USDA

# Forest Health Conditions in Alaska - 2017

A Forest Health Protection Report

Forest Service
Alaska Region

State of Alaska
Department of
Natural Resources
Division of Forestry

R10-PR-43

February 2018

**U.S. Forest Service, State & Private Forestry, Alaska Region**

Debbie Hollen, Director for State & Private Forestry
1220 SW Third Avenue, Portland, OR 97204, dahollen@fs.fed.us

Michael Shephard, Deputy Director State & Private Forestry
161 East 1st Avenue, Door 8, Anchorage, AK 99501, mshephard@fs.fed.us

Visit the updated Forest & Grassland Health web pages identifying Common Damage Agents in Alaska at https://www.fs.usda.gov/main/r10/forest-grasslandhealth

**Alaska Forest Health Specialists**

U.S. Forest Service, Forest Health Protection, http://www.fs.fed.us/r10/spf/fhp/
Anchorage, Southcentral Field Office
161 East 1st Avenue, Door 8, Anchorage, AK 99501
Phone: (907) 743-9453; Fax: (907) 743-9479 John Lundquist, Entomologist (FHP and PNW Research Station), jlundquist@fs.fed.us; Steve Swenson, Biological Science Technician, sswenson@fs.fed.us

Fairbanks, Interior Field Office
3700 Airport Way, Fairbanks, AK 99709
Phone: (907) 451-2701; Fax: (907) 451-2690
Stephen Burr, Entomologist, sburr@fs.fed.us; Garret Dubois, Biological Science Technician, garretddubois@fs.fed.us; Lori Winton, Plant Pathologist, lmwinton@fs.fed.us; Tricia Wurtz, Ecologist, twurtz@fs.fed.us

Juneau, Southeast Field Office
11175 Auke Lake Way, Juneau, AK 99801
Phone: (907) 586-8835; Fax: (907) 586-7848
Elizabeth Graham, Entomologist, eegraham@fs.fed.us; Tom Heutte, Aerial Survey Coordinator, theutte@fs.fed.us; Karen Hutten, Biological Scientist, khutten@fs.fed.us; Robin Mulvey, Plant Pathologist, rlmulvey@fs.fed.us

State of Alaska, Department of Natural Resources
Division of Forestry
550 W 7th Avenue, Suite 1450, Anchorage, AK 99501
Phone: (907) 269-8460; Fax: (907) 269-8931
Jason Moan, Forest Health Program Coordinator, jason.moan@alaska.gov

University of Alaska Fairbanks Cooperative Extension Service
1840 Bragaw, Suite 100, Anchorage, AK 99508
Phone: (907) 786-6300; Fax: (907) 786-6312
Gino Graziano, Invasive Plants Instructor, gagraziano@alaska.edu; Jessie Moan, Statewide Integrated Pest Management Technician, mjmoan@alaska.edu

Cover photo: Spruce beetle kill recorded during aerial survey in the MatSu Valley.

# Forest Health Conditions in Alaska - 2017

## FHP Protection Report R10-PR-43

Edited by: Stephen Burr and Karen Hutten

Contributors: Stephen Burr, Garret Dubois, Elizabeth Graham, Tom Heutte, Ed Holsten, Karen Hutten, John Lundquist, Jason Moan, Jessie Moan, Robin Mulvey, Michael Shephard, Steve Swenson, Lori Winton, Tricia Wurtz

Layout: Carol Teitzel

CITATION:

FS-R10-FHP. 2017. Forest Health Conditions in Alaska 2017. Anchorage, Alaska. U.S. Forest Service, Alaska Region. Publication R10-PR-43. 64 Pages

# Contents

# MAPS



# TABLES

# Introduction

*By Michael Shephard, Deputy Director,*
*State & Private Forestry, Alaska*

We are excited to present the Forest Health Conditions in Alaska—2017 report. This report summarizes monitoring data collected annually by our Forest Health Protection team and some of our key partners. This report, as one of our core missions, will provide technical assistance and information to stakeholders on the forest conditions of Alaska. The report also helps to fulfill a congressional mandate (The Cooperative Forestry Assistance Act of 1978, as amended) that requires survey, monitoring, and annual reporting of the health of the forests. This report also provides information used in the annual Forest Insect and Disease Conditions in the United States report.

We hope this report will help YOU, whether you are a resource professional, land manager, other decision-maker or someone who is interested in forest health issues affecting Alaska. This report integrates information from many sources, summarized and synthesized by our forest health team. Please feel free to contact us if you have any questions or comments.

We also want to let you know about some recent personnel changes in our Alaska forest health team:

**New Arrivals:** Please join us in welcoming **Karen Hutten**, our new Biological scientist working with the Juneau team. Karen brings a wealth of experience. **Penny Haner** will also be joining the larger State & Private team as the new Business Operations Lead for Alaska and the Pacific Northwest. Welcome to Karen and Penny!

**Recent Departures: Rachael Lesslie** has served as key administrative support to S&PF for three years in the Anchorage office. She has taken a new position with the FS acquisition team. We wish her the very best!

**Seasonal Technicians: Bryan Box** returned for a third season out of our Anchorage office. Thank You Bryan! **Isaac Davis**, worked as a seasonal technician for our Juneau office this year, after working in Fairbanks last year. Thank You Isaac! We also had an International Forestry Fellows Program student from Sweden work with our team out of Juneau this season as well. **Maja Nilsson** added greatly to our team in Southeast Alaska this season!

Remembering **Dr. Richard "Skeeter" Werner:** Many of us will very much miss Skeeter, who passed away this past July. Please see the following write-up by Dr. Edward Holsten who worked closely with Skeeter for many decades. Additionally, Dr. Werner initiated the long-term spruce beetle monitoring in Bonanza Creek outside of Fairbanks that has made the 2017 featured entomology essay possible.

Did you know that you can **request for our aerial survey team to examine specific forest health concerns** in your area? To do this, please contact our Aerial Survey Coordinator, Tom Heutte (theutte@fs.fed.us) or other members of our forest health team. Additionally, this report is available online at https://www.fs.usda.gov/main/r10/forest-grasslandhealth or in print by contacting Biological Science Technician, Garret Dubois (garretddubois@fs.fed.us).

We also wish to briefly mention a project that we were proud to assist: **Getting young students out** to see a small piece of the nearby Chugach National Forest.

Many of these students had never seen a glacier, been on a boat, had any familiarity with the wildlife or vegetation in the area, or visited the Chugach National Forest, despite its proximity to Anchorage. Both students and their parent-chaperones expressed great excitement and enthusiasm for the field trip! One teacher reported that in her twelve years of teaching, this was the best field trip she'd ever been able to take her class on. At this time we are still awaiting word if there will be funds to continue this program.

For the last two years, Alaska S&PF has worked with the Anchorage Park Foundation and Chugach National Forest to organize field trips to Portage Glacier for Anchorage elementary school students. Funding for this effort came from a national program called "Every Kid in a Park." Fourth-grade students, teachers, and parent-chaperones from four different Title 1 elementary schools rode busses along Turnagain Arm to the Begich, Boggs Visitor Center. They then boarded the Ptarmigan, a small boat that takes visitors from the Visitor Center across Portage Lake to the face of Portage Glacier. On the boat, Chugach National Forest interpretive rangers taught the students about glacier formation and change, glacial silt and moraine, and vegetation succession. The students were able to hold glacier ice and silt, and observe the vastness, colors, and crevasses of the glacier.

# *Remembering*

Dr. Richard "Skeeter" Allen Werner
February 20, 1936 - July 8, 2017

Alaska Forest Health and Research lost a great colleague and friend last July in Corvallis, Oregon.

Skeeter began his Alaska forest entomology career in Juneau, Alaska in 1960 where he studied the population dynamics of the black-headed budworm; a serious defoliator of western hemlock. After receiving his PhD in Forest Entomology from North Carolina State, Skeeter returned to Alaska full-time in 1974 where he was a Research Entomologist and Program Manager at the Institute of Northern Forestry (INF) in Fairbanks Alaska. Skeeter's first few years at INF were devoted to understanding the Spear-marked Black Moth's population dynamics as well as the identification of its pheromone complex. Skeeter later installed a number of spruce budworm long-term growth impact plots near Fairbanks. Spruce beetle populations started to increase in Southcentral Alaska in the 1980's and Skeeter turned his research activities to understanding the population dynamics and pheromone complex of this devastating forest insect. Skeeter also helped uncover the semio-chemical complex of the spruce engraver. Skeeter's 50 years of forest insect research also involved the effects of fire and climate change on boreal insect populations. Skeeter also helped develop preventative insecticide treatments against spruce beetle attacks in high valued areas such as campgrounds and home-owner lots. Among his more than 100 publications and book chapters, he also published on the effects of insecticide drift on aquatic organisms.

*His research also led him to become a world authority on the spruce beetle and other boreal forest insects.*

Skeeter retired in the 1990's and moved to Corvallis Oregon. His interest in forest entomology didn't stop with retirement. Skeeter returned to Alaska for many years studying the effects of climate change on ground beetles. In 2010, Skeeter received the coveted Founders Award presented by the Western Forest Insect Work Conference held in Penticton, British Columbia.

Skeeter was a prominent member of the forest entomology community. But more importantly, he will be remembered for his sense of humor, his friendship, and his mentoring to his friends and colleagues. He will be missed!

Ed Holsten, Cooper Landing, AK

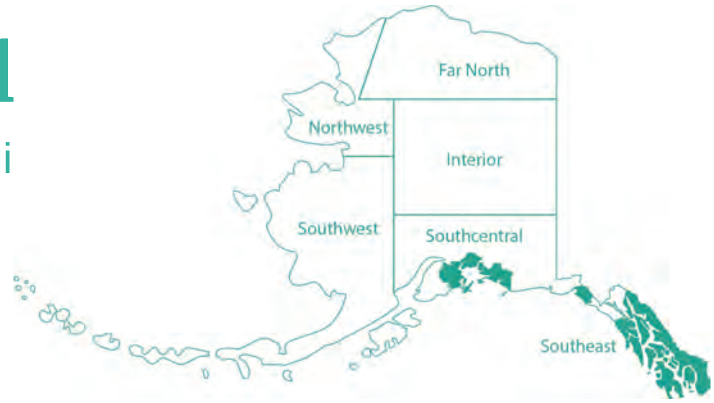
Skeeter installing Lindgren funnel trap in the spring of 1997.



Skeeter at Sunrise Café in Cooper Landing in 2004 with longtime friends/coworkers (from left), John Hard, Ed Holsten, and Ken Zogas.

# Highlights *for* 201

## State & Private Forestry, Alaska Regi




In 2017, aerial surveyors mapped over 840,000 acres of forest damage from insects, diseases, declines and abiotic agents on 27.5 million acres (Map 1 and Map 2); (Table 1 and Table 2). The number of acres surveyed in 2017 increased slightly (2%) compared to 2016, but the total recorded damage decreased 12% from the previous year (Table 3). While mapped damage of multiple damage agents decreased from 2016 to 2017, mortality due to spruce beetle increased substantially over this time period (Map 1).

### Diseases

Gemmamyces bud blight is a recently detected disease of spruce in Southcentral and Interior Alaska caused by the fungal pathogen *Gemmamyces piceae* (Figure 1). It was initially detected in 2013 near Homer and the causal agent identified in 2016. We are closely monitoring the distribution of the disease in Alaska and have partnered with experts at the University of Nebraska to evaluate the population structure and native/nonnative status. This collaboration has revealed that there are actually three different fungi causing bud blight of spruce in Alaska: *G. piceae*, *Dichomera gemmicola*, and a species of *Camarosporium*. These fungi are virtually indistinguishable in the field and have identical signs and symptoms. In 2017, plot-based surveys were implemented throughout the state to determine presence/absence and severity of *G. piceae*. While *G. piceae* was found on over 40% of the Southcentral/Interior plots, only *D. gemmicola* was found in Southeast. To date, over 200 locations with spruce bud blight caused by the three fungi have been detected in Southcentral and Interior Alaska.

**Figure 1.** *Gemmamyces piceae* on white spruce near Anchorage.

Shore pine mortality associated with the severe Dothistroma needle blight outbreak that began around 2010 near Gustavus and Glacier Bay National Park has slowed and few fungal fruiting structures were observed in 2017. This suggests that the outbreak may have run its course. Analysis of weather data has allowed us to pinpoint a wet, warm period in late July 2009 that likely precipitated the outbreak. Damage mapped near Haines, Klukwan, and Skagway in recent years has subsided without significant mortality. Permanent monitoring plots have been established near Gustavus and Haines.

An outbreak of hemlock canker disease that began in 2012 has caused mortality of western hemlock along more than 70 miles of roadside forest on Prince of Wales Island. Hemlock canker has also flared up in many other locations in Southeast Alaska, including locations farther north than previously reported (Juneau and Cordova). On Prince of Wales Island, this disease has caused mortality of crop trees in some managed stands closest to the main outbreak area near Naukati Bay and Staney Creek, indicating a severe but not unprecedented outbreak for this island.

Aspen running canker is caused by an unknown fungus that rapidly kills the cambium as it expands along much of the bole (Figure 2). Most trees die within the year as the tree is girdled. To gain a better understanding of its distribution and the factors influencing its spread, we initiated a joint venture agreement with Dr. Roger Ruess (University of Alaska Fairbanks). In 2017, we evaluated 32 Cooperative Alaska Forest Inventory sites, 5 Long Term Ecological Research sites, and 26 ad-hoc sites. We found canker at 51 of the 63 sites (81%). The percentage of infected trees at the sites with canker ranged from 1.5% - 64%.


**With Aspen running canker, most trees die within the year as the tree is girdled.**

**Figure 2.** Debarked lesion of aspen running canker. The darker the tissue the longer it has been dead. As the canker expanded toward the left, more recent lesion margins formed. Each of the three margins were numbered and sampled in an attempt to identify the fungus.

## Noninfectious Diseases & Disorders

2017 was another significant year for active yellow-cedar decline (dying trees with red-yellow crowns) in Southeast Alaska, with 47,500 acres mapped. Yellow-cedar decline in young-growth is an emerging issue that we are tracking to understand the key risk factors, extent, and management impacts. We have compiled a database of young-growth stands that contain yellow-cedar to facilitate monitoring. Decline has been confirmed in multiple managed stands on Zarembo Island, and fewer stands on Kupreanof, Mitkof, Wrangell, and Prince of Wales Islands. Many young-growth stands with crown discoloration symptoms identified by aerial survey and low-altitude imagery were ground-checked in 2016 and 2017. Porcupine damage to crop trees, rather than yellow-cedar decline, was the most significant cause of mortality in young-growth forests on Mitkof, Kupreanof and Wrangell Islands, while hemlock canker disease and flooding were the most common causes on Prince of Wales Island. Also on Prince of Wales Island, widespread topkill of western redcedar was reported in 2017.

## Invasive Plant Program

After years of studying, testing, applying for permits, and planning, the Fairbanks Soil and Water Conservation District made the first chemical application to Chena Slough, with a goal of eradicating the invasive aquatic plant elodea (*Elodea* spp.) from that waterbody. Herbicides with the active ingredient fluridone were applied in both liquid and pelleted forms. The majority of slough water samples collected during the summer had fluridone concentrations that fell within the target zone of 4 to 8 parts per billion. Within three weeks of the start of treatment, the elodea in the slough was showing signs of being affected by the herbicide. Well-water samples collected from five residences along the slough were uncontaminated with fluridone. The Fairbanks Soil and Water Conservation District has received a $500,000 grant from the Alaska Sustainable Salmon Fund to continue treating Chena Slough and begin treating another infestation in Totchaket Slough.

About forty people attended a training session on invasive species organized by the Alaska Department of Natural Resources, a part of the Division of Mining, Land and Water's continuing education series. It included an hour-long presentation on "Invasive species: why you should care," and the chance to examine fresh specimens of about 20 invasive plant species that are spreading in Interior Alaska. For comparison, a number of similar-looking native plant species were also available for viewing.

In August, an infestation of creeping thistle (*Cirsium arvense*) was discovered in Alaska about 75 miles north of the Arctic Circle, by John Morton of the US Fish and Wildlife Service. This find was a shock to Alaska's invasive species community; the farthest-north known infestations of this plant were previously several hundred miles to the south. Conversations have begun on treatment options for this site.

In 2017, the Anchorage Assembly made a significant contribution to the fight against the invasive European birdcherry (*Prunus padus*) when it enacted an ordinance to prohibit the sale of this ornamental tree in the municipality. Sponsored by Assemblyman Forrest Dunbar, the ordinance passed unanimously on August 8.

The Alaska Invasive Species Workshop, the annual meeting of the Alaska Committee for Noxious and Invasive Pest Management (CNIPM), was held in Anchorage in 2017. A keynote address, on the Arctic Invasive Alien Species Strategy and Action Plan, was given by Jamie Reaser, Executive Director of the National Invasive Species Council. Representatives of the Alaska legislature and the Anchorage Assembly spoke during a session on policy and planning. Two major foci of the meeting were elodea research and management, and environmental DNA. For the first time, student scholarships were offered to attend the meeting.

R10 FHP has joined forces with the Copper River Watershed Project (CRWP) to manage the Alaska Invasive Plant mini-grant project over the next two years. The mini-grant program is a source of small-grant funding for people and community groups anywhere in Alaska to manage invasive plants.

## Insects

A spruce beetle outbreak is occurring in Southcentral Alaska, over 400,000 acres of spruce beetle damage were observed, which is more than double the damage detected in 2016. It is the most damage recorded for spruce beetle since 1997, when the last major outbreak occurred. The majority of the damage (337,000 acres) is located in the Susitna Valley and adjacent drainages. Spruce beetle activity continued to build in the northwestern portion of the Kenai Peninsula and scattered small pockets of spruce beetle damage were noted in the area of Kenai, Soldotna, and Kasilof. Trap catches of spruce beetle are increasing in the Interior however increased damage is not yet apparent.

Spruce aphid activity drastically decreased throughout the Kenai Peninsula and Southeast Alaska after the cold winter of 2016/2017. Heavily impacted trees appear to be recovering, although a small number of trees in Homer have died. As an additional side benefit of the intensive spruce aphid surveys, several other damage agents of Sitka spruce that are not typically noted were observed. A spruce shoot gall midge was found throughout Southeast Alaska as well as several species of spruce sawfly, bud moths, and other gall makers.

Internal leaf feeding by leaf mining insects was generally lower in 2017, however aspen leaf miner was detected on approximately 148,000 acres in the Interior. Birch leaf miner activity was noted in Eagle River, Chugiak, Palmer and Wasilla however activity was low in Anchorage. Amber-marked birch leaf miner activity was high in Fairbanks and North Pole (Figure 4), and late birch leaf edge miner was detected for the first time in the Interior: five locations in Fairbanks, two locations north of Healy.

External leaf feeding on hardwoods was more prevalent than internal feeding. Late-season defoliation of alder by several species of sawflies and caterpillars was common throughout Southeast but not apparent during the aerial survey. Considerable hardwood defoliation by *Sunira verberata* was observed along the Richardson Highway between Valdez and Glennallen.

**Figure 3.** Inside a spruce tree attacked by spruce beetles. The cream colored larvae (left) feed under the bark creating the galleries filled with sawdust. They then create chambers where they turn into pupae (right) and complete their development.

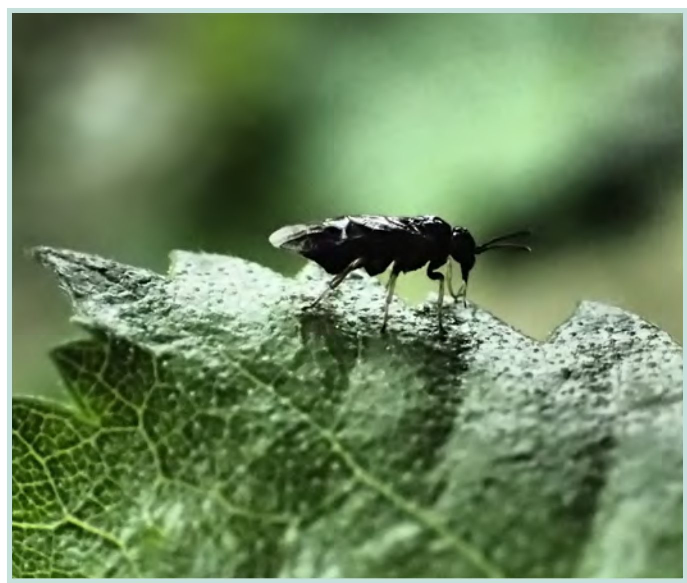
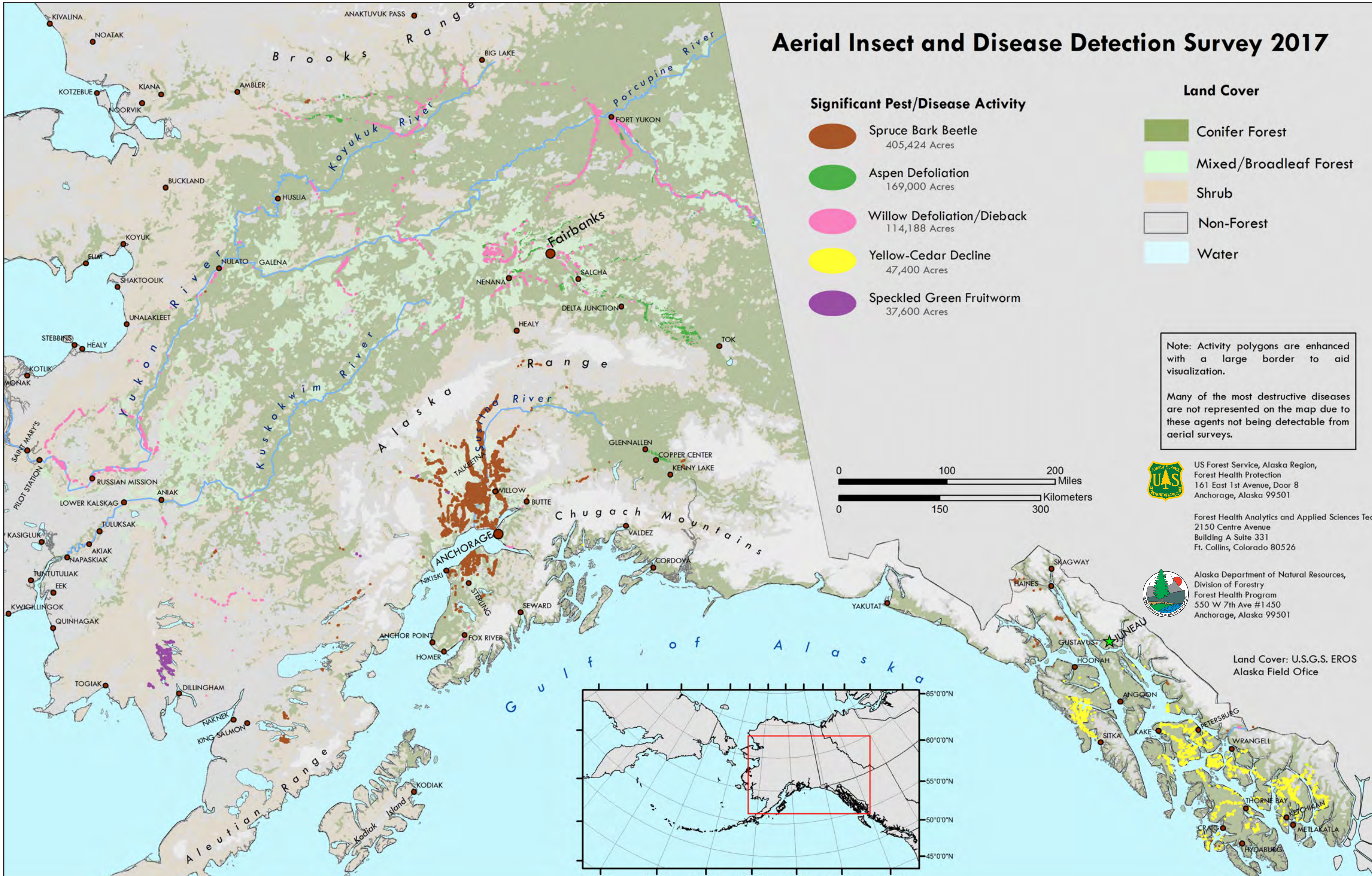


**Figure 4.** Amber-markerd birch leaf miner scouting oviposition sites in Fairbanks.

**Map 1.** Alaska aerial insect and disease detection survey, 2017.



**Map 2.** Alaska aerial insect and disease detection survey flight paths, 2017.

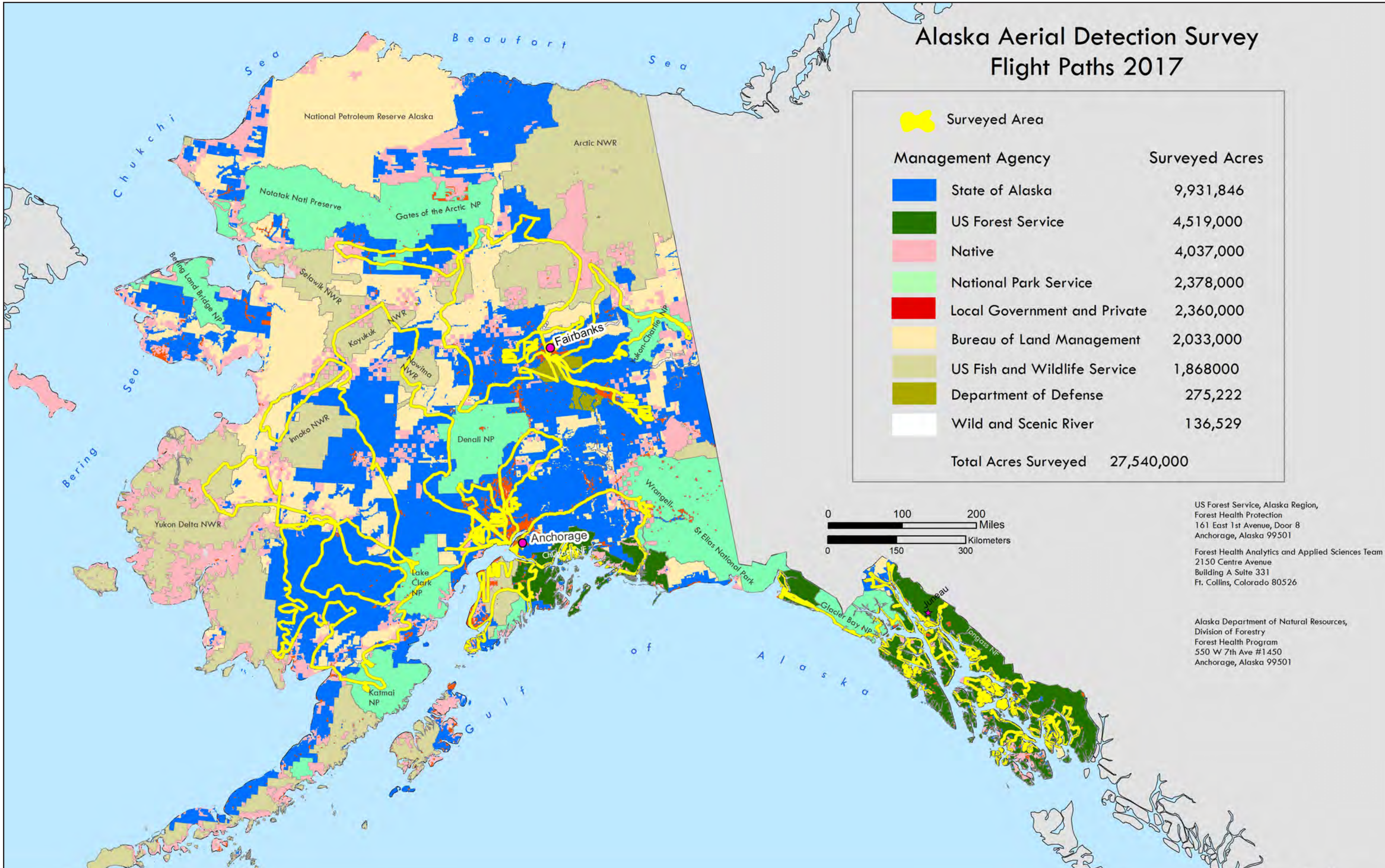


**Table 1.** Forest insect and disease activity detected during aerial surveys in Alaska 2017 by land ownership and agent. All values are in acres[1].

| Category | AGENT | Total Acres | National Forest | Native | Other Federal | State & Private |
|---|---|---|---|---|---|---|
| Forest Diseases | Hemlock canker | 2,632 | 2,602 | 0 | 0 | 30 |
| | Willow dieback | 1,038 | 0 | 70 | 383 | 585 |
| | Alder dieback | 972 | 189 | 407 | 65 | 310 |
| | Dothistroma needle blight | 325 | 104 | 0 | 135 | 87 |
| | Spruce broom rust | 189 | 0 | 79 | 108 | 3 |
| | Spruce needle rust | 76 | 0 | 0 | 0 | 76 |
| Defoliators | Aspen leaf miner | 147,554 | 0 | 27,088 | 23,082 | 97,383 |
| | Willow leafblotch miner | 72,986 | 0 | 31,810 | 21,064 | 20,111 |
| | Willow defoliation | 40,165 | 155 | 14,024 | 16,456 | 9,529 |
| | Speckled green fruitworm | 37,622 | 0 | 3,360 | 241 | 34,022 |
| | Spruce defoliation | 35,405 | 31,892 | 109 | 3,368 | 37 |
| | Aspen defoliation | 20,728 | 0 | 1,182 | 7,582 | 11,964 |
| | Hardwood defoliation | 5,533 | 0 | 3,623 | 1,112 | 798 |
| | Alder defoliation | 3,419 | 372 | 921 | 371 | 1,755 |
| | Birch aphid | 3,256 | 0 | 0 | 0 | 3,256 |
| | Birch defoliation | 2,899 | 0 | 690 | 1,672 | 537 |
| | Conifer defoliation | 1,130 | 497 | 34 | 34 | 564 |
| | Cottonwood defoliation | 979 | 0 | 672 | 235 | 72 |
| | Birch leaf roller | 607 | 0 | 78 | 398 | 131 |
| | Birch leaf miner | 450 | 0 | 0 | 0 | 450 |
| | Spruce aphid | 408 | 166 | 0 | 0 | 242 |
| | Spruce budworm | 331 | 0 | 201 | 66 | 64 |
| | Large aspen tortrix | 225 | 0 | 0 | 225 | 0 |
| | Alder sawfly | 2 | 0 | 0 | 0 | 2 |
| Mortality | Spruce beetle | 405,384 | 929 | 39,542 | 31,551 | 333,361 |
| | Northern spruce engraver beetle | 6,012 | 0 | 408 | 537 | 5,066 |
| | Hemlock mortality | 97 | 82 | 15 | 0 | 0 |
| | Western balsam bark beetle | 39 | 6 | 0 | 0 | 33 |
| Abiotic and Animal Mortality | Yellow-cedar decline | 47,406 | 43,052 | 1,650 | 0 | 2,703 |
| | Flooding/high-water damage | 2,830 | 450 | 133 | 517 | 1,730 |
| | Porcupine damage | 1,525 | 986 | 233 | 0 | 306 |
| | Birch crown thinning | 1,245 | 0 | 0 | 0 | 1,245 |
| | Hemlock branch flagging | 1,066 | 764 | 93 | 0 | 208 |
| | Windthrow/blowdown | 368 | 368 | 0 | 0 | 0 |
| | Landslide/avalanche | 114 | 101 | 8 | 0 | 5 |
| | Aspen discoloration | 19 | 0 | 0 | 0 | 19 |

[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.

**Table 2.** Mapped affected area (in thousands of acres) from 2013-2017 from aerial survey. Note that the same stand can have an active infestation for several years. For a detailed list of species and damage types that compose the following categories, see Appendix II on page 61.

| | | | | | |
|---|---|---|---|---|---|
| Abiotic damage | 6.2 | 13.6 | 11 | 3 | 5.6 |
| Alder defoliation | 83.9 | 51.5 | 26 | 2.9 | 3.4 |
| Alder dieback | 15.7 | 125.4 | 12 | 8.4 | 1.0 |
| Aspen defoliation | 53.4 | 138.6 | 118 | 229.3 | 168.5 |
| Birch defoliation | 278.2 | 586.7 | 42 | 85.5 | 7.2 |
| Cottonwood defoliation | 9.4 | 53.4 | 9.2 | 2.3 | 1.0 |
| Fir mortality | 0 | 0.2 | 0 | 0.027 | 0.0 |
| Hardwood defoliation | 2.8 | 42.1 | 190 | 161.9 | 38.7 |
| Hemlock defoliation | 13.3 | 46 | 0.1 | 0 | 0.0 |
| Hemlock mortality/dieback | 0 | 0 | 0.5 | 0 | 2.7 |
| Porcupine damage | 0.5 | 1.8 | 1 | 3.5 | 1.5 |
| Shore pine damage | 4.8 | 4.5 | 3.4 | 4.9 | 0.3 |
| Spruce damage | 7.5 | 60.1 | 8.8 | 36 | 36.1 |
| Spruce mortality | 35.1 | 22.1 | 42.3 | 204.5 | 411.4 |
| Spruce/hemlock defoliation | 121.2 | 4.1 | 3.1 | 3.1 | 1.1 |
| Willow defoliation | 16.2 | 146.1 | 67 | 156.3 | 113.2 |
| Willow dieback | 0 | 3.4 | 1.2 | 2.8 | 1.0 |
| Yellow-cedar decline | 13.4 | 19.9 | 39 | 39 | 47.4 |
| **Total damage acres** | **661.6** | **1320** | **574.6** | **949.8** | **840.3** |
| **Total acres surveyed** | 31,497 | 32,172 | 32,938 | 26,876 | 27,540 |
| **Percent of acres surveyed showing damage** | 2.10% | 4.10% | 1.70% | 3.50% | 3.05% |


Spruce beetles pulled from white spruce.

# Elevated Alaskan Interior Spruce Beetle Captures in 2017

*Stephen Burr PhD, USDA Forest Service*

Spruce beetle (*Dendroctonus rufipennis*) activity has risen substantially in Southcentral Alaska in the last two years, with damage concentrated in the Susitna River valley and the northwestern Kenai Peninsula. Recorded acreage of spruce (*Picea* spp.) lost to spruce beetle increased by over 500% from 2015 to 2016 and by 200% from 2016 to 2017. While spruce beetle-caused mortality has been prevalent in Southcentral Alaska, little spruce beetle damage has been recorded from Interior Alaska. Recently, questions have arisen regarding the likelihood of increased spruce beetle activity in the Alaskan Interior, so in conjunction with long-term bark beetle trapping efforts, additional spruce beetle trapping was instituted in 2017 to assess spruce beetle populations north of the Alaskan Range.

Historically, spruce beetle has had less of an impact in the northern portions of Alaska (Interior and the Seward Peninsula) compared to Southcentral Alaska, though spruce beetle outbreaks have occurred. Spruce beetle has caused tree mortality in roughly 660,000 acres of spruce forests in the Interior/Seward Peninsula in the last four decades (Table 3), compared to nearly 600,000 acres in Southcentral Alaska affected in just the past two years. The majority of recorded spruce beetle damage in the Interior (67%) occurred on the Yukon River south of Galena from 1986-93 (231,047 acres) and along the Kuskokwim, primarily between McGrath and Sleetmute from 1976-2010 (217,047 acres) (Table 3, page 12). It is essential to monitor as many of these locations as possible in the coming years while the spruce beetle outbreak in Southcentral Alaska persists.

While only small amounts of spruce beetle-caused tree mortality have been recorded in Interior Alaska during aerial or ground surveys over the last five years (2012-17), trap captures of the beetle in the region rose substantially in 2017.

**Bonanza Creek Long-Term Experimental Research: 1975-present**

Since 1975, in conjunction with the Bonanza Creek Long-Term Experimental Research program and University of Alaska Fairbanks (UAF), the USDA Forest Service has conducted annual bark beetle and woodborer trapping in Bonanza Creek Experimental Forest (located 27 miles SW of Fairbanks, AK). Insect trapping consists of five dry Lindgren funnel traps (Figure 5) (Forestry Distributing, Inc. Boulder, CO) placed in each of five locations. VaporTape II insecticidal strips (active ingredient 2, 2 Dichlorovinyl dimethyl phosphate) are used in all traps as a killing agent (Aberdeen Road Company d/b/s Hercon Environmental, Emigsville, PA) and are replaced monthly. Three of the traps in each location are baited with a pheromone lure targeting *Dendroctonus*, *Monochamus*, or *Ips* beetles, respectively, and the remaining two traps are baited with host volatiles (specifically stress chemicals) designed as general bark beetle and woodborer attractants (Ethanol and Ethanol + $\alpha$-pinene) (Alpha Scents, Inc. West Linn, OR). Lures were replaced monthly. Prior trap captures of spruce beetle averaged 95.3 ± 10.1 spruce beetles/year from 1975 to 2016. With the low counts of spruce beetle occurring in both 2005 and 2006 (5 spruce beetles/year) and a high of 257 spruce beetles collected in 2011 (Figure 6). In 2017, a total of 1585 spruce beetles were trapped in Bonanza Creek (a 6-fold increase compared to the previous high).


**Figure 5.** Lindgren funnel traps.

**Table 3.** Recorded spruce beetle impacted stands (acres and locations) in the Alaskan Interior/ Seward Peninsula from 1976 to present based on Forest Health Conditions Reports for Alaska (USDA Forest Service).

| Year(s) | Acres | Location |
|---|---|---|
| 1976-79 | 2,600 | Kuskokwim River, 15 miles south of Devil's Elbow |
| 1979 | 4,000 | 4 miles northeast of Little Russian Mission |
| 1980 | 2,414 | Kuskokwim River (unspecified location) |
| 1986-93 | 231,047 | Along the Yukon River south of Galena |
| 1988 | 14,000 | North of Wood-Tikchik State Park |
| 1988-93 | 45,706 | Kuskokwim River between Sleetmute and McGrath |
| 1989 | 5,000 | Along the Nulato River |
| 1989 | 13,700 | Mouth of the Koyukuk |
| 1989 | 2,257 | Windy Fork, Kuskokwim River |
| 1989 | 3,738 | South Fork, Kuskokwim River |
| 1991 | 31,373 | Yukon River, Fox Point Island north to Quail Island |
| 1991-92 | 15,724 | Nulato River, approximately 18 miles west of Nulato |
| 1992 | 7,020 | 15 Miles east of Aniak |
| 1994 | 52,111 | North Fork, Kuskokwim River |
| 1995-96 | 7,179 | Yukon River, south of Koyukuk to Kaltag |
| 1995 | 4,085 | East of Delta Junction |
| 1995-96 | 3,829 | McGrath to Devil's Elbow |
| 1995 | 1,500 | Along Big River |
| 1995 | 4,000 | South Fork, Kuskokwim River |
| 1996 | 3,522 | Kuskokwim River, McGrath south to Stony River |
| 1998 | 14,479 | Yukon River, Bullfrog Island to Nulato |
| 1999-03 | 14,293 | Near Sleetmute |
| 2000-02 | 7,115 | Kuskokwim River, down stream from McGrath |
| 2002 | 52 | Kobuk River west of Bettles |
| 2004-05 | 26,595 | Kuskokwim, McGrath to Red Devil |
| 2004 | 175 | Confluence of Kuskokwim to Stony Rivers |
| 2004 | 8,681 | Fish River, north of White Mts (Seward Peninsula) |
| 2004 | 81,389 | Mt. Kwiniuk to Moses Pass (Seward Peninsula) |
| 2005 | 4,000 | Confluence of Kuskokwim to Big Rivers |
| 2006-09 | 42,375 | Kuskokwim, McGrath to Sleetmute |
| 2008 | 2,000 | Scattered throughout Central Interior |
| 2010 | 1,000 | Kuskokwim River |
| 2011 | 2,290 | Near Elim along the Kwiniuk River (Seward Peninsula) |

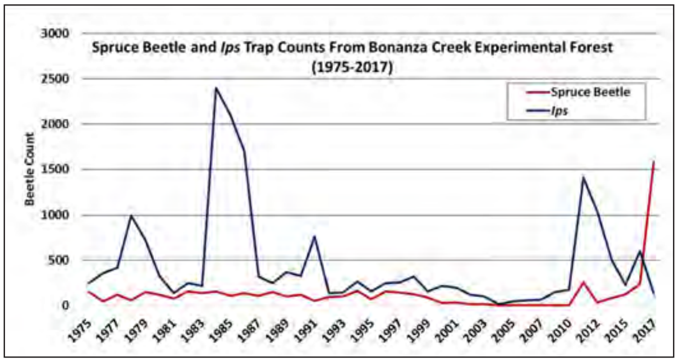



**Figure 6.** Spruce beetle and Ips captures at Bonanza Creek Experimental Forest 1975-2017.

On 6 June, 2017, a single trap, baited with a *Monochamus* lure captured 583 spruce beetles in a single two week period (Figure 7), which is twice the highest annual capture for this study to date. It is important to note, there was a freshly downed spruce tree next to the site with the high beetle trap captures. The downed tree may have attracted additional beetles to the location inflating spruce beetle numbers in traps. If we remove all trap captures from this location, the spruce beetle count for the year is 769 beetles, still nearly three times greater than the highest spruce beetle capture on record for this study. Additionally, if the tree did act as an attractant, we would have expected an increase in other bark beetles and woodborers, most notably *Ips perturbatus*, a major spruce killer in the Interior. *Ips* captures for this study were low: on average, 464.3 ± 87.2/year *I. perturbatus* were captured from 1975 to 2016. In 2017, 131 *I. perturbatus* were collected in traps, and damage was down across the state as well, falling from 14,400 impacted acres in 2016 to 6,012 acres in 2017.

**Other spruce beetle monitoring**

Additional spruce beetle trapping occurred along the George Parks Highway between Healy and Fairbanks, AK. A single funnel trap baited with a *Dendroctonus* lure was placed in spruce stands roughly every 10 miles. Traps were checked every two weeks from May through August. Total spruce beetle trap captures for this study (42 beetles) indicate beetle populations are not elevated at these locations.

The Early Detection Rapid Response (EDRR) monitoring program was conducted at three locations in the Fairbanks area: Fairbanks International Airport, Fort Wainwright Army Base, and Eielson Air Force Base. Trapping consisted of three traps at each location baited with an *Ips typographus* (European spruce beetle) pheromone (Alpha Scents, Inc. West Linn, OR), and two traps baited with the tree host volatiles described above. Lures specific to *Dendroctonus* are not a part of the EDRR study, but traps baited with tree volatiles targeting bark beetles and woodborers do attract spruce beetle when employed in Alaska. Traps for EDRR were checked every two weeks from May through September. Spruce beetle captures (49 beetles) did not indicate elevated populations at these locations.

Trapping conducted in 2017 at additional locations did not result in increased spruce beetle counts. Elevated trap captures of spruce beetle in the Interior appear isolated; however, further monitoring of Interior spruce forests is warranted. Spruce beetle is having a sizable impact in Southcentral Alaska and concerns for an outbreak in Interior spruce stands are justified. Forest Health Protection will continue to monitor spruce beetle populations with the bark beetle and woodborer study at Bonanza Creek, the *Dendroctonus* and EDRR studies, and ground and aerial surveys.

**Acknowledgements**

I would like to thank Richard “Skeeter” Werner, who initiated the Bonanza Creek LTER trapping project in 1975. Long-term data is invaluable in assessing insect population dynamics, and we would not have these records without his efforts. Skeeter passed away in 2017 (see Introduction), but his contributions to Alaska and the entomological community live on.

**Figure 7.** Spruce beetles captured in a single trap over a two week period (583 beetles).

**Figure 8.** ACUASI Ptarmigan Hexacopter with Sony NEX-7 on gimbal mount.

# Investigating Unmanned Aerial Systems for Forest Health Evaluations

*Tom Heutte and Lori Winton, USDA Forest Service; Michael Hatfield, University of Alaska, Fairbanks, Center for Unmanned Aerial Systems Integration*

Small Unmanned Aerial Systems (sUAS), commonly called drones, are an emerging technology that is experiencing rapid growth due to recent innovations in battery and computer control technologies. Drones can carry a camera or similar sensor and collect imagery of an area from a much lower height than fixed-wing aircraft or helicopters and have the potential to lower costs for imagery acquisition.

Several years ago, staff on the Alaska Region Forest Health Protection and Remote Sensing program areas proposed using sUAS to investigate canopy conditions and assess forest health at the forest stand spatial level. This led to a partnership between Alaska Region Forest Health and the University of Alaska Fairbanks, Alaska Center for Unmanned Aerial Systems Integration (ACUASI). In addition to providing aircraft, sensors and controls, ACUSASI was able to provide skilled pilots, operational clearance from the FAA, and flight planning expertise essential to safe and legal project implementation.

Use of sUAS is regulated by the Federal Aviation Administration. Over recent years, sUAS operations were limited as the FAA and US Forest Service worked to develop policy and regulations for this use of our airspace. Any government use of sUAS is considered a commercial use. Therefore, more stringent rules apply to pilot and aircraft certification as well as operational limitations, compared to hobbyist operations.

One significant limitation on sUAS operations is the need to practice "see and avoid" operations in order to prevent collisions with other aircraft operating in the area. This requires that the ground-based operator of the unmanned vehicle, or someone in direct contact with the operator, can keep the vehicle in sight and have the situational awareness to avoid collisions. Small UAS vehicles also can have more rigorous operational limitations (due to precipitation, visibility, dust and wind) than manned vehicles.

Very little work has been done using sUAS for evaluation of forest health, so the project has focused on learning what the technology can do, such as evaluating the trade-offs between small and inexpensive vs. larger and more expensive vehicles. The team began with a large number of parameters that needed to be investigated, each one offering tradeoffs. Larger vehicles can carry a larger payload for a longer period of time; but cost more to acquire and operate. Smaller vehicles offer greater portability and require less skill to operate; but offer shorter flight times and carry smaller payloads. Larger payloads give the option to fly more sophisticated sensors, such as digital SLR cameras capable of collecting much higher resolution imagery. Small consumer grade vehicles often carry only a small video camera with limited resolution and limited focal length. Other unknowns included optimal flight elevation, overlap between images, camera resolution, camera autofocus, focal length, shutter and aperture settings.

In 2016 we compared two sensor packages: 1) a small Sony Nex-7 point-and-shoot type camera, and 2) paired GoPro cameras set to collect frame imagery, one of which was modified to capture imagery in the infrared spectrum. We compared use of nadir imagery where the camera points straight down at the ground to oblique imagery where the camera shoots images at an angle to the ground. We compared infinity focus to auto focus. We flew over sites dominated by black spruce, dominated by white spruce and mixed white spruce-aspen-birch. Over 9000 images were collected during 29 flights lasting 5-12 minutes each. The stated objective of this project was to evaluate the ability of the system to detect spruce broom rust (Figure 8), which causes basketball-sized witches brooms in spruce trees that range from bright orange to dull brown. While brooms were detected in a couple of images, the frequency of this disease in the areas flown was too low to provide a good evaluation (Figure 9).

**Figure 9.** Oblique image showing spruce broom rust symptoms.

In early 2017, mission plans were developed with an objective of quantifying aspen trees killed by aspen running canker disease and comparing the results to data previously collected on the ground. A number of Cooperative Alaska Forest Inventory (CAFI) and Long Term Ecological Research (LTER) plots are distributed around the road system of the Tanana Valley of Interior Alaska within a day's drive of Fairbanks. These plots offer the advantage of already having data on tree species composition, size, and presence of damage agents including aspen canker (Figure 10). We compiled a list of 25 candidate sites with known aspen canker disease.

**Figure 10.** Image showing paper plate placed at CAFI plot corner indicates approximate 5 cm resolution from elevation of 300 feet.

The project team met and scouted sites evaluating each site for vegetative cover, line of sight, parking, and presence of a suitable launch site. Weather forecasts were consulted, Notams (Notice to Airmen) issued through the Federal Aviation Administration, and military airspace was deconflicted through calls to appropriate authorities. Most of the sites were well suited to the operations because these relatively flat dryland aspen stands have a thin canopy which facilitates keeping the aerial vehicle in sight. Denser forest will present challenges for maintaining line of sight (Figure 11).

**Figure 11.** Unprocessed nadir raw image of aspen stand showing canker-killed trees (circled) in CAFI plot. Trees with bright green crowns are birch, trees with silvery-green crowns are aspen.

Two sUAS were selected for the project based upon their flight characteristics, sensor packages, and intended application. These included: 1) ING Responder, an electric single-rotor based on the Gaui X7 frame with an open architecture 3DR Pixhawk autopilot, outfitted with a Nikon D810 camera and 35mm lens; 2) DJI Inspire UAS with the Zenmuse X3 camera. The Responder UAS was used to capture high-resolution still photographs (suitable for photogrammetry or image classification). During this campaign the Inspire was used to capture real-time video.

ACUASI and their contractor Northern Embedded Solutions provided military and commercial rated pilots. In particular the ING Responder used in 2017 requires operational skill and knowledge at the level of a manned helicopter due to the main and tail rotor configuration (Figure 12) which requires greater skill than a multirotor craft.

The project team scouted a total of nine sites. One was rejected for safety reasons due to heavy vehicle traffic. The team flew seventeen missions at eight sites, collecting over 1100 images. The larger Responder vehicle package includes laptop computers, controllers, a generator to recharge batteries, and unmanned helicopter. The entire package requires a pickup truck or ATV trailer to mobilize to site. Trained personnel were required at times to place themselves in the plots to maintain line of sight with the aerial vehicle, which was relayed to pilot by handheld radio.

Future project work will include making georeferenced image mosaics for each plot, and recording the location and number of canker-killed aspen trees. This can be compared with results from ground-based plot observations to statistically calculate the degree of agreement between sUAS and ground detection methods. This measure of reliability is necessary to evaluate the usefulness of sUAS for the purposes of forest health detection and monitoring.

Other potential applications of this technology for forest health may include verification and quality control of data obtained by aerial observation from manned fixed-wing aircraft. This new technology has the potential to greatly reduce the cost of obtaining certain types of data currently only obtained through slow and expensive ground-based methods.

**Figure 12.** ING Responder in Flight. Forest Service photo by Hannah Heutte.

# STATUS OF DISEASES


Forest Pathologist Lori Winton shaving bark away from the margin of a running aspen canker high up the bole of trembling aspen at Standard Creek near Fairbanks, Alaska. The exposed green wood is live and the brown has been killed by this fast-growing unknown fungus.


# 2017 PATHOLOGY SPECIES UPDATES

Shore pine crowns severely damaged by Dothistroma needle blight.

Most forest pathogens cannot be seen from the air, thus we rely heavily upon ground observations and surveys. These ground detections are recorded annually by Forest Health Protection (FHP) specialists and in partnership with permanent plot networks administered by the Cooperative Alaska Forest Inventory, the Bonanza Creek Long Term Ecological Research program, and the Department of Defense Forest Management program. In 2015, FHP began developing distribution maps of forest pathogens in Southcentral and Interior Alaska from georeferenced and verified ground and aerial detections (Map 3, pages 25-26). We will continue to build on this foundation. These maps will be refined each year, incorporating new ground observations, data from the Aerial Detection Survey, journal articles, and the US Forest Service Forest Inventory and Analysis program.

## Foliar Diseases

**Dothistroma Needle Blight**
*Dothistroma septosporum* (Dorog.) M. Morelet

The Dothistroma needle blight outbreak near Gustavus and Glacier Bay National Park (GBNP) that began around 2010, affecting at least 11,000 cumulative acres, has caused significant damage and mortality to shore pine (*Pinus contorta* subsp. *contorta*). The bulk of shore pine mortality occurred between 2013 and 2015. Nine permanent plots established near Gustavus in 2016 found 57% of shore pine trees and 34% of the pine basal area to be dead. Smaller pines were more likely to die, but surviving dominant and co-dominant trees often only retained live foliage in the upper 1-5 feet of the tree crown. In 2017, few Dothistroma fruiting structures were observed on shore pine and mortality rates had slowed, indicating that the outbreak may have run its course. Evaluation of weather data from Gustavus identified a prolonged wet period with temperatures greater than 62°F in late-July 2009 that likely precipitated the outbreak (Map 3a).

In 2017, aerial surveys mapped only 325 acres of Dothistroma damage along the northern Lynn Canal and east of Dry Bay in GBNP. This is a fraction of the damage mapped near Gustavus and the northern Lynn Canal in recent years; however, weather conditions prohibited aerial survey of the main outbreak area near Gustavus this year. In 2016, a large area of damage (3,500 acres) was mapped near Bartlett Lake in GBNP. About 2,200 acres of severe Dothistroma needle blight crown damage was aerially detected in northern Lynn Canal in 2015 and 2016, primarily along the Chilkat River between Haines and Klukwan, and from Skagway north along the Taiya River. The outbreaks near Haines and Skagway decreased in severity without causing significant pine mortality (8 permanent plots established in Haines in 2015/16 were revisited in 2017). Shore pine regeneration was observed in some affected stands, likely associated with stress cone crop production (Figure 13). A few other places in Southeast Alaska are known hotspots for Dothistroma needle blight, particularly localized muskegs near Juneau (Pt. Bridget State Park and Douglas Island) and Sitka (Gavin Hill Trail). The disease occurs throughout the range of shore pine in Alaska, usually without causing tree mortality.

**Figure 13.** Shore pine regeneration north of Haines where a recent outbreak of Dothistroma needle blight triggered stress cones to be produced by some affected trees.

**Spruce Needle Casts/Blights**
*Lirula macrospora* (Hartig) Darker
*Lophodermium piceae* (Fuckel) Höhn
*Rhizosphaera pini* (Coda) Maubl.

Although the fungus is widespread, Rhizosphaera needle cast disease caused little damage to the three spruce species in Alaska, since mainly the oldest needles were affected. A Rhizosphaera outbreak that occurred in 2009 in Southeast Alaska remains the largest on record. Also in Southeast, Lirula needle blight began to increase in some locations (e.g., Juneau and Kake) in 2014.

**Figure 14.** Spruce needle rust found along the Parks Highway between Nenana and Healey.

In 2016 and 2017, Lirula needle blight surpassed Rhizosphaera needle cast as the most damaging and widespread needle disease of spruce throughout the state at this time. Lophodermium needle cast is another common but minor foliage disease of spruce in Alaska (Map 3b).

**Spruce Needle Rust**
*Chrysomyxa ledicola* Lagerh.
*Chrysomyxa weirii* Jacks.

Spruce needle rust has historically been observed at many locations throughout Alaska's spruce forests and is one of the few diseases discernable by aerial detection when damage is severe. 2017 was the first year since 2012 with moderately high disease incidence in Southeast Alaska, probably due to the cool, wet summer weather. In 2017, nearly 80 acres of severe damage were mapped during aerial detection survey along the Skagway River. All other spruce needle rust damage was recorded through ground observations (Map 3c), usually rated as low or moderate severity. Observations throughout the Interior occurred along the Parks (Figure 14), Elliott, Dalton, Steese and Taylor Highways, as well as Chena Hot Springs Road and the Denali Park Road. In Southcentral, damage was recorded in Kasilof on the Kenai Peninsula and near Kennecott in Wrangell St. Elias National Park.

Although acres affected and severity of damage have been low in recent years, large outbreaks were reported in Southcentral Alaska in 2012, Western Alaska in 2011, Southeast Alaska in 2007, and Interior Alaska in 2008. This disease rarely results in tree mortality since only current-year needles are affected and infection severity varies by location between years.

*Chrysomyxa weirii* is another, less common and less damaging, spruce needle rust in Alaska that is occasionally observed on 1-year-old needles in spring. It has been documented in coastal forests from the Kenai Peninsula to Prince of Wales Island (Map 3d).

## Shoot, Twig, and Bud Diseases

**Sirococcus Shoot Blight**
*Sirococcus tsugae* Rossman, Castlebury, D.F. Farr & Stanosz

From 2014–2017, there has been pronounced damage to new growth of western and mountain hemlock from Sirococcus shoot blight near Yakutat, Juneau, Sitka, Kake, and other locations in Southeast Alaska (Map 3e). Mountain hemlock is considered more susceptible, but shoot symptoms have been widespread on both hemlock species. Hemlocks with evidence of repeated years of shoot dieback and compromised tree form are most often found along creeks and in mountain bowls. Chronic shoot disease observed in landscape plantings suggests that non-native hemlock varieties may be more susceptible to this disease.

**Spruce Bud Blights**
*Camarosporium* sp.
*Dichomera gemmicola* A. Funk & B. Sutton
*Gemmamyces piceae* (Borth.) Casagrande

Blighted spruce buds (entirely or partially dead from a fungal infection) were first noted in Alaska on ornamental Colorado blue spruce near Homer in 2013. In 2014 it was found for the first time on native white spruce in the forest near Anchorage. The causal fungus only infects through the bud; partially killed buds become twisted, looped, or zig-zagged branches. The symptomatic branch can then be used to date the original infection. In some locations it is evident that bud blight disease has been present, but undetected, for many years. FHP conclusively identified the pathogen from Anchorage as *Gemmamyces piceae* (Figure 15a), due to the 2016 publication of a journal article. The article described a massive outbreak of *G. piceae* causing significant mortality in Czech Republic Colorado blue spruce plantations. Only two prior North American records have been located, both from 1990 in New Brunswick and Nova Scotia on the east coast of Canada.

*Three bud blight fungi found in Alaska*: Symptoms of spruce bud blight have now been documented at over 200 locations in Alaska (Map 3f) on white, Sitka, and Lutz spruce (natural hybrid of Sitka and white spruce) in the forest, and Colorado blue spruce in ornamental settings; no mortality has been seen. Initially, all bud blight observations were recorded as *G. piceae*. However, laboratory analysis of numerous samples collected in 2017 by Dr. Gerry Adams (University of Nebraska-Lincoln) revealed that there are actually three different fungi causing bud blight in Alaska: *G. piceae*, *Dichomera gemmicola*, and a species of *Camarosporium*. These fungi cause nearly identical signs and symptoms that prevent field identification, but differences can be seen with a microscope. Microscopic examination of collected samples allowed us to verify and correct records for Southeast Alaska. In Interior and Southcentral Alaska, some samples were verified as *G. piceae*, whereas others lacked the developmental stage needed for identification. Therefore, some observations initially recorded as *G. piceae* may need to be reclassified after further collection and examination of samples from those sites.

Dr. Adams identified *D. gemmicola* (Figure 15b) on numerous samples from the coastal and coastal-boreal transition forests: Sitka spruce from Southeast Alaska (all 24 sampled sites) and white, Lutz, and Sitka spruce from the Southcentral coast to the Alaska Peninsula (6 sites). *D. gemmicola* was found on two samples of white spruce in the interior boreal forest (near Trapper Creek and Chicken). The *Camarosporium* species was found at

15 locations from the Kenai Peninsula to Fairbanks on white, Lutz, and Sitka spruce. It was also found on one ornamental blue spruce near Juneau and one Sitka spruce in the forest near Sitka. Detection of *D. gemmicola* and *Camarosporium* generally occurred outside of monitoring plots in Southeast Alaska. Most of the Interior Alaska samples examined by Dr. Adams were identified as *G. piceae*.

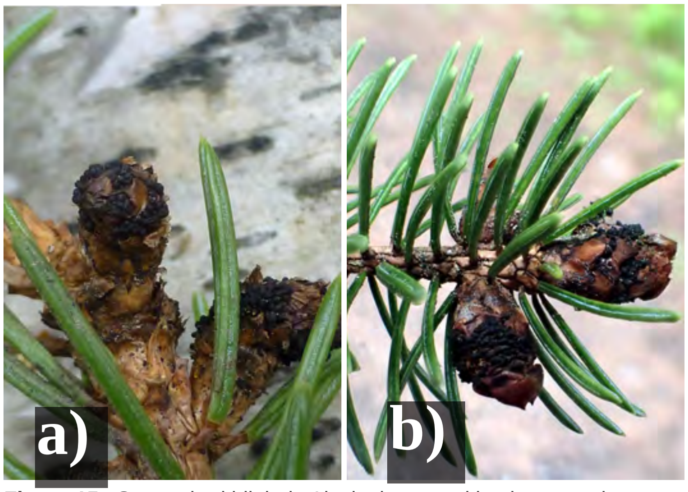



**Figure 15.** Spruce bud blight in Alaska is caused by three nearly indistinguishable fungal species, including: a) *Gemmamyces piceae* on white spruce near Anchorage, b) *Dichomera gemmicola* on Sitka spruce near Juneau.

Dichomera bud blight was first described in the early 1960s from British Columbia, where it has been more frequently reported on inland Douglas-fir, Engelmann spruce and white spruce than on coastal Sitka spruce. This disease usually is not a significant concern. *Camarosporium strobilinum* has been reported to cause needle and bud blight of true fir, Sitka spruce, and white spruce in Canada. It has also been found on Norway spruce and white spruce in Europe.

*Bud blight detection in study plots*: In 2017, 182 plots were installed to evaluate presence/absence of bud blight statewide. Three different sampling designs (fixed-radius, timed meander, and transect) were employed depending upon location, access, and available resources. We recorded *G. piceae* in 65 plots from the Kenai Peninsula, east to near Chicken, and just to the north of Fairbanks. We did not find bud blight on 117 of the plots and bud blight was absent from all but one plot in Southeast (*D. gemmicola* was found in one plot near Haines; *G. piceae* has not been found in this region). This corresponds to positive detections in 36% of the plots statewide and 44% in the Southcentral/Interior region. We recorded another 45 locations of bud blight within this region as general, exploratory observations. FHP installed monitoring plots near Anchorage and Fairbanks in 2016 and found that damaged buds affected up to 40% of the trees within 50ft-radius plots. Most trees that have the disease have very few damaged buds (less than 5%), but highly infected trees can have up to 100% of the buds dead or damaged.

*Assessing native vs. non-native status of Gemmamyces piceae*: That *G. piceae* is widely distributed in Alaska, has apparently been present for many years, and causes only minor tree damage here, are arguments for endemism (native and at a low and steady level of natural occurrence). However, the lack of prior observations might indicate that it is not native and was relatively recently introduced. Dr. Adams and his colleagues have initiated a population genetic study to address this question.

**Yellow-cedar Shoot Blight**
*Kabatina thujae* Schneider & Arx

There was no significant change in disease incidence in 2017. Terminal and lateral shoots on seedlings and saplings die from this disease in early spring, and symptoms can be confused with frost damage. The long-term tree structure of taller saplings is not thought to be compromised by leader infections. Jeff Stone at Oregon State University identified the causal fungus as *Kabatina thujae* in 2013.

## Stem Diseases

**Alder Canker**
*Valsa melanodiscus* Otth.
*Valsalnicola* spp. D. M. Walker & Rossman
And other fungi

Alder dieback, most commonly caused by canker forming fungi, was mapped during aerial detection survey on 972 acres in 2017, down from 8,000 acres in 2016. There has been a steady decline in mapped acreage since 2014, when 125,000 acres were mapped. In 2017, most alder dieback (600 acres) was mapped along the Copper River south of Chitina. The remaining roughly 300 mapped acres were located along Turnagain Arm, and spread throughout the Interior, western Alaska and the Kenai Peninsula.

Alder dieback remains a significant concern despite the low acreages observed in 2016 and 2017. Symptoms of alder defoliation (caused by insects) and dieback (caused by canker fungi) appear similar from the air. Aerial detection of insect defoliation was also dramatically less than in recent years (see page 24 for the alder defoliation update). Substantial alder dieback in Southcentral Alaska began in 2003. *Valsa melanodiscus* was identified as the main causal fungus, and several additional canker pathogens have been found on alder in Interior and Southcentral Alaska. Alder canker has also been confirmed on Sitka alder in Southeast Alaska (near Haines and along the Stikine and Taku Rivers), but damage has not been severe and none was mapped in 2016 or 2017.

A recurrent road survey found alder canker at nearly twice as many sites (80%) in 2016 compared to the inaugural survey in 2006 (41%). The most dramatic increase was noted for Sitka alder and Siberian alder (75% in 2016 compared to 28% in 2006). The incidence of canker also increased on thinleaf alder (84% in 2016), although it was already high at the time of the original survey (71% in 2006).

**Aspen Cankers**
Unknown aspen running canker fungus
Unknown aspen target canker fungus

Although trembling aspen is susceptible to several canker diseases, only two are prevalent in Alaska. We have documented significant mortality caused by both of these cankers throughout the boreal forest. The appearance and aggressiveness of the cankers vary depending on the causal fungi, although neither have yet been identified because fruiting bodies have been lacking. We are working with Dr. Gerry Adams (University of Nebraska Lincoln) and Dr. Jane Stewart (Colorado State University) to identify the fungi.

A very aggressive diffuse, running canker has been mapped in over 140 locations in the boreal forests of Interior and Southcentral Alaska (Map 3g). This canker is often subtle in appearance (although sometimes colorfully orange) and can girdle and kill trees within a single season with no apparent host defenses (Figure 16). It is called running canker because it rapidly kills cambium as it expands along nearly the entire bole. Most infected trees die within the year as the tree is girdled. To gain a better understanding of its distribution and the factors influencing its spread, we initiated a joint venture agreement with Dr. Roger Ruess (University of Alaska Fairbanks) in 2016. In 2017 we evaluated 32 Cooperative Alaska Forest Inventory sites, 5 Long Term Ecological Research sites, and 26 ad-hoc sites. We found canker at 51 of the 63 sites (81%). The percentage of infected trees at the sites with canker ranged from 1.5% - 64%.
Much less easy to find are localized pockets of distinctive target-shaped cankers with flaring bark. We have mapped target canker at 14 locations from the Kenai Peninsula, to the Canadian border, and north to the foothills of the Brooks Range (Map 3h). This disease progresses slowly and individual canker length and breadth is limited by tree response. It takes many years until numerous cankers form on a tree and effectively disrupt vascular transport, eventually killing it. We have isolated the fungus *Cytospora notastroma* from these cankers. *C. notastroma* is a newly described pathogen that has been found to be a major contributor to Sudden Aspen Decline in the Rocky Mountains. However, it is still unclear whether this is the only pathogen involved in aspen target canker in Alaska. Further work is needed to explore the role of these pathogens in the health of trembling aspen in Alaska.

**Diplodia Gall**
*Diplodia tumefaciens* (Shear) Zalasky

Diplodia gall is widely distributed throughout North America on trembling aspen, balsam poplar, and other *Populus* species. It has been mapped at 8 sites over the past few years, from Anchorage to the Canadian border, and north of Fairbanks (Map 3i). The patches are generally small and discrete, less than 2 acres in size. Anecdotal reports with matching descriptions have been received previously. When occurring on the trunk, it strongly resembles the cinder conk (*Inonotus obliquus*), but Diplodia gall has only been found on aspen in Alaska. The fungus can weaken trees and branches, but generally does not kill trees.

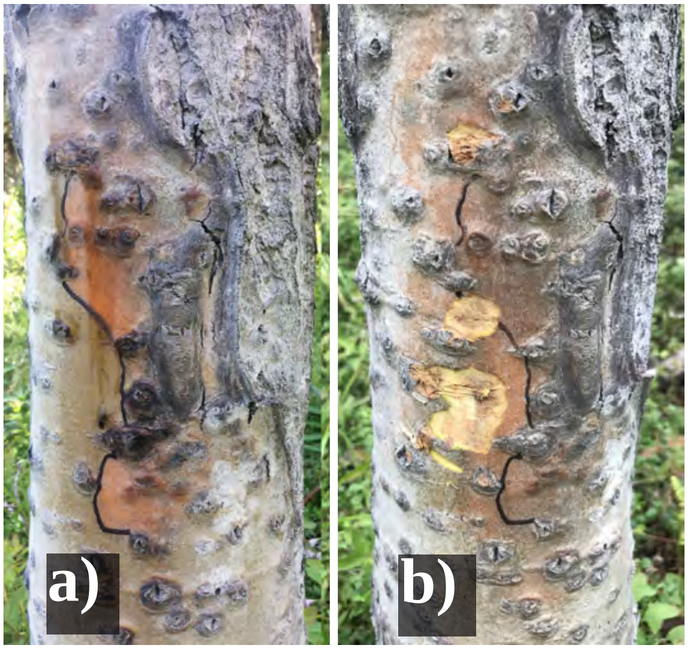



**Figure 16.** The unidentified fungus that causes aspen running canker grows within trees very quickly, eventually girdling and killing them. a) On July 12, 2017 a sharpie was used to document lesion margin on a living tree. To the left of the margin is live tissue and to the right is dead. b) On August 3, 2017 the tree was functionally dead; it no longer had foliage and the canker margin had expanded horizontally by 1.5 inches beyond the drawn line and vertically along nearly the entire bole.

**Hemlock Canker**
Unknown fungus

An outbreak of hemlock canker on Prince of Wales Island has been ongoing since 2012 and has been ground-mapped as occurring along more than 70 miles of the Prince of Wales road system. The most severe disease activity is between Thorne Bay and Coffman Cove, and Staney Creek and Whale Pass. Hemlock canker causes synchronized mortality of small and medium western hemlock trees and lower branches of large trees. This disease is most often seen along roads, rivers, and occasionally shorelines, but can also cause crop tree mortality in some young-growth stands as has recently been observed on Prince of Wales Island (Figure 17).

Hemlock canker is rarely mapped during aerial survey because it is only visible from the air when it occurs along coastlines. In 2017, 2,600 acres were mapped in Southeast Alaska, including 1,600 acres near Port Houghton and 800 acres along Thomas Bay on the coastal mainland north of Petersburg (Map 3j). Since 2015, hemlock canker symptoms have flared up in old-growth and managed forests on Zarembo Island, Woronkofski Island, the coastal mainland (Hobart Bay and LeConte Bay), Sitka (Harbor Mountain, Blue Lake and Silver Bay) and Falls Lake on Baranof Island, Poison Cove and Freshwater Bay on Chichagof Island, Juneau (Auke Lake, Fritz Cove and Lemon Creek), and Cordova. Historically, outbreaks have been documented a couple of times per decade on Prince of Wales, Kosciusko, Kuiu, and Chichagof Islands, usually along road systems. Current outbreaks have persisted longer and been noted farther north (Juneau and Cordova) than past reported outbreaks, and have also been observed far from roads.

Over the last several years, live tree and log inoculation trials have been conducted in collaboration with Dr. Gerald Adams at the University of Nebraska to determine the causal fungus. Potential causal pathogens include *Discocainea treleasei*, *Ophiostoma piceae*, *Pezicula livida*, and *Sirococcus tsugae*, but this work is ongoing. A potted hemlock seedling inoculation experiment with top candidate pathogens is slated for 2018.

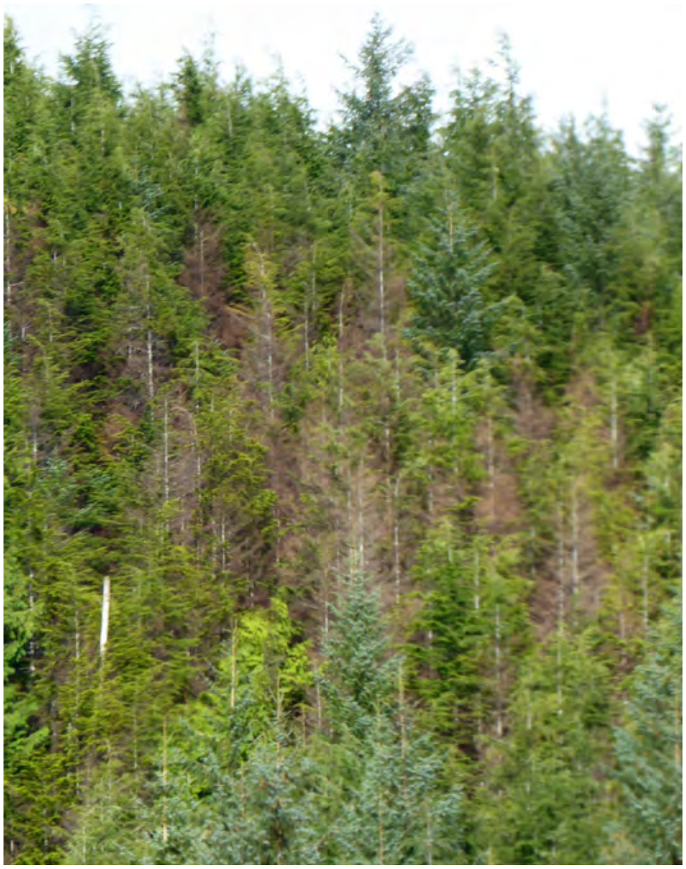


**Figure 17.** Hemlock canker-killed western hemlock crop trees in a young-growth stand harvested in 1973 on Prince of Wales Island near Naukati Bay.

**Hemlock Dwarf Mistletoe**
*Arceuthobium tsugense* (Rosendhal) G.N. Jones

Hemlock dwarf mistletoe, a parasitic plant, is the leading disease of western hemlock in unmanaged old-growth stands in Southeast Alaska, affecting at least 12% of the forested land area (Map 3k). Hemlock dwarf mistletoe brooms (prolific branching) provide important wildlife habitat, contribute to canopy gap creation, and serve as infection courts for decay fungi. Clear-cutting reduces dwarf mistletoe in second-growth timber stands; managers can choose to retain some mistletoe-infected trees for wildlife benefits without significant growth losses.

Hemlock dwarf mistletoe is apparently limited by climate (elevation and latitude), and is uncommon above 500 feet in elevation and 59°N latitude (Haines, AK). Dwarf mistletoe is absent from Cross Sound to Prince William Sound despite the continued distribution of western hemlock. Hemlock and hemlock dwarf mistletoe are expected to be favored by a warming climate, although spread rates will be limited by the biology of the host and pathogen.

**Spruce Broom Rust**
*Chrysomyxa arctostaphyli* Diet.

The incidence of the perennial brooms changes little over time, though aerial detection varies by surveyor, locations flown, and timing of symptom expression. In 2017, spruce broom rust was mapped on only 190 acres (Map 3l). The cumulative mapped acreage of spruce broom rust, in addition to ground and point observations, is more informative to our understanding of this pathogen's distribution.

Broom rust is common and widespread on white and black spruce branches and stems throughout Southcentral and Interior Alaska. Spruce broom rust is absent throughout most of Southeast Alaska but has been found on Sitka spruce in Glacier Bay, Haines and northern Lynn Canal, and near Halleck Harbor on Kuiu Island. The causal pathogen also completes lifecycle stages on kinnikinnik/bearberry shrubs (*Arctostaphylos uva-ursi*).

**Stem Decays of Conifers**
*Echinodontium tinctorium* (Ell. & Ev.) Ell. & Ev.
*Laetiporus sulphureus* (Bull. Ex Fr.) Bond. Et Sing.
*Porodaedalea pini* (Brot.) Murrill (=*Phellinus pini* (Brot.) Bondartsev & Singer)

A variety of fungi cause stem decay in Alaskan conifers. In mature forests of Southeast Alaska, conifer stem decays cause enormous wood volume loss. Approximately one-third of the old-growth timber volume in Southeast Alaska is defective, largely due to stem decay (Map 3m-o). There is very little decay in young-growth stands unless there is prevalent wounding. Stem decays are key disturbance agents in the coastal rainforest, because they predispose large old trees to bole breakage and windthrow; fire and other large-scale disturbances are uncommon in Southeast. Stem decays create canopy gaps, influence stand structure and succession, perform essential nutrient cycling functions, increase biodiversity, and enhance wildlife habitat. Trees with stem decay can be hazardous in managed recreation areas. In Southeast Alaska, brown rots are the most significant stem decays of Sitka spruce, while white rots are the most significant for western hemlock and western redcedar. Western redcedar is the most defective species, followed by western hemlock and Sitka spruce. In 2015, the paint fungus (*Echinodotium tinctorium*), thought to be absent from Southeast Alaska south of Skagway, was found to be abundant on western and mountain hemlock in one stand on Mitkof Island south of Petersburg.

**Stem Decays of Hardwoods**
*Fomes fomentarius* (L:Fr.) Kichx.
*Inonotus obliquus* (Pers.:Fr.) Pilat
*Piptoporus betulinus* (Bull.:Fr.) Karst.
*Phellinus igniarius* (L.:Fr.) Quel.
*Phellinus tremulae* (Bord.) Bond et Boriss

*Phellinus tremulae* is extremely widespread and common on both live and dead paper birch. Both *Fomes fomentarius* (Map 3p )and *Piptoporus betulinus* (Map 3r) are also widespread and common on paper birch, but are found on dead trees and dead parts of live trees. *Inonotus obliquus* (Map 3q), found in birch forests of the Northern Hemisphere, is widely distributed throughout

Southcentral and Interior Alaska. Considered a canker-rot, it is not often found on dead trees because it disintegrates soon after its host tree dies. Also known as Chaga, there has been a marked increase in birch trees damaged by collectors in recent years. *Phellinus tremulae* accounts for the majority of stem decay in trembling aspen (Figure 18, Map 3t).

**Western Gall Rust**
*Peridermium harknessii* J.P. Moore
(=*Endocronartium harknessii*)

The incidence of western gall rust, which causes spherical swellings on branches and tree boles, does not vary significantly from year to year. In 46 permanent plots established to evaluate the health of shore pine throughout Southeast Alaska (2012-13), 85% of live pines were infected, 34% had at least one gall on the main stem (bole galls) that could lead to top kill or whole tree mortality, and 25% had dead tops associated with bole galls. Western gall rust does not require an alternate host and is common throughout the range of shore pine in Southeast Alaska (Map 3u). In June 2017, western gall rust was observed sporulating at the edge of a large, diamond-shaped canker on a shore pine tree bole (Figure 19), suggesting western gall rust as the likely cause of this common form of damage. Disease severity is generally lower in relatively drier locations, such as Haines and Gustavus, although disease incidence is similarly high. Secondary insects and fungi frequently invade gall tissue, girdling infected boles and branches. Another stem rust, stalactiform blister rust caused by *Cronartium coleosporioides*, was detected on shore pine near Haines (molecularly confirmed) and Gustavus (suspected). The causal fungus completes part of its lifecycle on pines and another on plants in the family Scrophulariaceae/Orobanchaceae, especially paintbrush in the genus *Castilleja*.

**Figure 18.** *Phellinus tremulae decay and conks on a downed aspen tree.*

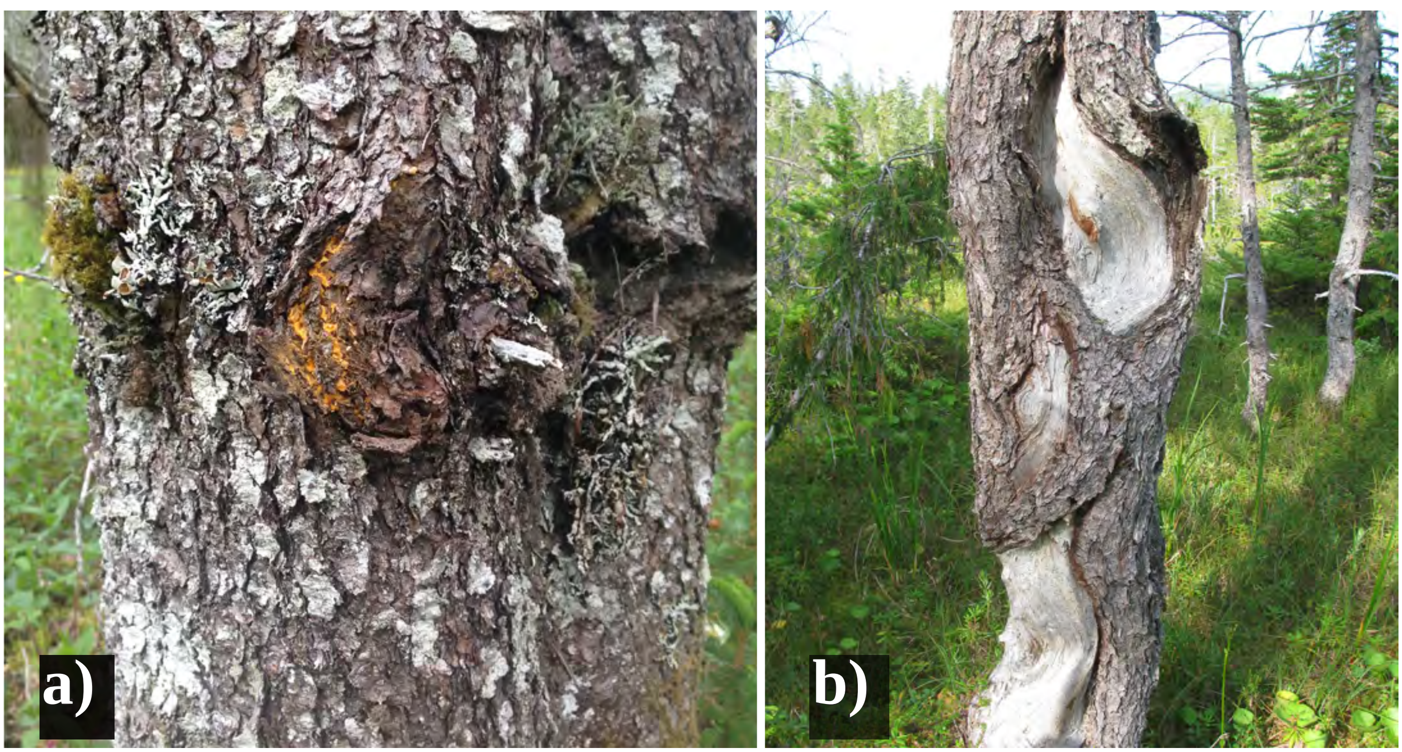



**Figure 19.** Cankers on shore pine probably caused by western gall rust (*Peridermium harknesii*). a) Orange sporulation on canker margin near Gustavus, b) Canker lacking bark and signs of animal chewing near Hoonah.

## Root and Butt Diseases

In Alaska, root diseases do not usually create the large canopy openings associated with those elsewhere in North America. The cedar type of *Phellinus weirii* causes butt rot of western redcedar and is thought to contribute to its high defect in Southeast Alaska. The spruce type of Heterobasidion root and butt rot (*Heterobasidion occidentale*) is present in Southeast Alaska, but does not spread through cut stumps and is not considered a serious management concern. We are continuing work to identify fungi that cause white butt rot of yellow-cedar and western redcedar, which is difficult because there are abundant fungi and other microorganisms in decayed wood in addition to the causal fungus. Also, compounds in cedar wood are known to interfere with molecular processing, especially polymerase chain reaction.

**Armillaria Root Disease**
*Armillaria* spp.

Armillaria root disease has been mapped on paper birch and white spruce in several locations in Interior and Southcentral Alaska (Map 3v). In Southeast Alaska, *Armillaria* species are common on all tree species, but are thought to merely hasten the death of stressed trees. John Hanna and Ned Klopfenstein from the Rocky Mountain Research Station have identified *Armillaria sinapina* from a dying yellow-cedar crop tree on Kupreanof Island and from dying western hemlock trees near Juneau. Collections from hardwood and conifer hosts from the Kenai Peninsula to the Arctic Circle in 2007 were also identified as *A. sinapina.*

**Pholiota Butt Rot**
*Pholiota* spp.

One or more species of *Pholiota* have been mapped in many locations in Alaska (Map 3w). *Pholiota* mushrooms have been observed fruiting primarily on the base of trembling aspen, but are also fairly frequent on paper birch (Figure 20). It has also been found once each on black spruce and a willow species. Usually host trees have no symptoms until they fall over or snap near the root collar.

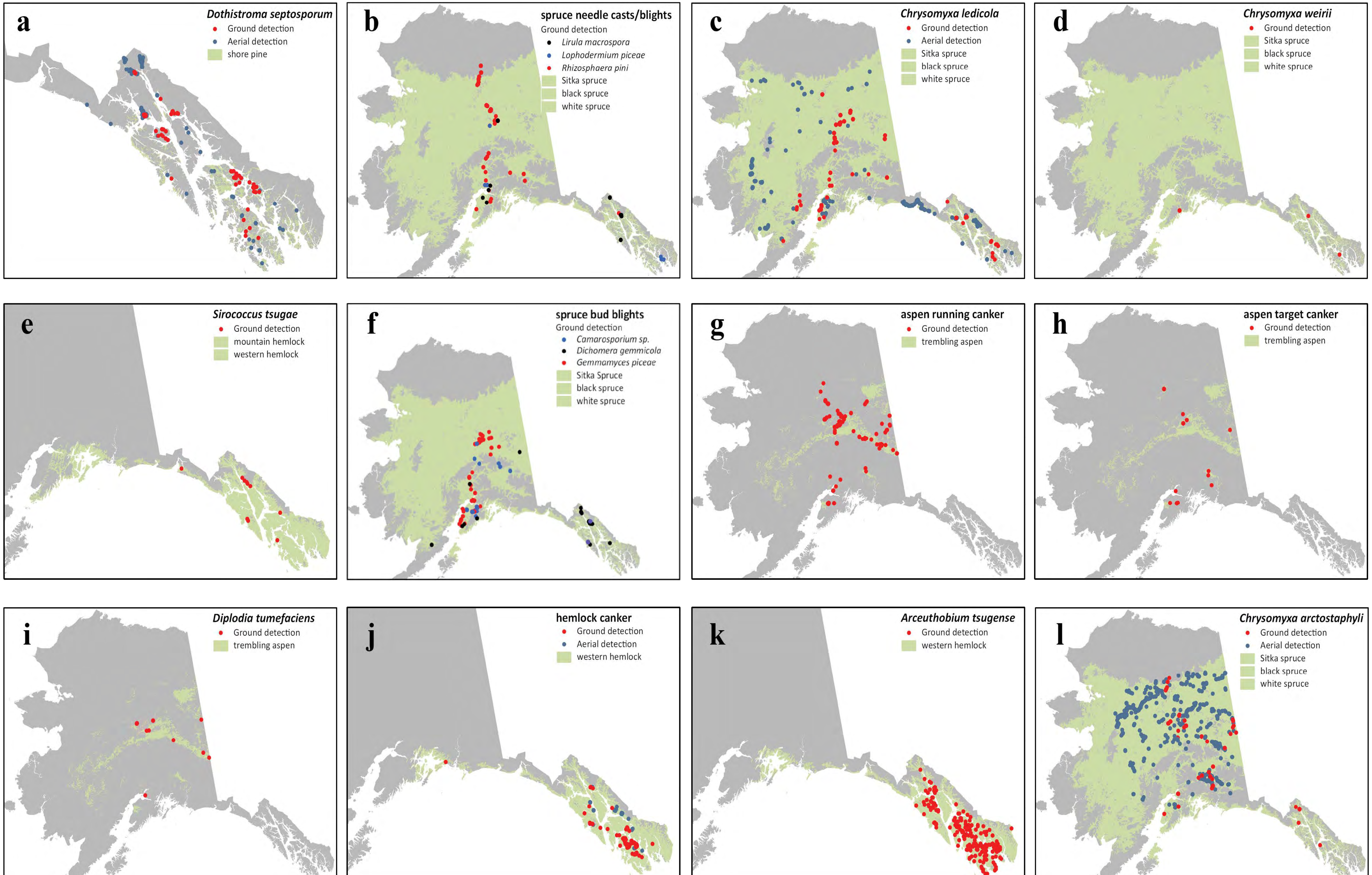
**Tomentosus Root Disease**
*Onnia tomentosa* (Fr.) P. Karst. (=*Inonotus tomentosus*)

The pathogen *Onnia tomentosa* is apparently widespread throughout spruce stands of Southcentral and Interior Alaska. However, because it is difficult to confidently identify without fruiting structures, it has only been confirmed and mapped in a few locations (Map 3x). Recent post-harvest stump surveys in Interior Alaska have shown very high incidence of decay and stain symptoms consistent with Tomentosus, however signs of the fungus are usually not found at the time of survey. Ephemeral fruiting bodies and the lack of above-ground diagnostic features are obstacles to detection and comprehensive surveys. In Southeast Alaska, this pathogen has been reported on spruce near Skagway and collected from dead shore pine near Hoonah. In 2017, an active root disease center with *O. tomentosa* fruiting structures (Figure 21) and killed and dying shore pine was detected in a monitoring plot north of Haines.

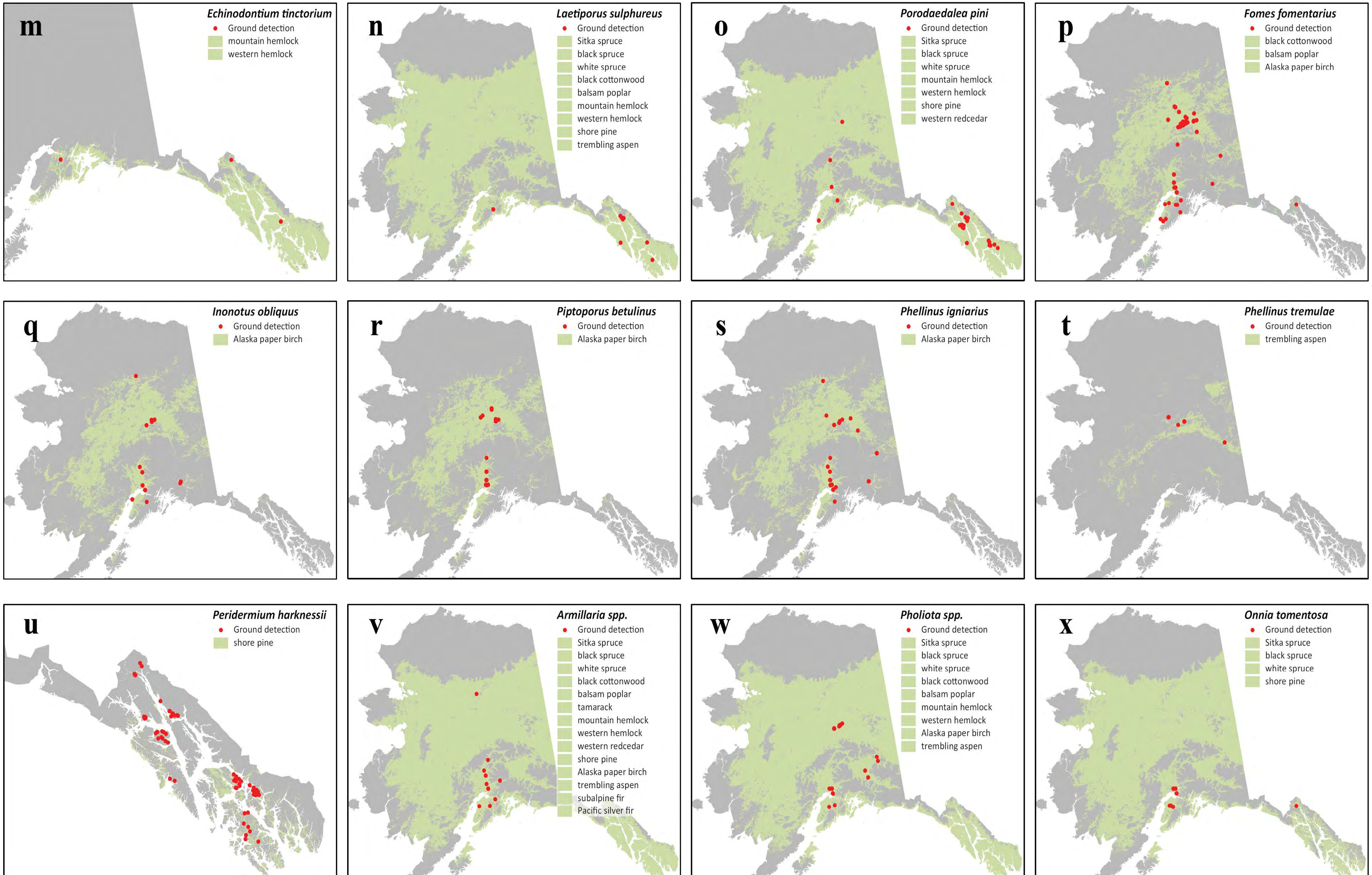
**Figure 20.** *Pholiota* sp. on the lower bole of a paper birch.

**Figure 21.** *Onnia tomentosa* fruiting structures and decay at the root collar of a snapped shore pine near Haines, AK. Conks were detected beneath several adjacent pines.

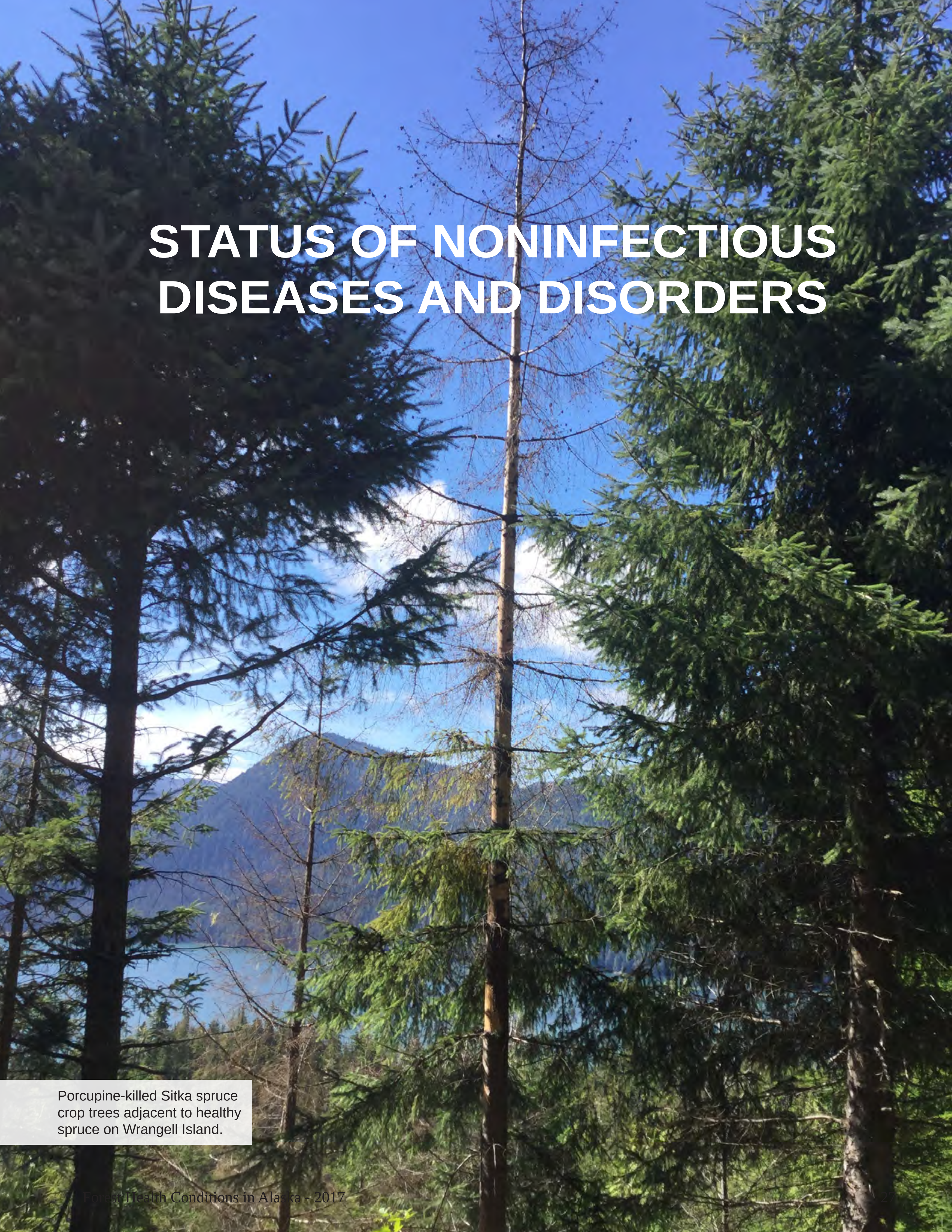
**Map 3.** Locations where disease agents have been found in ground surveys (2013-2017), published literature, and Aerial Detection Surveys (1989-2017). These maps do not include pathogen locations that are known but lack explicitly georeferenced observations. Modeled host tree layers were developed by the Forest Service Health Technology Enterprise Team in 2011 (240m-resolution, presence based on dominant tree species by tree diameter).



**Map 3.** Locations where disease agents have been found in ground surveys (2013-2017), published literature, and Aerial Detection Surveys (1989-2017). These maps do not include pathogen locations that are known but lack explicitly georeferenced observations. Modeled host tree layers were developed by the Forest Service Health Technology Enterprise Team in 2011 (240m-resolution, presence based on dominant tree species by tree diameter).



# STATUS OF NONINFECTIOUS DISEASES AND DISORDERS



Porcupine-killed Sitka spruce crop trees adjacent to healthy spruce on Wrangell Island.

# 2017 Noninfectious Diseases & Disorders Updates

A young-growth stand on Zarembo Island with significant yellow-cedar-decline mortality of crop trees.

## Abiotic Damage

Windthrow, flooding, drought, winter injury, and wildfires are the most common abiotic damage in Alaska and affect forest health and structure to varying degrees. Wildfire is not mapped during our aerial forest health surveys, but causes extensive tree mortality in Alaskan boreal forests, and may be especially severe after bark beetle outbreaks or in times of drought. The Alaska Interagency Coordination Center reported that 118 fires burned across 719,000 acres in Alaska in 2017, up from about half a million acres in 2016. Hemlock fluting, characterized by deeply incised vertical grooves that extend along boles into the tree crowns of western hemlock, is not detrimental to tree health but reduces economic value of hemlock logs in Southeast Alaska.

### Windthrow

Heavy winds often cause small-scale disturbance in Alaskan forests. It contributes to bole snap or uprooting of individual trees or clumps of trees. In 2017, less than 300 acres of windthrow were mapped during the aerial survey, most of which occurred near Yakutat. One fairly large windthrow event (180 acres) was mapped on the Yakutat foreland. The most recent major wind event occurred in the upper Tanana Valley between the Little Salcha River and Tanacross in 2012, and affected more than a million acres over a 70 mile stretch (see 2012 and 2013 USDA Forest Service-Forest Health Protection Reports). Although windthrown trees can create ideal breeding conditions for bark beetles, extensive outbreaks have not been associated with the 2012 event; nevertheless, spikes in northern spruce engraver beetle populations have been recorded in this area (see northern spruce engraver in Status of Insects section).

### Flooding

In 2017, 2,830 acres of flooding damage were mapped, less than in the last three years. Flooding damage was widely scattered throughout the state with the largest areas of flooding recorded along the Susitna River south of Talkeetna (1,098 acres) and just north of Juneau near the Eagle River (287 acres). Flooding damage is usually attributed to beaver dams and occasionally landslides, or abnormally high precipitation or snowmelt.

### Late-Winter Drought

In spring of 2017, Sitka spruce and western hemlock experienced excessive green needle drop at many locations in Southeast Alaska. This damage was thought to be due to the rapid warm-up and dry conditions in late-March following snow and cold temperatures. Conifers can be especially sensitive to dry conditions when coming out of winter dormancy. Affected trees produced new growth during the growing season and sustained no long-term damage. Sitka spruce at some exposed sites on Prince of Wales Island experienced significant tip-shearing damage (the loss of 2-4 inches from the tips of branches) prior to bud break. Damage was thought to be too severe and extensive to be caused by animals, and teeth marks were not evident on tip bases that littered the road and forest floor. The likely cause was a combination of freezing rain and heavy wind.

### Western Redcedar Topkill

Western redcedar is susceptible to topkill associated with drought. Widespread topkill of small and medium western redcedar trees was reported on Prince of Wales Island in 2017 (Figure 22), including damage to crop trees in stands managed for timber. Dead tops and multi-forked dead tops of western redcedar are common in old-growth forests, but red, actively dying tops are not frequently observed in Southeast Alaska. Western redcedar topkill is thought to result from specific environmental and weather conditions leading to drought injury expressed as topkill. Animal feeding, possibly from flying squirrels, was observed on some affected tree boles and may have contributed to topkill; however, chewing damage seldom encircled the full stem and was not consistently associated with topkill.

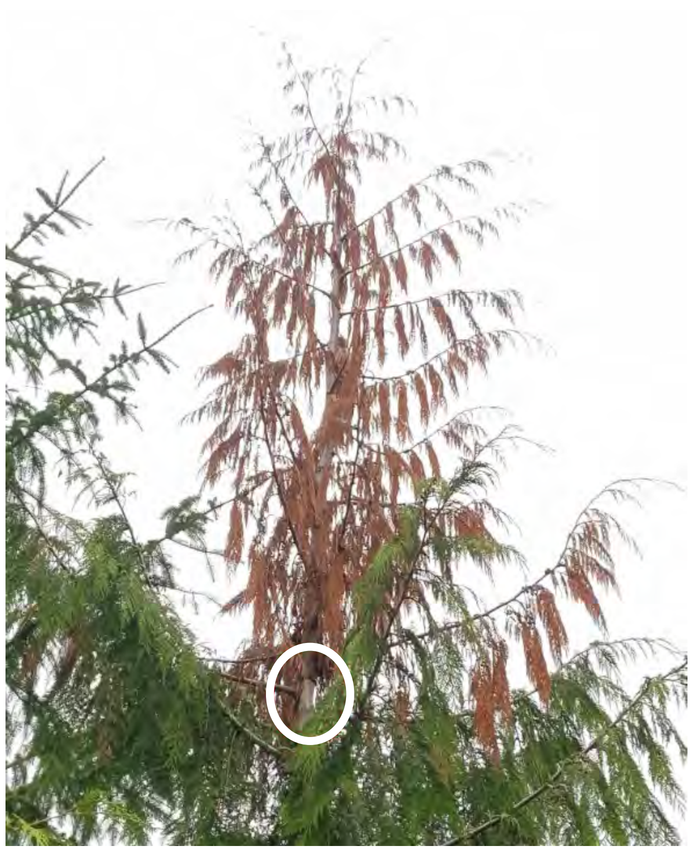


**Figure 22.** A western redcedar with topkill and a small portion of the bole without bark (circled), common on Prince of Wales in 2017. Forest Service photo by Molly Simonson.

## Animal Damage

Throughout the state, several animal species cause damage to forest trees; porcupines, beavers, moose, black bears and brown bears can be particularly destructive. Porcupines and beavers kill trees by girdling tree boles, and beavers also cause flooding which can lead to tree mortality. In Southeast Alaska, Brown bears selectively feed on the inner-bark of yellow-cedar trees in the spring, and approximately half of the yellow-cedar trees on islands with high brown bear populations show feeding scars.

**Porcupine**
*Erethizon dorsatum* L.

In 2017, 1,500 acres of porcupine damage were mapped in Southeast Alaska, similar to the acreage mapped in recent years. Annual variation in mapped porcupine activity is a function of areas flown; GIS tools, including low-altitude imagery (Figure 23), may prove useful for more accurately determining the impact and extent of damage in managed stands. Topkill and mortality from porcupine-feeding is often most severe in managed stands that are 10 to 30 years old, particularly on Wrangell, Etolin, Mitkof and Kupreanof Islands and on the coastal mainland near major river drainages, such as Hobart Bay/ Port Houghton. Porcupine feeding can be locally concentrated in these young-growth stands, but typically tapers off over time. In some places, porcupines are the leading cause of spruce and hemlock crop tree mortality. Where porcupines cause substantial damage to timber resources, managers may thin to a tighter spacing between trees to accommodate anticipated loss of crop trees and to favor tree species that porcupines avoid, such as yellow-cedar and western redcedar. Porcupines are absent from many islands in Southeast Alaska, including Admiralty, Baranof, Chichagof and Prince of Wales (although, single porcupines and damaged trees are occasionally reported on Chichagof Island).

## Forest Declines

**Yellow-Cedar Decline**

The 2016 report, A Climate Adaptation Strategy for Conservation and Management of Yellow-cedar in Alaska, contains further information regarding yellow-cedar decline and is available for download at http://www.fs.fed.us/pnw/pubs/pnw_gtr917.pdf.

*Yellow-Cedar Decline in Old-Growth*

In 2017, nearly 47,500 acres of forest with actively dying yellow-cedar trees (Figure 24) were mapped during the aerial survey (Map 4), similar to the acreage mapped in 2015 and 2016 but increased from 2014. Yellow-cedar forests along the coast of Glacier Bay and in Prince William Sound remain healthy. However, a 100-acre patch of yellow-cedar mortality with old snags was reported alongside La Perouse Glacier (within Glacier Bay National Park, 120 miles southeast of Yakutat), tens of miles northwest of the northernmost mapped decline. In 2016, Ben Gaglioti of the Lamont Doherty Earth Observatory confirmed that the snags are yellow-cedar, and that adjacent healthy forest contains yellow-cedar.

More than 600,000 acres of decline have been mapped in Southeast Alaska through aerial detection survey since surveys began in the late-1980s, with extensive mortality occurring in a wide band from the Ketchikan area to western Chichagof and Baranof Islands (Table 4). The cumulative estimate has been refined using GIS filters to exclude certain decline-mapped areas based on the distribution of yellow-cedar forest. For this reason, it is problematic to compare the cumulative acreage of decline across consecutive years in order to detect trends in yellow-cedar decline activity.


**Figure 23.** Severe porcupine damage to a young-growth stand on Mitkof Island observed using low-altitude imagery and ArcGIS tools.

**Figure 24.** Yellow-cedar decline in unmanaged old-growth forest observed during the 2017 aerial detection survey.

**Map 4.** Current and cumulative yellow-cedar decline mapped by aerial detection survey in Southeast Alaska.

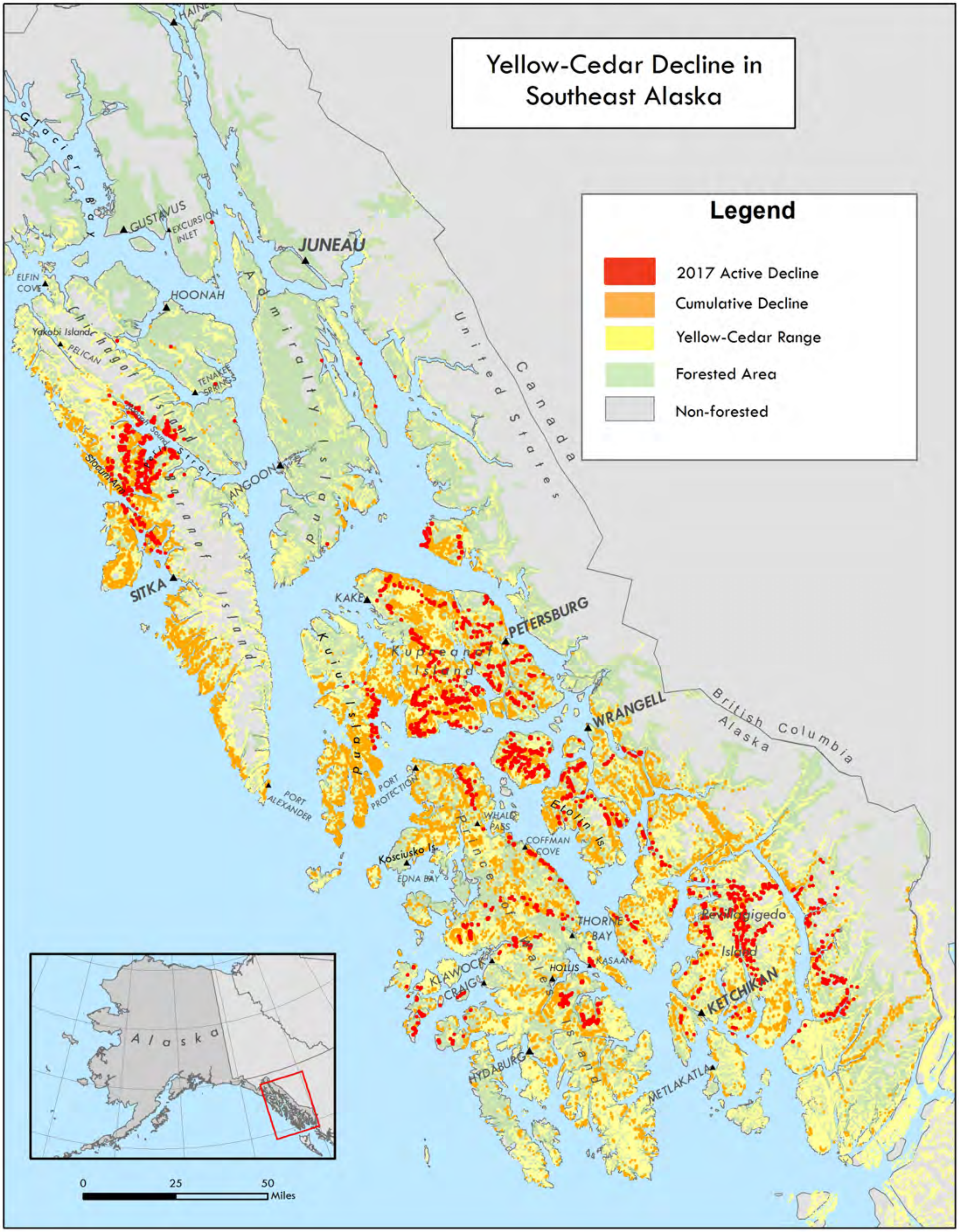


**Table 4.** Cumulative acreage of yellow-cedar decline mapped as of 2017 by aerial detection survey by land ownership, island, and USFS Ranger District.

| *Ownership* | *Cumulative Acres* |
|---|---|
| **National Forest** | **567,218** |
| **Admiralty NM** | **5,213** |
| Admiralty Is. | 5,213 |
| **Craig RD** | **37,836** |
| Dall Is. & Long Is. | 1,592 |
| POW Is. | 36,244 |
| **Hoonah RD** | **603** |
| Chichagof Is. | 603 |
| **Juneau RD** | **1,046** |
| Mainland | 1,046 |
| **Ketchikan RD** | **30,645** |
| Duke Is. | 15 |
| Gravina Is. | 1,925 |
| Mainland | 17,649 |
| Revillagigedo Is. | 11,056 |
| **Misty Fjords NM** | **37,781** |
| Revillagigedo Is. | 11,056 |
| Mainland | 26,725 |
| **Petersburg RD** | **183,690** |
| Kuiu Is. | 78,592 |
| Kupreanof Is. | 84,067 |
| Mainland | 10,209 |
| Mitkof Is. | 7,934 |
| Woewodski Is. | 2,887 |
| **Sitka RD** | **124,159** |
| Baranof Is. | 57,302 |
| Chichagof Is. | 41,762 |
| Kruzof Is. | 25,095 |
| **Thorne Bay RD** | **72,478** |
| Heceta Is. | 1,534 |
| Kosciusko Is. | 14,700 |
| Prince of Wales Is. | 56,244 |
| **Wrangell RD** | **73,767** |
| Etolin Is. | 26,101 |
| Mainland | 21,737 |
| Woronkofski Is. | 1,365 |
| Wrangell Is. | 12,136 |
| Zarembo Is. | 12,428 |

| *Ownership* | *Cumulative Acres* |
|---|---|
| **Native** | **29,490** |
| Annette Is. & Duke Is. | 2,285 |
| Admiralty Is. | 55 |
| Baranof Is. | 357 |
| Chichagof Is. | 1,027 |
| Dall Is. & Long ls. | 1,275 |
| Heceta Is. | 6 |
| Kosciusko Is. | 543 |
| Kruzof Is. | 135 |
| Kuiu Is. | 654 |
| Kupreanof Is. | 4,777 |
| Mainland | 1,738 |
| Prince of Wales Is. | 14,567 |
| Revillagigedo Is. | 2,071 |
| **State & Private** | **33,289** |
| Admiralty Is. | 21 |
| Baranof Is. | 4,046 |
| Chichagof Is. | 1,092 |
| Dall Is. & Long Is. | 51 |
| Etolin Is. | 4,198 |
| Gravina Is. | 1,873 |
| Heceta Is. | 63 |
| Kosciusko Is. | 288 |
| Kruzof Is. | 397 |
| Kuiu Is. | 1,810 |
| Kupreanof Is. | 2,826 |
| Mainland | 1,029 |
| Mitkof Is. | 2,262 |
| Prince of Wales Is. | 7,049 |
| Revillagigedo Is. | 4,264 |
| Woewodski Is. | 8 |
| Wrangell Is. | 1,871 |
| Zarembo Is. | 141 |
| **Grand Total** | **629,996** |

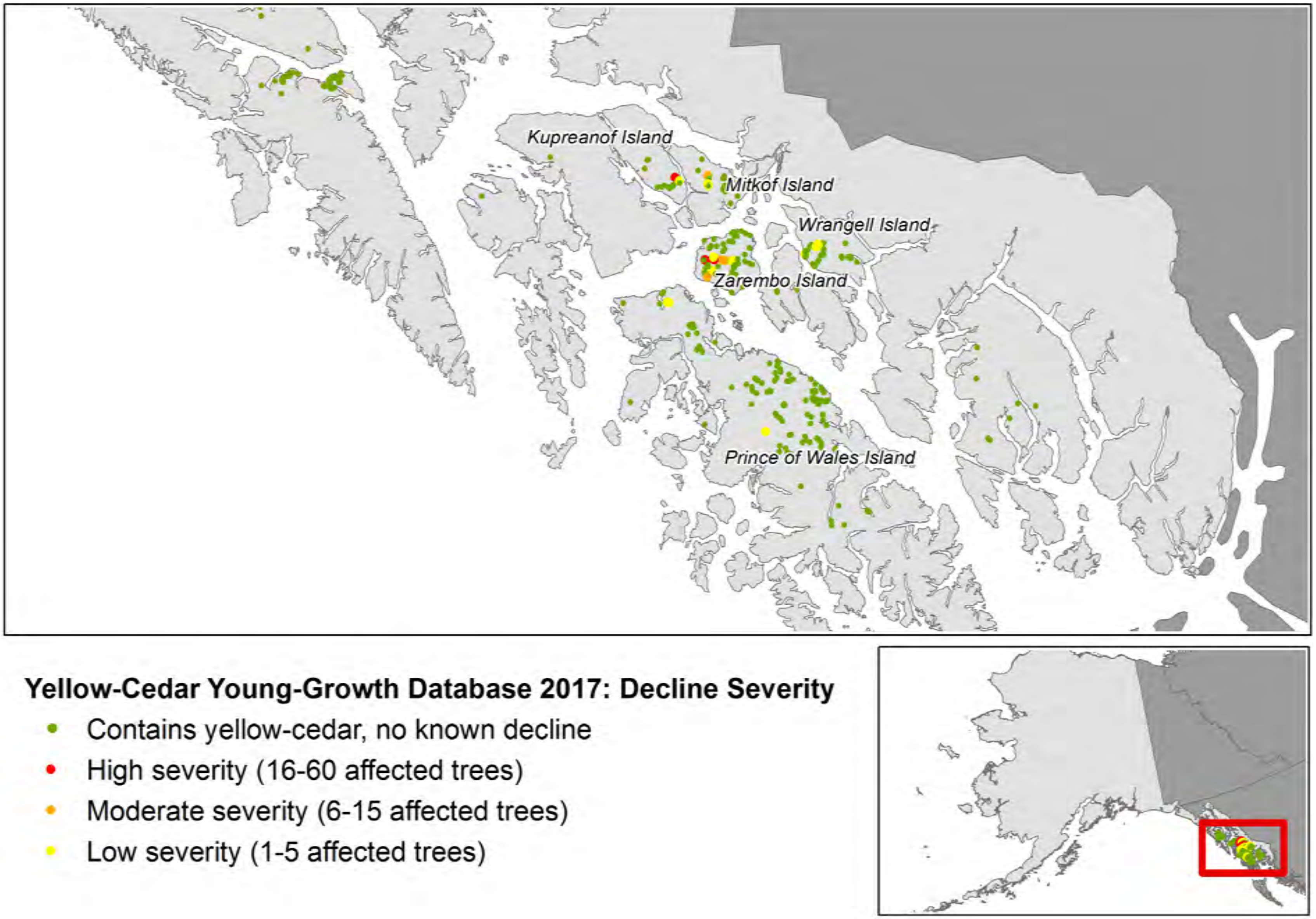
*Yellow-Cedar Decline in Young-Growth*

Until recently, it was thought that yellow-cedar decline was restricted to old-growth forests as symptomatic trees had not been observed in young-growth stands. It was presumed that the roots of yellow-cedar were protected by deeper soils on these relatively productive sites managed for timber. In 2013, dead and dying yellow-cedars (Figure 25) in two young-growth stands on Zarembo Island were examined and yellow-cedar decline was determined to be the cause. The Forest Health Protection team is working with staff on the Tongass National Forest to compile a growing list of young-growth stands with yellow-cedar (now 316 stands) to facilitate monitoring. Low-altitude aerial imagery and aerial surveys are used alongside the database to identify stands with suspected decline. To date, decline has been verified on the ground in 24 young-growth stands on Zarembo, Kupreanof, Wrangell, Mitkof and Prince of Wales Islands. Most of these stands currently have a low incidence of yellow-cedar mortality (1-15 trees), but three stands on Zarembo Island and one stand on Kupreanof Island are severely impacted (estimated approximately 50% of yellow-cedar crop trees are dead and dying) (Map 5). Affected stands tend to be 30-40 years old and thinned within the past decade; 42% of stands in the database are currently in this age range and 33% are younger. Current management recommendations are to maintain tight spacing between cedars (6-8 ft) during pre-commercial thinning to account for potential loss to crop trees, and to avoid thinning in wet portions of stands; thinning provides little tree-growth payoff on these sites and may contribute to greater soil temperature fluctuation.

Understanding the risk factors for yellow-cedar decline in young-growth is a major research need. Predicting where decline is likely to occur in young-growth could allow managers to prioritize other conifers during thinning in some units or portions of units expected to be vulnerable to decline.

**Figure 25.** A young-growth stand on Zarembo Island with significant yellow-cedar-decline mortality of crop trees.

**Map 5.** Young-growth stands known to contain yellow-cedar in Southeast Alaska and the severity of yellow-cedar decline based on ground assessments.



### *Yellow-Cedar Common Garden Update: Yakutat*

In 2009, 3,300 one-year-old plugs of yellow-cedar were planted across 30 total acres at three sites in Yakutat. Seedling survival was very high (90%) in post-planting measurements, but within the last two years survival has dropped to an estimated 20-30%. Planting sites were visited by Tongass silviculturists and Forest Health Protection staff in August 2017 (Figure 26). Restricted rooting depth and seasonal flooding at planting sites in the Yakutat forelands likely increased vulnerability to fine root freezing injury in the absence of insulating snowpack. Survival was noticeably higher along skid roads, where equipment had churned the soil. The use of plugs may have also resulted in compromised root structure (Figure 27). A canker disease was also detected on some seedlings and collected for diagnosis. The causal fungus was cultured and genetically sequenced and is thought to belong to the genus *Allantophomopsis*, but an exact species-level sequence match was not found.

### *Yellow-Cedar Petitioned for Endangered Species Act Listing*

The U.S. Fish and Wildlife Service received a petition to list yellow-cedar as endangered or threatened under the Endangered Species Act in June 2014. The initial finding was that a review of the science and status of yellow-cedar is warranted. As part of the scientific review of yellow-cedar, the Yellow-Cedar Biology, Ecology, and Emerging Knowledge Summit was held at the University of Alaska Southeast in October 2017. The meeting was attended by experts from many disciplines from the United States and Canada and covered the best available science and information needs regarding yellow-cedar. The Species Status Assessment is expected in spring 2018 and the listing decision is due in 2019.

**Figure 26.** Craig Buehler and Robin Mulvey inspect a dying yellow-cedar planted near Yakutat. Forest Service photo by Sheila Spores.

**Figure 27.** A J-shaped rootwad of a dying yellow-cedar planted near Yakutat. The wet site conditions and the planting of plugs may have contributed to widespread root injury several years after planting.

# STATUS OF INVASIVE PLANTS

In 2017, an infestation of creeping thistle (*Cirsium arvense*) was found in Alaska's far north by John Morton, of the US Fish and Wildlife Service. This infestation is about 75 miles north of the Arctic Circle and several hundred miles north of the previously known farthest-north infestation in the state.

# 2017 Invasive Plants Updates

Figure 28. Staff of the Fairbanks Soil and Water Conservation District apply herbicide granules to Chena Slough using a motorized spreader, in June 2017.

## Interior Alaska Elodea Update

Interior Alaska has four known infestations of the invasive aquatic plant elodea (*Elodea* spp.), with the largest in a waterbody called Chena Slough. Elodea reproduces almost exclusively vegetatively, and a single fragment floating downstream has the potential to start a new infestation. Because Chena Slough is connected to the Chena River, the Tanana River and the Yukon River watersheds, there is great concern about downstream spread. Fortunately, the siltiness and rate of flow of the Tanana and Yukon make the main stems of those rivers less suitable elodea habitat than Chena Slough. However, slow-moving side channels remain vulnerable. This concern was validated in 2015 when Totchaket Slough, 60 miles downriver of Fairbanks, was found to be heavily infested with the aquatic weed. So far, Totchaket Slough is the only known downriver infestation.

In the eight years since elodea was first discovered in Chena Slough, a variety of individuals, government agencies and non-governmental organizations have worked on responding to this infestation, via a group that has come to be known as the Fairbanks-Area Elodea Steering Committee. FHP was actively involved the first few years, searching the scientific literature on elodea, mapping the infestation, contributing to a "Control Options" document, and assisting with mechanical control trials. Mechanical control proved to be unfeasible and the focus shifted to doing the planning and seeking the permits required for chemical treatments. In recent years, the Steering Committee has been led by the Fairbanks Soil and Water Conservation District (FSWCD), the Alaska Division of Agriculture and the US Fish and Wildlife Service. All of those efforts culminated this year, when the first round of chemical treatments were applied in Chena Slough.

In June of 2017, the FSWCD applied nearly a ton of slow-release pellets of Sonar herbicide (active ingredient fluridone) to the slough (Figure 28), with the assistance of personnel from SePRO Corporation (Figure 29). A second round of pellets was applied in August. In addition, a drip system was set up that introduced a liquid formulation of fluridone to the slough from mid-June through mid-September at a point just upstream of the beginning of infestation. The rate of the drip was continually adjusted relative to the water level in the slough, with a goal of maintaining the concentration of herbicide in the slough water between 4 and 8 parts per billion (ppb). This sophisticated delivery system could be monitored and adjusted via cell phone by FSWCD personnel or by SePRO consultants in Indiana.

It was a challenging proposition to treat a ten-mile-long infestation in a shallow, meandering channel of moving water, and to attempt to maintain herbicide concentrations within a narrow target range. The concentration of fluridone in the slough's water was monitored weekly at five locations along the length of the infestation. Of 65 water samples collected over the summer, 41 had fluridone concentrations within the target range of 4 to 8 ppb. Twenty-one samples had concentrations that were slightly below target range and three were slightly above. Overall, the application prescription worked amazingly well.

Figure 29. From left to right, Mason Young and Scott Shuler of SePRO Corporation discuss the application of fluridone to Chena Slough with Karin Hendricksen, Pesticide Program Coordinator for the Alaska Department of Environmental Conservation.

Because fluridone binds tightly with organic matter, movement of the compound from the slough itself into adjacent soil groundwater was considered to be highly unlikely. Nevertheless, people living along the slough had expressed concern that the herbicide could turn up in their well-water. After extensive public outreach and discussion within the steering committee on this issue, FSWCD chose five homes along the slough for well-water sampling. Raw water samples were collected monthly throughout the summer and analyzed; none were found to be contaminated (with an analytical reporting limit of 0.075 ppb). Residents appreciated the Steering Committee's willingness to address this question head-on.

Other aspects of the slough environment are being monitored as well. Various agencies with membership on the steering committee are monitoring native vegetation, fish populations, and sediment chemistry in the slough.

Most importantly, the herbicide treatments appear to be working as intended. Elodea in the slough began to show fluridone effects about 3 weeks after the treatment began (Figure 30). The tips of elodea branchlets began to turn pink, and a few weeks later, many of the plants were becoming black and slimy. Normally, it can take 3 to 4 years of treatment with fluridone before an invasive aquatic plant can be safely considered eradicated from a body of water. While the steering committee is committed to that time-frame, far less time may be necessary. On the Kenai Peninsula, elodea was eradicated from small lakes in as little as two years of treatment.

With treatment of Chena Slough underway, the next step is to address remote Totchaket Slough. A recently announced $500,000 grant from the Alaska Sustainable Salmon Fund to the FSWCD will assist greatly in that effort. Kudos to the staff of FSWCD for the impressive progress made in 2017 on this important and challenging project (Figure 31).

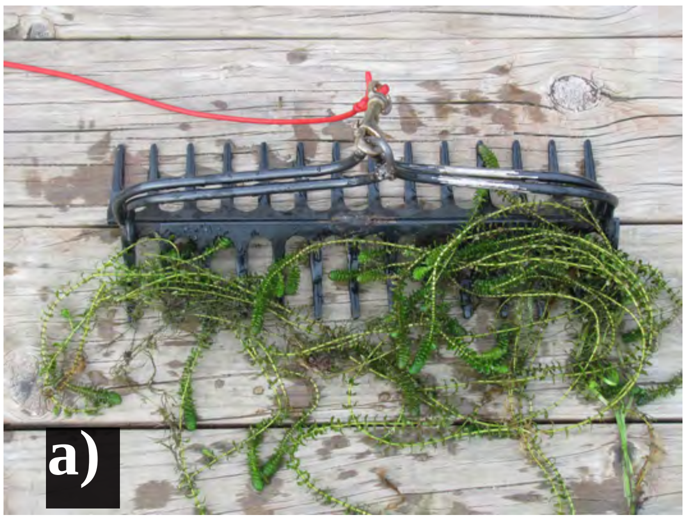





**Figure 30.** Three samples of elodea collected with a throw rake (a) from an untreated infestation at a different site; (b) from Chena Slough about three weeks after the fluridone treatment began; (c) from Chena Slough about ten weeks after the treatment began.

**Figure 31.** Staff of the Fairbanks Soil and Water Conservation District on the first day of chemical applications in Chena Slough.

**Figure 32.** About 40 people attended Alaska DNR's 2017 invasive species training session in Fairbanks.

**Alaska DNR Offers Training in Invasive Species**

In June, R10 FHP was invited to present at a training session for Alaska Department of Natural Resources employees on invasive species issues. Participants also included attendees from the Alaska Department of Transportation & Public Facilities, FSWCD, U.S. Bureau of Land Management, and University of Alaska Fairbanks. Organized by an employee in the state Division of Mining, Land, and Water, the session was part of the Division's continuing education series. It included an hour-long presentation on "Invasive species: why you should care," and the chance to examine fresh specimens of about 20 invasive plant species that are spreading in Interior Alaska and, for comparison, a number of similar-looking native plant species (Figure 32). About forty people attended. The session concluded with a visit to the Georgeson Botanical Garden on the University of Alaska Fairbanks campus, where the garden manager provided a tour of invasive plants in the garden.

**Creeping Thistle Discovered in Alaska's Far North**

In August, an infestation of creeping thistle (*Cirsium arvense*) was discovered in Alaska about 75 miles north of the Arctic Circle, by John Morton of the US Fish and Wildlife Service. This find was a shock to Alaska's invasive species community; previously the farthest-north known infestations of this plant were several hundred miles to the south. The infestation is located near milepost 308 of the Dalton Highway, 50 miles north of Atigun Pass, the place where the Dalton Highway passes through the Brooks Range. Fortunately the infestation is small, only about 30' by 50', and is located on State of Alaska land along a pipeline right-of-way issued to Alyeska Pipeline Service Company. Alyeska used a walk-behind mower to knock the creeping thistle down before it could go to seed, and then decontaminated the equipment. Snowfall a few days later ended the growing season, but conversations have begun on future treatment options for this site.

**New Ordinance Prohibits the Sale of European Birdcherry in Anchorage**

As one of the few flowering trees that tolerates the climate of Southcentral and Interior Alaska, European birdcherry (*Prunus padus*) has been widely planted as an ornamental in Anchorage and Fairbanks, as well as in Whitehorse, Yukon. Though its flowers are beautiful and fragrant, European birdcherry is not an ideal landscape tree. Its flowering period is very short. Mature trees produce thousands and thousands of small fruits that can leave a gloppy mess on a lawn or stain a sidewalk purple. Worst of all, about twenty years ago Alaskans began to realize that this species is invasive. It is spread by birds that consume the fruits, and by its vigorous sprouting habit. Any attempt to control this species with a chainsaw prompts the tree's below-ground parts to produce numerous sprouts (Figure 33).

Today, large portions of what used to be natural-forest green belts along Anchorage's Campbell and Chester Creeks are heavily infested with European birdcherry (Figure 34). In some places, the streamside forest has become a virtual birdcherry monoculture, with native birch (*Betula neoalaskana*), alder (*Alnus tenuifolia* and *A. viridis*) and spruce (*Picea glauca* and *P. mariana*) seemingly excluded by this aggressive invader. Birdcherry can create such dense thickets of vegetation that it becomes a public safety concern. Some residents report feeling unsafe in their neighborhood parks due to the heavy overgrowth of birdcherry trees, leading to reduced sight distance for trail users and hiding homeless camps. Individual birdcherry trees have been found in a number of remote sites around Alaska, suggesting that the species is beginning to invade Alaska's wild lands.

**Birdcherry can create such dense thickets of vegetation that it becomes a public safety concern.**

**Figure 33.** European birdcherry sprouts emerge from the below-ground parts of a tree cut at ground level.

Birdcherry growing along waterways has potential to affect juvenile salmon as well. Beginning in 2009, FHP partnered with the USFWS to support work by University of Alaska Fairbanks graduate student David Roon to examine the effects of birdcherry in streamside forests. Roon looked at the number and kinds of insects and slugs that fell into streams from the native forest, and compared them to the insects and slugs that fall in from birdcherry-dominated forests. These invertebrates are important components of the diet of the juvenile coho salmon (*Oncorhynchus kisutch*) that live in Campbell and Chester Creeks. Roon found that streamside birdcherry trees supported four to six times less terrestrial invertebrate biomass on its foliage, and contributed two to three times fewer insects to the stream systems, than native deciduous trees. This reduction in terrestrial invertebrate biomass was consistent between the two watersheds over 2 years. He concluded that as birdcherry continues to spread, this reduction of "terrestrial prey subsidies" to streams was likely to have negative consequences for salmon (Roon et al. 2016).

**Figure 34.** European birdcherry seedlings carpet much of the forest floor in Anchorage parklands.

For many years, R10 FHP has worked with the University of Alaska Fairbanks Cooperative Extension Service (CES), Chugach National Forest, the Anchorage Parks Foundation and private industry on the problem of European birdcherry in Anchorage. Each year, the Anchorage Cooperative Weed Management Area's annual Weed Smackdown targets small to medium-sized birdcherry trees growing in a different Anchorage park by arming volunteers with heavy-duty weed wrenches. This year's smackdown attracted eighty enthusiastic participants! With weed wrenches, volunteers can wrench entire saplings out of the ground, reducing the likelihood of sprouting (Figure 35). Wrenched saplings are chipped and hauled away. Through an FHP Special Technology Development Program grant, CES is working with faculty at University of Alaska Anchorage to develop and refine herbicide application techniques for this species. In addition, public outreach efforts have encouraged residents to choose non-invasive alternative species for their landscape plantings. More and more greenhouses and nurseries have begun to promote these alternative species, and though many have voluntarily stopped selling birdcherry, some have continued to offer the tree.

In 2017, the Anchorage Assembly made a significant contribution to the fight against birdcherry when it enacted an ordinance to prohibit the sale of this ornamental in the municipality. Sponsored by Assemblyman Forrest Dunbar, the ordinance passed unanimously on August 8th. Thanks to the Anchorage Assembly for supporting this long-needed and common-sense measure.

**CNIPM Meeting Held in Anchorage**

The Alaska Invasive Species Workshop, the annual meeting of the Alaska Committee for Noxious and Invasive Pest Management (CNIPM), was held in Anchorage in 2017. A keynote address, on the Arctic Invasive Alien Species Strategy and Action Plan, was given by Jamie Reaser, Executive Director of the National Invasive Species Council. Representatives of the Alaska legislature and the Anchorage Assembly spoke during a session on policy and planning.

Two major foci of the meeting were elodea research and management, and environmental DNA. Much effort is currently being expended in Alaska on developing methods to detect northern pike (*Esox lucius*) and elodea in water bodies using e-DNA. Other presentations described assessing risk of marine invasive species in the Bering Sea, invasive slugs in the Chugach National Forest, and the role of nitrogen fixation in competitive interactions between bird vetch (*Vicia cracca*) and native plant species.

For the first time, student scholarships were offered to attend the meeting. R10 FHP worked with CES to cover the conference registration fees of seven Alaskan students, ranging from a Metlakatla high schooler to a graduate student at the University of Alaska Anchorage. The scholarship recipients seemed to benefit from the meeting and appreciated the opportunity to attend.

**New Partner in Mini-Grant Management**

R10 FHP has joined forces with the Copper River Watershed Project (CRWP) to manage the Alaska Invasive Plant mini-grant project over the next two years. Based in Cordova, CRWP is a community non-profit whose mission is to "promote a salmon-rich, intact watershed and culturally diverse communities by forming partnerships for watershed-scale planning and projects." Over the last few years, the CRWP has itself been a recipient of some of these mini-grants, and has conducted several successful invasive plant projects. The mini-grant program is a source of small-grant funding for people and community groups anywhere in Alaska to manage invasive plants.

**Figure 35.** Anchorage Weed Smackdowns attract volunteers who enthusiastically spend a long morning wrenching birdcherry saplings out of the ground. Hundreds of saplings were wrenched, chipped and hauled away during this 2011 Smackdown in Tikishla Park.

**Literature**

Roon, D.A., Wipfli, M.S., Wurtz, T.L. and Blanchard, A.L. 2016. Invasive European bird cherry (*Prunus padus*) reduces terrestrial prey subsidies to urban Alaskan salmon streams. Can. J. Fish. Aquat. Sci. 73: 1679–1690.

# STATUS OF INSECTS

Spruce beetle (*Dendroctonus rufipennis*), currently in outbreak in Southcentral Alaska.

# 2017 Insect Updates

**Figure 36.** Green alder sawflies were commonly encountered in Juneau especially in August when their feeding damage peaks.

## Hardwood Defoliators- External Leaf Feeding

**Alder Defoliation**
*Epinotia solandriana* (L.)
*Eriocampa ovata* (L.)
*Hemichroa crocea* (Geoffroy)
*Lophocampa maculata* Harris
*Monsoma pulveratum* (Retzius)

Alder defoliation was detected on roughly 3,400 acres during the aerial survey; 2,600 acres in Southcentral, and 650 acres in Southeast. Defoliation of alder is the result of feeding by several different species of sawflies and caterpillars, often occurring on the same tree. In Southeast in 2017, external leaf feeding on alder was greater than internal feeding; however most of the damage occurred late in the season, after aerial surveys were conducted. The non-native green alder sawfly, *Monsoma pulveratum* (Figure 36), was observed feeding on red alder throughout Southeast Alaska but did not cause any notable damage. The majority of the feeding occurs at the end of the growing season when their impact on tree health is minimal. Woolly bear caterpillars continue to be prevalent in Southeast Alaska, garnering attention more for their wandering behavior, where the caterpillars are found crossing streets and trails in abundance, than for their feeding damage (Figure 37).

**Figure 37.** Woolly bear caterpillars feed on a variety of species, especially alder. They often garner attention due to their bright colors and wandering behavior.

**Birch Leaf Roller**
*Caloptilia strictella* (Walker)
*Caloptilia alniorella* (Chamber)
*Epinotia solandriana* (Linnaeus)

Birch leaf roller damage was mapped on 607 acres in 2017, this is a substantial decrease from the 27,000 acres mapped in 2016. The majority of recorded leaf roller damage was in the Interior at Blair Lakes, in Yukon-Charley Rivers National Preserve, and the Yukon Flats National Wildlife Refuge. Ground observations indicated the frequency of birch leaf roller damage was similar to last year, meaning it was observed in the majority of birch in the Interior, but the intensity (i.e. the number of affected leaves per tree) was substantially lower. Reductions in leaves impacted per tree decreases the possibility of identification from the air and is likely the cause of the drop in acres affected. Birch leaf roller also feed on alder in Southeast but activity was nominal.

**Large Aspen Tortrix**
*Choristoneura conflictana* (Walker)

Large aspen tortrix (LAT) was only mapped on 225 acres at Blair Lakes in the Tanana Flats. The small acreage of LAT damage mapped in 2017 is a substantial drop from the 15,000 acres mapped in 2016. Proper aerial identification of LAT has been made difficult due to the occurrence of an unidentified canker-causing fungus on aspen. Aspen mortality due to the canker appears similar to LAT defoliation from the air. If we were unable to confirm LAT from the ground, mapped aspen damage was coded as general aspen defoliation. Aspen defoliation was mapped on roughly 21,000 acres during the aerial detection survey in scattered areas around the Interior, western and Southcentral Alaska. Most of the damage (16,800 acres) was around the upper Kobuk River and Walker Lake in Gates of the Arctic National Preserve. The most likely damage agent was either LAT or an aspen canker.

**Miscellaneous Hardwood Defoliation**
*Epirrita undulata* (Harrison)
*Eriocampa ovata* (L.)
*Eulithis* spp. Hübner
*Hemichroa crocea* (Geoffroy)
*Hydriomena furcata* (Thunb.)
*Monsoma pulveratum* (Retzius)
*Operophtera bruceata* (Hulst)
*Orgyia antiqua* (L.)
*Orthosia hibisci* (Gueneé)
*Rheumaptera hastata* (L.)
*Sunira verberata* (Smith)

Hardwood defoliation can be attributed to several different species that often inhabit the same area. It is not uncommon to find multiple species on the host throughout the season. Some are host specific, whereas others are generalists and feed on multiple hosts. During aerial survey it is not possible to determine the specific species causing damage unless it is confirmed from the ground. During the 2017 aerial surveys, roughly 5,500 acres of hardwood defoliation that could not be attributed to a specific agent was detected. Most of this damage (roughly 4,800 acres) was along the lower Yukon and Anvik Rivers. *Orthosia hibisci*, a native generalist defoliator, was suspected as the primary damage agent in this area. Approximately 38,000 acres of hardwood defoliation attributed to *O. hibisci* were detected in 2017, a 77% decrease from the prior year.

Efforts are being made to determine the primary damage agent causing hardwood defoliation in parts of the Alaska Range, Aleutian Range, and Western Alaska over the last several years. Dieback is occurring in areas that have been defoliated for several consecutive years. Results from aerial surveys conducted in early summer in the Shell Lake area near Skwentna indicate that the outbreak in this area had significantly declined. Based on visual observations in this area and DNA identification results, *Orthosia hibisci* and the green alder sawfly (*Monsoma pulveratum*) appeared to be the most common damage agents in the area, though several species of Geometrid moths were also observed. Collections of larval specimens were also obtained from defoliated areas in McGrath and within the Wood-Tikchik State Park. McGrath specimens were confirmed as *O. hibisci*; DNA identification for the Wood-Tikchik larval specimens was unsuccessful.

During ground surveys this year, considerable hardwood defoliation was found along the Richardson Highway between Valdez and Glennallen. The larvae (Figure 38) were severely defoliating alder, willow, balsam poplar, shrubs and some herbaceous species. Larvae were collected, sent for DNA analysis, and identified as *Sunira verberata*. We were not able to aerial survey this area, so the extent of the damage is not known and the acres of defoliation not included, but hillsides in the region could be seen with severe defoliation for about 10-15 miles along the highway. Similar larvae were observed causing generalist defoliation elsewhere in Southcentral Alaska as well, though we are not aware of any specimen identifications that were obtained from other affected areas.

**Figure 38.** Mostly black larvae, which are likely *Sunira verberata*, causing considerable generalist hardwood defoliation along the Richardson Highway roughly halfway between Valdez and Glennallen.

The rusty tussock moth, *Orgyia antiqua*, was found feeding on willow trees at Dimond Park in Juneau. It has been reported as far south as Anan Creek, near Wrangell Island but typically occurs north of Haines.

## Hardwood Defoliators- Internal Leaf Feeding

**Aspen Leaf Miner**
*Phyllocnistis populiella* Chambers

Aspen leaf miner (ALM) was recorded on roughly 148,000 acres in 2017 and was common and nearly continuous in the Interior. Due to poor weather, fewer days were flown for Interior aerial surveys, so actual damage is likely substantially higher than recorded. Aspen damaged by ALM in Southcentral Alaska was found predominantly in the Glennallen area, other locations were patchy and scattered.

**Birch Leaf Miners**
*Fenusa pumila* (Leach)
*Heterarthrus nemoratus* (Fallén)
*Profenusa thomsoni* (Konow)

During 2017, birch trees infested with leaf miners were found primarily in and around major population centers, like Anchorage, Fairbanks, North Pole, Eagle River, and Wasilla. Outside of population centers, infestations were found between Denali National Park and Fairbanks and at various locations between Anchorage and Trapper Creek. Three species of leaf miners have been associated with this injury: the amber-marked birch leaf miner (*Profenusa thomsoni*) (AMBLM), the late birch leaf edge miner (*Heterarthrus nematorus*) and the birch leaf miner (*Fenusa pumila*).

Damage in Anchorage caused by the AMBLM peaked in 2006 followed by a steady decline (Figure 39). During this period (2006 to 2017), AMBLM dominance as a pest was replaced by the late birch leaf edge miner, which reached a peak of 47% severity (average proportion of infested leaves) in 2012 before it too declined in severity.

In 2017, a systematic roadside survey was conducted in the Interior and in Southcentral, north of Anchorage up the Susitna Matanuska Valley. Forested sites along these roads were examined at 10-mile intervals for the occurrence and severity of birch leaf miners. Areas of high intensity (>60% of leaves infested) feeding by late edge leaf miner were recorded in Eagle River, Chugiak, Palmer, and Wasilla areas, with low to moderate (6-60% leaves infested) levels recorded inside Anchorage. Amber-marked birch leaf miner were recorded at high intensity at one location in Wasilla and low to moderate throughout the rest of Southcentral (Map 6, Map 7).

Roads and population centers in the Interior were also surveyed to assess the spread of AMBLM and the late birch leaf edge miner. Methods used in the Interior follow the protocols from the Snyder et al. 2007 survey and the 2016 resurvey. Plots were located approximately every 10 miles along all major roads out of Fairbanks and continued until two consecutive sites were negative for leaf miners. Ratings of trace/present (1-5%), low (6-30%), moderate (31-60%) high (>60%) and not present were recorded as an average percentage of leaves affected/tree at a location. Fairbanks and North Pole areas had high infestation of amber-marked birch leaf miner, similar to 2016. The extent and severity of amber-marked birch leaf miner on the Richardson Highway also remained unchanged from 2016 with high damage closer to Fairbanks and low damage between Harding and Birch Lakes. Amber-marked birch leaf miner was recorded 10 miles further east on the Steese Highway, 20 miles further north on the Elliott Highway and 20 miles further south on the Parks Highway than previously detected. In 2016, amber-marked birch leaf miner activity on Chena Hot Springs Road ended in Two Rivers, but there was a 30+ mile jump east to the end of Chena Hot Springs Road where it was recorded as present in 2017. The late birch leaf edge miner was recorded for the first time in the Interior with five locations in Fairbanks: Creamers Field (Figure 40), University of Alaska Fairbanks campus, Bentley Mall, the Alaska DNR Office, and two locations roughly 30 miles north of Healy on the Parks Highway.

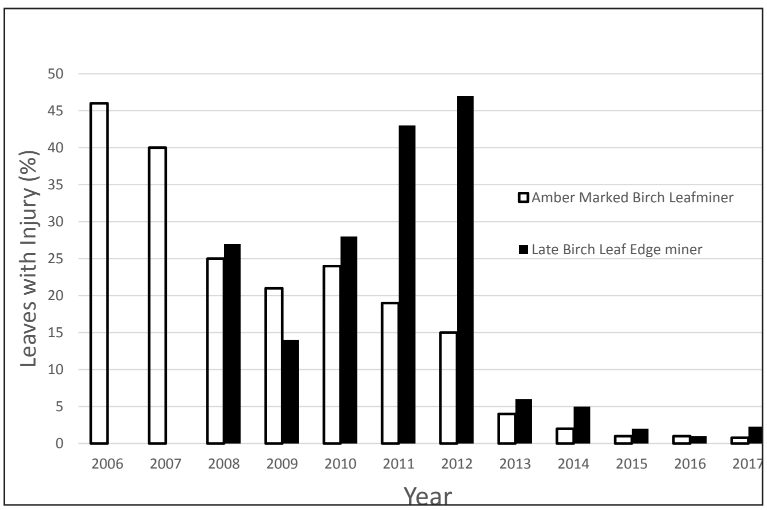
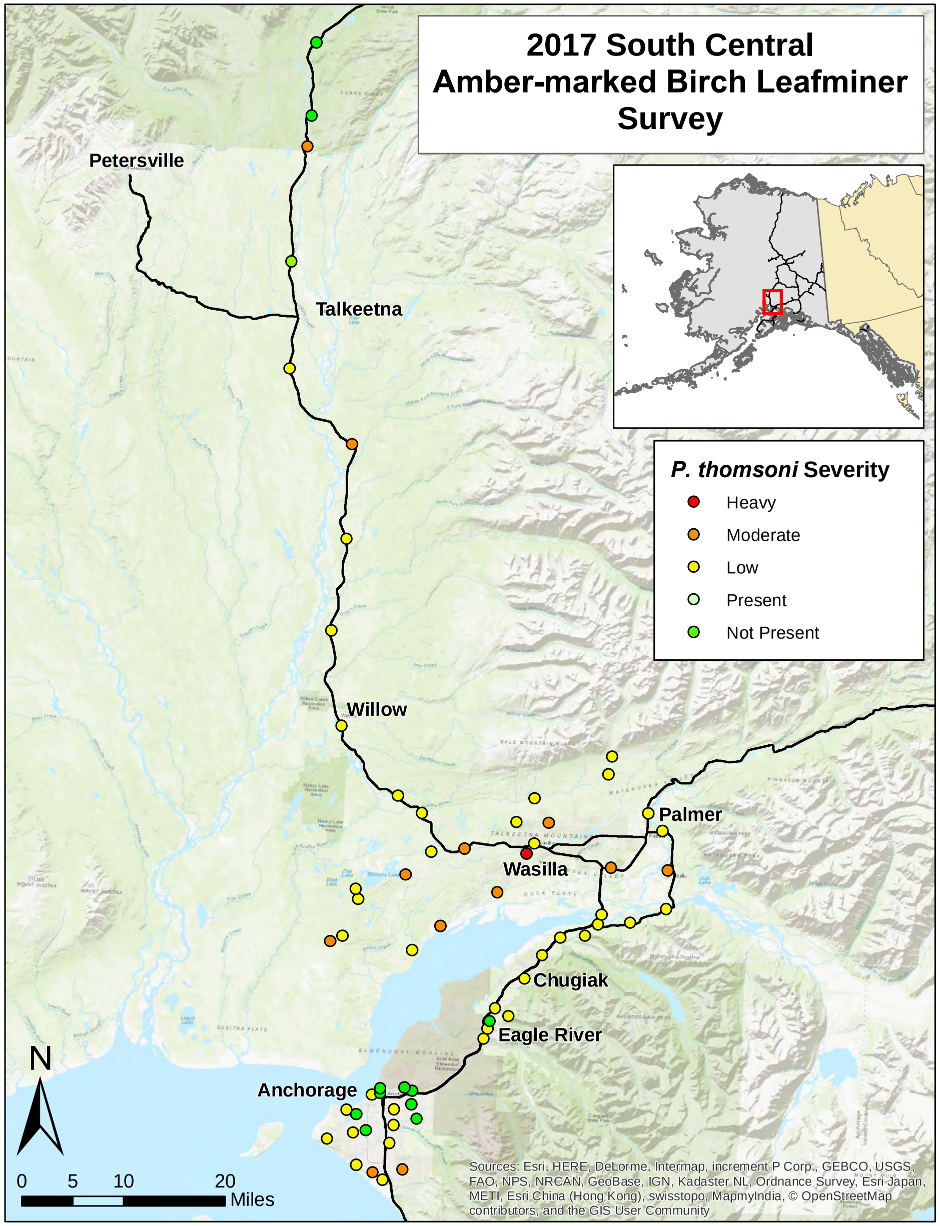


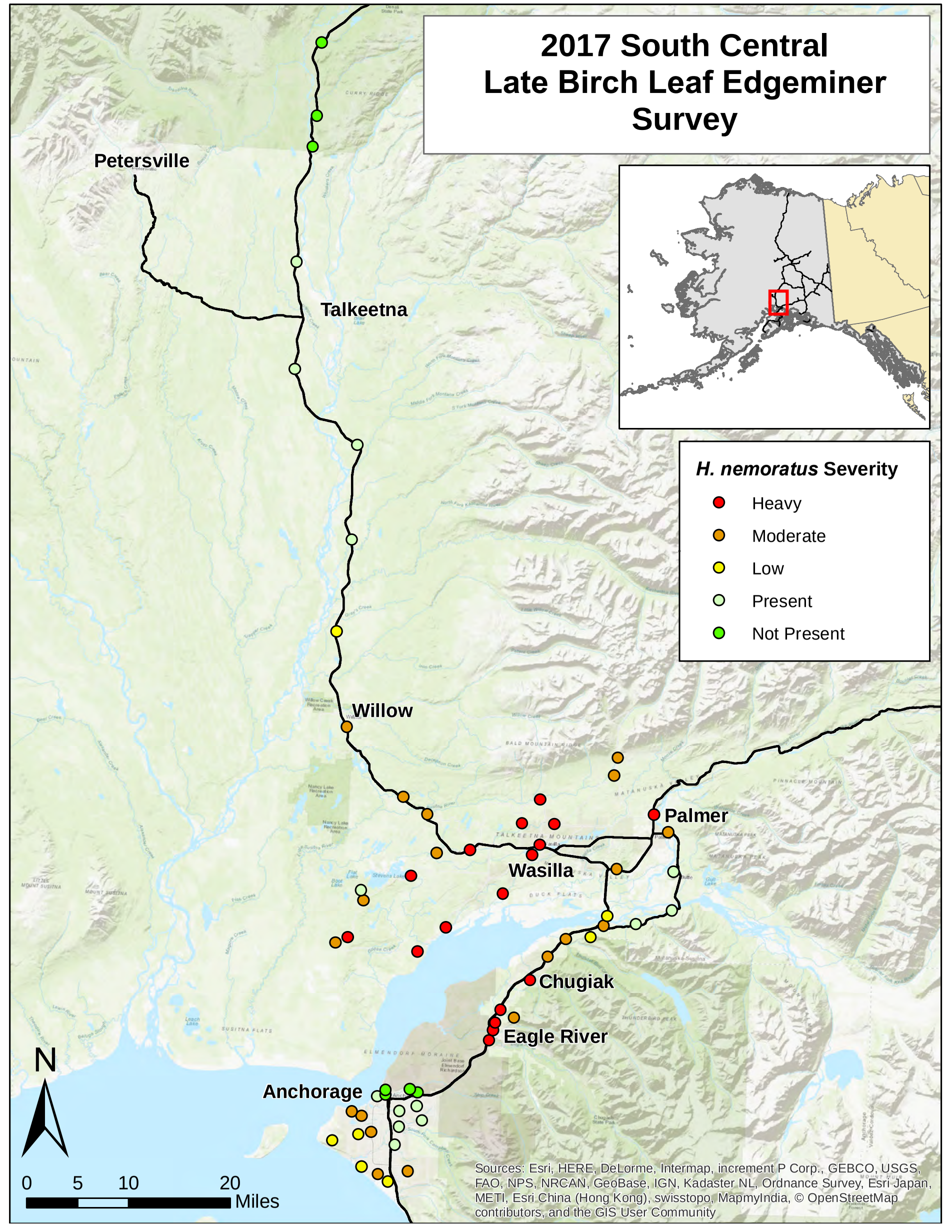

**Figure 39.** Severity of birch leafminers within Anchorage – 2006 to 2017.

**Figure 40.** Late birch leaf edge miner and amber-marked birch leaf miner activity on birch found at Creamers Field in Fairbanks.

**Map 6.** Severity of the amber-marked brich leafminer at various locations in Southcentral Alaska from Anchorage north.




**Map 7.** Severity of the late birch leaf edgeminer at various locations in Southcentral Alaska from Anchorage north.



**Willow Leafblotch Miner**
*Micurapteryx salicifoliella* (Chambers)

Willow leafblotch miner damage mapped during aerial survey decreased by half from 145,000 in 2016 to approximately 73,000 acres in 2017. The drop in acreage from 2016 could be as a result of less acreage flown in the Yukon Flats than previous years. Regardless, this is still the second greatest number of acres mapped since 2010. Over 70,000 acres of damage occurred in the Interior, and consistent with past years, the majority of damage (roughly 40,000 acres) occurred within the Yukon Flats. Approximately 2,000 acres of damage were mapped throughout western Alaska and 20 acres in Southcentral along Turnagain Arm in Indian.

In addition to the damage observed during aerial detection survey, substantial willow leaf blotch miner activity was observed along many Interior roads, including those in Fairbanks and North Pole. Willows along Chena Hot Springs Road and the Parks, Elliott, Steese, Taylor, Alaska, and Richardson Highways (Figure 41), as well as many local campgrounds, also had considerable willow leafblotch miner damage. Damage became less severe along the Dalton Highway and was absent north of Coldfoot. Southcentral reported very little additional willow leafblotch miner damage to that observed during the aerial surveys.

**Figure 41.** Willow leafblotch miner damage collected along the Parks Highway. In 2017 such damage was observed along most interior Roads.

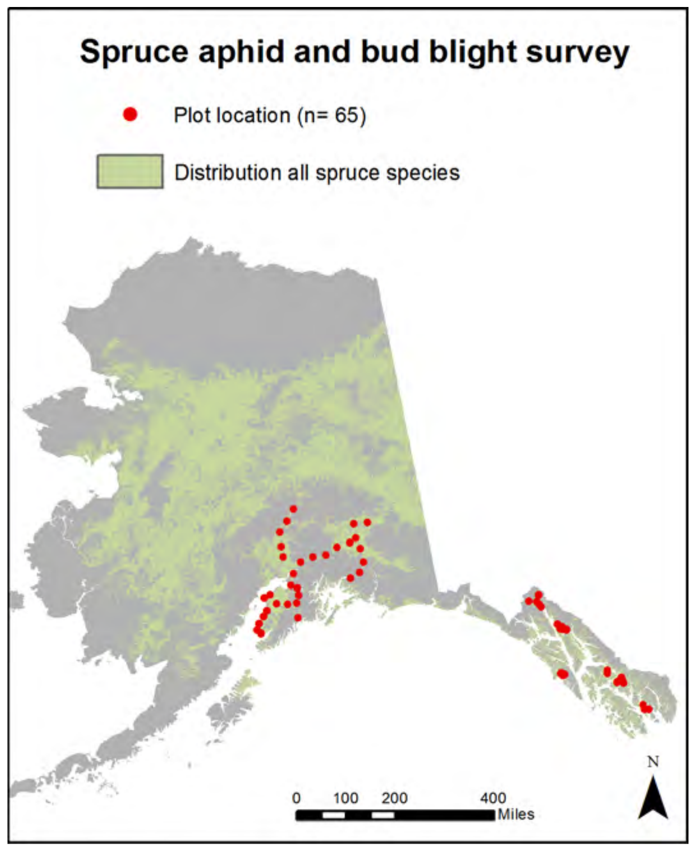
## Softwood Defoliators

**Spruce Aphid**
*Elatobium abietinum* (Walker)

A plot network was established throughout the state to monitor and detect spruce aphid and spruce bud blight (Map 8). During the survey, live spruce aphids were detected at eleven locations, all in Southeast. Spruce aphid activity drastically decreased throughout Southeast and the Kenai Peninsula after the cold winter of 2016/2017. Defoliation attributed to spruce aphid was observed on roughly 400 acres during aerial surveys in 2017, down from 34,200 acres in 2016.

With aphid populations down, ground surveys were conducted in the Homer area and on the south side of Kachemak Bay to determine the impact of the recent aphid outbreak on trees in the area. A five-class scale ranging from trace to very heavy was used to rate damage severity. On the south side of Kachemak Bay, 56 individual Sitka spruce trees were surveyed along the North Eldred, Saddle, and Lagoon trails within Kachemak Bay State Park. The Saddle and Lagoon trails are near Halibut Cove, where spruce aphid was first detected in the area, and the North Eldred trail is about eight miles southwest of Halibut Cove. At North Eldred, 86% of the trees surveyed exhibited trace to light aphid damage, whereas surveyed forests closer to the Halibut Cove area exhibited more of a range of damage severities (46% Trace to Light, 54% Moderate to Very Heavy). No aphid-caused tree mortality was observed in the surveyed areas on the south side of Kachemak Bay. Trees were additionally surveyed for spruce beetle and spruce bud blight which were not observed.

**Map 8.** Plot locations for surveying spruce aphid and spruce bud blight in Alaska.



These surveys included sites between Homer and Soldotna that were assessed during 2016, while aphid populations were extremely high. During the return visit, 80 trees were rated for damage severity, 10 of which had died. Nine of the dead trees had been identified as damage class 5 (very heavy) and 1 of the trees was rated as damage class 4 (heavy). In surveys conducted on the Kenai Peninsula in 2017, no live aphids were observed. Surviving aphid-impacted trees appeared to be recovering (Figure 42).

Spruce aphid activity was low throughout Southeast. Spruce aphid monitoring in Juneau showed an increase in population during the fall then crashed in November when temperatures reached single digits. Another cold winter will help to keep populations low and allow the trees to recover.

**Figure 42.** Spruce aphids are typically found on the underside of needles, note the discoloration caused by their piercing mouthparts.

**Spruce Budworm**
*Choristoneura fumiferana* (Clemens)
*Choristoneura orae* Freeman

In 2017, 330 acres of spruce budworm damage was recorded: 265 acres from a continuing outbreak on white spruce just north of Eagle on the banks of the Yukon River and 65 acres in Wrangell-Saint Elias National Preserve, at the toe of Long Glacier. This is the second year that an outbreak has been recorded near Eagle. The Eagle Campground was visited in September of 2017 and moderate spruce budworm damage was observed on white spruce (Figure 43). It is likely that this level of moderate damage observed (Figure 44) on the ground, is not intense enough to see from the air. Since 2004, spruce budworm populations have been monitored between the cities of Nenana and Fairbanks; in 2017 trapping efforts were expanded to include locations from Healy to Coldfoot, increasing the monitoring area by approximately 400 miles. Budworm trap captures were low along the sampled transect, indicating endemic population levels.

**Figure 43.** Spruce budworm damage in the Eagle Campground. Detritus and old pupal cases can be seen.

**Figure 44.** Moderate spruce budworm damage found throughout the Eagle Campground.

**Conifer Defoliation**
*Acleris gloverana* (Walsingham)
*Cecidomyiidae* sp.
*Cinara piceae* (Panzer)
*Dasineura swainei* Felt
*Neodiprion tsugae* Middleton
*Pikonema alaskensis* (Rohwer)
*Pikonema dimmockii* Cresson
*Zeiraphera* spp.

Defoliation of western and mountain hemlock defoliation continues to be low throughout Southeast Alaska. The most common defoliators are hemlock sawfly (*Neodiprion tsugae*) which only feed on hemlock and western blackheaded budworm (*Acleris gloverana*) which feed on both hemlock and spruce. General conifer defoliation was detected on approximately 1,000 acres, entirely in Southeast Alaska. The damage was distributed in small patches throughout the area, the heaviest concentration on Kupreanof and Prince of Wales Islands. Several agents are likely responsible. For instance, in Juneau, the damage was from a combination of hemlock canker (page 21), spruce needle blight (Page 18), late-winter drought (Page 28), and spruce aphid (Page 46).

As a result of the spruce aphid/bud blight monitoring survey, several minor defoliating and gall-making damage agents of spruce were noted that are not commonly observed during aerial survey or other monitoring efforts. Most occurred at low or moderate levels; the observations detailed below provide valuable baseline data of native defoliators.

Giant conifer aphids (*Cinara piceae*, Figure 45), a native pest of Sitka spruce, cause yellowing of foliage and reduced growth. They were encountered more often during the spruce aphid and bud blight survey than the non-native spruce aphid in Southeast. Spruce bud midge (*Dasineura swainei*) was common throughout Southcentral and the Interior. Although this insect usually causes little damage, a handful of heavily affected white spruce saplings in the Fairbanks area were observed with nearly every bud damaged by spruce bud midge.

Spruce bud moth (*Zeiraphera* sp. Figure 46) was common throughout Interior, Southcentral and Southeast Alaska. The larvae use silk to attach to the bud cap to the shoot and safely feed underneath. When populations are high spruce may appear red and fading from a distance but upon closer inspection it becomes apparent that the discoloration is actually the bud cap.

A spruce shoot gall midge, possibly *Piceacecis* sp., was observed throughout Southeast Alaska causing bent twigs, swellings, and needle drop of previous year's shoots (Figure 47). It was first observed damaging Sitka spruce at the Wrangell City Park (Figure 48). The same damage was observed at a single location in Interior Alaska along Chena Hot Springs Road at the Rosehip Campground within Chena River State Recreation Area. These would be the first reports of the genus in Alaska; however, heavy parasitism of the midge by several different species was also observed in Southeast which indicates it is likely native.

The yellow-headed and green-headed spruce sawflies (*Pikonema alaskensis* and *P. dimmockii*) were observed feeding on Sitka spruce throughout Southeast. Their feeding damage was minimal but was consistently observed during ground surveys.

**Figure 45.** Giant conifer aphids are often found feeding at the base of the needles of Sitka spruce.

**Figure 46.** Larva of the spruce bud moth, it uses silk to secure the bud cap thereby allowing them to feed on the new shoots under shelter.

**Figure 47.** Exit holes of the spruce shoot gall midge. Larvae feed inside previous year's shoots causing deformity and eventually needle drop. Pupal skins of parasitoid of spruce shoot gall midge also present.

**Figure 48.** Bent, engorged and deformed twigs caused by the spruce shoot gall midge. Damage was typically in the lower branches and only have a minor impact on tree health.

## Bark Beetles

### Spruce Beetle

*Dendroctonus rufipennis* (Kirby)

Spruce beetle activity (Figure 49) was observed on nearly 405,500 acres during aerial surveys this year, more than double the 193,500 acres observed in 2016 (Map 9). Numerous projects are ongoing to monitor spruce beetle populations from Interior to Southeast Alaska. These aerial and ground surveys confirm that a spruce beetle outbreak is occurring in Southcentral Alaska, primarily concentrated in the Susitna River valley and adjacent drainages.

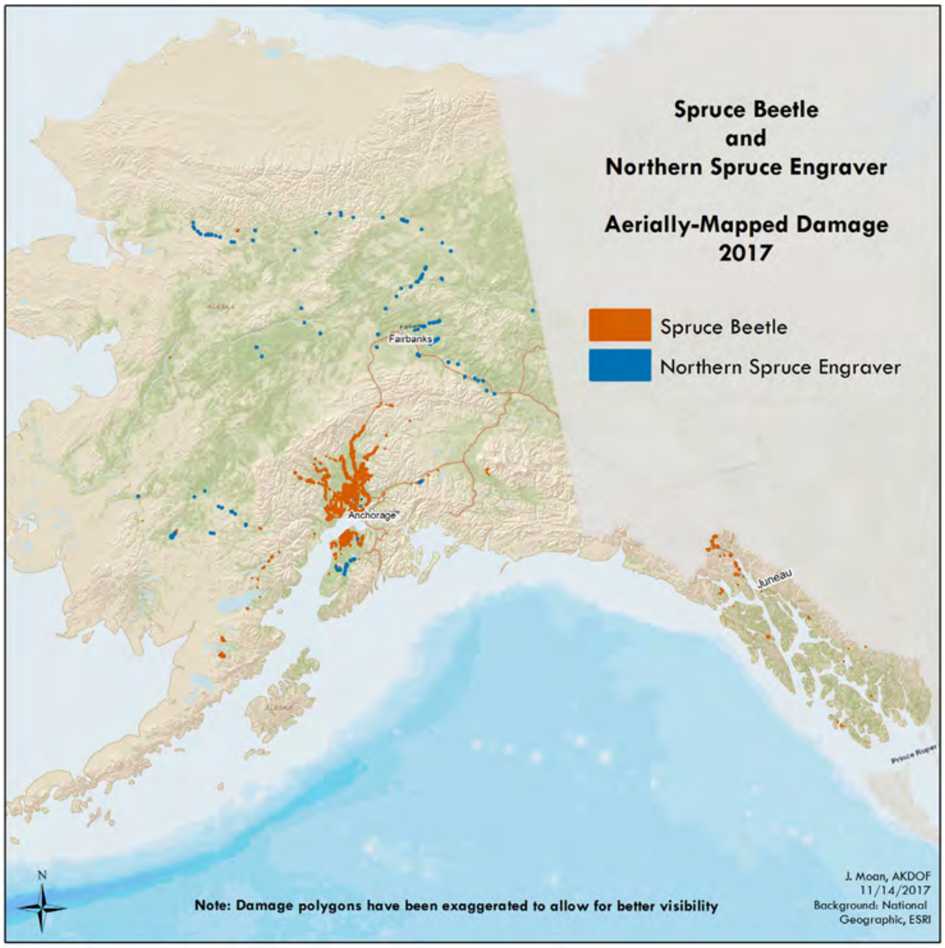
All surveyed areas experiencing notable spruce beetle activity are listed below, along with the damage acreage in 2016, where applicable. ***Areas without 2016 acreages listed either weren't flown or lacked notable damage in 2016.***

**Southcentral - Western: Susitna River valley and Kenai Peninsula:**

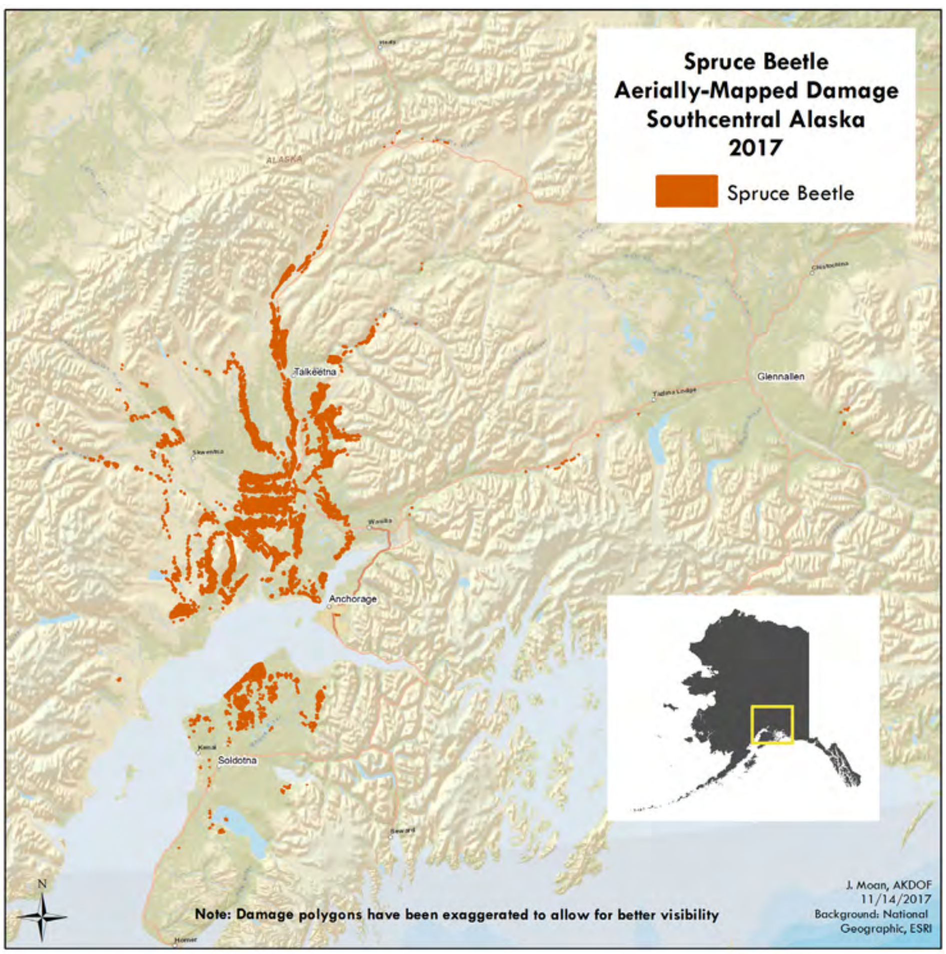
Of the 405,500 acres of damage observed statewide in 2017, more than 95% is occurring in the Susitna Valley, adjacent drainages, and on the northwestern Kenai Peninsula (Map 10). In both of these regions, the damage observed rose significantly in 2017 over that observed in 2016. In the Susitna River Valley and adjacent drainages, roughly 337,000 acres of spruce beetle damage were mapped in 2017 and 55,000 acres of damage were mapped on the northwestern Kenai Peninsula. In 2016, approximately 174,000 acres of damage were observed in the Susitna River Valley and adjacent drainages and 16,000 acres of spruce beetle damage were mapped on the Kenai Peninsula. When we account for differences in the amount of spruce surveyed in the impacted areas each year, the estimated percent increase in spruce beetle damage in 2017 over 2016 for the Susitna River valley area and the Kenai Peninsula are 68% and 261%, respectively. Analyzing the information in this way allows for the two years' data to be more reliably compared when differing amounts of the geographic area were surveyed each year.

Many of the affected forests within the outbreak area are composed of a mix of white, Lutz, and black spruce and birch; the proportion of spruce in these forests varies. White and Lutz spruce trees being attacked in the outbreak area range from mature large diameter trees to poletimber-sized trees around 5 or 6-inch diameter. Large diameter ornamental spruce in these areas are also being attacked and killed. Non-typical host trees, such as black spruce, are also being attacked; roughly 2,100 acres of black spruce mortality observed during the 2017 aerial surveys was attributed to spruce beetle attack. Less commonly, attacks have also been observed on Scots pine and Siberian larch, as previously discussed. The acreage observed in 2017 marks the most area impacted by spruce beetle in a given year since 1997, which was the year immediately following the peak of the spruce beetle outbreak in the 1990s.

**Figure 49.** Spruce beetle damage mapped along the Susitna River in 2016. Photo by Jason Moan, Alaska Department of Forestry.




**Map 9.** Spruce beetle and northern spruce engraver damage mapped during aerial detection survey in 2017.




**Map 10.** Observed spruce beetle damage in Southcentral Alaska.

**Susitna River Valley and adjacent drainages - areas affected (337,000 acres)**
All areas surveyed in this region showed some level of spruce beetle activity; however, we were not able to survey the entirety of the valley, and some notable survey gaps exist. In 2017, surveys did not cover the area roughly bounded by the Kahiltna River, downstream from Treasure Creek to the confluence of the Kahiltna and Yentna Rivers, and west to the Yenlo Hills. This area was also devoid of surveys in 2016. Attempts will be made to assess the spruce beetle activity in this area in 2018.

Significant damage was noted in the areas listed below. As there is much overlap in the areas of damage in this region, summarized acres values for the individual areas below were not calculated.

- Central Susitna River Valley between the lower Kahiltna River and Parks Highway near Kashwitna
- North along the Susitna River and Little Susitna River from Bell Island and Point McKenzie through the Houston, Willow, and Talkeetna areas.
- Chijuk and Kroto Creeks from their lower portions upstream to the Petersville Road area
- North from the Talkeetna area along the Chulitna River to Hurricane
- Beluga Lake/Mount Susitna area

Spruce beetle activity also appears to be building around Big Lake and Meadow Lakes and in the western part of the valley along the Yentna and Skwentna Rivers near the Yenlo and Shell Hills.

**Kenai Peninsula – areas affected (55,000 acres)**
Spruce beetle activity continued to build in the northwestern portion of the Kenai Peninsula. Over the last few years, spruce beetle damage on the peninsula has been concentrated in the northwest and has rarely been mapped in the Soldotna area and south. In 2017, however, scattered small pockets of spruce beetle damage were noted in the area of Kenai, Soldotna, and Kasilof (128 acres). Additionally, spruce beetle damage was documented just south of Skilak Lake and in areas immediately west and south of Tustumena Lake. Some of these areas of activity are adjacent to or otherwise near areas impacted by the Funny River Fire in 2014.

- Northwestern corner of Kenai Peninsula, north and east of Nikiski, west of the Moose and Chikaloon Rivers, and north of Sterling (45,892 acres; 13,903 acres in 2016)
- Nikiski area (1,867 acres; 279 acres in 2016)
- Skilak Lake north to Chikaloon Bay along the western edge of the Chugach Mountains (6,066 acres; 2,021 acres in 2016).
- Skilak Lake: south shore from Swan Lake to King County Creek (521 acres)
- Tustumena Lake: western edge near Berg Lake, on Caribou Island, and near Nikolai Lake (602 acres)

**Southcentral – Eastern: Copper River valley (266 acres)**
The data discussed in this section cover the Copper River basin and west along the Glenn Highway to the Matanuska Glacier. Overall, spruce beetle activity in this area remains low, though the region has seen a slight increase from 2015 with damage concentrated in two main areas: the Eureka area and the Chetaslina River area.

- Chetaslina River and East Fork Chetaslina River (128 acres, 55 acres in 2016)
- Lion Head to Mendeltna Creek (138 acres)

**West and Southwest (9,900 acres):**
Spruce beetle damage has been persistent in Lake Clark National Park and Katmai National Park for several years and the acreage affected has fluctuated. Katmai National Park saw a significant increase in spruce beetle damage in the area of Naknek Lake, both on the northwestern shore of Lake Colville (2,668 acres) and south of Brooks Camp along the Iliuk Arm of Naknek Lake (5,422 acres). In Lake Clark National Park, spruce beetle damage is scattered in small patches from the Tazimina River up the eastern shore of Lake Clark and up the Tlikakila River to Moose Pasture Pass.

- Katmai National Park (8,090 acres; 558 acres in 2016)
- Lake Clark National Park (963 acres; 1,730 acres in 2016)
- Eastern shore of Iliamna Lake (435 acres)
- Holitna River near Taylor Mountains; large areas of NSE damage were also mapped in this area (386 acres)

**Southeast (2,025 acres):**
Spruce beetle damage in Southeast Alaska generally consists of scattered small pockets of activity, though spruce beetle outbreaks can and have occurred in this region. The spruce beetle activity detected on the Stikine River in 2016 was confirmed from the ground in that year but did not persist. The damage documented in 2017 is concentrated in the northern portions of Southeast, north of Juneau. Specific areas affected throughout Southeast are listed below.

- Haines area: Klehini River (211 acres)
- Haines area: Takhin River (171 acres, 43 acres in 2016)
- Endicott River, near Lynn Canal (721 acres, 64 acres in 2016)
- Along Fingers and Berg Bays near Willoughby Island (600 acres)
- Excursion River, north of Excursion Inlet (77 acres)
- Southeast of Windham along the Chuck River (118 acres)
- Stikine River (5 acres, 277 acres in 2016)
- Cleveland Peninsula (46 acres)
- Baker Island and Suemez Island, near Bucareli Bay (60 acres)

## Spruce Beetle Attacks on Non-Spruce

When beetle populations are high, spruce beetles and other related bark beetles are known to occasionally attack non-spruce conifers. Limited instances of non-spruce conifers being attacked by bark beetles have been reported within the Susitna River Valley. Attacks on Scots pines (*Pinus sylvestris*) were observed and less commonly, attacks on Siberian larch (*Larix sibirica*) (Figure 50).

As Scots pines and Siberian larch are not native to Alaska and our native *Dendroctonus* bark beetles in Southcentral Alaska don't typically attack non-spruce hosts, there was a need for prompt identification of the beetles responsible for the attacks. Beetles were collected from attacked Scots pine and Siberian larch in this area and sent to the Oregon Department of Agriculture (ODA) for identification. Taxonomist Jim LaBonte (ODA) identified a subset of the collected beetles as males and, through examination of the seminal rod, confirmed the beetles as *Dendroctonus rufipennis*.

Many of the initial attacks on both non-native tree species appeared to have been unsuccessful, though gallery initiation was observed at several attack sites in Scots pine and in at least one attack site in larch. Lodgepole pine (*Pinus contorta*) were also present in many of the locations where Scots pines have been attacked, though no attacks have yet been observed in lodgepole pine in these areas. It is unclear at this time whether these beetle attacks in non-spruce hosts will be successful, both in terms of beetle reproductive success and in causing tree mortality. The progression of these attacks will be closely followed in 2018.

**Figure 50.** Bark beetle attacks on Scots pine (L) and on Siberian larch (R). In both cases, attacking beetles were confirmed to be the spruce beetle.

INSECTS

**Northern Spruce Engraver**
*Ips perturbatus* (Eichhoff)

Northern spruce engraver (NSE) activity was observed on 6,000 acres in 2017, which represents a 58% decrease from the 14,400 acres mapped in 2016 (Map 9). The acres of damage observed in 2017 are similar with NSE damage acres mapped during most years since 2011. Most NSE activity observed in 2017 occurred along or near the major river systems and their tributaries in the northern and central portions of Interior Alaska, which is consistent with historical patterns. Some small pockets of NSE activity were also noted on the Kenai Peninsula in the vicinity of recent fires.

Of note, NSE activity within the 2012 Tanana River Valley windstorm area between Delta Junction and Tok dropped considerably. In 2017, 360 acres of damage was observed in this area, compared to the roughly 8,200 acres of NSE activity observed in 2016. The 360 acres of damage observed this year is more in the range of damage noted in 2015 (665 acres) and 2014 (122 acres). This drop in observed damage cannot be explained solely by a change in flight coverage as there is much overlap between the 2017 and 2016 areas surveyed.

Monitoring of NSE populations has been ongoing since 2014 in a portion of the wind-impacted forests near Quartz Lake. Elevated populations of NSE were detected from 2014-2016 in many of the locations monitored in this area. No NSE damage was noted during the aerial surveys in this area in 2017 (403 acres in 2016) and processing of 2017 monitoring trap collections is currently underway. It remains to be seen if the 2017 monitoring traps will reflect a similar downward trend in NSE populations in the area.

Surveyed areas experiencing 50 or more acres of NSE activity are listed below. The largest two polygons of NSE damage observed in 2017 were 2,847 acres and 834 acres. These damage polygons are located approximately 5 miles apart in southwestern Alaska along the Holitna River.

***All acreages should be considered the total of several scattered small areas of damage unless otherwise noted. Areas without 2016 acreages listed either weren't flown or lacked notable damage in 2016.***

- Kobuk River Valley: Ambler to Akoliakruich Hills (167 acres, 10 acres in 2016)
- Along Teedriinjik (Chandalar) River from Caro to 15 miles southeast of Venetie (70 acres)
- Beaver Creek from Three Lakes south to Windy Creek (162 acres, 545 acres in 2016)
- Fairbanks Area: West of Fairbanks into Minto Flats, south to Tanana River at Nenana, north to Snowshoe Pass (60 acres, 954 acres in 2016)
- Chena River: near Pleasant Valley up Middle Fork to Blackshell Creek (184 acres, 271 acres in 2016)
- Salcha River from McCoy Creek upstream to Stone Boy Creek (494 acres, 730 acres in 2016)
- Tanana River area: Tanacross to Twentymile Lake (254 acres; 6,253 acres in 2016)
- Tanana River area: Goodpaster Flats to Healy Lake (84 acres, 216 acres in 2016)
- Tanana River area: Robertson River to near Cathedral Rapids (104 acres)
- Tanana River area: west side of river near Harding Lake (139 acres)
- Tanana River - Vachon Island to Yukon River to lower Tozitna river (82 acres)
- Holitna River near Taylor Mountain (3,681 acres)
- Stony River from Tishimna Lake to near Telaquana River (96 acres)
- Kenai Peninsula between and around Skilak and Tustumena Lakes (311 acres – 194 acres in white/ Lutz spruce & 117 acres in black spruce)

**Western Balsam Bark Beetle**
*Dryocoetes confusus* (Swain)

Western balsam bark beetle damage was observed on 39 acres in 2017, up from 27 acres in 2016. Activity tends to be concentrated in scattered pockets along the Skagway River near White Pass Fork and half of the 2017 mapped damage acreage was in this area. Two other small pockets of damage were noted outside of this area: western slope of Mt. Clifford (15 acres) and northwest slope of Twin Dewey Peaks (2 acres).

Western balsam bark beetle damage continues to be a minor component of the overall bark beetle damage mapped statewide annually, but a nonetheless important one. Western balsam bark beetle attacks subalpine fir (*Abies lasiocarpa*), which has a very limited range in Alaska.

**Urban Tree Pests**
*Caloptilia* spp. Hübner
*Dendroctonus rufipennis* (Kirby)
*Elatobium abietinum* (Walker)
*Epinotia solandriana* (L.)
*Euceraphis betulae* (Koch.)
*Heterarthrus nemoratus* (Fallén)
*Pikonema alaskensis* (Rohwer)
*Pristiphora erichsonii* (Hartig)
*Profenusa thomsoni* (Konow)

In 2017, spruce beetle was the most frequently observed pest in urban trees in Southcentral Alaska. Ground observations of spruce beetle damage and homeowner calls requesting identification or information on spruce beetle from the Anchorage bowl, the Kenai Peninsula, and the Matanuska-Susitna Valley were up from 2016. A survey of public lands in Anchorage conducted in the summer and fall of 2017 has found few instances of spruce beetle activity in the survey plots, though ornamental spruce beetle-killed trees were observed during the surveys in several parts of town. This survey also resulted in the identification of several additional Gemmamyces bud blight locations in Anchorage.

Dusky birch sawfly larvae and damage were identified from several ornamental trees in Fairbanks in 2017. These observations as well as others from the Interior are new distribution records for Alaska. Additionally, birch leaf miner damage continued to be a problem for urban birch in Interior Alaska and in parts of the Matanuska-Susitna Valley.

# APPENDICES


De Havilland Beaver float plane on a break from Western Alaska Aerial Survey, Turquoise Lake, Lake Clark National Park.

# Aerial Detection Survey Appendix I:

Aerial view of muskeg near Yakutat.

## Introduction

Aerial surveys are an effective and economical means of monitoring and mapping insect, disease and other forest disturbance at a coarse scale. In Alaska, Forest Health Protection (FHP) and the Alaska DNR Division of Forestry, monitor about 30 million acres of forest annually at a cost of less than a penny per acre. Much of the acreage referenced in this report is from aerial detection surveys, so it is important to understand how these data are collected and the data's inherent strengths and weaknesses. While there are limitations, no other method is currently available to detect subtle differences in vegetation damage signatures within a narrow temporal window at such low costs.

Aerial detection survey employs a method known as aerial sketch-mapping to observe and document forest change events from an aircraft. When an observer identifies an area of forest damage, a polygon or point is drawn on a computer touch screen. Trained observers have learned to recognize and associate damage patterns, discoloration, tree species, and other clues to distinguish particular types of forest damage from surrounding undamaged forest. Damage attributable to a known agent is a “damage signature”, and is often pest-specific.

Knowledge of these signatures allows trained surveyors to not only identify damage caused by known pests, but also to be alerted to new or unusual signatures. Detection of novel signatures caused by newly invasive species is an important component of Early Detection Rapid Response monitoring (EDRR).

Aerial sketch-mapping offers the added benefit of allowing the observer to adjust their perspective to study a signature from multiple angles and altitudes, but is challenged by time limitations, fuel availability and other factors. Survey aircraft typically fly at 100 knots and 1000 feet above ground level, and atmospheric conditions are variable. Low clouds, high winds, precipitation, smoke, and poor light conditions can inhibit the detection of damage signatures. Terrain, distance, and weather conditions prevent some areas from being surveyed altogether.

Prior to 1999, sketch-mapping was done on 1:250,000 (1 inch = 4 miles) USGS quadrangle paper maps. Today, forest damage information is sketched on 1:63,000 scale (1 inch = 1 mile) USGS quadrangle maps on a digital sketch-mapping system. This system displays the plane's location via GPS and has many advantages over paper maps including greater accuracy and resolution in polygon placement and shorter turnaround time for processing and reporting data. The sketch-map information is then put into a computerized Geographic Information System (GIS) for more permanent storage and retrieval by users. Over 35 years of aerial survey data has been collected in Alaska, giving a unique perspective of Alaska's dynamic and changing forests.

Many of the maps in this document are presented at a very small scale, up to 1:6,000,000. Depicting small damaged areas on a coarse scale map is a challenge. Damaged areas are often depicted with thick borders so they are visible, but this has the effect of exaggerating their size. This results in maps depicting location and patterns of damage better than they do the size of damaged areas.

No two observers will interpret and record an outbreak or pest signature in exactly the same way, but the essence of the event should be captured. While some observations are ground checked, many are not. Many times, the single opportunity to verify the data on the ground by examining affected trees and shrubs is during the survey mission, and this can only be done when the terrain will allow the plane to land and take off safely. Due to the nature of aerial surveys, the data provides estimates of the location and intensity of damage, but only for damage agents with signatures that can be detected from the air during the survey period. Many root diseases, dwarf mistletoe, stem decays and other destructive pathogens are not represented in aerial survey data because these agents are not detectable from an aerial view. Signs and symptoms of some pathogens (e.g. spruce needle rust) do not coincide with the timing of the survey.

Each year approximately 15 percent of Alaska's 126 million forested acres are surveyed, which equates to approximately 3 percent of the forested land in the United States. Unlike some regions in the United States, we do not survey 100 percent of Alaska's forested lands. Availability of trained personnel, short summers, vast land area, airplane rental costs, and limited time of all involved require a strategy to efficiently cover the highest priority areas.

In past years, surveys provided a non-systematic sampling of the forests via flight transects. Due to survey priorities, various client requests, known outbreaks, and a number of logistical considerations, some areas are rarely or never surveyed, while other areas are surveyed annually. The reported data should only be used as a partial indicator of insect and disease activity for a given year. When viewing the maps in this document, keep in mind Map 2 on page 8, which displays the aerial survey flight lines. Although general trends in non-surveyed areas could be similar to those in surveyed areas, this is not always the case. Establishing trends from aerial survey data is possible, but care must be taken to ensure that multi-year projections compare the same areas, and that sources of variability are considered.

Some states, such as Oregon, fly the entirety of their forest lands each year using a grid-based approach (Figure 51). Alaska has 126 million acres of forest and Oregon has 28 million, so this option would require about a six-fold increase in our aviation budget and hiring several new employees.

Another strategy would be to employ repeatable sampling methods and statistical analysis. Sampling-based methods derive conclusions from a subset of the population being measured. Employing a statistically valid sampling method would provide us with a way to document trends in the data and to measure our confidence in those trends. By surveying a portion of the state and applying statistical analysis, we could make defensible statements about trends and assign quantitative assessments about error. Using our previous methodology, only a major change in damage acres recorded from the survey could be plausibly reported as a trend. For instance, from 2015 to 2016, we saw a nearly tenfold increase in spruce beetle damage, so that even without a statistical analysis we feel confident in reporting a real, upward trend. When changes are less dramatic, we are forced to rely on professional judgment. For example, in 2016 we reported twice as much willow dieback (2750 acres) as we did in 2015 (1247 acres). Does that difference constitute a trend? Using our established methodology, we were unable to assign a statistically valid confidence interval to our trend reporting.

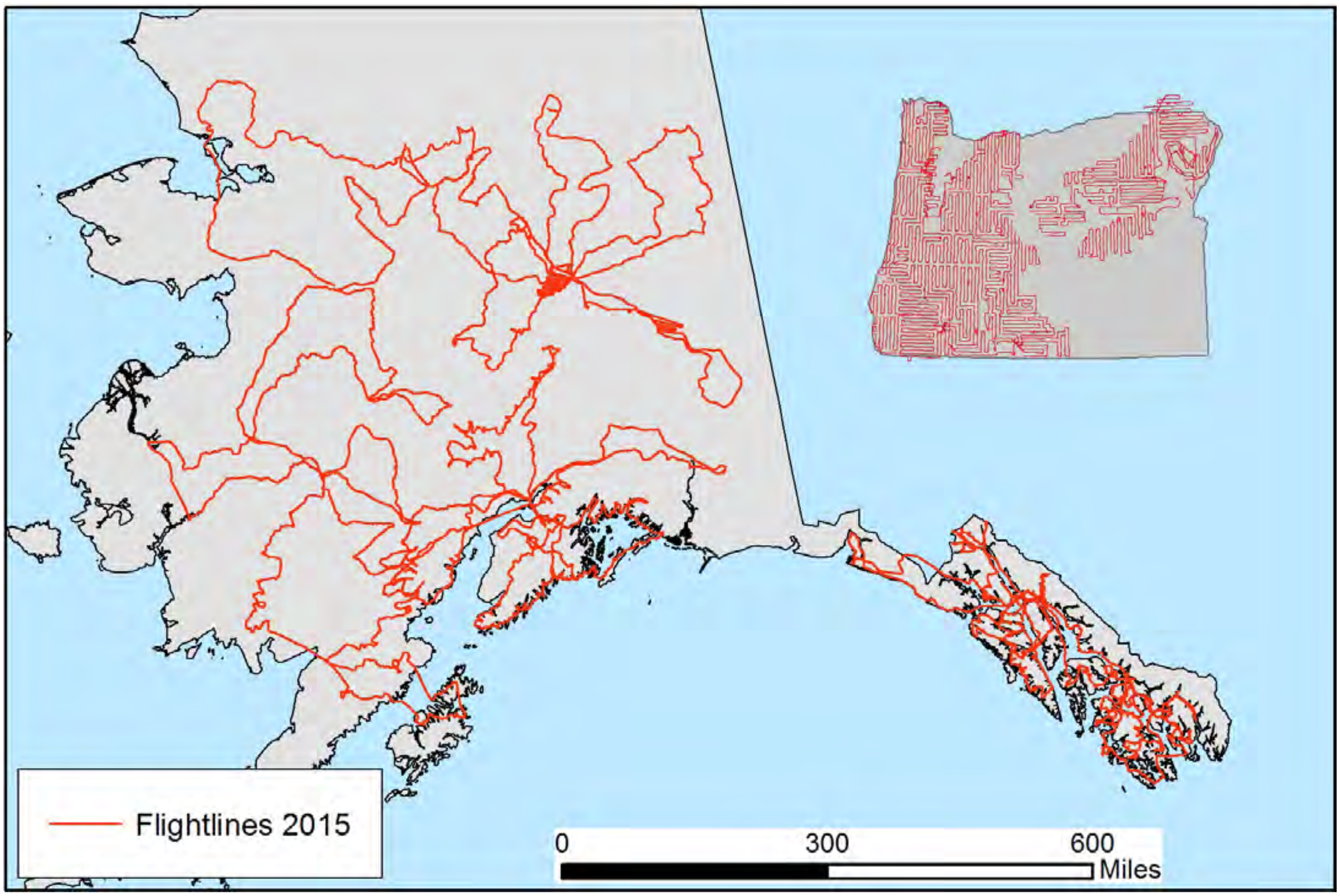



**Figure 51.** Comparison of survey coverage in Alaska and Oregon.

To address this issue, FHP and the Forest Health Assessment and Applied Sciences Analysis Team (FHAAST) have developed a sampling method that employs a scaled-up version of a sampling technique often used in field biology. For example, you could estimate number of blades of grass on your front lawn by randomly dropping small square frames on your yard, counting the blades of grass in each frame and calculating the total number in proportion to the total area of your yard. By looking at the variation from frame to frame, one could estimate the accuracy of the count. In our case, we scaled up that method to Alaska's 126 million acres of forest using a 20 x 20 mile sample frames, or cells. Within each sample cell, the aircraft makes a series of passes with flightlines spaced four miles apart, a spacing typically considered to be the effective distance at which surveyors can see substantial damage events. Flightlines follow a grid pattern in areas of low relief (Figure 52) and follow river drainages (Figure 53) in mountainous areas.

The 20 x 20-mile area was chosen to provide a balance between optimizing time spent surveying and sampling a large enough area to capture significant forest change. Cells were randomly assigned to achieve a sample spread across the forested area of the state and to ensure that we adequately survey seven forest tree species of interest. It was initially determined that a minimum of 80 sample cells and 80 alternate cells would provide the needed sample size and flexibility to achieve a reasonable confidence interval statewide (Figure 54).

In 2016, we tested our ability to plan and execute this sampling-based approach. We surveyed 22 sample cells wall-to-wall and reconnoitered an additional 41 cells to evaluate their suitability (presence if trees, accessibility, and safety). Results of the trial showed that the methodology is achievable given a commitment of additional budgetary and personnel resources on the order of a 1.5 to 2 times increase in survey budget and staff time.

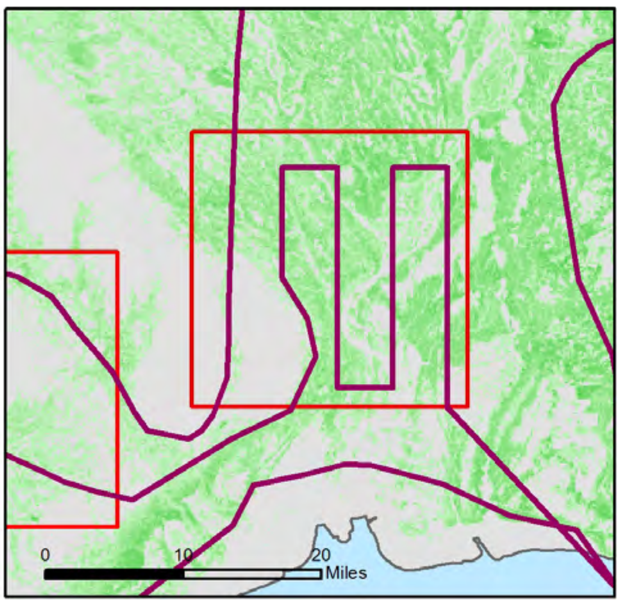



**Figure 52.** Grid Pattern.

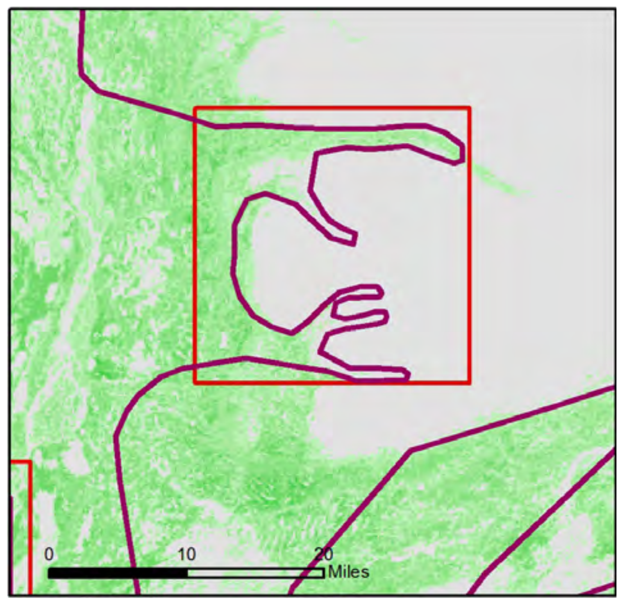



**Figure 53.** Drainage Pattern.

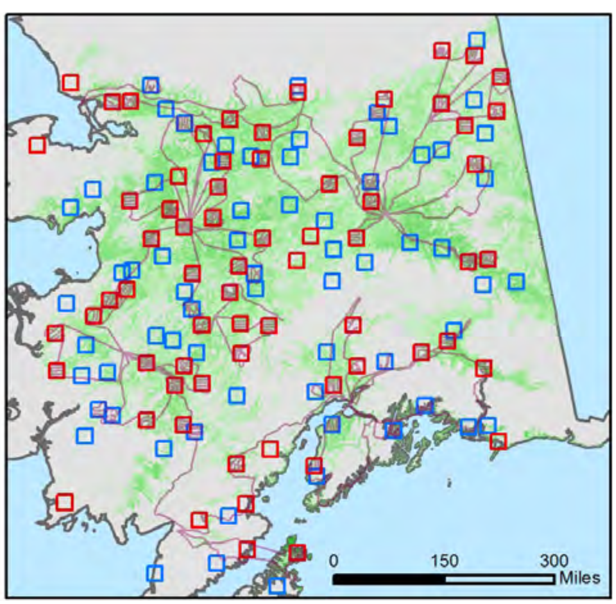



**Figure 54.** First draft sample design.

Lacking the increased resources needed to fully sample forests statewide, in 2017 we focused our sampling strategy on three areas of the state, comprising about 1/3 of the forested areas of the state. This subset focused sampling on more populated road-accessible areas and managed forests. This allowed us to provide a defensible sampling based strategy to the most accessible areas, while still allowing us to reconnoiter the more far-flung areas of the state (Figure 55). We were able to fly all of the sample cells needed to achieve an appropriate sample size.

Future work will involve further optimization of this sample design based on the specific goals of representing major forest damage agents while keeping sample size within budgetary constraints. Methods worked out here may be applied to other parts of the US. In the future, a combination of remote sensing and sampling can potentially replace the wall-to-wall methodology used elsewhere and contain costs nationally without losing data accuracy.

## Ground-Truthing

Ground-based verification is necessary to improve the quality of aerial survey data. The plane's speed and elevation lead to uncertainty in our ability to accurately identify damage and to place the damage in a geographically precise way. Surveyors also need regular feedback on their aerial observations to give them insight on the causal agents behind the damage signature.

However, there are several impediments to ground-truthing including limited time, personnel, and access. While some damage types, such as bark beetles, canker diseases, or cedar decline leave damage signatures that are more persistent on the landscape, many other types of damage are short lived. For example, most defoliating insects only cause damage as larvae; by the time the damage is noted from the air the larvae may have pupated and dispersed as adults. Trees defoliated early in the growing season may produce a second flush of leaves, hiding the damage. This means that for many types of damage, especially defoliation, verification must be made in a timely manner. Access is perhaps the biggest challenge. Alaska has very few roads, vast acreages of forest, and the most remote country in the US. Even forests that are close to roads can be difficult to access due to rugged terrain.

A closer view can sometimes be gotten from a roadside overlook, often aided by binoculars; but usually we hike to the damage site. All too often cliffs, canyons, marshes, or no trespassing signs are in the way. Our field trips for other purposes take us far and wide, and we are always keeping aerial survey verification in mind when in the field. New tablet-based data technology

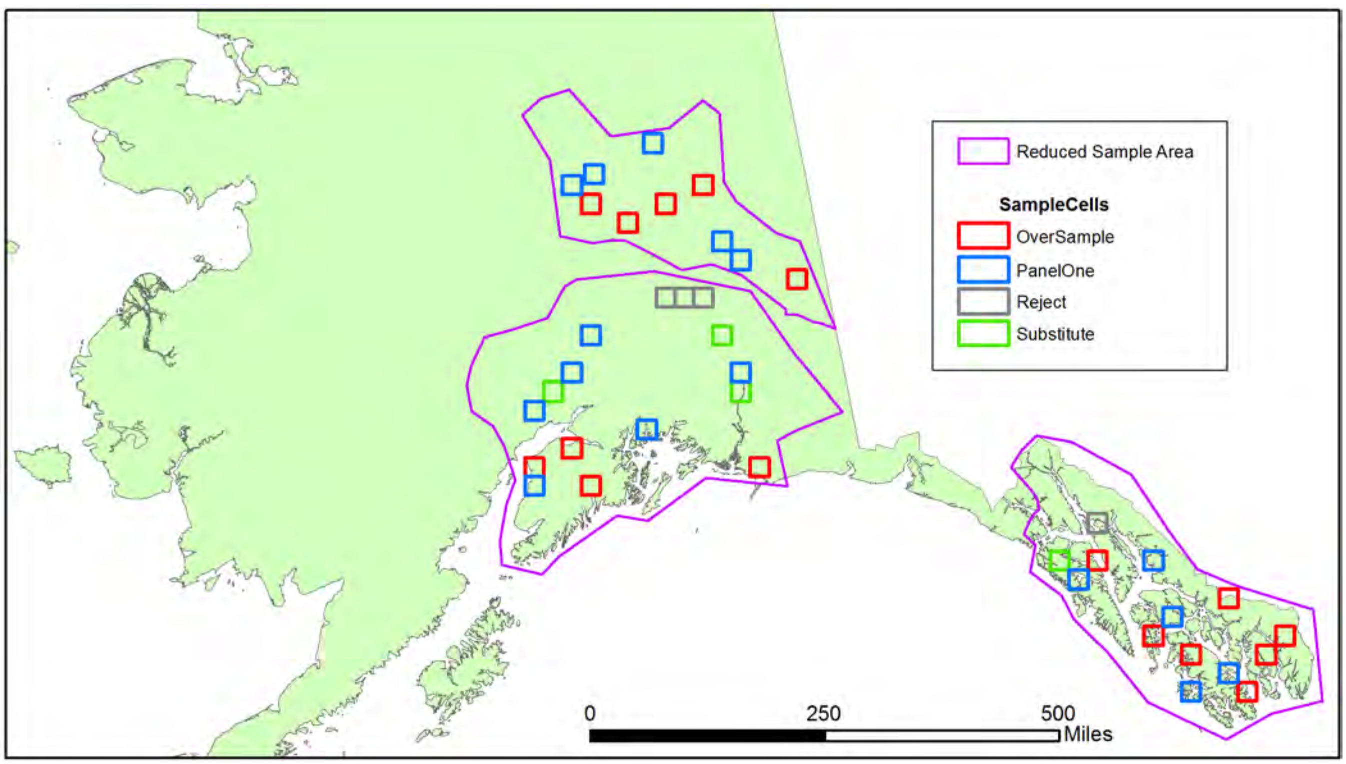



**Figure 55.** Reduced sample area with three zones.

allows us to quickly access aerial survey data from the ground in near-real time. Remote areas off the road system, accounting for the majority of mapped acreage, are never visited unless an on-the-spot visit can be made by halting the survey, landing the survey float plane and seeing the site close-up. In most years we manage a handful of these spot visits, but the decision must be made quickly and carefully - the damage site has to be near a water body suitable for takeoffs; and the flight crew has to balance the need for the information against the increased time, fuel, and risk.

A promising new technology is small unmanned aerial vehicles (UAV) carrying cameras or other sensors. FHP has conducted test flights with the University of Alaska Center for Unmanned Aerial Systems Integration to prove this concept. A number of technical and regulatory issues need to be addressed before this tool could be used; but we may eventually use UAVs to capture close-up imagery to verify observations from manned fixed-wing aircraft.

## Ground-Truthing Summary

A total of 13 polygons were reported as ground-checked using digital sketchmapping system. These resulted in confirmation of polygon spatial placement and minor refinements of damage causing agent.

A number of other sites were checked more informally. This included confirmation of alder defoliation within four polygons in downtown Juneau. Five sites were checked by Sara Cleaver with Duke University in Yakutat. Information confirmed scattered damage to hemlock and spruce but was unable to confirm widespread damage.

Spruce budworm in Eagle: Staff ground checked Eagle Campground, very close to an area along the Yukon River that had moderate spruce budworm damage for the last two years. The campground showed moderate signs and symptoms of spruce budworm. Nearly every tree we inspected at the campground had spruce budworm damage to some degree. Because it is difficult to get to them, we didn't inspect the mapped stand or the polygons along the river. We can't comment on placement, but we are quite sure that they are coded correctly as spruce budworm.

Willow leafblotch miner and aspen leaf miner in the Interior: The bulk of the damage coded in the interior in 2017 was attributed to willow leafblotch miner and aspen leaf miner. Although a great deal of mined willow and aspen were quite accessible, most polygons coded as willow leafblotch miner and aspen leaf miner were not located close enough to access points to be inspected. Willow leaf blotch miner affected about 75-80% of all the willow and aspen leaf miner affected 60-70% of aspen.

## How to request surveys and survey data

We encourage interested parties to request aerial surveys, and our surveyors use these requests and other information to determine which areas should be prioritized. Areas that have several years' worth of data collected are surveyed annually to facilitate analysis of multi-year trends. In this way, general damage trend information for the most significant, visible pests is assembled and compiled in this annual report. It is important to note that for much of Alaska's forested land, the aerial detection surveys provide the only information collected on an annual basis.

Forest insect and disease data can be obtained through the FHP Mapping and Reporting Portal (http://foresthealth.fs.usda.gov/portal/).

A number of applications are available, offering access to forest health data from Alaska and nationwide. The IDS Explorer (http://foresthealth.fs.usda.gov/IDS) allows the user to interactively visualize forest damage by agent and geographical area and print an area of interest. High quality full size 1:250,000 scale USGS quad maps may be generated with forest damage on them and downloaded as pdfs. GIS data from 1997 (by selecting all years when downloading) to the present can be downloaded from the site for all agents by state or region.

Other applications available on the Portal include forest pest conditions, data summaries, alien forest pest database, forest disturbance monitor, risk maps, tree species distribution data, forest health advisories, hazard rating information, and soil drainage and productivity. All available information within the FHP Mapping and Reporting Portal is on a national scale. Some products may not be complete for Alaska.

For aerial survey requests or data prior to 2009, contact Tom Heutte at theutte@fs.fed.us. Alaska Region Forest Health Protection also has the ability, as time allows, to produce customized pest maps and analysis tailored to projects conducted by partners.

**Aerial Detection Survey Data Disclaimer:**
Forest Health Protection and its partners strive to maintain an accurate Aerial Detection Survey (ADS) dataset, but due to the conditions under which the data are collected, FHP and its partners shall not be held responsible for missing or inaccurate data. ADS are not intended to replace more specific information. An accuracy assessment has not been done for this dataset; however, ground checks are completed in accordance with local and national guidelines (http://www.fs.fed.us/foresthealth/aviation/qualityassurance.shtml). Maps and data may be updated without notice. Please cite "USDA Forest Service, Forest Health Protection and its partners" as the source of this data in maps and publications.

# Appendix II: Damage Type by Host Species

**Abiotic**
Flooding
Landslide/avalanche
Windthrow
Winter damage

**Alder Defoliation**
Alder defoliation
Alder leaf roller
Alder sawfly

**Alder Dieback**
Alder dieback

**Aspen Defoliation**
Aspen defoliation
Aspen leaf blight
Aspen leaf miner
Large aspen tortrix

**Birch Defoliation**
Birch aphid
Birch defoliation
Birch leaf miner
Birch leaf roller
Dwarf birch defoliation
Spear-marked black moth

**Cottonwood Defoliation**
Cottonwood defoliation
Cottonwood leaf beetle
Cottonwood leaf miner
Cottonwood leaf roller

**Fir Mortality**
Western balsam bark beetle
Hardwood defoliation
Hardwood defoliation
Speckled green fruitworm

**Hemlock Defoliation**
Hemlock looper
Hemlock sawfly

**Hemlock Mortality/Dieback**
Hemlock canker
Hemlock mortality

**Larch Defoliation**
Larch budmoth
Larch sawfly

**Larch Mortality**
Larch beetle

**Shore Pine Damage**
Dothistroma needle blight
Shore pine dieback

**Spruce Damage**
Spruce aphid
Spruce broom rust
Spruce budworm
Spruce defoliation
Spruce needle cast
Spruce needle rust

**Spruce Mortality**
Northern spruce engraver beetle
Spruce beetle

**Spruce/Hemlock Defoliation**
Black-headed budworm
Conifer defoliation

**Willow Defoliation**
Willow defoliation
Willow leafblotch miner
Willow rust

**Willow Dieback**
Willow dieback

**Yellow-Cedar Decline**
Yellow-cedar decline

# Appendix III: Information Delivery

## Publications:

Bidlack, A., S. Bisbing, B. Buma, D. D'Amore, P. Hennon, T. Heutte, J. Krapek, R. Mulvey and L. Oakes. 2017. Alternative interpretation and scale based context for "No evidence of recent (1995-2013) decrease of yellow-cedar in Alaska" (Barrett and Pattison 2017). Canadian Journal of Forest Research. 47:1145-1151. https://doi.org/10.1139/cjfr-2017-0070.

Hollingsworth, T., T. Barrett, E. Bella, M. Berman, M. Carlson, P. Clark, R.L. DeVelice, G. Hayward, J.E. Lundquist, D. Magness, and T. Schwörer. 2017. Chapter 6: Historic, current, and future vegetation distribution in the Chugach National Forest and Kenai Peninsula. pp. 163 – 265. In: Hayward et al. Climate Change Vulnerability Assessment for the Chugach National Forest and the Kenai Peninsula. PNW-GTR-950 368 p.

Lojewski, N., V.A. Bravo, J.E. Lundquist and R.M. Reich. 2018. Forest stand structure and the abundance and productivity of blueberry plants in Southcentral Alaska. Journal of Sustainable Forestry. (in press).

Moan, J., G.D. Dubois and S. Swenson. 2017. *Orthosia hibisci* (Guenée), the speckled green fruitworm: confirmed causing extensive hardwood defoliation in Southcentral and Western Alaska. Alaska Entomological Society Newsletter. 10:4-8. https://doi.org/10.7299/x7p55npx.

Seybold, S.J., B.J. Bentz, C.J. Fettig, J.E. Lundquist, R.A. Progar and N.E. Gillette. 2018. Management of western North American bark beetles with semiochemicals. Annual Review of Entomology. 63: 407-432.

Winton, L.M. 2017. Widespread aspen canker disease in Alaska. Briefing paper.

Winton, L.M. 2017. Spruce bud blight in Alaska. Briefing paper.

## Presentations:

Box, B. 2016. Insects of the forest. Homer Middle School. December 9. Homer, AK. Oral presentation.

Box, B. 2017. Forest insects. Rabbit Creek Community Assn Day Camp, July 10. Anchorage, AK. Oral presentation.

Box, B. 2017. Forest entomology in Alaska. University of Alaska Anchorage STEM Day. September 17. Anchorage, AK. Oral presentation.

Box, B. and J.E. Lundquist. 2017. Field identification and assessment of forest insects in Alaska. FIA Training Session. May 15. Anchorage, AK. Oral presentation.

Burr, S.J. 2017. 2016 Forest health conditions & key insect species in Alaska. Alaska Entomological Society. February 4. Fairbanks, AK. Oral Presentation.

Burr, S.J. 2017. Trees, insects, & firewood. 13th Annual Sustainable Agriculture Conference. February 23. Fairbanks, AK. Oral Presentation.

Burr, S.J. 2017. Where the maxilla meets the meristem: an examination of how bark beetles kill ponderosa pine in northern Arizona, Society of American Foresters. April, 19. Fairbanks, AK. Oral Presentation.

Burr, S.J. 2017. Forest insects of the Alaskan Interior. FIA Tree Damage Training Session. May, 19. Fairbanks, AK. Oral Presentation.

Graham, E.E. 2017. Insects in the forest. Jensen-Olsen Arboretum. Juneau, AK. Oral Presentation.

Graham, E.E. 2017. Forest health update for the Tongass National Forest. September. Tongass National Forest Silviculture Meeting. September 22. Ketchikan, AK. Oral presentation.

Graham, E.E. and R.L. Mulvey. 2017. Spruce bud blights of Alaska. September. Tongass National Forest Silviculture Meeting. September 22. Ketchikan, AK. Oral presentation.

Graham, E.E. 2017. Entomology in Alaska. December. Alaska Native Science and Engineering Meeting. Juneau, AK. Oral presentation.

Lundquist, J.E. 2017. Forest insects on the Chugach NF. Chugach NF Forest Plan Revision Committee. February 1. Anchorage, AK. Oral presentation.

Lundquist, J.E. 2017. Spruce beetles in Alaska – A short history. Alaska Forum on the Environment, Anchorage. February 6. Anchorage, AK. Oral presentation.

Lundquist, J.E., J. Moan, and J. Moan. 2017. The Forest health trail at the Alaska Botanical Gardens. 98th Annual Western Plant Meeting. May 12. Anchorage, AK. Oral presentation.

Lundquist, J.E. and B. Box. 2017. Forest insects of the Kenai Peninsula. UAF NRM 290 Field Trip. May 12. Cooper Landing, Alaska. Oral presentation.

Mulvey, R.L. 2017. What's happening to our pines: shore pine health near Gustavus, AK? Gustavus Community Center Sciences Series. Gustavus Public Library. June. Gustavus, AK. Oral presentation.

Mulvey, R.L. and E.E. Graham. 2017. Spruce bud blight monitoring in Southeast Alaska. Sitka Ranger District. Sitka, AK. August. Oral presentation.

Mulvey, R.L. and E.E. Graham. 2017. Young-growth yellow-cedar decline. Yellow-Cedar Biology, Ecology and Emerging Knowledge Summit. October 24. Juneau, AK. Oral presentation.

Mulvey, R.L., L.M. Winton and G. Adams. 2017. Next generation sequencing with Koch's Postulates to discern causal agent(s) of dieback on western hemlock, Southeast Alaska. Mycological Society of America. July 16-19. Athens, GA. Oral presentation.

Shephard, M.E. 2017. Updates on Alaska forest health and other State and Private programs for the Tongass. Tongass National Forest Leadership Team Meeting. July 19. Petersburg, AK. Oral Presentation.

Shephard, M.E. and D.A. Hollen. 2017. Updates on State and Private programs for R10 & R06 with specific examples for Alaska. Office of Management and Budget and others. August 28. Juneau, AK. Oral Presentation.

Shephard, M.E. and D.A. Hollen. 2017. Updates on Alaska forest health and other State and Private programs for the Chugach. Chugach National Forest Leadership Team Meeting. October 17. Anchorage, AK. Oral Presentation.

Winton, L.M. 2017. Common & problem tree diseases in Interior & Southcentral Alaska. Woodlot Management Workshop: Annual Alaska Sustainable Agriculture Conference. February 21. Fairbanks, AK. Oral presentation.

Winton, L.M. 2017. Key forest diseases of Interior and Southcentral Alaska. Chugach Land Management Planning Committee, February 2. Anchorage, AK. Oral Presentation.

Winton, L.M. 2016. Gemmamyces bud blight of spruce in Alaska. Western International Forest Disease Work Conference: Foliage & Twig Disease Committee. October 4. Parksville, BC, Canada. Oral Presentation.

Winton, L.M. 2017. Common aspen diseases of Alaska's boreal forest. Aspen workshop, May 9-13. Sitka, AK. Oral Presentation.

Winton, L.M. 2017. Forest diseases of Southcentral Alaska. FIA Tree Damages Training Session. May 11. Anchorage, AK. Oral presentation.

Winton, L.M. 2017. Forest diseases of Interior Alaska. FIA Tree Damages Training Session. May 12. Fairbanks, AK. Oral presentation.

Wurtz, T.L. 2017. Bird vetch: an invasive plant likely to affect woodlots in Alaska. Woodlot Management Workshop of the 13th annual Alaska Sustainable Agriculture Conference, Invasive plants in woodlots. February 21. Fairbanks, AK. Oral presentation.

Wurtz, T.L. 2017. Invasive species and fire suppression activities. Interagency Spring Fire Operations Meeting. March 31. Fairbanks, AK. Oral presentation.

Wurtz, T.L. 2017. Does Alaska really have to worry about invasive species? Western Plant Board annual meeting. May 9. Anchorage, AK. Oral presentation.

Wurtz, T.L. 2017. Invasive species: why you should care? AK DNR training session on invasive species. June 27. Fairbanks, AK. Oral presentation.

## Trip Reports

Box, B. Road survey of spruce on the Swanson River road and inspection of spruce forest in the vicinity of Rainbow Lake Campground-Trip Report. Forest Health Protection R10S&PF-FHP. May 17, 2017.

Box, B. Assessment of spruce trees impacted by 2016 spruce aphid outbreak in Homer, Alaska Trip Report. Forest Health Protection R10S&PF-FHP. August 11, 2017.

Box, B. Site surveys of damage and recovery of Sitka spruce trees in Homer following 2016 infestation of invasive spruce aphid Trip Report. Forest Health Protection R10S&PF-FHP. 2017.

Box, B. Assessment of spruce health in Homer following the 2016 spruce aphid infestation. Trip Report. Forest Health Protection R10S&PF-FHP. 2017.

Box, B. Observations of mixed hemlock and spruce stands along the Copper River highway in Cordova, Alaska. Trip Report. Forest Health Protection R10S&PF-FHP. September 18, 2017.

Box, B. 2017. Second assessment of spruce health, and observation of spruce bud blight in Homer following the 2016 spruce aphid infestation Trip Report. Forest Health Protection R10S&PF-FHP. October 11, 2017.

Burr, S.J. Request to assess private property in Delta Junction, AK-Trip Report. Forest Health Protection R10S&PF-FHP. August 21, 2017.

Burr, S.J. and G.D. Dubois. Interior Alaskan birch leafminer survey 2017-Trip Report. Forest Health Protection R10S&PF-FHP. August 21, 2017.

Dubois, G.D. and S.J. Burr. Interior Alaska campground forest health surveys-Trip Report. Forest Health Protection R10S&PF-FHP. August 28, 2017.

Graham, E.E. and K. Hutten.Woronofski Forest Health Assessment-Trip Report. Forest Health Protection R10S&PF-FHP. June 13, 2017.

Swenson, S. and G.D. Dubois. Special aerial survey mission: Shell Lake, Sevenmile Lake and Chakachamna Lake- Trip Report. Forest Health Protection R10S&PF-FHP. June 9, 2017.

Swenson, S. Western aerial survey field notes- Trip Report. Forest Health Protection R10S&PF-FHP. December 5, 2017.

Swenson, S. and J.E. Lundquist. Spruce beetle damage along the Parks Highway to Trapper Creek and out Petersville Road-Forest Health Protection R10S&PF-FHP. June 14, 2017.

www.fs.usda.gov/main/r10/forest-grasslandhealth
From a TTY call 711 to be connected to (907) 743-9455.