	188	0	11	139	38
	Hemlock canker	45	35	0	0	9
Defoliators	Aspen leaf miner	239,834	0	46,159	41,891	151,784
	Birch leaf miner	108,612	0	1,350	2,270	104,991
	Hemlock sawfly	48,567	45,258	840	78	2,392
	Willow leafblotch miner	35,763	0	13,697	12,302	9,763
	Birch defoliation	24,110	0	1,884	15,767	6,459
	Aspen defoliation	17,944	0	1,498	11,830	4,617
	Speckled green fruitworm	8,453	0	1,435	0	7,018
	Hardwood defoliation	6,566	87	3,486	1,623	1,370
	Conifer defoliation	4,165	2,251	623	59	1,231
	Willow defoliation	4,101	22	600	3,219	259
	Cottonwood defoliation	3,625	1,668	1,018	700	238
	Large aspen tortrix	1,960	0	1,200	631	130
	Spruce defoliation	1,863	1,604	13	4	242
	Alder defoliation	860	134	293	207	226
	Spruce aphid	126	106	6		15
	Birch leaf roller	61	0	0	0	61
Mortality	Spruce beetle	592,630	647	30,754	59,383	501,846
	Aspen canker	5,651	0	512	94	5,046
	Northern spruce engraver	1,633	0	828	592	212
	Western balsam bark beetle	112	0	0	0	112
	Hemlock mortality	25	25	0	0	0
	Eastern larch beetle	10	0	0	0	10
Noninfectious and Miscellaneous Damage	Yellow-cedar decline	17,721	14,952	1,250	18	1,501
	Flooding/high-water damage	3,729	604	1,188	1,361	576
	Porcupine damage	2,491	1,408	377	0	707
	Windthrow/blowdown	1,001	92	367	411	131
	Larch discoloration	399	0	0	396	4
	Landslide/avalanche	235	76	114	0	45
	Hemlock flagging	143	94	13	0	36
	Birch crown thinning	124	0	0	0	124

[1] Acre values are only relative to survey transects and do not represent the total possible area affected. Table entries do not include many diseases (e.g. decays and dwarf mistletoe), which are not detectable in aerial surveys.

Map 2. Alaska aerial detection survey flight paths, 2018.

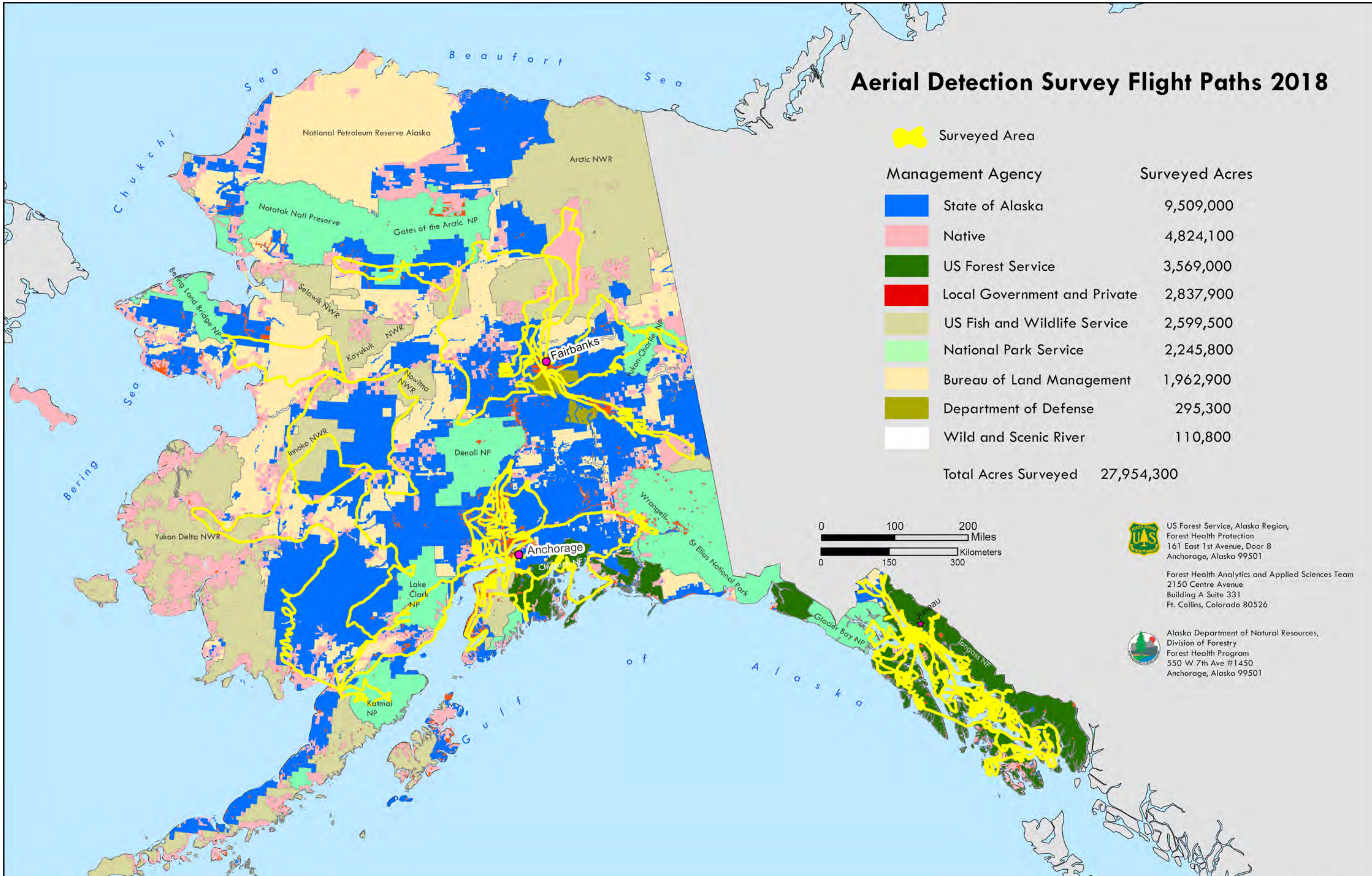

Table 2. Mapped affected area (in thousands of acres) from 2014 to 2018 from aerial survey. Note that the same stand can have an active infestation for several years. For detailed list of species and damage types that compose the following categories, see Appendix II on page 64.

Damage Type	2014	2015	2016	2017	2018
Abiotic damage	13.6	11	3.3	5.6	5.0
Alder defoliation	51.5	26	2.9	3.4	0.9
Alder dieback	125.4	12	8.4	1.0	3.2
Aspen defoliation	138.6	118	229.3	168.5	259.7
Aspen mortality	0.0	0.0	0.0	0.0	5.7
Birch defoliation**	586.7	42	85.5	7.2	132.8
Cottonwood defoliation	53.4	9.2	2.3	1.0	3.6
Fir mortality	0.2	0.02	0.03	0.04	0.1
Hardwood defoliation	42.1	190	161.9	38.7	15
Hemlock defoliation	46	0.1	0.0	0.0	48.6
Hemlock mortality	0	0.5	0.0	2.7	0.1
Larch mortality	*	*	*	*	0.01
Porcupine damage	1.8	1	3.5	1.5	2.5
Shore pine damage	4.5	3.4	4.9	0.3	3.7
Spruce damage	60.1	8.8	36.2	36.1	2.5
Spruce mortality	22.1	42.3	204.5	411.4	594.3
Spruce/hemlock defoliation	4.1	3.1	3.1	1.1	4.2
Willow defoliation	146.1	67	156.3	113.2	39.9
Willow dieback	3.4	1.2	2.8	1.0	0.0
Yellow-cedar decline	19.9	39	39.3	47.4	17.7
Other damage	*	*	*	*	0.7
Total damage acres	**1320**	**574.6**	**949.8**	**840.3**	**1139.9**
Total acres surveyed	32,172	32,938	26,876	27,540	27,954
Percent of acres surveyed showing damage	4.10%	1.70%	3.50%	3.05%	4.08%

* not documented in previous reports

** 2018 increase due to timing of surveys. In the Anchorage/Mat-Su region, birch leaf miner damage appears in August, which is usually after we have completed aerial surveying. This year we completed a couple of late survey flights that allowed us to map the birch damage. Ground surveys show little change in birch leaf miner activity since 2015.

The Willow Leafblotch Miner in Interior Alaska

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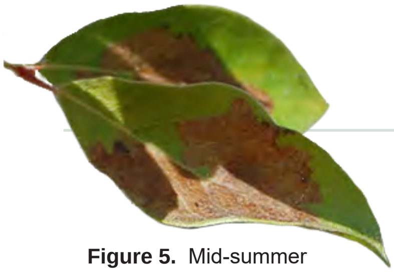

Figure 5. Mid-summer willow leafblotch miner damage on Bebb's willow (*Salix bebbiana*).

In recent years it has become common to see brown willows when driving around Fairbanks in mid-summer. The brown leaves (Figure 5) are mostly the result of feeding damage by an insect that has become increasingly common in recent decades: the willow leafblotch miner (*Micrurapteryx salicifoliella*). The willow leafblotch miner was first documented in Alaska in 1991, when thousands of acres of damage were noted along the drainages of the Yukon and Kuskokwim Rivers. That outbreak lasted only three years but was followed by another in 1998-1999 within the Yukon Flats National Wildlife Refuge. Since then, outbreaks of willow leafblotch miner have become both frequent and widespread in Interior Alaska, reducing willow performance and potentially affecting other species that use willows as food, such as moose.

As the name suggests, leaf miners feed on, and dwell within, the interior tissues of the leaf. Early instars of the willow leafblotch miner are confined to the lower epidermis of the leaf, where they move laterally and feed by puncturing cells to release the fluid contents, a behavior known as "sap-feeding". This is the same feeding behavior used by larvae of the aspen leaf miner (*Phyllocnistis populiella*), another common Alaskan herbivore. However, unlike the aspen leaf miner, which is confined to the epidermis of a single leaf throughout larval development, willow leafblotch miner larvae undergo a morphological change during development, allowing them to move into the leaf center and feed on photosynthetic cells. There, they can virtually hollow the leaf. In addition, newly developed legs allow the older larvae to exit mines, move down branches, and re-enter leaves to form new mines (Figure 6). In this mobile phase, larvae may damage progressively younger foliage, thereby damaging many more leaves than were available at the time the eggs were laid.

Figure 6. Willow leafblotch miner larvae initiating a mine on willow.

While susceptibility to the willow leafblotch miner varies across willow species, few species are immune from attack. Susceptible species tend to lack a key physical defense: trichomes, or leaf hairs, on the bottom side of the leaf. Because of their highly specialized morphology, newly-hatched larvae must enter leaf tissue directly from the egg. The eggs of the willow leafblotch miner sink into the epidermis of the leaf as they develop, permitting larvae to hatch directly into the epidermal cell layer without moving through air. The transition from egg to larva therefore requires a tight connection between egg and leaf; a connection that is disrupted by the presence of trichomes. For example, the feltleaf willow (*Salix alaxensis*) (Figure 7), with its thick layer of trichomes on bottom side of the leaf, sustains very little damage from the willow leafblotch miner. While physical defense plays a key role in determining susceptibility, chemical defense appears to be of lesser importance. For example, the feltleaf willow lacks phenolic glycosides, compounds that are bitter and harmful to some herbivores, whereas many willow species that regularly sustain high levels of leaf mining damage express phenolic glycosides in their leaves.

Figure 7. Thick layer of trichomes on the bottom surface of feltleaf willow leaves.

Leaf herbivory during the summer can impact the feeding behavior of mammalian browsers feeding on the same plants during winter, well after leaves have dropped. A recent experiment conducted along the Tanana River found that winter-feeding moose removed more willow biomass, and a greater percentage of the biomass produced, on plots that had been sprayed early in summer to reduce leaf herbivory than on control plots subject to natural levels of herbivory. The insecticide treatments were more effective against leaf miners than leaf chewers, suggesting that leaf mining damage was key to the moose feeding response. While there was no evidence that reducing leaf herbivory increased the nutritional quality or palatability of the woody tissue in winter, there was evidence that leaf herbivory changed the amount of woody tissue that a willow produced, and this difference in growth may be responsible for altering browsing behavior. A preference by moose for plants with more stem biomass could explain their preference for willows on insecticide-sprayed plots. These results suggest that outbreaks of insect species such as the willow leafblotch miner can impact both forage availability and the feeding preferences of browsers, including species of high economic and cultural value.

Despite anecdotal reports of increased willow mortality during leafblotch miner outbreaks, the effect of this insect on mortality of susceptible species has not been carefully studied. Willows tend to be resilient to herbivory, but repeated outbreaks may overwhelm the ability of willows in severely hit areas to regrow. Studies of willow mortality over appropriate time scales will be critical to understanding the implications of repeated outbreaks of species such as the willow leafblotch miner on Alaskan ecosystems, including successional processes and trophic interactions.