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Forest Insect and Disease Conditions in Alaska—1993

FOREST INSECT AND DISEASE CONDITIONS IN ALASKA -- 1993

General Technical Report R10-TP-40

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Prepared by:

Paul Hennon, Pathologist
Roy Mask, Entomologist
Ed Holsten, Entomologist

Forest Health Management
State and Private Forestry
Alaska Region
USDA Forest Service
3301 "C" Street, Suite 522
Anchorage, AK 99503

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CONDITIONS IN BRIEF

Forest insect and disease populations and related damage increased throughout Alaskan forests in 1993. All of Alaska experienced an early and record warm spring and summer; the driest summer in almost 75 years. As a consequence, insect populations responded with population increases and shortened life cycles. Spruce bark beetle activity increased for the fifth consecutive year. New and ongoing bark beetle infestations, as determined by 1993 aerial surveys, now affect approximately 700,000 acres. While spruce beetle populations have increased dramatically in the Kenai Peninsula and Copper River Basin areas, they have been offset by a decrease in beetle activity along the Yukon River and on the west side of Cook Inlet. Spruce beetle populations in Sitka spruce along Turnagain Arm have remained static, although an increase along the Sixmile River and Hope Road, primarily near Walker Creek, was noted. Spruce beetle populations have also increased in the Kachemak Bay area where more than 14,000 acres of Sitka spruce are infested on the south side of the bay.

Hardwood defoliator activity has decreased from 150,000 acres in 1992 to 41,000 acres in 1993. A significant decline in the amount of defoliated willow accounts for much of this reduction. Spruce budworm defoliation in interior Alaska also declined in 1993 by more than 133,000 acres. However, almost 4,000 acres of new budworm defoliation was detected near Lake Clark this year. Black-headed budworm populations have continued to decline in the Prince William Sound and in the Turnagain Pass/Portage areas.

In southeast Alaska, coastal spruce-hemlock forests are experiencing the largest black-headed budworm epidemic in the past 40 years. For the third consecutive year, vast areas were impacted by budworm defoliation. Over 258,000 acres of black-headed budworm defoliation was noted in 1993. Budworm activity was concentrated primarily north of Frederick Sound. Increases in defoliated acreage are expected again in 1994, as the outbreak continues. Hemlock sawfly populations in southeast Alaska also increased, impacting approximately 19,000 acres, a threefold increase over 1992. The most spectacular defoliation observed in the spruce-hemlock forests of southeast Alaska in 1993 was apparent on approximately 12,000 acres, where black-headed budworm and hemlock sawfly caused simultaneous impact. Spruce beetle activity in 1993 continued at two locations in southeast Alaska. The outbreak near Haines continued to expand and activity was noted on approximately 20,000 acres. Salvage operations are ongoing on portions of the Haines State Forest. Spruce beetle activity in Glacier Bay National Park declined and now totals approximately 2800 acres. Spruce beetles remain a concern in the Park, however, as the area of current activity includes the visitor's center and related developments. After causing substantial damage to southeast Alaska Sitka spruce in 1992, spruce needle aphid populations collapsed during extended periods of sub-freezing temperatures in January and February, 1993. Defoliation of Sitka alder (by several insect species) was prevalent throughout most of southeast Alaska in 1993.

Yellow-cedar decline, wood decay of live trees, and hemlock dwarf mistletoe were the most significant diseases of Alaskan forests. All three have both economic impact and alter ecological conditions including forest structure, composition, and succession. Wildlife habitat is provided directly by heart rot and dwarf mistletoe through the formation of tree cavities and witches brooms, respectively. More than 526,000 acres of cedar decline occur in Southeast Alaska in a broad band from western Chichagof Island through the Ketchikan area. Heartrot and buttrot fungi caused significant cull in all tree species in Alaska. Hemlock dwarf mistletoe continued to cause growth loss and mortality in old-growth forests of Southeast Alaska; its impact in young-growth stands appears to depend on the presence of large infected residuals left after harvesting of the previous stands. An outbreak of hemlock canker, apparently caused by a fungus and possibly aggravated by dust, killed small hemlocks and the lower branches of large hemlock trees along unpaved roads on Prince of Wales Island, near Rowan Bay on Kuiu Island, Corner Bay on Chichagof Island, and Caroll Inlet on Revillagigedo Island. The disease was found for the first time away from roads in natural openings in forests and along streams. Spruce needle rust was present at high levels throughout Alaska, particularly around Petersburg, but most other foliar pathogens occurred at low to moderate levels in 1993. *Rhizosphaera pini* needle cast was found causing considerable damage to the lower crowns of Sitka spruce for the first time in southeast Alaska. Porcupines continued to damage spruce and hemlock in valuable young-growth stands in southeast Alaska. Decay, canker, and foliar fungi caused a large, but unmeasured damage to hardwood species in interior Alaska.

Table 1 summarizes insect and disease activity by land ownership.

Table 1. 1993 Forest insect and disease infestation in Alaska by land ownership and agent.[a]

Pest	National Forest	Other Federal	Native	State & Private
	Acres			
Spruce beetle	26,240	191,300	150,810	356,400
Engravers	----	1,990	1,970	330
Spruce budworm	----	6,860	----	26,700
Black-headed budworm	199,300	----	21,800	37,950
Hemlock sawfly	12,100	----	780	6,090
Spruce needle aphid	620	----	----	----
Large aspen tortrix	----	14,000	24,050	25,380
Alder defoliation	430	120	310	100
Birch defoliation	----	----	----	150
Cottonwood defoliation	1,550	930	10	410
Willow defoliation	----	36,380	1,900	2,360
Larch Sawfly	-----	1,780	500	9,940
Black Moth	----	5	----	5,450
Yellow-cedar decline[b]	541,350	-----	17,670	10,430
Totals	781,590	253,365	219,800	481,690

Grand Total = 1,736,445 acres

[a] Table entries do not include many of the most destructive diseases (e.g., wood decays and dwarf mistletoe) because these losses are not detectable in aerial surveys.

[b] Value of yellow-cedar decline is not restricted to the acreage with a high concentration of dying trees for this year; it represents stands that generally have long-dead trees, recently-dead trees, dying trees, and some healthy trees. See discussion of yellow-cedar decline for a detailed listing of acreage affected by island and Ranger District.

STATUS OF INSECTS

ROLE OF SPRUCE BEETLE IN FOREST ECOSYSTEMS

There are a variety of impacts associated with spruce beetle infestations to forest resources, both timber and non-timber. These impacts can be viewed positively or negatively depending on the forest resources in question. Some of the impacts associated with spruce beetle infestations include, but are not limited to: **(1) Loss of merchantable value of killed trees:** The value of a spruce as sawtimber is reduced within three years of attack in south-central Alaska as weather checking and increased sap-rots occur. The value of a beetle killed tree as houselogs, chips, or firewood continues for some time; **(2) Long term stand conversion:** To optimally regenerate both spruce and birch, a site disturbance (i.e. fire, windthrow, flooding, etc.) is required which results in a seed bed comprised of bare mineral soil with some organic material. If there is adequate seed source, such site disturbances provide excellent sites for regeneration. However, what is occurring on many sites in south-central Alaska after spruce beetles have "opened up" the canopy is that there is a paucity of regeneration coming in as there has been minimal site disturbance. Under such conditions, grass and other competing vegetation quickly invade the site and prevent future colonization by tree species; **(3) Impacts to wildlife habitat:** Those wildlife species that are dependent on large diameter spruce stands are negatively impacted. Those species that benefit from early successional stage vegetation will benefit from spruce beetle infestations as stand composition changes; **(4) Impact to scenic quality:** Recent studies have demonstrated that there is a significant decline in scenic quality of spruce beetle impacted stands and that scenic beauty is an important forest resource. Along scenic corridors, maintaining or enhancing scenic quality necessitates minimizing impacts from spruce beetle infestations; **(5) Fire hazard:** There is concern that fire hazard of spruce beetle impacted stands will increase over time as dead trees fall, dry grass accumulates, thus increasing fuel loading; and **(6) Impact to fisheries:** If salmon spawning streams are bordered by large diameter spruce and if these trees are subsequently killed by spruce beetles, there is a concern as to the long term availability of large woody debris in the streams. A continual supply of large woody debris in spawning streams is a necessary component for spawning habitat integrity.

There are a variety of techniques that can be used to prevent, mitigate, or reduce impacts associated with spruce beetle infestations. However, before pest management prescriptions can be developed, the resource objective(s) for a particular stand, watershed, landscape, etc. must be determined. 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.

SPRUCE BEETLE
Dendroctonus rufipennis Kirby

Spruce beetle continue to impact vast areas in Alaska (Fig. 1). Areas of active infestation have increased by almost 100,000 acres in 1993. This large increase was offset somewhat by the continued decline of outbreaks along the Yukon River and on the west side of Cook Inlet. An exceptionally warm spring and summer for the fifth consecutive year may have lent impetus to the expanding spruce beetle populations in the Copper River Basin and throughout the Kenai Peninsula.

Spruce mortality on the Chugach National Forest remained nearly static (28,658 acres in 1992 vs. 26,224 acres in 1993). The areas of major activity on the Forest are: Russian, Kenai, and Cooper Lakes--18,449 acres; Summit Lake to Broadview Guard Station--3,503 acres; Ingram Creek to Hope and Palmer Creek--905 acres; and the Moose Pass area including Trail and Grant Lakes and the Placer River--4,593 acres.

From Pt. Possession at the northern tip of the Kenai Peninsula to Kachemak Bay in the south, spruce beetle caused mortality has increased by almost 100,000 acres. The 1993 total is 397,771 acres (300,000 acres in 1992). From Skilak Lake south to Ninilchik and Homer and east to Caribou Hills, almost 57,000 acres of mortality was noted. East of the Caribou Hills, in the Fox River drainage, approximately 30,000 acres of spruce beetle activity was aerially detected in 1993.

In the Kachemak Bay area, acres impacted by spruce beetles have more than tripled this year, from 12,454 acres in 1992 to 40,401 acres in 1993. The most intense areas of activity are along the north side of the bay and in the Fox River Valley. Much of the affected acreage is located on lands in private ownership along East End Road. On the south shore of the bay, spruce beetle activity is as follows: Humpy Creek to Bradley Lake--9,808 acres; Halibut Cove--2,180 acres; China Poot lake--934 acres; Sadie Cove--234 acres; Tutka Bay--311 acres; and Seldovia--545 acres.

On the west side of Cook Inlet, from Beluga Lake to Skwentna River, spruce beetle activity decreased by half from 2,958 acres in 1992 to 1,570 acres in 1993. The most significant area of spruce beetle activity occurs north of the Skwentna River, about 6 miles northwest of Porcupine Butte and covers 6,000 acres between Finger Lake and Shirley Lake. The infestation detected in 1992 along the McArthur River remains unchanged (1,168 acres in 1992 vs. 1,036 acres in 1993).

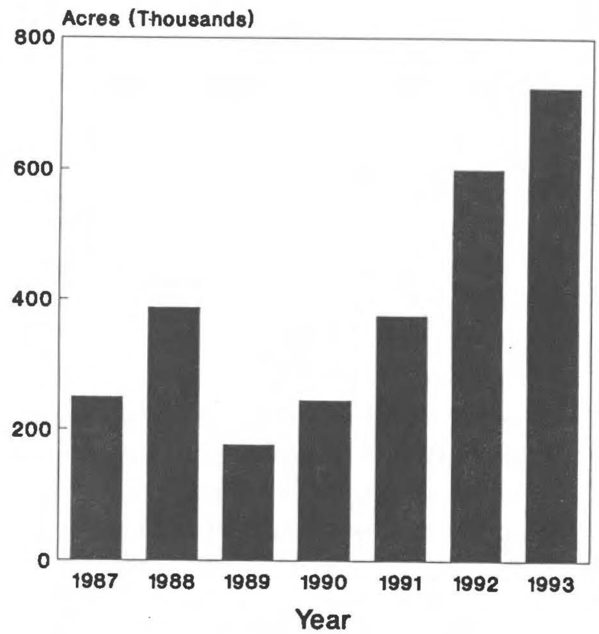


Figure 1. Acres of ongoing and new spruce beetle infestations in Alaska, 1987-1993.

Spruce beetle activity decreased in 1993 in stands of Sitka spruce along Turnagain Arm; 585 acres in 1992 vs. 155 acres in 1993. Activity did increase, however, along the Hope Road and Sixmile Creek to 475 acres with about 300 of those acres located at the mouth of Walker Creek. Along Resurrection Creek Road and Palmer Creek Road, mortality attributed to spruce beetles amounted to 420 acres.

Spruce beetle activity increased by more than 1,000 acres over 1992 levels in the Anchorage Bowl area. The outbreak in south Anchorage remained static with 1,125 acres of infested spruce reported again this year. Fire Island spruce beetle activity rose sharply from 415 acres to 925 acres in 1993 with heavy activity noted in several areas of spruce. The Pt. Campbell Military Reservation sustained 190 acres of spruce mortality with another 45 acres on lands immediately adjacent.

Just north of Anchorage, the spruce beetle continues to be quite active; 1,435 acres of infested spruce in the lower Eagle River Valley were reported while an additional 120 acres were detected at the head of the valley. This compares to 1,070 acres reported in 1992. In the Eklutna River Valley, 1,314 acres of spruce beetle activity were detected. Activity in the Knik River/Palmer/Bodenburg Butte area accounted for 4,599 acres. The most intense area of activity in the Matanuska Valley occurs along the Glenn Highway from Chickaloon to Gunsight Mountain where 15,880 acres of infested spruce were detected in 1993. This represents an increase of 9,886 acres over levels noted in 1992.

Southwest of Anchorage, in the Iliamna-Lake Clark area, spruce beetle activity is on the increase. Throughout the east end of Lake Iliamna, from Kakhonak Lake to Pile Bay, spruce beetle caused mortality was detected over 24,063 acres; an increase of 13,362 acres over 1992 levels. In the Lake Clark area, from the northeast end of the lake to the pass, an increase of 1,265 acres over levels infested in 1992 was noted.

The Copper River Basin represents the most rapidly expanding area of spruce beetle activity in the state. All infested areas noted in 1992 have increased in size and new areas have been detected. From Gulkana in the north to Chitina in the south, and east to McCarthy, acres infested by spruce beetles have increased from 77,426 to 170,045 acres; an increase of 92,619 acres. New areas of activity include: Klutina Lake--33,706 acres; from Chitina south along the Copper River to Spirit Mountain--20,473 acres; and along the Chitina River from the mouth of Tebay River east to McCarthy--19,694 acres. Areas of continuing and expanding activity include: 83,214 acres from Copper River to the Tiekel River, west of the Copper River--+ 23,508 acres over 1992 levels; 20,084 acres along the east side of the Copper River from Copper Center to Chitina within the Wrangell-St. Elias National Park, and 7,400 acres in the Glennallen/Gulkana area which represents an increase of 2,057 acres over 1992 levels.

Spruce beetle activity decreased by 41,267 acres along the Yukon River since 1992; 11,047 acres remain infested in 1993. The largest area of activity (8,096 acres across the Yukon River from Kaltag) was found to have less than one infested tree per acre in 1993. The Nulato River area, where 11,365 acres of spruce beetle activity was detected in 1992, was not flown in 1993; but will be re-surveyed in 1994.

The Kuskokwim River Drainage experienced a slight decline in spruce beetle activity. Although spruce beetle activity between Sleetmute and Deacon's Landing remained high (10,406 acres), a 7,000 acre block of spruce beetle activity detected in 1992, 15 miles east of Aniak declined to 20 acres in 1993. Likewise, the infested areas along the Kuskokwim River from McGrath downriver to Deacon's Landing decreased from 4,500 acres in 1992 to 3,000 acres in 1993.

In Southeast Alaska, the spruce beetle outbreak near Haines continued to expand, while the outbreak in Glacier Bay National Park declined. The two outbreaks combined impact approximately 24,000 acres.

During the last 15 years in Glacier Bay National Park, approximately 29,000 acres of mature Sitka spruce have been impacted by spruce beetle. Areas of heavy mortality, located among the Beardsley Islands, are now being regenerated primarily by western hemlock.

In 1993, spruce beetle activity was noted on approximately 2800 acres, located primarily within the Beardsley Islands and on the mainland between the park's visitor center and Point Gustavus. Although spruce beetle activity in the Park has declined in three of the last four years, concern is high since the area of current infestation includes the visitor's center and associated developments. The Park has recently implemented a hazard tree management program to address beetle-killed trees in developed areas. In the absence of catastrophic windthrow events, spruce beetle activity within Glacier Bay National Park should continue to decline during the next few years.

The spruce beetle outbreak on state and adjoining lands near Haines continued to expand in 1993. Current activity totals almost 21,000 acres on state, private and federal (BLM, USDI) lands. Beetle activity occurs in the Klehini, Chilkat, Kelsall and Tsirku River drainages. Scattered windthrow events at various times during 1992 and 1993 will contribute to the outbreak's duration.

Salvage and sanitation harvests within spruce beetle-impacted and wind damaged areas are ongoing (or planned) on state lands in the Klehini and Kelsall River drainages.

In 1993, spruce beetle infestations throughout Alaska by ownership are as follows; National Forest land --26,240 acres; State and Private--356,400 acres, Native land--150,810 acres and other Federal lands (e.g. Kenai National Wildlife Refuge, National Parks, etc.)--191,300 acres.

ENGRAVERS
Ips perturbatus Eichh.

1993 aerial detection surveys noted an increase of 2,352 acres of engraver infested white spruce over levels detected in 1992. All but about 400 acres were located throughout the Yukon Flats area along the Yukon, Porcupine, Chandalar, and Christian Rivers. The remainder is divided more or less evenly in small pockets along the Kuskokwim, Koyukuk, and Tanana Rivers.

SPRUCE BUDWORM
Choristoneura sp.

Spruce budworm populations declined sharply throughout south-central and interior Alaska in 1993. Along the Yukon and Tanana Rivers, acres of budworm defoliated white spruce fell from over 125,000 acres in 1992 to only 400 acres in 1993. The major exception is the on-going infestation in the Bonanza Creek/Goldstream Valley areas north and west of Fairbanks. This infestation has also declined but not as dramatically as those along the Yukon and Tanana Rivers. In 1992, about 35,000 acres of defoliated spruce were detected but declined to 22,886 acres in 1993. One new area of spruce budworm defoliation was noted in 1993; 3,975 acres of defoliated spruce were detected throughout the western side of Lake Clark Pass in southwestern Alaska.

In southeast Alaska, spruce budworm defoliated 3400 acres of Sitka spruce and western hemlock along the Chilkat River north of Klukwan. 1993 marked the fourth consecutive year of budworm activity there, but defoliation was much lighter than that of the previous three years. Light defoliation in this area is expected again in 1994.

WESTERN BLACK-HEADED BUDWORM
Acleris gloverana Walsingham

The 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 1900's. Budworm populations in Alaska have been cyclic, arising quickly, impacting vast areas, then subsiding within a few years (Fig. 2).

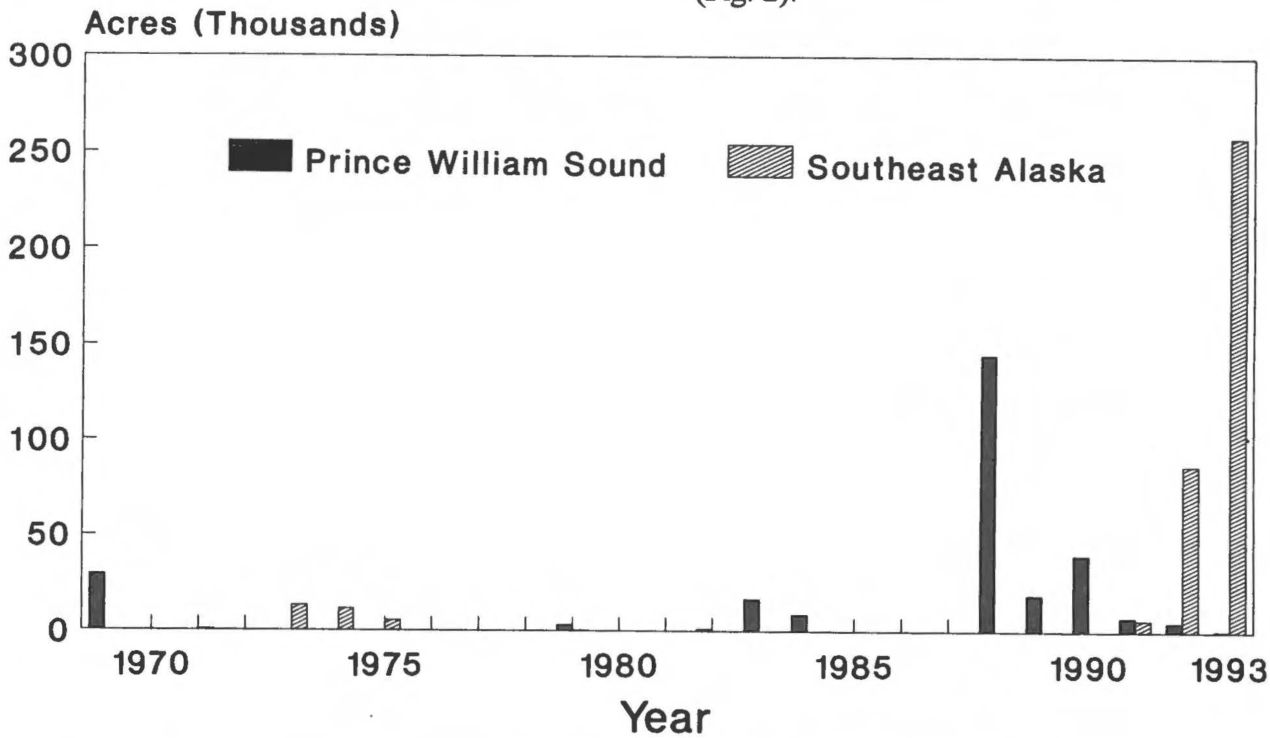


Figure 2. Acres of black-headed budworm defoliation in the Prince William Sound area and Southeast Alaska, 1969-1993.

In southeast Alaska, western hemlock is the budworm's preferred host, but Sitka spruce and mountain hemlock are also fed upon (Fig. 5). The overall ecological role of the black-headed budworm in Alaska's forests is not known. However, many aspects of the budworm's role are known and several inferences can be made from available information.

Repeated years of budworm defoliation may cause growth loss, top-kill and in severe cases, death of the host. Heavily defoliated trees may also be more susceptible to other mortality agents. As a major forest defoliator, black-headed budworm ultimately influences both stand composition and structure in some areas. To the extent that defoliation reduces overstory crown density (through tree death or crown thinning), less shade tolerant understory plants may become established. Such habitats favor small mammals, deer, predaceous and parasitic insects, and some insectivorous bird species. By consuming needles and depositing nutrient-rich fecal material on the forest floor, budworms are also accelerating nutrient cycling processes. Aquatic studies conducted in 1993 indicate that budworm defoliation may have impacts on fisheries as well.

The western black-headed budworm infestations of Prince William Sound continued their decline. Only 527 acres of defoliated spruce and hemlock were detected this year; down from 4,990 acres in 1992. The only area of notable budworm activity within the Sound is 467 acres of defoliation at the head of Port Fidalgo, about 28 miles northwest of Cordova. Black-headed budworm infestations in the Turnagain Pass/Portage Valley areas of Turnagain Arm declined as well. In 1992, nearly 3,600 acres were infested; declining to 320 acres in 1993, most of which occurs in the Seattle Creek Valley and the Ingram Creek areas.

As of 1993, the coastal spruce-hemlock forests of southeast Alaska are experiencing the largest black-headed budworm outbreak in the past 40 years. Over 258,000 acres of budworm-caused defoliation was mapped in July and August of 1993 (Fig. 3). Of that, 96,000 acres were classified as light defoliation (slight discoloration of hemlock only) and 162,000 acres were noted as heavy defoliation (extreme discoloration evident on hemlock and/or spruce). Defoliation was evident in both second-growth and old growth forests. Similar to 1992, black-headed budworm activity in 1993 was concentrated in areas north of Frederick Sound.

Budworm defoliation was most severe where it occurred in conjunction with the hemlock sawfly on more than 12,000 acres. The two insects in combination caused heavy defoliation of western hemlock (and in some instances Sitka spruce) along the Chilkoot River and adjacent to Chilkoot Lake near Haines (4700 acres); adjacent to Crab Bay on Chichagof Island (4200 acres); on Mitkof Island near Blind Slough (1550 acres); on Kupreanof Island near North Pt. (625 acres); and from Calder Bay to El Capitan Lake on Prince of Wales Island (935 acres). Continued defoliation of similar magnitude in 1994 will likely result in top-kill of some hemlock in these areas.

The greatest concentration of black-headed budworm defoliation in southeast Alaska occurred on Admiralty Island. Heavy defoliation was noted on Mansfield Peninsula, adjacent to Hawk Inlet and Young Bay, at numerous locations on Glass

Peninsula, above Florence Lake, in an almost solid line between Fishery Creek and Angoon, encompassing Thayer Lake, between Windfall Harbor and Hasselborg Lake, in an almost continuous swath between Mole Harbor and Gambier Bay, and encompassing all of Hood Bay and most all of Whitewater Bay. On Admiralty Island, heavy defoliation totalled approximately 84,000 acres. Interspersed with areas of heavy defoliation were an additional 49,000 acres of light defoliation.

Substantial budworm defoliation was also evident on Chichagof and northern Baranof Islands. On Chichagof, 1200 acres of light defoliation was noted adjacent to Neka Bay; 470 acres (light) near Spasski Bay; 1100 acres (light) southeast of Whitestone Harbor; 4200 acres (light) encompassing Freshwater Bay; 1400 and 620 acres of light and heavy defoliation, respectively, from Tenekee east to East Pt.; 1700 and 900 acres of light and heavy defoliation, respectively, on the north side of Tenekee Inlet; and 930 and 6700 acres of light and heavy defoliation, respectively, on the south side of Tenekee Inlet. The Crab Bay area was defoliated by both black-headed budworm and hemlock sawfly, and was the most heavily defoliated area on Chichagof Island.

The greatest concentration of budworm defoliation on Chichagof Is. included an area from the North and South Arms of Hoonah Sound southeast to Ushk Bay, including Moser and Emmons Islands. Acres of defoliation in this area were 4200 (light) and 21,900 (heavy). To the southeast along the south side of Peril Strait (Baranof Island), on Duffield Peninsula and adjacent to Saook Bay, light and heavy budworm defoliation totalled 5600 and 3100 acres, respectively.

Heavy defoliation was evident at numerous locations on the mainland north of Frederick Sound. Some of the most spectacular defoliation on the mainland occurred on the slopes above Chilkoot Lake, near Haines. Approximately 4500 acres of mature hemlock were defoliated by both black-headed budworm and hemlock sawfly. Budworm caused light defoliation on an additional 150 acres in the same area. Light defoliation (460 acres) was also evident on the Chilkat Peninsula south of Haines. To the south, in Lynn Canal, 2200 acres (light) and 700 acres (heavy) were defoliated on Lincoln and Shelter Islands. Southwest of these islands, 4500 acres of light defoliation was evident in the Couverden area.

On the mainland from Juneau northwest to the Katzehin River, heavy budworm defoliation totalled 13,200 acres. Light defoliation scattered across the same area totalled approximately 3000 acres. Budworm defoliation in the Juneau area totalled 10,500 acres (4600 light, 5900 heavy). For the second consecutive year, defoliation of ornamental spruce and hemlock occurred at numerous locations between Lemon Creek and Auke Bay, and on north Douglas Island. Budworm defoliation on Douglas Island totalled 5700 acres (3400 light and 2300 heavy).

On the mainland south of Juneau, approximately 3500 acres of heavy defoliation occurred from Greely Pt. (Taku Inlet) to Taku Harbor. To the south, Snettisham Peninsula had 930 acres of light defoliation; 150 and 1200 acres of light and heavy defoliation, respectively, were observed adjacent to Windham Bay; 460 acres of heavy defoliation was evident at Cape Fanshaw; and 150 and 900 acres of

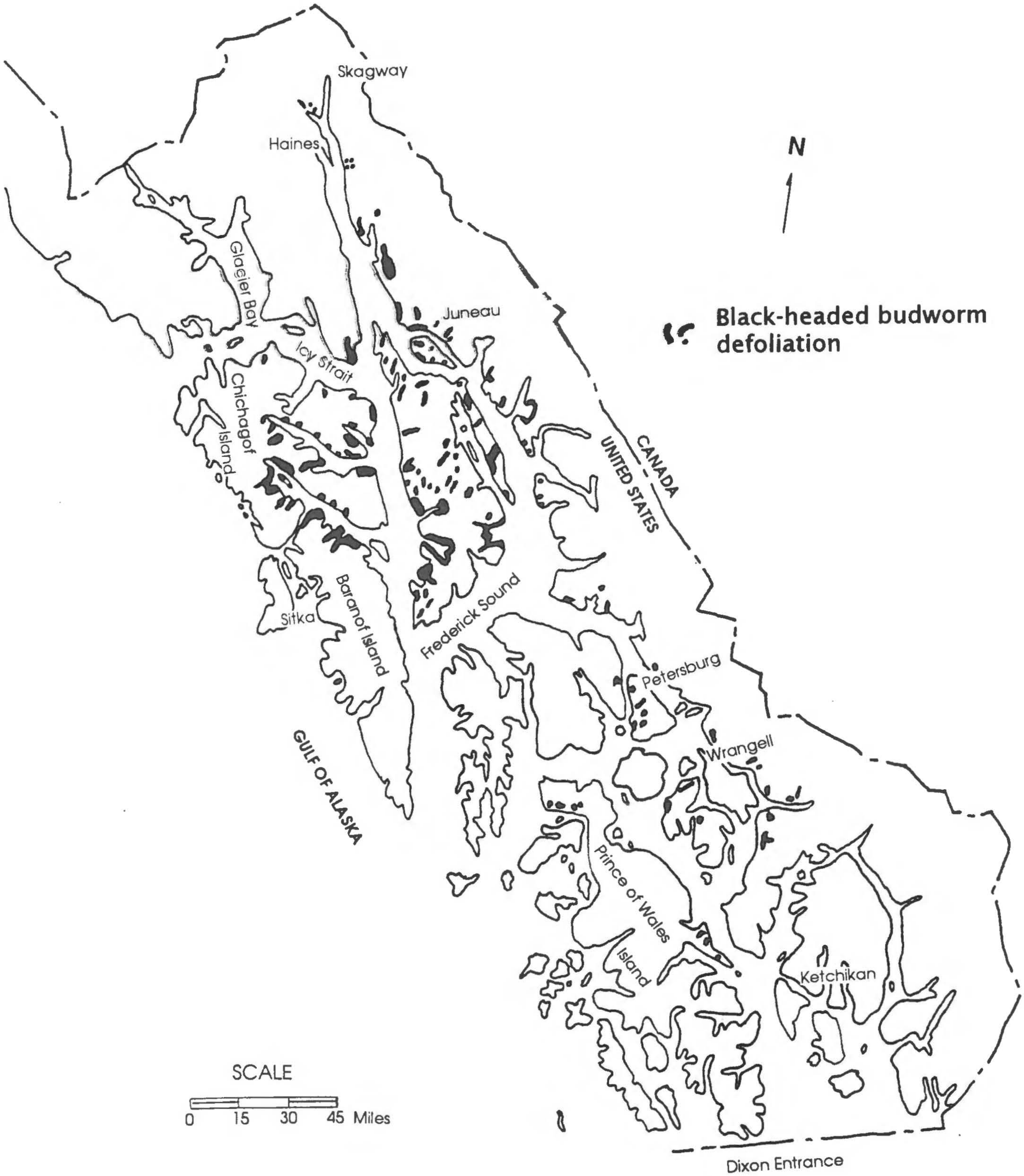


Figure 3. Defoliation of southeast Alaskan forests by the black-headed budworm. Over 258,000 acres of defoliation were mapped in 1993.

light and heavy defoliation, respectively, was noted near Farragut Bay.

Areas of budworm defoliation south of Frederick Sound were widely scattered and included: On the mainland - 120 acres of heavy defoliation at Horn Mountain, east of Petersburg; 2300 acres of heavy defoliation and 300 acres of light defoliation along Eastern Passage southeast of Wrangell; 1200 acres of light defoliation on the east side of Blake Channel; 1100 acres (heavy) on the north side of Bradfield Canal; 300 acres (light) near the bear viewing area at Anan Creek; and 1500 acres (light) along the east side of Ernest Sound. The area near Ernest Sound is of particular interest, since the earliest documented budworm outbreak in southeast Alaska (1917) was first reported there.

Budworm defoliation noted elsewhere south of Frederick Sound included: 1400 acres (heavy) on Petersburg Mountain, Kupreanof Is.; 3900 acres (heavy) on slopes facing Wrangell Narrows, Mitkof Island; 300 acres (light) on west Dry Is.; 900 acres of heavy defoliation on northernmost Etolin Island; light defoliation totalling 930 acres on northern Etolin Island and along the east side of Burnett Inlet; 880 acres of light defoliation on Kuiu Island between Saginaw Bay and Washington Bay; 600 acres (heavy) above Vallenar Creek, Gravina Is; and on Prince of Wales Is. - 470 and 780 acres of light and heavy defoliation, respectively, on Kasaan Peninsula; and approximately 460 acres each of heavy and light defoliation from Calder Bay east to El Capitan Lake.

Numbers of black-headed budworm larvae sampled from defoliator plots varied greatly north and south of Frederick Sound. As in 1992, numbers of larvae (and acres of defoliation) were consistently higher north of Frederick Sound. The greatest numbers of larvae were collected at Patterson Bay (Chichagof Island) and at a nearby plot in the North Arm of Hoonah Sound. Substantial numbers were also collected at most plots on Admiralty Island and at Taku Harbor (mainland).

South of Frederick Sound, the largest numbers of black-headed budworm larvae were collected on Prince of Wales Island, at Calder Bay and near Tuxekan.

The black-headed budworm outbreak in southeast Alaska is expected to continue in 1994. Budworm populations (and resulting defoliation) are expected to increase. Quantity and severity of defoliation will again be greatest within forests north of Frederick Sound, however, substantial increases south of Frederick Sound also appear likely.

In 1993, studies were initiated to assess the impact of the current budworm outbreak on southeast Alaska's managed and unmanaged forests. These, and related studies on the budworm's ecological significance will continue throughout the life of the outbreak.

HEMLOCK SAWFLY
Neodiprion tsugae Middleton

Hemlock sawflies are common defoliators of western hemlock and are found throughout southeast Alaska. Historically, sawfly outbreaks in southeast Alaska have been larger and of longer duration in areas south of Frederick Sound.

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

In southeast Alaska, defoliation of western hemlock by hemlock sawfly increased about threefold from 1992 to 1993. Almost 19,000 acres of sawfly defoliation was mapped in 1993. Unlike black-headed budworm, sawfly activity was scattered throughout southeast Alaska, with few large concentrations.

The most spectacular sawfly activity was that observed in conjunction with budworm defoliation at two locations: Chilkoot Lake near Haines (4700 acres); and adjacent to Crab Bay, on Chichagof Is. (4200 acres). Other areas where the two insects in association caused heavy defoliation included: Mitkof Island, near Blind Slough (1550 acres); Kupreanof Is. near North Pt. (625 acres); and from Calder Bay to El Capitan Lake on Prince of Wales Is. (935 acres). Heavy defoliation caused primarily by hemlock sawfly occurred at Edna Bay on Kosiusko Island (1400 acres).

Light defoliation totalling 1420 acres was observed on Prince of Wales Is. within the South Prince of Wales Wilderness (300 acres); near the site of Cholmondeley (460 acres); at the head of Klakas Inlet (300 acres); and on the north side of Trocadero Bay (360 acres). Sawfly defoliation totalling 380 acres (light) was noted on nearby Sukkwan Island. Other areas of light sawfly defoliation were: Annette Island, near Indian Rock (150 acres), Carroll Inlet and Princess Bay, Revilla Island (1550 acres); Smooth Mountain, Gravina Island (1000 acres); and Farallon Bay, Dall Island (620 acres).

The highest sawfly larvae counts of the 1993 survey were collected at Chilkoot Lake near Haines and at Calder Bay, Prince of Wales Island. Increased sawfly activity is expected throughout southeast Alaska in 1994.

SPRUCE NEEDLE APHID
Elatobium abietinum Walker

Spruce needle aphids feed on older needles of Sitka spruce, often causing significant amounts of needle drop (defoliation). Aphid defoliation causes reduced tree growth and often predisposes the host to other mortality agents, such as spruce beetle. Likewise, severe cases of defoliation alone may result in tree mortality. Spruce under stress, such as those in urban settings, are most seriously impacted. Spruce aphids feed primarily in the lower, innermost portions of tree crowns, but may impact entire crowns during outbreaks. Spruce aphid outbreaks in southeast Alaska are usually preceded by mild winters.

Following the mild winter of 1991-92, spruce needle aphid populations in southeast Alaska expanded rapidly, causing over 25,000 acres of Sitka spruce defoliation. Needle aphid populations crashed in 1993, due to extended periods with sub-freezing temperatures during January and February. The only substantial area of needle aphid activity observed in 1993 was along four miles of shoreline on the east side of Glass Peninsula, Admiralty Island.

Aphid activity from 1992 resulted in some ornamental spruce mortality in several southeast Alaska communities, including: Sitka, Elfin Cove, Ketchikan, Wrangell, Petersburg, Craig, Klawock, and Thorne Bay.

LARGE ASPEN TORTRIX
Choristoneura conflictana Wlkr.

Tortrix populations increased threefold in 1993 to 63,409 acres. The Matanuska Valley accounted for about 10,000 of these acres, while 4,748 acres of defoliated aspen were detected along the Chitina River between Chitina and McCarthy. 1,090 acres of defoliated aspen were noted near Ft. Richardson in the Anchorage Bowl area and another 2,000 acres were detected on the Kenai Peninsula in the Mystery Hills-Round Mountain areas. The remaining 40,000 acres of tortrix infested aspen were located in the Yukon Flats area primarily along the Christain and Chandalar Rivers.

WILLOW DEFOLIATION

Beginning in 1991, an outbreak of a willow leaf blotchminer, *Micrurapteryx salicifolliela* (Lep:Gracillaridae) occurred for hundreds of miles in the Yukon and Kuskokwim River drainages. Larvae of this miner cause blotches that result in a yellow or reddish discoloration of foliage easily visible from the air. The outbreak worsened in 1992 but subsided to a great extent in 1993, however, certain willow species were still severely infested locally. This insect displays profound host specificity; some intermingled willow species are free of it while others may be severely infested.

The amount of willow defoliation decreased from the approximately 150,000 acres detected in 1992 to 40,641 acres noted in 1993. Of this total, 35,527 acres were located in the Yukon Flats area along the Yukon, Chandalar, Christain, and Porcupine Rivers. Although this represents a decline of almost 110,000 acres, it must be kept in mind that the 40,000-plus acres noted this year is a very conservative figure. Many of the smaller drainages in the area were not surveyed. Often times the apparent defoliation continued far beyond our flight-lines. Other areas of activity by the willow defoliator complex included: the Kantishna River between the Tanana River and the Denali National Park Boundary--1,523 acres; the North Fork of the Kuskokwim River--440 acres, and along the Yukon River downstream from Galena--4,114 acres.

COTTONWOOD DEFOLIATION
***Chrysomela* sp. and *Lyonetia* sp.**

Defoliation of cottonwood by leaf beetles (*Chrysomela* sp.) and leafminers (*Lyonetia* sp.) is common throughout much of the tree's range in Alaska. Defoliation is most pronounced near the tops of affected trees. Defoliation is believed to cause reduced tree growth. The biology and overall ecological significance of leaf beetles (*Chrysomela* sp.) in Alaska is not well known.

Approximately 989 acres of cottonwood defoliation were detected by the 1993 aerial surveys. This represents a decline of 12,747 acres over 1992 levels. Of these defoliated acres, 779 acres were detected on the Chugach National Forest east of Cordova along the lower Copper River. The only other notable activity was a 100-acre area near Moose Creek in the Matanuska Valley.

Cottonwood defoliation by leaf beetles totalled approximately 2000 acres in southeast Alaska in 1993. Defoliation was noted along the Chilkat, Katzehin, Taiya, and Berners Rivers.

ALDER DEFOLIATION

Defoliation of Sitka alder was prevalent throughout most of southeast Alaska in 1993. The most conspicuous areas of defoliation were: the east side of Taiya Inlet, south of Skagway; along the Takhin River, west of Haines; at several locations in the immediate Haines vicinity; along Port Frederick opposite of Hoonah, Chichagof Island; near Chimney Rock, north Chichagof Island; adjacent to Thayer Lake, Admiralty Island; and at Hooligan Slough, near the mouth of the Stikine River.

Insects causing the defoliation were the striped alder sawfly, *Hemichroa crocea*; the alder woolly sawfly, *Eriocampa ovata*; an aphid, likely *Pterocallis alni*; and a leaf roller, *Epinotia* sp.

The overall ecological significance of these defoliators is not known, but sawflies and leaf rollers are food sources for insectivorous birds and some small mammals. Sawfly and leafroller larvae, as well as aphids are fed upon by predacious insects and and are hosts for some parasitic insect species.

LARCH SAWFLY
Pristiphora erichsonii (Hartig)

A total of 12,215 acres of larch sawfly defoliation was detected for the first time in more than 20 years. The area most affected by sawfly defoliation was located south and east of McGrath between the Kuskokwim River and Big River. Other defoliated areas included: 623 acres along the Yukon River 6-15 miles downstream from Ruby; 856 acres along the Yukon River from Fox Pt. Island to Bullfrog Island; and between Stevens Village and Ft. Yukon in the Yukon Flats area. Heavy defoliation was also noted southeast of Fairbanks to Harding Lake.

Larch sawfly populations occur wherever there is host material; from Maine to Alaska. Sawfly larvae feed on both eastern and western larch. Effects of heavy defoliation normally result in a reduction in growth rate with little or no mortality occurring. Records collected during a 1955 sawfly outbreak in northern Minnesota indicated that 7 years' moderate to heavy defoliation will kill an occassional larch. The life cyle of the sawfly varies from one to two years. In a 1-year cycle, adults emerge in the spring, lay eggs, and larvae develop throughout the summer. Mature larvae spin to the ground in late summer and enter the duff, spin tough, papery brown cocoons in which they winter. Some larvae spend two winters before they pupate and emerge as adults.

GYPSY MOTH
Lymantria dispar (L.)

The European gypsy moth was accidently introduced into Massachusetts from Europe in 1869 and the rest is history! Since then, the gypsy moth has been responsible for considerable damage to the hardwood forests of the eastern United States. Millions of dollars are spent annually attempting to reduce the amount of damage and restrict the distribution of this important forest pest. The European gypsy moth also arrived in the western U.S. in the early 1980's.

Historically, there has been little gypsy moth activity in Alaska. In 1985, several larvae were detected by moving company employees on lawn furniture which had been shipped to Juneau from the East Coast. Every summer since 1986, USDA Forest Health Management personnel along with the Cooperative Extension Service and the USDA Animal and Plant Health Inspection Service have placed pheromone monitoring traps throughout Alaska, especially in locations frequented by out-of-state vehicles, including campgrounds and port areas. To date, only two male European gypsy moths have been trapped: one in a campground near Anchorage in 1987 and the other in a campground near Fairbanks in 1992. Due to the recent detection of the Asian gypsy moth, a much more damaging race of the European gypsy moth, in the Pacific Northwest, the Alaskan pheromone trapping program was expanded in 1993; more than 300 traps were placed throughout Alaska from Petersburg to Nome, including Dutch Harbor. No Asian or European gypsy moths were encountered. If the Asian gypsy moth becomes established in the western U.S., including Alaska, the potential impacts to forests and riparian areas could be tremendous. The extensive trapping program will be carried out again next year.

SPEAR-MARKED BLACK MOTH
***Rheumaptera hastata* (L.)**

Black moth larvae are a common defoliator on interior Alaska paper birch. From 1974-75, more than 2 million acres of paper birch were infested by epidemic populations of the spear-marked black moth. There is one generation per year with pupae overwintering in the duff-layer. Severe defoliation results in a temporary reduction in radial and terminal growth. Branch dieback is quite common. Repeated defoliation can result in tree mortality.

The majority of spear-mark black moth activity detected during the 1993 aerial surveys continues to be centered around the Fairbanks area, particularly in the Bonanza Creek area where 3,970 acres were detected. Other defoliated areas occur about 35 miles southeast of Fairbanks in the Harding Lake area and 50 acres of birch were defoliated 8 miles ESE of Tanana.

Figure 4. Spruce beetle-caused mortality near Copper Center, Alaska.

Figure 5. Heavy defoliation of western hemlock caused by black-headed budworm and hemlock sawfly, Calder Bay, Prince of Wales Island, July 1993.

Figure 6. The first reported outbreak of the spruce needle blight fungus *Rhizosphaera pini* in southeast Alaska.

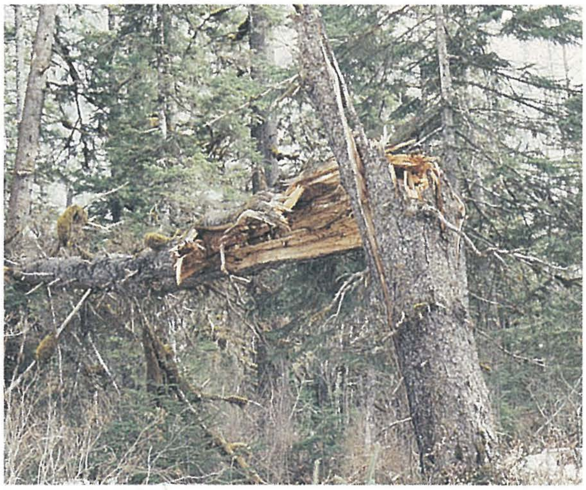
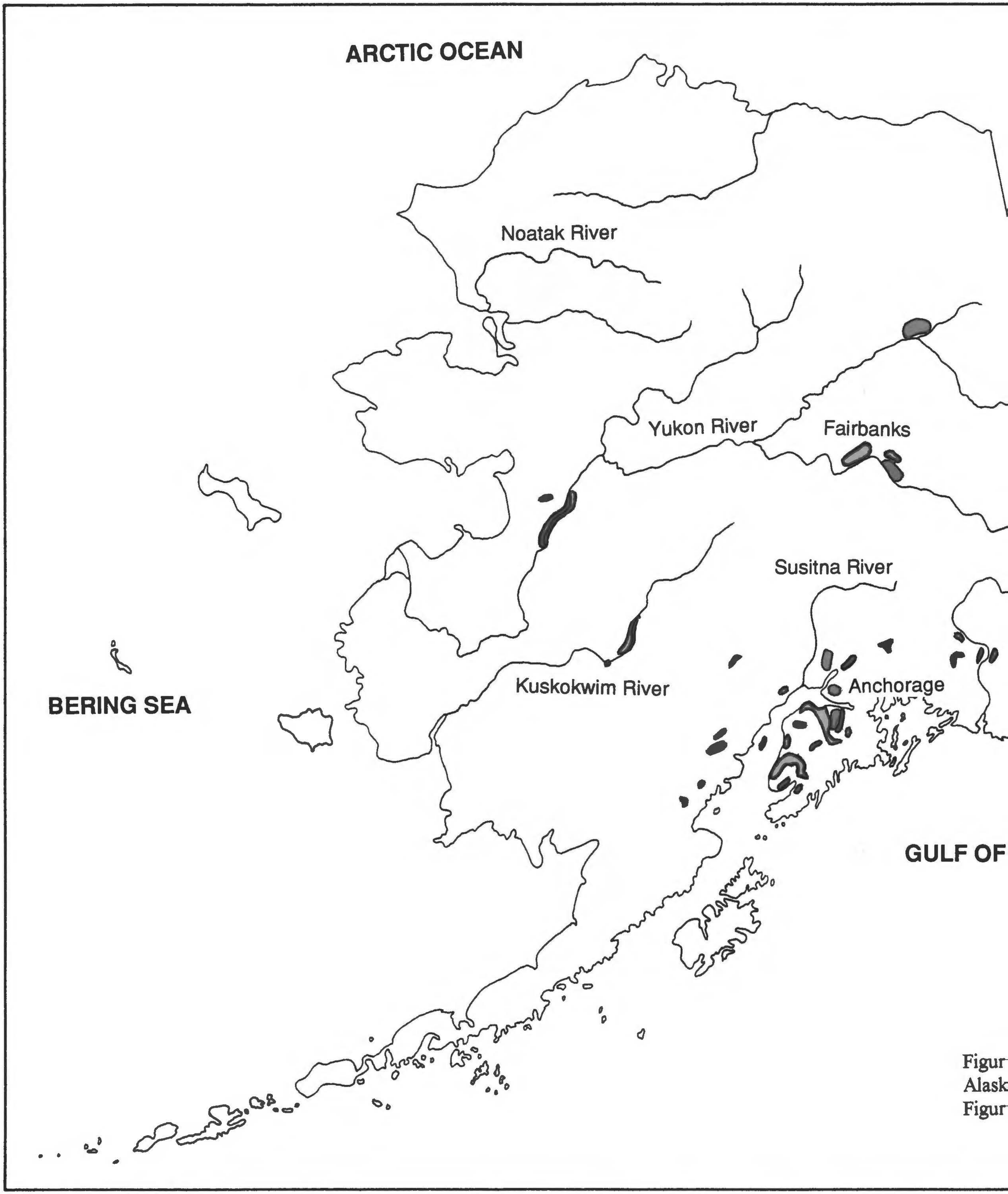


Figure 7. By predisposing large old trees to bole breakage, heart rot decay fungi play a vital role in succession as well as altering structure and providing wildlife habitat in coastal forests.



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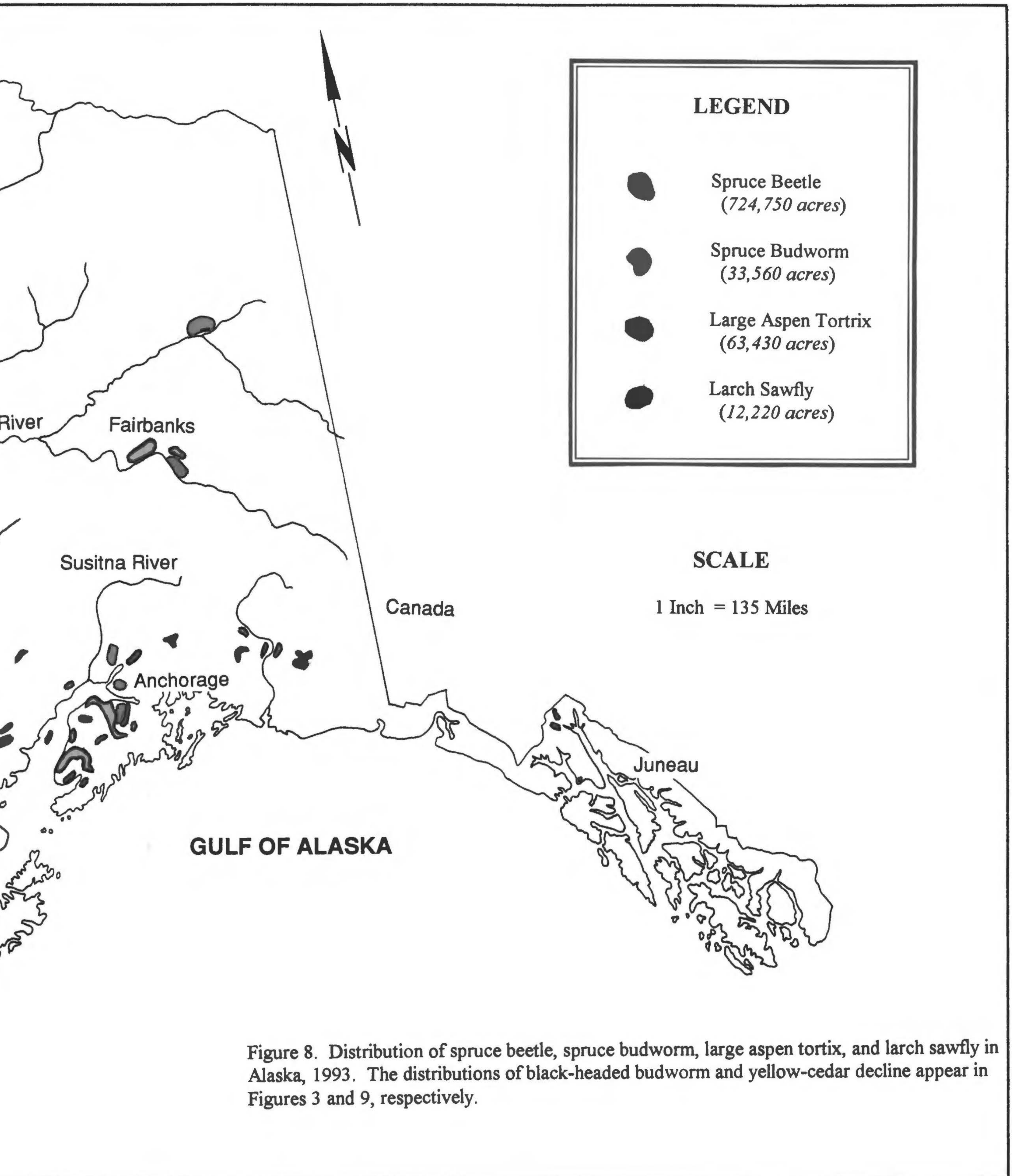

Figure 8. Distribution of spruce beetle, spruce budworm, large aspen tortix, and larch sawfly in Alaska, 1993. The distributions of black-headed budworm and yellow-cedar decline appear in Figures 3 and 9, respectively.

STATUS OF DISEASES

ECOLOGICAL ROLES OF FOREST DISEASES

Until recently, forest diseases were viewed primarily as factors that reduced timber volume and value. The aim of management was to eliminate or reduce disease to minimal levels. But we learning to appreciate the functional role of disease in our forest ecosystem. Different diseases enhance diversity, provide wildlife habitat, and alter forest structure, composition, and succession. As agents of succession in the western hemlock/Sitka spruce type, diseases are apparently responsible for the "breaking up" of even-aged stands as they are in transition (i.e., 100 to 200 years old) to old-growth, and then appear to be the primary factors that maintain the old-growth phase through canopy-gap disturbance.

To reduce disease to minimal levels in all instances is to diminish the various desirable characteristics that they shape and to alter successional patterns. Thus, forest health can actually be diminished by zealous disease control. On the other hand, overly abundant levels of some diseases negatively affect these resources. For example, excessive hemlock dwarf mistletoe can lead to canopy collapse in a stand which reduces vertical structure and thermal cover so that even habitat for most wildlife is reduced.

The two major types of disease that alter forest structure, heart rot fungi and dwarf mistletoe, are manageable within desirable parameters. Levels of heart rot can be manipulated by controlling the incidence of bole wounding during stand entries. Levels of dwarf mistletoe can be manipulated through the distribution, size, and infection levels of residual trees that remain after alternative harvests. Based on ongoing research, the effects of different degrees of these two types of diseases will be predictable through time. Thus, one of our objectives in ecosystem management is to develop the tools for managing moderate disease levels that will enhance many resource values but also maintain productivity of the timber resource.

STEM DISEASES

HEMLOCK DWARF MISTLETOE
Arceuthobium tsugense (Rosendhal) G.N. Jones

Dwarf mistletoe is the most important disease of western hemlock in unmanaged, old-growth stands throughout southeast Alaska as far north as Haines. Within the range of western hemlock, dwarf mistletoe is absent from Cross Sound to the northwest along the Gulf of Alaska; thus, managers need not be concerned about the disease in these areas.

Old-growth hemlock stands in southeast Alaska vary in disease levels from stands in which almost every western hemlock tree is infected to other stands in which the parasite is absent. Sitka spruce and mountain hemlock are only rarely infected. Most old-growth stands below about 500 feet elevation have some level of infestation. The disease is uncommon at higher elevations.

Heavily infected western hemlock trees have branch proliferations (witches- brooms), bole deformities, reduced radial growth, or may

TABLE 2. Effects of common diseases on major ecological characteristics and processes in Alaskan forests. Effects by each disease or disorder are qualified as: - = negligible or minor effect, + = some effect, ++ = dominant effect.

	ECOLOGICAL FUNCTION ALTERED			
DISEASE	STRUCTURE	COMPOSITION	SUCCESSION	WILDLIFE HABITAT
STEM DISEASES				
Dwarf mistletoe	++	+	+	++
Hemlock canker	-	+	-	+
Hardwood cankers	+	+	+	-
Spruce broom rust	+	-	-	++
Hemlock bole fluting	-	-	-	-
Western gall rust	-	-	-	-
HEART ROTS (Many species)	++	+	++	++
ROOT DISEASES (Several species)	+	-	+	-
FOLIAR DISEASES				
Spruce needle rust	-	-	-	-
Spruce needle blights	-	-	-	-
Hemlock needle rust	-	-	-	-
Cedar foliar diseases	-	-	-	-
Hardwood leaf diseases	-	-	-	-
SHOOT DISEASES				
Sirococcus shoot blight	-	-	-	-
Shoot blight of yellow-cedar	-	+	-	-
DECLINES				
Yellow-cedar decline	++	++	++	+
ANIMAL DAMAGE				
Porcupines	+	-	-	+
Brown Bears	+	-	-	+

die -- all potential problems in stands managed for wood production. Growth loss in heavily infested stands can reach 40%. 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 example, witches-brooms may provide hiding or nesting habitat for birds or small mammals. The inner bark of swellings and the seeds and shoots of the parasitic plants are nutritious and often consumed by small mammals. Heavily infested hemlock stands can begin to decline and collapse to the extent that diversity and animal habitat are diminished, however. Stand composition is altered when mixed-species stands are heavily infested; growth of resistant species such as Sitka spruce and cedar is enhanced.

Spread of the parasite into young-growth stands is typically by: 1) infected non-merchantable hemlock trees (residuals) which are sometimes left standing in cut-over areas, 2) infected old-growth hemlocks on the perimeters of cut-over areas, and 3) infected advanced reproduction. Residual trees may play the most important role in the initial spread to young stands. Managers using alternative harvest techniques (e.g., large residuals left standing in clearcuts, small harvest units, or partial harvests) should recognize the increased impact of dwarf mistletoe in hemlock overstory trees and in regeneration.

Recent extensive surveys in young-growth stands up to rotation age in southeast Alaska indicate that the disease occurs at low frequency and low impact as long as large infected residual trees are not present. Current studies are examining the incidence and impact of hemlock dwarf mistletoe in mixed-storied stands.

HEMLOCK CANKER
Xenomeris abietis Barr. and other fungi

Hemlock canker continued to develop at outbreak levels for the fourth consecutive year on Prince of Wales Island in 1993 where small hemlocks and the lower crowns of large hemlock trees were killed along more than 60 miles of road. Outbreaks continued for the second year along unpaved roads near Rowan Bay (Kuiu Island), Corner Bay (Chichagof Island), and near Carroll Inlet (Revillagigedo Island). The disease is most common in old stands with multiple canopy layers, but it also damages or kills hemlocks in young-growth stand (e.g., at Prince of Wales and Rowan Bay). In 1993, the disease was observed for the first time on Long Island along short distances of unpaved road. It was also noted for the first time in roadless areas where it occurred along streams and in stand openings at Alvin Bay on Kuiu Island.

The causal agent has not been conclusively determined. The fungus *Xenomeris abietis* is sometimes associated with dead hemlock, but another unidentified imperfect fungus has been more frequently isolated from cankered tissues. Inoculation tests were initiated in 1993 with this new fungus to determine its disease-causing abilities.

The role of road dust in the disease has now been questioned as hemlock canker was been found well away from roads this year. It is still conceivable that dust is a contributing factor in the disease, although not an absolutely necessary one in its development.

Ecologically, stand composition and structure are the primary effects of hemlock canker. Tree species other than western and mountain hemlock are resistant and favored by the disease. Wildlife habitat, particularly for deer, may be enhanced where the disease kills understory hemlock which competes with the more desirable forb species.

SPRUCE BROOM RUST
Chrysomyxa arctostaphyli **Diet.**

This perennial disease is common throughout interior and southcentral 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 only wherever spruce grows near the alternate host, bearberry or kinnikinnik (*Arctostaphylus uva-ursi*) in Alaska. The fungus cannot complete its life cycle unless both host types (spruce and bearberry) are present.

Infections by the rust fungus result in dense clusters of branches (witches brooms) on white, Lutz, Sitka, and black spruce. The incidence of spruce broom rust changes little from year to year.

The disease may cause slowed growth on spruce, although this has not been determined by research. The dense clusters of branches and needles (brooms) are known to provide nesting and hiding habitat for some birds and perhaps for small mammals.

WESTERN GALL RUST
Peridermium harknessii **J.P. Moore**

Gall rust was common throughout the distribution of pine in Alaska. Infection by the rust fungus *P. harknessii* causes spherical galls on branches and main boles of shore pine. Infected pine tissues are swollen but are not always killed by the rust fungus. Another fungus, *Nectria macrospora*, colonized and killed many of the pine branches with these galls this year. In cases where galls were located on the main bole, the combination of the rust fungus and *N. macrospora* commonly caused top-kill. Even though very abundant, the disease does not appear to have major ecological roles in Alaska.

HEART ROT DECAYS

HEART ROTS OF CONIFERS

Heart rot decay fungi cause enormous loss of wood volume in Alaskan coniferous forests. Decay effects are substantial in southeast Alaska where long-lived tree species predominate in old-growth forests, and the slow-growing decay fungi have ample time to cause significant losses. Decay fungi play an important role in the structure and function of coastal old-growth forests where fire and other forms of catastrophic disturbance are uncommon. By predisposing large old trees to bole breakage, these fungi serve as important disturbing factors that cause small scale canopy gaps. Heartrot fungi enhance wildlife habitat -- indirectly by increasing forest diversity through gap formation and more directly by creating hollows in logs or live trees for species such as cavity nesting birds.

The importance of decay fungi in managed young-growth conifer stands is less certain. Wounds on live trees caused by logging activities allow decay fungi to cause appreciable losses. Studies in progress are investigating how frequently fungi enter wounds of different sizes and the rate of subsequent decay in these wounded trees.

In southeast Alaska, the following fungi are the most important causes of wood decay in live trees:

Sitka spruce
- *Fomitopsis pinicola*
- *Phellinus pini*
- *Armillaria* sp.
- *Phaeolus schweinitzii*
- *Laetiporus sulphureus*

Western hemlock
- *Fomitopsis pinicola*
- *Armillaria sp.*
- *Heterobasidion annosum*
- *Laetiporus sulphureus*
- *Phaeolus schweinitzii*
- *Phellinus hartigii*
- *Phellinus pini*

Western redcedar
- *Poria albipellucida*
- *Phellinus weirii*

With the exception of *Armillaria* sp., all decay fungi important on Sitka spruce are also important in decay of white spruce in south-central and interior Alaska (and on Lutz spruce on the Kenai Peninsula). In addition, significant volume loss occurs in white and Lutz spruce from butt rot caused by *Coniophora puteana* and *Pholiota alnicola*.

Saprot fungi typically decay dead branches and large woody debris and therefore play an essential role in recycling wood in unmanaged forests. However, saprot decay also routinely becomes established in spruce trees attacked by spruce bark beetles. Large volumes of potentially recoverable timber volume are currently being lost annually on the Kenai Peninsula, where salvage logging has not kept pace with tree mortality from the continuing spruce beetle outbreak. Significant volume loss from saprot appears to begin about 4-5 years following tree death. Several species of saprot fungi are associated with spruce beetle-caused mortality, but *Fomitopsis pinicola* occurs most commonly.

HEART ROTS OF HARDWOODS

Heart rots are the most important cause of volume loss in Alaskan hardwood species. Incidence of heartrot in hardwood species of interior and south-central Alaska is generally high by the time a stand has reached maturity (about 50 years old). Substantial volume loss can be expected in stands 80 years old or older. Detailed data on volume losses by stand age class and forest type are currently lacking; studies are needed to better characterize these relationships.

Pleurotus sp. and *Pholiota* sp., which produce annual sporophores, commonly occur on trembling aspen, black cottonwood, and paper birch, but are not as common as heartrot fungi that form perennial sporophores on these tree species. *Phellinus igniarius* (L. ex Fr.) Quel. and *Fomes fomentarius* (Fr.) Kichx. account for the majority of decay in paper birch, with the former stem decay fungus being the most important in terms of both incidence and decay volume. *Phellinus tremulae* (Bord.) Bond & Boriss. accounts for the majority of stem decay in both trembling aspen and black cottonwood.

SHOOT DISEASES

SIROCOCCUS SHOOT BLIGHT
Sirococcus strobilinus Pruess.

The shoots of young-growth western hemlock were killed in moderate levels by the blight fungus *S. strobilinus* in southeast Alaska this year. Sitka spruce and mountain hemlock are sometimes also attacked. Thinning may be of some assistance in reducing damage by the fungus as thinned stands have fewer infections than in unthinned stands.

This disease is typically of minimal ecological consequence because infected trees are not often killed and young hemlock stands are so densely stocked. Species composition may be altered to some degree where trees other than western hemlock may be favored by the disease.

SHOOT BLIGHT OF YELLOW-CEDAR
Apostrasseria sp.

Regenerating yellow-cedar suffered substantial infection and shoot blight by the fungus *Apostrasseria* sp. in southeast Alaska in 1993. The disease does not affect mature cedar trees, however. The incidence of shoot blight has not changed appreciably over the past several years. Attack by the fungus causes terminal and lateral shoots to be killed back 10 to 20 cm or so on seedlings and saplings during winter or early spring. Entire seedlings up to 0.5 m tall are sometimes killed. The newly discovered fungus that causes the disease, *Apostrasseria* sp., is closely related to other fungi that cause disease on plants under snow. The fungus *Herpotrichia juniperi* is often found as a secondary invader on seedlings after they die. An inoculation study was initiated in 1993 to confirm the pathogenicity of *Apostrasseria* sp.

This shoot blight disease probably has more ecological impact than similar diseases on other host species because the natural regeneration of yellow-cedar is limited in many areas. By killing the leaders of yellow-cedar seedlings and diminishing their ability to compete with other vegetation, this disease reduces the regeneration success of yellow-cedar and thereby alters species composition.

FOLIAR DISEASES

SPRUCE NEEDLE RUST
Chrysomyxa ledicola Lagerh.

Spruce needle rust occurred at moderate and high levels in 1993. The disease was noted as abundant on poorly drained sites near Petersburg, Juneau, and other areas.

The spores that infect spruce needles are produced on the alternate host, Labrador-tea (*Ledum* spp.), a plant that is common in boggy areas; thus the disease on spruce is most pronounced in these boggy (muskeg) areas. Although the disease can give spruce trees the appearance of being nearly dead, trees rarely die from this disease even in years of intense infection.

On Sitka spruce, the primary ecological consequence of the disease may be to reduce tree vigor of a species already poorly adapted to boggy sites. Repeated infection of spruce in may alter forest composition by favoring other tree species.

SPRUCE NEEDLE BLIGHTS

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

The most important needle disease of Sitka spruce, caused by *Lirula macrospora*, occurred at low levels in 1993. It was most common on young Sitka spruce and the lower crowns of larger trees throughout coastal Alaska. *Lophodermium picea* was also found at low infection levels in 1993. This disease is more typical of larger, older spruce of all species in Alaska. *Rhizosphaera pini* was found for the first time in damaging levels in coastal Alaska where it was killing the lower, inner crown of Sitka spruce in Auke Bay and other areas of Juneau. Damage closely resembles that caused by spruce needle aphid and microscopic observation of the tiny fruiting bodies on infected needles is needed for proper identification.

The primary impact of these needle diseases is one of appearance. They have only negligible ecological consequence. Repeated heavy infections may slow the growth of spruce and benefit neighboring trees, thereby altering species composition to some degree.

HEMLOCK NEEDLE RUST

Pucciniastrum vaccinii (Rab.) Joerst.

Hemlock needle rust once again occurred at low, endemic levels on needles of western hemlock in 1993. The disease has not been found at outbreak levels since the late 1970's. The blueberry alternate hosts for this rust fungus (*Vaccinium alaskensis* and *V. ovalafolium*) are very common understory plants in hemlock-spruce forests. With the great abundance of both hemlock and blueberry hosts, reasons for the low incidence of this disease are not known. This disease apparently has minimal ecological effect even during years of relatively high infection levels.

FOLIAGE 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. *D. thujina* was the more damaging of the two and was common wherever its host was found. Infection by neither fungus resulted in severely defoliated nor death of cedar trees. Neither disease has major ecological effects.

DECLINES AND ABIOTIC FACTORS

YELLOW-CEDAR DECLINE

Decline and mortality of yellow-cedar persists as one of the most spectacular forest problems in Alaska. About 570,000 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.

All research suggests that no contagious organism is the primary cause for this extensive mortality. Some abiotic (non-living) site factor, probably associated with the poorly-drained anaerobic soils where decline occurs, appears to be responsible for initiating and continuing cedar decline. Two hypotheses have been proposed to explain the primary cause of cedar decline -- death could result from (1) toxins produced by anaerobic decomposition in the wet, organic soils or (2) freezing damage to shallow fine roots in wet soils associated with climatic warming and reduced insulating snowpacks in the last century. Whatever the primary cause of this mysterious decline, it is probably a naturally-occurring phenomenon.

A detailed list of acreage affected by Alaska-yellow cedar decline has been determined from a composite map developed by mapping dead and dying cedar during annual aerial detection surveys conducted over previous years. 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) into adjacent stands. Contained within most declining stands are trees that died up to 100 years ago (snags still standing), more recently killed yellow-cedars, dying yellow-cedars (with yellow, red, or thinning crowns), healthy yellow-cedars, and other tree species.

Ground surveys indicate 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 from cedars and on other sites they experience slowed growth and mortality because of site deterioration (poor drainage). Succession to western hemlock and mountain hemlock appears to be occurring in some stands where decline has occurred for up to almost a century.

Little is known about wildlife use and dependency of yellow-cedar forests, whether these forests are experiencing excessive mortality or not. The primary ecological effect of yellow-cedar decline is to alter stand structure (addition of numerous snags), composition (yellow-cedar diminishing and other tree species becoming more numerous), and the eventual succession to other conifer species. The creation of numerous snags is not particularly beneficial to cavity-using animals because of the decay resistance of yellow-cedar wood. 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.

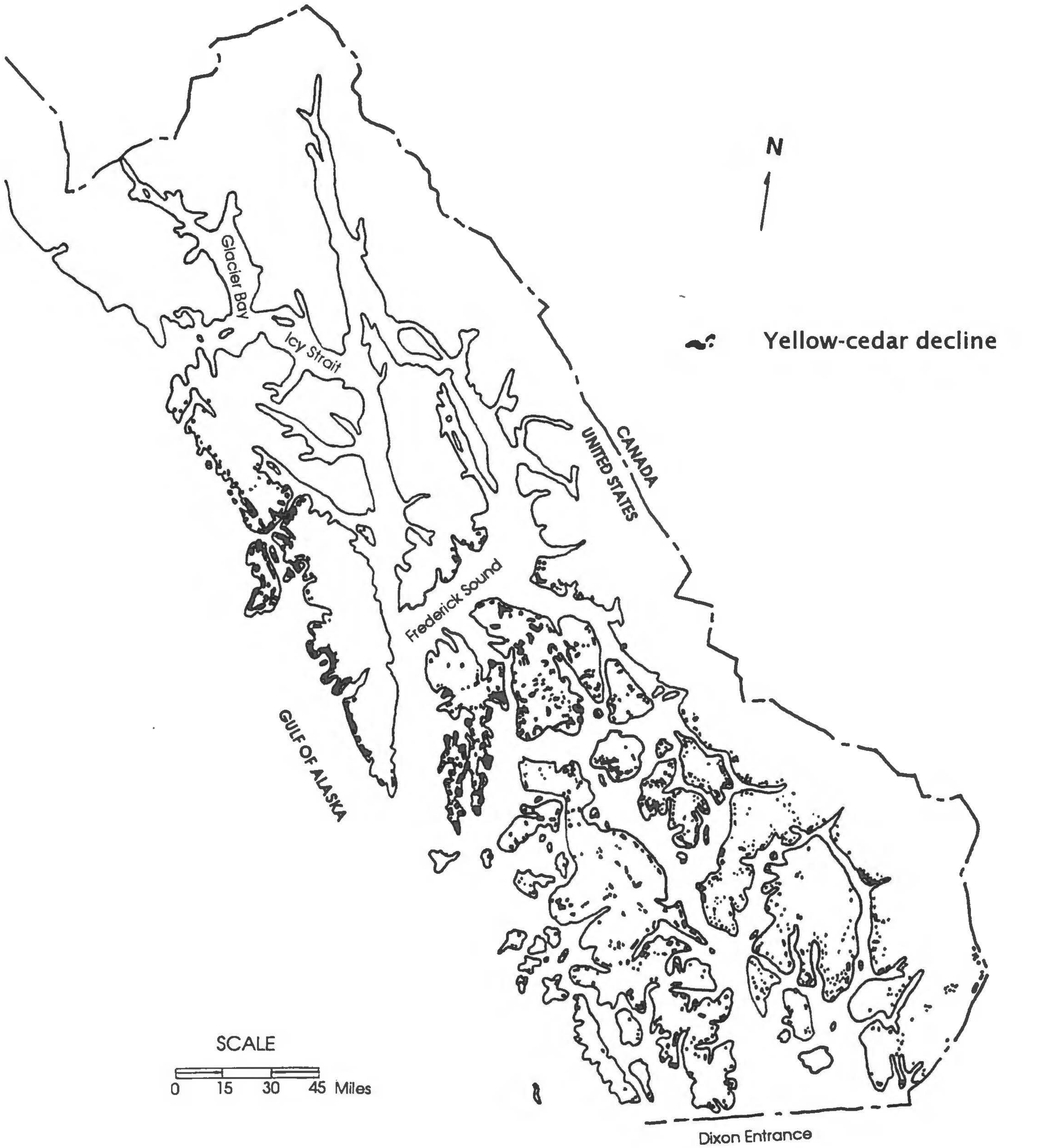

Figure 9. Distribution of yellow-cedar decline in southeast Alaska

Table 3. Acreage affected by yellow-cedar decline in southeast Alaska.

	Acres
NATIONAL FOREST LAND	541,349
Chatham Area	132,590
Juneau Ranger District	1,167
Hoonah Ranger District	2,179
Sitka Ranger District	
Chichagof I	36,897
Baronof I	58,564
Kruzof I	27,971
Total	123,432
Admiralty Island Nat'l Mon. Wilderness	5,812
Stikine Area	233,870
Petersburg Ranger District	
Kupreanof I	79,913
Kuiu I	66,653
Mitkof I	8,602
Woewodski I	2,258
Mainland	7,707
Total	165,133
Wrangell Ranger District	
Etolin I	26,077
Wrangell I	16,648
Zarembo I	9,496
Woronofski I	622
Mainland	15,894
Total	68,737
Ketchikan Area 174,889	
Thorne Bay Ranger District	
Prince of Wales I	29,204
Kosciusko I	12,027
Heceta I	1,463
Total	42,694
Ketchikan Area (continued)	
Craig Ranger District	
Prince of Wales I	41,152
Dall I. and Long I	1,323
Total	42,475
Ketchikan Ranger District	
Revillagigedo I	24,208
Gravina I	6,780
Mainland	22,028
Total	53,016
Misty Fjords Nat'l Mon. Wilderness	
Revillagigedo I	13,623
Mainland	23,081
Total	36,704
NATIVE LAND	17,667
Prince of Wales I	10,196
Kupreanof I	312
Sukkwan I	156
Ketchikan area	5,058
Annette I	1,945
STATE AND PRIVATE LAND	10,430
Sitka area	1,246
Mitkof I	1,362
Kupreanof I	234
Prince of Wales I	943
Wrangell area	311
Pelican area	156
Ketchikan area	2,131
Gravina I	2,958
Koscusko I	1089
TOTAL LAND AFFECTED	**569,446**

HEMLOCK FLUTING

Deeply incised grooves and ridges extending vertically along boles of western hemlock characterize hemlock fluting. Bole fluting is common on western hemlock throughout 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 known, but associated factors include increased wind-firmness of fluted trees, common occurrence on sites with shallow soils, triggering of fluting by growth release, and patterns of fluting on boles that follow translocation. The asymmetrical radial growth appears to be caused by unequal distribution of carbohydrates caused by 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 is no longer outwardly visible in some trees because they have attained more equal translocation and fluting patterns have been engulfed within the stem.

Bole fluting has important economic impact, but probably does not have much ecological consequence beyond adding to windfirmness.

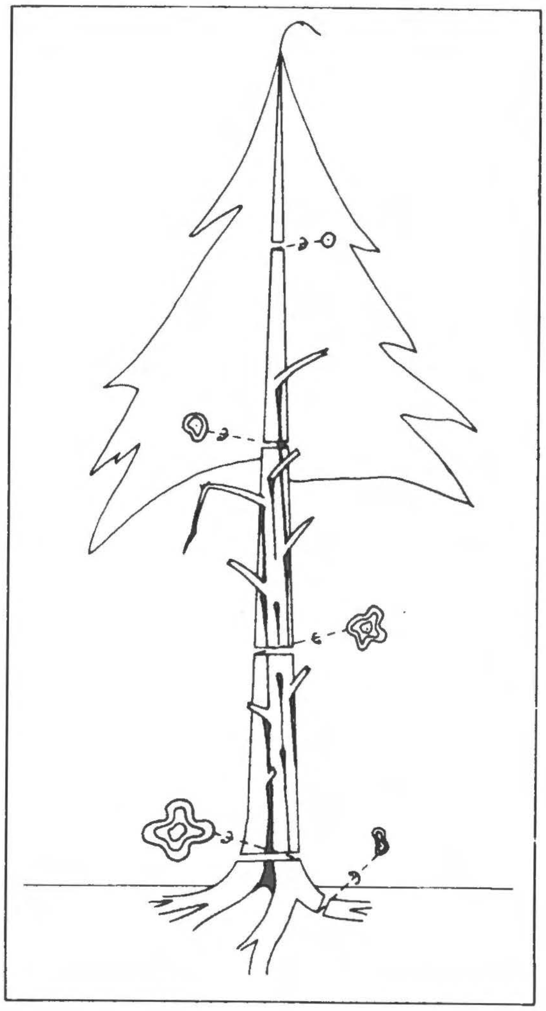

Figure 10. Bole fluting on western hemlock.

STATUS OF ANIMAL DAMAGE

PORCUPINE
Erethizon dorsatum

Porcupines cause severe damage to Sitka spruce and western hemlock in numerous local areas of southeast Alaska. An extensive survey documents the level of porcupine damage in young-growth stands. Feeding injuries to trees are confined to the known distribution of porcupine; thus, trees are not damaged where the porcupine is absent such as Prince of Wales, Kuiu, Baranof, Chichagof, and Admiralty Islands. Damage is especially serious on Mitkof Island in southeast Alaska. Other damage has been noted at Thomas Bay, Cleveland Peninsula, Bradfield Canal, Anita Bay, Douglas Island, and the Juneau area. Shore pine near Haines has been damaged the last few years. Porcupines also damage trees throughout interior Alaska where bark beetles, including *Ips* spp., have been found infesting damaged trees.

In southeast Alaska, feeding behavior of porcupines changes as forests age 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, porcupines climb fewer trees and 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: (i) to provide greater diversity of structure and vegetation in young-growth even-aged conifer stands through aggregated tree mortality and (ii) to provide greater levels of heart rot decay by the creation of infection courts (wounds) in older trees.

BROWN BEAR
Ursus arctos

Yellow-cedar trees were wounded by brown bears in spring on Baranof and Chichagof Islands. Brown bears rip the bark away from the lower boles of these trees, apparently to taste the sweet cambium. Other tree species are unaffected. Trees with old scars have associated columns of wood decay that will limit the value of their butt logs. Ecologically, this interaction of bears and trees may benefit the bears directly by providing nourishment. In addition, stand structure may be altered by greater heart rot levels due to bole wounding.

INTEGRATED PEST MANAGEMENT ACTIVITIES

Integrated pest management 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:

(1) Participation in a cooperative effort with the Alaska Agricultural Research Station and the Cooperative Extension Service to provide pest management information to Alaska residents. The program, which includes education, research and survey activities, and provides integrated pest management information concerning urban forestry and garden and greenhouse pests. The IPM Technician Program provides the principles of integrated pest management to the Alaska public through the expertise and activities of the Technicians. The program is educational in nature and provides the public with a means to learn about pest management in an informal and accessible manner. IPM Technicians were located in Anchorage, Palmer, Soldotna, Fairbanks, Delta Junction, Juneau, and Kodiak. They also served surrounding communities within their districts. The Anchorage and Soldotna sites both had a full time and a half time Technician; the remaining locations had one IPM Technician for the season. The total recorded client contacts reached well over three thousand and each IPM Technician conducted at least one field workshop during the 1993 season and had at least one contact with the media. Four issues of "The IPM Scout" were produced and distributed to more than 2,500 subscribers. In addition each IPM Technician submitted four monthly area reports and one feature article during the course of the season.

(2) Ground applications of methylcyclohexenone (MCH) for the prevention of spruce beetle attacks and population build-up in standing, uninfested spruce as well as uninfested right-of-way clearing debris were undertaken in the spring of 1993. MCH is the naturally occurring antiaggregating pheromone of the spruce beetle. That is, it functions as a repellent. The objective of the study was to see if the application of MCH in a Bubble-cap and bead formulation would significantly reduce the number of spruce beetle attacks and subsequent brood production on large diameter standing and felled spruce. The ground applied MCH beads at various dosage levels did not provide protection of felled or standing spruce from spruce beetle infestation. Similar results were obtained in southeast Alaska in a study involving windthrown Sitka spruce. It still appears that MCH does not elute sufficiently from MCH impregnated beads to deter spruce beetles in Alaska. The use of MCH bubble caps, however, appears feasible as an operational use strategy for protecting high value stands of spruce where spruce beetle populations are low, but increasing. Bubble caps applied to standing trees at a density of 32 and 50 bubble caps/acre protected 83 and 95 percent of the trees compared to 79 percent of the trees attacked in the untreated control plots.

(3) The current black-headed budworm outbreak in southeast Alaska is impacting

trees in both forest and urban settings. A study was initiated in the Juneau area to assess the value of insecticide implants in protecting ornamental spruce and hemlock from defoliation by the black-headed budworm. The impact of some natural control agents is also being assessed. The study will continue in 1994 and will be completed by 1995.

Insecticide implants have been found to be a safe and effective method for protecting high value trees (e.g. seed orchard trees, ornamentals, and trees in recreation areas) against the negative impacts of several insect species.

(4) Carbaryl is one of the most frequently used pesticides for prevention of spruce beetle attacks on standing spruce. One application of a 2% formulation provides almost three years of protection. However, carbaryl is not an effective pesticide for other species of *Dendroctonus*, specifically the southern pine beetle. Environmental fate studies with respect to carbaryl were initiated the last two years in Alaska, California, and North Carolina. The objectives of these studies are: a) delineate the persistence of carbaryl on the bark of loblolly pine and Lutz spruce, and b) determine the effects of climatic factors on the movement of carbaryl in forest litter and soils in wet and dry sites in three different ecosystems and geographic areas of North America.

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. When collected
    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. 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 address inside shipping box.
3. Mark on outside: "Fragile: Insect-disease specimens enclosed. For scientific purposes only. No commercial value."

FOREST INSECT AND DISEASE BIOLOGICAL EVALUATIONS, TECHNICAL REPORTS, AND MISCELLANEOUS PUBLICATIONS

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Holsten, E.H. 1993. Spruce bark beetle activity-Lake Clark National Park. USDA For. Serv. R10 FHM Biological Evaluation R10-TP-43. 23 p.

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Julin, K.R.; Shaw, C.G., III; Farr, W.A.; Hinckley, T.M. 1993. The fluted western hemlock of Alaska. II. Stand observations and synthesis. Forest Ecology and Management 60: 133-141.

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Schulz-Blitz, B.K. 1993. Insects and diseases of Alaskan woody ornamental plants. CES Pub. No. 100 B-0-067. Fairbanks, AK. 100 p.

Werner, R.A. 1993. Response of the engraver beetle, *Ips perturbatus*, to semiochemicals in white spruce stands of interior Alaska. USDA For. Serv., Pacific Northwest Research Paper PNW-RP-465, Portland, Ore. 9 p.

ALASKA FOREST HEALTH SPECIALISTS

Anchorage

Forest Health Management
USDA Forest Service
State and Private Forestry
3301 'C' Street, Suite 522
Anchorage, AK 99503-3956
Phone: (907) 271-2575

Jerry Boughton, Program Manager
Edward H. Holsten, Entomologist
Robert Wolfe, Biotechnician
Kenneth P. Zogas, Biotechnician
Beth Schultz, Ecologist
Keith M. Reynolds, Research Pathologist

Juneau

Forest Health Management
USDA Forest Service
State and Private Forestry
2770 Sherwood Lane, Suite 2A
Juneau, AK 99801
Phone: (907) 586-8883
(907) 586-8769

Paul E. Hennon, Pathologist
Roy A. Mask, Entomologist
Paul W. Reid, Biotechnician
Loreen M. Trummer, Coop. Ed. Student

Fairbanks

Institute of Northern Forestry
USDA Forest Service
Pacific Northwest Research Station
308 Tanana Drive
Fairbanks, AK 99701
Phone: (907) 474-3304

Richard A. Werner, Res. Entomologist

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