DECLINES AND ABIOTIC FACTORS

Yellow-cedar Decline

Decline and mortality of yellow-cedar persists as one of the most spectacular forest problems in Alaska. Approximately 478,453 acres of decline have been mapped during aerial detection surveys. Concentrated mortality occurs in a wide band from western Chichagof and Baranof Islands to the Ketchikan area (M4).

All research suggests that contagious organisms are not the primary cause for 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:

- Toxins are produced by decomposition in the wet, organic soils, or
- Shallow fine roots are damaged from freezing, associated with climatic warming and reduced insulating snowpack in the last century.

These hypotheses are developed in some detail (Hennon and Shaw 1994, 1997). Interestingly, considerable concentrations of newly-killed trees were evident in declining forests during 1996 and 1997, perhaps a response to the unusually prolonged cold temperatures with little snowpack that persisted during the previous two winters. Whatever the primary cause of this mysterious decline, all available information indicates that it is probably a naturally-occurring phenomenon. We are now monitoring soil temperature and hydrology in one area to evaluate these ideas.

Research suggests that the total acreage of yellow-cedar decline has been increasing very gradually; the slow increase in area has been a result of the expansion of existing decline (<3 feet/year). Most stands contain trees that died up to 100 years ago (snags still standing), as well as recently killed cedars, dying cedars (with yellow, red, or thinning crowns), healthy cedars, and other tree species.

Ground surveys show that 65% of the basal area of yellow-cedar is dead on this acreage. Other tree species are affected in different ways: on some sites they produce increased growth, presumably due to less competition, and on other sites they experience slowed growth and mortality due to deteriorating site conditions (poor drainage). Species change to western hemlock and mountain hemlock and large increases in understory biomass accumulation for brushy species appear to be occurring in some stands where decline has been ongoing for up to a century.

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. The creation of numerous snags is probably not particularly beneficial to cavity-using animals because yellow-cedar wood is less susceptible to decay. Region-wide, this excessive mortality of yellow-cedar may lead to diminishing populations (but not extinction) of yellow-cedar, particularly when the poor regeneration of the species is considered.

Figure 29. Dead yellow-cedar trees dominate some stands in southeast Alaska.

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.

Little is known about wildlife use and dependency on yellow-cedar forests. We would like to evaluate birds' use of each of the snag classes as nesting or feeding habitat. In a companion study that we have initiated, we are investigating the insect community on dead cedars; insects on recently killed trees may be an important prey source for insectivorous birds.

Table 7. Acreage affected by yellow-cedar decline in southeast Alaska in 2000 by ownership

	Acres
NATIONAL FOREST LAND	***437,444***
Chatham Area Total	***116,724***
Juneau Ranger District	865
Hoonah Ranger District	977
Sitka Ranger District	
Chichagof I	33,802
Baranof I	48,754
Kruzof I	26,905
Sub-total	109,461
Admiralty Island Nat'l Mon. Wilderness	5,421
Stikine Area Total	***197,711***
Petersburg Ranger District	
Kupreanof I	72,786
Kuiu I	65,976
Mitkof I	5,221
Woewodski I	2,316
Mainland	8,419
Sub-total	154,718
Wrangell Ranger District	
Etolin I	16,169
Wrangell I	9,151
Zarembo I	4,209
Woronofski I	441
Mainland	13,023
Sub-total	42,993
Ketchikan Area Total	***123,009***
Craig Ranger District	
Prince of Wales I	23,957
Dall I & Sumez I	1549
Noyes I, Baker I & Lulu I	1,081
SukkwanI & Long I	557
Sub-total	27,144
Ketchikan Ranger District	
Revillagigedo I	14,608
Gravina I & Duke I	826
Mainland	13,748
Sub-total	29,182

Ketchikan Area (continued)	Acres
Thorne Bay Ranger District	
Prince of Wales I	28,431
Kosciusko I	10,349
Heceta I	754
Coronation I & Warren I	1,414
Sub-total	40,948
Misty Fjords Nat'l Mon. Wilderness	
Revillagigedo I	8,990
Mainland	16,745
Sub-total	25,735
NATIVE LAND	***19,130***
Prince of Wales I	8,281
Dall and Sumez I	721
Kupreanof I	4,358
Baranof and Kruzof I	390
Chichagof I	871
Revillagigedo I	2,285
Annette I	971
Kuiu I	99
Mainland	877
Noyes I, Baker I, & Lulu I	239
Sukkwan I & Long I	38
STATE & PRIVATE LAND	***21,557***
Admiralty I	9
Baranof I	3,101
Dall and Sumez I	61
Chichagof I	1,110
Gravina I	1,087
Mitkof I	1,392
Kosciusko I	117
Kuiu I	764
Kupreanof I	1,458
Prince of Wales I	3,942
Wrangell area	1,227
Revillagigedo	3,744
Kruzof I	298
Other Mainland	3,247
Other Federal	***322***
Baranof I	322
Total Land Affected	***478,453****

*Acreage by ownership was tabulated using Alaska land status data from State of AK, Department of Natural Resources. In prior years a different ownership layer was used to tabulate this information. Other changes in acreage figures are due to a change in the resource, refined sketch-mapping or changes in GIS techniques.

Avalanche Damage

The winter of 1999-2000 was noted nationally for the number of avalanches that occurred in Alaska. Many areas that experienced avalanches are what experts call “one-in a hundred year” (where an avalanche occurs approximately every 100 years) chutes. Within that 100-year time span, many of these chutes become forested and the force of the avalanche snaps those trees in its path. While many of the trees killed were hardwoods, some were also spruce. With the high population of spruce beetle already in south-central Alaska, these dead spruce trees might serve as ideal breeding habitat.

Water Damage

Flood damage was minimal in 2000. Approximately 452 acres were noted in 17 scattered locations across the state. Flood damage is expected to increase in 2001 due to high water flow noted in the Matanuska – Susitna River valley (B5) in July 2000. This is not uncommon as flood damage occurs annually to conifer and hardwood stands adjacent to rivers and lakes on the Alaska mainland.

Hemlock Fluting

Deeply incised grooves and ridges extending vertically along boles of western hemlock characterize hemlock fluting. 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. Bole fluting is common on western hemlock in many areas of southeast Alaska. This condition reduces the value of hemlock logs because they yield less sawlog 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). The asymmetrical radial growth appears to be caused by unequal distribution of carbohydrates due to the presence of dead branches. Researchers have documented the development of fluting in young hemlock stands that regenerated following clearcut harvesting or other disturbance. 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 windfirmness. 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).

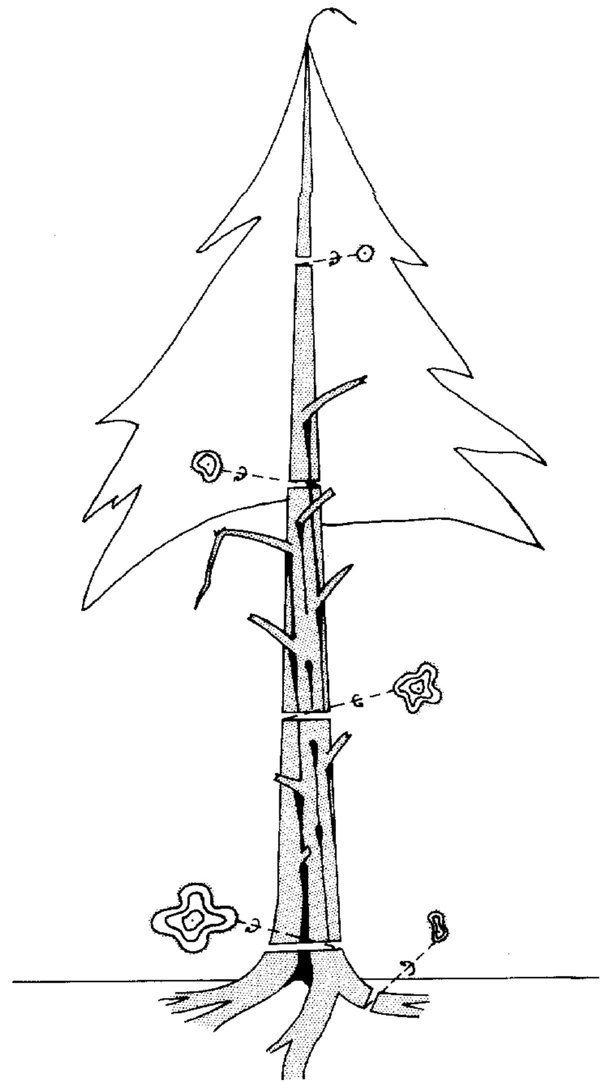


Figure 30. Hemlock fluting branches disrupt the vertical flow of carbohydrate in the stem causing annual rings to become asymmetrical. Flutes originate beneath decadent branches and extend downward, forming long grooves where other branches are intersected. ***(Figure and caption from Julin, K.R.; Farr, W.A. 1989. Stem Fluting of Western Hemlock in Southeast Alaska).***

STATUS OF ANIMAL DAMAGE

Moose

Alces alces

At many locations across south-central and interior Alaska, moose damage hardwoods by repeatedly browsing stems and wounding tree boles. Heavy, repeated browsing on the bole of live trees, particularly aspen and willow, results in broken branches, wounds and stunted malformed stems. Wood decay fungi are known to invade trunk wounds caused by moose.

Snowshoe Hare

***Lepus* sp.**

Bole wounds, terminal and lateral bud damage, and seedling mortality were attributed to browsing by snowshoe hares on hardwoods and conifers in the interior this year. Old damage to mature trees and new damage to seedlings was evident in surveys of pre-commercially thinned white spruce stands near Tok. Years ago, hare browsing killed the main stem; the characteristic angled browse mark is still evident on the dead leader. Live mature trees retain the dead leader but have a pronounced stem crook at the point where a lateral branch became dominant following leader death. The dead leaders provided an infection court for heart rot decay by *Phellinus chrysoloma*. New terminal and lateral bud browsing was evident on white spruce, paper birch, and aspen seedlings across the Interior. Recovery potential of trees following severe browsing in not known.

Porcupine

Erethizon dorsatum

Porcupines cause severe damage to Sitka spruce and western hemlock trees in numerous local areas of southeast Alaska. An extensive survey has documented the level of porcupine damage in young-growth stands. Feeding injuries to trees are confined to the known distribution of porcupine. Damage is especially serious on Mitkof Island in southeast Alaska. Other damage has been noted at Thomas Bay, Cleveland Peninsula, Bradfield Canal, Anita Bay and other areas of Etolin Island, Douglas Island, and the Juneau area (M4). Porcupines also damage trees throughout interior Alaska. Bark beetles, including *Ips* spp., have been found infesting the damaged trees.

In southeast Alaska, the feeding behavior of porcupines changes as forests develop and trees become larger and older. Porcupines climb smaller trees and kill or cause topkill by removing bark along the entire bole, or the bole near the top of the tree. As trees become larger, around 40-50 years old, most of the damage is in the form of basal wounding. Most of these larger trees are not killed, but the large basal scars allow fungi to enter the bole and begin to cause wood decay.

The primary ecological consequences of porcupine feeding are: (1) to provide greater diversity of structure and vegetation in young, even-aged conifer stands through mortality and (2) to provide greater levels of heart rot decay by wounding older trees. This latter effect can alter mortality patterns in old forests as trees may often die through bole breakage.

Bear

Ursus arctos
Ursus americanus

Yellow-cedar trees were wounded in the spring by brown bears on Baranof and Chichagof Islands (M4). Brown bears rip the bark away from the lower boles of these trees, apparently to lick the sweet cambium. The majority of yellow-cedar trees in some stands have basal wounds from bear feeding. Other tree species in southeast Alaska are unaffected. Black bears caused injury to the lower boles of white and Lutz spruce and occasionally aspen in the lowland forests of the Kenai Peninsula (B5). Trees with old scars may have associated columns of wood decay.

APPENDICES

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." Current IPM activities in Region 10 include:

- Participation in a cooperative effort with the Alaska Cooperative Extension Service (ACES) to provide pest management information to Alaska residents. The program, which completed its 20th season, includes education, research and survey activities, 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 2000, IPM Technicians were located in Fairbanks, Delta, Palmer, Anchorage, and Soldotna. The Anchorage office had two full time technicians; the remaining locations had one seasonal IPM Technician from May through the end of September. The total recorded client contacts reached more than 4500. Technicians conducted more than 1,200 educational contacts including workshops, more than sixty media contacts (newspaper articles, television and radio "spots"), more than 300 site visits, and more than 2,500 clients assisted via phone calls and walk-in requests. More than 50% of the IPM Technician activities occurred in the Anchorage Bowl; home to over 40% of the state population.

- A spruce beetle antiaggregant (MCH) field study utilizing a new release system developed by Med-E-Cell (San Diego, CA) was undertaken in 2000. MCH is precisely released into the atmosphere with this device that is powered by a programmable battery. Previous MCH field studies used release devices that were dependent upon ambient temperature for the release of MCH. Thus, the amount of MCH being released varied significantly from day to day resulting with disappointing results. The 2000 field study was successful; plots treated with MCH delivered through the Med-E-Cell device averaged less than two attacked trees per acre. Untreated plots averaged ten attacked trees per acre. We will continue to test this release device in 2001.

- The attractant semiochemical blend of *Ips perturbatus* was determined from field and laboratory studies to be a combination of *cis*-verbenol, ipsdienol, and ipsenol. Laboratory analysis determined that adult *I. perturbatus* also produce verbenone; a known anti-aggregant semiochemical of other species of *Ips*. A field test was conducted in 2000 with the objective of determining the effectiveness of verbenone as an anti-aggregant. The addition of verbenone to traps baited with the attractant semiochemical blend significantly reduced (by a factor of ten) the number of beetles trapped. We plan to conduct another field study in 2001 using a slow release formulation of verbenone to deter dispersing *Ips* beetles from attacking fresh logging debris.

- A field survey and retrospective study is currently underway on the Kenai Peninsula to determine impacts of primary and secondary bark beetles on residual spruce in harvested stands and stands that have received heavy spruce beetle mortality during the 10 plus year epidemic.

- Yellow-cedar wood is often devalued because of dark-staining. Some evidence suggests that insects are involved in introducing a dark-staining fungus. Wood boring insect tunnels of woodwasps were found in association with the dark stained areas. Since these wood wasps are believed to have only a one year life cycle, many of them can be reared from infested logs and isolations can be made from the sac at the base of the ovipositor (of the females). It can then be determined if dark-stain fungi are being inoculated into trees at the time of egg laying. Wood wasps in other tree species are known to introduce decay fungi. Isolations reveled *Sporidesmium* sp. and *Phialophora melinii* as two of the most common dark fungi.

- The spread and intensification of hemlock dwarf mistletoe is currently under study in even-aged stands, stands that have received different selective harvest treatments, and stands that experienced extensive wind damage in the 1880s. Plots within these stands have been used to quantify the short, medium, and long-term effects of the disease under different selective harvesting strategies. Results show a substantial difference by stand management. Impact of the disease is light to absent in later developmental stages of even-aged forests but can be severe in forests under some forms of selective harvesting. This indicates a wide range of disease severity that can be related to simple measures of inoculum load at the time of harvest. Distances and intensities of spread are being determined to provide information so that managers can design appropriate harvesting scenarios in relation to expected disease levels. The influence of the disease on tree growth and mortality is also under investigation.

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);
    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 screw-top vials or bottles containing at least 70% isopropyl (rubbing) alcohol and 30% water. Make certain the bottles are sealed well. Include in each vial adequate information, or a code, relating the sample to the written description and information. Labels inserted in the vial should be written on with pencil or India ink. Do not use a ballpoint pen, as the ink is not permanent.
    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: Insect-disease specimens enclosed. For scientific purposes only. No commercial value."

BIOLOGICAL EVALUATIONS, TECHNICAL REPORTS, AND PUBLICATIONS

Campbell, S., Dale, J., Hooper, C., Ripley, K., Schulz, B. 2000. Forest Health in West Coast Forests 1997-1999. Salem, OR: Oregon Department of Forestry. 76 p.

DeGroot, Rodney C.; Woodward, Bessie; Hennon, Paul E. 1999. Natural decay resistance of heartwood from dead, standing yellow-cedar trees: laboratory evaluations. Forest Products Journal 50: 53-59.

Hennon, P.E.; McWilliams, M.J. 1999. Symptoms do not develop in yellow-cedar grafted from dying trees. Can. J. For. Res. 29: 1985-1988.

Hennon,P.E.; Rajchenberg, M. 2000. El mal del cipres: algunas observaciones, compariciones e ideas. Patagonia Forestal (Esquel, Argentina) 6(2): 4-6. In Spanish.

Hennon, P.E.; Trummer, L.M. 2001. Yellow-cedar (Chamaecyparis nootkatensis) at the northwest limits of its natural range in Prince William Sound, Alaska. Northwest Science. Vol. 75: 61-71.

Hennon, P.E.; Wittwer, D.; Stevens, J.; Kilborn, K. 2000. Pattern of deterioration and recovery of wood from dead yellow-cedar in southeast Alaska. Western Journal of Applied Forestry. 15: 49-58.

Holsten, E.H., Burnside, R.E., and S.J. Seybold. 2000. Attractant semiochemicals of the engraver beetle, Ips perturbatus, in south-central and interior Alaska. USDA Forest Service, Pacific Northwest Research Station research paper PNW-RP-529, Portland, OR. 9 p.

Holsten, E.H. 2000. Evaluation of larch sawfly damage and spruce blowdown: Innoko National Wildlife Refuge. USDA Forest Service, Alaska Region Biological Evaluation R10-TP-88. 11 p.

Lewis, K.; Trummer, L. 2000. Tomentosus root rot: Comparisons of disease expression and management between Alaska and British Columbia, Canada. USDA Forest Service, Alaska Region, FHP. Gen. Tech. Rep. R10-TP-83. 16 p.

McClellan, Michael H.; Swanston, Douglas N.; Hennon, Paul E.; Deal, Robert L.; Willson, Mary F.; Wipfli, Mark S. 2000. Alternatives to clearcutting in the old-growth forests of southeast Alaska: study plan and establishment report. Gen. Tech. Rep. PNW-GTR-494. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Rose, C.; Sorenson, R. 2000. Alaska Integrated Pest Management Statewide Technician Activities. 2000, yearend report – Anchorage District and Overall Statewide Statistics. University of Alaska. Cooperative Extension Service.

Schultz, M.E.; P.E. Hennon, and D.T. Wittwer. 2000. Glacier Bay National Park Long-Term Spruce Beetle Mortality Plot Results. R10-TP-XX. In Press.

Schulz, B. 2000. Resurrection Creek Permanent Plots Revisited. USDA Forest Service Alaska Region. Technical Report R10-TP-89. Anchorage AK. 14p.

Wittwer, D.; Matthews, K.; Zogas, K.; Trummer, L.; Holsten, E.; Schulz, B.; Hennon, P.; Schultz, M.; Burnside, R.; Mortenson, D; Riggs J. 2000. Forest Insect and Disease Conditions in Alaska--1999. USDA Forest Service, Alaska Region, FHM. Gen. Tech. Rep. R10-TP-82. 55 p.

APPENDIX D

ALASKA ECOREGION DESCRIPTIONS

The ecoregions of Alaska and neighboring territories are briefly described below. These descriptions are abbreviated versions of those given by Nowacki and all (2000). They reflect the results of an interagency effort to unify the designations given in Gallant and all (1995) and Nowacki and Brock (1995). Climate, surficial geology, and vegetation communities are described in a tri-archical format.

Polar

Arctic Tundra: These open, wind-swept lands are gripped by polar conditions year around. Temperatures fluctuate substantially among seasons, though always cold. Mean monthly temperatures in the summer generally do not surpass 10^{o}C – a threshold that approximately delimits tree growth. The cold is reinforced by sea-ice that hugs the shorelines over much of the year. The severe atmospheric cold limits water-holding capacity, thus depriving this area of precipitation (<50cm/yr). Even so, surfaces are often moist or wet due to thick permafrost that impedes drainage. These high-latitude areas are covered by tundra dominated by tussock sedges, mosses and low shrubs.

> ***Beaufort Coastal Plain (P9):*** This treeless, wind-swept plain gradually ascends from the Arctic Ocean to the foothills of the Brooks Range. Unconsolidated deposits of marine, fluvial, and glacial origin overlay thick layers of continuous permafrost. There is a lack of bedrock control so the physiography is flat. The moist and wet sedge tussock tundra is comprised mainly of sedges, herbs, and mosses. Low shrubs occur mostly in small drainages where microtopography allows deeper rooting.
>
> ***Brooks Foothills (P1)*:** These dissected hills and ridges form the northern flank of the rugged Brooks Range as it descends toward the Beaufort Coastal Plain. The surface is underlain by thick continuous permafrost and displays ice-related features such as pingos, solifluction lobes, ice-wedge polyons, and stone stripes. Soils in the active permafrost layer are fairly wet. Moist tussock sedge tundra spans across the landscape interspersed with willow communities along river corridors.
>
> ***Brooks Range (P3):*** This rugged, east-west trending range represents the northern extension of the Rocky Mountains. The dry polar climate coupled with underlying permafrost make growing conditions difficult for plant life, particularly at high elevations or on steep slopes with active scree movement. Alpine, moist, and tussock tundra of lichens, sedges, and ericaceous plants exist where conditions permit (lower summits and mountainsides). The arctic tree line enters larger drainages along the south portion of the Brooks Range. Here, taller shrub communities fringe these forested valleys.

Bering Tundra: These wind-swept lands occur in and adjacent to the Bering Sea. Here, the sea influences the polar climate only a limited extent (slight temperature moderation and increase in summer precipitation) because of its inherent coldness and long presence of sea ice during the year. With sea ice descends a common Arctic denizen, the polar bear, into the northern reaches of the Bering Sea. Temperatures are cold year around allowing, for the most part, only low growing tundra vegetation to grow. Scattered patches of spruce occur along rivers in the eastern portion of the region.

> ***Kotzebue Sound Lowlands (P5):*** Shaped by past sea-level fluctuations, the land was once connected to Siberia and formed a part of a large unglaciated area called Beringia during glacial periods when water was locked in continental ice sheets and sea levels were low. Today, this flat plain of marine sediments, deltas, and low-lying glacial till is limited to a rim of lowlands surrounding the Kotzebue Sound. Much of the area is covered by a thick loess blanket blown off nearby outwash plains during glacial periods. Thawing permafrost is widespread, creating a thaw-lake cycle that forms a diverse mosaic of wetlands including marshes, wet meadows, riparian shrublands, and intervening ridges with tussock tundra as lakes form and drain, and ground ice aggrades in the exposed sediments.
>
> ***Seward Peninsula (P4):*** This cold, wind-swept landmass jutting out into the Bering Sea represents the southernmost haunt of polar bears on mainland Alaska. Sedimentary, metamorphic, and volcanic rocks intertwine to form a landscape mosaic of coastal lowlands, expansive convex hills with scattered broad valleys, and small, isolated groups of rugged mountains. Vegetation is principally tundra, with alpine Dryas-

lichen tundra and barrens at high elevations and moist sedge-tussock tundra at lower elevations. Patches of low-growing ericaceous and willow-birch shrubs occur on better-drained areas. Scattered spruce occur along river drainages on the extreme eastern edge of the region. Permafrost is continuous but oscillates from thin to moderately thick. Soils are often wet, shallow, and organic due to permafrost.

Bering Sea Islands (P7): These treeless rocky volcanic islands are scattered thoughout shallow portions of the Bering Sea. Here, a peculiar mix of polar and maritime climates exist dependent on season. Thin to moderately thick permafrost underlies mainly thin, rocky soils. Moist tundra communities of sedges, grasses, low shrubs and lichens are surrounded by rocky cliffs and shorelines.

Bering Taiga: These open coastal areas bordering the Bering Sea are dominated by cold, seasonally-moist, subpolar conditions. During the summer, moisture is derived from the adjacent Bering Sea and carried on land by the prevailing westerlies. Summers are sufficiently long and warm enough to allow patches of stunted trees (i.e., taiga) to grow primarily along rivers and streams. However, summer warming is tempered by the cold prevailing winds off the Bering Sea.

***Nulato Hills (P2)*:** These low-rolling hills are the remains of an ancient mountain range after extended periods of downcutting, weathering, and erosion. East of Norton Sound, these hills ripple inland in a southwest-northeast orientation with streams flowing in intervening valleys. Vegetation patterns generally follow the terrain, with alpine Dryas-lichen tundra and moist sedge-tussock tundra on hilltops grading into short then tall willow-birch-alder shrublands and eventually spruce woodlands at progressively lower elevations. Permafrost is continuous but oscillates from thin to moderately thick.

Yukon-Kuskokwim Delta (P8): The Yukon and Kuskokwim rivers nourish this vast marshy plain as they fan out to meet the Bering Sea. Marine sediments and alluvium principally underlie this flat, lake-studded lowland. Isolated basalt hills and volcanic cinder cones jut up in places. Moderately thick to thin permafrost underlies wet and shallow organic soils. Many low-gradient streams meander dynamically across the surface. Moist tundra communities of sedge, herbs, grasses and lichens predominate with shrubs and scattered trees occurring near rivers and on hills.

Ahklun Mountains (P10): This coastal group of rugged steep-walled mountains spans two expansive wetland complexes (Yukon-Kuskokwim Delta and Bristol Bay Lowlands) along the southern Bering Sea. Here, mountain glaciers coalesced during the Pleistocene ice age and carved many broad U-shaped valleys. On the south side of the mountains, these valleys have subsequently filled with water forming large "finger" lakes. Dwarf shrub-lichen tundra dominates mountain crests and upper slopes where permafrost is discontinuous. Shrubs (willows, birches, and alders) become progressively more abundant and robust at lower elevations as permafrost becomes more fragmented. In valleys, shrublands are punctuated by sedge-tussock tundra meadows and mixed forests.

***Bristol Bay Lowlands (P6)*:** This flat to gently-rolling lowland is comprised mainly of glacial till and outwash deposited by various Pleistocene glaciers from the surrounding Ahklun Mountains and Aleutian Range. This basin is underlain with mixes of glacial, alluvial, and marine sediments all cloaked with varying amounts of loess. Permafrost occurs in scattered isolated masses. Wet organic soils support low and dwarf shrub communities of willow, birch, and alder. Mosses and lichens are abundant groundcovers.

Boreal

Intermontane Boreal: These areas experience extreme seasonal temperature changes from long, cold winters to short, moderately-warm summers. Boreal woodlands and forests cover much of this undulating landscape. The continental climate is fairly dry throughout the year and forest fires rage during summer droughts. This intermontane terrain sandwiched between the Brooks and Alaska Ranges remained largely ice-free during the last ice age, forming part of the "Beringia Corridor".

Kobuk Ridges and Valleys (B12): A series of paralleling ridges and valleys radiate southwards from the Brooks Ranges. Permafrost of thin to moderate thickness underlies most of the area. Forests and woodlands dominate much of valley bottoms and mountainsides with black spruce in wetland bogs, white spruce and balsam poplar along rivers, and white spruce, birch, and aspen on well-drained uplands. Tall and short shrublands of willow, birch, and alder communities occur in ridges. Trees become increasingly sparse, less robust, and restricted to lower elevations in the west – here forest succession is slowly progressing along rivers (e.g., lower Noatak River).

Ray Mountains (B2): The Ray Mountains are an overlapping series of compact, east-west trending ranges underlain by Ruby terrane. The metamorphic bedrock is usually covered with rubble and soils are subsequently shallow and rocky. Permafrost is generally discontinuous and ranges from thin to moderate thickness. Open scrubby forests of spruce and aspen interspersed with tall shrublands prevail over much of the area. Low shrubs and alpine tundra progressively dominate at higher elevations. Forest fires are common in the summer.

Davidson Mountains (B14): Along the south flank of the eastern Brooks Range lie rugged mountains dissected by broad floodplains of glacial origin. The mountains are draped by course rubble whereas river valleys and floodplains are lined with unconsolidated glacial and alluvial sediments. Continuous permafrost from thin to moderate thickness underlies most of the area. Boreal forests cover much of the terrain with black spruce in bogs, white spruce and balsam poplar along rivers, and white spruce, birch and aspen on uplands. Tall willow, birch, and alder communities also occur. Forest fires are frequent.

Yukon-Old Crow Basin (B6): This gently-sloping basin along the Porcupine River is comprised of terraces, hilly moraines, and mountain toeslopes that ring the Yukon and Old Crow Flats. The marshy flats have developed in deep alluvial and glaciolacustrine deposits underlain by discontinuous permafrost. The poorly-drained flats and terraces harbor vast wetlands pockmarked with dense concentrations of thaw lakes and ponds. Opaque with glacial silts and shoreline mud, the Yukon River forms an aquatic maze of islands, sandbars, and back sloughs as it crisscrosses the lower flats. Vegetation varies with soil drainage grading from wet grass marshes and low shrub swamps to open black spruce forests to closed spruce-aspen-birch forests on better-drained uplands. Summer forest fires are common.

North Ogilvie Mountains(B15): This terrain consists of flat-topped hills and eroded remnants of a former plain. Sedimentary rocks, especially limestone, underlie most of the area. Shallow soils have developed in rocky colluvium on mountainsides where landslides, debris flows, and soil creep frequently occur. On lower slopes, soils are deeper, moister, and underlain by extensive permafrost. Low shrub tundra of willow, alder, and birch and aspen and spruce woodlands occur at lower elevations. These mountains are the source of many streams that eventually feed the Porcupine, Yukon, and Peel rivers. Lakes are relatively rare.

Yukon-Tanana Uplands (B13): These dissected mountains are of moderate height. The topography of smooth-topped ridges deeply incised by narrow valleys is indicative of a lack of glaciation in the past. Permafrost is discontinuous but widespread, and is particularly abundant on moist lower slopes and valley bottoms. This area straddles treeline with vegetation ranging from alpine tundra on ridges and upper slopes to boreal forests on lower slopes and valleys. Stunted black spruce woodlands occur on cold, north-facing slopes whereas mixed forests (spruce, aspen, birch, poplar) occur on warm south-facing slopes. This area includes the highest incidence of lightening strikes in the Yukon and forest fires are consequently frequent.

Tanana-Kuskokwim Lowlands (B10): This alluvial plain slopes gently northward from the Alaska Range. Streams flowing across this north-sloping plain ultimately drain into one of two large river systems -- the Tanana or Kuskokwim. Even though a rain shadow exists due to the neighboring Alaska Range, surface moisture is rather abundant due to the gentle topography and poor soil drainage due to underlying permafrost. Boreal forests dominate the landscape with black spruce in bogs, white spruce and balsam poplar along rivers, and white spruce, birch, and aspen on hills. Tall willow, birch, and alder communities are scattered throughout.

Yukon River Lowlands (B7): An expansive wetland system occurs along major rivers coursing through central Alaska. Deep deposits of undifferentiated sediments underlie these floodplains, lowlands, and intervening hills. Surface moisture is abundant due to the gentle grade, poor soil drainage, and presence of permafrost. Boreal forests dominate the landscape with black spruce in bogs, white spruce and balsam poplar along rivers, and white spruce, birch, and aspen on hills. Tall willow, birch, and alder communities are scattered throughout. Many flat organic surfaces are pockmarked with dense concentrations of lakes and ponds. This unit is distinguished from the Tanana-Kuskokwim Lowlands by having lower elevations, a slightly wetter climate, and more robust vegetation.

Kuskokwim Mountains (B11): This subdued terrain is comprised of old, low-rolling mountains that have eroded down largely without the aid of recent past glaciations. Mountains are composed of eroded bedrock and rubble whereas intervening valleys and lowlands are comprised of undifferentiated sediments. Thin to moderately thick permafrost underlies most of the area. Boreal forests dominate grading from white spruce, birch, and aspen on uplands to black spruce and tamarack in lowlands. Tall willow, birch, and alder shrub communities are scattered throughout, particularly where forest fires burned in the recent past. Rivers meander through this undulating landscape following fault lines and highly eroded bedrock seams.

Alaska Range Transition: Boreal forests occur within the basins and troughs fringed by the Alaska Range. This area is considered transitional since some climatic moderation is afforded by the nearby Pacific Ocean (i.e., maritime moisture). Ice sheets heavily scoured this area during the last glaciation and small ice caps and glaciers still exist at high elevations.

Lime Hills (B4): The Lime Hills are glacially-dissected mountains descending from the west side of the Alaska Range. The ridges and mountainsides are covered with colluvial rubble whereas the valleys contain glacial moraines and outwash with some alluvial deposits along rivers. The continental climate is moderated somewhat by maritime influences of the Bering Sea and North Pacific Ocean. The area is underlain by isolated masses of permafrost. Vegetation is predominately tall and low shrub communities of willow, birch, and alder. Spruce forests and woodlands confined to valley bottoms and mountain toeslopes.

Alaska Range (B3): A series of accreted terranes conveyed from the Pacific Ocean have fused to form this arcing mountain range. Landslides and avalanches frequently sweep the steep, scree-lined slopes. Discontinuous permafrost underlies shallow and rocky soils. Because of its height, a cold continental climate prevails and much of the area is barren of vegetation. Occasional streams of Pacific moisture are intercepted by the highest mountains and help feed small icefields and glaciers. Alpine tundra occurs on mid and upper slopes. Shrub communities of willow, birch, and alder occupy lower slopes and valley bottoms. Forests are relegated to the low-elevation drainages.

***Cook Inlet Basin (B5)*:** This gently-sloping lowland has been buried by ice and flooded by proglacial lakes several times during the Pleistocene. As such, the basin is comprised of fine-textured lacustrine deposits ringed by coarse-textured glacial tills and outwash. Numerous lakes, ponds, and wetlands occur. The basin is generally free of permafrost. A mix of maritime and continental climates prevail with moderate fluctuations of seasonal temperature and abundant precipitation. This climate coupled with the flat to gently-sloping, fine-texture surfaces give rise to wet, organic soils clothed with black spruce forests and woodlands. Ericaceous shrubs are dominant in open bogs. Mixed forests of white and Sitka spruce, aspen and birch occur on better-drained sites and grade into tall shrub communities of willow and alder on slopes along the periphery of the basin.

Copper River Basin (B8): This mountain basin lies within the former bed of Glacial Lake Ahtna on fine-textured lacustrine deposits ringed by coarse glacial tills. The basin is a large wetland complex underlain by thin to moderately thick permafrost and pockmarked with thaw lakes and ponds. A mix of low shrubs and black spruce forests and woodlands clothe the wet organic soils. Cottonwood, willow, and alder line rivers and streams as they braid or meander across the basin. Spring floods are common along drainages. The climate is strongly continental, with steep seasonal temperature variation. The basin acts as a cold-air sink and winter temperatures can get bitterly cold.

Coast Mountains Transition: The high mountains on the interior-side of the Coast Mountains are exposed to a peculiar mix of climates. Because of their sheer height, these mountains capture ocean-derived moisture as it passes inland. Yet, due to their proximity to the Interior, these mountains possess a fair degree of seasonal temperature change similar to a continental climate. Climatic influences change with elevation, with maritime conditions on mountaintops (feeding ice caps and glaciers) grading to continental conditions at their base (boreal forests).

Wrangell Mountains (B9): This volcanic cluster of towering, ice-clad mountains occurs at the northwest edge of the St. Elias Mountains. The Wrangell Mountains possess a peculiar mix of climates because of their size and geographic location (i.e., on the Interior-side of the Coastal Mountains). The abundant maritime snows feed extensive ice fields and glaciers interspersed by dull gray ridges draped with rock shard slopes and patches of alpine meadows. The climate grades to a dry continental at lower elevations where the Wrangell Mountains abut the cold-air basin of the Copper River. Shrublands of willow and alder with scattered spruce woodlands ring the lower slopes. Spruce and cottonwood occur along larger drainages. The Wrangell Mountains are highly dynamic due to active volcanism, avalanches, landslides, and stream erosion. Soils are thin and stony and underlain by discontinuous permafrost.

Kluane Range (B1): The Kluane Range encompasses the drier interior portion of the St. Elias Mountains spanning from the ablation zone (area where glacial ice melts faster than it accumulates) eastward to a fault line scarp along the Shakwak Valley. The area has a dry continental climate. It lies within a partial rainshadow of the St. Elias Mountains whereby moisture from the Pacific Ocean is effectively rung-out of the atmosphere on its accent over these towering peaks. The high-relief topography has been exposed to mass wasting, stream erosion and glacial scouring. Swift streams cascade down steep mountainsides where scree movement, rock falls, landslides, and soil creep actively occur. Permafrost is discontinuous. Vegetation is comprised principally of alpine tundra and barrens of lichens, prostrate willows, and ericaceous shrubs. Taller shrub communities occur at mid elevations. White spruce is found on lower slopes and valleys along the eastern boundary.

Maritime

Aleutian Meadows: This peninsula and associated island arc divides the cold and stormy waterbodies of the North Pacific Ocean and Bering Sea. Harsh weather conditions prevail over these exposed landscapes including high winds, persistent clouds, rain and fog, and salt spray. This volcanic arc, built along the Pacific Plate Subduction Zone, is one of the most seismically active in the world. The vegetation is comprised mainly of shrub and herbaceous plants that can tolerate the stressful growing conditions.

Alaska Peninsula (M7): The Aleutian Range serves as the spine of this peninsula which divides Bristol Bay from the North Pacific Ocean. The folded and faulted sandstone bedrock is dotted with symmetrical cinder cones clad with ice, pumice, and volcanic ash. Earthquakes are common and some of the most active volcanos on the continent occur here. The Pleistocene Glaciation has produced strongly contrasting topographies along this peninsula with smooth glacial moraines and colluvial shields on the north side and rugged deeply-cut fjordlands on the south side. Dominant vegetation is low shrublands of willow, birch, and alder interspersed with ericaceous/heath and Dryas-lichen communities. Alpine tundra and glaciers occur on mountaintops. Spruce forests occur along the shores at the mouth of Cook Inlet and within the northern reached of this region.

Aleutian Islands (M1): These fog-shrouded islands represent volcanic summits of a submarine ridge extending from the Alaska Peninsula to the Kamchatka Peninsula. It is one of the most seismically and volcanically active areas in the world. These islands are free of permafrost, covered by volcanic-ash soils, and dissected radially by short, swift streams. Terrestrial warming is subdued by incessant cold ocean winds and perpetual overcast clouds and fog, which limits solar insolation. The flora is a blend of species from two continents, grading from North American to Asian affinities from east to west. Mountain flanks and coastlines dominated by low shrubs of willow, birch, and alder interspersed with ericaceous-heath, Dryas-lichen, and grass communities. Alpine tundra and glaciers occur on mountains.

Coastal Rainforests: These coastal areas adjacent to the North Pacific Ocean receive copious amounts of precipitation throughout the year. Seasonal temperature changes are limited due to proximity to open ocean. A cool, hypermaritime climate dominates with minor seasonal temperature variation and extended periods of overcast clouds, fog, and precipitation. These areas warm sufficiently in the summer to allow trees to grow and dominate at lower elevations. Massive ice fields and glaciers are common in the mountains.

Alexander Archipelago (M4): This island-rich fjordland formed when the glacier-carved landscape filled with seawater after deglaciation. Rounded mountains with rolling till plains occur where continental glaciers overrode the land whereas angular mountains exist where continental glaciers did not. Glacial rebound has raised marine terraces where rich coastal lowlands and estuaries now exist. Winter snow, though abundant in locations, is ephemeral at sea level. Lush, lichen-draped temperate rain forests of hemlock and spruce blanket the shorelines and mountain slopes where soil drainage affords. Open and forested wetlands occur on poorly-drained soils especially on compact glacial tills, marine terraces, and gentle slopes. On upper slopes, forests progressively give way to shrublands, landslide and avalanche tracks, and alpine tundra.

Boundary Ranges (M2): A northwest-southeast trending batholith of resistant granite and granodiorite underlies this portion of the Coast Mountains. Abundant maritime snows feed huge icefields and glaciers that form an undulating matrix around exposed, rugged peaks called nunataks. Summer meltwaters accumulate and flow across these icefields and glaciers, often plunging into deep, icy crevasses called moulins. The southern most extent of tidewater glaciers on the North American continent occurs here. Only a few large rivers (Taku and Stikine Rivers) manage to breach this mountain range from the Interior. These, together with smaller streams, support large salmon runs of all five Pacific species. Alpine tundra habitats consist of sedges, grasses, and low shrubs.

Chugach-St. Elias Mountains (M6): Arcing terranes of Pacific origin have been thrusted onto the North American continent forming a rugged ice-clad mountain chain that surrounds the Gulf of Alaska. This is the largest collection of ice fields and glaciers found on the globe outside the polar region. The steer height of these mountains together with their expansive ice fields forms an effective barrier for Interior species except along the Alsek and Copper River corridors. Thin and rocky soils exist where mountain summits and slopes are devoid of ice, snow, and active scree. Here, alpine communities of sedges, grasses, and low shrubs grow. Deeper soils have formed in unconsolidated morainal and fluvial deposits underlain by isolated pockets of permafrost in broad u-shaped valleys. Alder shrublands and mixed forests occur on lower slopes and valley floors.

Gulf of Alaska Coast (M5): The northern shorelines and adjacent mountain slopes along the Gulf of Alaska form this region. A fjordal coastline and archipelago exists around Prince William Sound and points west where continental ice sheets repeatedly descended in the past. A coastal foreland extends from the Copper River Delta southeast to Icy Point fringed by the slopes and glacier margins of the Chugach-St. Elias Mountains. Here, unconsolidated glacial, alluvial, and marine deposits have been uplifted by tectonics and isostatic rebound to form this relatively flat plain. Snow is abundant in the winter and persists for long periods at sea level. Permafrost is absent. Lush, lichen-draped temperate rain forests of hemlock and spruce occur where soil drainage occurs, interspersed with open wetlands.

Kodiak Island (M3): This rugged, fjord-carved island complex is a geologic extension of the Chugach Mountains with a similar suite of folded and faulted sedimentary rocks of Pacific origin. During past glaciations, a solid ice sheet spanned Shelikof Strait connecting this group of islands with the mainland. Today, high sharp peaks with cirque glaciers and low rounded ridges overtop glacially-scoured valleys covered with till or lacustrine deposits. The flora of island group is still recovering from the last glaciation. For instance, trees did not survive the last Pleistocene glaciation and only recently has Sitka spruce and black cottonwood managed to regain a foothold on the northeastern portion of this island group. At present, luxuriant forb/grass meadows and willow and alder thickets cover the majority of these islands. Some alpine tundra exists at higher elevations. Snow blankets these islands during the winter from lows sweeping eastward along the Aleutians. These islands are entirely free of permafrost.

References:

APPENDIX D

Gallant, A.L., E.F. Binnian, J.M. Omernik, and M.B. Shasby. 1995. Ecoregions of Alaska. U.S. Geological Survey Professional Paper 1567.

Nowacki, G. and T. Brock. 1995. Ecoregions and Subregions of Alaska, ECOMAP Version 2.0 [map]. USDA Forest Service, Alaska Region, Juneau, AK, scale 1:5,000,000.

Nowacki, G.J., P. Spencer, T. Brock, M. Fleming, and T. Jorgenson. 2001. Ecoregions of Alaska and Neighboring Territories. U.S. Geological Survey Miscellaneous Investigations Series I Map (in press).

APPENDIX E

WORLD WIDE WEB LINKS

Forest insect and disease survey information and general forest health information:

http://fsweb.r10.fs.fed.us/intranet/staff/spf/fhpr10.htm
USFS, State & Private Forestry, Forest Health Protection site for Alaska with information on Alaskan insects & diseases, bibliography listing, and links to other Forest Health sites. The section presents a program overview, personnel information, current forest insect and disease conditions throughout the state, forest insect and disease biology, control, impacts, Sbexpert software and other Forest Health issues. This Home Page is periodically updated and is a good source of information on Alaska Forest Health issues.

http://www.dnr.state.ak.us/forestry/index.htm
An Alaska Department of Natural Resources, Division of Forestry home page was assembled in late 1996 for the fire and resource management programs. The site is currently under development but information is available on several of Forestry's programs, including forest health and forest insect surveys. Information will be updated as personnel and funding permit. Users may check the site for information relating to forest health. A link is provided on the home page for accessing forest health and insect survey information and to send an e-mail message. The URL for this insect and disease link is **http://www.dnr.state.ak.us/forestry/res_faq.htm.**

http://www.asgdc.state.ak.us
This is the **State of Alaska, Department of Natural Resources' Geographic Data Clearinghouse site** that is directly patterned and linked to the AGDC site maintained at the U. S. Geological Survey, EROS (Earth Resource Observation Satellite) field office in Anchorage--SEE AGDC link below. The State of Alaska-maintained section of this site contains data layers information in the form of metadata, or "data about the data", that describe the content, quality, condition, and other characteristics of the data. The metadata is compliant with federal geographic data committee (FGDC) standards. For example, data on land status, transportation, physical boundaries—such as coastline, conservation units, etc., and links to state resource information (e.g., forest pest damage surveys, Exxon Valdez restoration data, CIIMMS) and links to other agency forest pest and forest health information and data can be found here. The site is not complete since statewide participation for data submission and access links does not exist at this time, however, the goal is to make this a clearinghouse node for state and local agencies. One example of a clearinghouse node, which does presently exist for data about the Kenai Peninsula that has fairly complete agency participation, is the CIIMMS (Cook Inlet Information Management & Monitoring System) site that can be found at **http://www.dec.state.ak.us/ciimms/**

http://agdc.usgs.gov
The **Alaska Geospatial Data Clearinghouse** is a component of the **National Spatial Data Infrastructure (NSDI)**. The Clearinghouse provides a pathway to find geospatial referenced data and associated metadata. The site is a link to data available from a multiple of federal, state and local agencies. The site is currently administered at the U.S. Geological Survey, EROS field office in Anchorage. From this website the Forest Health Monitoring Clearinghouse can be reached.

http://agdc.usgs.gov/data/projects/fhm
The **Forest Health Monitoring Clearinghouse** provides special resource databases of forest health related information to land managers, scientists, and the general public. Fourteen statewide data layers are available for downloading, including Vegetation/land cover, ECOMAP and Ecoregions, Wetlands Inventory, Timber Harvest and other disturbances, Yearly Insect and Disease Damage, Fire History, Fire Protection Zones, Fire Management Boundaries, Fire Fuels Models, Land Status/Ownership, Elevation, Hydrography, Soils, and Permafrost.

http://www.fs.fed.us/r6/nr/fid/fidls/fidl127.htm
An USDA Forest Service Oregon/Washington Home-page. This is a link to the **FIDL publication #127 on the Spruce Beetle** This publication has been recently revised nationally by the U.S. Forest Service and is available in brochure form.

APPENDIX E

http://www.state.ak.us/local/akpages/FISH.GAME/habitat/geninfo/forestry/INFEST/infesthome.htm
The **Interagency Forest Ecology Study Team (INFEST)** home-page. This site has ecological information pertaining to wildlife and forests, spruce bark beetle, basic silvics, and other Alaska ecosystem considerations.

http://www.bugwood.caes.uga.edu
A site maintained by the University of Georgia on forest and **urban pests**, including a good section on **bark beetles**. This is just one example of some of the insect and disease information resources that can be found on the World Wide Web.

http://www.borough.kenai.ak.us/sprucebeetle/default.htm
Kenai Peninsula Borough Spruce Bark Beetle Web Site. This site supplies a direct link to the Kenai Peninsula Borough's Ecosystem Level **Vegetation Mapping Initiative (ELVMI).** This initiative is a vegetation mapping project to provide detailed vegetation mapping information to support fire risk and hazard management in the aftermath of a major spruce beetle epidemic on the Kenai Peninsula. The site gives a progress update on the mapping project, which is designed to produce a forest health/hazard map and GIS data base.

APPENDIX F

INFORMATION AVAILABLE FROM STATEWIDE AERIAL SURVEYS

Each year, forest damage surveys are conducted over approximately 30 million acres. This annual survey is a cooperative effort between U.S. 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% 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.

In this way, forest damage information is sketched on 1:250,000 scale USGS quadrangle maps at a relatively small scale. For example, at this scale one inch would equal approximately 4 miles distance on the ground. When cooperators request specialized surveys, larger scale maps are sometimes used for specific areas to provide more detailed assessments. 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 agency and other landowner partners for survey nominations. The federal and state biological technicians and entomologists decide which areas are highest priority from the nominations. In addition, areas are selected where several years' data are collected to establish trends from the year-to-year mapping efforts. In this way, general damage trend information is assembled for the most significant pests and compiled in this annual Conditions Report. The sketch-map information is also 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. Due to the relatively high cost of mass-producing hard copy materials from the survey data, including colored maps, a number of other map products that are available have not been included with this report. In addition, maps which show the general extent of forest insect damage from 2000 and previous statewide aerial surveys, landowner boundaries, and other types of map and digital data can be made available in various formats depending on the resources available to the user:

Submit data and map information requests to:

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

Kathy Matthews, Biotechnician
USDA Forest Service,
State and Private Forestry, Forest
Health Protection
3301 C Street, Suite 522
Anchorage, AK 99503-3956
Phone: (907) 271-2574
Fax: (907) 271-2897
E-mail: kmatthews03@fs.fed.us

APPENDIX F

Map information included in this report: "Forest Insect And Disease Conditions In Alaska -2000"

- **Aerial Detection Survey, Significant Pest Activity,** 11x17 in. format, depicting spruce beetle, *Ips*, spruce aphid, larch sawfly defoliation, willow defoliation and cedar decline “hot spots” (color; showing enhanced representation of damage areas).

- **2000 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 2000 aerial surveys).

- **Kenai Peninsula Region Spruce Beetle Activity 1995-2000**, 8 ½ x 11 in. format, depicting sequential year-by-year spruce beetle activity in south-central Alaska, including the Kenai Peninsula, Cook Inlet area to Anchorage & Talkeetna (includes vegetation base layer).

- **A Decade of Spruce Beetles: Year 2000**, 8 ½ x 11 in. format, depicting 2000 damage in red and prior damage, 1991-1999 in yellow (includes color shaded relief base showing extent of forest landscape and sample photos of spruce beetle impact).

- **Southeast Alaska Cedar Decline 2000 Aerial Detection Surveys**, 8 ½ x 11 in. format, depicting cumulative Alaska yellow-cedar decline over several years (includes a sample photo of cedar decline. Forested areas are delineated with color shaded relief background)

- **Spruce Aphid and Willow Leaf Blotchminer Defoliation,** 8 ½ x 11 in. format, depicting defoliation of the respective regional areas and 3 years of defoliation by the respective insect (includes color shaded relief base showing extent of forest landscape and sample photos of impact).

[Map data for maps provided by USFS/S&PF and AKDNR, Anchorage; cedar decline data provided by USFS/S&PF, Juneau]

Map and GIS Products Available Upon Request:

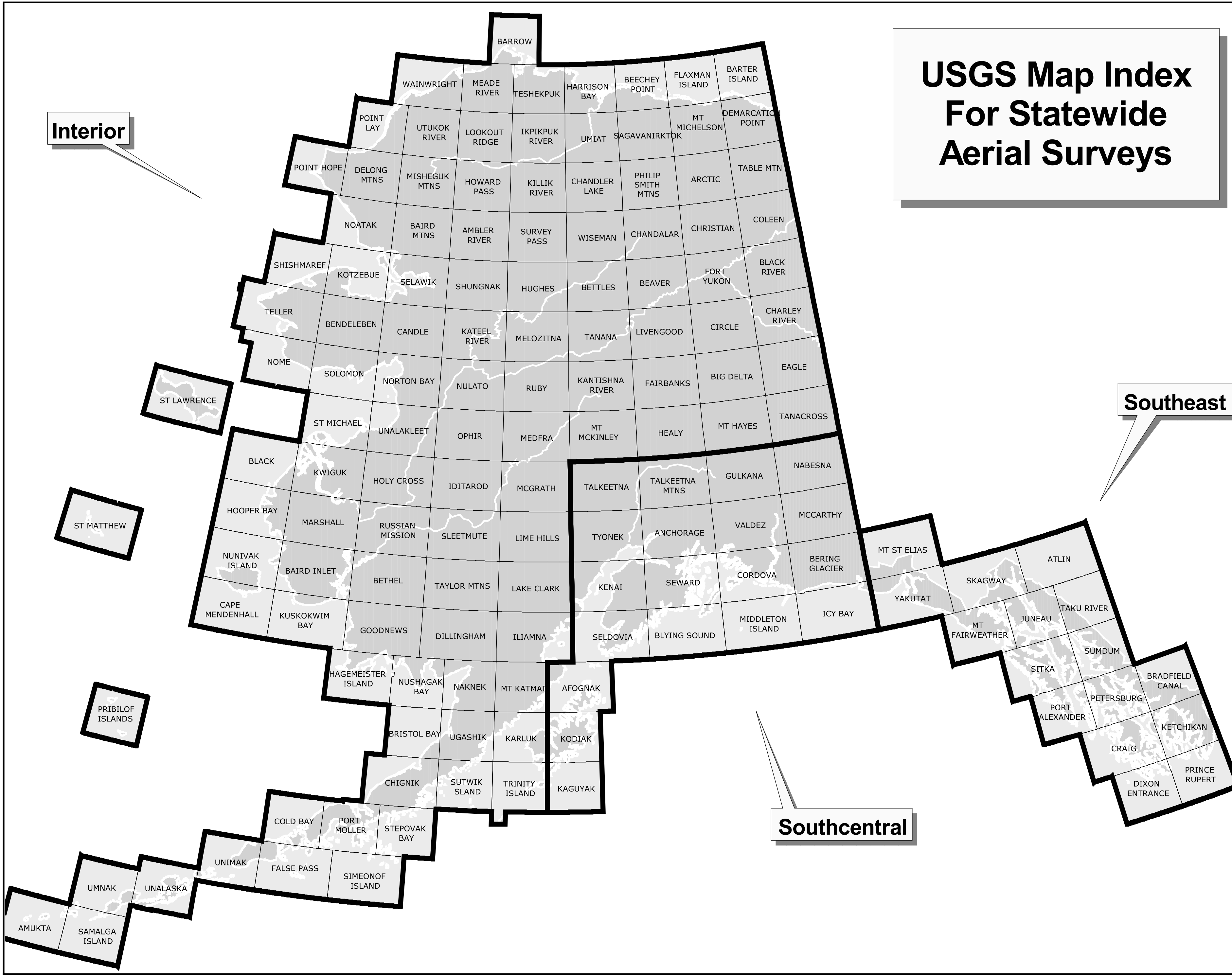
1. Digital data file of 1999 forest damage coverage in ArcInfo cover or ArcView shapefile(ESRI, Inc.) format. GIS data files are available at the following URL: **http://agdc.usgs.gov/data/projects/fhm/**.

2. 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://fsweb.r10.fs.fed.us/intranet/staff/spf/fhpr10.htm.**

3. Cumulative forest damage or specific-purpose damage maps prepared from AK/DOF or AK USFS, S&PF, FHP geographic information system database.

4. Forest Insect & Disease Conditions in Alaska CD-ROM (includes most of digital forest damage coverages in the AKDNR/DOF database in viewable formats and a copy of the 2000 Alaska Forest Insect & Disease Conditions Report in .pdf format; a fee may be assessed depending on availability of copies and amount of data required for the project).

USGS Map Index For Statewide Aerial Surveys



Quadrangle Areas Flown During 2000 Statewide Aerial Surveys:

*Quads with no insect damage reported for 2000 are marked with an asterisk.

South-central Alaska
Anchorage
Cordova*
Gulkana*
Kenai
McCarthy
Nabesna
Seldovia
Seward
Talkeetna
Talkeetna Mts.*
Tyonek
Valdez
Interior Alaska
Ambler River*
Arctic*
Baird Mts.*
Beaver
Bendeleben*
Bethel*
Bettles
Black River
Charley River
Christian
Circle
Coleen*
Dillingham*
Eagle
Fairbanks
Fort Yukon
Healy
Holy Cross
Hughes
Iditarod*
Iliamna
Kantishna River
Kateel River*
Kotzebue*
Lake Clark
Lime Hills
Livengood
McGrath
Medfra
Melozitna
Misheguk Mtn.*
Mt. Hayes*
Mt. McKinley
Noatak*
Nome*
Norton Bay*
Nulato
Ophir*
Ruby
Russian Mission
Shungnak
Sleetmute
Solomon
Survey Pass
Tanacross
Tanana
Taylor Mts.
Unalakleet
Wiseman
Southeast Alaska
Bradfield Canal
Craig
Dixon Entrance
Juneau
Ketchikan
Mt. Fairweather
Petersburg
Port Alexander
Prince Rupert*
Sitka
Skagway
Sumdum
Taku River
Yakutat

Tree damage codes used in 1989-2000 aerial surveys and GIS map products.

* The codes used for 2000 aerial surveys and GIS maps are marked with an asterisk.

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

Note: For all insect activity, the 4th character in the digital data (L, M, or H) denotes intensity. For quantitative descriptors of the intensity levels refer the metadata accompanying the digital data. Digital data can be found at the following URL: http://agdc.usgs.gov/data/projects/fhm/