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Forest Health Conditions in Alaska—2008

A Forest Health Protection Report

Alaska Forest Health Specialists

U.S. Forest Service, Forest Health Protection

Alaska Forest Health Specialists

U.S. Forest Service, Forest Health Protection http://www.fs.fed.us/r10/spf/fhp/

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On the cover: Photo of the Bonasila River, west of the Yukon River, taken during the annual 2008 aerial survey.

Forest Health Conditions in Alaska—2008

FHP Protection Report R10-PR20

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U.S. Forest Service, Department of Agriculture. Alaska Region, Forest Health Protection

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Introduction

By Steve Patterson

I am happy to present to you the *Forest Health Conditions in Alaska—2008* report. One of the primary goals of this report is to summarize monitoring data collected annually by our Forest Health Protection team. The report helps to fulfill a 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 component information for the annual *Forest Insect and Disease Conditions in the United States* report. In addition, the *Forest Health Conditions in Alaska—2008* report facilitates accomplishment toward an integral part of our core mission: technical assistance for you, our stakeholders. Our hope in presenting this report is that it will help resource professionals, land managers, and other decision-makers identify and monitor existing and potential forest health risks and hazards. In reality, this report is an integration of a vast array of information from many sources summarized and synthesized by our forest health team. It's as much about your forests as it is reflective of our collective abilities to monitor and describe their conditions.

The information in this report was generated as a combined effort with many cooperators, partners, and other stakeholders, especially our "forest health team," the staff of the State of Alaska, Department of Natural Resources, Division of Forestry and the University of Alaska Cooperative Extension Service.

There are approximately 127 million acres of forested land in Alaska. In 2008, we completed aerial detection of 36.4 million acres, supplemented by ground surveys, permanent plot monitoring efforts, site visits, and early detection work. That's a remarkable feat of dedication and effort. The Cooperative Extension Service alone made more than 14,000 educational contacts with citizens and conducted hundreds of site visits. All this was completed with several key staff positions temporarily vacant (including the CES Invasive Plant Coordinator, DOF Forest Health Coordinator, Forest Service permanent technicians in Anchorage and Fairbanks) and our Fairbanks entomologist, Jim Kruse, having been called to a year of active duty in Iraq. My sincere thanks to all of our forest health team and to Chuck Frank (who detailed into Fairbanks from the Ottawa National Forest): you rallied to make this report as complete and accurate as possible. Our team is incredible!

This report is organized around three categories of damaging agents: insect pests, diseases and declines, and invasive plants. Each category is then organized by the extent of the individual agent's impact. Where acreage extent is not known, our staff has estimated the relative extent of these agents. Please check out and refer others to our website **http://www.fs.fed.us/r10/spf/fhp**, for information about submitting specimens for identification, integrated pest management, Alaska Forest Health Protection Strategic Plan, World Wide Web resources, USGS quad maps showing forest damage from the 2008 aerial detection survey, publications, and forest health updates.

I invite you to read this report at whatever pace or in whatever mode you might choose: find a pest or condition of concern, look for what's changed since last year, examine the focus-on pieces, or study it cover-to-cover. I hope you find the information of interest and value, but please let me or any of the contributors know how we can improve future versions of this report to make it more useful for you. The coming year promises to be one marked by further change and new accomplishment. I hope you can interface with our forest health team, especially the new members, to provide data and/or observations to make this report relevant and reflective of the true scope and magnitude of impacts from insects, disease, abiotic conditions and invasive plants to our cherished forests of Alaska.

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Alaska Forest Health Highlights

2008 Survey Year

State & Private Forestry, Forest Health Protection (FHP), together with Alaska Department of Natural Resources (DNR), conducts annual statewide aerial detection surveys across all land ownerships. In 2008, staff and cooperators identified over 450,000 acres of forest damage from insects, disease, declines and selected abiotic agents on over 36.4 million acres surveyed (**Map 1**). This marks a notable decrease in aerially-observed forest disturbance as compared to recent years (**Table 1**). The decline may be due to the fact that all across Alaska, 2008 was a relatively cool, wet year. The aerially-recorded damage numbers generally do not represent the acres affected by pathogens, since many of the most destructive disease agents (i.e. wood decay fungi, root diseases, dwarf mistletoe, canker fungi, etc.) are not visible by aerial survey. Additional information regarding forest health provided by ground surveys and monitoring efforts is also included in this report, complementing the aerial survey findings. Forest Health Protection staff also continually work alongside many agency partners on invasive plant issues, including roadside and high-impact area surveys, public awareness campaigns, and general education efforts.

Insects

The cool, wet weather that Alaska experienced in 2008 may have contributed to the lower damage levels for insect defoliators than were observed in previous years. In interior Alaska, this was the eighth consecutive year of outbreak of the **aspen leaf miner**, which normally attacks early in the summer and within a short time infests much of the aspen in that part of the state. At this point, aspen leaf miner populations appear to be collapsing and next year's trend will likely reveal whether this outbreak has run its course or will continue indefinitely.

Similarly, **willow leaf blotch miner** damage acres declined compared with 2007 levels. Damage caused by the **amber-marked birch leaf miner** and the **birch leaf roller** were much less obvious this year than in recent years past. Many of the birch trees examined in the Fairbanks area had some level of leaf damage caused by these two insects, but for the most part, the damage was light.

Monitoring of the **spruce budworm** continued this summer. There were very few reports of budworm larvae this spring and damage to trees was light, indicating that the

Table 1. 2008 forest insect and disease activity as detected during aerial surveys in Alaska by land ownership[1] and agent[2]. All values are in acres[3].

Damage Agent	National Forest	Native Corp.	Other Federal	State & Private	Total Acres
Aspen defoliation[4]		117	2,156		2,273
Aspen Leaf Miner		37,909	33,878	138,448	210,235
Black-headed budworm	1,737	549	121	334	2,741
Cedar decline faders[5]	8,070	254		705	9,029
Cottonwood defoliation[4]		2,259	969	9,994	13,172
Flooding/high-water damage	193	437	951	1,270	2,851
IPS and SPB[6]		3,608	4,482	7,661	15,751
Ips engraver beetle		14,006	21,710	8,159	43,875
Landslide/Avalanche	496			141	637
Large aspen tortrix		60	2,960	4,164	7,184
Porcupine damage	611	73		446	1,130
Spruce beetle	976	9,329	25,780	33,306	69,391
Spruce budworm		1,385	162	4,546	6,093
Unknown hemlock mortality	1,731	36		261	2,028
Western gall rust	35	276	3,806		4,117
Willow defoliation[7]		23,722	37,097	15,996	76,815
Windthrow/Blowdown	163	34	155	40	392

[1]Ownership derived from 2008 version of Land Status GIS coverage, State of Alaska, DNR/Land records Information Section. State & Private lands include: state patented, tentatively approved, or other state acquired lands, and of patented disposed federal lands, municipal, or other private parcels.

[2] Acre values are only relative to survey transects and do not represent the total possible area affected. Table entries do not include many of the most destructive diseases (e.g., wood decays and dwarf mistletoe) which are not detectable in aerial surveys. Damage acres from animals and abiotic agents are also not shown in this table.

[3] See appendix for a discussion about the nature and limitations of aerial detection survey data.

[4]Significant contributors include leaf miners and leaf rollers for the respective host. Drought stress also directly caused reduced leaf size or premature foliage loss.

[5] Acres represent only spots where current faders were noticed. Cumulative cedar decline acres can be found in Table 9.

[6]These acreage values are a cumulative effect IPS engraver beetle (*Ips perturbatus)* and Spruce Bark Beetle (*Dendroctonus rufipennis)* working in tandem on the same stands of trees.

[7] Acres recorded for willow defoliation are primarily from leaf miners. The affected acreage is much more extensive than can be mapped.

current outbreak is likely in decline. Again, a possible reason for the reduced activity this year may have been the unusually cool and wet summer of 2008.

In contrast to other insect activity, there was a pronounced increase in **spruce beetle** and **engraver beetle** activity in interior Alaska during summer 2008. Pockets of both spruce beetle and northern spruce engraver are still active on the fringes of the large burns of 2004 and 2005 and it's becoming more apparent that these two species are working in concert over significant areas of the interior. This complicates our survey estimates for these species. Also, this year's tally of total spruce beetle activity in the southcentral part of the state is very likely underestimated, because an unexpected reallocation of Federal funding midway into the summer eliminated that area from survey coverage. Regardless, both spruce beetle and northern spruce engraver beetles continued to maintain active populations in Alaska's interior and across several other areas in 2008.

Several small and active engraver beetle infestations were located on privately-owned parcels between Tok and Fairbanks. These likely resulted from improper slash management or the disposal of infested slash from building-site clearing, firewood cutting, or white spruce house-log cutting activities.

Forest health staff provided technical assistance and advice to several affected landowners, including direct assistance with one semiochemical *Ips* baiting and trapout project north of Fairbanks, during 2008.

Diseases

Alder *Phytophthora*, *Phytophthora alni* subsp. *uniformis*, was detected in five riparian locations in Alaska in 2007 and 2008. A very closely related pathogen is responsible for widespread mortality of alder across Europe. No alder *Phytophthora* subspecies were known to exist in natural alder ecosystems in North America before the Alaska findings. The significance of this finding and impact to Alaskan alder species is not yet understood. Monitoring and research is underway.

An apparently **new *Phytophthora* species**, currently undescribed, was also found during riparian alder surveys. Although we know very little about the hosts, ecology or pathology of the new species, we do know it is taxonomically related to several other tree pathogens of importance, including *P. lateralis*, a canker pathogen of Port Orford-cedar; *P. hibernalis*, a citrus pathogen that also can cause cankers on Port Orford-cedar; *P. foliorum*, a new species of unknown virulence and host range; and *P. ramorum*, an oak pathogen. It is agreed that the new Phytophthora isolate is unique and that its formal description is worth pursuing. Since the new isolate is in the same group (Clade 8C) which contains *P. ramorum*, the new isolate may be useful for improving the accuracy of detection assays for *P. ramorum*.

Statewide, **wood decay** and **root rot** of live trees occur on every tree species across millions of acres and, on an annual basis, substantially reduce tree volume and contribute to tree mortality. In southeast Alaska, for example, approximately one-third of the gross volume of forests is defective due to stem and butt rot fungi. Also, wood decay fungi annually cause considerable defect in mature white spruce, paper birch, and aspen stands of southcentral and interior Alaska.

In southeast Alaska, **hemlock dwarf mistletoe** continues to cause growth loss, top-kill, and mortality but also provides wildlife habitat in old-growth forests. **Yellow-cedar decline** has been mapped on approximately 500,000 acres across an extensive portion of southeast Alaska. Active tree mortality was at fairly low levels in 2008, indicating a slowing of the problem on previously-impacted acres. The cause appears to be related to spring freezing injury in open canopy forests characterized by reduced snowpack, although many areas received heavy snow the last two winters. In 2008, **spruce needle rust** (*Chrysomyxa ledicola)* occurred at the highest levels in memory in interior Alaska. Reports were received of rivers running yellow with the extremely high rust spore load.

Table 2. Affected area (in thousands of acres) for each host group and damage type over the prior five years and a 10-year cumulative sum.

Host Group/ Damage Type[1]	2002	2003	2004	2005	2006	2007	2008	Ten Year Cumulative[2]
Alder Defoliation[3]	1.8	2.8	10.5	17.3	10.6	10.0	0.7	60.0
Aspen Defoliation	301.9	351.4	591.5	678.9	509.5	796.0	2,190.7	2,923.5
Birch Defoliation	83.0	217.5	163.9	47.5	13.2	1.5	0.1	452.2
Cottonwood Defoliation	19.9	13.1	16.7	8.0	24.6	11.5	13.1	116.6
Hemlock Defoliation	1.4	0.2	0.5	0.2	0.0	0.1	0.1	8.9
Hemlock Mortality	0.2	0.0	0.0	0.1	0.0	0.0	2.0	2.6
Larch Defoliation	0.0	0.6	14.2	16.8	2.7	0.1	0.2	269.4
Larch Mortality	4.8	22.5	11.8	0.0	0.0	0.0	0.2	69.8
Spruce Defoliation	11.0	61.5	93.4	31.9	68.1	41.9	6.9	433.6
Spruce Mortality	53.6	92.8	145.2	93.8	130.6	183.9	129.1	1,115.0
Spruce/Hemlock Defoliation	3.4	15.1	1.5	1.4	1.5	10.3	2.8	81.1
Spruce/Larch Defoliation	0.0	0.3	0.0	0.3	2.8	0.0	0.0	3.4
Sub Alpine Fir Mortality	0.2	0.0	0.2	0.8	0.5	0.1	0.0	1.7
Willow Defoliation	0.3	83.9	111.2	44.5	50.7	92.7	76.8	649.3
Total damage acres	**481.5**	**861.7**	**1,160.50**	**941.5**	**814.8**	**1,148.1**	**451.75**	**6,187.09**
Total acres surveyed	24,001	25,588	36,343	39,206	32,991	38,365	36,402	
Percent of acres surveyed showing damage	**2.0**	**3.4**	**3.2**	**2.4**	**2.5**	**3.0**	**1.2**	

[1]Summaries identify damage, mostly from insect agents. Foliar disease agents contribute to the spruce defoliation and hemlock mortality totals. Damage agents such as fire, wind, flooding, slides and animal damage are not included. Cedar mortality is summarized in Table 9.

[2] The same stand can have active infestation for several years. The cumulative total is a union of all areas from 1999 through 2008 and does not double count acres.

[3] This total includes defoliation on alder from alder canker, drought and insects.

Rust fungi were at low to moderate levels in southeast in 2008, down from the peak year of 2007. The **shoot and foliar blight fungus**, ***Sirococcus tsugae***, was found at high levels and killed small mountain hemlock trees in 2008, particularly where they were planted in ornamental settings in the Juneau area. Also, the **canker fungus *Grovesiella abieticola*** was found killing ornamental true fir in Juneau.

In southcentral and interior Alaska, widespread alder mortality caused by ***Valsa melanodiscus* and other alder canker fungi** continued to intensify in all alder species. Hardwood canker fungi of birch and aspen continue to be widespread, contributing to growth loss and stem breakage. **Saprophytic decay** continues to degrade spruce beetle-killed trees. A wood deterioration study on Kenai Peninsula indicated a relatively slow overall decomposition rate (1.5%/year). Beetle-killed trees are predicted to influence fire behavior and present a hazard for over seven decades.

Except for yellow-cedar decline and foliar pathogens, most disease agents in Alaska are (1) rarely detected by aerial surveys and (2) underestimated for their presence and impacts. Most native diseases and declines are chronic factors that annually significantly influence the commercial value of timber resources and alter key ecological processes such as forest structure, composition, nutrient cycling, and succession.

Invasive Plants

FHP personnel, other Region 10 employees and a wide network of cooperators contributed to several landmark events related to invasive plant management in Alaska in 2008. Some of these events were the culmination of years of effort.

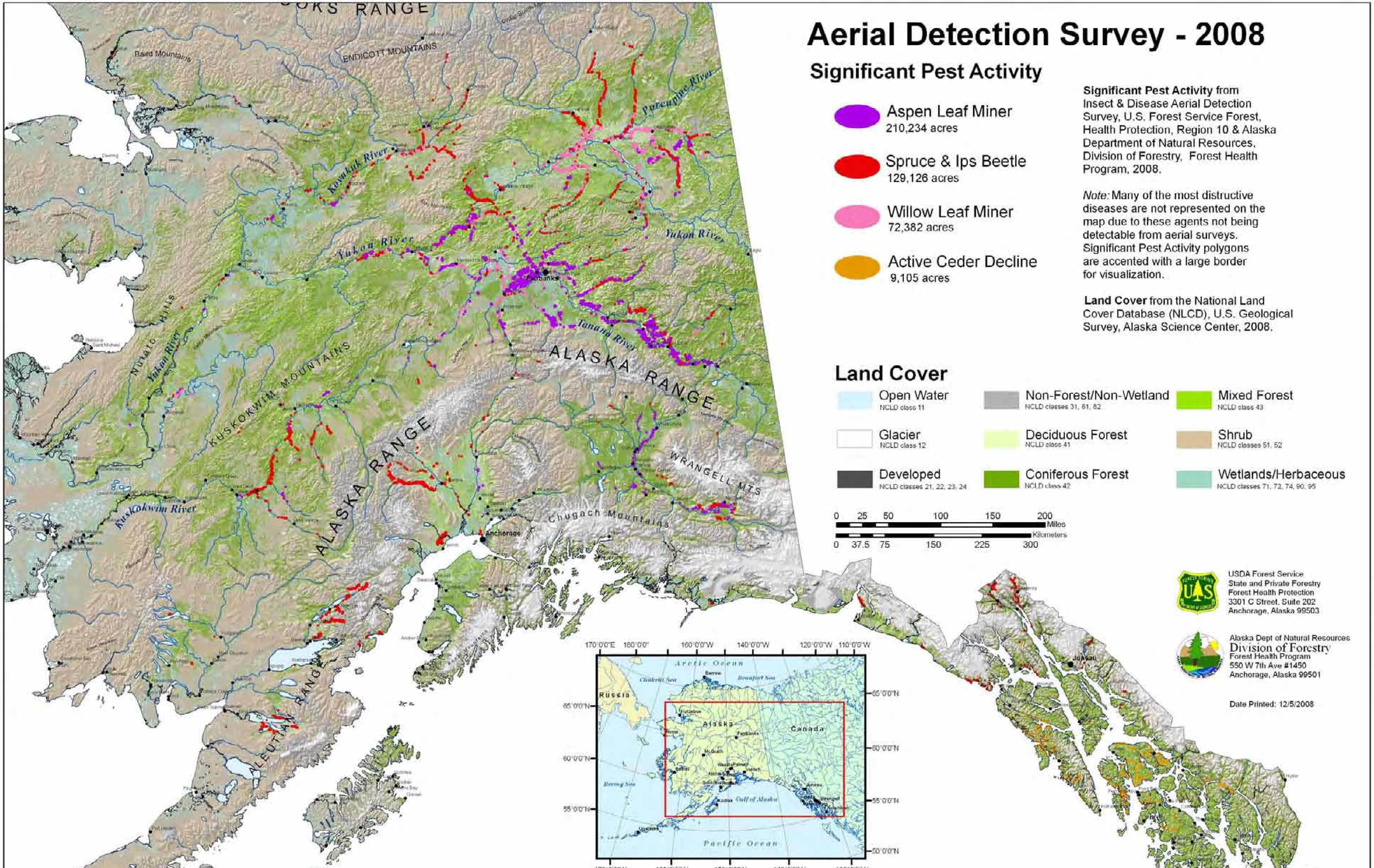
At a June 24, 2008 weed fair in Anchorage, **Governor Sarah Palin signed HB 330,** "an act relating to noxious weed, invasive plant and agricultural pest management and education." This legislation established a position of weed and pest coordinator for the state. A citizen-initiated **Cooperative Weed Management Area** in Anchorage was formally established in January 2008, with State and Private Forestry as one of the original signatories. A logo was unveiled by Governor Palin in June, and five weed pulls were conducted over the summer, focusing on **Canada thistle, orange hawkweed, Ox-eye daisy, birdvetch**, and **purple loosestrife**. On July 1, **Forest Service Chief Gail Kimbell** and **Regional Forester Denny Bschor** were briefed on cooperative invasive plant control efforts on, and adjacent to, the Chugach National Forest. They assisted in a reed canary grass control effort adjacent to the Forest.

FHP partnered with the University of Alaska Fairbanks to map invasive plants on the UAF campus. FHP will continue to be involved in the University's development of a long-term weed management plan. Many years in the making, the ***Invasiveness Ranking System for Non-Native Plants of Alaska*** was published in hard copy in 2008. The publication is the result of the combined efforts of several different authors and agencies, but FHP was among the most significant and sustaining contributors. The approach developed in this weed ranking system is being used as a model by the Invasive Plant Council of British Columbia and by The Nature Conservancy in New York.

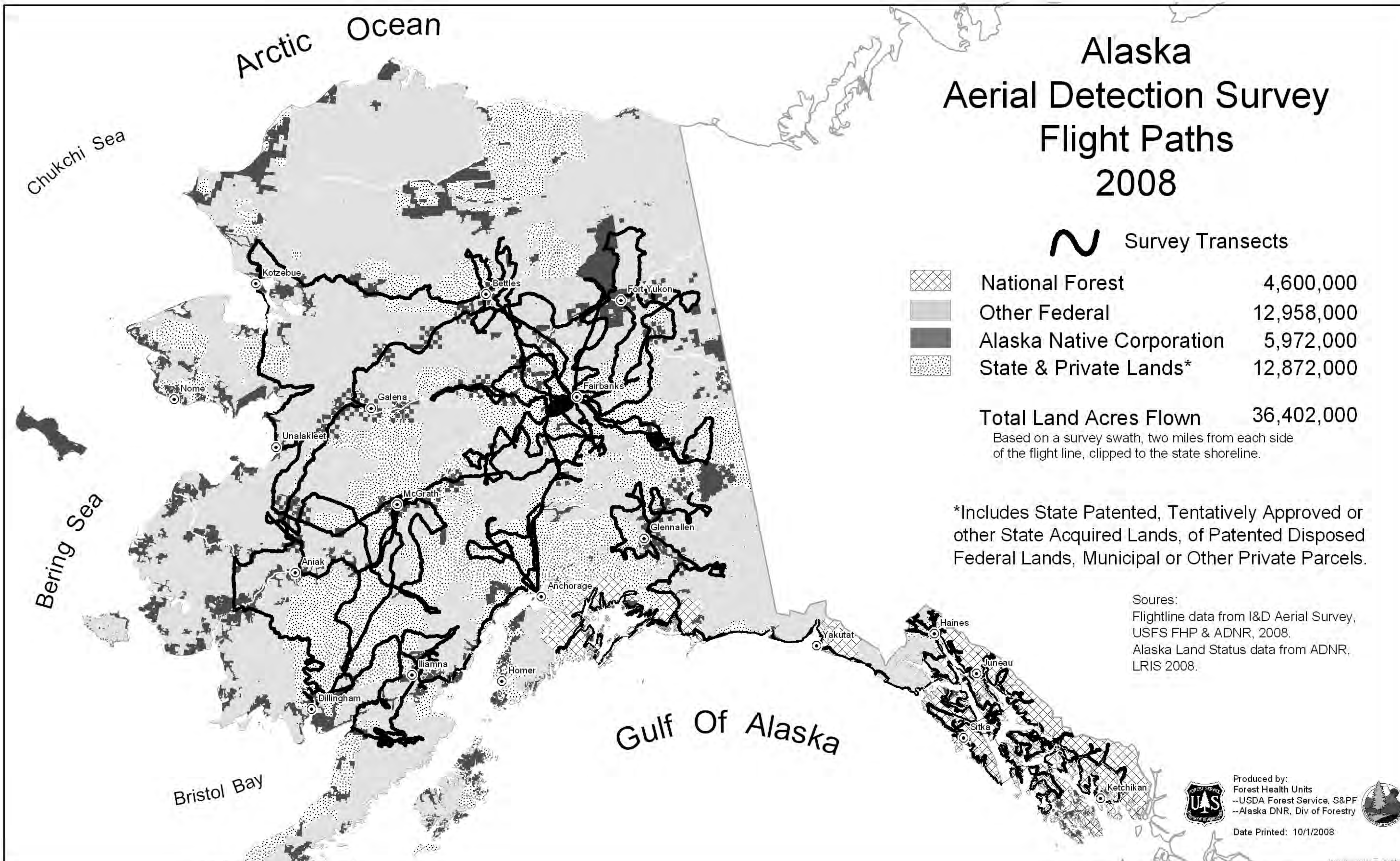
In 2008, Forest Health Protection worked with the Alaska Committee for Noxious and Invasive Plant Management, and the Alaska Division of Agriculture to encourage the government of the Yukon (Canada) to respond immediately to an infestation of **leafy spurge** that had been documented in 2007 near Dawson City, YT. This species has not yet been found in Alaska. The Yukon Branch of Agriculture has begun an active management effort coupled with follow-up monitoring.

This year, Forest Health Protection delved into **citizen science** in its collaboration with the Alaska Association of Conservation Districts to develop an early-detection, rapid-response system focusing on five invasive plant species: "A citizen's guide to identifying and reporting infestations in Alaska." The booklet describes how citizens can identify the species, distinguish them from similar-looking plants, and report the finding. Hundreds of these booklets were distributed around the state.

Map 1. General forest pest activity, from 2008 aerial survey



Map 2. Survey flight paths and general ownership



Focus On FHP Partnerships

By Steve Patterson

Why partnerships? Did you know that two horses can pull about 9,000 pounds? You might think, then, that four horses could pull 18,000 pounds, but you'd be wrong. They can actually pull over 30,000 pounds. It's synergy that makes the difference and that's one big reason why partnerships are so important! Not that we are a herd of horses, but we can achieve much more by working together than just the sum of our individual accomplishments. Partnering involves forming voluntary collaborative agreements in which all participants agree to work together to achieve a common purpose or undertake a specific task, sharing risks, responsibilities, resources, competencies and benefits.

Trying to monitor and provide technical assistance regarding the impacts of insects, diseases, and/or invasive plants on the health of Alaska's 127 million acres of forested land is a daunting, complex task. Our FHP staff currently consists of only nine people, with some additional seasonal help, and we hope to add back two full-time bio-technician positions that have been vacant. That's why meaningful partnerships are the foundation for success. In a huge state like Alaska, we cannot go it alone.

2008 Highlights

FHP was engaged in many outstanding partnerships in 2008. Our premier, long-standing, partnership is with the University of Alaska Cooperative Extension Service (CES). Our combined efforts in Integrated Pest Management and Invasive Plants continue to shine as effective ways for both organizations to provide a "first contact" for the interested and concerned public as technical assistance and create a critical citizens' monitoring safety network for early detection of invasive insect, disease, and plants. This year, CES made over 14,000 public contacts at fairs, symposia, master gardener sessions, and when individual citizens phoned or emailed with concerns about the health of their backyard trees, or with questions about invasive plants. We worked on several important projects with our other long-standing partner, Alaska Division of Forestry, such as establishing and monitoring seven Early Detection Rapid Response (EDRR) bark beetle pheromone lure sites across the state, studies on impacts on eastern larch by sawflies and beetles, and management guidelines for treating spruce boles and slash to avoid *Ips* buildup. We also worked closely with Alaska Division of Forestry and APHIS monitoring and trapping gypsy moth. (See "Focus On: Forest Health Protection working with the State of Alaska, APHIS and others to prevent the introduction of gypsy moth" page 29 of this volume). The Nature Conservancy is helping us immensely in a project to collect and analyze plot data in southeast Alaska. The goal is to develop a distribution map for yellow cedar that will eventually lead to a species conservation assessment and, if needed, a plan of action. The Alaska Natural Heritage Program at University Alaska Anchorage is similarly working with us to pull together all available plot data from southcentral and interior Alaska, to verify the vegetation typing being developed by the LANDFIRE Program and to create a data set for our input into the 2011 National Insect and Disease Risk Assessment. Then there is our invasive plant partnership work on the UAF campus, Alaska Association of Conservation Districts' work developing Cooperative Weed Management Areas (our newest, Anchorage!) and

EDRR monitoring/treatments. We're working with the Municipality of Anchorage in combating riparian impacts from invasive European birdcherry (or mayday) trees, and we continue our involvement, with a wide variety of other dedicated organizations, to make the Alaska Committee for Noxious and Invasive Plant Management (CNIPM) such an important, vibrant organization. Invasive insects—yes, we'd have much less capacity to monitor and respond to them if not for help from partnerships with APHIS and expert collaboration from the University of Massachusetts and the University of Alberta on biocontrol of the birch leafminer. Diseases—we've been getting great assistance from the University of Wisconsin and Oregon State University in deciphering our new *Phytophthora* finds. Internally in the Forest Service we have had good collaboration with PNW and other Research Station scientists on the design of a latitudinal transect from the town of Seward to the Brooks Mountain Range for monitoring climate change. The Forest Health Technology Enterprise Team headquartered in Ft. Collins, Colorado is helping us by developing remote sensing tools, and our resource managers on the Tongass and Chugach National Forests have been transferring the knowledge into management action.

Future Partnership Opportunities

We're involved in developing and nourishing several new partnerships. Alaska Botanical Gardens have provided sites for monitoring and research as well as wonderful educational and interpretive opportunities. This year we began a collaboration with the University of Georgia to develop user-friendly interface for the Alaska Exotic Plant Information Clearinghouse (AKEPIC) database. Some people and organizations with whom we hope to partner more in the near future: the new Alaska Division of Agriculture Weed and Pest Coordinator, Alaska Department of Transportation, the Wildlife Society, Alaska Native Villages, non-profits, corporations, Alaska Invasive Species Working Group, U.S. Customs and Border Protection, new Cooperative Weed Management Areas, and individuals and organizations interested in western bark beetle prevention/suppression/restoration grants.

If your organization wants to consider working with us toward a common goal, we are always looking for willing partners.

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Status of Insects

Figure 1. European yellow underwing moth.

Figure 2. Spruce aphid.

Figure 3. Aspen leaf miner damage. Photo provided by UAF Cooperative Extension Service.

Figure 4. Larch sawfly larvae.

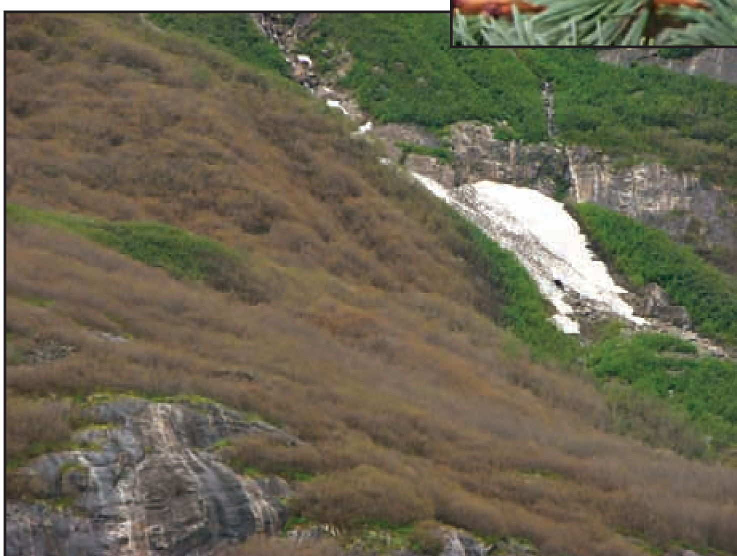


Figure 5. Probable *Sunira* moth damage.

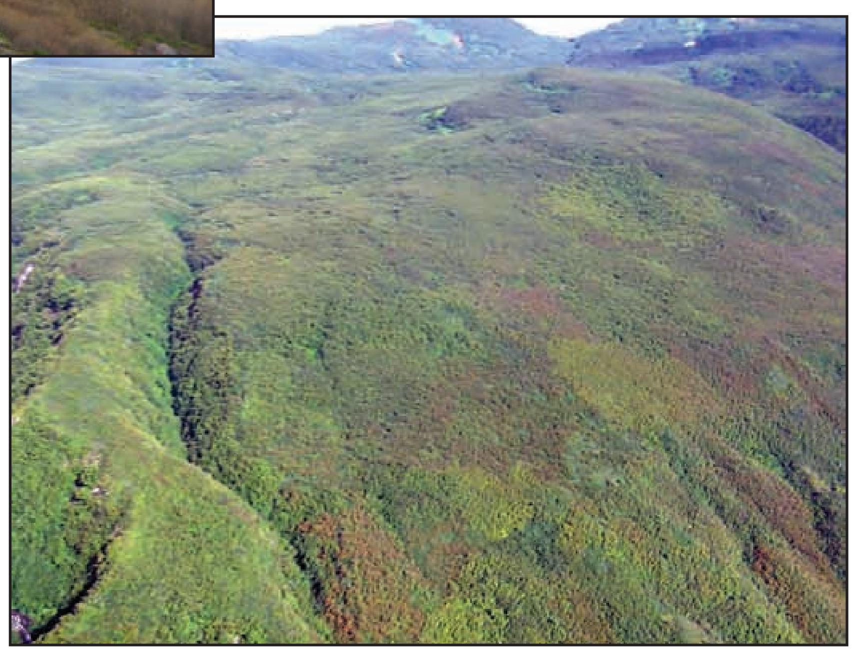


Figure 6. Alder browning at Pile River.

Status of Insects

By Jim Kruse, John Lundquist, Mark Schultz, Ken Zogas, Roger Burnside, and Charles Frank

Insects—Weather and Climate

Damage caused by insects in Alaskan forests was less obvious in 2008 than it has been in recent years. Aerial surveys during the summer detected diminished activity with spruce beetle, spruce budworm, aspen leaf miner, large aspen tortrix, willow leaf blotch miner and others. These surveys detected increased activity for only a few insects, the most notable being the northern spruce engraver. While there could be any number of reasons for reduced forest insect activity, the most likely explanation is weather.

Figure 7. Snow accumulation has an impact on forest insect activity.

Weather can be defined as short-term environmental conditions, which is actually a composition of many phenomena. Weather conditions or phenomena include air temperatures, rain, snow, fog, wind, cloud, dust storms, and extreme events like tornadoes, hurricanes and ice storms. The term "weather" usually refers to activity of these phenomena over short periods of time (hours or days) in localized areas.

This summer, weather in Alaska was dominated by persistent cloud cover, lower-than-average temperatures and localized record rains. The Fairbanks International Airport recorded an average summer temperature of 58.6 °F, approximately one degree below normal. The Anchorage International Airport recorded an average summer temperature of just 54.3 °F, making it the third coldest summer on record.[1] Similarly, the Juneau Airport recorded the fourth coldest summer on record with an average temperature of 52.7 °F. The average daytime temperature in much of the interior was only slightly lower than normal, but record-setting rains occurred during the last week of July and first week of August in Fairbanks, North Pole, Big Delta, and Nenana.[2] The development of most forest insects is slowed under these kinds of weather conditions.

Most insects are ectothermic organisms, making them very sensitive to temperature. Many have an optimum temperature range in which they thrive; a deviation from the optimal range can:

- ❖ limit dispersal and/or feeding activity,
- ❖ slow development,
- ❖ reduce relative abundance,
- ❖ interrupt species population cycles,
- ❖ affect predation and parasitism (either positively or negatively)

[1]http://climate.gi.alaska.edu/News/2008/summer08.html
[2]Alaska Climate Research Center, University of Alaska Fairbanks

Likewise, heavy rains can:

- ❖ limit adult dispersal to new host trees; e.g., bark beetles,
- ❖ retard specific developmental stages,
- ❖ kill some insects, particularly defoliators.

The larvae of some defoliators, such as the leaf miners, are protected from rain by the very leaf they destroy, while the larvae of other insects, like that of the *Sunira* moth, after consuming parts of host leaves, are exposed to the vagaries of the weather. Larval development times are slowed during the cool, wet periods. Some habitats (e.g., leaf epidermis) protect against predation, infection, and some forms of parasitism. Forest trees also thrive under specific ranges of temperature. Some tree species do better than their insect pests during cool, wet periods, while their health is stable, the activity and abundance of their insect pests are restricted. Conversely, periods of drought and warm weather will stress some tree species, while providing optimal conditions for many tree pests. The effects of weather on insects are complex and the ways that insects have adapted to protect themselves from, or take advantage of, weather anomalies are remarkably diverse.

If *weather* is defined as short-term environmental conditions, *climate* then can be defined as long-term environmental conditions. Climate is commonly expressed in terms of average and extreme conditions and patterns over time.

Climatic patterns vary across the geographic range of Alaska (Figure 8). But the general trend, all across the state, is that growing seasons are lengthening and winters are becoming less severe.

Year-to-year and localized variations and fluctuations in climate trends can be expected to differ from the long-term averages. In this regard, climatic patterns vary across the geographic range of Alaska (Figure i). However the statewide general trend is that growing seasons are lengthening and winters are becoming less severe. Such changes have the potential to affect insects dramatically and in a variety of ways, including shifts in latitudinal or elevational ranges; host (food source) changes; and changes in rates of development.

Because of the potentially serious effects that climate change may have on both beneficial and damaging insect species, our Forest Health Protection group initiated a program to establish baseline information on insect populations, and to use changes in their populations as a basis for monitoring climate changes. Because weather conditions change dramatically with latitude in Alaska, a latitudinal transect of monitoring plots has been established along the roadways from the town of Seward to the Brooks Range (Figure ii). As it has elsewhere, latitude will be used as a substitute for climate change; viz., conditions occurring in the south will in time occur in the north in response to a changing climate.

Bioindicators are organisms that reflect the abiotic state of the environment. Insects are potentially useful bioindicators of climate change because their life cycles are so much shorter than most plants and trees, and their long-term development and short-term day-to-day activities are dictated by weather patterns, especially temperature. R10 FHP is working in cooperation with several cooperators to evaluate potential insect bioindicators for northern forests in Alaska. Documenting changes in insect populations will help determine when significant thresholds have been reached as the climate of Alaska changes.

Figure i. Average monthly temperature (˚F) at three latitudinally separated locations in Alaska in 2008. The timing and duration of temperatures that are favorable for insect development varies with latitude.

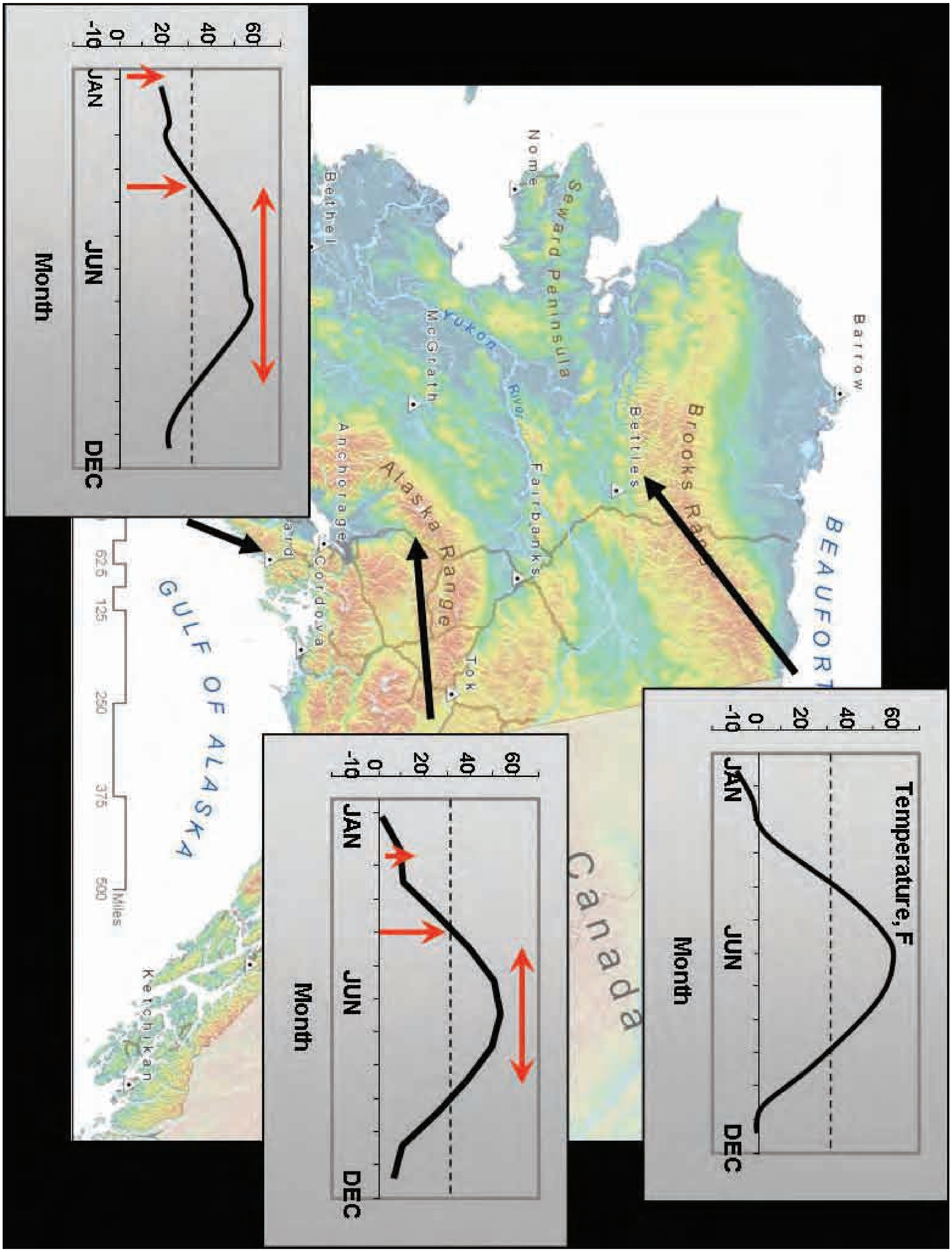
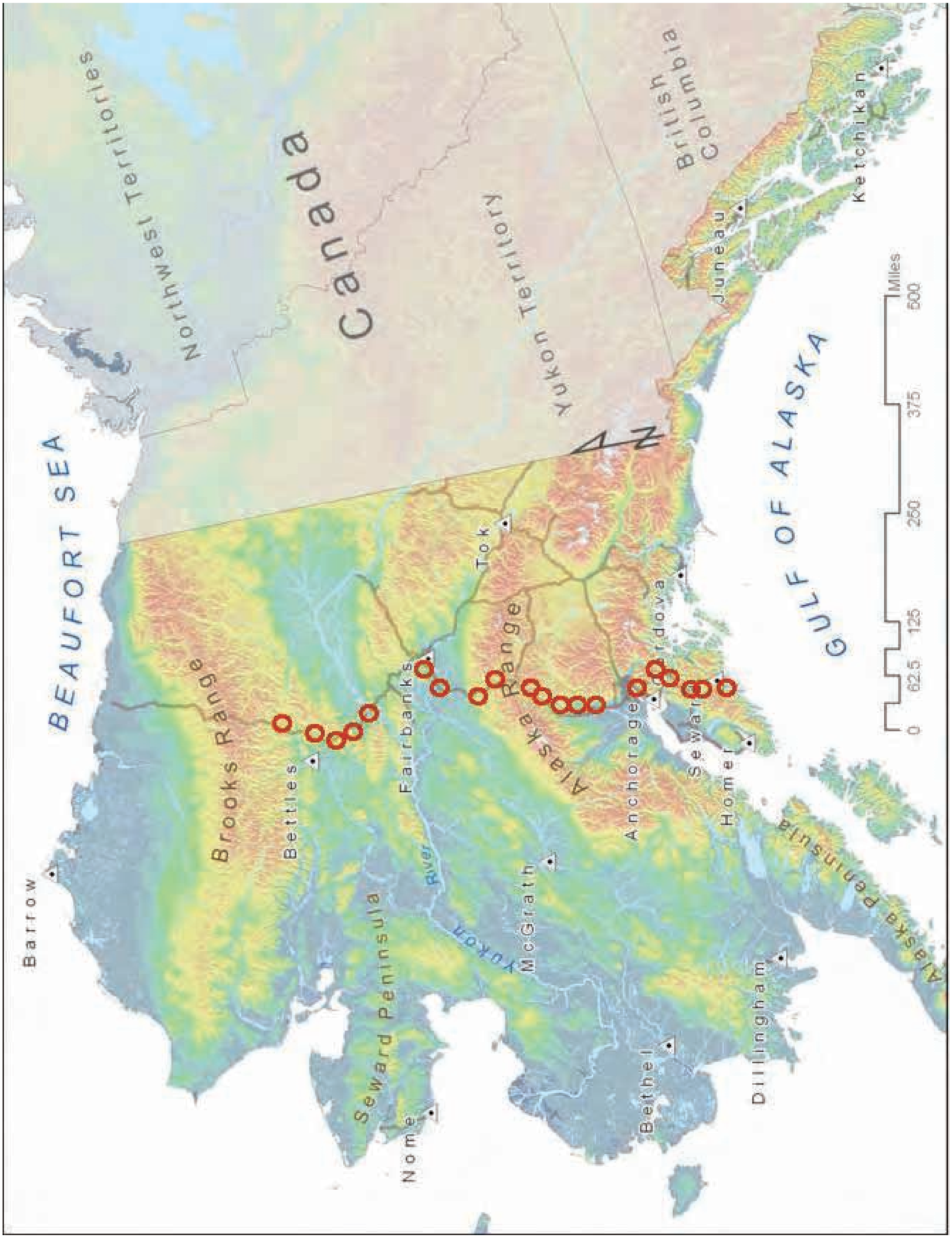


Figure ii. Latitudinal transect plot locations.



Defoliators

Birch Leaf Miners

***Profenusa thomsoni* (Konow), *Fenusa pumila* Leach, *Heterarthrus nemoratus* Klug**

In recent years, birch leaf miner injury in Alaska has been caused by a complex of sawflies involving the amber-marked birch leaf miner (*P. thomsoni)*, the late birch leaf edge miner *(H. nemoratus*) and the birch leaf miner (*F. pusilla*). The amber-marked birch leaf miner has been the dominant species for several years, but assessments across the Anchorage Bowl during summer 2008 suggest that the late birch leaf miner is becoming increasing common, and in some locations dominant. Apparently, *F. pusilla* remains relatively less active.

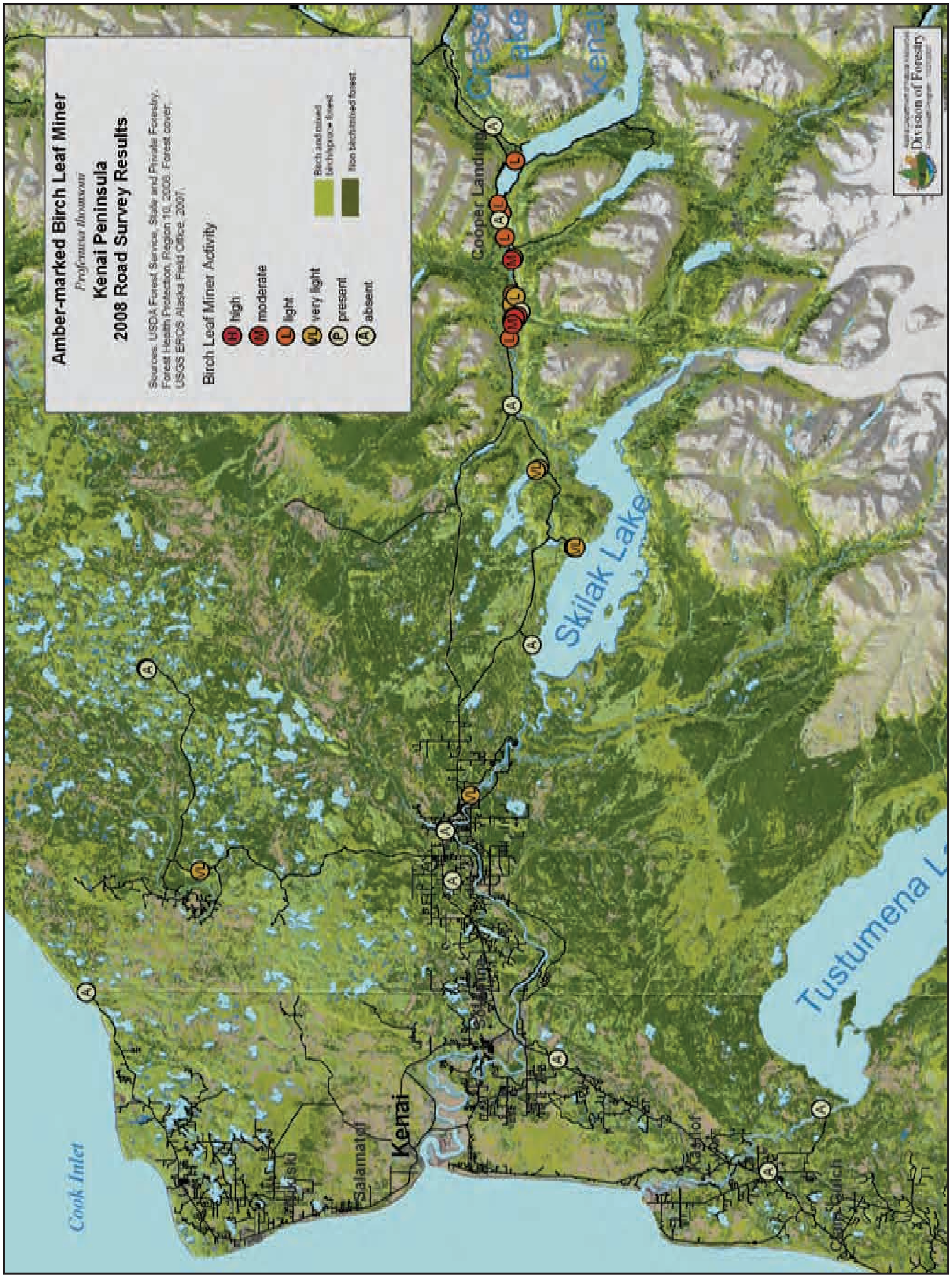
Leaf miners were active around Anchorage and Fairbanks and on the Kenai Peninsula during 2008, but severity was notably less than in preceding years. An intensive survey of the spread of leaf miners into and across the Kenai Peninsula found leaf miners on 28 of 38 (= 74%) examined sites, compared to 35 of 38 (= 92%) sites in 2007. Severity was lower at 12 of the sites and higher at 4, and no change at 19 sites. As noted in the 2007 Forest Conditions Report, impacts from the amber-marked birch leaf miner were confined to road corridors, and were visible primarily at places where cars are parked, such as parking lots and highway pullouts. There was limited spread into the surrounding forest. The basis behind this apparent trend may be related to the swarming habit of the adult insects; it appears that they may easily be transported inadvertently in vehicles. The leaf edge miner had a strikingly different distribution pattern. The distribution of the late birch leaf miner extended well beyond the road corridor, much further into the surrounding forest than the amber-marked birch leaf miner, suggesting that the mode of dispersal is different than the amber-marked birch leaf miner. Dispersal mechanisms of the former are currently being studied.

The amber-marked birch leaf miner continues to be active in the Fairbanks area, especially at Eielson Air Force base where parasitoid wasps were released in 2007 as potential biocontrol agents. These release sites were re-assessed during 2008. Results indicate that eighty-five percent of the trees surveyed had at least some evidence of leaf miner damage. On most trees, however, damage was light to very light, with only two trees sampled having moderate to heavy damage.

In July 2008, a site visit to Eielson Air Force Base was conducted to search for parasitoids, and collect larval samples to examine for parasitism. Heavy rains and cold temperatures limited the thoroughness of this sampling effort, but several adult parasitoids were captured. These parasitoids proved to be species other than that released in 2007. At this time, the larvae collected at Eielson have yet to be examined for parasitism.

A variety of other studies aimed at understanding the ecology and distribution of birch leaf miners, and developing alternative biocontrol methods, are underway. A cooperative study with Colorado State University is applying spatial modeling to map the severity of birch leaf miner impact as it varies across the Anchorage Bowl. Various small-scale population and dispersal dynamics studies were conducted in 2008. A biocontrol

Map 3. Amber-marked birch leaf miner on the Kenai Peninsula in 2008.



project using fungal and nematode agents was also conducted this year. This last project involved several study plots established in the Alaska Botanical Gardens as a cooperative effort with the U.S. Forest Service, Pacific Northwest Research Station and the University of Alaska Fairbanks, Cooperative Extension Service.

In recognition of the need to systematically examine existing pest management options, to identify what additional tools could be useful, and to develop a strategy based on best practices, the amber-marked birch leaf miner Working Group was formed early in 2008. This working group is chartered to work cooperatively toward achieving a desired condition where leaf miners are managed and impacts are limited to acceptable levels. The geographic extent of the Working Group includes the Anchorage Bowl, Kenai Peninsula, and the Mat-Su Valley. Lessons learned from this collaborative effort with amber-marked birch leaf miner will help us respond effectively to future invasive threats.

The working group is composed of representatives from the following agencies:

- Alaska Botanical Garden
- Animal and Plant Health Inspection Service (APHIS)
- Forest Health Protection, U.S. Forest Service
- Kenai Peninsula Borough
- Municipality of Anchorage
- State of Alaska DNR–Division of Forestry–Community Forestry Program
- State of Alaska DNR–Division of Forestry–Forest Health Program,
- UAA Cooperative Extension Service
- State of Alaska–DNR–Division of Agriculture
- U.S. Forest Service, Pacific Northwest Research Station.

Aspen Leaf Miner

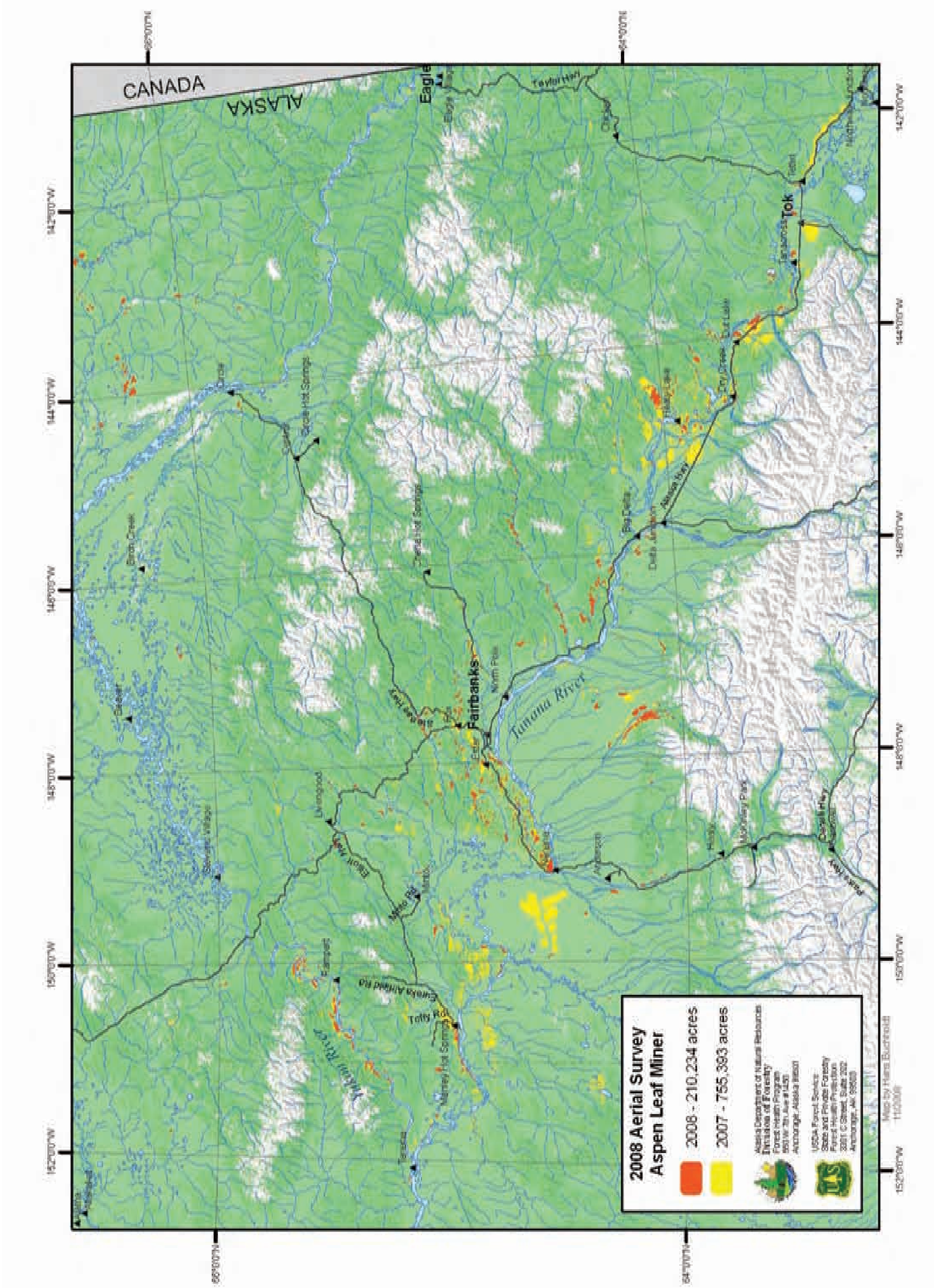
Phyllocnistis populiella Chambers

A total of 210,234 acres of aspen forest were infested with the aspen leaf miner in 2008. This was the eighth consecutive year of outbreak conditions. Although the total acreage of aspen trees infested was down 72% from 2007, this pest remains the most widespread and prevalent of all insect pests in Alaskan forests.

The overall distribution of aspen leaf miners more or less paralleled that of 2007. Specifically, affected trees were common in the interior portions of Alaska from the south slopes of the Brooks Range to the west side of Galena, south to Talkeetna and east to Tok. The heaviest infestations appeared to occur west of Fairbanks on the Nenana Ridge.

Figure 8. Aspen leaf miner damage. Photo provided by UAF Cooperative Extension Service.

Map 4. Aspen leaf miner damage aerially mapped in 2008.



Defoliation severity varied among stands. In some stands, groups of trees were more heavily infested than surrounding trees. Several severely infested trees were tagged for monitoring to follow health and mortality in subsequent years. Repeated heavy defoliation presumably reduces growth rate and might result in branch dieback. Repeated severe defoliation may cause mortality.

Research projects in cooperation with Colorado State University have been conducted during the last two years to examine the potential use of spatial modeling and remote sensing to more accurately map the distribution of the aspen leaf miner. A similar project using remote sensing by a graduate student at the University of Alaska Fairbanks was completed this year.

Spruce Budworm

Choristoneura fumiferana (Clemens)

A total of 6,093 acres of spruce budworm defoliation was mapped in 2008, down markedly from the 37,441 acres in 2007. Damage was distributed in scattered patches in an area from Cantwell north to Livengood and from Livengood south towards Delta.

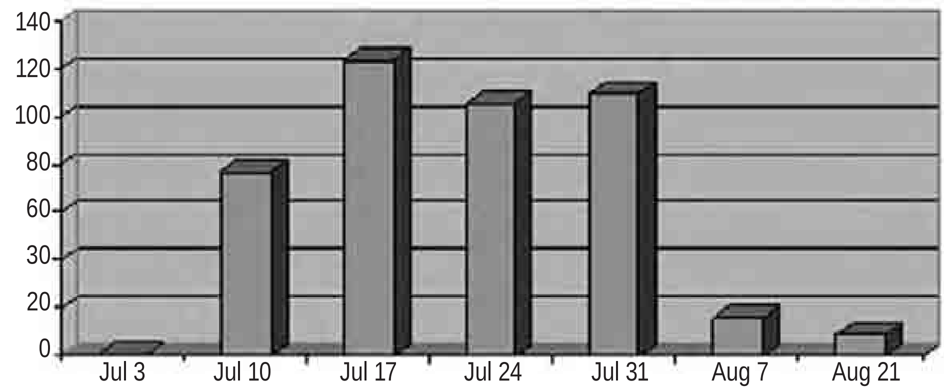
Figure 9. Spruce budworm larvae feeding on white spruce.

An outbreak in the hills around Fairbanks that began in 2002 and peaked in 2004 is now down to pre-outbreak levels, based on the 2008 aerial survey mapping. This dramatic decline in acres of damage mapped confirms the 2007 prognosis that this rather mild outbreak was in decline. Numbers of adult budworms trapped in this area were down for the second consecutive year, as were the numbers of larvae observed. The majority of adults were trapped during the last three weeks of July, with significantly fewer being caught after the first week of August .

Figure 10. Chuck Frank checks a budworm wing trap as part of Nenana Ridge monitoring project. Fairbanks, 2008.

In a separate project, spruce budworm traps were placed along a latitudinal transect running from Seward to the very northern extent of spruce. Results of this trapping are still being analyzed, but preliminary findings of particular interest include a large catch of budworm adults near the Yukon River, and the capture of budworm at the northern limit of spruce trees in Alaska.

Figure iii. Number of spruce budworm caught in traps in the Fairbanks area by trapping date.



Large Aspen Tortrix

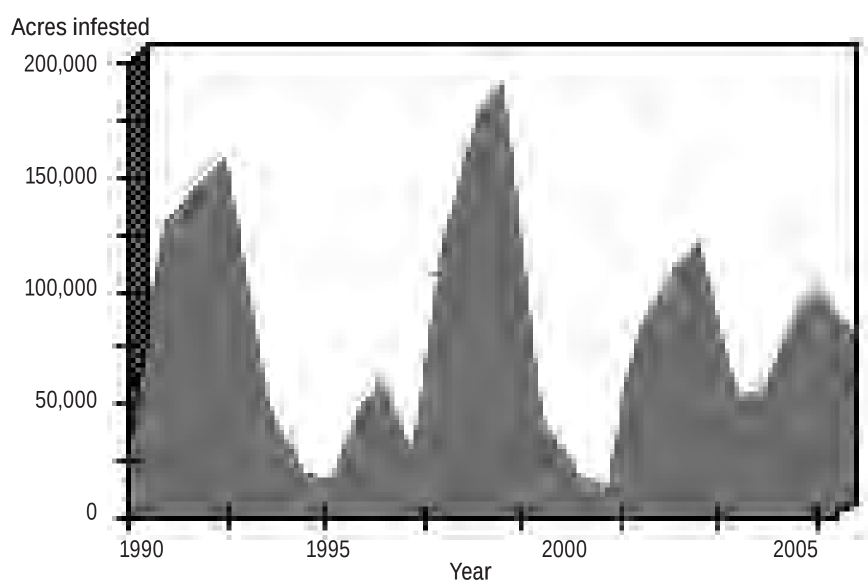
Choristoneura conflictana Walker

Populations of large aspen tortrix characteristically increase to locally epidemic levels that last for two to three years, then collapse. This collapse is commonly thought to be caused by the tortrix larvae consuming all available food, and then starving. In 2008, the number of tortrix-infested acres declined by 82% to 7,184 acres. Approximately one half of the acreage was located in the Copper River Valley, and the rest occurred across Cook Inlet from Anchorage. One further area of significant activity, reported by ground observers, was along the Glenn Highway between Sutton and Sheep Mountain. Notably, tortrix damage commonly occurred where aspen leaf miner also occurred, thus raising a question of the role of interspecific competition for resources in the regulation of tortrix populations.

Willow Leaf Blotch Miner

Micurapteryx salicifolliela (Chambers)

Figure iv. Acres of willow infested by willow leaf blotch miner.



Willow leaf blotch miner activity declined 13% statewide in 2008 to 72,382 acres. Since the first notice of this leaf miner in the early 1990s, its activity has been characterized by relatively large year-to-year population fluctuations. This year, willow leaf blotch miner activity was found only in the interior portion of the state.

More than one-half of the reported activity this year occurred throughout the upper Yukon River Valley and its tributaries, from Beaver to Circle. This has historically been the area of the heaviest and most widespread activity, and one in which considerable willow mortality has been observed. The central interior, along the Tanana and Kantishna Rivers accounted for another one-third of all reported activity. In that area, infestation was particularly severe. The condition was especially severe along roadways around Fairbanks. Many stands that were heavily infested in previous years showed significant branch dieback and some mortality. In cooperation with the Pacific Northwest Research Station, a study was initiated to examine the survival of severely infested willow stands, and the Alaska Department of Fish and Game is investigating the potential effects of willow leaf blotch miner on moose browse quality.

Spruce Aphid

Elatobium abietinum (Walker)

The outbreak of spruce aphid in southeast Alaska appears to be declining, possibly due to several cold winter temperature events. The current outbreak started in 1998 with the greatest number of acres, 46,300, occurring that year, followed by 14,982 acres in 2005, and 9,120 acres mapped in 2006. Defoliation occurred on just 311 acres in 2008. Defoliated trees were mapped only east and west of Pt. Gustavus, south of Lituya Bay, and as far west as Cape Yakataga (west of Icy Bay).

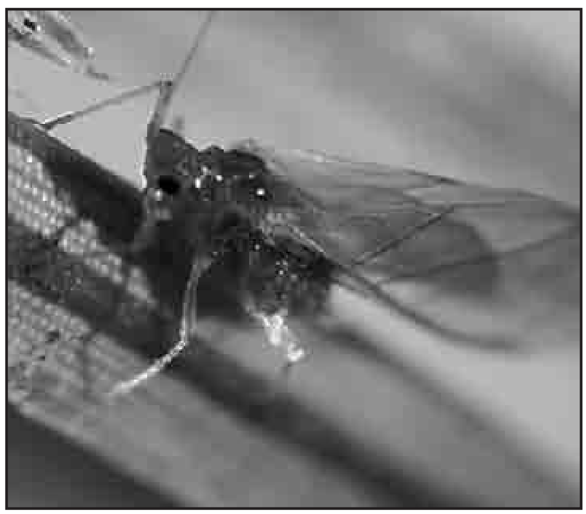


Figure 11. Winged spruce needle aphid feeding.

During the winter of 2007-2008, three low temperature events totaling approximately 15 days below -10 °C occurred in Juneau: December 2–4, January 26–February 1, and February 5–10. Within the first and last of these events there were seven and 14 hours below -15 °C between December 3–4 and between February 7–8, respectively.

Black-headed Budworm

Acleris gloverana (Walsingham)

The 2008 aerial survey recorded over 2,700 acres of western black-headed budworm damage on western hemlock and Sitka spruce, mostly in Prince William Sound. The heaviest damage occurred along the north side of the sound from Port Wells to Cordova. Damage also occurred on Hinchinbrook Island, in Yakutat Bay and on Admiralty Island. The budworm damage was ground verified as active black-headed budworm defoliation in Cordova and southcentral Alaska (Turnagain Arm) during late summer in 2007.

Figure 12. Hemlock defoliation.

Small outbreaks of black-headed budworm have been mapped around Prince William Sound and in southeast Alaska for the past four years. Western black-headed budworm populations in Alaska have generally been cyclic. They appear rapidly, affecting extensive areas, and then decrease just as dramatically in a few years.

Alder Defoliation

Eriocampa ovata (L.), *Hemichroa crocea* (Geoffroy), and an unidentified species.

Aerial surveys in July detected alder defoliation on 628 acres, mostly in the upper Yukon River Valley. This decline from previous years in infested acreage is almost certainly an underestimate. Ground observations in August and September noted severe defoliation of riparian alders, primarily *Alnus tenuifolia*, a species widespread in southcentral Alaska. The discrepancy between the aerial surveys and ground observations is almost certainly due to the timing of the insect injury, which became most apparent in late summer after the aerial surveys had been conducted.

Figure 13. Woolly alder sawfly feeding.

Although leaf beetles account for some of the defoliated alder, the vast majority and most severe defoliation was caused by three species of sawflies: woolly alder sawfly *Eriocampa ovata* (L.); striped alder sawfly *Hemichroa crocea* (Geoffroy) and; an as yet unidentified pale green sawfly. The woolly sawfly is an introduced species. All three species skeletonize the leaves of alders. Their ranges overlap in southcentral Alaska, and it is not uncommon to encounter more than one species feeding on the same plant, and at times, all three. Thus, stands of alder may be completely defoliated by mid- to late August. Alder mortality has been recorded in these stands, although direct evidence that this defoliation is the cause of mortality has not been established.

Nearly 15,000 acres of alder mortality were recorded in and around Katmai National Park, and work is underway to establish the causal agents. These alder stands were severely defoliated for at least five seasons by the moth *Sunira verberata* and we believe that the stress of repeated, severe defoliation contributed at least in part to this mortality.

Birch Leaf Roller

Epinotia solandriana (L.)

Birch leaf rollers are a recurrent problem throughout southcentral and interior Alaska; they occur every year in low to moderate numbers. Heavy infestations result in significant defoliation of trees. There has been a definite downward trend in the number of acres of birch leaf roller damage mapped each year from a high of more than 185,000 acres in 2003. In 2004, this number dropped to under 18,000 acres, and then to about 6,700 acres in 2005. This activity continued to decline in 2006 with fewer than 3,600 acres mapped and fewer than 200 acres in 2007.

No acres were mapped from the air in 2008. It should be noted, however, casual observations in the Fairbanks area revealed many infested birch trees, but at a low level of infestation that would have been difficult to detect from the air.

Yellow-headed Spruce Sawfly

Pikonema alaskensis (Rohwer)

This sawfly is a native defoliator throughout the northern United States and Canada. Noted only from a few isolated spruce trees several years ago, this species has gained prominence in recent years throughout Anchorage and surrounding areas. The severe defoliation caused by this sawfly is harmful to spruce trees for both aesthetic and environmental reasons. Early detection is necessary for successful control of this species; otherwise, defoliation before bud set during mid-summer may contribute to a myriad of problems. The larvae feed on new foliage of spruce (*Picea*), especially Engelmann, white, black, Norway, and Colorado blue spruce; on native spruce, ornamentals and shelterbelt spruce alike.

Larch Mortality Due to Larch Sawfly and Eastern Larch Beetle

Pristiphora erichsonii (Hartig) *and Dendroctonus simplex* LeC.

It is often difficult to separate larch mortality caused by the larch beetle and mortality resulting from repeated defoliation by the larch sawfly. For that reason, the number of acres damage by both insects is combined in this report. Approximately 340 acres of larch defoliation and mortality were mapped in 2008, up from the 130 acres mapped in 2007. The largest concentration (approximately half) was mapped southeast of Anvik, with the other half being mapped in scattered locations near Medfra, North Pole, and Big Delta.

In 2006 and 2007, special aerial surveys were conducted to update the mapped distribution of larch in Alaska, and to document the extent of healthy larch stands. Utilizing information from these surveys, comprehensive field exams were conducted in 2008 on seven separate road-accessible larch stands near Fairbanks. Because larch is generally a minor component of lowland and river bottom stands with black and white spruce in interior Alaska, GIS information from the archived aerial survey database was used to develop and model a sampling universe of "larch" stands based on past larch infestation, mortality, and healthy larch distribution polygons. The field exams consisted of random transects placed through the stands and information such as the cause of mortality for each dead larch, the total number of all live and dead trees by species, presence/absence of recent larch cone-production, and an estimate of larch regeneration potential in the stand compared to that of other species present (e.g., black spruce, white spruce, birch, cottonwood, willow, etc.). In addition, a basal-bole "cookie" was cut from selected dominant and co-dominant larch and spruce in each stand to obtain an estimate of stand age/establishment and to determine the year of death.

Results of these exams are currently being analyzed. A similar project is planned for 2009 to look at additional larch stands across the more remote range of larch distribution in interior Alaska.

Miscellaneous Defoliators

Sunira Moth *Sunira verberata* (Smith)

Spear-marked Black Moth *Rheumaptera hastata* (L.)

Rusty Tussock Moth *Orgyia antiqua nova* Fitch

Others

Figure 14. Larvae collected from Endicott Arm in 2008, and damage pattern is likely that of *Sunira* moth.

A suite of insects are associated with defoliation of alder, birch, willow and aspen in Alaska. The most notable are listed above, but can include many caterpillar and sawfly pests. In 2008, a defoliator of red alder, suspected to be *Sunira* moth, defoliated 68 acres just east of Endicott Arm near Dawes Glacier, southeast Alaska. Reared larvae collected in Endicott Arm produced pupae but not adults. Consequently, *Sunira* moth could not be positively confirmed as the causal agent. Aerial sureyors observed 13,918 acres of alder and willow defoliation caused by this insect in 2006 in Katmai National Park. In 2008, spear-marked black moth defoliated 53 acres of birch at the confluence of the Salcha River, interior Alaska. The last major outbreak of these moths occurred in the mid-1970's when nearly 3 million acres of interior Alaskan birch were defoliated. The most significant recent activity was when aerial surveys in 2006 identified 7,946 acres of locally concentrated activity in a number of widely scattered areas.

Bark Beetles

Spruce Beetle

Dendroctonus rufipennis (Kirby)

Spruce beetle activity declined by more than half relative to 2007 levels, to only 69,500 acres in 2008. Nevertheless, spruce beetle remains the most significant mortality agent in the white and Lutz spruce stands of interior, southcentral and southwestern Alaska and the Sitka spruce stands of southeast Alaska. The severe wildfire season in the western U.S. led to a sudden and unexpected reallocation of federal funds in August 2008, requiring the elimination of local spruce beetle surveys intended to cover much of southcentral Alaska. This region traditionally accounts for more than half of the spruce beetle activity observed in the state. It would be reasonable to assume therefore, that the actual acreage infested by spruce beetle in 2008 is probably closer to the figure of 150,000 acres reported in 2007. Furthermore, in interior Alaskan spruce stands, spruce beetle and *Ips* beetle often work in concert. Aerial observers code these areas as *Ips*/spruce beetle. If these 16,000 additional acres are included as spruce beetle activity, this year's figure for total spruce beetle activity would likely exceed last year's.

Figure 15. Lindgren trap catch is checked.

Southeast Alaska—Although there is some history of large-scale spruce beetle outbreaks in Southeast Alaska, typically outbreaks are confined to small, scattered patches of activity. This was the case once again south of the Haines-Skagway area where numerous, small patches (<50 acres) of activity were reported as far south as Petersburg. One of the more concentrated areas of activity, from Haines to just north of Skagway, declined in 2008. Reported acres of infestation were down 20% from 2007 figures following a 90% reduction the year before. Activity continues in an area west of Gustavus, where 1,100 acres were reported primarily along the open coast north and south of Palma Bay. The two largest concentrated areas of spruce beetle activity in Southeast Alaska occur further north and west along the coast. Along the east coast of Yakutat Bay, 875 acres of activity were reported between Knight Island and Logan Bluffs, and in the Suckling Hills near Bering Glacier, 503 acres of activity were observed.

Matanuska-Susitna Valley—Of the spruce beetle infestations observed in 2008, those on the west side of Cook Inlet are the most active and account for the largest single blocks of activity in the state. Nearly one-half of the reported acreage statewide is attributable to two infestations, one just northeast of Tyonek, and another along the Iditarod Trail from Skwentna to treeline at Rainy Pass Lodge. Activity has intensified in both of these areas since 2007.

Copper River Basin—Spruce beetle activity in the Basin has declined for the second consecutive year signaling the end of the infestation that has been active in the McCarthy area for more than 10 years. In the past year alone, acres infested fell by 70%, to 4,315 acres. The majority of the remaining activity occurs along the base of the hills along the Chitina River, east of McCarthy.

Upper Yukon River Valley—Inclement weather precluded flying the Yukon River between Eagle and Circle where in 2007, more than 9,000 acres of beetle activity were observed. Every attempt will be made to fly and ground check this area in 2009 to determine the extent of this outbreak and to determine with more certainty whether the observed mortality was due to spruce beetle, *Ips* beetle, or both, working in concert. *Ips* beetles are the primary tree-killing bark beetle in interior Alaska and there is historical precedence for large-scale I*ps* outbreaks in the upper Yukon River valley. However, in the beetle outbreak of the 1980s in the mid-Yukon River valley spruce stands between Galena and Holy Cross, the mortality was found to be caused by both *Ips* and spruce beetle working in concert. Lacking ground checks, it is difficult from the air to determine with certainty the causal agent(s) of these interior Alaskan beetle outbreaks. Most of the identified areas of spruce beetle activity in the upper Yukon River valley in 2008 were occurring north and west of Fort Yukon.

Lake Iliamna/Lake Clark—Although 7,000 acres of light beetle activity were observed in 2007 in the Kakhonak area of Lake Iliamna, no new activity was reported in 2008. A considerable volume of mature susceptible white spruce remains, and further activity in this area is possible. On the north side of the lake however, beetles were quite active. A total of 3,000 acres of beetle activity were identified in two areas—east of Roadhouse Mountain approximately 15 miles northeast of Iliamna, and along the shores of Tazimina Lake. The infestation at Tazimina has been active for 3-4 years, while the activity near Roadhouse Mountain is new.

Katmai National Park—It appears the spruce beetle infestation at Katmai National Park has collapsed. For the second straight year these populations have declined significantly. Between 2006-07, populations fell by one-half. Between 2007-08, the remaining acreage infested was reduced by 90%, to only 3,500 acres. There remain susceptible stands of spruce in the area and light spruce beetle activity can be expected for the next several years.

Kuskokwim River—This infestation, which has been active for nearly 10 years, continues, but with a reduction in infested acres and at lower intensity. Acres of beetle activity fell by nearly 25% from 2007 levels, to 17,675 acres this year. Much of the activity would be characterized as light to moderate. This infestation has been one in which both spruce beetles and *Ips* beetles have played a part and it's impossible from the air to judge the degree of contribution of either species individually.

Central Interior—Approximately 2,000 acres of spruce beetle activity were observed scattered throughout the central interior portion of the state. No large concentrations of activity were reported. Spruce beetles are considered a secondary tree-killer in interior Alaska, and when observed, are often found in association with the primary tree-killing bark beetle, the *Ips* beetle.

Northern Spruce Engraver Beetle

Ips perturbatus **(Eichhoff)**

The northern spruce engraver, *Ips perturbatus*, continues to be a significant bark beetle in the interior and is one of the few forest insects in Alaska to increase over 2007. Aerial surveys in 2008 mapped 43,875 acres of engraver beetle activity statewide, up from the 32,811 acres mapped in 2007. When combined with acreage figures for those areas where both the engraver and spruce beetle are active, the total area affected by the engraver beetle approximates 59,630 acres in the 2008 aerial detection survey.

The majority of *Ips* activity was noted in the northeast part of the state between Fairbanks, Bettles, and Fort Yukon. This area accounted for over 56% of the mapped mortality. Other areas with notable *Ips* damage include about 6,000 acres mapped between Delta Junction and Fairbanks; 500 acres near Tanana, and almost 2,000 acres south of McGrath.

Ips beetles generally attack trees that are stressed as a result of drought, flooding, mechanical damage, soil compaction, windthrow or fire scorching. At high populations, however, *Ips* will readily attack healthy trees.

A common way populations of *Ips* can increase rapidly is through poor slash management practices. Construction projects and timber harvest (including fuelwood cutting) often creates significant amounts of slash. Beetles will mature in the slash and then drop to the ground where they over-winter in the soil and accumulated duff layers. The following spring new adults emerge and attack nearby host trees. As more and more people depend on fuelwood to offset the high cost of energy, they oftentimes bring *Ips*-infested wood back to their own property and stack it near healthy spruce trees. The following spring and summer they notice their yard trees turning brown.

Western Balsam Bark Beetle

Dryocoetes confus us **Swaine**

Only trace subalpine fir mortality caused by western balsam bark beetle was noted in 2008. Mortality occurred between Pitchfork Falls and White Pass Valley, just north of Skagway.

Invasive Insects in Alaska

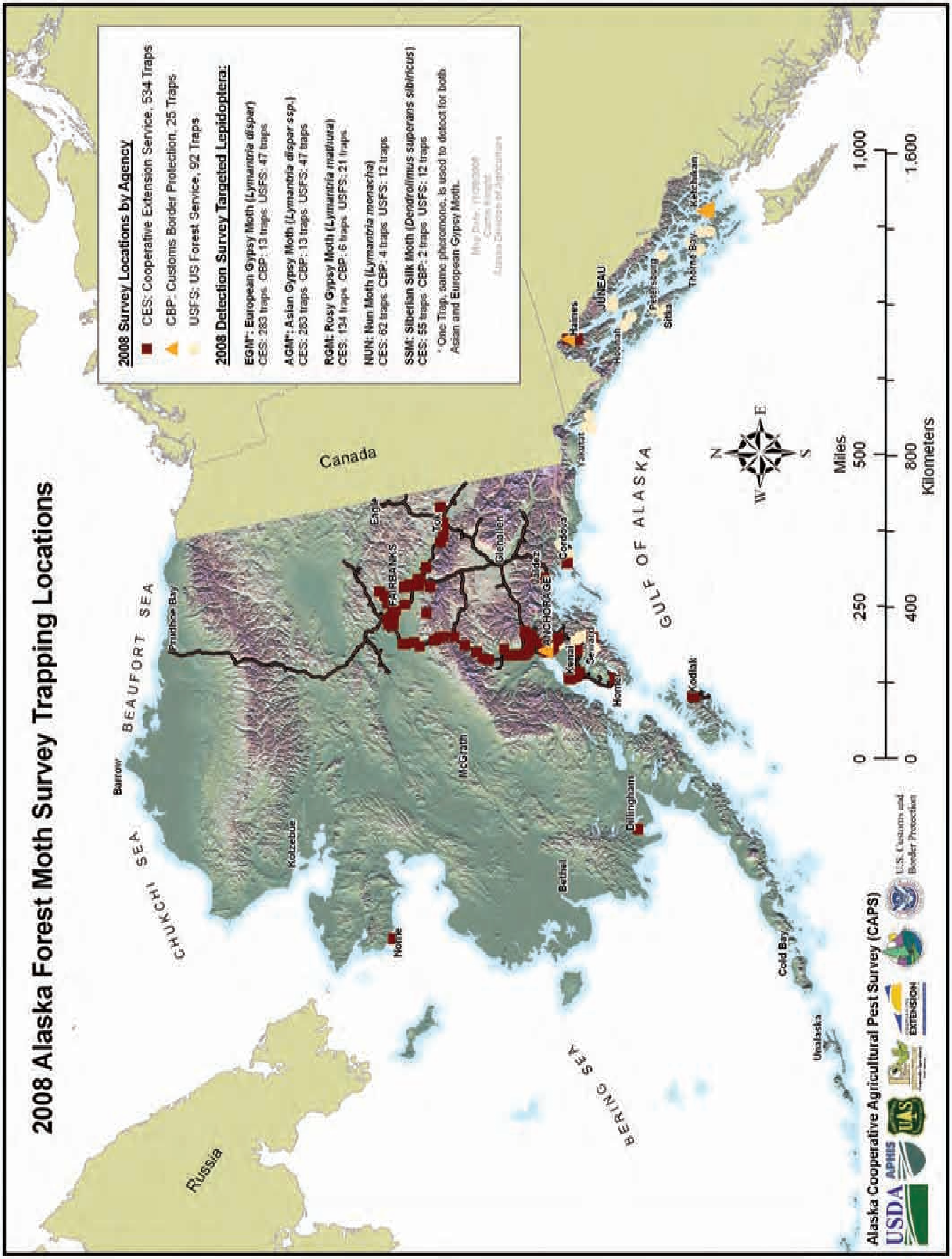
Gypsy Moth *Lymantria dispar* (L.)

and Exotic Forest Moth Detection Surveys

During Summer 2008, there was an apparent increase in the number of Asian gypsy moth egg mass detections on marine vessels from Asian ports destined for ports along the west coast. Several of these detections occurred in Alaska waters and were indicated to have occurred on vessels destined for Ketchikan and Kodiak. Agents of the U.S. Customs and Border Protection intercepted one vessel destined for Ketchikan that contained Asian gypsy moth egg masses. The egg masses were confirmed by USDA-APHIS-PPQ national identifiers as the Asian strain of gypsy moth.

Though no Lepidoptera targeted in the Cooperative Agricultural Pest Survey (CAPS) were detected in the traps deployed throughout Alaska in 2008, the recent offshore

Map 5. Alaska forest moth survey trapping locations.



vessel detections warrant a concern for the possibility of overwintering egg masses in or near Alaska's port communities. Interagency cooperation and support in these survey efforts is essential in maintaining an early detection, rapid response network throughout the state.

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Focus On: Forest Health Protection Working with the State of Alaska, APHIS and Others to Prevent the Introduction of Gypsy moth.

The European gypsy moth (EGM) was accidentally introduced into Massachusetts from Europe in 1869 by a French naturalist attempting to breed them with silkworms. Several larvae escaped. Since then, the gypsy moth has been responsible for considerable damage to the hardwood forests of the eastern United States. Millions of dollars are spent annually attempting to reduce the amount of damage and restrict the distribution of this important forest pest. The EGM arrived in the western U.S. in the early 1980s.

The Alaska Department of Natural Resources, Division of Agriculture, in cooperation with U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ), conducts low-risk detection surveys for European (North American) gypsy moth (*Lymantria dispar* (L.)), Asian gypsy moth, (*Lymantria dispar dispar* (L.)), rosy gypsy moth (*Lymantria mathura* Moore), nun moth (*Lymantria monacha* (L.)), and Siberian silk moth (*Dendrolimus superans sibiricus* Tschetverikov). If introduced, these species would pose a significant threat to Alaska's forested ecosystems from both an economic and biological perspective and are closely regulated and monitored by APHIS-PPQ and state agricultural agencies.

Survey participants throughout the state representing Cooperative Extension Service (CES), Customs Border Protection (CBP), and U.S. Forest Service (USFS) cooperated in 2008 to deploy 652 Lepidoptera monitoring traps, collect relevant data, and report findings (see map 5). Survey data are reported into two national databases, the National Agricultural Pest Information System (NAPIS), and the Integrated Survey Information System (ISIS). The databases capture statewide and national pest survey information collected by APHIS-PPQ and Cooperative Agricultural Pest Survey (CAPS) cooperators. CAPS is a cooperative effort by Federal and State agricultural organizations to detect and monitor exotic plant pests of economic concern. The CAPS program did not detect any targeted species in 2008.

Prior to this year, only the EGM had been captured in Alaska (see Table 1 for trapping records and detection information). All adult gypsy moth captures in Alaska have been single-moth detections and appear to be associated with recreational vehicle traffic into the state or outdoor equipment shipped from infested areas. However, there is increasing concern of a possible port introduction into Alaska. Alaska has approximately 44,000 miles of coastline, with ports dispersed throughout much of its southern latitudinal ranges (below 62° N), particularly in the southeast and southcentral coastal regions. Alaska ports receive marine vessel traffic throughout the year from Asian ports where the Asian gypsy moth occurs in its native range. The potential for port introductions increases when outbreaks occur overseas.

The Asian strain poses a much greater risk to Alaska's forested resources than the EGM as it differs in several significant ways. First, the female Asian moths have the ability to fly, while the female EGM are flightless. This characteristic would greatly increase the ability of Asian moths to disperse throughout North America, if introduced. Second, Asian moths have a much broader range of conifer hosts (about 600 total species compared to roughly 250 species for the EGM).

The Asian gypsy moth findings illustrate the value of the CAPS program as a system of monitoring and baseline-data development. These data will become increasingly valuable as more exotic pests are detected in the future.

European Yellow Underwing Moth

Noctua pronuba L.

The European yellow underwing moth was discovered in Alaska in 2005. Since then, its presence has been confirmed throughout southeast Alaska and some areas of southcentral Alaska. In 2008, several individuals were captured in Anchorage, a significant increase since the initial capture in 2006. Studies are planned in 2009 to determine whether it has also moved into the Mat-Su valley and the Interior.

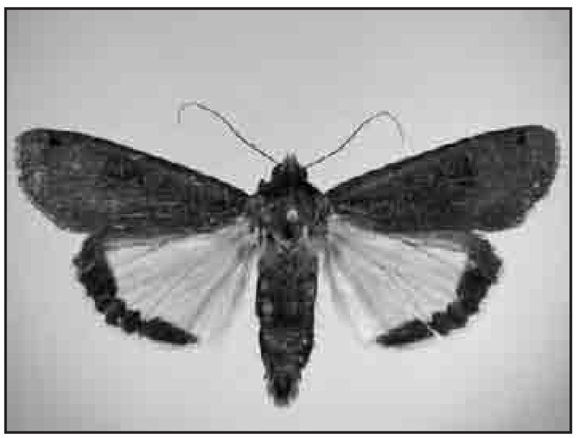


Figure 16. European yellow underwing moth.

This well-known European pest was introduced in Nova Scotia in 1979, and has been rapidly spreading across the continent ever since. Based on the rapid movement of this species, it is likely to be quite numerous throughout most areas of Alaska over the next few years. Its final distribution will likely be throughout southeast, southcentral, and interior Alaska as far north as the Brooks Range. It has been recorded in tundra around northwestern Hudson's Bay, so there is the potential to impact Alaska's tundra ecosystem.

The European yellow underwing is largely an agricultural pest. The larvae are generalist feeders and have been recorded on grasses, dock and dandelions, and a wide range of wild and cultivated herbaceous plants. They also attack tomato, potato, carrot, beet, lettuce, grape, and strawberry, and are pests on garden flowers.

Uglynest Caterpillar

Archips cerasivorana Fitch

Although this leaf-tying Lepidopteran is native to North America, its introduction to Alaska several years ago has had an impact on both ornamental and native plant species. Populations have remained steady over the past several years, primarily in the downtown and west Anchorage areas. This summer the telltale webbing caused by gregarious larval feeding and pupation was noticeable along the Chester Creek greenbelt in Anchorage. This feeding damage occurred within native willow and alder stands. This was the first year we noticed the damage outside of landscape and residential settings.

Rose Tortrix Moth

Archips rosana (L.)

Rose tortrix leaf roller damage occurred on many hardwoods in the Anchorage area. Once again, dozens of moth traps with pheromone baits were placed around Anchorage in order to determine what species of tortricid moths are active in the area. The rose tortrix moth continues to be one of the most common leaf roller species found on a multitude of plant material throughout the Anchorage area. The Municipality of Anchorage continues to find this introduced leaf-tying lepidopteran one of the most problematic and difficult pests to control. This species was introduced to North America from Europe over a century ago.

Dalmation Toadflax Weevil

Gymnetron antirrhini Paykull

This beetle was identified on certain infestations of toadflax (*Linaria vulgaris*) in the Anchorage area. This beetle is a well-known biological control agent of toadflax species in the lower 48 states and in areas of Canada. However, this is the first time that this weevil has been reported in southcentral Alaska, although anecdotal evidence that it has previously been here. This weevil has been responsible for decreasing seed production of toadflax species by 80%, which could be incorporated into an integrated pest management plan targeted at toadflax.

Amethyst Cedar Borer

Semanotus amethystinus (LeConte)

This wood borer was discovered in a bulk order of pine lumber. Only one beetle was found and brought into the Cooperative Extension Service for identification. This beetle is described in the U.S. Forest Service publication Western Forest Insects as attacking the large branches of *Libocedrus decurrens*, *Thuja plicata*, and *Chamaecyparis lawsoniana*. Its range is from British Columbia into California, but it has never been documented in Alaska. Areas in southeast Alaska have tree species that may be suitable host material for this beetle.

Christmas trees brought into Alaska were found to contain a number of exotic insect imports. First, Christmas trees that were denied entry into Hawaii in December 2007 because of the presence of insects, were shipped to Alaska to be sold at discount prices. The trees were originally from a non-quarantined area in Oregon. Multiple species of the western yellowjacket, *Vespula pensylvanica* Rohwer, were positively identified on this shipment of trees. The presence of these wasps were one of the reasons the shipment was rejected in Hawaii, and this species is not documented in Alaska. Also, multiple Christmas trees being sold at a local box store were found to contain the western conifer seed bug *Leptoglossus occidentalis* Heidemann, another species not known to be present in Alaska.

Monitoring for Early Detection of Exotic Beetles & Wood Borers

Early Detection and Rapid Response (EDRR) monitoring to detect exotic bark beetles (scolytids) and wood borers (cerambycids and syricids) is a national program which has been conducted in Alaska since 2002. This monitoring, using standard survey protocols, is occurring in three primary locations: Fairbanks, Juneau, and Anchorage (EDRR monitoring was also conducted at one site near Homer, on the Kenai Peninsula).

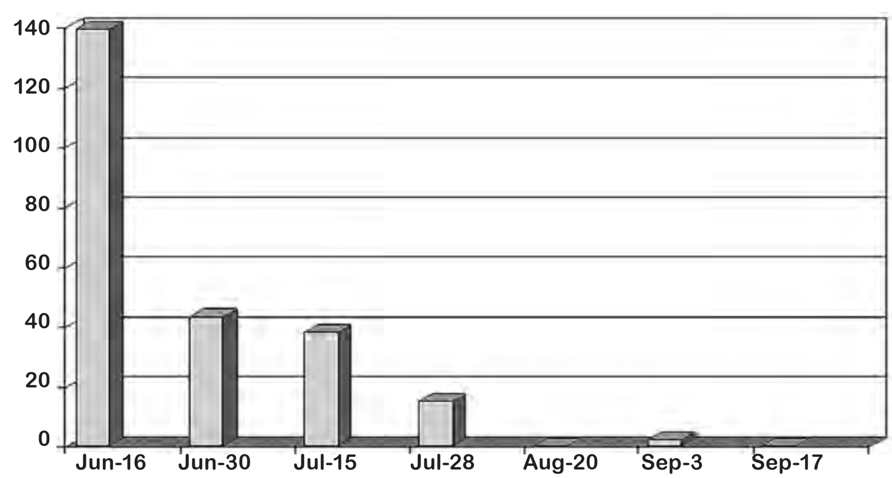
Lindgren™ funnel traps were set at selected forested areas near potential introduction sites at each of the geographic locations and baited with one of the following lures: Exotic *Ips*, ethanol, and a combination of ethanol and α pinene. A standard series of EDRR lures were employed to draw targeted non-native bark beetle species attracted to specific tree- and insect-produced volatiles (pheromone blend); but also high release lure devices containing tree host-produced compounds (alcohols and terpenes) which attract hardwood- and conifer-loving bark beetles from a variety of taxonomic groups.

Due to lack of personnel, EDRR traps were placed in Fairbanks the first week of June, which was slightly later than desired. Traps at the other Alaska locations were placed in early-to-late May. At Fairbanks, the first trap collections, made about two weeks after placement, yielded the greatest number of scolytids caught during any two-week period in 2008. Numbers fell off sharply after that, with a few being caught as late as September.

Similar EDRR surveys were conducted in Anchorage and Juneau, where numbers of trapped scolytids were down considerably from previous years. This reduction in overall numbers of scolytids trapped is most likely a result of the abnormally cool and wet summer weather experienced throughout Alaska in 2008. It's equally likely that release (elution) of the chemical attractants was either prevented, or at least diminished by the cold summer temperatures which resulted in few or no beetles coming to the traps.

Prescreening for the identification of all captured scolytids indicated only native species were collected at all EDRR sites across Alaska in 2008. EDRR trapping results from all participating states are assembled in a national database maintained by USFS Forest Health Protection in Washington, D.C.

Figure v. Number of scolytids trapped by collection date at Fairbanks EDRR sites (2008).



In addition to the sites used for the formalized EDRR monitoring surveys, scolytid traps were placed in several other locations in and around Fairbanks chosen for their abundance of host material (white spruce) and proximity to cargo transportation corridors. This includes monitoring of at least one active lumberyard per year and the fringe of the 2004 Boundary Fire burn area along the Steese Highway. In addition, several traps are set for invasive woodboring wasps (siricids) in and around Fairbanks (see below). To date, no invasive woodborers or bark beetles have been found at these monitoring plots, but we continue to learn about post-fire forest pest conditions and localized outbreaks of native species.

Wood Wasps

FHP personnel monitored for wood wasps, including the exotic *Sirex noctilio*, in the Fairbanks area again in 2008. For logistical reasons, the *Sirex* traps were placed in the same general area as the scolytid EDRR traps, separating them far enough apart to prevent cross-interference of the lures. Because similar attractants are used for both *Sirex* and scolytids, the scolytid traps caught a large number of *Sirex* species. The captured wood wasps have all been identified as native species.

Pinewood Nematode/White Spotted Sawyer Surveys

The pinewood nematode (PWN) (*Bursaphelenchus xylophilus* [Steiner and Buhrer] Nickle) is a major concern in China. The PWN kills trees by feeding within the tissues of trees, blocking the transport of water and eventually causing wilting and death of the foliage. Because these nematodes are unable to move from tree to tree on their own, a vector is required to spread this organism. In Alaska, this vector is the white spotted sawyer *Monochamus scutellatus* (Say), a round-headed woodborer attracted to recently dead, bark-beetle killed, and fire damaged white spruce. The Alaska Department of Natural Resources Division of Forestry (AKDOF) received funding via a congressional appropriation to APHIS/PPQ in 2003 to conduct a survey for PWN and its *Monochamus* vector in the primary coastal wood production areas that have been harvested for pulp and round log exports to Japan, Korea and China[1]. The key outcome was to establish ground-based documentation of the presence/absence of the PWN's woodborer vector in the coastal spruce hemlock forests and any likely pathways for establishment of a pathogenic form of PWN in the coastal forests if its native *Monochamus* vector could be found. The ultimate goal was to provide data to relax a trade and plant regulatory restriction imposed by China for mandatory fumigation of all unprocessed wood product from North America, including Alaska.

A key finding from the 2003-2004 PWN and woodborer survey work by AKDOF was the absence of the PWN insect vector in the coastal Alaska forests. This early work established that PWN was not present in these mature Sitka spruce and Hemlock stands

[1]Primarily the Sitka spruce/western hemlock forests of the Kodiak Archipelago (e.g., Afognak Island), southern coast from Icy Bay to Wrangell, and southeastern panhandle from Haines to Ketchikan (including Prince of Wales Island). PWN vector surveys were also conducted at other southeast Alaska marine, rail and road terminus port areas in 2003 and 2004 (e.g., Skagway, Juneau and Hyder).

of southeast and other coastal stands (e.g., Afognak Island), which have long been important to the wood export industry to Asian markets. The next step was to confirm the presence/absence of any nematodes carried by native *Monochamus* woodborers, insects that are relatively common in the more extensive white spruce forests of Alaska's interior regions. The more fire-prone boreal spruce forests in Alaska's interior have likely provided the most consistent link to *Monochamus* woodborer populations so it was natural that forest health staffs explore the insect populations for any associated nematodes, including the PWN.

Additional funding was obtained from APHIS/PPQ to conduct an initial PWN/woodborer survey in interior Alaska during 2005 and 2006 by examining flown and unflown (reared) woodborers for nematodes. These exploratory surveys determined that about 9% of unflown, native *Monochamus scutellatus* carry a non-pathogenic form of immature *Bursaphelenchus*-type nematodes in the thoracic spiracles. Live samples of the nematode were subsequently reared to adults and identified by two nematologists as either the non-pathogenic "mucronate" form of *Bursaphelenchus xylophilus* or possibly *B. mucronatus*.

Monochamus-infested material was again collected in 2007 and placed in a rearing tent in 2008. Unflown adults were collected in July and August and examined for nematodes. Nematodes were found in two specimens and an attempt was made to rear the larval nematodes to adults for taxonomic confirmation and identification. It's important to also note here that attempts were made in early 2008 to obtain reference material and slides from the 2006 Alaska nematode adult identifications. These attempts were unsuccessful and it was later determined that the 2006 voucher specimens had been either lost or destroyed, one of the nematode taxonomists had retired and left university employ and the samples could not be located. For the 2008 project work, Alberto Pantoja (USDA ARS) provided assistance in rearing the nematodes, but, unfortunately, the nematodes failed to mature. As a result of this attempt, the technique for collecting and rearing the nematodes has been refined and we are optimistic about future success in rearing and identifying nematodes associated with Alaska *Monochamus*. Although rearing adult nematodes proved unsuccessful, DNA was collected from the 2008 larval samples and may help with identification.

Additional *Monochamus*-infected logs were collected near Fairbanks in September, 2008 and will be used to continue the Alaska *Monochamus* nematode taxonomic and genetic characterization work in 2009. Ongoing work on this "PWN" survey project will attempt to cross-compare voucher specimens of the phoretic nematode found in native *Monochamus scutellatus* with a suitable DNA standard. Hopefully, this will confirm the validity of the original taxonomic determination of a non-pathogenic mucronate form of *B. xylophilus* in Alaska.

Focus On: The Health of Alder in Alaska

A brief look at a complex series of factors affecting this shrub statewide

By Lori Trummer and Ken Zogas

The four species of alder in Alaska, (*Alnus incana* subsp. *tenuifolia*, *A. fruticosa*[1] *(A. crispa auct.)*, *A. sinuata*, *A. rubra*), are abundant keystone nitrogen-fixing shrubs growing in a variety of habitats from wetland to tree line. Recently, aerial and ground surveys suggest a decrease in the health of alder statewide.

Our surveys reveal increased defoliation, premature leaf death, stem dieback, stem death, and whole clump mortality at the local and landscape scales. Some of these symptoms appear linked to insects causing defoliation or canker fungi causing dieback and death. Other symptoms remain unexplained.

As alder has evolved into a species of considerable interest, we recognized how little is known about the factors affecting its health. Teasing out the multiple biotic (living) and abiotic (nonliving) factors remains a challenge for forest health specialists. In this essay, we describe some of the most common disease and insect problems of alder and the on-going efforts to monitor the health of this ecologically important shrub.

Alder Canker Fungi

(example *Valsa melanodiscus*)

Across southcentral and interior Alaska, canker fungi continue to cause noticeable widespread death of alder, primarily the riparian species *A. incana* subsp. *tenuifolia*. Other alder species, *A. fruticosa* and *A. sinuata*, are killed but less so than *A. incana*. Once infected, long narrow diffuse cankers girdle and kill stems. Entire clumps have died, and in many cases, resprouting does not occur. Although we suspect these fungi are native, they seem more aggressive and widespread than previously reported. Perhaps a changing climate favors aspects of the fungal lifecycle while disfavoring the host. Our understanding of 13 known canker fungi involved and factors affecting them is evolving. We continue to monitor these fungi through inoculation trials, monitoring plots, and landscape assessments of alder. See also the Disease section in the 2008 Forest Insects and Diseases Conditions Report for further information on alder canker fungi.

Figure 17. Canker fungus *Valsa melanodiscus.*

[1]Formerly referred to as *Alnus crispa*. The name was previously misapplied to alders in Alaska but true *A. crispa* does occur in other regions.

Alder Phytophthora

(Phytophthora alni subsp. *uniformis)*

Since November 2007, six isolates of *Phytophthora alni uniformis* (PAU) have been isolated from soil beneath alder from three riparian areas; two in southcentral Alaska along the Kenai River and its tributaries and one in interior Alaska along Panguingue Creek. This is the first time this hybrid pathogen has been found in North America. Alder *Phytophthora,* primarily subsp. *alni* (PAA), is a well-documented lethal root and collar disease of alder in nearly a dozen European countries. The PAU subspecies, however, is considered less aggressive than PAA, though our understanding of this is evolving. Finding PAU in three locations in Alaska is perplexing; the threat to Alaskan alder from this pathogen is unknown. No root or root collar symptoms of this pathogen have been noted in extensive root excavation surveys in Alaska. Perhaps PAU has coexisted benignly in Alaska with alder and has not been noted due to the lack of surveys such as those conducted since 2007. Monitoring and research related to this organism, particularly its origin, will continue.

Insects of Alder

Alder hosts a range of insect pests. With the exception of occasional localized outbreaks of the non-native woolly alder sawfly in southcentral and southeast Alaska, alder insect pests have remained at endemic levels.

About five years ago, aerial surveyors began noticing patches of "browning" alder in many areas around the state. These patches were widely separated geographically, located in a variety of ecotypes, and lacked consistent symptomatology. When possible, surveyors landed their plane to examine affected trees and found that cause varied with the area. For example, in Katmai National Park on the Alaska Peninsula and the Wood River–Tikchik Lakes State Park in southwest Alaska, mortality was attributed to eight continuous years of defoliation by the native generalist hardwood defoliator, *Sunira verberata*.

More recently, increased activity by leaf rolling insects such as the birch leaf roller (*Epinotia solandriana*) and an invasive leaf mining sawfly (most likely a species of *Heterarthrus*) have been observed.

Insect populations rapidly respond to stresses and other factors that cause host trees to become more vulnerable, to favorable climatic conditions that increase brood survival, or to conditions that negatively affect the predator/parasite complex that normally keep insect populations in check. Short- or long-term climate changes such as drought, which can stress plants, or warming temperatures, which can favor increased brood production and survival, may account for some of the observations of alder; however more research is needed to understand this complex interplay of events.

The woolly alder sawfly, *Eriocampa ovata*, a non-native species, and the striped alder sawfly, *Hemichroa crocea,* have recently caused widespread, severe defoliation on riparian alders in southcentral Alaska. A third and as yet unidentified pale green sawfly has been equally active in the same areas. These three sawflies are termed "skeletonizers," insects that consume all leaf tissue except major veins. *Alnus incana* subsp. *tenuifolia* is the preferred host, while *A. sinuata* and *A. fruticosa* are seldom defoliated. In areas of severe defoliation, it is not uncommon to find all three species infesting the same shrub simultaneously. Alder mortality has been observed in areas where severe defoliation has occurred over several successive growing seasons, though a direct cause and effect has not been conclusively established. Studies are on-going to determine the life cycle of these insects, their range and distribution in Alaska, and their contribution to the declining health of alder statewide.

Figure 18. Woolly alder sawfly.

Figure 19. Striped alder sawfly.

Status of Diseases and Declines


Figure 20. Spruce broom rust in interior Alaska.


Figure 21. Dead tree infested with hemlock dwarf mistletoe.


Figure 23. Dying yellow cedar.


Figure 22. *Hericium* fungi causes stem decay in spruce and hemlock.

Figures 24 and 25. Spruce needle rust and the alternate host, Labrador tea, in the background below.

Figure 26. Aspen canker at Wrangell-St. Elias.

Figure 27. Velvet top fungus (*Phaeolus schweinitzii*) fruiting bodies on Sitka spruce.

Status of Diseases and Declines

Alaska Forest Disease Management in the 21st Century

By Lori Trummer and Paul Hennon

Most native diseases and declines are chronic factors that significantly and annually affect the economic value of and ecological processes in our forests (Table 3). While these native diseases are difficult in their own right to detect and manage, a changing climate coupled with new disease introductions will continue to add new challenges to our current strategies for disease detection and management. Detection of diseases, however, does not equate to a need for management. Landowners and forest managers must decide whether the presence of a particular disease necessitates management planning and on-the-ground implementation to alter disease levels.

Figure 28. Excavating roots to survey for *Phytophthora.*

Research on yellow-cedar decline continues to link this widespread phenomenon in southeast Alaska with climate change. A web page on multiple aspects of this important decline syndrome is available at http://www.fs.fed.us/r10/spf/fhp/cedar/. A conservation management strategy has been proposed that shifts more of the southeast Alaska timber production to the dead yellow-cedar forests and supports active regeneration of the species on sites not currently declining. Current research is aimed at identifying long-term suitable habitat for yellow-cedar in the context of a warming climate.

It is conceivable that climate change is already altering the incidence and severity of some chronic native pathogens. An example is the canker fungi of alder. The current widespread mortality of alder in southcentral and interior Alaska has been attributed to many canker fungi, though primarily *Valsa melanodiscus*. While alder is known to periodically dieback, the intensive and extensive nature of the current outbreak is unprecedented and perhaps linked to climate change influences that stress the host and favor the pathogens.

Disease introductions as well as unique findings in Alaska are anticipated as we expand and enhance disease surveys statewide. An example is the finding of *Phytophthora alni* subsp. *uniformis* in five riparian locations in Alaska. Because a very closely related pathogen is responsible for widespread mortality of alder across Europe and no alder

Table 3. Suspected effects of common diseases on ecosystem functions in Alaska forests.

	Ecological Function Altered			
Disease	**Structure**	**Composition**	**Succession**	**Wildlife Habitat**
Stem Diseases				
Dwarf mistletoe	●	◗	◗	●
Hemlock cankers	○	◗	○	◗
Hardwood cankers	◗	◗	◗	○
Spruce broom rust	◗	○	○	●
Hemlock bole fluting	○	○	○	◗
Western gall rust	○	○	○	○
Heart Rots				
(Many species)	●	◗	●	●
Root Diseases				
(Several species)	○	●	●	○
Foliar Diseases				
Spruce needle rust	○	○	○	○
Spruce needle blights	○	○	○	○
Hemlock needle rust	○	○	○	○
Cedar foliar diseases	○	○	○	○
Hardwood leaf diseases	○	○	○	○
Shoot Diseases				
Sirococcus shoot blight	○	○	○	○
Shoot blight of yellow-cedar	○	◗	○	○
Declines				
Yellow-cedar decline	●	●	●	◗
Animal Damage				
Porcupines	◗	○	○	◗
Brown bears	◗	○	○	◗
Moose	◗	◗	●	●

Effects by each disease, disorder, or animal are qualified as:

○ = negligible or minor effect
◗ = some effect
● = dominant effect

Phytophthora subspecies were yet known to exist in natural alder ecosystems in North America, this finding has received substantial national and international attention. However, the significance of this finding and impact to Alaskan alder species is not yet understood. Perhaps this organism has coexisted benignly in Alaska with alder and has not been noted due to the lack of *Phytophthora* surveys such as those recently conducted. Surveys for other pathogens will likely reveal additional new and unique findings statewide.

Detection and management of most disease agents in Alaska is influenced by two facts. Most disease agents are, unfortunately, 1) not detected by aerial surveys (except for yellow cedar and distinctive foliar pathogens) and 2) underestimated for their presence and impacts. For many disease agents, ground surveys and research continue to close the gaps on detection and management.

Figure 29. Broken hemlock bole with heart rot—detection of most disease agents are from on-the-ground observation.

For those diseases that are managed in Alaska, appropriate or desirable disease levels will vary with the intended resource goals. Fortunately, several of the most important forest diseases such as hemlock dwarf mistletoe and heart rot can be manipulated silviculturally to predictably achieve a range of disease levels and impacts. Thus, disease management can be tailored to help meet simple or complex resource management goals. For more information on reducing, maintaining or enhancing disease levels in Alaskan forests, we refer you to this introductory section in the 2005 or 2006 Forest Health Conditions in Alaska reports.

Invasive Pathogens

Currently, no serious exotic tree pathogens are known to occur in Alaska. Several exotic pathogens have been found, but because of the limited number of plant species that these pathogens can attack, none present pose a serious threat to the health of Alaskan forests.

Two examples worth noting are the recent findings of alder *Phytophthora* and white pine blister rust in Alaska. *Cronartium ribicola,* the cause of white pine blister rust, was found in Ketchikan on a single ornamental pine several years ago, but to our knowledge has no capability of infecting native tree species in Alaska. *Phytophthora alni* subsp. *uniformis* (PAU) was isolated from soil under alders at five riparian locations across southcentral and interior Alaska. Although a very closely related pathogen is a well documented lethal root and collar disease of alder in Europe, PAU is considered to be a less aggressive subspecies of *Phytophthora alni*. Finding PAU in five locations across Alaska without host symptoms is surprising and perplexing; the threat to Alaskan alder or any of the

Map 6. Locations where *Phytophthora alni* subsp. *uniformis* has been detected in association with alder.

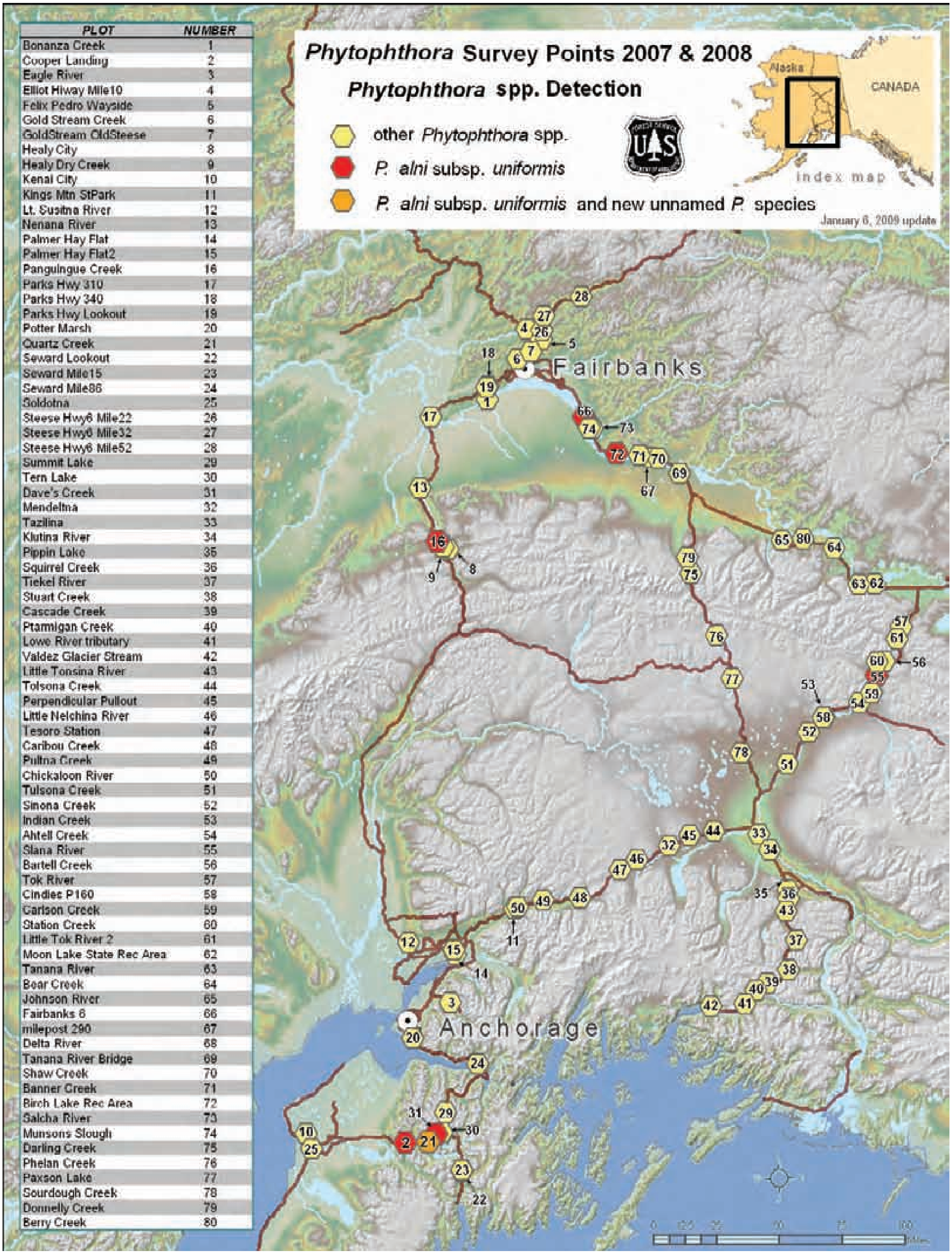


Table 4. Invasive pathogens either present, or not in Alaska, and invasive ranking.

Common name	Scientific name	Present in Alaska?	Invasive ranking
Spruce needle rust	*Chrysomyxa abietis* (Wallr.) Unger	No	High
Rhododendron-spruce needle rust	*Chrysomyxa ledi* var. rhododendri (de Bary.) Savile	No	Moderate
Resinous stem canker	*Cistella japonica* Suto et Kobayashi	No	Moderate
Cedar shot hole	*Didymascella chamaecyparidis* (J. F. Adams.) Maire	No	Moderate
Cedar leaf blight	*Lophodermium chamaecyparissi* Shir & Hara.	No	Moderate
Poplar rust	*Melampsora larici-tremulae* Kleb.	No	Moderate
Seiridium shoot blight	*Seiridium cardinale* (Wagener) Sutton & Gibson	No	Moderate
Phytophthora root disease	*Phytophthora lateralis* Tucker & Milbrath	No	Moderate
Alder Phytophthora	*Phytophthora alni* subsp. *uniformis*	Yes	Low[1]
Black knot	*Apiosporina morbosa* (Schwein.:Fr.) Arx	Yes	Low
Pine wilt nematode	*Bursaphelenchus xylophilus*	No	Low
White pine blister rust	*Cronartium ribicola* J.C. Fischer: Rabh.	Yes	Low
Fire blight	*Erwinia amylovora* (Burrill) Winslow	Yes	Low
Sudden oak death	*Phytopthora ramorum* Werres deCock Man in't Veld	No	Low
Birch leaf curl	*Taphrina betulae* (Fckl.) Johans.	No	Low
Birch witches broom	*Taphrina betulina* Rostr.	No	Low
Valsa canker	*Valsa harioti*	No	Low

[1] Pathogen found in Alaska in 2007. To date it is unknown whether it is invasive or native.

Alaskan hardwood species from this pathogen is unknown, though presumed low. It is possible that this organism has coexisted benignly with alder in Alaska and has not been noted due to the paucity of *Phytophthora* surveys statewide. Map 6 displays the locations sampled for *Phytophthoras* in 2007/08, including those sites with (+) PAU isolations. Extensive briefing papers on this finding can be found at http://www.fs.fed.us/r10/spf/fhp/.

We have initiated a review of worldwide literature in an attempt to identify the tree pathogens that, if introduced, could cause damage to native tree species in Alaska. Our approach is mainly based on host taxa; that is, to review scientific literature on the fungal pathogens that infect close relatives (e.g., same genus) of Alaska tree species. A number of species have been identified from Europe and Asia that are potential threats to Alaska (Table 4). Preliminary qualitative rankings are given for each of these species based on the type and severity of the disease that they cause in their native forests, their adaptability to Alaska's climate, and their likelihood of introduction. This year, we will be making formal submissions of information and quantitative rankings on many of these species to the EXFOR database (Exotic Forest Pest Information System for North America).

Stem Diseases

Hemlock Dwarf Mistletoe

Arceuthobium tsugense (Rosendhal) G.N. Jones

Hemlock dwarf mistletoe is an important disease of western hemlock in unmanaged old-growth stands throughout southeast Alaska as far north as Haines. Although the range of western hemlock extends to the northwest along the Gulf of Alaska, dwarf mistletoe is absent from Cross Sound to Prince William Sound.

Figure 30. Dwarf mistletoe infection of western hemlock.

It is difficult to detect dwarf mistletoe during aerial surveys, but new estimates of occurrence are available from Pacific Northwest Research Station, Forest Inventory and Analysis (FIA) plots. Approximately 12 percent of forest land in southeast Alaska is infested with hemlock dwarf mistletoe (Table 5). Ignoring the inaccessible wilderness not sampled, hemlock dwarf mistletoe occurs on approximately 830,000 acres.

Including wilderness areas would increase this estimate to more than one million acres of forest infested with hemlock dwarf mistletoe in southeast Alaska. Most of this occurrence is in the old sawtimber classes, and both the young and old sawtimber classes have a higher proportion occurrence (19.8 and 13.5%, respectively) than in the smaller size classes. These values are likely conservative estimates because dwarf mistletoe may not have been recorded when other damage agents were present. Also, it is important to note that scattered larger trees may have been present in the plots designated as smaller and younger classes. This could explain, in part, the higher level of hemlock dwarf mistletoe in the young sawtimber class.

Hemlock dwarf mistletoe is concentrated at low elevations in southeast Alaska (Figure vi). Productive forest land represents most of the occurrence. There is an apparent threshold at approximately 500 ft on both productive and unproductive forest lands, above which the parasite can occur but is less common. The principle host, western hemlock is distributed well above this threshold, suggesting that some climatic factor limits the distribution of hemlock dwarf mistletoe at higher elevations. With the ideal that snow levels or length of growing season limits the reproduction of dwarf mistletoe, we are beginning a project to model its possible upslope spread through time given climate warming scenarios.

The dominant small-scale (canopy gap) disturbance pattern in the old forests of coastal Alaska favors the short-range dispersal mechanism of hemlock dwarf mistletoe and may explain the common occurrence of the disease here. Infection of Sitka spruce is

Table 5. Occurrence of hemlock dwarf mistletoe on Forest Inventory and Analysis (FIA) plots in southeast Alaska.

Stand size class[2]	Accessible forest sampled[1] (Acres, thousands)	Mistletoe present (Acres, thousands)	Mistletoe present %
Seedling/sapling	667	27	4.1
Poletimber	423	10	2.3
Young sawtimber	699	138	19.8
Old sawtimber	4,863	655	13.5
Nonstocked	217	0	0.0
All size classes	6,869	830	12.0

[1] Includes all forest lands in southeast Alaska extending to the Malaspina Glacier northwest of Yakutat; does not include wilderness areas (i.e., inaccessible) not sampled by FIA.

[2] Size classes terms from FIA and defined by plurality of stocking by live, growing stock trees. Poletimber sized trees: dbh > 5 in and < sawtimber sized; Sawtimber sized trees: dbh > 9 in for softwoods and > 11 in for hardwoods. Young sawtimber and old sawtimber distinguished by aging of sample trees.

uncommon and infection of mountain hemlock is rare. Heavily infected western hemlock trees have branch proliferations or "witches' brooms," bole deformities, reduced height and radial growth, less desirable wood characteristics, and a greater likelihood of heart rot, top-kill, and death. The aggressive heart rot fungus, ***Phellinus hartigii***, is associated with large mistletoe brooms on western hemlock.

These symptoms are all potential problems in stands managed for wood production. Growth loss in heavily infested stands can reach 40 percent or more. On the other hand, witches' brooms, wood decay associated with bole infections, and scattered tree mortality can result in greater diversity of forest structure and increased animal habitat for birds or small mammals, although this topic has not been adequately researched in Alaska. The inner bark of swellings and the seeds and shoots of the parasitic plants are nutritious and often consumed by small mammals (e.g., flying squirrels). Stand composition is altered when mixed-species stands are heavily infected; growth of resistant species such as Sitka spruce and cedar is enhanced.

Spread of the parasite into young-growth stands that regenerate following clearcutting is typically by: 1) infected non-merchantable hemlock trees (residuals) which are sometimes left standing in cutover areas, 2) infected old-growth hemlocks on the perimeter of cutover areas, and 3) infected advanced reproduction. Residual trees may play the most important role in the initial spread and long-term mistletoe development in young stands. Managers using alternative harvest techniques (e.g., large residuals left standing in clearcuts, small harvest units, or partial harvests) should recognize the potential reduction in timber volume and value from hemlock dwarf mistletoe under some of these silvicultural scenarios. Substantial reductions to timber are only associated with very high disease levels, however. High levels of hemlock dwarf mistletoe will only result if numerous large, intensely infected hemlocks are well distributed after harvest. Selective harvesting techniques will be the silvicultural method for maintaining desirable levels of this disease if management intends to emphasize structural and biological diversity along with timber production.

We worked with a Canadian scientist in 2007 to publish a full literature review and synthesis on the biology and management of hemlock dwarf mistletoe (Muir, J. A.; Hennon, P. E. 2007. A synthesis of the literature on the biology, ecology and management of western hemlock dwarf mistletoe. Gen. Tech. Rep. PNW-GTR-718. Portland, OR: U.S. Department of Agriculture, Forest Service, Pac. Northwest Research Station. 141p.)

Heart Rots of Conifers

Heart rot decay causes enormous loss of wood volume in all major tree species in Alaskan forests annually (Table 6). Approximately one-third of the old-growth timber volume in southeast Alaska is defective largely due to heart rot fungi. These extraordinary effects occur where long-lived tree species predominate, such as old-growth forests in southeast Alaska where fire is absent and stand replacement disturbances are infrequent. The great longevity of individual trees allows ample time for the slow-growing decay fungi to cause significant amounts of decay. By predisposing large old trees to bole breakage, these fungi serve as important disturbance factors that cause small-scale canopy gaps.

Figure vi. Occurrence of hemlock dwarf mistletoe in southeast Alaska by elevation zones (100 foot classes) on lands supporting either "unproductive" (stocked, but not capable of producing 1.399 cubic meters per hectare per year at culmination of mean annual increment) or "productive" forests (capable of producing 1.399 cubic meters per hectare per year at culmination of mean annual increment). Data from Pacific Northwest Research Station, Forest Inventory and Analysis (FIA) plots covering all of southeast Alaska except inaccessible wilderness areas. FIA data were collected between 1995 and 2000.

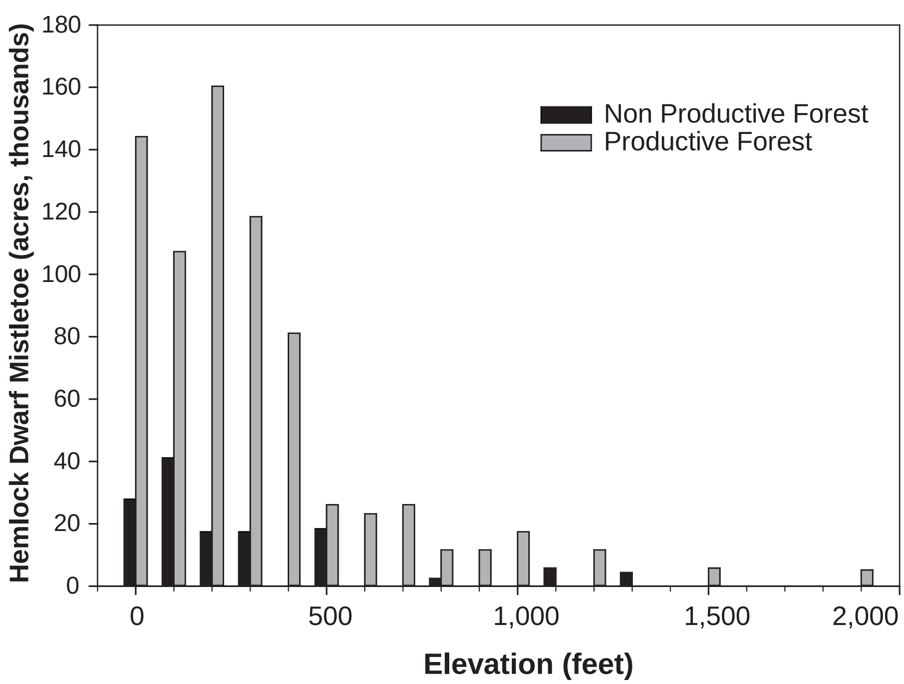


Table 6. Common wood decay fungi on live conifer trees in Alaska.

Heart and butt rot fungi[1]	Tree Species Infected: Western hemlock	Sitka spruce	Western redcedar	White/Lutz spruce	Mountain hemlock
Laetiporus sulphureus	X	X		X	X
Phaeolus schweinitzii	X	X		X	
Fomitopsis pinicola	X	X		X	X
Phellinus hartigii	X				
Phellinus pini	X	X		X	X
Ganoderma sp.	X	X		X	
Coniophora sp.				X	X
Armillaria sp.	X	X	X	X	X
Inonotus tomentosus				X	
Heterobasidion annosum	X	X			
Ceriporiopsis rivulosa			X		
Phellinus weirii			X		
Echinodontium tinctorium					X

[1] Some root rot fungi were included in this table because they are capable of causing both root and butt rot of conifers.

In the boreal forests, large-scale disturbance agents, including wildfire, insect outbreaks (e.g., spruce beetle), and flooding are key factors influencing forest structure and composition. Although small-scale disturbances from the decay fungi are less dramatic, they have an important influence on altering biodiversity and wildlife habitat at the individual tree and stand level. In southcentral and interior Alaska, heart rot fungi cause considerable volume loss in mature white spruce forests.

Heart rot fungi enhance wildlife habitat indirectly by increasing forest diversity through gap formation and more directly by creating hollows in live trees or logs for species such as bears and cavity nesting birds. The "white rot" fungi can be responsible for actual hollows because these fungi degrade both cellulose and lignin, leaving a void. The lack of hollows caused by "brown rot" fungi, which leave lignin largely intact, would appear to lead to less valuable habitat for some animals, although primary excavators can create cavities in this soft wood. Wood decay in both live and dead trees is a center of biological activity, especially for small organisms. Wood decay is the initial step in nutrient cycling of wood substrates and, in the case of brown rot, contributes large masses of stable carbon structures (e.g., partially modified lignin) to the humus layer of soils.

Figure 31. Heart rot and bole breakage.

The importance of decay fungi in managed young-growth conifer stands is less certain. Wounds on live trees caused by logging activities provide decay fungi with entrance courts to potentially invade and cause appreciable losses. Heart rot in managed stands can be manipulated to desirable levels by varying levels of bole wounding and top breakage during stand entries. In some instances, bole breakage is sought to occur in a specific direction (e.g., across streams for coarse woody debris input). Artificially wounding trees on the side of the bole that faces the stream can increase the likelihood of tree fall in that direction. Generally, larger, deeper wounds and larger diameter breaks in tops result in a faster rate of decay. Wound-associated heart rot development is much slower in southeast Alaska than areas studied in the Pacific Northwest.

Wood decay fungi decompose branches, roots, and boles of dead trees; therefore, they play an essential role in recycling wood in forests. This is particularly the case in southeast Alaska where fires are rare and thus do not contribute to carbon recycling.

In southcentral and interior Alaska, sap rot decay routinely and quickly develops in spruce trees attacked by spruce beetles. Significant volume loss occurs within 3 to 5 years after tree death. Thus, large amounts of potentially recoverable timber volume are lost annually following the massive spruce beetle outbreak of the 1980s and 90s that killed over 3.4 million acres of spruce on the Kenai Peninsula. Research indicates that the most common and conspicuous sap rot fungus associated with dead spruce is ***Fomitopsis pinicola,*** the red belt fungus. However, over 70 taxa have been detected in dead and down beetle-killed trees.

Figure 32. Red belt conk, *Fomitopsis pinicola*. This fungus is an important heart rot agent of live trees and the dominant decomposer of dead conifers.

A wood deterioration study of beetle-killed trees on the Kenai Peninsula assessed the rate at which beetle-killed trees decompose. Preliminary results from measurements in 2002 indicate an overall decomposition rate of 1.5% per year, which is slow compared to other spruce ecosystems worldwide. Beetle-killed trees are predicted to influence fire behavior and present a hazard for over 70 years. Estimates indicate it would take over 200 years for beetle-killed trees to completely decompose. Decomposition rates were remeasured in 2008. With this final data set, overall decomposition rates will be refined from our 2002 preliminary results.

Stem Decay of Hardwoods

Stem decay causes substantial volume loss and reduces wood quality in Alaskan hardwood species annually. The incidence of stem decay is high by the time most hardwood forests reach maturity. The most reliable sign of decay is the presence of fruiting bodies (mushrooms or conks) on the stem. Frost cracks, broken tops, dead-broken branches, and poorly healed trunk wounds all provide entrance courts for decay fungi.

Stem decay fungi alter stand structure and composition and appear to be important factors in the transition of even-aged hardwood forests to mixed species forests. Bole breakage of hardwoods creates canopy openings, allowing release of understory conifers. Trees with stem decay, broken tops, and collapsed stems are preferentially selected by wildlife for cavity excavation. Several mammals, including the northern flying squirrel, are known to specifically select tree cavities for year-round nest and cache sites. In southcentral and interior Alaska several fungi are the primary cause of wood decay in live paper birch and aspen (Table 7).

Figure 33. *Pholiota* mushrooms. This funus causes a stem decay in Alaskan hardwoods.

Spruce Broom Rust

Chrysomyxa arctostaphyli Diet.

Broom rust is common on spruce branches and stems throughout southcentral and interior Alaska, but is found in only localized areas of southeast Alaska (e.g., Halleck Harbor area of Kuiu Island and Glacier Bay). Infections by the rust fungus result in dense clusters of branches or witches' brooms. The actual infection process may be favored during specific years, but the incidence of the perennial brooms changes little from year to year.

The disease may impair spruce growth, and witches' brooms have served as entrance courts for heart rot fungi, including ***Phellinus chrysoloma***. Ecologically, the dense brooms provide important nesting and hiding habitat for birds and small mammals. In interior Alaska, research on northern flying squirrels suggests that brooms in white spruce are an important habitat feature for communal hibernation and survival in the coldest periods of winter.

Western Gall Rust

Peridermium harknessii J.P. Moore

Infection by the gall rust fungus causes spherical galls on branches and main boles of shore pine. Annually, the disease is common throughout the distribution of shore pine in Alaska. Infected pine tissues are swollen but not always killed by the rust fungus. Another fungus, ***Nectria macrospora***, colonized and killed many of the pine branches with rust fungus galls this year. The combination of the rust fungus and *N. macrospora* frequently caused top-kill. The disease, although exceedingly abundant, does not appear to have a major ecological effect in Alaskan forests.

Table 7. Common wood decay fungi on live hardwood trees in Alaska.

	Tree Species Infected	
Heart and butt rot fungi	Paper Birch	Trembling Aspen
Phellinus igniarius	X	
Inonotus obliquus	X	
Phellinus tremulae		X
Pholiota spp.	X	X
Armillaria spp.	X	X
Ganoderma applanatum	X	X

Shoot Blights and Cankers

Alder Canker Fungi

Valsa melanodiscus Otth.

Numerous Other Canker Causing Fungi

Across southcentral and interior Alaska, canker fungi continue to cause noticeable widespread death of alder, primarily the riparian species *A. incana* subsp. *tenuifolia*. Other alder species, *A. fruticosa* and *A. sinuata*, are also infected but less dramatically than *A. incana,* although reports on these species is increasing. Road surveys conducted by USFS staff and reports from staff at other state and federal agencies have detected canker fungi killing alders at over 100 locations across southcentral and interior Alaska. Long narrow diffuse cankers girdle and kill alder stems. Entire genets have died back, and in many cases, re-sprouting does not occur, thus recovery of alder in some areas is uncertain. Widespread alder mortality may have negative ecosystem consequences, such as the loss of nitrogen fixation inputs.

Surveys in Katmai National Park by NPS staff detected high levels of lethal alder canker fungi (undescribed) on live and dead alder following many years of severe defoliation by the *Sunira* moth, a generalist hardwood defoliator. Approximately 60% of the *A. sinuata* is dead along the Dumpling Mountain trail. Canker fungi did not appear to affect new growth and there was some evidence cankers had been “walled off” with new growth occurring below this point. The long term survival and recovery of alder will be monitored in subsequent years.

In previous Conditions Reports, *Valsa melanodiscus* was reported as the only canker fungus contributing to the widespread alder dieback and death. We now recognize that more than a dozen fungal species have been associated with diffuse cankers of alder by staff from Michigan State University (MSU), University of Wisconsin- Madison (UW), University of Alaska – Fairbanks (UAF), and USDA (Table 8). While *V. melanodiscus* appears to be the most common canker fungus in southcentral Alaska, the story is less clear on the roles of the other fungi in the Interior.

All of the canker fungi identified in Table 8 can cause similar diffuse cankers on the stems of alder, making precise identification difficult without molecular diagnostic tools or light microscopy. Although we suspect these fungi are native, they seem more aggressive and widespread than previously reported. Perhaps a changing climate or other factors favor aspects of the fungal lifecycle while disfavoring the alder host. Our understanding of canker fungi and factors affecting them is evolving. We continue to monitor these fungi through inoculation trials, monitoring plots, and landscape assessments of alder.

Figure 34. Canker caused by *Valsa melanodiscus.*

Current research and monitoring studies of alder canker fungi include:

1. Genetics of *Valsa melanodiscus* (MSU)
2. Molecular identification of alder canker fungi (MSU, UAF, USDA)
3. Greenhouse inoculation studies in Madison and Fairbanks (UW and UAF)
4. Field inoculations in southcentral Alaska in spring and fall (UW, UAF, USFS)
5. Alder monitoring at 26 sites in southcentral and interior AK (USFS)
6. Assessments on the Tanana River (UAF)
7. Roadside surveys of alder in southcentral and interior Alaska (USFS)
8. Impacts of dieback and death of alder on nitrogen fixation rates (UAF)
9. Assessment of bird communities in cankered and healthy alder stands (AK Bird Observatory)

Sirococcus Shoot Blight

Sirococcus tsugae Rossman, Castlebury, D.F. Farr & Stanosz

In 2008, *Sirococcus* shoot blight was found at the highest infection levels in recent memory. It was common on western hemlock, and particularly severe on mountain hemlock. Some mountain hemlock trees that had been attacked for several consecutive years finally succumbed and died in 2008. For unknown reasons, ornamental mountain hemlocks experienced heavier infections than trees in forested settings.

Thinning has been reported to be of some value in reducing damage by the fungus, perhaps because of increased airflow and reduced humidity. The severe infection of widely spaced ornamental mountain hemlock casts doubt on this form of disease management,

Table 8. Fungi associated with, or peripheral to, diffuse cankers on alders.

Alder Species	Location (Southcentral, Interior, or both)	Fungal Species
A. incana	Both	*Ophiovalsa suffusa*
A. incana	Southcentral	*Diatrype cf. disciformis*
A. incana	Southcentral	*Eutypella cf. cerviculata*
A. incana	Interior	*Eutypella stellata*
A. incana	Southcentral	*Hypoxylon cf. multiforme*
A. incana	Both	*Ophiovalsa femoralis*
A. incana	Southcentral	*Valsa diatrypoides*
A. incana	Both	*Valsa melanodiscus*
A. incana	Both	*Botryosphaera* sp.
A. incana	Southcentral	*Melanconis alni*
A. incana	Interior	*Melanconis alni* (98%)[1]
A. incana	Interior	*Diaporthe phaseolorom* (95%)[1]
A. fruticosa[2]	Interior	*Pezicula aurantiaca* (99%)[1]
A. fruticosa[2]	Interior	*Melanconis stilbostoma* (89%)[1]
A. fruticosa[2]	Interior	*Discula* sp. (94%)[1]
A. fruticosa[2]	Interior	*Melanconis alni* (98%)[1]
A. fruticosa[2]	Interior	*Eutypella cerviculata* (98%)[1]

[1]DNA sequence similarity (values in parentheses) of unknown Alaskan samples and the highest named match in GenBank, a public DNA sequence database, at the ITS region as determined by UAF and USDA personnel. Other identifications in the table were determined by MSU staff.

[2]*A. fruticosa* formerly referred to as *Alnus crispa*. *A. crispa* was previously misapplied in Alaska, however, it occurs in other regions.

however. Ornamental trees can be protected by the application of fungicides in the spring just after bud break when the pathogen produces its infectious spores. Species composition in natural forests may be altered to some degree by this disease where other trees species may be favored over infected hemlocks.

Shoot Blight of Yellow-cedar

Apostrasseria sp.

The shoot blight fungus, *Apostrasseria* sp., in southeast Alaska was common in yellow-cedar regeneration in 2008. The disease does not affect mature cedar trees. Infection by the fungus caused terminal and lateral shoots to be killed back 10 to 20 cm on seedlings and saplings during winter or early spring. Numerous leaders were found infected in 2008, but yellow-cedar is capable of producing new terminal leaders and thus may not experience long-term form problems. Entire seedlings up to 1.5 ft. tall are sometimes killed. The fungus that causes the disease, *Apostrasseria* sp., is closely related to other fungi that cause disease on plants under snow. Efforts to identify this species will continue in 2009.

This shoot blight disease probably has more ecological impact than similar diseases on other host species by contributing to yellow-cedar's inability to compete with other vegetation in young-growth forests. The additive effects of freezing injury, browsing by deer, and this shoot disease can reduce the success of yellow-cedar artificial or natural regeneration.

Canker Fungi of Hardwoods

***Cryptosphaeria lignyota (Fr.:Fr.)* Auersw**

***Encoelia pruinosa* (Ell. &Ev.) Torkelson and Eckblad**

***Ceratocystis fimbriata* Ell. & Halst.**

***Cytospora chrysosperma* Pers. ex Fr.**

***Nectria galligena* Bres.**

Figure 35. *Ceratocystis fimbriata* on aspen.

Canker-causing fungi annually infect aspen and other hardwoods. The actual infection process may be favored during specific years, but the incidence of the perennial cankers changes little from year to year. Most of these fungi cause discreet perennial target-shaped cankers except for *E. pruinosa* and *C. lignyota* which cause long diffuse stem cankers several meters in length. The vascular tissue beneath the cankers is killed. Although most are considered weak parasites, *E. pruinosa* and *C. lignyota* can girdle and kill aspen trees within a few years. *C. lignyotais* causing substantial mortality of older aspen trees adjacent to the Wrangell St. Elias visitors center. Bole breakage typically occurs at the canker infection sites because of stem weakening at that point.

Hemlock Canker

Unknown fungus

The hemlock canker disease was at low levels in 2008, as it has been the previous several years. This disease has been common along roads and natural openings where it kills small hemlocks and the lower crowns of larger trees. Modification of stand composition and structure are the primary effects of hemlock canker. Other tree species, such as Sitka spruce, are resistant and benefit from reduced competition. Wildlife habitat, particularly for deer, may be enhanced where the disease kills understory hemlock which tends to out-compete the more desirable browse vegetation.

Grovesiella Canker

Grovesiella abieticola (Zeller and Goodd.) Morelet and Gremmen

Cankers, top kill, and branch death were common on ornamental true firs in Juneau in 2008. The causal fungus was *Grovesiella abieticola*, which sporulated abundantly on diseased material in late summer. This is one of two canker fungi found on true firs, the other is *Cytospora abietis* Sacc. A survey of these diseases in natural true fir stands has not yet been conducted in Alaska.

Root Diseases

In Alaska, there are three important tree root diseases: *Tomentosus* root rot; *Annosus* root disease, and *Armillaria* root disease. The laminated root disease caused by a form of the fungus *Phellinus weirii*, important in some western forests of British Columbia, Washington, and Oregon, is not present in Alaska. A form of the fungus that does not cause root disease is present in southeast Alaska. There it causes a white rot stem decay in western red cedar, contributing to the very high defect levels in this tree species.

Tree infected with root diseases are prone to uprooting, bole breakage, and outright mortality due to the extensive decay of root systems and the lower tree bole. Volume loss attributed to root disease can be substantial, up one third of the gross volume. In managed stands, root rot fungi are considered long-term site problems because they can remain alive and active in large roots and stumps for decades, impacting the growth and survival of susceptible host species on infected sites.

Root diseases are considered natural, perhaps essential, parts of the forest. They alter stand structure, composition, and increase plant community diversity through canopy openings and scattered mortality. Resistant tree species benefit from reduced competition within infection centers. Wildlife habitat may be enhanced by small-scale mortality centers and increased volume of large woody downed material.

Tomentosus Root Disease

Inonotus tomentosus (Fr.) Teng.

Inonotus tomentosus is the most important root and butt-rot of spruce and may also attack lodgepole pine and tamarack. The disease appears to be widespread across the native range of spruce in south-central and interior Alaska. Recently, *Tomentosus* root rot was found for the first time in southeast Alaska, infecting Sitka spruce near Dyea. Surveys in the Dyea area indicated a high level of *Tomentosus* root disease with nearly one third of surveyed trees infected. Uprooting of root diseased trees at the Dyea site is a concern for public safety.

Figure 36. Uprooting results when root diseases severely compromise the root systems of infected trees.

Inonotus tomentosus will remain alive in colonized stumps for at least three decades, and successfully attack adjacent trees through root contacts. Thus, spruce seedlings planted in close proximity to infected stumps are highly susceptible to infection through contacts with infected roots.

Recognition of this root disease is particularly important in managed stands where natural regeneration spruce is limited and adequate restocking requires planting. The incidence of this root rot is expected to increase on infected sites that are replanted with spruce.

Annosus Root & Butt Rot

Heterobasidion annosum (Fr.) Bref.

Annosus commonly causes root and butt-rot in old-growth western hemlock and Sitka spruce forests in southeast Alaska. The form present in Alaska is the "S type," which causes internal wood decay, but is not typically a tree killer. The high rate of heart rot in old-growth hemlock that was attributed to *H. annosum* by Kimmey in 1956 by examining the appearance of wood decay should probably be reevaluated using modern genetic methods. *Heterobasidion annosum* has not yet been documented in southcentral or interior Alaska.

Elsewhere in the world, spores of the fungus are known to readily infect fresh stump surfaces, such as those found in clearcuts or thinned stands. Studies in managed stands in southeast Alaska, however, indicate limited stump infection and survival of the fungus. Thus, this disease poses minimal threat to young managed stands from stump top infection. Reasons for limited stump infection may be related to climate. High rainfall and low temperatures, common in Alaska's coastal forests, apparently hinder infection by spores.

Armillaria Root Disease

Armillaria spp.

Several species of *Armillaria* occur in the coastal forests of southeast Alaska, but in general, these species are less aggressive saprophytic decomposers that only kill trees that are under some form of stress. Studies in young, managed conifer stands indicate that *Armillaria* can colonize stumps, but will not successfully attack adjacent trees. *Armillaria* may be an important agent in the death and decay of older red alder.

Figure 37. Black shoestring-like rhizomorphs within roots indicate *Armillaria* infection.

Several species of *Armillaria,* including *A. gallica,* occur in southcentral and interior Alaska. Some species invade conifers and others invade hardwoods. Most species appear to be weak pathogens invading trees under stress. Mature stands of paper birch and trembling aspen are particularly susceptible to attack by *Armillaria*.

Specimens of the root pathogen, *Armillaria sinapina,* were collected from various host species during a roadside reconnaissance along a latitudinal transect spanning roughly 400 miles from Seward to the Arctic Circle. Host substrate included willow, white spruce, birch, mountain hemlock, and aspen. The wide geographic range of *A. sinapina* on diverse hosts under different climates in Alaska raises potential implications for trees stressed by climate change.

Foliar Diseases

Spruce Needle Rust

Chrysomyxa ledicola Lagerh.

Disease levels of spruce needle rust (*Chrysomyxa ledicola*) varied widely across the state in 2008. In southeast, the disease was at fairly low to moderate levels, down substantially from a peak year in 2007. In contrast, in interior Alaska, spruce needle rust occurred at the highest levels in memory. The Kuskokwim River was reported to be running yellow with the high spore load, causing much concern about water quality to the villagers of the area.

Outbreaks by this fungus are probably triggered by specific weather events when the fungus infects newly emerging spruce needles in May. Symptoms in infected needles do not become noticeable until early August, however. The small acreage mapped during the mid-summer aerial survey does not capture the area of infected spruce because needle symptoms are not yet fully developed.

The disease appears in forested areas and in neighborhoods, but always near bogs. The rust fungus must infect Labrador tea, a bog-inhabiting plant as part of its life cycle. The fungus cycles back and forth between Labrador tea and spruce. There is some evidence in genetic resistance in spruce, as scattered trees remain minimally infected despite being surrounded by very heavily infected trees, with presumably high spore loads in the entire area.

The disease typically does not occur at epidemic infection levels in successive years. If the disease subsides next year, the trees infected this year will have thinner crowns, with the compliment of previously infected needles largely missing. The prognosis for such trees is good. They may experience a temporary reduction in potential growth, but mortality is rarely an outcome of this disease.

Spruce Needle Discoloration

The needle discoloration so prominent on Lutz spruce across the Kenai Peninsula in 2007 was virtually undetectable in 2008. Concern by homeowners was high since the trees looked very unhealthy and many homeowners had lost trees during the outbreak of bark beetles. Environmental stressors likely contributed to these dramatic symptoms in 2007 and their abatement in the cool wet summer of 2008. With the current years needles basically healthy, affected trees are expected to have a high potential for full recovery.

Declines

Many other factors affect forest health along with insects and pathogens. The term forest decline is used in situations where a complex of interacting factors leads to widespread tree death. Because of this complexity, it is difficult to determine how all the factors interrelate and many forest declines throughout the world remain unresolved. The factors are often grouped into predisposing, inciting, and contributing. Predisposing factors, which are long term processes, provide conditions for the following factors to injure trees. These include forest age, genetic potential, climate change, urban disturbances, poor soil fertility and drainage. Factors with relatively short duration periods but that can cause severe stress, known as inciting factors, include drought, frost, wind, and fire. The contributing factors are biotic agents such as insects and weak pathogens that are able to kill or speed the death of trees weakened by the previous two factors. The topic of forest decline is timely, as they may serve as examples of how climate change will be manifested on the Alaskan landscape. This section describes the most important declines mapped, monitored, or surveyed in 2008.

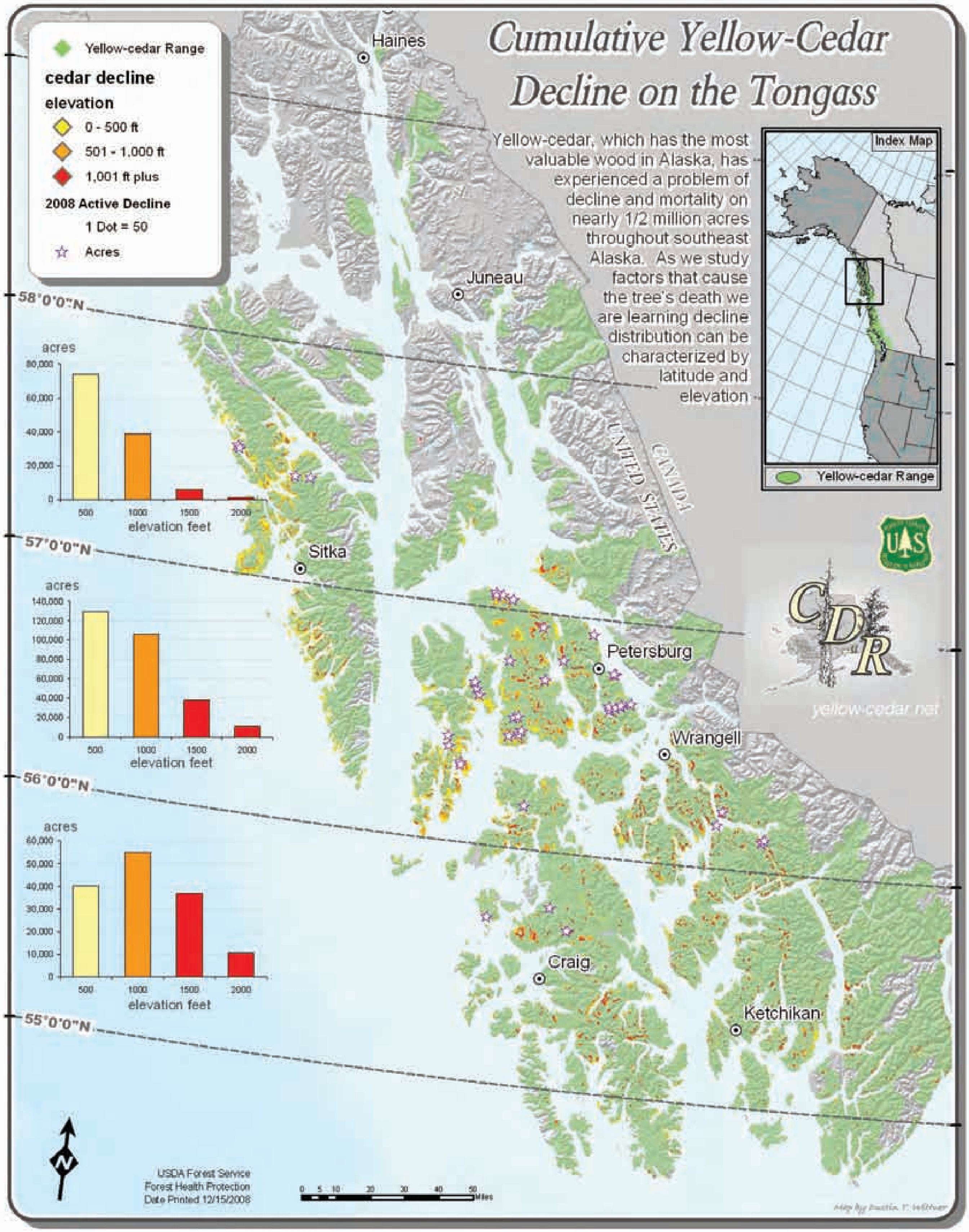
Yellow-cedar Decline

Yellow-cedar decline is one of the most prominent forest health issues in Alaska and a leading example of the impact of climate change on a forest ecosystem. The principal tree species affected, yellow-cedar, is an economically and culturally important tree. An abnormal rate of mortality to yellow-cedar began in about 1900, accelerated in the mid-1900s and continues today. These dates roughly coincide with the end of the Little Ice Age and a period of enhanced warming, respectively. Impacted forests generally now have mixtures of old dead, recently dead, dying, and living trees, indicating the progressive nature of tree death. The extreme decay resistance of yellow-cedar results in trees remaining standing for about a century after death and allowed for the reconstruction of cedar population dynamics through the 1900s.

Approximately 500,000 acres of decline have been mapped during aerial detection surveys. The extensive mortality occurs in a wide band from western Chichagof and Baranof Islands to the Ketchikan area (Table 9). Actively dying trees, with crowns appearing yellow to red from the air, were found on only 9,000 ac in 2008, which followed another year of relative inactivity—26,000 ac in 2007. Most of the mapped active mortality in 2008 was in the central region of southeast Alaska (Wrangell, Kupreanof, and Kuiu Islands). This decrease in active mortality is consistent with high levels of snow that last few winters. Note that it takes 10 to 15 years for trees to die from the time crown symptoms appear until final death; thus, it is difficult to associate observations from aerial surveys to weather events in particular years.

New analysis of aerial survey mapping shows the effect of both latitude and elevation on the occurrence of decline. Decline occurs somewhat higher in elevation at the southerly latitude of 55-56 degrees, but is more restricted to lower elevations at the next two northerly latitudes (Map 7). These are climate signals that suggest the possibility of low snow in defining where yellow-cedar decline occurs.

Map 7. Cumulative yellow-cedar decline on the Tongass.



Several years ago, we discovered that yellow-cedar decline extend approximately 100 miles south into British Columbia, where mapping efforts by the BC Forest Service continued in 2007 and 2008.

The entire distribution of yellow-cedar decline suggests climate as a trigger for initiating the forest decline. Our current state of knowledge suggests that yellow-cedar decline is a form of seasonal freezing injury. Trees may be predisposed by growing on wet sites where roots are shallow and temperature fluctuations are extreme. A change in climate about 5,000 years BP may be considered a predisposing factor as a shift to a cool and wet climate initiated peat development and poorer drainage. Soil warming in these exposed growing conditions may cause premature dehardening and contribute to spring freezing injury. Our collaborative research with experts from Vermont on cold tolerance testing of cedar supports this hypothesis, as yellow-cedar trees are quite cold hardy in fall and

Table 9. Acreage affected by yellow-cedar decline in southeast Alaska by ownership.

National Forest	**523,069**	**Native Land**	**20,739**
Admiralty National. Monument	4,667	Admiralty Island	55
Craig Ranger District	34,038	Baranof Island	318
Dall & Long Islands	1,115	Chichagof Island	952
Prince of Wales Island	32,924	Dall and Long Island	1,378
Hoonah Ranger District	528	Kruzof Island	143
Chichagof Island	528	Kuiu Island	635
Juneau Ranger District	950	Kupreanof Island	4,302
Mainland	950	Mainland	882
Ketchikan Ranger District	37,128	Prince of Wales Island	9,774
Annette & Duke Islands	1,626	Revillagigedo Island	2,302
Gravina Island	1,348	**Other Federal**	**489**
Mainland	16,790	Baranof Island	61
Revillagigedo Island	17,365	Chichagof Island	3
Misty Fiords Nat. Monument	29,153	Etolin Island	34
Mainland	19,929	Kuiu Island	174
Revillagigedo Island	9,223	Kupreanof Island	137
Petersburg Ranger District	179,139	Prince of Wales Island	80
Kuiu Island	74,590	**State & Private Land**	**25,919**
Kupreanof Island	85,451	Admiralty Island	31
Mainland	8,906	Baranof Island	3,990
Mitkof Island	7,374	Chichagof Island	1,117
Woewodski Island	2,818	Dall and Long Island	52
Sitka Ranger District	123,431	Etolin Island	18
Baranof Island	56,839	Gravina Island	1,256
Chichagof Island	39,576	Heceta Island	66
Kruzof Island	27,016	Kosciusko Island	232
Thorne Bay Ranger District	53,267	Kruzof Island	310
Heceta Island	1,491	Kuiu Island	711
Kosciusko Island	12,909	Kupreanof Island	2,377
Prince of Wales Island	38,868	Mainland	3,419
Wrangell Ranger District	60,767	Mitkof Island	2,063
Etolin Island	22,699	Prince of Wales Island	4,602
Mainland	18,927	Revillagigedo Island	4,211
Woewodski I	20	Wrangell Island	1,459
Woronofski I	912	Zarembo Island	4
Wrangell Island	11,421		
Zarembo Island	6,787		
			Total Land Affected 570,216

mid winter, but are susceptible to spring freezing. Snow appears to be the key environmental factor in yellow-cedar decline; where snow is present in spring, yellow-cedar trees appear to be protected from this presumed freezing injury. Thus, weather events in late winter and early spring are the inciting events that cause injury. A recent analysis of the weather station data from southeast Alaska supports this scenario by showing that late winter months have been warming, winter snow pack reducing, but there has been a persistence of spring freezing weather in the 20th Century. Insects and pathogens play very minor roles as contributing agents.

Mapping yellow-cedar decline at three different spatial scales also is consistent with this climate-thaw-freeze explanation. At the broadest scale, the distribution of yellow-cedar decline is associated with parts of southeast Alaska that have mild winters with little snow pack. At the mid-scale, we are finding elevation limits to yellow-cedar decline, above which cedar forests appear healthy. This elevation limit is consistent with patterns of snow persistence in spring. For example, the mortality problem is found up to 1,000 ft or slightly higher on some southern aspects, but only to about 500 ft on nearby northern aspects in a study area at Peril Strait and Mount Edgecumbe. Our studies at the fine scale help us define the role of wet soils in creating exposed conditions for trees. Here, we also measure the influence of exposure on soil warming and rapid air temperature fluctuations, as well as snow deposition and persistence.

Throughout most of its natural range in North America, yellow-cedar is restricted to high elevations. We speculate that yellow-cedar trees became competitive at low elevation in southeast Alaska during the Little Ice Age (approximately 1500 to 1850 AD) when there were periods of heavy snow accumulation. Our information on tree ages indicates that most of the trees that died during the 1900s, and those that continue to die, regenerated during the Little Ice Age. Trees on these low elevation sites are now susceptible to exposure-freezing injury due to inadequate snow pack during this warmer climate.

The primary ecological effect of yellow-cedar decline is to alter stand structure (i.e., addition of numerous snags) and composition (i.e., yellow-cedar diminishing and other tree species becoming more abundant) that leads to eventual succession favoring conifer species such as western hemlock and mountain hemlock (and western redcedar in many areas south of latitude 57). Also, in some stands where cedar decline has been ongoing for up to a century, large increases in understory biomass accumulation of shrubby species is evident. Nutrient cycling may be altered, especially with large releases of calcium as yellow-cedar trees die. The creation of numerous snags is probably not particularly beneficial to cavity-using animals because yellow-cedar wood is less susceptible to decay. Region-wide, this excessive mortality of yellow-cedar may lead to diminishing populations (but not extinction) of yellow-cedar, particularly when the poor regeneration of the species is considered. Planting of yellow-cedar is encouraged in harvested, productive sites where the decline does not occur to make up for these losses in cedar populations.

The large acreage of dead yellow-cedar and the high value of its wood suggest opportunities for salvage. Cooperative studies with the Wrangell Ranger District, the Forest Products Laboratory in Wisconsin, Oregon State University, Pacific Northwest Research Station, and State and Private Forestry have investigated the mill-recovery and wood properties of snags of yellow-cedar that have been dead for varying lengths of time. This work includes wood strength properties, durability (decay resistance), and heartwood chemistry.

We are working with managers to devise a conservation strategy for yellow-cedar in southeast Alaska. The first step in this strategy is partitioning the landscape into areas where yellow-cedar is no longer well adapted (i.e., maladapted in declining forests), areas where yellow-cedar decline does not now occur but is projected to develop in a warming climate, and areas where decline will not likely occur. Aerial surveys, analysis of various forest inventory plots, and future climate and snow modeling are all used to achieve this landscape partitioning. Salvage recovery of dead standing yellow-cedar trees in declining forests can help produce valuable wood products and offset harvests in healthy yellow-cedar forests. Yellow-cedar can be promoted through planting and thinning in areas suitable for the long-term survival of this valuable species on sites at higher elevation with adequate spring snow or on sites with good drainage that support deeper rooting.

Western Hemlock Mortality

An unusual tree death of western hemlock was detected during the forest health aerial survey in 2008. Mature western hemlock trees were dead on about 2,000 acres scattered around the northern half of southeast Alaska. These areas included southwest Baranof I., southern Admiralty I., and Gastineau Channel near Juneau.

We observed some of these dead and dying mature western hemlocks near Juneau. Some had heavy infections by hemlock dwarf mistletoe, but some were uninfected. The cause is not known. Observations did not uncover any obvious indications of insect or disease activity. Monitoring of this problem will continue in 2009.

Figure 38. Dying western hemlock observed during the 2008 surveys.

Abiotic Agents and Animal Damage

Along with insects and diseases, abiotic agents also influence the forest at large and small scales. This section describes the most important abiotic agents and animal damage mapped, monitored or surveyed in 2008. Drought, windthrow and wildfires affect forest health and structure to varying degrees. Hemlock fluting, though not detrimental to the tree, reduces economic value of hemlock logs in southeast Alaska. Various animals damage forest trees throughout the state; porcupines can be particularly locally severe in some locations of southeast Alaska.

Hemlock Fluting

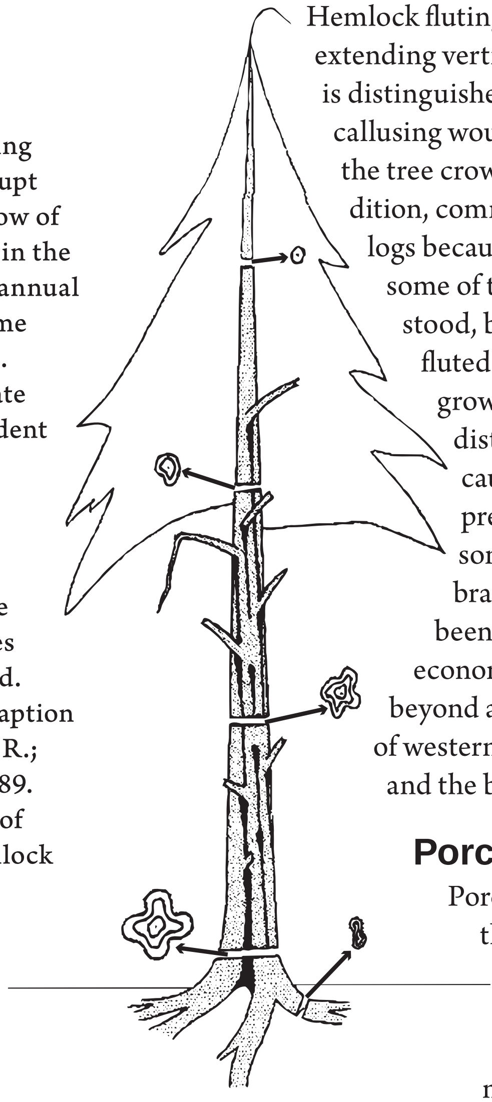


Figure 39. Hemlock fluting branches disrupt the vertical flow of carbohydrate in the stem causing annual rings to become asymmetrical. Flutes originate beneath decadent branches and extend downward, forming long grooves where other branches are intersected. (Figure and caption from Julin, K.R.; Farr, W.A. 1989. Stem Fluting of Western Hemlock in Southeast Alaska.).

Hemlock fluting is characterized by deeply incised grooves and ridges extending vertically along boles of western hemlock (Figure 4). Fluting is distinguished from other characteristics on tree boles, such as old callusing wounds and root flaring, in that fluting extends near or into the tree crown and fluted trees have more than one groove. This condition, common in southeast Alaska, reduces the value of hemlock logs because they yield less saw log volume and bark is contained in some of the wood. The cause of fluting is not completely understood, but associated factors include: increased wind-firmness of fluted trees, shallow soils, and a triggering mechanism during growth release (e.g., some stand management treatments or disturbance). The asymmetrical radial growth appears to be caused by unequal distribution of carbohydrates due to the presence of dead branches. After several centuries, fluting sometimes is no longer outwardly visible in trees because branch scars have healed over and fluting patterns have been engulfed within the stem. Bole fluting has important economic impact, but may have little ecological consequence beyond adding to wind firmness. The deep folds on fluted stems of western hemlock may be important habitat for some arthropods and the birds that feed upon them (e.g., winter wren).

Porcupine Feeding

Porcupines represent one of the only disturbance agents in the young-growth forests of southeast Alaska. Feeding on the boles of spruce and hemlock leads to top-kill or mortality, reducing timber values but enhancing stand structure. This form of tree mortality leads to a thinning in these forests; however, the largest, fastest growing trees are frequently killed. Porcupines are absent from several areas of southeast Alaska, most notably Admiralty, Baranof, Chichagof, Prince of Wales, and nearby islands. Feeding appears most severe on portions of Mitkof and Etolin Islands in the center of southeast Alaska. The distribution of porcupines suggests points of entry and spread from the major river drainages in interior regions of British Columbia. Feeding is intense in young-growth stands in southeast Alaska that are about 10 to 30 years of age and on trees that are about 4 to 10 inches in diameter. As stands age, porcupine feeding typically tapers off, but top-killed trees often survive to form forked tops and internal wood decay as a legacy of earlier feeding. Thinning plans are being developed in these areas with porcupines by personnel from the Wrangell Ranger District, Tongass National Forest. Western redcedar and yellow-cedar are not attractive to porcupines as a source of food; thus, young stands with a component of cedar provide more thinning options.

Status of Invasive Plants

Figure 40. *Vicia cracca* in bloom.

Figure 41. *Prunus padus*, or European birdcherry, has been widely planted as an ornamental in the Fairbanks and Anchorage areas. FHP cooperators are documenting its spread on the University of Alaska Fairbanks campus (see page 72), and along riparian areas in the Anchorage bowl (page 77).

Figure 42. Orange hawkweed in Girdwood.

Figure 43. Common tansy.

Figure 44. Canada thistle found in an Anchorage park.

Status of Invasive Plants

Focus on: Cooperative Weed Management Areas in Alaska

Introduction by Melinda Lamb

It takes a tremendous cooperative effort to make a difference when it comes to invasive plant management and prevention. Because there are no impermeable walls protecting one land parcel from receiving invasive plants from a neighboring property, it is necessary to form agreements and open lines of communication to manage invasive plants across ownerships. Cooperative Weed Management Areas (CWMAs) are made up of folks dedicated to addressing invasive plant issues. These groups often include private homeowners, land managers for federal, state, and private agencies, and individuals working with or in the gardening industry and community. The primary goal of CWMAs is to work cooperatively to address invasive plant issues in particular geographic areas.

CWMAs are being formed across Alaska in order to stimulate and coordinate involvement in invasive plant activities. These groups often receive grants through the Alaska Association of Conservation Districts (AACD), with funding provided by FHP, for invasive plant work statewide. In April of 2008, FHP provided funds to support the travel of representatives from five Alaskan CWMAs to a national conference on CWMA formation and action. This conference provided essential information on the successful formation of CWMAs, funding options, volunteer and citizen monitoring involvement, state laws and regulations related to weeds across the nation, and more.

Many CWMAs are coming together across Alaska. The following locations have established CWMAs or are in the process of solidifying a group in their area: Kodiak, Juneau, Sitka, Kenai, Mat-Su, Fairbanks, Anchorage, Dalton Highway, Copper Center, Kenai, and Prince of Wales Island.

Here is the story of how one CWMA began.

Keeping Weeds Out of the Picture with the Anchorage Cooperative Weed Management Area

by Lori Zaumseil, Citizens Against Noxious Weeds Invading the North (CANWIN)

The Cooperative Weed Management Area (CWMA) model is used successfully all over the country by states, counties and other groups battling invasive weeds. As citizens who had only just stepped off the cliff into noxious weed madness during the summer of 2007, my husband Troy and I wondered why there wasn't such a group in Anchorage. It seemed obvious to us that, as one of the epicenters of invasive plants in Alaska, Anchorage needed to get organized!

A quick review to explain how a couple of hobby gardeners with no formal scientific, botanical or environmental education found themselves coordinating the start-up of the Anchorage Cooperative Weed Management Area (ANC-CWMA).

We consider ourselves "accidental activists." By coincidence, we purchased a vegetable plant at a store in Anchorage with a Canada thistle growing in the pot; by choice we began to seek avenues to report, rectify and remedy a situation where a known noxious, invasive weed could so easily find its way into Alaska. We were frustrated to learn that no such avenue existed! We had only a basic understanding of invasive weeds at that time, but a simple Google search began to lead us to many websites, inside and outside of Alaska. We found reports describing all the ways that this species threatens our economy, ecology and environment! In less than 30 minutes we were concerned, but after an hour of information gathering, we were activists!

The short version of the story is that we got involved in many ways—contacting legislators, speaking to community councils, writing letters, meeting with state officials and attending conferences. Our free time began to change from dinner and movie dates to recon missions around Anchorage seeking out and photographing invasive weed infestations, gathering and absorbing information. We learned not just that Alaska faced a serious crisis, but also how much was to be gained by acting quickly to prevent invasive plants from becoming established here. In retrospect, we recognize now the gentle suggestions and knowing smiles we got from the professionals around Anchorage who already understood what was just slowly becoming apparent to us. We suspect that they perhaps hoped that we could be helpful in the fight, but were worried that our blooming fanaticism might somehow become a noxious weed in itself!

As our journey progressed, we met more and more experts who were working on the issue of invasive weeds for their respective agencies. During a conversation with one of those experts, FHP cooperator Jamie Nielsen, Invasive Weeds Coordinator for UAF CES, I mused that "we would all be so much more effective as a group than we are individually." Jamie told me about the CWMA concept, and went on to explain that Anchorage had no CWMA. More wheels began to turn and internet searches commenced. I found an online CWMA Cookbook published by weed fighters in Idaho who had gone to great lengths to share what they had learned. The cookbook gave Troy and I the courage to say "We can do this!" We began to work on a memorandum of understanding.

I have always said that neither Troy nor I are the most qualified to be doing what we're doing, just the most enthusiastic. We had energy, we believed in the benefit to Alaska by moving the idea forward and we were determined. We also got a lot of help from the real experts in making it happen. Jamie Nielsen was our "mentor" and a bit of a regulator on the throttle when we might have spun out of control at times. We got additional assistance from invasive plants specialists at the USF&WS and the National Park Service.

Our ANC-CWMA was officially created in January 2008. The membership has grown quickly and now includes the U.S. Forest Service–State & Private Forestry, the Alaska Division of Forestry, the Municipality of Anchorage, the Bureau of Land Management, the National Park Service, the U.S. Fish and Wildlife Service, the Anchorage Fire Department, the University of Alaska Fairbanks, and Citizens Against Noxious Weeds Invading the North, a non-profit group that Troy and I founded.

In June, the ANC-CWMA planned an Invasive Weeds Awareness Kick-Off event. We had several reasons to celebrate that day. Our CWMA was up and running. Alaska Governor Sarah Palin had signed a proclamation declaring June 23-29, 2008, as Invasive Weeds Awareness Week. In addition, House Bill 330, which established an invasive weeds coordinator for the state, had passed unanimously in the Alaska legislature. Governor Palin accepted our invitation to sign the bill in person, present her proclamation and do us the honor of "cutting the ribbon and unveiling the logo" of our newly-formed ANC-CWMA. It was exciting and energizing for everyone who had worked on these projects for so long!

Figure 45. Lori Zaumseil speaks at the Alaska Weed Awareness Week Weed Fair, June 24, in Anchorage. Listening are, from left, Alaska Governor Sarah Palin, State Division of Agriculture Director Franci Havemeister, and State Representative Craig Johnson. Photo by Jeff Heys.

The ANC-CWMA continues to grow and we are gratified to have several sustaining members—citizens who recognize the need for action and are lending their talents to protect Alaska. Plans for the future include developing a website, bringing a curriculum on invasive weeds to Anchorage elementary schools, continued community outreach to both property owners and professionals in the landscape and greenhouse industry, developing a Best Management Practices guideline and continued work in the field, doing plain old-fashioned weed eradication!

Throughout 2008, Region 10 Forest Health Protection has continued to provide leadership for invasive plants initiatives in Alaska, maintaining strong working partnerships with agencies and organizations at the local, state, and federal levels.

Over the past year, we have strengthened current working partnerships and pursued new opportunities for collaboration. Successful ongoing collaboration with the UAF Cooperative Extension Service (CES) Integrated Pest Management Program continues to emphasize invasive plant prevention and early detection. Acting as a bridge to the Alaskan public, CES provides public education over much of the state as well as invasive plant scouting and inventory work. The "Focus On" essay by Lori Zaumseil is testimony to the influence of our CES partners in Alaska. Forest Health Protection also works closely with the Alaska Association of Conservation districts, which supports and promotes a wide variety of invasive plant projects across the state.

Weed and Pest Legislation Is Signed

On June 24, Governor Sarah Palin signed HB 330, "an act relating to noxious weed, invasive plant and agricultural pest management and education." This important legislation directs the Alaska Division of Agriculture to establish a position of weed and pest coordinator for the state. The coordinator will develop a statewide strategic plan for the management of noxious and invasive weeds and agricultural pests, review current laws and regulations regarding importation, sale and transport of plants and other potential avenues of pest introduction, and propose revisions to existing laws and regulations.

The coordinator will compare the land management practices of Federal, State, Tribal, Municipal and other subdivisions of Government within the State with particular attention to construction, maintenance operations and other activities in corridors where invasive plants and agricultural pest movement can occur. The State of Alaska has already tapped a long-time FHP collaborator and knowledgeable invasive plant specialist, Gino Graziano, to fill this important position.

University of Alaska Fairbanks Partners with FHP to Document Campus Invasives

University of Alaska Fairbanks (UAF) researchers have been studying agricultural production in the far north since 1906. The University has two main experimental farms, one located in Fairbanks and one in the Matanuska Valley. Research efforts over the years worked to develop cold-hardy varieties of crops with potential uses as forage, in grain production, and for revegetation or soil stabilization. An unanticipated result of these trials has been that, over the years, several of the studied species have spread beyond the boundaries of the experimental farms. At least three of these species are now recognized in Alaska as among our most aggressive invasive plants and have become widely distributed in the state.

Figure 46. Bird vetch (*Vicia cracca*) growing over a wire fence at the University of Alaska Fairbanks Agriculture and Forestry Experiment Station Farm.

In 2008, FHP began a partnership with UAF's School of Natural Resources and Agricultural Sciences (SNRAS) and UAF Cooperative Extension to address the problem of invasive plants spreading from the UAF campus and experimental farms. Mapping the invasive plants on UAF's campus became the senior thesis project of SNRAS student Jessica Guritz. She produced high-resolution, GIS-based maps of the distribution of 14 invasive plant species on the campus. One of the species mapped was bird vetch (*Vicia cracca*), a vine-like, purple-flowering nitrogen-fixer that has spread extensively on the campus and beyond. Some people refer to bird vetch as "the Alaskan kudzu." Guritz's work also documented the spread of species planted as ornamentals, such as European birdcherry and Siberian peashrub. (See one of her maps on page 74.) These maps will be used for the next step of the effort: the development of a long-term invasive plant management plan for the campus. Forest Health Protection continues to play a major role, along with UAF faculty, students, University Facilities Services, and Alaska Cooperative Extension.

Invasiveness Ranking System for Non-Native Plants of Alaska

Figure 47. Jessica Guritz examines white sweetclover (*Melilotus alba*) growing on the University of Alaska Fairbanks campus.

Several years ago, in an effort to provide science-based information regarding which exotic plant species have the greatest potential to spread aggressively and negatively impact Alaska's natural systems, Forest Health Protection funded the UAA Alaska Natural Heritage Program's Invasive Plant Ranking Project. Forest Health Protection actively participated in the ranking process, along with the National Park Service, the Agricultural Research Service, the UAF Cooperative Extension Service, and the U.S. Geological Survey. This year the ranking system was published in hard copy as well as becoming available online at:

http://www.fs.fed.us/r10/spf/fhp/invasive/invasiveness%20ranking%20report.pdf.

The system developed in Alaska is now being used as a model by the Invasive Plant Council of British Columbia, and by The Nature Conservancy in New York.

Collaboration with Canadian Invasive Plant Specialists

In 2007, Canadian invasive plant managers announced the discovery of an infestation of leafy spurge near Dawson City, Yukon. The climate of the Dawson City area is similar to that of interior Alaska, but as yet leafy spurge is not known to exist in Alaska. In 2008, Forest Health Protection worked with the Alaska Committee for Noxious and Invasive Plant Management and the Alaska Division of Agriculture to encourage the government of the Yukon to respond immediately to this infestation. The Yukon Branch of Agriculture has begun an active management effort coupled with follow-up monitoring. An additional outcome of this cross-frontier collaboration was that FHP invasive plants specialists were invited to attend the first-ever invasive species conference held in the Yukon in October. Invasive plant specialists from British Columbia also attended, and a listserv has been established to promote future coordination.

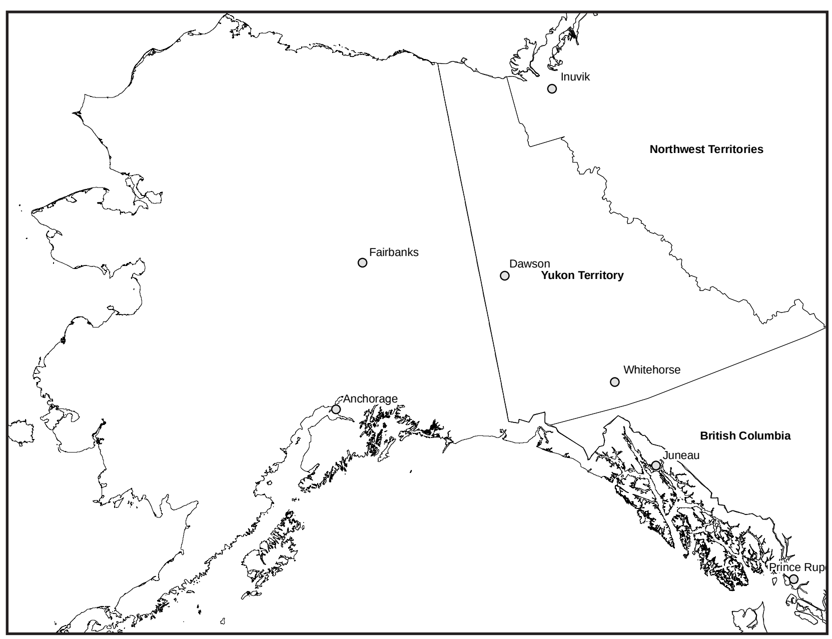
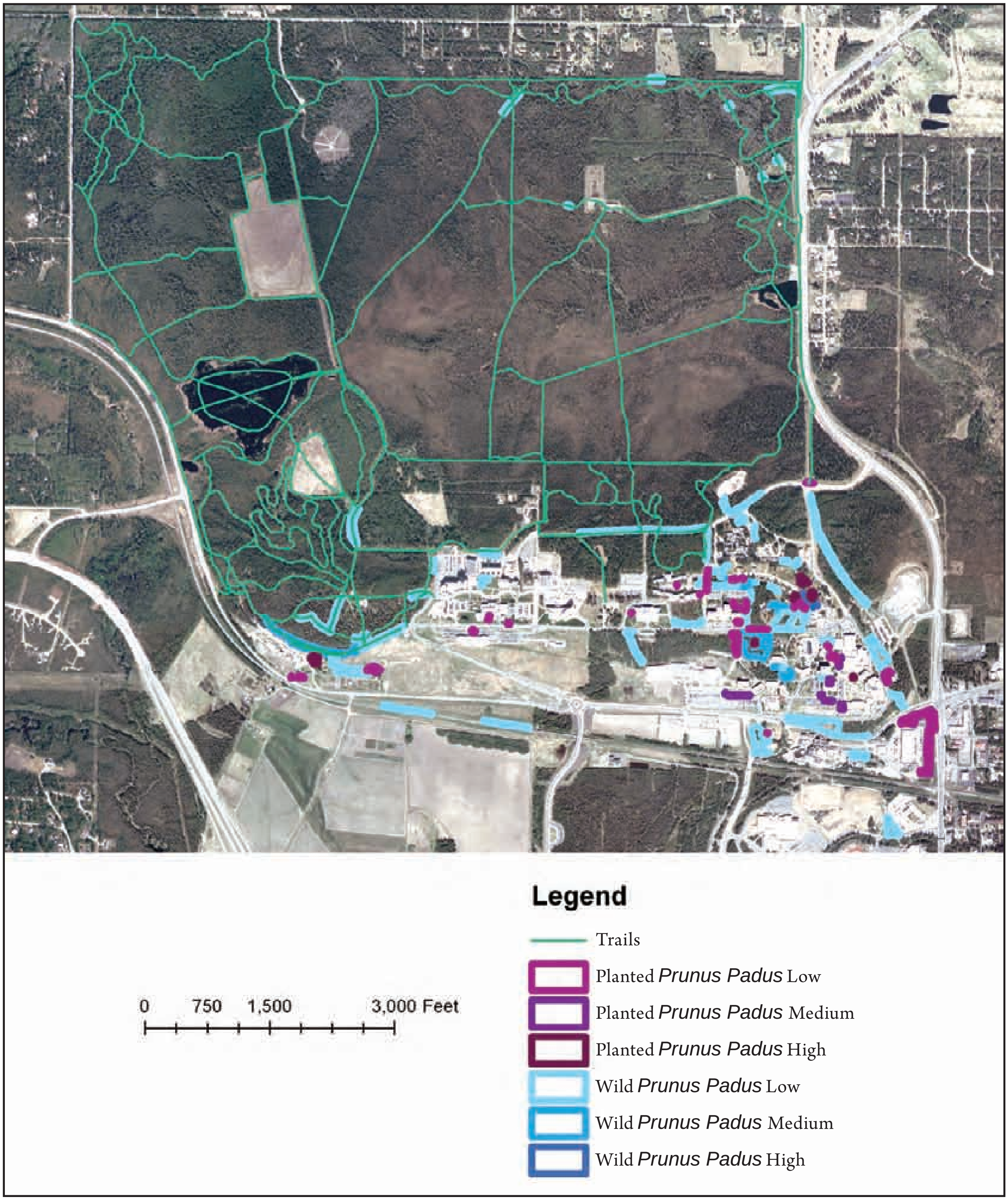


Figure 48. Leafy spurge has been found in Dawson, close to the Alaska border.

Map 8. Distribution of European birdcherry (*Prunus padus*) (both planted and wild) on UAF campus. *Prunus padus* is widely planted in Alaska as an ornamental. This map shows where this species has been planted (purple) and where it has been spread by birds to other areas (blue).



A Citizen's Guide to Identifying and Reporting Infestations in Alaska

This year, Forest Health Protection collaborated with the Alaska Association of Conservation Districts and with the Center for Invasive Species and Ecosystem Health at the University of Georgia to develop an early detection, rapid response system focusing on five plant species. Spotted knapweed (*Centaurea stoebe*) and purple loosestrife (*Lythrum salicaria*) have been found at a very limited number of locations in Alaska. Smooth cordgrass (*Spartina alterniflora*), leafy spurge (*Euphorbia esula*), and giant hogweed (*Heracleum mantegazzianum*) have not been detected in Alaska yet but are found close to its borders. The booklet describes how citizens can identify these species, distinguish them from similar-looking plants, and use one of three different methods to report the infestation. Hundreds of these booklets were distributed around the state.

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Each year, our Conditions Report focuses on the invasive plant challenges in a different part of the state. This year, the focus is on Southcentral Alaska.

Invasive Plants in Southcentral Alaska 2008

by Trish Wurtz and Michael Rasy

Bird Vetch

Vicia cracca L.

Bird vetch is a climbing, vine-like perennial with three coiling tendrils at the terminus of each stem. By climbing and covering surrounding vegetation, this species is able to monopolize sunlight, leaving underlying vegetation stunted and chlorotic. Infestations of bird vetch have the potential to negatively impact forest regeneration in open areas.

Figure 49. Bird vetch is an aggressive invader whose rate of spread has increased in recent years.

Intentionally introduced in Alaska in the early 1900s, bird vetch has spread along road corridors from Fairbanks to Soldotna. Dense mats of this species can be found overtopping young trees, shrubs, meadow vegetation, riparian vegetation, and roadside landscaping throughout the Matanuska–Susitna Valley and the Anchorage area. Previously thought to be restricted to roadsides and areas of disturbance, bird vetch has been observed moving into open forest and other natural areas.

Many weed-pulling events in 2008 concentrated on bird vetch, as it is comparatively easy to pull and because vetch infestations are commonplace in the Anchorage area.

Map 9. Invasive plant locations in Southeast Alaska as documented in the AKEDIC database.

Many of the weed pulls in Anchorage were chosen in an effort to keep this climbing perennial from further choking out the desirable vegetation in landscapes and parks. However, after repeatedly pulling vetch from specific locations over multiple years, this species continues to thrive. While pulling eliminates many of the flowers and much of the potential seed production, the plant continues to spread, both vegetatively and from what appears to be an extensive seed bank.

Bull Thistle

Cirsium vulgare (Savi) Ten.

Bull thistle is an impressive biennial plant with prickly leaves and large, branching, winged stems. Its large purple flower heads grow to two inches in diameter, and produce up to 4,000 wind-borne seeds. Bull thistle does not reproduce vegetatively. It relies on cross-pollination to set fertile seed, which does not persist in the seed bank. Because new infestations often occur in areas of recent construction activities, it appears that construction, landscaping activity, and the movement of heavy equipment may contribute to the dispersal of this species.

Although known to occur in southeast Alaska (especially on Prince of Wales Island), only three infestations of bull thistle have been identified in southcentral Alaska. Unlike many invasive plants, bull thistle is controllable by consistent hand-pulling. The infestation at the Rabbit Hutch, in south Anchorage, was pulled for multiple years and the last survey in that area detected no new plants. The land has since been sold and construction has begun on a new building. The new landowners are aware of the previous infestation and will allow monitoring for this species in the future. The two other known infestations of bull thistle in southcentral Alaska have also been pulled annually and only one is still producing new plants. This active infestation has been the target of multiple weed-pulling events and in 2008 was monitored and pulled repeatedly by members of the non-profit group Citizens Against Noxious Weeds Invading the North (CANWIN). Bull thistle is a good candidate for early detection and rapid response in southcentral Alaska where complete eradication is still possible.

Canada Thistle

Cirsium arvense (L.) Scop.

This perennial thistle is characterized by spiny stems which sit atop an extensive network of horizontal and lateral roots. Though Canada thistle can spread by seed, it spreads especially readily by root fragments. It rapidly colonizes areas of disturbance, including public parks, greenbelts, trails, roadsides, and construction sites. Dense patches also spread along forest edges and into meadows. Canada thistle clones can expand up to six feet in diameter in a single growing season, creating spiny barriers to human and animal traffic and out-competing native vegetation.

Canada thistle is an aggressive species that in recent years has spread rapidly across the Anchorage Basin. Large, multiple-acre infestations can be found in South Anchorage and new infestations have recently become established along the banks of Campbell Creek. Unfortunately, nursery and landscape tree and shrub containers continue to be a source of new thistle seedlings. As these ornamental plants are purchased and transported throughout the area, hitchhiking thistle seedlings move with them. In addition, the below-ground parts of Canada thistle are easily dispersed when infested soil

Figure 50. Canada thistle growing in a newly-developed Anchorage park.

is moved for fill material and other construction uses.

Isolated populations of Canada thistle have been identified across the Kenai Peninsula, as far south as the city of Homer. Increasingly, public and private organizations have begun to treat Canada thistle clones with herbicides, attempting to kill both the above-ground stems as well as the below-ground portions of the plant. Control efforts have begun on persistent and long established infestations located on city parkland, with efficacy results still pending. Although eradication of Canada thistle from Alaska appears unlikely, preventing its spread to new areas of the state is still a worthwhile endeavor.

Common Tansy

Tanacetum vulgare L.

Popular with gardeners and herbalists, this hardy perennial was introduced to North America from Europe and western Asia. Today this species is listed as noxious in five states and several Canadian provinces. Common tansy is easily identified by its distinctive yellow button-like flowers, feathery leaves, and strong odor. Common tansy spreads by seeds and rhizomes and does not require disturbance to become established, but can seed into vegetated areas. Once established, it grows aggressively and creates a dense canopy of stems up to 6 feet tall.

Figure 51. Common tansy is easily identified by its distinctive, yellow, button-like flowers.

A relatively small number of common tansy infestations have been found growing outside of the garden setting in southcentral Alaska, however, it continues to be imported and cultivated by unwary gardeners. Escaped infestations have been found along roadsides and in waste places in the Matanuska-Susitna valley and on the Kenai Peninsula, on roadsides in Valdez, and in the Kenai Mountains. Common tansy is sometimes seen as an herb entry at the Alaska State Fair.

Common Toadflax

***Linaria vulgaris* P. Mill.**

Common toadflax or "butter and eggs" has become ubiquitous in southcentral Alaska, growing on roadsides and trails, and in parks and meadows. Producing thousands of seeds per plant and also able to spread by creeping rhizomes, common toadflax forms dense colonies and suppresses surrounding vegetation. This species contains a glucoside that is toxic to grazing animals. Common toadflax can tolerate cold temperatures and short growing seasons; it is one of the most problematic invasive plants of alpine areas in Rocky Mountain National Park. In southcentral Alaska, common toadflax is spreading rapidly along the eastern shores of Cook Inlet, and has been found in increasingly remote locations in the Kenai Mountains.

European Bird Cherry, Canada Red Cherry

***Prunus padus* L.**

***Prunus virginiana* L. var. Schubert**

The European bird cherry is a small ornamental tree with cylindrical spikes of showy white flowers in spring. Long a staple of nursery and landscape industries in Alaska, the European bird cherry, or "mayday tree," has escaped and colonized parks, greenbelts, and riparian areas in Anchorage and Fairbanks. The seeds of this species are dispersed by birds, and bird cherry seedlings now dominate the understory of riversides, streamsides, and forests originally composed of alder, willow, birch, spruce, and cottonwood. In areas surveyed in 2005, bird cherry seedlings and saplings made up nearly 96 percent of the forest understory. A close relative to *Prunus padus*, the common chokecherry, *Prunus virginiana*, has also become more prolific along streambanks and riparian areas in Anchorage. This species has similar qualities to bird cherry, and is readily found growing along both Chester and Campbell Creeks.

Forest Health Protection is partnering with the U.S. Fish and Wildlife Service and the University of Alaska Fairbanks to support a graduate research project studying the impacts of these species along creeks in the Anchorage Bowl. The project will examine the aquatic and terrestrial invertebrates along riparian corridors that are critical to spawning salmon. This research will shed light on what residents might expect from a species that is well on its way to becoming the dominant over-story tree along these riparian corridors.

Public awareness of the invasiveness of European bird cherry has increased in recent years, however. Although this small tree is still sold at nurseries, it is no longer recommended by landscape architects in the Anchorage area, and is rarely used in commercial landscaping projects. Ornamental species such as crabapple, Ussurian pear, linden, and lilac are being promoted as alternatives to chokecherry varieties.

Japanese Knotweed

***Polygonum cuspidatum* Sieb. & Zucc.**

This highly invasive knotweed is a major problem in Southeast Alaska, but has yet to act aggressively in southcentral. It has long been utilized in Anchorage gardens for its bamboo like growth habit and appearance. In 2008, CES cooperators documented several cases of Japanese knotweed growing in Anchorage landscapes, one of which is located very close to Chester Creek. Residents were contacted and encouraged to replace their knotweed with alternative ornamental species. Several residents voluntarily complied.

Meadow Hawkweed, Mouseear Hawkweed, Narrowleaf Hawkweed

***Hieracium caespitosum* Dumort.**
***Hieracium pilosella* L.**
***Hieracium umbellatum* L.**

Similar in appearance and behavior to orange hawkweed, the yellow-flowered meadow hawkweed has become established in the City of Valdez, and begun to radiate out of that community, spreading along roadways and ATV trails. The largest known infestation of meadow hawkweed occupies roughly two miles along the Richardson Highway and adjoining meadows north of Valdez.

Mouseear hawkweed, a more diminutive yellow-flowered hawkweed with long white hairs on its leaves and stems, is present as a dense infestation at the Kenai Community Garden in the City of Kenai. This is the only known infestation of this species of hawkweed in Alaska, although there is a strong possibility that seeds and propagules from this well-established infestation have been carried to surrounding areas.

Extensive road construction along the Parks Highway in the Matanuska–Susitna Valley has contributed to rapidly expanding populations of narrowleaf hawkweed. Increasingly common, this species has colonized roadsides through Anchorage, and south onto the Kenai Peninsula. The spread of narrowleaf hawkweed appears to be due, in large part, to the dispersal of prolific amounts of seed. Narrowleaf hawkweed can be distinguished from the other yellow-flowered hawkweeds in Alaska by its tall stature, leaves that arise from the stem, and the presence of persistent withered leaves at the base of the stem. Although native to regions of North America, narrowleaf hawkweed is not considered native to Alaska.

Orange Hawkweed

***Hieracium aurantiacum* L.**

Of all the invasive exotic plants that have been introduced to Alaska, none seem better suited to Alaskan climates than the exotic *Hieracium* species. Orange hawkweed is no exception. A perennial plant with a rosette of densely-hairy light green leaves, 2- to 24-inch stems, and distinctive fiery orange-red flowers, populations of orange hawkweed have exploded across southcentral Alaska. With its bright flowers and hardy growth pattern, orange hawkweed continues to be popular in gardens, roadsides and cemeteries. Sharing of seeds and plants continues, despite outreach and education efforts. The plants spread by wind-borne seed, creeping rhizomes, and stolons, and rapidly exclude competing vegetation in meadows, open areas, and forest edge.

Many lawns and gardens on the Anchorage hillside have large infestations of orange hawkweed and horse trails along roadways continue to spread this species into more remote and undisturbed locations. Orange hawkweed is now found throughout the populated areas of the Kenai Peninsula, the Anchorage basin and Girdwood, and as far north as Talkeetna and surrounding communities. Dense infestations of orange hawkweed along airstrips in communities such as Talkeetna and Skwentna have given rise to concerns about the spread of seeds and propagules to pristine landing sites in the interior.

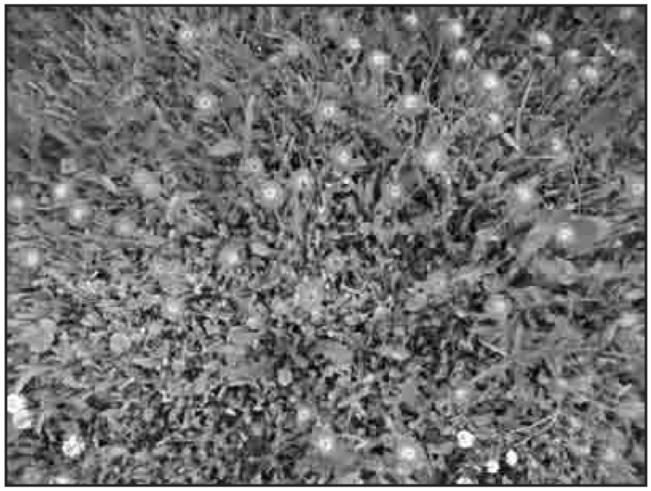


Figure 53. Orange hawkweed dominating a roadside near Girdwood, Alaska.

Since this plant does not respond well to either mowing or pulling, most of the research and successful control strategies in Alaska have relied on herbicides. Continuing education and outreach to gardeners and the businesses that serve them will be an important component to any long-term control of this species.

Oxeye Daisy

Leucanthemum vulgare **P. Miller**

This daisy is no lightweight. Unlike the non-invasive "Shasta Daisy," and others in this family, oxeye daisy is very aggressive and able to spread outside cultivation and out-compete native vegetation. Sold by nurseries and as part of wildflower mixes, this species has been purposely spread into many landscapes and gardens in southcentral Alaska. Oxeye daisy continues to be used in revegetation efforts following road construction projects.

Ornamental Jewelweed

Impatiens glandulifera **Royle**

Ornamental jewelweed (also known as "policeman's helmet") is listed as noxious in the state of Washington and in British Columbia. This herbaceous annual can grow to be five feet tall, and has hollow stems with swollen nodes, and flowers that range from white to pink, red, or purple. Ornamental jewelweed thrives in moist areas, and is capable of forming dense stands in streams, lowlands, and drainage areas. Popular with unwary gardeners, this species is increasingly propagated in horticultural settings in the Anchorage area.

Perennial Sowthistle, Spiny Sowthistle

Sonchus arvensis ssp. uliginosus **(Bieb.) Nyman**

Sonchus asper **(L.) Hill**

Perennial sowthistle has yellow, dandelion-like flowers and clasping leaves with prickly margins, and can grow to five feet tall. With its extensive horizontal root system, perennial sowthistle is able to monopolize moisture and form dense stands.

Perennial sowthistle continues to be a problem along roadways and other areas of disturbance in southcentral Alaska. Although populations are sporadic, dense stands continue to expand and little effort has been given to controlling this species. Many of the sites are along busy highway corridors, complicating control efforts. In addition, spiny sowthistle is an annual that has continued to spread throughout landscapes and disturbed locations in the Anchorage area.

Purple Loosestrife

Lythrum salicaria L.

Purple loosestrife is a perennial species with tall spikes of pink-purple flowers, and a persistent woody base. Many varieties of loosestrife are stocked by nurseries and greenhouses in Alaska, and are propagated by home gardeners in southcentral Alaska. These varieties were thought to produce only sterile seed, until a well-established infestation of purple loosestrife was discovered in Chester Creek in Anchorage in October 2005. Although the source of this infestation remains unknown, the presence of mature plants and a large cohort of seedlings at the infestation site indicate that at least one local variety of purple loosestrife was able to produce viable seed and colonize a natural area.

The Chester Creek infestation has been the subject of much media attention and numerous Municipality-of-Anchorage-sponsored weed-pull events. Fewer than half a dozen new plants were found in 2008. These plants were found growing in the same area of the original infestation. Some of these plants were in areas that would normally be submerged in water during the growing season and were only found after water levels had dropped due to cooler temperatures. These plants were immature, not flowering and not easily visible because of the grasses and sedges surrounding them. The infestation in Chester Creek seems to be responding well to hand-pulling and it now seems possible that the only wild population of loosestrife known in Alaska can be eradicated.

Rampion Bellflower

Campanula rapunculoides L.

Rampion bellflower is horticultural plant cultivated for its showy purple flowers. In Anchorage, it has spread vigorously in neighborhoods and into adjoining city greenbelts. This species' creeping ability makes it difficult to control in the garden and it has shown its ability to move into more natural areas with a closed canopy. Many unsuspecting gardeners and homeowners living along greenbelts throw their green lawn clippings and other green material over the fence into the natural areas bordering them. This allows this species to move right into these areas where it is able to thrive. Certain neighborhoods in Anchorage have this bellflower in almost every garden or landscape, most of which not intentionally planted. There is a similar plant commonly called Ladybells, *Adeniphora liliifolia* that resembles rampion bellflower closely, but does not share its invasive traits.

Reed Canarygrass

Phalaris arundinaceae L.

Reed canarygrass, widespread in the southern half of Alaska, is a robust, mat-forming, perennial grass which produces 4- to 6-foot-tall stems from creeping rhizomes. Intentionally introduced for erosion control and as a forage crop, it is also sold as ornamental ribbongrass, a variegated horticultural variety for the garden. Reed canarygrass is recognized as one of the most aggressive invaders in Alaska, forming monocultures in riparian areas, lowlands, and meadows, excluding other vegetation and restricting waterways.

In southcentral Alaska, reed canarygrass continues to occupy Anchorage waterways and wetland areas. Multiple control efforts have been made within the Municipality of Anchorage in order to prevent the further spread of this species. More alarming is the threat posed by reed canarygrass to the Copper River Delta (CRD), adjacent to the Chugach National Forest. The CRD is an incredible wetland formed by six glacial river systems stretching across a 60-mile arc, including hundreds of thousands of acres of marshland, rushing rivers, braided streams, and quiet ponds. The distribution of reed canarygrass in the Delta is currently limited to small populations adjacent to Forest Service land, but the vast expanse and wetland resources of the CRD are at risk. Forest Health Protection partnered with the Chugach National Forest and Cordova Ranger District to contribute to the second year of reed canary grass removal efforts along the Copper River Highway. Forest Service Chief Gail Kimbell and Regional Forester Denny Bschor visited and participated in the control efforts.

Figure 54. Regional Forester Denny Bschor and Forest Service Chief Gail Kimbell pull invasive reed canary grass near Cordova in July 2008.

Spotted Knapweed

Centaurea stoebe

Notoriously problematic in many western states, spotted knapweed is a prime candidate for early detection and rapid response in Alaska. Although small patches of this species have been discovered in several locations, it has not yet become widespread. Spotted knapweed is listed as noxious in at least 15 states, and is known to spread rapidly, eliminating surrounding vegetation through the production of allelopathic chemicals. Monocultures of spotted knapweed displace native vegetation, degrade wildlife habitat, and increase soil erosion.

In 2008, all four known infestations of spotted knapweed along Turnagain Arm were visited and inventoried. Two of the sites were found to have no spotted knapweed growing, but monitoring will be needed to ensure eradication. One site that has been pulled for two consecutive years was found to have only two plants; both were pulled. The fourth site, which has been the most extensive and persistent, was once again found to have spotted knapweed growing, though there were fewer plants than in previous years. About 100 plants were pulled before they were able to go to flower and many were small juveniles. This site will require follow-up visits for the next several years due to an existing seed bank. In addition, a new, large infestation was discovered this year along Turnagain Arm, at the popular Beluga Point tourist pullout. All the plants were pulled; most were still in flower and only a few had gone to seed. This site and areas to the south will require thorough and intensive survey for new infestations in 2009.

Tansy Ragwort

***Senecio jacobaea* L.**

Highly toxic to humans and animals, tansy ragwort is an invasive plant species of primary concern in Alaska. This is a biennial species with bright yellow flowers and deeply lobed leaves with a "ruffled" or "ragged" appearance. Several small incipient populations of this species were manually removed from an Anchorage park in 2004. Multiple surveys since then have not found any plants. Seeds of this plant are reported to remain viable for only 3 to 5 years, so there is a good chance that the 2004 removal effort completely eliminated this plant from the park.

White Sweetclover, Yellow Sweetclover

***Melilotus alba* Medikus**
***Melilotus officinale* (L.) Lam**

The sweetclovers are tall, branching members of the pea family, with fragrant white or yellow flowers. Both white and yellow sweetclover are described as biennial, but have been found to flower and produce seed after one growing season in Alaska, possibly due to the long hours of daylight during summer months. The sweetclovers alter soil chemistry through nitrogen fixation and contain coumarin, a chemical that is toxic to grazing animals and livestock.

The year 2008 saw a remarkable explosion of white sweetclover along roadways throughout southcentral Alaska. Both the Glenn and Seward Highways saw an increase in this fragrant legume. Populations of sweetclover have persisted for years along these roadways, but were much denser and more noticeable in 2008, even drawing the attention of local media outlets. It's unclear whether this species is being intentionally seeded. New trail and road construction projects on the Anchorage Hillside have enabled this species to spread into more sensitive natural areas. White sweetclover is becoming the dominant plant along local roadways, outcompeting our native fireweed (*Epilobium spp*.). Sweetclover has been the focus of weed pulling efforts at the BLM Campbell Creek Science Center, and multiple years of pulling have had good results.

Yellow Alfalfa

Medicago sativa* L. *ssp. falcata

Commonly grown as a forage crop, yellow alfalfa is planted in all 50 states and Canada. Outside of cultivation, yellow alfalfa grows along roadsides and trails in both interior and southcentral Alaska. It is unknown whether this member of the pea family is being introduced to these areas as a component of roadside seed mixes, or a contaminant in top soil or mulching material. Restricted to roadsides in most cases, yellow alfalfa was recently reported to be spreading along the Exit Glacier River corridor on the Kenai Peninsula—the first documented incidence of movement by this species into riparian plant communities in Alaska.

Yellow Salsify

Tragopogon dubius Scop. L

Yellow salsify (also known as "western salsify") is a taprooted biennial plant with distinctive grey-green grass-like leaves and yellow flowers in which the long subfloral bracts extend beyond the length of the petals. A key infestation of this species occurs just south of Anchorage, along the Seward Highway. Despite three years of intensive manual control efforts by citizens' groups and local organizations, this infestation has spread along miles of the highway bordering Turnagain Arm, displacing native grasses and wildflowers. Yellow salsify has also been pulled in Soldotna and the Glenn Highway near the Palmer Hay Flats.

Aerial Detection Survey

Aerial surveys are an effective and economical means of monitoring and mapping insect, disease and other forest disturbance at a coarse level. In Alaska, State & Private Forestry, Forest Health Protection (FHP), together with Alaska Division of Natural Resources (DNR), monitor 30–40 million acres annually at a cost of less than ½ cent per acre. Much of the acreage referenced in this report is from aerial detection surveys so it's important to understand how these data are collected and their inherent limitations. But, while there are limitations to these data and those limitations must be recognized, 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 surveys, also known as aerial sketch-mapping, is a technique for observing forest change events from an aircraft and documenting those events manually onto

Figure 55. Aerial surveys are commonly conducted in small, high-wing float planes to allow for maximum visibility and logistical flexibility.

a map base. When an observer identifies an area of forest damage, a polygon or point will be delineated onto a paper map or computer touch screen. Together with ground intelligence, trained observers have learned to recognize and associate damage patterns, discoloration, tree species and other subtle clues to distinguish a particular type of forest damage from the surrounding, healthier forest areas. This is known as a damage "signature" and in most cases is pest specific. Aerial sketchmapping could perhaps be considered "real time photo interpretation" with the added challenge of transferring the spatial information from a remote landscape view to a map or base image. Sketchmapping offers the added benefit of adjusting the observer's perspective to study a signature from multiple angles and altitudes but it is challenged by time limitations and other varying external factors. Survey aircraft typically fly at 100 knots and atmospheric conditions are variable.

During aerial surveys, forest damage information has traditionally been sketched on 1:250,000 scale USGS quadrangle maps, a relatively small scale. For example, at this scale one inch would equal approximately four miles distance on the ground. Larger scale maps are sometimes used for specific areas to provide more detailed assessments. A digital sketch-mapping system has been used in recent years in place of paper maps for recording the forest damage. This system displays the sketchmapper's location via GPS input and allows the observer to zoom to various display scales. The many advantages of using the digital sketch map system over paper sketch-mapping include more accurate and resolute damage polygon placement and a shorter turnaround time for processing and reporting data.

No two sketchmappers will interpret and record an outbreak or pest signature in the same way but the essence of the event should be captured. While some data are ground checked, much of it is not. Many times the only opportunity to verify the data on the ground is during the survey missions, if the opportunity to land and examine the affected foliage is available. Due to the nature of aerial surveys, the data will only provide rough estimates of location and intensity and only for damage that is detectable from the air. Many of the most destructive forest diseases are not represented in aerial survey data because these agents are not detectable from an aerial view.

Unlike FHP units in many other areas in the United States, the Alaska FHP team does not survey 100 percent of our region's forested lands. The short Alaska summers, vast area, high airplane rental costs, and the short time frame when pest damage signs and tree symptoms are most evident, all require a strategy to efficiently cover the highest priority areas with available resources. The surveys we conduct provide a sampling of the forests via flight transects. Each year we survey approximately 25 percent of Alaska's 129 million forested acres. Due to survey priorities, various client requests, known outbreaks and a number of logistical challenges some areas are rarely or never surveyed while other areas are surveyed annually. Prior to the annual statewide forest conditions survey, letters are sent to various state and federal agency and other landowner partners for survey nominations. The federal and state biological technicians and entomologists decide which areas are highest priority from the nominations. In addition, areas are selected where several years' data are collected to establish trends from the year-to-year mapping efforts. In this way, general damage trend information is assembled for the most significant pests and compiled in this annual Conditions Report.

The sketch-map information is digitized and put into a computerized Geographic Information System (GIS) for more permanent storage and retrieval by users. No attempt is made to extrapolate infestation acres to non surveyed areas. The reported data should only be used as a partial indicator of insect and disease activity for a given year. Establishing trends from aerial survey data is possible, but care must be taken to ensure that projections are comparing the same areas and sources of variability are considered.

For a complete listing of quadrangle areas flown and agents mapped during 2008 statewide aerial detection surveys please visit our website: http://www.fs.fed.us/r10/spf/fhp. Digital data and metadata can be found at the following URLs: **http://agdc.usgs.gov/data/projects/fhm/**.

Map 10. USGS map index for statewide aerial surveys.

2008 Cooperative Projects

Following summaries include projects supported by Forest Health Protection through grants and contracts.

Entomology

Forest Health Protection joins with the Alaska Botanical Gardens and the UAF Cooperative Extension Service to educate the public about research on biocontrol of the invasive exotic amber marked birch leaf miner.

Julianne McGuinness, Director of the Alaska Botanical Garden, and staff

Research plots were established along an easily accessed, highly visible, tail in the Alaska Botanical Gardens in Anchorage. The aim of these research plots is to test various potential biocontrol agents as part of an integrated pest management program for the amber marked birch leaf miner (*Profenusa thomsoni*). Interpretive signs were designed and produced by Corlene Rose and Michael Rasy of the UAF Cooperative Extension Service and placed at strategic locations along the trail explaining the methods and aims of this study, and some of the biology and impacts of this insect pest in the Anchorage bowl. By this public display of a working research project, we hope to help educate the public about insect pests and our programs aimed at managing these pests region-wide.

Forest Health Protection teams up with the Pacific Northwest Research Station to study entomopathogenic fungi and nematodes as biocontrol agents of amber-marked birch leafminer.

Rob Progar, Pacific Northwest Research Station.

Beauveria bassiana and *Metarhizium anisopliae* are fungi and *Steinernema carpocapsae* is a nematode that grow naturally in soils throughout the world, causing disease of various insect pest. These insect pathogens, or entomopathogenic agents, as they are sometimes called, have been used safely as biological controls against many other insect pests elsewhere, but little is know about their effectiveness against the amber marked birch leaf miner in Alaska. This study examines the efficacy of these organisms against this leaf miner under Alaska conditions. The summer of 2008 was the first of a three year cooperative study.

Use of the parasitoid, *Lathrolestes sp.*, as a biological control agent of the amber-marked birch leaf miner.

Forest Health Technical Enterprise Team and Anna Soper, University of Massachusetts

An expanded project that originally started in 2003 as a cooperative effort among the Forest Service, the Canadian Forest Service, Forest Heath Technical Enterprise Team, and the University of Alberta aimed at using the ichneumonoid parasitoid, *Lathrolestes* sp. as a biological control of the amber-marked birch leaf miner in Alaska. At least 3,636 individuals of this parasitoid have been released since 2004. In 2007 and 2008 several *Lathrolestes* sp. were recovered form Anchorage release sites, indicating that this species

Cooperative Projects

is now established and increasing in numbers. Anna discovered that what was originally thought to be *L. luteolator* was actually a new species, and that the leafminer population is attacked also by a local *Lathrolestes* sp., which is apparently a native to this area. According to Anna, it is expected that the Anchorage population of amber-marked birch leaf miner will eventually collapse, but this may take 5 or more additional years.

Forest Health Protection works with scientists at Colorado State University to develop methods to assess insect pest conditions in remote regions of Alaska using satellite imagery and spatial models.

Robin Reich of Colorado State University

2008 was the second year of a study that evaluates and adapts a technique that would facilitate and possibly improve existing pest survey methods by applying spatial modeling techniques using the aspen leaf miner as an initial model system. The long range goal is to eventually work with all major forest pest insects in Alaska. This study evaluates the ability to 1) detect the spatial distribution of aspen leaf miner, 2) estimate severity of the damage caused by the leaf miner, 3) assess the accuracy of these assessments, 4) model the spatial distribution of forest structure affected by this insect pest, 5) compare and contrast the use of Landsat imagery with MODIS in the above evaluations. The long range aim of this study is to eventually develop methods that will enable us to determine the spatial distributions of different forest insect pests in areas lacking roads and falling between annual aerial survey flight lines.

Latitudinal Transect to Measure and Monitor Climate Change and Forest Health.

Pacific Northwest Research Station, the Southwest Forest Research Station, Oregon State University, Colorado State University, and others.

During 2008, we established a latitudinal transect that will hopefully enable us to eventually monitor changes in forest health in the northern forests of Alaska due to climate change. Our efforts have been aimed at identifying useful bio-indicators based on insect assemblages and developing methods and metrics to measure these indicators.

Forest Health Protection leads in the formation of an Integrated Pest Management Working Group for addressing the amber-marked birch leaf miner in Southcentral Alaska.

A Working Group was chartered to work cooperatively toward achieving a desired condition where the amber-marked birch leaf miner is managed and impacts are limited to acceptable levels. What is learned from this effort with amber-marked birch leaf miner will be applicable to future invasive threats. The scope of the Working Group is the Anchorage area, including the Anchorage Bowl, Kenai Peninsula, and the Matsu Valley, and members include representatives from the following: Alaska Botanical Garden; Animal and Plant Health Inspection Service (APHIS); Forest Health Protection, USDA Forest Service; Kenai Peninsula Borough; Municipality of Anchorage, State of Alaska DNR, Division of Forestry, Community Forestry Program; State of Alaska DNR, Division of Forestry, Forest Health Program; UAF Cooperative Extension Service; and the State of Alaska, Department of Natural Resources, Division of Agriculture.

Pathology Projects in 2008

Mapping and modeling western redcedar and yellow-cedar in Southeast Alaska

John Caouette, Statistician, The Nature Conservancy, Juneau, AK

We are locating and using all forest inventory plot information to map and model the distribution and habitat preferences of the two native cedar tree species in Alaska. Currently, a map or GIS layer depicting the occurrence of cedars is not available. Dead yellow-cedar can be mapped from the air or on remotely sensed images, but live cedars cannot be reliably distinguished from other tree species. To remedy this situation, we are using FIA (Forest Inventory and Analysis) and Tongass inventories, stand exam data, and other sources. Our approach is to document the association of cedar occurrence with different landscape factors including latitude, elevation, aspect, and soils. In addition, we are using plot data to determine where the cedars have elevated mortality rates and where regeneration is occurring. These findings will help generate an overall understanding of how the cedars are responding to a changing climate in southeast Alaska.

Comparing the Alaskan alder pathogens to isolates from other regions of the United States.

Gerard Adams, Department of Plant Pathology, Michigan State University, East Lansing, Michigan 48824-1311

This project, in cooperation with Region 10 SPF-FHP, is examining the plant pathogens associated with extensive dieback and mortality of *Alnus incana* subsp. *tenuifolia*. Long narrow cankers that were girdling branches and trunks were sampled from infected alder from Seward to Fairbanks. From the canker margins, strains of a plant pathogenic fungus were routinely isolated. DNA sequence data, morphology and phylogenetic analysis confirmed the identity of the fungus as *Valsa melanodiscus* based on a one-gene tree. This pathogen is common on alder throughout North America, and yet, never has it been observed to cause such extensive and widespread damage. Research is continuing to determine whether the Alaskan strains of the pathogen represent a unique genetic population distinct from populations in other parts of the United States that cause little damage.

Searching for invasive pathogens of Alnus incana related to on-going alder mortality

Gerard Adams, Department of Plant Pathology, Michigan State University, East Lansing, Michigan 48824-1311

Two major objectives of this project are:

A) Examine the genetic diversity in the populations of *Valsa melanodiscus* and *Valsa diatrypoides* in Alaska to determine whether the species are recent invasive species (low genetic diversity) or native species of long residence (high genetic diversity). The results will inform us as to whether the dieback and mortality of *A. incana* is the result of a native, or recent invasive, canker pathogen.

B) Bait and trap species of *Phytophthora* in the root systems, forest soils, and adjacent water sources in *Alnus* riverine areas experiencing dieback and mortality. *Phytophthora* species isolated will be identified to group and species in order to determine whether *P. alni* or other new species and hybrids have invaded Alaska. The results will inform us as to whether *P. alni* is contributing to the dieback and mortality of *A. incana*, as is the described situation throughout Europe.

The *Phytophthora* survey project has yielded *P. alni uniformis*, a first finding for North America. We describe this finding in detail in briefing papers at http://www.fs.fed.us/r10/spf/fhp/. Other rare *Phytophthoras* and some previously undescribed species have also been found during the surveys.

Testing pathogenicity of fungi associated with cankers on *Alnus incana* in Alaska

Glen R. Stanosz, Departments of Plant Pathology and Forest Ecology and Management, University of Wisconsin-Madison 53706

This project is conducting greenhouse inoculation trials and pathogenicity testing of several canker causing fungi on vegetative cuttings of *Alnus incana* subsp. *tenuifolia* from Alaska and Colorado. Work in the greenhouse has been slowed by difficulty in propagation of Alaska source alders, but a replicated inoculation trial with a repeat is now underway using vegetatively propagated Colorado source *A. incana* stock and well-characterized isolates of the suspected canker pathogen *Valsa melanodiscus*. Field inoculations with the same isolates in Alaska during 2007, however, were successful. In May at each of two sites, multiple stems of *A. incana* were wounded and then inoculated with either of two isolates of *V. melanodiscus* from Alaska (non-inoculated controls were included). Cankers resembling those present naturally and attributed to *V.melanodiscus* resulted. Cankers were harvested in September and this fungus was re-isolated from every inoculated stem, but not from any control stems, confirming the ability of the fungus to produce symptoms associated with alder dieback. A second round of field inoculations was initiated in fall at three sites. Comparisons of spring and fall inoculation success is underway.

Remeasurement of deterioration of spruce bark beetle-killed trees

Mark Harmon, Department of Forest Ecology and Society, Oregon State University 97331

This project is the second and final measurement of the 2002 project "The Fate of Dead Spruce on the Kenai Peninsula". All plots from 2002 were visited and are being re-analyzed to improve our estimates of deterioration rates. The report from the 2002 initial project is available at http://www.fs.fed.us/r10/spf/fhp/.

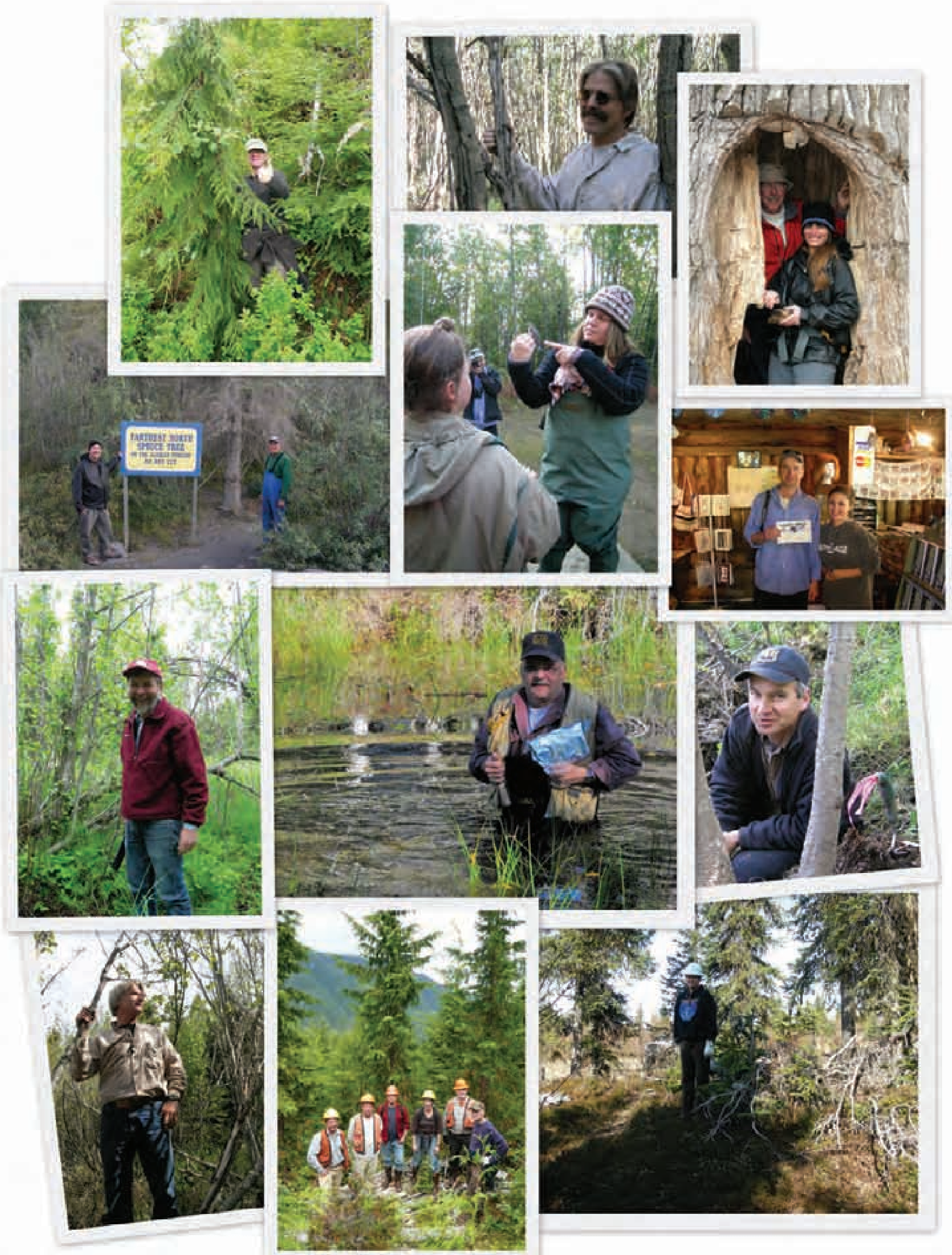
Review of alder mortality in southcentral Alaska

Everett Hansen, Department of Botany & Plant Pathology, Oregon State University 97331

This project, field assessed the current thinking of alder mortality across southcentral and interior Alaska. Dr. Hansen traveled to over 30 sites, utilized *Phytophthora* field test kits, and assessed *Phytophthora* root disease signs and symptoms.

R10 FHP Visiting Contributors

The 2008 field season was enlivened by many out-of-state collaborators who visited Alaska and contributed to FHP projects. The photos below were taken in 2008 and include many of our important partners.



Cooperative Projects

Information Delivery

Publications

Adams, G.C.; Catal, M.; Trummer, L.M.; Hansen E.M.; Reeser, P.; Worrall, J. 2008 *Phytophthora alni* subsp. *uniformis* found in Alaska beneath thinleaf alders Plant Health Progress. In Press.

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Glaeser, J.A.; Lindner, D.L.; Banik, M.T.; Trummer, L. 2009. Wood Decay Fungi Associated with Beetle-killed Lutz Spruce (*Picea x lutzii*) from the Kenai Peninsula, AK: Culture Studies. In: Baker, F. compiler, Proceedings of the Western International Forest Disease Work Conference, October 27-31, 2008, Missoula MT. Accepted for publication.

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Adams, G.; Catal, M.; Trummer, L.; Worrall, J. 2008. *Phytophthora* and *Pythium* species new to North America, Alaska, or Colorado from beneath declining *Alnus* spp. Presented at 2008 Mycological Society of America, August 9-13, 2008, Pennsylvania State University, State College, PA. Poster.

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Hennon, P.E. 2008. Problem Solving—what is killing cedars in Alaska? Latseen Camp for Native students. June 23 and June 30, 2008. Univ. of Alaska Southeast, Juneau, AK. Four oral presentations.

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Rasy, M. 2008. Insects and diseases of fruit trees. Pioneer Fruit Tree Growers Meeting, Oral presentation, January 2008, Anchorage, AK.

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