2021 Highlights

Forest health issues, such as insect and disease outbreaks and invasive plant infestations, do not adhere to management boundaries. Alaska's expansive forests encompass diverse ecoregions and ownership. Nested within the State & Private Forestry branch of the U.S. Forest Service, Forest Health Protection monitors across all lands to meet the needs of federal, state, tribal, and private stakeholders.

Of 126 million acres of forestland in Alaska, nearly 11 million acres are contained within the United States' two largest National Forests: the Chugach (1.1 million acres) and the Tongass (9.8 million acres). One-quarter of all federal forestland and 43 percent of all state-owned forestland in the country can be found here. Completely outside National Forest boundaries, there are 115 million acres of boreal forest. Another unique aspect of Alaska's forest management is that more than 200 Alaska Native Corporations own 35 million acres of non-industrial private forestland.

In 2021, Alaska's aerial detection surveys resumed after a one-year hiatus due to the COVID-19 pandemic. Approximately 1.2 million acres of damage (Table 1) were mapped across the 15.7 million acres aerially surveyed (Table 2). In addition, our forest health team made more than 800 ground observations of forest damage from diseases (430 records), insects (359 records), and noninfectious agents (21 records), which can be accessed through the interactive data dashboard at https://arcg.is/1SH58a. Ground survey observations are summarized in Table 3, alongside research grade observations from iNaturalist. For the second year, Forest Health Protection solicited observations for the Alaska Forest Health Observations iNaturalist project, receiving 1,255 research grade observations and 2,000 total observations in 2021. Genera that commonly damage trees and plants in Alaska are automatically filtered into the project. Learn more at: https://www.inaturalist.org/projects/alaska-forest-health-observations.

Pathology Highlights

Significant progress on the aspen running canker disease has been made in the past year with the publication of three peer-reviewed journal articles. We completed and published results of pathogenicity tests on both live trees and cut logs to determine that the causal agent was an undescribed fungus (Figure 1). Dr. Pedro Crous at the Westerdijk Fungal biodiversity Institute (Netherlands) led the effort to name this new fungus *Neodothiora populina* Crous, G.C. Adams & Winton. In a third study, we measured over 16,000 trees within 88 sites distributed over six ecoregions and found canker at 82% of the sites. Modeling climate, regional, and site characteristics suggests that the disease is exacerbated by drought and a long-standing aspen leafminer outbreak.

Noninfectous Highlights

Yellow-cedar decline was mapped on about 8,150 acres during aerial detection surveys, about half the typical acreage. Widespread defoliation from the western blackheaded budworm outbreak likely masked decline detection. The northern margin of decline on the outer coast of Chichagof and Yakobi Islands was monitored for the first time in several years. Three small patches of dying yellow-cedar were observed along the outer coast of Glacier Bay National Park during the aerial detection survey. The cause of this damage will be ground verified and carefully tracked moving forward, as yellow-cedar has been healthy in those forests. Monitoring of managed young-growth stands with yellow-cedar decline continues.

Figure 1 | Forest Pathologist Lori Winton pointing to a lesion of aspen running canker. The bark has been scraped away at the margin between healthy and infected tissue. USDA Forest Service photo.

Figure 2 | A western redcedar tree with fresh topkill. USDA Forest Service photo by Molly Simonson.

Figure 3 | A group of western redcedar trees on Prince of Wales Island with dieback and topkill symptoms associated with severe drought. USDA Forest Service photo by Molly Simonson.

Figure 4 | Western blackheaded budworms feed on the new foliage of western hemlock and other conifers leaving the trees with a reddish appearance. USDA Forest Service photo by Elizabeth Graham.

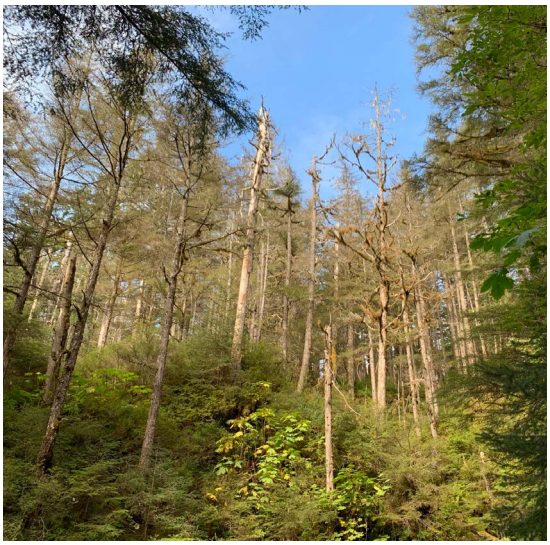


Figure 5 | Topkill and mortality as a result of the hemlock sawfly outbreak from 2018-2020. USDA Forest Service photo by Elizabeth Graham.

Figure 6 | Spruce beetle damage along the Denali Highway near Cantwell. USDA Forest Service Photo by Sydney Brannoch.

Observations over the past several years suggest that there are two distinct causes of western redcedar damage, which is concentrated on Prince of Wales Island in Southeast Alaska. The first cause is topkill associated with bole injury of unknown cause (Figure 2). The second cause is direct impacts of the drought of 2018 and 2019 (Figure 3). In Southeast, the return of adequate precipitation over the past two years will limit drought damage in the near-term, though impacts have continued elsewhere in the Pacific Northwest. There is a range-wide effort to track forest health issues of western redcedar.

Insect Highlights

Western blackheaded budworm populations, which began to rise in 2020, increased into an outbreak that has extended across much of Southeast Alaska. Defoliation was recorded on 520,000 acres and was heaviest in the central Tongass area, including Kuiu, Kupreanof, Mitkof, and Zarembo Islands, as well as Chichagof and Admiralty Islands and several drainages on the mainland (Figure 4). Large numbers of moths were observed, indicating that this outbreak will continue in 2022.

Impacts of the hemlock sawfly outbreak that started in 2018, peaked in 2019, and crashed in 2020 are still being observed. Topkill associated with hemlock sawfly feeding was recorded on >186,000 acres in Southeast Alaska during aerial detection surveys, mostly in the central part of the Tongass National Forest (Figure 5). Mortality from severe defoliation was observed on another 21,000 acres, half of which was on Admiralty Island.

The ongoing spruce beetle outbreak has impacted over 1.6 million acres in Southcentral Alaska since it was first detected in 2016. In 2021, damage was most prevalent along the northern portions of the Matanuska-Susitna Borough, the southern portions of the Denali Borough, and around Cooper Landing, Kenai, and Soldotna on the Kenai Peninsula. Activity near Cantwell (Figure 6) will be monitored closely in 2022 as the outbreak is nearing more Interior-like forests and conditions. The activity within the Chugach National Forest has prompted a large-scale response to manage spruce beetle impacts across the landscape. Nearly 194,000 acres of spruce beetle activity were mapped statewide in 2021, with more than 98% observed within the outbreak area.

Invasive Plant Highlights

In early-August 2021, a dense infestation of white sweetclover extending along eight miles of the Seward Highway was hand pulled by dedicated weed warriors from six agencies and organizations. Weed warriors have worked diligently for over a decade to keep this invasive plant off the Kenai Peninsula. In just two days, six dumpsters were filled with bagged white sweetclover and the flowering plants were nowhere in sight between the Placer River and the "Welcome to the Kenai Peninsula" sign.

As part of a larger effort to control the spread of invasive chokecherries, Alaska DOF developed the *Prunus* Remove and Replace program for the Municipality of Anchorage. This program provides a $100 voucher to homeowners who choose to remove their invasive chokecherry and replace it with a non-invasive tree. The intent of this program is to raise awareness about the issues associated with the invasive chokecherries. Public response has been overwhelming with over 120 applications received for 80 available vouchers.

The Fairbanks Soil and Water Conservation District were busy again this year with Elodea control and surveys. Although their control work has been successful, surveys unfortunately identified 10 new infestations in lakes and ponds; nine located on Eielson Air Force Base and one located on Fort Wainwright military lands.

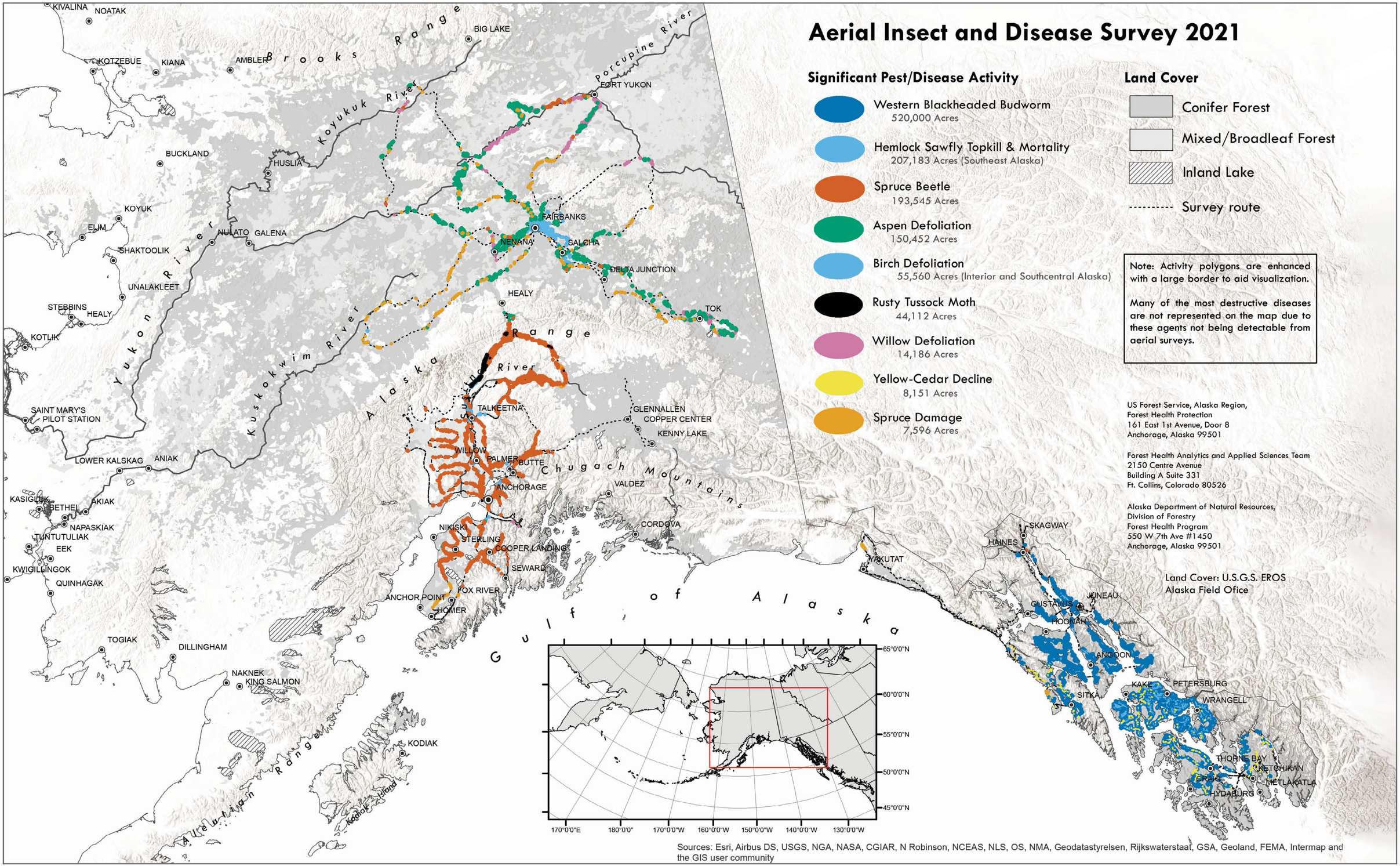
Table 1 | Forest insect and disease activity detected during aerial surveys in Alaska in 2021 by land ownership and agent. All values are in acres*.

Category	Agent	Total Acres	National Forest	Native	Other Federal	State & Private
Disease	Alder dieback	138	52	2	40	44
Disease	Aspen running canker	56	0	0	0	56
Disease	Dothistroma needle blight	428	0	0	86	342
Disease	Spruce broom rust	123	0	20	32	72
Disease	Spruce needle rust	6,619	0	6	3,457	3,155
Disease	Western gall rust dieback	73	59	0	5	10
Noninfectious	Drought	104	0	0	23	81
Noninfectious	Flooding/high-water damage	13,962	236	1,591	1,493	10,641
Noninfectious	Hemlock flagging	29	8	0	16	5
Noninfectious	Landslide/avalanche	1,044	264	368	234	178
Noninfectious	Porcupine damage	209	97	24	79	9
Noninfectious	Windthrow/blowdown	1,619	1,531	38	0	50
Noninfectious	Yellow-cedar decline	8,151	7,520	236	43	352
Insect	Aspen leafminer	146,189	0	41,249	26,712	78,228
Insect	Birch aphid	79	0	0	0	79
Insect	Birch leafminer	47,708	0	693	4,112	42,903
Insect	Cottonwood leaf beetle	5	0	0	0	5
Insect	Hemlock sawfly mortality	21,030	20,012	137	0	881
Insect	Hemlock sawfly topkill	186,153	170,908	4,699		10,545
Insect	Northern spruce engraver	5	0	0	4	1
Insect	Rusty tussock moth	44,112	0	115	2,690	41,307
Insect	Spruce beetle	193,545	6,974	31,630	44,064	110,877
Insect	Western balsam bark beetle	90	33	0	9	47
Insect	Western blackheaded budworm	520,000	460,845	20,733	3,947	34,476
Insect	Willow leafblotch miner	14,178	0	9,760	3,000	1,418
General Damage	Alder defoliation	3,052	129	208	427	2,289
General Damage	Aspen defoliation	4,263	0	2,511	990	762
General Damage	Birch defoliation	7,773	0	418	723	6,633
General Damage	Cottonwood defoliation	676	30	0	415	231
General Damage	Hardwood defoliation	443	0	0	3	440
General Damage	Spruce defoliation	854	796	13	0	45
General Damage	Willow dieback	12	6	0	0	6
	TOTAL	**1,222,722**	**669,501**	**114,452**	**92,605**	**346,166**

*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.

**General Damage is tree damage that cannot be attributed to a particular agent because more than one agent is known to similarly damage the same host. Either or both insects and pathogens may cause the damage. Damage caused by a currently unidentified agent is also included in this category.

Map 1 | 2021 Aerial Insect and Disease Survey. The light-blue color used twice in the legend to represent two different agents; these are separated by region, one active only in Southeast Alaska and the other in the Interior and Southcentral Alaska. For more information on changes to the survey methods in 2021, please see Appendix 1, page 58.



Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community

Map 2 | 2021 Aerial Detection Survey Flight Paths. For more information on changes to the survey methods in 2021, please see Appendix 1, page 58.

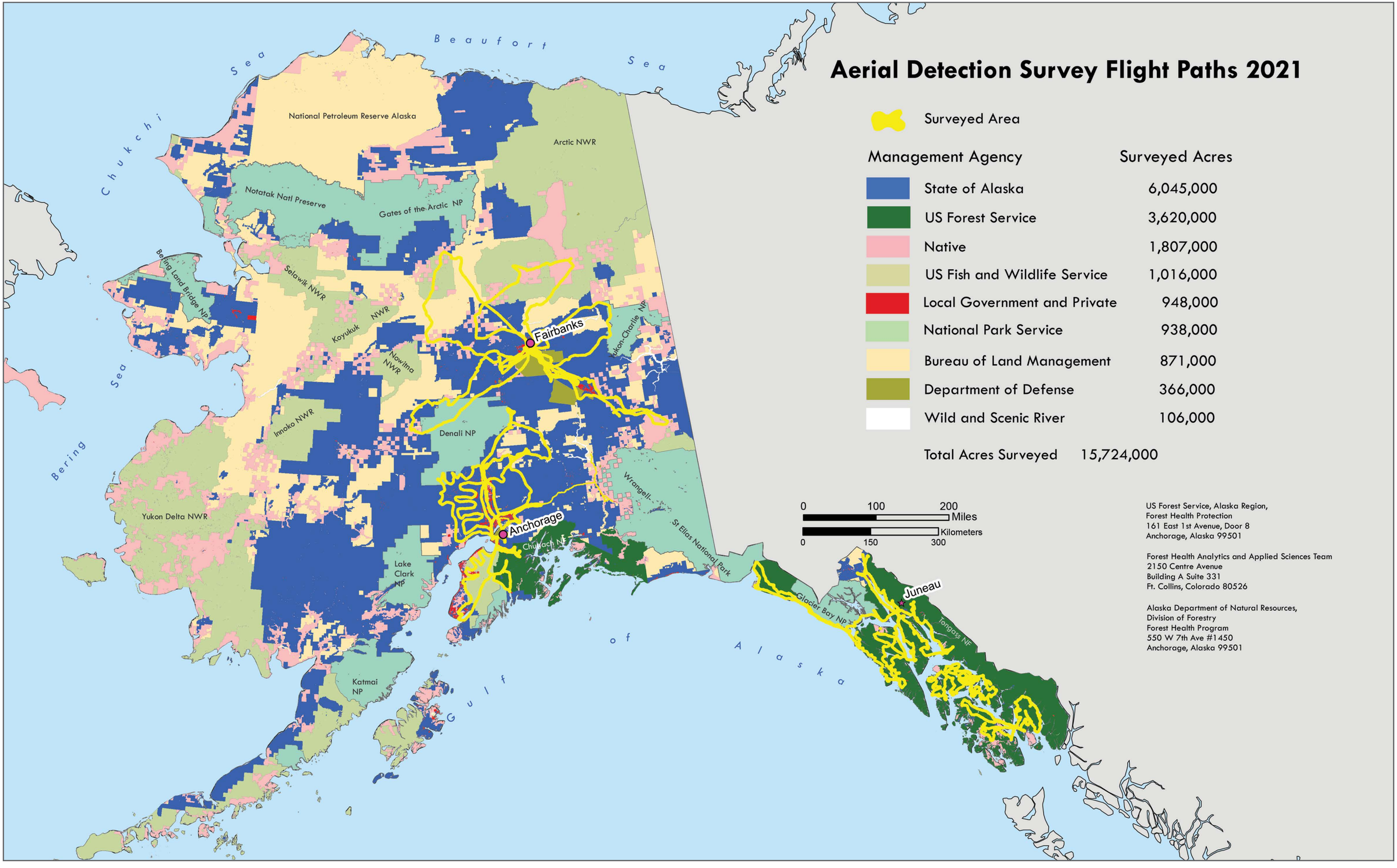


Table 2 | Mapped affected area (in thousands of acres) from 2017 to 2021 from aerial detection survey.

Damage Type	2017	2018	2019	2020	2021
Abiotic damage	5.6	5.0	10.8	0.2	16.7
Alder defoliation	3.4	0.9	2.6	1.0	3.1
Alder dieback	1.0	3.2	1.2	0.0	0.1
Aspen defoliation	168.5	259.7	132.4	38.8	150.5
Aspen mortality	0.0	5.7	0.1	0.0	0.1
Birch defoliation	7.2	132.8	283.4	3.9	55.6
Cottonwood defoliation	1.0	3.6	1.7	0.7	0.7
Fir mortality	0.04	0.1	0.1	0.0	0.1
Hardwood defoliation	38.7	15	3.9	0.1	0.4
Hemlock defoliation	0.0	48.6	381	124.4	520.0
Hemlock mortality	2.7	0.1	0.0	80.0	21.0
Larch mortality	*	0.01	0.0	0.0	0.0
Porcupine damage	1.5	2.5	1.9	0.1	0.2
Shore pine damage	0.3	3.7	0.4	0.0	0.5
Spruce damage	36.1	2.5	117.8	0.7	7.6
Spruce mortality	411.4	594.3	140.6	145.3	193.7
Spruce/hemlock defoliation	1.1	4.2	0.0	0.0	0.0
Willow defoliation	113.2	39.9	32.7	0.5	58.3
Willow dieback	1.0	0.0	0.6	0.0	0.0
Yellow-cedar decline	47.4	17.7	20.0	10.4	8.2
Other damage	*	0.7	9.5	0.0	0.0
Total damage acres	**840.3**	**1139.9**	**1140.8**	**342.0**	**1036.7**
Total acres surveyed	**27,540**	**27,954**	**24,421**	**7,322**	**15,724**
Percent of acres surveyed showing damage	**3.05%**	**4.08%**	**4.67%**	**5.4%**	**6.59%**

* Not documented in previous reports.

Table 3 | Ground observations of forest insects and pathogens in Alaska in 2021. Cumulative ground observations by forest health professionals are displayed in our interactive Ground Survey Dashboard at https://arcg.is/1SH58a. Ground survey protocols are described in Appendix 2 on page 62. Ground observations by citizen scientists can be found in The Alaska Forest Health Observations project on iNaturalist, accessed at https://www.inaturalist.org/projects/alaska-forest-health-observations. Observations of unidentified or noninfectious agents from our ground surveys and species not closely tied to forest health are excluded.

Damage Agent Category	Damage Causing Agent	Scientific Names	Ground Observations*	iNaturalist Research Grade Observations**	Total
Insects	Adelgidae	*Adelgidae spp.*	6	0	6
Insects	Alder woolly sawfly	*Eriocampa ovata*	1	6	7
Insects	Amber-marked birch leafminer	*Profenusa thomsoni*	20	0	20
Insects	Aspen leafminer	*Phyllocnistis populiella*	28	10	38
Insects	Balsam woolly adelgid	*Adelges piceae*	0	0	0
Insects	Battered sallow	*Sunira verberata*	0	2	2
Insects	Birch aphid	*Euceraphis betulae*	5	0	5
Insects	Birch leafminer/roller	*Caloptilia spp.*	18	0	18
Insects	Birch leafroller	*Epinotia solandriana*	10	0	10
Insects	Cooley spruce gall adelgid	*Adelges cooleyi*	0	0	0
Insects	Cottonwood leaf beetle	*Chrysomela scripta*	8	0	8
Insects	Eriophyid mite	*Eriophyidae spp.*	20	5	25
Insects	Engraver beetles	*Ips spp.*	0	0	0
Insects	Gall midge	*Cecidomyiidae spp.*	0	15	15
Insects	Giant conifer aphid	*Cinara spp.*	0	0	0
Insects	Green alder sawfly	*Monsoma pulveratum*	20	8	28
Insects	Hemlock sawfly	*Neodiprion tsugae*	9	1	10
Insects	Hemlock woolly adelgid	*Adelges tsugae*	0	0	0
Insects	Larch sawfly	*Pristiphora erichsonii*	1	0	1
Insects	Late birch leaf edgeminer	*Heterarthrus nemoratus*	22	0	22
Insects	Leaf beetles spp.	*Leaf beetles spp.*	1	13	14
Insects	Rusty tussock moth	*Orgyia antiqua*	5	32	37
Insects	Spotted tussock moth	*Lophocampa maculata*	0	41	41
Insects	Spruce aphid	*Elatobium abietinum*	0	0	0
Insects	Spruce beetle	*Dendroctonus rufipennis*	2	10	12
Insects	Spruce bud moth	*Zeiraphera canadensis*	6	0	6
Insects	Spruce budworm	*Choristoneura spp.*	1	0	1
Insects	Striped alder sawfly	*Hemichroa crocea*	2	1	3
Insects	Western blackheaded budworm	*Acleris gloverana*	32	19	51
Insects	Western tent caterpillar	*Malacosoma californicum*	4	1	5
Insects	Willow leafblotch miner	*Micrurapteryx salicifoliella*	27	2	29

*"Ground Observations" are observations made by Forest Health Protection professionals in the field via direct observation, these include 20-minute timed meanders along the road system as well as opportunistic surveys. A single ground observation in this table can represent damage detected on 1 tree, 2-5 trees, 6-15 trees, 16-30 trees, or more than 30 trees.

** "iNaturalist Research Grade Observations" are observations reported by citizen scientists on iNaturalist that are identified to species and have 2/3rds community agreement in the taxonomic identification. While species-level IDs are typically needed to establish an observation as "research grade," observations can be deemed "research grade" at any taxonomic level below family, as long as the iNaturalist community votes that the observation does not need more specific IDs.

*** FHP staff recorded brown crumbly rot as *Fomitopsis pinicola sensu lato* (a species complex), whereas iNaturalist users further identified to the species level. There are two species that occur within Alaska: *F. mounceae* and *F. ochracae*.

Table 3 | continued

Damage Agent Category	Damage Causing Agent	Scientific Names	Ground Observations*	iNaturalist Research Grade Observations**	Total
Pathogens	Artist's conk	*Ganoderma applanatum*	6	14	20
Pathogens	Aspen running canker	*Neodothiora populina*	11	0	11
Pathogens	Aspen shoot blight	*Venturia mucularis*	5	0	5
Pathogens	Aspen target canker	*Cytospora notastroma*	2	0	2
Pathogens	Bear's tooth fungus	*Hercicium abietis*	1	6	7
Pathogens	Birch polypore	*Fomitopsis betulina*	3	38	41
Pathogens	Brown crumbly rot	*Fomitopsis mounceae****	—	30	30
Pathogens	Brown crumbly rot	*Fomitopsis ochracae****	—	84	84
Pathogens	Brown crumbly rot	*Fomitopsis pinicola sensu lato****	10	—	10
Pathogens	Brown cubical butt rot	*Phaeolus schweinitzii*	15	23	38
Pathogens	Canker-rot of birch	*Inonotus obliquus*	2	14	16
Pathogens	Coral tooth fungus	*Hericium coralloides*	0	18	18
Pathogens	Cottonwood/Polar shoot blight	*Venturia populina*	1	0	1
Pathogens	Diplodia gall	*Diplodia tumefaciens*	1	3	4
Pathogens	Dothistroma needle blight	*Dothistroma septosporum*	1	0	1
Pathogens	Hardwood leaf rusts	*Melamspora spp.*	12	11	23
Pathogens	Hartig's conk	*Phellinus hartigii*	3	0	3
Pathogens	Hemlock dwarf mistletoe	*Arceuthobium tsugense*	6	6	12
Pathogens	Hemlock-blueberry rust	*Naohidemyces vaccinii*	16	0	16
Pathogens	Lacquer/varnish conk	*Ganoderma oregonense*	2	8	10
Pathogens	Lirula needle cast	*Lirula macrospora*	13	1	14
Pathogens	Paint fungus	*Echinodontium tinctorium*	0	1	1
Pathogens	Quinine conk	*Laricifomes officinalis*	0	2	2
Pathogens	Red ring rot	*Porodaedalea pini*	18	9	27
Pathogens	Sirococcus shoot blight	*Sirococcus tsugae*	9	0	9
Pathogens	Spruce broom rust	*Chrysomyxa arctostaphyli*	10	11	21
Pathogens	Spruce bud blights	*Spruce bud blights spp.*	156	0	156
Pathogens	Spruce bud rust	*Chrysomyxa woroninii*	4	8	12
Pathogens	Spruce needle rust	*Chrysomyxa ledicola*	23	11	34
Pathogens	Sulfur fungus	*Laetiporus conifericola*	7	98	105
Pathogens	Tinder conk/hoof fungus	*Fomes fomentarius*	7	27	34
Pathogens	Tomentosus root rot	*Onnia tomentosa*	0	6	6
Pathogens	Trunk rot of aspen	*Phellinus tremulae*	11	5	16
Pathogens	Trunk rot of birch	*Phellinus igniarius*	7	19	26
Pathogens	Viburnum leaf and stem rust	*Puccinia linkii*	0	20	20
Pathogens	Weir's cushion rust	*Chrysomyxa weirii*	2	0	2
Pathogens	Western gall rust	*Endocronartium harknessii*	3	2	5
Pathogens	Yellow cap fungus	*Pholiota spp.*	0	9	9