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State of Alaska
Department of
Natural Resources
Division of Forestry

Forest Health Conditions in Alaska—2004

A Forest Health Protection Report



Cedar Decline



White Sweet Clover



Spruce Aphid



Noctuid Defoliator



Drought Stress



Alder Canker

Alaska Forest Health Specialists

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Protection Report R10-PR-3

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Conditions in Brief

Aerial detection mapping is conducted annually to document the location and extent of active forest insect and disease damage. These surveys (southeast Alaska, interior Alaska, and south-central Alaska) cover approximately one-fifth of the forested land in the State. Over 36 million acres throughout Alaska were surveyed in 2004. This marks an approximate 40 percent increase in acres surveyed over previous years. In 2004 forest damage, from insect, disease and select other abiotic factors, totaled 1,178,743 acres. Above average temperatures and below average precipitation in 2004 has contributed to stressed forest conditions, prime for many types of insect and disease damage.

Insects:

There was a 40 percent increase in active spruce beetle *Dendroctonus rufipennis* (Kirby) infestations in 2004. The majority of this increase occurred in the Seward Peninsula where more than 80,000 acres of infested spruce were detected. This outbreak has been on-going for at least three to five years. Northern spruce engraver *Ips perturbatus* (Eichhoff) populations increased four-

fold in 2004, especially in interior Alaska. Western balsam bark beetle *Dryocoetes confuses* Swaine is responsible for subalpine fir mortality in the Skagway river watershed, northeast of Skagway. Weather records show conditions have become more favorable for beetle development for this area in recent years.

Spruce budworm *Choristoneura fumiferana* (Clemens) defoliation as well as larch sawfly *Pristiphora erichsonii* (Hartig) defoliation increased in 2004 in interior Alaska. Further increases by both of these defoliators are expected in 2005. In 2004, there was an increase black-headed budworm *Acleris gloverana* (Wlsm.) activity in southeast Alaska.

Spruce aphid *Elatobium abietinum* (Walker) defoliation in southeast Alaska declined by 75 percent in southeast Alaska. Thirty-nine percent occurred on National Forest Lands and primarily on the western and southwestern beach fringe of Prince of Wales Island.

The largest outbreak of aspen leaf miner *Phyllocnistis populiella* Chambers on record in Alaska continues and has expanded in 2004. Activity on 584,405 acres was mapped state-wide in 2004. Leaf miner activity continues in the Yukon Flats National Wildlife Refuge, and has expanded in the Fairbanks and Upper Tanana River Valley. Birch leaf roller *Epinotia solandriana* (L.) infestations decreased by 80 percent over 2003 levels. The largest infestation continues north of Tyonek in south-central Alaska.

Due to continued mild weather conditions, insect defoliator populations increased around the Anchorage area with noticeable damage to alder species. Damage was noted from Palmer to Seward, but heaviest in the Anchorage Bowl. The primary defoliator of thin-leaf alder was the introduced alder wooly sawfly *Eriocampa ovata* (L.).

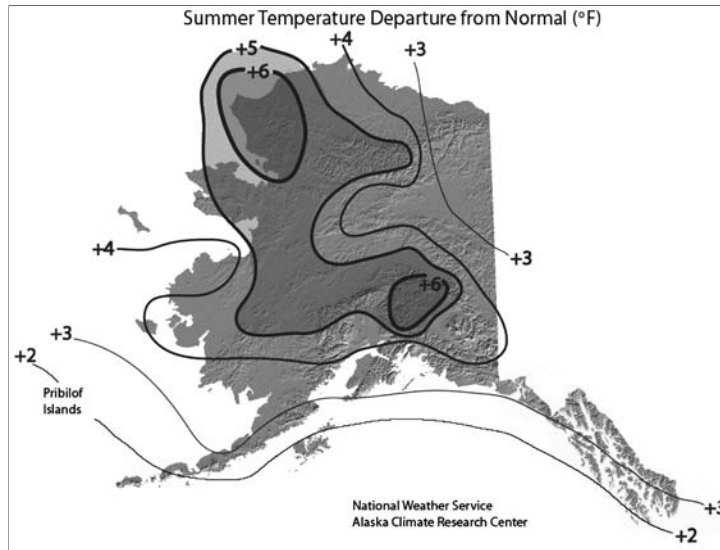


Figure 1. Alaska experienced record-breaking temperature throughout the state this summer.

Amber-marked birch leaf miner *Profenusa thomsoni* (Konow) populations once again exploded in south-central Alaska. More than 138,000 acres (vs. 32,000 acres in 2003) of heavily defoliated birch were detected this year. This introduced insect has now spread north and south of Anchorage to Soldotna, on the Kenai Peninsula. Ground surveys detected low levels of leaf miner activity in Fairbanks. Ground surveys have also detected leaf miner activity in Haines and Skagway in southeast Alaska. A biological control program, the release of a hymenopteran parasitoid, is underway.

Other 2004 introduced insects of interest are: (1) one male European gypsy moth *Lymantria dispar* (L.) was trapped near Fairbanks, (2) Western tent caterpillars *Malacosoma californicum* (Packard) were once again introduced, and hopefully eradicated, in Anchorage, and (3) the European pine shoot moth *Rhyacionia buoliana* (Denis & Schiff.), was introduced on ornamental Scotch pine, and hopefully eradicated, in the Anchorage Bowl.

Diseases:

The most important chronic diseases and declines of Alaskan forests in 2004 were wood decay of live trees, root disease of white spruce, hemlock dwarf mistletoe, and yellow-cedar decline. Except for yellow-cedar decline, trees affected by these diseases are difficult to detect by aerial surveys. Nonetheless, all are chronic factors that significantly influence the commercial value of the timber resource and alter key ecological processes including forest structure, composition, and succession.

In southeast Alaska approximately one-third of the gross volume of forests is defective due to stem and butt rot fungi. Hemlock dwarf mistletoe continues to cause growth loss, top-kill, and mortality in old-growth forests.

Approximately 500,000 acres of yellow-cedar decline have been mapped across an extensive portion of southeast Alaska. In 2004, several areas of active decline, totaling 13,000 acres, were noted. Yellow-cedar decline was found at numerous locations in British Columbia during a reconnaissance survey in 2004, extending the southern limits of the distribution at least 100 miles south of the Alaska-British Columbia border.

A single ornamental white pine tree was found to be infected by white pine blister rust, *Cronartium ribicola*, in Ketchikan in 2004. Later in summer, infected gooseberry (*Ribes* spp.) bushes were found in the same area. The fungus is not native to North America and, while causing devastating mortality in native white pine in some areas of the U.S. and Canada, it does not pose a threat in Alaska because of no native trees are susceptible.

A stem/branch canker pathogen of alder, tentatively identified as belonging to the *Cytospora* group was reported for the first time in 2003 killing thin-leaf alder (*Alnus tenuifolia*) stems. In 2004, ground surveys indicated the pathogen was intensifying and that Sitka alder (*Alnus crispa*) was also a host. Although, to date few alder clumps have completely died, the canker continues to spread, killing individual stems across thousands of acres in south-central and interior Alaska. Stressed plants appear more readily infected by the canker. Stress factors, though presently poorly defined, likely include drought and insect defoliation.

Cone and other foliar diseases of conifers were generally at low levels throughout Alaska in 2004, with the exception of a large outbreak of spruce needle rust on the Kenai Peninsula and near Iliamna Lake. Canker fungi on conifers, particularly on Sitka spruce and sub-alpine fir occurred at higher than normal levels and caused branch dieback in southeast Alaska. Canker fungi, except for the alder canker, were at endemic levels in south-central and interior Alaska.

In south-central and interior Alaska, tomentosus root rot continues to cause growth loss and mortality of white spruce in all age classes. For the first time, tomentosus root rot was reportedly found in southeast Alaska, infecting Sitka spruce near Dyea. Since this is the first report, continued surveys and identification of conks will continue in 2005 to confirm the presence of tomentosus root rot in southeast Alaska. Various stem and butt rot fungi cause considerable defect in mature white spruce, paper birch and aspen stands. Saprophytic decay of spruce bark beetle-killed trees, primarily caused by the red belt fungus, rapidly develops on and degrades dead spruce trees.

Table 1. 2004 forest insect and disease activity as detected during aerial surveys in Alaska by land ownership¹ and agent².

Damage Agent	National Forest	Native Corp.	Other Federal	State & Private	Total Acres 2004
Alder decline	251	1,807	919	6,377	9,354
Aspen leaf miner	0	94,092	144,709	345,605	584,406
Birch leaf miner	0	1,702	11,439	125,694	138,834
Birch leaf roller	0	11,798	3,059	2,992	17,849
Black-headed budworm	841	107	0	535	1,483
Cedar decline faders ³	12,736	479	0	444	13,659
Cottonwood defoliation ⁴	185	4,291	9,030	3,168	16,674
Ips engraver beetle	0	807	2,384	12,908	16,099
Larch beetle	0	0	4,907	6,924	11,831
Larch sawfly	0	338	4,723	9,154	14,215
Large aspen tortrix	0	348	1,524	4,445	6,317
Spruce aphid	3,431	2,512	1,177	638	7,758
Spruce beetle	1,101	99,641	15,423	12,898	129,063
Spruce broom rust	0	10	553	116	678
Spruce budworm	0	25,368	30,711	27,910	83,989
Spruce needle rust	0	87	646	236	969
Subalpine fir beetle	87	0	0	102	190
Willow defoliation ⁵	0	48,874	57,658	4,667	111,199

¹ Ownership derived from 2004 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 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. Some forest damage acres are not shown because a specific agent could not be identified. Damage acres from animals and abiotic agents are also not shown in this table.

³ Acres represent only spots where current faders were noticed. Cumulative cedar decline acres can be found in Table 6.

⁴ Significant contributors include cottonwood leaf beetle and leaf rollers. Acreage where both willow and cottonwood defoliation occurred concurrently is included in these totals.

⁵ Significant contributors include leaf miners and leaf rollers for the respective host.

Table 2. Affected area for each host group and damage type over the prior five years and a 10-year cumulative sum

Host Group/ Damage Type ¹	1999	2000	2001	2002	2003	2004	Ten Year Cumulative ²
Alder defoliation ³	1.8	5.6	1.2	1.8	2.8	10.5	23.6
Aspen defoliation	13.4	12.6	9.4	301.9	351.4	591.5	1,287.0
Birch defoliation	2.8	2.8	3.2	83	217.5	163.9	667.6
Cottonwood defoliation	5.6	5.4	9.9	19.9	13.1	16.7	85.5
Hemlock defoliation	0.1	5.2	1.3	1.4	0.2	0.5	28.4
Hemlock mortality	0	0	0.1	0.2	0	0.0	0.6
Larch defoliation	159.5	64.9	17.8	0	0.6	14.2	1,569.8
Larch mortality	18.4	0	0	4.8	22.5	11.8	57.4
Spruce defoliation	5.1	84.7	61.1	11	61.5	93.4	777.4
Spruce mortality	258	120.9	104.2	53.6	92.8	145.2	3,353.1
Spruce/Hemlock defoliation	0.1	0	50.7	3.4	15.1	1.5	111.0
Spruce/Larch defoliation	0	0	0	0	0.3	0.0	2.3
Subalpine fir mortality	0	0	0.1	0.2	0	0.2	0.4
Willow defoliation	181.6	36.5	10.9	0.3	83.9	111.2	623.5
Total damage acres	646.4	338.6	269.9	481.5	861.7	1160.5	8,587.7
Total acres surveyed	31,346.0	27,185.0	22,296.0	24,001.0	25,588.0	36,343.0	88,988.0
Percent of acres surveyed showing damage	2.1	1.2	1.2	2.0	3.4	3.2	9.7

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 6.

² The same stand can have active infestation for several years. The cumulative total is a union of all areas from 1995 through 2004 and does not double count acres.

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

⁴ Acres in thousands.

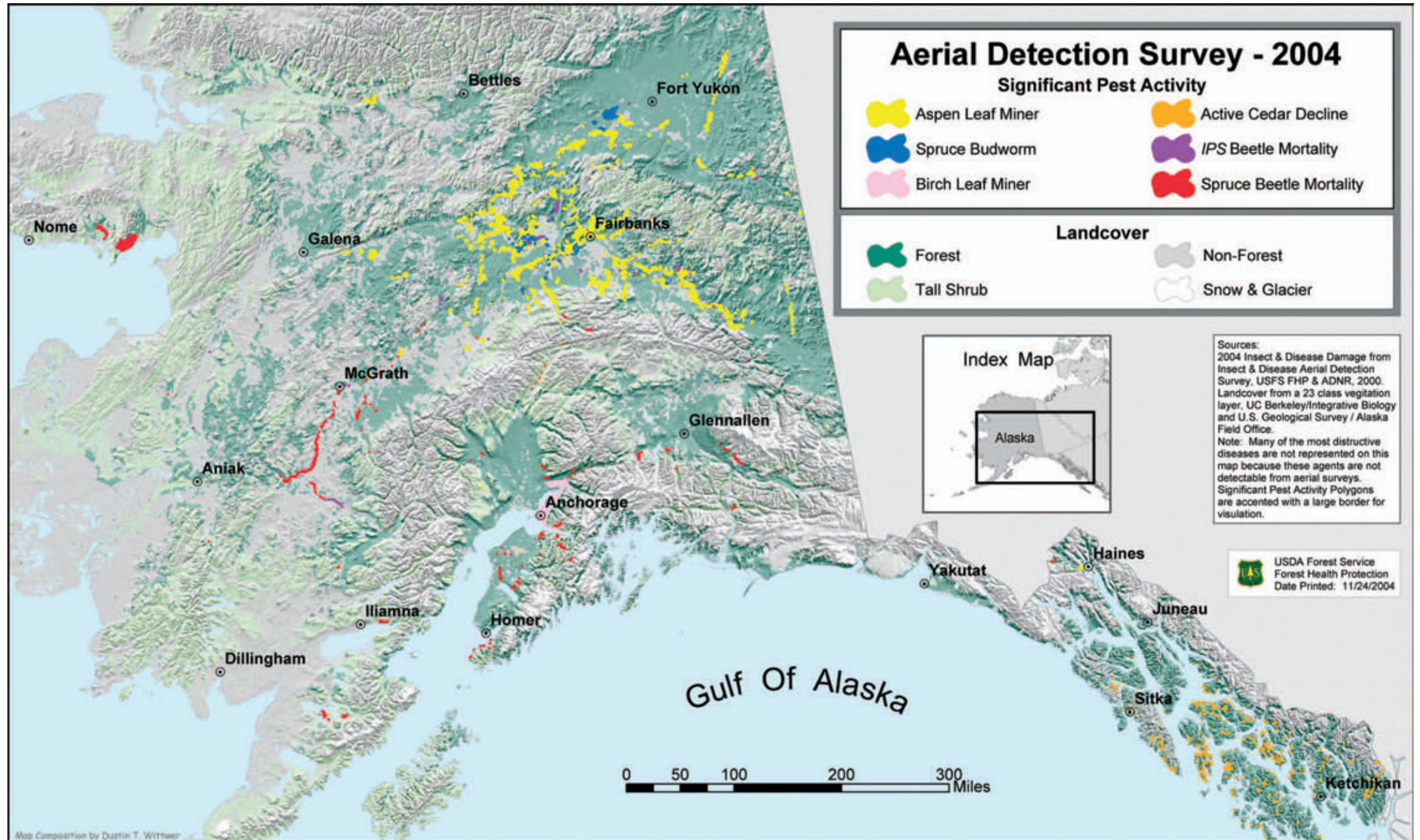
Invasive Plants:

Several species continue to spread in the state. With the warmer summer, orange Hawkweed *Hieracium aurantiacum* has expanded tremendously. New infestations of spotted knapweed *Centaurea biebersteinii* were found and pulled in Anchorage and Haines, and the infestation in Valdez was pulled. A one-acre patch of ornamental jewelweed *Impatiens glandulifera* was found growing along a beach right in Haines. Bull thistle *Cirsium vulgare*, which was thought to be only at two locations across the state, has proven to be much more abundant, as additional surveys were conducted in Haines, Prince of Wales Island, Anchorage and the Matanuska Valley.

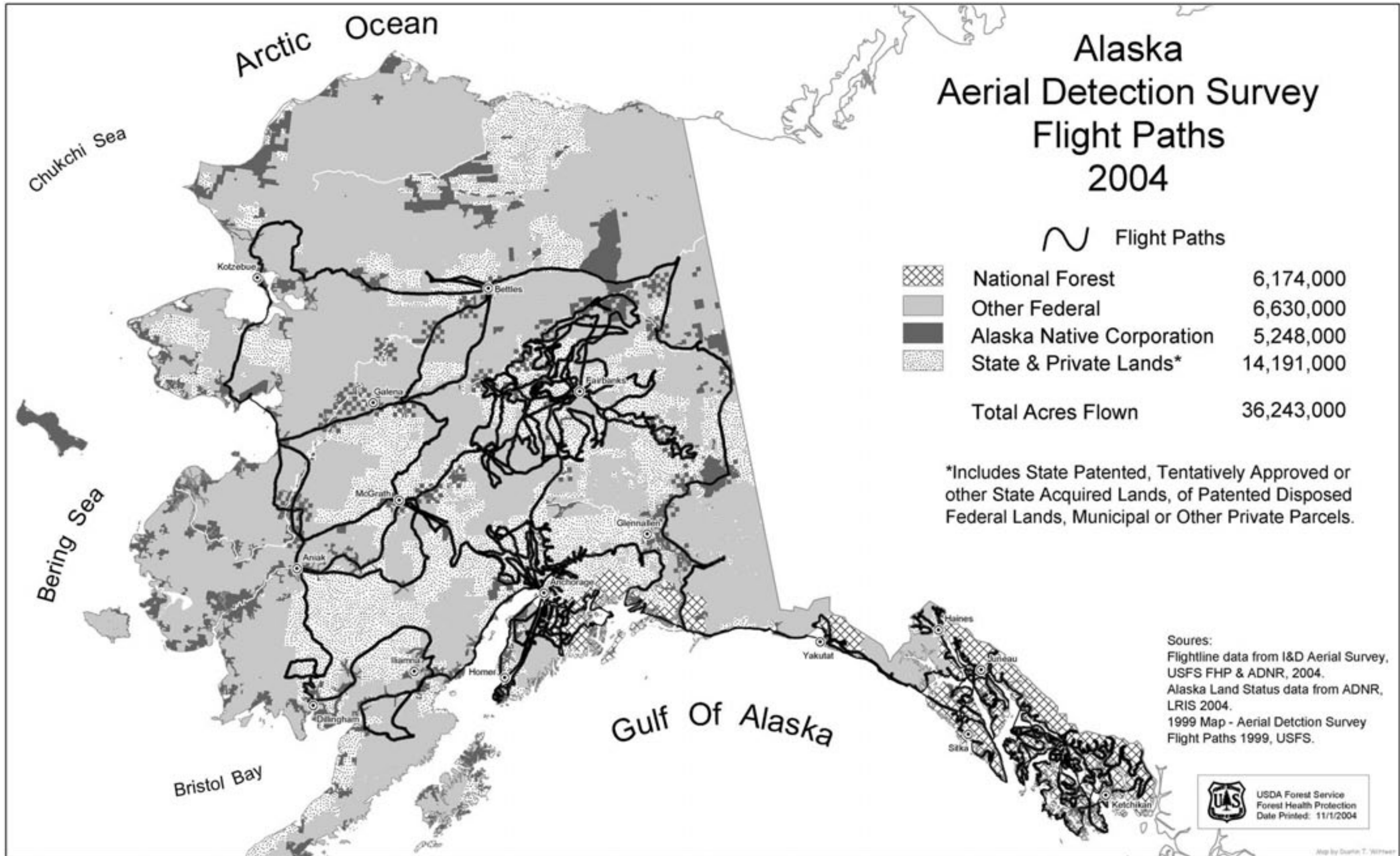
The garlic mustard, *Alliaria petiolata*, infestation in Juneau was pulled several times in the early spring, resulted in a notable reduction of new plants across the area of infestation. Unfortunately a new infestation was found on the Tongass National Forest north of town.

Many other species are being mapped across the State. Interagency and interest group inventories are coordinated for consistency and entered into a statewide GIS inventory base that FHP has helped create. As a result of these coordination efforts, Cooperative Weed Management Areas are being set up through the Soil and Water Conservation Districts to address these newly recognized forest health threats to Alaska resources.

Map 1. General Forest Pest Activity in 2004.



Map 2. 2004 Survey Flight Paths and General Ownership.



The Role of Disturbance in Ecosystem Management

Forests may appear static to the casual forest user, but in fact, most forests are in some stage of reestablishment after one or more disturbances. In Alaska, geological processes, climatic forces, insects, plant diseases, and the activities of animals and humans have shaped forests. To consider the management and sustainability of these ecosystems, we must understand how these cycles of disturbances have shaped and continue to influence the forest's structure and ecological functions.

Disturbances result in changes to ecosystem function. In forests, this often means the death or removal of trees. Disturbances caused by physical forces such as volcanoes, earthquakes, storms, droughts, and fire can affect the entire plant community, although some species may be more resistant to damage than others. Insects, plant diseases, animal and human activities are usually more selective, directly affecting one or several species.

Cycles of disturbance and recovery repeat over time and across landscapes. From evidence of past disturbances on a landscape, we can predict what type of disturbance is likely to occur in the future. Landscapes supporting large areas of single age stands indicate rare, but intense large-scale disturbances.



Figure 2. 2004 marked a record year for fires in interior Alaska.

Landscapes with a variety of age classes and species suggest more frequent smaller scale events. Usually, several types of disturbances at various scales of space, time, and intensity have influenced forest structure and composition on a given site. The role of disturbance in ecological processes is well illustrated in Alaska's two distinct forest ecosystem types and transition zones.

The temperate rain forests of southeast Alaska are dominated by western hemlock. Sitka spruce, Alaskan yellow-cedar, western redcedar, shore pine and mountain hemlock are also important components of the forest. Along the mainland in southeast Alaska black cottonwood, paper birch, and several conifers appear in small amounts. Trees are long-lived, but become heavily infected with heart-rot fungi, hemlock dwarf mistletoe, and root rot fungi as they age. Weakened trees commonly break under the stress of gravity and snow loading. Canopy gaps generated this way do not often result in exposed mineral soil. Trees on productive sites can attain great size due to abundant rainfall, moderate temperatures, and infrequent disturbance.

Wind is the major large-scale disturbance agent in southeast Alaska. Degree of impact and scale depends on stand composition, structure, age and vigor and as well as wind speed, direction, duration and topographic effects on wind flow. The forest type most susceptible to wind throw is mature spruce or hemlock on productive, wind-exposed sites. The large, topheavy canopies act as sails and uprooting is common, resulting in soil churning, which expedites nutrient cycling and increases soil permeability. Even-aged forests develop following large-scale catastrophic wind events. Old-growth forest structure develops in landscapes protected from prevailing winds. In these areas, small gap-forming events dominate.

The boreal forests of interior Alaska are comprised of white spruce, black spruce, paper birch, quaking aspen, balsam poplar and tamarack. The climate is characterized by long, cold winters, short, hot summers, and low precipitation. Cold soils and permafrost limit nutrient cycling and root growth. Topographic features strongly influence microsite conditions; north-facing slopes have wet, cold soils, whereas south-facing slopes are warm and well drained during the growing season. Soils are usually free from permafrost along river drainages, where flooding is common. Areas more distant from rivers are usually underlain by permafrost and are poorly drained. Fire is the major large-scale disturbance agent; lightning strikes are commonly the source of ignition. All tree species are susceptible to damage by fire, and all are adapted, in varying degrees, to regeneration following fire. Fire impacts go beyond removal of vegetation. Depending on the intensity and duration of a fire, soil may be warmed, upper layers of permafrost may thaw, and nutrient cycling may accelerate. Patterns of forest type development across the landscape are defined by the basic silvics of the species involved. Hardwoods are seral pioneers, resprouting from roots or stumps. White spruce stands are usually found on better-drained soils, along flood plains, river terraces, and on slopes with southern exposure. Black spruce and tamarack occur in areas of poor drainage, on north-facing slopes, or on upland slopes more distant from rivers where permafrost is common.

South-central Alaska is a transition zone between the coastal marine climate of the southeast and the continental climate of the interior. These forest communities are more similar to those in the interior, except where Sitka spruce and white spruce ranges overlap and the Lutz spruce hybrid is common. Fire has been a factor in the forest landscape patterns we see today. These fires, however, were mostly the result of human activity since lightning strikes are uncommon in the Cook Inlet area. Major disturbances affecting these forests in the past century have been human activity and spruce beetle caused mortality. Earthquakes, volcanic eruptions, and flooding following storm events have also left significant signatures on the landscape.

Disturbances play an important role in shaping forest composition, structure, and development. With knowledge of disturbance regimes, managers can understand key processes driving forest dynamics and gain insight into the resiliency (the ability to recover) and resistance (the ability to withstand change) of forests to future disturbance. As we improve our understanding of the complexities of these relationships, we are better able to anticipate and respond to natural disturbances and mimic the desirable effects with management activities. Ecological classification is one tool available to help us understand disturbance patterns.

Several useful systems of classification have been developed for Alaska's ecosystems and vegetation. Field and resource specialists representing a variety of organizations, including representatives from Canada, delineated ecoregions based on climate, physiography, vegetation, and glaciation. In Alaska, three distinct climatic-vegetation regimes exist: polar, boreal, and maritime. These regimes cover broad areas and grade from one to another across the state (see map on page 16). To accommodate this spatial arrangement, ecoregion groups were arranged in a triarchy, reflecting the major regimes and gradations between them (see Figure 3). Through this triarchy, the natural associations among ecoregion groups are displayed as they occur on the land without loss of information (i.e., retains the spatial interrelations of the groups). An ecoregion map can be seen on page 16 and ecoregion descriptions can be found at: <http://agdc.usgs.gov/data/projects/fhm/>.

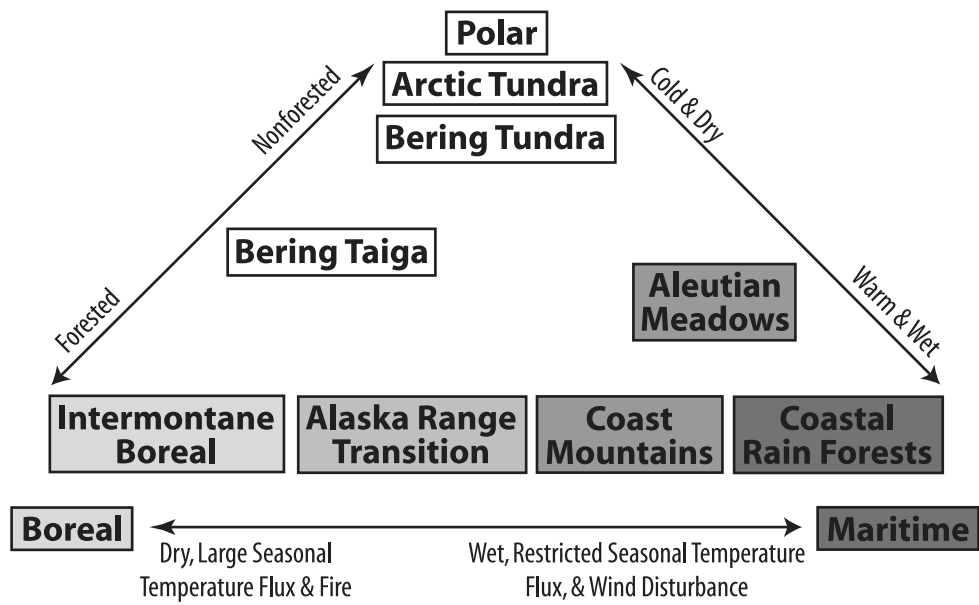
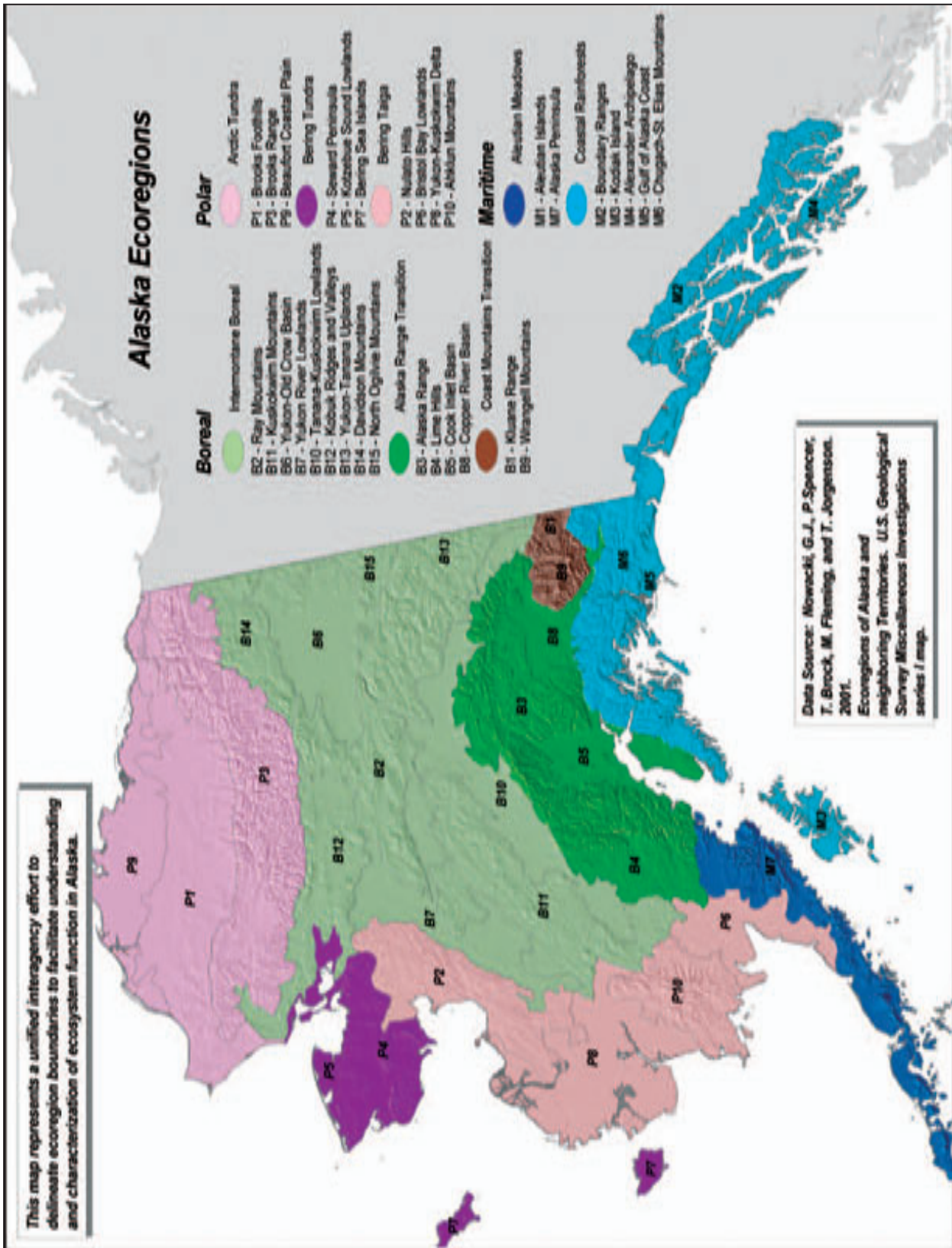


Figure 3. This triarchy illustrates the major regimes and gradations between the Alaska ecoregions.

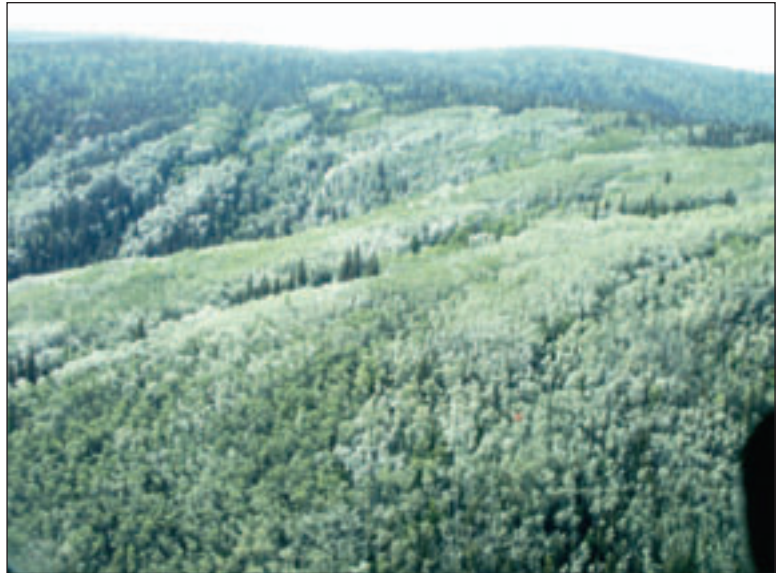
Map 3. Alaska ecoregion map.



Status of Insects



Engravers, page 26



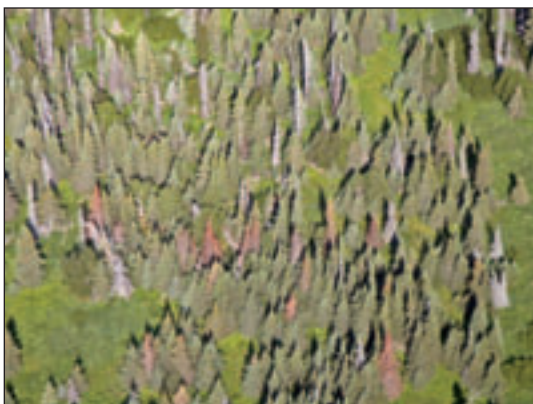
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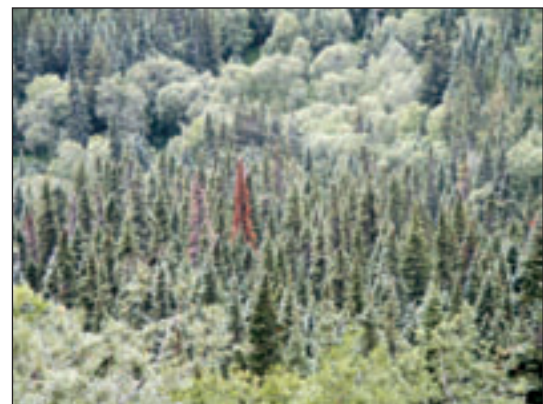
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Status of Insects

Bark Beetles

Bark Beetles as Agents of Disturbance

Insects are active and significant components of Alaska's ecosystems. Arctic and boreal insects are characterized by having few species and large population numbers. Boreal insects are opportunistic in their behavior. They respond quickly to changes in climate and the availability of food and breeding material. Spruce beetles, for example, are one of the most important disturbance agents in mature Lutz and white spruce stands in south-central and white spruce stands in interior Alaska. Bark beetles respond quickly to large-scale blow-down, fire-scorched trees, and spruce injured by flooding. Large numbers of beetles can be produced in such breeding material, leading to potential outbreaks.

A variety of changes occur to forest resources when many trees are killed. In the long run these changes are biological or ecological in nature. There are also socioeconomic consequences in the short term that can be viewed as either positive or negative, depending on the forest resource in question. Some of the impacts associated with spruce beetle infestations include, but are not limited to:

- ▲ **Loss of merchantable value of killed trees:** The value of spruce as saw timber is reduced within three years of attack in south-central Alaska due to weather checking and sap-rots. The value of beetle-killed trees as house logs, chips, or firewood continues for many years if the tree remains standing.
- ▲ **Long-term stand conversion:** The best regeneration of white and Lutz spruce and birch occur on a seedbed of bare mineral soil with some organic material. Site disturbances such as fire, windthrow, flooding, or ground scarification can provide excellent sites for germination and establishment of seedlings if there is an adequate seed source. However, on some sites in south-central Alaska, blue-joint reed grass and other competing vegetation quickly invade the sites where spruce beetles have "opened up" the canopy. This delays reestablishment of tree species. Regeneration requirements for Sitka spruce are less exacting; regeneration is thus, less problematic.
- ▲ **Impacts on wildlife habitat:** Wildlife populations, which depend on live, mature spruce stands for habitat requirements, may decline. We expect to see decreases in red squirrels, spruce grouse, Townsend warblers, ruby-crowned kinglets, and possibly marbled murrelet populations. On the other hand, wildlife species (moose, small mammals and their predators, etc.) that benefit from early successional vegetation such as willow and aspen may increase as stand composition changes.
- ▲ **Impacts on scenic quality:** Scenic beauty is an important forest resource. It has been demonstrated that there is a significant decline in public perception of scenic quality where spruce beetle impacted stands adjoin corridors such as National Scenic Byways. Maintaining or enhancing scenic quality necessitates minimizing impacts from spruce beetle infestations. Surveys have also shown that the public is evenly divided as to whether spruce beetle outbreaks damage scenic quality in backcountry areas.
- ▲ **Fire hazard:** Fire hazard in many spruce beetle impacted stands has increased. After a spruce beetle outbreak, grass or other fine vegetation increases and fire spreads rapidly through these vegetation types. As the dead trees break or blow down (5–10 years after an outbreak), large woody debris begins to accumulate on the forest floor. This material is the largest component of the fuels complex. Heavy fuels do not readily ignite,

but once ignited they burn at higher temperatures for a longer period. A dangerous fire behavior situation results from a combination of fine, flashy fuels and abundant large woody debris. Rate of fire spread may increase as well as burn intensity. Observations from recent fires on the Kenai Peninsula have shown an increase in crown fires. This fire behavior is caused by fire traveling up the dead spruce trees and spotting into the crowns of adjacent beetle killed trees.

- ▲ **Impact on fisheries:** If salmon spawning streams are bordered by large diameter spruce and these trees are subsequently killed by spruce beetles, there is a concern as to the future availability of large woody debris in the streams. Large woody debris in spawning streams is a necessary component for spawning habitat integrity. Likewise, stream temperatures may increase.
- ▲ **Impact on watersheds:** Intense bark beetle outbreaks can kill large amounts of forest vegetation. The “removal” of significant portions of the forest will impact to some degree the dynamics of stream flow, timing of peak flow, etc. There have been no hydrologic studies in Alaska quantifying or qualifying impacts associated with spruce beetle outbreaks. Impact studies, however, have been done elsewhere. In Idaho watersheds impacted by the Mountain Pine Beetle, there was a 15 percent increase in annual water yield, a 2–3 week advance in snowmelt, and a 10–15 percent increase in low flows.

There are a variety of techniques that can be used to prevent, mitigate, or reduce impacts associated with spruce beetle infestations. Before pest management treatment options can be developed, the forest manager must evaluate the resource values and economics of management actions for each stand in light of management objectives. The beetle population level must also be considered because population levels will determine the priority of management actions and the type of strategy to be invoked. The key to sustainable forest ecosystems is to manage vegetation patterns in order to maintain species diversity, both plant and animal, while providing for a multitude of resources such as recreation, fisheries, wildlife, and the production of wood fiber. Properly applied silvicultural practices as well as fire management in south-central and interior Alaska can maintain the forest diversity needed to provide the range of products and amenities available in the natural forest for now and in the future.

Spruce Beetle

***Dendroctonus rufipennis* (Kirby)**

Total area of new spruce beetle activity aerially mapped across Alaska increased in 2004 (+40 percent) to 129,063 acres. Active infestations were observed in several areas that have received beetle pressure since the spruce beetle outbreak peaked in 1996, although most of these stands currently have only light to moderate infestation levels as residual stands of susceptible spruce are attacked. Spruce beetle populations have maintained endemic levels in most areas of the state since the epidemic. Nonetheless, the record warm 2004 summer in Alaska, including a record 6.5+ million acres of wildfire activity, have put forest managers on alert to continued potential catastrophic wildfire due to the large volume of beetle-killed spruce that remain in affected areas across interior and south-central Alaska. Continuance of this warming trend and the recent extensive fire activity could place additional stress on susceptible spruce as the beetles respond to climatic changes and stand disturbances.

Many areas of the state have been rendered unsuitable for further, large-scale beetle activity due to changes in stand structure and composition. Spruce beetle populations are at endemic levels in these areas. Several areas, however, still need to be monitored for increased

beetle activity, especially spruce stands weakened by recent fire, as well as areas containing a significant component of uninfested mature spruce.

Lake Iliamna

The spruce beetle outbreak in the Iliamna Lake area, which began in 1990, and peaked in 1996 with more than 85,000 acres of activity, has moved into one of the last remaining stands of susceptible timber on the eastern end of the lake. This infestation, which had remained static for the past two years at ~25,000 acres, declined by 87 percent in 2004. 3,242 acres of light to moderate activity were mapped in the Knutson River Valley during this year's aerial survey. Spruce beetle activity in this area will probably persist at this level for one or two more



Figure 4. Spruce beetle larvae feed on the live tree tissue under the bark, which interrupts nutrient flow and causes tree death.

years until the remaining susceptible spruce are killed by the beetle. A few susceptible stands remain, mostly in the Kakhonak Bay area. These stands were surveyed intensively in 2004, but no current spruce beetle activity was observed. Extensive stands of spruce lie just 30 miles to the north of Lake Iliamna in the Lake Clark region, however, no spruce beetle activity has been observed in that area.

Katmai National Park

Spruce beetle activity has declined within Katmai National Park by 28 percent in 2004. However, not all the areas flown in 2003 were reflown in 2004 due to logistical constraints. The intensity of the current activity, observed on 2,900 acres along the shore of Iliuk Arm of Naknek Lake, is considered generally "light", with approximately 1–5 trees per acre infested. Due to the different characteristics of the spruce stands at Naknek Lake as opposed to those around Iliamna Lake just to the north i.e. less contiguous, less extensive, it is expected that the spruce beetle activity at Naknek Lake will continue in 2005 at nearly the same level.

Dillingham

No current spruce beetle activity was observed in the Dillingham area. During 2003 aerial surveys, very light activity was noted approximately five miles northwest of Dillingham. At the request of the Bristol Bay Native Corporation, a brief road system survey was undertaken through Dillingham to assess spruce beetle potential and current conditions. No active infestations were found. The potential for future activity exists; however, based on the history of that area to support spruce beetle infestations, particularly in the lakes area north of Dillingham. Stand disturbance activities such as right-of-way clearing, home site clearing, and logging for local use, were identified as potential sources of instigation of future beetle activity.

Kenai Peninsula

New spruce beetle activity was mapped on 4,924 acres of Kenai Peninsula stands in 2004, a 72 percent decrease. Spruce beetle activity continues, however, in discrete pockets along the Kenai River lowlands and tributaries from Soldotna to Skilak Lake (773 acres), the south side of Kachemak Bay from Sadie Cove to Seldovia (213 acres), the Chugach National Forest (1,444 acres), and portions of the Kenai National Wildlife Refuge (2,330 acres). Scattered, light spruce beetle activity (477 acres) was observed along the coastal road system from Kenai to Homer and appears to be associated with mature spruce stands that were untouched by beetles during the 1980s-1990s epidemic because they were not yet of optimal size for the beetles. Most of this new spruce beetle activity in the vicinity of Port Graham, Seldovia, Soldotna, Sterling, Kenai, Anchor Point, and Homer, is likely a result of forest disturbance (harvest and land and right-of-way clearing) that occurred or continues to occur near previously undisturbed stands. Spruce beetle activity will be potentially greatest in stands that are increasing in susceptibility to spruce beetle attack (avg. diameter approaching 10 inches or larger; 70 percent or higher composition of spruce) and that have experienced some type of disturbance that favors a buildup of beetle populations. On the Kenai Peninsula and other areas, the last 20 years of spruce beetle infestations have left behind a sea of dead trees, concerns, hazards and a changed ecosystem.

Copper River Valley

In 2004, 2,854 acres of ongoing light to moderate spruce beetle activity were mapped along and adjacent to the Chitina/McCarthy Road in the Copper River Valley, an 18 percent decline. Within the town of McCarthy, 294 acres of activity were noted, static with respect to 2003 levels. Immediately to the east of McCarthy, along McCarthy Creek, a near total loss of the spruce component due to intense spruce beetle activity over the past several years was discovered. Further decline of spruce beetle activity is expected in the McCarthy area, while light, scattered activity is expected to continue along the road system. A 3,900-acre patch of light spruce beetle activity was noted along the Nelchina River approximately ten miles southeast of Eureka Roadhouse. Spruce beetle activity has been ongoing in this area for several years at this level of intensity.

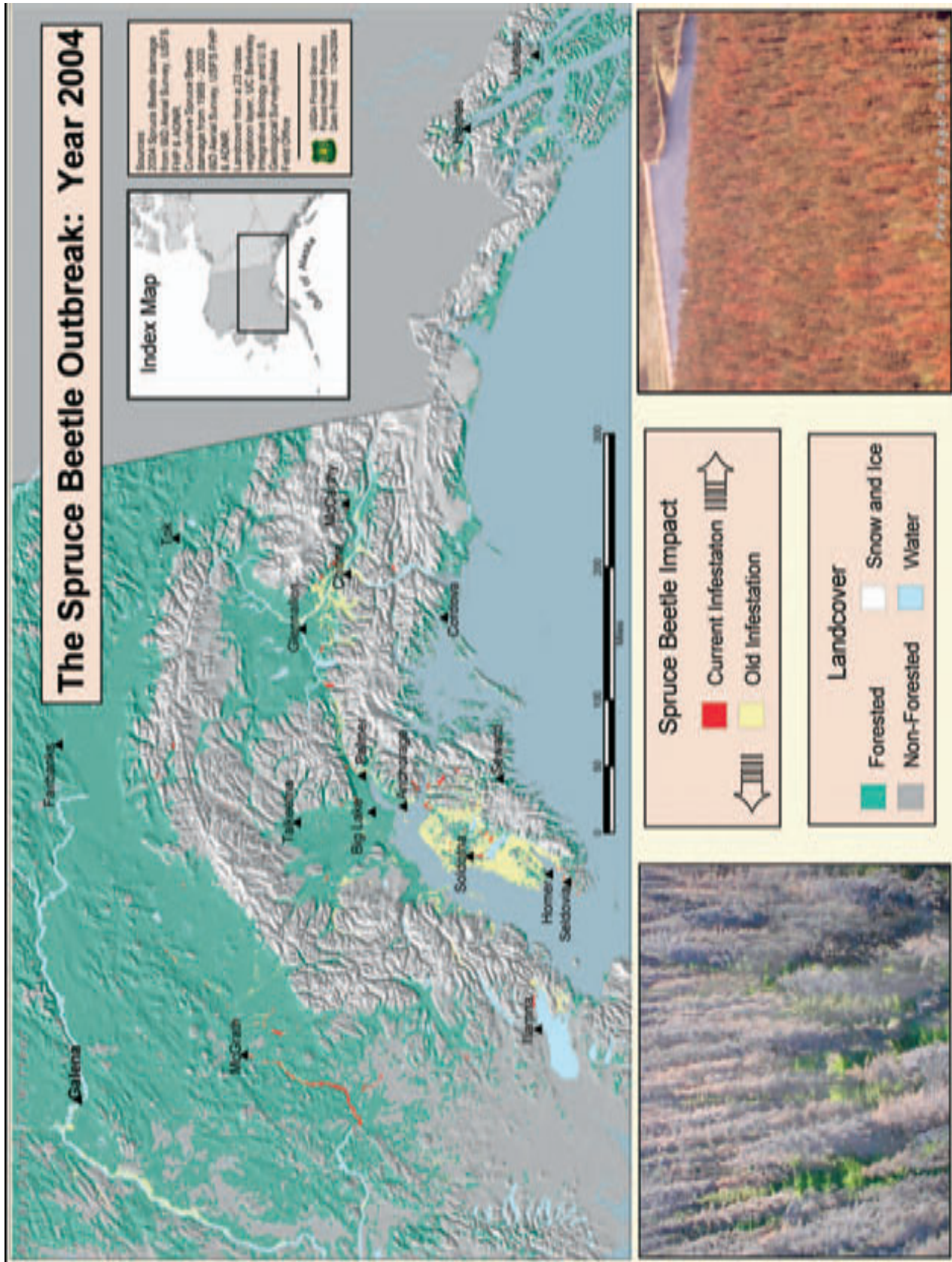
Municipality of Anchorage (Turnagain Arm to Eklutna)

Spruce beetle activity appears to be building again within the forested valleys along upper Turnagain Arm. Moderate to heavy spruce beetle activity was mapped above Indian (680 acres) and Bird (488 acres) Valleys this year. This outbreak has been building for 2-3 years. Girdwood Valley, which showed some spot beetle activity on the northern slope of Chugach State Park in the early 1990s, appears to remain healthy and with no new spruce beetle activity. Elsewhere within the municipality, spruce beetle populations maintain endemic levels. Spruce beetle activity is still occurring in remote, localized pockets from Eagle River Valley to Eklutna Lake. Fire hazard created from stands killed in the 1990s outbreak in the inhabited mid- to upper-hillside areas within the municipality continues to put this area at risk of a potential catastrophic fire.

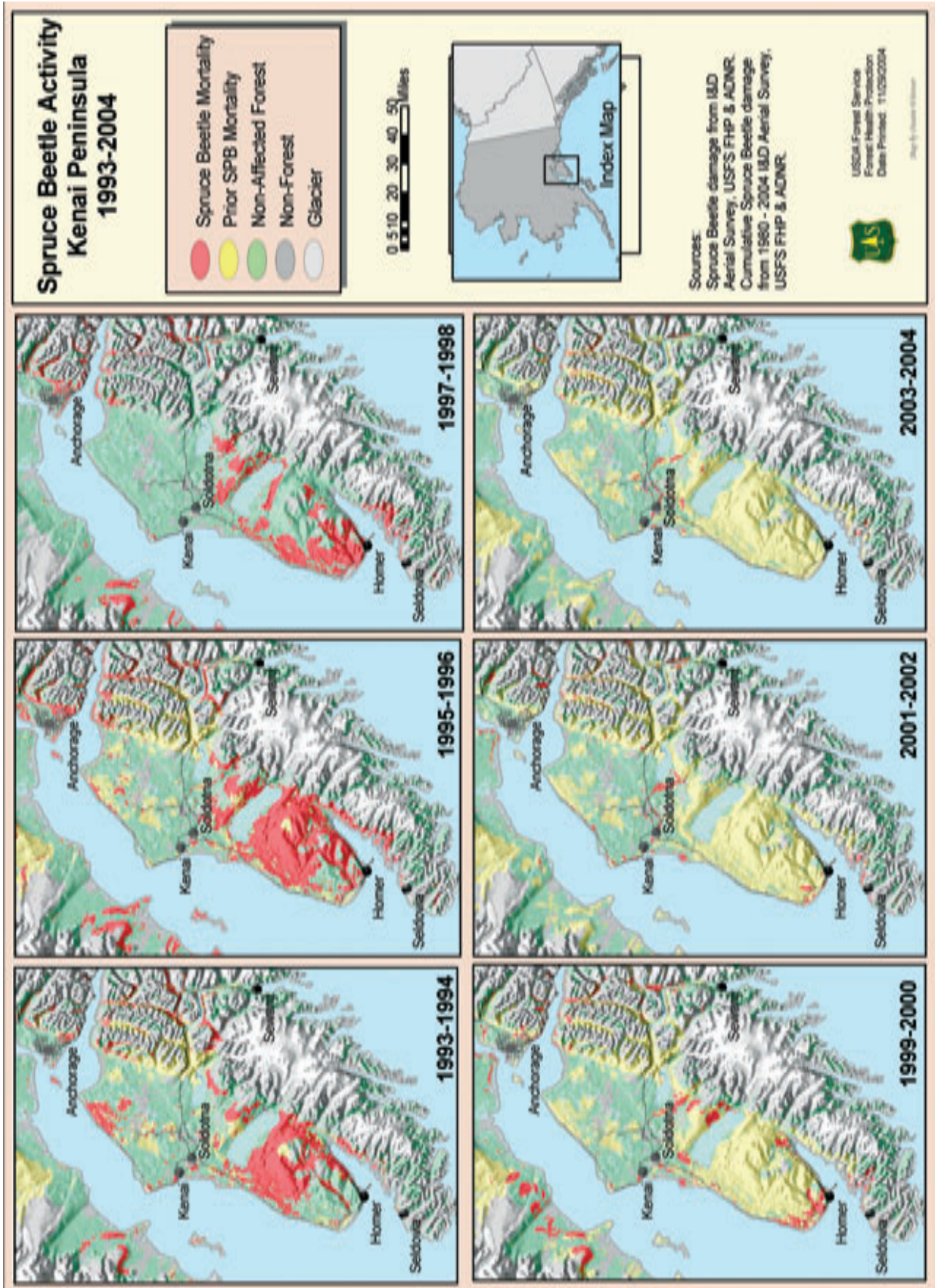
Matanuska-Susitna Valley

The Matanuska-Susitna Valley is a large forested area of lakes and rivers draining the heavily glaciated south slope of the Alaska Range that is composed predominantly of birch and cottonwood stands with a minor component of mature spruce throughout. Only 224 acres of new beetle activity were mapped east of the Susitna River north of Talkeetna in 2004. Beetle populations appear to have crashed throughout the eastern upper Susitna River drainage, predominantly the Yentna and Skwentna drainages, which support a larger component of spruce.

Map 4. Spruce beetle outbreak: year 2004.



Map 5. Sequential spruce beetle effect on the Kenai Peninsula: 1993-2004.



Southeast Alaska

Spruce beetle activity was detected on 44 acres in 2004 compared to 227 in 2003 and 335 in 2002. Light spruce beetle activity was noted near Porcupine along the Klehini River northwest of Haines.

Interior Alaska

Aerial survey coverage in interior Alaska was expanded in 2004 to include a more specialized “local” survey covering a 150-mile radius from Fairbanks. The area of expansion included several large forested tracts maintained and administered by the Fort Wainwright and Eielson military bases generally east of Fairbanks from the Tanana River flats and southeast to Tok. Survey of these areas was limited due to smoke from wildfires and areas closed as a result of the extensive wildfire activity this summer; however, Forest Health Protection staff anticipates continuing this more intensive, expanded survey.

New spruce beetle activity encountered during the Fairbanks area survey was minimal, although occasional spruce beetle spots (1–5 trees) were observed along the fringes of active fires west to the Tanana River lowlands and as far north as the Yukon River. The fire fringe areas will be included in future surveys for any bark beetle (spruce beetle, *Ips* engraver) and wood boring insect activity.

Spruce beetle activity along the Kuskokwim River, between McGrath and Red Devil has increased significantly for the second year in a row with 13,042 acres of current activity mapped. The majority of activity occurred between Devil’s Elbow and Sleetmute. As in 2003, all observed activity was confined to the river bottom stands and adjacent slopes, and remains light in intensity. Light activity also continues on the Stony River from its confluence with the Kuskokwim River to a point approximately 20 miles upriver where 175 acres of light, widely scattered spruce beetle activity were mapped. For the past several years, very small, scattered patches of light spruce beetle activity have been observed along the Big River, midway between its headwaters and confluence with the Kuskokwim River. This year, 2,200 acres of light activity were mapped in this area. It appears that the beetle has moved from those small “centers” into the adjoining stands.

Seward Peninsula

Spruce beetle has heavily impacted two areas on the Seward Peninsula over the past several years. In the first, from Mount Kwiniuk to Moses Point along the coast and back to the Kwiniuk River, 81,389 acres of spruce have been killed. Only very light, scattered activity was observed in 2004. This severe outbreak has resulted in the near total loss of the forest resource. The second area is the Fish River, north of White Mountain. In 2004, 8,681 acres of activity were mapped, with the majority characterized as “light” intensity, while 1,000 acres were considered “moderate.” The bulk of the activity occurs in the hills behind and around White Mountain; however, pockets extend upriver to at least Glacier Creek. Beyond that point, reliable observations were unable to be made due to heavy smoke from wildfires.

Western Balsam Bark Beetle

***Dryocoetes confusus* Swaine**

Mortality of subalpine fir totaling 268 acres was spread along the Skagway River and White Pass Fork from 2001 to 2003. In 2004, 190 acres of mortality were recorded along the Warm Pass Valley. The outbreak is probably continuing because of higher spring and fall temperatures, which could be beneficial to many species of bark beetles. Southeast Alaska in particular has been affected by record high maximum temperatures (see Figure 1 under

“Climate and Forest Health”). Since the range of subalpine fir is very limited in Alaska, even a small outbreak has a significant impact on the resource.

Eastern Larch Beetle

Dendroctonus simplex LeC.

Aerial surveys in 2004 detected 11,831 acres of tamarack infested by the eastern larch beetle, about half of the 22,536 acres recorded last year. The infestations were located sporadically along the Tanana River drainage. Historically, large infestations of larch beetle have been recorded in the Alaskan interior. From 1974–1980 for example, over 8 million acres of tamarack scattered throughout the interior were infested. Ground surveys in the Innoko National Wildlife Refuge in 1999, conducted to assess impact to tamarack by the larch sawfly, found one percent of the trees infested with larch beetle. *Dendroctonus simplex* generally attacks injured and recently down trees, and those weakened by fire, flooding, and those trees previously defoliated by the larch sawfly. Frequently, aerial surveys are unable to detect or separate larch beetle activity from that of the larch sawfly.

Engravers

Ips perturbatus (Eichhoff)

Infestations of *Ips* engravers increased in 2004. Aerial surveys identified a total of 16,099 acres infested by engraver beetles. This is up from 465 acres in 2002 and 1,200 acres in 2003. There were three large infestations: 5,072 acres in the Tolovana River Valley south of Livengood, 6,754 acres along the Tanana River near Minto, and 1,840 acres along the Yukon River in the Yukon–Charley Rivers National Preserve. There were many other small, localized infestations spread throughout the interior. *Ips* activity can be distinguished from spruce beetle damage by dying and reddening upper crowns in mature spruce. *Ips* infestations occur mainly along river flood plains and areas disturbed by erosion, spruce top breakage (e.g., snow-loading), harvest, or wind.

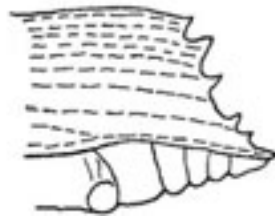


Figure 5. *Ips* beetles have characteristic spines on the posterior.

Increased tree mortality in Alaska caused by *Ips* spp. has stimulated research on new management tactics utilizing semiochemicals such as pheromones and tree bark volatiles to minimize damage from bark beetles. As part of this effort, single tree protection studies were conducted on the Kenai Peninsula 2004 to determine if the application of verbenone and conophthorin (interrupts of *Ips perturbatus*) would eliminate successful attacks. 100 percent of the treated trees were unattacked;

all baited control trees were successfully attacked. This is the first instance in Alaska where bark beetle produced semiochemicals have protected spruce from engraver beetle attack. Additional studies are planned for 2005.

Defoliators

Defoliators as Agents of Disturbance

Defoliator insects eat the leaves or needles of forest trees. Defoliators are found throughout Alaska and on all tree types. Bark beetles are often considered the more significant disturbance agents in boreal Alaska (due to the high potential for causing tree mortality). Even so, defoliators can have a significant affect on both coniferous and deciduous trees, and can cause tree mortality with several seasons of defoliation. In maritime ecosystems where conifers dominate, such as Prince William Sound and southeast Alaska, defoliators tend to

be the more significant agents of change. If complete defoliation of a conifer occurs before midsummer, the trees will not have formed buds for the following year and the tree could be killed.

In a defoliator outbreak where insect populations are at epidemic levels, vast acreages can be affected. During an outbreak, nearly every tree in a stand can be affected to varying degrees. This defoliation often results in a variety of biological and ecological impacts, but there are socioeconomic impacts as well. Some of the impacts associated with a defoliator infestation include, but are not limited to:

- ▲ **Impacts on wildlife habitat:** Wildlife may be positively or negatively affected by defoliator outbreaks. Larvae are a necessary food source to fledgling chicks, but bird habitat may be negatively affected by the decrease in cover. Conversely, predatory birds may benefit from the cover change. The added light to the forest floor will result in an increased ground cover of herbaceous plants, benefiting browse animals such as deer.
- ▲ **Impacts on aquatic systems:** Aquatic systems may also be positively or negatively affected. Nutrient cycling is accelerated as foliage and insect waste enters the aquatic system. Larvae may drop into streams and can serve as a food source for fish. In addition, the loss of overstory cover can increase sunlight exposure to the stream, affecting the aquatic environment.
- ▲ **Economic concerns:** Heavy defoliation will decrease the growth rate of trees resulting in the delayed harvesting of merchantable trees. In addition to growth loss, repeated and or heavy defoliation events can cause top kill and, in some cases, tree death.
- ▲ **Aesthetics and recreation:** The visual impact of a stand in the midst of an outbreak can be quite alarming and often will lose attractiveness for recreation. Large numbers of larvae can be a nuisance in picnic grounds and campgrounds. Dead tops and dead trees pose a hazard in recreational areas. However, the effect is often short term, and the following year, scenic quality usually returns to “normal.”

Defoliator outbreaks tend to be cyclic and closely tied to climatic conditions. The synchronization of larval emergence and tree bud break is closely related to population increases. The better the synchronization of insect and host throughout larval development, the more likely that an epidemic will occur. Higher temperature during pupation and oviposition of western black-headed budworm, for example, improves adult emergence and survival, which increases the number of viable eggs that develop into larvae, the most damaging insect stage. Favorable climate for insect development resulted in a tremendous acreage of defoliated western hemlock in the early 1950s. Up to 25 percent of the foliage was stripped from western hemlock by western black-headed budworm (McCambridge, 1953). At the end of this epidemic, however, only 10 percent of heavily defoliated trees were top killed and only a small number of those died.

Outbreaks of spruce aphid are closely tied to the survival of overwintering adults. Short duration but very cold temperatures (below -10 °C), especially in April, probably have an effect on aphid populations, and research data are now being collected to confirm this.



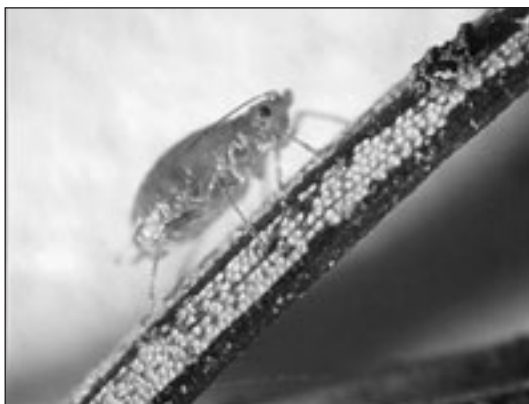
Figure 6. A decision was made in 2004 to discontinue the traditional defoliator plot monitoring during the aerial survey but to land, as needed, where atypical defoliation or mortality was present next to the beach fringe.

Suppression efforts of insect populations are usually limited to small-scale urban settings or high value recreational sites. Suppression techniques vary depending on the species of defoliator. Healthy forests include periodic insect defoliation. Land managers should consider the predicted duration and extent of the event and predicted effects on the resource when considering suppression actions.

Spruce Aphid

Elatobium abietinum (Walker)

Figure 7. An individual spruce aphid feeding on a spruce needle.



Spruce aphids feed on older needles of Sitka spruce, often causing significant amounts of needle drop (defoliation). Extensive feeding may result in wilting of the new foliage in young trees. Defoliation by aphids reduces tree growth and can predispose the tree to other mortality agents, such as spruce beetle. Severe cases of defoliation alone may result in tree mortality. Spruces in urban settings and along marine shorelines are most seriously impacted. Spruce aphids feed primarily in the lower, innermost portions

of tree crowns, but may impact entire crowns during outbreaks. Outbreaks in southeast Alaska are usually preceded by mild winters (figure 8). Since the late 1960s the outbreaks have been more frequent and of more acres.

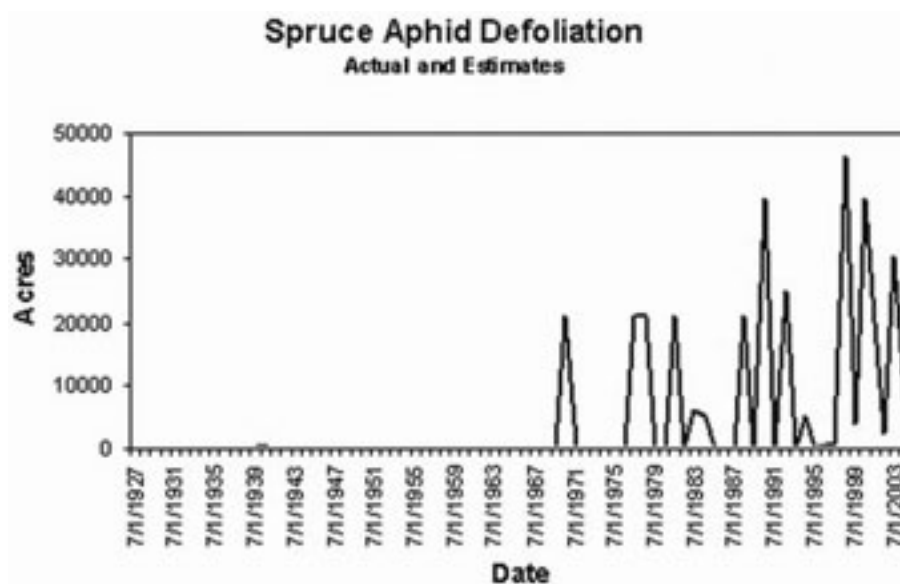


Figure 8. Spruce aphid outbreak acres were derived from condition report records. Some years had no reported acres but did have a general description of location of defoliation. Years 1927, '33, '39, '40, '67, and '71 acres (300 acres) of defoliation were based upon outbreaks that were local to one borough. Years 1970, '77, '78, '81, '88 acres (20,817 acres) were based upon an average of outbreaks in 1992, '97, '98, 2001, 2002, and 2003, outbreaks that covered the entire Tongass National Forest. Years 1984 and 1994 acres (5,000 acres) were based upon the average outbreak acres for 1983 and 1999, outbreaks near Ketchikan, Juneau, and Sitka boroughs.

The current outbreak started in 1998, but the worst year was in 2003, when defoliation occurred on 30,627 acres and was distributed over more of the area surveyed than in the previous five years.

In 2004, one low temperature event on January 26, -18 to -15 °C (0 to 5 °F) depending on the site, caused the aphid population to crash. There was only a total of 7,758 acres of spruce aphid defoliation: 210 acres on northern Dall Island, 341 acres on the southwest side of Suemez Island, 1,365 acres within Craig and just south in Port St. Nicholas, 720 acres near the city of Klawock, 203 acres on the eastern side of Big Salt Lake, 1,268 acres on south Kupreanof Island between Lovelace Creek and Totem Bay, 339 acres near the town of Kake, and 1,063 acres between Lituya Bay and Icy Point. Although defoliation was difficult to aerially map in the Sitka area because of crown color, it did occur within the city. In 2005, tree mortality is expected to occur in the Sitka area as some trees have already been severely defoliated and have September aphid colonies.

Spruce Budworm

Choristoneura fumiferana (Clemens)

In 2004, 83,989 acres of spruce in interior Alaska were defoliated by the spruce budworm. Near Fairbanks, 25,873 acres were infested, mostly in the hills and ridges around Fairbanks (Nenana Ridge, Parks Ridge, Chena Ridge) and along the Tanana River from Fairbanks west to Manley Hot Springs, with pockets of infestation along the Nenana River south to Anderson. Additionally, 44,081 acres were infested along the Yukon River in the Lower Birch Creek area.

Spruce budworm is one of the most destructive insect pests of white spruce in North America. In Alaska, budworm has only recently become a major issue. During outbreaks, budworms are responsible for significant mortality of young white spruce and a factor in spruce regeneration, as mature trees that are top-killed do not produce cones. During the previous recorded 1990–1996 budworm outbreak, over 150,000 acres of white spruce were defoliated along the Tanana and Yukon Rivers. Moderate defoliation of localized areas around Fairbanks to Nenana was observed in 2002–2003. In 2004, indications are that another outbreak has begun. Terminal leader mortality was observed in most trees following the outbreak in the early 1990s. Young seedlings and saplings are often killed by repeated severe defoliation.

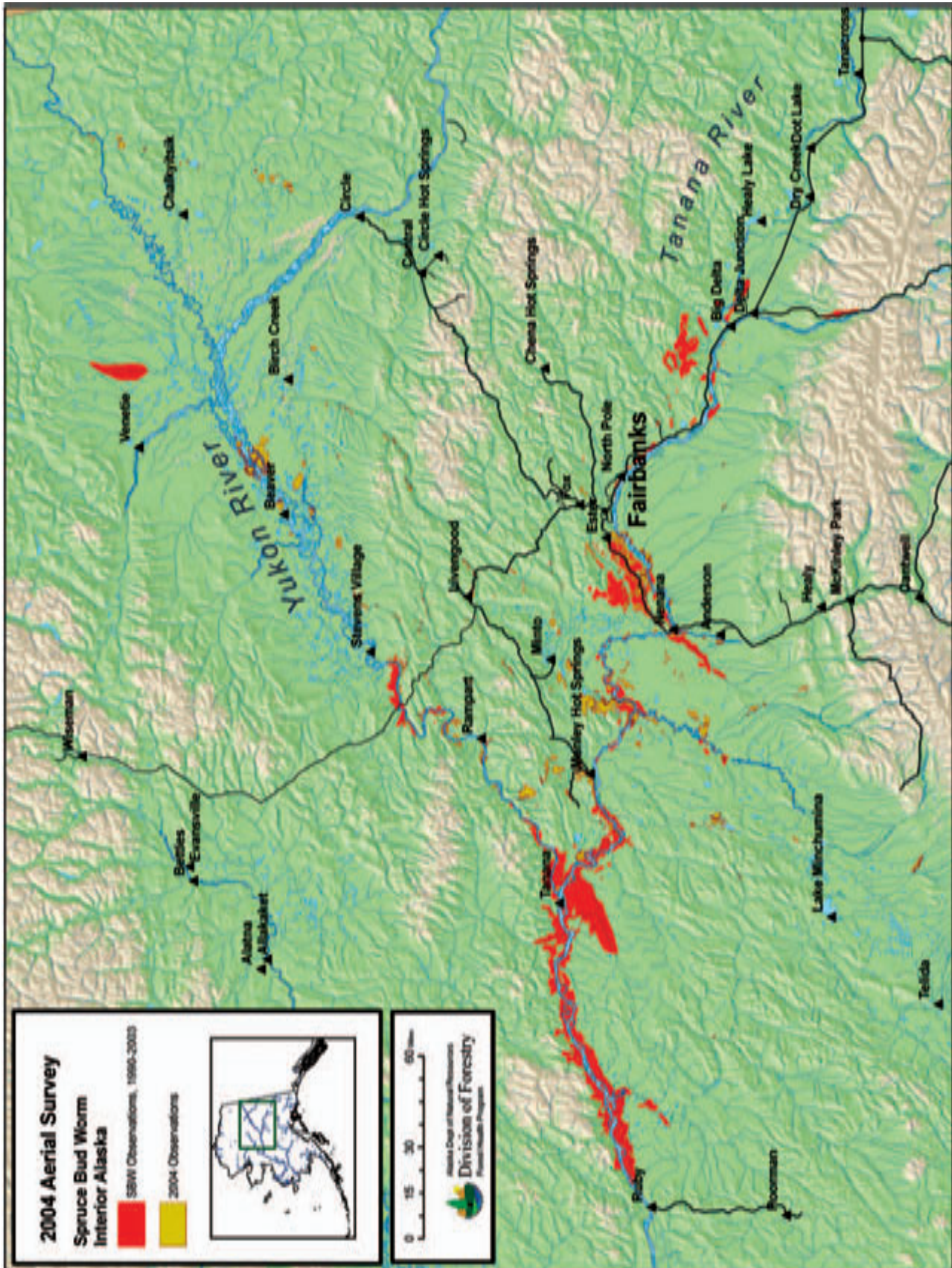
Western Black-Headed Budworm

Acleris gloverana (Walsingham)

The western black-headed budworm is native to the forests of coastal and southwestern Alaska. It occurs primarily in southeast Alaska and has been documented there since the early 1900s. More recently, black-headed budworm populations followed a general increasing trend during the early 1990s but have been declining since that time. A peak year for budworm defoliation occurred in 1993, impacting approximately 258,000 acres. The last black-headed budworm outbreak of this magnitude occurred over a ten-year span between the late-1940s and mid-1950s. From 1998 through 2000, no black-headed budworm defoliation was detected during the annual aerial surveys throughout the coastal areas, including the southeast Alaska panhandle.

In 2004 there were 1,483 acres compared to 3,283 in 2003. There were 950 acres of defoliation on the islands (Kosciusko, Hoot, Tuxekan, Heceta) surrounding Davidson Inlet, and 265 acres were near Howard Cove, Kuiu Island.

Map 6. Current and historical spruce budworm defoliation in the interior.



A ground survey of defoliated western hemlock was conducted at Edna Bay, Kosciusko Island. Black-headed budworm was found on most of the foliage, and black-headed budworm larvae were found spinning down from defoliated portions of live tree crowns. The amount of upper and lower crown tree defoliation was quantified and averaged for 97 trees. Results showed that approximately half of the trees were over 50 percent defoliated and most of the defoliation occurred in either the upper crown or lower crown, but not both.

Budworm populations in Alaska have been cyclic, appearing quickly, affecting extensive areas, and then decreasing just as dramatically in a few years. Consecutive years of budworm defoliation may cause growth loss, top-kill, and in severe outbreaks, substantial lateral branch dieback can lead to the death of large numbers of trees. Generally, heavily defoliated trees may be weakened and predisposed to secondary mortality agents. As a major forest defoliator, black-headed budworm can significantly influence both stand composition and structure to favor small mammals, deer, predaceous and predatory insects, and some insectivorous birds as a direct result of increases in shade tolerant understory plants (i.e., through tree death or crown thinning).

Yellow-Headed Spruce Sawfly

Pikonema alaskensis (Rohwer)

Defoliation was heavy and almost complete on many, especially ornamental, spruce that was planted in stressed microsites. The very intensive but localized infestation, which was observed in the same six-block area along Tudor Road in east Anchorage for the past two years, expanded to a number of nearby locations including Providence Hospital and UAA grounds. This defoliator is not considered a serious forest pest, but can affect the aesthetic value of urban trees, and can cause mortality with repeated years of heavy defoliation. Due to the continuation of extraordinarily warm and dry early spring weather conditions, many overwintering yellow-headed spruce sawfly are able to survive and contribute to the next generation. Abnormally hot and dry conditions persisted throughout the summer and sawfly populations built rapidly.

Hemlock Sawfly

Neodiprion tsugae Middleton

Hemlock sawfly, a common defoliator of western hemlock, is found throughout southeast Alaska. Historically, sawfly outbreaks have been larger and of longer duration in areas south of Frederick Sound. In 2004, over 454 acres of 535 acres mapped were in Endicott Arm.

Unlike the larvae of the black-headed budworm, hemlock sawfly larvae feed in groups, primarily on older hemlock foliage. These two defoliators, feeding in combination, have the potential to completely defoliate western hemlock. Heavy defoliation of hemlock by sawflies is known to reduce radial growth and cause top-kill, thus may ultimately influence both stand composition and structure. The larvae are a food source for numerous birds, other insects, and small mammals.

Larch Sawfly

Pristiphora erichsonii (Hartig)

Larch sawfly activity increased significantly from less than 600 acres in 2003 to 14,215 acres in 2004, reversing a decline that began after 1999 when sawfly populations impacted nearly 450,000 acres. Infestations were concentrated in two areas, the Yukon Flats National Wildlife Refuge where 4,363 acres were reported infested, and 9,136 acres 15 miles north of

McGrath. In the current McGrath infestation, trees are widely scattered and the intensity of activity is light. Larch sawfly has been very active for a number of years in the general vicinity of McGrath and the Farewell Burn. Light, scattered activity, less than one tree per acre, was observed in numerous small patches. Typically, low level activity such as this would not be considered significant, however, the trees infested this year represent some

Figure 9. Late instar larvae have shiny black heads.



of the last remaining live trees in many of these areas.

A biological evaluation conducted in August 2000 within the Innoko National Wildlife Refuge by Forest Health Protection staff found that within the areas studied, 70 percent of the live larches were severely defoliated, while 27 percent of the total component of larch had died. A 2003 follow-up evaluation indicated that 80 percent of the larch defoliated in 2000 had died.

In south-central Alaska, the larch sawfly has continued its advance southward affecting ornamental Siberian larch plantings from Sterling to Homer on the Kenai Peninsula. While larch is not native south of the Alaska Range,

it is a popular landscape tree. Siberian larch appears to be less susceptible to stress from repeated defoliation by the sawfly, and respond better to nonchemical control measures. Expansion of the larch sawfly into urban areas has been swift, and it appears that eradication is not feasible or practical.

Aspen Leaf Miner

***Phyllocnistis populiella* Chambers**

Aspen leaf miner infested acreage increased significantly for the fourth consecutive year. In 2004, 584,405 acres were mapped by aerial surveys, compared to 351,058 acres in 2003. In the current outbreak, leaf miner activity in the extensive Interior hardwood stands surrounding Fairbanks was first noticeable in 2000: 1,400 acres were mapped that year compared to almost negligible leaf miner activity throughout the previous decade of the 1990s. In 2004, the largest and most severe infestations were also located in interior Alaska, bounded by Ruby to the west, south to the Alaska Range, east along the Tanana drainage and the Yukon–Charley Rivers Preserve close to the Alaska Yukon border, and north to the confluence of the Colleen and Porcupine Rivers. Additionally, there was an isolated infestation near Hughes of 12,129 acres, and two small localized infestations in south-central and southeast Alaska, one north of Tyonek and another northwest of Skagway.

Adult moths over winter in the duff layer and under bark scales. Adults become active in late May to early June and deposit eggs singly on the leaf edges then slightly fold the leaf to form a protective covering for the egg until larval emergence. Newly hatched larvae bore into and feed between epidermal leaf tissues. Meandering larval mines of *P. populiella* are

produced in the epidermal layers on the underside of leaves. Affected foliage takes on an almost silvery sheen as the larvae mature in the last stages of development and consumes most of the green photosynthetic area of affected leaves. Adult emergence generally occurs prior to or sometimes after the leaves drop in late August and September.

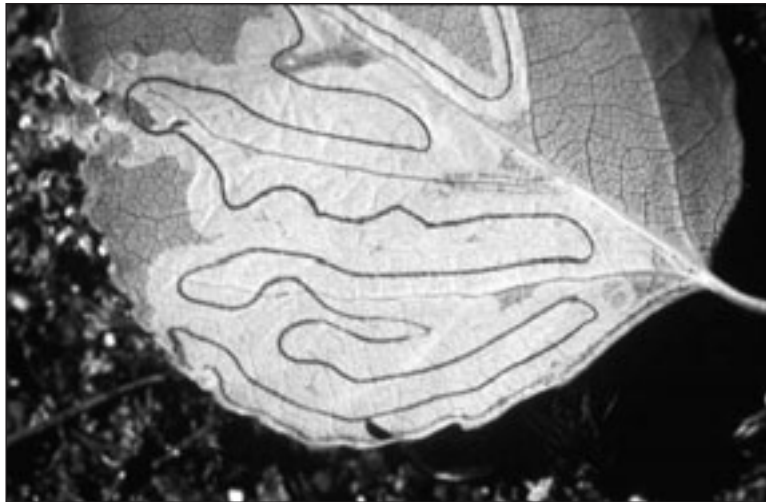


Figure 10. Note the meandering path left by the aspen leaf miner.

Overall, the intensity of the 2004 outbreak seems to be less in light of the vast new acreage involved. In 2004, 29 percent of the total leaf miner activity was classified as “heavy”, 41 percent as “medium”, and 30 percent as “light.” In 2003 infestations were characterized as 56 percent “heavy”, 37 percent “medium” and 7 percent “light.” This year, however, light leaf miner defoliation was also observed on some birch in mixed stands with aspen, indicating that aspen leaf miner populations were very high on some sites. Defoliation intensity is expected to increase next year in the more recently affected areas.

Heavy, repeated attacks by the aspen leaf miner can reduce tree growth and may cause branch dieback, or in some cases, tree death. Many aspen trees, especially in the hills, were severely drought stressed this year, and began losing leaves already by late-July. The effects of drought stress and the repeated stress of leaf miner may begin to take its toll on the aspen in the Interior.

Birch Leaf Roller

Epinotia solandriana (L.)

Acres of birch leaf roller defoliation significantly decreased from 185,020 acres in 2003 to 17,848 acres in 2004. Most infestations were only a few hundred acres or less. These occurred along the Cascaden Ridge southwest of Livengood, from Fairbanks southwest to Nenana, and 45 miles west northwest of Anchorage. The largest infestation reported was 11,754 acres 35 miles north of Tyonek, which accounted for 66 percent of the total acreage infested. Although the 2003 outbreak along the Susitna and Yentna Rivers has collapsed, the 2004 activity north of Tyonek is in the same general area on the opposite side of Mount Susitna. There were 5,165 acres defoliated along the Kantishna River, Muddy and Birch Creeks, from Lake Minchumina to the Denali National Park Boundary along the Kantishna.

Generally, defoliation results in a minor growth reduction and occasional branch dieback. Adverse weather, parasites, predators, and disease reduce large populations of leaf rollers, and a significant fluctuation in acres infested from year to year is not uncommon.

Cottonwood Defoliation

In 2004, 6,084 acres of cottonwood defoliation were observed during aerial surveys. The largest area of defoliation was 2,832 acres along the Kantishna River, Birch Creek, and McKinley River, southwest of Fairbanks. There were small pockets, < 100 acres, of defoliation located in the interior near Fairbanks, Circle, and Beaver. Included in the total acreage defoliated is 545 acres of defoliation caused by cottonwood leaf beetle located in the south-central region of the state near Anchorage and in the southeastern part of the state near Juneau and Skagway. In Denali National Park and Preserve, cottonwood leaf miner infested 36 acres, and cottonwood leaf roller infested 198 acres near Tanana and along the Kantishna River.

Willow Leaf Blotch Miner

***Micrurapteryx salicifolliela* (Chambers)**

The willow leaf blotch miner outbreak, which began in the Yukon Flats National Wildlife Refuge in 1991, exhibited a series of rather unpredictable increases and declines in the past 13 years. Twice during that period, the number of acres infested fell to nearly undetectable levels, only to rise the following year. The distribution of this activity has also varied over time. From the initial outbreak in the Yukon Flats, leaf miner activity moved west and south, eventually being observed throughout the Interior as far south as the Holitna River. The only activity observed during 2003 surveys was 12,300 acres near Sleetmute on the Holitna River. During 2004 surveys, no activity was reported along the Holitna. However, activity statewide has increased dramatically to 81,600 acres. The bulk of this activity, 76,400 acres (93.6 percent of total acreage), fell within the Yukon Flats National Wildlife Refuge between Fort Yukon and Stevens Village. Another 3,500 acres were mapped along the Kantishna River approximately 10 miles east of Lake Minchumina. Small centers of activity were noted on the Koyukuk River between Hughes and Allakaket, along the Toklat River 50 miles west of Healy, and along the Anvik River just west of the village of Anvik. Historically it has been difficult to predict the outcome of willow leaf miner outbreaks. Though never quantified, considerable willow mortality had been noted in the Yukon Flats NWR following five years of heavy leaf mining activity during the 1990s. Currently affected areas will be reflowed during 2005 surveys to monitor and reassess outbreak status.

Noctuid Defoliator

Sunira verberata (Smith)

For the second consecutive year, heavy defoliation of birch, alder, and willow occurred on more than 6,900 acres in southwest Alaska. The casual agent has been identified as a noctuid moth, *S. verberata*. Defoliation levels increased in intensity and extent in 2004 no doubt due to the record warm 2004 summer experienced throughout Alaska. More than 5,700 acres of defoliation occurred along the north shore of Lake Grosvenor in Katmai National Park. The remainder of the defoliation occurred north of Dillingham on the north side of Lake.

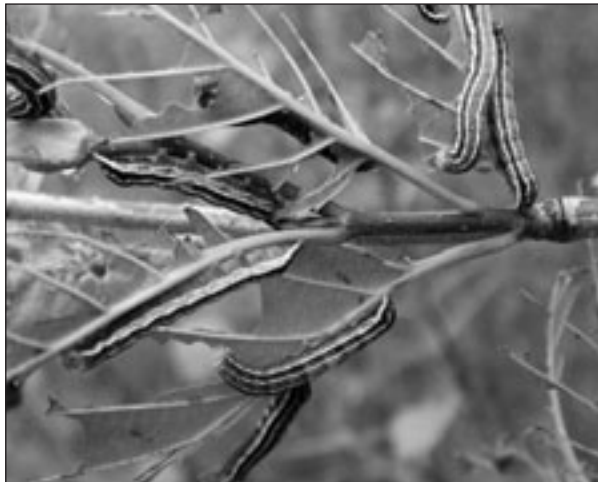


Figure 11. *The Noctuid defoliator caused heavy defoliation on multiple hardwood species.*

Alder Defoliation

Defoliation of alder was noted throughout the south-central region totaling 10,155 acres, but was especially intense in riparian areas surrounding the lower Knik River near Anchorage and Palmer and the lower Kenai and Snow Rivers north of Seward. This defoliation is caused by a suite of insects such as rusty tussock moth *Orgyia antiqua* (L.) and alder wooly sawfly *Eriocampa ovata* (L.) (refer also to Invasive Pests section). Although not considered an economically important species, alder is an important shrub species in some areas, most notably thin-leaf alder (*Alnus tenuifolia*) in riparian areas and red alder (*A. rubra*) on sun-exposed slopes. Defoliation of alder usually results in minor growth reduction and occasional branch dieback. However, heavy defoliation over a period of years in conjunction with drought conditions has the potential of causing heavy mortality in areas of high water stress. Alder is a major nitrogen fixer and nurse species for other plants (e.g., spruce) over the successional continuum; it is also an



Figure 12. *This alder branch is suffering partly from insect feeding but mostly from drought stress.*

important pioneer species, stabilizing soil on eroded slopes and other disturbed sites throughout Alaska.

2004 weather conditions in south-central and interior Alaska were unusual, with hot and dry conditions prevailing much of the year. Although a good snow pack stayed through the winter, spring “break-up” was atypical in that the underlying soil was thawed enough to absorb the snowmelt rather than keeping it on the surface. These conditions are favorable for elevated insect population build-ups. Precipitation was lacking through the summer months with record high temperatures recorded in the Anchorage Bowl and Mat-Su Valley. The resulting water stress was evident especially in native hardwoods and shrubs. Alder, especially the riparian thin-leaf alder, was strongly affected.

Status of Diseases



Tomentosus Root Disease, page 50



Alder Canker symptoms, page 44



Hemlock Dwarf Mistletoe, page 40



Ecological role of Disease, page 38



Canker symptoms of Sitka Spruce, page 47

Status of Diseases

Ecological Roles of Forest Diseases

The economic impacts of forest diseases in Alaska have long been recognized. In southeast Alaska, heart rot fungi cause substantial cull of nearly one-third of the volume of live trees in old-growth hemlock–spruce forests. In the south-central and interior regions, substantial cull from decay fungi also occurs in white spruce, paper birch, and aspen forests. Traditionally, management goals sought to eliminate or reduce disease to minimal levels in an effort to maximize timber outputs. As forest management goals broaden to include enhancement of multiple resources and retaining structural and biological diversity, forest disease management can also be assessed from an ecological perspective.

Figure 13. *Decay fungi play vital roles in recycling nutrients, producing habitat, and causing small-scale disturbance.*



Diseases can play key ecological roles in the development and sustainability of Alaskan forest ecosystems. They enhance biological diversity, provide wildlife habitat, and alter forest structure, composition, and succession. As agents of disturbance in the western hemlock–Sitka spruce forests of southeast Alaska, diseases apparently contribute to the “breaking up” of even-aged stands as they are in transition (i.e., 150 to

200 years old) to old-growth phase. Diseases appear to be among the primary factors that maintain stability in the old-growth phase through small-scale (canopy-gap) level disturbance. Heart rot of live trees causes large, old trees to collapse and fall to the ground, creating a canopy opening for the emergence of previously suppressed trees. Less is known about the ecological role of diseases in south-central and interior forests, however diseases appear to be agents of small-scale disturbance altering ecological processes in spruce and hardwood stands.

Forest practices can be used to alter the incidence of diseases to meet management objectives. Two of the principal types of conifer disease that influence forest structure in Alaska, heart rot and dwarf mistletoe, can be managed to predictable levels. Both diseases are associated with older forests. If reducing disease to minimal levels is a management objective, then both heart rot and mistletoe can be largely eliminated through clearcut harvesting and even-aged management. However, to reduce disease to minimal levels in all instances is to diminish the various desirable characteristics of forest structure and ecosystem functions that they influence. Research indicates that various silvicultural techniques can be used to retain structural and biological diversity by manipulating these diseases to desired levels. Since heart rot in coastal stands is associated with natural bole scars and top breakage, levels of heart rot can be manipulated by controlling the incidence of bole wounding and top breakage during stand entries for timber removal. Levels of dwarf mistletoe can be manipulated through the distribution, size, and infection levels of residual trees that

remain after harvest. Our ongoing research indicates that the incidence and effects of these diseases will vary through time in a predictable manner by whatever silvicultural strategy is adopted.

Research is currently underway in south-central and interior Alaska to assess the economic and ecological impacts of root diseases. Root diseases are difficult to detect, remain active on site in trees and stumps for decades, infect multiple age classes, and cause substantial volume loss. Ecologically, root diseases create canopy gaps that contribute to biodiversity, provide wildlife habitat, and alter succession processes. Elimination of root rot from an infected site is challenging because the diseased material is primarily located in buried root systems. Establishment of nonhost material within root rot centers is an effective option for manipulating levels of root disease. Ongoing research on the relationship between species composition and root disease incidence in south-central and interior Alaska will provide important information to forest managers for both ecological and economic considerations for disease management.

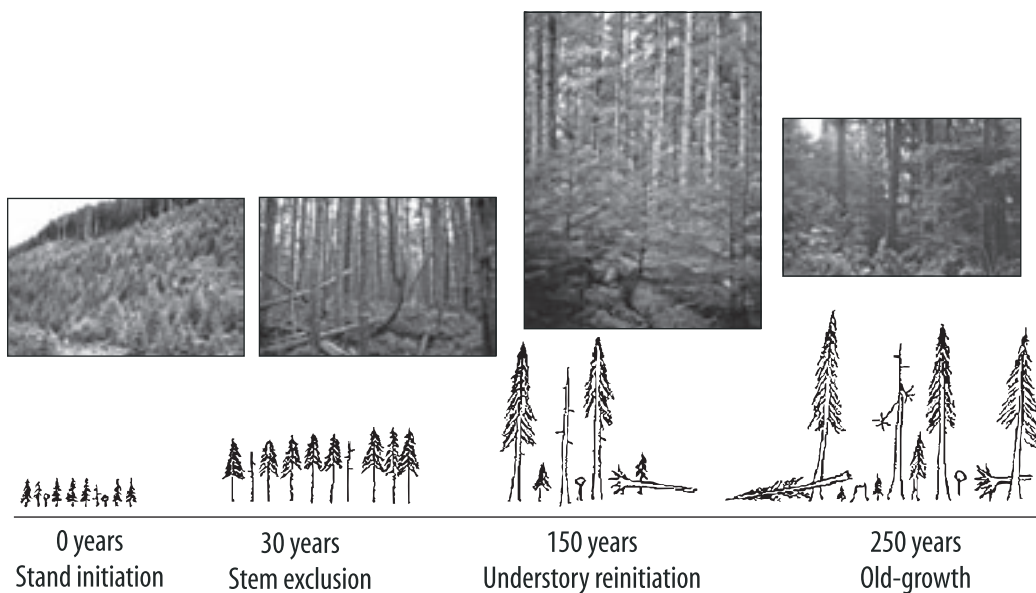


Figure 14. Stages of stand development and associated forms of tree mortality following catastrophic disturbance (e.g., clearcut or storm). Competition causes most mortality in young stands and trees usually die standing. Disease in the form of heart rot plays an active role in small-scale disturbance in the third, transitional stage and then is a constant factor in the maintenance of the old-growth stage. The time scale that corresponds to stages of stand development varies by site productivity. Many old-growth structures and conditions may be present by 250 years on some sites in Southeast Alaska. The old-growth stage may persist for very long periods of time in protected landscape positions.

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

Disease	Structure	Ecological Function Altered		
		Composition	Succession	Wildlife Habitat
Stem Diseases				
Dwarf mistletoe	●	▶	▶	●
Hemlock cankers	○	▶	○	▶
Hardwood cankers	▶	▶	▶	○
Spruce broom rust	▶	○	○	●
Hemlock bole fluting	○	○	○	▶
Western gall rust	○	○	○	○
Heart Rot				
(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 of disorder are qualified as:
negligible or minor effect = ○
some effect = ▶
dominant effect = ●.

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. The incidence of dwarf mistletoe varies in old-growth hemlock stands from stands in which every mature western hemlock is severely infected to other stands in which the parasite is absent. 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 uncommon and infection of mountain hemlock is rare. The disease is uncommon on any host above elevations of approximately 1,000 feet. Heavily infected western hemlock trees have branch proliferations “witches’ brooms,” bole deformities, reduced height and radial growth, less desirable wood characteristics, greater likelihood of heart rot, top-kill,

and death. We have found the aggressive heart rot fungus, *Phellinus hartigii*, 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



Figure 15. This tree has multiple “brooms” (growth deformation) caused by mistletoe.

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 “clear cutting” 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.

Spruce Broom Rust

***Chrysomyxa arctostaphyli* Diet.**

Broom rust is common on spruce throughout south-central and interior Alaska, but is found in only several local areas of southeast Alaska (e.g., Halleck Harbor area of Kuiu Island and Glacier Bay). The disease is abundant where spruce grows near the alternate host, bearberry or kinnikinnick (*Arctostaphylos uva-ursi*). The fungus cannot complete its life cycle unless both hosts (spruce and bearberry) are present.

Infections by the rust fungus result in dense clusters of branches or witches' brooms on white, Lutz, Sitka, and black spruce. 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 cause slowed growth of spruce, and witches' brooms may serve as entrance courts for heart rot fungi, including *Phellinus pini*.

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. The disease was common throughout the distribution of pine in Alaska in 2004. 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 the rust fungus galls this year. The combination of the rust fungus and *N. macrospora* frequently caused top-kill. The disease, although abundant, does not appear to have a major ecological effect in Alaskan forests.

Heart Rots of Conifers

Various species

Heart rot decay causes enormous loss of wood volume in all major tree species in Alaskan forests. In south-central and interior Alaska heart rot fungi cause considerable volume loss in mature white spruce and hardwood forests. 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.

In the boreal forests, large-scale disturbance agents, including wild-fire, 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.



Figure 16. *Borealis conk* on the end of a conifer log.

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. 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, has associated bacteria that fix nitrogen, and contributes large masses of stable structures (e.g., partially modified lignin) to the humus layer of soils.

The importance of decay fungi in managed young-growth conifer stands is less certain. Wounds on live trees caused by logging activities permit for the potential of decay fungi to 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 recycle carbon. However, sap rot decay also routinely and quickly develops in spruce trees attacked by spruce beetles. Significant volume loss from sap rot fungi typically occurs several years after tree death. Large amounts of potentially recoverable timber volume are lost annually due to sap rot fungi on the Kenai Peninsula. The most common sap rot fungus associated with spruce beetle-caused mortality is *Fomitopsis pinicola*, the red belt fungus.

A deterioration study of beetle-killed trees was initiated on the Kenai Peninsula in 2002 to assess the rate at which beetle-killed trees decompose. This information is critical for the future planning of salvage, fire risk, and impacts on soil fertility and wildlife habitat. A preliminary report of this study will be available in spring 2005.

Table 4. Common wood decay fungi on live trees in Alaska

Heart and butt rot fungi*	Tree Species Infected				
	Western hemlock	Sitka spruce	Western redcedar	White/Lutz spruce	Mountain hemlock
<i>Laetiporus sulphureus</i>	x	x		x	x
<i>Phaeolus schweinitzii</i>	x	x		x	
<i>Fomitopsis pinicola</i>	x	x		x	x
<i>Phellinus hartigii</i>	x				
<i>Phellinus pini</i>	x	x		x	x
<i>Ganoderma</i> spp.	x	x		x	
<i>Coniophora</i> spp.				x	x
<i>Armillaria</i> spp.	x	x	x	x	x
<i>Inonotus tomentosus</i>				x	
<i>Heterobasidion annosum</i>	x	x			
<i>Ceriporiopsis rivulosa</i>			x		
<i>Phellinus weirii</i>			x		
<i>Echinodontium tinctorium</i>					x

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

Stem Decay of Hardwoods

Stem decay causes substantial volume loss and reduced wood quality in Alaskan hardwood species. In south-central and interior Alaska, incidence of stem decay fungi increases as stands age. Research indicates that 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 provide an entrance court for wound decay fungi. Decay fungi will limit harvest rotation age of forests that are managed for wood production purposes.

Figure 17. A relatively young *Phellinus igniarius* conk on paper birch.



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 south-central and interior Alaska the following fungi are the primary cause of wood decay in live trees:

Paper birch

Phellinus igniarius
Inonotus obliquus
Pholiota sp.
Armillaria sp.

Trembling aspen

Phellinus tremulae
Pholiota sp.
Ganoderma applanatum
Armillaria sp.

Other fungi cause minor amounts of decay in birch and aspen. Many fungi cause stem decay in balsam poplar, black cottonwood, and other hardwood species in Alaska.

Shoot Blights and Cankers

Alder Canker

Unidentified fungi, *Cytospora* group

For the second year individual stems within clumps of thin-leaf alder (*Alnus tenuifolia*) were killed by one or more unidentified canker fungi. One canker-causing fungi was tentatively identified as *Ophiovalsa suffusa* (*Cytospora* group) in 2003, however, the pathogenicity of *O. suffusa* is in question because the fungus is considered ubiquitous on alder branches. In 2004, ground surveys indicated that the infection was intensifying and that Sitka alder (*Alnus crispa*) was also a suitable host. Even though few alder clumps have completely died, the canker continues to spread within clumps, killing individual stems across thousands of acres in south-central and interior Alaska. Mortality is not detectable by aer-

ial surveys, therefore ground surveys and permanent plots are used to detect and quantify alder mortality.

Mortality of alder is not typically considered a problem; however, continued extensive mortality of a specific riparian alder species might have important long-term ecological consequences. Anecdotal observations suggest the pathogen(s) have been active in stressed alder trees in the Mat-Su Valley since 2000, but only caused noticeable mortality since 2003. All age classes of thin-leaf alder appear to be susceptible, but the canker fungus appears to attack only severely stressed trees. Stress factors seem to include a suite of defoliating insects and drought. A canker on alder was reported from Alaska in the 1950s, indicating that this fungus may be native. Sample comparison between the initial (1950s) canker and the currently reported canker will confirm if the two cankers are indeed caused by the same fungus. Further studies of the biology, ecology, and impacts of this fungus are planned for 2005. Meanwhile, mortality of thin-leaf alder by the alder canker is expected as drought conditions and heavy insect defoliation continues to affect alder.



Figure 18. Internal damage from “alder canker” is exposed.

Sirococcus Shoot Blight

***Sirococcus conigenus* (D.C.) P.F. Cannon & Minter**

The shoots of young western hemlock were killed in moderate levels by the *Sirococcus conigenus* in southeast Alaska during 2004. Mountain hemlock appears to be more susceptible to this pathogen than western hemlock. Several small mountain hemlock trees were found attacked severely in 2003. A few of these trees were attacked again in 2004 and were so defoliated that they died. A fungal specimen from a small mountain hemlock in Juneau was sent to pathology colleagues in Wisconsin as part of a study on the taxonomy of North American *Sirococcus* species. There is evidence that the *Sirococcus* affecting hemlock in southeast Alaska is morphologically and genetically distinct from the *Sirococcus* affecting pine throughout much of North America. Subsequent results indicate the old name, *S. strobilinus* has been judged to be improper. The species present in Alaska is the “T group” of *S. conigenus*, which will eventually be described as a new species, with the type specimen coming from the Juneau collection.

Thinning may be of some value in reducing damage by the fungus as thinned stands have fewer infections than unthinned stands. Ornamental trees can be protected by the application of fungicides in the spring just after bud break when the pathogen produces its infectious spores. This disease is typically of minimal ecological consequence as infected trees are not often killed and young hemlock stands are usually densely stocked. However, species composition in a given area may be altered to some degree where other trees may be favored by the disease.

Shoot Blight of Yellow-cedar

Apostrasseria sp.

The shoot blight fungus *Apostrasseria* sp. in southeast Alaska infected yellow-cedar regeneration in 2004. The disease does not affect mature cedar trees, however. Attack by the fungus causes terminal and lateral shoots to be killed back 10 to 20 cm on seedlings and saplings during winter or early spring. Entire seedlings up to 0.5 m 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. The severe late spring frosts in both 2002 and 2003 affected so many small yellow-cedar trees that new cases of shoot blight were difficult to detect this year.

The fungus *Herpotrichia juniperi* is often found as a secondary invader on seedling tissues that die from any of these causes. This shoot blight disease probably has more ecological impact than similar diseases on other host species because by killing the leaders of yellow-cedar seedlings and diminishing their ability to compete with other vegetation, the pathogen reduces the regeneration success of yellow-cedar and thereby alters species composition.

Canker Fungi of Birch and Aspen

Cryptosphaeria populina (Pers.) Sacc.

Cenangium singulare (Rehm.) D. & Cash

Ceratocystis fimbriata Ell. & Halst.

Cytospora chrysosperma Pers. ex Fr.

Nectria galligena Bres.

All the canker-causing fungi of paper birch and aspen were at endemic levels in 2004.

Figure 19. *N. galligena* causes “target” cankers particularly on paper birch.



These fungi cause perennial stem deforming cankers and wood decay of many hardwood species, particularly trembling aspen, in south-central and interior Alaska. Although most are considered weak parasites, *C. singulare* can girdle and kill a tree in three to ten years. *N. galligena* causes perennial “target” cankers particularly on paper birch. A low incidence of wood decay is associated with infection by this canker fungus. *Cytospora* sp., probably *chrysosperma*, is also associated with the willow bark beetle, *Trypophloeus striatulus* (Mann.), in dying stems of feltleaf willow, *Salix alaxensis* wherever it occurs throughout the Interior, rivers draining the north slope of the Brooks Range, and rivers draining into Norton Sound and Kotzebue Sound. Ecologically, canker fungi alter stand structure, composition, and successional patterns through trunk deformity and bole breakage.

Hemlock Canker

Unknown fungus

The hemlock canker disease subsided in 2004, although the outbreak from the previous several years was still evident as dead stems and branches persisted in several areas in southeast Alaska. The most recent outbreak was especially noticeable in young forests on Prince of Wales Island and Etolin Island. One notable outbreak was in thinned, young western hemlock crop trees near Polk Inlet that were subsequently killed. In past out-

breaks, the disease has been common along unpaved roads and roadless areas on Prince of Wales Island, Kuiu Island (Rowan Bay road system), Chichagof Island (Corner Bay road system), and near Carroll Inlet on Revillagigedo Island. 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.

Canker of Sitka Spruce

Unknown fungus.

Branch dieback was noted on several mature Sitka spruce trees in the Juneau area during late summer, 2004. Close inspection revealed spherical or elongated galls with callus tissue in proximal positions on each dead branch. This may be the same unidentified canker that has been sporadically infecting Sitka spruce in the Haines area. No fungal fruiting bodies were found on spruce in Juneau. Inspection should be conducted in spring, when canker fungi tend to sporulate.

Foliar Diseases

Spruce Needle Rust

Chrysomyxa ledicola Lagerh.

Chrysomyxa weirii Jacks.

Spruce needle rust, caused by *C. ledicola*, occurred at low levels across the State in 2004, except for a large outbreak on the Kenai Peninsula and near Iliamna Lake. The disease can be found wherever spruce and Labrador tea coexist on wet, peatland soils. With missing needles caused by outbreaks in the last few years, spruce trees appear thin. Infection levels were quite low the last two years, however, and these trees are now acquiring a fuller crown.

The spores that infect spruce needles are produced on the alternate host, Labrador tea (*Ledum* spp.), a plant that is common in peatland areas. Although the disease can give spruce trees the appearance of being nearly dead, trees rarely die of this disease even in years of intense infection. The primary ecological consequence of the disease to Sitka spruce may be to reduce tree vigor of a species already poorly adapted to peatland sites.

The foliar rust fungus *C. weirii* was found to be abundantly sporulating on one-year-old Sitka spruce needles in several areas of southeast Alaska during spring of 2004. Unlike most other rust fungi, no alternate host is necessary to complete its life cycle. Little ecological or economic impact results from this disease, as infection levels never reach close to 100 percent on an age class of needles, however, repeated infection of spruce might alter forest composition by favoring other tree species.

Hemlock Needle Rust

Pucciniastrum vaccinii (Rab.) Joerst.

Hemlock needle rust was found at low endemic levels in 2004. The last year of high levels of this disease was in 1996, when the disease was most damaging near Yakutat. There, it caused defoliation of western hemlock, especially on trees growing adjacent to harvested sites. Elsewhere, infected needles were found, but hemlock trees were not heavily defoliated. The alternate hosts for the rust fungus include several blueberry (*Vaccinium*) species, which are extremely abundant in most forests and therefore would not be limiting the suc-

cess of the disease. Infection levels usually return to endemic levels in about a year, and it is not expected to effect major ecological change.

Foliar Diseases of Cedars

Gymnosporangium nootkatense Arth.
Didymascella thujina (Durand) Maire

Two fungi that infect the foliage of cedar, *G. nootkatense* on yellow-cedar and *D. thujina* on western redcedar, occurred at endemic levels this year. *G. nootkatense* was found at the very northwest limits of the natural range of yellow-cedar in Prince William Sound several years ago. *D. thujina* was the more damaging of the two fungi and was common wherever its host was found. Homeowners sometimes complain about *D. thujina* because infection can be severe enough to alter the general appearance of ornamental redcedar trees. Neither fungus results in severe defoliation or death of cedar trees, nor has major ecological effects.

Flagging was particularly visible this year, perhaps due to the warm, dry summer. Flagging of older foliage on western redcedar is a normal phenomenon that sometimes causes concern because it appears suddenly in late summer. This phenomenon is not caused by any disease agent, and appears to be how western redcedar normally discards older foliage.

Spruce Needle Blights

Lirula macrospora (Hartig) Darker
Lophodermium picea (Fuckel) Hhn.
Rhizosphaera pini (Corda) Maubl.



Figure 20. Spruce needle blight, *Lirula macrospora*, on Sitka spruce. The fruiting bodies can be seen on the underside of individual needles.

All of these needle diseases occurred across the state at low to moderate levels in 2004. The fungus *L. macrospora* is the most important needle pathogen of spruce. Severely infected trees were found in a few areas, but they were not common. *L. picea* was present at low levels in 2004. This disease is typical of larger, older trees of all spruce species in Alaska. *R. pini* continued at endemic levels after causing damage several years ago along the coast. The dead older needles closely resemble damage caused by spruce needle aphid. Microscopic observation of the tiny fruiting bodies erupting from stomata on infected needles is necessary for proper identification.

The primary impact of these needle diseases is generally one of appearance. They can cause severe discoloration or thinning of crowns but typically have negligible ecological consequences. However, repeated heavy infections may slow the growth of spruce and benefit neighboring trees, thereby altering species composition to some degree.

Pine Needle Blight

Lophodermium seditiosum (Min., Sta.& Mill.)

In previous years, the fungus *Lophodermium seditiosum* was found infecting native shore pine that had been planted as ornamentals in the Juneau area, but was not noticeable in 2004. Some of the trees that were significantly defoliated are now dead. This disease will be monitored over the next few years.

Root Diseases

Three important tree root diseases occur in Alaska: tomentosus root rot; annosus root disease, and armillaria root disease. The laminated root disease caused by a form of the fungus *Phellinus weirii*, so 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 in western redcedar, contributing to the very high defect levels in this tree species.

Although relatively common in Alaskan forests, root diseases are often misdiagnosed or overlooked. Diagnosing root disease can be challenging because the infected tissue is primarily below ground in roots, and infected trees may lack above ground symptoms or express symptoms easily confused with other problems. Identification of a root disease should not be made solely on the basis of crown symptoms. Above ground symptoms, such as chlorotic foliage, stress cone crop, and reduced branch growth can be caused by a wide array of stress factors other than root diseases.

Root disease pathogens affect groups of trees in progressively expanding disease centers. Typically, disease pockets contain dead trees in the center, and living but infected trees in various stages of decline at the edges. Root disease fungi spread most efficiently through root contacts. Infected trees 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 diseases 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.

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 stands indicate that *Armillaria* sp. can colonize stumps, but will not successfully attack adjacent trees. *Armillaria* may be an important agent in the death and decay of red alder. A few red alder trees were found apparently killed by *Armillaria* in 45-year old mixed hardwood-conifer for-

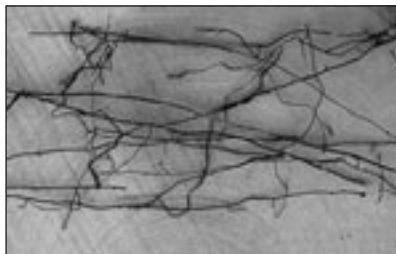


Figure 21. The black rhizomorphs, found under the bark of dead or dying trees, have a shoestring-like appearance.

ests in the Maybeso Valley of Prince of Wales Island. Many more affected red alders were found in a 100+ year-old mixed forests on Baranof Island and Chichagof Island, indicating that the disease may be important in the senescence of alder as these stands age.

Several species of *Armillaria* occur in south-central and interior Alaska where some attack conifers while others attack hardwoods. Most species appear to be weak pathogens invading trees under some form of stress. Research is currently underway to determine the species present and their impacts in the boreal forests.

Tomentosus Root Disease

***Inonotus tomentosus* (Fr.) Teng.**

Inonotus tomentosus causes root and butt-rot of white, Lutz, Sitka, and black spruce. The fungus may also attack lodgepole pine and tamarack, but not hardwood trees. The disease appears to be widespread across the native range of spruce in south-central and interior Alaska, but until 2004 has never been reported from southeast Alaska. For the first time tomentosus root rot was reportedly found in southeast Alaska, infecting Sitka spruce near Dyea. Since this is the first report, continued surveys and identification of conks will continue in 2005 to confirm the presence of tomentosus root rot in southeast Alaska.

Spruce trees of all ages are susceptible to infection through contact with infected roots. Infected trees exhibit growth reduction or mortality, depending on age. Younger trees may be killed outright while older trees may persist in a deteriorating condition for many years. Trees with extensive root and butt decay are prone to uprooting and bole breakage. Volume loss in the butt log of older infected trees can be substantial, up to one-third of the gross volume. Individual mortality centers (groups of infected trees) are typically small; however, coalescing centers can occupy large areas.

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I. 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 of 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 of white and Lutz 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.

Tomentosus root disease can be managed in a variety of ways depending on management objectives. Options include: establishment of nonsusceptible species in root rot centers (i.e., hardwood trees), avoid planting susceptible species within close proximity of diseased stumps, and removal of diseased stumps and root systems. Pre- and postharvest walk-through surveys in managed stands can be used to stratify the area by disease incidence. Research is currently underway to assess mortality in young growth stands and to determine site factors that influence disease incidence and severity.

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 methods. *H. annosum* has not yet been documented in south-central or interior Alaska.

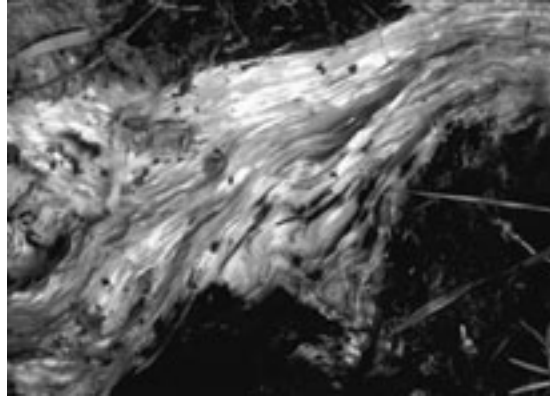


Figure 22. Wood decay caused by *Annosus* (photo by John Schwandt, Forestry Images).

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.

Status of Exotic Invasive Organisms



Canada Thistle, page 61



Orange Hawkweed, page 63



Common Tansy, page 65



Ornamental Jewelweed, page 59



Invasive Knotweeds, page 59



Birch Leaf Miner, page 68



Fire Blight, page 75



Uglynest Caterpillar, page 72



Woodboring Beetle, page 67



Gypsy Moth page 72

Status of Exotic Invasive Organisms

Invasive plants, insects and diseases have gained increased publicity both nationally and within Alaska. Sudden oak death (disease) nation-wide, gypsy moths (insects) in the east and midwest, and spotted knapweed (plants) in the interior west are all rapidly becoming well known across the country. Invasive pests (introduced nonindigenous plants, animals, insects, and microbes) are among the most serious threats to biological diversity in Alaska; although, to date, few invasive pests have been introduced and established in Alaska. Of concern are the movement of organisms from the continental U.S., Canada, and the Russian Far East into Alaska in light of climate change and increased commerce. Likewise, the movement of native insects and pathogens from one area to another is also problematic. As the arctic regions are warming most rapidly with global climate change, there is an increased probability that organisms accidentally introduced into Alaska will become established. Once established, invasive pest populations can become difficult to control and manage since the complement of parasites and predators that normally control their numbers are at low levels, or absent.

It is inevitable that we are going to see more and more introduced pests “invading” both rural and urban forest areas of Alaska. If pest introductions are left to “run their course” or if we are not prepared to expend the efforts to safeguard our ecosystems, Alaska will be poorer in terms of resources and biological diversity. For example, without eradication efforts, many invasive insects could inadvertently become a dominant influence affecting native species of both pest and nonpest insect populations. The ability of many introduced pests to out-compete or displace the native species will complicate Integrated Pest Management (IPM) efforts already in place. USDA Animal & Plant Health Inspection Service (APHIS), the State of Alaska Divisions of Agriculture and Forestry (AKDOF), University of Alaska Cooperative Extension Service (CES), and the USDA Forest Service, Forest Health Protection already have programs in place to monitor and detect potential insect or plant introductions. Alaska residents, resource professionals, and land managers all need to play a role in early detection of new introduced species. Contact CES, APHIS, or AKDOF if new invasive species are detected. If introduced pests are positively and quickly identified, the probability of successful eradication or IPM control efforts is increased.

This section of the Conditions Report highlights those invasive plants, insects and diseases that most directly impact forests of Alaska to date. This section does not cover invasive exotic animals such as northern pike, rats, mud snails, slugs etc. Contact the Alaska Department of Fish and Game for further information on these invasive animals.

Invasive Plants

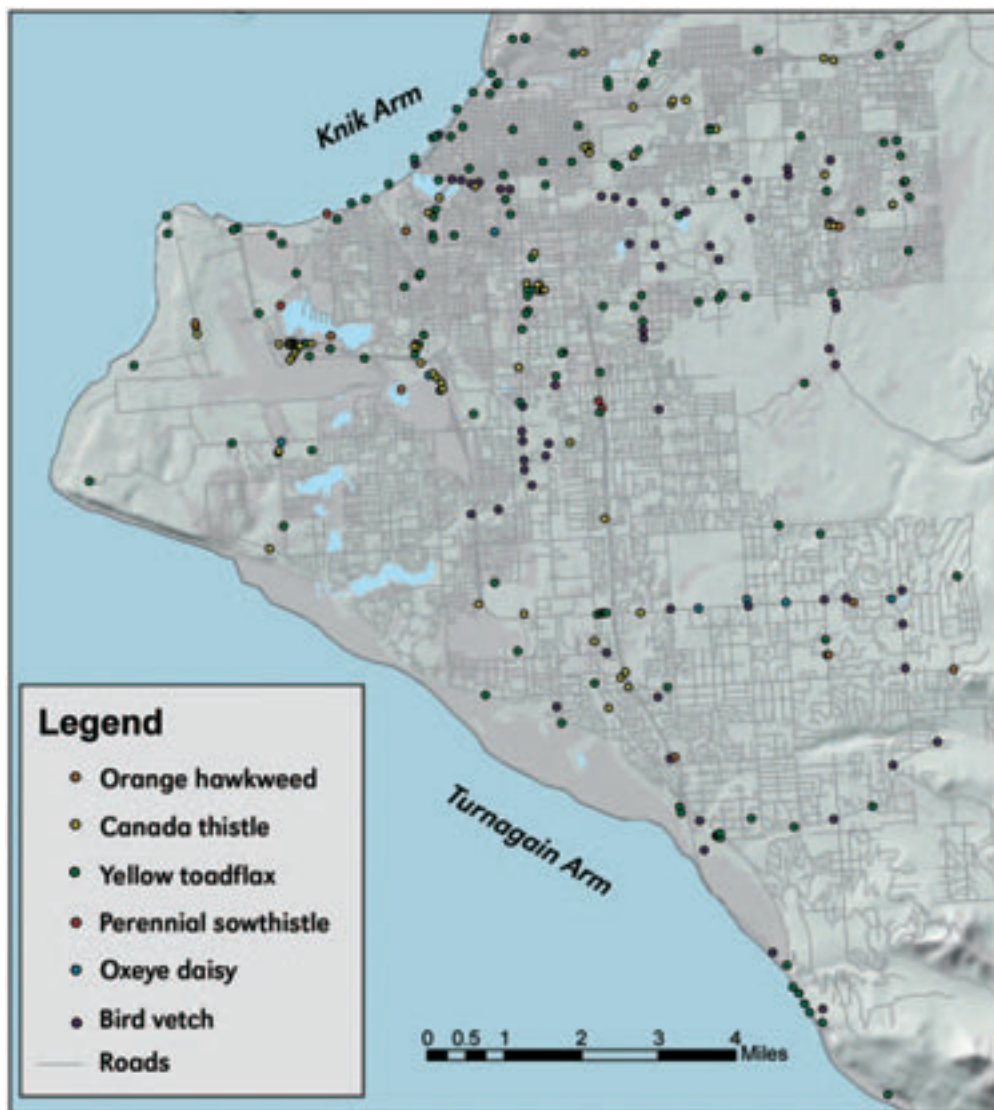
Although Alaska is still in the early stages of invasive plant detection and management, it has become clear that the state is no longer beyond the reach of the invasive plants that have caused extensive economic losses and environmental degradation throughout the Lower 48 States and Canada. The number of newly-detected invasive plant species in Alaska, and the expansion of already-established infestations have continued to increase in 2004. The Forest Health Protection Program has responded with a number of initiatives, aimed at developing and strengthening prevention through public awareness, early detection of incipient populations, and rapid response (rapid treatment of high-priority infestations). Within each of these initiatives, working partnerships have been formed with

agencies and organizations at the local, state, and federal levels, in an effort to respond to the problem before invasive plants become costly to control and impossible to eradicate in Alaska.

Prevention activities, in collaboration with the UAF Cooperative Extension Service, have continued to emphasize public awareness. Several new invasive plant publications and on-line resources have been generated, including two sets of voluntary guidelines for reducing the spread of invasive plants in Alaska, and a full-color weed booklet covering 24 of the species of greatest concern statewide. Community weed pulls, workshops, presentations, and informational materials distribution at public events were also an important component of our education and outreach efforts.

Invasive plant inventory work took place around the state, with the most intensive sampling focused on the western Kenai Peninsula, the Mat-Su Valley region, and several of Alaska's National Parks. The statewide AKEPIC (Alaska Exotic Plants Information

Map 7. Surveyed locations for six selected invasive plants in Anchorage, Alaska.



Source: Alaska Exotic Plants Information Clearinghouse (AKEPIC) <http://akweeds.uaa.alaska.edu/>

Table 5. Plant invasiveness ranking: of the 50 plant species ranked in 2004, species ranked 60 points or higher in the Weed Risk Assessment System for Alaska.

Common Name	Scientific Name	Family	Location ¹	Invasiveness ranking ²	Acres infested ³
Eurasian watermilfoil, Spike watermilfoil	<i>Myriophyllum spicatum</i>	Haloragaceae	N	89	NI
Spotted knapweed	<i>Centaurea biebersteinii</i>	Asteraceae	SE, A	88	T
Invasive knotweeds	<i>Polygonum cuspidatum</i> , <i>P. x bohémica</i> , <i>P. sachalinense</i>	Polygonaceae	SE	84	L
Reed canarygrass	<i>Phalaris arundinacea</i>	Poaceae	All	83	M
Ornamental jewelweed, Policeman's helmet	<i>Impatiens glandulifera</i>	Balsaminaceae	SE	82	T
White sweetclover	<i>Melilotus alba</i>	Fabaceae	All	80	H
Cheatgrass	<i>Bromus tectorum</i>	Poaceae	All	78	T
Purple loosestrife & European wand loosestrife	<i>Lythrum salicaria</i> & <i>L. virgatum</i>	Lythraceae	N	78	P
Canada thistle	<i>Cirsium arvense</i>	Asteraceae	All	76	L
Bird vetch	<i>Vicia cracca</i>	Fabaceae	FD, MS, A, K	75	H
Orange hawkweed	<i>Hieracium aurantiacum</i>	Asteraceae	SE, K, A, MS	71	L
Garlic mustard	<i>Alliaria petiolata</i>	Brassicaceae	SE	70	T
Scotchbroom	<i>Cytisus scoparius</i>	Fabaceae	SE	69	T
Tatarian honeysuckle	<i>Lonicera tatarica</i>	Caprifoliaceae	FD	67	T
Yellow sweetclover	<i>Melilotus officinalis</i>	Fabaceae	All	65	L
Siberian peashrub	<i>Caragana arborescens</i>	Fabaceae	FD, A, MS	65	T
Common dandelion	<i>Taraxacum officinale</i>	Asteraceae	All	64	H
Butter and eggs, Yellow toadflax	<i>Linaria vulgaris</i>	Scrophulariaceae	All	63	L
Stinking Willie, Tansy	<i>Senecio jacobaea</i>	Asteraceae	SE, A	63	T
ragwort					
Foxtail barley	<i>Hordeum jubatum</i>	Poaceae	All	63	H
Smooth brome	<i>Bromus inermis</i> ssp. <i>inermis</i>	Poaceae	All	62	L
Oxeye daisy	<i>Leucanthemum vulgare</i>	Asteraceae	All	61	L
European bird cherry	<i>Prunus padus</i>	Rosaceae	FD, A	61	P
Bull thistle	<i>Cirsium vulgare</i>	Asteraceae	A, SE	60	T

¹Location: SE = Southeast, K = Kenai, A = Anchorage, MS = Matanuska-Susitna Valley, FD = Fairbanks/Delta, All = all areas, N = Not yet present or escaped in Alaska, but highly problematic in regions with climates similar to Alaska's

²Invasiveness ranking: Based on a scale of 1 to 100. Higher rankings indicate higher potential for invasiveness in Alaskan ecosystems

³Acres infested: All are estimates; NI = No information; P = Present but acreage unknown; T = Trace 0.1–50 acres; L = Low 50.1–300 acres; M = Medium 300.1–1,000 acres; H = High >1,000 acres.

Clearinghouse) database now contains almost 1,100 data points, taken at nearly 4,000 locations around the state, all accessible on-line. Non-Forest Service collaborators continuing to inventory and contribute data include the UAF Cooperative Extension Service, the UAA Natural Heritage Program, the Alaska Department of Natural Resources, the Bureau of Land Management, the U.S. Fish and Wildlife Service, the National Park Service, and the NRCS Soil and Water Conservation Districts.

In the case of many recently arrived invasive plant species, little is known about how they will behave in Alaskan climates. For example, spotted knapweed (*Centaurea biebersteinii*), which is notoriously problematic in the western Lower 48 states, has only recently arrived in Alaska. As Alaskans seek to establish invasive plant guidelines and management practices, there is great need for comprehensive, science-based information on which species have the greatest potential to become aggressive invaders. In cooperation with the UAA Natural Heritage Program, an Invasiveness Ranking System has been developed. Nearly 50 nonnative species have been researched and assigned an invasiveness ranking this year, through the Invasive Plant Ranking Project, with species assessments and summaries available on-line. Species with a ranking of 60 or higher are outlined in Table 5.

Using the NRCS Alaska Soil and Water Conservation Districts' existing infrastructure, Cooperative Weed Management Areas (CWMAs) are being created in order to address regionwide invasive plant problems across geopolitical boundaries. US Forest Service startup grants made possible the formation of three new CWMAs in 2004, in Fairbanks, Anchorage, and the Mat-Su region. Five CWMAs and 12 Soil and Water Conservation Districts can now submit proposals for federal funding through a Rapid Response Program. Proposals are evaluated by a multiagency committee, and funding is appropriated for immediate eradication and/or control of high-priority infestations.

The invasive plants section in this report focuses on the species of greatest concern in southeast Alaska. Based on information provided by the U.S. Forest Service, the UAF Cooperative Extension Service, and other participating organizations, the following species have been identified as posing the greatest threat to southeastern Alaska's ecosystems.

2004 Spotlight: Invasive Plants in Southeast Alaska

Due in part to limited human activity and development, southeast Alaska has so far largely escaped damage by invasive plant species prevalent in much of the other 49 states. The region was long thought to be immune to invasion by nonnative weed species due to its isolation, climate, and ecological exclusion by competition in intact native plant communities. However, in recent years a growing body of knowledge indicates that southeast Alaska may not be immune to the problem after all.

Over the past three years, Region 10 Forest Health Protection has spearheaded an effort to inventory nonnative plant species on Alaskan lands. Thousands of hours have been spent in an effort to begin cataloging alien plant species found in the area, as well as their distribution, extent, and rate of spread. The results of these surveys are tallied in the statewide database known as the Alaska Exotic Plant Species Information Clearinghouse (AKEPIC), a cooperative effort of federal, state, and nongovernmental organizations coordinated by the Alaska Region Forest Health Protection Program.

To date, recon surveys have been conducted in virtually all of the communities of southeast Alaska, and in a number of outlying points throughout the region. A total of 57 species have been cataloged at 969 sites. Survey efforts have focused on areas most likely to have invasive plants, but only represent a small fraction of the potential sites, however, the data begins to paint a picture of the overall situation. About half of these alien species are

thought to have potential for spread into native plant communities, and about a dozen are species of serious concern, either because of the behavior of existing infestations in Alaska, or because of severe problems they have caused in other parts of the continent.

Several of the species of concern are in the early stages of establishment and could be easily eradicated if action is taken soon. These include garlic mustard, tansy ragwort, bull thistle, spotted knapweed, and ornamental jewelweed. The following highlights 15 invasive plant species of particular concern in southeast Alaska!

Species of Concern

Ornamental Jewelweed

Impatiens glandulifera Royle

Ornamental jewelweed is a native of the Himalayan Mountains that is listed as a noxious weed in Washington and British Columbia, and is considered invasive in much of Europe. Also known as touch-me-not, or policeman's helmet, jewelweed explosively ejects seeds from mature pods up to 20 feet. Its unusual height and capability to reseed itself enable it to form dense stands and out-compete native vegetation. It is also known to produce large quantities of nectar, an advantage in competition for pollinators, possibly leading to decreased seed set by competing native plants.

In 2004 we found an acre-sized patch of jewelweed growing on the upper beach fringe in the city of Haines. The plants were growing in a naturally disturbed site normally occupied by native vegetation. The plants were found growing with Canada thistle and competing with the very aggressive, invasive reed canarygrass (*Phalaris arundinacea*).



Figure 23. Flower of ornamental jewelweed

Invasive knotweeds

Polygonum cuspidatum Sieb. & Zucc.

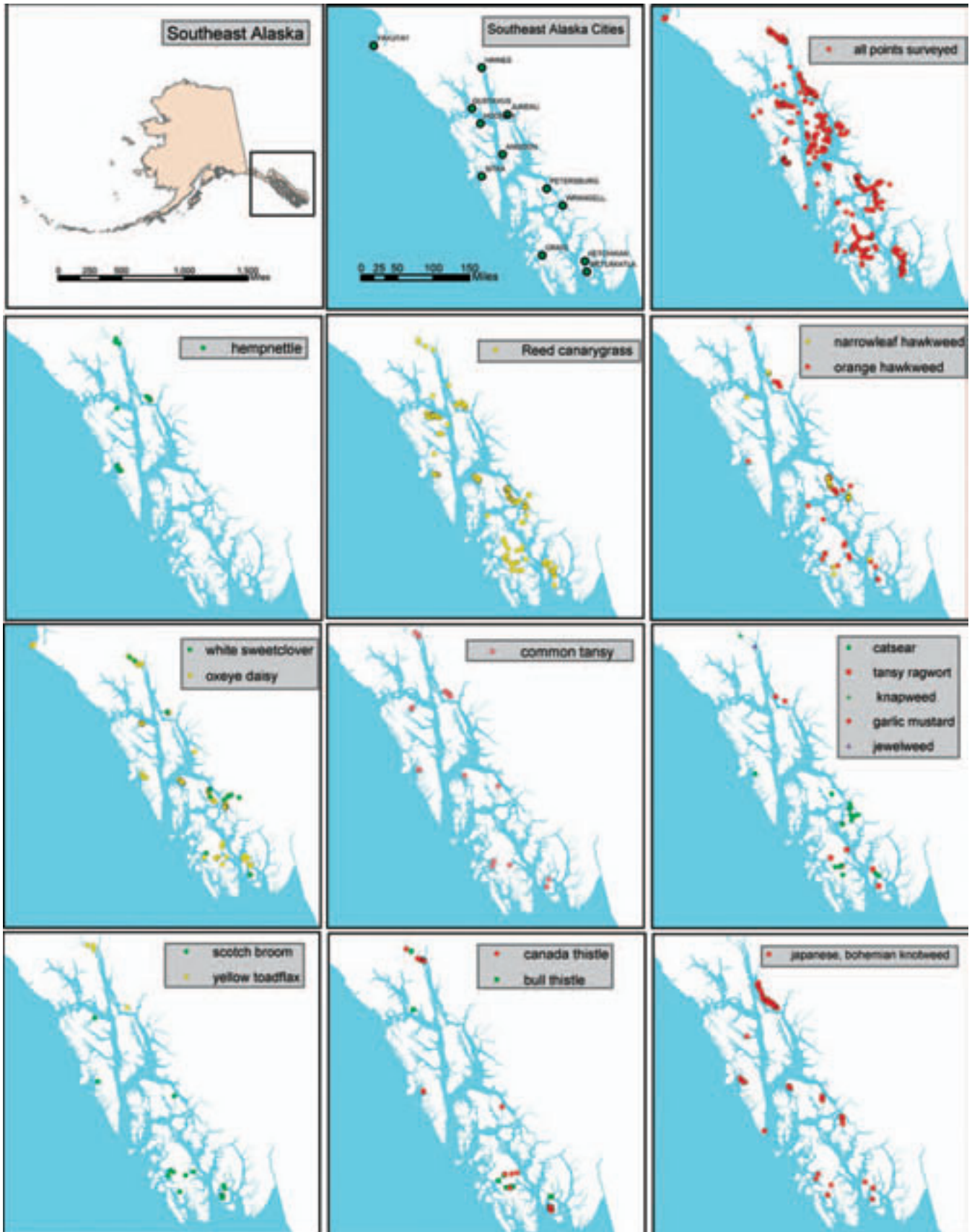
Polygonum x bohemicum (Chrtek & Chrtkova)

Polygonum sachalinense F. Schmidt ex Maxim.

Invasive knotweeds are some of the more prominent invasive plants in southeast Alaska. The invasive knotweeds are native to the Pacific Rim islands of Hokkaido and Sakhalin, the Kuriles, and the Kamchatka Peninsula. Forests of these areas are known for their aggressive canopy gap filling species. Knotweed's habit of growing in very thick stands with distinctive bamboo-like stems makes these plants very easy to spot.

Most likely, knotweeds were introduced as fast-growing hedge plants. In some places these species were apparently planted to stabilize steep slopes. Knotweeds are now widespread throughout the communities of southeast Alaska. Much of this spread is due to the moving of soil from one place to another during construction projects and road and ditch maintenance. Japanese knotweed has strong potential to become invasive in natural ecosystems. It has been encroaching into areas dominated by red alder in a number of locations around Juneau. Once established in riparian areas, knotweed infestations have the potential to

Map 8. Invasive weed locations in Southeast Alaska.



inhibit the regeneration of native streamside vegetation, simplifying forest structure and composition, and reducing the quality of terrestrial and aquatic wildlife habitats.

In 2004, Forest Health Protection personnel working with researchers from the Pacific Northwest Forest Science Laboratory discovered that contrary to previous assumption, the “Japanese” knotweeds around southeast Alaska are actually “Bohemian” knotweed, a hybrid of Japanese and giant knotweeds (*Polygonum x bohemica*). We also discovered that both knotweeds are producing fruit in Alaska. Knotweeds were long thought to only reproduce by vegetative means, but many workers in Washington and Oregon have observed seedlings of *P. x bohemica* and *P. cuspidatum* taking root in riparian habitats. This could have important implications for the management of knotweed in Alaska.



Figure 24.
Knotweed leaves and flowers.

Canada thistle

Cirsium arvense (L.)

A perennial originally from Eurasia, this species is now listed as noxious in over 35 states and Canadian provinces. This species has prickly stems and leaves, and produces prodigious amounts of seed from each plant. Recorded in Palmer as early as the 1940s, it is now spreading rapidly in Anchorage and Fairbanks. It is now being detected in various other locations around the state, and seems to be spreading via seed within the root balls of ornamental trees and shrubs.

In 2004 FHP workers became aware of the presence of established infestations of Canada thistle in the Haines Borough and on Prince of Wales Island. Canada thistle was introduced into Haines at least ten years ago. Today it is prevalent in yards and waste places throughout downtown Haines, and is beginning to spread into beach fringe areas outside of town. The beach fringe is a naturally disturbed habitat that is an important source of forage plants for bears and Sitka black-tail deer. This raises the alarming possibility of negative impacts by Canada thistle on this important habitat throughout the islands of southeast Alaska. Canada thistles were also discovered growing in a few isolated patches along highways on Prince of Wales Island. One straw bale used for erosion control on a construction site had numerous stems of Canada thistle growing out of it.

Bull thistle

Cirsium vulgare (Savi)

Bull thistle is a large-headed biennial with a short, fleshy taproot that reproduces only by seeds. Each plant produces up to 4,000 seeds in a growing season, which can be transported by wind. It can colonize areas in relatively undisturbed grasslands, meadows and forest openings, competing with native plants for water, nutrients, and space, often displacing them, and decreasing forage sites for grazing animals.

Small infestations of bull thistle have been located in Anchorage, Haines, Gustavus, Metlakatla, Ketchikan, and Prince of Wales Island. Many of these plants were hand pulled in the summer of 2004 by an emergency volunteer weed pull sponsored by the Craig Ranger District on Prince of Wales Island, and by FHP staff conducting weed surveys. Bull thistles are relatively uncommon, and due to their strong taproot, biennial lifecycle, and short seed bank longevity, represent an excellent opportunity for early detection and rapid response programs.

White Sweetclover

Melilotus alba Medikus

Figure 25. White sweetclover growing on gravel bar in the Nenana River.



White sweetclover is the most successful invader of undisturbed or naturally disturbed habitats in Alaska. Found in all 50 states and all Canadian provinces, sweetclover was most likely introduced into Alaska as a forage crop for livestock and nectar source for beekeepers. Sweetclover plants in Alaska have a biennial life cycle. This species produces up to 350,000 seeds per plant, which are viable for over 80 years in soil and are dispersed by water. Its ability to fix nitrogen leads to alteration of the soil fertility and fundamental ecosystem processes. It competes with native plants for nutrients, light, and water. Its copious production of nectar allows it to compete with native plants for pollinators which can lead to decreased reproduction rates of native plants.

White sweetclover prefers disturbed sites, withstands infrequent flooding, and tolerates sandy, gravelly or silty soils. These

characteristics allow it to proliferate on riparian areas throughout the state. It has taken over hundreds of acres on several major river systems in the state, including the Stikine, Matanuska, and Nenana Rivers. While the establishment of sweetclover is probably too extensive for complete eradication, it is important to protect intact river systems from further invasion. All sweetclover should be eradicated from near bridges and stream crossings to keep this species from invading more river systems.

Garlic mustard

Alliaria petiolata (Bieb.)

Garlic mustard is well known in eastern and midwestern states as an invader of natural areas where it effectively eliminates native ephemeral spring wildflowers in woodland habitats, and is a nuisance weed in landscaped areas. It is biennial; first year rosette seedlings grow close to the ground, forming a low dense groundcover, and second year plants grow up to three feet tall, producing hundreds of seeds per plant in July and August. Garlic mustard tolerates cool weather and begins growing very soon after spring thaw. It tolerates heavy shade but can grow in full sun.

Garlic mustard was found growing in Juneau in the summer of 2001 by staff of the Central Council of Tlingit and Haida. In Juneau, it is found growing among unmowed grass, salmonberry, thimbleberry, cow parsnip, and European mountain ash. It grows very well in unmanaged weedy vegetation and does well on steep slopes. Garlic mustard begins growing very early in the spring and can be more easily found before native vegetation begins to leaf out. A second, much smaller patch of garlic mustard was found on National Forest Lands at a recreation site just outside of Juneau. New garlic mustard plants continue to sprout in the downtown Juneau site. The seed bank viability of garlic mustard is at least 5 years, so several years of hand pulling are anticipated. The density and percentage cover of the infestation appears to be gradually decreasing, so the goal of containment has been met. More importantly, the eventual goal of eradication still remains possible, if the current level of effort is continued for several more years. There were three garlic mustard pulls in 2004, and the Juneau Ranger District is planning control projects for the spring of 2005.

Orange Hawkweed

Hieracium aurantiacum L.

Meadow Hawkweed

Hieracium caespitosum Dumort.

Orange and meadow hawkweed are members of a genus of alpine wildflowers from Europe and Asia. There are over 200 species of the genus *Hieracium* in Europe. Hawkweeds reproduce by seeds and by stolons (runners), and are capable of dominating a site through vegetative reproduction. Hawkweeds have the ability to establish in undisturbed remote sites such as forest clearings and mountain meadows. Because of this, they are a species of great concern in Alaska.

Orange hawkweed is found in most, if not all, coastal communities in Alaska. In many cases, the plant is too widespread to eradicate, but in Yakutat, a one meter square patch was eradicated by removing all the sod from the small site. This is an excellent example of communities pulling together in an early detection and rapid response situation. A large infestation of orange hawkweed growing in an undisturbed wet meadow in 2003 on the Kodiak National Wildlife Refuge has been the target of an ongoing herbicide treatment program



Figure 26. Orange hawkweed after it has gone to seed.

that has shown good success. A favorite plant of unwary gardeners, orange hawkweed has been introduced into numerous sites in Anchorage and the Kenai Peninsula, where infestations are expanding at an alarming rate, and new infestations are discovered regularly. FHP invasive plant surveys in Alaska in 2004 also discovered acre-sized infestations of meadow hawkweed in Juneau and Valdez. This plant is likely to be found in other locations as scouting efforts continue.

Tansy Ragwort

Senecio jacobaea L.

Tansy ragwort is one of the most notorious invasive plants in the intermountain west and is a particular problem in Oregon. Tansy ragwort is poisonous to several types of livestock, and leads to major losses by ranchers. In Alaska, it has been found in the cities of Anchorage, Ketchikan, and Metlakatla and on several sites around Prince of Wales Island. Tansy ragwort is a prime candidate for early detection and rapid response efforts due to its small populations, short seed bank longevity, and susceptibility to hand pulling.

Spotted Knapweed

Centaurea biebersteinii DC

Spotted knapweed is a biennial or perennial that reproduces exclusively by seed. One plant may produce over 20,000 seeds, which remain viable in soil for over eight years. Spotted knapweed forms dense stands in native plant communities. It produces and exudes toxins into the soil (allelopathy), and thus inhibits the establishment and growth of surrounding vegetation. Spotted knapweed infestations in the western United States have been found to alter soil chemistry and hydrology, increase erosion and sedimentation of streams and rivers, and reduce the availability of browse for wildlife. Spotted knapweed control efforts, environmental damages, and economic losses have cost several western states millions of dollars, and the costs are still growing.

In 2004, spotted knapweed was located and pulled by FHP staff in Valdez and Haines. Cooperative Extension Service staff found knapweed in the Turnagain Arm near Anchorage and Forest Service District staff found knapweed on Prince of Wales Island. In all cases the infestations were very small, consisting of less than 25 plants each, but it is suspected that many of these plants were able to produce seed. Therefore, diligent eradication efforts at each of these sites will necessary for a minimum of 8–10 years.

Common Tansy

Tanacetum vulgare L.

A perennial introduced from Europe as a medicinal or garden flower, this species has been spreading into waste places in southeast and south-central Alaska. It is easily spotted, and given the small number of locations in which it occurs, it is currently plausible to eradicate before it spreads further. In 2004, new infestations were found on Prince of Wales Island and Haines.



Figure 27. *Common tansy has yellow disc flowers, but no ray flowers.*

Reed Canarygrass

Phalaris arundinacea L.

Reed canarygrass is an aggressive nonnative cultivar that was originally introduced as a soil stabilization plant for development projects and for hay production. This species can quickly form a dense mat, excluding all other vegetation and preventing forest regeneration in some situations. Reed canarygrass can be found in literally thousands of locations throughout southeast Alaska. It is spreading beyond roadways into otherwise unspoiled habitat. Reed canarygrass tolerates a variety of moisture conditions from upland well drained areas to ponds and lakes, and is taking over wetlands and natural areas. Reed canarygrass is not used by wildlife for food or cover and may interfere with spawning by anadromous fish such as salmon by trapping sediment and blocking the flushing action which maintains gravel beds. Reed canarygrass is extremely difficult to eradicate once established.

Perennial Sowthistle

Sonchus arvensis L.

Perennial sowthistle can establish in both the “South Coastal” and “Interior Boreal” ecoregions of Alaska. It can modify successional establishment of native species. Perennial sowthistle has appeared in numerous locations around Fairbanks and Anchorage, and occasionally in Juneau. A crew from Admiralty National Monument found a patch of sowthistle on Admiralty Island and pulled several hundred plants in 2004.

Hairy Catsear

Hypochaeris radicata L.

Hairy catsear is a dandelion-like weedy perennial that has been found in numerous locations around the southern half of southeast Alaska. It is found in Petersburg, Wrangell, and Ketchikan and in numerous roadside locations on Prince of Wales Island. This plant is beginning to spread aggressively, and has the potential to dominate forest roadsides if not checked.

Oxeye daisy

Leucanthemum vulgare Lam.

Oxeye daisy is a shallow rooted perennial that is often a component of “wildflower” seed mixes used in revegetation. It can quickly replace up to 50 percent of grass species in meadows. It has a disagreeable odor and grazing animals avoid it. Heavy infestations have a potential to increase soil erosion. Oxeye daisy is found in a wide variety of locations around Alaska. In southeast Alaska it has been recorded in Yakutat, Hoonah, Haines, Juneau,

Figure 28. An effort was made in Yakutat to eradicate oxeye daisy.



Petersburg, Kake, Wrangell, Ketchikan and numerous locations on Prince of Wales Island. District staff and the Yakutat Salmon Board started a project in 2004 to monitor and control oxeye daisies in the town of Yakutat.

Introduced Insects

Invasive Insects Early Warning System

Introductions of exotic invasive insects have caused much concern and resulted in substantial control expenditures in the United States. Asian long-horned beetle and emerald ash borer introductions in the Lower 48 are two examples that have potentially devastating effects for native ecosystems and have resulted in control efforts costing tens of millions of dollars. The recent introduction of the amber-marked birch leaf miner, along with increasing tourism and international trade through Alaska, has served to highlight the increasing risk to Alaska ecosystems from exotic insect introductions and the need to further develop an early warning system with a wider scope for detecting introductions.

It is widely accepted that the most effective and lowest cost defense against exotic species introductions is to have an effective monitoring system to detect introductions early and allow cost effective rapid response control actions.

Gypsy Moth

Lymantria dispar (L.)

Alaska has maintained a detection monitoring system focused on the gypsy moth, a serious defoliator of hardwoods, for several years. Both the European and Asian gypsy moths are of concern to Alaska (see Invasive Insect section). To address this concern, annual gypsy moth trapping has and continues to be done in cooperation with the Animal and Plant Health Inspection Service (APHIS) in several locations across Alaska.

Exotic Bark Beetles

Recently, concern for exotic bark beetle and wood borer introductions have increased. Beginning in 2002, baited trap monitoring for potential exotic bark beetles and wood borers was initiated at five coastal port sites in Anchorage and Juneau with monitoring in Fairbanks added in 2003. Funding for this bark beetle and wood boring insect monitoring project was provided to Alaska Division of Forestry by the APHIS/PPQ Cooperative Agricultural Pest Survey (CAPS) program, with supplemental funding and other services provided by the USFS Forest Health Monitoring program and USFS/PNW Research Station RDESPP program (Rapid Detection of Exotic Scolytids Pilot Project). RDESPP is an exotic beetle monitoring project operated by the US Forest Service in conjunction with APHIS/PPQ.

In addition to monitoring for exotic beetles, the Alaska invasive insect monitoring project is being used to assess diversity and background information on native bark beetles and borers and the efficacy of various beetle attractant compounds and exotic beetle pheromones on native beetles. Forest Health Protection staff and the UAF Alaska Cooperative Extension Service are also participating in the Western Plant Diagnostic



Figure 29. *Sampling a western hemlock snag for wood boring is being conducted under an APHIS wood pest survey grant.*

Network effort to coordinate an “early detection and warning” system for identifying potentially damaging plant and insect agents into Alaska.

Pinewood Nematode

***Bursaphelenchus xylophilus* (Steiner and Buhner) Nickle**

Alaska needs to be as concerned about exporting insects to other countries as it is in having exotics introduced here. Pinewood nematode is a major concern to China with all round-log shipments from North America into China currently requiring fumigation. In 2003 APHIS provided funding to conduct a pinewood nematode and “wood pest” survey in the coastal wood production areas of southeast Alaska and Afognak Island. To date, no pinewood nematodes have been found during export phytosanitary inspections and two years of field surveys conducted under the APHIS Wood Pest Survey grant.

Future Plans for an Alaska Early Warning System for Exotic Insects.

The USFS RDESPP program will soon move from a pilot project to an operational program nationwide. Alaska has a good start at implementing this early warning system through the APHIS/PPQ Cooperative Agricultural Pest Survey (CAPS) described above. Discussion is underway with the aim of establishing annual exotic beetle monitoring in Alaska as part of the RDESPP program in 2005.

Invasive Insects

Birch Leaf Miners

***Profenusa thomsoni* (Konow)**

***Fenusa pusilla* (Lepeletier)**

***Heterarthrus nemoratus* (Fallen)**

Five species of birch-leaf mining sawflies were inadvertently introduced to North America from Europe in the last century, three of which have made their way to Alaska. *Fenusa pusilla* and *H. nemoratus* were collected from birch in 2003, however, these two species are rare in occurrence and cause little defoliation. *Profenusa thomsoni*, the amber-marked birch leaf miner, on the other hand, has become a widespread pest of native and introduced birch in Alaska. Birch defoliation was very noticeable in the Anchorage Bowl, Eagle River, and the Mat-Su Valley from late-July through August. More than 138,000 acres of defoliated birch were mapped during aerial surveys, a significant increase from last year. This increase is attributed to the record warm, dry 2004 summer which favored leaf miner reproduction and dispersal. Although these hardwoods have been defoliated for several consecutive years, as yet there doesn't appear to be any lasting damage.

Large leaf miner populations have spread as far south as Bird Ridge; approximately 30 miles south of Anchorage. Ground surveys have indicated low levels of leaf miner defoliation as far south as Soldotna on the Kenai Peninsula and as far north as Talkeetna (Parks Highway) and Pinnacle Mountain (Glenn Highway). It has been identified from southeast Alaska near Haines and Skagway. It was also accidentally introduced into the Fairbanks area, probably through repeated introductions via nursery/landscape birch stock from the Anchorage area. More than 1,000 heavily defoliated birch were observed on Eielson AFB and leaf miner populations were detected this year on the Richardson Highway outside of Eielson AFB, in the town of North Pole, on the east side of Fairbanks in the downtown area and east throughout the western side of Fort Wainwright, in the Farmers Loop/Ballaine

Road area on the northwest edge of Fairbanks, and along street trees down Airport Way bisecting Fairbanks east to west. On Eielson AFB, evidence was discovered that proved that the amber-marked birch leaf miner could complete development within the much smaller leaves of dwarf birch (probably *Betula glandulosa*).

The amber-marked birch leaf miner was first reported in eastern United States in the early 1900s. The adult is black, about 3 mm long, and similar in appearance to a common fly. Sawfly populations are comprised entirely of females, and so reproduction is parthenogenetic. Prepupae overwinter in cocoons in the soil and adults appear in the summer months from late-May through August. The female deposits her eggs singly on mature leaves. At times, almost every leaf is mined by as many as ten developing larvae, giving it a brown color. When mature, the larva cuts a hole through the leaf and drops to the ground. There the larva builds a cell in which it over-winters. One generation per year is normal for this leaf miner.

The amber-marked birch leaf miner was first reported in Edmonton, Alberta, Canada in the early 1970s. This leaf miner became the most important exotic leaf miner on

Figure 30. Female birch leaf miner parasitoid, *Lathrolestes luteolator* (Courtesy of Dominique Collet).



Edmonton's birch trees. In the early 1990s a highly specific biological control agent, a holarctic ichneumonid parasitoid wasp, *Lathrolestes luteolator* (Gravenhorst) appeared in Edmonton. Not only did this wasp cause the 20 year long outbreak to collapse, it has made this exotic leaf miner rare, eliminating the need for one of the most entrenched and widely practiced insecticide treatments in Edmonton.

A cooperative biological control program (USDA Forest Service & APHIS; State of Alaska/Div. of Forestry, Canadian Forestry Service, and the University of Alberta) was initiated in 2002. Small numbers of *L. luteolator* were released in Anchorage during the summer of 2004. Parasitoid releases

are planned for Anchorage and Fairbanks in 2005 and 2006. In the absence of an efficient biological control agent, birch leaf miner populations will continue to spread unchecked throughout many parts of south-central and interior Alaska's birch forests.

Alder Woolly Sawfly

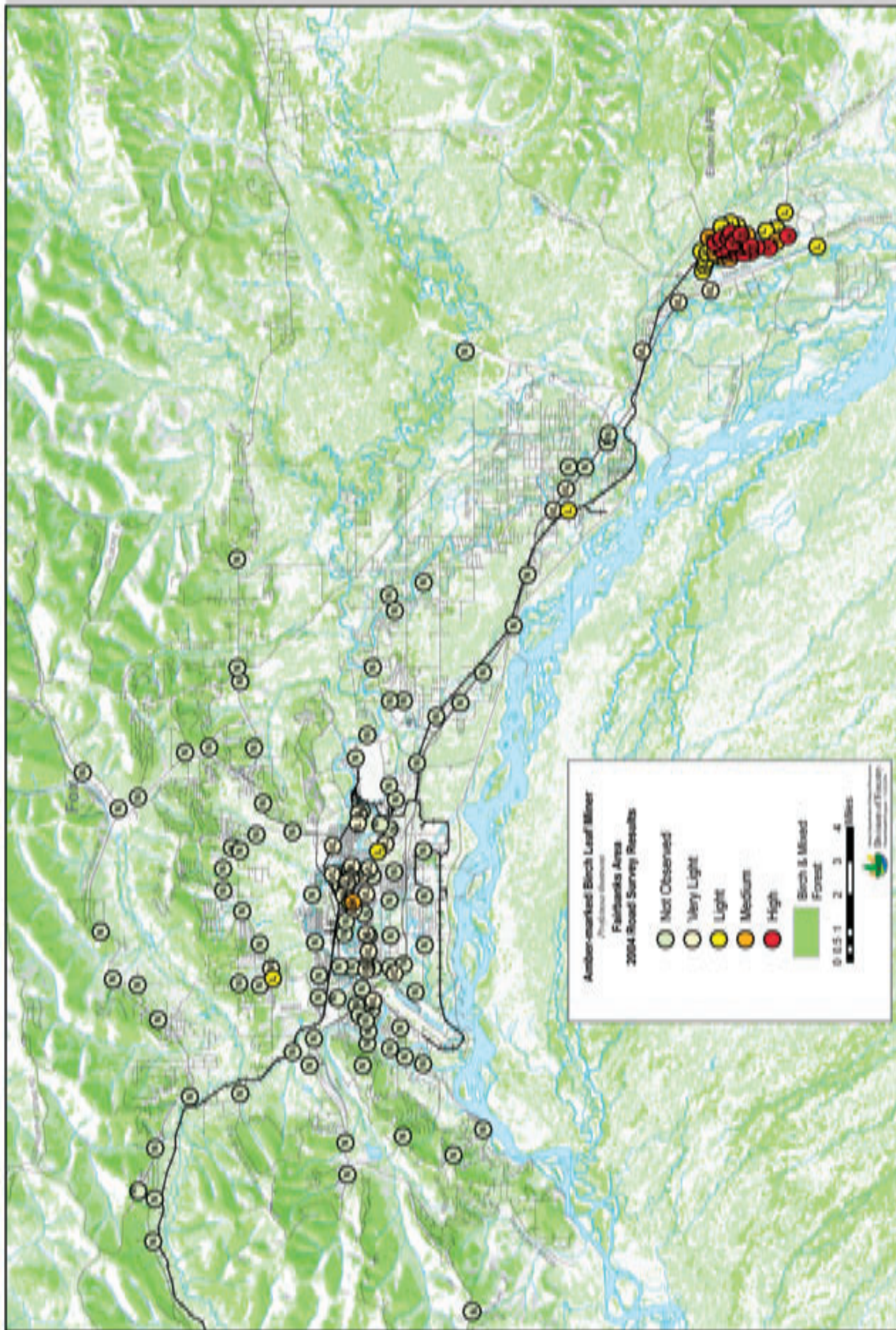
Eriocampa ovata (L.)

Figure 31. The alder woolly sawfly has a white "sugar-coated" appearance.



Defoliation by alder woolly sawfly remained consistently moderate to heavy on thin-leaf alder (*Alnus tenuifolia*) in many areas of south-central Alaska from Palmer to Seward. Severe damage continued in the Anchorage Bowl, however, damage was most severe in riparian areas along the Seward Highway on the Kenai Peninsula. Sitka alder (*A. sinuata*) was seldom defoli-

Map 10. Birch leaf miner monitoring survey in the Fairbanks vicinity.



ated. This European species is well-established throughout the northern U.S. and Canada. The larvae are easily recognized because they are covered with a distinctive shiny, woolly secretion. They skeletonize the leaves of young alders, primarily in the lower canopy, consuming all leaf tissue except major veins. Although not considered a major forest pest in Alaska, continued defoliation may result in reduced growth, branch dieback and may be a key stress factor for subsequent attack of stressed alder trees by the alder canker (see the disease section for more information on the alder canker).

Gypsy Moth

Lymantria dispar (L.)

The European gypsy moth was accidentally introduced into the eastern U.S. in the late 1800s and has been responsible for considerable damage to the hardwood forests of the east and midwest. The gypsy moth has also been introduced to the western U.S. where millions of dollars have been spent on its eradication.

Since 1986, Forest Health Protection, in conjunction with UAF CES, USDA APHIS, and the State of Alaska Division of Agriculture has placed gypsy moth pheromone monitoring traps in 15 Alaska communities. In 2004, UAF CES Integrated Pest Management technicians performed statewide gypsy moth trapping, with 240 detection traps placed at various locations near Fairbanks, Matanuska, Susitna, Anchorage, Kenai Peninsula, Valdez, Cordova, Yakutat, Skagway, Hoonah, Juneau, Angoon, Sitka, Petersburg, Wrangell, Prince of Wales Island, Ketchikan, and Dutch Harbor, Alaska in 2004. One male European gypsy moth was trapped at the Tanana Campground in Fairbanks. Previously, only two European gypsy moths have been trapped in Alaska. As far as is known, populations of the gypsy moth have not been established in Alaska. Additional trapping will be done in this area in 2005. Of note, in addition to gypsy moth trapping, nun moth *Lymantria monacha* (L.) traps were placed at various locations throughout Alaska, but none were collected.

Uglynest Caterpillar

Archips cerasivorana Fitch

Populations of this introduced pest declined in 2004, as evidenced by significantly fewer inquiries to Anchorage pest specialists and a general lack of defoliation in its various haunts throughout the city. The outbreak in west Anchorage, downtown and in south Anchorage in 2001, has apparently declined to endemic levels. The species was originally

transplanted on ornamental plantings, and has confined its damage to cotoneaster, mountain ash, *Prunus*, *Malus*, and *Salix* spp. along disturbed roadsides and industrial areas between the downtown port area to south Anchorage.

The uglynest caterpillar has one generation per year, over-wintering in the egg stage. The adult moths are active from June through

Figure 32. Tents constructed by the uglynest caterpillar on cotoneaster (South Anchorage, 2001-photo by Roger Burnside).



August; the front wing is crossed with reddish brown striations and has an iridescent sheen; hind wings are bright orange. Larvae are yellowish to yellowish-green as they reach maturity with dark brown or black heads. Larvae are gregarious and live in silk-covered tents or nests that become filled with frass as the larvae grow. This insect can be a problem in nurseries or ornamental plantings because of the unsightly appearance of the larval nests. The larval feeding may also cause some branch deformity.

Western Tent Caterpillar

Malacosoma californicum (Packard)

The western tent caterpillar was accidentally introduced via nursery stock and subsequently eradicated in Anchorage in 1988 and 2003. On two different occasions in 2004, Western Tent Caterpillar was discovered on nursery landscape trees. These isolated populations were subsequently treated and eradicated utilizing chemical controls.

European Pine Shoot Moth

Rhyacionia buoliana (Denis & Schiff.)

The European pine shoot moth was discovered for the first time in 2004 in new landscape plantings of Scotch pine (*Pinus sylvestris*). The trees were imported from Idaho and planted in a new road construction project in Anchorage. Attacked trees are deformed and their growth is retarded, but trees are seldom killed. Infested terminal shoots and leaders were removed and the trees were sprayed with Carbaryl. Hopefully, this introduced shoot moth was eradicated.

Invasive Diseases

Black Knot

Apiosporina morbosum (Schwein.:Fr.) Arx

Black knot was first discovered in Anchorage in the early to mid 1980s. The fungus quickly spread, and by 1987 the municipality of Anchorage had pruned black knot from over 135 trees throughout the city. The disease is now established in the Anchorage bowl. *Prunus padus* and *P. virginiana* are the most commonly affected ornamental trees in south-central Alaska, while the Amur chokecherry, *P. maackii*, does not appear to be susceptible to the disease. Reports of damage to ornamental trees continued in 2004 in Anchorage.

Infected trees develop perennial black corky swellings or “knots” on branches or the tree bole. Tree mortality has not been attributed to this fungus, although branch dieback has been observed. The primary impact from this disease is loss of aesthetic and economic value of ornamental *Prunus* plantings. Black knot is costly to landscape contractors, nurserymen, businesses, local government, and homeowners, due to the dismissal of infected stock and/or the removal and replacement of infected trees.

White Pine Blister Rust

Cronartium ribicola J.C. Fischer ex Rabh.

Figure 33. Aecial pustules of the white pine blister rust fungus, *Cronartium ribicola*, on an ornamental eastern white pine planted in Ketchikan.



A single ornamental white pine tree was found to be infected by white pine blister rust in Ketchikan in 2004. The rust fungus was also found sporulating on leaves of the alternate host, an ornamental black currant, at the same location in Ketchikan. This is the first report of white pine blister rust in Alaska. Later in the summer, infected ornamental gooseberry (*Ribes* sp.) bushes were found in the same area. The fungus is not native to North America and, while causing devastating mortality in native white pine in some areas of the US and Canada, it does not pose a threat in Alaska because no native trees are susceptible. The tree, probably an eastern white pine, was planted over 20 years ago and is being repeatedly reinfected, as evidenced by small young infected branches. The avenue of the original introduction into Ketchikan is not certain. Introduction by infected gooseber-

ry is one possibility, as is infection by airborne spores originating from ornamental plantings in Prince Rupert, BC, or from native whitebark pine–*Ribes* complex in the mountains of British Columbia to the east of Ketchikan.

Fire Blight

Erwinia amylovora (Burrill) Winslow et al.

Fire blight, caused by a bacterium, is detected periodically in Anchorage on ornamental apple trees and rose bushes. The disease is likely introduced from imported plant material. It is not known whether this disease is established. The bacterium causes leaves and blossoms near the tips to turn brown and die. Infections can move to older portions of the plant, causing cankers and branch dieback. Cankers may weep a cloudy, bacteria-laden sap. A concern is the possibility of an outbreak of fire blight on mountain ash (*Sorbus* sp.) trees.

Status of Declines and Abiotic Factors



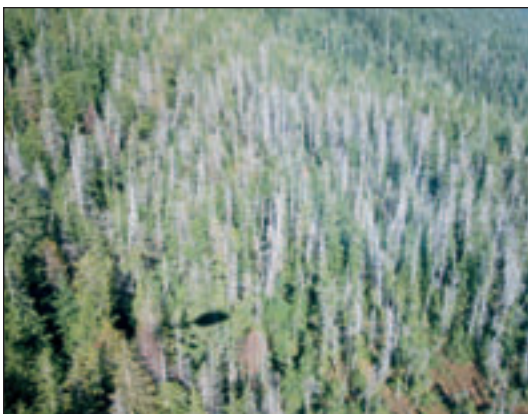
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Status of Declines and Abiotic Factors

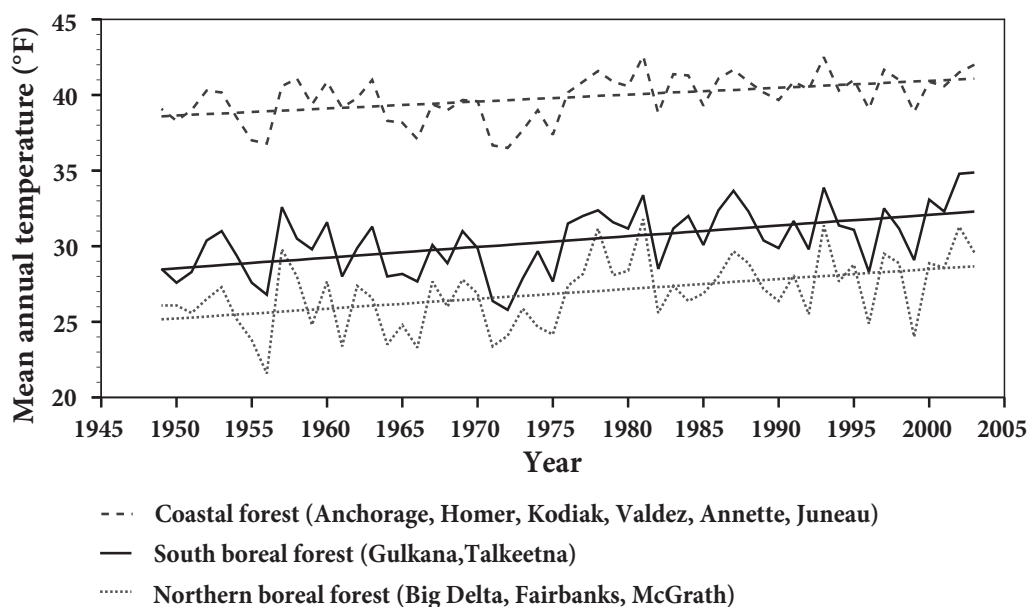
Climate and Forest Health

Alaska, like other arctic and subarctic regions, is experiencing a change in its climate, with well-documented increases in mean annual temperatures, maximum daily temperatures, minimum daily temperatures, growing degree days, and the frost-free season. For example, the aggregate mean annual temperature for forested regions of Alaska rose 2.5–3.5 °F between 1949 and 2003 (Figure 33). Associated changes in the health of Alaska’s forested are expected because both biotic (e.g. insects) and abiotic (e.g. fire) disturbance agents respond to climate.

Climate-related forest health problems have already been documented in Alaska. The spruce beetle outbreak on the Kenai Peninsula has been linked to a warmer and drier climate that allowed the spruce beetle to increase its reproductive rate, while simultaneously reducing the ability of spruce trees to resist attacks by spruce beetles. In interior Alaska, the first recorded spruce budworm outbreak, from 1993–1995, resulted from elevated summer temperatures that produced drought stress in the host white spruce trees while simultaneously resulting in increased budworm reproductive rates. A second spruce budworm outbreak that began in 2002–2003 is believed to be the result of the continued trend in warm, dry summers in interior Alaska. The 2004 wildfire season, the largest on record, was a direct result of record temperatures and little precipitation. In the discontinuous permafrost region of south-central and interior Alaska, increasing temperatures have been associated with both the loss of wetland habitats and increasing rates of the development of thermokarst topography, both of which result from permafrost thawing. Thermokarsting—the collapsing of ice-rich ground surfaces—in forested landscapes leads to the loss of forested land area.

Climate-related forest health problems are expected to continue. Drought stress and reduced growth rates of some trees species are expected, thereby leading to larger and

Figure 34. Aggregate mean annual temperature, from 1949–2003, for three forested regions of Alaska. A linear regression line is shown for each region. Data are from first-order weather stations and were provided by the Alaska Climate Research Center.



more frequent insect outbreaks. Larger and more severe fires are expected to result from a continuation of warmer, drier summers. Loss of forested acres will continue as a result of thawing of permafrost-laden soils. Also, the total number of new species in the Arctic, including Alaska, is expected to increase as a result of an influx of new species under a warmer climate. Some of these species will be invasive plants and insects that will create new forest health issues. All of the above changes will alter the composition and dynamics of Alaska's forests.

Yellow-cedar Decline

Decline and mortality of yellow-cedar persists as one of the most dramatic forest problems in Alaska. Approximately 500,000 acres of decline have been mapped during aerial detection surveys. Extensive mortality occurs in a wide band from western Chichagof and Baranof Islands to the Ketchikan area. In 2004, more than 13,000 acres were mapped as very active; that is, they had high concentrations of dying trees with bright yellow or red crowns. The remainder of the acreage is dominated by concentrations of dead standing trees. We speculate that more yellow-cedar trees died in patches of forest decline because of the historically warm, dry spring and summer in 2004. These trees probably had abundant dead roots before this warm season, but the unseasonably warm conditions sped the rate of crown symptom development. The active areas were found scattered throughout the distribution of dead cedars, but were particularly abundant in Peril Strait (Baranof and Chichagof Islands), the southwestern portion of Baranof Island, north Kupreanof Island, south Kuiu Island, Etolin Island, Kosciusko Island, and Boca de Quadra, southeast of Ketchikan.

All research suggests that contagious organisms are not the primary cause of this extensive mortality. Some site factor, probably associated with poorly drained anaerobic soils, appears to be responsible for initiating and continuing cedar decline. Two hypotheses have been proposed to explain the primary cause of death in yellow-cedar decline: (1) Toxins are produced by decomposition in the wet, organic soils, or through cation mobilization, or; (2) The lack of snowpack at lower elevations allows solar radiation to penetrate the open-canopy forests and trigger early loss of cold tolerance in cedars, predisposing these trees to suffer some form of freezing injury.

Ongoing research and circumstantial evidence favors the second hypothesis. In particular, we are finding elevational limits to yellow-cedar decline, above which cedar forests appear healthy. This elevational limit is consistent with patterns of snow persistence in spring. For example,



Figure 35. *Dead cedar in southeast Alaska represents a significant resource as the wood quality remains very good long after tree death.*

Map 11. Yellow-cedar decline in southeast Alaska, 2004.

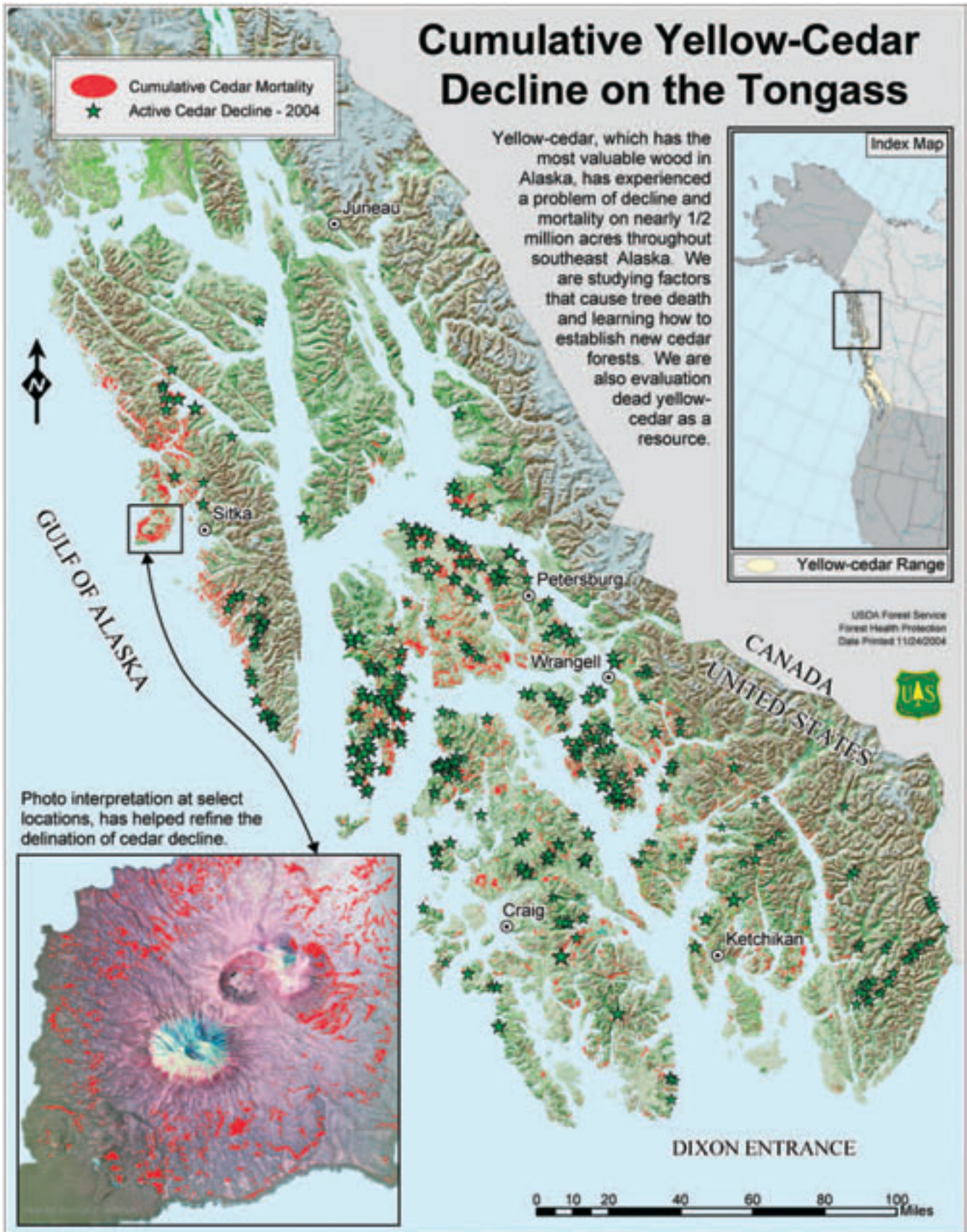


Table 6. Acreage affected by yellow-cedar decline in southeast Alaska in 2004 by ownership.

National Forest	461,065	Native Land	19,256
Admiralty Nat. Monument	5,404	Admiralty Island	55
Craig Ranger District	30,102	Baranof Island	256
Dall & Long Islands	1,013	Chichagof Island	819
Prince of Wales Island	29,089	Dall and Long Island	1,351
Hoonah Ranger District	1,047	Kruzof Island	143
Chichagof Island	1,047	Kuiu Island	579
Juneau Ranger District	952	Kupreanof Island	4,062
Mainland	952	Mainland	878
Ketchikan Ranger District	32,965	Revillagigedo Island	2,287
Annette & Duke Islands	1,771	Prince of Wales Island	8,825
Gravina Island	811	Other Federal	804
Mainland	15,070	Baranof Island	363
Revillagigedo Island	15,313	Chichagof Island	3
Misty Fjords Nat. Monument	26,159	Prince of Wales Island	89
Mainland	17,136	Etolin Island	35
Revillagigedo Island	9,023	Kuiu Island	176
Petersburg Ranger District	157,020	Kupreanof Island	138
Kuiu Island	67,384	State & Private Land	21,562
Kupreanof Island	73,644	Admiralty Island	9
Mainland	5,680	Baranof Island	3,145
Mitkof Island	8,193	Mainland	3,045
Woewodski Island	2,319	Chichagof Island	1,163
Sitka Ranger District	111,570	Dall and Long Island	62
Baranof Island	49,024	Gravina Island	1,388
Chichagof Island	35,635	Heceta Island	29
Kruzof Island	26,911	Kosciusko Island	141
Thorne Bay Ranger District	47,282	Kruzof Island	300
Heceta Island	1,054	Kuiu Island	574
Kosciusko Island	11,835	Kupreanof Island	1,312
Prince of Wales Island	34,393	Mitkof Island	1,356
Wrangell Ranger District	48,564	Prince of Wales Island	3,594
Etolin Island	19,755	Revillagigedo Island	4,305
Mainland	13,891	Wrangell Island	1,139
Woronofski Island	498	Total Land Affected	502,687
Wrangell Island	9,401		
Zarembo Island	5,019		

* Acreage by ownership was tabulated using Alaska land status data from State of Alaska, Department of Natural Resources. Changes in acreage figures are due to a change in the resource, refined sketch-mapping, or changes in GIS techniques.

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 two case study areas. We are also examining the role of exposure in yellow-cedar decline and the relationship of canopy coverage on snow deposition and temperature variation.

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 numerous) that leads to eventual succession favoring other conifer species such as western hemlock and mountain hemlock (and western redcedar in areas south of latitude 57) and, in some stands where decline has been ongoing for up to a century, large increases in understory biomass accumulation of brushy 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. Regionwide, this excessive mortality of yellow-cedar may lead to diminishing populations (but not extinc-

tion) 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.

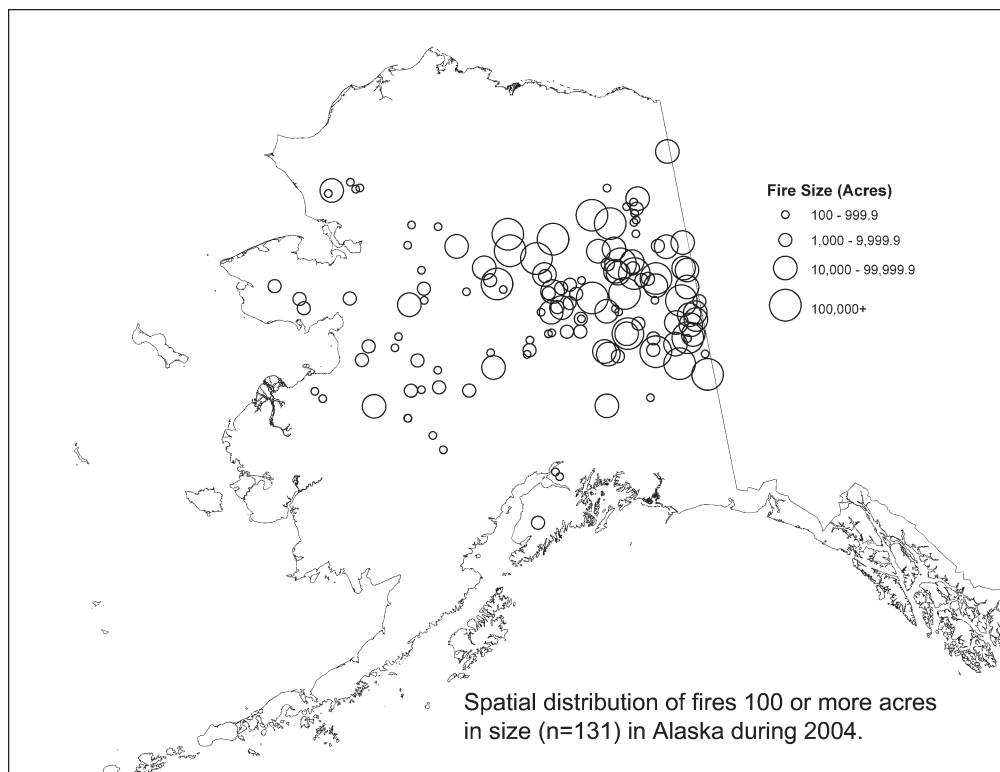
The large acreage of dead yellow-cedar and the high value of its wood suggest opportunities for salvage. Cooperative studies with the Wrangell Ranger District, the Forest Products Laboratory in Madison, Wisconsin, Oregon State University, and State and Private Forestry are investigating the mill-recovery 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.

Wildfires

The summer of 2004 was a record fire season, with over 6.76 million acres burned. This represented 33.9 percent more acres burned than during the previous record year of 1957 when 5.05 million acres were consumed by fire. At the time of writing this report, the Alaska Fire Service had recorded 714 fires in which at least 0.1 acres were burned; an additional 55 fire starts (i.e. no burned acreage recorded) were also documented. The 2004 fire season was also unique because a large amount of burned land area was located along major highways, such as the Steese, Elliott, and Taylor Highways.

There was an inverse relationship between the distribution of fire sizes and the amount of land area burned by each fire size class (Map 12). The majority of fires (n=399, 55.9 percent) were less than 1.0 acre in size, but they only burned 62 acres (0.0009 percent) in total. Conversely, the largest 54 fires (7.6 percent), which were at least 10,000 acres in size, accounted for 97.3 percent of the total acreage that was burned.

Map 12. Major large fires (100 acres +) during 2004 in Alaska.



Two projects related to the 2004 fires are being planned for next year. A monitoring project will be implemented to determine the abundance of wood-boring beetles along the fire perimeters, as well as associated beetle-induced tree mortality. A second monitoring project will be implemented to determine if invasive plant species will become established in burned over areas along the road corridors and in staging areas, fire lines, and camp sites associated with fire fighting activity.

Blowdown

Slightly over 500 acres of blowdown were mapped in the southeast during the 2004 surveys. This resembles the data collected in 2003 where a little less than 500 acres of blowdown were mapped in southeast Alaska, however, the acreage was underestimated in the interior because wind-thrown patches were not visible during the aerial survey due to the cover of nearby trees. The large blowdown in 2003 occurred due to a bora wind that swept throughout south-central Alaska and it is very likely this storm knocked down many trees scattered across the landscape.

During a November 2001 storm, a 3,580-acre blowdown event occurred in the Yakutat Forelands near Russell Fiord. No spruce beetles were found in any of these trees. During the winter of 1981 a similar event occurred in the same area on 3,500 acres and spruce bark beetle populations subsequently expanded to outbreak levels killing 22 percent of the surrounding spruce in the following 2–5 years.

In 2003, the first revisit to the permanent plots since 1992 was conducted. Nine of the twenty plots were found intact. Four plots were not found and seven plots were in salvage-logged areas. Six percent of 365 spruce trees had been attacked by spruce beetle. Two trees were recent attacks. Eleven percent had been attacked by ambrosia beetles.

Hemlock Fluting

Hemlock fluting is characterized by deeply incised grooves and ridges extending vertically along boles of western hemlock. 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).

Appendix A

Integrated Pest Management

Integrated pest management (IPM) has been described as a “systems approach to alter pest damage to acceptable levels through a variety of techniques, including predators and parasites, genetically resistant hosts, natural environmental modifications, and when necessary and appropriate, chemical pesticides.” Some IPM activities the Alaska Region Forest Health Protection Program is involved in include:

Collaboration with the Alaska Cooperative Extension Service

- ▲ Funding and technical assistance are provided by the Forest Health Protection program to Alaska Cooperative Extension Service (CES) in a cooperative effort providing pest management information to Alaska residents. The program includes education, research, and survey activities, and also provides integrated pest management information concerning urban forestry as well as garden and greenhouse pests. The program is educational in nature and provides the public with a means to learn about pest management in an informal and accessible manner. In 2004, there were 6 seasonal IPM Technicians in 6 districts plus 2 full-time program staff in Anchorage. A summary of IPM work for 2004 includes: 10,500 total client contacts made from October 1, 2003–September 30, 2004; 1,100 specimens (insects, weeds, trees & plants, tree diseases and abiotic disorders) identified for the public; more than 200 site visits undertaken primarily for community tree disorder diagnosis; and 25 media contacts made statewide. More than 50 percent of the IPM Technician activities occurred in the Anchorage Bowl, which is home to over 40 percent of the state population.

Invasive Plants

- ▲ A full-time CES program assistant position was created for 2004–2005, focused solely on statewide invasive plants issues. Educational outreach efforts under this position included invasive plant presentations, workshops, and trainings around the state, individual contacts via mail, telephone, and email, site visits, grant writing assistance to new Cooperative Weed Management Areas, collaboration on invasive plant initiatives at the local, state, and federal levels, and invasive plant publication production and editing. Two full-color publications on the public’s role in reducing the spread of invasive plants in Alaska were jointly produced and distributed by the Forest Health Protection program and CES, along with numerous smaller informational fliers and a booklet of 24 invasive plants of concern in Alaska.
- ▲ In 2004 the Juneau Cooperative Weed Management Area a group of representatives from city, state, tribal, and federal agencies worked together to develop a memorandum of understanding for forming a Cooperative Weed Management Area (CWMA) to set priorities, coordinate management efforts, and pool resources in order to manage exotic and invasive plant species in the Juneau Area. The CWMA organized a series of community weed pulling parties to control garlic mustard in downtown Juneau, part of an ongoing effort to eradicate this noxious weed, which has only been found in two locations in the State.
- ▲ An additional three Cooperative Weed Management Areas were formed in 2004 to collaboratively manage nonnative invasive plant infestations in the regions of the Anchorage Basin, the Matanuska–Susitna Valley, and Fairbanks. A Rapid Response Program was established, in order to provide CWMA’s with the financial resources to treat problematic invasive plant infestations, with technical information on plant life cycles and treatment options provided by the Alaska Cooperative Extension Service.

Insects

- ▲ A cooperative biological control program for the amber-marked birch leaf miner was initiated in 2003. Agencies involved include: USDA Forest Service, USDA APHIS, State of Alaska/Division of Forestry, Municipality of Anchorage, the Canadian Forestry Service, and the University of Alberta. Leaf miner life table studies were initiated and Canadian collections of the parasitic wasp, *Lathrolestes luteolator*, were successfully completed. The first release of this host-specific parasitoid was made in the Anchorage Bowl in the summer of 2004. Additional releases will be made in Anchorage and Fairbanks in 2005 and 2006.

- Alaska Division of Forestry conducted the second year of funnel trapping to control an outbreak of *Ips perturbatus* at Tanacross Native Village. This operational project was designed to mitigate *Ips*-caused tree mortality within a fuels hazard reduction (thinned) white spruce stand in the Alaska Native village approximately 10 miles west of Tok. A September 2004 evaluation of the trapout found no new attacked trees. *Ips* populations have returned to endemic levels in the Tanacross area, in contrast to other parts of interior Alaska where *Ips* populations will likely increase in response to trees weakened from the recent record fire activity. The Forest Health Protection, Insect Suppression Fund provided significant funding to complete this important project that demonstrates management tactics utilizing semiochemicals to minimize damage from localized bark beetle outbreaks.
- In February 2004, Alaska Division of Forestry, FHP and USFWS staff organized and conducted a forest management and research symposium in Homer, Alaska, attended by over 160 individuals. The “INFEST (Interagency Forest Ecology Study Team) Symposium” addressed the biology and forest ecosystem effects of the past 70+ years of spruce beetle outbreaks in Alaska as well as management and the effects of management of the 1989–2000 spruce beetle epidemic in south-central Alaska. This effort would not have been possible without significant financial sponsorship from the Kenai Peninsula Borough, which covered venue expenses, travel reimbursements to graduate students, and publishing of a Proceedings CD-ROM. Symposium costs were paid from a conservation education fund established by Congressional funds received in the early 2000s to assist the borough with management of the 1.4 million acre beetle infestation.

Appendix B

Submitting Insects and Diseases for Identification

The following procedures for the collection and shipment of specimens should be used for submitting samples to specialists:

I. Specimen collection:

1. Adequate material should be collected
2. Adequate information should be noted, including the following:
 - a. Location of collection;
 - b. Date of collection;
 - c. Who collected the specimen;
 - d. Host description (species, age, condition, # of affected plants);
 - e. Description of area (e.g., old or young forest, bog, urban); and
 - f. Unusual conditions (e.g., frost, poor soil drainage, misapplication of fertilizers or pesticides?).
3. Personal opinion of the cause of the problem is very helpful.

II. Shipment of specimens:

1. General: Pack specimens in such a manner to protect against breakage.
2. Insects: If sent through the mail, pack so that they withstand rough treatment.
 - a. Larvae and other soft-bodied insects should be shipped in small (4 dram or less) screw-top vials or bottles containing at least 70 percent isopropyl (rubbing) alcohol or 70 percent ethanol. Make certain the bottles are sealed well. Include adequate information in each vial, or a code, relating the sample to the written description and information. Labels inserted in the vial should be written in pencil. Do not use a ballpoint pen, as the ink is not permanent in alcohol.
 - b. Pupae and hard-bodied insects may be shipped either in alcohol or in small boxes. Specimens should be placed between layers of tissue paper in the shipping boxes. Pack carefully and make certain that there is very little movement of material within the box. Do not pack insects in cotton.
3. Needle or foliage diseases: Do not ship in plastic bags. Sprinkle lightly with water before wrapping in newspaper. Pack carefully and make sure that there is very little movement of material within the box. Include the above collection information. For spruce and other conifers, include a description of whether current year's-needles, last-year's needles, or old-needles are attacked.
4. Mushrooms and conks (bracket fungi): Do not ship in plastic bags. Either pack and ship immediately, or first air dry and then pack. To pack, wrap specimens in dry newspaper and pack into a shipping box with more newspaper. If on wood, include some of the decayed wood. Be sure to include all collection information.

III. Shipping:

1. Ship as quickly as possible, especially if specimens are fresh and not air-dried. If samples cannot be shipped rapidly, then store in a refrigerator.
2. Include return address inside shipping box.
3. Mark on outside: "**Fragile: dried specimens for scientific study. No commercial value.**"

Appendix C

2004 Biological Evaluations, Technical Reports & Publications

- Burnside, R., et al. 2004. INFEST (Interagency Forest Ecology Study Team) Proceedings: A changing Alaskan ecosystem: effects of spruce beetle outbreaks and associated management practices on forest ecosystems in South-central Alaska, Feb. 24-26, 2004, Homer, AK. CD-ROM format. On file at State of Alaska, Department of Natural Resources, Division of Forestry, Anchorage.
- Burnside, R.E. and G.W. Mahal. 2004. Entomology Field Investigation Report—June 29-30, 2004: Raspberry Island-Selief Bay area & Afognak Island. 6 p., illus. On file at State of Alaska, Department of Natural Resources, Division of Forestry, Anchorage.
- Deal, R.L., et al. 2004. Stand dynamics of mixed red alder–conifer forests of southeast Alaska. *Can. J. For. Res.* 34: 969-980.
- Deal, R.L., et al. 2003. Development of multi-functional forests using red alder in young-growth conifer stands of southeast Alaska, USA. Proceedings of the IUFRO International Interdisciplinary Conference. Uneven-aged Forest Management: Alternative Forms, Practices and Constraints. Helsinki, Finland, June 8-17, 2003. Finnish Forest Research Institute (METLA), Helsinki, Finland. Pp. 115-117.
- Furniss, M.M. 2004a. Exploratory wood borer survey: Prince of Wales Island and Hyder, Alaska. May 2004. 8 p., illus. On file at State of Alaska, Department of Natural Resources, Division of Forestry, Anchorage.
- Furniss, M.M. 2004b. Fourth Exploratory wood borer survey: Skagway, Haines, and Yakutat, Alaska. September 2004. 6 p., illus. On file at State of Alaska, Department of Natural Resources, Division of Forestry, Anchorage.
- Furniss, M.M. 2003. Exploratory wood borer survey in southeast Alaska-July 2003. Report submitted to Alaska Dept. of Natural Resources, Div. of Forestry, Anchorage, AK, APHIS cooperative agricultural pest survey (CAPS) grant project, 6p.
- Furniss, M.M. 2003. Exploratory wood borer survey on Prince of Wales Island, Alaska. September 2003. Report submitted to Alaska Dept. of Natural Resources, Div. of Forestry, Anchorage, AK, APHIS Pinewood nematode and wood pest survey grant project 7p.
- Harmon, M., et al.; 2005. The Fate of Beetle-killed Spruce on the Kenai Peninsula: A Preliminary Report. USDA Forest Service, Special Report. In Press.
- Hennon, P.E. and M.H. McClellan, 2003. Tree mortality and forest structure in temperate rain forests of southeast Alaska. *Can. J. For. Res.* 33: 1621-1634.
- Heutte, T.M. and M.E. Shephard, 2003 Japanese Knotweed, Trifold Pamphlet
- Heutte, T.M. and M.E. Shephard, 2003 Canada Thistle, Trifold Pamphlet
- Lewis, K.J., L.M. Trummer, and R.D. Thompson. 2004. Incidence of Tomentosus Root Disease Relative to Spruce Density and Slope Position in South-central Alaska. *For. Ecol and Mgmt.* 194:159-167.
- Morales-Ramos, J.A.; Rojas, M.G.; Hennon, P.E. 2004. Black stain fungus effects on the natural resistance properties of Alaskan yellow-cedar to the Formosan subterranean termite (Isoptera: Rhinotermitidae). *Environmental Entomology Physiological and Chemical Ecology.* 32: 1234-1241.
- Orlikowoska, E.H., et al. 2004. The role of red alder in riparian forest structure along headwater streams in southeastern Alaska. *Northwest Science.* 78: 111-123.
- Schultz, M.E. 2003. Southeast Alaska Wood Borer/Bark Beetle Survey—Juneau insect collection information, Juneau and Hoonah survey. 5 p.
- Schultz, M.E. 2004. Woodborer Field Investigation Report. Survey of Prince of Wales Island and area near Hyder—May 24–25. 2p.
- Schultz, M.E. 2004. Japanese Knotweed Ecology Field Trip—June 21–22. 3p.
- Schultz, M.E. 2004. Japanese Knotweed Ecology and Genetics Field Trip September 16–20. 4p.

- Schultz, M.E. 2004 Woodborer Field Investigation Report. Survey of area near Skagway and Haines—September 7–9. 4p.
- Shephard, M.E., et al. 2004 Selected Invasive Plants of Alaska; Booklet 55 pp.
- Snyder, C.L. and M.E. Shephard. 2004 Orange Hawkweed, Trifold Pamphlet
- Snyder, C.L. and M.E. Shephard 2004 Spotted Knapweed, Trifold Pamphlet
- Wipfli, M.S., et al. 2003. Chapter 3. Compatible management of red alder-conifer ecosystems in southeastern Alaska. In Monserud, R.A., Haynes, R., and Johnson, A. (eds.). *Compatible Forest Management*. Kluwer Academic Publ., Dordrecht, The Netherlands. Pp. 55-81.
- Thistle, H.W., et al. 2004. Surrogate Pheromone Plumes in Three Forest Trunk Spaces: Composite Statistics and Case Studies. *Forest Science* (In Press)

Appendix D

World Wide Web Resources

Alaskan Forest Health

USDA Forest Service, State & Private Forestry, Forest Health Protection, Alaska Region:

<http://www.fs.fed.us/r10/spf/fhp>

This web site presents information on insects, diseases, and invasive plants that threaten Alaskan forests. Focus is on the biology, impacts, control, and monitoring of these agents statewide. Available resources include a program overview, staffing information, GIS data/products, Sbexpert software, a comprehensive bibliography, and links to other forest health related sites.

State of Alaska, Department of Natural Resources, Division of Forestry:

<http://www.dnr.state.ak.us/forestry/index.htm>

Information is available on several of Forestry's programs, including forest health, urban and community forestry, and fire. Links are provided to access forest health and insect survey results, spruce bark beetle information, and to send an e-mail message.

Hazard Tree Management in Alaska:

<http://www.fs.fed.us/r10/spf/fhp/hazard/>

This web page was designed to provide managers with basic understanding of hazard trees. The information is presented with a logical flow from hazard tree theory to recognition, evaluation, and prevention.

USDA Forest Service, Western Forest Insects and Disease Catalog:

<http://www.fs.fed.us/r6/nr/fid/wid.shtml>

This valuable online catalog contains information on the identification, biology, and management of western forest insects and diseases.

The Kenai Peninsula Borough Bark Beetle Mitigation Program:

<http://www.borough.kenai.ak.us/sprucebeetle>

This site is dedicated to the borough's efforts to mitigate the impacts of the largest spruce bark beetle outbreak in North American history. Helpful items include maps, photographs, and publications as well as the proceedings from the 2004 symposium, "A Changing Alaskan Forest Ecosystem: Effect of Spruce Beetle Outbreaks and Associated Management Practices on Forest Ecosystems in South-central Alaska."

Cooperative Extension Service Land Resources and Community Development:

<http://www.uaf.edu/ces/programs/lrpro.html>

The University of Alaska Cooperative Extension Service Land Resources and Community Development page has information on Cooperative Extension Programs including Integrated Pest Management, Pesticide Safety Education Program, Master Gardeners Program, and Sustainable Agriculture.

GIS Products and Data

The Alaska Geospatial Data Clearinghouse:

<http://agdc.usgs.gov>

The AGDC is a component of the National Spatial Data Infrastructure (NSDI). The Clearinghouse provides a pathway to geospatially referenced data and associated metadata for Alaska from a multiple of federal, state and local agencies. From this website the Forest Health Monitoring Clearinghouse and the State of Alaska, DNR Geographic Data Clearinghouse can be reached.

The Forest Health Monitoring Clearinghouse:

<http://agdc.usgs.gov/data/projects/fhm>

This site provides spatial resource databases of forest health related information for Alaskan land managers, scientists, and the general public. Available statewide data layers include: yearly insect and disease damage, fire history, timber harvest and other disturbances, vegetation/land cover, soils, permafrost, ECOMAP and ecoregions, and land status/ownership among others.

The State of Alaska, Department of Natural Resources' Geographic Data Clearinghouse:

<http://www.asgdc.state.ak.us>

Data offered on this site includes, land status, transportation, physical boundaries, cultural, biologic, etc. State resource information (e.g., forest pest damage surveys, Exxon Valdez restoration data, CIIMMS) and various maps are also available.

Exotic & Invasive Species

Alaska Exotic Plants Information Clearinghouse and weed ranking project:

<http://akweeds.uaa.alaska.edu/>

AKEPIC (Alaska Exotic Plants Information Clearinghouse) is a database to track nonnative plant location data being collected by a number of cooperating agencies. The AHNP Weed Ranking Project is a project to develop threat assessments of selected invasive plants by collecting ecological data and incorporating that information into a ranking system.

Invasivespecies.gov:

<http://www.invasivespecies.gov/geog/state/ak.shtml>

A gateway to Federal and State invasive species information, activities and programs. Databases on invasive plants and a list of regulated noxious weeds can be found.

Alaska Committee for Noxious and Invasive Plants Management:

<http://www.cnipm.org>

The goal of this site is to heighten the awareness of the problems associated with nonnative invasive plants in Alaska and to bring about greater statewide coordination, cooperation, and action to halt the introduction and spread of undesirable plants.

USDA Forest Service, State & Private Forestry, Northeastern Area – St. Paul Field Office:

<http://www.na.fs.fed.us/spfo/index.htm>

This web site is a source of information on exotic insects and diseases of interest in other areas of the country, many of which could impact Alaskan forest resources. Also, an extensive online library of forestry/forest health publications is accessible.

The Exotic Forest Pest Information System for North America:

<http://www.exoticforestpests.org/english/english.htm>

An online system for identifying and recording exotic insects, mites and pathogens with potential to cause significant damage to North American forest resources. The database contains background information and risk ratings for each identified pest.

Invasive.org:

<http://www.invasive.org>

This joint project of The University of Georgia's Bugwood Network, USDA Forest Service and USDA APHIS PPQ provides an easily accessible, useable, archive of high quality images related to forest health and silviculture.

USDA Interagency Research Forum on Gypsy Moth and other Invasive Species:

<http://www.fs.fed.us/ne/morgantown/4557/forum>

An outlet for nationwide coordinated research efforts on nonnative insects and pathogens.

Other Forest Health Sites of Interest

USDA Forest Service, National Forest Health Monitoring Program:

<http://www.na.fs.fed.us/spfo/fhm>

USDA Forest Service, State and Private Forestry (National):

<http://www.fs.fed.us/spf>

USDA Forest Service, Forest Health Protection Program (National):

<http://www.na.fs.fed.us/spfo/fhm>

USDA Animal and Plant Health Inspection Service:

<http://www.aphis.usda.gov>

Western Forestry Leadership Coalition:

http://www.wflccenter.org/index_flash.html

Appendix E

Information Available From Statewide Aerial Surveys

Each year, forest damage surveys are conducted over approximately 25–35 million acres. This annual survey is a cooperative effort between USDA Forest Service, State and Private Forestry, Forest Health Protection (S&PF/FHP) and State of Alaska, Department of Natural Resources, Division of Forestry (AKDNR/DOF) forest health staffs to assess general forest conditions on Alaska's 129 million acres of forested area. About 25 percent of Alaska's forested area is covered each summer using fixed-wing aircraft and trained observers to prepare a set of sketch-maps depicting the extent (polygons) of various types of forest damage including recent bark beetle mortality, various hardwood and conifer defoliation, and abiotic damage such as yellow-cedar decline. A number of other damage types are noted including flooding, wind damage, and landslide areas during the survey. The extent of many significant forest tree diseases, such as stem and root decays, are not estimated from aerial surveys since this damage is not visible from aerial surveys as compared to the pronounced red topped crowns of bark beetle-killed trees.

Forest damage information has traditionally been sketched on 1:250,000 scale USGS quadrangle maps at a relatively small scale. For example, at this scale one inch would equal approximately four miles distance on the ground. When cooperators request specialized surveys, larger scale maps are sometimes used for specific areas to provide more detailed assessments. A digital sketch mapping system, augmented with paper maps, has been used in recent years. This system displays the sketch mapper'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 include more accurate and resolute damage polygon placement and a shorter turnaround time for processing and reporting data. In 2004 the digital sketch map systems were used for 95 percent of the surveys.

Due to the short Alaska summers, long distances required, high airplane rental costs, and the short time frame when the common pest damage signs and tree symptoms are most evident (i.e., usually only during July and August), sketch mappers must strike a balance to efficiently cover the highest priority areas with available personnel schedules and funding.

Prior to the annual statewide forest conditions survey, letters are sent to various State and Federal agencies and other landowner partners for survey nominations. The Federal and State biological technicians and entomologists decide which areas are the highest priorities 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.

Information listed in this Appendix is a sample of the types of products that can be prepared from the statewide surveys and GIS databases that are available. The survey data is available at <http://agdc.usgs.gov/data/projects/fhm>.

Submit data and map information requests to:

Roger Burnside, Entomologist
State of Alaska Department of Natural Resources
Division of Forestry, Central Office, Resource Section
550 W. 7th Avenue, Suite 1450
Anchorage, Alaska 99501-3566
Phone: (907) 269-8460
Fax: (907) 269-8902
E-mail: rogerb@dnr.state.ak.us

Dustin Wittwer, Bio-technician
USDA Forest Service, State & Private Forestry
Forest Health Protection
2770 Sherwood Lane, Suite 2A
Juneau, Alaska 99801
Phone: (9907) 586-7971
Fax: (907) 586-7848
E-mail: dwittwer@fs.fed.us

Forest Health Map information included in this report:

- ▲ Aerial Detection Survey, 2004, Significant Pest Activity, 11x17 inch format, depicting aspen leaf miner, active yellow-cedar decline, spruce budworm, engraver beetle, birch leaf miner, and spruce beetle (color; showing enhanced representation of damage areas).
- ▲ 2004 Alaska Forest Damage Surveys Flight Lines and Major Alaska Landownership Blocks (includes table listing acres surveyed by landowner based on flight lines flown for the 2004 aerial surveys).
- ▲ Kenai Peninsula Region Spruce Beetle Activity 1993–2004, 8 x 11 inch format, depicting sequential 2 year intervals of spruce beetle activity in south-central Alaska, including the Kenai Peninsula, Cook Inlet area to Anchorage, and Talkeetna (includes vegetation base layer).
- ▲ The Spruce Beetle Outbreak: Year 2004, 8 x 11 inch format, depicting 2004 damage in red and prior damage, 1989-2003 in yellow (includes color shaded relief base showing extent of forest landscape and sample photos of spruce beetle impact).
- ▲ Southeast Alaska Cedar Decline 2004 Aerial Detection Surveys, 8 x 11 inch format, depicting cumulative Alaska yellow-cedar decline over several years and points of current activity. Forested areas are delineated with color shaded relief background.
- ▲ Birch Leaf Miner, 8 x 11 inch format, depicting 2004 birch defoliation in the Fairbanks vicinity extending south to Eielson AFB. The map displays road survey data points divided into 5 colored intensity categories.
- ▲ 2004 Anchorage Bowl Locations, Exotic Insect Monitoring, 8 x 11 inch format showing monitoring location of Amber-marked birch leaf miner, gypsy moth, nun moth, and various woodborers.
- ▲ Spruce Budworm in Interior Alaska, 8 x 11 inch format, depicting current (red) and historical (orange) spruce budworm defoliation, mostly on the Tanana and upper Yukon Rivers.
- ▲ Distribution of six invasive weed in the Anchorage basin, 5 x 7 inch format, shows survey results of seven important invasive weeds from 2002–2004.
- ▲ Southeast Alaska invasive weed inventory, 2004, 8 x 11 inch format showing locations of some common and important invasive weeds in Southeast Alaska.

Map and GIS products available upon request:

- ▲ Digital data file of 2004 forest damage coverage in ArcInfo cover or ArcView shape file (ESRI, Inc.) format. GIS data files are available at the following URL: <http://agdc.usgs.gov/data/projects/fhm/>.
- ▲ An electronic version of this report, including maps and images, will be available at the Alaska USFS, State & Private Forestry, Forest Health Protection web site (URL: <http://www.fs.fed.us/r10/spf/fhp>)
- ▲ Cumulative forest damage or specific-purpose damage maps prepared from AK/DOF or AK USFS, S&PF, FHP geographic information system database.

Map 13. USGS 1:250,000 Map Index for Aerial Surveys.

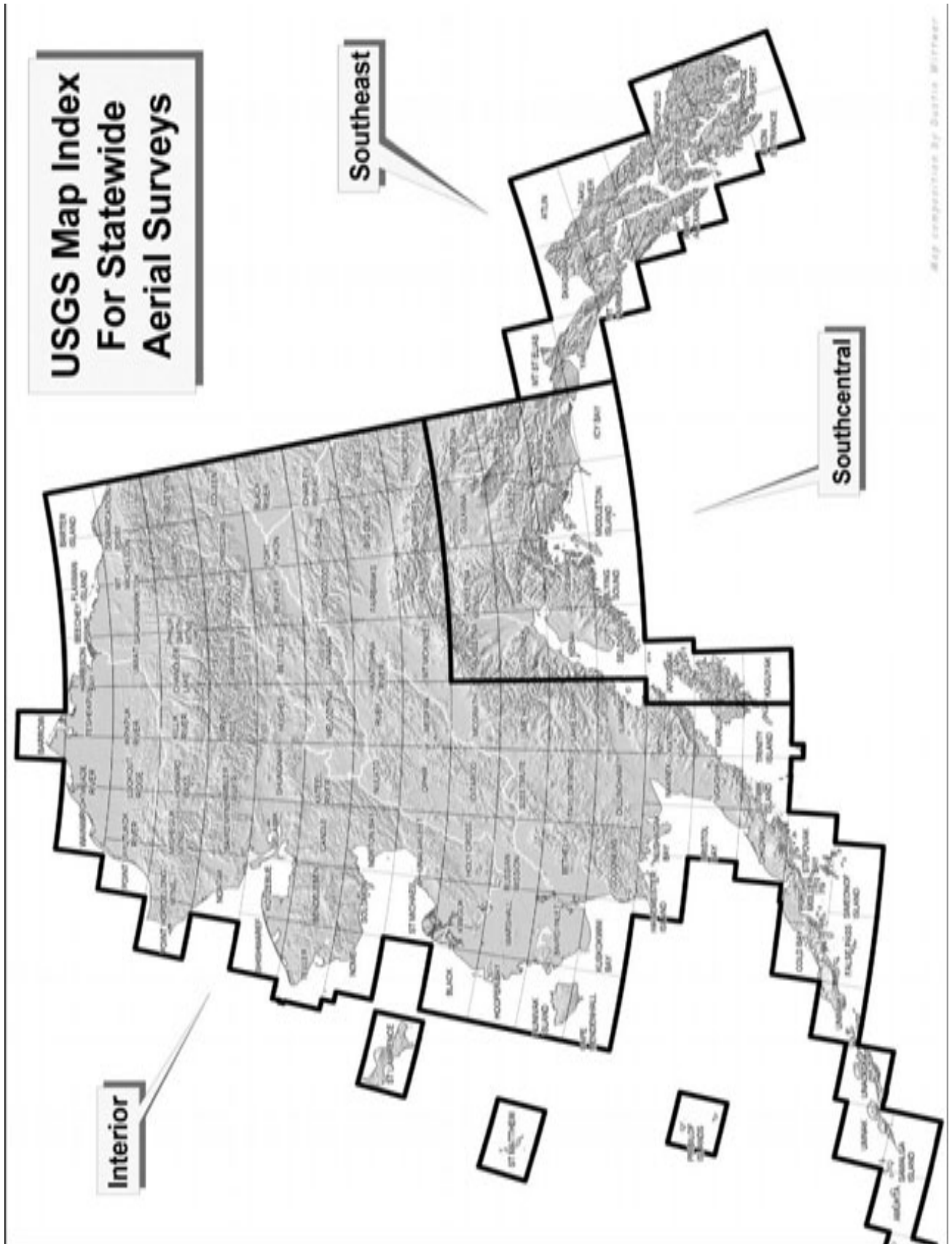


Table 7. Quadrangle and corresponding acres flown during 2004 statewide aerial surveys

South-central Alaska		Interior Alaska		
	Anchorage	1,212,967	* Ambler River	122,677
*	Bering Glacier	147,743	Baird Mtns	365,012
*	Blying Sound	3,299	Beaver	372,814
	Cordova	378,011	* Bendeleben	189,163
*	Gulkana	175,338	Bethel	85,701
*	Icy Bay	55,128	Bettles	514,868
	Kenai	994,957	Big Delta	989,774
	Mccarthy	184,344	Black River	273,662
	Nabesna	214,276	* Chandalar	212,977
	Seldovia	401,439	Charley River	332,622
	Seward	1,075,633	* Christian	33,260
	Talkeetna	818,570	Circle	518,694
	Talkeetna Mtns	234,632	Coleen	48,429
	Tyonek	1,283,449	Dillingham	796,634
	Valdez	666,763	Eagle	202,608
Southeast Alaska		Fairbanks	1,645,241	
	Atlin	5,154	Fort Yukon	807,610
*	Bradfield Canal	491,361	Goodnews	157,666
	Craig	829,210	Healy	822,956
	Dixon Entrance	105,971	Holy Cross	461,874
	Juneau	627,469	Hughes	343,233
	Ketchikan	877,176	Iditarod	372,669
	Mt Fairweather	200,834	Iliamna	461,717
*	Mt St Elias	14,313	Kantishna River	1,109,021
	Petersburg	1,213,919	* Kotzebue	90,498
	Port Alexander	389,869	Lake Clark	285,997
	Prince Rupert	7,067	Lime Hills	335,996
	Sitka	752,525	Livengood	1,791,365
	Skagway	440,543	Mcgrath	877,118
	Sumdum	327,952	Medfra	472,661
*	Taku River	98,306	* Melozitna	293,348
	Yakutat	482,493	* Misheguk Mtns	14,575
			Mt Hayes	280,989
			Mt Katmai	238,314
			Mt Mckinley	927,829
			Naknek	126,886
			* Noatak	238,891
			* Norton Bay	165,145
			* Nulato	259,824
			* Nushagak Bay	593
			* Ophir	293
			Ruby	517,442
			Russian Mission	257,748
			* Selawik	69,038
			* Shungnak	116,189
			Sleetmute	560,293
			Solomon	172,049
			Survey Pass	169,521
			Tanacross	440,435
			Tanana	691,958
			* Taylor Mtns	253,952
			Unalakleet	442,573
			* Wiseman	199,635

*Quads without insect damage reported for 2004 are marked with an asterisk.

Table 8. Tree damage codes used in 1989-2004 aerial surveys and GIS map products.

Code	Agent	Code	Agent
* ADL	Alder decline	* HSF	Hemlock sawfly
ALB	Aspen leaf blight	HTB	Hardwood top breakage
* ALD	Alder defoliation	HWD	Hardwood defoliation
* ALM	Aspen leaf miner	IPB	IPS and SPB
* ALR	Alder leaf roller	* IPS	Ips engraver beetle
* ASD	Aspen defoliation	* LAB	Larch beetle
ASF	Alder sawfly	* LAS	Larch sawfly
BAP	Birch aphid	* LAT	Large aspen tortrix
* BHB	Black-headed budworm	LBM	Larch budmoth
BHS	BHB/HSF	OUT	Out (island of no damage)
* BID	Birch defoliation	* POD	Porcupine damage
* BLM	Birch leaf miner	SBM	Spruce/Larch budmoth
* BLR	Birch leaf roller	* SBR	Spruce broom rust
BSB	BHB/SPB	* SBW	Spruce budworm
* CDL	Cedar decline	* SLD	Landslide/Avalanche
* CLB	Cottonwood leaf beetle	SMB	Spear-marked black moth
* CLM	Cottonwood leaf miner	* SNA	Spruce needle aphid
* CLR	Cottonwood leaf roller	SNC	Spruce needle cast
* COD	Conifer defoliation	* SNR	Spruce needle rust
CTB	Conifer top breakage	* SPB	Spruce beetle
* CWD	Cottonwood defoliation	SPC	SPB and CLB
* CWW	CWD and WID	* WID	Willow defoliation
FIR	Fire damage	WIR	Willow rust
* FLO	Flooding/high-water damage	* WLM	Willow leaf blotch miner
* FRB	Subalpine fir beetle	WNT	Winter damage
HCK	Hemlock canker	* WTH	Windthrow/Blowdown
HLO	Hemlock looper		

*The codes used for 2004 aerial surveys and GIS maps are marked with an asterisk.

Note: In the digital data all insect and disease activity has an intensity attribute. Agents typically resulting in defoliation or discoloration are attributed with a High, Medium or Low. Agents typically resulting in mortality are attributed with a tree per acre estimate. Digital data and metadata can be found at the following URLs: <http://agdc.usgs.gov/data/projects/fhm/> or <http://www.fs.fed.us/r10/spf/fhp>

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