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LITERATURE SURVEY

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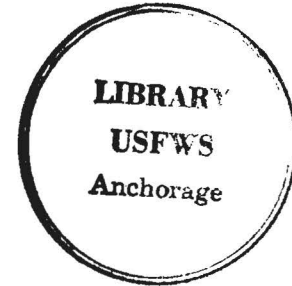
VEGETATION OF

THE ALEUTIAN ISLANDS,

ALASKA

by

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INTRODUCTION

The vegetation of the Aleutian Islands is alpine-like and has been classified as maritime tundra (Amundsen 1977). With the exception of a few trees which were planted in the Aleutians during World War II, the islands are treeless. Portions of the eastern part of the Aleutian Islands have traces of subalpine plant communities with medium to tall shrubs such as Salix barclayi and Alnus crispa (Hultén 1960). Subalpine Alnus crispa thickets also occur on the Kamtchatka Peninsula (U.S.S.R.) at the opposite end of the chain and separated by 2500 km from the eastern Aleutians. Communities with medium or tall shrubs as dominants are not found on the rest of the islands.

The overall height of the vegetation of the Aleutians is less than 50 to 75 cm. In protected valley bottoms, it may reach 100 to 150 cm. in height. Most of the community types in this region are some form of a "crowberry-sedge-grass-lichen meadow" (Amundsen 1977, Schacklette et al. 1969, Hultén 1960). Some of the higher elevation areas have plant communities with a significant heath component (Heusser 1978). Thus, the heaths are found on exposed places, while the meadows occur in more sheltered valleys or hollows between the small hills, ridges, or plateaus (Hultén 1960).

It is unusual for a region of the latitude of the Aleutian Islands to be treeless. The vegetation of the adjacent continental areas is typically a coniferous forest (Good 1974). Current explanations for the absence of trees in the vegetation include the reduced level of insolation due to the high frequency of cloud cover, generally low soil temperatures, severe winds and

isolation of the islands (Amundsen 1977). The lower insolation reduces productivity. The low soil temperatures retard respiration. Severe winds cause transpiration stress in the shoots during the winter when the soil moisture is frozen and unavailable. Winds also cause physical abrasion with ice particles to the exposed shoot parts. Tree seedlings planted on Adak in 1976 were observed in 1979 to be undamaged in protected sites. On exposed sites or when the shoot extended above the surrounding vegetation, dead trees and shoot tips were frequently observed. The successful production of viable seeds has not been observed in Sitka spruce (Picea sitchensis) trees planted on Adak Island. Viable seeds were found in cones collected from spruce trees on Sand Point in the Shumagin Islands.

The Aleutian vegetation usually forms a thick rhizomatous mat. Effective sexual reproduction is not common in the species of this flora. The fragmentation of rhizomes is probably the most effective mode of reproduction. The rhizomes of different species are complexly interlaced. Because of the complex rhizome pattern and the frequency of vegetative reproduction, it is usually very difficult to determine the extent of an individual plant.

Colinvaux (1964, 1967a, 1976b), Heusser (1973, 1978) and Nybakken (1966) have conducted palynological studies on islands in the Bering Sea Region. All concluded that the vegetation of the islands has not changed significantly in the last 10,000 years. Nybakken (1966) reported no change in the vegetation

on Umnak for the last 5,000 years. Heusser (1973) noted an increase in willow pollen on Umnak Island during the last 10,000 years. The increase in willow pollen was said to correspond to warming during the Hypsithermal. A similar change in the pollen profiles was not observed by Heusser (1978) on Adak Island in the central Aleutians.

The flora of the Aleutian Islands tends to be more similar to the flora of the North American source areas than the Asian source areas (McCord 1980). This conclusion supported the designation of Hultén's line as a phytogeographic division between the Aleutian and Commander Islands (Tatewaki 1963).

In the central Aleutians the flora is very depauperate probably due to the relatively short time since the glacial period, when most of the plants were extirpated (Hultén 1960).

In terms of vascular plant species diversity, the area of an island is the most important geographic variable used in the prediction of the number of species (McCord 1980). The mechanism underlying this species-area relationship is not known, but a relationship between area and environmental heterogeneity may account for part of it.

A popular account of the Aleutian flora is found in Davids (1984).

Vegetation descriptions in this literature survey are shown in relation to the island or islands they include as follows:

Amundsen (1972)	Amchitka
Amundsen & Clebsch (1971)	Amchitka
Bank (1951)	Aleutians
Byrd (1984)	Buldir
Cooper (1936)	Aleutians
Hultén (1960)	Aleutians
Lebednik <u>et al.</u> (1971)	Amchitka
McRoy, 1968)	Aleutians
Shacklette <u>et al.</u> (1969)	Amchitka
Walker (1945)	Aleutians
Williams (1980)	Adak

The reports are organized according in the literature survey into broad habitat types: 1) unvegetated substrates (rocky shores and reefs, beaches and tidal flats, cliffs, scree and barren fellfield); 2) fresh and brackish water (lacustrine, fluviatile); 3) meadows (wet meadow, mesic meadow); 4) scrub (dwarf scrub, medium scrub); and 5) marine.

ROCKY SHORES AND REEFS

Intertidal zone

Bank (1951)

Reefs of wave-cut basalt supporting abundant edible algae extend from every point of land and are also present in many of the bays.

McRoy (1968)

Zostera marina grows in the soft sediments of shallow waters in bays on the Alaska Peninsula and the Aleutian Islands as far west as Atka and Adak Islands. The plants on Adak Island are evidently the result of transplantation experiments by the U.S. Fish and Wildlife Service. Zostera is apparently lacking in the western Aleutian Islands probably because of a lack of protected bays. The Zostera beds in Izembek Lagoon on the Alaska Peninsula are the largest known single stand of this species.

Walker (1945)

Clear cold water, rocky bottoms, surging waves, and strong currents are ideal for seaweeds, and they are found in great luxuriance. They cover the rocks from high tide level down to 40 fathoms. The alga Fucus grows around the low

tide level; from well below low tide to a depth of many fathoms are kelps, the most common being Alaria; Ulva is common in quiet waters and on less rocky or even muddy bottoms.

Zostera marina is common along seacoasts where there are muddy bottom and quiet waters.

Lebednik et al. (1971)

Littoral vegetation is well developed due to maritime climate, little air temperature variation, high sky cover and relative humidity. The midlittoral region is composed of three zones (1) "Fucus zone" with Fucus disticus and Halosaccion glandiforme; (2) "Hedophyllum zone" with Hedophyllum sessile and Halosoccion glandiforme, and (3) "Alaria zone" with Alaria crispa and Hedophyllum sessile. The sublittoral fringe is discussed under "Maritime."

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BEACHES AND TIDAL FLATS

Strand and supratidal meadow

Amundsen (1972); Amundsen and Clebsch (1971)

A diffuse community of decumbent succulent herbs occurs between the Elymus zone and the mean high tide mark. Principal species are Senecio pseudo-arnica, Mertensia maritima, Honckenya peploides, and Lathyrus maritimus.

A grass community occurs above the high tide line on beaches and on small islets off the coast and on some of the larger seastacks. Elymus arenarius is dominant in these stands, but Festuca rubra and Poa eminens are also common.

Bank (1951)

Seaward of the Elymus zone are scattered growths of Cochlearia officinalis and Lathyrus maritimus as well as a few grasses.

Sea cliffs and soil patches among beach boulders contain growths of Pohlia cruda, Plagiothecium roseanum, Brachythecium albicans, Poa spp., Potentilla villosa, P. nana, P. palustris, and Saxifraga bracteata.

Grass hummocks dominated by Elymus arenarius are found on Aleutian beach

slopes. A number of other plants are associated with the Elymus.

Shacklette et al. (1969)

A Honckenya peploides-Senecio pseudo-arnica community occurs on shorelines of sand, pebbles, or cobbles. The Senecio may grow as tall as 1.5 m and be so closely spaced that passage through the community is difficult. Abundant driftwood in this community indicates that it is submerged in sea water from time to time.

The Elymus arenarius community grows on sandy beaches, old terraces, and on tops of sea cliffs 25 to 100 ft above sea level. On dunes of dark-colored sand, pebbles, and cobbles there is a community of Rhacomitrium lanuginosum-Schistidium apocarpum-Ulota phyllantha.

Hultén (1960)

The "Elymus association" is found on the infrequently occurring sandy beaches. Primary species are Elymus arenarius, Senecio pseudo-arnica, Lathyrus maritimus, Honckenya peploides, and Mertensia maritima.

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Byrd (1984)

"Cochlearia-Achillea Community." -- No quantitative description was made for this Buldir Island community which occurs in scattered locations along the few sandy shorelines just above high tide line. The most common species are Cochlearia officinalis, Achillea borealis, Draba hyperborea, Senecio pseudo-arnica, and Honckenya peploides.

Cooper (1936)

Species of strands and shifting dunes are Mertensia maritima, Honckenya peploides, Lathyrus jajonicus, and Fragaria chiloensis.

Williams (1980)

At Kuluk Bay, Adak Island, foredunes were composed of Honckenya peploides and Elymus mollis. Senecio pseudo-arnica is added to these on the first terrace and Lathyrus maritimus on the second terrace. The main dune slope was dominated by Elymus mollis and Festuca brachyphylla with secondary species Senecio pseudo-arnica, Lathyrus maritimus, Heracleum lanatum, and Ligusticum scoticum.

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BLOCK FIELDS

Byrd (1984)

The "Talus Community" is found on vegetated boulder slides and occur locally from sea level to over 500 m in elevation on Builder Island. Like other upland communities, no overstory occurs. Festuca rubra covers over 50% of the middle story. Dryopteris dilitata, Angelica lucida, Achillea borealis, and Epilobium behringianum are found frequently, but only Angelica has a cover value of over 5%. The ground story includes 14 taxa. Mosses, Stellaria spp., Cardamine umbellata, liverworts, and Saxifraga bracteata are all important.

CLIFFS

Shacklette et al. (1969)

Amchitka Island is almost completely bordered with precipitous sea cliffs of andesite, breccia, and other igneous rocks. These range from a few to 100 ft above the sea. Four communities grow in these cliffs, but one is limited to sites too high and dry to qualify as wetlands. The other communities are:

(1) On beach boulders, rock pinnacles, and cliff faces to the very cliff summits is a Eurhynchium praelongum-Puccinellia langeana-Calaplaca granulosa community. These species have a great tolerance to salt water. Furthermore the moss and the grass grow very luxuriantly where manured by birds; (2) The Potentilla villosa-Draba hyperborea-Saxifraga bracteata community grows in rock crevices from 10 ft above the sea to the tops of cliffs; (3) The Xanthoria candelaria-Ramalina scoparia-R. alquistii community occurs near the summits of high cliffs and offshore sea stacks; and

(4) Elymus-Ligusticum-Anenome community occurs on sloping faces of the less steep cliffs, at the brink of vertical cliffs, and on large flat-topped sea stocks.

Inland bedrock outcrops throughout the island support plant communities different from these of the sea cliffs. Two communities are recognized according to elevation: (1) "Low-altitude bedrock communities" range in altitude from about 150-160 ft asl (outcrops at lower altitudes are on the sea coasts), characteristic species are Veronica stelleri, Cassiope lycopodioides,

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Tofieldia coccinea, and Salix rotundifolia. Some conical outcrops are used by birds as perches and are recognizable by the thick turf of grasses at the summits and sides of the mounds, and (2) "high-altitude bedrock communities" occur above 600 ft is rich in cryptogams but low in vascular plants; not used very often as perches by birds; characteristic plants are Carex circinnata, Umbilicaria proboscidea, and Agrostis borealis.

Bank (1951)

Low altitude rock cliffs are usually associated with seepage areas with a rank growth of ferns - Athyrium felix-femina, Cystopteris fragilis; other species include Claytonia sibirica, Saxifraga bracteata, S. rivularis, and Selaginella selaginoides.

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SCREE, BARREN FELLFIELD

Byrd (1984)

The "Moss-Willow-Empetrum Community" occurs as scattered patches at lower edges of the upland overlooking the alluvial valley on Builder Islands. There is no overstory. A thinly-vegetated middle story contains Salix spp., Geum calthifolium, and Carex circinnata. A thick mat of Empetrum nigrum, mosses, Cassiope lycopodioides, and 10 other species of dwarf plants, interspersed with bare areas, form the ground story.

The "Fell-Field Community" occurs on windswept ridges and plateaus at high elevations. The tallest plant found in this community is 5 cm tall. Salix spp. is the only taxon with a cover value greater than 5% in the middle story, although 14 other species are recorded. Like the middle story, the ground story is mostly bare or covered by gravel. Mosses are the most dominant species, and lichens occur in every plot. Total plant cover is less than 20%.

Shacklette et al. (1969)

"Frost-scar community." -- Frost scars as much as 1 m or more in diameter occur throughout Empetrum heath. Mineral soil is exposed. Characteristic species are Antennaria dioica, Cardamine umbellata, Deschampsia beringensis,

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and Oncophorus wahlenbergii.

Hultén (1960)

Patchy heaths occur in the uppermost alpine and consist of areas 20-50 cm in extent with larger tracts of bare earth between them. They are a subtype of the "Empetrum-lichen" association. Plants that survive such conditions are Empetrum nigrum, Polygonum viviparum, Campanula lasiocarpa, Salix rotundifolia, Primula cuneifolia, Lagotis glauca, Cassiope lycopodioides, and Luzula arcuata.

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LACUSTRINE

Pond and Lake

Amundsen (1972); Amundsen and Clebsch (1971)

Ephemeral pools are usually dominated by Juncus balticus, Alopecurus aequalis, Sparganium hyperboreum, or Caltha palustris.

Hultén (1960)

Lakes are comparatively rare and are very sparsely vegetated. A few aquatic plants such as Potamogeton perfoliatus, Myriophyllum spicatum, Sparganium hyperboreum, Ranunculus trichophyllus, Hippuris vulgaris, and Isoetes braunii usually occur singly or in patches.

Shacklette et al. (1969)

Two kinds of lakes occur on the low plateaus of Amchitka Island. Those with an origin related to geologic structure are relatively deep with a bedrock or cobble bottom, while others develop on undulated surfaces of old, elevated marine platforms are shallow and have a muck or soil bottom. With few exceptions only the latter lake type contains emergent or immersed

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bottom-rooted vascular plants. These form two communities: Hippuris vulgaris-Ranunculus trichophyllus and Isoetes muricato-Ranunculus reptans-Limosella aquatica.

Pools form in depressions of the vegetation, bedrock or colluvium, and peat mantle of the Empetrum heath. Three plant communities grow in these pools: Juncus triglumis-Eriophorum russeolum, Subularia aquatica-Callitriche anceps, and Siphula ceratites-Scapania paludosa.

Walker (1945)

Lakes and ponds are common on many islands. The principal submerged aquatics are Potamogeton alpinus, Myriophyllum spicatum, Hippuris vulgaris, and Sparganium hyperboreum.

Fresh water marsh

Bank (1951)

Flat areas generally receive water from surrounding slopes. These seldom have standing water but are continually wet. Common in such situations are Platanthera hyperborea, P. dilatata, and P. tipuloides (the latter principally in the western Aleutians).

The vegetation of true marshes varies according to the amount of standing water present. Typically present are Polygonum viviprum, Eriophorum medium, Carex rariflora, Scirpus caespitosus, Iris setosa, and Geum calthifolium.

Hultén (1960)

The zonation in marshy areas surrounding ponds is: 1) pond margin, pure Carex lyngbyaei; 2) above this on drier ground (but still marshy) is Carex pluriflora as the primary species with sparse C. anthoxanthea, Plantago macrocarpa, and Erigeron peregrinus secondary. This uppermost marsh zone grades to a drier community composed of fragments of subalpine meadow and Calamagrostis canadensis which is replaced by Empetrum heath at yet higher elevations.

Shacklette et al. (1969)

The first two communities (listed here as marshes) are considered bogs by Shacklette. He differentiated them from marshes on the basis of their bryophyte-dominated vegetation and the fact that they are odorless when disturbed. Nevertheless, these communities occur on mineral substrates. A Philonotis americana-Parnassia kotzebuei community occurs on very gently slopes where water moves through the saturated inorganic substrate. A Scapania paludosa-Nardia scalaris-Marsupella emarginata community occupies drainage channels and wet areas, but only at altitudes above 4,000 ft. The

primary species also grow in the snow-bed community (discussed below) but are there associated with different species of vascular plants.

The next two communities are considered marshes by Shacklette. They have a preponderance of sedges and forbs and give off a strong odor of hydrogen sulfide when stirred up, even in winter. A wet sedge-meadow community typically occurs at the borders of lakes but also develops on very wet slopes and beside streams in the Empetrum heath. Characteristic species are Carex lyngbyaei, C. pluriflora, C. anthoxanthea, C. macrochaeta, Eriphorum russeolum, and Juncus triglumis. A Caltha palustris-Claytonia sibirica community occurs most commonly on wet, inorganic substrates that have enough water moving through them to prevent freezing in winter.

A snow-bed community occurs in mountain valleys along the margins of small streams derived from melting snow. Characteristic species are Anthelia julacea, Scapania paludosa, Saxifraga hirculus, and Leptarrhena pyrolifolia.

Peatland

In this region of Alaska it becomes more difficult to separate the fresh water marsh from the bog categories, and the nomenclature of these types of sites has become somewhat confusing. Heath vegetation, dominated by Empetrum nigrum, is characteristic of the Aleutians and is underlain in most places by a layer of peat 30-420 cm or more thick. The wetter parts of this heath are treated here as peatlands.

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Amundsen (1972); Amundsen and Clebsch (1971)

The lowland tundra is a "wet meadow" with sedges and lichens more prominent in the wetter areas and grass and subshrubs more prevalent in drier areas. The substrate is mostly a sedge-lichen peat, 30 to 60 cm deep on moderate slopes and up to 420 cm deep on lower slope transitions. It is dotted with ponds and shallow lakes underlain by peat.

The lowland tundra can be divided into three wet lowland community types, in addition to "ephemeral pools" (Figure 1). 1) "Breakaway tundra" is the wettest of the three. It is very fragile vegetation dominated by sedges and lichens (particularly Cladonia pacifica) that "breaks away" when walked on. 2) "Sedge-lichen meadow" is similar to the breakaway tundra but contains enough rooted plants (grasses and sedges) to stand up under light foot traffic. 3) "Crowberry-sedge-grass meadow (Empetrum nigrum-Carex spp.-Calamagrostis nutkaensis)" is the driest of the three lowland communities. With increasing elevation and drainage it grades into the crowberry-grass-sedge meadow of the uplands.

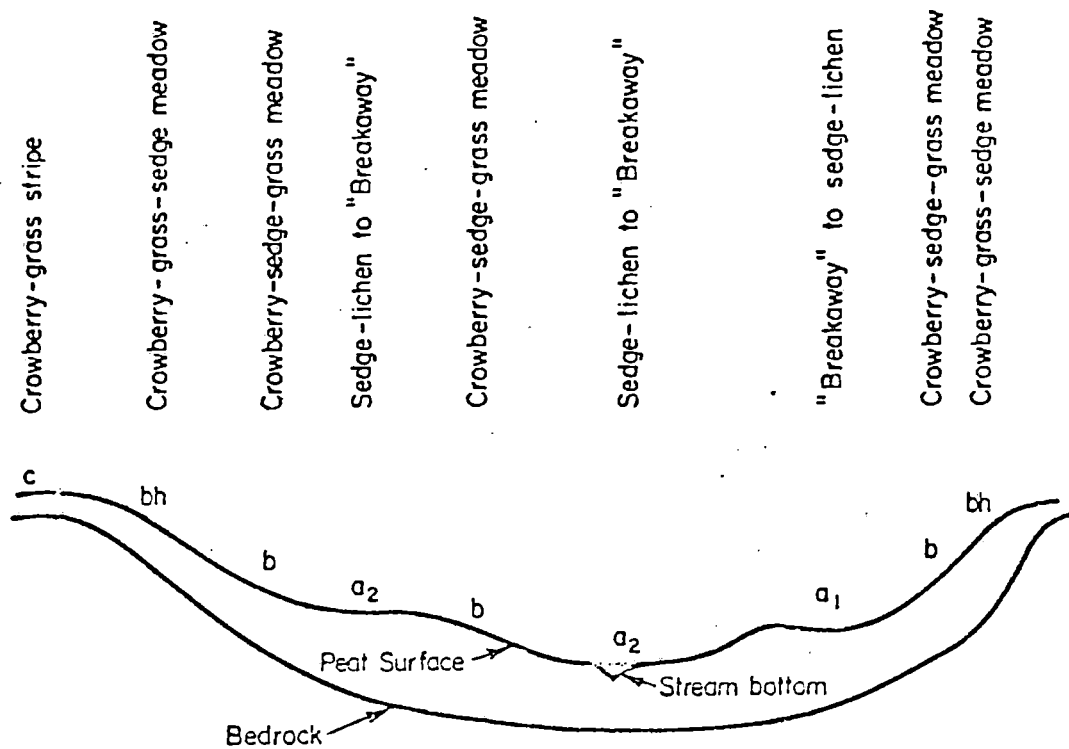


Figure 1. A modal soil-depth profile through an upland tundra-lowland tundra transitional basin on Amchitka Island. The vertical exaggeration is about ten to one. The maximum depth represented is 3 m; the width of the area is about 365 m. (From Amundsen, 1972, figure 2, p. 13).

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Bank (1951)

Boglike areas are common throughout the Aleutians on the sides of hills both at lower altitudes and in the alpine regions. These are seepage slopes, with water essentially oozing underground draining from the hills above. The vegetation consists mainly of mosses (including Sphagnum) and liverworts. Floating Sphagnum mats are not to be found.

Hultén (1960)

Real Sphagnum bogs were not observed in the Aleutian Islands. However, an association of Rubus chamaemorus, Empetrum nigrum, Vaccinium uliginosum, V. vitis-idaea, Carex rariflora, mosses including Sphagnum, and lichens does occur.

Shacklette et al. (1969)

Most bogs on Amchitka are soligenous and occur on gently to moderate slopes. A "Sphagnum bog" community occurs and is best developed in seepage channels or broader areas of gentle slope. This community intergrades in places with wet sedge meadows. The borders of lakes and pools do not support bogs.

Shacklette considered two other communities as bog communities because they

are dominated by bryophytes, but they are treated here in the fresh water marsh category because they occur on mineral soils.

In addition to the Sphagnum bog, three communities are characterized by saturated peaty substrates: 1) The "Empetrum-Carex-lichen community" is characteristic of slopes and summits of low ridges and is commonly hummocky, interdigitated with ecotonal variants, and interrupted by pools and lakes. The substrate is a fibrous peat from a few cm to 60 cm thick and is saturated with water throughout the year. Characteristic species are Empetrum nigrum, Carex pluriflora, C. macrochaeta, Cladonia pacifica, and Sphaerophorus globosus.

2) the "Cladonia-Carex meadow community" occurs adjacent to the Empetrum Carex-lichen community and merges with it. It is normally located on more level areas or on the lower parts of gentle slopes and is therefore wetter than the Empetrum-Carex-lichen community. Characteristic species are Cladonia pacifica, Carex lyngbyaei, and C. macrochaeta.

3) a small, artificially created community is the peat bank community, formed by excavations related to military operations during World War II. These disturbed sites have been invaded by plants adapted to a saturated organic substrate, strong winds, and full exposure to light. These plants are mostly bryophytes and a few lichens. Characteristic species are Pogonatum alpinum, Polytrichum commune, Cephalozia bicuspidata, and Dicranella heteromalla.

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FLUVIATILE

Stream

Bank (1951)

Fontinalis neomexicana, Ranunculus aquatilis, and Myriophyllum spicatum are found in streams.

Byrd (1984)

"Carex lyngbyaei Marsh Community." -- The only two Carex marshes at Buldir occur along the westernmost stream in the alluvial valley. Carex lyngbyaei forms dense stands averaging over 50 cm tall in standing or slowly moving water. Luzula parviflora and Arctophila fulva are the only other common overstory plants, although 15 other species are recorded. Common middle story plants are Festuca rubra and Epilobium behringianum, and 28 other species occur in this layer. Mosses are the most common ground story plants.

Shacklette et al. (1969)

Most streams are narrow, swift, and short. For the most part they flow at a fairly steady rate, except for periods of greatly increased flow following heavy rainfall and snow melt. They are deeply entrenched in the vegetation and peat mantle and have a bedrock, gravel, or colluvium channel bottom. They appear to have become entrenched by the growth and deposition of vegetation at

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their margins (as opposed to being erosional). Characteristic plants are Fontinalis neomexicana and Ranunculus trichophyllus.

Riparian gravel bar and cutbank

Though gravel bars may occasionally occur on major streams in some parts of the Aleutians, their vegetation has not been described in the literature. The vegetation described below occurs mostly on peaty substrates adjacent to small streams or on peat cutbanks above entrenched streams.

Bank (1951)

Streptopus amplexifolius, Linnaea borealis, Juncus balticus, grasses, ferns, Carex spp., Veratrum album and Veronica americana, the last two especially in the western Aleutians grow along stream margins.

Shacklette et al. (1969)

The narrow, deeply entrenched streams of gentle slopes and valleys support a distinctive plant community that is especially conspicuous in June, when the bright green of the stream-side plants contrasts strongly with the brown tones of the adjacent Cladonia-Carex meadows. An understory of forbs, bryophytes, and lichens adapted to reduced light grows on the steep stream banks.

Characteristic species are Athyrium filix-femina, Carex lyngbyaei, Heracleum lanatum, Geum macrophyllum, and Dryopteris dilatata.

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WET MEADOW

Snow-Bed

Shacklette et al. (1969)

In narrow alpine meadows in the mountains on Amchitka, wind velocity is greatly reduced, and in some places snow accumulation may persist until mid-June. Snow-bed communities develop in the wettest parts of the valleys where snow melt water saturates the ground. Characteristic species Anthelia julacea, Scapania paludosa, Saxifraga hirculus, and Leptarrhena pyrolifolia.

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MESIC MEADOW

Byrd (1984)

Several plant communities were recognized from the "Lowland Tall Plant Complex" on Buldir Island.

- 1) "Umbel-Fern Community." -- This tall herb community is found primarily near the base of Northwest Point in relatively deep soil, riddled with nesting burrows of storm-petrels, Oceanodroma spp. Elymus arenarius is practically absent whereas Heracleum lanatum, Athyrium felix-femina, and Angelica lucida dominate the overstory. Claytonia sibirica is the most common species in the middle story. Renunculus occidentalis is also frequently found, and eight other species are present too. Mosses blanket approximately 60% of the ground story, where Cardamine umbellata and Coptis trifolia are also important.

- 2) "Calamagrostis Community." -- Most of the relatively-flat alluvial valley is covered by this community, and patches are also found on the lower adjacent slopes. This community has a very high stem density. Calamagrostis nutkatensis dominates the overstory, but Carex macrochaeta and Angelica lucida are also important. The middle story has Festuca rubra, Carex macrochaeta, and 18 other species. Dead plants, representing undecayed production from previous years, cover over 80% of the ground story.

- 3) "Artemisia-umbel-Elymus Community." -- This restricted community occurs in isolated patches on northeast and southeast sloped in draws or creek

drainages. Artemisia unalaskensis and Heracleum lanatum are the major overstory species. Elymus arenarius occurs in over 50% of the plots, but it has a low cover value. Only four other overstory species are found. Claytonia sibirica is even more common in this community than in the Elymus-umbel and Elymus-umbel fern communities. It nearly excludes other plants, covering nearly 75% of the story. Mosses dominant frequently recorded, but they have low cover values.

4) "Carex-Fescue Meadow Community." -- This community is most frequently found at the upper edge of the lowland complex. The key overstory species are Carex macrochaeta and Angelica lucida. The middle story is one of the most diverse, containing 51 species. Festuca rubra is the primary species; but Angelica lucida, Achillea borealis, Carex macrochaeta, and Geranium erianthum are also common. The ground story is diverse, containing 19 species. Mosses are most common, and Coptis trifolia and Cardamine umbellata are frequently found.

5) "Elymus-umbel-fern Community." -- This community is mostly situated on southern, southeastern, and eastern sea-facing slopes. It has one of the tallest overstories, and subjectively it was determined to have a relatively high stem density. The overstory includes the three dominant species in the Elymus-umbel community. Nevertheless, Elymus arenarius is less important, although it is found in over 70% of the plots.

Instead, Athyrium felix-femina is much more important. Heracleum lanatum and Angelica lucida have similar cover values and frequencies of occurrence in the

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two communities. The cover value estimated for Athyrium is probably too low since a significant portion of the value for unidentified fern could probably be referred to Athyrium felix-femina.

The Elymus-umbel fern community has a similar overstory diversity to the Elymus-umbel, approximately 21 species. Claytonia sibirica is the most common plant in the middle story, but 34 other species are found. Mosses cover about 40% of the ground, and 17 other species occur.

6) "Elymus-umbel Community." -- This is the most extensive lowland community occurring on all aspects and reaching from just above sea level to the upper reaches of the lowland complex. The overstory averages nearly 60 cm tall, but it frequently exceeds 1 m. Elymus arenarius, Heracleum lanatum, and Angelica lucida are the most important overstory species. In the middle story Claytonia sibirica and Festuca rubra are dominant. No other species has high cover values, but this diverse story contains 45 species. Unidentified mosses cover over 35% of the ground story where Cardamine umbellata and Coptis trifolia are ubiquitous but have low cover values. Seventeen other species occur in the ground story.

Hultén (1960)

"Tall forb meadow." -- Found on the westernmost Aleutian Islands especially on Attu but does not go further east. Most grow on slopes in sheltered valleys amidst tall herbaceous communities that are otherwise unknown in the

Aleutians. They constitute the last outpost towards the east of the luxuriant high-grown vegetation of southern Kamtchatka (U.S.S.R.). This community is a distinctly Kamtchatkan type corresponding to the vegetation found in the open meadow-like spots between Alnus shrubs on Kamtchatka.

Primary species are Veratrum album, Aruncus sylvester, Cacalia auriculata, Senecio congestus, Cirsium kamtchaticum, and Sorbus sambucifolia.

"Subalpine meadows." -- Restricted to small areas in the bottom of the broad valleys in the eastern part of the Aleutians. Primary species are Artemisia unalaschensis, Epilobium angustifolium, Calamagrostis canadensis, Geranium erianthum, Anaphalis margaritacea, Aconitum kamtchaticum, Polygonum viviparum and Trientalis borealis.

"Alpine meadows." -- Areas in the alpine where meadows occur are very narrow being invaded from below by subalpine meadows and above by strongly developed heaths. Primary species are Calamagrostis canadensis, Aremon narcissiflora, Erigeron peregrinus, Artemisia arctica, Geranium erianthum, and Salix crassijulis.

"Bird mounds." -- Found on exposed points along the coast. They consist of earth strongly interwoven with roots so as to form a very solid and resistant, pyramidal, broad-shaped, or irregular lump covered with grasses and sedges (Carex macrochaeta, Trisetum spicatum, Festuca brachyphylla, and Poa spp.). Apparently formed by vegetation growing on bird excrement from birds returning to the same spot.

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Shacklette et al. (1969)

"Alpine meadow community." -- Limited to higher areas, generally above 600 ft, in well sheltered valleys. Characteristic species are Achillea borealis, Arnica unalaschensis, Chrysanthemum arcticum, Claytonia sibirica, Geum calthifolium and Ranunculus occidentalis.

"Cladonia-Carex meadow community." -- This community occurs in Empetrum heath habitat but in more level areas or lower parts of the gentle slopes. Also, there is a greater abundance of Carex lyngbyaei and a less prominent role of Empetrum nigrum.

"Moss mound community." -- Conical mounds covered with vegetation are characteristics of many of the central and western Aleutian Islands. On the low plateaus the thousands of moss mounds are the most conspicuous features of the landscape. They usually are associated with Empetrum heath. The open of the mound is dominated by Rhacomitrium lanuginosum, Dicranum elongatum, D. groenlandicum, D. howellii, D. fuscescens, and Oncophorus wahlenbergii, sides of mound have Calamagrostis nutkaensis, C. macrochaeta, etc., base of mound Empetrum nigrum, Calamagrostis nutkaensis, and Carex lyngbyaei.

"Organic bird-perch mound community." -- Mounds that support this community are in the Empetrum heath habitat and are organic throughout, in contrast to "bird perch mounds" formed over boulders and conical projections of bedrock. Examples of plant species found in open of mounds Festuca brachyphylla, Poa arctica, Puccinellia langeana; sides of mounds. Antitrichia curtispindula,

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Brachythecium albicans, Calamagrostis nutkaensis, and base of mound

Calamagrostis nutkaensis, Carex lyngbyaei, and Empetrum nigrum.

DWARF SCRUB

Shacklette et al. (1969)

"Empetrum-Carex-lichen community." -- This community is characteristic of the summits and slopes of the low ridges and is commonly hummocky and interdigitated with ecotonal variants and interrupted by pools and lakes. Characteristic species are Empetrum nigrum, Carex pluriflora, C. macrochaeta, Cladonia pacifica, and Sphaerophorus globosus.

Byrd (1984)

"Moss-Willow Tundra Community." -- This community is the most extensive on Buldir covering over 80% of the upland complex. The community has scattered tall plants, but only the middle and ground stories are very well developed. Areas of solifluction give parts of this community a stair-step appearance, caused by alternating 0.3 to 1 m-wide strips of vegetation and bare soil. Several species of willow (including S. arctica) are dominant. Carex spp., Polygonum viviparum, Veronica spp., and Festuca rubra are also found frequently, but all have cover values of less than 5%. The middle story has at least 38 different species.

Mosses covered over 40% of the ground in this community. Various unidentified lichens, Cassiope lycopodioides, and Empetrum nigrum are also frequently found. The moss-willow tundra has one of the most diverse ground stories, 30 species.

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Hultén (1960)

"Empetrum-lichen heaths." -- This vegetation type occurs on winds exposed sites. Common species are dwarf shrubs, Empetrum nigrum, Vaccinium uliginosum, V. vitis-idaea, Cassiope lycopodioides, Linnaea borealis, Salix reticulata, S. crassijulis; graminoids, Carex macrochaeta, C. pluriflora, C. circinnata, Calamagrostas purputascens, Hirochloe alpina, Tofieldia coccinea; and forbs, Campanula lasiocarpa, Achillea borealis, Anemone narcissiflora, Lupinus nootkatensis, Polygonum viviparum, Antennaria monocephala, Lycopodium clavatum, L. alpinum, and L. selago.

"Artemisia arctica - Rhododendron kamtchaticum-Salix arctica association." -- This association is closely related to alpine meadows and is a variation of the meadows occurring toward the altitudinal limit of the complex. It is a mixed heath-meadow type. Primary species are Rhododendrum kamtchaticum, Artemisia arctica, Geranium erianthum, Cornus suecica, Gramineae, Lloydia serotina, and Anemone narcissiflora.

"Empetrum-moss-lichen mat." -- This type occurs on the better drained hilltops at lower altitudes. Their vegetation includes Empetrum nigrum, Lycopodium spp., Cladonia spp., Vaccinium uliginosum, V. vitis-idaea, Rhacomitrium lanuginosum and others.

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SCRUB

Hultén (1960)

"Salix barclayi thickets." -- This scrub type is composed of shrubs 1-2 m in height. It occurs in the eastern Aleutian Islands and covers only small areas. They do not occur in eastern Asia. Understory composition is like that of "subalpine meadows," e.g. ferns, Epilobium angustifolium, Calamagrostis canadensis, Geranium erianthum.

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MARINE

Lebednik et al. (1971)

The sublittoral fungi is composed of the "Laminaria zone" with Laminaria longipes and Alaria crispa.

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