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The Alaska Vegetation Classification

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Abstract

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The Alaska vegetation classification presented here is a comprehensive, statewide system that has been under development since 1976. The classification is based, as much as possible, on the characteristics of the vegetation itself and is designed to categorize existing vegetation, not potential vegetation. A hierarchical system with five levels of resolution is used for classifying Alaska vegetation. The system, an agglomerative one, starts with 888 known Alaska plant communities, which are listed and referenced. At the broadest level of resolution, the system contains three formations-forest, scrub, and herbaceous vegetation. In addition to the classification, this report contains a key to levels I, II, and III; complete descriptions of all level IV units; and a glossary of terms used.

Keywords: Vegetation, classification, Alaska, tundra, boreal forest, coastal forest, plant communities.

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Introduction

The first draft of this classification system was produced at the Alaskan Rangeland Workshop in Anchorage in February 1976. It was a rudimentary effort with four levels of resolution. Improvements were made, and a revision was sent out for review in June 1976. Members of the committee that worked on these early drafts were William Gabriel (Bureau of Land Management, Anchorage), Samuel Rieger (Soil Conservation Service, Anchorage), David Murray (University of Alaska Fairbanks), and Leslie A. Viereck and C. Theodore Dyrness (Institute of Northern Forestry, Fairbanks). There was considerable statewide interest in the effort, and several suggestions for improvements in the system were received. In 1977, Murray and Batten (1977) produced an unpublished provisional classification of tundra communities in Alaska; Batten also reviewed many vegetation descriptions and determined the synonymy of many vegetation types. Their work was incorporated into a much more comprehensive classification system for Alaska's vegetation.

The first publication of the system appeared in 1980 under the title, "A preliminary classification system for vegetation of Alaska" (Viereck and Dyrness 1980). This publication was widely distributed and apparently was well received; but it constituted only the first approximation of a comprehensive, statewide system, and much work remained to be done. A revision of the classification system was released in May 1981 (Viereck and others 1981) and was distributed rather widely with a call for suggestions by users for further improvements. This 1981 revision incorporated two major changes: (1) tundra as a level I formation was discontinued, and the tundra units were retained and incorporated into the scrub and herbaceous vegetation formations; and (2) wetland units were developed fully and were clearly identified at level IV. This portion of the revision was based largely on a 1980 unpublished report by Batten (1980).

A workshop on classification of Alaska vegetation held in Anchorage in December 1981 led to a second revision of the published system, which was issued in May 1982 (Viereck and others 1982). At the workshop, the classification was revised to level III, definitions were agreed on that helped delineate the major units of the classification, and descriptions of the "descriptors" and "states" for determining the various levels were discussed. As a result of these discussions, many changes were made in system terminology, and categories in level I were reduced from four to three with the placement of aquatic vegetation in the herbaceous category. Workshop participants also agreed that the final version should include keys, descriptions of vegetation units, photographs typifying some of the more common units, and a glossary.

Another well-attended workshop involving those interested in classifying Alaska's vegetation was held in Anchorage in February 1983. Participants expressed strong interest in seeing the final version of the classification system published, and an interagency committee was appointed to aid in this endeavor. Members of the committee were Stephen Talbot (U.S. Fish and Wildlife Service), Page Spencer (Bureau of Land Management), Merlin Wibbenmeyer (Alaska Department of Natural Resources), Jon Martin (USDA Forest Service), David Murray (University of Alaska Fairbanks), and Pete Scorup (University of Alaska, Palmer).

In 1984, the authors received funding from the Alaska Department of Natural Resources, USDA Soil Conservation Service, U.S. Fish and Wildlife Service, and National Park Service to begin compiling material on Alaska vegetation types into an expanded and revised version of the Alaska vegetation classification. The funds were depleted before this sizable undertaking was finished, but an interim report of progress, yet another unpublished revision of the classification system, was distributed in March 1986 (Viereck and others 1986). This edition contained descriptions of all the herbaceous and scrub types at level IV except the dwarf tree scrub types, some minor revisions of the basic classification, an updated and expanded list of references, and a key to the first three levels in the classification.

We have attempted to devise a pure classification system; that is, one based, as much as possible, on the characteristics of the vegetation itself. The characteristic most frequently used is species composition. Inevitably the purity of the system is sometimes compromised and habitat features must be included in the definition for clarity. The feature most often included in a unit definition along with species composition is character of the substrate; for example, at level IV we have included such units as ericaceous shrub bog and halophytic sedge wet meadow, which are partially defined by physical and chemical characteristics of their substrate.

Bailey and others (1978) summarize the types and characteristics of resource classification systems. They note that the most basic system is a taxonomic classification independent of place. For maximum usefulness, a classification should be based on many characteristics. Our classification is based on all the plants at any location-the relative abundance of individual plant species. Our proposed system is a taxonomic classification designed to serve many needs. In this respect, it is a natural rather than an artificial classification designed to meet a narrowly defined need (Bailey and others 1978).

This system is designed to classify existing vegetation, not potential vegetation. A classification for potential vegetation must be built on a solid background of knowledge of successional relations of all vegetation types. Because the successional status of many plant communities in Alaska is, as yet, unknown, we concentrated on existing vegetation. The successional relations are important and are described in the level IV descriptions when information is available.

Our classification was developed by aggregation, with plant communities as the basic elements. We started with known communities and grouped them into broader classes based on similarity of composition by species. Some plant communities we have listed have been described in great detail, others only sketchily. In all cases, we attempted to list at least one published reference for each community. The communities generally are named for dominant species in principal layers (tree, tall shrub, low shrub, and herb). In some cases, species with high indicator value are also listed.

We have constructed a hierarchical classification containing units at five levels of resolution (levels I through V). In the ideal hierarchical system, each unit is exclusive of all others, and when one class at any level is known, all levels above it are automatically known. The broadest, most generalized level (level I) consists of three formations-forest, scrub, and herbaceous. At the finest level of resolution (level V) units are discrete plant communities, with levels II, III, and IV intermediate in resolution. We have not attempted to name levels II, III, and IV, although level IV in forest is comparable to Daubenmire's (1952) series. The scope of the system is shown by the number of units: level II contains 11 units; level III, 30 units; level IV, 146 units; and level V, 888 units.

General Description of the Classification System

To be considered as a vegetation type in this system, at least 2 percent of cover must be vegetation. Any area with less than 2 percent in cover is not included here and is considered to be unvegetated or barren.

The forest units are based on tree crown canopy coverage and tree species composition down through level IV. The level II classes for forest are needleleaf, broadleaf, and mixed. A needleleaf forest is one where over 75 percent of total tree cover is contributed by needleleaf (coniferous) species. Similarly, a broadleaf forest has over 75 percent of the tree cover in broadleaf tree species. In a mixed forest, neither needleleaf nor broadleaf species have clear dominance; both contribute 25 to 75 percent of the total canopy cover. Classes in level III are based on amounts of total tree canopy cover and are those suggested by Fosberg (1967): closed, open, and woodland. Closed stands have from 60 to 100 percent crown canopy. Open stands have from 25 to 60 percent crown canopy cover. Woodland has only scattered trees and a canopy cover of 10 to 25 percent. Level IV units are defined by the dominant tree species in the overstory. To be listed under a level IV unit, a tree species must comprise at least 25 percent of the total tree canopy.

Scrub vegetation classes are based on shrub height, shrub canopy coverage, and species composition down through level IV. The level II scrub classes are dwarf tree scrub, tall scrub, low scrub, and dwarf scrub. Dwarf tree scrub is defined as vegetation having 10 percent or more of cover in tree species that on the site will not achieve 3 meters (10 ft) in height at maturity. Tall scrub vegetation is 1.5 meters (5 ft) or more in height, with 25 percent or more of the cover in tall shrubs. Low scrub vegetation is between 20 centimeters (8 in) and 1.5 meters (5 ft) in height and has 25 percent or more cover in low shrubs. Dwarf scrub vegetation is less than 20 centimeters (8 in) high, and has 25 percent or more cover in dwarf shrubs. Level III classes in dwarf tree scrub are the same used for forest; that is, closed, open, and woodland. Level III classes for tall and low scrub are closed and open. Closed tall and low scrub units have over 75 percent shrub canopy cover, and open units are defined as having less than 75 percent shrub cover. For dwarf scrub, the level III units are based on dominant plant species groups. These classes are dryas dwarf scrub, ericaceous dwarf scrub, and willow dwarf scrub.

Herbaceous vegetation is dominated by nonwoody species that may range from terrestrial grasses to aquatic algae. Level II units in the herbaceous category are designed to divide this tremendous diversity into four more manageable classes: graminoid herbaceous, forb herbaceous, bryoid herbaceous, and aquatic herbaceous. Graminoid herbaceous vegetation has the predominance of cover in grasses or sedges. Forb herbaceous vegetation has the dominant plant cover in nongraminoid species (broadleaf herbs, ferns, and horsetails). Bryoid herbaceous is a special category of vegetation in which the predominance of cover is in mosses or lichens. Aquatic herbaceous vegetation consists of floating or submerged plants growing in water. This unit includes aquatic mosses and algae as well as vascular plants. Level III units for the graminoid and forb herbaceous classes are differentiated by moisture content of the substrate: dry, mesic, and wet. Wet sites are those that are saturated or semipermanently flooded. In the bryoid herbaceous class, there are two level III units: mosses and lichens. Level III divisions under aquatic herbaceous vegetation are based on degree of salinity of the water. The three units are freshwater, brackish water, and marine.

Naming the Plant Communities

Under level V, we list the plant communities and references known to us. We have standardized the community names by listing only the most significant species. Species in community names separated by hyphens are in the same layer; **a** slash (/) between species indicates a change in layer (tree layer to shrub, tall shrub to low shrub, shrub to herb layer, and so forth). Many tundra communities have shrubs and herbs in a single layer; dominants in this layer are separated by hyphens. Some references listed for the communities give complete descriptions; others may mention only the community name.

In many cases, elements of higher levels easily can be combined with community names for greater clarity. For example, a *Picea mariana/feathermoss-Cladonia* community is listed under open black spruce and a similar *Picea mariana/Sphagnum-Cladonia* community is under black spruce woodland. In actual practice, these communities should be referred to as open *Picea mariana/feathermoss-Cladonia* and woodland *Picea mariana/Sphagnum-Cladonia,* respectively. This not only improves differentiation between the two community types but also provides more information in the community name.

Review Of Vegetation Classification Work in Alaska

Viereck and Dyrness (1980) give a brief review of some of the past vegetation classification efforts in Alaska. To provide a background for our suggested classification, it may be helpful to present an updated version of that review here. To facilitate our discussions both here and in the descriptions of level IV units, we have divided the State into seven broad, generally recognized physiographic units. These units are southeast, Aleutians, south-central, southwest, northwest, arctic, and interior Alaska (fig.1).

Southeast Alaska

Most vegetation classification work in southeast Alaska has been done in recent years by Forest Service ecologists (Martin 1989). In some cases the work is still going on, and in others results have not yet appeared in published form. Alaback (1980b) developed a list of provisional forest communities on the basis of his experience in conducting ecological research there for several years. Martin and others (1985) classified forest communities in the Sitka area. The results of this work are unpublished. In addition, Martin and other ecologists have been working on vegetation classification in the Ketchikan area. Preliminary results of this work also are unpublished but are available (West 1986).

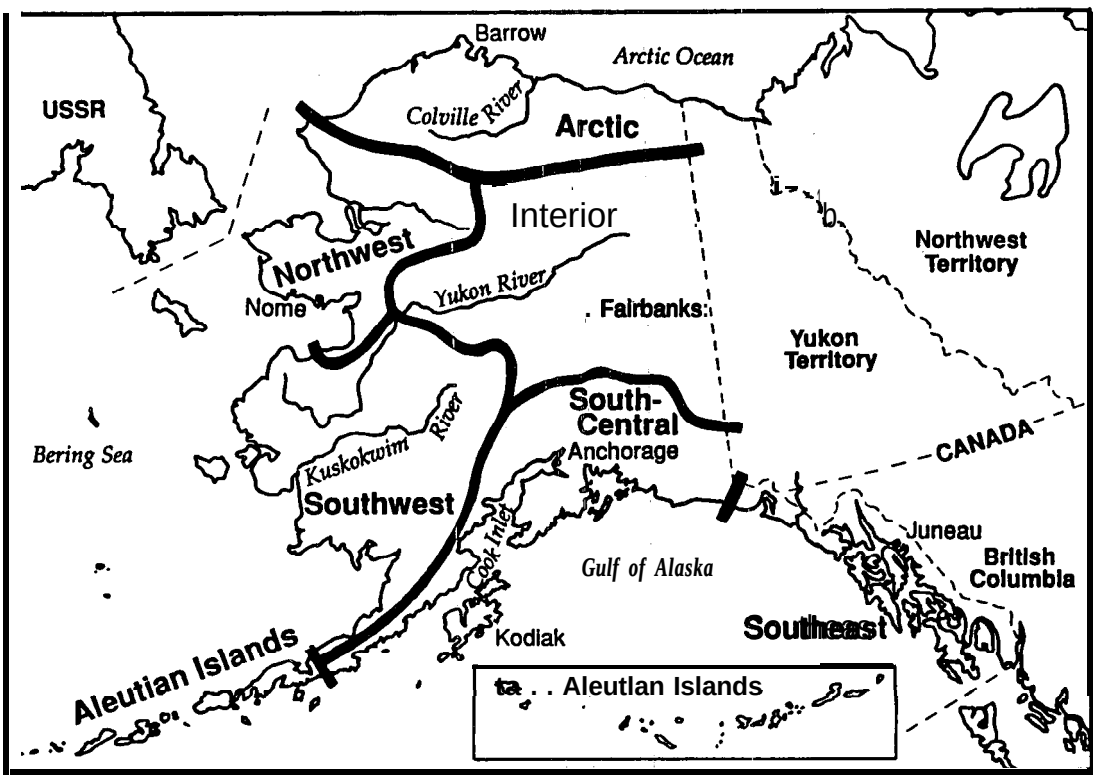

Figure l-Major geographic regions in Alaska.

Older studies generally were localized in coverage. Klein (1965) provides detailed descriptions of the vegetation on Coronation and Woronkofski Islands, and Cooper (1942) does the same for portions of Prince William Sound. Also, Borchers and others (1989) describe 16 forest plant associations from Montague Island on the south side of Prince William Sound. Palmer (1942) provides general information on the vegetation of southeast Alaska to the Fish and Wildlife Service; his report lists only two forest types and six nonforest types for the entire area. Neiland (1971) describes bog vegetation of southeast Alaska but does not separate distinct vegetation types. Glacier Bay has been the subject of numerous studies of plant succession after deglaciation (Cooper 1924, 1939; Crocker and Major 1955; Lawrence 1958).

Aleutian Islands

Vegetation on many of the Aleutian Islands has not been described in detail. Much of the early, detailed work was focused on Amchitka Island. Amundsen (1972) describes 10 plant community types on Amchitka; a more detailed description of the vegetation was given by Shacklette and others (1969); they listed 15 habitats with 41 plant communities by using the system presented by Fosberg (1967). More recently, Byrd (1984) describes the vegetation on Buldir Island.

Virtually the only general descriptions of vegetation for the entire Aleutian Island chain come from the work of Hultën (1960), Tatewaki and Kobayashi (1934), and Bank (1951).

South-Central Alaska

This diverse region, including an area from the peaks of the Alaska Range to the coastal marshes, has attracted considerable attention from those interested in vegetation classification and inventory, especially during the last decade. A multiresource inventory was conducted from 1978 to 1980 of the huge Susitna River Basin (16 million acres). As a result of this inventory, 19 forest types, 7 herbaceous types, and 6 shrub types were described (U.S. Department of Agriculture 1986). These units are equivalent to level IV units in this classification. The Anchorage-area vegetation is described by Tande (1983) for Elmendorf Air Force Base and by Hogan and Tande (1983) for the local wetlands.

Prince William Sound, Cook Inlet, Kenai Peninsula, and Kodiak Island all offer a tremendous variety of coastal habitats. Copper River Delta comprises the largest wetland on the west coast of North America and, because of its extreme importance for waterfowl habitat, more and more plant ecological work has been undertaken there. Scheierl and Meyer (1976, 1977) prepared maps of the vegetation on the Copper River Delta, and Crow (1968) discusses ecological relations in the area. Crow (1977a, 1977b) and Crow and Koppen (1977) describe salt marsh vegetation in coastal areas elsewhere in south-central Alaska. Beals (1966) studied the vegetation of cottonwood forests on Kodiak Island.

Examples of alpine tundra are common in south-central Alaska, as are snow and ice fields and other nonvegetated mountainous areas. Pegau (1972) and Viereck (1962, 1963) describe plant communities in the Alaska Range, and Scott (1974a) supplies descriptions of alpine plant communities in the Wrangell Mountains.

Southwest Alaska

Southwest Alaska includes the Bristol Bay area, Kuskokwim Bay, and the extensive Yukon-Kuskokwim Delta region (fig. 1). Much of this region is low and poorly drained; consequently, wetland vegetation types are common. Not much vegetation classification work has been undertaken in the area; some work has been carried out, however, in wildlife refuges, and other projects are currently underway. Tande and Jennings (1986) report on an intensive vegetation classification and mapping effort on a portion of the Yukon Delta National Wildlife Refuge. They identify and describe 77 community types ranging from halophytic wet meadows to tundra communities dominated by low shrubs. Talbot and others (1986) also worked on a vegetation reconnaissance and mapping project in Yukon Delta National Wildlife Refuge, and Byrd and Ronsse (1983) classified plant communities in the intertidal zone of the central Yukon Delta. Farther south, broad vegetation types have been mapped by using **LANDSAT** imagery in the Bristol Bay region (Wibbenmeyer and others 1982).

Northwest Alaska

Northwest Alaska extends from just north of the Yukon River Delta to Cape Lisburne (fig. 1). This region includes Norton Sound, Seward Peninsula, Kotzebue Sound, and the Kobuk and Noatak River drainages. As in southwest Alaska, not much vegetation classification work has been done in this area. Some of the earliest work was conducted by Hopkins and Sigafoos (1951) who describe general vegetation patterns on the Seward Peninsula. Hanson (1953) describes some vegetation types in northwest Alaska and compares them with communities in other arctic areas. Johnson and others (1966) describe eight broad vegetation types in the Cape Thompson area: *Eriophonrm* tussock, Dryas fell-field, *Eriophonrm-Carex* wet meadow, *Eriophorum-Carex* solifluction slope, ericaceous shrub polygon, Dryas step and stripe, *Carex bigelowii* high-center polygon, and saline meadow. Young (1974b) describes the vegetation of the Noatak River valley.

An extensive vegetation mapping and classification project in the Kobuk River drainage recently has been described by Craighead and others (1988). Vegetation was mapped by using the **LANDSAT** multispectral scanning system over an area of 33,768 square kilometers (13,034 mi^2). Vegetation classification was based on data collected from 880 ground plots; 15 vegetation complexes were mapped. These complexes contain 68 separate plant communities and range from a tidal marsh complex to an alpine tundra complex. A variety of willow, shrub tundra, and both riparian and upland white spruce communities are described.

Arctic Alaska

Much vegetation description and classification work has been undertaken in arctic Alaska, especially around Barrow and, more recently, near Prudhoe Bay. Therefore, it is impossible to review all the studies and here we will attempt to discuss only some exemplary reports. Notable studies in the past include those of Churchill (1955), Spetzman (1959), Britton (1967), and Johnson and Tieszen (1973). Churchill (1955) describes tundra communities in the Umiat region. Both Spetzman (1959) and Britton (1967) give general vegetation descriptions of arctic tundra north of the crest of the Brooks Range. Johnson and Tieszen (1973) review the vegetation work in arctic Alaska and list 42 community types in 10 physiographic habitats. They do not describe the community types but correlate eight major types with soil texture, drainage, soil type, and level of permafrost. The 42 community types represent a mix of habitats and general vegetation physiognomy and plant groups.

Walker and others (1982) mapped landforms, soils, and vegetation in a 5,700-square-kilometer (2,200-mi^2) portion of the Arctic National Wildlife Refuge by using **LANDSAT** data. Vegetation units mapped include wet sedge tundra, dry prostrate shrub, forb tundra, moist sedge-prostrate shrub tundra, moist sedge tussock-prostrate shrub tundra, moist sedge tussock-dwarf shrub tundra, and shrub tundra. Walker (1985b) also carried out a detailed study of vegetation and environmental gradients at Prudhoe Bay. A total of 92 permanent study plots were established on which 42 vegetation types were identified. Factors studied for their possible control over vegetation distribution included temperature, soil moisture, soil pH, organic matter content, soil nutrients, snow depth, hummock size, cryoturbation, and animal activity. Walker (1983) presents an arctic Alaska tundra classification, especially designed for mapping applications.

The tundra vegetation near Barrow is described by Brown and others (1980a, 1980b). This report describes results of tundra biome research conducted under the International Biological Program. Murray (1978) presents a very helpful summary of the state of knowledge of vegetation, floristics, and phytogeography of northern Alaska.

Hettinger and Janz (1974) describe the vegetation and soils of the eastern portion of arctic Alaska. They identify and describe 67 vegetation types, ranging from tundra to forest, and correlate them with terrain and soil features.

Interior Alaska

Until about 1975, little work in vegetation classification had been done in interior Alaska. Viereck (1975), after reviewing available information on taiga communities, developed a classification that follows the system of Fosberg (1967) for the International Biological Program. Whenever possible, Viereck made his classification compatible with Reid's (1974) for an adjacent area in Canada. Viereck also shows relative positions of all vegetation types along hypothetical moisture and temperature gradients.

Dyrness and Grigal (1979) identify and describe one white spruce and four black spruce communities along a 3-kilometer (1.9-mi) slope transect. They correlate occurrence of these communities with presence of permafrost, thickness of forest floor, and quantities of soil nutrients. Yarie (1983) studied the forest vegetation on 365 plots in a 3 600 000-hectare (8,895,600-acre) area north of the Yukon River and centered on the Porcupine River drainage. By using ordination methods, he classified the vegetation into 40 forest communities. Forest types in the Porcupine Block include black spruce, white spruce, mixed black and white spruce, aspen, balsam poplar, aspen-balsam poplar, aspen-birch, aspen-white spruce, aspen-black spruce, white spruce-birch, and black spruce-birch. Foote (1983) describes changes in vegetation following fire on black spruce and white spruce sites in interior Alaska south of the Yukon River. She describes six developmental stages characteristically encountered after fire: (1) newly burned, (2) moss-herb, (3) tall shrub-sapling, (4) dense tree, (5) hardwood or hardwood-spruce, and (6) spruce. In addition, Foote classifies and describes 12 mature forest communities.

Since the early 1970s intensive studies of the structure and function of forest communities have been done near Fairbanks. Some results appeared in a special issue of the Canadian Journal of Forest Research (1983: vol. 13, issue 5) and in a book (Van Cleve and others 1986). As a part of these efforts, successional stages were identified and described for the Tanana River flood plain and white spruce sites on the upland (Van Cleve and Viereck 1981, Van Cleve and others 1980). Eight primary successional stages are described for the flood plain that range from bare, recently deposited alluvium to mature white spruce and seven successional stages in the uplands, starting with newly burned and ending with mature white spruce. Results of a study of vegetation, soils, and forest productivity in 23 stands in the Fairbanks area are reported by Viereck and others (1983). Forest types studied included black spruce, white spruce, mixed black and white spruce, balsam poplar, birch, and aspen. In these stands, tree productivity was strongly correlated with soil temperature during the growing season. Prelogging examination of the vegetation on Willow Island in the Tanana River disclosed 10 white spruce communities plus one willow and one balsam poplar community (Dyrness and others 1988).

Entire State of Alaska

All published statewide vegetation classifications we are aware of were developed for use with large-scale vegetation maps of Alaska. Spetzman's (1963) map, at a scale of 1:2,500,000, is the basis for several subsequent vegetation maps of Alaska. Map units shown are four forest types (coastal western hemlock-Sitka spruce, bottomland spruce-poplar, upland spruce-hardwood, and lowland spruce-hardwood); three tundra types (moist, wet, and alpine); two shrub types (high brush and low brush); and muskeg-bog. A slightly modified version of this map was prepared at the same scale by the Joint Federal-State Land Use Planning Commission for Alaska (1973). Viereck and Little (1972) prepared a map of the vegetation of Alaska only slightly modified from Spetzman's map; they provide an extensive description of the mapped units, as well as further division and description of additional vegetation units.

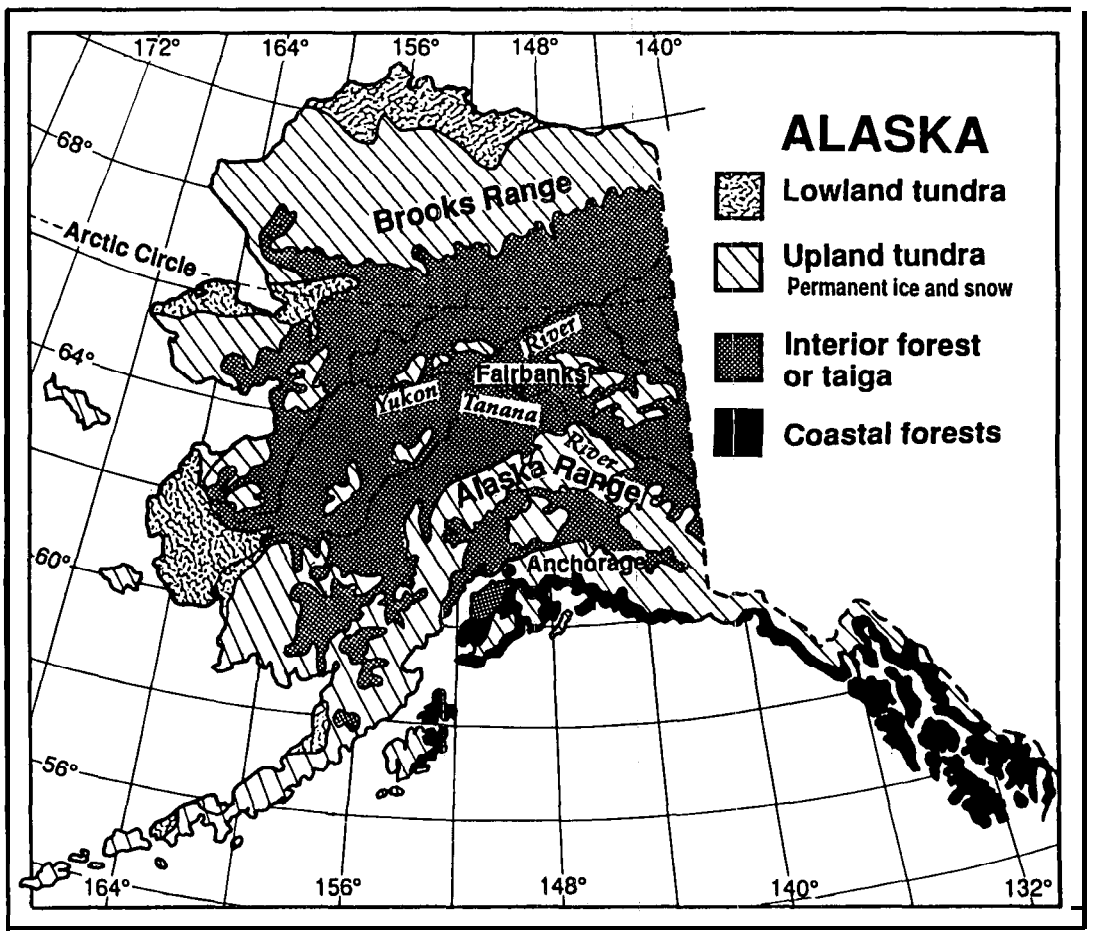

Figure 2-Vegetation type map of Alaska.

The National Atlas of the USA (Küchler 1969) includes a map of the potential vegetation of Alaska at a scale of 1:7,500,000. The vegetation units are similar to Spetzman's (1963), although many names were changed. In the taiga, Kuchler combined the upland units into one unit called spruce-birch forests; the low mixed type he renamed black spruce forest; and the wet, moist, and alpine tundra of Spetzman he renamed water sedge tundra, cotton sedge tundra, and dryas meadows and barrens, respectively. Kuchler also recognized that vegetation of the Aleutian Islands differs from that of northern and western Alaska by identifying two distinct types: Aleutian meadows and Aleutian heath and barrens.

Two provisional statewide classifications were used to develop our system. Murray and Batten (1977) constructed a suggested classification of Alaska tundra communities. Several years later Batten (1980) proposed a classification framework for Alaska wetland and aquatic vegetation. Neither report is published.

Because of the small scale (1:10,000,000) of the vegetation map (fig. 2), we have divided the State into only four major vegetation zones: (1) coastal forest, (2) boreal forest or taiga, (3) lowland tundra, and (4) upland tundra. Within each of these major vegetation zones there is a mosaic of vegetation types at all levels of our classification.

Coastal forests are dominated by closed and open evergreen forests, primarily Sitka spruce-western hemlock. Closed and open deciduous forests are rare and limited primarily to stands of black cottonwood or red alder on flood plains, streamsides, and recently disturbed sites. Woodland lodgepole pine communities grade into bog types (locally called muskegs) on poorly drained sites. On coastal deltas, extensive areas of halophytic and freshwater sedge and grass wet meadows dominated by *Carex lyngbyaei* are common.

Boreal forest or taiga forms an extensive vegetation zone between the coastal forest and the northern and western limits of forest growth. It is dominated by closed, open, and woodland evergreen forests of black and white spruce, but has extensive areas of open and closed deciduous forests of paper birch, aspen, and balsam poplar. Within this vegetation zone are extensive mosaics of shrub and herbaceous types, including extensive areas of subarctic lowland sedge and sedge-moss bog meadows as well as willow, sweetgale, and graminoid bogs. There are also extensive areas of closed and open shrubs of alder and willows in successional communities after fire and alluvial deposition.

Lowland tundra occurs primarily on the coastal plain in northern Alaska and in low-lying deltas and other coastal areas in western Alaska. The dominant vegetation is a wet sedge meadow of *Eriophorum angustifolium* and *Carex aquafilis* interspersed with many lakes. *Eriophorum vaginatum* tussock tundra occurs on the dryer sites.

Upland tundra in Alaska includes three major vegetation zones as mapped by most vegetation maps of Alaska; moist tundra, dry or alpine tundra, and shrub or high brush tundra. Over much of arctic and western Alaska, this type is dominated by *Eriophorum vaginatum* tundra with areas of *Dryas* dwarf shrub tundra on exposed ridges and dry rocky sites. In mountainous areas above treeline, *Dryas* and ericaceous shrub tundra are the most widespread plant communities. In many areas in western Alaska and in most areas near treeline in the Alaska and Brooks Ranges, the zone includes extensive areas of shrubland, primarily low shrub dwarf birch. On the Aleutian Islands, the most widespread community is *Empetrum* heath, but extensive areas of dry and mesic graminoid herbaceous vegetation of *Elymus arenarius, Calamagrostis nutkaënsis,* and *Deschampsia beringensis* also occur.

The Classification System

The Alaska vegetation classification system is presented on the following pages. Table 1 presents the classification to level III and can be used as a quick reference to the broad vegetation types in Alaska. This is followed by a key to the first three levels of the classification. Following the key is a detailed presentation of all five levels of the system in tabular form (table 2). Finally, detailed descriptions of levels I, II, III, and IV are given on pages 55 to 212.

Table I-Alaska vegetation classification to level III

Level I	Level II	Level III
I. Forest	A. Needleleaf (conifer) forest	(1) Closed needleleaf (conifer) forest (2) Open needleleaf (conifer) forest (3) Needleleaf (conifer) woodland
	B. Broadleaf forest	(1) Closed broadleaf forest (2) Open broadleaf forest (3) Broadleaf woodland
	C. Mixed forest	(1) Closed mixed forest (2) Open mixed forest (3) Mixed woodland
II. Scrub	A. Dwarf tree scrub	(1) Closed dwarf tree scrub (2) Open dwarf tree scrub (3) Dwarf tree scrub woodland
	B. Tall scrub	(1) Closed tall scrub (2) Open tall scrub
	C. Low scrub	(1) Closed low scrub (2) Open low scrub
	D. Dwarf scrub	(1) Dryas dwarf scrub (2) Ericaceous dwarf scrub (3) Willow dwarf scrub
III. Herbaceous	A. Graminoid herbaceous	(1) Dry graminoid herbaceous (2) Mesic graminoid herbaceous (3) Wet graminoid herbaceous (emergent)
	B. Forb herbaceous	(1) Dry forb herbaceous (2) Mesic forb herbaceous (3) Wet forb herbaceous (emergent)
	C. Bryoid herbaceous	(1) Mosses (2) Lichens
	D. Aquatic (nonemergent) herbaceous	(1) Freshwater aquatic herbaceous (2) Brackish water aquatic herbaceous (3) Marine aquatic herbaceous

Key to Levels I, II, and III of the Alaska Vegetation Classification

Descriptions of levels I, II, III, and IV follow the classification table.

Ia. Trees over 3 meters (10 ft) tall are present and have a canopy cover of 10 percent or more . . . . . I. Forest 2

1 b. Trees over 3 meters (10 ft) tall are absent or nearly so, Less than 10 percent cover. (Dwarf trees, less than 3 meters [10 ft] tall may be present and abundant 7

I. Forest

2a. Over 75 percent of tree cover contributed by needleleaf (conifer) species . . . . . , ... I.A Needleleaf forest 3

2b. Less than 75 percent of tree cover contributed by needleleaf (conifer) species 4

3a. Tree canopy of 60-100 percent cover . . . . . I.A.1 Closed needleleaf forest

3b. Tree canopy of 25-59 percent cover . .. . , ... I.A.2 Open needleleaf forest

3c. Tree canopy of 10-24 percent cover . . . . . I.A.3 Needleleaf woodland

4a. Over 75 percent of tree cover contributed by broadleaf species . . . . . l.B Broadleaf forest 5

4b. Broadleaf or needleleaf species contribute 25 to 75 percent of the tree cover 6

5a. Tree canopy of 60-100 percent cover . . . . . I.B.1 Closed broadleaf forest

5b. Tree canopy of 25-59 percent cover . . . . . .I.B.2 Open broadleaf forest

5c. Tree canopy of 10-24 percent cover . . . . . I.B.3 Broadleaf woodland

6a. Tree canopy of 60-100 percent cover. . . . . l.C.1 Closed mixed forest

6b. Tree canopy of 25-59 percent cover. . . . . l.C.2 Open mixed forest

6c. Tree canopy of 10-24 percent cover . . . . . l.C.3 Mixed woodland

7a. Vegetation with at least 25 percent cover of erect to decumbent shrubs or with at least 10 percent cover of dwarf trees (less than 3 meters [10 ft] tall) 8

7b. Vegetation herbaceous (may have up to 25 percent shrub cover) 15

II. Scrub

8a. Vegetation with at least 10 percent cover of dwarf trees . . . . . II.A Dwarf tree scrub 9

8b. Vegetation with at least 25 percent cover of shrubs and less than 10 percent cover of dwarf trees 10

9a. Dwarf tree canopy of 60-100 percent cover . . . . . .II.A.1 Closed dwarf tree scrub

9b. Dwarf tree canopy of 25-59 percent cover . . . . . ll.A.2 Open dwarf tree scrub

9c. Dwarf tree canopy of 10-24 percent cover . . . . . ll.A.3 Dwarf tree scrub woodland

10a. Shrubs more than 1.5 meters (5 ft) tall . . . . . .II.B Tall scrub 11

10b. Shrubs less than 1.5 meters (5 ft) tall . . . . . l 2

11 a. Shrub canopy cover greater than 75 percent. . . . . II.8.1 Closed tall scrub

11 b. Shrub canopy cover of 25-74 percent . . . . . .ll.B.2 Open tall scrub

12a. Shrubs 20 centimeters to 1.5 meters tall . . . . . II.C Low scrub 13

12b. Shrubs under 20 centimeters in height . . . . . II.D Dwarf scrub 14

13a. Shrub canopy cover greater than 75 percent . . . . . II.C.l Closed low scrub

13b. Shrub canopy cover of 25-74 percent, or as low as 2 percent if little or no other vegetation cover present . . . . . ll.C.2 Open low scrub

14a. Dryas species dominant in the dwarf shrub layer . . . . . II.D.1 Dryas dwarf scrub

14b. Ericaceous species dominant in the dwarf shrub layer . . . . . ll.D.2 Ericaceous dwarf scrub

14c. Willow species dominant in the dwarf scrub layer . . . . . .ll.D.2 Willow dwarf scrub

III. Herbaceous

15a. Terrestrial vegetation, or if growing in the water, dominated by emergent vegetation 16

15b. Dominant vegetation growing submerged in water or floating on the water surface, but not emerging above the water . . . . . III.D Aquatic herbaceous 21

16a. Grasses, sedges, or rushes (graminoid) plants dominant . . . . . .III.A Graminoid herbaceous 17

16b. Forbs or bryophytes dominant 18

17a. Grasslands of well-drained, dry sites, such as south-facing bluffs, old beaches, and sand dunes. Typically (but not always) dominated by *E/ymus* spp., *Festuca* spp., and *Deschampsia* spp. . . . . III.A.l Dry graminoid herbaceous

17b. On moist sites, but usually not with standing water. Usually dominated by *Calamagrostis* spp., *Carex* spp. or *Eriophorum* spp.; tussocks often present . . . . . lll.A.2 Mesic graminoid herbaceous

17c. On wet sites, standing water present for part of the year; dominated by either sedges or grasses; includes wet tundra, bogs, marshes, and fens . . . . . lll.A.3 Wet graminoid herbaceous

18a. Vegetation dominated by forbs (broadleaf herbs, ferns, or horsetails) . . . . . III.8 Forb herbaceous 19

18b. Vegetation dominated by mosses or lichens . . . . . , ...III.C Bryoid herbaceous 20

19a. On dry sites, usually rocky and well drained; mostly tundra sites . . . . . , ... III.B.1 Dry forb herbaceous

19b. On moist sites but without standing water, mostly within forested areas . . . . . .lll.B.2 Mesic forb herbaceous

19c. On wet sites, usually with standing water for part of the year . . . . . lll.B.3 Wet forb herbaceous

20a. Vegetation cover dominated by mosses . . . . . III.C.1 Bryoid moss

20b. Vegetation cover dominated by lichens . . . . . lll.C.2 Bryoid lichen

21a. Vegetation submerged or floating in fresh water. . . . . III.D.1 Freshwater aquatic herbaceous

21 b. Vegetation submerged or floating in brackish water . . . . . lll.D.2 Brackish water aquatic herbaceous

21c. Vegetation submerged or floating in salt water . . . . . lll.D.3 Marine aquatic herbaceous

Table P-Classification for Alaska vegetation

Level I	Level II	Level Ill	Level IV	Level V
I. Forest	A. Needleleaf forest	(1) Closed needleleaf forest (canopy 60-100 percent)	a. Sitka spruce-occupies wet sites in southeastern Alaska, primarily alluvial flood plains; occurs as a narrow coastal band in south-central Alaska and occupies much of the forested area on Afognak Island.	*Picea sitchensis/Oplopanax horridus-Rubus spectabilis/Cornus canadensis* (Alaback 1980b, Martin and others 1985, Neiland 1971 a, Stephens and others 1969) *Picea sitchensis/Oplopanax horridus/Lysichiton americanum* (Martin and others 1985) *Picea sitchensis/Oplopanax horridus/Circaea alpina* (Pawuk and Kissinger 1989) *Picea sitchensis/Calamagrostis nutkaënsis* (Martin and others 1985)
			b. Western hemlock-is a widespread forest type in southeastern Alaska, usually with a Sitka spruce component.	*Tsuga heterophylla/Vaccinium* spp. (Fox 1983, Martin and others 1985) *Tsuga heterophylla/Vaccinium* spp./Dryopteris *dilatata* (Martin and others 1985) *Tsuga heterophylla/Vaccinium* spp.-Oplopanax *horridus* (LaBau 1981, Martin and others 1985) *Tsuga heterophylla/Oplopanax horridus* (Martin and others 1985)
			c. Sitka spruce-western hemlock-occurs on moist sites throughout southeastern Alaska and in a narrow coastal band in south-central Alaska.	*Picea sitchensis-Tsuga heterophylla/Lysichiton americanum/ Sphagnum* spp. (Alaback 1980b, Neiland 1971 a, Stephens and others 1969) *Picea sitchensis-Tsuga heterophylla/Vaccinium* spp.-Menziesia *ferruginea* (Neiland 1971 a, Stephens and others 1969) *Picea sitchensis-(Tsuga heterophylla)*[a]*/Oplopanax horridus/ Lysichiton americanum* (Martin and others 1985) Picea *sitchensis-(Tsuga heterophylla)*[a]*/Vaccinium* spp./Oplopanax *horridus* (Martin and others 1985) *Picea sitchensis-(Tsuga heterophylla)*[a]*/Vaccinium* spp. (Martin and others 1985) *Picea sitchensis-(Tsuga heterophylla)*[a]*/Vaccinium spp./Lysichiton americanum* (DeMeo and others 1989)
			d. Western hemlock-Sitka spruce-(western redcedar)-is a wide-spread forest type in southeastern Alaska. It also occurs in a narrow coastal band in south-central Alaska. Western redcedar is present only south of 57° N. lat.	*Tsuga heterophylla-Picea sitchensis-(Thuja plicata)/Vaccinium spp./ Rhytidiadelphus loreus* (Alaback 1980b; Neiland 1971 a, Stephens and others 1969) *Tsuga heterophylla-Picea sitchensis-(Thuja plicata)/Lysichiton americanum/Sphagnum recurvum* (Neiland 1971 a) *Tsuga heterophylla-(Picea sitchensis)*[a]*/Vaccinium* spp./Oplopanax *horridus* (Martin and others 1985) *Tsuga heterophylla-(Picea sitchensis)*[a]*/Vaccinium spp./Lysichiton americanum* (Martin and others 1985)

Footnote on page 54.

Table 2-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
I. Forest (continued)	A. Needleleaf forest (continued)	(1) Closed needleleaf forest (canopy 60-100 percent) (continued)	e. Western hemlock-Alaska-cedar-occurs on a variety of upland sites at all elevations below the subalpine zone throughout southeastern Alaska.	*Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium* spp. (Martin and others 1985) *Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium* spp. *Lysichiton americanum* (Martin and others 1985) *Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinium* spp./ *Oplopanax horridus* (DeMeo and others 1989)
			f. Mountain hemlock-occurs near treeline, normally on saturated soil. This type covers considerable land area both on the mainland and the major islands of southeastern Alaska. It also occurs as a narrow subalpine band in south-central Alaska.	*Tsuga mertensiana/Vaccinium* spp. (Fox 1983, Martin and others 1985)
			g Western hemlock-western redcedar-occurs on low-producing, poorly drained sites in the southern part of southeastern Alaska.	*Tsuga heterophylla-Thuja plicata/Vaccinium spp./Lysichiton americanum* (Alaback 1980b, Stephens and others 1969)
			h. Silver fir-western hemlock-has a limited distribution in southern-most southeastern Alaska.	*Abies amabilis-Tsuga heterophylla* (Juday and others 1980)
			i. Subalpine fir-occurs in scattered locations near tree-line in south-eastern Alaska.	*Abies lasiocarpa-Tsuga mertensiana* (Harris 1965, Worley and Jaques 1973)
			j. White spruce-is widespread in south-central and interior Alaska and extends to the limits of tree growth along the Brooks Range. It generally occupies sites with well-drained, permafrost-free soils.	*Picea* glauca/feathermosses (Buckley and Libby 1957; Craighead and others 1988; Drury 1956; Dyrness and others 1988; Viereck 1970a, 1975) *Picea glauca/Alnus tenuifolia/Hylocomium splendens* (Dyrness and others 1988) *Picea glauca/Viburnum edule/Equisetum arvense* (Foote 1983) *Picea glauca/Linnaea borealis-Equisetum sylvaticum* (Foote 1983) *Picea glauca/Rosa acicularis/Linnaea borealis/Hylocomium splendens* (Viereck 1989) *Picea glauca/Rosa acicularis-Shepherdia canadensis/Linnaea borealis* (Yarie 1983) *Picea glauca/Alnus spp./Arctostaphylos uva-ursi* (Yarie 1983) *Picea glauca/Mertensia* spp./Gramineae (Yarie 1983)

		Picea glauca/Salix spp./Shepherdia canadensis/Arctostaphylos spp./ *Peltigera* spp. (Yarie 1983) *Picea glauca/Rosa acicularis/Equisetum* spp. (Yarie 1983) *Picea glauca/Shepherdia canadensis/Equisetum spp.-Arctostaphylos spp. (Yarie 1983)* *Picea glauca/Alnus crispa/Rosa acicularis/Arctostaphylos rubra* (Yarie 1983) *Picea glauca/Rosa acicularis-Shepherdia canadensis/Arctostaphylos rubra-Linnaea borealis* (Yarie 1983)
	k. Black spruce-generally occurs on poorly drained organic soils, often underlain by permafrost. It has wide distribution in interior and south-central Alaska.	*Picea* mariana/feathermosses (Drury 1956, Lutz 1956, Neiland and Viereck 1977, Viereck 1975) *Picea mariana/Rosa acicularis/Peltigera* spp. (Foote 1983, La Roi 1967) *Picea mariana/Ledum decumbens/Vaccinium vitis-idaea/Cladonia spp. (Yarie 1983)* *Picea mariana/Rosa acicularis/Equisetum spp./Cladonia rangiferina* (Yarie 1983)
	l. Black spruce-white spruce-occurs in interior Alaska near the northern and western limits of trees. It also occurs on terraces and at the bases of south-facing slopes.	*Picea mariana-P.* glauca/feathermosses (Foote 1983; La Roi 1967; Neiland and Viereck 1977; Viereck 1970a, 1975) *Picea glauca-P. mariana/Salix spp./Arctostaphylos* spp. (Yarie 1983) *Picea glauca-P. mariana/Salix spp./Vaccinium vitis-idaea/Hylocomium splendens* (Yarie 1983) *Picea glauca-P. mariana/Salix spp./Vaccinium* vitis-idaea/lichens (Yarie 1983) *Picea mariana-P. glauca/Salix* spp./Ledum *decumbens/Empetrum nigrum* (Yarie 1983) *Picea mariana-P. glauca/Salix spp./Potentilla fruticosa/Rubus arcticus-Arctostaphylos* spp. (Yarie 1983)
(2) Open needleleaf forest (canopy 25-60 percent)	a. Sitka spruce-occurs in coastal areas in south-central and south-eastern Alaska, often on alluvial deposits and glacial moraines and outwash:	*Picea sitchensis/Alnus sinuata/Calamagrostis canadensis* (Viereck 1979, Worley 1977) *Picea sitchensis/Alnus* spp. (Martin and others 1985)
	b. Western hemlock-Sitka spruce-occurs from mid-elevations to lower elevations in southeastern Alaska.	*Tsuga heterophylla-(Picea sitchensis)*[a]*/Oplopanax horridus/Lysichiton americanum* (Martin and others i 985)
	c. Mountain hemlock-is found primarily at high elevations on mountain slopes in south-central and southeastern Alaska.	*Tsuga mertensiana/vaccinium spp.-Cassiope mertensiana* (Alaback 1980b, Jaques 1973, Martin and others 1985) *Tsuga mertensiana/Vaccinium spp.-Cladothamnus pyrolaeflorus/ Fauria crisista-galli* (Alaback 1980b, DeMeo and others 1989, Martin and others 1985, Pawuk and Kissinger 1989, Stephens and others 1969)

[a] *footnote on page 54.*

Table P-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
I. Forest (continued)	A. Needleleaf forest (continued)	(2) Open needleleaf forest (canopy 25-60 percent) (continued)	d. Mixed conifer-stands with 3 to 5 conifer species in the overstory are common on level or gently sloping wet sites in southeastern Alaska.	*Tsuga heterophylla-Chamaecyparis nootkatensis- Tsuga mertensiana/ Picea sitchensis/Vaccinium spp./Lysichiton americanum* (Martin and others 1985) *Tsuga heterophylla-Chamaecyparis nootkatensis-Tsuga mertensiana-Picea sitchensis/Lysichiton americanum-Athyrium filix-femina* (Martin and others 1985) *Chamaecyparis nootkatensis- Tsuga mertensiana- Tsuga heterophylla-Picea sitchensis-Pinus contoita/Vaccinium spp./Fauria cristagalli* (Martin and others 1985)
			e. White spruce-is similar to the closed white spruce type but with more shrub cover because of the more open tree canopy. Found commonly on well-drained sites and near tree line in interior, southwest, northwest, and south-central Alaska.	*Picea glauca/Alnus tenuifolia/Hylocomium splendens* (Dyrness and others 1988) *Picea glauca/Alnus crispa-A. tenuifolia/Vaccinium vitis-idaea/ Hylocomium splendens* (Dyrness and others 1988, Viereck 1989) *Picea glauca/Alnus tenuifolia/Calamagrostis canadensis-Vaccinium vitis-idaea* (Dyrness and others 1988) *Picea glauca/Betula glandulosa/Hylocomium splendens* (Hettinger and Janz 1974; Viereck 1970b, 1975, 1979; Williamson and Peyton 1962) *Picea glauca/Betula glandulosa/Sphagnum* spp. (Hettinger and Janz 1974; Viereck 1970b, 1975, 1979; Williamson and Peyton 1962) *Picea glauca/Betula glandulosa/Cladonia* spp. (Racine and Anderson 1979, Viereck 1979) *Picea glauca/Salix bebbiana/Rosa acicularis/Equisetum* spp.-*Epilobium* spp./lichens (Yarie 1983) *Picea glauca/Salix spp./Shepherdia canadensis/Vaccinium vitis-idaea* (Yarie 1983) *Picea glauca/Salix spp./Ledum decumbens/Vaccinium vitis-idaea* (Yarie 1983) *Picea glauca/Alnus crispa-Salix spp./Equisetum arvense* (Craighead and others 1988) *Picea glauca/Vaccinium* spp.-Salix *spp./Equisetum arvense* (Craighead and others 1988) *Picea glauca/Salix spp./Equisetum arvense* (Craighead and others 1988) *Picea glauca/Salix* spp./feathermosses (Craighead and others 1988) *Picea* glauca/feathermosses (Craighead and others 1988) *Picea glauca/Alnus* crispa/feathermosses (Craighead and others 1988) *Picea glauca/Alnus crispa-Salix spp./Vaccinium uliginosum/* feathermosses (Craighead and others 1988) *Picea glauca/Betula nana-Vaccinium* uliginosum/feathermosses (Craighead and others 1988)

f. Black spruce-is extremely common on poorly drained, cold sites in interior and south-central Alaska.	*Picea mariana/Vaccinium* spp./feathermosses (Drury 1956; Foote 1983; Lutz 1956; Viereck 1975, 1979) *Picea mariana/Ledum groenlandicum/Hylocomium splendens* (Viereck 1989) *Picea* mariana/feathermosses-Cladonia spp. (Foote 1983; Viereck 1975, 1979) *Picea mariana/Betula glandulosa-Ledum decumbens/Sphagnum* spp. (Dachnowski-Stokes 1941, Drury 1956, Dyrness and Grigal 1979, Neiland and Viereck 1977) *Picea mariana/Alnus tenuifolia/Betula nana-Ledum decumbens/ Sphagnum* spp. (Batten and others 1978, McCormick and Pichon 1978) *Picea mariana/Arctostaphylos rubra-Empetrum nigrum/Cladonia* spp. (Yarie 1983) *Picea mariana/Betula nana-Potentilla fruticosa/Carex* spp. (Yarie 1983) *Picea mariana/Betula nana-Carex* spp. (Yarie 1983) *Picea mariana/Alnus crispa/Betula nana/Vaccinium spp./Cladonia spp.* (Yarie 1983) *Picea mariana/Vaccinium uliginosum/Empetrum* **nigrum/lichens** (Yarie 1983) *Picea mariana/Vaccinium uliginosum/Arctostaphylos rubra/Dicranum* spp. (Yarie 1983) *Picea mariana/Salix spp./Potentilla fruticosa/Arctostaphylos rubra/ Peltigera* spp. (Yarie 1983) *Picea mariana/Betula* glandulosa/feathermosses (Jorgenson and others 1986)
g. Black spruce-white spruce-occurs mostly near tree line in interior Alaska.	*Picea glauca-P. mariana/Ledum groenlandicum-Vaccinium vitis-idaea/Pleurozium schreberi* (Viereck 1989) *Picea mariana-P. glauca/Betula glandulosa* (Viereck 1979) *Picea glauca-P. marianaNaccinium uliginosum/Arctostaphylos rubra/Dicranum* spp. (Yarie 1983) *Picea mariana-P. glauca/Betula nana/Arctostaphylos rubra-Vaccinium uliginosum* (Yarie 1983) *Picea marianaP. glauca/Ledum decumbens/Petasites* spp./ *Dicranum* spp. (Yarie 1983) *Picea mariana-P. glauca/Shepherdia canadensis/Epilobium* spp./ *Peltigera* spp. (Yarie 1983) *Picea glauca-P. mariana/Vaccinium uliginosum-Carex bigelowii* (Craighead and others 1988) *Picea mariana-P. glauca/Rubus chamaemorus-Ledum decumbens-Vaccinium spp.* (Craighead and others 1988)
h. Black spruce-tamarack-is found on wet lowland sites with permafrost in interior Alaska.	*Picea mariana-Larix laricina* (undescribed)

Table 2-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
I. Forest (continued)	A. Needleleaf forest (continued)	(3) Needleleaf woodland (canopy 10-25 percent)	a. Lodgepole pine-is found only in southeastern Alaska and is generally on boggy, poorly drained sites.	*Pinus contorta/Empetrum nigrum* (Martin and others 1985, Neiland 1971 a)
			b. Sitka spruce-bog has been reported from Glacier Bay in southeastern Alaska on poorly drained sedge peat.	*Picea sitchensis/Vaccinium uliginosum-Trichophorum caespitosum/ Sphagnum fuscum-S. papoillosum* (Worley 1977)
			c. White spruce-is common at the northern and elevational tree lines.	*Picea glauca/Betula* glandulosa/feathermosses-Cladonia spp. (Hettinger and Janz 1974; Racine 1975; Viereck 1975, 1979; Williamson and Peyton 1962) *Picea glauca/Dryas* spp.-moss (Viereck 1979) *Picea glauca/Cladonia* spp. (Racine 1976) *Picea glauca/Salix lanata/Cladonia* spp. (LaPerriere 1976) *Picea glauca/Ledum groenlandicum- Vaccinium vitis-idaeal* feathermosses (Dyrness and others 1988) *Picea glauca/Alnus tenuifolia/Arctostaphylos* uva-ursi/lichens (Dyrness and others 1988) *Picea glauca/Dryas octopetala-Salix reticulata-Empetrum nigrum* (Craighead and others 1988) *Picea glauca/Alnus crispa-Salix spp./Equisetum arvense* (Craighead and others 1988) *Picea glauca/Salix spp./Equisetum arvense* (Craighead and others 1988) *Picea glauca/Salix* spp./feathermosses (Craighead and others 1988) *Picea glauca/Vaccinium* spp.-Salix *spp./Equisetum arvense* (Craighead and others 1988) *Picea glauca/Vaccinium spp.-Empetrum nigrum* (Craighead and others 1988) *Picea glauca/Salix alaxensis-S. glauca-S. lanata/Carex scitpoidea* (Craighead and others 1988) *Picea glauca/Alnus* crispa/feathermosses (Craighead and others 1988) *Picea glauca/Alnus crispa-Salix* spp./ *Vaccinium uliginosum/* feathermosses (Craighead and others 1988) *Picea glauca/Vaccinium uliginosum-Carex bigelowii* (Craighead and others 1988) *Picea glauca/Ledum groenlandicum- Vaccinium vitis-idaeal* feathermosses (Dyrness and others 1988) *Picea glauca/Alnus tenuifolia/Arctostaphylos* uva-ursi/lichens (Dyrness and others 1988)

		d. Black spruce-is found on wet, boggy sites, often with sphagnum mosses, and on dry upland sites where lichens frequently are important in the understory. It is common in interior, south-central, southwest, and northwest Alaska.	*Picea mariana/sphagnum spp.-Cladonia* spp. (Heilman 1966; Viereck 1975, 1979) *Picea mariana/Cladonia* spp. (Foote 1983; Racine 1976; Viereck 1975, 1979) *Picea mariana/Vaccinium* spp.-Salix *spp./Sphagnum* spp. (Racine 1976, Webber and others 1978, Williamson and Peyton 1962) *Picea mariana/Betula nana/Eriophorum spp./Sphagnum* spp. (Yarie 1983) *Picea mariana/Salix spp./Hylocomium splendens-Cladonia rangiferina* (Yarie 1983) *Picea mariana/Eriophorum vaginatum* (Jorgenson and others 1986) *Picea mariana/Ledum decumbens-Vaccinium* spp. (Jorgenson and others 1986) *Picea mariana/sphagnum* spp. (Jorgenson and others 1986)
		e. Black spruce-white spruce occurs in interior, south-central, southwest, and northwest Alaska, especially near the northern, western, and altitudinal limit of trees.	*Picea mariana-P. glauca/Betula* glandulosa/feathermosses (Viereck 1979) *Picea glauca-P.* mariana/lichens (Foote 1983) *Picea mariana-P. glauca/Alnus crispa-Betula glandulosa/Pleurozium schreberi* (Jorgenson and others 1986, Viereck and others 1983) *Picea mariana-P. glauca/Rubus chamaemorus-Ledum decumbens-Vaccinium* spp. (Craighead and others 1988)
B. Broadleaf forest	(1) Closed broadleaf forest (canopy 60-100 percent)	a. Red alder-occupies moist sites and disturbed areas in south-eastern Alaska.	*Alnus rubra* (del Moral and Watson 1978)
		b. Black cottonwood-is generally found along streams in south-eastern and south-central Alaska.	*Populus trichocarpa* (undescribed)
		c. Balsam poplar-occurs most frequently on flood plains in interior, south-central, and southwestern Alaska, although there are several isolated stands on the north slope of the Brooks-Range.	*Populus balsamifera/Alnus tenuifolia/Calamagrostis canadensis* (Buckley and Libby 1957; Drury 1956; Hettinger and Janz 1974; Lutz 1956; Neiland and Viereck 1977; Racine 1976; Viereck 1970a, 1975) *Populus balsamifera/Alnus tenuifolia/Rosa acicularis/Equisetum* spp. (Dyrness and others 1988, Viereck 1989) *Populus balsamifera/Salix barclayi/Heracleum lanatum* (Viereck 1970b) *Populus balsamifera/Salix* spp.-Alnus spp./herbs (Viereck 1979) *Populus balsamifera/Alnus* spp.-Salix spp./Rosa *acicularis/ Equisetum* spp. (Yarie 1983) *Populus balsamifera/Rosa acicularis/Equisetum* spp.-Pyrola spp. (Yarie 1983) *Populus balsamifera/Arctostaphylos uva-ursi/Peltigera* spp. (Yarie 1983)

Table P-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
I. Forest (continued)	B. Broadleaf forest (continued)	(1) Closed broadleaf forest (canopy 60-100 percent) (continued)	d. Paper birch-occurs on many upland sites, both with and without permafrost, in interior and south-central Alaska.	*Betula papyrifera/Alnus crispa/Calamagrostis* spp. (Buckley and Libby 1957, Lutz 1956, Viereck 1975) *Betula papyriferaNiburnum edule* (Foote 1983) *Betula papyrifera/Alnus* spp.-Salix spp. (Racine 1976) *Betula papyrifera/Ledum groenlandicum/Pleurozium schreberi-Polytrichum juniperinum* (Jorgenson and others 1986)
			e. Quaking aspen-occurs on warm, well-drained upland soils in interior and south-central Alaska.	*Populus tremuloides/Viburnum edule/Linnaea borealis* (Foote 1983) *Populus tremuloides/Salix spp./Arctostaphylos uva-ursi* (Hettinger and Janz 1974, Viereck 1975) *Populus tremuloides/Salix spp./Drepanocladus* spp. (Yarie 1983)
			f. Paper birch-quaking aspen-is found on moderately warm sites in interior and south-central Alaska.	**Populus *tremuloides-Betula* papyifera/Rosa acicularis/Arctostaphy/os** uva-ursi/lichens (Yarie 1983)
			g. Quaking aspen-balsam poplar-occurs on flood plains in interior Alaska.	*Populus tremuloides-P. balsamifera/Rosa acicularis* (Yarie 1983)
		(2) Open broadleaf forest (canopy 25-60 percent)	a. Paper birch-occurs on dry to moist sites in interior, south-central, and western Alaska. On dry sites, lichens are important in the understory; on moist sites, shrubs are dominant.	*Betula papyrifera/Cladonia* spp. (Racine 1976) *Betula papyrifera/Betula glandulosa/Hylocomium* spp. (Hanson 1953; Hettinger and Janz 1974; Viereck 1975, 1979) *Betula papyrifera/Viburnum edule/Calamagrostis* spp. (Foote 1983) *Betula papyrifera/Alnus crispa/ledum groenlandicum* (Jorgenson **and** others 1986)
			b. Quaking aspen--occurs primarily on extremely dry sites on steep south slopes in interior and south-central Alaska.	*Populus tremuloides/Salix spp./Arctostaphylos* uva-ursi/Gramineae (Yarie 1983) *Populus tremuloides/Salix spp./Arctostaphylos uva-ursi/Epilobium* spp. (Yarie 1983) *Populus tremuloides/Elaeagnus commutata-Shepherdia canadensis/Arctostaphylos* spp./lichens (Neiland and Viereck 1977) *Populus tremuloides/Shepherdia canadensis/Calamagrostis purpurascens* (Viereck and others 1983)
			c. Balsam poplar (black cottonwood)-occurs as open clumps near tree-line in interior, south-central, south-western, and northwestern Alaska and as isloated groves on the north slope of the Brooks Range. Black cottonwood is restricted to south-central and southeastern Alaska.	*Populus balsamifera/Salix* spp.-Alnus *spp./Calamagrostis* spp. (Racine and Anderson 1979, Viereck 1979) *Populus balsamifera/Salix hastata-Shepherdia canadensis-Epilobium angustifolium/Hylocomium splendens-Pleurozium schreberi* (Edwards and Dunwiddie 1985) *Populus balsamifera/Alnus tenuifolia/Equisetum* spp. (Viereck 1989)

	(3) Broadleaf woodland (canopy 10-25 percent)	a. Paper birch-occurs on dry sites, such as old sand dunes and coarse gravel deposits, in northwest Alaska and the northern portion of interior Alaska.	*Betula papyrifera/Cladonia* spp. (Racine 1976)
		b. Balsam poplar-has been reported from the flood plain of the Susitna River in south-central Alaska.	*Populus balsamifera*[b]
		c. Paper birch-balsam poplar-has been reported from the Susitna Valley in south-central Alaska.	*Betula papyrifera-Populus balsamifera*[b]
C. Mixed forest	(1) Closed mixed forest (canopy 60-100 percent)	a. Spruce-paper birch-tends to occur on cool wet sites when black spruce is present in the mixture; white spruce favors warmer, drier sites. The type is found primarily in interior and south-central Alaska and, to a lesser extent, in northwest and southwest Alaska.	*Picea glauca-Betula papyrifera/Alnus crispa/Calamagrostis canadensis* (Buckley and Libby 1957, Hettinger and Janz 1974, Lutz 1956, Viereck 1975) *Picea mariana-Betula papyrifera/Alnus crispa/Hylocomium splendens* (Jorgenson and others 1986) *Picea mariana-Betula papyrifera/ledum* spp. (undescribed) *Betula papyrifera-Picea glauca-P. mariana/Calamagrostis* spp. (Foote 1983) *Picea glauca-Betula papyrifera/Alnus* spp.-Salix spp./Galium *boreale* (Yarie 1983) *Picea glauca-Betula papyrifera/Alnus crispa/Ledum groenlandicum* (Jorgenson and others 1986) *Picea marianaBetula papyrifera/Arctostaphylos* uva-ursi/lichens (Yarie 1983) *Picea marianaBetula papyrifera/Ledum decumbens/Vaccinium vitis-idaea* (Yarie 1983)
		b. White spruce-paper birch-balsam poplar (black cottonwood)-reported from the Susitna Valley in south-central Alaska.	*Picea glauca-Betula papyrifera-Populus balsamifera (trichocarpa)*[b]
		c. Spruces-paper birch-quaking aspen-reported from interior Alaska.	*Picea mariana-Betula papyrifera-Populus tremuloides/Ledum groenlandicum* (Jorgenson and others 1986)
		d. Quaking aspen-spruce-is an intermediate successional stage, with spruce as the eventual climax. Aspen generally occurs with white spruce on warm, well-drained sites. The type is most common in interior and south-central Alaska.	*Populus tremuloides-Picea glauca/Arctostaphylos uva-ursi* (Buckley and Libby 1957, Lutz 1956, Viereck 1975) *Populus tremuloides-Picea mariana/Ledum* spp. (Viereck 1975) *Populus tremuloides-Picea mariana/Cornus canadensis* (Foote 1983) *Populus tremuloides-Picea glauca/Salix spp./Epilobium* spp. (Yarie 1983) *Populus tremuloides-Picea glauca/Salix spp./Arctostaphylos uva-ursi* (Yarie 1983) *Populus tremuloides-Picea mariana/Salix* spp./Rosa *acicularis/ Equisetum* spp. (Yarie 1983)

 Footnote on page 54.

Table 2-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
I. Forest (continued)	C. Mixed forest (continued)	(1) Closed mixed forest (canopy 60-100 percent) (continued)	e. Balsam poplar-white spruce-is an intermediate successional stage leading to white spruce climax on flood-plain sites in interior, south-central, southwestern, and north-western Alaska.	*Populus balsamifera-Picea glauca/Alnus spp./Oplopanax horridus* (U.S. Department of Agriculture 1986) *Populus balsamifera-Picea glauca/Alnus tenuifolia/Equisetum* spp. (Viereck 1989)
		(2) Open mixed forest (canopy 25-60 percent)	a. Spruce-paper birch-occurs on a variety of upland sites in interior, south-central, southwestern, and northwestern Alaska.	*Picea glauca-Betula papyrifera/Calamagrostis canadensis-Hylocomium splendens* (Hettinger and Janz 1974, Viereck 1975) *Picea glauca-Betula papyrifera/Alnus crisps/Sphagnum* spp. (Viereck 1975) *Picea glauca-Betula papyrifera/Salix planifoia/Sphagnum* spp. (Viereck 1970b) *Picea mariana-Betula papyrifera/Cladonia* spp. (undescribed)
			b. Quaking aspen-spruce-has been reported from the Porcupine River area in interior Alaska.	*Populus tremuloides-Picea mariana/Vaccinium uliginosum/ Polytrichum* spp. (Yarie 1983)
			c. Paper birch-balsam poplar-spruce-has been reported from the Susitna Valley in south-central Alaska.	*Betula papyriferaPopulus balsamifera-Picea glauca*[b]
			d. Spruce-balsam poplar-has been reported from the Susitna Valley in south-central Alaska.	*Picea glauca-Populus balsamifera*[b]
		(3) Mixed woodland (canopy 10-25 percent)	a. Spruce-paper birch-has been reported from the Susitna Valley in south-central Alaska.	*Picea mariana-Betula papyrifera*[b]
II. Scrub	A. Dwarf tree	(1) Closed dwarf tree scrub (canopy 60-100 percent)	a. Mountain hemlock-occurs at tree line in southeastern Alaska.	*Tsuga mertensianalVaccinium ovalifolium/Rubus pedatus/Dicranum scoparium-Rhytidiadelphus loreus* (Worley 1977) *Tsuga mertensiana/vaccinium* spp./Cassiope *mertensiana-Rubus pedatus* (Fox 1983)
			b. Subalpine fir-forms dense stands of dwarf trees at altitudinal tree line in southeast Alaska.	*Abies lasiocarpa/Phyllodoce aleutica-Fauria crista-galli* (Harris 1965, Worley and Jaques 1973)

	2. Open dwarf tree scrub (canopy *25-60* percent)	a. Black spruce-is found on very cold or wet soils barely capable of supporting trees in interior, south-central, and western Alaska.	*Picea mariana/Myrica gale-Ledum decumbens/Trichophorum* caespitosum/feathermosses-Sphagnum spp. (Hogan and Tande 1983) *Picea mariana/Ledum decumbens-Vaccinium vitis-idaea/Rubus chamaemorus/Sphagnum* spp. (Luken and Billings 1983) *Picea mariana/Eriophorum vaginatum* (Craighead and others 1988)
		b. Mountain hemlock-is common on peatlands and sometimes on exposed ridges in southeast Alaska.	*Tsuga mertensiana/Cladothamnus pyrolaeflorus/Empetrum nigrum-Calamagrostis canadensis* (Worley 1977)
	(3) Dwarf tree scrub woodland (canopy 10-25 percent)	a. Black spruce-is common in interior, south-central, and western Alaska on very cold or wet sites barely capable of supporting trees.	*Picea mariana/Ledum decumbens/Shagnum* spp. (Hogan and Tande 1983, Tande 1983, Webber and others 1978) *Picea mariana/Eriophorum vaginatum* (Craighead and others 1988) *Picea mariana/Betula nana/Carex* spp. (Yarie 1983)
B. Tall scrub	(1) Closed tall scrub (canopy 75-100 percent)	a. Willow-(sometimes called willow thickets) is especially characteristic of flood plains and common throughout Alaska except for the Aleutian Islands and Arctic coast.	*Salix alaxensis* (Bliss and Cantlon 1957, Brock and Burke 1980, Craighead and others 1988, Griggs 1936, Hanson 1953, Johnson and others 1966, Pegau 1972, Racine and Anderson 1979, Spetzman 1959, Viereck 1963) *Salix alaxensis/Calamagrostis spp.-Equisetum arvense* (Farjon and Bogaers 1985) *Salix a/axensis/Equisetum arvense* (Craighead and others 1988) *Salix alaxensis-S. glauca-S. lanata* (Drew and Shanks 1965, Komarkova and Webber 1980, Spetzman 1959, Wiggins and Thomas 1962, Young 1974b) *Salix alaxensis-S. glauca-S. planifolia/Equisetum arvense* (Craighead and others 1988) *Salix alaxensis-S. planifolia* (Johnson and others 1966, Young and Racine 1977) *Salix alaxensis-S. planifolia-Alnus tenuifolia/Vaccinium uliginosum-Betula glandulosa* (Jorgenson and others 1986) *Salix alaxensis-S. arbusculoides-S. glauca/Equisetum arvense-Pyrola grandiflora* (Batten 1977, Bliss and Cantlon 1957) *Salix alaxensis-S. arbusculoides/Calamagrostis canadensis-Equisetum pratense* (Hutten 1966) *Salix planifolia* (Craighead and others 1988, Hopkins and Sigafoos 1951, Hulten 1962, Johnson and others 1966) *Salix glauca-S. planifolia-S. lanata* (Batten 1977, Childs 1969, Griggs 1936, Hanson 1953, Koranda 1960, Pegau 1968, Racine 1977, Racine and Anderson 1979, Viereck 1962) *Salix barclayi* (del Moral and Watson 1978, Hulten 1960)

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Table P-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
II. Scrub (continued)	B. Tall scrub (continued)	(1) Closed tall scrub (canopy 75-100 percent) (continued)	b. Alder-is common throughout most of the State on steep slopes, flood plains, and streambanks.	*Alnus crispa/Calamagrostis canadensis* (Hanson 1953; Hultén 1960, 1962; Jorgenson and others 1986; Racine and Anderson 1979; Viereck 1962; Young and Racine 1977) *Alnus crispa-Salix planifolia/Arctagrostis latifolia-Equisetum avrense* (Craighead and others 1988) *Alnus crispa/Spiraea beauverdiana* (Craighead and others 1988) *Alnus crispa/festuca altaica-Arctagrostis latifolia* (Craig head and others 1988) *Alnus crispa/carex bigelowii-Festuca altaica-Arctagrostis latifolia* (Craighead and others 1988) *Alnus crispa/Equisetum arvense* (Craighead and others 1988) *Alnus crispa-Salix glauca-S. planifolia/Equisetum arvense* (Craighead and others 1988) *Alnus crispa-Salix arbusculoides-S. glauca/Delphinium glaucum-Aconitum deiphinifolium-Calamagrostis* spp. (Viereck 1963) *Alnus sinuata* (Batten and others 1978, Cooper 1942, Palmer 1942, Young and Racine 1978) *Alnus sinuata/Calamagrostis canadensis* (Hanson 1951; Hultén 1960, 1962; Worley 1980) *Alnus sinuata/Rubus spectabilis* (Heusser 1960, lsleib and Kessel 1973, Streveler and Paige 1971) *Alnus tenuifolia* (Hogan and Tande 1983, Van Cleve and others 1971) *Alnus tenuifolia/Calamagrostis canadensis* (Hanson 1953)
			c. Shrub birch-is generally found in openings in taiga in interior Alaska near tree line.	*Betula glandulosa* (Hanson 1953) *Betula glandulosa/Ledum decumbens-Vaccinium* spp. (Jorgenson and others 1986)
			d. Alder-willow-occurs on flood-plain terraces and drainageways on slopes throughout most of the State except the Aleutian Islands and the arctic coastal plain.	*Alnus crispa-Salix planifolia/Carex bigelowii* (Craighead and others 1988, George and others 1977, Racine and Anderson 1979) *Alnus crispa-Salix glauca/Arctagrostis latifolia-Pyrola grandiflora* (Churchill 1955) *Alnus crispa-Salix lanata-S. planifolia-S. glauca* (Bliss and Cantlon 1957) *Alnus tenuifolia-Salix spp./Equisetum* spp. (Van Cleve and others 1971, Viereck 1989) *Alnus tenuifolia-Salix a/axensis/Calamagrostis canadensis* (Ritchie and others 1981) *Alnus sinuata-Salix barclayi-S. sitchensis* (Batten and others 1978)

	e. Shrub birch-willow-is apparently not a very common type but is present on the Seward Peninsula.	*Betula glandulosa-Salix planifolia-S. lanata-Alnus crispa* (Hanson 1953)
	f. Shrub swamp-is common on sites with poorly drained, fine-textured soil and hummocky microrelief with the depressions containing standing water. It is common in interior, south-central, and southeastern Alaska.	*Salix planifolia/Calamagrostis canadensis/Sphagnum* spp. (Webber and others 1978) *Alnus tenuifolia/Calamagrostis canadensis* (Batten and others 1978, Hanson 1953, Quimby 1972) *Alnus tenuifolia/Carex aquatilis* (Ritchie and others 1981) *Betula papyrifera-Alnus tenuifolia/Calamagrostis canadensis* (Hogan and Tande 1983, McCormick and Pichon 1978, Ritchie and others 1981, Tande 1983) *Alnus sinuata/Calamagrostis canadensis* (Crow 1968, Scheierl and Meyer 1977)
(2) Open tall scrub (canopy 25-75 percent)	a. Willow--occupies a variety of sites, from dunes to riverbanks. It is most common in interior, western, south-central, and arctic Alaska.	*Salix alaxensis-S. glauca* (Komarkova and Webber 1980) *Salix alaxensis/Arctostaphy/os rubra* (Webber and others 1978) *Salix alaxensis/Astragalus alpinus-Epilobium latifolium* (Webber and others 1978) *Salix alaxensis/Shepherdia canadensis/Dryas octopetala-Arctostaphylos rubra-Cladonia pyxidata (Scott* 1974a) *Salix a/axensis/Equisetum arvense* (Craighead and others 1988) *Salix alaxensis-S. glauca-S. planifolia/Equisetum arvense* (Craighead and others 1988) *Salix alaxensis/Rhacomitrium canescens* (Viereck 1970a) *Salix brachycarpa-S. barclayi-S. glauca/Hylocomium splendens* (Viereck 1966) *Salix planifolia-S. glauca/Calamagrostis canadensis-Epilobium angustifolium-Equisetum pratense* (Young and Racine 1978) *Salix lanata-S. planifolia* (Hanson 1951) *Salix barclayi-S. glauca/Calamagrostis canadensis* (Ritchie and others 1981) *Salix barclayi-S. glauca/Carex lyngbyaei* (Ritchie and others 1981) *Salix bebbiana/Calamagrostis canadensis* (Ritchie and others 1981)
	b. Alder-is not nearly as abundant as closed alder communities but can be found throughout the State.	*Alnus crispa/Calamagrostis canadensis* (Young and Racine 1977) *Alnus crispa/Vaccinium-uliginosum* (Brock and Burke 1980). *Alnus crispa/Spiraea beauverdiana* (Craighead and others 1988) *Alnus crispa/Carex bigelowii-Festuca altaica-Arctagrostis latifolia* (Craighead and others 1988) *Alnus crispa/Festuca altaica-Arctagrostis latifolia* (Craighead and others 1988) *Alnus sinuata/Calamagrostis canadensis* (Crow 1968) *Alnus tenuifolia/Calamagrostis canadensis* (Tande 1983)
	c. Shrub birch-occurs at and above tree line, especially in the Alaska Range.	Undescribed

Table 2-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
II. Scrub (continued)	B. Tall scrub (continued)	(2) Open tall scrub (canopy 25-75 percent) (continued)	d. Alder-willow-occurs on flood-plain terraces and steep slopes near tree line in interior and northern Alaska.	*Alnus crispa-Salix lanata-S. planifolia/Ledum decumbens-Carex bigelowii/Sphagnum* spp. (Viereck 1963) *Alnus crispa-Salix planifolia/Carex bigelowii* (Craighead and others 1988)
			e. Shrub birch-willow-occurs near tree line, especially in the Alaska Range and western Alaska.	*Betula glandulosa-Salix planifolia-S. lanata-Alnus crispa* (Hanson 1953)
			f. Shrub swamp-occurs on flood plains and in drainageways in interior and south-central Alaska.	*Alnus tenuifolia/Carex aquatilis-Calamagrostis canadensis* (Ritchie and others 1981) *Alnus tenuifolia/Myrica gale-Calamagrostis canadensis* (Ritchie and others 1981) *Alnus tenuifolia/Rosa acicularis-Calamagrostis canadensis* (Hogan and Tande 1983) Salix *planifolia-Alnus crispa/Betula nana-Calamagrostis* spp. (Brock and Burke 1980)
	C. Low scrub	(1) Closed low scrub	a. Shrub birch-thickets are not common but do occur on the Seward Peninsula and in interior Alaska.	*Betula nana* (Craighead and others 1988, Hopkins and Sigafoos 1951, Racine and Anderson 1979) *Betula glandulosa/Pleurozium schreberi-Hylocomium splendens* (Viereck 1966)
			b. Low willow-is common in interior, western, and northern Alaska along streambanks and lakeshores.	*Salix planifolia* (Craighead and others 1988) *Salix planifolia-Vaccinium spp./Arctagrostis latifolia* (Craighead and others 1988) *Salix planifolia-S. lanata-Myrica gale/Calamagrostis canadensis* (Craighead and others 1988) Salix *planifolia/Equiselum arvense* (Webber and others 1978) *Salix glauca-S. planifolia-S. lanatalEquisetum arvense* (Craighead and others 1988; Pegau 1968; Racine 1977; Racine and Anderson 1979; Viereck 1962, 1963) *Salix glaucalPetasites frigidus* (Churchill 1955) *Salix lanata/Carex* spp. (Craighead and others 1988) *Salix lanata/Equisetum* spp. (Craighead and others 1988) *Salix lanata/Carex aquatilis-Equisetum arvense (Scott* 1974a) *Salix* spp./Festuca *rubra* (Crow 1968) *Salix spp./Equisetum pratense* (Crow 1968)
			c. Shrub birch-willow-occupies alluvial deposits in northern and western Alaska.	*Betula nana-Salix planifolia/Hylocomium splendens-Aulacomnium turgidum* (Jorgenson 1984) *Betula nana-Salix planifolia-Ledum decumbens* (Craighead and others 1988) *Betula nana-Salix planifolia/Petasites frigidus* (Craighead and others 1988)

		Betula nana-Salix planifolia-Vaccinium uliginosum (Craighead and others 1988)
	d. Ericaceous shrub-occurs near tree line in southeast Alaska.	*Cladothamnus pyrolaeflorus* (Shacklette 1965)
	e. Low alder-willow-has been reported from southeastern Alaska on poorly drained soils.	*Alnus* spp.-Salix spp. (Wibbenmeyer and others 1982)
(2) Open low scrub	a. Mixed shrub-sedge tussock tundra-is one of the most extensive tundra units in the State; is centered in northern and western Alaska.	*Eriophorum vaginatum-Salix planifolia-S. lanata* (Koranda 1960) *Eriophorum vaginatum-Carex bigelowii-Ledum decumbens-Vaccinium vitis-idaea* (Childs 1969, Dean and Chesemore 1974, Hanson 1950) *Eriophorum vaginatum-Betula nana-Ledum decumbens-Vaccinium* spp. (Bliss and Cantlon 1957, Clebsch 1957, Craighead and others 1988, Drew and Shanks 1965, Hanson 1953, Jorgenson 1984, Pegau 1968, Peterson and Billings 1978, Racine and Anderson 1979, Ugolini and Walters 1974, Young and Racine 1978) *Eriophorum vaginatum-Betula nana-Salix planifolia-Ledum decumbens-Vaccinium* spp. (Johnson and others 1966, Koranda 1960, Young 1974b) *Eriophorum vaginatum-Betula nanasalix lanata-Ledum decumbens-Vaccinium* spp. (Webber and others 1978) *Eriophorum vaginatum-Betula nana-Ledum decumbens-Vaccinium* spp.-Carex *bigelowii* (Brock and Burke 1980; Churchill 1955; Craighead and others 1988; Hopkins and Sigafoos 1951; Nodler and others 1978; Racine 1976, 1977; Racine and Anderson 1979; Viereck 1966; Young and Racine 1977) *Eriophorum vaginatum-Betula nana-Salix planifolia-Ledum decumbens-Vaccinium* spp.-Carex *bigelowii* (Spetzman 1959, Webber and others 1978) *Eriophorum vaginatum-Betula nana* (Jorgenson 1984, Kessel and Schaller 1960, Komarkova and Webber 1980, Webber and others 1978) *Carex bigelowii-Betula nana-Salix planifol-Ledum decumbens-Vaccinium* spp. (Craighead and others 1988, Racine and Anderson 1979, Racine and Young 1978) *Carex bigelowii-Salix* spp.Dryas *integrifolia* (Craighead and others 1988) *Carex bigelowii-Vaccinium* uliginosum-feathermosses (Craighead and others 1988) *Carex bigelowii-Spiraea beauverdiana* (Craighead and others 1988) *Carex bigelowii-Vaccinium spp./Sphagnum* spp. (Brock and Burke 1980) *Eriophorum vaginatum-Carex bigelowii-Betula nana-Ledum decumbens-Alnus crispa* (Brock and Burke 1980)
	b. Mixed shrub-sedge tussock bog-occurs in lowland areas of interior and south-central Alaska.	*Eriophorum vaginatum-Betula nana-Ledum decumbens/Sphagnum* spp. (Calmes 1976, Dyrness and Grigal 1979, Neiland and Viereck 1977, Pegau 1972, Talbot and others 1984, Wibbenmeyer and others 1982)

Table 2-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
II. Scrub (continued)	C. Low scrub (continued)	(2) Open low scrub (continued)	c. Mesic shrub birch-ericaceous shrub-occupies alpine areas in the Alaska Range and northward.	*Betula glandulosa/Vaccinium uliginosum-Empetrum nigrum-Ledum* decumbens/lichens (Anderson 1974, Batten 1977, Hanson 1953, Hettinger and Janz 1974, Hultén 1966, Jorgenson 1984, Kessel and Shaller 1960, Pegau 1968, Steigers and others 1983, Webber and others 1978, Young and Racine 1978) *Betula glandulosa/Festuca altaica-Vaccinium* spp./feathermosses-lichen (Hanson 1951, Hettinger and Janz 1974, Pegau 1972, Viereck 1963) *Betula glandulosa/Festuca* altaica/feathermosses (Batten and others 1979; Viereck 1962, 1966) *Betula glandulosa-Vaccinium* spp.-Carex *bigelowii* (Churchill 1955, Hanson 1950) *Betula glandulosa-Ledum decumbens-Vaccinium vitis-idaea-Arctagrostis latifolia* (Churchill 1955) *Betula glandulosa-Salix* spp./Carex *bigelowii-Ledum decumbensl* feathermosses-lichens (Hanson 1951, Scott 1972) *Betula nana-Rubus chamaemorus-Ledum decumbens-Vaccinium* spp. (Craighead and others 1988)
			d. Shrub birch-ericaceous shrub bog-is common on peat mounds and ridges of poorly drained lowlands in all of Alaska except southeastern Alaska and the Aleutian Islands.	*Betula glandulosa-Vaccinium vitis-idaea-Rubus chamaemorus/ Sphagnum* spp. (Bos 1967, Dachnowski-Stokes 1941, Drew and Shanks 1965, Fries 1977, Hanson 1953, Hogan and Tande 1983, Johnson and others 1966, Jorgenson 1984, Komarkova and Webber 1978, Racine 1976, Racine and Anderson 1979, Rigg 1914, Rosenberg 1986, Steigers and others 1983, Tande 1983, Webber and others 1978, Young and Racine 1978) *Betula glandulosa-Vaccinium uliginosum-Carex spp./Sphagnum* spp. (Brock and Burke 1980; Hanson 1950, 1953; Hogan and Tande 1983; Racine 1978a, 1978b; Viereck 1970b) *Betula glandulosa-Andromeda polifolia/Sphagnum* spp. (Hogan and Tande 1983, Ritchie and others 1981) *Betula glandulosa-Rhododendron lapponicum-Carex* spp. (Drew and Shanks 1965) *Betula glandulosa-Myrica gale-Andromeda polifolia/Sphagnum* spp. (Drury 1956, Hanson 1951, Hogan and Tande 1983) *Betula glandulosa-Myrica gale-Carex spp./Sphagnum* spp. (Griggs 1936) *Potentilla fruticosa-Myrica gale-Betula glandulosa/Empetrum nigruml Sphagnum* spp. (Hogan and Tande 1983, Racine 1978b) *Potentilla fruticosa-Myrica gale-Betula glandulosa-Ledum decumbens/* feathermosses (Hogan and Tande 1983)

e. Ericaceous shrub bog-is common in the maritime climate of south-eastern and south-central Alaska and the Aleutian Islands.	*Ledum decumbens-Vaccinium vitis-idaea/Sphagnum* spp. (Dachnowski-Stokes 1941, Racine 1978b, Rigg 1914, Young and Racine 1976) *Empetrum nigrum-Ledum decumbens/sphagnum* spp. (Bos 1967, Cooper 1942, Rigg 1914, Viereck 1970b) *Empetrum nigrum-Vaccinium spp.-Carex pluriflora-Rubus chamaemorus/Sphagnum* spp. (Hultén 1960) *Empetrum nigrum-Vaccinium uliginosum-Eriophorum angustifolium-Carex pauciflora/Sphagnum recurvum-Pleurozium schreberi*[c] *Empetrum nigrum-Carex pluriflora-C. pauciflora/Sphagnum* spp. (Batten and others 1978, Dachnowski-Stokes 1941, Heusser 1960, Scheierl and Meyer 1977) *Empetrum nigrum-Eriophorum angustifolium-Carex pluriflora/ Sphagnum recurvum-Pleurozium schreberi*[c] *Empetrum nigrum-Eriophorum angustifolium/Sphagnum magellanicum-S. warnstorfii* (Reiners and others 1971, Streveler and others 1973) *Kalmia polifolia-Empetrum nigrum-Trichophorum caespitosum-Eriophorum angustifolium/Sphagnum* spp. (Dachnowski-Stokes 1941; Neiland 1971 a; Stephens and others 1969, 1970) *Chamaedaphne calyculata-Salix* spp.-Carex spp. (Calmes 1976) *Kalmia polifolia-Empetrum nigrum-Trichophorum caespitosum-Carex* spp. (Dachnowski-Stokes 1941, Stephens and others 1969) *Andromeda polifolia/Sphagnum* spp. (Luken and Billings 1983, Racine 1976)
f. Shrub birch-willow-occurs in poorly drained lowlands and on moist slopes in northern, interior, south-central, and southwestern Alaska.	*Betula nana-Salix brachycarpa-S. planifolia-S. lanata/Arctostaphylos rubra-Cassiope tetragona-Ledum decumbens* (Spetzman 1959) *Betula nana-Salix lanata/Carex aquatilis-Equisetum* spp. (Craighead and others 1988) *Salix arbusculoides-S. glauca-S. hastata-Betula glandulosa/Bromus pumpellianus-festuca altaica* (Batten 1977) *Betula glandulosa-Salix glauca-S. planifolia/Festuca altaica-Vaccinium vitis-idaea-Arctostaphylos alpina/Hylocomium splendens* (Viereck 1963) *Salix glauca-Betula nana* (Childs 1969) *Betu/a glandulosa-Salix planifolia-Vaccinium uliginosum* (Steigers and others 1983) *Betula glandulosa-Salix spp.-Eriophorum spp./Hylocomium splendens* (McCartney 1976, Talbot and others 1984)

Footnote on page 54.

Table P-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
II. Scrub (continued)	C. Low scrub (continued)	(2) Open low scrub (continued)	g. Willow-occurs on moist uplands in northern, interior, and south-central Alaska.	*Salix glauca/Arctostaphylos rubra-Vaccinium uliginosum-Arctagrostis latifolia* (Hettinger and Janz 1974) *Salix glauca/Dryas octopetala-Betula nana* (Hettinger and Janz 1974) *Salix glauca/Petasites frigidus* (Churchill 1955) *Salix glauca/Dryas octopetala* (Webber and others 1978) *Salix glauca/S. reticulata-Carex podocarpa-Artemisia arctica* (Scott 1974a) *Salix glauca/Arctostaphylos rubra-Dryas octopetala-Salix reticulata-Oxytropis deflexa (Scott* 1974a) *Salix glaucaS. planifolia-S. lanata/Equisetum arvense* (Craig head and others 1988) *Salix lanata-S. glauca/Dryas integrifolia* (Komarkova and Webber 1978) *Salix lanata/Equisetum arvense* (Craighead and others 1988, Webber and others 1978) *Salix planifolia/S. rotundifolia-S. phlebophylla-Petasites frigidus-Poa arctica-Luzula confusa* (Clebsch 1957) *Salix planifolia-S. lanata/Calamagrostis canadensis* (Craig head and others 1988) *Salix planifolia-S. lanata-Myrica gale/Calamagrostis canadensis* (Craighead and others 1988) *Salix glauca/Arctostaphylos alpina* (Webber and others 1978) *Salix glauca/Hylocomium splendens* (Jorgenson 1984) *Salix planifolia/Petasites frigidus-Sphagnum* spp. (Jorgenson 1984) *Salix planifolia/Betula glandulosa-Vaccinium uliginosum* (Brock and Burke 1980)
			h. Willow-sedge shrub tundra-occurs on poorly drained lowlands of arctic and western Alaska.	*Salix planifolia-Carex aquatilis* (Komarkova and Webber 1978, 1980) *Salix lanata-Carex aquatilis* (Webber and Walker 1975, Webber and others 1978) *Salix lanata-Carex vaginata/Hylocomium splendens* (Hettinger and Janz 1974) *Salix lanata/Carex* spp. (Craighead and others 1988) *Salix planifolia-Spiraea beauverdiana/Carex aquatilis* (Hultén 1966) *Salix planifolia/Carex bigelowii* (Craighead and others 1988) *Salix planifolia/Carex bigelowii-Petasites frigidus/Hylocomium splendens* (Hanson 1958, Hettinger and Janz 1974) *Salix planifolia/Carex podocarpa-Petasites frigidus* (Anderson 1974) *Salix planifolia/Carex bigelowii-Arctagrostis latifolia* (Churchill 1955)
			i. Willow-graminoid shrub bog-occurs in wet stream bottoms and depressions in interior, southwestern, south-central and southeastern Alaska.	*Salix* spp./Carex *spp./Sphagnum* spp.[c] *Salix commutata/Carex aquatilis/Calliergon giganteum* (Streveler and others 1973) *Salix barclayi/Calamagrostis canadensis-Carex* spp. (Streveler and others 1973)

	Salix spp.Betula *nana/Calamagrostis canadensis-Carex aquatilis* (Batten 1979) *Salix spp./Calamagrostis canadensis/Potentilla palustris* (Rosenberg 1986)
j. Sweetgale-graminoid bog-occupies poorly drained lowlands and pond margins in southeastern, south-central, and southwestern Alaska.	*Myrica gale/Trichophorum caespitosum/Sphagnum* spp. (Hogan and Tande 1983, Tande 1983, Viereck 1970b) *Myrica gale/Empetrum nigrum-Eriophorum angustifolium-Carex pluriflora/Sphagnum recurvum-Pleurozium schreberi*[c] *Myrica gale/Calamagrostis canadensis* (Batten and others 1978, Frohne 1953, Hanson 1951, McCormick and Pichon 1978, Quimby 1972, Ritchie and others 1981) *Myrica gale-Salix spp./Calamagrostis canadensis* (Crow 1968, Scheierl and Meyer 1977) *Myrica gale-Betula nana-Salix spp./Calamagrostis canadensis-Carex* spp. (Seguin 1977) *Myrica gale/Carex* spp. (Hogan and Tande 1983, Ritchie and others 1981) *Myrica gale-Salix* spp./Carex spp. (Ritchie and others 1981) *Myrica gale/Rubus chamaemorus/Sphagnum* spp. (Griggs 1936, Wibbenmeyer and others 1982) *Myrica gale/Hordeum brachyantherum* (Crow 1968) *Myrica gale/Poa eminens* (Crow 1968) *Myrica gale-Potentilla fruticosa-Betula nana/Ledum decumbens-Rubus chamaemorus* (Rosenberg 1986) *Myrica gale/Menyanthes trifoliata-Carex* spp. (Rosenberg 1986)
k. Low alder-willow-occurs near tree line in interior Alaska and on river terraces in arctic Alaska.	*Alnus crispa-Salix* spp./Carex *bigelowii-Empetrum nigrum-Vaccinium vitis-idaea/Cetraria cucullata-Cladonia* spp. (Bliss and Cantlon 1957, Viereck 1963) *Alnus crispa-Salix planifolia/Eriophorum angustifolium/Sphagnum* spp. (Brock and Burke 1980)
l. Low alder-occupies moist areas, especially drainageways, in most of Alaska, except southeastern and the Aleutian Islands.	*Alnus crispa/Vaccinium uliginosum-Ledum decumbens-Betula nana-Carex bigelowii/Hylocomium splendens-Aulocomnium palustre* (Bliss and Cantlon 1957) *Alnus crispa/Betula glandulosa-Ledum decumbens/Sphagnum* spp. (Drew and Shanks 1965, Ritchie and others 1981)
m. Sagebrush-juniper-is known to exist on steep south-facing bluffs in interior and south-central Alaska, but has not yet been described.	Undescribed
n. Sagebrush-grass-occurs on south-facing bluffs in interior and south-central Alaska.	*Artemisia frigida-Bromus pumpellianus* (Hanson 1951)

 Footnote on page 54.

Table P-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
II. Scrub (continued)	D. Dwarf scrub	(1) Dryas dwarf scrub	a. Dryas tundra-is a very widespread type throughout the northern two-thirds of Alaska.	*Dryas octopetala* (Craighead and others 1988, Drew and Shanks 1965, Hanson 1953, Hettinger and Janz 1974, Johnson and others 1966, Nodler and others 1978, Pegau 1968, Viereck 1963) *Dryas octopetala-Salix arctica-Oxytropis nigrescens* (Bos 1967) *Dryas octopetala-Vaccinium* spp. (Jorgenson 1984, Racine and Young 1978, Talbot and others 1984) *Dryas octopetala-Cassiope tetragona* (Craighead and others 1988) *Dryas octopetala-Salix reticulata-Cassiope tetragona* (Anderson 1974; Batten 1977; Kessel and Schaller 1960; Viereck 1962, 1963) *Dryas octopetala-Vaccinium uliginosum-Salix reticulata* (Anderson 1974) *Dryas octopetala-Arctostaphylos alpina* (Jorgenson 1984, Webber and others 1978, Young 1974b) *Dryas octopetala-Arctostaphylos alpina-Tomenthypnum nitens-Carex bigelowii* (Webber and others 1978) *Dryas integrifolia* (Hettinger and Janz 1974, Komarkova and Webber 1978, Webber and Walker 1975) *Dryas integrifolia-Arctostaphylos rubra* (Jorgenson 1984, Koranda 1960, Webber and others 1978) *Dryas integrifolia-Lupinus arcticus* (Churchill 1955) *Dryas integrifolia-Hedysarum alpinum-Festuca rubra* (Hanson 1951) *Dryas drummondii-D. integrifolia* (Viereck 1966) *Dryas integrifolia-Poa glauca-Oxytropis borealis* (Koranda 1960) *Dryas integrifolia-Vaccinium* spp. (Drew and Shanks 1965, Jorgenson 1984) *Dryas integrifolia-Salix reticulata-Equisetum arvense* (Craighead and others 1988)
			b. Dryas-sedge tundra-is common on alpine sites throughout the northern two-thirds of Alaska.	*Dryas octopetala-Carex scirpoidea* (Gjaerevoll 1954) *Dryas octopetala-Kobresia myosuroides* (Drew and Shanks 1965, Hanson 1951, Johnson and others 1966, Spetzman 1959) *Dryas octopetala-Kobresia simpliciuscula* (Gjaerevoll 1954) *Dryas octopetala-Vaccinium vitis-idaea-Luzula* spp.-Carex *misandra* (Childs 1969) *Dryas octopetala-Carex franklinii* (Gjaerevoll 1954) *Dryas octopetala-Salix arctica-Carex bigelowii-mosses* (Anderson 1974) *Dryas integrifolia-Salix reticulata-Carex scirpoidea* (Batten 1977, Drew and Shanks 1965, Hanson 1953, Hettinger and Janz 1974) *Dryas integrifolia-Carex misandra-Rhytidium rugosum* (Hettinger and Janz 1974) *Dryas octopetala-Carex microchaeta* (Webber and others 1978) *Dryas octopetala-Carex misandra-C. bigelowii* (Hanson 1951) *Dryas octopetala-Carex* glacialis (Gjaerevoll 1954) *Dryas octopetala-Carex nardina-C.* vaginata-lichens (George and others 1977)

		Dryas integrifolia-Carex scirpoidea-Kobresia simpliciuscula (Koranda 1960) *Dryas octopetala-Salix reticulata-Carex bigelowii* (Hanson 1950, Viereck 1963) *Dryas octopetala-Salix reticulata-Carex podocarpa (Scott* 1974a) *Dryas integrifolia-Carex scirpoidea* (Drew and Shanks 1965, Hettinger and Janz 1974) *Dryas integrifolia-Carex bigelowii* (Craighead and others 1988, Jorgenson 1984) *Dryas integrifolia-Oxytropis nigrescens-Carex rupestris* (Koranda 1960, Webber and Walker 1975) *Dryas integrifolia-Carex* spp. (Craighead and others 1988) *Dryas integrifolia-Eriophorum scheuchzeri-Tomenthypnum nitens* (Jorgenson 1984)
	c. Dryas-lichen tundra-occurs on windswept alpine sites, especially on the Seward Peninsula.	*Dryas octopetala-Cetraria spp.-Cladonia* spp. (Pegau 1968, Viereck 1962) *Dryas octopetala-lichens* (Anderson 1974, Brock and Burke 1980, Childs 1969, George and others 1977, Hanson 1951, Spetzman 1959) *Dryas integrifolia-lichens* (Drew and Shanks 1965, Hanson 1951, Komarkova and Webber 1978, Webber and Walker 1975) *Dryas octopetala-lichens-Oxytropis nigrescens-Salix phlebophylla-Carex microchaeta* (Johnson and others 1966) *Dryas octopetala-Stereocaulon tomentosum* (Scott 1974a) *Dryas octopetala-Cetraria cucullata (Scott* 1974a, Viereck 1962) *Dryas octopetala-Empetrum nigrum-Salix arctica-Cetraria* spp.-*Cladonia* spp. (Young and Racine 1978) *Dryas octopetala-Salix reticulata-Cladonia rangiferina* (Scott 1974a)
(2) Ericaceous dwarf scrub	a. Bearberry tundra-occurs in alpine areas in interior and arctic Alaska, but is most common in western Alaska.	*Arctostaphylos alpina-Vaccinium vitis-idaea* (Hanson 1953) *Arctostaphylos alpina-Rhododendron camtschaticum* (Pegau 1968) *Arctostaphylos rubra-Cladina stellaris* (Webber and others 1978) *Arctostaphylos alpina-Vaccinium* spp.-Empetrum *nigrum-Cassiope tetragona-lichens* (Jorgenson 1984) *Arctostaphylos alpina-Vaccinium uliginosum-Dicranum* spp.-*Rhacomitrium lanuginosum* (Jorgenson 1984) *Arctostaphylos alpina-Carex bigelowii* (Racine and Anderson 1979)

Table 2-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
II. Scrub (continued)	D. Dwarf scrub (continued)	(2) Ericaceous dwarf scrub (continued)	b. Vaccinium tundra-is common in alpine areas of interior, northern, and western Alaska.	*Vaccinium vitis-idaea-Dryas octopetala-Empetrum nigrum-Festuca altaica (Scott* 1974a) *Vaccinium vitis-idaea-Salix phlebophylla-Arctostaphylos alpina* (Anderson 1974) *Vaccinium vitis-idaea-Empetrum nigrum-Cladina* spp. (Racine and Anderson 1979) *Vaccinium uliginosum-Diapensia lapponica-Phyllodoce coerulea-Salix Polaris-S. arctica* (Fries 1977) *Loiseleuria procumbens-Vaccinium uliginosum-Salix arctica-Ledum decumbens* (Griggs 1936) Bryophyte-Vaccinium *uliginosum-Dryas octopetala-Carex bigelowii* (Anderson 1974) *Vaccinium* spp.-Ledum *decumbens-Arctostaphylos alpina-Cassiope tetragona* (Hanson 1958, Johnson and others 1966) *Ledum decumbens-Vaccinium vitis-idaea-Cetraria* spp. (Hanson 1951) *Rhododendron lapponicum-Vaccinium uliginosum-V. vitis-idaea* (Drew and Shanks 1965) *Festuca altaica-Vaccinium vitis-idaea-V. uliginosum-Empetrum nigrum-Dryas octopetala* (Hanson 1951) *Vaccinium uliginosum-V. vitis-idaea* (Hettinger and Janz 1974) *Vaccinium uliginosum-Empetrum nigrumdedum decumbens-Cladonia* spp. (Steigers and others 1983) *Vaccinium* uliginosum-lichens (Craighead and others 1988)
			c. Crowberry tundra-is characteristic of southern Alaska and the Aleutian Islands.	*Empetrum nigrum-Cassiope stelleriana-Phyllodoce aleutica-Vaccinium* spp. (Cooper 1942, Fox 1983, Heusser 1960, lsleib and Kessel 1973, Palmer 1942) *Empetrum nigrum-Vaccinium* spp. (Friedman 1982, Griggs 1936, Racine and Young 1978) *Empetrum nigrum-Lycopodium spp./Brachythecium albicans-Cladonia* spp. (Bank 1951) *Empetrum nigrum-Carex pluriflora-C. macrochaeta/Cladonia* spp. (Bank 1951, Everett 1971, Huttén 1960, Shacklette and others 1969) *Empetrum nigrum-Cassiope lycopodioides-Carex circinnata-mosses* (Byrd 1984) *Empetrum nigrum-Arctostaphylos alpina* (Bos 1967, Fries 1977) *Empetrum nigrum-Vaccinium uliginosum* (Huttén 1962) *Empetrum nigrum-Carex bigelowii-Arctostaphylos alpina* (Bos 1967) *Empetrum nigrum-Salix arctica-Cetraria* spp. (Young and Racine 1978)
			d. Mountain-heath tundra-is common on alpine slopes in south-central and southeastern Alaska.	*Phyllodoce aleutica-Cassiope stelleriana* (Heusser 1960) *Phyllodoce aleutica-Cassiope spp.-Vaccinium* spp. (Klein 1965) *Phyllodoce aleutica-Cassiope mertensiana* (Jaques 1973) *Luetkea pectinata-Phyllodoce* spp.-Cassiope spp. (Racine and Young 1978, Streveler and others 1973)

	e. Cassiope tundra-is widespread on moist alpine sites throughout Alaska.	*Cassiope tetragona* (Anderson 1974; Komarkova and Webber 1978, 1980; Pegau 1968; Scott 1974a; Webber and others 1978) *Cassiope tetragona-Salix rotundifolia-mosses* (Batten 1977, Jorgenson 1984, Webber and Walker 1975) *Cassiope tetragona-Vaccinium uliginosum-mosses* (Hanson 1953, Scott 1974a) *Cassiope tetragona-Vaccinium vitis-idaea* (Childs 1969, Webber and others 1978) *Cassiope tetragona-Dryas integrifolia* (Komarkova and Webber 1978, 1980; Koranda 1960) *Cassiope tetragona-Vaccinium vitis-idaea-Carex bigelowii-Hylocomium* splendens-lichens (Jorgenson 1984) *Cassiope tetragona-Dicranum* spp. (Jorgenson 1984) *Cassiope mertensiana-C. stelleriana-Empetrum nigrum* (Fox 1983; Heusser 1954, 1960; Ward 1957) *Luetkea pectinata-Cassiope stelleriana-Lycopodium alpinum-Cladonia* spp. (Hanson 1951)
(3) Willow dwarf scrub	a. Willow tundra-is common in alpine areas throughout the State except for southeastern Alaska.	*Salix rotundifolia* (Klein 1959, Komarkova and Webber 1978, White and others 1975) *Salix rotundifolia-Oxyria digyna* (Anderson 1974) *Salix ovalifolia-Empetrum nigrum-Festuca rubra-Calamagrostis deschampsioides* (Hanson 1951) *Salix Polaris-S. reticulata-Hylocomium splendens-Carex podocarpa* (Scott 1974a) *Salix ovalifolia* (White and others 1975) *Salix reticulata-Carex microchaeta-Rhacomitrium lanuginosum* (Hettinger and Janz 1974) *Salix reticulata-Carex saxatilis* (Hettinger and Janz 1974) *Salix rotundifolia-Potentilla vahliana-Saxifraga oppositifolia* (Racine and Anderson 1979) *Salix polaris-Cetraria islandica-Cladina rangiferina (Scott* 1974a) *Salix arctica-Carex nesophila-Cladina alpestris-Cetraria cucullata* (Klein 1959) *Salix arctica-S. rotundifolia-Empetrum nigrum* (Shacklette and others 1969) *Salix rotundifolia-S. ovalifolia-Cassiope lycopodioides-Empetrum nigrum* (Shacklette and others-l 969) - *Salix ovalifolia-Artemisia borealis* (Webber and others 1978) *Salix rotundifolia-S. phlebophylla* (Clebsch 1957) *Salix phlebophylla* (Craighead and others 1988) *Salix reticulata-Dryas integrifolia-Carex bigelowii-Tomenthypnum nitens* (Hettinger and Janz 1974) *Salix reticulata-Ledum decumbens* (Hettinger and Janz 1974) *Salix* spp.-Cassiope *lycopodioides* (Byrd 1984) *Salix reticulata-Carex bigelowii-Aulocomnium* spp. (Jorgenson 1984) *Salix reticulata-Dryas octopetala-Carex scirpoidea* (Anderson 1974)

Table 2-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
III. Herbaceous	A. Graminoid herbaceous	(1) Dry graminoid herbaceous	a. Elymus-occurs on beaches, dunes, gravel outwash flats, and dry slopes mostly in coastal areas but occasionally in the Alaska Range, Brooks Range, and interior Alaska.	*Elymus arenarius* (Bank 1951; Batten and others 1978; George and others 1977; Griggs 1936; Hanson 1951, 1953; Johnson and others 1966; Klein 1959; Meyers 1985; Racine and Anderson 1979; Rosenberg 1986; Shacklette and others 1969; Spetzman 1959; Stephens and Billings 1967; Ugolini and Walters 1974; Young 1971) *Elymus arenarius-Honckenya peploides* (Manuwal 1979) *Elymus arenarius-Honckenya peploides-Mertensia maritima* (Fries 1977, Potter 1972, Wiggins and Thomas 1962) *Elymus arenarius-Poa eminens-Calamagrostis canadensis* (Quimby 1972) *Elymus arenarius-Poa eminens-Carex ramenskii* (Byrd and Ronsse 1983) *Elymus arenarius-Senecio pseudo-arnica-Lathyrus maritimus* (Bank 1951, Hultén 1960, Rausch and Rausch 1968) *Elymus arenarius-Senecio pseudo-arnica-Claytonia sibirica* (Friedman 1982) *Elymus arenarius-Lathyrus maritimus* (Hanson 1951) *Elymus arenarius-Lathyrus maritimus-Poa eminens* (Hanson 1953) *Elymus arenarius-Heracleum lanaturn-Angelica lucida* (Byrd 1984) *Elymus arenarius-Heracleum lanaturn-Angelica lucida-Athyrium filix-femina* (Byrd 1984) *Elymus arenarius-Ligusticum scoticum-Anemone narcissiflora* (Shacklette and others 1969) *Elymus arenarius/Potentilla egedii* (Crow and Koppen 1977) *Elymus arenarius-Festuca rubra* (Hanson 1951, Palmer and Rouse 1945) *Elymus arenarius-Lathyrus maritimus-Senecio pseudo-arnica-Angelica lucida* (Fries 1977) *Elymus arenarius-Polemonium boreale-Senecio pseudo-arnica* (Young and Racine 1978) *Elymus arenarius-Calamagrostis canadensis-Deschampsia beringensis* (Friedman 1982) *Elymus arenarius-Dryas integrifolia* (Komarkova and Webber 1980) *Elymus innovatus-Festuca altaica/Hylocomium splendens* (Viereck 1966) *Elymus innovatus-Poa glauca* (Hanson 1951)
			b. Dry fescue-occupies dry slopes in interior, south-central, and western Alaska.	*Festuca altaica* (Hanson 1951, 1953; Pegau 1972; Viereck 1962) *Festuca altaica-Calamagrostis canadensis* (Hanson 1951)

c. Midgrass-shrub-is common on localized, steep, south-facing bluffs in interior and south-central Alaska.	*Festuca altaica-Salix lanata-Artemisia arctica (Scott* 1974a) *Calamagrostis purpurascens-Artemisia frigida* (Batten and others 1979, Hanson 1951) *Festuca altaica-Empetrum nigrum-Salix reticulata (Scott* 1974a) *Agropyron spicatum-Artemisia frigida* (Batten and others 1979, Hanson 1951) *Festuca altaica-Calamagrostis canadensis-Empetrum nigrum* (Bos 1967) *Poa glauca-Artemisia frigida-Calamagrostis purpurascens* (Hanson 1951)
d. Midgrass-herb-occupies various sites from alpine meadows to streambanks. It is found in the Aleutian Islands, south-central, southeastern, and interior Alaska.	*Festuca altaica-Anemone narcissiflora* (Anderson 1974, Pegau 1972) *Festuca altaica-Lupinus arcticus (Scott* 1974a) *Festuca altaica-Carex podocarpa-Aconitum delphinifolium-Mertensia paniculata-Artemisia arctica* (Hanson 1951) *Festuca altaica-Sanguisorba stipulata-Lycopodium alpinum-Salix* reticulata/feathermosses (Hanson 1951) *Festuca altaica-Calamagrostis canadensis-Cornus canadensis-Geranium erianthum* (Hanson 1951) *Festuca rubra-Dodecatheon pulchellum-Lathyrus palustris* (Hanson 1951) *Festuca rubra-Angelica lucida-Achilles borealis-Cardamine umbellata* (Byrd 1984) *Festuca rubra-Carex supina-Agropyron boreale* (Hanson 1951) *Festuca rubra-Angelica lucida* (Byrd 1.984) *Festuca brachyphylla-Poa arctica* (Shacklette and others 1969). *Poa eminens-Potentilla egedii* (Crow 1977b, Ritchie and others 1981) *Poa eminens-Festuca rubra-Potentilla egedii* (Vince and Snow 1984) *Poa eminens-Deschampsia beringensis-Festuca rubra* (Shacklette and others 1969) *Agropyron pauciflorum-Epilobium angustifolium* (Hanson 1951) *Carex macrochaeta-Festuca rubra* (Byrd 1984) *Agropyron pauciflorum-Festuca rubra-Achilles borealis-Lathyrus palustris* (Hanson 1951) *Poa glauca-Carex macrochaeta-Calamagrostis canadensis-Angelica lucida (Hanson_l951)* *Carex macrochaeta-Deschampsi beringensii* (Friedman 1982) *Potentilla egedii-Festuca rubra* (del Moral and Watson 1978) *Hedysarum alpinum-Deschampsia beringensis* (Crow 1968)
e. Hair-grass-is common in the Aleutian Islands and along the southern coast of Alaska.	*Deschampsia beringensis* Batten and others 1978, Hanson 1951, Ritchie and others 1981, Seguin 1977, Stephens and Billings 1967[d]) *Deschampsia beringensis-Juncus arcticus* (Batten and others 1978) *Deschampsia beringensis-Carex lyngbyaei* (McCartney 1976) *Deschampsia beringensis-Festuca rubra* (Batten and others 1978, Hanson 1951)

Footnote on page 54.

Table 2--Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
III. Herbaceous (continued)	A. Graminoid herbaceous (continued)	*(2)* Mesic graminoid herbaceous	a. Bluejoint meadow-is found throughout the State except for southeastern and arctic Alaska. It occupies large areas in south-central and southwestern Alaska.	*Calamagrostis canadensis* (Bank 1951; Batten and others 1978; Burns 1964; Craighead and others 1988; Friedman 1982; Fries 1977; Hanson 1951, 1953; Heusser 1960; Hultén 1966; McCormick and Pichon 1978; Pegau 1968, 1972; Racine 1976; Racine and Anderson 1979; Ritchie and others 1981; Tande 1983; Wibbenmeyer and others 1982; Young and Racine 1976) *Calamagrostis canadensis/Galium trifidum* (Crow 1977b) *Calamagrostis nutkaënsis/Festuca rubra* (Amundsen and Clebsch 1971, Byrd 1984)
			b. Bluejoint-herb-is widely distributed in the southern half of the State.	*Calamagrostis canadensis-Epilobium angustifolium* (Hanson 1951, Klein 1959, Mitchell and Evans 1966, Young and Racine 1978) *Calamagrostis canadensis-Epilobium angustifolium-Geranium erianthum* (Heusser 1960) *Calamagrostis canadensis-Thalictrum minus-Geranium erianthum-Epilobium angustifolium* (Hultén 1960) *Calamagrostis canadensis-Epilobium angustifolium-Heracleum lanaturn-Angelica genuflexa* (Griggs 1936) *Calamagrostis canadensis-Deschampsia beringensis-Heracleum lanaturn-Angelica lucida* (Bank 1951) *Calamagrostis canadensis-Festuca altaica* (Hanson, 1951) *Calamagrostis canadensis-Festuca altaica-Elymus arenarius* (Hanson 1951) *Calamagrostis canadensis-Elymus arenarius* (Hanson 1951) *Calamagrostis canadensis-C. nutkaënsis-Geranium erianthum* (Friedman 1982) *Calamagrostis canadensis-Equisetum sylvaticum* (Hanson 1951) *Calamagrostis canadensis-Equisetum fluviatile-Potentilla palustris* (Ritchie and others 1981) *Calamagrostis canadensis-Hordeum brachyantherum* (Batten and others 1978) *Calamagrostis canadensis-Deschampsia beringensis* (Batten and others 1978, Hanson 1951) *Calamagrostis canadensis-Angelica genuflexa* (Hanson 1951) *Calamagrostis canadensis-Carex macrochaeta-Angelica lucida* (Hanson 1951) *Calamagrostis canadensis-Carex macrochaeta* (Hanson 1951) *Calamagrostis canadensis-Athyrium filix-femina* (Hanson 1951) *Carex macrochaeta-Calamagrostis nutkagnsis* (Friedman 1982) *Calamagrostis nutkaansis-Heracleum lanatum* (del Moral and Watson 1978)
			c. Bluejoint-shrub-is extensive in southwestern Alaska and probably also common in south-central and interior Alaska.	*Calamagrostis canadensis-Alnus sinuata* (Griggs 1936)

d.	Tussock tundra-is widely distributed throughout western, interior, and northern Alaska.	*Eriophorum vaginatum* (Batten 1977, Craighead and others 1988, Johnson and others 1966, Komarkova and Webber 1978, Young 1974b) *Eriophorum vaginatum-Salix planifolia-Carex bigelowii/ Hylocomium splendens* (Hettinger and Janz 1974) *Eriophorum vaginatum-Carex bigelowii* (Brock and Burke 1980, Churchill 1955, Craighead and others 1988, Jorgenson 1984)
e.	Mesic sedge-grass meadow tundra-is usually of minor extent in arctic and alpine settings.	*Carex aquatilis-Poa arctica* (Clebsch 1957, Webber 1978) *Carex microchaeta-Poa arctica* (Batten 1977) Carex *podocarpa-Arctagrostis latifolia (Scott* 1974a)
f.	Mesic sedge-herb meadow tundra-'is usually of minor extent in alpine regions.	*Carex macrochaeta-Geranium erianthum-Erigeron peregrinus-Lupinus nootkatensis* (Hjeljord 1971)
g.	Mesic grass-herb meadow tundra-occurs in small, limited areas. It has been reported from the arctic slope but is probably more widespread.	*Bromus pumpellianus-Trisetum spicatum-Bupleurum triradiatum* (Koranda 1960) *Luzula confusa-Poa arctica-Petasites frigidus* (Wiggins 1951)
h.	Sedge-willow tundra-is widely distributed in tundra areas throughout Alaska except the south-central and southeastern parts; it probably is most abundant from the Brooks Range northward.	*Carex aquatilis-Salix planifolia* (Childs 1969, Clebsch 1957, Dennis 1968, Hanson 1951, Hettinger and Janz 1974, Koranda 1960, Webber and others 1978) *Carex aquatilis-Salix lanata* (Craighead and others 1988, Spetzman 1959) *Carex aquatilis-Alnus crispa-Salix* spp. (Bliss and Cantlon 1957) *Carex bigelowii-Salixplanifolia* (Hettinger and Janz 1974, Johnson and others 1966, Koranda 1960, Viereck 1963) *Carex bigelowii-Salix reticulata-S. planifolia* (Batten 1977, Hettinger and Janz 1974) *Carex bigelowii-Salix reticulata* (Drew and Shanks 1965, Hettinger and Janz 1974) *Eriophorum angustifolium-Salix planifolia* (Fries 1977) *Eriophorum angustifolium-Salix fuscescens* (Johnson-and others 1966) *Eriophorum angustifolium-Carex pluriflora-Salix reticulata* (Hanson 1951) *Carex bigelowii-C. membranacea-Salix polaris-Equisetum arvense* (Hanson 1950) *Carex nesophila-Salix rotundifolia-S. reticulata* (Klein 1959) *Carex subspathacea-Dupontia fischeri-Salix ovalifolia* (Meyers 1985)
	Sedge-birch tundra-is known from northern Alaska.	*Carex bigelowii-C. aquatilis-Betula nana* (Hettinger and Janz 1974)

Table 2-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
III. Herbaceous (continued)	A. Graminoid herbaceous (continued)	(2) Mesic graminoid herbaceous (continued)	i. Sedge-dryas tundra-is widely distributed in tundra areas throughout the State except southeastern Alaska.	*Carex aquatilis-Dryas integrifolia* (Webber and Walker 1975, Webber and others 1978) *Carex bigelowii-Dryas integrifolia* (Childs 1969, Hettinger and Janz 1974, Webber and others 1978) *Carex bigelowii-Eriophorum angustifolium-Dryas integrifolia* (Drew and Shanks 1965) *Carex bigelowii-Eriophorum angustifolium-Dryas octopetala* (Anderson 1974) *Carex bigelowii-C. membranacea-Dryas octopetala* (Hanson 1950) *Carex bigelowii-Dryas octopetala* (Johnson and others 1966) *Carex bigelowii-Dryas octopetala-Salix reticulata* (Anderson 1974, Scott 1974a, Webber and others 1978) *Kobresia simpliciuscula-Dryas integrifolia* (Webber and others 1978) *Eriophorum angustifolium-Dryas integrifolia* (Webber and Walker 1975, Webber and others 1978)
		(3) Wet graminiod herbaceous	a. Wet sedge meadow tundra-is found in very wet areas, generally underlain by permafrost, in every part of the State except the south-east and the Aleutian Islands.	*Eriophorum angustifolium* (Craighead and others 1988,. Holowaychuk and Smeck 1979, Murray 1974, Racine 1976, Racine and Anderson 1979, Viereck 1963, White and others 1975) *Eriophorum angustifolium-E. scheuchzeri* (Britton 1967) *Eriophorum angustifolium-Carex membranacea* (Murray 1974) *Eriophorum angustifolium-E. brachyantherum-Carex aguatilis* (Murray 1974, Young 1974b) *Eriophorum angustifolium-Trichophorum caespitosum* (Murray 1974) *Eriophorum angustifolium-Carex pluriflora-Salix reticulata* (Hanson. 1951) *Eriophorum angustifolitim-Carex aquatilis-C. lachenalii* (Klein 1959, Rausch and Rausch 1968) *Eriophorum angustifolium-Carex bigelowii* (Anderson 1974, Drew and Shanks 1965, Hanson 1950) *Eriophorum angustifolium-Carex chordorrhiza* (Webber and others 1978) *Eriophorum angustifolium-Equisetum fluviatile* (Craighead and others 1988) *Eriophorum scheuchzeri/Drepanocladus revolvens* (Jorgenson 1984) *Carex aquatilis-Eriophorum angustifolium* (Batten 1977; Bergman and others 1977; Childs 1969; Craighead and others 1988; Hopkins and Sigafoos 1951; Porter 1966; Racine 1977, 1978a, 1978b; Spetzman 1959) *Carex aquatilis-Eriophorum angustifolium/Drepanocladus lycopodioides* (Webber and Walker 1975, Webber and others 1978) *Carex aguatilis-Eriophorum angustifolium/Rhytidium rugosum* (Johnson and others 1966) *Carex aquatilis-Eriophorum augustifolium/Scorpidium scorpioides* (Neiland and Hok 1975, Webber and Walker 1975) *Carex aquatilis-Eriophorum angustifolium/Sphagnum* spp. (Bos 1967, Johnson and others 1966)

Carex aquatilis-Eriophorum angustifolium-Carex rotundata (Hanson 1953, Jorgenson 1984)
Carex aquatilis-Eriophorum angustifolium-E. russeolum (Murray 1974; Racine 1978a, 1978b)
Carex aquatilis-Eriophorum angustifolium-E. scheuchzeri (Jorgenson 1984, Koranda 1960, Pegau 1968)
Carex aquatilis (Bergman and others 1977; Britton 1967; Churchill 1955; Clebsch 1957; Craighead and others 1988; Dennis 1968; Fries 1977; George and others 1977; Kessel and Schaller 1960; Komarkova and Webber 1978; Koranda 1960; Meyers 1985; Murray 1974; Pegau 1972; Peterson and Billings 1978; Racine 1976, 1978a, 1978b; Racine and Anderson 1979; Spetzman 1959; Webber 1978; White and others 1975; Young 1971)
Carex aquatilis/Scorpidium scorpioides (Neiland and Hok 1975, Webber and Walker 1975, Webber and others 1978)
Carex aquatilis/Drepanocladus spp. (Webber and others 1978)
Carex aquatilis-C. rotundata (George and others 1977; Hanson 1951, 1953; Webber and others 1978)
Carex aquatilis-Eriophorum russeolum/Drepanocladus lycopodioides (Webber 1978)
Carex aquatilis-Eriophorum scheuchzeri (Britton 1967, Webber and others 1978)
Carex aquatilis-Eriophorum scheuchzeri-Carex rotundata (Jorgenson 1984)
Carex aquatilis-C. chordorrhiza-C. limosa-C. microglochin-Eriophorum scheuchzeri-E. angustifolium (Drew and Shanks 1965)
Carex chordorrhiza (Batten 1977, Spetzman 1959)
Eriophorum scheuchzeri (Racine 1976)
Carex rariflora (Batten 1977, Hanson 1951)
Carex bigelowii-C. rariflora-C, saxatilis (Hettinger and Janz 1974)
Carex rariflora-Hippuris tetraphylla/Sphagnum spp. (Hultén 1962)
Carex rotundata (Brock and Burke 1980)

Table P-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
III. Herbaceous (continued)	A. Graminoid herbaceous (continued)	*(3)* Wet graminiod herbaceous (continued)	b. Wet sedge-grass meadow tundra-is largely confined to the arctic coastal plain in very wet areas underlain by shallow permafrost.	*Dupontia fischeri* (Britton 1967, Clebsch 1957, Dennis 1968, Meyers 1985, Potter 1972, Wiggins 1951) *Dupontia fischeri-Alopecurus alpinus* (Bergman and others 1977) *Dupontia fischeri-Petasites frigidus* (Dennis 1968) *Dupontia fischeri-Eriophorum angustifolium* (Brown and others 1970, Dennis 1968, Meyers 1985, Webber 1978, Young 1971) *Dupontia fischeri-Eriophorum angustifolium/Bryum* spp. (Webber 1978) *Dupontia fischeri-Eriophorum scheuchzeri* (Spetzman 1959) *Eriophorum angustifolium-Carex glareosa-Deschampsia caespitosa-Dupontia fischeri-Arctagrostis latifolia* (Johnson and others 1966) *Carex aquatillis-Dupontia fischeri* (Potter 1972, Webber and others 1978, Wiggins 1951) *Carex aquatilis-Dupontia fischeri/Oncophorus wahlenbergii* (Webber 1978) *Carex aquatilis-Dupontia fischeri/Bryum* spp. (Webber and Walker 1975, White and others 1975) *Carex aquatilis-Dupontia fischeri-Carex membranacea* (Koranda 1960) *Eriophorum scheuchzeri-Alopecurus alpinus* (Koranda 1960) *Alopecurus alpinus* (Britton 1967)
			c. Wet sedge-herb meadow tundra-is found on very wet, poorly drained sites with standing water, such as oxbow lakes and alpine bogs. Apparently widely distributed throughout Alaska.	*Carex aquatilis-Menyanthes trifoliata* (Racine 1976, Webber and others 1978) *Carex aquatilis-C. membranacea-Petasites frigidus (Scott* 1974a) *Carex aquatilis-Potentilla palustris* (Bliss and Cantlon 1957, Webber and others 1978) *Carex nigricans-Eriophorum angustifolium-Fauria crista-galli-Trichophorum caespitosum* (Fox 1983, Jaques 1973) *Trichophorum caespitosum-Triglochin palustris* (Webber and others 1978)
			d. Fresh sedge marsh-is found in south-central and southeastern Alaska, and may be present in interior Alaska.	*Scirpus validus* (Batten and others 1978, del Moral and Watson 1978, Hanson 1951, Neiland 1971 b, Ritchie and others 1981) *Eleocharis palustris-Hippuris vulgaris* (Heusser 1960) *Eleocharis palustris-Myriophyllum spicatum* (Crow 1968) *Eleocharis palustris-Equisetum fluviatile-E. palustre* (Worley 1980)
			e. Fresh grass marsh-is common in ponds, slow-flowing streams, lake margins, and thermokarst pits in northern and western Alaska. Depth of water ranges from seasonally flooded up to 2 meters.	*Arctophila fulva* (Batten 1977, Bergman and others 1977, Britton 1967, Childs 1969, Clebsch 1957, Hultén 1966, Komarkova and Webber 1978, Meyers 1985, Murray 1974, Potter 1972, Racine and Anderson 1979, Rausch and Rausch 1968, Streveler and others 1973, Webber and others 1978, Wiggins and Thomas 1962) *Arctophila fulva-Carex aquatilis* (Webber and Walker 1975, Wiggins 1951) *Arctophila fulva-Ranunculus pallasii* (Johnson and others 1966, Spetzman 1959, Webber 1978, Young 1974b)

	Arctophila fulva-Menyanthes trifoliata (Spetzman 1959) *Arctophila fluva-Calamagrostis canadensis* (Craighead and others 1988) *Glyceria borealis-Eleocharis palustris* (Rosenberg 1986)
f. Subarctic lowland sedge wet meadow-is common in very wet areas on flood plains, margins of ponds, lakes, and sloughs and in depressions in upland areas. It has been reported from western, interior, south-central, and south-eastern Alaska and the Aleutian Islands.	*Carex aquatilis* (Ritchie and others 1981, Rosenberg 1986) *Carex aquatilis-Menyanthes trifoliata/Scorpidium* spp. (Ritchie and others 1981) *Carex aquatilis-Equisetum arvense* (Johnson and Vogel 1966, Murray 1974, Scott 1974a) *Carex aquatilis-C. saxatilis* (Hanson 1951, Pegau 1972) *Carex saxatilis* (Rosenberg 1986) *Carex saxatilis-Calamagrostis canadensis/Calliergon giganteum* (Drury 1956) *Carex rostrata* (Craighead and others 1988; Racine 1976, 1978b; Ritchie and others 1981; Rosenberg 1986) *Carex rostrata-C. aquatilis* (Calmes 1976, Dachnowski-Stokes 1941, Drury 1956, Hultén 1966, Rosenberg 1986, Tande 1983) *Carex rostrata-Eriophorum angustifolium-Calamagrostis canadensis* (Racine 1978b) *Carex rostrata-Eriophorum angustifolium-Equisetum fluviatile* (Porsild 1939) *Carex rostrata-Eriophorum angustifolium-Arctophila fulva* (Porsild 1939) *Carex rostrata-Equisetum fluviatile* (Craighead and others 1988) *Carex rostrata-C. saxatilis-Equisetum fluviatile* (Porsild 1939) *Carex lyngbyaei* (Byrd 1984, Griggs 1936, Hultén 1960, Scheierl and Meyer 1977) *Carex lyngbyaei-C. aquatilis* (Dachnowski-Stokes 1941, Streveler and others 1973) *Carex lyngbyaei-C. sitchensis* (Neiland 1971 b, Quimby 1972, Ritchie and others 1981) *Carex lyngbyaei-C. saxatilis* (Streveler and others 1973) *Carex lyngbyaei-Calamagrostis canadensis* (Batten and others 1978, Crow 1977b, Hanson 1951) *Carex lyngbyaei-Lathyrus palustris* (Batten and others 1978, Crow 1968) *Carex lyngbyaei-Cicuta mackenziana* (Crow 1968) *Carex lyngbyaei-C .pluriflora-C. anthoxanthea-C. macrochaeta* -. (Armundsen and Clebsch 1971, Shacklette and others 1969) *Carex lyngbyaei-C. macrochaeta/Cladina portentosa* (Amundsen 1977, Amundsen and Clebsch 1971, Everett 1971, Shacklette and others 1969) *Carex pluriflora-Deschampsia beringensis* (Crow 1977b) *Deschampsia beringensis-Carex lyngbyaei* (McCartney 1976) *Carex sitchensis* (Ritchie and others 1981) *Carex sitchensis-Caltha palustris* (Thomas 1957) *Carex lasiocarpa* (Rosenberg 1986) *Eriophorum angustifolium-Carex livida* (Rosenberg 1986),

Table 2-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
III. Herbaceous (continued)	A. Graminoid herbaceous (continued)	*(3)* Wet grarniniod herbaceous (continued)	g. Subarctic lowland sedge-shrub wet meadow-occupies upper parts, of coastal marshes in south-central and southeastern Alaska.	*Carex lyngbyaei-Salix* spp. (Scheierl and Meyer 1977) *Carex lyngbyaei-Myrica gale* (Frohne 1953) *Scirpus microcarpus-Salix barclayi-S. sitchensis* (Worley 1980)
			h. Halophytic grass wet meadow-commonly occupies tidal mud flats along the entire Alaska coast.	*Puccinellia nutkaënsis-Spergularia canadensis* (Crow 1977b, Crow and Koppen 1977) *Puccinellia nutkaënis-Suaeda depressa* (Crow and Koppen 1977) *Puccinellia nutkaënsis-Plantago maritima* (Crow and Koppen 1977) *Puccinellia nutkaë/nsis-Glaux maritima* (Crow 1977b, Crow and Koppen 1977) *Puccinellia nutkaënsis-Fucus* spp. (Crow 1977b, Crow and Koppen 1977) *Puccinellia nutkaënsis-Honckenya peploides* (Crow 1977b) *Puccinellia nutkaënsis* (Batten and others 1978, Cooper 1931, Streveler and others 1973, Vince and Snow 1984) *Puccinellia grandis-Triglochin maritimum* (McCormick and Pichon 1978, Neiland 1971 b, Quimby 1972) *Puccinellia grandis-Plantago maritima-Elymus arenarius* (Neiland 1971b) *Puccinellia grandis* (Batten and others 1978, McCormick and Pichon 1978) *Puccinellia glabra-Plantago maritima* (Hanson 1951) *Puccinellia borealis-Potentilla egedii* (Hanson 1953) *Puccinellia phryganodes* (Jefferies 1977, Meyers 1985, Rosenberg 1986) *Puccinellia phryganodes-Triglochin maritimum* (Quimby 1972, Rosenberg 1986, Vince and Snow 1984) *Puccinellia phryganodes-Salicornia europaea* (Hanson 1951) *Puccinellia phryganodes-Cochlearia officinalis* (Thomas 1951) *Puccinellia andersonii* (Meyers 1985)
			i. Halophytic sedge wet meadow-is common on tidal flats along the entire Alaska coast.	*Carex subspathacea* (Hanson 1951, 1953; Meyers 1985) *Carex subspathacea-Puccinellia phryganodes* (Bergman and others 1977, Byrd and Ronsse 1983, Nodler and others 1978, Webber and others 1978) *Carex ursina* (Jefferies 1977) *Carex mackenziei* (Byrd and Ronsse 1983, Ritchie and others 1981) *Carex ramenskii* (Batten and others 1978, Hanson 1951, Jefferies 1977, Neiland 1971b, Quimby 1972, Vince and Snow 1984) *Carex ramenskii-Potentilla egedii* (Byrd and Ronsse 1983, George and others 1977, Rosenberg 1986) *Carex ramenskii-Triglochin maritimum-Potentilla egedii* (Hanson 1951, Ritchie and others 1981)

		Carex lyngbyaei (Batten and others 1978; Craighead and others 1988; Crow 1968, 1977b; Crow and Koppen 1977; del Moral and Watson 1978; Friedman 1982; Frohne 1953; Hanson 1951; Klein 1965; McCormick and Pichon 1978; Neiland 1971b; Racine and Anderson 1979; Ritchie and others 1981; Rosenberg 1986; Stephens and Billings 1967; Streveler and others 1973; Vince and Snow 1984; Wibbenmeyer and others 1982) *Carex lyngbyaei-Poa eminens-Potentilla egedii* (Rosenberg 1986) *Carex lyngbyaei-Triglochin maritimum* (Crow 1968, Crow and Koppen 1977, Ritchie and others 1981) *Carex lyngbyaei-Potentilla egedii* (Crow 1977b) *Carex lyngbyaei-Eleocharis palustris* (Crow 1968, 1977b) *Carex lyngbyaei-Hippuris tetraphylla* (Crow 1968) **Carex** *lyngbyaei-Polygonurn amphibium* (Thomas 1957) *Carex pluriflora* (Vince and Snow 1984) *Carex plurifora-C. lyngbyaei* (Hanson 1951, Ritchie and others 1981, Rosenberg 1986) *Carex pluriflora-Triglochin palustris* (Crow 1977b) *Carex pluriflora-Deschampsia beringensis* (Crow 1977b) *Carex rariflora-Salix ovalifolia-Empetrum nigrum* (Byrd and Ronsse 1983, Hanson 1951) *Eleocharis palustris* (Crow 1977b, del Moral and Watson 1978) *Scirpus paludosus* (McCormick and Pichon 1978, Neiland 1971b, Quimby 1972)
	j. Subarctic lowland sedge bog meadow-develops on peat deposits, sometimes forming quaking sedge mats, in filled lakes, ponds, and depressions throughout the southern two-thirds of Alaska.	*Eriophorum russeolum-E. scheuchzeri* (Wilson and Underwood 1979) *Eriophorum spp.-Menyanthes trifoliata* (Dachnowski-Stokes 1941) *Eriophorum russeolum-Carex kelloggii-Calamagrostis canadensis* (Heusser 1960) *Eriophorum russeolum-Carex limosa-Calamagrostis canadensis* (Cooper 1939, Streveler and others 1973) *Carex limosa-C. chordorrhiza* (Calmes 1976, Drury 1956) *Carex limosaC. capillaris* (Viereck 1970b) *Carexpluriflora* (Hultén 1960) *Carex pluriflora-Eriophorum russeolum* (Bank 1951) *Carex kelloggii-C. canescens* (Shacklette 1961a) *Carex-livida-Menyanthes trifoliata* (Hogan and Tande 1983)

Table 2-Classification for Alaska vegetation (continued)

Level I	Level II	Level- III	Level IV	Level V
III. Herbaceous (continued)	A. Graminoid herbaceous (continued)	(3) Wet graminiod herbaceous (continued)	k. Subarctic lowland sedge-moss bog meadow-occurs on peat soils, including seepage slopes on the Aleutian Islands; on raised bogs, slope bogs, and early stages of flat bogs in southeastern Alaska; and on a variety of peat-filled depressions and floating bogs in south-central and interior Alaska.	*Carex aquatilis-Menyanthes trifoliata/Sphagnum* spp. (Scheierl and Meyer 1977) *Carex aquatilis/Sphagnum riparium* (Luken and Billings 1983) *Carex nigricans-C. limosa/Sphagnum recurvum* (Cooper 1942) *Carex limosa-C. chordorrhiza/Sphagnum* spp. (Calmes 1976; Drury 1956; Hanson 1953, 1958) Carex *limosa-Eriophorum russeolum/Sphagnum* fuscum-S. *papillosum* (Dachnowski-Stokes 1941) *Carex pluriflora-Calamagrostis spp./Sphagnum* spp.[c] (Thomas 1957) Carex chordorrhiza-Menyanthes trifoliata/Sphagnum spp. (Scheierl and Meyer 1977) *Carex canescens-C. magellanica/Sphagnum teres* (Calmes 1976, Drury 1956) *Eriophorum russeolum-Eguisetum fluviatile/Sphagnum* spp. (Racine 1978b) Eriophorum russeolum-Carex rotundata/Sphagnum spp. (Rosenberg 1986) *Eriophorum russeolum-Carex pluriflora/Sphagnum* spp. (Rosenberg 1986) *Eriophorum russeolum-Carex limosa/Sphagnum squarrosum* (Hogan and Tande 1983) *Eriophorum* scheuchzeri-Menyanthes trifoliata/Sphagnum spp. (Heusser 1960) *Trichophorum caespitosum-Eriophorum spp.-Rhynchospora alba/* Sphagnum spp. (Dachnowski-Stokes 1941, Streveler and others 1973) *Rhynchospora alba-Drosera anglica/Sphagnum lindbergii-S. tenellum* (Neiland 1971a) *Carex pluriflora-Eriophorum russeolum/Sphagnum teres-S. magellanicum* (Shacklette and others 1969)
	B. Forb herbaceous	(1) Dry forb herbaceous (herbaceous tundra)	a. Seral herbs-are found throughout Alaska on flood plains, riverbanks, and eroding bluffs.	*Epilobium latifolium* (Scott 1974a, Webber and others 1978) *Epilobium latifolium-Artemisia tilesii* (Batten 1977, Bliss and Cantlon 1957, Johnson and others 1966, Spetzman 1959) *Epilobium latifolium-Crepis nana* (Young 1974b) *Hedysarum alpinum-Artemisia arctica* (Webber and others 1978) *Cochlearia officinalis-Oxyria digyna-Saxifraga rivularis* (Potter 1972) *Cochlearia officinalis-Phippsia algida-Stellaria humifusa* (Webber 1978) *Artemisia arctica* ssp. *comata* (Meyers 1985) Wilhelmsia physodes-Attemisia arctica-Chrysanthemum *arcticum* (Thomas 1951) *Equisetum variegatum* (Helm and others 1984, Young 1974b) *Dryas drummondii-Epilobium latifolium* (Talbot and others 1984)

b. Alpine herb-sedge (snowbed)-includes a wide variety of types below late-lying snowbanks in mountainous areas throughout the State.	*Cetraria delisei-Oxyria digyna-Koenigia islandica-Saxifraga rivularis* (Johnson and others 1966) *Carex lachenalii-Oxyria digyna-Claytonia sarmentosa (Scott* 1974a) *Rhacomitrium canescens-Dicranoweisia cirrata-Oxyria digyna* (Scott 1974a) *Anthelia julacea-Scapania paludosa-Saxifraga hirculus-Leptarrhena pyrolifolia* (Shacklette and others 1969) *Rubus arcticus-Sedum rosea-Polygonurn bistorta-Saxifraga hirculus* (Racine and Young 1978) *Carex nigricans* (Jaques 1973)
c. Alpine herbs-occur as sparse vegetation on talus and blockfields, and in some well-vegetated herbaceous meadows in alpine valleys throughout the State.	*Saxifraga tricuspidata-Draba caesia* (Batten 1977, Johnson and others 1966) *Saxifraga oppositifolia* (Griggs 1936) *Saxifraga oppositifolia-Epilobium latifolium* (Viereck 1963) *Saxifraga tricuspidata-Altemisia arctica* (Webber and others 1978) *Potentilla hyparctica-Cerastium aleuticum-Draba aleutica* (Shacklette and others 1969) *Potentilla villosa-Draba hyperborea-Saxifraga bracteata* (Shacklette and others 1969) *Atiemisia arctica-Potentilla hyparctica-Hierochlog alpina* (Heusser 1954, 1960) *Diapensia lapponica-Saxifraga bronchialis-Sibbaldia procumbens-Trisetum spicatum* (Griggs 1936) *Saxifraga* spp.-Festuca *brachyphylla-Poa glauca-Luzula confusa-Minuartia* spp. (Spetzman 1959) *Oxyria digyna-Saxifraga punctata-Sedum rosea-Primula tschuktschorum* (Fries 1977) *Veronica stelleri-Cassiope lycopodioides-Tofieldia coccinea-Salix rotundifolia* (Shacklette and others 1969) *Carex circinnata-Umbilicaria proboscidea-Agrostis borealis* (Shacklette -and others 1969) *Geum rossii-Silene acaulis-Oxyria digyna* (Friedman 1982) *Hierochloë alpina-Luzula tundricola-Potentilla elegans* (Racine and Anderson 1979)

Footnote on page 54.

Table P-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
III. Herbaceous (continued)	B. Forb herbaceous (continued)	(2) Mesic forb herbaceous (subarctic herbs)	a. Mixed herbs-occur on mesic slopes and streambanks throughout most of the State.	*Fauria crista-galli* (Shacklette 1965) *Fauria crista-galli-Caltha biflora* (Fox 1983, Klein 1965) *Achilles borealis-Arnica unalaschcensis-Claytonia sibirica-Geum calthifolium* (Shacklette and others 1969) *Polygonurn viviparum-Campanula lasiocarpa-Primula cuneifolia-Cardamine umbellata* (Bank 1951) *Epilobium latifolium-Mertensia paniculata-Arctagrostis latifolia* (Anderson 1974) *Aconitum delphinifolium-Aquilegia formosa-Sanguisorba stipulata-Geranium erianthum* (Cooper 1942) *Streptopus amplexifolius-Linnaea borealis-Juncus arcticus* (Bank 1951) *Platanthera spp.-Fritillaria camschatcensis-Polygonum viviparum-Erigeron peregrinus* (Bank 1951) *Athyrium filix-femina-Carex lyngbyaei-Heracleum lanaturn-Geum macrophyllum* (Shacklette and others 1969) *Lupinus arcticus-Aconitum delphinifoiium-Anemone narcissiflora* (Brock and Burke 1980) *Fritillaria camschatcensis-Aconitum maximum-Angelica lucida* (Friedman 1982) *Iris setosa-Dodecatheon pulchellum* (Frohne 1953) *Hedysarum alpinum-Equisetum variegatum* (Crow 1968) *Lupinus nootkatensis-Lathyrus maritimus-Achilles borealis* (Hanson 1951)
			b. Fireweed-occurs on disturbed areas in south-central and interior Alaska.	*Epilobium angustifolium* (undescribed)
			c. Large umbel-occurs on moist to wet areas, often along drainages, in southeastern and south-central Alaska and the Aleutian Islands.	*Heracleum lanaturn-Veratrum viride-Senecio triangularis* (Cooper 1942, Fox 1983) *Heracleum lanaturn-Athyrium filx-femina-Angelica lucida* (Byrd 1984, Friedman 1982) *Artemisia tilesii-Heracleum lanaturn-Elymus arenarius* (Byrd 1984)
			d. Ferns-are restricted to localized areas in southeastern and south-central Alaska and the Aleutian Islands.	*Athyrium filix-femina-Cystopteris fragilis-Botrychium* spp.-*Gymnocarpium dryopteris* (Bank 1951)
		(3) Wet forb herbaceous (wetland herbs)	a. Fresh herb marsh-is found in ponds, sloughs, and oxbow lakes in interior, southwestern, south-central and southeastern Alaska.	*Equisetum fluviatile* (Craighead and others 1988, Racine 1976, Ritchie and others 1981) *Equisetum fluviatile-Menyanthes trifoliata* (Hultén 1966, Racine 1978b, Ritchie and others 1981, Rosenberg 1986) *Equisetum fluviatile-Polygonum amphibium* (Young and Racine 1976)

b. Subarctic lowland herb wet meadow-is found in seepage areas, ephemeral pools, pond margins and upper edges of coastal marshes on the Aleutian Islands and in western, south-central, and southeastern Alaska.	*Equisetum arvense* (Craighead and others 1988, Hultén 1960) *Equisetum arvense-E. variegatum* (Batten and others 1978) *Equisetum arvense-E. variegatum/Philonotis fontana* (Cooper 1939) *Caltha palustris* (Murray 1974) *Caltha palustris-Claytonia sibirica* (Shacklette and others 1969) *Caltha palustris-Sparganium hyperboreum* (Amundsen 1977, Amundsen and Clebsch 1971) *Caltha palustris-Angelica lucida-Platanthera* spp. (Friedman 1982) *Juncus arcticus* (del Moral and Watson 1978, Hanson 1951) *Senecio congestus* (Racine and Anderson 1979) *Parnassia kotzebuei/Philonotis fontana* (Shacklette and others 1969)
c. Subarctic lowland herb bog meadow-commonly forms floating mats or occurs along the margins of bog ponds in interior, south-central, and southeastern Alaska. It also occurs in wet areas above streams in the Aleutian Islands.	*Menyanthes trifoliata* (Dachnowski-Stokes 1941, Griggs 1936, Palmer 1942, Ritchie and others 1981, Rosenberg 1986, Young and Racine 1976) *Menyanthes Crifoliata/Sphagnum* spp. (Racine 1978b, Scheierl and Meyer 1977, Seguin 1977) *Menyanthes trifoliata-Ranunculus pallasii* (Webber and others 1978) *Menyanthes trifoliata-Potentilla palustris* (Griggs 1936, Tande 1983)
d. Halophytic herb wet meadow-occurs on a variety of wet sub-strates (from clays to gravels) on beaches and seaward parts of coastal marshes along the entire Alaska coastline.	*Hippuris vulgaris-Menyanthes trifoliata* (Cooper 1942) *Viola langsdorffii/Sphagnum girgensohnii-Rhytidiadelphus triquetrus* (Bank 1951) Triglochin maritimum (Frohne 1953, Quimby 1972, Ritchie and others 1981) *Triglochin maritimum-Potentilla egedii* (Hanson 1951, Vince and Snow 1984) *Triglochin maritimum-Plantago maritima* (Batten and others 1978, Vince and Snow 1984, Ritchie and others 1981) *Triglochin maritimum-Puccinellia* spp. (Racine 1978b) *Triglochin palustris-Atriplex gmelini* (Neiland 1971b) *Honckenya peploides* (Batten and others 1978, Crow 1977b, Meyers 1985) *Mertensia maritima-Honckenya peploides* (Amundsen and Clebsch 1971, Batten and others 1978, Britton 1967, Griggs 1936, Hanson 1953, Potter 1972, Spetzman 1959, Streveler and others 1973, Thomas 1951) *Cochlearia officinalis* (Wigginsand Thomas 1962) *Cochlearia officinalis-Lathyrus maritimus* (Bank 1951) *Cochlearia officinalis-Puccinellia phryganodes* (Webber and others 1978) *Honckenya peploides-Senecio pseudo-arnica* (Shacklette and others 1969, Young 1971) *Cochlearia officinalis-Fucus distichus* (Batten and others 1978) *Cochlearia officinalis-Achilles borealis* (Byrd 1984) *Plantago maritima-Puccinellia* spp. (Hanson 1951) *Stellaria humifusa* (Meyers 1985)

Table 2-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
	C. Bryoid	(1) Bryophyte	a. Wet bryophyte-occurs on a wide variety of small and localized, mostly wet sites in the southern part of the State.	*Gymnocolea acutiloba* (Shacklette 1961 a) *Scapania paludosa-Nardia compressa* (Shacklette 1965) *Nardia scalaris-Bryum stenotrichum* (Shacklette 1961a) *Pleuroclada albescens* (Shacklette 1961a) *Scapania paludosa-Nardia scalaris-Marsupella emarginata* (Shacklette and others 1969)
III. Herbaceous (continued)	C. Bryoid (continued)	(1) Bryophyte (continued)	b. Dry bryophyte-occurs on gravelly slopes, sand dunes, and mounds.	*Rhacomitrium lanuginosum-Dicranum* spp. (Shacklette and others 1969) *Rhacomitrium lanuginosum-Grimmia apocarpa-Ulota phyllantha* (Shacklette and others 1969) *Andreaea rupestris-Grimmia apocarpa-Rhacomitrium lanuginosum* (Shacklette and others 1969)
		(2) Lichen	a. Crustose lichen-occurs on extremely harsh, dry, windblown rocky sites with little or no soil development primarily in alpine regions throughout Alaska.	*Umbilicaria* spp. (Rausch and Rausch 1968) *Umbilicaria spp.-Rhizocarpon* spp. (Anderson 1974, Hanson 1953, Kessel and Schaller 1960, Klein 1959, Pegau 1968, Rausch and Rausch 1968, Webber and others 1978) *Umbilicaria spp.Parmelia* spp. (Webber and others 1978) *Umbilicaria spp.-Cetraria spp.-Cornicularia spp.-Pseudephebe* spp. (Talbot and others 1984) *Xanthorea candelaria-Ramalina scoparia-R. almquistii* (Shacklette and others 1969) *Lecanora spp.-Parmelia saxatilis-Xanthorea candelaria* (Racine and Anderson 1979)
			b. Foliose and fruticose lichen-occurs on dry fellfields and exposed ridges.	*Cladina stellaris-Sphaerophorus fragilis* (Klein 1959) *Cladonia spp.-Cetraria* spp. (Johnson and others 1966) *Cladonia spp.-Cladina* spp. (Brock and Burke 1980) *Alectoria* spp.-Stereocaulon spp. (Brock and Burke 1980)
	D. Aquatic herbaceous (floating and submerged)	(1) Freshwater aquatic herbaceous	a. Pondlily-in fairly large ponds with mineral substrates. Widely distrib-uted throughout southeastern, south-central;-interior, and western Alaska.	*Nuphar polysepalum* (Dachnowski-Stokes 1941; Griggs 1936; Hogan-and Tande 1983; Heusser 1960; Johnson and Vogel 1966; Palmer 1942; Porsild 1939; Racine 1976, 1978b; Ritchie and others 1981; Tande 1983) *Nuphar polysepalum-Callitriche verna* (Streveler and others 1973) *Nuphar polysepalum-Sparganium angustifolium* (Cooper 1942) *Nuphar polysepalum-lsoëtes muricata* (Shacklette 1961b) *Nuphar polysepalum-Hippuris vulgaris* (Drury 1956, lsleib and Kessel 1973) *Nuphar polysepalum-Potamogeton gramineus* (Rosenberg 1986) *Nuphar polysepalum-Potamogeton* spp. (Talbot and others 1984)

b.	Common marestail-is found in oxbows, tundra ponds, and sluggish sloughs in southeastern, south-central, western, and northern Alaska.	*Hippuris vulgaris* (Potter 1972, Racine 1976, Ritchie and and others 1981) *Hippuris vulgaris-Potamogeton gramineus* (Webber and others 1978) *Hippuris vulgaris-Sparganium hyperboreum* (Hultén 1966, Porsild 1939, Streveler and others 1973) *Hippuris vulgaris-Potentilla palustris* (Spetzman 1959)
C.	Aquatic buttercup-occurs in shallow ponds and flooded gravel pits in south-central, western, and northern Alaska.	*Ranunculus trichophyllus-Hippuris vulgaris* (Friedman 1982, Hanson 1953, Shacklette and others 1969) *Ranunculus trichophyllus-Potamogeton natans* (Seguin 1977) *Ranunculus hyperboreus-R. gmelini-R. trichophyllus* (Johnson and others 1966) *Ranunculus hvperboreus-R. trichophyllus* (Griggs 1936) *Fontinalis neomexicana-Ranunculus trichophyllus* (Bank 1951, Shacklette and others 1969) *Ranunculus trichophyllus* (Streveler and others 1973)
d.	Burreed-occurs in shallow ponds and lakes in southeastern, south-central, western, and northern Alaska.	*Sparganium hyperboreum* (Heusser 1960, Johnson and others 1966, Murray 1974, Spetzman 1959) *Sparganium hyperboreum-Potamogeton perfoliatus* (Hultén 1966) *Sparganium hyperboreum-Potamogeton pectinatus* (Racine 1978b, Young 1974b) *Sparganium hyperboreum-Ranunculus pallasii* (Racine 1976, Racine and Anderson 1979, Wiggins and Thomas 1962, Young 1974b)
e.	Water milfoil-is found in shallow, freshwater ponds in interior, south-central, and western Alaska.	*Myriophyllum spicatum-Potamogeton perfoliatus* (Batten and others 1978, Racine 1976) *Myriophyllum spicatum-Potamogeton* spp. (Dachnowski-Stokes 1941, Ritchie and others 1981, Young 1974b) *Myriophyllum spicatum-Utricularia vulgaris* (Porsild 1939, Racine and Anderson 1979)
f.	Fresh pondweed-is present in small ponds and pools throughout Alaska.	*Potamogeton gramineus-P, alpinus* (Porsild 1939) *Potamogeton berchtoldi-P. alpinus* (Porsild 1939) *Potamogeton pectinatus* (Spetzman 1959) *Potamogeton filiformis-Ruppia spiralis (Cooper* 1939) *Potamogeton perfoliatus* (Ritchie and others 1981)
g.	Water star-wort-has been reported from shallow seasonal pools with rock bottoms on Amchitka Island.	*Subularia aquatica-Callitriche anceps* (Shacklette and others 1969)
h.	Cryptogam-types have been little described but probably are widely distributed in shallow lakes and ponds throughout Alaska.	*Fontinalis antipyretica* (Worley 1972) *Siphula ceratites-Scapania paludosa* (Shacklette and others 1969) *Isoëtes muricata-Ranunculus reptans-Limosella aquatica* (Shacklette and others 1969)

Table 2-Classification for Alaska vegetation (continued)

Level I	Level II	Level III	Level IV	Level V
III. Herbaceous (continued)	D. Aquatic herbaceous (floating and submerged) (continued)	(2) Brackish water aquatic herbaceous	a. Four-leaf marestail-occurs on deltas, tidal flats, and bays along the Alaska coastline.	*Hippuris tetraphylla* (Potter 1972) *Hippuris tetraphylla-Potamogeton pectinatus* (Batten and others 1978) *Hippuris tetraphylla-Potamogeton filiformis-Myriophyllum spicatum* (Crow 1968, Isleib and Kessel 1973) *Hippuris tetraphylla-Potamogeton filiformis* (del Moral and Watson 1978, Thomas 1957)
			b. Brackish pondweed-occurs in permanent brackish ponds in southeastern, south-central, and southwestern Alaska.	*Myriophyllum spicatum-Potamogeton filiformis* (Crow 1968) *Potamogeton filiformis* (Crow 1968) *Potamogeton* spp. (Neiland 1971 b, Palmer 1942) *Potamogeton spp.-Zannichellia palustris* (Rosenberg 1986)
		(3) Marine aquatic herbaceous	a. Eelgrass-occupies subtidal and low intertidal sites with clear water in bays, inlets, and lagoons from southeast Alaska to the Seward Peninsula.	Zostera *marina* (Batten and others 1978, McRoy 1968, Palmer 1942, Roth 1986)
			b. Marine algae-are found on subtidal and intertidal sites, often in exposed rocky areas on the south-central, southeastern, and Aleutian coasts.	Species of *Fucus, Gigartina, Porphyra,* and *Ulva* are important (Batten and others 1978, Druehl 1970, Palmer 1942, Stevens 1965)

[a] Name in parentheses not included in Martin's plant association name.
[b] Winterberger, Kenneth; LaBau, V.J. 1981. Personal communication at workshop on classification of Alaska vegetation, December 3-4, 1981, Anchorage, Alaska.
[c] Neiland, Bonita J. 1976. Unpublished field notes. On file with: University of Alaska Museum-Herbarium, 907 Yukon Drive, Fairbanks, AK 99775-1200.
Reported as *Deschampsia (= Vahlodea) atropurpura* but species identification questionable.

Descriptions of Level I, II, III, and IV Types

I. Forest

Vegetation with at least 10 percent cover of trees. Trees are defined as single-stemmed woody plants at least 3 meters (10 ft) tall at maturity. This classification includes the following tree species: *Picea sitchensis, Tsuga heterophylla, Thuja plicata, Chamaecyparis nootkatensis, Abies amabilis, Abies lasiocarpa, Taxus brevifolia, Picea glauca, Tsuga mertensiana, Picea mariana, Larix laricina, Pinus contorta, Alnus rubra, Populus trichocarpa, Populus balsamifera, Populus tremuloides,* and *Betula papyrifera.*

I.A. Needleleaf Forest

Needleleaf forest communities are dominated by needleleaf (coniferous) tree species. In mixtures with broadleaf trees, needleleaf tree species contribute over 75 percent of the total tree cover.

I.A.1. Closed Needleleaf Forest

Closed needleleaf forest communities have a crown canopy cover of 60 to 100 percent (fig. 3A and B). The tree canopy is comprised of at least 75 percent of needleleaf (coniferous) tree species.

I.A.1.a. Closed Sitka Spruce Forest

Description- Sitka spruce dominates the overstory of these communities, providing 40 to 85 percent cover (fig. 4). Western hemlock may be common, but provides less than 40 percent cover (usually less than 25 percent cover) and is overtopped by the spruce. Other tree species are uncommon. Total canopy cover is 60 percent or more. Seedlings of both western hemlock and Sitka spruce are common, but conditions favor spruce regeneration. Spruce trees in mature stands average 75 to 100 centimeters (30 to 40 in) in diameter at breast height (d.b.h.) and 36 to 67 meters (110 to 220 ft) in height.

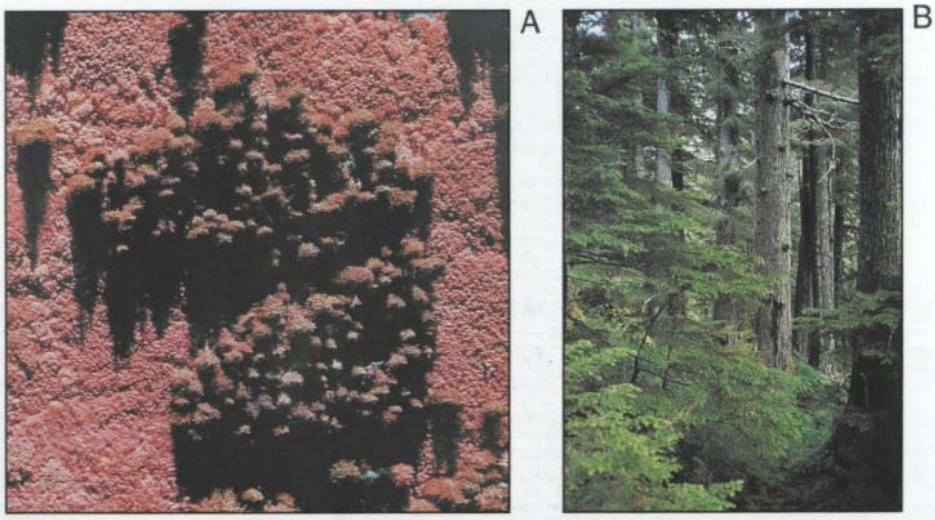


Figure 3—**A.** Aerial photograph of a small clump of closed needleleaf forest of Sitka spruce and western hemlock surrounded by a closed tall shrub stand of *Alnus sinuata* in southeastern Alaska. Color infrared film gives a reddish color for deciduous trees and shrubs. **B**. Closed needleleaf forest of Sitka spruce and western hemlock stand shown in 3A.

Figure 4-Closed needleleaf forest of Sitka spruce with an understory of *Oplopanax horridus, Vaccinium* spp., and mosses from Chichagof Island in southeastern Alaska. (Photograph courtesy Jon Martin.)

A dense shrub layer averages over 70 percent cover. Dominant shrubs are *Oplopanax horridus, Alnus* spp., *Rubus spectabilis, Ribes* spp., *Vaccinium alaskaense,* and *V. ovalifolium.*

The herb layer is commonly dominated by the ferns *Gymnocarpium dryopteris, Dryopteris dilatata,* and *Athyrium filix-femina,* and the herbs *Tiarella trifoliata, Rubus pedatus, Lysichiton americanum, Calamagrostis nutkaënsis,* and *Streptopus* spp. The herb layer cover is usually only moderate, averaging 29 percent cover.

Phases- On coasts subject to salt spray, high winds, and storms, a variant grows in which the shrub layer is sparse or absent and the herb layer is dominated by *Calamagrostis nutkaënsis.* Associated herb species are various but commonly include *Prenanthes alata, Rubus pedatus, Gymnocarpium dryopteris,* and *Cornus* spp. Western hemlock occurs in small quantities or is absent, and the spruce is smaller than in inland stands, averaging 50 to 63 centimeters (20 to 24 in) d.b.h. and 27 to 36 meters (80 to 110 ft) tall. Conifer seedlings are uncommon or absent.

Distribution and site characteristics- Sitka spruce forest occurs primarily at low elevations in southeastern Alaska where it is common on wet, well-drained alluvial fans and flood plains and along a narrow coastal strip. It is also found at mideleva-tions on steep mountain slopes adjacent to channels, along snow avalanche paths, on slopes subject to mass-wasting, and on sites subject to annual deposits of loess. Soils are generally deep, poorly developed, and well drained, with a thin organic layer on the surface.

Successional status- Soil disturbance caused by flooding, salt spray, and ava-lanching seems to be the primary environmental factors allowing the spruce and shrub species, such as *Oplopanax horridus,* to maintain dominance on these sites. These communities seem to represent stable late-seral or climax units.

Closely related types- Closed Sitka spruce communities are similar to closed spruce-hemlock forests but have less hemlock. They also are similar to open Sitka spruce communities but have more trees and less understory diversity.

Photographs- Figure 4, this publication.

Primary reference- Martin and others 1985.

Communities- *Picea sitchensis/Oplopanax horridus-Rubus spectabilis/Cornus canadensis* (Alaback 1980b, Neiland 1971a, Martin and others 1985, Stephens and others 1969). *Picea sitchensis/Oplopanax horrid/Lysichiton americanum* (Martin and others *1985). Picea sitchensis/Oplopanax horridus/Circaea alpina* (Pawuk and Kissinger *1989). Picea sitchensis/Calamagrostis nutkaënsis* (Martin and others 1985).

I.A.1.b. Closed Western Hemlock Forest

Description- These communities are dominated by western hemlock in the overstory (fig. 5). Sitka spruce may be present but provides less than 25 percent (usually much less) of the overstory cover. Total overstory canopy cover ranges from 60 to 100 percent. Other conifer species are uncommon. Mature trees range from 37 to 75 centimeters (14 to 30 in) d.b.h. and are about 24 to 36 meters (70 to 110 ft) tall.

The shrub layer is dominated by some combination of *Vaccinium alaskaense/ ovalifolium, Oplopanax horridus,* and *Menziesia ferruginea.* The shrub layer is generally 1 to 1.5 meters (3 to 5 ft) tall. Common ferns and herbs include *Gymnocarpium dryopteris, Dryopteris dilatata, Athyrium filix-femina, Tiarella trifoliata, Cornus* spp., *Streptopus* spp., and *Rubus pedatus.*

Distribution and site characteristics- Western hemlock communities are widespread in southeastern Alaska where they occur from lowlands to the subalpine on several landforms including inactive alluvial fans and flood plains, footslopes, and steep mountain slopes. Soils usually are deep and well drained with a thin (10 to 15 centimeters [4 to 6 in]) forest floor layer.

Successional status- These communities are usually stable (climax). Some are moderately influenced by periodic surface or by subsurface groundwater flows (Martin and others 1985).

Closely related types--These communities are similar to closed Sitka spruce-western hemlock communities but have less spruce.

Photographs-- Figure 5, this publication.

Primary reference- Martin and others 1985.

Communities- Tsuga *heterophylla/Vaccinium* spp. (Fox 1983, Martin and others *1985). Tsuga heterophylla/Vaccinium spp./Dryopteris dilatata* (Martin and others 1985). *Tsuga heterophylla/Vaccinium spp.-Oplopanax horridus* (LaBau 1981, Marlin and others *1985). Tsuga heterophylla/Oplopanax horridus* (Marlin and others 1985).

Figure 5--Closed needleleaf forest of western hemlock with an understory of *Vaccinium* spp and *Dryopteris dilatata* from southeastern Alaska. (Photograph courtesy Jon Martin.)

I.A. l.c. Closed Sitka Spruce- Western Hemlock Forest

Description- These communities are dominated by Sitka spruce and western hemlock. The spruce provides 35 to 60 percent cover and constitutes most of the overstory. Mature spruce trees generally are 30 to 50 meters (95 to 145 ft) tall and 50 to 100 centimeters (20 to 40 in) d.b.h. Hemlock usually provides an understory 25 to 40 meters (80 to 125 ft) high with 30 to 60 percent cover. Average diameter of mature hemlock is 40 to 65 centimeters (15 to 25 in). Other tree species are uncommon.

A well-developed shrub layer 1 to 1.5 meters (3 to 5 ft) tall is usually present and consists of combinations of *Oplopanax horridus, Vaccinium* spp., and Rubus *spectabilis.* Common ferns and herbs include *Gymnocarpium dryopteris, Dryopteris dilatata, Coptis aspleniifolia, Comus* spp., *Rubus pedatus, Maianthemum dilatatum, Lysichiton americanurn, Tiarella trifoliata,* and *Streptopus* spp.

Distribution and site characteristics- Closed Sitka spruce-western hemlock stands are common in southeastern Alaska and in a narrow coastal strip in south-central Alaska, mostly at low elevations on alluvial fans, flood plains, footslopes, and uplifted beaches. These communities occur on deep, well-drained, well-developed soils on interfluves and on poorly drained, weakly developed soils on lowlands subject to flooding. They also are found at midelevations on steep slopes near periodically active channels and snow avalanche paths and on mass-wasting slopes.

Successional status- sitka spruce-western hemlock communities are climax or near-climax.

Closely related types-These communities are similar to both Sitka spruce communities and western hemlock communities but have substantial quantities of both tree species. They also are similar to open Sitka spruce-western hemlock communities but have greater tree cover.

Primary reference-Martin and others 1985.

Communities- Picea *sitchensis-Tsuga heterophylla/Lysichiton americanum/ Sphagnum* spp. (Alaback 1980b, Neiland 1971a, Stephens and others 1969). *Picea sitchensis-Tsuga heterophylla/Vaccinium spp.-Menziesia ferruginea* (Neiland 1971a, Stephens and others 1969). *Picea sitchensis-(Tsuga heterophy/la)*[1]*/Oplopanax horridus/Lysichiton americanum* (Martin and others 1985). *Picea sitchensis-(Tsuga heterophylla)(see* footnote 1 *)/Vaccinium spp./Oplopanax horridus* (Martin and others 1985). *Picea sitchensis-(Tsuga heterophy//a)(see* footnote *1)/Vaccinium* spp. (Martin and others 1985). *Picea sitchensis-(Tsuga heterophylla)(see footnote 1)/Vaccinium spp./Lysichiton americanurn* (DeMeo and others 1989).

[1] Name in parentheses not included in the plant association name by Martin and others (1985).

I.A. 1.d. Closed Western Hemlock-Sitka Spruce-(Western Redcedar) Forest

Description- These communities are dominated by western hemlock. Sitka spruce is codominant but secondary to the hemlock in cover. Stands often are fairly open, but have about 60 percent overstory cover or more. South of 57° north latitude, western redcedar *(Thuja plicata)* often is included in stands to the point of being codominant. Mature trees range from 38 to 50 centimeters (15 to 20 in) in d.b.h. and from 24 to 30 meters (75 to 90 ft) in height. Western hemlock seedlings are common. A well-developed shrub layer 1 to 1.5 meters (3 to 5 ft) tall is dominated by some combination of *Oplopanax horridus, Vaccinium* spp., *Menziesia ferruginea,* and Rubus *spectabilis.* Common ferns and herbs include *Gymnocarpium dryopteris, Dryopteris dilatata, Rubus pedatus, Tiarella trifoliata,* and *Lysichiton americanum.*

Distribution and site characteristics- These communities are common in southeastern Alaska and in a narrow strip along the coast of south-central Alaska at all elevations below the subalpine zone. They generally occur on steep, stony slopes where the soil is shallow but well drained. Rock outcrops are common. Soils are mineral and often disturbed by periodic surface and subsurface water flows. The forest floor layer is variable in thickness. A distinct microtopography of hummocks and hollows may be present.

Successional status- These are climax communities.

Closely related types- These communities are similar to Sitka spruce-western hemlock communities but have more hemlock and less spruce. They also are similar to Sitka spruce communities and western hemlock communities but differ in that both species are well represented.

Primary reference- Marlin and others 1985.

Communities- Tsuga *heterophylla-Picea sitchensis-(Thuja plicata)/Vaccinium spp./Rhytidiadelphus loreus* (Alaback 1980b, Neiland 1971a, Stephens and others *1969). Tsuga heterophylla-Picea sitchensis-(Thuja plikata)/Lysichiton americanum/ Sphagnum recurvum* (Neiland 1971a). *Tsuga heterophylla-(Picea sitchensis)(see* footnote *[1])/Vaccinium spp./Oplopanax horridus* (Marlin and others 1985). *Tsuga heterophylla-(Picea sitchensis)(see* footnote *1)/Vaccinium* spp./Lysichiton *americanum* (Martin and others 1985).

I.A. 1.e. Closed Western Hemlock-Alaska-Cedar

Description- These communities are dominated by western hemlock and Alaska-cedar *(Chamaecyparis nootkatensis).* Sitka spruce is uncommon, and mountain hemlock *(Tsuga mertensiana)* occurs in minor quantities. Canopy cover is usually at the lower end of the closed category (55 to 70 percent). Mature trees average 24 to 30 meters (75 to 90 ft) tall and 38 to 50 centimeters (15 to 20 in) d.b.h. Hemlock seedlings are abundant: Alaska-cedar seedlings are uncommon.

A well-developed shrub layer 1 to 1.5 meters (3 to 4.7 ft) tall is dominated by *Vaccinium* spp. and *Menziesia ferruginea.* Common ferns and herbs include *Gymnocarpium dryopteris, Blechnum spicant, Cornus* spp., *Rubus pedatus, Coptis aspleniifolia,* and *Lysichiton americanum.*

Distribution and site characteristics- western hemlock-Alaska-cedar communities occur at all elevations below the subalpine zone in southeastern Alaska. They primarily are found on stable mountain slopes, hillslopes, and footslopes where drainage or root growth are impeded. Erosive surface or subsurface water-flow does not occur. Microtopography is sometimes characterized by mounds and depressions. *Lysichiton americanum* is usually restricted to depressions.

Soils are mineral and may be either deep and somewhat poorly drained or shallow and well drained. The most common restricting layers of shallow soils are bedrock, compact till, and compact ash. Soils of localized depressions generally have a thick organic horizon.

Successional status- These communities are thought to be climax. When sites supporting these communities are logged, they tend to come back to *Vaccinium* spp. and *Menziesia ferruginea* if the soil is not seriously disturbed, and to *Alnus sinuata* and *Rubus spectabilis* if the soil has been seriously disturbed.

Closely related types-Closed western hemlock-Alaska-cedar communities are similar to some western hemlock stands but have more yellow-cedar. They also may be similar to some open mixed conifer stands but have slightly greater tree cover and fewer dominant tree species.

Primary reference-Martin and others 1985.

Communities- Tsuga *heterophylla-Chamaecyparis nootkatensis/Vaccinium* spp. (Martin and others 1985). *Tsuga heterophylla-Chamaecyparis nootkatensis/ Vaccinium* spp./Lysichiton *americanum* (Martin and others 1985). *Tsuga heterophylla-Chamaecyparis nootkatensis/Vaccinim spp./Oplopanax horridus* (DeMeo and others 1989).

I.A.1.f. Closed Mountain Hemlock Forest

Description-Mountain hemlock *(Tsuga mertensiana)* dominates the overstory (fig. 6). Sitka spruce may be present but occupies less than 10 percent of the overstory. Western hemlock may occur in the transition zone at the lower elevational extent of these communities. Overstory cover is greater than 60 percent, usually nearer 70 or 75 percent. Mature mountain hemlock trees range from 18 to 25 meters (55 to 75 ft) tall and from 38 to 50 centimeters (15 to 20 in) d.b.h.

A well-developed shrub layer about 1 meter (3 ft) high and providing about 65 percent cover is dominated by *Vaccinium* spp. Common herbs and ferns include *Cornus canadensis, Rubus pedatus, Coptis aspleniifolia, Blechnum spicant,* and *Fauria crista-galli*

Distribution and site characteristics-Mountain hemlock communities occur most often on upper mountain slopes. They also occur to a minor extent at lower elevations in frost pockets and on steep, north-facing mountain slopes. Typical elevations range from 400 to 500 meters (1,300 to 1,600 ft). Slope gradients are steep (on the order of 45 to 60 percent). Soils generally are shallow, poorly to well drained, and weakly to well developed.

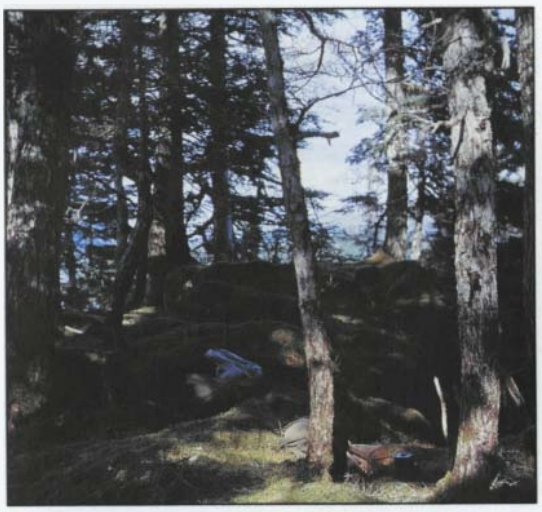


Figure 6-Closed needleleaf forest of mountain hemlock with a sparse understory of *Vaccinium* spp. and a dense forest floor covering of feathermosses in Prince William Sound in south-central Alaska.

Successional status- These communities are thought to be climax. Because they rarely are logged and rarely are affected by windthrow, secondary succession is poorly understood. Because of the dense shrub layer and poor growing conditions at these sites, they probably require substantial time to return to climax condition after disturbance.

Closely related types- Closed mountain hemlock communities are similar to open mountain hemlock communities but have greater canopy cover. At lower elevations, they grade into western hemlock, western hemlock-Alaska-cedar, and western hemlock-western redcedar communities.

Photographs- Figure 6, this publication.

Primary reference- Martin and others 1985.

Communities-- *Tsuga mertensiana/Vaccinium* spp. (Fox 1983, Martin and others 1985).

I.A.7.g. Closed Western Hemlock-Western Redcedar Forest

Description- These stands are dominated by western hemlock and western redcedar. Other tree species of significance include Alaska-cedar and mountain hemlock. A dense shrub layer composed of *Vaccinium alaskaense, V. ovalifolium, V. parvifolium, Menziesia ferruginea, Oplopanax horridus,* and *Gaultheria shallon* is present. *Lysichiton americanum* is common as are patches of *Sphagnum* spp.

Distribution and site characteristics- These stands are common in the southern portion of southeast Alaska (south of Wrangell) on moderately to highly productive sites with somewhat poorly to moderately well-drained soil. The soils may be organic or mineral.

Successional status-These communities appear to be climax. After logging or other disturbance, sites supporting these communities often go through a stage dominated by western hemlock, with small proportions of Sitka spruce and frequently a lodgepole pine component.

Closely related types- These communities are closely related to western hemlock-Alaska-cedar communities but have more western redcedar and less Alaska-cedar. Western hemlock-Alaska-cedar communities often are found north of the range of western redcedar but on sites similar to those occupied by western hemlock-western redcedar farther south. Western hemlock-western redcedar communities also are similar to open mixed conifer communities but have greater arboreal cover and a stronger dominance of western hemlock and western redcedar.

Primary references- Alaback 1980b, Stephens and others 1969.

Communities- Tsuga *heterophylla- Thuja plicata/Vaccinium* spp./Lysichiton *americanum* (Alaback 1980b, Stephens and others 1969).

I.A. 1.h. Closed Silver Fir- Western Hemlock Forest

Description- These stands are dominated by Pacific silver fir *(Abies amabilis)* and western hemlock. Sitka spruce and western redcedar also may be important. Maximum size of silver fir is approximately 115 centimeters (45 in) in diameter and 47 meters (143 ft) in height. A well-developed and productive shrub layer is present and is dominated by *Vaccinium alaskaense.* Other common shrubs include *Menziesia ferruginea* and *Rubus spectabilis.* Common ferns include *Dryopteris dilatata, Athyrium filix-femina,* and *Gymnocarpium dryopteris.* The herb layer consists primarily of *Cornus canadensis* and the low trailing shrub *Rubus pedatus.* Common mosses include *Rhytidiadelphus loreus, Hylocomium splendens,* and *Plagiothecium undulatum.*

Distribution and site characteristics-Silver fir-western hemlock stands are scattered in southernmost southeast Alaska (south of lat. 55°15' N.), primarily on north- and east-facing slopes. They are most common on low- and mid-elevation slopes but sometimes extend from tidewater to tree line. Pacific silver fir shows the strongest dominance in stands in the northern part of its Alaska range.

Successional status- This is a climax forest type. Some stands have been logged in the past and have returned to silver fir codominance.

Closely related types- Pacific silver fir may be present in Sitka spruce-western hemlock stands and western hemlock-Sitka spruce-(western redcedar) stands.

Primary reference- Juday **and** others 1980.

Communities- Abies *amabilis-Tsuga heterophylla* (Juday and others 1980).

I.A. 1.I. Closed Subalpine Fir Forest

Description- These communities are dominated by subalpine fir *(Abies lasiocarpa).* Other important tree species include Sitka spruce, mountain hemlock, and Alaska-cedar. The largest subalpine firs are on the order of 18 meters (55 ft) tall and 45 centimeters (18 in) d.b.h. Most trees are considerably smaller, at least on the island sites. On severely wind-exposed sites, subalpine fir readily forms krummholz by growing in dense mats as low as 15 centimeters (6 in). Sitka spruce and mountain hemlock, on the other hand, when present on these exposed sites, do not as readily form mats but occur as clumps of small trees surrounded by low mats of subalpine fir. Layering appears to be the primary form of reproduction, at least on the island sites. Although abundant cones are formed, the seeds frequently are not viable. Common understory species include *Fauria crista-galli, Cornus canadensis,* and *Phyllodoce aleutica.*

Distribution and site characteristics- Small, widely scattered stands occur on upper slopes and ridges at a few localities in southeastern Alaska. Most of these are on relatively continental sites at the heads of mainland fjords, but a few are in maritime settings on islands. Stands are generally above 460 meters (1,500 ft) in elevation and extend upward to the limit of tree growth, over 945 meters (2,850 ft) in places. Subalpine fir forests are found most commonly on organic soils but also grow well on shallow, stony soils.

Successional status- As far as is known, these are climax stands; the subalpine fir maintains itself primarily by layering. Postdisturbance succession has not been described.

Closely related types- At the upper altitudinal limit of tree growth, the subalpine fir type becomes open and shrublike in form and grades into both an open forest type and a dwarf tree scrub type. At the other extreme, subalpine fir forest can grade into open or closed mountain hemlock and western hemlock-Sitka spruce stands. As trees become even less dense, the vegetation may grade into alpine shrub communities such as mountain heath tundra.

Primary references-- Harris 1965, Worley and Jacques 1973.

Communities- *Abies lasiocarpa-Tsuga mertensiana* (Harris 1965, Worley and Jaques 1973).

I.A.1.j. Closed White Spruce Forest

Description-The closed white spruce forest type represents the best developed, most productive forest sites in the taiga of Alaska (fig. 7). The overstory canopy cover, usually entirely white spruce but occasionally with either scattered paper birch or balsam poplar, can range from 60 to 100 percent. On the best sites, trees reach 30 meters (100 ft) in height and 60 to 90 centimeters (2 to 3 ft) in diameter but average much less and may be only 12 to 15 meters (40 to 50 ft) tall toward the western and northern fringes of the taiga. Tree densities may be as high as 4000 to 5000 per hectare (1,600 to 2,000 per acre) in the younger stands but are usually from 600 to 1000 per hectare (250 to 400 per acre) in the older stands.

Figure 7-Closed needleleaf forest of white spruce with a shrub layer of *Rosa acicularis* and a forest floor layer of *Linnaea borealis* and feathermosses on the flood plain of the Tanana River in interior Alaska.

Because of the dense tree canopy, the tall shrub layer of alders and willows is only sparsely developed and generally contributes little cover. Low shrubs and dwarf shrubs, such as *Vaccinium uliginosum, Ledum groenlandicum, Vaccinium vitis-idaea, Empetrum nigrum,* and *Betula nana,* become common in older stands as the canopy begins to open.

A well-developed moss layer consisting primarily of the feathermosses *Hylocomium splendens, Pleurozium schreberi,* and less commonly, *Rhytidialdelphus triquetrus* is characteristic of these stands. Herbaceous growth is usually sparse but horsetails, primarily *Equisetum sylvaticum* and *E. arvense,* may provide as much as 50 percent cover in flood-plain stands. Other forbs include *Pyrola* spp., *Linnaea borealis, Geocaulon lividum, Mertensia paniculata,* and *Goodyera repens.*

Phases- A phase of this type, with lichens dominating the ground cover, has been reported from southwestern Alaska (Wibbenmeyer and others 1982). In the Porcupine River area of northeastern Alaska, *Shepherdia canadensis* and *Arctostaphylos rubra* are important shrubs and subshrubs in this type on dryer sites.

Distribution and site characteristics- This type is found on the most productive sites throughout the Alaska taiga. It occurs on young river terraces, especially where permafrost is lacking, and on low-elevation slopes with well-drained soils on south, west, or east aspects. The type is most extensive in central Alaska but occurs in isolated small stands along rivers and in warm upland sites nearly to the northern and western tree lines. The soils are usually moderately well drained and lack permafrost or have a deep active layer.

Successional status-The closed white spruce type is considered by many to be the climax vegetation on the well-drained upland and flood-plain sites in much of the Alaska taiga. In the upland, white spruce stands occasionally may regenerate directly after fire, but more commonly white spruce replaces successional hardwood stands of aspen or birch. On the flood plain, white spruce stands usually develop after shrub and balsam poplar stages, and there is considerable evidence that over long periods, perhaps one to two generations, the white spruce stands are replaced by black spruce as permafrost develops on the site.

Closely related types-The closed white spruce forest is similar to the open white spruce type, except that the latter has more shrub cover and the moss layer may be partially replaced by lichens. On some transitional sites in the upland and on the flood plain, a mixture of white and black spruce occurs but with much the same understory vegetation as in the closed white spruce stands. In most publications, the type is referred to as the closed white spruce forest type or the white spruce forest type.

Photographs- Figure 7, this publication.

Primary references- Drury 1956, Foote 1983, Lutz 1956, Viereck and others 1983, Wibbenmeyer and others 1982, Yarie 1983.

Communities- *Picea glauca/feathermosses* (Buckley and Libby 1957; Craighead and others 1988; Drury 1956; Dyrness and others 1988; Viereck 1970a, 1975). *Picea glauca/Alnus tenuifolia/Hy/ocomium splendens* (Dyrness and others 1988). *Picea glauca/Viburnum edule/Equisetum arvense* (Foote *1983). Picea glauca/Linnaea borealis-Equisetum sylvaticum* (Foote *1983). Picea glauca/Rosa acicularis/Linnaea borealis/Hylocomium splendens* (Viereck 1989). *Picea glauca/Rosa acicularis-Shepherdia canadensis/Linnaea borealis* (Yarie 1983). *Picea glauca/Alnus* spp./ *Arctostaphylos uva-ursi* (Yarie 1983). *Picea glauca/Mertensia* spp./Gramineae (Yarie *1983). Picea glauca/Salix spp./Shepherdia canadensis/Arctostaphylos spp./Peltigera* spp. (Yarie 1983). *Picea glauca/Rosa acicularis/Equisetum* spp. (Yarie 1983). *Picea glauca/Shepherdia canadensis/Equisetum* spp. *-Arctostaphylos* spp. (Yarie 1983). *Picea glauca/Alnus crispa/Rosa acicularis/Arctostaphylos rubra* (Yarie *1983). Picea glauca/Rosa acicularis-Shepherdia canadensis/Arctostaphylos rubra-Linnaea borealis* (Yarie 1983).

I.A.1.k. Closed Black Spruce Forest

Description- These forest communities are dominated by black spruce *(Picea mariana)* (fig. 8). White spruce and paper birch may be present but are not very important. Black spruce trees average 9 meters (30 ft) tall and 10 centimeters (4 in) d.b.h. Productivity is very low, trees often requiring 100 years or more to reach average size. Tree density is high with 12,000 to 15,000 stems per hectare (4,900 to 6,070 stems per acre), but volume is low at 177 cubic meters per hectare (2,529 ft^3/acre) and mean annual increment is, at best, only 1.7 cubic meter per hectare (24 ft^3/acre). Black spruce regeneration is usually abundant, primarily from layering of lower branches.

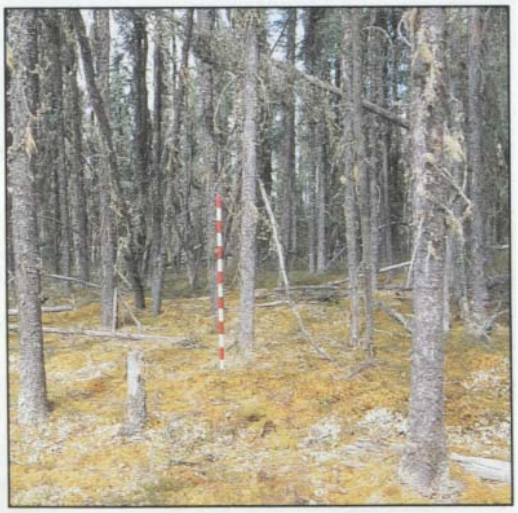


Figure 8-Closed needleleaf forest of black spruce with a thick mat of the feathermosses *Hylocomium splendens* and *Pleurozium schreberi* and foliose lichens, primarily *Peltigera canina* and *P. aphthosa,* in the uplands in interior Alaska.

Patches of *Alnus crispa* several meters high commonly grow intermixed with the black spruce. Common understory shrubs growing 0.5 to 2.0 meters (1.5 to 6 ft) tall include *Rosa acicularis, Salix* spp., and Ledum *groenlandicum.* Common low shrubs include *Vaccinium uliginosum, V. vitis-idaea,* and *Linnaea borealis. Ledum decumbens* and *Empetrum nigrum* may be important locally. The moss layer varies from patchy to continuous and is composed primarily of *Hylocomium splendens* and *Pleurozium schreberi. Sphagnum* spp. may be important on many of the wetter sites. The moss mat is generally about 20 centimeters (8 in) thick, but may be up to a meter (3 ft) thick beneath mounds of sphagnum. Foliose lichens such as *Peltigera aphthosa* and *P. canina* are common.

Most black spruce stands are burned before they are 100 years in age. Older trees are found occasionally, usually as stringers or islands within younger stands: Older stands have greater cover of mosses and low shrubs and less cover provided by tall shrubs.

Distribution and site characteristics-Closed black spruce forest is found on flood-plain terraces and on level to undulating uplands in interior and south-central Alaska. Soils range from well-drained alluvial gravels to poorly drained Cryaquepts. Permafrost is usually present at depths ranging from 30 centimeters (12 in) to over 1 meter (3 ft) but sometimes is absent from stands growing on coarse alluvium or on shallow soils over bedrock.

Successional status-Many of these stands seem to be stable until they are burned. After fire they eventually return to nearly their original composition. In the long term, they may be transitional between white spruce forests and open black spruce stands common on wetter and colder soils. This transition to open black spruce is probably driven by a tendency for the soil to become more poorly drained and for the permafrost table to rise as the moss mat becomes thicker and the soil becomes colder.

Closely related types-Closed black spruce communities are related to open black spruce communities but have a greater cover of black spruce and a thinner moss layer. They also are related to black spruce dwarf tree scrub communities but have taller trees. They may be similar to some closed black spruce-white spruce stands but are more strongly dominated by black spruce. They may resemble some stands of open or closed spruce-birch mixed forest but with less birch.

Photographs- Figure 8, this publication.

Primary references- Foote 1983, Neiland and Viereck 1977, Viereck and others 1983, Yarie 1983.

Communities- Picea mariana/feathermosses (Drury 1956, Lutz 1956, Neiland and Viereck 1977, Viereck 1975). *Picea mariana/Rosa acicularis/Peltigera* spp. (Foote 1983, La Roi 1967). *Picea mariana/Ledum decumbens/Vaccinium vitis-idaeal Cladonia* spp. (Yarie 1983). *Picea mariana/Rosa acicularis/Equisetum spp./Cladonia rangiferina* (Yarie 1983).

I.A.1.I. Closed Black Spruce-White Spruce Forest

Figure 9--Closed needleleaf forest of mixed black and white spruce with *Equisetum arvense, E. pratense,* and the mosses *Hylocomium splendens* and *Rhytidiadelphus triquetrus* in the herb and moss layers.

Description- These stands have tree cover of more than 60 percent that is almost entirely contributed by black spruce and white spruce (fig. 9). These are slow-growing stands, and the trees rarely exceed 25 centimeters (10 in) d.b.h. and 24 meters (75 ft) tall, even at 100 to 200 years of age. White spruce is often older and larger than the black spruce in these stands. A few paper birch trees may be present, but they do not provide significant cover. Reproduction is usually abundant and primarily black spruce, but occasionally numerous white spruce seedlings occur. On some sites, reproduction may be nonexistent or consist of only a few birch seedlings.

The shrub layer generally is weakly developed. *Alnus crispa* and willows several meters tall usually are present. Other understory shrubs growing less than 1.5 meters (5 ft) tall include *Rosa acicularis, Viburnum edule, Ledum groenlandicum, Vaccinium uliginosum, V. vitis-idaea, Ribes* spp., and sometimes *Empetrum nigrum. Equisetum* sylvaticum frequently dominates the ground layer of flood-plain stands. Cornus *canadensis* and *Linnaea borealis* are common herbs. A thick layer of feathermosses usually is present, generally dominated by *Rhytidiadelphus triquetrus* and *Hylocomium splendens. Sphagnum* spp. may be important locally.

Phases- At high elevations, *Betula nana* and *Arctostaphylos rubra* may be important shrubs. *Aulacomnium* spp. and fruticose lichens dominate the moss and lichen layer.

Distribution and site characteristics- Closed black spruce-white spruce forests are common near the northern and western limits of trees, on flood-plain terraces in interior Alaska, and at the bases of south-facing slopes. Soils generally are poorly drained silts with a surface horizon about 10 centimeters (4 in) thick that is overlain by a decimeter or two of organic remains and the living moss mat. Soil pH is usually slightly acid (6.5) to neutral. Permafrost is often present at depths of 50 to 60 centimeters (20 to 24 in). These communities occasionally are found on moderately well-drained soil, but permafrost is almost always present.

Successional status- On flood-plain terraces, these communities generally are transitional between closed white spruce stands on well-drained soils of the younger terraces and open black spruce stands on poorly drained soils of older terraces. Soil organic matter, depth to permafrost, and drainage are intermediate between the white spruce and black spruce communities.

Closely related types- Closed black spruce-white spruce stands can resemble both open and closed stands of both white spruce forest and black spruce forest, depending on the proportion of the two species and the density of the tree cover.

Photographs- Viereck 1970a, figure 5; figure 9, this publication.

Primary references- Viereck 1970a, Viereck and others 1983, Yarie 1983.

Communities- *Picea mariana-P.* glauca/feathermosses (Foote 1983; La Roi 1967; Neiland and Viereck 1977; Viereck 1970a, 1975). *Picea glauca-P. mariana/Salix* spp./Arctostaphylos spp. (Yarie 1983). *Picea glauca-P. mariana/Salix* spp./Vaccinium *vitis-idaea/Hy/ocomium splendens* (Yarie *1983). Picea glauca-P. mariana/Salix* spp./ *Vaccinium* vitis-idaea/lichens (Yarie 1983). *Picea mariana-P. glauca/Salix* spp./Ledum *decumbens/Empetrum nigrum* (Yarie 1983). *Picea mariana-P. glauca/Salix* spp./ *Potentilla fruticosa/Rubus arcticus-Arctostaphylos* spp. (Yarie 1983).

I.A.2. Open Needleleaf Forest

Open needleleaf forest communities have from 25 to 60 percent tree crown canopy cover. When mixed with broadleaf tree species, needleleaf (coniferous) trees contribute at least 75 percent of total tree cover (fig. 10, A and B).

I.A.2.a. Open Sitka Spruce Forest

Description- Large Sitka spruce dominate the overstory and provide 35 to 55 percent cover (fig. 11). Small amounts of western hemlock may occur, but other conifer species are rare. Mature spruce range in height from 29 to 49 meters (95 to 160 ft) and from 51 to 102 centimeters (20 to 40 in) in d.b.h. Seedlings of both western hemlock and Sitka spruce may occur, but survival is limited. *Alnus rubra* or *A. sinuaia* usually dominate a tall shrub layer 3 to 12 meters (10 to 40 ft) in height and provide 15 to 40 percent cover.

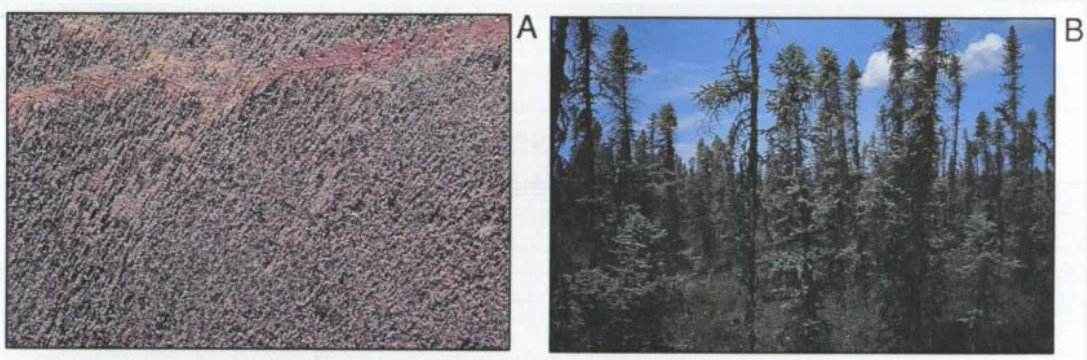


Figure 10-A. Aerial photograph of open needleleaf forest of black spruce in interior Alaska. B. Ground view of open needleleaf forest of black spruce shown in A.

Figure 11-Open needleleaf forest of Sitka spruce with an understory of *Oploplanax horridus* from Baranof Island in southeastern Alaska. (Photograph courtesy jon Martin.)

A lower well-developed shrub layer about 2 meters high is dominated by Oplopanax *horridus, Rubus spectabilis, Ribes* spp., and *Vaccinium* spp. Common ferns and herbs include *Gymnocarpium dryopteris, Athyrium filix-femina,* and *Tiarella trifoliata.*

Distribution and site characteristics- Open Sitka spruce forest occurs most often at low elevations on active alluvial fans and flood plains. It is sometimes also present at midelevations on steep mountain slopes adjacent to active channels and on active snow avalanche paths. The soils are generally deep, well drained, and weakly developed. The surface organic layer is thin because of frequent disturbance by water flow, snow movement, or mass-wasting. The mineral horizons are mixed, thereby reflecting their alluvial or colluvial origin.

Successional status- Open Sitka spruce (spruce/alder) communities appear to be stable over long periods of time. Periodic severe hydrologic disturbance seems to be the main environmental factor allowing spruce and alder to share dominance on these sites. Alder and *Rubus spectabilis* dominate these sites after clearcut logging. Conifers are slow to establish because of the thick shrub cover and the frequent disturbance of soil by mass movement.

Closely related types- These communities are similar to some closed tall alder scrub communities but have a substantial overstory of Sitka spruce. They also are similar to closed Sitka spruce communities but with less canopy cover.

Photographs- Figure 11, this publication.

Primary reference- Martin and others 1985.

Communities- *Picea sitchensis/Alnus sinuata/Calamagrostis canadensis* (Viereck 1979, Worley 1977). *Picea sitchensis/Alnus* spp. (Martin and others 1985).

I.A.2.b. Open Western Hemlock-Sitka Spruce Forest

Description- These communities have an open overstory dominated by western hemlock and Sitka spruce (fig. 12). Total tree cover is usually in the range of 45 to 65 percent with most of it provided by hemlock, but Sitka spruce provides at least 25 percent of the canopy cover. Mature western hemlock range from 21 to 27 meters (70 to 90 ft) tall and from 38 to 64 centimeters (15 to 25 in) d.b.h. Mountain hemlock may occur but generally in small quantities. Mature spruce average 29 meters (95 ft) in height and 64 centimeters (25 in) in d.b.h. A well-developed shrub layer 1 to 1.5 meters (3 to 5 ft) tall is dominated by *Oplopanax horridus, Vaccinium* spp., *Menziesia ferruginea,* and *Rubus spectabilis.* Common herbs are *Lysichiton americanum, Rubus pedatus,* and *Athyrium filix-femina.*

Figure 12-Open needleleaf forest of western hemlock with scattered Sitka spruce, scattered *Oplopanax horridus* in the shrub layer, and conspicuous *Lysichiton americanum* in the herb layer on Chichagof Island in southeastern Alaska. (Photograph courtesy Jon Marlin.)

Distribution and site characteristics- open hemlock-spruce communities are commonly found on slopes of less than a 30-percent gradient from midelevation to lower elevations. Common landforms supporting these communities include footslopes, mountainside benches, and concave slopes. Thick organic soils and surface and subsurface water flow characterize sites where these communities are found. Sites with understories dominated by *Oplopanax horridus* have a greater water runoff than those where *Lysichiton americanum* dominates. Soils are deep, poorly drained, and weakly developed and have a thick surface organic layer of 15 to 30 centimeters (6 to 12 in).

Successional status- Successional relations are largely unknown. Conifer seedlings do not seem to grow well on the poorly drained organic soils.

Closely related types- These communities are similar to closed western hemlock-Sitka spruce communities, the closed Sitka spruce-western hemlock communities and some closed western hemlock communities but canopy cover averages less than 60 percent. They also are similar to some open mixed-conifer communities, but are more strongly dominated by western hemlock and Sitka spruce.

Photographs- Figure 12, this publication.

Primary reference- Martin and others 1985.

Communities-- Tsuga *heterophylla-(Picea sitchensis)(see* footnote *1)/ Oplopanax horridus/Lysichiton americanum* (Martin and others 1985).

I.A.2.c. Open Mountain Hemlock Forest

Description-Mountain hemlock dominates the overstory of these forest communities by providing 15 to 60 percent cover (fig. 13). Overstory trees average 9 to 21 meters (30 to 70 ft) in height and 25 to 50 centimeters (10 to 20 in) in d.b.h. Mountain hemlock seedlings are generally common to abundant. Other conifer species, particularly Sitka spruce, may occur occasionally but are not important.

A well-developed shrub layer is present and is dominated by some combination of *Vaccinium alaskaense, V. ovalifolium, Menziesia ferruginea,* and *Cladothamnus pyrolifolia.* These shrubs grow 1 to 1.5 meters (3 to 5 ft) tall and provide 50 to 70 percent cover. In some communities, a layer of low alpine shrubs dominated by some combination of *Cassiope mertensiana, C. stelleriana, Phyllodoce aleutica* spp. *glanduliflora,* and *Luetkea pectinata* is present.

Figure 13-Open needleleaf forest of mountain hemlock with understory of *Vaccinium* spp. and *Cassiope mertensiana* in southeastern Alaska. (Photograph courtesy Jon Martin.)

A layer of herbs and ferns provides 40 to 60 percent cover. Common species include *Rubus arcticus, Coptis aspleniifolia, Veratrum viride, Cornus canadensis,* and *Fauria crista-galli* In some communities, sedges (including *Carex aquatilis, C. nigricans,* and *Trichophorum caespitosum)* may be common. In others, ferns (primarily *Blechnum spicant)* may be present.

Distribution and site characteristics-Mountain hemlock communities are found in south-central and southeastern Alaska. They primarily occupy sites at high elevations on upper mountain slopes but also may be found in isolated frost pockets or on steep north slopes at low elevations. They become increasingly common at low elevations near the western limit of the range of this type. Soils are shallow and often rather poorly drained. Soils may be either predominately mineral or organic.

Successional status-These communities are stable over long periods. They are rarely disturbed, either naturally or by humans; therefore, secondary succession patterns are unknown.

Closely related types-These communities are similar to closed mountain hemlock communities but have less than 60 percent tree cover. Some of these communities are similar to mountain-heath tundra communities dominated by species of *Phyllodoce, Cassiope,* and *Luetkea.*

Photographs- Figure 13, this publication.

Primary reference- Martin and others 1985.

Communities-- *Tsuga mertensiana/Vaccinium* spp. -*Cassiope mertensiana* (Alaback 1980b, Jaques 1973, Martin and others 1985). *Tsuga mertensianalvaccinium spp.-Cladothamnus pyrolaeflorus/Fauria crista-galli* (Alaback 1980b, DeMeo and others 1989, Martin and others 1985, Pawuk and Kissinger 1989, Stephens and others 1969).

I.A.2.d. Open Mixed Conifer Forest

Description-These communities are dominated by various combinations of Alaska-cedar *(Chamaecyparis nootkatensis),* western hemlock, mountain hemlock, and Sitka spruce (fig. 14). Lodgepole pine *(Pinus contorta)* may be a minor constituent of the overstory. At the southern end of southeast Alaska, western redcedar *(Thuja plicata)* and Pacific *yew (Taxus brevifolia)* also may be present. Overstory cover ranges from 25 to 50 percent, with height averaging 11 to 24 meters (35 to 80 ft) and d.b.h. averaging 25 to 50 centimeters (10 to 20 in). Spruce and hemlock seedlings are usually abundant; cedar seedlings are uncommon.

Figure 14-Open needleleaf forest of several conifer species, an understory of Vaccinium spp., and Fauria *crista-galli* in the herb layer in southeastern Alaska. (Photograph courtesy Jon Martin.)

The shrub layer is dominated by some combination of *Vaccinium alaskaense, V. ovalifolium, Menziesia ferruginea,* and *Gaultheria shallon.* This layer is 1 to 1.5 meters (3 to 5 ft) tall,and is variable in its density; it provides from 20 to 80 percent cover. In some areas, a low shrub layer dominated by *Empetrum nigrum* is present.

Common species in the herb layer include *Lysichiton americanum, Comus canadensis, Coptis aspleniifolia, Tiarella trifoliata, Fauria crista-galli, Carex* spp., *Blechnum spicant, Athyrium filix-femina,* and *Gymnocarpium dryopteris.* Total herb cover ranges from 40 to 80 percent.

Distribution and site characteristics- These communities are common in southeast Alaska on nearly level sites, hilltops, benches, lowlands, and valley bottoms, as well as gentle slopes. Soils are wet and poorly drained; they are either organic or have thick organic surface horizons.

Successional status-- These communities are stable and slow to change. Because they are rarely disturbed, secondary succession patterns leading to these communities are unknown. Tree growth rate on these sites is low; therefore, recovery from severe disturbance undoubtedly would be slow.

Closely related types- Some of these communities resemble open mountain hemlock or open western hemlock-Sitka spruce stands, but they have a greater diversity of overstory tree species and are less strongly dominated by mountain hemlock or western hemlock and Sitka spruce. At the other extreme, some stands may resemble lodgepole pine woodlands but have greater overstory cover (greater than 25 percent), a greater diversity of overstory species, and a greatly reduced dominance of lodgepole pine. Open mixed conifer forest also may resemble certain shrubby bog types but is differentiated by greater cover of trees.

Photographs- Figure 14, this publication.

Primary reference-Martin and others 1985.

Communities- Tsuga *heterophylla-Chamaecyparis nootkatensis-Tsuga mertensianal* Picea sitchensis/Vaccinium spp./Lysichiton *americanum* (Martin and others 1985). *Tsuga heterophylla-Chamaecyparis nootkatensis-Tsuga mertensiana-Picea sitchensis/ Lysichiton americanum-Athyrium filix-femina* (Martin and others 1985). *Chamaecyparis nootkatensis-Tsuga mertensiana-Tsuga heterophylla-Picea sitchensis-Pinus contorta/ Vaccinium spp./Fauria crista-galli* (Martin and others 1985).

I.A.2.e. Open White Spruce Forest

Description- These stands are dominated by white spruce with total tree cover in the range of 25 to 60 percent (fig. 15). Trees are relatively small but variable in size. The largest trees are typically about 16 meters (50 ft) in height and 30 centimeters (12 in) d.b.h. Black spruce, paper birch, and aspen may be present but do not provide much cover. A shrub layer dominated by *Betula glandulosa* 1 to 2 meters (3 to 6 ft) tall is usually well developed. Alder *(Alnus crispa* or *A. sinuata)* and willows (primarily *Salix planifolia* and *S. lanata)* are common locally, especially on wetter sites. Low shrubs such as *Shepherdia canadensis* and *Rosa acicularis* may be present, particularly on lowland sites. Common herbs include *Linnaea borealis, Equisetum* spp., and *Calamagrostis canadensis.* Beneath the tall shrubs is a nearly continuous layer of feathermosses, primarily *Pleurozium schreberi* and *Hylocomium splendens.*

Figure 15-Open needleleaf forest of white spruce with a shrub layer of *Alnus crispa, A. tenuifolia,* and *Rosa acicularis;* the low subshrub *Vaccinium vitis-idaea* on the forest floor; and a thick feathermoss layer on the flood plain of the Tanana River in interior Alaska.

Phases- On moist lowland sites in the Yukon Flats, willows (particularly *Salix bebbiana)* may replace Betula glandulosa as the dominant shrub. The ground cover may be dominated by foliose lichens such as *Parmelia* spp. and *Peltigera* spp. Feathermosses are important associates.

Sphagnum replaces feathermosses in the ground layer on many sites in south-western Alaska because of the abundant precipitation and poor soil drainage.

Distribution and site characteristics- Open white spruce communities are common on well-drained timberline sites and occasionally occur on certain somewhat poorly drained to well-drained lowland sites. They are found throughout interior, northwest, southwest, and south-central Alaska. Soils are commonly Cryaquepts, Cryochrepts, or Cryofluvents and range from somewhat acid to almost basic. Permafrost may be present or absent; but if present, it is generally deeper than 70 centimeters (30 in). Brooks Range tree-line stands commonly are on stream and river terraces or alluvial fans where silts overlie alluvial gravels.

Successional status- Most stands appear to be stable and some are very old (up to 250 years). Tree-line stands, in particular, are probably climax. Successional sequences after disturbance are unknown. Some tree-line stands would remain unforested for long periods of time if severely disturbed.

Closely related types- These communities are similar to closed white spruce and white spruce woodland communities but differ in the amount of tree cover present (25 to 60 percent for open white spruce communities). Some stands may be similar to open black spruce-white spruce or open white spruce-paper birch communities, but have less black spruce or paper birch. Some stands are similar to certain scrub communities but have at least 25 percent tree cover.

Photographs- Figure 15, this publication.

Primary references- Viereck 1970b, 1979; Yarie 1983.

Communities- Picea *glauca/Alnus tenuifolia/Hylocomium splendens* (Dyrness and others 1988). *Picea glauca/Alnus crispa-A. tenuifolia/Vaccinium vitis-idaeal Hylocomium splendens* (Dyrness and others 1988, Viereck 1989). *Picea glauca/ Alnus tenuifolia/Calamagrostis canadensis-Vaccinium vitis-idaea* (Dyrness and others 1988). *Picea glauca/Betula glandulosa/Hylocomium splendens* (Hettinger and Janz 1974; Viereck 1970b, 1975, 1979; Williamson and Peyton 1962). *Picea glauca/Betu/a glandulosa/Sphagnum* spp. (Hettinger and Janz 1974; Viereck 1970b, 1975, 1979; Williamson and Peyton 1962). *Picea glaucaBetula glandulosa/Cladonia* spp. (Racine and Anderson 1979, Viereck *1979). Picea glauca/Salix bebbiana/Rosa acicularis/ Equisetum spp.-Epilobium* spp./lichens (Yarie 1983). *Picea glauca/Salix* spp./ *Shepherdia canadensis/Vaccinium vitis-idaea* (Yarie *1983). Picea glauca/Salix* spp./Ledum *decumbens/Vaccinium vitis-idaea* (Yarie 1983). *Picea glauca/Alnus crispa-Salix spp./Equisetum arvense* (Craighead and others 1988). *Picea glauca/ Vaccinium* spp.-Salix *spp./Equisetum arvense* (Craighead and others 1988). *Picea glauca/Sa/ix spp./Equisetum arvense* (Craighead and others 1988). *Picea glauca/ Salix* spp./feathermosses (Craighead and others 1988). *Picea* glauca/feathermosses (Craighead and others 1988). *Picea glauca/Alnus* crispa/feathermosses (Craighead and others 1988). *Picea glauca/Alnus crispa-Salix spp./Vaccinium uliginosum/* feathermosses (Craighead and others 1988). *Picea glauca/Betula nana-Vaccinium* uliginosum/feathermosses (Craighead and others 1988).

I.A.2.f. Open Black Spruce Forest

Description-Open black spruce forest is generally dominated by small black spruce trees 3 to 9 meters (9 to 30 ft) tall and 4 to 7 centimeters (1.5 to 3 in) d.b.h. growing at densities of 1200 to 3700 stems per hectare (480 to 1,500 stems per acre) (fig. 16). Stands over 100 years old occasionally are found; however, most stands are younger. In older stands the trees are larger (up to 18 centimeters [7 in] d.b.h. and 17 meters [56 ft] tall) and grow less densely. Black spruce seedlings and saplings are common in some stands; in others, reproduction is primarily by layering. Other tree species that may be present in minor quantities include paper birch, white spruce, and tamarack *(Larix laricina).*

An open to nearly continuous cover of low shrubs 10 to 100 centimeters (4 to 39 in) tall is characteristic of these communities. Common shrubs include *Vaccinium uliginosum, V. vitis-idaea, Ledum groenlandicum,* and sometimes *Rosa acicularis, Potentilla fruticosa, Empetrum nigrum* and *L. decumbens.* The tall shrubs *Alnus crispa, Betula glandulosa,* and *Salix* spp. also occur in some stands. Common herbs include *Calamagrostis* spp., *Equisetum sylvaticum, Rubus chamaemorus, Eriophorum vaginatum,* and *Carex bigelowii.* The ground layer generally is dominated by feather-mosses (commonly *Pleurozium schreberi* and *Hylocomium splendens),* though *Polytrichum* spp., *Sphagnum* spp., and fruticose and foliose lichens are usually present and may be dominant in some stands.

Distribution and site characteristics-Open black spruce forests are extremely common on vast areas of poorly drained, cold terrain in interior and south-central Alaska. Soils are usually Histic Pergelic Cryaquepts and sometimes Cryochrepts. Permafrost usually is present at depths of 30 to 60 centimeters (12 to 24 in) but may be absent in the southern part of the State and where the soil is shallow over bedrock. The forest floor layer is usually 5 to 20 centimeters (2 to 8 in) thick but sometimes is over 1 meter (3 ft) thick.

Figure 16-Open needleleaf forest of black spruce with a shrub layer of *Betula glandulosa, Ledum groenlandicum,* and Vaccinium *uliginosum* and a thick moss mat of the feathermosses *Hylocomium splendens* and *Pleurozium schreberi* in the uplands of interior Alaska.

Successional status—These communities are climax on cold, poorly drained sites. They burn frequently, and stands older than 100 years are rare. Postfire succession is complex and ranges from direct re-establishment of black spruce to successional seres involving various moss-herb, shrub, and tree communities.

Closely related types- Open black spruce communities are intermediate in tree cover between closed black spruce communities and black spruce woodland communities. In some areas, additional tree species such as paper birch, white spruce, tamarack, or quaking aspen (Populus tremuloides) occur in black spruce communities but provide little cover. As the cover of these other tree species increases, the vegetation grades into communities where dominance is shared by black spruce and the associated species (black spruce-white spruce, aspen-spruce, and so forth). Scrubby stands of open black spruce are similar to open black spruce dwarf tree scrub communities.

Photographs- Figure 16, this publication.

Primary references- Foote 1983, Viereck and others 1983, Yarie 1983.

Communities- Picea *mariana/Vaccinium* spp./feathermosses (Drury 1956; Foote 1983; Lutz 1956; Viereck *1975, 1979). Picea mariana/Ledum groenlandicum/ Hylocomium splendens* (Viereck 1989). *Picea* mariana/feathermosses-Cladonia spp. (Foote 1983; Viereck *1975,* 1979). *Picea mariana/Betula glandulosa-Ledum decumbens/Sphagnum* spp. (Dachnowski-Stokes 1941, Drury 1956, Dyrness and Grigal 1979, Neiland and Viereck *1977). Picea mariana/Alnus tenuifolia/Betula nana-Ledum decumbens/Sphagnum* spp. (Batten and others 1978, McCormick and Pichon 1978). *Picea mariana/Arctostaphylos rubra-Empetrum nigrum/Cladonia* spp. (Yarie 1983). *Picea mariana/Betula nana-Potentilla fruticosa/Carex* spp. (Yarie 1983). *Picea mariana/Betula nana-Carex* spp. (Yarie 1983). *Picea mariana/Alnus crispa/ Betula nana/Vaccinium spp./Cladonia* spp. (Yarie *1983). Picea mariana/Vaccinium uliginosum/Empetrum* nigrum/lichens (Yarie 1983). *Picea mariana/Vaccinium uliginosum/Arctostaphylos rubra/Dicranum* spp. (Yarie *1983). Picea mariana/Salix spp./Potentilla fruticosa/Arctostaphylos rubra/Peltigera* spp. (Yarie *1983). Picea mariana/Betula* glandulosa/feathermosses (Jorgenson and others 1986).

I.A.2.g. Open Black Spruce-White Spruce Forest

Description-These open stands are made up of black spruce and white spruce as codominants. Total arboreal cover is between 25 and 60 percent. Paper birch and quaking aspen may be present in small amounts. The trees tend to be small; the largest trees are about 5 to 10 centimeters (2 to 4 in) d.b.h. and 6 to 10 meters (18 to 30 ft) tall. Tree reproduction may be either black spruce or white spruce, or a mixture. A well-developed tall shrub layer dominated by *Betula glandulosa* 1 to 2 meters (3 to 6 ft) high often is present, especially at sites near treeline. Other tall shrubs locally important on moist sites include *Alnus crispa, A. sinuata, Salix* spp., and *Rosa acicularis.* A low shrub layer usually is present and consists primarily of some combination of *Vaccinium uliginosum, V. vitis-idaea, Potentilla fruticosa, Arctostaphylos rubra, Empetrum nigrum,* and *Ledum* spp. Grasses and sedges may be common, especially in young stands, but in other stands herbs may be scarce. The moss layer is continuous or nearly **so and** dominated by a combination of *Hylocomium splendens, Pleurozium schreberi, Polytrichum* spp., and *Dicranum* spp. Lichens such as *Cladonia* spp. are important on some sites.

Distribution and site characteristics- open black spruce-white spruce forests are found at tree line, especially in the Yukon-Tanana uplands and on the northern slopes of the Alaska Range. These tree-line stands are similar to the more common tree-line stands of open white spruce forest but have a significant admixture of black spruce. Open black spruce-white spruce forests are occasionally found at lower elevations and have been reported from the Porcupine Plateau in northeastern Alaska. Soils are Pergelic Cryaquepts and Pergelic Cryochrepts. Permafrost usually is present at depths of 60 centimeters or more but is absent from some soils.

Successional status- Many stands, particularly those near tree line, may be climax or at least stable. Others may be in the process of changing from closed white spruce forests to black spruce forests in response to increasing organic layer thickness, a rising permafrost table, decreasing soil temperature, and decreasing soil drainage. Succession after disturbance on these sites has not been adequately described.

Closely related types- Open black spruce-white spruce forests may resemble closed black spruce-white spruce forests and black spruce-white spruce woodlands but have roughly 25 to 60 percent tree cover. They also may be similar to open white spruce forests and open black spruce forests, but have significant amounts of both species.

Primary references- Viereck 1979, Yarie 1983.

Communities- Picea *glauca-P. mariana/Ledum groenlandicum-Vaccinium vitis-idaea/Pleurozium schreberi* (Viereck *1989). Picea mariana-P. glauca/Betula glandulosa* (Viereck *1979). Picea glauca-P. mariana/Vaccinium uliginosum/ Arctostaphylos rubra/Dicranum* spp. (Yarie *1983). Picea mariana-P. glauca/Betula nana/Arctostaphylos rubra-Vaccinium uliginosum* (Yarie *1983). Picea mariana-P. glauca/Ledum decumbens/Petasites spp./Dicranum* spp. (Yarie 1983). *Picea mariana-P. glauca/Shepherdia canadensis/Epilobium* spp./Peltigera spp. (Yarie 1983). *Picea glauca-P. mariana/Vaccinium uliginosum-Carex bigelowii* (Craighead and others 1988). *Picea mariana-P. glauca/Rubus chamaemorus-Ledum decumbens-Vaccinium spp.* (Craighead and others 1988).

I.A.2.h. Open Black Spruce-Tamarack Forest

Description-- Open forest stands dominated by black spruce and tamarack are known to exist, but descriptions have not been published (fig. 17). The trees are small and stunted; the understory is similar to that of open black spruce forest.

Distribution and site characteristics- Black spruce-tamarack stands are found on wet lowlands in interior Alaska with a shallow active layer above permafrost.

Successional status- The successional status of these stands is unknown, but they appear to be stable.

Closely related types- Open black spruce-tamarack stands are similar to open black spruce stands but with a significant tamarack component.

Photographs- Figure 17, this publication.

Figure 17-Open needleleaf forest of tamarack and black spruce with a shrub layer of Betula *glandulosa* and *Ledum groenlandicum* and a moss cover of feathermosses and sphagnum mosses on an old river terrace in interior Alaska.

Primary reference- None.

Communities-- *Picea mariana-Larix laricina* (undescribed).

I.A.3. Needleleaf Woodland

Needleleaf woodland communities have from 10 to 25 percent total tree canopy coverage (fig. 18, A and B). Needleleaf (coniferous) tree species make up at least 75 percent of the total tree canopy.

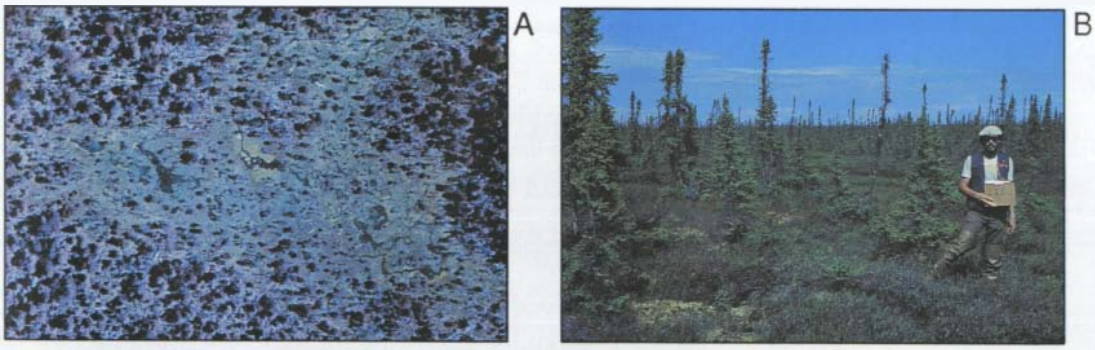


Figure 18-A. Aerial view of needleleaf woodland of black spruce (center of photograph) in interior Alaska. B. Ground view of black spruce needleleaf woodland shown in A.

I.A.3.a. Lodgepole Pine Woodland

Description-- The overstory of these communities is dominated by lodgepole pine (fig. 19). Total tree cover ranges from 10 to 25 percent. Scattered Alaska-cedar, western redcedar, and mountain hemlock also may be present in the overstory. The maximum size of lodgepole pine is about 25 to 40 centimeters (10 to 15 in) d.b.h. and 8 to 11 meters (25 to 35 ft) tall. A discontinuous layer of shrubs 1 to 2 meters (3 to 6 ft) tall is usually present but provides little cover. Important species include *Menziesia ferruginea, Vaccinium alaskaense,* and *V. ovalifolium.* Shrubs usually are rooted on mounds at bases of trees. Dwarf shrubs are more important and provide 15 percent cover or more. Primary low shrub species are *Empetrum nigrum, Vaccinium caespitosum, V. uliginosum, V. vitis-idaea, Kalmia polifolia, Andromeda polifolia, Ledum groenlandicum,* and *Vaccinium oxycoccos.* Common herbs include *Fauria crista-galli, Trichophorum caespitosum, Carex canadensis, Eriophorum angustifolium,* and *Cornus canadensis.* Mosses, including *Sphagnum* **spp.,** are abundant.

Distribution and site characteristics- Lodgepole pine woodlands are common on poorly drained sites at all elevations below the subalpine zone in southeast Alaska. These sites are either level or gently sloping and most commonly occur on lowland plateaus with compact till. Soils are deep, organic, and poorly drained.

Successional status- Lodgepole pine woodlands are climax communities; they change to bogs only slowly as paludification leads to tree death and bog expansion, or as increased drainage enables spruce and hemlock to invade in quantity.

Closely related types- Lodgepole pine woodlands are closely related to open low ericaceous shrub bog communities but have more than lo-percent tree cover. They also are related to some poorly drained open forest types such as open mixed conifer forest.

Photographs- Figure 19, this publication.

Primary references- Martin and others 1985, Neiland 1971.

Communities- *Pinus contorta/Empetrum nigrum* (Martin and others 1985, Neiland 1971a).

Figure 19- Needleleaf woodland of lodgepole pine with a shrub layer of *Menziesia ferruginea* and *Vaccinium* spp; a dwarf shrub layer of *Empetrum nigrum. Vaccinium caespitosum, V. uliginosum, V. vitis-idaea, Kalmia polifolia,* and *Andromeda polifolia;* and an herb layer of *Fauria crista-galli* and *Eriophorum angustifolium* in southeastern Alaska.

I.A.3.b. Sitka Spruce Woodland

Description-- Sitka spruce woodland has an open overstory of stunted Sitka spruce. Tall shrubs are absent. Low shrubs are common and include Vaccinium uliginosum, *Vaccinium oxycoccos, Empetrum nigrum,* and *Andromeda polifolia.* The herb layer is diverse and well represented. *Carex* spp., *Trichophorum caespitosum, Geum calthifolium, Drosera rotundifolia, Fauria crista-galli,* and *Dodecatheon jeffreyi* are abundant. Mosses form a continuous carpet, with *Sphagnum* spp. being the most important components.

Distribution and site characteristics- This type is known only from the Boussole Valley in Glacier Bay National Park. It occurs on gently sloping or undulating valley lowlands on outwash or till where peat accumulates. Soils are organic.

Successional status- These communities apparently are stable. Large, well-decayed stumps are present at several sites.

Closely related types-The Sitka spruce woodland is similar to open ericaceous shrub bogs and may be similar to some sedge-moss bogs. It is, in fact, questionable whether spruce provides more than 10 percent of the cover in these particular stands. If spruce cover is less than 10 percent, then according to our classification, this would be an open ericaceous shrub bog community with scattered, stunted Sitka spruce.

Primary reference- Worley 1977.

Communities- *Picea sitchensis/Vaccinium uliginosum-Trichophorum caespitosum/ Sphagnum fuscum-S. papillosum* (Worley 1977).

I.A.3.c. White Spruce Woodland

Description- These communities have 10 to 25 percent tree cover and are dominated by white spruce (fig. 20). Paper birch, black spruce, and occasionally aspen may be present on some sites, but they provide little cover. An open shrub layer dominated by *Betula glandulosa* is common. The ground layer beneath the shrubs is dominated by feathermosses, primarily *Pleurozium schreberi* and *Hylocomium splendens.* The open areas between the shrubs are occupied primarily by fruticose lichens such as *Cladonia* spp.

Figure 20-Needleleaf woodland of white spruce with a shrub layer of *Betula glandulosa, Salix richardsonii,* and *Spiraea beuverdiana* and a moss and lichen layer of feathermosses and *Cladonia* spp. near the limit of trees in southwestern Alaska.

Phases- On old sand dunes in the Kobuk Valley and the Kantishna River area, the shrub layer is absent, and fruticose lichens dominate the openings between the scattered spruce trees. The most important lichens are species of Cladonia, Cladina, and Stereocaulon. A few prostrate ericaceous shrubs are present (primarily Empetrum nigrum and Vaccinium vitis-idaea), but these do not provide much cover.

On highly exposed sites near the attitudinal treeline, white spruce may grow as an overstory in what otherwise would be alpine mat and cushion tundra. On these sites, Dryas octopetala dominates low vegetation mats in which *Arctostaphylos rubra, Salix arctica,* Empetrum nigrum, and Vaccinium vitis-idaea also are important. Fruticose lichens, such as *Cetraria* cucullata and C. *islandica,* are interspersed throughout the mat. Mosses, primarily *Pleurozium schreberi* and *Rhytidium rugosum,* are found in moist depressions.

Distribution and site characteristics-white spruce woodlands are most common near the latitudinal and elevational tree lines, especially in the Brooks and Alaska Ranges. They generally are found on fairly exposed sites where conditions are even more severe than on sites supporting open white spruce forest. Soils are generally thin and well drained. Depth to permafrost is more than 50 centimeters (20 in), or permafrost may be nonexistent.

Successional status-These communities are probably climax and are held in their open state by a combination of low temperatures and exposure to wind. Their response to disturbance is unknown, but some sites might not return to forest vegetation if the trees were destroyed even if a seed source was available upwind.

Closely related types-White spruce woodlands are similar to open white spruce forests but have less than 25 percent cover. On the other hand, stands with very sparse tree cover resemble certain shrubland communities with scattered spruce (primarily open low mesic shrub birch-ericaceous shrub, dryas or dryas-dwarf shrub tundra, and lichen dwarf shrub tundra). Stands containing black spruce may be similar to black spruce-white spruce woodlands, but have less than 25 percent of the canopy cover contributed by black spruce.

Photographs- Racine 1976, figure 19; figure 20, this publication.

Primary references- Racine 1976, Viereck 1979.

Communities- Picea *glauca/Betula* **glandulosa/feathermosses-Cladonia spp.** (Hettinger and Janz 1974; Racine 1975; Viereck 1975, 1979; Williamson and Peyton 1962). *Picea glauca/Dryas* spp.-mosses (Viereck *1979). Picea glauca/Cladonia* spp. (Racine 1976). *Picea glauca/Salix lanata/Cladonia* spp: (LaPerriere 1976). *Picea glauca/Ledum groenlandicum-Vaccinium* vitis-idaea/feathermosses (Dyrness and others *1988). Picea glauca/Alnus tenuifolia/Arctostaphylos* uva-ursi/lichens (Dyrness and others 1988). *Picea glauca/Dryas octopetala-Salix reticulata-Empetrum nigrum* (Craighead and others *1988). Picea glauca/Alnus crispa-Salix spp./Equisetum arvense* (Craighead and others 1988). *Picea glauca/Salix spp./Equisetum arvense* (Craighead and others 1988). *Picea glauca/Salix* spp./feathermosses (Craighead and others 1988). *Picea glauca/Vaccinium* spp.-Salix *spp./Equisetum arvense* (Craighead and others *1988). Picea glauca/Vaccinium spp.-Empetrum nigrum* (Craighead and others 1988). *Picea glauca/Salix alaxensis-S. glauca-S. lanata/Carex scirpoidea* (Craighead and others 1988). *Picea glauca/Alnus* crispa/feathermosses (Craighead

and others 1988). *Picea glauca/Alnus crispa-Salix spp./Vaccinium uliginosum/* feathermosses (Craighead and others 1988). *Picea glauca/Vaccinium uliginosum-Carex bigelowii* (Craighead and others 1988). *Picea glauca/Ledum groenlandicum-Vaccinium* vitis-idaea/feathermosses (Dyrness and others 1988). *Picea glauca/Alnus tenuifolia/Arctostaphylos* uva-ursi/lichen (Dyrness and others 1988).

I.A.3.d. Black Spruce Woodland

Description- These open stands have a total tree cover of 10 to 25 percent and are dominated by black spruce (fig. 21). Paper birch and tamarack may be present but provide little cover. Trees of these communities are very slow growing, with the largest trees (over 100 years old) being on the order of 15 centimeters (6 in) d.b.h. and 11 meters (37 ft) tall, or smaller. Tree density is often surprisingly great considering the open canopy. Densities of 445 to 2900 stems per hectare (180 to 1,200 per acre) for stems with diameters greater than 2.5 centimeters (1 in) have been reported. Basal areas are from 0.3 to 6.8 square meters per hectare (1.3 to 30 ft^2 per acre). Most stands have enough black spruce regeneration, usually by layering, to maintain the woodland cover.

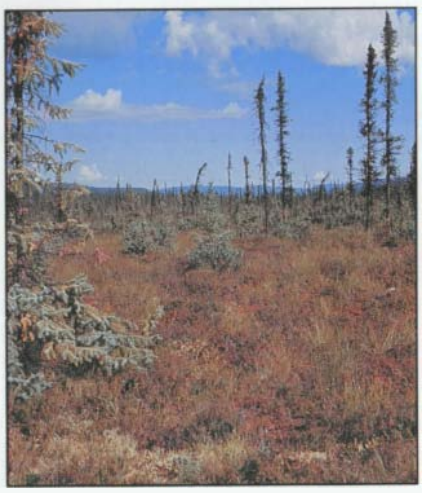


Figure 21-Needleleaf woodland of black spruce with a low shrub layer of Betula *glandulosa, Ledum groenlandicum,* and *Vaccinium uliginosum* and a scattered herbaceous layer with *Eriophorum vaginatum* and a moss and lichen layer of *Sphagnum,* feathermosses, and *Cladonia* spp. on a toe slope in interior Alaska.

Tall shrubs in these stands consist of scattered clumps of *Alnus crispa* 1 to 3 meters (3 to 6 ft) tall, *Betula glandulosa,* sometimes with willows such as *Salix lanata, S. planifolia,* and *S. glauca.* Low shrubs are common in most stands and include *Vaccinium uliginosum, V. vitis-idaea, Ledum decumbens, L. groenlandicum,* and *Empetrum nigrum.* The herb layer ranges from sparse to dense. Common herbs include *Carex* spp., *Eriophorum vaginatum, Calamagrostis canadensis, Rubus chamaemorus,* and *Geocaulon lividum.* The moss and lichen layer is continuous or nearly *so.* The mosses *Hylocomium splendens, Pleurozium schreberi,* and *Sphagnum* spp. generally dominate beneath the shrubs. Although *Sphagnum* spp. are commonly dominant, they are absent or nearly so from some communities. On moist and wet sites, the areas between the trees are usually dominated by shrubs and the associated mosses. On drier sites, the shrubs are restricted to the vicinity of the trees; the openings between trees are occupied by fruticose and foliose lichens (fig. 22). Important lichens include *Nephroma arcticum, Cladonia* spp., *Cladina* spp., *Cetraria* spp., and *Peltigera* spp.

Figure 22-Needleleaf woodland of black spruce with a scattered shrub layer of *Vaccinium uliginsoum* and *Ledum groenlandicum* and a nearly continuous lichen layer of *Cladonia* spp. and *Peltigera* spp. on a well-drained soil in interior Alaska.

Distribution and site characteristics-Black spruce woodlands are found throughout interior, western, and south-central Alaska, primarily on cold, wet, poorly drained soils, but occasionally on some cold, well-drained soils. They are found in several topographic positions including flood plains, slopes, and ridges. Permafrost may be present or absent. Soils are shallow to permafrost, bedrock, or raw parent material. They are generally Cryaquepts or, more rarely, Cryochrepts, with a surface organic layer 10 to 30 centimeters (4 to 12 in) thick.

Successional status-Many black spruce woodlands seem to be a fire climax. When burned, these communities pass through several herb and shrub stages before returning to black spruce woodland.

Closely related types-Black spruce woodlands often resemble open black spruce forest but have less than 25 percent tree cover. When tree canopy cover becomes less than 10 percent, the more open black spruce woodlands resemble various open scrub communities, such as mixed shrub-sedge tussock bog, shrub birch-ericaceous shrub bog, and mesic shrub birch-ericaceous shrub scrub. Stands containing white spruce can resemble black spruce-white spruce woodland, but contain less white spruce. Stunted trees on very poor sites may resemble black spruce dwarf tree woodland scrub.

Photographs- Racine 1976, figure 22; figures 21 and 22, this publication.

Primary references- Foote 1983, Racine 1976, Viereck and others 1983, Yarie 1983.

Communities- Picea *mariana/Sphagnum spp.-Cladonia* spp. (Heilman 1966; Viereck 1975, 1979). *Picea mariana/Cladonia* spp. (Foote 1983; Racine 1976; Viereck 1975, 1979). *Picea mariana/Vaccinium* spp.-Salix *spp./Sphagnum* spp. (Racine 1976, Webber and others 1978, Williamson and Peyton 1962). *Picea mariana/Betula nana/Eriophorum spp./Sphagnum* spp. (Yarie 1983). *Picea mariana/Salix* spp./Hylocomium *splendens-Cladonia rangiferina* (Yarie 1983). *Picea mariana/Eriophorum vaginatum* (Jorgenson and others 1986). *Picea mariana/Ledum decumbens-Vaccinium* spp. (Jorgenson and others 1986). *Picea mariana/Sphagnum* spp. (Jorgenson and others 1986).

I.A.3.e. Black Spruce- White Spruce Woodland

Description- These communities are comprised of black spruce and white spruce as codominants. Although both species provide a significant amount of cover, they may differ in size and age class. Trees tend to be slow growing but occasionally grow to relatively large sizes. The largest trees, usually white spruce, may reach 32 centimeters (13 in) d.b.h. and over 10 meters (33 ft) in height. More typical sizes are 7 to 11 centimeters (3 to 4 in) d.b.h. and 3 to 7 meters (10 to 23 ft) in height. Regeneration of both species generally is present, though there is a tendency for a larger proportion of young trees to be black spruce rather than white spruce.

A well-developed tall shrub layer, consisting primarily of *Betula glandulosa* and *Alnus crispa,* is characteristically present. A low shrub layer occupies the spaces between the tall shrubs and trees. Common low shrubs include, *Vaccinium uliginosum, V. vitis-idaea, Empetrum nigrum,* and *Ledum groenlandicum.* The herb layer is sparse and consists predominantly of *Calamagrostis canadensis* and *Carex bigelowii.* A continuous or nearly continuous layer of mosses is dominated by *Pleurozium schreberi, Hylocomium splendens,* and *Polytrichum* spp. Foliose and fruticose lichens such as *Cladonia* spp., *Cladina* spp., *Cetraria* spp., and *Peltigera* spp. contribute a substantial amount of cover to the moss layer.

Distribution and site characteristics- Black spruce-white spruce woodlands are found near tree line in interior, western, and south-central Alaska. Near Fairbanks, they are reported on east- and west-facing slopes above 700 meters (2,300 ft). They often occupy the coldest sites capable of supporting forest vegetation. The poorly developed, stony, mesic to dry soils are shallow and may lie directly on fractured bedrock. A 0- to 3-centimeter-thick (0- to 12-in-thick) organic layer covers the soil surface. Permafrost is absent or fairly deep.

Successional status- These woodlands appear to be climax but probably are in a very delicate balance with climate. A series of warm, moist summers might allow many seedlings to establish, which would lead to a more closed canopy in a few decades. On the other hand, some catastrophically disturbed stands may not return to a forested condition at all.

Closely related types- Densely treed stands resemble open black spruce-white spruce forest but have less than 25 percent tree cover. Very open stands grade into open low mesic shrub birch-ericaceous shrub scrub communities with scattered spruce. Depending on the relative proportions of the two spruce species present, these communities may resemble either black spruce woodland or white spruce woodland but have significant cover of both species.

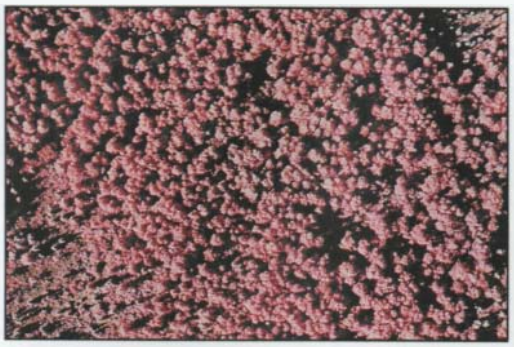
Photographs- Foote 1983, figure 13.

Primary references- Foote 1983, Viereck and others 1983.

Communities- Picea *mariana-P. glauca/Betula* glandulosa/feathermosses (Viereck 1979). *Picea glauca-P.* mariana/lichens (Foote 1983). *Picea mariana-P. glauca/Alnus crispa-Betula glandulosa/Pleurozium schreberi* (Jorgenson and others 1986, Viereck and others 1983). *Picea mariana-P. glauca/Rubus chamaemorus-Ledum decumbens-Vaccinium* spp. (Craighead and others 1988).

I. B. Broadleaf Forest

Broadleaf forest communities have at least 75 percent of tree canopy coverage contributed by broadleaf tree species. Alaska broadleaf tree species are *Alnus rubra, Betula papyrifera, Populus trichocarpa, P. balsamifera,* and *P. tremuloides.*



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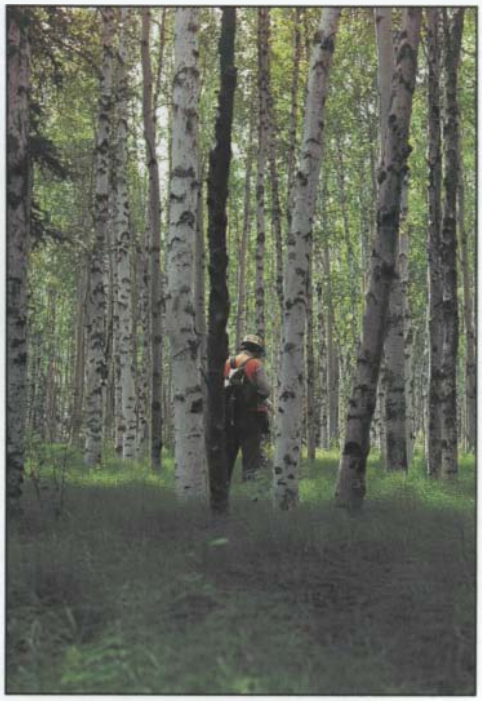

B

Figure 23—**A.** Aerial view of closed broadleaf forest in interior Alaska. **B.** Ground view of closed broadleaf paper birch forest similar to that shown in **A.**

I.B.7. Closed Broadleaf Forest

Closed broadleaf forest communities have from 60 to 100 percent tree canopy coverage. Less than 25 percent of the total tree coverage is contributed by needleleaf (coniferous) tree species (fig. 23, A and B).

I.B.1.a. Closed Red Alder Forest

Description- These communities are dominated by red alder *(Alnus* rubra) and have a total tree cover of 60 percent or more (fig. 24). Red alder reaches heights of 6 to 12 meters (20 to 40 ft) and diameters of 10 to 40 centimeters (4 to 16 in). This type has been described only from the Stikine area in southeastern Alaska, and substantial variations from the description are to be expected. Woody plants other than alder are scarce. Common species in the understory include *Carex macrochaeta, Calamagrostis nutkaënsis,* and in wet areas, *Carex lyngbyaei* and *Potentilla palustris.*

Distribution and site characteristics- Red alder forests are common on wet, well-drained sites with rich, stony, moist soils along creek bottoms and on river terraces in southeastern Alaska. They also occupy old clearcuts and other disturbed areas on moist, well-drained sites. Red alder, often with green alder, also forms dense thickets on avalanche slopes.

Successional status- Red alder communities can be part of a hydrosere between marsh and Sitka spruce-western hemlock forest. Stands on flood plains and river terraces may remain stable for long periods. Red alder also is successional on disturbed sites, establishes itself in pure stands on skid trails after clearcut logging and dominates these areas for several decades.

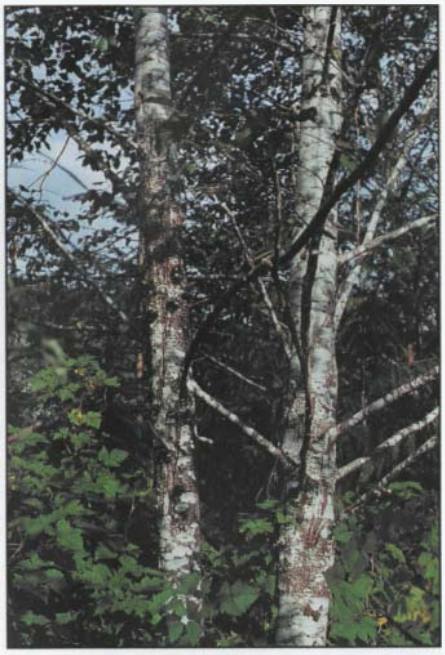

Figure 24-Closed broadleaf forest of red alder in southeastern Alaska.

Closely related types- Red alder forests differ from tall alder scrub by being composed of a taller and more treelike alder. They also are similar to open Sitka spruce forests but have less spruce and more alder.

Photographs- Figure 24, this publication.

Primary references- del Moral and Watson 1978, Viereck and Little 1972.

Communities- *Alnus rubra* (del Moral and Watson 1978).

I.A.1.b. Closed Black Cottonwood Forest

Description- These communities are dominated by black cottonwood (Populus trichocarpa), which commonly grow 24 to 30 meters (80 to 100 ft) tall and reach diameters of up to 1 meter (3 ft). Young stands tend to have continuous tree cover with sparse understories. As the stands age, openings in the canopy allow the understory to develop more fully. Common shrubs include *Rosa acicularis, Viburnum edule,* and *Oplopanax horridus. Calamagrostis canadensis* and *Equisetum* spp. are the dominant species of the herb layer.

Distribution and site characteristics- Black cottonwood communities are common on moist, well-drained sites on flood plains in south-central and southeastern Alaska.

Successional status- These are seral communities in the primary succession of stream terraces and flood plains that are intermediate between various early seral shrub communities on the one hand, and birch and spruce forest communities on the other.

Closely related types- Black cottonwood forests are closely related to balsam poplar forests, and the trees themselves are sometimes considered conspecific. The seed capsules of black cottonwood split into three parts at maturity, as opposed to those of balsam poplar which split into two parts at maturity. Closed black cottonwood communities resemble open black cottonwood communities in species composition but have much greater tree cover.

Primary references- U.S. Department of Agriculture 1986, Viereck and Little 1972.

Communities- *Populus trichocarpa* (undescribed).

I.B.l.c. Closed Balsam Poplar Forest

Description- These forests are dominated by balsam poplar and have more than 60 percent canopy cover (fig. 25). This species commonly reaches diameters of 40 centimeters (16 in) and heights of 30 meters (90 ft). Flood-plain balsam poplar stands are the most productive forest stands in interior Alaska. Annual tree production averages 551 grams per square meter per year (4,900 lb/acre) and reaches 950 grams per square meter per year (8,500 lb/acre) on the most productive sites. Young stands have densities on the order of 2,000 stems per hectare (800 stems/acre), but densities drop to 600 to 800 stems per hectare (200 to 300 stems/acre) in older stands.

Alnus crispa and *A. tenuifolia* are common shrubs in these stands. Willows are common to abundant in young stands, but drop out after the balsam poplar canopy begins to close. Other common shrubs include *Rosa acicularis* (which may form a nearly continuous layer about 1.5 meters [5 ft] high), *Viburnum edule,* and sometimes *Cornus stolonifera.* Dwarf shrubs are absent. A dense layer of herbs usually is dominated by Calamagrostis *canadensis* and *Equisetum* spp. Other common herbs include *Geocaulon lividum, Galium boreale,* and *Mertensia paniculata.* Mosses and lichens usually are sparse because they are intolerant of the heavy leaf fall and frequent flooding that the forest floor is subject to. Some mosses usually are present, though, on the bases of the tree trunks, and the lichens *Peltigera* spp. and *Cladonia* spp. can be found on sites flooded relatively infrequently.

Phases- South of the Alaska Range, *Oplopanax horridus* may dominate the herb layer and a variety of ferns becomes important.

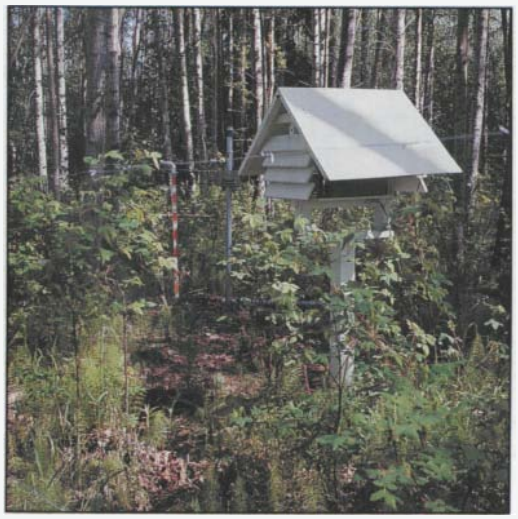

Figure 25--Closed broadleaf forest of balsam poplar with a shrub layer of *Alnus tenuifolia, Rosa acicularis,* and *Viburnum edule* and a herbaceous layer primarily of *Equisetum arvense* and E. *pratense* on the flood plain of a river in interior Alaska.

Occasionally, small stands of balsam poplar occur on slopes near timberline throughout Alaska. Associated species differ considerably between different parts of the State, but a scattered shrub layer of *Salix* spp., *Rosa acicularis,* and *Viburnum edule* usually is present. *Calamagrostis canadensis* usually dominates the herb layer. In the Brooks Range and possibly the Alaska Range, a ground layer dominated by *Arctostaphylos rubra* may be present.

Distribution and site characteristics- Balsam poplar stands are found primarily on flood plains in interior, south-central, and southwestern Alaska. A few small stands are isolated well north of treeline on the Arctic Slope along major rivers in the northern foothills of the Brooks Range. Soils are well-drained Cryofluvents lacking permafrost. They are essentially unmodified by soil-forming processes, with the soil profile layers remaining as they were originally deposited. The soil surface is covered by 2 to 15 centimeters (1 to 6 in) of leaf litter, the depth depending on the time since the last flooding and siltation episode.

Tree-line balsam poplar stands usually are on slopes with weakly developed, well-drained, thin soils without permafrost or with very deep permafrost.

Successional status- Flood-plain balsam poplar communities are part of a successional sequence from willow-alder thickets to balsam poplar to white spruce, and eventually to black spruce. Substantial numbers of white spruce seedlings and saplings are present in some stands. In other stands, white spruce may be very slow to invade, depending on the proximity of a white spruce seed source and the timing of good white spruce seed crops. Some balsam poplar stands are over 200 years old, but most are replaced by white spruce at about 100 years of age.

Closely related types- Closed balsam poplar communities are similar to open balsam poplar communities but have 60 percent tree cover or more. Stands where white spruce contribute to the canopy are similar to closed poplar-spruce mixed forest or closed spruce-birch-poplar forest, but they have less canopy cover of spruce or birch. At the other extreme, young stands where balsam poplar shares the canopy with species of willow may resemble closed tall willow thickets but have a greater dominance of balsam poplar.

Photographs- Foote 1983, figure 8; Viereck 1970a, figure 3; figure 25, this publication.

Primary references-Foote 1983; Viereck 1970a, 1979; Viereck and others 1983; Yarie 1983.

Communities- *Populus balsamifera/Alnus tenuifolia/Calamagrostis canadensis* (Buckley and Libby 1957; Drury 1956; Hettinger and Janz 1974; Lutz 1956; Neiland and Viereck 1977; Racine 1976; Viereck 1970a, 1975). *Populus balsamifera/Alnus tenuifolia/Rosa acicularis/Equisetum* spp. (Dyrness and others 1988, Viereck 1989). *Populus balsamifera/Salix barclayi/Heracleum lanatum* (Viereck 1970b). *Populus balsamifera/Salix* spp.-Alnus spp./herbs (Viereck 1979). *Populus balsamifera/Alnus* spp.-Salix spp./Rosa *acicularis/Equisetum* spp. (Yarie 1983). *Populus balsamifera/ Rosa acicularis/Equisetum* spp.-Pyrola spp. (Yarie *1983). Populus balsamifera/ Arctostaphylos uva-ursi/Peltigera* spp. (Yarie 1983).

I.B.1.d. Closed Paper Birch Forest

Description- These are communities with paper birch dominating the overstory and with at least 60 percent tree cover (fig. 26). Large trees reach 30 to 45 centimeters (12 to 18 in) in d.b.h. and 18 to 25 meters (60 to 80 ft) in height. Densities can range from 15,500 trees per hectare (6,300 trees/acre) for young stands (20 to 25 years old) to 370 trees per hectare (150 trees/acre) for old stands (120 years). Annual aboveground tree biomass increment is about 343 to 572 grams per square meter (3,060 to 5,100 lb/acre). Leaf fall is heavy, on the order of 250 grams per square meter per year (2,230 lb/acre). Birch regeneration is limited mostly to stem suckers sprouting from the bases of old trees. White spruce and black spruce seedlings and saplings may be present but usually are not abundant.

Figure 26-Closed broadleaf forest of paper birch with a scattered shrub layer of Viburnum *edule* and *Rosa acicularis* and an herbaceous layer of *Equisetum arvense* and *E. sylvaticum* in the uplands of interior Alaska.

In most stands, a discontinuous tall-shrub layer several meters tall is made up of *Alnus crispa* or *A. sinuata. Rosa acicularis* and *Viburnum edule* commonly form a shrub layer 1 to 2 meters (3 to 6 ft) high, though in some stands, particularly those with abundant alder, these shrubs may be lacking or nearly so. Dwarf shrubs may be absent or may be represented only by *Vaccinium vitis-idaea* and *Linnaea borealis.* The herb layer usually is dominated by *Calamagrostis canadensis.* The importance of *Calamagrostis* generally increases with age of the stand. *Mertensia paniculata* and Equisetum spp. also may be common. Mosses and lichens are rare, probably because of the heavy leaf litter.

Distribution and site characteristics- Paper birch forests are common on several upland sites in interior and south-central Alaska. Soils generally are moderately drained to well-drained silts. In some areas, the soil is stony and shallow over bedrock. Permafrost usually is absent, but some birch forests develop on soils with permafrost and a shallow active layer. The organic horizon over the mineral soil is thin and consists mostly of decaying birch leaves. Mosses and lichens usually are absent from the forest floor.

Successional status- Paper birch communities generally result from fires or other disturbances and usually will be replaced by open or closed white spruce, black spruce, or black spruce-white spruce communities after passing through several types of spruce-birch mixtures. In south-central and interior Alaska, open mixtures of white spruce and birch with grassy openings may be climax on some sites (Neiland and Viereck 1977).

White spruce and paper birch may become established at the same time; however, the birch grows faster than the spruce. When the birch become overmature and die, the spruce is already present. It is more difficult for spruce to invade after a birch forest is well established, because the heavy leaf fall prevents the survival of spruce seedlings (Gregory 1966). Eventually, however, a few spruce become established as the aging birch weaken and die.

Mature birch can survive low-intensity ground fires, but the aerial parts are easily killed by moderate and severe fires. If the roots survive the fire, the stumps sprout vigorously, which leads to an abundance of multiple-stemmed trees in the resulting forest.

Closely related types- Closed paper birch communities resemble open paper birch communities but have a greater overstory cover. Birch communities with spruce understories just beginning to reach into the birch canopy may resemble spruce-birch mixed forest, but they have less spruce in the canopy. If aspen is present, birch communities may resemble birch-aspen communities but with less aspen.

Photographs- Foote 1983, figures 4 and 5; figure 26, this publication.

Primary references- Foote 1983, Neiland and Viereck 1977, Viereck and others 1983.

Communities-- Betula *papyrifera/Alnus crispa/Calamagrostis* spp. (Buckley and Libby 1957, Lutz 1956, Viereck 1975). *Betula papyrifera/Viburnum edule* (Foote 1983). *Betula papyrifera/Alnus* spp.-Salix spp. (Racine 1976). *Betula papyrifera/ Ledum groenlandicum/Pleurozium schreberi-Polytrichum juniperinum* (Jorgenson and others 1986).

I.B.1.e. Closed Quaking Aspen Forest

Description- These stands are dominated by aspen and total tree cover is 60 percent or more (fig. 27). The largest aspen trees reach 25 to 36 centimeters (10 to 14 in) in d.b.h. and 18.3 meters (60 ft) in height. Aspen may grow in pure stands or be associated with small quantities of white spruce, black spruce, balsam poplar, or paper birch. White spruce seedlings and black spruce regeneration may be present. Tree densities range from 1,200 trees per hectare (480/acre) for mature stands (50 to 80 years old) to 700 trees per hectare (280/acre) for overmature stands.

Scattered clumps of *Alnus crispa* and *Salix bebbiana* that are several meters tall are commonly present. A broken to nearly continuous shrub layer 1 to 2 meters (3 to 6 ft) high consists primarily of *Viburnum edule, Rosa acicularis, Salix* spp., and *Shepherdia canadensis.* The herb layer is poorly developed, but scattered plants of *Calamagrostis canadensis, Epilobium angustifolium, Equisetum arvense, Pedicularis labradorica, Linnaea borealis, Geocaulon lividum,* and *Galium boreale* usually can be found. Mosses and lichens are scarce.

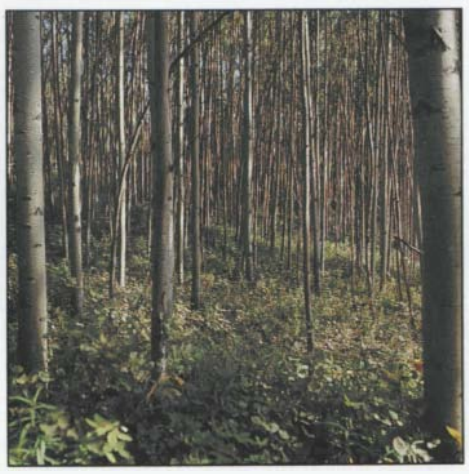

Figure 27-Closed broadleaf forest of quaking aspen with a shrub layer of *Rosa acicularis, Viburnum edule,* and *Shepherdia canadensis;* a scattered herbaceous layer of *Calamagrostis canadensis* and *Epilobium angustifolium;* and the creeping subshrub *Linnaea borealis* on a south-facing slope with a thick deposit of loess in the uplands of interior Alaska.

Distribution and site characteristics- Closed **aspen forests grow on warm,** well-drained upland slopes in interior and south-central Alaska. These are the forested sites in central Alaska. Slope gradient ranges from 7 to 40 percen are generally well-drained, sometimes shallow and stony, silt loams (ofte Cryochrepts). Snow melts early in spring, and seasonal frost retreats to a 80 centimeters (30 in) below the surface by late June. Soils supporting as lack permafrost or have a thick active layer. The soils can become extre during droughty summers.

Successional status- Aspen can colonize burned-over white spruce forest sites under some circumstances. Aspen are killed by hot fires, but in pure sta characteristically light (Neiland and Viereck 1977). Fires therefore tend aspen stands. Aspen sprouts vigorously from roots when aerial portions are killed; thus, when aspen stands are burned or otherwise disturbed, quickly regenerate themselves.

White spruce often seeds in at the same time that the aspen is establishe spruce initially grows much more slowly than the aspen, but in the abse short-lived aspen eventually die and leave the spruce to assume dominance. When the spruce overtop the aspen canopy, the demise of the shade-intolerant hastened.

Black spruce stands on shallow, stony soils, if severely burned so that mat is removed, may be replaced by aspen. Presumably these sites even return to black spruce if they are not reburned.

Closely related types-Closed aspen stands are similar to open aspen stands but have more than 60 percent tree cover. They also are similar to birch-aspe balsam poplar, and spruce-aspen communities but have low amounts of cover contributed by the associated tree species.

Photographs- Foote 1983, figure 3; figure 27, this publication.

Primary references- Foote 1983, Neiland and Viereck 1977, Viereck and others 1983, Yarie 1983.

Communities- Populus *tremuloides/Viburnum edule/Linnaea borealis* (Foote 1983). *Populus tremuloides/Salix spp./Arctostaphylos uva-ursi* (Hettinger and Janz 1974, Viereck 1975). *Populus tremuloides/Sa/ix spp./Drepanocladus* spp. (Yarie 1983).

1.B.1-f. Closed Paper Birch-Quaking Aspen Forest

Description- These are communities in which dominance in the canopy is share by paper birch and quaking aspen and the total tree cover is 60 percent Published descriptions of these communities are limited to very young stands on the Porcupine Plateau in northeastern Alaska. These stands have tree reproduction of black spruce, aspen, and birch. *Alnus crispa* and several species of willow shrub layer. A rather open, low shrub layer is composed of *Rosa acicularis* a *Shepherdia canadensis.* The ground layer is dominated by *Arctostaphylos uva-ursi* and *Equisetum* spp. Other common herbs include *Epilobium angustifolium, Linnaea borealis,* and *Arctostaphylos rubra.* Scattered lichens include species of *Cladonia, Cladina, Peltigera,* and *Cetraria.*

Distribution and site characteristics- Birch-aspen communities are found on moderately warm sites, primarily upland slopes, in interior and south-central Alaska. Permafrost is absent or more than a meter below the surface.

Successional status- Most stands originate after fire and most likely, in the absence of fire, will be replaced eventually by white spruce or black spruce.

Closely related types- Birch-aspen communities are related to paper birch communities and aspen communities but have both species well represented in the canopy. If a spruce understory is beginning to enter the canopy, this community may resemble a spruce-birch-aspen mixed forest.

Primary reference- Yarie 1983.

Communities- Populus *tremuloides-Betula papyrifera/Rosa acicularis/Arctostaphylos* uva-ursi/lichens (Yarie 1983).

I.B.7.g. Closed Quaking Aspen-Balsam Poplar Forest

Description- These forest communities are dominated by aspen and balsam poplar and have a total tree cover of 60 percent or more. Scattered white spruce also may be present in the overstory. Regeneration of aspen and balsam poplar usually is present, and frequently white spruce regeneration is as well. Annual productivity averages about 113 grams per square meter (1,000 lb/acre) per year.

Willows commonly form a tall shrub layer, especially in young stands. Characteristic low shrubs include *Rosa acicularis* and *Shepherdia canadensis.* Common herbs include *Mertensia paniculata, Calamagrostis canadensis, Equisetum* spp., *Epilobium angustifolium,* and *Galium* spp. Mosses and lichens are sparse; *Dicranum* spp. are perhaps the most common mosses.

Distribution and site characteristics-Aspen-balsam poplar communities have been reported only from the Yukon Flats but are thought to be more widespread on flood plains in interior Alaska. They commonly occur on moderately well-drained soils (Cryofluvents). These tend to be young soils with circumneutral to slightly acidic soil reaction and only a few centimeters of organic matter on the mineral soil surface. Permafrost is at least 50 centimeters (20 in) below the surface at sites in the Yukon Flats and probably is lacking from many sites farther south.

Successional status- Flood-plain stands generally develop after alder and willow thickets. Usually the aspen and balsam poplar establish at the same time as the alder and willows but are overtopped for a few years by the faster growing shrubs. Most of these stands, if left undisturbed, would be expected to be replaced by white spruce. After a still longer time, the white spruce theoretically may give way to black spruce.

Closely related types- Aspen-balsam poplar stands are similar to aspen stands and balsam poplar stands, but dominance is shared by both species. Young stands, where the tree canopy has recently emerged above the alder and willows, are similar to tall alder, tall willow, and tall alder-willow shrub communities. Older stands where spruce is beginning to enter the canopy may resemble aspen-spruce or balsam poplar-spruce stands.

Primary reference- Yarie 1983.

Communities- *Populus tremuloides-P. balsamifera/Rosa acicularis* (Yarie 1983).

Figure 28-A. Aerial view of open broadleaf forest of paper birch in interior Alaska. B. Ground view of open broadleaf forest of paper birch similar to that shown in A.

1.B.2. Open Broadleaf Forest

Open broadleaf forest communities have from 25 to 60 percent total tree canopy coverage. Over 75 percent of the canopy is made up of broadleaf tree species (fig. 28, A and B).

I.B.2.a. Open Paper Birch Forest

Description-These communities are dominated by paper birch and have a total tree cover of 25 to 60 percent (fig. 29). Scattered white spruce or black spruce also may be present. On moist sites, such as those near the western treeline and many sites near the elevational treeline, shrubs dominate the openings between the trees. Betula *glandulosa,* 1 to 2 meters (3 to 6 ft) tall, is characteristic of this shrub layer. Alder and willows also are present. Ericaceous shrubs form an open dwarf shrub layer beneath the taller shrubs. The ground layer consists of a nearly continuous layer of feathermosses, primarily *Hylocomium splendens* and Pleurozium schreberi.

Dry sites support lichens instead of shrubs in the openings between the trees. Common lichens include species of the genera Cladonia, Cladina, and *Stereocaulon.*

Another type of open birch community consists of overmature birch stands on upland slopes in interior and south-central Alaska; it lacks a spruce understory to replace the birch trees as they die. These stands have a low shrub layer composed primarily of *Rosa acicularis* and *Viburnum edule.* Clumps of tall alder are occasional. The herb layer is commonly dominated by *Equisetum arvense* or *Calamagrostis canadensis.*

Figure 29-Open broadleaf forest of mature paper birch with a shrub layer of *Alnus crispa* and a herbaceous layer *of Calamagrostis canadensis* and *Lycopodium complanatum* on an east-facing slope in the uplands of interior Alaska

Distribution and site characteristics- Overmature open birch stands are common in interior and south-central Alaska. The open birch stands with a lichen understory are apparently fairly rare; they occur mostly near the western tree line and near the elevational tree line of interior, western, and south-central Alaska. Elevational tree-line stands may have originated as a result of fires burning through white spruce stands. Moist sites, such as those near tree line, support shrubby understories. Dry sites, including stabilized sand dunes and possibly some elevational tree-line sites, support fruticose lichens in the forest openings. Soils are moderately well drained in the mature open upland birch sites. Permafrost is absent or with a deep active layer.

Successional status- The successional status of many open birch stands is unknown. Some probably will be replaced by white spruce if sufficient time elapses. Others, particularly certain overmature birch communities in south-central Alaska, do not appear to be heading toward spruce dominance. Perhaps they are reverting to open shrub communities with grassy openings (Neiland and Viereck 1977).

Closely related types- Open birch communities are similar to closed birch communities and birch woodland communities but have less tree cover than the former and more tree cover than the latter (25 to 60 percent tree cover).

Photographs- Racine 1976, figure 9; figure 29, this publication.

Primary references- Foote 1983, Hanson 1953, Neiland and Viereck 1977, Racine 1976.

Communities- *Betula* papyrifera/Cladonia spp. (Racine 1976). Betula *papyrifera/ Betula* glandulosa/Hylocomium spp. (Hanson 1953; Hettinger and Janz 1974; Viereck 1975, 1979). *Betula papyrifera/Vburnum edule/Calamagrostis* spp. (Foote 1983). *Betula papyrifera/Alnus crispa/Ledum groenlandicum* (Jorgenson and others 1986).

I.B.2.b. Open Quaking Aspen Forest

Description- Open quaking aspen stands are dominated by generally small aspen trees that provide roughly 10 to 60 percent canopy cover (fig. 30). These trees rarely are larger than 12 centimeters (5 in) d.b.h. and 15 meters (50 ft) tall. A representative basal area is 8.7 square meters per hectare (37 ft^2/acre). *Rosa acicularis* 1 to 2 meters (3 to 6 ft) tall may be present. *Shepherdia canadensis* is a common low shrub, and *Arctostaphylos uva-ursi* may form a patchy ground cover. Common herbs include *Calamagrostis purpurascens, Galium boreale,* and *Pulsatilla patens.* Neither mosses nor lichens provide significant cover. Flood-plain sites may support substantial quantities of tall willows in addition to the aspen.

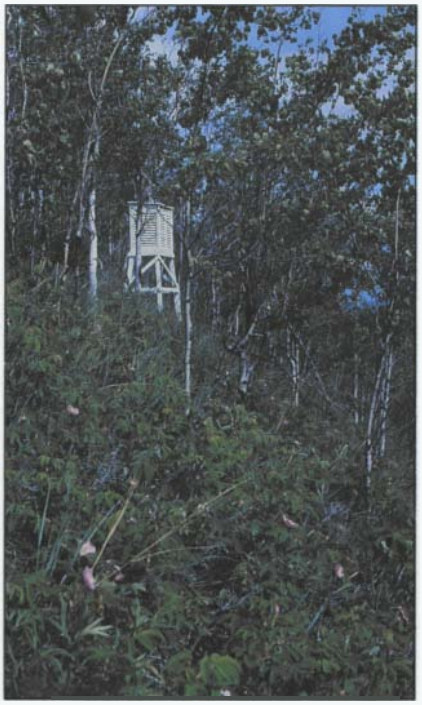

Figure 30-Open broadleaf forest of quaking aspen with a shrub layer of Shepherdia *canadensis* and Rosa *acicularis* and an herbaceous layer of *Calamagrostis purpurescens, Pulsatilla patens,* and the subshrub *Arctostaphylos uva-ursi* on a steep, south-facing bluff in interior Alaska.

Distribution and site characteristics- open aspen stands usually occur on very dry sites on steep, south-facing slopes along rivers in interior and south-central Alaska. They commonly are associated with dry midgrass-shrub or sagebrush-grass communities. Soils generally are shallow silt loams over fractured bedrock and are quite warm and dry. Open aspen stands also infrequently occur on more or less level, well-drained alluvium. If permafrost is present, it will be at depths greater than 70 centimeters (28 in).

Successional status- Open aspen communities frequently develop on sites where white spruce stands have been destroyed by fire. White spruce may be unable to reinvade steeply sloping, dry sites, though small changes in summer climate may enable such an invasion at some time in the future. A series of hot, dry summers may stress the aspen to the point of making them susceptible to death by certain diseases, thus converting the open aspen stands to dry midgrass-shrub communities or open sagebrush-grass communities. On the other hand, **a series of wet, cool** summers presumably could lead to the expansion of aspen forest at the expense of grassland and shrubland.

On most flood-plain sites aspen will be replaced by white spruce if left undisturbed.

Closely related types- open aspen communities are similar to closed aspen communities but have less tree cover and generally occur on steeper and dryer slopes.

Photographs- Figure 30, this publication.

Primary references-Neiland and Viereck 1977, Viereck and others 1983, Yarie 1983.

Communities- Populus *tremuloides/Salix spp./Arctostaphylos* uva-ursi/Gramineae (Yarie 1983). *Populus* tremuloides/Salix spp./Arctostaphylos *uva-ursi/Epilobium* spp. (Yarie *1983). Populus tremuloides/Elaeagnus commutata-Shepherdia canadensis/ Arctostaphylos* spp./lichens (Neiland and Viereck 1977). *Populus tremuloides/ Shepherdia canadensis/Calamagrostis purpurascens* (Viereck and others 1983).

I.B.2.c. Open Balsam Poplar (Black Cottonwood) Forest

Description-These open stands are dominated by balsam poplar or black cottonwood and have a total tree cover of 25 to 60 percent (fig. 31). Other tree species generally are absent. Balsam poplar reaches sizes of 40 centimeters (16 in) d.b.h. and 20 to 30 meters (65 to 100 ft) in height. The trees of most open stands, particularly those near timberline, rarely exceed 10 to 12 meters (30 to 40 ft) tall, though the, maximum diameters remain about the same. Black cottonwood may grow slightly larger than balsam poplar. Understory composition is variable, but there usually is a scattered tall shrub layer consisting of *Salix* spp. and *Alnus* spp. and a low shrub layer dominated by *Viburnum edule, Rosa acicularis, Shepherdia canadensis* (restricted to balsam poplar), or *Oplopanax horridus* (restricted to black cottonwood). Common herbs are *Calamagrostis canadensis, Pyrola* spp., *Mertensia paniculata, Epilobium angustifolium,* and *Arctostaphylos rubra. Hylocomium splendens* and *Pleurozium schreberi* are common bryophytes.

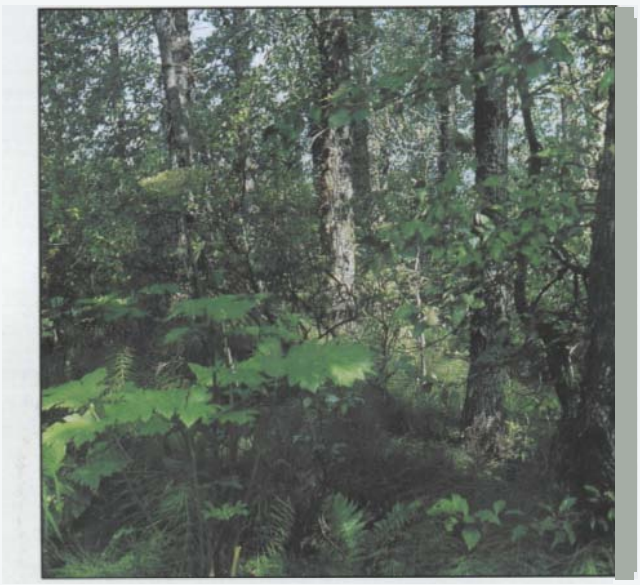

Figure 31-Open broadleaf forest of balsam poplar with a shrub layer of *Salix barclayi* and *Alnus crispa* and an herbaceous layer of *Calamagrostis canadensis. Equisetum pratense,* and *Heracleum lanatum* on the flood plain of a river in southwestern Alaska.

Distribution and site characteristics- Black cottonwood stands are found only along the southeastern and southern coasts of Alaska. Balsam poplar stands occur over the remainder of forested areas in Alaska. When the two species' ranges meet, as in the Cook Inlet area, hybrids between the two species occur, making it difficult to determine which species dominates in some stands (Viereck and Foote 1970). Open balsam poplar and black cottonwood communities often are found on flood plains, but they occasionally occur on slopes. Flood-plain communities usually grow on well-drained sands and gravels capped by a thin layer of silt and an even shallower layer of organic material on the surface of the mineral soil. Stands on slopes usually occupy shallow, stony mineral soils over bedrock. Soils on both upland and flood-plain sites either lack permafrost or have deep active layers (70 centimeters 128 in] or more).

Successional status- Tree-line stands seem fairly stable. On flood plains, these stands maintain themselves in the face of severe flooding disturbance, including silt deposition and erosion. On such flood-plain sites, poplar or cottonwood is seral and white spruce or Sitka spruce is the eventual climax tree species.

Closely related types-Open balsam poplar or black cottonwood communities are similar to closed balsam poplar communities and closed black cottonwood communities but have less tree cover. They also are similar to balsam poplar woodlands but have more tree cover.

Photographs-- Murray 1980, figure 2; figure 31, this publication.

Primary references- Edwards and Dunwiddie 1985, Racine and Anderson 1979, Viereck 1979.

Communities- *Populus balsamifera/Salix* spp.-Alnus *spp./Calamagrostis* spp. (Racine and Anderson 1979, Viereck 1979). *Populus balsamifera/Salix hastata-Shepherdia candensis-Epilobium angustifolium/Hylocomium splendens-Pleurozium schreberi* (Edwards and Dunwiddie *1985). Populus balsamifera/Alnus tenuifolia/ Equisetum* spp. (Viereck 1989).

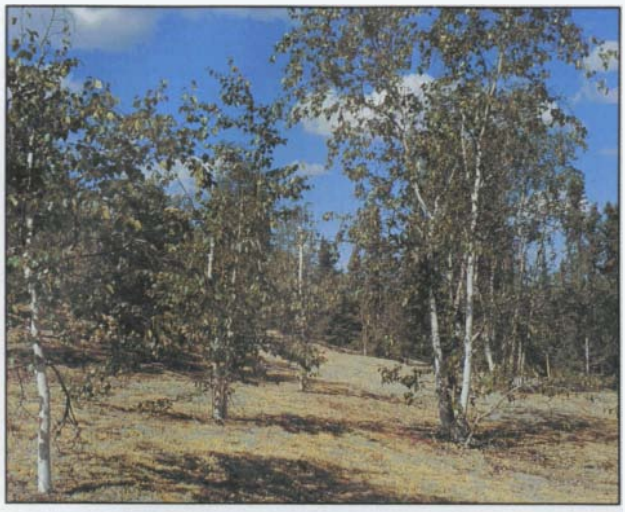

Figure 32-Broadleaf woodland of paper birch with a lichen and moss layer of the lichens *Cladina* spp.. *Cladonia* spp., *Cetraria* spp., and *Stereocaulon* spp. and the moss *Rhacomitrium uliginosum* on a well-drained gravel ridge in northern interior Alaska.

I.B.3. Broadlead Woodland

Broadleaf woodland communities have from 10 to 25 percent total tree cover. At least 75 percent of this total tree cover is contributed by broadleaf tree species.

I.B.3.a. Paper Birch Woodland

Description- Paper birch woodlands are characterized by open-grown paper birch, which has roughly 10 to 25 percent cover (fig. 32). The birches usually are multi-stemmed and rather stunted in growth form. Typical tree heights are 6 to 10 meters (20 to 32 ft) and tree diameters range up to 20 centimeters (8 in) but usually are less than half that. The ground cover consists primarily of fruticose lichens of the genera *Cladonia, Cladina,* Cetraria, and *Stereocaulon.* Lichen cover tends to be sparser than in the white spruce woodland, possibly because of increased litter fall. Shrubs and herbs are not important components of communities that have been described.

Distribution and site characteristics- Paper birch woodlands occur on dry sites in northwestern Alaska and northern interior Alaska. They have been reported growing on stabilized sand dunes and coarse alluvial gravels. Permafrost is deep below the surface or absent from these soils.

Successional status- The successional relations of these communities is unknown. Similar sites also have white spruce woodlands with a few scattered, subordinate birches. Possibly the pure birch stands owe their existence to severe fire or other disturbances. Perhaps white spruce will replace the birch in the absence of further disturbance as it does on many other sites; however, evidence for this has not been reported.

Closely related types- Paper birch woodlands are similar to open paper birch forests but have less tree cover. Sparsely wooded stands may grade into some type of shrub tundra or dryas-lichen tundra.

Photographs- Racine 1976, figure 9; figure 32, this publication.

Primary reference- Racine 1976.

Communities- *Betula papyrifera/Cladonia* spp. (Racine 1976).

I.B.3.b. Balsam Poplar Woodland

Description- These stands are dominated by balsam poplar in the tree layer and are very open with only 10 to 25 percent tree cover. They are similar to open balsam poplar stands but have larger openings. Alders and willows are common tall shrubs. Other typical shrubs include *Rosa acicularis, Viburnum edule,* and (in black cottonwood stands) *Oplopanax horridus.* Common herbs include *Calamagrostis canadensis, Epilobium angustifolium, Mertensia paniculata,* and *Pyrola* spp.

Distribution and site characteristics- Balsam poplar woodlands have been reported from the Susitna Valley but have not yet been described in any detail. They have been found on flood plains but probably are more common on slopes near tree line.

Successional status- Successional relations of these woodlands are unknown. It is uncertain whether white spruce, open shrubland, or grassland with scattered trees is climax on these sites.

Closely related types- These woodlands are similar to the equivalent open forests but have less cover. On the other hand, they may be similar to certain shrubland or grassland types with a few scattered trees.

Primary reference- U.S. Department of Agriculture 1986.

Communities- Populus *balsamifera*[2]

I.B.3.c. Paper Birch-Balsam Poplar Woodland

Description-These woodlands are made up of open stands of paper birch and balsam poplar. Total tree cover is 10 to 25 percent. Birch-poplar woodlands have been reported from the Susitna Valley but have not yet been described in any detail.

Distribution and site characteristics-These woodlands have been reported from the Susitna Valley of south-central Alaska. Soils are well drained to moderately well drained, and many of them are alluvial in origin. Permafrost is generally absent.

Successional status-The successional status of these communities is unknown.

Closely related types- Birch-balsam poplar woodlands are similar to birch woodlands and balsam poplar woodlands but are composed of a mixture of the two species. The more sparsely treed communities may resemble various shrubland or grassland types.

Primary references- None.

Communities-- *Betula papyrifera-Populus balsamifera* (see footnote 2).

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[2] Winterberger, Kenneth; LaBau, V.J. Personal communication at workshop on classification of Alaska vegetation, December 3-4, 1981, Anchorage, AK.

Figure 33-Closed mixed forest of paper birch and white spruce with a sparse shrub layer of *Viburnum edule* and Rosa *acicularis.*

I.C. Mixed Forest

In mixed forest, neither needleleaf nor broadleaf tree species have clear dominance. Both needleleaf and broadleaf contribute 25 to 75 percent of the total canopy cover. Tree cover totals at least 10 percent.

I.C.1. Closed Mixed Forest

Closed mixed forest communities have tree canopy coverages ranging from 60 to 100 percent. Dominance in the tree layer is shared between broadleaf and needleleaf species, with both groups contributing from 25 to 75 percent of the total tree cover.

I.C.1.a. Closed Spruce-Paper Birch Forest

Description-These stands are made up of paper birch and either white or black spruce or a mixture of both (fig. 33). White spruce-paper birch stands generally are dominated by large white spruce and paper birch that reach maximum diameters of about 30 to 35 centimeters (12 to 14 in) d.b.h. and maximum heights of 18 to 23 meters (60 to 75 ft). Tree regeneration is usually scattered and largely restricted to spruce. Stands commonly reach 140 years of age. Older stands tend to be more open (total tree cover decreases), and the relative cover of spruce increases as the overmature birch trees drop out. The birch component of these stands is even aged; the spruce component becomes more uneven aged as the stand matures. A moderately dense tall shrub layer consisting of *Alnus crispa, Salix bebbiana,* and S. scouleriana often is present. A low shrub layer dominated by *Rosa acicularis* or Viburnum *edule,* or both, is characteristic of these communities. Other common low shrubs include *Ribes triste, Spiraea beauverdiana,* and *Vaccinium vitis-idaea.* Common herbs include *Calamagrostis canadensis, Cornus canadensis, Linnaea borealis, Mertensia paniculata,* and *Equisetum arvense.* A patchy carpet of feathermosses commonly dominated by *Hylocomium splendens* occupies the forest floor.

Black spruce-paper birch stands 40 to 70 years old have black spruce averaging 7 to 9 centimeters (3 to 4 in) d.b.h. and 2 to 17 meters (6 to 56 ft) tall. Black spruce seedlings and saplings are common. Paper birch, ranging up to 20 centimeters (8 in) d.b.h., are less abundant than black spruce. Little birch regeneration is present. The birch become overmature and slowly die as the stand ages; few are left by the time

stands reach 120 years of age. A tall shrub layer consisting of *Alnus crispa, Salix bebbiana, S. glauca,* and *S. scouleriana* may be present. Low shrubs are always present and are represented by *Rosa acicularis, Vaccinium vitis-idaea, V. uliginosum, Ledum groenlandicum,* and sometimes *Empetrum nigrum.* The herb layer often is poorly developed, but *Calamagrostis canadensis* usually is present. The ground layer is dominated by the feathermosses *Pleurozium schreberi* and *Hylocomium splendens,* especially under spruce trees. Lichens are not abundant.

Distribution and site characteristics- Closed spruce-birch forests are common in interior and south-central Alaska and occasional in northwest and southwest Alaska. White spruce-birch stands tend to occur on well-drained to moderately well-drained soils (cryorthents or cryochrepts) on flood plains and slopes. Permafrost usually is lacking, except for sites near the northern or western limit of the range of these communities, where permafrost may be present as close to the surface as 30 centimeters (12 in).

Black spruce-birch stands usually occur on poorly drained soils, commonly classed as Cryaquepts, on flood-plain terraces and slopes. Similar stands can sometimes occur on well-drained sites, however. Permafrost usually is present at depths of 30 to 70 centimeters (12 to 28 in).

Successional status- Spruce-birch stands usually develop from stands of pure or nearly pure birch as the slower growing spruce reach the birch canopy and as the relatively short-lived birch begin to mature and die. In some areas, the birch and spruce establish at the same time, and the stand is dominated for many years by the faster growing birch. In other stands, only birch is present at the outset, and the spruce slowly comes into the stand over a long period.

Spruce-birch stands eventually develop into stands of pure spruce as the birch trees continue to drop out without replacement. In some cases, the resultant spruce stands may be fairly open if spruce regeneration is insufficient to maintain a closed overstory canopy.

Closely related types- Stands in which either the birch or the spruce is considerably more abundant in the overstory canopy may resemble closed birch, closed white spruce, or closed black spruce communities. Relatively open stands may resemble open spruce-birch communities.

Photographs- Lutz 1956, figure 13; figure 33, this publication.

Primary references- Jorgenson and others 1986, Lutz 1956, Yarie 1983.

Communities- Picea *glauca-Betula papyrifera/Alnus crispa/Calamagrostis canadensis* (Buckley and Libby 1957, Hettinger and Janz 1974, Lutz 1956, Viereck 1975). *Picea mariana-Betula papyrifera/Alnus crispa/Hylocomium splendens* (Jorgenson and others 1986). *Picea mariana-Betula papyrifera/Ledum* spp. (undescribed). *Betula papyrifera-Picea glauca-P. mariana/Calamagrostis* spp. (Foote *1983). Picea glauca-Betula papyrifera/Alnus spp.-Salix spp./Galium boreale* (Yarie *1983). Picea glauca-Betula papyrifera/Alnus crispa/Ledum groenlandicum* (Jorgenson and others *1986). Picea mariana-Betula papyrifera/Arctostaphylos* uva-ursi/lichens (Yarie 1983). *Picea mariana-Betula papyrifera/Ledum decumbens/Vaccinium vitis-idaea* (Yarie 1983).

I.C.1.b. Closed Whlte Spruce-Paper Birch-Balsam Poplar (Black Cottonwood) Forest

Description- These stands are made up of white spruce, paper birch, and either balsam poplar or black cottonwood. The canopy coverage is at least 60 percent.

Distribution and site characteristics- This type has been reported from flood plains in the Susitna River basin in south-central Alaska, but descriptions have not been published.

Successional status- These stands are in a successional sequence leading to a climax of white spruce or mixtures of white spruce and paper birch.

Closely related types- Depending on the proportions of the dominant species in the canopy, these communities could resemble closed white spruce, closed spruce-birch, closed birch, or closed cottonwood communities. These communities also could resemble open birch-cottonwood-spruce communities, but they have more canopy cover.

Primary references-None.

Communities- Picea *glauca-Betula papyrifera-Populus balsamifera (trichocarpa)* (see footnote 2).

I.C.1.c. Closed Spruce-Paper Birch-Quaking Aspen Forest

Description- Dominance in these stands is shared by birch, aspen, and white or black spruce. Only communities with black spruce codominance have been reported to date. Scattered tall shrubs include *Salix bebbiana, S. scouleriana,* and *Betula glandulosa.* A closed low shrub layer is dominated by *Ledum groenlandicum. Vaccinium uliginosum, V. vitis-idaea,* and *Rosa acicularis* are also well represented. Common herbs include *Geocaulon lividurn, Epilobium angustifolium,* and *Lycopodium complanatum.* The ground layer is dominated by the feathermosses *Pleurozium schreberi* and *Hylocomium splendens.*

Distribution and site characteristics- These stands have been reported from interior Alaska at the bases of south-facing slopes. Soils are generally fine grained and moist and have been classified as Cryorthents. Permafrost may be present.

Successional status- These stands are seral and part of a successional sequence after fire. If they remain undisturbed, the birch and aspen will slowly drop out leaving a forest (closed or open) of nearly pure black spruce.

Closely related types- Depending on the proportions of the three dominants, these stands may resemble pure stands of any of the dominant species or spruce-birch, spruce-aspen, or birch-aspen types.

Primary reference- Jorgenson and others 1986.

Communities- Picea *mariana-Betula papyrifera-Populus tremuloides/Ledum groenlandicum* (Jorgenson and others 1986).

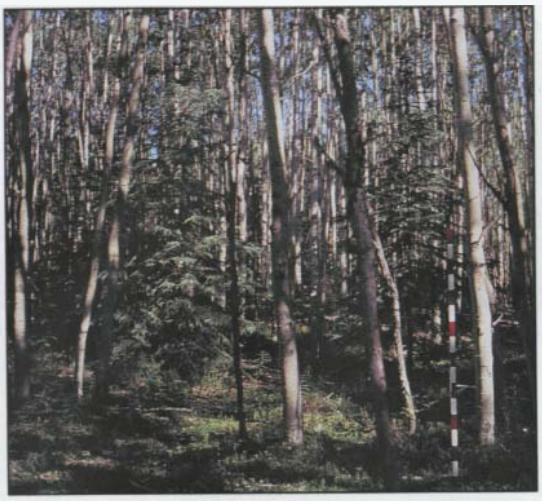

Figure 34-Closed mixed forest of aspen and white spruce with an understory of *Linnaea borealis, Vaccinium vitis-idaea, Lycopodium complanatum,* and *Epilobium angustifolium* in interior Alaska. (Photograph courtesy A. Youngblood)

I.C.1.d. Closed Quaking Aspen-Spruce Forest

Description- These forests are codominated by quaking aspen and white spruce, black spruce, or both (fig. 34). Tree canopy coverage is over 60 percent. Small quantities of balsam poplar may be present in these stands. Spruce seedlings and saplings are usually common. Aspen root suckers may be abundant, but these normally live only a few years and then die. The largest trees of both aspen and white spruce in mature and overmature stands reach about 25 to 30 centimeters (10 to 12 in) d.b.h. and 18 to 22 meters (60 to 72 ft) in height. The aspen in aspen-black spruce stands is smaller. The largest black spruce reach 6 to 7 centimeters (2.5 to 3 in) d.b.h. and 4 to 12 meters (12 to 40 ft) in height. The aspen are taller than the spruce in both cases and begin to die if they are overtopped. The aspen are always even aged; the spruce are usually uneven aged as they come in slowly after the initial establishment of the stand. Stand densities are high in young stands, about 2,500 to 6,000 stems per hectare (1,000 to 2,40O/acre) at 20 years. Density decreases with age, reaching 1,500 aspen stems per hectare (600/acre) and 400 black spruce stems per hectare (160/acre) in aspen-black spruce stands at maturity (60 to 70 years). Density in aspen-white spruce stands decreases to 1,000 to 1,500 stems per hectare (400 to 600/acre) at about 100 years.

Occasional tall shrubs such as Alnus crispa, Salix bebbiana, S. scouleriana, and perhaps other species of *Salix,* usually are present. Rosa acicularis commonly forms an intermittent low shrub layer. Common dwarf shrubs include Vaccinium *vitis-idaea, V. uliginosum, Arctostaphylos uva-ursi, Linnaea borealis,* and *Shepherdia canadensis* in aspen-white spruce stands, and *Vaccinium vitis-idaea, V. uliginosum, Ledum groenlandicum, Linnaea borealis,* and *Arctostaphylos rubra* in aspen-black spruce stands. Common herbs include *Epilobium angustifolium, Equisetum* spp., *Cornus canadensis, Calamagrostis canadensis, Mertensia paniculata,* and *Pyrola* spp. Common mosses on the forest floor of both white spruce and black spruce types are various combinations of *Drepanocladus* spp., *Hylocomium splendens,* and *Polytrichum* spp., with the addition of *Pleurozium schreberi* in stands where black spruce is present. *Peltigera aphthosa* is a common lichen.

Distribution and site characteristics- Aspen-white spruce communities occur on relatively warm, dry sites in interior and south-central Alaska. Aspen-black spruce stands occur on sites made relatively dry, at least temporarily, by fires in terrain normally occupied by black spruce forest. Soils of aspen-black spruce types are commonly Pergelic Cryaquepts developed on loess, bedrock, or alluvium. A thin organic layer (4 to 12 centimeters [2 to 5 in] thick) commonly is present. Permafrost usually is found at depths of 65 to 100 centimeters (26 to 40 in) in aspen-black spruce stands but is absent in aspen-white spruce stands.

Successional status- These stands commonly develop after fires. The aspen typically establishes itself very quickly after fire and is even aged. White spruce usually comes in slowly over many years after the aspen is already established. Black spruce often establishes immediately after a burn because its semiserotinous cones are opened by the heat of the fire; it may also seed in more slowly in densely burned areas. The aspen grows quickly and generally is present in greater numbers than spruce in young stands. The aspen generally begin to decline at 60 to 100 years of age, which allows the spruce to rapidly gain in importance. Fire generally is more destructive to spruce than to aspen because of the thin bark, flammable low-growing foliage, and inability to generate root sprouts (unlike aspen). Fires consequently can transform these stands into more or less pure aspen stands, although spruce ultimately will invade again. In the absence of fire or other severe disturbance, these communities eventually will be transformed into white spruce or black spruce forest.

Closely related types- These communities may be similar to quaking aspen, black spruce, white spruce, and black spruce-white spruce communities but are dominated by a mixture of aspen and spruces. They also may be similar to open aspen-spruce communities but have 60 percent total tree cover or more.

Photographs- Foote 1983, figure 9; Lutz 1956, figure 15; figure 34, this publication.

Primary references- Foote **1983,** Lutz 1956, Yarie 1983.

Communities- *Populus tremuloides-Picea glauca/Arctostaphylos uva-ursi* (Buckley and Libby 1957, Lutz 1956, Viereck 1975). *Populus tremuloides-Picea mariana/Ledum* spp. (Viereck 1975). *Populus tremuloides-Picea mariana/Cornus canadensis* (Foote 1983). *Populus tremuloides-Picea glauca/Salix spp./Epilobium* spp. (Yarie 1983). *Populus tremuloides-Picea glauca/Salix spp./Arctostaphylos uva-ursi* (Yarie 1983). *Populus tremuloides-Picea mariana/Salix* spp./Rosa *acicularis/Equisetum* spp. (Yarie 1983).

I.C.1.e. Closed Balsam Poplar- White Spruce Forest

Description- These forests are made up of balsam poplar and white spruce, usually with the balsam poplar dominating the canopy cover (fig. 35). In stands where white spruce is dominant, the balsam poplar tend to **be** decadent and there are many standing dead trees. In south-central Alaska, the poplars tend to be large, 75 to 100 centimeters (30 to 40 in) d.b.h. with smaller, younger spruce. In interior Alaska,

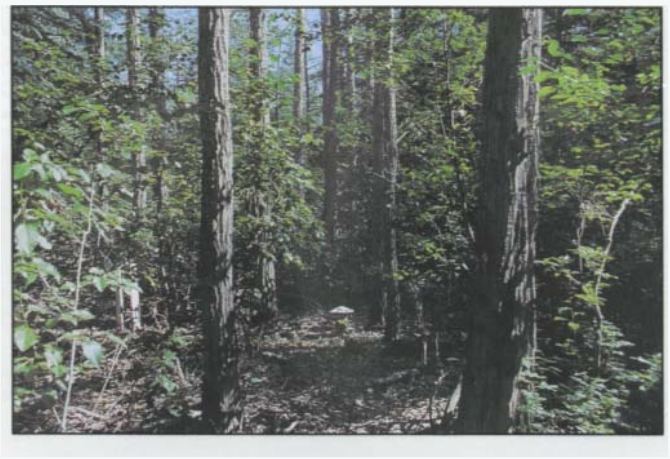

Figure 35-Closed mixed forest of balsam poplar and white spruce with a shrub layer of *Alnus tenuifolia, Viburnum edule,* and Rosa *acicularis* with an herbaceous layer of Equisetum arvense on the flood plain of a river in interior Alaska.

the two species usually are similar in size and age but only 25 to 45 centimeters (10 to 18 in) d.b.h. Scattered openings where poplars have died usually are present. Common tall shrubs include *Alnus* spp. and *Salix* spp. Important low shrubs are *Rosa acicularis, Viburnum edule, Rubus idaeus,* and *Oplopanax horridus.* Common herbs are *Epilobium angustifolium, Galium boreale, Calamagrostis canadensis, Mertensia paniculata, Pyrola* spp., and *Trientalis europaea.*

Distribution and site characteristics- These communities are found on flood plains in interior, south-central, southwestern, and northwestern Alaska. Soils are alluvial, well drained, and poorly developed. Permafrost is absent or very deep.

Successional status- Balsam poplar-white spruce stands are transitional between stands of pure balsam poplar and climax stands of white spruce in the flood-plain successional sequence.

Closely related types- These communities are similar to closed balsam poplar or black cottonwood communities and to closed white spruce communities but are dominated by both species. They also may be similar to open spruce-balsam poplar communities, but tree cover totals 60 percent or more.

Photographs- Figure 35, this publication.

Primary **reference-** U.S. Department of Agriculture 1986.

Communities- *Populus balsamifera-Picea glauca/Alnus spp.lOplopanax horridus* (U.S. Department of Agriculture *1986). Populus balsamifera-Picea glauca/Alnus tenuifolia/Equisetum* spp. (Viereck 1989).

I.C.2. Open Mixed Forest

Open mixed forest communities have from 25 to 60 percent total tree canopy coverage. Tree cover dominance is shared by both needleleaf and broadleaf tree species, with each contributing from 25 to 75 percent.

Figure 36- Open mixed forest of white spruce and paper birch with a shrub layer of *Alnus crispa* and a herbaceous layer dominated by *Calamagrostis canadensis* in south-central Alaska.

I.C.2.a. Open Spruce-Paper Birch Forest

Description- These stands are comprised of paper birch and either white or black spruce (fig. 36). Total tree cover is between 25 and 60 percent. The trees usually are fairly small, though trees in white spruce-paper birch stands may reach 15 meters (50 ft) in height and 20 centimeters (8 in) d.b.h. *Alnus crispa* and various species of willow may be important tall shrubs. Important understory species include *Calamagrostis canadensis* and low shrubs such as *Betula glandulosa, Spiraea beauverdiana, Vaccinium uliginosum, V. vitis-idaea,* and *Ledum decumbens.* Feathermosses such as *Hylocomium splendens* and *Pleurozium schreberi* generally dominate the ground layer. In southwestern Alaska, open white spruce-paper birch stands have been reported from wet sites where the ground layer is a continuous thick mat of *Sphagnum spp.* Both foliose and fruticose lichens are important on some sites.

Distribution and site characteristics- open spruce-paper birch forests occur on several upland sites in interior, south-central, southwestern, and northwestern Alaska. Many of these sites are relatively wet and poorly drained.

Successional status- Successional relations of these communities are poorly understood. Many of these communities appear to be stable and may be climax on some sites. On other sites, with time, the birch is replaced by white or black spruce.

Closely related types-- These communities may be similar to open white spruce, open black spruce, and open paper birch types but are dominated by a mixture of spruce and birch. They also are similar to closed spruce-paper birch communities, but with less than 60 percent cover, and to spruce-birch woodland, but with more than 25 percent cover. They also may be similar to some of the dwarf tree scrub types.

Photographs- Figure 36, this publication.

Primary references- U.S. Department of Agriculture 1986, Viereck 1970b.

Communities- Picea *glauca-Betula papyrifera/Calamagrostis canadensis-Hylocomium splendens* (Hettinger and Janz 1974, Viereck 1975). *Picea glauca-Betula papyrifera/Alnus crispa/Sphagnum* spp. (Viereck 1975). *Picea glauca-Betula papyrifera/Salix planifolia/Sphagnum* spp. (Viereck 1970b). *Picea mariana-Betula papyrifera/Cladonia* spp. (undescribed).

I.C.2.b. Open Quaking Aspen-Spruce Forest

Description-These communities are dominated by mixtures of quaking aspen and white or black spruce. The only communities described (Yarie 1983) have had black spruce as the codominant species; however, open aspen-white spruce stands are known to exist. Both aspen and black spruce are stunted, rarely reaching 10 centimeters (4 in) d.b.h. The aspen usually are taller than the spruce. In one stand described, reproduction of both aspen and black spruce was present but not in sufficient quantities to make canopy closure likely.

Common understory low shrubs include *Rosa acicularis, Vaccinium uliginosum, V. vitis-idaea,* and *Empetrum nigrum.* Common herbs include *Cornus canadensis, Epilobium angustifolium, Calamagrostis canadensis,* and *Pedicularis* spp.

Distribution and site characteristics-Open aspen-black spruce stands are common on uplands of the Porcupine Plateau. The soils generally are Pergelic Cryorthents or Pergelic Cryaquepts. They are poorly drained but may be relatively dry because the surface organic layer has been removed by fire.

Successional status--Open aspen-black spruce stands are common on burned-over lands that previously supported black spruce. These stands probably will persist for some time, until the shorter lived aspen drops out of the stand and the surface organic layer becomes thick enough and the soils cold enough to inhibit growth of aspen roots and root suckers. The resultant climax vegetation is expected to be open black spruce or open black spruce-white spruce forest.

Closely related types-Open aspen-spruce communities are similar to open aspen, open white spruce, and open black spruce communities but consist of more or less equal mixtures of both aspen and spruce. They also are similar to closed aspen-spruce communities but have less than 60 percent tree cover.

Primary reference- Yarie 1983.

Communities- Populus *tremuloides-Picea mariana/Vaccinium uliginosum/ Polytrichum* spp. (Yarie 1983).

I.C.2.c. Open Paper Birch-Balsam Poplar-Spruce Forest

Description- Described stands fitting this community have been dominated by white spruce, paper birch, and black cottonwood. All three species grow taller than 10 meters (32 ft). Tall shrubs include *Alnus* spp. and *salix* spp. Common low shrubs include *Vaccinium uliginosum, V. vitis-idaea, Cornus canadensis, Empetrum nigrum, Spiraea beauverdiana, Rubus arcticus, Rosa acicularis,* and *Ledum groenlandicum.* Common herbs include *Calamagrostis canadensis, Equisetum* spp., *Epilobium angustifolium, Trientalis europaea, Mertensia paniculata, Streptopus amplexifolius,* and *Geranium erianthum.*

Distribution and site characteristics- Spruce-birch-cottonwood forests have been described from creek bottoms in south-central Alaska.

Successional status- The balsam poplar or cottonwood is expected to drop out of the stand over time, thereby leaving white spruce and paper birch. Over even more time, the paper birch also may drop out. In some south-central Alaska settings, paper birch appears to regenerate itself and persist in climax associations (Neiland and Viereck 1977).

Closely related types- Depending on the proportions of the dominant species in the canopy, these communities might resemble open white spruce, open spruce-birch, open paper birch, or open cottonwood communities. They also could resemble closed birch-cottonwood-spruce communities but have less canopy cover (25 to 60 percent).

Primary reference-U.S. Department of Agriculture 1986.

Communities- Betula *papyrifera-Populus balsamifera-Picea glauca (see* footnote 2).

I.C.2.d. Open Spruce-Balsam Poplar

Description- These communities are characterized by white spruce and balsam poplar dominance in the overstory. Total tree cover falls between 25 and 60 percent. Stands described thus far have been dominated by white spruce and balsam poplar. Important shrubs include *Salix* spp. and *Alnus sinuata 2* or more meters (6 or more feet) tall, and *Viburnum edule, Rosa acicularis, Oplopanax horridus,* and *Rubus idaeus* growing 1 to 2 meters (3 to 6 ft) tall. The herbaceous layer includes *Epilobium angustifolium, Cornus canadensis, Trientalis europaea, Pyrola* spp., *Mertensia paniculata, Equisetum* spp. and the ferns *Athyrium filix-femina, Dryopteris dilatata,* and *Gymnocarpium dryopteris.* Mosses are common on the forest floor.

Distribution and site characteristics- open white spruce-balsam poplar forests have been described from south-central Alaska where they occur in rather localized areas within low shrub vegetation at treeline, just above the elevational limit of open white spruce forest. In some locations they appear to be associated with high-elevation streams.

Successional status- The successional status of these stands is unknown.

Closely related types- Open spruce-balsam poplar (black cottonwood) communities are similar to closed poplar-spruce communities but have less than 60 percent tree cover. They also can be similar to open white spruce, open balsam poplar, or open black cottonwood communities but are dominated by mixtures of coniferous and broadleaved trees.

Primary reference- U.S. Department of Agriculture 1986.

Communities- Picea *glauca-Populus balsamifera* (see footnote 2).

I.C.3. Mixed Woodland

Mixed woodland communities have from 10 to 25 percent total tree cover. Dominance in the tree canopy is shared by both needleleaf and broadleaf tree species, with each group contributing from 25 to 75 percent of total tree cover.

I.C.3.a. Spruce-Paper Birch Woodland

Description-Spruce-birch woodlands are dominated by mixtures of paper birch and black spruce or white spruce, or both. Total tree cover is 10 to 25 percent. Published descriptions of these communities are lacking. Spruce-birch woodlands probably are similar to open spruce-birch forests but have less tree cover and the trees generally are smaller.

Distribution and site characteristics- Spruce-birch woodlands have been reported from the Susitna Valley in south-central Alaska.

Successional status- The successional status of these stands is unknown.

Closely related types- Spruce-birch woodlands may be similar to open spruce-birch forests but have less tree cover. Depending on the dominant species present, they can resemble black spruce woodlands, white spruce woodlands, or paper birch woodlands, but they are dominated by mixtures of spruce and paper birch.

Primary reference- Viereck and others 1986.

Communities- Picea *mariana-Betula papyrifera* (see footnote 2).

II. Scrub

Scrub communities have less than 10 percent cover of trees over 10 meters (3 ft) in height. A tree is defined to be an individual of a tree species (for example, *Picea* spp., *Betula papyrifera, Larix laricina, Tsuga* spp., *Abies* spp., *Pinus* spp., *Chamaecyparus* spp., *Thuja* spp., *Taxus brevifolia, Populus* spp., or *Alnus rubra)* that has grown to a height of 3 meters (10 ft) or more at the site under consideration. Scrub communities have 10 percent or more cover of dwarf trees (that is, mature trees less than 3 meters [10 ft] in height) or 25 percent or more cover of shrubs (woody plants of species other than trees), or as little as 2 percent woody plant cover (dwarf trees or shrubs) if no herbaceous or bryoid plants are present.

It is necessary% differentiate between “true” trees and “dwarf” trees only on sites where tree species provide the dominant overstory cover. A stand on a good site with a closed canopy of tall shrubs and abundant spruce seedlings and saplings beneath the shrub canopy is a closed tall shrub stand. It is not a forest, even though the spruce reproduction would be considered “true” trees because they probably will grow to be several tens of meters tall at maturity.

Scrub communities are composed of various combinations of dwarf trees, tall shrubs (over 1.5 meters [5 ft] tall), low shrubs (0.2 to 1.5 meters [8 in to 5 ft] tall), and dwarf shrubs (less than 0.2 meter [8 in] tall). Subshrubs, such as *Dryas* spp., also are considered shrubs. Breaks between open and closed cover and between dwarf, low, and tall canopy heights are arbitrary and intended to be used only as approximate references. When individual stands span these dividing points, observers must use their own judgment and knowledge of the regional vegetation to arrive at a decision on classifying the stand.

II.A. Dwarf Tree Scrub

Dwarf tree scrub communities are dominated by dwarf trees, usually shrublike in form, under 3 meters (10 ft) tall. Tree cover of trees over 3 meters (10 ft) tall is less than 10 percent, and dwarf tree cover is 10 percent or more. Shrubs may be absent or abundant.

II.A.1. Closed Dwarf Tree Scrub

Closed dwarf tree scrub communities are composed of trees less than 3 meters (10 ft) tall. Cover of dwarf trees is 60 percent or more. Trees over 3 meters (10 ft) tall provide less than 10 percent cover.

II.A.1.a. Closed Mountain Hemlock Dwarf Tree Scrub

Description- These communities are dominated by mountain hemlock that are less than 3 meters (10 ft) tall at maturity. On sites with severe exposure to wind, mountain hemlock may form a mat only 30 centimeters (12 in) tall. Total tree cover is at least 60 percent. Sitka spruce sometimes occurs with the hemlock, but other tree species are rare or absent. A sparse low shrub cover of *Vaccinium ovalifolium* may be present. The dwarf shrub layer is well developed and consists of combinations of *Rubus pedatus, Cassiope mertensiana, Vaccinium caespitosum, Empetrum nigrum, Phyllodoce aleutica, Luetkea pectinata, Cassiope stelleriana,* and *Vaccinium uliginosum.* Herb cover is generally low, although scattered clumps of *Fauna crista-galli* may be conspicuous. Important mosses include *Dicranum scoparium, Rhyhdiadelphus loreus, Pleurozium schreberi,* and *Hylocomium splendens.*

Distribution and site characteristics- Closed mountain hemlock dwarf tree scrub communities are found on windblown ridges near treeline in southeast Alaska. Wind and blowing winter snow are the primary factors preventing the trees from growing taller.

Successional status- Successional relations are unknown, but these communities appear to be stable and may be climax for the specialized settings where they occur.

Closely related types- Closed mountain hemlock dwarf tree scrub communities are similar to closed mountain hemlock forests but are composed of smaller trees. They also are similar to open mountain hemlock dwarf tree scrub but have more than 60 percent total tree cover.

Primary reference- Worley 1977.

Communities- Tsuga *mertensiana/Vaccinium ovalifolium/Rubus pedatus/Dicranum scoparium-Rhytidiadelphus loreus* (Worley *1977). Tsuga mertensiana/Vaccinium* spp./Cassiope *mertensiana-Rubus pedatus* (Fox 1983).

II.A.1.b. Closed Subalpine Fir Dwarf Tree Scrub

Description- These communities are dominated by subalpine fir (Abies lasiocarpa) growing less than 3 meters (10 ft) tall. Other tree species that may be present include mountain hemlock and Sitka spruce. Although cones are abundantly produced, viable seed may not be, and the principal method of reproduction seems to be layering. On sheltered sites, these trees grow taller than 3 meters (10 ft) and grade into subalpine fir forest. On highly exposed sites, they may form prostrate mats no more than 15 centimeters (6 in) in height. The associated conifers, if present, do not form mats but project through the subalpine fir mat as erect (though stunted) trees. Species common in the understory include *Phyllodoce aleutica, Cornus canadensis,* and *Fauria crista-galli.*

Distribution and site characteristics- Closed subalpine fir dwarf tree scrub communities are common at tree line on the southeast Alaska mainland and at a few sites on islands. They occur in areas highly exposed to the wind. The wind and the abrasion of blowing snow in the winter are the primary causes of the stunted tree growth.

Successional status- Successional relations have not been studied, but these communities seem to be self-perpetuating and stable.

Closely related types- Closed subalpine fir dwarf tree scrub communities are similar to closed subalpine fir forest communities, but the trees are less than 3 meters (10 ft) tall and usually in krummholz form. They also may grade into closed mountain hemlock dwarf tree scrub and forest communities as mountain hemlock becomes more important in the canopy, usually with decreasing: elevation. As clump size becomes smaller, they may be regarded as scattered trees in various types of alpine shrub vegetation, primarily dwarf scrub mountain-heath tundra communities.

Photographs- Worley and Jacques 1973, figures 2 and 3.

Primary references- Harris 1965, Worley and Jacques 1973.

Communities- Abies *lasiocarpa/Phyllodoce aleutica-Fauria crista-galli* (Harris 1965, Worley and Jaques 1973).

ll.A.2. Open Dwarf Tree Scrub

These communities are composed of dwarf trees (tree species less than 3 meters [10 ft] tall) with a cover of 25 to 60 percent. "True" trees provide less than 10 percent cover. Shrubs may be absent or abundant but usually are fairly common.

ll.A.2.a. Open Black Spruce Dwarf Tree Scrub

Description- These communities are similar to open black spruce forest communities but are composed of trees averaging less than 3 meters (10 ft) in height at maturity. Dwarf tree cover is 25 to 60 percent and "true" tree cover (provided by trees more than 3 meters [10 ft] in height) is less than 10 percent. Dwarf tamarack and paper birch also may be present in addition to the dominant black spruce. The understory is composed mainly of the same shrubs and herbs that make up the open black spruce forest understory.

Distribution and site characteristics- open black spruce dwarf tree scrub communities are common in interior, south-central, and western Alaska on very cold or wet soils barely capable of supporting tree growth. At least 30 cm (12 in) of peat overlies poorly drained mineral soil, which is saturated with water throughout most of the growing season. Permafrost is continuous beneath a shallow, active layer 30 centimeters (12 in) thick in interior and western Alaska but is only sporadic in south-central Alaska. In south-central Alaska, these communities are common on the ridges of string bogs. In inferior Alaska, they may occur on both patterned and unpatterned bogs. They also occur at both the latitudinal and altitudinal tree line.

Successional status- These communities are climax on cold wet sites that cannot support trees taller than 3 meters (10 ft). Many of these sites burn frequently, and stands older than 60 years are rare. Postfire succession is complex and ranges from direct re-establishment of black spruce to successional seres involving various moss-herb, shrub, and tree communities, to the re-establishment of an open black spruce dwarf tree scrub.

Closely related types-Open black spruce dwarf tree scrub communities are similar to open black spruce forests, except that the height of mature trees is less than 3 meters (10 ft). Stands also may be similar to black spruce dwarf tree woodland, but have more than 25 percent cover of dwarf trees.

Photographs- Hogan and Tande 1983, plate 8.

Primary references- Hogan and Tande 1983, Luken and Billings 1983.

Communities- Picea *mariana/Myrica gale-Ledum decumbens/Trichophorum caespitosum/feathermosses-Sphagnum* spp. (Hogan and Tande 1983). *Picea mariana/Ledum decumbens-Vaccinium vitis-idaea/Rubus chamaemorus/Sphagnum* spp. (Luken and Billings 1983). *Picea mariana/Eriophorum vaginatum* (Craighead and others 1988).

II.A.2.b. Open Mountain Hemlock Dwarf Tree Scrub

Description- These communities are dominated by mountain hemlock growing less than 3 meters (10 ft) tall. Total cover of dwarf trees is 25 to 60 percent and total cover of trees taller than 3 meters (10 ft) is less than 10 percent. Other tree species are absent or unimportant, although the tall shrub, Sitka mountain-ash *(Sorbus sitchensis),* is sometimes present. Important low shrubs that have been reported include *Cladothamnus pyrolaeflorus, Menziesia ferruginea,* and *Vaccinium ovalifolium.* The dwarf shrub *Empetrum nigrum* also is common. Common herbs include *Calamagrostis canadensis, Cornus canadensis,* and *Fauria crista-galli.* Dominant mosses are *Pleurozium schreberi, Hylocomium splendens, Rhytidiadelphus loreus,* and *Ptilium crista-castrensis.*

Distribution and site characteristics-open mountain hemlock dwarf tree scrub communities have been reported as copses or islands of low trees within peatlands in southeastern Alaska. These sites are slightly elevated above the general level of the peatlands and, though wet, are substantially better drained than are the peatlands themselves. These communities also may be present on exposed subalpine ridges.

Successional status-Successional relations are unknown, but these communities probably persist for substantial periods and may be climax or near-climax on the specialized sites where they occur,

Closely related types-Open mountain hemlock dwarf tree scrub communities resemble closed mountain hemlock dwarf tree scrub but have a more open canopy. They also are similar to open mountain hemlock forest but are composed of trees less than 3 meters (10 ft) tall.

Primary reference- Worley 1977.

Communities- Tsuga *mertensiana/Cladothamnus pyrolaeflorus/Empetrum nigrum-Calamagrostis canadensis* (Worley 1977).

II.A.3. Dwarf Tree Scrub Woodland

These communities are composed of dwarf trees (tree species less than 3 meters [10 ft] tall) with a cover of 10 to 25 percent. If shrubs, herbaceous vegetation, and bryoid vegetation are lacking, dwarf tree cover can be as low as 2 percent. Trees over 3 meters (10 ft) tall provide less than 10 percent cover. Shrubs may be absent or abundant but usually are common.

ll.A.3.a. Black Spruce Dwarf Tree Woodland

Description- These communities consist of a sparse overstory of stunted black spruce less than 3 meters (10 ft) tall. Total dwarf tree cover is 10 to 25 percent. The communities are very similar to black spruce woodlands but the trees tend to be noticeably shorter and fewer. Other tree species normally are not present. Common understory shrubs include *Betula nana, Ledum decumbens, Vaccinium uliginosum, V. vitis-idaea,* and *Myrica gale. Myrica* generally occurs on the wettest, though not the coldest, sites supporting these communities. Sedges, such as *Eriophorum vaginatum* and *Carex bigelowii,* are common. The moss mat may be either continuous or discontinuous. Common dominants include *Aulacomnium* spp., *Hylocomium splendens,* and *Sphagnum* spp. Lichens, including *Peltigera aphthosa* and *Cladonia* spp., generally are present.

Distribution and site characteristics- Black spruce dwarf tree woodlands are common near tree line in interior, south-central, and western Alaska on cold, wet sites just barely capable of supporting trees. Soils are poorly drained and usually have a surface peat layer at least 30 centimeters (12 in) thick. Permafrost is present 30 to 60 centimeters (12 to 24 in) below the surface in interior and western Alaska but may be absent or sporadic on south-central Alaska sites.

Successional status-Black spruce dwarf tree woodlands appear to be climax. After being burned, these sites pass through several herb and shrub stages before returning to black spruce woodland.

Closely related types- Black spruce dwarf tree woodlands resemble open black spruce dwarf tree scrub but have less than 25 percent dwarf tree cover. They also resemble black spruce woodlands and open black spruce forests but have trees less then 3 meters (10 ft) tall. The more open black spruce woodlands resemble various open scrub communities, such as mixed shrub-sedge tussock bog, shrub birch-ericaceous shrub bog, and mesic shrub birch-ericaceous shrub scrub.

Photographs- Hogan and Tande 1983, plate 7; Tande 1983, plate 18.

Primary references- Hogan and Tande 1983, Tande 1983, Webber and others 1978.

Communities- Picea *mariana/Ledum decumbens/Sphagnum* spp. (Hogan and Tande 1983, Tande 1983, Webber and others 1978). *Picea marianal/Eriophorum vaginatum* (Craighead and others 1988). *Picea mariana/Betula nana/Carex* spp. (Yarie 1983).

II.B. Tall Scrub

Tall scrub communities have at least 25 percent cover of tall (1.5 meters [5 ft] or taller) shrubs, unless tall shrubs are the only plants present; cover then can be as low as 2 percent. Trees contribute less than 10 percent cover and often are absent. Low and dwarf shrubs may be present or absent. Maximum shrub heights of 4 to 6 meters (12 to 20 ft) commonly are attained, and even taller stands may develop on good sites in the southern part of Alaska.

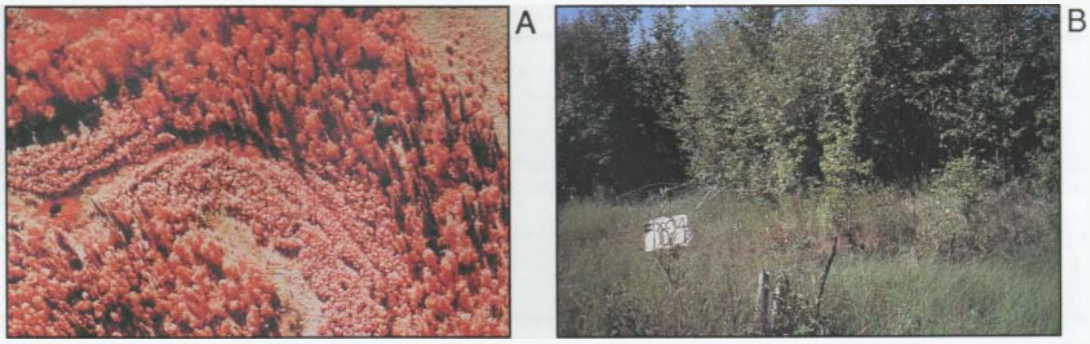

Figure **37-A.** Aerial view of closed tall shrub of willow and alder surrounded by a mixed birch-spruce stand adjacent to a small stream in south-central Alaska. B. Ground view of closed tall shrub shown in A.

II.B.1. Closed Tall Scrub

Closed tall scrub communities have 75 percent or more cover of shrubs 1.5 meters (5 ft) tall or taller (fig. 37, A and B). Tree species overtopping the shrub canopy provide less than 10 percent cover. Seedlings and saplings of tree species may be absent or abundant beneath the shrub canopy. Low shrubs and dwarf shrubs are usually sparse or absent. Mosses may be abundant.

II.B.1.a. Closed Tall Willow Shrub

Description-These stands have about 75 percent or greater cover of shrubs (principally willows) taller than 1.5 meters (5 ft) (fig. 38). Maximum heights range from 2 to 3 meters (6 to 10 ft) in the north to over 6 meters (20 ft) in well-developed thickets in the south. Common dominant species include *Salix alaxensis, S. arbusculoides, S. planifolia,* and *S. lanata,* as well as S. *barclayi* and S. *sitchensis* in the southern part of the State. Sometimes a few alders *(Alnus* spp.) contribute to the overstory canopy, and scattered balsam poplar *(Populus balsamifera)* or black cottonwood *(Populus trichocarpa)* overtop the willows. Low shrubs such as *Potentilla fruticosa, Salix hastata,* and *S. brachycarpa* are usually uncommon and restricted to openings. The understory is sparse in dense stands, though mosses, including *Polytrichum* spp., *Hylocomium splendens,* and *Drepanocladus uncinatus,* may grow abundantly Slightly more open stands may have a dense understory of *Calamagrostis canadensis, Festuca altaica,* and *Equisetum* spp.

Distribution and site characteristics-Closed stands of tall willow are common throughout the State except for the Aleutian Islands and a narrow strip of tundra next to the Arctic Ocean. They are especially common in south-central, western, and interior Alaska and occur primarily on flood plains and streambanks, but they also are common on roadsides, burns, alpine drainageways, and (especially in western Alaska) sheltered slopes and lake margins. Soils usually are well to moderately drained and range in texture from loam to gravel. Permafrost is absent or 50 centimeters (20 in) or more below the surface.

Successional status-Closed tall willow communities on flood plains are successional, usually developing from seral herb communities and eventually replaced by some kind of forest. Tall willow communities developing on burns usually are replaced by forests in the forested parts of the State. In tundra regions, closed tall

Figure 38-Closed tall willow shrub of *Salix* interior, *S. alaxensis, S. novae-angliae, S. brachycarpa,* and *S. lasiandra* and an herbaceous layer of *Equisetum arvense* and *E. pratense* on a river flood plain in interior Alaska.

willow stands slowly degenerate as the permafrost table rises. The willow stands become lower and more open and are eventually replaced by wet sedge meadow or tussock tundra types. Successional relations of stands on sheltered upland slopes are less clear. Some of these stands may persist for long periods.

Closely related types- Closed tall willow communities are similar to open tall willow communities but have greater than 75 percent of their cover in tall shrubs. They also are similar to closed low willow communities, but the canopy height is generally greater than 1.5 meters (5 ft). They are similar to closed tall alder-willow communities but have little or no alder. Some of the moister closed tall willow stands, particularly those dominated by Salix *planifolia,* S. lanata, or S. barclayi, may closely resemble some closed tall shrub swamps, but the shrub swamps are wetter with permanent or semipermanent standing water.

Photographs- Figure 38, this publication.

Primary references- Bliss and Cantlon 1957, del Moral and Watson 1978, Hanson 1953, Racine and Anderson 1979, Viereck 1963.

Communities- *Salix alaxensis* (Bliss and Cantlon 1957, Brock and Burke 1980, Craighead and others 1988, Griggs 1936, Hanson 1953, Johnson and others 1966, Pegau 1972, Racine and Anderson 1979, Spetzman 1959, Viereck 1963). *Salix alaxensis/Calamagrostis* spp.-Equisetum *arvense* (Farjon and Bogaers 1985). *Salix alaxensis/Equisetum arvense* (Craighead and others 1988). *Salix alaxensis-S. glauca-S. lanata* (Drew and Shanks 1965, Komarkova and Webber 1980, Spetzman 1959, Wiggins and Thomas *1962,* Young 1974b). *Salix alaxensis-S. glauca-S. planifolia/ Equisetum arvense* (Craighead and others 1988). *Salix alaxensis-S. planifolia* (Johnson and others 1966, Young and Racine 1977). *Salix alaxensis-S. planifolia-Alnus tenuifolia/Vaccinium uliginosum-Betula glandulosa* (Jorgenson and others *1986). Salix alaxensis-S. arbusculoides-S. glauca/Equisetum arvense-Pyrola grandiflora* (Batten 1977, Bliss and Cantlon *1957). Salix alaxensis-S. arbusculoides/ Calamagrostis canadensis-Equisetum pratense* (Hultén *1966). Salix planifolia* (Craighead and others 1988, Hopkins and Sigafoos 1951, Hultén 1962, Johnson and others *1966). Salix glauca-S. planifolia-S. lanata* (Batten 1977, Childs 1969, Griggs 1936, Hanson 1953, Koranda 1960, Pegau 1968, Racine 1977, Racine and Anderson 1979, Viereck 1962). *Salix barclayi (del* Moral and Watson 1978, Hultén 1960).

Figure 39-Closed tall alder shrub of *Alnus tenuifolia* with an herbaceous layer of *Equisetum arvense, E. pratense, E. palustre, Moeringia laterifolia,* and *Calamagrostis canadensis* on a river flood plain in interior Alaska.

II.B.1.b. Closed Tall Alder Shrub

Description- Closed tall alder stands are dominated by alder *(Alnus* spp.) generally over 1.5 meters (5 ft) tall, with a tall shrub cover of 75 percent or more (fig. 39). Interior stands are generally 1.5 to 4.0 meters (5 to 13 ft) tall, depending on site conditions. *Alnus sinuata* may grow considerably taller. Sometimes tall willows are scattered through the stand, and occasionally a balsam poplar, black cottonwood, or spruce will overtop the shrub canopy. Understory shrubs are generally absent, but scattered *Ribes* spp., Rosa acicularis, and *Rubus spectabilis* (in southeast Alaska) may occur. Understory herbs may be sparse or dense. Common species in this layer include *Calamagrostis canadensis, Equisetum arvense, Aconitum delphinifolium, Epilobium latifolium, E. angustifolium, Mertensia paniculata,* and *Athyrium filix-femina.* A discontinuous mat of mosses, largely feathermosses, may be present. A few lichens may be present.

Distribution and site characteristics- Tall closed alder stands are common on steep subalpine slopes, drainages, and avalanche tracks, at forest edges, flood plains, and along streambanks. *Alnus crispa* commonly dominates on upland and well-drained flood-plain sites in south-central, interior, and western Alaska. *Alnus sinuata* dominates well-drained uplands and avalanche tracks in south-central and southeast Alaska. *Alnus tenuifolia* occasionally will be dominant, but most *A. tenuifolia* stands are shrub swamps. Soils usually are moist loams, often thin and stony.

Successional status- Closed tall alder stands are a topoedaphic climax at many sites, including avalanche tracks, steep alpine slopes, and tundra uplands. Subarctic lowland alder communities eventually will be replaced by forests in most instances; many have established themselves on sites disturbed by fire or land-clearing activities.

Closely related types- Closed tall alder communities resemble closed tall alder-willow communities but have few or no willows. They also resemble open tall alder communities and closed low alder communities but have 75 percent or more cover of shrubs about 1.5 meters (5 ft) tall or taller. Many of the moister closed tall alder communities resemble some shrub swamp communities but are drier, with a less

hummocky substrate and usually are dominated by *Alnus crispa* or *A. sinuata* (as opposed to *A. tenuifolia,* which typically dominates alder shrub swamps). Red alder is considered a tree, so stands of this species are classified as broadleaf forest.

Photographs- Figure 39, this publication.

Primary references- Batten and others 1978; Hanson 1951; Racine and Anderson 1979; Viereck 1962, 1963.

Communities- Alnus *crispa/Calamagrostis canadensis* (Hanson 1953; Hultén 1960, 1962; Jorgenson and others 1986; Racine and Anderson 1979; Viereck 1962; Young and Racine *1977). Alnus crispa-Salix planifolia/Arctagrostis latifolia-Equisetum arvense* (Craighead and others 1988). *Alnus crispa/Spiraea beauverdiana* (Craighead and others *1988). Alnus crispa/Festuca altaica-Arctagrostis latifolia* (Craighead and others *1988). Alnus crispa/Carex bigelowii-Festuca altaica-Arctagrostis latifolia* (Craighead and others 1988). *Alnus crispa/Equisetum arvense* (Craighead and others *1988). Alnus crispa-Salix glauca-S. planifoia/Equisetum arvense* (Craighead and others *1988). Alnus crispa-Salix arbusculoides-S. glauca/Delphinium glaucum-Aconitum delphinifolium-Calamagrostis* spp. (Viereck *1963). Alnus sinuata* (Batten and others 1978, Cooper 1942, Palmer 1942, Young and Racine 1978). *Alnus sinuata/Calamagrostis canadensis* (Hanson 1954; Hultén 1960, 1962; Worley 1980). *Alnus sinuata/Rubus spectabilis* (Heusser 1960, lsleib and Kessel 1973, Streveler and Paige 1971). *Alnus tenuifolia* (Hogan and Tande 1983, Van Cleve and others 1971). *Alnus tenuifolia/Calamagrostis canadensis* (Hanson 1953).

II.B.1.c. Closed Tall Shrub Birch Shrub

Description- These communities are dominated by *Betula glandulosa* or hybrids of *B. glandulosa* and *B. papyrifera.* The shrub canopy is generally 1.5 meters (5 ft) tall or taller and provides 75 percent cover or more. A few tall willows may be present but do not provide much cover.

Distribution and site characteristics- Closed tall shrub birch communities are rather uncommon types that occur primarily in forest openings near tree line in interior Alaska and on moderate, protected slopes beyond tree line in western Alaska, especially on the Seward Peninsula.

Successional status- Successional relations are largely unknown. On sites within tree line, these communities are probably late in a successional sequence that originated after some disturbance.

Closely related types- Closed tall shrub birch communities resemble other shrub birch communities (open tall shrub birch, closed low shrub birch, and open low shrub birch) but differ in having a tall shrub canopy at least 1.5 meters (5 ft) high with a cover of at least 75 percent. They also are similar to closed tall shrub birch-willow communities but have less willow cover.

Primary references- Hanson 1953, Jorgensen and others 1986.

Communities- Betula *glandulosa* (Hanson 1953). *Betula glandulosa/Ledum decumbens-Vaccinium pp.* (Jorgenson and others 1986).

Figure 40-Closed tall alder-willow shrub of *Alnus tenuifolia, Salix alaxensis, S. novae-angliae, S. lasiandra.* and S. *brachycarpa* with an herbaceous layer of *Equisetum arvense, E. palustre,* and *Calamagrostis canadensis* on a river flood plain in interior Alaska.

II.B.1.d. Closed Tall Alder- Willow Shrub

Description- These communities are codominated by alders and willows (fig. 40). The average canopy height is 1.5 meters (5 ft) or more above the ground, and tall shrub cover averages at least 75 percent. The dominant alder is usually *Alnus crispa* or *A. sinuata,* but may occasionally be *A. tenuifolia.* Dominant willows include *Salix alaxensis, S. barclayi, S. sitchensis, S. planifolia, S. glauca, S. lanata,* and S. *arbusculoides.* Within the forested part of the state, scattered trees (Populus spp., *Betula papyrifera,* or *Picea* spp.) may overtop the shrub canopy, but they provide less than 10 percent cover. Understory shrubs are scarce or absent, but seedlings and saplings of tree species (especially spruce) may be present on sites within the forest zone. The herb layer is often sparse and commonly includes *Arctagrostis latifolia, Carex bigelowii,* and *Pyrola grandiflora* in tundra areas and *Calamagrostis canadensis, Equisetum arvense, Athyrium filix-femina,* and *Epilobium* spp. in forested areas. Mosses may be present, but individual species have not been reported.

Distribution and site characteristics- Closed tall alder-willow communities occur on terrace edges and upland drainageways on slopes in northern and western Alaska and on raised beaches, streambanks, and flood plains in interior, south-central, and southeastern Alaska. They also occur as narrow ecotones between forests and various treeless communities. Soil textures range from river gravels to upland loams. Soils usually are adequately drained. Permafrost is absent or at least 50 centimeters (20 in) below the surface.

Successional status- In tundra areas, these communities can probably persist permanently on sites with a thick active layer and adequate drainage. Within the forested part of the State, alder-willow shrub communities are eventually replaced by trees.

Closely related types- Closed tall alder-willow communities are similar to closed tall alder and closed tall willow communities but have a substantial cover of both shrubs. They are similar to open alder-willow communities but have 75 percent or more of tall shrub cover. They also may resemble some shrub swamps but are much drier (lack semipermanent standing water).

Photographs- Figure 40, this publication.

Primary references- Batten and others 1978, Bliss and Cantlon 1957, George and others 1977.

Communities- Alnus *crispa-Salix planifolia/Carex bigelowii* (Craighead and others 1988, George and others 1977, Racine and Anderson 1979). *Alnus crispa-Salix glauca/Arctagrostis latifolia-Pyrola grandiflora* (Churchill *1955). Alnus crispa-Salix lanata-S. planifolia-S. glauca* (Bliss and Cantlon 1957). *Alnus tenuifolia-Salix* spp./ *Equisetum* spp. (Van Cleve and others 1971, Viereck 1989). *Alnus tenuifolia-Salix alaxensis/Calamagrostis canadensis* (Ritchie and others 1981). *Alnus sinuata-Salix barclayi-S. sitchensis* (Batten and others 1978).

II.B.1.e. Closed Tall Shrub Birch- Willow Shrub

Description- These communities are codominated by willows and either shrub birches or shrub birch-tree birch hybrids. The average canopy height is 1.5 meters (5 ft) or more and tall shrub cover is 75 percent or more. Common willows include *Salix planifolia* and *S. lanata.* Occasional trees may overtop the canopy, and alder may be scattered within the canopy of some stands. Low shrubs are sparse or absent; spruce seedlings and saplings may be present. Herb and moss layers probably are present but have not been described.

Distribution and site characteristics-Closed tall shrub birch-willow stands are rare, and have been reported only from near tree line on the Seward Peninsula.

Successional status-Successional relations are unknown, but many of these stands may be fairly stable.

Closely related types-Closed tall shrub birch-willow stands are similar to several other shorter or more open birch-willow stands but have canopies 1.5 meters (5 ft) or more high that provide 75 percent cover or more. They also are similar to closed tall shrub birch and closed tall willow stands, but both birches and willows are codominant.

Primary reference-Hanson 1953.

Communities- Betula *glandulosa-Salix planifolia-S. lanata-Alnus crispa* (Hanson 1953).

II.B.1.f. Closed Tall Shrub Swamp

Description-The unifying characteristic of shrub swamp stands is an excess of moisture with standing water present throughout all or ‘much of the growing season. Closed tall shrub swamps usually are dominated by alder, typically *Alnus tenuifolia. Alnus sinuata* has been reported only rarely as a dominant. Some shrub swamps are dominated or codominated by willows, commonly *Salix planifolia* or *S. lanata.* Sometimes scattered trees rise above the shrub canopy, which is 1.5 meters (5 ft) or more tall (commonly 3 to 5 meters [10 to 16 ft]) and provides at least 75 percent cover. A low shrub layer may be absent or may be represented by such species as *Chamaedaphne calyculata, Viburnum edule, Ribes* spp., *Sambucus callicarpa, Rosa acicularis,* and *Oplopanax horridus.* Common herbs include *Calamagrostis canadensis, Equisetum* spp., *Cornus canadensis, Trientalis europaea, Potentilla palustris,* and *Carex* spp. *Sphagnum* spp. or various other hydrophytic mosses such as *Calliergon sarmentosum* are usually present.

Distribution and site characteristics- Closed tall shrub swamps are common in interior, south-central, and southeastern Alaska on marshy streambanks, poorly drained forest openings, bog edges, seepage areas below bluffs, and other poorly drained sites with relatively nutrient-rich water. The substrate is usually hummocky, with water in the depressions throughout all or much of the growing season. The water is not stagnant but moves slowly through the system. The substrate generally consists of fine-textured mineral soil, sometimes with substantial quantities of inter-mixed, well-decomposed organic matter and sometimes with **a** thin surficial peat layer. Soil reaction is normally circumneutral to acid but usually above pH 5.0.

Successional status- These communities probably represent topoedaphic climaxes in many cases and will persist as long as the hydrologic conditions causing seepage and flooding persist.

Closely related types-Closed tall shrub swamps resemble closed tall alder, willow, and alder-willow stands but are much wetter. *Alnus tenuifolia* is a common (but not universal) dominant of shrub swamps and rarely dominates scrub communities on mesic sites. Closed tall shrub swamps are also similar to open tall shrub swamps but have 75 percent or more of tall shrub cover.

Photographs-- Crow 1968, figure 9; Hogan and Tande 1983, plate 9; Tande 1983, plate 19.

Primary references- Batten and others 1978, Crow 1968, Hogan and Tande 1983, Ritchie and others 1981, Tande 1983, Webber and others 1978.

Communities- Salix *planifolia/Calamagrostis canadensis/Sphagnum* spp. (Webber and others 1978). *Alnus tenuifolia/Calamagrostis canadensis* (Batten and others 1978, Hanson 1953, Quimby 1972). *Alnus tenuifolia/Carex aquatilis* (Ritchie and others 1981). *Betula papyrifera-Alnus tenuifolia/Calamagrostis canadensis* (Hogan and Tande 1983, McCormick and Pichon 1978, Ritchie and others 1981, Tande *1983). Alnus sinuata/Calamagrostis canadensis* (Crow 1968, Scheierl and Meyer 1977).

II.B.2. Open Tall Scrub

This includes communities of tall (1.5 meters [5 ft] or taller) shrubs with open (25 to 75 percent tall shrub cover) canopies. Low shrubs may be abundant or absent. Tall shrub cover may be as low as 2 percent if mosses, herbs, and low shrubs are absent.

II.B.2.a. Open Tall Willow Shrub

Description-These are communities where the overstory canopy is dominated by willows about 1.5 meters (5 ft) high or higher, with a tall shrub cover of 25 to 75 percent (fig. 41). Common dominant species include *Salix alaxensis, S. glauca, S. barclayi, S. planifolia, S. lanata,* and *S. bebbiana.* Scattered trees, primarily white spruce and balsam poplar, may be present but total less than 10 percent cover. Low shrubs are unusual, but *Salix brachycarpa, Rosa acicularis, Shepherdia canadensis,* or others are sometimes present. The herb layer may be sparse or dense. If sparse, it is usually composed of species common in seral herb communities, such as *Oxytropis* spp., Astragalus spp., Epilobium latifolium, and Artemisia spp.; denser herb

Figure 41- Open tall willow shrub of *Salix bebbiana* with a low shrub layer of *Vaccinium uliginosum* and *Ledum groenlandicum* and a herbaceous layer of *Equisetum arvense* and *Epilobium angustifolium* that has developed after a fire in black spruce in interior Alaska.

layers may contain *Calamagrostis canadensis, Epilobium angustifolium, Geranium erianthum, Aconitum delphinifolium,* and other forbs. Mosses may be common or absent. *Rhacomitrium canescens* may be present on dry gravelly sites; *Polytrichum* spp., *Hylocomium splendens,* and *Drepanocladus uncinatus* may be common on mesic sites. Lichens are generally rare, which reflects the early successional status of most of these stands.

Distribution and site characteristics- open tall willow communities occur on flood plains and recent outwash deposits. They also occur on sand dunes, in drainage-ways, and on sheltered slopes. They are common throughout most of the State except for southeastern Alaska and the Aleutian Islands. The substrate consists of excessively drained alluvial sands and gravels or loams. The coarser substrates tend to be quite dry except when flooded. Flood-plain sites are subject to periodic flooding. Most flood-plain sites lack relief, but in some fine-textured soils, hummocks and hollows may be present. In forested areas permafrost is absent or far below the surface; in tundra areas the active layer may be as shallow as 30 centimeters (12 in).

Successional status- Flood-plain open tall willow communities frequently develop from seral herb communities as willow seedlings grow and begin to dominate. In forested parts of the State, most of these communities will be replaced by trees after several intermediate stages if the communities are not redisturbed by flooding or erosion. In tundra areas, the willows eventually become decadent and do not grow as tall as an organic soil layer builds up and soil temperatures decrease. The willows usually are replaced by dwarf shrub-sedge tussock tundra or, in some cases, wet sedge meadow tundra. Successional relations of nonflood-plain open tall willow stands are mostly unknown.

Closely related types- Open tall willow communities are similar to closed tall willow communities but have less than 75 percent cover. They also are similar to open low willow communities but are taller with canopy heights averaging 1.5 meters (5 ft) or more. Some stands may be similar to open tall alder-willow or open tall birch-willow, but alders and birches are absent or only minor components of willow communities.

Photographs- Figure 41, this publication.

Primary references- Hanson 1951, Ritchie and others 1981, Viereck 1970a, Webber and others 1978.

Communities- Salix *alaxensis-S. glauca* (Komarkova and Webber 1980). *Salix alaxensis/Arctostaphylos rubra* (Webber and others *1978). Salix alaxensis/Astragalus alpinus-Epilobium latifolium* (Webber and others 1978). *Salix alaxensis/Shepherdia canadensis/Dryas octopetala-Arctostaphylos rubra-Cladonia pyxidata (Scott* 1974a). *Salix alaxensis/Equisetum arvense* (Craighead and others 1988). *Salix alaxensis-S. glauca-S. planifolia/Equisetum arvense* (Craighead and others 1988). *Salix alaxensis/ Rhacomitrium canescens* (Viereck 1970a). *Salix brachycarpa-S. barclayi-S. glauca/ Hylocomium splendens* (Viereck 1966). *Salix planifolia-S. glauca/Calamagrostis canadensis-Epilobium angustifolium-Equisetum pratense* (Young and Racine 1978). *Salix lanata-S. planifolia* (Hanson *1951). Salix barclayi-S. glauca/Calamagrostis canadensis* (Ritchie and others 1981). *Salix barclayi-S. glauca/Carex lyngbyaei* (Ritchie and others 1981). *Salix bebbiana/Calamagrostis canadensis* (Ritchie and others 1981).

II.B.2.b. Open Tall Alder Shrub

Description- These communities have an open (25 to 75 percent cover) canopy of tall shrubs (about 1.5 meters [5 ft] or more), primarily alders. Dominant alders include *Alnus crispa, A. sinuata,* and (more rarely) *A. tenuifolia.* Tree species (primarily balsam poplar and white spruce) occasionally may overtop the alder canopy, but they provide less than 10 percent cover. Low shrubs may be absent or common. *Betula glandulosa, Vaccinium uliginosum,* and *Ledum* spp. often are common in tree-line stands. *Calamagrostis canadensis* often dominates the herb layer, especially in lowland stands; *Carex bigelowii* may be common in tree-line stands. Mosses and lichens have not been reported.

Distribution and site characteristics-open tall alder communities are found near the altitudinal tree line, on old burns, and on creek and river banks in interior and south-central Alaska. Soils mostly are undescribed but moist silty loams have been reported. Soils are not flooded or water saturated (in contrast to those of shrub swamp communities, ll.B.2.f.). Permafrost probably is absent or soils have a thick active layer.

Successional status- Successional relations are unknown for the most part. Many alder stands on slopes below tree line will be replaced by forests. Stands at tree line and along riverbanks subject to periodic flooding may be relatively stable.

Closely related types- Open tall alder communities have a more open (less than 75 percent cover) canopy than closed tall alder communities and are taller than open low alder communities. They also are similar to open tall shrub swamps (which often are dominated by *Alnus tenuifolia)* but are drier.

Photographs- Tande 1983, plate 20.

Primary references- Brock and Burke 1980, Tande 1983, Wibbenmeyer and others 1982.

Communities- Alnus *crispa/Calamagrostis canadensis* (Young and Racine 1977). *Alnus crispa/Vaccinium uliginosum* (Brock and Burke *1980). Alnus crispa/Spiraea beauverdiana* (Craighead and others 1988). *Alnus crispa/Carex bigelowii-Festuca altaica-Arctagrostis latifolia* (Craig head and others 1988). *Alnus crispa/Festuca altaica-Arctagrostis latifolia* (Craighead and others 1988). *Alnus sinuata/ Calamagrostis canadensis* (Crow *1968). Alnus tenuifolia/Calamagrostis canadensis* (Tande 1983).

II.B.2.c. Open Tall Shrub Birch Shrub

Description- These communities are dominated by shrub birch averaging 1.5 meters (5 ft) or more in height with 25 to 75 percent tall shrub cover. Communities of shrub birch 1 to 2 meters (3 to 6 ft) tall have been reported (Batten and others 1979) but are classed with open low shrub birch communities rather than dividing the communities into low and high phases.

Distribution and site characteristics-These communities are not nearly as common as low shrub birch communities but may exist near tree line in the Alaska Range.

Communities-Undescribed.

II.B.2.d. Open Tall Alder- Willow Shrub

Description- These communities have an open canopy (25 to 75 percent cover) of tall shrubs (1.5 meters [5 ft] or taller) codominated by alder and willow (fig. 42). Common dominants include *Alnus crispa, A. sinuata, Salix lanata, S. glauca, S. planifolia,* and *S. barclayi.* At sites below tree line, occasional trees might overtop the shrub canopy, but these provide less than 10 percent cover. Low shrubs, such as *Betula glandulosa, Ledum decumbens,* and *Vaccinium uliginosum,* are common. *Calamagrostis canadensis* may be abundant. *Carex bigelowii* may be abundant at tree line sites, and *Sphagnum* spp. may dominate the ground layer on-cold, moist sites.

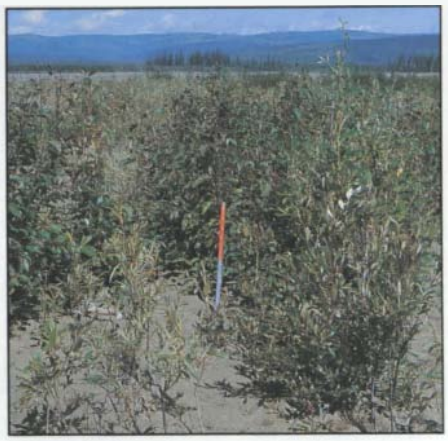

Figure 42-Open tall alder-willow shrub of *Alnus tenuifolia, Salix alaxensis, S. interior,* and *S. brachycarpa* on a river flood plain in interior Alaska.

Distribution and site characteristics- Open tall alder-willow shrub communities have been reported from flood plains, gentle slopes, and steep north slopes near and above tree line in interior, northern, and southwestern Alaska. Soils may be moderately well-drained loams on lowland sites or stony lithosols with thick organic mats on alpine north slopes. Permafrost may be present at some sites.

Successional status- In the generally forested part of the State, many of these stands will be replaced by forest vegetation. Above and beyond the trees, these communities may be a topoedaphic climax on terrace edges and steep slopes. Elsewhere they may become progressively shorter amd more open, eventually to be replaced by dwarf shrub-tussock tundra or wet sedge meadow.

Closely related types- These communities resemble closed tall alder-willow and open low alder-willow communities but have less than 75 percent cover and an average canopy height of 1.5 meters (5 ft) or more. They also resemble some open tall shrub swamp communities but are drier, without standing water.

Photographs- Figure 42, this publication.

Primary references- Viereck 1963, Wibbenmeyer and others 1982.

Communities- Alnus *crispa-Salix lanata-S. planifolia/Ledum decumbens-Carex bigelowii/Sphagnum* spp. (Viereck *1963). Alnus crispa-Salix planifolia/Carex bigelowii* (Craighead and others 1988).

II.B.2.e. Open Tall Shrub Birch- Willow Shrub

Description- These stands have an open canopy (25 to 75 percent cover) of tall (1.5 meters [5 ft] or greater) shrubs dominated by shrub birches and willows. Dominant species include *Betula glandulosa, Salix planifolia,* and *S. lanata.* **Tree** species, especially spruce, may overtop the shrub canopy, but they provide less than 10 percent cover. *Alnus crispa* sometimes may be scattered in the tall shrub canopy. Low shrubs, such as *Salix fuscescens, Spiraea beauverdiana, Ledum decumbens,* and *Vaccinium uliginosum,* may be present. *Calamagrostis canadensis, Festuca altaica,* and *Mertensia paniculata* may be abundant in some stands. Mosses, including *Sphagnum* spp., may form extensive mats in wetter areas, and fruticose lichens (such as *Cladonia* spp. and *Stereocaulon tomentosum)* are locally abundant in drier, more open stands.

Distribution and site characteristics- open tall shrub birch-willow stands occur on moderate upland slopes near the western and altitudinal tree-line, especially in the Alaska Range and on the Seward Peninsula. Soils are often moist silt loams, though no detailed descriptions are available. Permafrost may be present at some sites, probably at depths of 50 centimeters (20 in) or more.

Successional status- Successional relations are unknown. In their position near tree line, these communities may be fairly stable, perhaps occupying sites sub-marginal for tree growth but sufficiently warm to inhibit organic matter accumulation, soil cooling, and other edaphic phenomena leading to tundra development.

Closely related types- Open tall shrub birch-willow stands are similar to closed tall and open low birch-willow but are more open (25 to 75 percent cover) than the former and taller (1.5 meters [5 ft] tall or more) than the latter. They also are similar to open tall shrub birch and open tall willow stands but are equally dominated by both shrub genera.

Primary reference-Hanson 1953.

Communities- Betula *glandulosa-Salix planifolia-S. lanata-Alnus crispa* (Hanson 1953).

II.B.2.f. Open Tall Shrub Swamp

Description- These are wetland scrub communities with waterlogged soils and standing water throughout all or much of the growing season. They are characterized by an open (25 to 75 percent cover) canopy of tall (1.5 meters [5 ft] or more) shrubs. Common dominants include *Alnus tenuifolia, Salix planifolia,* and *S. lanata.* Sometimes *Alnus crispa* **or** *A. sinuata* may be dominant or codominant, especially where *A. tenuifolia* is absent from the flora. Tree species occasionally may overtop the shrub canopy but provide less than 10 percent cover. Low shrubs that may be common include *Myrica gale, Spiraea beauverdiana, Viburnum edule, Rosa acicularis,* and *Ribes triste.* A dense herb layer often is present and can include species such as *Calamagrostis canadensis, Carex aquatilis, Equisetum arvense, E. fluviatile, Potentilla palustris,* and *Polemonium acutiflorum.* Mosses, including *Mnium* spp., feathermosses, and sometimes *Sphagnum* spp., are common but usually discontinuous. Lichens are scarce.

Distribution and site characteristics-open tall shrub swamps occur on wet soils on flood-plain terraces, on wet creek banks and drainageways, and in other places receiving seepage or relatively nutrient-rich water in interior and south-central Alaska. The substrate is usually hummocky, with microrelief of up to 70 centimeters (28 in). The hollows are usually flooded with water. This water is generally not stagnant but flows slowly through the system. Soils may be mineral, a mixture of well-decomposed organic material and mineral material, or sometimes peat. Soil pH is circumneutral to slightly acid (ca. 6). Permafrost is generally absent but may be present at the northernmost sites.

Successional status- Successional relations are unknown. Most stands probably are fairly stable as long as the hydrologic regime remains constant.

Closely related types- Open tall shrub swamp communities are similar to closed tall shrub swamp communities but have more open shrub canopies (25 to 75 percent tall shrub cover). They also are similar to open tall willow, alder, and alder-willow communities but are wetter, with saturated soils and standing water during all or much of the growing season. *Alnus tenuifolia,* rarely dominant in nonwetland communities, commonly dominates shrub swamps. Some communities may be similar to willow-graminoid scrub bogs but have taller shrubs and usually have a substantial alder component.

Photographs- Hogan and Tande 1983, plate 5.

Primary references- Brock and Burke 1980, Hogan and Tande 1983, Ritchie and others 1981.

Communities- Alnus *tenuifolia/Carex aquatilis-Calamagrostis canadensis* (Ritchie and others 1981). *Alnus tenuifolia/Myrica gale-Calamagrostis canadensis* (Ritchie **and** others 1981). *Alnus tenuifolia/Rosa acicularis-Calamagrostis canadensis* (Hogan and Tande 1983). *Salix planifolia-Alnus crispa/Betula nana-Calamagrostis* spp. (Brock and Burke 1980).

1I.C. Low Scrub

These communities are dominated by low shrubs (shrubs 20 centimeters [8 in] to 1.5 meters [5 ft] tall). Specifically, these communities have at least 25 percent cover by shrubs at least 20 centimeters (8 in) tall; trees provide less than 10 percent cover and tall shrubs (taller than 1.5 meters [5 ft]) provide less than 25 percent cover. Dominant plants are generally alders, willows, and shrub birches. *Myrica gale, Potentilla fruticosa,* and some ericaceous shrubs may dominate some communtites. Some ericaceous shrubs transcend the boundary between dwarf scrub and low scrub. In general, *Vaccinium uliginosum* and *Ledum* spp. are considered to be low shrubs; *Empetrum nigrum, Vaccinium vitis-idaea, Arctostaphylos* spp., *Loiseleuria procumbens,* and *Diapensia lapponica* are considered to be dwarf shrubs. Communities containing shrub birch as a codominant species always are placed in either the tall or low scrub unit.

II.C.1. Closed Low Scrub

Closed low scrub includes communities with at least 75 percent cover by shrubs 20 centimeters (8 in) tall or taller. Trees provide less than 10 percent cover and shrubs over 1.5 meters (5 ft) tall provide less than 25 percent cover.

Figure 43-Closed low birch shrub of *Betula glandulosa* with scattered *Salix planifolia* subsp. *pulchra, S. glauca, Calamagrostis canadensis,* and *Epilobium angustifolium* between the birch dumps, just above treeline on the south slope of the Alaska Range in south-central Alaska.

II.C.1.a. Closed Low Shrub Birch Shrub

Description- These communities have at least 75 percent of their cover by shrubs at least 20 centimeters (8 in) tall (fig. 43). Trees provide less than 10 percent cover and shrubs over 1.5 meters (5 ft) tall provide less than 25 percent cover. Trees and tall shrubs usually are absent. The low shrub (0.2 to 1.5 meters [8 in to 5 ft] tall) canopy is dominated by shrub birch (Betula glandulosa or B. nana). Sometimes scattered willows also are present in the overstory. Lower shrubs, such as Vaccinium uliginosum and Empetrum *nigrum,* may be common under the birch canopy and in small openings. Herbs generally are scarce, but feathermosses commonly form a continuous mat and lichens may be common.

Distribution and site characteristics- Closed low shrub birch communities occur on river terraces in interior Alaska and on steep slopes and banks on the Seward Peninsula. The soil is fairly well drained and usually has an organic mat up to 30 centimeters (12 in) thick. Acid conditions predominate especially in the organic mat, which may be at least as acidic as pH 4.5. Permafrost is usually absent or at least 50 centimeters (20 in) below the surface.

Successional status- On terraces, the successional trend is usually toward increasing organic layer thickness, decreasing soil drainage and temperature, and decreasing size and density of shrubs. On such sites, shrub birch communities tend to be slowly transformed into shrub-tussock communities. On steep slopes and banks, closed low shrub birch communities may be a topographic climax.

Closely related types- Closed low shrub birch communities are similar to closed tall shrub birch communities and open low shrub birch communities, but the birches are less than 1.5 meters (5 ft) tall on the average and provide at least 75 percent cover. Closed low shrub birch-willow shrub has more willow.

Photographs- Viereck 1966, figure 8; figure 43, this publication.

Primary references- Hopkins and Sigafoos 1951, Racine and Anderson 1979, Viereck 1966.

Communities- *Betula nana* (Craighead and others 1988, Hopkins and Sigafoos 1951, Racine and Anderson 1979). *Betula glandulosa/Pleurozium schreberi-Hylocomium splendens* (Viereck 1966).

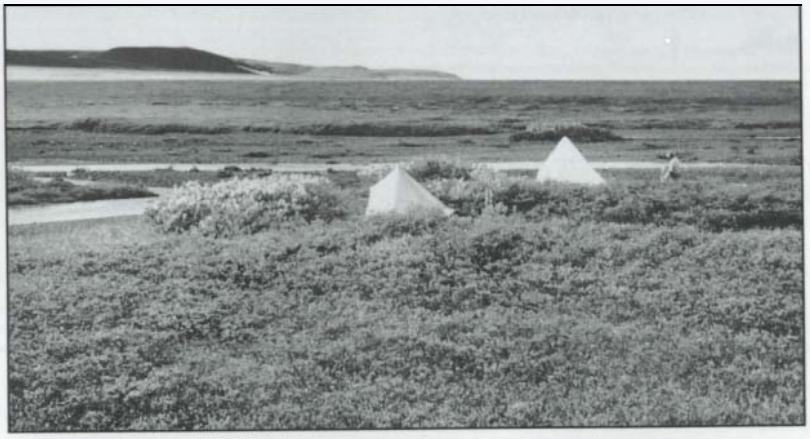

Figure 44-Closed low willow shrub of *Salix planifolia* subsp. *pulchra* along a small stream in northwest Alaska.

II.C.1.b. Closed Low Willow Shrub

Description- These communities have at least 75 percent cover by shrubs at least 20 centimeters (8 in) tall (fig. 44). Trees provide less than 10 percent cover, and shrubs over 1.5 meters (5 ft) tall are absent or provide less than 25 percent cover. Willows commonly dominating the shrub canopy include *Salix glauca, S. planifolia,* and S. lanata. *Myrica gale* also may be present on wet sites. Common species in the herb layer include *Calamagrostis canadensis, Equisetum* spp., *Sanguisorba stipulata, Lathyrus palustris, Festuca rubra, Amemone* spp., and *Astragalus alpinus.* Feather-mosses, especially *Hylocomium splendens,* often are common.

Distribution and site characteristics- Closed low willow communities occur in moist protected gullies and drainageways, streambanks, and on steep scarps around lakes and ponds in arctic and alpine tundra of interior, northern, and western Alaska. They also are present on major river deltas in south-central Alaska and probably at the fringes of other low-elevation wetlands in south-central and interior Alaska. Soils are usually moist and fairly well drained. A thin organic layer may be present. Stands in topographic depressions (gullies and drainageways) are protected by a thick layer of snow during winter, which melts relatively early in the spring. Permafrost usually is absent or at least 50 centimeters (20 in) below the surface.

Successional status- Communities in depressions in tundra regions may represent topoedaphic climaxes. If they change at all, it is probably in the direction of shrub-tussock tundra. Lowland communities in south-central and interior Alaska are replaced eventually by forests, but this may take a long time, especially on the wetter sites.

Closely related types- Closed low willow shrub is similar to closed tall willow shrub and open low willow shrub but has less than 25 percent cover of shrubs over 1.5 meters (5 ft) tall and at least 76 percent cover in shrubs 20 centimeters (8 in) and taller. Closed low shrub birch-willow is codominated by dwarf birch and willow.

Photographs- Racine and Anderson 1979, figure 4; figure 44, this publication.

Primary references- Churchill 1955; Crow 1968; Racine and Anderson 1979; Viereck 1962, 1963.

Communities- *Salix planifolia* (Craighead and others *1988). Salix planifolia-Vaccinium* spp./Arctagrostis *latifolia* (Craighead and others *1988). Salix planifolia-S. lanata-Myrica gale/Calamagrostis canadensis* (Craighead and others 1988). *Salix planifolia/Equisetum arvense* (Webber and others *1978). Salix glauca-S. planifolia-S. lanata/Equisetum arvense* (Craighead and others 1988; Pegau 1968; Racine 1977; Racine and Anderson 1979; Viereck *1962, 1968). Salix glauca/Petasites frigidus* (Churchill 1955). *Salix lanara/Carex* spp. (Craighead and others 1988). *Salix lanata/Equisetum* spp. (Craighead and others 1988). *Salix lanata/Carex aquatilis-Equisetum arvense* (Scott 1974a). *Salix* spp./festuca *rubra* (Crow 1968). *Salix* spp./Equisetum *pratense* (Crow 1968).

II.C.1.c. Closed Low ***Shrub*** *Birch-Willow Shrub*

Description- These communities have at least 75 percent cover by shrubs at least 20 centimeters (8 in) tall (fig. 45). Trees provide less than 10 percent cover and shrubs over 1.5 meters (5 ft) tall provide less than 25 percent cover. The shrub canopy is dominated by shrub birch *(Betula glandulosa* or *B. nana)* and willows (commonly *Salix planifolia* and *S. lanata).* The herb layer is usually sparse. Mosses, such as *Hylocomium* spp and *Aulacomnium spp.,* form a mat under the shrubs.

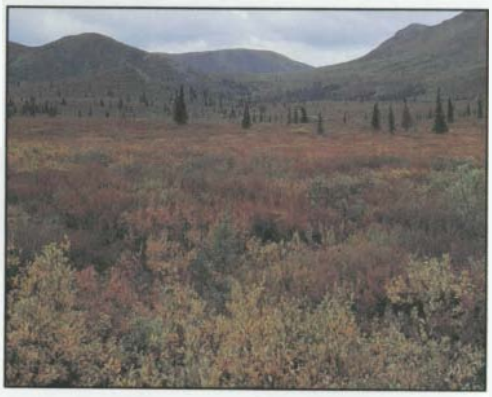

Figure 45--Closed low mixed birch and willow shrub of *Betula glandulosa, Salix lanta* subsp. *richardsonii,* S. *glauca.* and *Salix planifolia* subsp. *pulchra* with scattered white spruce on a river terrace in the Alaska Range.

Distribution and site characteristics- Closed low shrub birch-willow shrub is uncommon vegetation that has been reported from the northern foothills of the Brooks Range, where it occupies colluvial deposits near valley bottoms. Soils are generally Pergelic Cryaquepts or Histic Pergelic Cryaquepts. Microrelief patterns are absent. Permafrost is present, but thickness of the active layer is unknown.

Successional status- Shrub birch-willow shrub often is replaced by shrub-tussock tundra or wet sedge meadow, depending on soil moisture. This probably takes a long time, and it may be better to consider these communities as topoedaphic climaxes.

Closely related types- Closed low shrub birch-willow shrub is similar to closed tall shrub birch-willow shrub and open low shrub birch-willow shrub but has at least 75 percent shrub cover and less than 25 percent tall shrub cover. It also is similar to closed low shrub birch shrub and closed low willow shrub but has a dominant component of both shrub birch and willow.

Photographs- Figure 45, this publication.

Primary reference- Jorgenson 1984.

Communities-- Betula *nana-Salix planifolia/Hylocomium splendens-Aulacomnium turgidurn* (Jorgenson 1984). *Betula nana-Salix planifolia-Ledum decumbens* (Craighead and others 1988). *Betula nana-Salix planifolia/Petasites frigidus* (Craighead and others 1988). *Betula nana-Salix planifolia-Vaccinium uliginosum* (Craighead and others 1988).

II.1.d. Closed Low Ericaceous Shrub

Description- These rare communities have at least 75 percent cover by shrubs at least 20 centimeters (8 in) tall. Trees provide less than 10 percent cover and shrubs over 1.5 meters (5 ft) tall provide less than 25 percent cover. These communities are dominated by ericaceous shrubs having a true shrub physiognomy. The only closed low ericaceous shrub community described to date is dominated by copperbush *(Cladothamnus pyrolaeflorus).* This shrub forms dense thickets with no important associated species.

Distribution and site characteristics-Copperbush communities have been reported from near tree line in southeast Alaska, where they commonly occur in depressions and at the bases of steep banks where deep snow accumulates in the winter and persists until late spring.

Successional status- Copperbush communities appear to be a topoedaphic climax in areas of deep snow accumulation.

Closely related types- Closed low ericaceous shrub may be similar to dwarf ericaceous shrub tundra (II.D.l.g.) but are dominated by ericaceous shrubs that characteristically grow much taller than the 20-centimeter (8-in) boundary between dwarf shrubs and low shrubs.

Primary reference-- Shacklette 1965.

Communities- Cladothamnus *pyrolaeflorus* (Shacklette 1965).

II.C.1.e. Closed Low Alder- Willow Shrub

Description- These communities have at least 75 percent cover by shrubs at least 20 centimeters (8 in) tall. Trees provide less than 10 percent cover and shrubs over 1.5 meters (5 ft) tall provide less than 25 percent cover. The shrub canopy is codominated by alder and willow. Species of alder and willow present in these communities have not been documented but probably include *Alnus crispa, A. sinuata, Salix glauca, S. barclayi, S. planifolia,* and *S. lanata.* Dwarf ericaceous shrubs, such as *Arctostaphylos alpina, Empetrum nigrum,* and *Vaccinium vitis-idaea* may be common in the understory. Nonsphagnaceous mosses also are common.

Distribution and site characteristics- Closed low alder-willow communities have been reported from southeastern Alaska on poorly to moderately drained soils on flood plains and gentle slopes. They also may occur in other pans of the State, particularly interior and western Alaska near and beyond tree line.

Successional status- On gentle slopes beyond the treeline, these may be climax communities or at least stable over long periods. In flood-plain stands shrub density, soil drainage, and soil temperature probably decrease with time, resulting in replacement of shrub community by open forests or shrub tundra, depending on soil or climate.

Closely related types-Closed low alder-willow communities are similar to closed tall alder-willow communities and open low alder-willow communities, but the canopy is primarily less than 1.5 meters (5 ft) tall and provides at least 75 percent cover. These communities also are similar to closed low willow communities but have a substantial alder component.

Primary reference- Wibbenmeyer and others 1982.

Communities- Alnus spp.-Salix spp. (Wibbenmeyer and others 1982).

II.C.2. Open Low Scrub

Open low scrub communities are characterized by an open canopy (25 to 75 percent cover) of low shrubs (0.2 to 1.5 meters [8 in to 5 ft] tall). More specifically, they have 25 to 75 percent cover by shrubs at least 20 centimeters (8 in) tall, shrubs taller than 1.5 meters (5 ft) provide less than 25 percent cover, and trees overtopping the shrub canopy provide less than 10 percent cover. If low shrubs are the only plants present, cover can be as low as 2 percent. Many shrubby wetlands and tundra types are included in this unit. Many ericaceous shrubs sometimes grow shorter than 20 centimeters (8 in) and sometimes grow taller. In practice, ericaceous shrub communities on wetlands and those containing shrub birch are treated as open low scrub. Other ericaceous shrub communities (primarily alpine heath vegetation) are treated in the dwarf scrub unit (II.D.).

II.C.2.a. Open Low Mixed Shrub-Sedge Tussock Tundra

Description- These communities have at least 25 percent shrub cover and are dominated by tussock-forming sedges, usually *Eriophorum vaginatum* but sometimes *Carex bigelowii.* Tussocks are commonly 5 to 30 centimeters (2 to 12 in) high and 15 to 35 centimeters 6 to 14 in) wide, often with **a** density of 2-4 tussocks per square meter (10.8/ft^2) (Hopkins and Sigafoos 1951, Racine and Anderson 1979). Trees are absent or very scarce. Mosses and dwarf shrubs form **a** mat surrounding the tussocks. Common shrubs include *Betula glandulosa, B. nana, Ledum decumbens, Vaccinium vitis-idaea,* and *V. uliginosum.* Other shrubs sometimes common include *Empetrum nigrum* (especially in western Alaska), *Rhododendron lapponicum* (especially in calcareous areas), *Salix planifolia, S. reticulata,* and *Arctostaphylos rubra.* Rarely an open overstory of scattered alders *(Alnus crispa)* or willows up to 1 meter (3 ft) tall is present. Herbs other than the tussock-formers are generally scarce, though *Rubus chamaemorus* is locally common and *Arctagrostis latifolia, Poa arctica, Eriophorum angustifolium* (especially in frost scars), *Pedicularis labradorica,* and *Petasites frigidus* may be present. Common mosses include *Pleurozium schreberi, Hylocomium splendens, Aulacomnium* spp., and *Sphagnum* spp. Sphagnum is often a rather minor constituent, **or** even absent, but is sometimes quite important. Lichens, such as *Cetraria cucullata, C. islandica, Cladonia* spp., *Cladina rangiferina,* and *Thamnolia subuliformis,* may be common.

Distribution and site characteristics- Mixed shrub-sedge tussock tundra is characteristic of polygonal ground and wet to mesic gentle slopes in northern and western Alaska and in alpine areas of interior Alaska. It is one of the most extensive tundra vegetation units in the State and occupies vast areas of the Arctic Foothills and the Seward Peninsula. It commonly occurs on Pergelic Cryaquepts and Histic Pergelic Cryaquepts (upland tundra and meadow tundra) soils. Permafrost generally is present 30 to 40 centimeters (12 to 16 in) below the surface but may be as much as 90 centimeters (35 in) below the surface on the Seward Peninsula (Hopkins and Sigafoos 1951, Racine and Anderson 1979).

An organic mat of variable thickness in which the shrubs are rooted often is present at the soil surface. The tussocks always are rooted in mineral soil so that the organic mat is never thicker than the active layer. Pockets of standing water usually are present at spring breakup and the soil remains moist to wet throughout the growing season. In many areas, water will seep slowly into soil pits dug at any time in the growing season. The mineral soil is a fine-textured gley with gray or dark-gray mottling, which indicates anaerobic conditions and periodic waterlogging. Soils are generally acid with pH values of 4.4 to 4.9 at the surface; these usually increase with depth.

Frost scars (unvegetated or slowly revegetating patches of mineral soil thrust to the surface by frost action) may be absent or abundant. *Carex bigelowii* tends to dominate on steeper, better drained, and less acid soils than *Eriophorum vaginatum.*

Successional status- Shrub-tussock communities probably are the climax vegetation for large areas of arctic Alaska. But if local climatic conditions lead to the accumulation of organic matter, mosses and shrubs thrive at the expense of the tussocks (the tussocks must stay above the rising tide of peat but keep their roots in unfrozen mineral soil). Eventually, mosses and shrubs invade the tussocks, thereby leading to tussock senescence and death. This generally leads to the development of wet shrub birch-ericaceous shrub communities. Disturbances such as fire favor the tussocks by burning back the shrubs and moss and by releasing nutrients from the peat mat that the tussocks can use more effectively than the shrubs can use them (Fetcher and others 1984).

Closely related types- These communities are very similar, if not identical, to mixed shrub-sedge tussock bog communities but occur in arctic and alpine areas (beyond the trees) instead of in subarctic lowland areas (within the trees). They also are similar to tussock tundra (lll.A.2.d.) but have more than 25 percent shrub cover. They are similar to mesic shrub birch-ericaceous shrub communities and shrub birch-ericaceous shrub bog communities, except that these two communities lack tussocks.

Photographs- Drew and Shanks 1965, figure 11; Johnson and others 1966, figure 13; Kessel and Schaller 1960, figures 2 and 3; Racine 1976, figure 33; Viereck 1966, figure 9.

Primary references- Brock and Burke 1980, Holowaychuk and Smeck 1979, Hopkins and Sigafoos 1951, Johnson and others 1966, Racine and Anderson 1979, Viereck 1966.

Communities- Eriophorum *vaginatum-Salix planifolia-S. lanata* **(Koranda 1960).** *Eriophorum vaginatum-Carex bigelowii-Ledum decumbens-Vaccinium vitis-idaea* **(Childs 1969, Dean and Chesemore 1974, Hanson 1950).** *Eriophorum vaginatum-Betula nana-Ledum decumbens-Vaccinium* **spp. (Bliss and Cantlon 1957, Clebsch 1957, Craighead and others 1988, Drew and Shanks 1965, Hanson 1953, Jorgenson 1984, Pegau 1968, Peterson and Billings 1978, Racine and Anderson 1979, Ugolini and Walters 1974, Young and Racine 1978).** *Eriophorum vaginatum-Betula nana-Salix planifolia-Ledum decumbens-Vaccinium* **spp. (Johnson and others 1966, Koranda** 1960, **Young 1974b).** *Eriophorum vaginatum-Betula nana-Salix lanata-Ledum decumbens-Vaccinium* **spp. (Webber and others** *1978). Eriophorum vaginatum-Betula nana-ledum decumbens-Vaccinium* **spp.-Carex** *bigelowii* **(Brock and Burke 1980; Churchill 1955; Craighead and others 1988; Hopkins and Sigafoos 1951; Nodler and others 1978; Racine 1976, 1977; Racine and Anderson 1979; Viereck 1966; Young and Racine** *1977). Eriophorum vaginatum-Betula nana-Salix planifolia-Ledum decumbens-Vaccinium* **spp.-Carex** *bigelowii* **(Spetzman 1959, Webber and others 1978).** *Eriophorum vaginatum-Betula nana* **(Jorgenson 1984, Kessel and Schaller 1960, Komarkova and Webber 1980, Webber and others 1978).** *Carex bigelowii-Betula nana-Salix planifolia-Ledum decumbens-Vaccinium* **spp. (Craighead and others 1988, Racine and Anderson 1979, Racine and Young 1978). Carex bigelowii-Salix spp.-Dryas** *integrifolia* **(Craighead and others 1988).** *Carex bigelowii-Vaccinium* **uliginosum-feathermosses (Craighead and others 1988).** *Carex bigelowii-Spiraea beauverdiana* **(Craighead and others 1988).** *Carex bigelowii-Vaccinium spp./Sphagnum* **spp. (Brock and Burke** *1980). Eriophorum vaginatum-Carex bigelowii-Betula nana-Ledum decumbens-Alnus crispa* **(Brock and Burke 1980).**

II.C.2.6. Open Low Mixed Shrub-Sedge Tussock Bog

Description-These communities are dominated equally by sedge tussocks (usually *Eriophorum vaginatum)* **and low shrubs. The tussocks are as high as 50 centimeters (20 in) above the surface and reach a maximum of 35 centimeters in diameter, though usually they are considerably smaller. Low shrubs provide at least 25 percent cover. They are commonly represented by** *Betula glandulosa, B. nana, Ledum decumbens, Vaccinium ulignosum,* **and** *V. vitis-idaea.* **Other low shrubs that may be present include** *Chamaedaphne calyculata, Vaccinium oxycoccos, Potentilla fruticosa, Salix planifolia, S. fuscescens,* **and** *Alnus tenuifolia.* **Trees provide less than 10 percent cover and usually are restricted to scattered, stunted individuals of black spruce. Herbs generally are sparse, but** *Rubus chamaemoms, Equisetum* **spp., and** *Carex* **spp. may be common. Mosses form a nearly continuous mat between tussocks. Common mosses include** *Sphagnum* **spp.,** *Pleurozium schreberi,* **and** *Hylocomium splendens.* **Lichens appear to be scarce, though** *Peltigera canina* **is sometimes present.**

Distribution and site characteristics--Mixed shrub-sedge tussock bog communities are found in the lowlands of interior and south-central Alaska in filled-in sloughs on flood plains and on cold, poorly drained slopes and terraces in wet silty mineral soil with a surface peat layer 10 to 40 centimeters (4 to 16 in) thick surrounding the tussocks. The soil is saturated most of the year. The organic layer is usually highly acidic (pH 3.5 to 5.7). Permafrost is present at 30 to 40 centimeters (12 to 16 in) below the surface. Some of these communities have evidently been burned in the past (Calmes 1976). As in the tussock tundra types, the tussocks are rooted in mineral soil and the shrubs are rooted primarily in the organic mat.

Successional status-- Many of these communities appear to be quite stable amd may be topoedaphic climaxes; others may require periodic disturbance, such as fire, to persist. If soils are not too wet, black spruce or tamarack, or both, may invade in sufficient numbers for development of woodland or open forest (or dwarf tree scrub) vegetation. If the organic mat becomes thick, mosses and shrubs may invade tussocks, thereby leading to their senescence and death. On the other hand, fire burns back the shrubs and moss, which releases nutrients for uptake by the tussocks. Shrub-tussock bogs seem to develop on permafrost soils, with fine-textured mineral soil composing at least the base of the active layer, on sites slightly too dry to support wet sedge meadows.

Closely related types- Mixed shrub-sedge tussock bogs are very similar to mixed shrub-sedge tussock tundra, and are differentiated primarily by locality. The shrub-tussock bogs occur in flood-plain depressions and poorly drained slopes within the generally forested part of the State. Shrub-tussock tundra occupies poorly drained slopes, plateaus, and valleys in northern, western, and interior Alaska above or beyond tree line. Mixed shrub-sedge tussock bogs also are similar to some black spruce woodland and black spruce dwarf tree scrub woodland communities but have less than 10 percent tree cover.

Photographs- Calmes 1976, figures 4, 11, and 18.

Primary references- Calmes 1976, **Dyrness** and Grigal 1979, Neiland and Viereck 1977.

Communities- Eriophorum *vaginatum-Betula nana-Ledum decumbens/Sphagnum* spp. (Calmes 1976, Dyrness and Grigal 1979, Neiland and Viereck 1977, Pegau 1972, Talbot and others 1984, Wibbenmeyer and others 1982).

II.C.2.c. Open Low Mesic Shrub Birch-Ericaceous Shrub

Description-These communities have 25 to 75 percent cover by shrubs at least 20 centimeters (8 in) tall (fig. 46). Trees overtopping the shrubs provide less than 10 percent cover, and tall shrubs (taller than 1.5 meters [5 ft]) provide less than 25 percent cover. Common dominants include *Betula glandulosa, B. nana, Vaccinium uliginosum, V. vitis-idaea, Ledum decumbens, Arctostaphylos* spp., and *Empetrum nigrum.* Other ericaceous shrubs are commonly present in smaller amounts. Sa/ix *reticulata, S. arctica, S. glauca, S. planifolia,* and *Dryas integrifolia* may be important locally. Scattered trees, primarily white spruce and black spruce, may be present. The shrub birch frequently forms an overstory 0.5 to 1.5 meters (20 in to 5 ft) tall, or sometimes slightly taller, with the ericaceous shrubs and any herbs present forming an understory below and between the taller shrubs. In less productive stands, the shrub birch may grow only 20 to 50 centimeters (8 to 20 in) tall and form a single layer of birch, ericaceous shrubs, and herbs. In both types, common herbs include *Festuca altaica, Hierochloë alpina,* and *Carex bigelowii.* A moss mat usually is present, especially under the shrubs. *Hylocomium splendens, Pleurozium schreberi, Polytrichum* spp., and *Tomenthypnum nitens* may be common. Lichens may be common to abundant. Important lichen species include *Cetraria islandica, C. cucullata, Stereocaulon tomentosum, Cladonia* spp., and *Thamnolia vermicularis.*

Figure 46-Open low mesic shrub birch-ericaceous shrub tundra with *Betula glandulosa, Ledum decumbens. Vaccinium uliginosum,* and *Vaccinium vitis-idaea* near tree line in the Alaska Range in interior Alaska.

Distribution and site characteristics- Mesic shrub birch-ericaceous shrub communities occupy extensive areas of mesic slopes in the Alaska Range, in alpine areas of interior and south-central Alaska, and in northern and western Alaska. These communities can develop on sites with a wide variety of moisture, temperature, and edaphic conditions. The soil is generally mineral with a well-decomposed organic layer 5 to 30 centimeters (2 to 12) thick. Much mineral material is admixed into the base of the organic layer. Silt loams or stony silt loams are common. Soil reaction is usually somewhat acidic; pH *4.5* to 6.0 is fairly typical. Permafrost is generally present but usually at least 50 centimeters (20 in) below the surface.

Successional status- Many of these communities appear to be stable and to change little over time. Some may develop on burned-over spruce forests and woodlands near tree line (Pegau 1972); these stands may be slowly reverting to forest. Mesic shrub birch-ericaceous communities tend to grade into shrub-tussock communities as moisture increases, into shrub birch-ericaceous shrub bogs as moisture increases on thick peat deposits, and into dwarf shrub (mat and cushion) fellfield communities as moisture decreases and wind exposure increases.

Closely related types- Mesic shrub birch-ericaceous shrub communities are similar to shrub birch-ericaceous bog communities, but lack hydrophytic sedges (such as *Carex aquatilis, C. pluriflora,* and *Eriophorum angustifolium)* and *Sphagnum* spp. *Festuca altaica,* present in many of the mesic communities is absent from the bog communities. Mesic birch-ericaceous communities also are similar to some mixed shrub-sedge tussock communities but lack tussock-forming sedges. At the other extreme, some communities resemble dwarf shrub (mat and cushion) communities but have abundant birch and usually are not as windswept and unproductive. They also are similar to open tall birch shrub communities but are dominated by low shrubs (generally 0.2 to 1.5 meters [8 in to 5 ft] tall). They are similar to closed low shrub birch communities but have an open canopy (25 to 75 percent cover) and frequently a more diverse understory. Some white spruce woodlands are similar to mesic birch-ericaceous shrub communities but have at least 10 percent tree cover. Some ericaceous dwarf shrub and dryas dwarf shrub communities are similar to mesic shrub birch-ericaceous shrub communities but lack significant cover of shrub birch.

Photographs- Viereck 1966, figure 7; figure 46, this publication.

Primary references- Hanson 1951; Pegau 1972; Steigers and others 1983; Viereck 1963, 1966, 1983.

Communities- Betula *glandulosa/Vaccinium uliginosum-Empetrum nigrum-Ledum* decumbens/lichens (Anderson 1974, Batten 1977, Hanson 1953, Hettinger and Janz 1974, Hultén 1966, Jorgenson 1984, Kessel and Shaller 4960, Pegau 1968, Steigers and others 1983, Webber and others 1978, Young and Racine 1978). *Betula glandulosa/Festuca altaica-Vaccinium* spp./feathermosses-lichens (Hanson 1951, Hettinger and Janz 1974, Pegau 1972, Viereck 1963). *Betula glandulosal Festuca* altaica/feathermosses (Batten and others 1979; Viereck 1962, 1966). *Betula glandulosa-Vaccinium* spp.-Carex *bigelowii* (Churchill 1955, Hanson 1950). *Betula glandulosa-Ledum decumbens-Vaccinium vitis-idaea-Arctagrostis latifolia* (Churchill 1955). *Betula glandulosa-Salix* spp./Carex *bigelowii-Ledum decumbens/* feathermosses-lichens (Hanson 1951, Scott 1972). *Betula nana-Rubus chamaemorus-Ledum decumbens-Vaccinium* spp. (Craighead and others 1988).

II.C.2.d. Open Low Shrub Birch-Ericaceous Shrub Bog

Description-These communities have 25 to 75 percent cover by shrubs at least 20 centimeters (8 in) tall. Trees overtopping the shrub canopy provide less than 10 percent cover and tall shrubs (over 1.5 meters or 5 ft) provide less than 25 percent cover. Common dominants include *Betula glandulosa, B. nana, Vaccinium uliginosum, V. vitis-idaea, Ledum decumbens, Empetrum nigrum,* and *Andromeda polifolia.* Other locally common shrubs include *Myrica gale, Potentilla fruticosa, Salix planifolia,* and *S. reticulata.* Small stunted spruce trees are scattered in some stands, usually black spruce in interior and south-central Alaska lowlands and white spurce near tree line. A wide variety of sedges and other herbs may be present. Some common species include *Rubus chamaemorus, Eriphorum angustifolium, Carex aquatilis, C. limosa, C. pauciflora, C. rotundata,* and *C. magellanica.* Occasional *Eriophorum vaginatum* or *Carex bigelowii* tussocks may be present, and *Equisetum fluviatile* sometimes is abundant. *Sphagnum* spp. are abundant at most sites but also can be absent. Feathermosses, *Dicranum* spp. and *Polytrichum* spp., are locally common. Common lichens include *Cetraria islandica, C. cucullata, Cladonia* spp., and *Cladina* spp.

Distribution and site characteristics- shrub birch-ericaceous bog communities are common on wet, peaty substrates in south-central, interior, western, and to some extent northern Alaska. In many cases, these communities occupy the ridges of string bogs but they also occupy unpatterned wetlands. The substrate is peat, usually if not always composed at least partially of sphagnum mosses. The peat is at least 20 centimeters (8 in) thick, and accumulations greater than 4 meters (13 ft) thick have been reported (Hogan and Tande 1983). Microrelief is usually present, consisting of hummocks or narrow elongated ridges. The peat usually is acid with a pH of about 4.5 to 5.5. Permafrost is present at depths of 30 to 100 centimeters (12 to 40 in) at most sites but is absent from many of the southernmost stands.

Successional status- These communities may develop in some cases from sedge meadows or bog meadows as peat accumulates and the upper part of the peat becomes hummocky and drier, thereby enabling shrub invasion. They also may develop from shrub-tussock bogs if peat accumulates and overruns the tussocks. If growing-season warmth is adequate and the peat is not too wet, trees (primarily black spruce) may invade these sites and eventually transform them to woodlands or dwarf tree woodland scrub.

Closely related types- Shrub birch-ericaceous shrub bogs are similar to mesic shrub birch-ericaceous shrub communities but occur on peats and have peat-forming mosses or sedges, or both, as part of the community. *Sphagnum spp.* and hydrophytic sedges (for example, *Carex aquatilis* and C. *limosa)* generally indicate a bog community. Birch-ericaceous bogs also are similar to ericaceous shrub bogs, but the latter lack shrub birch and are restricted mainly to maritime climates or extremely wet sites. Birch-ericaceous bogs also are similar to shrub-tussock bogs but lack tussocks. Some are similar to black spruce woodland and black spruce dwarf tree woodland scrub but have less than 10 percent tree cover.

Photographs- Drew and Shanks 1965, figures 15 and 17; Drury 1956, figure 11; Hogan and Tande 1983, plates 13, 14, 16, 17, 19, and 22; Johnson and others 1966, figure 16; Racine 1976, figure 30; Racine 1978b, figure 40.

Primary references- Brock and Burke 1980, Dachnowski-Stokes 1941, Drew and Shanks 1965, Drury 1956, Griggs 1936, Hanson 1951, Hogan and Tande 1983, Johnson and others 1966, Racine and Anderson 1979, Viereck 1966.

Communities- *Betula glandulosa-Vaccinium vitis-idaea-Rubus chamaemoms/ Sphagnum* spp. (Bos 1967, Dachnowski-Stokes 1941, Drew and Shanks 1965, Fries 1977, Hanson 1953, Hogan and Tande 1983, Johnson and others 1966, Jorgenson 1984, Komarkova and Webber 1978, Racine 1976, Racine and Anderson 1979, Rigg 1914, Rosenberg 1986, Steigers and others 1983, Tande 1983, Webber and others 1978, Young and Racine 1978). *Betula glandulosa-Vaccinium uliginosum-Carex spp./Sphagnum* spp. (Brock and Burke 1980; Hanson 1950, 1953; Hogan and Tande 1983; Racine 1978a, 1978b; Viereck 1970b). *Betula glandulosa-Andromeda polifolia/Sphagnum spp.* (Hogan and Tande 1983, Ritchie and others 1981). *Betula glandulosa-Rhododendron lapponicum-Carex* spp. (Drew and Shanks 1965). *Betula glandulosa-Myrica gale-Andromeda polifolialSphagnum* spp. (Drury 1956, Hanson 1951, Hogan and Tande 1983). *Betula glandulosa-Myrica gale-Carex spp./Sphagnum* spp. (Griggs *1936). Potentilla fruticosa-Myrica gale-Betula glandulosa/Empetrum nigrum/Sphagnum spp.* (Hogan and Tande 1983, Racine 1978b). *Potentilla fruticosa-Myrica gale-Betula glandulosa-Ledum* decumbens/feathermosses (Hogan and Tande 1983).

II.C.2.e. Open Low Ericaceous Shrub Bog

Description- These communities are dominated by ericaceous shrubs generally forming a loose mat 20 to 50 centimeters (8 to 20 in) thick. Shrubs provide 25 to 75 percent cover. Common shrubs include *Kalmia polifolia, Empetrum nigrum, Vaccinium uliginosum, V. vitis-idaea, Andromeda polifolia, Vaccinium oxycoccos,* and *Ledum decumbens. Ledum decumbens, Vaccinium uliginosum,* and *V. vitis-idaea* are most common in interior, south-central, and southwestern Alaska. *Kalmia polifolia* is limited to southeast Alaska. Scattered trees may be present in oceanic bogs (southeast Alaska and the gulf coast of Alaska). Common trees include lodgepole pine, Alaska-cedar, and mountain hemlock in southeast Alaska and Sitka spruce and western hemlock along the gulf coast. Interior sites generally are too wet to support any trees at all; sites dry enough to support trees

generally also have an abundance of shrub birch, thereby becoming shrub birch-ericaceous shrub bogs. Sedges such as *Eriophorum angustifolium, Trichophorum caespitosum, Carex pluriflora,* and *C. pauciflora* often are common or codominant. Other herbs commonly important include *Rubus chamaemorus, Drosera* spp., and *Gentiana douglasiana;* the last is restricted to southeastern Alaska. *Sphagnum* spp. are always present and usually dominate the moss layer. Other mosses, such as feathermosses, also may be common. Lichens may be present on mounds.

Distribution and site characteristics- Ericaceous shrub bogs occur on peat deposits in maritime climates (southeast Alaska, gulf coast, and Aleutian Islands) where shrub birch is absent and in a few extremely wet, young bogs in interior and south-central Alaska that are dominated by ericaceous shrubs and have not yet been invaded by shrub birch. In maritime areas, these communities occur on topogenous bogs and blanket bogs (bogs with thick peat deposits blanketing large areas of slopes and rounded summits). In south-central and interior Alaska, they are more or less restricted to topogenous bogs occupying lowland depressions. Peat depth is variable but generally is at least 45 centimeters (18 in) and often 1 to 2 meters (3 to 6 ft) or more. The peat usually is composed at least partially of sphagnum at the surface and often grades into sedge or woody peat with depth. The peat is highly acid, with pH values from 3.6 to 5.2. Bryophyte production of a bog near Fairbanks that is dominated by *Andromeda polifolia* has been measured at 115 grams per square meter per year (1,025 lb/acre) (Luken and Billings 1983) and was produced by three species of *Sphagnum.* Permafrost generally is absent but has been reported at a depth of 60 centimeters (24 in) along the Bering Sea side of the Alaska Peninsula (Racine 1978a).

Successional status- No clear successional pattern is apparent in southeastern Alaska. Many of these bogs have remained stable for extended periods, others have been invaded by forest, and still others have expanded through paludification of forests (Neiland 1971). Relations among bog meadows (lacking substantial shrubs), ericaceous shrub bogs, and woodlands or open forests are complex and involve precipitation, temperature, vegetation, and peat composition.

In interior Alaska, ericaceous shrub bogs seem to develop from sedge meadows or sedge bog meadows as enough peat accumulates to provide a sufficiently dry surface for ericaceous shrub invasion. Dwarf birch also would be expected to invade in a relatively short time.

Closely related types- Ericaceous shrub bogs are similar to shrub birch-ericaceous shrub bogs but have little or no shrub birch. Many are' similar to some mat and cushion (dwarf scrub) tundra types but are wetter and. have more sphagnum and thicker peat accumulations. The dwarf scrub tundra types generally lack *Sphagnum* spp. or at most have them as minorconstituents. Some ericaceous shrub bog communities are similar to bog meadow communities but have at least 25 percent shrub cover, primarily in ericaceous shrubs.

Photographs- Calmes 1976, figure 14; Dachnowski-Stokes 1941, figure 17; Scheierl and Meyer 1977, figure 28 (aerial view).

Primary references-Cooper 1942; Dachnowski-Stokes 1941; Luken and Billings 1983; Neiland 1971a, 1971b; Reiners and others 1971.

Communities- Ledum *decumbens-Vaccinium vitis-idaea/Sphagnum* spp. (Dachnowski-Stokes 1941, Racine 1978b, Rigg 1914, Young and Racine 1976). *Empetrum nigrum-Ledum decumbens/Sphagnum* spp. (Bos 1967, Cooper 1942, Viereck 1970b). *Empetrum nigrum-Vaccinium* spp.-Carex *pluriflora-Rubus chamaemorus/Sphagnum* spp. (Hultén *1960). Empetrum nigrum-Vaccinium uliginosum-Eriophorum angustifolium-Carex pauciflora/Sphagnum recurvum-Pleurozium schreberi*[3] *Empetrum nigrum-Carex pluriflora-C. pauciflora/Sphagnum* spp. (Batten and others 1978, Dachnowski-Stokes 1941, Heusser 1960, Scheierl and Meyer 1977). *Empetrum nigrum-Eriophorum angustifolium-Carex pluriflora/Sphagnum recurvum-Pleurozium schreberi* (see footnote 3). *Empetrum nigrum-Eriophorum angustifolium/Sphagnum magellanicum-S. warnstorfii* (Reiners and others 1971, Streveler and others *1973). Kalmia polifolia-Empetrum nigrum-Trichophorum caespitosum-Eriophorum angustifolium/Sphagnum* spp. (Dachnowski-Stokes 1941; Neiland 1971 a; Stephens and others 1969, 1970). *Chamaedaphne calyculata-Salix* spp.-Carex spp. (Calmes 1976). *Kalmia polifolia-Empetrum nigrum-Trichophorum caespitosum-Carex* spp. (Dachnowski-Stokes 1941, Stephens and others 1969). *Andromeda polifolia/Sphagnum* spp. (Luken and Billings 1983, Racine 1976).

II.C.2.f. Open Low Shrub Birch- Willow Shrub

Description- These communities have 25 to 75 percent cover of shrubs at least 20 centimeters (8 in) tall, less than 25 percent cover of shrubs taller than 1.5 meters (5 ft), and less than 10 percent cover of trees overtopping the shrub canopy. The canopy is dominated by shrub birch *(Betula glandulosa, B. nana)* and willows *(Salix* spp.). Common willows include *Salix glauca, S. planifolia, S. lanata,* and *S. brachycarpa.* Scattered black or white spruce may be present. Low shrubs common beneath the canopy and in openings include *Vaccinium vitis-idaea, V. uliginosum, Ledum* spp., and *Empetrum nigrum.* Common herbs include *Calamagrostis canadensis, Eriophorum angustifolium,* and *Carex* spp. on mesic to wet (usually lowland) sites and *Festuca altaica* and *Hierochloë alpina* on mesic to dry (usually subalpine) sites. Scattered *Eriophorum vaginatum* tussocks may be present on wet sites. A continuous moss mat is present, which is usually composed of feathermosses (such as *Hylocomium splendens* and *Pleurozium schreberi), Tomenthypnum nitens,* and *Aulacomnium palustre.*

Distribution and site characteristics- Shrub birch-willow open low shrub communities occur in poorly drained lowlands and moist slopes near tree line in interior, south-central, and southwestern Alaska and on terraces and cutbanks in arctic Alaska. They occur on mineral soils with a surface organic-rich horizon several centimeters thick. The soil is usually somewhat acid, with a pH of about 5 to 6. Permafrost is nearly always present at depths of 50 to 100 centimeters (20 to 39 in) (possibly shallower at the northernmost localities).

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[3] Neiland, Bonita J. 1976. Unpublished field notes. On file with: University of Alaska Museum-Herbarium, 907 Yukon Drive, Fairbanks, AK 99775-1200.

Successional status- Communities on alpine and subalpine slopes are probably stable, though possibly subject to slow colonization by forests. Subarctic lowland stands also may be fairly stable as long as moisture conditions are constant. A drop in the water table probably favors tree invasion, and a rise in the water table might allow shrub-tussock communities or shrub birch-ericaceous shrub bog communities to occupy the site. Arctic stands generally develop from closed shrub thickets as the permafrost table rises and the active layer becomes wetter. In time, many of these stands will develop into shrub-tussock tundra.

Closely related types- Open low shrub birch-willow shrub is similar to mesic shrub birch-ericaceous shrub communities and shrub birch-ericaceous shrub bog communities but has more willows, willow being codominant with birch. They also resemble some open low willow communities but have shrub birch. They are similar to closed low birch-willow and open tall birch-willow communities but are more open and shorter, respectively. Some stands may approach shrub-tussock bog or shrub-tussock tundra, but *Eriophorum vaginatum* is much less important than it is in those types.

Primary references- Spetzman 1959, Steigers and others 1983, Talbot and others 1984, Viereck 1963.

Communities- Betula *nana-Salix brachycarpa-S. planifolia-S. lanata/Arctostaphylos rubra-Cassiope tetragona-Ledum decumbens* (Spetzman 1959). *Betula nana-Salix lanata/Carex aquatilis-Equisetum* spp. (Craighead and others 1988). *Salix arbusculoides-S. glauca-S. hastata-Betula glandulosa/Bromus pumpellianus-Festuca altaica* (Batten *1977). Betula glandulosa-Salix glauca-S. planifolia/Festuca altaica-Vaccinium vitis-idaea-Arctostaphylos alpina/Hylocomium splendens* (Viereck 1963). *Salix glauca-Betula nana* (Childs *1969). Betula glandulosa-Salix planifolia-Vaccinium uliginosum* (Steigers and others 1983). *Betula glandulosa-Salix spp.-Eriophorum* spp./Hylocomium *splendens* (McCartney 1976, Talbot and others 1984).

II.C.2.g. Open Low Willow Shrub

Description-These communities have 25 to 75 percent cover of shrubs (primarily willows), at least 20 centimeters (8 in) tall (fig. 47). Shrubs taller than 1.5 meters (5 ft) provide less than 25 percent cover and trees overtopping the shrubs provide less than 10 percent cover. The understory is generally dominated by dwarf shrubs or forbs. Willows commonly dominant include *Salix glauca, S. planifolia* and *S. lanata.* Trees are generally absent. Shrubs important in the understory include ericaceous shrubs such as *Arctostaphylos rubra* and *Vaccinium uliginosum,* dwarf willows such as *Salix reticulata,* or subshrubs such as *Dryas* spp. Common understory species include *Petasites frigidus, Festuca altaica, Carex bigelowii,* and *Artemisia arctica.* Nonsphagnaceous mosses may form patchy to continuous mats. On wet sites, *Sphagnum spp.* are sometimes present. Lichens are generally unimportant.

Figure 47-Open low willow shrub with Salix *brachycarpa, Salix lanata* subsp. *richardsonii,* and S. *planifolia* subsp. *pulchra* with a subshrub layer of *Dryas octopetala* on glacial moraine in the Alaska Range in interior Alaska.

Distribution and site characteristics- Open low willow communities are found on terraces, bluffs, dune complexes, and moist uplands in northern Alaska and on moist slopes near treeline in interior and south-central Alaska. *Salix glauca* tends to occur on moist to dry sites and S. *lanata* and S. *planifolia* on moist to wet sites. *Dryas* spp. in the understory generally indicates dry sites, and *Petasites frigidus* indicates wet sites. Soils include dune sands and, more commonly, organic-rich silts, often with intermixed sand and gravel. Higher, more windswept sites generally have less organic matter and more rock fragments than lower, moister sites. The silty soils are generally somewhat acid, with a single measured pH value (from south-central Alaska) of 5.1 to 5.3. Frost scars are abundant in many stands. Microrelief features, such as hummocks and solifluction lobes, are also common at many of the moister sites. Permafrost is probably present at most sites. Depth to permafrost has not been measured but is probably from 30 to 100 centimeters (12 to 40 in).

Successional status- Several diverse communities are included in this unit, each with different successional relations, which are mostly unknown. Many communities may be fairly stable. Some stands on moist slopes grade upward into mesic shrub birch-ericaceous shrub communities as the soil becomes dry on windblown sites at high elevations (Brock and Burke 1980).

Closely related types- Open low willow communities are similar to willow-sedge tundra and willow-graminoid bog, except that graminoids are not important in the understory and the communities are not generally tundralike (the willows are taller with erect shrub physiognomy, or the sites are not located in tundra areas) or boglike (they lack hydrophytic sedges and Sphagnum spp.). They also are similar to open low birch-willow and alder-willow communities, but shrub birch and alder are unimportant in them. They are similar to open tall willow and closed low willow, but have canopies less than 1.5 meters (5 ft) tall (or less than 25 percent cover of shrubs taller than that height) and open shrub canopies (less than 75 percent shrub cover), respectively.

Photographs- Figure 47, this publication.

Primary references- Brock and Burke 1980, Hanson 1958, Jorgenson 1984, Komarkova and Webber 1978. Webber and others 1978.

Continue

Communities- Salix *glauca/Arctostaphylos rubra-Vaccinium uliginosum-Arctagrostis latifolia* (Hettinger and Janz 1974). *Salix glauca/Dryas octopetala-Betula nana* (Hettinger and Janz 1974). *Salix glauca/Petasites frigidus* (Churchill 1955). *Salix glauca/Dryas octopetala* (Webber and others 1978). *Salix glauca/S. reticulata-Carex podocarpa-Artemisia arctica* (Scott 1974a). *Salix glauca/Arctostaphylos rubra-Dryas octopetala-Salix reticulata-Oxytropis deflexa* (Scott 1974a). *Salix glauca-S. planifolia-S. lanata/Equisetum arvense* (Craighead and others 1988). *Salix lanata-S. glauca/ Dryas integrifolia* (Komarkova and Webber 1978). *Salix lanata/Equisetum arvense* (Craighead and others 1988, Webber and others 1978). *Salix planifolia/S. rotundifolia-S. phlebophylla-Petasites frigidus-Poa arctica/Luzula confusa* (Clebsch 1957). *Salix planifolia-s. lanata/Calamagrostis canadensis* (Craighead and others 1988). *Salix planifolia-s. lanata-Myrica gale/Calamagrostis canadensis* (Craighead and others *1988). Salix glauca/Arctostaphylos alpina* (Webber and others 1978). *Salix glauca/ Hylocomium splendens* (Jorgenson 1984). *Salk planifolia/Petasites frigidus-Sphagnum* spp. (Jorgenson *1984). Salix planifolia/Betula glandulosa-Vaccinium uliginosum* (Brock and Burke 1980).

II.C.2.h. Open Low Willow-Sedge Shrub Tundra

Description- These communities have 25 to 75 percent cover of shrubs, primarily willows, at least 20 centimeters (8 in) high (fig. 48). Shrubs taller than 1.5 meters (5 ft) provide less than 25 percent cover and tree canopy cover is less than 10 percent. *Salix planifolia* or *S. lanata* most commonly dominate these communities. These often are quite low, 20 to 50 centimeters (8 to 20 in) tall. *Carex aquatilis* typically dominates the understory, though other sedges, such as *C. vaginata* and *C. bigelowii,* are sometimes dominant. Other vascular plants commonly present include *Salix arctica* and *S. reticulata.* Nonsphagnaceous mosses, commonly including *Tomenthypnum nitens, Distichium capillaceum, Drepanocladus* spp., and *Campylium stellatum,* often are abundant. Lichens are scarce.

Distribution and site characteristics- Willow-sedge tundra occurs on terraces, pond margins, streambanks, low-center polygons, drained lake basins, and sometimes strangmoor strang in northern and western Alaska. It also may occur on moist alpine slopes in interior Alaska but has not been reported from there. Soils are poorly drained, usually more poorly drained than shrub-tussock tundra. Permafrost is present; reported active layer thicknesses range from 60 to 75 centimeters (24 to 30 in), but some northern stands may have permafrost at shallower depths.

Figure 48-Open low willow sedge-shrub tundra with *Salix* planifolia subsp. *pulchra* and scattered *Betula nana* and *Carex* spp. between the shrub clumps in arctic Alaska.

Successional status- Successional relations are mostly unknown. Many stands may be fairly stable. Drying trends may produce changes toward shrub-tussock tundra. Increased moisture may cause a decrease in willows and shift toward wet sedge meadow.

Closely related types- Willow-sedge tundra is similar to open low willow communities but has a strong sedge component. They are similar to willow-graminoid bogs but occur in tundra (arctic) settings. They also are similar to sedge-willow tundra but have more than 25 percent shrub cover, primarily willows.

Photographs-- Figure 48, this publication.

Primary references- Komarkova and Webber 1978, Webber and Walker 1975, Webber and others 1978.

Communities- Salix planifolia-Carex aquatilis (Komarkova and Webber 1978, 1980). Salix *lanata-Carex* aquatilis (Webber and Walker 1975, Webber and others 1978). *Salix lanata-Carex vaginata/Hylocomium splendens* (Hettinger and Janz 1974). *Salix lanata/Carex* spp. (Craighead and others 1988). Salix *planifolia-Spiraea beauverdiana/ Carex aquatilis* (Hultén 1966). *Salix planifolia/Carex bigelowii* (Craighead and others 1988). *Salix planifolia/Carex bigelowii-Petasites frigidus/Hy/ocomium splendens* (Hanson 1958, Hettinger and Janz 1974). Salix planifolia/Carex podocarpa-Petasites *frigidus* (Anderson 1974). *Salix planifolia/Carex bigelowii-Arctagrostis latifolia* (Churchill 1955).

II.C.2.i. Open Low Willow-Graminoid Shrub Bog

Description-These communities have 25 to 75 percent cover of shrubs at least 20 centimeters (8 in) tall, primarily willows. Shrubs taller than 1.5 meters (5 ft) provide less than 25 percent cover, and tree canopy cover is less than 10 percent. Dominant willows include *Salix barclayi, S. commutata,* and probably others. Scattered individuals of shrub birch *(Betula glandulosa* and *B. nana)* sometimes are present. Trees are absent or scarce. Understory dominants include *Calamagrostis canadensis, Carex aquatilis,* and *C. pluriflora.* Nonsphagnaceous mosses are abundant in some sites. Sphagnum is sometimes present. Lichens are absent or sparse.

Distribution and site characteristics- Willow-graminoid bogs occur in wet stream bottoms and lowland depressions in interior, southwestern, south-central, and southeast Alaska, but peat is generally thin. Permafrost is generally absent.

Successional status- Successional relations are largely unknown. If the substrate surface builds up or the water level drops, trees may invade, which leads to forest development. Willow graminoid bogs sometimes develop from wet meadows or bog meadows.

Closely related types- These communities are similar to willow-sedge tundra but occur within the trees (subarctic lowland sites). They are similar to open low willow communities but have a strong component of grasses or sedges in the understory. Some stands may be similar to sweetgale-graminoid bogs but have more willows and less sweetgale. Some may be similar to open tall scrub swamps but are not as tall and lack a significant alder component.

Photographs- Hogan and Tande 1983, plates 20 and 21.

Primary references- Hogan and Tande 1983, Streveler and others 1973, Wibbenmeyer and others 1982.

Communities- Salix spp./Carex spp./Sphagnum spp. (See footnote 3). Salix commutata/Carex aquatilis/Calliergon giganteum (Streveler and others 1973). *Salix barclayi/Calamagrostis canadensis-Carex* spp. (Streveler and others 1973). *Salix* spp. *-Betula nana/Calamagrostis canadensis-Carex aquatilis* (Batten 1979). *Salix* spp.-Calamagrostis *canadensis/Potent palustris* (Rosenberg 1986).

II.C.2.j. Open Low Sweetgale-Graminoid Bog

Description- These communities have 25 to 75 percent cover of shrubs at least 20 centimeters (8 in) tall, primarily sweetgale *(Myrica* gale) (fig. 49). Shrubs taller than 1.5 meters (5 ft) provide less than 25 percent cover, and tree canopy cover is less than 10 percent. Other shrubs that may be present include Salix *fuscescens, S. barclayi, Chamaedaphne calyculata, Betula glandulosa, B. nana,* and *Alnus tenuifolia.* Scattered birch and spruce trees may be present. Commonly dominant graminoids include *Calamagrostis canadensis, Carex livida, C. aquatilis, C. pluriflora, C. limosa, C. sitchensis, C. magellanica, C. canescens, C. lyngbyaei,* and *Trichophorum caespitosum.* Other common plants are *Potentilla palustris, Menyanthes trifoliata,* and *Equisetum* spp. *Utricularia* spp. may be present in flooded hollows between hummocks. Mosses, usually including *Sphagnum* spp., are abundant and together with the shrubs form a thick mat. Lichens are absent or sparse.

Distribution and site characteristics-Sweetgale-graminoid bogs occupy poorly drained lowlands (sometimes at the inland edge of coastal marshes), gentle slopes, depressions in string bogs, and floating bog mats at pond margins in southeastern, south-central, and southwestern Alaska. These sites are extremely wet, and standing water usually is present. The substrate is peat composed of sedges or mosses, or both, often with abundant woody fragments. The peat is at least 15 to 20 centimeters (6 to 8 in) thick and usually overlies silt or gravelly silt. Hummocky microrelief often is present. Soil reacton is only slightly acidic, with most recorded values clustering around pH 6. Permafrost is absent.

Figure 49-Open low shrub sweetgale-graminoid bog of *Myrica* gale and *Carex aquatilis,* which form a zone around a subarctic lowland sedge wet meadow of *Carex rostrata* in south-central Alaska.

Successional status- Successional relations are unknown. These communities appear to be fairly early stages of bog succession, given the thin peat accumulations and relatively high pH's of many stands. Exactly how they fit into a successional sequence remains to be discovered. Possibly ericaceous shrubs become more important as peat thickness increases and pH decreases. Bogs do not necessarily show a uniform increase in peat thickness with age (for example, string bogs). Patterns of peat generation and decomposition within a bog probably result from a complex interplay of many factors.

Closely related types-Some stands that are more or fess intermediate between sweetgate-graminoid bogs and willow-graminoid bogs are found, but willows are secondary to sweetgate in sweetgale-graminoid bogs. These communities also are similar to subarctic lowland sedge-shrub wet meadows (III.A.3.h.) but have at least 25 percent shrub cover, primarily in sweetgale.

Photographs- Hogan and Tande 1983, plates 11, 12, 15, and 18; Scheierl and Meyer 1977, figure 21 (aerial view); figure 49, this publication.

Primary references- Crow 1968, Griggs 1936, Hanson 1951, Hogan and Tande 1983, Ritchie and others 1981.

Communities- Myrica *gale/Trichophorum caespitosum/Sphagnum* spp. (Hogan and Tande 1983, Tande 1983, Viereck 1970b). *Myrica gale/Empetrum nigrum-Eriophorum angustifolium-Carex pluriflora/Sphagnum recurvum-Pleurozium schreberi (See* footnote *3). Myrica gale/Calamagrostis canadensis* (Batten and others 1978, Frohne 1953, Hanson 1951, McCormick and Pichon 1978, Quimby 1972, Ritchie and others 1981). *Myrica gale-Salix spp./Calamagrostis canadensis* (Crow 1968, Scheierl and Meyer 1977). *Myrica gale-Betula nana-Salix spp./Calamagrostis canadensis-Carex* spp. (Seguin 1977). *Myrica gale/Carex* spp. (Hogan and Tande 1983, Ritchie and others 1981). *Myrica gale-Salix* spp./Carex spp. (Ritchie and others 1981). *Myrica gale/Rubus chamaemorus/Sphagnum* spp. (Griggs 1936, Wibbenmeyer and others 1982). *Myrica gale/Hordeum brachyantherum* (Crow 1968). *Myrica gale/Poa eminens* (Crow 1968). *Myrica gale-Potentilla fruticosa-Betula nana/Ledum decumbens-Rubus chamaemorus* (Rosenberg 1986). *Myrica gale/Menyanthes trifoliata-Carex* spp. (Rosenberg 1986).

II.C.2.k. Open Low Alder-Willow Shrub

Description- These communities have 25 to 75 percent cover of shrubs at least 20 centimeters (8 in) tall. Shrubs taller than 1.5 meter (5 ft) provide less than 25 percent cover and tree canopy cover is less than 10 percent. Alders and willows dominate the shrub canopy. Common species include *Alnus crispa, Salix lanata, S. planifolia,* and *S. glauca.* Trees are scarce or, more commonly, absent. Shrubby understory species include *Spiraea beauverdiana, Betula glandulosa, B. nana, Empetrum nigrum, Vaccinium vitis-idaea,* and *Ledum decumbens.* Common herbs include *Equisetum arvense, Eriophorum angustifolium, Rubus chapaemorus, Petasites frigidus,* and *Carex bigelowii. Eriophorum vaginatum* tussocks may be scattered. A continuous moss mat consisting of feathermosses or sphagnum, or both, often is present. Lichens, such as *Cetraria cucullata* and *Cladonia* spp., are present locally.

Distribution and site characteristics- open low alder-willow shrub occurs on steep north slopes and along drainageways near tree line in interior Alaska and on river terraces in northern Alaska. The shrubs and mosses form a hummocky mat over mineral soil or rocks. Permafrost is probably present at most of these sites, but the thickness of the active layer has not been measured.

Successional status- These communities are probably fairly stable at many sites. With decreasing elevation and decreasing slope steepness, communities on drainageways grade into tall alder-willow communities. North Slope terrace communities probably become shrub-tussock tundra communities as the permafrost table rises and soils become colder and wetter.

Closely related types-Open low alder-willow shrub communities are similar to open tall alder-willow shrub and closed low alder-willow shrub but are composed primarily of low (less than 1.5 meters [5 ft] tall) shrubs and have open (less than 75 percent) shrub canopies. They also are similar to open low alder and open low willow communities but have substantial cover of both kinds of shrubs. Some stands may be similar to shrub-tussock tundra but have more and usually taller alders and willows and few tussocks.

Primary references- Bliss and Cantlon 1957, Brock and Burke 1980, Viereck 1963.

Communities- Alnus *crispa-Salix* spp./Carex *bigelowii-Empetrum nigrum-Vaccinium vifis-idaea/Cetraria cucullata-Cladonia* spp. (Bliss and Cantlon 1957, Viereck 1963). *Alnus crispa-Salix planifolia/Eriophorum angustifolium/Sphagnum* spp. (Brock and Burke 1980).

II.C.2.I. Open Low Alder Shrub

Description- These communities have 25 to 75 percent cover of shrubs at least 20 centimeters (8 in) tall, which are primarily alders. Shrubs taller than 1.5 meters (5 ft) 'provide less than 25 percent cover and tree canopy cover is less than 10 percent. *Alnus crispa* dominates most of these communities, but *A. tenuifolia* is dominant in some stands. Common understory species include Betula *nana* and the ericaceous shrubs *Ledum decumbens, Empetrum nigrum, Vaccinium uliginosum, V. vitis-idaea,* and *Arctostaphylos alpina. Carex bigelowii* is often present, and *Eriophorum vaginatum* tussocks may be present but not abundant. Mosses, such as *Hylocomium splendens, Aulacomnium* spp., *Tomenthypnum nitens,* and sometimes *Sphagnum* spp., form a continuous mat.

Distribution and site characteristics- Open low alder shrub occurs on gentle alpine slopes, broad drainageways, and locally in poorly drained flats in southwestern, south-central, and interior Alaska and on river terraces in northern Alaska. The substrate consists of an organic mat over mineral soil and is generally acid. Permafrost is present at many of these sites.

Successional status- Successional relations are unknown. In northern Alaska, open low alder communities seem to occur in areas adjacent to and slightly better drained than areas supporting shrub-tussock tundra. Sometimes these areas are quite moist, but the water is moving (for example, open low alder shrub in broad drainageways receiving water from shrub-tussock tundra upslope). On level ground away from drainageways, open low alder shrub may give way to shrub-tussock tundra as the permafrost table rises and the soil becomes wetter and colder.

Closely related types- Open low alder shrub is similar to open tall alder shrub, but the general level of the canopy is lower than 1.5 meters (5 ft). These communities also are similar to open low alder-willow communities but have little or no willow cover. Some are similar to shrub-tussock tundra but have more alder and few, if any, tussocks.

Primary references- Bliss and Cantlon 1957, Drew and Shanks 1965.

Communities- Alnus crispa/Vaccinium *uliginosum-Ledum* decumbens-Betula nana-*Carex bigelowii/Hylocomium splendens-Aulacomnium palustre* (Bliss and Cantlon *1957). Alnus crispa/Betula glandulosa-Ledum decumbens/Sphagnum* spp. (Drew and Shanks 1965, Ritchie and others 1981).

II.C.2.m. Sagebrush-Juniper

Description- Although these communities are known to exist on steep south-facing bluffs in interior and south-central Alaska, none has been described.

II.C.2.n. Sagebrush-Grass

Description- These communities have 25 to 75 percent cover of shrubs taller than 20 centimeters (8 in), which is primarily sagebrush (fig. 50). Shrubs taller than 1.5 meters (5 ft) generally are absent or at most contribute less than 25 percent cover. Tree canopy cover, primarily aspen, is less than 10 percent. Common sagebrushes include *Artemisia frigida* and *A. alaskana.* Common associated grasses include *Calamagrostis purpurascens, Agropyron spicatum, Bromus pumpellianus,* and *Festuca altaica.* Other common species include *Potentilla pennsylvanica* and *Poa glauca.* Mosses are scarce and lichens are scattered.

Distribution and site characteristics- Sagebrush-grass communities occur locally on steep south-facing bluffs primarily along major river systems in interior and south-central Alaska. The substrate varies from silt loams to rocky silts and is extremely steep, unstable, and dry. Plant cover is discontinuous and much bare ground is exposed. Soil reaction is generally circumneutral, pH 6-8. Permafrost is absent.

Successional status- These communities are stable in the specialized localities they exist in. They sometimes share the bluffs with open stands of stunted aspen, which presumably are on slightly moister microsites.

Figure 50-Open low sagebrush-grass shrub of *Artemisia frigida, Bromus pumpellianus, Calamagrostis purpurascens,* and *Agropyron spicatum* on a south-facing river bluff in interior Alaska.

Closely related types- Sagebrush-grass communities are similar to some of the dry grassland communities (especially some midgrass-shrub communities) but have at least 25 percent shrub (primarily sagebrush) cover. They also are similar to sagebrush-juniper communities, but juniper is much less important or absent. Some may grade into aspen woodlands but have less than 10 percent tree cover.

Photographs- Figure 50, this publication.

Primary reference- Hanson 1951.

Communities- Artemisia frigida-Bromus *pumpellianus* (Hanson 1951).

II. D. Dwarf Scrub

These communities are dominated by dwarf shrubs (shrubs less than 20 centimeters [8 in] tall) and have at least 25 percent shrub cover. Trees provide less than 10 percent cover and usually are entirely absent; shrubs taller than 20 centimeters (8 in) provide less than 25 percent cover. If dwarf shrubs are the only plants present then cover can be as low as 2 percent (fig. 51, A and B).

Dominant plants are most commonly ericaceous shrubs or species of *Dryas.* Willows that normally exceed 20 centimeters (8 in) in height (including *Salix planifolia, S. lanata, S. glauca,* and *S. brachycarpa)* are absent or nearly so. A community with 50 percent cover of *Salix planifolia* would be classified as open low willow shrub regardless of the height of the willows. Ericaceous shrub communities on wetlands and those containing shrub birch as a codominant are treated as low shrub communities (shrubs 20 to 150 centimeters [8 in to 5 ft] tall). Other ericaceous shrub communities (primarily alpine heath) are treated here as dwarf shrub tundra (less than 20 centimeters [8 in] tall).

Closed and open forms of dwarf scrub tundra have been combined because the percentage of shrub cover is not as meaningful as it is in taller shrub-dominated communities. The dwarf shrub layer is overtopped by the herb layer, so changes in dwarf shrub cover have a relatively small effect on physiognomy.

Figure 51—**A.** Aerial view of dryas dwarf shrub tundra area in the uplands between the Tanana and Yukon Rivers in interior Alaska. **B.** Ground view of the same area as shown in A.

II.D.1. ***Dryas Dwarf Scrub***

These are dwarf scrub communities dominated by species of the genus *Dryas.* Ericaceous shrubs, willows, sedges, and lichens may be abundant or even codominant.

II.D.1.a. Dryas Dwarf Shrub Tundra

Description- These communities are dominated by species of the genus *Dryas,* which form mats a few centimeters thick (figs. 52 and 53). Dwarf shrubs other than dryas may be absent or common, or sometimes even codominant. Common dwarf shrubs include ericads *Vaccinium vitis-idaea, V. uliginosum, Cassiope tetragona, Arctostaphylos alpina,* and *A. rubra,* and prostrate willows *Salix reticulata* and *S. phlebophylla.* Shrub birch is absent or nearly so, as are shrubby willows such as Salix glauca and S. brachycarpa. Graminoids, such as *Hierochloë alpina, Trisetum spicarum, Carex microchaeta,* and *C. scirpoidea* may be present, but provide little cover. Forbs, including *Oxytropis. nigrescens, Hedysarum alpinum, Minuartia* spp., *Anemone* spp., and *Saxifraga* spp. may be common. Mosses, such as *Tomenthypnum nitens* and *Rhacomitrium* spp., usually are present in small quantities, and lichens (such as *Cetraria cucullata, Cetraria* spp., *Cladina alpestris, Thamnolia* spp., and *Stereocaulon* spp.) may be common but not codominant. Trees are absent, and shrubs taller than 20 centimeters (8 in) are absent or provide less than 25 percent cover. Plant cover ranges from sparse to complete. Patterns, commonly steps or stripes, may be present.

Distribution and site characteristics- Dryas dwarf shrub **tundra is** common on windswept alpine sites throughout the northern two-thirds of the State and occasionally is present on well-drained, exposed arctic lowland sites. Soils are mostly thin, well drained, and stony (generally Pergelic Cryaquolls, Cryoborolls, or Cryochrepts). Permafrost usually is present, but the active layer is at least 50 centimeters (20 in) thick and usually much thicker. Most sites are exposed to strong winds, which remove fines and organic material.

Successional status-Successional relations are largely unknown. Most of these communities are probably quite stable. Soils change very slowly in these exposed settings, which creates a relatively constant environment for plant growth.

Closely related types- Dryas tundra is similar to dryas-sedge tundra and dryas-lichen tundra but has fewer sedges and lichens, respectively. Some stands may be similar to dwarf ericaceous tundra or dwarf willow tundra, but ericaceous shrubs and willows, if present at all, are subordinate to dryas in the dryas tundra communities. Some open low shrub communities (such as low willow and mesic shrub birch-ericaceous shrub) have large quantities of dryas, but dryas tundra lacks shrub birch and erect shrubby willows.

Photographs-Johnson and others 1966, figures 2 and 6; Racine and Anderson 1979, figure 12; figures 52 and 53, this publication.

Primary references-Johnson and others 1966; Jorgenson 1984; Komarkova and Webber 1978; Racine and Anderson 1979; Viereck 1962, 1963; Webber and others 1978.

Figure 52-Dryas dwarf shrub tundra with a nearly continuous mat of *Dryas octopetala* with scattered *Salix reticulata* and *Cassiope tetragona* in the Alaska Range in interior Alaska.

Figure 53—Dryas dwarf shrub tundra composed of mats of *Dryas drummondii* and *Dryas integrifolia*, a seral community on glacial outwash in the Alaska Range.

Communities- *Dryas octopetala* (Craighead and others 1988, Drew and Shanks 1965, Hanson 1953, Hettinger and Janz 1974, Johnson and others 1966, Nodler and others 1978, Pegau 1968, Viereck *1963). Dryas octopetala-Salix arctica-Oxytropis nigrescens* (Bos *1967). Dryas octopetala-Vaccinium* spp. (Jorgenson 1984, Racine and Young 1978, Talbot and others 1984). *Dryas octopetala-Cassiope tetragona* (Craighead and others 1988). *Dryas octopetala-Salix reticulata-Cassiope tetragona* (Anderson 1974; Batten 1977; Kessel and Schaller 1960; Viereck 1962, 1963). *Dryas octopetala-Vaccinium uliginosum-Salix reticulata* (Anderson 1974). *Dryas octopetala-Arctostaphylos alpina* (Jorgenson 1984, Webber and others 1978, Young 1974b). *Dryas octopetala-Arctostaphylos alpina-Tomenthypnum nitens-Carex bigelowii* (Webber and others 1978). *Dryas infegrifolia* (Hettinger and Janz 1974, Komarkova and Webber 1978, Webber and Walker *1975). Dryas integrifolia-Arctostaphylos rubra* (Jorgenson 1984, Koranda 1960, Webber and others 1978). *Dryas infegrifolia-Lupinus arcticus* (Churchill *1955). Dryas infegrifolia-Hedysarum alpinum-Festuca rubra* (Hanson 1951). *Dryas drummondii-D. integrifolia* (Viereck 1966). *Dryas integrifolia-Poa glauca-Oxytropis borealis* (Koranda *1960). Dryas integrifolia-Vaccinium* spp. (Drew and Shanks 1965, Jorgenson 1984). *Dryas integrifolia-Salix reticulata-Equisetum arvense* (Craighead and others 1988).

II.D.1.b. Dryas-Sedge Dwarf Shrub Tundra

Description- These communities are dominated by *Dryas* spp. and also have a strong sedge component. *Carex scirpoidea, C. misandra, C. bigelowii, Kobresia myosuroides,* and several other sedges can be codominant with the dryas. Other dwarf shrubs, such as *Salix reticulata* and *Arctostaphylos* spp., may be common. Grasses and broad-leaved herbs may be scattered (for example, *Hierochloë alpina, Hedysarum* spp., *Saxifraga* spp.). Mosses, commonly *Tomenthypnum nitens, Rhytidium rugosum,* and *Hylocomium splendens,* are common as are fruticose lichens such as *Cladonia* spp. and *Cetraria* spp. The dryas, associated shrubs, and mosses form a mat a few centimeters thick through which the sedges and other herbs, if present, grow to heights of 10 to 30 centimeters (4 to 12 in). Trees are absent, and shrubs taller than 20 centimeters (8 in) are absent or provide less than 25 percent cover. Shrub species that normally grow taller than 20 centimeters (8 in) (such as *Betula glandulosa, B. nana, Salix glauca,* and *S. brachycarpa)* are absent or provide less than 20 percent cover. Total plant cover ranges from open to complete but often is greater than 75 percent.

Distribution and site characteristics- Dryas-sedge dwarf shrub tundra communities are common on alpine sites throughout the northern two-thirds of the State. They occupy well-drained soils that are usually not quite as exposed and windswept as those supporting dryas tundra communities. The permafrost table is at least 50 centimeters (20 in) below the surface and usually much deeper.

Successional status- Successional relations are unknown. Most of these communities probably are stable and change slowly with time.

Closely related types- Dryas-sedge tundra is similar to dryas tundra but has more sedges. It also is similar to dryas-lichen tundra, but sedges are more important than lichens. It is similar to sedge-dryas (herbaceous) tundra but has more than 25 percent shrub cover, primarily dryas. Some stands may be similar to some of the dwarf ericaceous scrub tundra types or dwarf willow scrub tundra types, but ericaceous shrubs and willows are less important or absent entirely. Some stands may even resemble some mesic shrub birch-ericaceous shrub communities but lack a shrub birch component and have only minor quantities of ericaceous shrubs.

Primary references- Drew and Shanks 1965, Gjaerevoll 1954, Viereck 1963.

Communities- Dryas *octopetala-Carex scirpoidea* (Gjaerevoll 1954). *Dryas octopetala-Kobresia myosuroides* (Drew and Shanks 1965, Hanson 1951, Johnson and others 1966, Spetzman 1959). *Dryas octopetala-Kobresia simpliciuscula* (Gjaerevoll 1954). *Dryas octopetala-Vaccinium vifis-idaea-Luzula* spp.-Carex *misandra* (Childs *1969). Dryas octopetala-Carex franklinii* (Gjaerevoll 1954). *Dryas octopetala-Salix arctica-Carex* bigelowii-mosses (Anderson 1974). *Dryas integrifolia-Salix reticulata-Carex scirpoidea* (Batten 1977, Drew and Shanks 1965, Hanson 1953, Hettinger and Janz 1974). *Dryas infegrifolia-Carex misandra-Rhytidium*

rugosum (Hettinger and Janz 1974). *Dryas octopetala-Carex microchaeta* (Webber and others 1978). *Dryas octopetala-Carex misandra-C.* bigelowii (Hanson 1951). *Dryas octopetala-Carex glacialis* (Gjaerevoll 1954). *Dryas octopetala-Carex nardina-C.* vaginata-lichens (George and others 1977). *Dryas integrifolia-Carex scirpoidea-Kobresia simpliciuscula* (Koranda 1960). *Dryas octopetala-Salix reticulata-Carex bigelowii* (Hanson 1950, Viereck 1968). *Dryas octopetala-Salix reticulata-Carex podocarpa* (Scott 1974a). *Dryas integrifolia-Carex scirpoidea* (Drew and Shanks 1965, Hettinger and Janz 1974). *Dryas integrifolia-Carex bigelowii* (Craighead and others 1988, Jorgenson 1984). *Dryas infegrifolia-Oxytropis nigrescens-Carex rupestris* (Koranda 1960, Webber and Walker 1975). *Dryas integrifolia-Carex* spp. (Craighead and others 1988). *Dryas integrifolia-Eriophorum scheuchzeri-Tomenthypnum nitens* (Jorgenson 1984).

II.D.1.c. Dryas-Lichen Dwarf Shrub Tundra

Description- These communities are codominated by dryas and fruticose lichens (fig. 54). Common lichens include *Alectoria* spp., *Cetraria* spp. (especially *C. cucullata), Cladina* spp., and *Thamnolia vermicularis.* Mosses, including *Tomenthypnum nitens, Rhacomitrium* spp. and *Polytrichum* spp., may grow intertwined with the dryas mat. Dwarf shrubs other than dryas may be present, commonly *Salix reticulata, S. phlebophylla, Empetrum nigrum, Arctostaphylos* spp., and other ericaceous shrubs. Graminoids such as *Festuca* spp., *Hierochloe; alpina,* and *Carex* spp. may be present. Broad-leaved herbs, including *Oxytropis nigrescens, Minuartia* spp. and *Saxifraga* spp., may be common. Trees are absent and shrubs taller than 20 centimeters (8 in) (as well as shrub species normally growing taller than 20 centimeters [8 in], such as *Betula* spp., *Salix glauca,* and *S. brachycarpa)* are absent or provide less than 25 percent cover. Plant cover ranges from 2 to 100 percent. A substantial amount of the total cover is contributed by fruticose lichens.

Figure 54-Dryas-lichen tundra with scattered mats of *Dryas octopetala,* a wide variety of other subshrubs and herbs, including *Oxytropis* nigrescens, *Minuartia arctica, Silene acaulis, Geum glaciale,* and *Potentilla biflora;* and an open cover of lichens, especially *Alectoria* spp., *Cetraria* spp., and *Cladonia* spp. in arctic Alaska.

Distribution and site characteristics- Dryas-lichen dwarf shrub tundra occurs throughout alpine regions of the northern two-thirds of the State on exposed wind-swept sites. It reaches its best development in western Alaska, particularly on the Seward Peninsula. Soils are young, thin, dry, and stony (Entisols). The permafrost table is at least 50 centimeters (20 in) below the surface and usually deeper. The lichens are extremely fragile when dry and subject to damage by trampling. Exposure to strong winds with consequent deflation of fines and organic material causes soil development to proceed extremely slowly on most sites occupied by these communities.

Successional status- Little is known except that lichens require many years (on the order of decades) to recover from severe trampling (Palmer and Rouse 1945). Most dryas-lichen stands seem to be stable as long as they are not overgrazed.

Closely related types- Dryas-lichen tundra is similar to dryas tundra and dryas-sedge tundra, but lichens are much more important and provide substantial cover. Some stands may be similar to some of the ericaceous scrub tundra types (particularly vaccinium, bearberry, and crowberry), but dryas is the most important vascular plant present. Some mesic shrub birch-ericaceous low shrub communities have abundant dryas and lichens, but shrub birch is absent or unimportant in dryas-lichen tundra. Dryas-lichen tundra also can be similar to lichen tundra but has much more dryas. Vascular plants are scarce in lichen tundra stands.

Photographs- Figure 54, this publication.

Primary references- Drew and Shanks 1965, Hanson 1951, Johnson and others 1966, Pegau 1968, and Viereck 1962.

Communities- Dryas *octopetala-Cetraria spp.-Cladonia* spp. (Pegau 1968, Viereck 1962). *Dryas* octopetala-lichens (Anderson 1974, Brock and Burke 1980, Childs 1969, George and others 1977, Hanson 1951, Spetzman 1959). *Dryas infegrifolia*-lichens (Drew and Shanks 1965, Hanson 1951, Komarkova and Webber 1978, Webber and Walker 1975). *Dryas octopetala-lichens-Oxytropis nigrescens-Salix phlebophylla-Carex microchaeta* (Johnson and others 1966). *Dryas octopetala-Stereocaulon tomentosum* (Scott 1974a). *Dryas octopetala-Cetraria cucullata (Scott* 1974a, Viereck 1962). *Dryas octopetala-Empetrum nigrum-Salix arctica-Cetraria* spp.-Cladonia spp. (Young and Racine 1978). *Dryas octopetala-Salix reticulata-Cladonia rangiferina (Scott* 1974a).

II.D.2. Ericaceous Dwarf Scrub

These communities are dominated by ericaceous shrubs. Several of the level IV units are closely related, and assignment of communities to them is sometimes arbitrary.

II.D.2.a. Bearberry Dwarf Shrub Tundra

Description- These types are dominated by bearberry (Arctostaphylos *alpina* or *A. rubra).* Other ericaceous shrubs also may be abundant or even codominant, particularly *Vaccinium vitis-idaea, V. uliginosum, Ledum decumbens, Empetrum nigrum,* and *Cassiope tetragona.* Prostrate willows such as *Salix phlebophylla* and *S. rotundifolia* also may be common. Shrub birch is absent or unimportant as are normally erect willows such as *Salix glauca.* Common herbs include *Carex bigelowii,*

Oxytropis nigrescens, Hierochloë alpina, and *Carex* spp. but these generally provide little cover. Mosses are commonly intertwined in the mat of ericaceous shrubs or, in the case of *Rhacomitrium* spp., occur as distinct polsters. Moss species reported include *Dicranum* spp. and *Rhacomitrium lanuginosum. Tomenthypnum nitens* and *Hylocomium splendens* probably also are common on many sites. Fruticose lichens may be abundant. Common species include *Cladina stellaris, C. rangiferina, C. arbuscula, Cetraria cucullata,* and *Stereocaulon tomentosum.* Trees generally are absent and never provide more than 10 percent cover. Shrubs taller than 20 centimeters (8 in) (and shrub species normally taller than 20 centimeters [8 in], such as *Betula* spp., *Salix glauca,* and *S. planifolia)* are absent or provide fess than 25 percent cover. The mat of shrubs, mosses, and lichens commonly provides nearly complete vegetative cover, although open stands are present on exposed sites.

Distribution and site characteristics- Bearberry dwarf shrub tundra communities occupy alpine areas of interior, northern, and western Alaska, possibly being most common in the west. They occupy shallow, rocky, well-drained soils on slopes and windswept ridges that are not as exposed as those supporting dryas tundra communities. Permafrost is at least 50 centimeters (20 in) deep and usually deeper.

Successional status-Successional relations are mostly unknown. Sometimes these communities occur on slopes between low scrub communities (such as mesic shrub birch-ericaceous shrub) and dryas communities. Bearberry dwarf shrub tundra communities seem to be stable over long periods. There may be a trend for shrub birch to establish and become more important as soil development proceeds and as exposure to wind decreases.

Closely related types- Bearberry tundra is closely related to vaccinium tundra and, in some cases, to crowberry tundra. Assigning stands to these units can become very arbitrary. Bearberry is more abundant in bearberry tundra than in the other ericaceous scrub tundras. Some dry windswept stands of bearberry tundra may be similar to some of the dryas-dominated communities but have less dryas and more bearberry. Bearberry tundra also may be similar to some dwarf willow scrub tundra communities but have more bearberry and less willow. Some bearberry stands may resemble some open low shrub communities, such as mesic shrub birch-ericaceous shrub or open low willow, but lack significant quantities of shrub birch or erect willows. Moist bearberry stands may resemble ericaceous scrub bogs but lack sphagnum and peat-forming sedges and generally occur on drier sites. They also may resemble mixed shrub-sedge tussock tundra but lack tussocks.

Photographs-- Racine and Anderson 1979, figure 13.

Primary references- Hanson 1953, Jorgenson 1984, Racine and Anderson 1979, Webber and others 1978.

Communities- Arctostaphylos *alpina-Vaccinium vitis-idaea* (Hanson 1953). *Arctostaphylos alpina-Rhododendron camtschaticum* (Pegau *1968). Arctostaphylos rubra-Cladina stellaris* (Webber and others 1978). *Arctostaphylos alpina-Vaccinium spp.-Empetrum nigrum-Cassiope* tetragona-lichens (Jorgenson 1984). *Arctostaphylos alpina- Vaccinium uliginosum-Dicranum* spp. *-Rhacomitrium lanuginosum* (Jorgenson 1984). *Arctostophylos alpina-Carex bigelowii* (Racine and Anderson 1979).

Figure 55-Eriaceous dwarf shrub tundra of *Vaccinium uliginosum. V. vitis-idaea, Ledum decumbens, Cassiope tetragona.* and *Arctostaphylos alpina,* a snowbed community in arctic Alaska.

II.D.2.b. Vaccinium Dwarf Shrub Tundra

Description- Vaccinium dwarf shrub tundra communities are dominated by *Vaccinium uliginosum* or *V. vitis-idaea* (fig. 55). Other ericaceous shrubs, especially *Ledum decumbens, Arctostaphylos rubra, A. alpina, Empetrum nigrum,* and *Cassiope tetragona,* may be abundant or even codominant. Dwarf willows such as *Salix phlebophylla, S. rotundifolia,* and *S. arctica* also may be common. Common herbs include *Hierochloë alpina, Polygonurn bistorta, Anemone* spp., *Festuca altaica,* and *Luzula* spp. Mosses, such as *Polytrichum* spp., *Dicranum* spp., and *Hylocomium splendens* may be common, but usually do not contribute much cover. Fruticose lichens may provide substantial cover or may even codominate with the shrubs. Common lichens include *Cladina stellaris, C. rangiferina, Cetraria islandica, C. delisei, C. cucullata, Stereocaulon* spp., *Alectoria nigricans, Thamnolia vermicularis,* and *Sphaerophorus fragilis.* Trees usually are absent and always provide less than 10 percent cover. Shrubs taller than 20 centimeters (8 in) (and shrub species that normally grow taller than 20 centimeters [8 in], such as *Betula* spp., *Salix glauca,* and *S. planifolia)* are absent or provide less than 25 percent cover.

Distribution and site characteristics- Vaccinium dwarf shrub tundra communities are common in alpine areas of interior, northern, and western Alaska on slopes and windswept ridges. They generally occupy shallow, stony, fairly well-drained soils. Permafrost is present at depths of 30 centimeters (12 in) or usually more. Sites are generally exposed to the wind and do not accumulate much snow in the winter but usually are not as exposed as sites supporting dryas communities.

Successional status- Successional relations are mostly unknown. Sometimes these communities occur on slopes between low scrub communities (such as mesic shrub birch-ericaceous shrub) and dryas communities. Many vaccinium communities seem to be stable over long periods. There may be a long-term trend for shrub birch to invade and become more important as soil development proceeds or as exposure to wind decreases.

Closely related types- Vaccinium dwarf shrub tundra is closely related to bearberry tundra and, in some cases, to crowbeny tundra and even cassiope tundra. *Vaccinium* spp. are more abundant in vaccinium tundra than in the other ericaceous units. Dry windswept stands of vaccinium tundra can be similar to dryas tundra or dwarf willow tundra but have more vaccinium and less dryas or willow. Mesic vaccinium stands can resemble mesic shrub birch-ericaceous shrub or open low willow shrub but lack significant quantities of shrub birch and erect willows. Moist vaccinium stands can also resemble ericaceous shrub bogs but lack sphagnum and peat-forming sedges; they generally occur on drier sites. They can also resemble mixed shrub-sedge tussock tundra but lack tussocks.

Photographs- Figure 55, this publication.

Primary references- Drew and Shanks 1965, Hanson 1951, Johnson and others 1966, Webber and others 1978.

Communities- Vaccinium *vitis-idaea-Dryas octopetala-Empetrum nigrum-Festuca altaica (Scott* 1974a). *Vaccinium vitis-idaea-Salix phlebophylla-Arctostaphylos alpina* (Anderson 1974). *Vaccinium vitis-idaea-Empetrum nigrum-Cladina* spp. (Racine and Anderson *1979). Vaccinium uliginosum-Diapensia lapponica-Phyllodoce coerulea-Salix Polaris-S. arcfica* (Fries *1977). Loiseleuria procumbens-Vaccinium uliginosum-Salix arctica-Ledum decumbens* (Griggs 1936). Bryophyte-Vaccinium *uliginosum-Dryas octopetala-Carex bigelowii* (Anderson 1974). *Vaccinium* spp.-Ledum *decumbens-Arctostophylos alpina-Cassiope tetragona* (Hanson 1958, Johnson and others *1966). Ledum decumbens-Vaccinium vitis-idaea-Cetraria* spp. (Hanson 1951). *Rhododendron lapponicum-Vaccinium uliginosum- V. vitis-idaea* (Drew and Shanks. *1965). Festuca altaica-Vaccinium vitis-idaea-V. uliginosum-Empetrum nigrum-Dryas octopetala* (Hanson 1951). *Vaccinium uliginosum-V. vitis-idaea* (Hettinger and Janz *1974). Vaccinium uliginosum-Empetrum nigrum-Ledum decumbens-Cladonia* spp. (Steigers and others 1983). *Vaccinium* uliginosum-lichens (Craighead and others 1988).

II.D.2.c. Crowberry Dwarf Shrub Tundra

Description- Crowberry dwarf shrub tundra communities are dominated by *Empetrum nigrum* (fig. 56). Other dwarf shrubs may be abundant. *Vaccinium uliginosum, V. vitis-idaea, Arctostaphylos alpina, Cassiope tetragona, Salix arctica,* and *Dryas octopetala* are common associates in the more continental, northern parts of the range of this unit; *Phyllodoce aleutica, Cassiope stelleriana, C. lycopodioides, C. mertensiana, Vaccinium caespitosum,* and *Luetkea pectinata* are common in the oceanic climate prevalent in the Aleutian Islands and along the gulf coast. The herb component is variable and usually provides little cover; It may include *Geum calthifolium, Arnica* spp., *Campanula* spp., *Pedicularis* spp., *Artemisia arctica, Fauria crista-galli,* and *Carex* spp. Mosses apparently are common in most stands, but species names have not been reported. Lichens, especially *Cladonia* spp., are common in many stands. Trees usually are absent and always provide less than 10 percent cover. Shrubs taller than 20 centimeters (8 in) (including shrub birch) are absent or provide less than 25 percent cover.

Figure 56-Crowberry tundra dominated by Empetrum *nigrum* with *Carex* spp. and *Calamagrostis nutkaënsis* in the Aleutian Islands.

Distribution and site characteristics- These communities are common in the Aleutian Islands and northwestern, southwestern, and south-central Alaska on slopes and level ground. They become infrequent east of Prince William Sound, apparently being replaced **by** mountain-heath dwarf shrub tundra communities. Soils are variable, ranging from thin well-drained mineral soil (most common in western Alaska and windswept Aleutian localities) to rather poorly drained peats. The peat is generally less than 30 centimeters (12 in) thick and often is broken by bedrock outcrops. Permafrost is present at depths of 30 to 60 centimeters (12 to 24 in) at most western and southwestern sites but is absent elsewhere.

Successional status- Successional relations are unknown, but crowberry tundra communities occupy large areas and appear to be stable.

Closely related types- Crowberry dwarf shrub tundra can be similar to all other dwarf shrub types, especially the ericaceous ones, but has more Empetrum nigrum. It also is similar to some ericaceous scrub bog communities but occurs on thin peats and has little or no sphagnum. Some western Alaska stands may resemble mesic shrub birch-ericaceous scrub communities, or even mixed shrub-sedge tussock tundra communities, but have more crowberry and lack sedge tussocks and shrub birch.

Photographs- Figure 56, this publication.

Primary references- Bos 1967, Byrd 1984, Cooper 1942, Everett 1971, Griggs 1936.

Communities- *Empetrum nigrum-Cassiope stelleriana-Phyllodoce aleutica-Vaccinium* spp. (Cooper 1942, Fox 1983, Heusser 1960, Isleib and Kessel 1973, Palmer 1942). *Empetrum nigrum-Vaccinium* spp. (Friedman 1982, Griggs 1936, Racine and Young 1978). *Empetrum nigrum-Lycopodium spp./Brachythecium albicans-Cladonia* spp. (Bank 1951). *Empetrum nigrum-Carex pluriflora-C. macrochaeta/Cladonia* spp. (Bank 1951, Everett 1971, Hultén 1960, Shacklette and others 1969). *Empetrum nigrum-Cassiope lycopodioides-Carex circinnata/* mosses (Byrd 1984). *Empetrum nigrum-Arctostaphylos alpina* (Bos 1967, Fries 1977). *Empetrum nigrum-Vaccinium uliginosum* (Hultén 1962). *Empetrum nigrum-Carex bigelowii-Arctostaphylos alpina* (Bos 1967). *Empetrum nigrum-Salix arctica-Cetraria* spp. (Young and Racine 1978).

ll.D.2.d. Mountain-Heath Dwarf Shrub Tundra

Description- Mountain-heath dwarf shrub tundra communities **are** dominated by *Phyllodoce aleutica (P. aleutica* ssp. *glanduliflora* in southeastern Alaska). Associated (sometimes codominant) dwarf shrubs include *Cassiope mertensiana, C. stelleriana, Luetkea pectinata, Vaccinium uliginosum,* and *V. caespitosum.* Several herbs, including *Lupinus nootkatensis, Valeriana sitchensis,* and *Sedum rosea,* may be minor components of the vegetation. Mosses and lichens probably are common, but species names have not been reported. Trees are absent or provide less than 10 percent cover. Shrubs taller than 20 centimeters (8 in) are absent or provide less than 25 percent cover. Plant cover ranges from open to complete but usually is fairly high.

Distribution and site characteristics- Mountain-heath dwarf shrub tundra communities are common on alpine slopes and snowbed margins in south-central and southeastern Alaska. Most are well protected by snow in winter. Soils usually are relatively thin and often are stony.

Successional status-Successional relations are unknown. These communities appear to be stable.

Closely related types-Mountain-heath dwarf shrub tundra can be similar to crowberry tundra and some stands of cassiope tundra but has a greater proportion of *Phyllodoce* spp. Some stands also may be similar to dricaceous shrub bogs but have little or no sphagnum or other peat formers and much more mountain-heath.

Primary references-Klein 1965, Racine and Young 1978, Streveler and others 1973.

Communities- Phyllodoce *aleutica-Cassiope stelleriana* (Heusser 1960). *Phyllodoce aleutica-Cassiope spp.-Vaccinium* spp. (Klein *1965). Phyllodoce aleutica-Cassiope mertensiana* (Jaques *1973). Leutkea pectinata-Phyllodoce* spp.-Cassiope spp. (Racine and Young 1978, Streveler and others 1973).

ll.D.2.e. Cassiope Dwarf Shrub Tundra

Description- Cassiope dwarf shrub tundra communities are dominated by *Cassiope tetragona* in the northern two-thirds of the State and by *Cassiope mertensiana* in snow beds in the mountains bordering the Pacific Coast (fig. 57). Common associated dwarf shrubs (sometimes codominant) include *Vaccinium vitis-idaea, V. uliginosum, Empetrum nigrum, Salix reticulata, S. arctica,* and *Dryas* spp. with *Cassiope tetragona;* and *Cassiope stelleriana, Phyllodoce aleutica* ssp. *glanduliflora, Vaccinium uliginosum, V. caespitosum,* and *Empetrudm nigrum* with *Cassiope mertensiana.* Herbs, including *Luzula* spp., *Pyrola* spp., *Saxifraga* spp., and *Carex bigelowii,* are minor components of these communities! Mosses, including *Distichium capillaceum, Tomenthypnum nitens, Drepanocladus rebolvens, Aulacomnium palustre,* and *Hylocomium splendens,* are abundant in *Cassiope tetragona* stands. Mosses associated with *C. meltensiana* are unknown. Lichens, such as *Cetraria richardsonii* and *C. cucullata,* are common in *Cassiope tetragona* stands but provide little cover. Trees are absent, and shrubs over 20 centimeters (8 in) tall (including shrub birch of any height) are absent or provide less than 25 percent cover. Plant cover is usually complete or nearly so.

Figure 57-Ericaceous dwarf shrub tundra of Cassiope *tetragona* with some *Dryas octopetala* and *Vaccinium vitis-idaea,* a snowbed community in the Alaska Range.

Distribution and site characteristics- Cassiope dwarf shrub tundra is widespread on moist alpine sites throughout Alaska with the possible exception of the Aleutian Islands. It occurs on moist, thin, stony soils, commonly on north slopes, gelifluction lobes, or snow accumulation areas, although it can occur on ridge crests and slopes of all aspects. Sometimes the soil is a thin organic mat over boulders. Cassiope tundra occurs on sites well protected by snow in winter that become snow free in the early to middle part of the growing season.

Successional status- Successional relations are unknown. These communities seem extremely stable.

Closely related types- Cassiope mertensiana communities may be similar to mountain-heath and crowberry communities but have a greater cover of *Cassiope* spp. They also may be similar to some ericaceous shrub bog communities but lack sphagnum and peat-forming sedges, occur on better drained soils at higher elevations, and are dominated by *Cassiope* spp.

Cassiope tetragona communities may be similar to bearberry, vaccinium, and crowberry communities but have a greater cover of *Cassiope tetragona.* Some stands might intergrade with mesic shrub birch-ericaceous shrub stands, but cassiope tundra lacks shrub birch, generally has lower species diversity, and is dominated by *Cassiope tetragona.*

Photographs- Figure 57, this publication.

Primary references- Hanson 1953, Jorgenson 1984, Ward 1957, Webber and others 1978.

Communities- Cassiope *tetragona* (Anderson 1974; Komarkova and Webber 1978, 1980; Pegau 1968; Scott 1974a; Webber and others 1978). *Cassiope tetragona-Salix rotundifolia-mosses* (Batten 1977, Jorgenson 1984, Webber and Walker 1975). *Cassiope tetragona- Vaccinium* uliginosum-mosses (Hanson 1953, Scott 1974a). *Cassiope tetragona-Vaccinium vitis-idaea* (Childs 1969, Webber and others 1978). *Cassiope tetragona-Dryas integrifolia* (Komarkova and Webber 1978, 1980; Koranda 1960). *Cassiope tetragona- Vaccinium vitis-idaea-Carex bigelowii-Hylocomium* splendens-lichens (Jorgenson 1984). *Cassiope tetragona-Dicranum* spp. (Jorgenson

1984). Cassiope mertensiana-C. stelleriana-Empetrum nigrum (Fox 1983; Heusser 1954, 1960; Ward *1957). Luetkea pectinata-Cassiope stelleriana-lycopodium alpinum-Cladonia* spp. (Hanson 1951).

11.D.3. Willow Dwarf Scrub

These are dwarf scrub communities dominated by prostrate willows. Shrubs taller than 20 centimeters (8 in) (including normally erect willow species such as *Salix planifolia* and *S. brachycarpa* of any height) are absent or provide less than 25 percent cover.

ll.D.3.a. Willow Dwarf Shrub Tundra

Description-Willow dwarf shrub tundra communities are dominated by dwarf willows such as *Salix Polaris, S. reticulata, S. phlebophylla, S. rotundifolia, S. ovalifolia,* and *S. arctica.* Other common dwarf shrubs (sometimes codominant) include *Empetrum nigrum, Cassiope lycopodioides, Dryas* spp., *Vaccinium uliginosum, V. vitis-idaea,* and *Ledum decumbens.* Dwarf birch is absent or nearly so, as are shrubby, normally erect willows such as *Salix planifolia, S. lanata, S. glauca,* and *S. brachycarpa.* Common herbs include *Hierochloë alpina, Minuartia* spp., *Carex microchaeta, C. scirpoidea, Carex* spp., *Saxifraga* spp., *Poa arctica;* and *Anemone* spp. Mosses, including *Dicranum* spp., *Aulacomnium* spp., *Hylocomium splendens, Tomenthypnum nitens,* and *Rhacomitrium spp.,* may be common. Lichens may be common but usually do not provide much cover. Species include *Dactylina arctica, Cladonia rangiferina, C. alpestris, Sphaerophorus globosus, Thamnolia vermicularis, Cetraria cucullata,* and, in rocky fell-fields, *Rhizocarpon* spp. and *Umbilicaria* spp. Trees are absent or provide less than 10 percent cover. Shrubs taller than 20 centimeters (8 in) are absent or provide less than 25 percent cover. Plant cover ranges from very sparse to complete.

Distribution and site characteristics- Willow dwarf shrub tundra communities are common in alpine areas and other windswept tundra settings throughout the State except for southeastern Alaska. They occupy a wide variety of habitats including snowbeds, wet high-alpine drainage channels, gelifluction lobes, windblown high-center polygon summits, stabilized sand dunes, mesic slopes, exposed slopes, and ridges. Soils are generally thin and well drained but range from wet (snowbeds and some gelifluction lobes) to dry. In moist and mesic settings, a thin organic mat may be present at the surface. Permafrost is present 30 centimeters (12 in) or more below the surface at most sites, except for the Aleutian Islands where permafrost is absent.

Successional status- Successional relations are unknown. Most communities seem to be stable.

Closely related types- Willow dwarf shrub tundra communities are similar to many dwarf ericaceous shrub tundra communities but have greater cover by dwarf willows. They also are similar to some open low shrub willow and birch communities but lack significant quantities of shrubby birches and willows. They also resemble mesic sedge-willow tundra but have more than 25 percent shrub cover, primarily of dwarf willows.

Photographs- Byrd 1984, figure 6; Shacklette and others 1969, figure 29.

Primary references- Anderson 1974, Byrd 1984, Hettinger and Janz 1974, Klein 1959, Shacklette and others 1969.

Communities- Salix *rotundifolia* (Klein 1959, Komarkova and Webber 1978, White and others *1975). Salix rotundifolia-Oxyria digyna* (Anderson 1974). *Salix ovalifolia-Empetrum nigrum-Festuca rubra-Calamagrostis deschampsioides* (Hanson 1951). *Salix Polaris-S. reticulata-Hylocomium splendens-Carex podocarpa (Scott* 1974a). *Salix ovalifolia* (White and others *1975). Salix reticulata-Carex microchaeta-Rhacomitrium lanuginosum* (Hettinger and Janz 1974). *Salix reticulata-Carex saxatilis* (Hettinger and Janz 1974). *Salix rotundifolia-Potentilla vahliana-Saxifraga oppositifolia* (Racine and Anderson *1979). Salix polaris-Cetraria islandica-Cladina rangiferina (Scott* 1974a). *Salix arctica-Carex nesophila-Cladina alpestris-Cetraria cucullata* (Klein 1959). *Salix arctica-S. rotundifolia-Empetrum nigrum* (Shacklette and others 1969). *Salix rotundifolia-S. ovalifolia-Cassiope lycopodioides-Empetrum nigrum* (Shacklette and others 1969). *Salix ovalifolia-Artemisia borealis* (Webber and others 1978). *Salix rotundifolia-S. phlebophylla* (Clebsch 1957). *Salix phlebophylla* (Craighead and others 1988). *Salix reticulata-Dryas integrifolia-Carex bigelowii-Tomenthypnum nitens* (Hettinger and Janz 1974). *Salix reticulata-Ledum decumbens* (Hettinger and Janz 1974). *Salix* spp. *-Cassiope tycopodioides* (Byrd 1984). *Salix reticulata-Carex bigelowii-Aulocomnium* spp. (Jorgenson 1984). *Salix reticulata-Dryas octopetala-Carex scirpoidea* (Anderson 1974).

III. Herbaceous

Herbaceous communities lack woody plants or have less than 10 percent of their cover in tree species and less than 25 percent of their cover in shrubs. Most of these communities are dominated by graminoids (grasses or sedges), but others are dominated by broad-leaved herbs (forbs) or bryoids (bryophytes or lichens). Many tundra communities are included in the herbaceous unit, but the term “tundra” is not used above level IV. Communities of aquatic herbs are grouped within level II as aquatic communities.

III.A. Graminoid Herbaceous

Graminoid herbaceous communities are dominated by grasslike plants, usually grasses (Gramineae) or sedges (Cyperaceae). Horsetails (Equisetaceae) and rushes (Juncaceae) are not included (unless codominant with a grass or sedge) but are treated instead as forbs in this classification.

III.A.1. Dry Graminoid Herbaceous

These are communities dominated by graminoids, occurring on well-drained to excessively drained sites. Forbs may be codominant in some stands. Shrubs may be present but provide less than 25 percent cover.

III.A.1.a. Elymus

Description- These communities are dominated by species of the genus *Elymus,* usually *E. arenarius* (fig. 58). Often the elymus grows in dense pure stands, but it also commonly mixes with other grasses or forbs. Common secondary, or sometimes codominant, species include the strand plants *Lathyrus maritimus, Senecio pseudo-arnica, Honckenya peploides, Ligusticum scoticum,* and *Mertensia maritima* and the grasses *Poa eminens* and *Festuca rubra.* A different species, *Elymus innovatus,* dominates certain dry inland sites; common codominants with this species include *Festuca altaica* and *Poa glauca.* Mosses, lichens, and woody plants are scarce or absent in most elymus communities, though feathermosses are abundant in some.

Figure 58-Dry graminoid herbaceous stand of Elymus *arenarius* with *Senecio pseudo-arnica* and *Mertensia maritima* on sand dunes in the Aleutian Islands.

Elymus arenarius ranges in height from around 20 centimeters (8 in) in the Arctic to over 1 meter (3 ft) in the southern part of the State. Elymus innovates is usually 30 to 70 centimeters (12 to 30 in) tall depending on site conditions. Vegetative cover of communities of both species may be complete or sparse.

Distribution and site characteristics- Elymus arenarius communities are characteristic of coastal and near-coastal sand dunes and the upper parts of coastal sand beaches around the State. Exceptions are the Aleutian Island communities where dominance is shared by ferns or large forbs of the family Umbelliferae (Apiaceae), which do not occur on coastal sands but on well-drained, mesic soils on slopes. In northen Alaska, because of the small tidal range and the extreme erosive force periodically exerted on beaches by storms, elymus communities are rare on exposed beaches and more commonly are found on the inland side of spits and barrier islands. Along much of the Beaufort Sea coast, sand substrates are rare and elymus communities are restricted mostly to dune fields at river mouths and small isolated pockets of sand scattered along the coast. Elymus innovatus communities form small localized stands on flood plains and dry south-facing slopes in the Alaska and Brooks Ranges. Substrates of the coastal Elymus *arenarius* communities consist of circumneutral (pH 6.4 to 7.3) sands or pebbles. Although many of these communities are inundated by infrequent storm surges, water drains quickly without leaving any appreciable quantity of salt in the soil. Substrates of other elymus communities are well drained and consist of silt loams to river gravels. Permafrost is absent from all but the most northern sites; even there it is at least 1 meter (3 ft) below the surface.

Successional status-- *Elymus arenarius* is normally the first species to colonize shifting dune sands. On beaches, elymus communities gradually replace halophytic herb communities as uplift or beach progradation decreases the frequency of tidal inundation. Increasing numbers of grasses, sedges, forbs, or low shrubs invade the elymus communities as the substrate is stabilized; the exact species depends on site characteristics and location. In western Alaska, ericacious shrubs, particularly crowberry *(Empetrum nigrum),* and several grasses and sedges gradually replace the elymus. In south-central and southeastern Alaska, succession proceeds through various herbaceous and shrubby types to culminate in Sitka spruce forest.

Elymus innovatus types on flood plains develop from pioneer perennial-herb communities, apparently in a few decades if the sites are not disturbed. In the Alaska Range, *Betula glandulosa* commonly invades the elymus communities to produce an open low birch shrub scrub in a relatively short time. *Elymus innovatus* types on steep slopes appear to be stable and may represent microclimatic, topographic, or edaphic climaxes.

Closely related types-Most coastal elymus communities grade seaward into halophytic herb communities. The point at which *Elymus arenarius* is sufficiently abundant to constitute an elymus community is often somewhat arbitrary. Some midgrass-herb communities of silty coastal slough levees resemble elymus communities but have less *Elymus arenarius* and often contain *Puccinellia* spp. or *Triglochin maritimum,* species not typical of elymus communities. The Aleutian Island elymus-umbel communities closely resemble some umbel or umbel-fern (mesic forb) communities, distinguished only by a higher cover of *Elymus arenarius.* The *Elymus innovatus* types are similar physiognomically to, and sometimes grade into, some of the dry fescue and midgrass types but differ in dominant species.

Photographs-- Byrd 1984, figure 3 and 4; Hanson 1951, figure 30; Shacklette and others 1969, figure 5; Viereck 1966, figure 5; figure 58, this publication.

Primary references- Byrd 1984, Hanson 1951, Johnson and others 1966, Racine and Anderson 1979, Shacklette and others 1969, Viereck 1966.

Communities- Elymus *arenarius* (Bank 1951; Batten and others 1978; George and others 1977; Griggs 1936; Hanson 1951, 1953; Johnson and others 1966; Klein 1959; Meyers 1985; Racine and Anderson 1979; Rosenberg 1986; Shacklette and others 1969; Spetzman 1959; Stephens and Billings 1967; Ugolini and Walters 1974; Young 1971). *Elymus arenarius-Honckenya peploides* (Manuwal *1979). Elymus arenarius-Honckenya peploides-Mertensia maritima* (Fries 1977, Potter 1972, Wiggins and Thomas 1962). *Elymus arenarius-Poa eminens-Calamagrostis canadensis* (Quimby *1972). Elymus arenarius-Poa eminens-Carex ramenskii* (Byrd and Ronsse *1983). Elymus arenarius-Senecio pseudo-arnica-Lathyrus maritimus* (Bank 1951, Hultén 1960, Rausch and Rausch *1968). Elymus arenarius-Senecio pseudo-arnica-Claytonia sibirica* (Friedman *1982). Elymus arenarius-Lathyrus maritimus* (Hanson 1951). *Elymus arenarius-Lathyrus maritimus-Poa eminens* (Hanson 1953). *Elymus arenarius-Heracleum lanaturn-Angelica lucida* (Byrd 1984). *Elymus arenarius-Heracleum lanaturn-Angelica lucida-Athyrium filix-femina* (Byrd 1984). *Elymus arenarius-Ligusticum scoticum-Anemone narcissiflora* (Shacklette and others 1969). *Elymus arenarius/Potentilla egedii* (Crow and Koppen 1977). *Elymus arenarius-Festuca rubra* (Hanson 1951, Palmer and Rouse 1945). *Elymus arenarius-Lathyrus maritimus-Senecio pseudo-arnica-Angelica lucida* (Fries *1977). Elymus arenarius-Polemonium boreale-Senecio pseudo-arnica* (Young and Racine 1978). *Elymus* arenarius-Calamagrostis canadensis-Deschampsia beringensis (Friedman 1982). *Elymus arenarius-Dryas integrifolia* (Komarkova and Webber 1980). *Elymus innovatus-Festuca altaica/Hylocomium splendens* (Viereck *1966). Elymus innovatus-Poa glauca* (Hanson 1951).

Figure 59-Dry fescue stand of Festuca altaica and *Elymus innovatus* with scattered herbs of *Aconitum delphinifolium* and *Solidago multiradiata* on glacial outwash in the Alaska Range.

III.A.1.b. Dry Fescue

Description- Dry fescue communities that have been reported are dominated by Festuca altaica, though stands dominated by *F. rubra* may exist and then would belong here also (fig. 59). *Festuca* altaica may grow in pure stands, or other grasses such as *Calamagrostis canadensis* or *C. purpurascens* may be common or even co-dominant. Forbs, including *Epilobium angustifolium, Achillea borealis,* and *Mertensia paniculata,* may be common but not codominant. Mosses often are abundant, primarily feathermosses and sometimes also *Polytrichum* spp. Scattered low shrubs may be present but are not conspicuous. Lichens usually are sparse.

Distribution and site characteristics- Dry fescue communities occur on various dry to mesic sites, including level lowland meadows in south-central Alaska, dry slopes at low elevations in interior Alaska, and alpine and subalpine slopes in the mountains (except in southeastern Alaska). Associated species differ among these sites; they range from *Calamagrostis canadensis, Angelica lucida,* and *Sanguisorba stipulata* in south-central lowlands to *Calamagrostis purpurascens* and *Artemisia frigida* on dry interior slopes to *Carex* spp., *Salix reticulata,* and ericaceous shrubs in alpine meadows. The substrate is usually mesic to dry, slightly to highly acid (pH 4.6 to 6.6) silts or loams. Permafrost is absent with the possible exception of some alpine stands.

Successional status- Edaphic evidence indicates that at least some of the coastal fescue communities may have replaced *Carex lyngbyaei* halophytic sedge wet meadows. Willows probably invade the fescue meadows ultimately and convert them to low or tall scrub (Hanson 1951).

Hanson (1951) suggests that fire may initiate development of some fescue communities on dry slopes in interior Alaska. These grasslands are then slowly reclaimed by willow, birch, and white spruce.

Little is known of successional relations of alpine and subalpine fescue communities, but many appear to be fairly stable over long periods.

Closely related types- Some dry fescue communities are similar to some dry *Elymus innovatus* communities, and others are similar to mesic bluejoint communities; the dry fescue communities have a greater cover of fescue. With increasing shrubs or herbs, dry fescue communities grade into midgrass-shrub or midgrass-herb communities, respectively. Shrubs are inconspicuous in dry fescue communities and forbs are not dominant.

Photographs- Figure 59, this publication.

Primary references-- Hanson 1951, Viereck 1962.

Communities- Festuca *altaica* (Hanson 1951, 1953; Pegau 1972; Viereck 1962). *Festuca altaica-Calamagrostis canadensis* (Hanson 1951).

III.A.1.c. Midgrass-Shrub

Description- These communities are commonly dominated by medium-height grasses such as *Festuca altaica, Calamagrostis purpurascens, Agropyron spicatum, Poa* spp., and *Bromus pumpellianus* (fig. 60). Shrubs are conspicuous but provide less than 25 percent cover. The shrubs occasionally provide more cover than the grass but still less than 25 percent. Common shrubs on alpine and subalpine slopes include ericaceous shrubs, such as *Vaccinium vitis-idaea* and *Empetrum nigrum,* and low willows. Sagebrush *(Artemisia* spp., especially *Artemisia frigida)* is the common shrub on dry slopes. Feathermosses may be common (especially on alpine sites) or absent. Lichens often are common but may be absent. Total canopy cover is open (dry slope communities are almost always open) or closed. The grasses generally are 30 to 70 centimeters (12 to 30 in) tall, the shrubs 10 to 30 centimeters (8 to 12 in) tall.

Distribution and site characteristics-- Midgrass-shrub communities occur on dry slopes at low elevations and on mesic to dry slopes and plateaus in alpine and subalpine settings. They generally are restricted to interior and south-central Alaska and the surrounding mountain ranges.

Soils are typically silt loams, often with abundant intermixed gravel or rock fragments. Low-elevation dry slope soils are generally slightly acid to moderately basic (pH 6 to 8). Alpine soils are usually acid (pH 5 to 6). Permafrost has not been reported but may be present under some alpine stands.

Successional status- These communities appear to be fairly stable. The *Festuca altaica-ericaceous* shrub types may have developed from dry fescue communities and may be evolving toward open ericaceous shrub scrub. The dry slope types appear to be stable and generally occupy slopes too steep and dry for woody plants other than sagebrush.

Closely related types- The *Festuca altaica-shrub* types are similar to dry fescue communities but have a conspicuous shrub element. The dry slope grass-sagebrush types are similar to sagebrush-juniper open low shrub scrub, but juniper is lacking, grasses are dominant, and sagebrush has less than 25 percent cover.

Photographs- Figure 60, this publication.

Primary references- Hanson 1951, Scott 1974a.

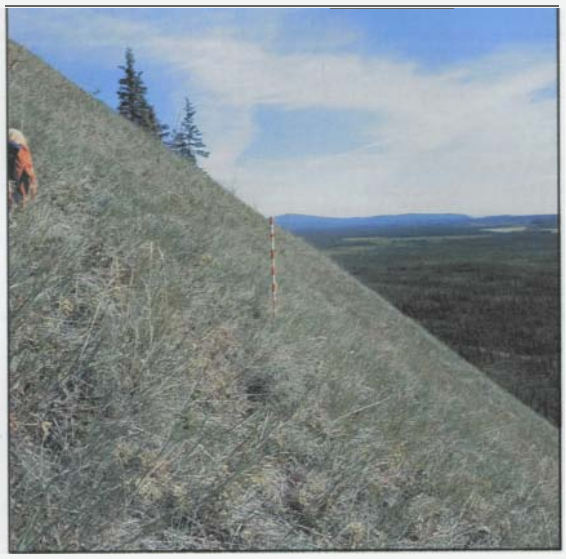

Figure 60-Midgrass-shrub stand of the grasses *Calamagrostis purpurascens, Bromus pumpellianus,* and *Elymus innovatus,* shrubs of *Artemisia frigida,* and the herbs *Pulsatilla patens, Antenarria rosea, Silene menziesii,* and *Arabis holboellii on* a south-facing bluff in interior Alaska.

Communities- *Festuca altaica-Salix lanata-Artemisia arctica* **(Scott** 1974a). Calamagrostis *purpurascens-Artemisia frigida* (Batten and others 1979, Hanson 1951). *Festuca altaica-Empetrum nigrum-Salix reticulata* (Scott 1974a). *Agropyron spicatum-Artemisia frigida* (Batten and others 1979, Hanson 1951). *Festuca altaica-Calamagrostis canadensis-Empetrum nigrum* (Bos 1967). *Poa glauca-Artemisia frigida-Calamagrostis purpurascens* (Hanson 1951).

III.A.1.d. Midgrass-Herb

Description- These communities are dominated by middle-height grasses and broad-leaved herbs (fig. 61). A few communities have been included here that are dominated entirely by grasses, or grasses and sedges are codominant. Common dominant grasses include *Festuca altaica, F. rubra, Deschampsia beringensis, Poa eminens,* and *Agropyron subsecundum.* Herbs reported as codominant include *Anemone narcissiflora, Lupinus arcticus, Aconitum delphinifolium, Mertensia paniculata, Cornus canadensis, Geranium erianthum, Potentilla egedii,* and *Achilles borealis.* Woody plants are rare or absent. Nonsphagnaceous mosses (especially feathermosses) are common in many of these communities. Plant cover is usually high.

Distribution and site characteristics- Midgrass-herb communities are found on various mesic sites, including alpine and subalpine meadows, streambanks, lowland meadows, and coastal slough levees. Coastal slough levee variants are found throughout the State, but the others are restricted to the Aleutian Islands and interior south-central, and southeastern Alaska. On coastal slough levees, the substrate is usually barely modified, tidally deposited silt. Other midgrass-herb communities generally occur on well-developed, well-drained silt loams or occasionally on sands. Soil pH is circumneutral to acid (usually 5.4 to 7.4), but values as low as 4.6 have been reported. The alpine sites tend to be acidic and the low-elevation sites circumneutral. Permafrost generally is absent but has been reported at depths of about 1 meter (3 ft) from sites in the Alaska Range. Associated species characteristic of coastal slough levees are *Festuca rubra, Poa eminens,* and *Potentilla egedii. Agropyron* spp. and *Deschampsia beringensis* are restricted to low elevations; *Festuca altaica* and most of the herbs occur over a broad elevational range.

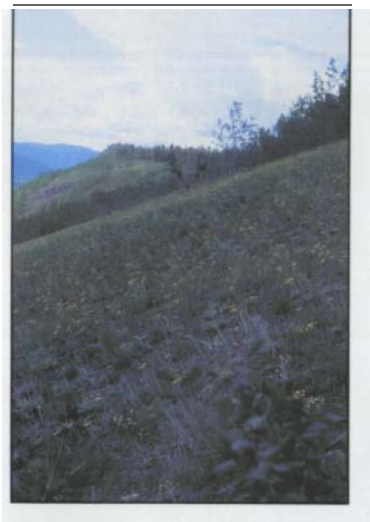

Figure 61-A midgrass-herb stand dominated by the herbs *Eriogonum flavum* and *Bupleurum triradiatum,* and the grass *Calamagrostis purpurascens,* with scattered shrubs of *Artemisia frigida* on a south-facing bluff in interior Alaska.

Successional status- The slough levee types often develop from halophytic herb communities as silt accumulation decreases flooding frequency. Tall willows, and eventually alder and *Populus* spp., invade these sites with further soil development and further removal from tidal influence. Successional relations of the other midgrass-herb communities are less clear. Some of the coastal meadow sites probably developed from coastal marshes (halophytic sedge wet meadows) and eventually may succeed to tall scrub and forest unless paludification leads to bog development. Some of the stands on slopes appear to persist indefinitely.

Closely related types- These communities are similar to some of the hair-grass and dry fescue types but are dominated by forbs, or at least dominated by two or more different kinds of grasses. Some midgrass-herb types also are similar to mesic mixed herb communities but differ in having a codominant grass element.

Coastal levee communities often grade seaward into halophytic herb communities but differ in having substantial quantities of *Poa eminens* or *Festuca rubra.* As the levees become higher or sandier, these communities may grade into *Elymus arenarius* types.

Photographs- Hanson 1951, figure 24; figure 61, this publication.

Primary references- Hanson 1951, Ritchie and others 1981.

Communities- Festuca *altaica-Anemone narcissiflora* (Anderson 1974, Pegau 1972). *Festuca altaica-Lupinus arcticus* (Scott 1974a). *Festuca altaica-Carex podocarpa-Aconitum delphinifolium-Mertensia paniculata-Artemisia arctica* (Hanson 1951). *Festuca altaica-Sanguisorba stipulata-Lycopodium alpinum-Salix reticulata/* feathermosses (Hanson 1951). *Festuca altaica-Calamagrostis canadensis-Comus canadensis-Geranium erianthum* (Hanson 1951). *Festuca rubra-Dodecatheon pulchellum-Lathyrus palustris* (Hanson 1951). *Festuca rubra-Angelica lucida-Achilles borealis-Cardamine umbellata* (Byrd 1984). *Festuca rubra-Carex supina-Agropyron boreale* (Hanson 1951). *Festuca rubra-Angelica lucida* (Byrd 1984). *Festuca brachyphylla-Poa arctica* (Shacklette and others 1969). *Poa eminens-Potentilla egedii*

(Crow 1977b, Ritchie and others 1981). *Poa eminens-Festuca rubra-Potentilla egedii* (Vince and Snow *1984). Poa eminens-Deschampsia beringensis-Festuca rubra* (Shacklette and others 1969). *Agropyron pauciflorum-Epilobium angustifolium* (Hanson *1951). Carex macrochaeta- Festuca rubra* (Byrd 1984). *Agropyron pauciflorum-Festuca rubra-Achillea borealis-Lathyrus palustris* (Hanson 1951). *Poa glauca-Carex macrochaeta-Calamagrostis canadensis-Angelica lucida* (Hanson 1951). *Carex macrochaeta-Deschampsia beringensis* (Friedman *1982). Potentilla egedii-Festuca rubra* (del Moral and Watson *1978). Hedysarum alpinum-Deschampsia beringensis* (Crow 1968).

III.A.1.e. Hair-Grass

Description- These communities are dominated by hair-grasses *(Deschampsia* spp.), usually *D. beringensis.* Broad-leaved herbs may be common but not codominant. Mosses may be common or absent. Woody plants and lichens generally are rare. The canopy may be open or closed, and the hair-grass usually grows 40 to 80 centimeters (16 to 32 in) tall.

These are often rather diverse stands, with small numbers of a great many species. Sometimes the hair-grass is only weakly dominant over the other species in the stand. Common associated species (not all are likely to be present at any one site) include *Potentilla egedii, Calamagrostis canadensis, Poa eminens, Achilles borealis, Festuca rubra,* and *Hedysarum alpinum.*

Distribution and site characteristics- Hair-grass communities are found in southern Alaska (including the Aleutian Islands) in coastal or near-coastal settings such as channel levees, fringes of coastal marshes, cliff tops, and cliff bases. Soils are generally well drained and mesic to dry. Textures range from clays to sands, and pH generally is circumneutral to slightly acid, with the few reported values hovering around 6.7 to 6.8. Some hair-grass communities are flooded irregularly by brackish water during storm surges, but this seems to have no appreciable effect on soil salinity. Permafrost is absent.

Successional status-Hair-grass communities may be near the middle of several successional sequences. Communities on coastal channel levees probably develop from halophytic herb communities via midgrass-herb communities. Hair-grass communities at the upper fringes of coastal marshes may develop from halophytic sedge (especially *Carex lyngbyaei)* stands if drainage is adequate and the marsh is prograding.

Some hair-grass communities may be invaded by *Calamagrostis canadensis* (Hanson 1951) and eventually replaced by it. Other stands may be replaced eventually by willows or alders.

Closely related types-Hair-grass communities are most similar to midgrass-herb communities but lack a dominant broad-leaved herb (forb) component. Forbs may be common or scarce but not codominant. Some hair-grass communities have a substantial cover of *Calamagrostis canadensis* and are similar to bluejoint meadows or bluejoint-herb meadows but have less bluejoint *(Calamagrostis canadensis)* and more hair-grass.

Primary references- Hanson 1951, Ritchie and others 1981, Stephens and Billings 1967.

Communities- Deschampsia *beringensis* (Batten and others 1978, Hanson 1951, Ritchie and others 1981, Seguin 1977, Stephens and Billings 1967[4]). Deschampsia *beringensis-Juncus arcticus* (Batten and others 1978). *Deschampsia beringensis-carex lyngbyaei* (McCartney 1976). *Deschampsia beringensis-Festuca rubra* (Batten and others 1978, Hanson 1951).

III.A.2. Mesic Graminoid Herbaceous

Communities dominated or codominated by graminoids and occupying relatively mesic sites are included here. Forbs may be codominant in some communities and shrubs may be present, but these provide less than 25 percent cover.

III.A.2.a. Bluejoint Meadow

Description- Bluejoint meadows are dominated by bluejoint reedgrass *(Calamagrostis canadensis),* though a community dominated by *C. nutkaënsis* has been reported from the Aleutian Islands (fig. 62). Other grasses and herbs may be present but not codominant. Mosses are often absent or scarce, especially in well-developed, dense stands of bluejoint. In slightly more open stands, a patchy layer of feathermosses may be present. Lichens and woody plants are absent or scarce within the bluejoint meadows, though often a mosaic pattern composed of bluejoint meadows and tall shrub (especially alder) communities exists. The vegetation is usually very dense; cover is usually complete and canopy height is 0.8 to 1.4 meters (32 to 55 in), occasionally reaching 2 meters (6 ft). Bluejoint meadows often occur as nearly pure stands of *Calamagrostis canadensis,* but sometimes minor amounts of species such as *Heracleum lanatum, Angelica lucida, Epilobium angustifolium, Trientalis europaea, Mertensia paniculata, Viburnum edule,* and *Equisetum arvense* are present.

Distribution and site characteristics-Bluejoint meadows are very common in south-central and southwestern Alaska and are present in the Aleutian Islands and northwestern and interior Alaska. They occur on flood plains, upland slopes from valley bottoms to tree line, streambanks, lowland fens, and recently drained lake basins. They often occur in a mosaic pattern with shrub or broadleaf forest communities. They do not occur on windswept alpine sites. Though sometimes abundant at the fringes of coastal marshes, they are freshwater communities. Soils are usually silts, loams, mucks, or sedge peats and may be extremely wet (more or less permanently flooded with a few centimeters of water) to mesic or even dry. A mulch of decaying plant material several centimeters or even decimeters thick usually is present at the soil surface. The wetter sites usually are hummocky. Soils are acid, usually ranging from pH 5 to 6. Permafrost has not been reported in bluejoint meadows but may exist at depths of 1 meter (3 ft) or more below the surface of communities in western Alaska.

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[4] Reported by Stephens and Billings (1967) as *Deschampsia (= Vahlodea) atropurpura,* but species identification is questionable.

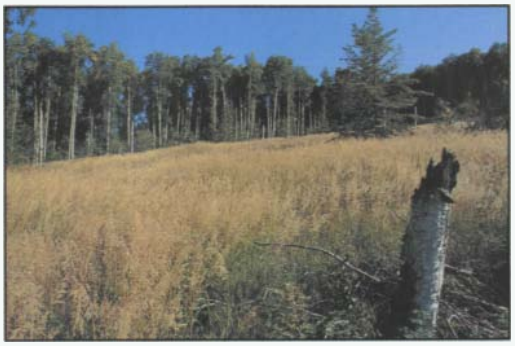

Figure 62-A bluejoint meadow of Calamagrostis *canadensis* that has developed after logging and fire in interior Alaska.

Successional status- In southwestern Alaska, bluejoint meadows are stable and appear to be climax or near-climax (Griggs 1936). They seem to develop from bluejoint-herb communities as the bluejoint gradually excludes other herbs.

Bluejoint communities on the Seward Peninsula are small and largely restricted to disturbed sites such as villages and recently drained lake basins (Racine and Anderson 1979). It seems likely that accumulation of organic matter in these sites will eventually raise the permafrost table and inhibit drainage, thereby leading to replacement by tussock tundra or wet sedge meadow.

Within the tree line, development of bluejoint communities is generally initiated by disturbance such as fire or land-clearing. Bluejoint communities may be preceded by a bluejoint-herb stage. Though bluejoint meadows may persist for some time, most probably will evolve through alder or willow scrub to a forest community if disturbance is not renewed (Mitchell and Evans 1966).

Closely related types- Bluejoint meadows are similar to bluejoint-herb meadows but are more strongly dominated by bluejoint (Calamagrostis canadensis). Some bluejoint stands are invaded by willows, alders, or other shrubs. As long as these remain minor components of the vegetation, the stand is considered bluejoint meadow; otherwise it would be considered a bluejoint-shrub community. Some bluejoint stands may have small admixtures of midgrasses (such as Deschampsia *beringensis* and Festuca *altaica)* and resemble some of the dry midgrass communities, but again these stands are more strongly dominated by *Calamagrostis canadensis.*

Photographs- Racine and Anderson 1979, figure 12; Tande 1983, plate 24; figure 62, this publication.

Primary references- Byrd 1984, Hanson 1951, Racine and Anderson 1979, Ritchie and others 1981.

Communities- *Calamagrostis canadensis* (Bank 1951; Batten and others 1978; Burns 1964; Craighead and others 1988; Friedman 1982; Fries 1977; Hanson 1951, 1953; Heusser 1960; Hultén 1966; McCormick and Pichon 1978; Pegau 1968, 1972; Racine 1976; Racine and Anderson 1979; Ritchie and others 1981; Tande 1983; Wibbenmeyer and others 1982; Young and Racine 1976). *Calamagrostis canadensis/ Galium trifidum* (Crow 1977b). *Calamagrostis nutkaënsis/Festuca rubra* (Amundsen and Clebsch 1971, Byrd 1984).

III.A.2.b. Bluejoint-Herb

Description- Bluejoint-herb communities are dominated equally by bluejoint *(Calamagrostis canadensis)* and various herbs, commonly including *Epilobium angustifolium, Angelica lucida, Athyrium filix-femina, Equisetum arvense,* and *E. fluviatile.* Sedges and other grasses, such as *Carex macrochaeta, Deschampsia beringensis,* and *Festuca rubra,* also may be present in significant amounts. Woody plants are absent or scattered. Feathermosses may be absent or common and *Polytrichum* spp. are sometimes present. *Sphagnum* spp. are sometimes present in small quantities on certain wet sites. Lichens are scarce or absent. The canopy is about 0.8 to 1.5 meters tall, sometimes taller. Cover usually is complete or nearly so. Productivity of a mesic stand in south-central Alaska was determined to be 465 grams per square meter per year (4,150 lb/acre), primarily *Epilobium angustifolium* and *Calamagrostis canadensis* (Mitchell and Evans 1966).

Distribution and site characteristics- Bluejoint-herb communities are common in the southern half of the State and occupy the same wide range of sites as bluejoint meadows: flood plains, upland slopes from valley bottoms to tree line, streambanks, and fens. Soils also are similar to those of bluejoint meadows, usually silts or loams or sometimes sedge peats. They may be extremely wet (flooded with 10 to 30 centimeters [4 to 12 in] of fresh water) but more commonly are mesic. The wetter sites usually have a hummocky microrelief pattern. Soil reaction is moderately acid, generally pH 5 to 6 (minimum value reported is pH 4.4). A layer of decaying plant material often is present at the surface but usually is not as thick as in pure bluejoint stands. Permafrost has not been reported from any of these communities but may exist at depths of 1 meter (3 ft) or more under stands in western Alaska.

Successional status-In southwestern Alaska, bluejoint-herb communities may develop from fell-fields as soils become richer and deeper and from dwarf birch-ericaceous shrub communities as drainage improves (Griggs 1936). Where drainage and soil development are adequate, the bluejoint may eventually suppress the herbs thereby resulting in the bluejoint-alder grassland climax of that area.

In the forested parts of the State, most of the mesic bluejoint-herb communities.have developed when fire, land-clearing, or some other disturbance destroyed forest communities. If disturbance is not renewed, most of these stands eventually are invaded by shrubs (alder or willow, or both) and transformed to scrub vegetation and ultimately forest. If shrub invasion is delayed long enough, the bluejoint may crowd out other herbs, thereby producing a bluejoint meadow.

The wet types may be derived from wet sedge meadows or wet herb marshes. In turn, they eventually are invaded by shrubs and become scrub communities.

Closely related types-Bluejoint-herb communities are similar to bluejoint meadows but have a substantial component of broad-leaved herbs or, rarely, other graminoids or ferns. They also may be similar to some bluejoint-shrub stands but lack a significant shrub component. Some mesic forb herbaceous communities may contain bluejoint but as a nondominant. *Elymus* spp. and various midgrasses may be present in some bluejoint herb communities but are less abundant than they are in the elymus or midgrass communities.

Photographs-Mitchell and Evans 1966, figure 1.

Primary references- Batten and others 1978, del Moral and Watson 1978, Griggs 1936, Hanson 1951, Mitchell and Evans 1966, Ritchie and others 1981.

Communities- Calamagrostis *canadensis-Epilobium angustifolium* (Hanson 1951, Klein 1959, Mitchell and Evans 1966, Young and Racine 1978). *Calamagrostis canadensis-Epilobium angustifolium-Geranium erianthum* (Heusser 1960). *Calamagrostis canadensis-Thalictrum minus-Geranium erianthum-Epilobium angustifolium* (Hultén 1960). *Calamagrostis canadensis-Epilobium angustifolium-Heracleum lanaturn-Angelica genuflexa* (Griggs *1936). Calamagrostis canadensis-Deschampsia beringensis-Heracleum lanaturn-Angelica lucida* (Bank 1951). *Calamagrostis canadensis-Festuca altaica* (Hanson 1951). *Calamagrostis canadensis-Festuca altaica-Elymus arenarius* (Hanson 1951). *Calamagrostis canadensis-Elymus arenarius* (Hanson 1951). *Calamagrostis canadensis-C. nutkaensis-Geranium erianthum* (Friedman *1982). Calamagrostis canadensis-Equisetum sylvaticum* (Hanson 1951). *Calamagrostis canadensis-Equisetum fluviatile-Potentilla palustris* (Ritchie and others 1981). *Calamagrostis canadensis-Hordeum brachyantherum* (Batten and others 1978). *Calamagrostis canadensis-Deschampsia beringensis* (Batten and others 1978, Hanson 1951). *Calamagrostis canadensis-Angelica genuflexa* (Hanson 1951). *Calamagrostis canadensis-Carex macrochaeta-Angelica lucida* (Hanson 1951). *Calamagrostis canadensis-Carex macrochaeta* (Hanson 1951). *Calamagrostis canadensis-Athyrium filix-femina* (Hanson 1951). *Carex macrochaeta-Calamagrostis nutkaënsis* (Friedman 1982). *Calamagrostis nutkaënsis-Heracleum lanaturn* (del Moral and Watson 1978).

III.A.2.c. Biuejoint-Shrub

Description- Bluejoint-shrub communities are dominated by bluejoint *(Calamagrostis canadensis)* and have a conspicuous shrub element. The shrubs can be tall or short but must total less than 25 percent cover. The only such community reported consists of scattered clumps of tall alder *(Alnus sinuata)* growing in a matrix of pure bluejoint. Bluejoint-willow and bluejoint-sweetgale stands certainly must exist, however. Herbs other than bluejoint may be common or absent. Mosses are absent where the bluejoint is dense (as is usually the case) but may be present in more open stands. Lichens are scarce or absent.

Distribution and site characteristics-Although bluejoint-shrub communities have been reported only from southwestern Alaska, they probably are distributed widely in south-central and interior Alaska on the full range of sites occupied by bluejoint meadows: flood plains, upland slopes from valley bottoms to tree line, and fens. Soils are wet to mesic silts, loams, or peats with acid reaction (pH 5 to 6).

Successional status-Griggs (1936) considers a landscape mosaic of bluejoint meadows and tall alder copses to be climax in southwestern Alaska beyond the tree line. He believes it to be the endpoint of both wet (via dwarf birch-ericaceous shrub communities and bluejoint-herb communities) and dry (via bluejoint-herb communities) seres on sites where soil development can proceed toward a mesic condition.

In forested parts of the State, bluejoint-shrub communities probably develop when shrubs invade bluejoint meadows or bluejoint-herb stands, though sometimes they may develop directly after fire or other disturbance. If disturbance is not renewed, bluejoint-shrub communities probably develop into scrub and then forest communities.

Closely related types- Bluejoint-shrub communities are similar to bluejoint meadows and bluejoint-herb communities but have a substantial (but still less than 25 percent cover) component of low or tall shrubs. They are also similar to open low or tall shrub communities with bluejoint understories but have less shrub cover. Wet bluejoint-shrub types grade into shrub-grass fen communities but have less shrub cover.

Photographs- Griggs 1936, figure 11.

Primary reference- Griggs 1936.

Communities- Calamagrostis *canadensis-Alnus sinuata* (Griggs 1936).

III.A.2.d. Tussock Tundra

Description- Tussock tundra is dominated by sedges in a tussock growth form (fig. *63). Eriophorum vaginatum* is the primary tussock-former, but in some stands Carex bigelowii is the dominant tussock-forming sedge. Tussocks occur in many sizes and densities but commonly are 10 to 60 centimeters (4 to 24 in) tall and spaced 30 to 60 centimeters (12 to 24 in) apart. Low shrubs often grow between the tussocks; occasionally these grow as high as the tops of the sedges but usually are much lower. These shrubs, commonly *Betula nana, Ledum decumbens, Vaccinium vitis-idaea, V. uliginosum,* and *Empetrum nigrum,* total less than 25 percent cover. Mosses are common between tussocks. *Sphagnum* spp. may be locally abundant but more commonly are absent or sparse. Lichens are common.

Distribution and **site characteristics-** Tussock tundra is widespread in northern and western Alaska on poorly drained, acid soils over permafrost on flats and gentle slopes with gradients up to 10 percent. It typically occurs on upland tundra or meadow tundra soils (Pergelic Cryaquepts or Histic Pergelic Cryaquepts). These are poorly drained, gleyed soils, often with a poorly decomposed organic horizon at the surface, which may constitute most of the active layer. Soil pH is usually in the range of 4.4 to 5.5. Permafrost usually is present at depths of 30 to 50 centimeters (12 to 20 in). In some areas, the vegetation and surface organic mat frequently are broken by frost scars of mineral soil. *Carex bigelowii* tussock tundra is much less common than *Eriophorum vaginatum* tussock tundra and usually occupies slightly steeper and better drained sites when the two occur in the same area.

Successional status- Tussock tundra, especially in the arctic foothills and the hilly parts of the arctic coastal plain, is very stable and may represent climax vegetation on poorly drained flats, plateaus, benches, and gentle slopes. It may develop from wet sedge meadows if drainage improves (usually through headward erosion of streams and gullies). Conversely, it sometimes may develop from dwarf birch-ericaceous shrub communities if drainage is impeded or if the permafrost table rises. If sphagnum can invade and accumulate to the point of overtopping the sedge tussocks, the tussocks will be killed and the site may convert to an ericaceous shrub-herb/sphagnum community. Tussock senescence also occurs if the permafrost table rises into the organic mat at the soil surface, because the roots of a tussock-former must reach mineral soil to survive.

Disturbance, such as soil frost activity or fire, may be necessary for the maintenance of some tussock tundra stands, particularly in more southerly areas.

Figure 63-Tussock tundra dominated by the *sedge Eriophorum vaginatum* with scattered shrubs of *Ledum decumbens, Betula nana,* and *Salix planifolia* subsp. *pulchra* in arctic Alaska.

Closely related types- A continuous gradation exists from stands of pure Eriophorum vaginatum with no shrubs to stands with shrub cover of 50 percent or even more. Tussock communities with more than 25 percent shrub cover are grouped with birch and ericaceous shrub tundra or (within tree line) mixed shrub-sedge tussock/sphagnum bog. Locally in western Alaska, small stands of bluejoint or medium-height grasses may be physiognomically similar to tussock tundra when the grasses take on a tussock growth form. Tussock tundra is, however, always dominated by sedges. Some poorly drained treeless communities within the tree line are similar to tussock tundra, but usually a substantial shrub cover also is present and the communities can be grouped with mixed shrub-sedge tussock/sphagnum bogs.

Photographs- Figure 63, this publication.

Primary references- Brock and Burke 1980, Komarkova and Webber 1978.

Communities- Eriophorum vaginatum (Batten 1977, Craighead and others 1988, Johnson and others 1966, Komarkova and Webber 1978, Young 1974b). *Eriophorum vaginatum-Salix planifolia-Carex bigelowii/Hylocomium splendens* (Hettinger and Janz 1974). *Eriophorum vaginatum-Carex bigelowii* (Brock and Burke 1980, Churchill 1955, Craighead and others 1988, Jorgenson 1984).

III.A.2.e. Mesic Sedge-Grass Meadow Tundra

Description- These are tundra communities (alpine or arctic) dominated by combinations of grasses and sedges. Dominant sedges are commonly *Carex microchaeta, C. podocarpa,* C. *bigelowii,* and *C. aquatilis.* Dominant grasses reported include *Poa arctica* and *Arctagrostis latifolia. Festuca* spp., *Hierochlolë alpina,* and *Trisetum spicatum* also may be codominants. Forbs and woody plants are absent or scattered. Lichens and nonsphagnaceous mosses may be common. Canopy heights usually are fairly low, but *Arctagrostis latifolia* may grow to 1 meter (3 ft). Plant cover usually is complete or nearly *so.* A *Carex aquatilis-Poa arctica* stand at Barrow with abundant mosses produced an aboveground biomass of 362 grams per square meter per year (3,230 lb/acre) and an aboveground vascular annual production of 39 grams per square meter (350 lb/acre) (Webber 1978).

Distribution and site characteristics- Small stands of sedge-grass tundra are found infrequently in alpine and arctic tundra on sheltered well-drained sites, including old beach ridges, high-center polygons, streambanks, south-facing mesic alpine slopes, and protected alpine swales. Soils are well-drained, thin, and predominantly mineral, though an organic or organic-rich horizon of variable thickness may be present at the surface. Some soils are highly acid (pH 4.2), but others may be circumneutral. Permafrost is present at depths as shallow as 36 centimeters (14 in) beneath sites on the arctic coastal plain but is much further below the surface of south-facing alpine sites.

Successional status- Successional relations of mesic sedge-grass meadow tundra are unknown, but most stands seem to be stable.

Closely related types- Mesic sedge-grass meadows with *Carex aquatilis* are similar to wet sedge meadows and wet sedge-grass meadows, but the soil is better drained and the codominant grass is never *Dupontia fischeri.* Other stands may be similar to mesic sedge-herb, grass-herb, or sedge-willow tundras but lack a codominant herb or willow component.

Primary references- Batten 1977, Webber 1978.

Communities- Carex *aquatilis-Poa arctica* (Clebsch 1957, Webber 1978). *Carex microchaeta-Poa arctica* (Batten 1977). *Carex podocarpa-Arctagrostis latifolia (Scott* 1974a).

III.A.2.f. Mesic Sedge-Herb Meadow Tundra

Description- Mesic sedge-herb meadow tundra communities are characterized by the codominance of sedges and broad-leaved herbs. *Carex macrochaeta* has been reported as a codominant sedge, but any of the sedges important in mesic sedge-grass meadow tundra also could be important here. *Calamagrostis canadensis* may be present but is not a codominant. A wide variety of herbs can occur with the sedge, including *Geranium erianthum, Erigeron peregrinus, Anemone* spp., *Pedicularis* spp., *Saxifraga* spp., and *Polygonum* spp. Woody plants are scarce to common but total less than 25 percent cover. Willows are not conspicuous. Nonsphagnaceous mosses are common to abundant. Lichens are scarce or common. The plant canopy is usually low (under 50 centimeters [20 in]), and cover is usually high.

Distribution and site characteristics- scattered small stands of mesic sedge-herb meadow tundra occur on sheltered alpine slopes throughout the State. Soils are well drained, loamy, sometimes stony and thin, and sometimes thicker with an organic surface horizon. Moist stands near valley bottoms may have hummocky microrelief features. Permafrost is present at northern sites but absent from southern alpine localities.

Successional status- Successional relations of these communities are unknown.

Closely related types- These stands are similar to mesic sedge-grass meadow tundra but have more forbs and fewer grasses. They can be similar to mesic sedge-willow tundra but have fewer willows and more forbs. Stands with abundant forb cover are similar to mesic mixed herb communities but have a codominant sedge component. They are also similar to alpine herb-sedge (snowbed) communities, but sedge-herb tundra usually has more sedge cover, higher total vegetation cover, and different dominant sedge species.

Primary reference- Hjeljord 1971.

Communities- Carex *macrochaeta-Geranium erianthum-Erigeron peregrinus-Lupinus nootkatensis* (Hjeljord 1971).

III.A.2.g. Mesic Grass-Herb Meadow Tundra

Description- Mesic grass-herb meadow tundra is dominated by grasses (commonly *Arctagrostis latifolia, Bromus pumpellianus, Trisetum spicatum,* and *Poa* spp.) and forbs (including *Oxyria digyna, Petasites frigidus,* and *Saxifraga* spp., among many others). Canopy height is usually under 50 centimeters (20 in). Plant cover is variable (open to closed).

Distribution and site characteristics- These communities are restricted to occasional small stands on various mesic sites throughout the arctic part of the State, including streambanks, sheltered pockets on slopes, and high-center polygons. Soils are relatively thin and well drained. Permafrost is probably present beneath all stands but may be under a thick active layer.

Successional status- Successional relations of mesic grass-herb meadow tundra are unknown, but it seems likely that the successional trend would be for sedges or low shrubs to gradually invade and gain dominance on at least some of these sites.

Closely related types-These stands are similar to mesic sedge-herb tundra but have more grasses and few sedges. Some stands may be similar to some mesic mixed herb communities but have more grass cover.

Primary reference- Koranda 1960.

Communities- Bromus *pumpellianus-Trisetum spicatum-Bupleurum triradiatum* (Koranda 1960). *Luzula confusa-Poa arctica-Petasites frigidus* (Wiggins 1951).

III.A.2.h. Sedge- Willow Tundra

Description- Sedge-willow tundra is dominated by sedges (commonly *Carex aquatilis, C. bigelowii,* or *C. microchaeta)* and has a conspicuous willow component, though total shrub cover is less than 25 percent. Common willows include *Salix planifolia, S. lanata, S. fuscescens, S. reticulata, S. phlebophylla, S. rotundifolia, S. ovalifolia,* and *S. arctica.* Other shrubs may be present but are usually minor components of the vegetation. *Dryas integrifolia* may be common at some sites. Mosses, especially species of *Aulacomnium, Tomenthypnum, Hylocomium,* and *Polytrichum,* are common and may form a continuous mat. *Sphagnum* spp. are generally rare, but are abundant at some sites. Lichens are relatively scarce but common locally. Canopy height is about 15 to 50 centimeters (6 to 20 in); cover usually is complete.

Distribution and site characteristics- Sedge-willow tundra is found on wet to mesic sites on flood plains, benches, plateaus, low-center polygons, drained lake basins, and north slopes, primarily in the Arctic but also in alpine areas. Frost scars are abundant in some communities. *Carex aquatilis* dominates the wetter sites; other sedges dominate on the more mesic sites. Acid to circumneutral tundra soils (poorly drained, fine-textured mineral soils with a surface organic mat of variable thickness) commonly form the substrate, with permafrost at about 35 to 150 centimeters (14 to 60 in) (the deeper extremes from Alaska Range alpine sites). Low microrelief ridges, hummocks, or solifluction lobes often are present, and the shrubs often are concentrated on these features.

Successional status- Successional status of these stands is largely unknown, but many sedge-willow tundra stands appear to be stable. If drainage were to improve, through lowering of the permafrost table or some other cause, the willows might increase in area and size and form scrub communities. If the sites became wetter, the willows might decrease and wet sedge meadows form. Considerable fluctuation in moisture regimen of these sites may have minimal impact, however, on the moisture conditions within the small raised microrelief features where the willows are concentrated.

Closely related types- Subarctic lowland sedge-shrub wet meadows are the subarctic counterpart of sedge-willow tundra and are differentiated primarily by geography, though the dominant sedge species commonly also are different. *Carex* aquatilis-willow communities are similar to some wet sedge meadow types but have more willows. Other sedge-willow communities resemble mesic sedge-grass tundra but likewise have a greater cover of willows. Some of the shrubbier sedge-willow tundra stands resemble willow-sedge tundra and willow-sedge fen but have less than 25 percent shrub cover.

Photographs- Batten 1977, figure 14; Drew and Shanks 1965, figure 10; Hettinger and Janz 1974, plate 10C; Johnson and others 1966, figures 10 and 15.

Primary references- Drew and Shanks 1965; Hanson 1950, 1951; Johnson and others 1966; Viereck 1963.

Communities- Carex *aquatilis-Salix planifolia* (Childs 1969, Clebsch 1957, Dennis 1968, Hanson 1951, Hettinger and Janz 1974, Koranda 1960, Webber and others 1978). *Carex aquatilis-Salix lanata* (Craighead and others 1988, Spetzman 1959). *Carex aquatilis-Alnus crispa-Salix* spp. (Bliss and Cantlon 1957). *Carex bigelowii-Salix planifolia* (Hettinger and Janz 1974, Johnson and others 1966, Koranda 1960, Viereck 1963). *Carex bigelowii-Salix reticulara-S. planifolia* (Batten 1977, Hettinger and Janz 1974). *Carex bigelowii-Salix reticulata* (Drew and Shanks 1965, Hettinger and Janz 1974). *Eriophorum angustifolium-Salix planifolia* (Fries 1977). *Eriophorum angustifolium-Salix fuscescens* (Johnson and others 1966). *Eriophorum angustifolium-Carex pluriflora-Salix reticulata* (Hanson 1951). *Carex bigelowii-C. membranacea-Salix polaris-Equisetum arvense* (Hanson 1950). *Carex nesophila-Salix rotundifolia-S. reticulata* (Klein 1959). *Carex subspathacea-Dupontia fischeri-Salix ovalifolia* (Meyers 1985).

lll.A.2.1. Sedge-Birch Tundra

Description- Sedge-birch tundra is dominated by sedges (commonly *Carex aquatilis* or C. *bigelowii)* with a substantial admixture of shrub birch *(Betula nana* or *B. glandulosa).* Total shrub cover is less than 25 percent. Mosses, including feathermosses and *Sphagnum* spp., may be common.

Distribution and site characteristics- sedge-birch tundra has been infrequently reported from flood plains and gentle slopes in northern Alaska. A hummocky microtopography usually is present, and the shrubs usually are concentrated on the hummocks.

Successional status-Successional relations of these communities are unknown.

Closely related types- Sedge-birch tundra is similar to wet sedge meadow tundra and mesic sedge-grass tundra but has a substantial dwarf birch component. At the other extreme, some shrubby stands may be similar to birch-sedge fens (not yet reported from northern Alaska) or birch and ericaceous shrub tundra but have less than 25 percent shrub cover.

Photographs- Hettinger and Janz 1974, plate 11 A.

Primary references- Hettinger and Janz 1974. !

Communities- Carex *bigelowii-C. aquatilis-Betula nana* (Hettinger and Janz 1974).

III.A.2.j. Sedge-Dryas Tundra

Description- Sedge-dryas tundra communities are dominated by sedges (most commonly *Carex aquatilis* or C. *bigelowii* but *Eriophorum angustifolium* and *Kobresia simpliciuscula* also are included) and have a substantial component of *Dryas integrifolia* or *D. octopetala.* Total shrub cover (including dryas) is less than 25 percent. Willows and ericaceous shrubs may be minor components of the vegetation. Nonsphagnaceous mosses (often including *Drepanocladus* spp. and *Tomenthypnum nitens)* are common; lichens usually are scarce. Canopy height is less than 30 centimeters (12 in) and commonly lower. Cover may be open to complete.

Distribution and site characteristics- Sedge-dryas tundra is common on protected mesic alpine slopes and calcareous tundra lowlands throughout the State except southeastern Alaska. In lowland wet to mesic areas (terraces, flats, polygon rims), it is more or less restricted to calcareous substrates with circumneutral soil reaction. In alpine areas, it is found on both calcareous and acidic, parent materials. Sometimes these communities occur in a mosaic pattern with other communities. An example would be low-center polygons with wet sedge meadow tundra in the centers and sedge-dryas tundra on the rims.

Lowland soils supporting these communities include Pergelic Cryaquepts and Pergelic Cryaquolls. An organic mat a few centimeters thick usually is present at the surface. Solifluction lobes are common in communities on slopes. Permafrost has been reported at depths of 25 to 30 centimeters (10 to 12 in) at sites on the arctic coastal plain; the active layer is probably thicker at alpine sites.

Successional status- Successional relations of sedge-dryas tundra are unknown. Drying trends probably would favor the dryas; trends toward increasing moisture or (in the lowlands at least) increasing acidity probably would favor the sedges.

Closely related types- Some sedge-dryas communities are similar to mesic sedge-herb tundra communities but have a greater cover of dryas. At the other extreme, stands with abundant dryas are similar to dryas-sedge tundra (open dwarf scrub) but have less than 25 percent of dryas cover.

Photographs-Drew and Shanks 1965, figure 12; Johnson and others 1966, figures 5 and 9; Webber and Walker 1975, p. 85.

Primary references-Drew and Shanks 1965, Johnson and others 1966, Webber and Walker 1975, Webber and others 1978.

Communities- Carex *aquatilis-Dryas integrifolia* (Webber and Walker 1975, Webber and others 1978). *Carex* bigelowii-Dryas *integrifolia* (Childs 1969, Hettinger and Janz 1974, Webber and others *1978). Carex bigelowii-Eriophorum angustifolium-Dryas integrifolia* (Drew and Shanks *1965). Carex bigelowii-Eriophorum angustifolium-Dryas octopetala* (Anderson 1974). *Carex bigelowii-C. membranacea-Dryas octopetala* (Hanson 1950). *Carex bigelowii-Dryas octopetala* (Johnson and others 1966). *Carex bigelowii-Dryas octopetala-Salix reticulata* (Anderson 1974, Scott 1974a, Webber and others 1978). *Kobresia simpliciuscula-Dryas integrifolia* (Webber and others 1978). *Eriophorum angustifolium-Dryas integrifolia* (Webber and Walker 1975, Webber and others 1978).

III.A.3. Wet Graminoid Herbaceous

Communities dominated or codominated by graminoids and occupying wet sites are included here. Forbs may be codominant in some communities, and shrubs may be present but provide less than 25 percent cover. Soils are saturated with water or are underwater for all or most of the growing season.

III.A.3.a. Wet Sedge Meadow Tundra

Description- Wet sedge meadow tundra is commonly dominated by *Carex aquatilis, Eriophorum angustifolium,* or both (fig. 64). Woody plants are generally absent, though sometimes prostrate willows are important. Mosses, commonly of the genera *Scorpidium* or *Drepanocladus,* may be absent or common. Sphagnum is usually not important but is codominant on a few sites. Lichens are rare or absent.

Scorpidium scorpioides indicates circumneutral, many soils; *Sphagnum* spp. indicates acid sites; *Carex chordorrhiza* is characteristic of very wet, floating sedge peats.

Distribution and site characteristics- Large stands of wet sedge meadow tundra are common on arctic lowlands, and small stands are locally common in alpine areas everywhere except southeast Alaska. They occur on drained lake basins, lake margins, depressions, and on level to gently sloping flood plains and terraces.

Soils are fine-grained and poorly drained. They may be mineral or organic, or may consist of a few centimeters of organic matter over mineral soil. Permafrost is present, usually 30 to 50 centimeters (12 to 20 in) below the surface, though possibly up to 1 meter (3 ft) below the surface near the southern limit of this type. Soil pH ranges from circumneutral (7.5) to highly acid (4.5) (Drew and Shanks 1965, Holowaychuk and Smeck 1979). The soil is generally flooded at breakup, with a few centimeters of standing water persisting into at least the early part of the growing season.

Successional status- Successional relations among tundra communities are complex (Britton 1967). It appears that wet sedge meadows may replace grass marshes *(Arctophila fulva)* if sedimentation or drainage causes the water table to drop. A further decrease in moisture may enable tussock tundra to move in. A rise in the water table may cause tussock tundra to be replaced by wet sedge meadow.

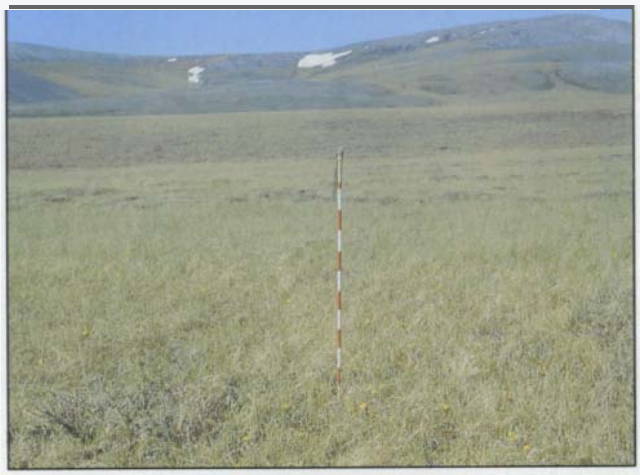

Figure 64-Wet sedge meadow tundra of *Eriophorum angustifolium* and *Carex aquatilis* in arctic Alaska.

Closely related types- Wet sedge meadow tundra is similar to subarctic lowland sedge wet meadow (lll.A.3.g.), which occupies similar sites within the tree line. Although some species commonly dominate both, many species dominating the subarctic sites are not present in the Arctic. Also, *Eriophorum angustifolium* is less commonly dominant on the subarctic sites than it is in the Arctic. This unit is also similar to wet sedge-grass and wet sedge-herb meadow tundras (which are esentially variants of wet sedge meadow tundra) but lack conspicuous grass or broad-leaved herb elements. Fresh sedge marsh also is similar but does not include any tundra (arctic) communities, is permanently flooded with relatively deep water, and is dominated by genera other than Carex.

Photographs- Batten 1977, figure 13 (aerial view); Bergman and others 1977, plates I, II, and III; Churchill 1955, figure 9; Drew and Shanks 1965, figure 14; Hettinger and Janz 1978, plate 10E; Johnson and others 1966, figures 8, 9, 15, and 16; Komarkova and Webber 1978, figure 66; Racine 1978a, figures 12 and 13; Racine and Anderson 1979, figure 24; Webber 1978, figure 7; figure 64, this publication.

Primary references- Drew and Shanks 1965, Racine and Anderson 1979, Webber and Walker 1975.

Communities- *Eriophorum angustifolium* (Craighead and others 1988, Holowaychuk and Smeck 1979, Murray 1974, Racine 1976, Racine and Anderson 1979, Viereck 1963, White and others 1975). *Eriophorum angustifolium-E. scheuchzeri* (Britton 1967). *Eriophorum angustifolium-Carex membranacea* (Murray 1974). *Eriophonrm angustifolium-E. brachyantherum-Carex aquatilis* (Murray 1974, Young 1974b). *Eriophorum angustifolium-Trichophorum caespitosum* (Murray 1974). *Eriophorum angustifolium-Carex pluriflora-Salix reticulata* (Hanson 1951). *Eriophorum angustifolium-Carex aquatilis-C. lachenalii* (Klein 1959, Rausch and Rausch 1968). *Eriophorum angustifolium-Carex* bigelowii (Anderson 1974, Drew and Shanks 1965, Hanson 1950). *Eriophorum angustifolium-Carex chordorrhiza* (Webber and others *1978). Eriophorum angustifolium-Equisetum fluviatile* (Craighead and others 1988).

Eriophomm scheuchzeri/Drepanocladus revolvens (Jorgenson 1984). *Carex aquatilis-Eriophorum angustifolium* (Batten 1977; Bergman and others 1977; Childs 1969; Craighead and others 1988; Hopkins and Sigafoos 1951; Porter 1966; Racine 1977, 1978a, 1978b; Spetzman *1959). Carex aquatilis-Eriophorum angustifolium/ Drepanocladus lycopodioides* (Webber and Walker 1975, Webber and others 1978). *Carex aquatilis-Eriophorum angustifolium/Rhytidium rugosum* (Johnson and others *1966). Carex aquatilis-Eriophorum augustifolium/Scorpidium scorpioides* (Neiland and Hok 1975, Webber and Walker 1975). *Carex aquatilis-Eriophorum angustifolium/ Sphagnum* spp. (Bos 1967, Johnson and others 1966). *Carex aquatilis-Eriophorum angustifolium-Carex rotundata* (Hanson 1953, Jorgenson 1984). *Carex aquatilis-Eriophorum angustifolium-E. russeolum* (Murray 1974; Racine 1978a, 1978b). Carex *aquatilis-Eriophorum angustifolium-E. scheuchzeri* (Jorgenson 1984, Koranda 1960, Pegau 1968). *Carex aquatilis* (Bergman and others 1977; Britton 1967; Churchill 1955; Clebsch 1957; Craighead and others 1988; Dennis 1968; Fries 1977; George and others 1977; Kessel and Schaller 1960; Komarkova and Webber 1978; Koranda 1960; Meyers 1985; Murray 1974; Pegau 1972; Peterson and Billings 1978; Racine 1976,1978a, 1978b; Racine and Anderson 1979; Spetzman 1959; Webber 1978; White and others 1975; Young 1971). *Carex aquatilis/Scorpidium scorpioides* (Neiland and Hok 1975, Webber and Walker 1975, Webber and others 1978). *Carex aquatilis/ Drepanocladus* spp. (Webber and others 1978). *Carex aquatilis-C. rotundata (George* and others 1977; Hanson 1951, 1953; Webber and others 1978). *Carex aquatilis-Eriophorum russeolum/Drepanocladus lycopodioides* (Webber *1978). Carex aquatilis-Eriophorum scheuchzeri* (Britton 1967, Webber and others 1978). *Carex aquatilis-Eriophorum scheuchzeri-Carex rotundata* (Jorgenson 1984). *Carex aquatilis-C. chordorrhiza-C. limosa-C. microglochin-Eriophorum scheuchzeri-E. angustifolium* (Drew and Shanks 1965). *Carex chordorrhiza* (Batten 1977, Spetzman 1959). *Eriophorum scheuchzeri* (Racine 1976). *Carex rariflora* (Batten 1977, Hanson 1951). *Carex bigelowii-C. rariflora-C. saxatilis* (Hettinger and Janz 1974). *Carex rariflora-Hippuris tetraphylla/Sphagnum* spp. (Hultén 1962). *Carex rotundata* (Brock and Burke 1980).

III.A.3.b. Wet Sedge-Grass Meadow Tundra

Description- Communities of this unit are dominated by sedges and grasses, or sometimes by grasses alone. Dominant sedges commonly are *Carex aquatilis* or *Eriophorum angustifolium,* or sometimes both. The dominant grass usually is *Dupontia fischeri* but sometimes is *Alopecurus alpinus* or other grasses (but not *Arctophila fulva,* which is characteristic of grass marsh types). The presence of *Dupontia fischeri* as a codominant species often is sufficient to include a community with this unit. Woody plants and lichens are absent or unimportant; mosses are common; sphagnum occasionally is present. Cover usually is close to 100 percent. Biomass of a stand at Barrow has been reported to be 84 to 92 grams per square meter (750 to 820 lb/acre) aboveground and 995 to 1,305 grams per square meter (8,875 to 11,640 lb/acre) belowground, with total vascular plant production of 45 to 52 grams per square meter per year (400 to 460 lb/acre) (Webber 1978).

Distribution and site characteristics- wet sedge-grass meadow tundra communities that have been reported all have been within **a** few kilometers of the Arctic coast, where they occupy shallow polygon troughs, streambanks, and low wet areas. Soils range from tundra humic gleys to histosols and are wet and fine textured. They usually are somewhat acid, with reactions as low as pH 4.1 reported (Webber 1978) and may be flooded by up to 15 centimeters (6 in) of water much of the growing season. Permafrost is present at shallow depths (ca. 30 to 40 centimeters [12 to 16 in]).

Successional status- Most wet sedge-grass meadow tundra communities probably are fairly stable ecologically. They may replace fresh grass marsh if the water table drops.

Closely related types- This unit differs from fresh grass marsh in that the latter is wetter and dominated by *Arctophila fulva.* Wet sedge meadow tundra lacks grass; wet sedge-herb meadow tundra has a substantial component of broad-leaved herbs. Mesic sedge-grass meadow tundra rarely is dominated by *Carex aquatilis* and never is dominated by *Eriophorum angustifolium* or *Dupontia fischeri.*

Photographs- Webber 1978, figures 5 and 66.

Primary references- Webber 1978, Webber and Walker 1975.

Communities- Dupontia *fischeri* (Britton 1967, Clebsch 1957, Dennis 1968, Meyers 1985, Potter 1972, Wiggins 1951). *Dupontia fischeri-Alopecurus alpinus* (Bergman and others 1977). *Dupontia fischeri-Petasites frigidus* (Dennis 1968). *Dupontia fischeri-Eriophorum angustifolium* (Brown and others 1970, Dennis 1968, Meyers 1985, Webber *1978,* Young 1971). *Dupontia fischeri-Eriophorum angustifolium/Bryum* spp. (Webber 1978). *Dupontia fischeri-Eriophorum scheuchzeri* (Spetzman 1959). *Eriophorum angustifolium-Carex glareosa-Deschampsia caespitosa-Dupontia fischeri-Arctagrostis latifolia* (Johnson and others *1966). Carex aquatilis-Dupontia fischeri* (Potter 1972, Webber and others 1978, Wiggins 1951). *Carex aquatilis-Dupontia fischeri/Oncophorus wahlenbergii* (Webber *1978). Carex aquatilis-Dupontia fischeri/ Bryum* spp. (Webber and Walker 1975, White and others 1975). *Carex aquatilis-Dupontia fischeri-Carex membranacea* (Koranda *1960). Eriophorum scheuchzeri-Alopecurus alpinus* (Koranda *1960). Alopecurus alpinus* (Britton 1967).

III.A.3.c. Wet Sedge-Herb Meadow Tundra

Description-These communities are dominated by sedges and broad-leaved herbs (forbs). *Carex aquatilis* is often the dominant sedge, but several other carices may dominate in certain settings. Several herbs may share dominance; some of the most common are *Menyanthes trifoliata, Petasites frigidus,* and *Potentilla palustris.* In southeast Alaska, *Fauria crista-galli* may be the codominant herb. Woody plants and lichens are absent or rare. Mosses may be present or absent, but sphagnum is absent or at least unreported from these communities. Plant cover is usually open or even sparse.

Distribution and site characteristics- Small stands of these communities are locally common in tundra areas (arctic and alpine) throughout the State in very wet, poorly drained sites with standing water, such as oxbow lakes, lake and pond margins, kettles and other depressions, and very wet polygon pans. The standing water is usually shallow (15 centimeters [6 in] or less) but probably is sometimes deeper. Soils are poorly drained and fine textured, mineral or organic-rich, but without a well-preserved organic mat. Soil pH ranges from basic to acid but probably are not extremely acid. Permafrost is present at most sites 50 to 100 centimeters (20 to 40 in) below the surface but is absent from southeastern and south-central Alaska alpine sites.

Closely related types-- This is a variant of wet sedge meadow tundra, differing in having a codominant broad-leaved herb component. It is similar to the subarctic lowland sedge meadow (lll.A.3.f.) within the tree line, though with more herbs. With increasing sphagnum, it also is similar to the subarctic lowland sedge-moss bog meadow (lll.A.3.k.). Mesic sedge-herb meadow tundra (lll.A.2.f.) is dominated by different species and occupies well-drained soils, usually on slopes. The wet herb units under the wet forb herbaceous branch of this classification (level 3, III.B.3.) lack a significant sedge component and are generally restricted to the forested parts of the State.

Primary references- Bliss and Cantlon 1957, Webber and others 1978.

Communities- Carex *aquatilis-Menyanthes trifoliata* (Racine 1976, Webber and others 1978). *Carex aquatilis-C. membranacea-Petasites frigidus (Scott* 1974a). *Carex aquatilis-Potentilla palustris* (Bliss and Cantlon 1957, Webber and others 1978). *Carex nigricans-Eriophorum angustifolium-Fauria crista-galli-Trichophorum caespitosum* (Fox 1983, Jaques *1973). Trichophorum caespitosum-Triglochin palustris* (Webber and others 1978).

lll.A.3.d. Fresh Sedge Marsh

Description- These communities are dominated by tall emergent sedges, primarily *Scirpus validus* **or** *Eleocharis palustris* (fig. 65). Trees, shrubs, and lichens are absent; aquatic mosses may be present, but are not abundant. Plant cover may appear fairly dense when viewed from the side but generally is less than 50 percent because the dominant plants have no leaves.:

Distribution and site characteristics- Fresh sedge marshes occur locally in deep (15 to 100 centimeters [6 to 14 in]) water of ponds, sloughs, and oxbow lakes in south-central and southeastern Alaska. Our reports have been from coastal settings where fresh sedge marshes occur in fresh water, although most of these sites are infrequently flooded by sea water during storm surges. These communities also are expected to occur in inland lakes, ponds, and sluggish streams. Soils are mineral or organic-rich mucks.

Successional status- These communities are early colonizers of ponds and other water bodies and may be replaced eventually by wet sedge meadow as plant detritus and other sediments accumulate. Under certain circumstances, these communities could be encroached upon by horizontal growth of peat mats of adjacent bog or fen communities.

Figure 65-Fresh sedge marsh of emergent sedges, *Carex aquatilis, Scirpus validus,* and *Eleocharis palustris,* surrounding a small lake in south-central Alaska

Closely related types- Wet sedge meadows are similar to fresh sedge marshes but have less water and are generally dominated by species of the genus Carex. Fresh grass marshes are dominated by grasses (primarily *Arctophila fulva)* and are most common in the Arctic. Fresh sedge marsh communities dominated by *Eleocharis* palustris are similar to halophytic sedge wet meadow communities dominated by that species but are found in sites not susceptible to tidewater flooding.

Photographs- Batten and others 1978, figure 54; figure 65, this publication.

Primary references- Batten and others 1978, del Moral and Watson 1978.

Communities- *Scirpus validus* (Batten and others 1978, del Moral and Watson 1978, Hanson 1951, Neiland 1971b, Ritchie and others 1981). *Eleocharis palustris-Hippuris vulgaris* (Heusser 1960). *Eleocharis palustris-Myriophyllum spicatum* (Crow *1968). Eleocharis palustris-Equisetum fluviatile-E. palustre* (Worley 1980).

lll.A.3.e. Fresh Grass Marsh

Description- These communities are dominated by grasses growing in deep water. *Arctophila fulva* is characteristically dominant or codominant. Woody plants and lichens are absent. Aquatic mosses (not sphagnum) often are present but usually contribute little cover or biomass. Total plant cover may be sparse or dense but usually is less than complete.

Distribution and site characteristics-This vegetation is common in deep (generally 15 to 200 centimeters or 6 to 79 in) water in ponds, slow-flowing streams, lake margins, and thermokarst pits in arctic and northwestern Alaska, primarily the arctic coastal plain, though small stands can be found on lake margins throughout the State. It generally seems to occur in shallower water in the southern part of the State and sometimes grows in wet mud without standing water. Soils can be mineral or organic; water pH ranges from circumneutral down to about 5.0.

Successional status- Marshes are early colonizers of water bodies and may eventually be replaced by wet meadow communities.

Closely related types- Fresh sedge marshes are similar, but they are dominated by species of the leafless (or nearly so) genera *Scirpus* and *Eleocharis* and do not occur in the Arctic. Wet meadow communities are flooded by shallow water, if flooded at all, and are dominated by different species.

Photographs- Webber and Walker 1975, p. 89.

Primary references- Bergman and others 1977, Webber and Walker 1975, Wiggins and Thomas 1962.

Communities- *Arctophila fulva* (Batten 1977, Bergman and others 1977, Britton 1967, Childs 1969, Clebsch 1957, Hultén 1966, Komarkova and Webber 1978, Meyers 1985, Murray 1974, Potter 1972, Racine and Anderson 1979, Rausch and Rausch 1968, Streveler and others 1973, Webber and others 1978, Wiggins and Thomas 1962). *Arctophila fulva-Carex aquatilis* (Webber and Walker 1975, Wiggins 1951). *Arctophila fulva-Ranunculus pallasii* (Johnson and others 1966, Spetzman 1959, Webber 1978, Young 1974b). *Arctophila fulva-Menyanthes trifoliata* (Spetzman 1959). *Arctophila fulva-Calamagrostis canadensis* (Craighead and others 1988). *Glyceria borealis-Eleocharis palustris* (Rosenberg 1986).

lll.A.3.f. Subarctlc Lowland Sedge Wet Meadow

Description- This group of freshwater wetland communities is dominated by coarse, relatively tall sedges, such as *Carex aquatilis, C. lyngbyaei, C. rostrata, C. saxatilis,* and C. *sitchensis* (fig. 66). *Carex lyngbyaei* is restricted to settings near the coast. Woody plants and lichens are scarce, if present at all. Mosses, both bryaceous and sphagnaceous, may be common but clearly are subordinant to the sedges. In most stands, the sedges are not rooted in a moss mat. Plant cover usually is complete or nearly so.

Distribution and site characteristics- These wetlands are common throughout the subarctic parts of the State. They occur on flood plains and near lake and pond margins, sloughs, and upland depressions. Soils are water saturated or flooded. Flooding usually is shallow (up to 15 centimeters [6 in]), but water depths up to 1 meter (3 ft) are reported from sites near the coast, particularly around Cook Inlet (Neiland 1971b, Ritchie and others 1981). Soils may be either mineral or organic, but if organic they are usually well decomposed. Well-preserved peats are rare substrates for these types. Permafrost generally is absent.

Successional status- Wet meadows eventually may replace fresh sedge marshes as sedimentation raises the soil level or drainage lowers the water level. If climatic and edaphic conditions allow peat to accumulate, wet sedge meadows eventually may succeed to sedge-bog meadows.

Closely related types-This unit is comparable to wet sedge meadow tundra (III.A.3.a.) in the Arctic, except that *Eriophorum angustifolium* seems to be more important in the arctic type, and most of the *Carex* spp. that commonly dominate subarctic sites are not present in the Arctic (except *Carex aquatilis).* It is similar to the subarctic lowland sedge bog meadow (lll.A.3.j.) but differs from it in having much coarser and more densely grown sedges and in lacking a peat substrate. It is similar to subarctic lowland herb wet meadow but is dominated by sedges instead of broad-leaved herbs or *Equisetum* spp. Some communities, particularly those dominated by *Carex lyngbyaei,* are similar to certain halophytic sedge wet meadow communities but occur on sites never flooded by tidewater.

Photographs- Drury 1956, figure 16; Racine 1976, figure 35; Racine 1978a, figures 14 and 15; figure 66, this publication.

Primary references- Drury **1956,** Neiland 1971 b, Shacklette and others 1969.

Figure 66-Subarctic lowland sedge wet meadow of *Carex aquatilis, C. lyngbyaei, C. rostrata, C. saxatilis,* and *C. sitchensis* near the coast in south-central Alaska.

Communities- *Carex* aquatilis (Ritchie and others 1981, Rosenberg 1986). Carex aquatilis-Menyanthes *trifoliata/Scorpidium* spp. (Ritchie and others 1981). Carex *aquatilis-Equisetum arvense* (Johnson and Vogel 1966, Murray 1974, Scott 1974a). *Carex aquatilis-C. saxatilis* (Hanson 1951, Pegau 1972). *Carex saxatilis* (Rosenberg 1986). *Carex saxatilis-Calamagrostis canadensis/Calliergon giganteum* (Drury 1956). *Carex rostrata* (Craighead and others 1988; Racine 1976, 1978b; Ritchie and others 1981; Rosenberg 1986). *Cafex rostrata-C. aquatilis* (Calmes 1976, Dachnowski-Stokes 1941, Drury 1956, Hultén 1966, Rosenberg 1986, Tande 1983). *Carex rostrata-Eriophorum angustifolium-Calamagrostis canadensis* (Racine 1978b). *Carex rostrata-Eriophorum angustifolium-Equisetum fluviatile* (Porsild 1939). *Carex rostrata-E Eiophorum angustifolium-Arctophila fulva* (Porsild 1939). *Carex rostrata-Equisetum fluviatile* (Craighead and others 1988). *Carex rostrata-C. saxatilis-Equisetum fluviatile* (Porsild 1939). *Carex lyngbyaei* (Byrd 1984, Griggs 1936, Hultén 1960, Scheierl and Meyer 1977). *Carex lyngbyaei-C. aquatilis* (Dachnowski-Stokes 1941, Streveler and others 1973). *Carex lyngbyaei-C. sitchensis* (Neiland 1971b, Quimby 1972, Ritchie and others 1981). *Carex lyngbyaei-C. saxatilis* (Streveler and others 1973). *Carex lyngbyaei-Calamagrostis canadensis* (Batten and others 1978, Crow 1977b, Hanson 1951). *Carex lyngbyaei-Lathyrus palustris* (Batten and others 1978, Crow 1968). *Carex lyngbyaei-Cicuta mackenziana* (Crow 1968). *Carex lyngbyaei-C. pluriflora-C. anthoxanthea-C. macrochaeta* (Amundsen and Clebsch 1971, Shacklette and others 1969). *Carex lyngbyaei-C. macrochaeta/Cladina portentosa* (Amundsen 1977, Amundsen and Clebsch 1971, Everett 1971, Shacklette and others 1969). *Carex pluriflora-Deschampsia beringensis* (Crow 1977b). *Deschampsia beringensis-Carex* lyngbyaei (McCartney 1976). *Carex sitchensis* (Ritchie and others 1981). *Carex sitchensis-Caltha palustris* (Thomas 1957). *Carex lasiocarpa* (Rosenberg 1986). *Eriophorum angustifolium-Carex livida* (Rosenberg 1986).

III.A.3.g. Subarctic Lowland Sedge-Shrub Wet Meadow

Description- These wetland types are dominated by sedges but have **a** conspicuous shrub component. Trees are absent or insignificant. Shrubs are conspicuous but still total less than 25 percent cover. Lichens are scarce; mosses are occasional to common. *Carex lyngbyaei* is the only dominant sedge reported, but communities dominated by other coarse sedges probably exist. Important shrubs are commonly *Myrica gale* or *Salix* spp.

Distribution and site characteristics- These types have been reported infrequently from the upper parts of coastal marshes in south-central and southeastern Alaska. They may be more widespread than the paucity of reports indicates and could be expected to occur near edges of wetlands in the interior as well. The coastal marsh sites are quite wet and usually have a hummocky surface. The water is essentially fresh, though sites that have been reported may be subject to infrequent sea-water flooding during extreme storm surges.

Successional status- These communities seem to represent broad ecotones between sedge wetlands and adjacent scrub types.

Closely related types- Some stands are similar to the sweetgale-grass type but with less sweetgale *(Myrica gale)* and with sedge instead of grass. This type also is similar to some wet sedge meadow types but has 'more shrubs. The arctic counterpart of this unit is mesic sedge-willow tundra.

Photographs- Scheierl and Meyer 1977, figure 28 (aerial).

Primary reference- Frohne 1953.

Communities- Carex *lyngbyaei-Salix* spp. (Scheierl and Meyer 1977). *Carex lyngbyaei-Myrica gale* (Frohne *1953). Scirpus microcarpus-Salix barclayi-S. sitchensis* (Worley 1980).

lll.A.3.h. Halophytic Grass Wet Meadow

Description- These are communities dominated or codominated by grasses, characteristically species of the salt-tolerant genus *Puccinellia.* Halophytic forbs, such as *Honckenya peploides, Triglochin maritimum, Plantago maritima, Spergularia canadensis* or *Cochlearia officinalis* are often codominant. Woody plants, mosses, and lichens are absent; marine algae are present at some sites. Vegetation is sparse and productivity is low. Aerial standing crop reaches a maximum of about 400 grams per square meter (3,600 lb/acre) dry matter in southern Alaska (Crow and Koppen 1977); amounts approximately one-fifth this large might be more typical.

Distribution and site characteristics- These communities are found at the seaward edges of coastal marshes throughout the State. Soils are mostly clays and fine silts subject to regular, if not daily, tidal inundation. Salinity ranges from 1 to 35 parts per thousand (Vince and Snow 1984), with most reports averaging around 10 parts per thousand. The soil reaction is generally circumneutral (pH 6.5 to 7.5), at least in the southern part of the State. Water runs off quickly after high tides and the surface rapidly dries, but beneath the surface the soil remains wet (Neiland 1971). Permafrost is absent except at the northernmost sites.

These communities become smaller and less common as one goes north, probably as a result of decreasing tidal range and the extreme erosive power of sea ice combined with storm surges.

Successional status-Where sediment continues to accumulate, marsh development will probably cause gradual seaward migration of these communities and replacement at the inland edge by halophytic sedge wet meadow communities.

Closely related types- Halophytic grass wet meadow communities occur in the same settings as and are very similar to halophytic herb wet meadows, except that the latter lack significant grass cover. Halophytic grass meadows often grade inland into halophytic sedge wet meadows, which are generally taller, denser, and more productive. The ecotone between the two usually is narrow and abrupt

Photographs-- Batten and others 1978, figures 24 and 39; Neiland 1971 b, figure 10.

Primary references- Crow and Koppen 1977, Jefferies 1977, Meyers 1985, Neiland 1971 b, Vince and Snow 1984.

Communities- *Puccinellia* nutkaënsis-Spergularia canadensis (Crow 1977b, Crow and Koppen 1977). *Puccinellia nutkaënsis-Suaeda depressa* (Crow and Koppen *1977). Puccinellia nutkaënsis-Plantago maritima* (Crow and Koppen 1977). *Puccinellia nutkaënsis-Glaux maritima* (Crow 1977b, Crow and Koppen *1977). Puccinellia nutkaënsis-fucus* spp. (Crow 1977b, Crow and Koppen 1977). *Puccinellia nutkaënsis-Honckenya peploides* (Crow 1977b). *Puccinellia nutkaënsis* (Batten and others 1978, Cooper 1931, Streveler and others 1973, Vince and Snow 1984). *Puccinellia grandis-Triglochin maritimum* (McCormick and Pichon 1978, Neiland 1971b, Quimby 1972). *Puccinellia grandis-Plantago maritima-Elymus arenarius* (Neiland 1971b). *Puccinellia grandis* (Batten and others 1978, McCormick and Pichon 1978). *Puccinellia glabra-Plantago maritima* (Hanson 1951). *Puccinellia borealis-Potentilla egedii* (Hanson 1953). *Puccinellia phryganodes* (Jefferies 1977, Meyers 1985, Rosenberg 1986). *Puccinellia phryganodes-Triglochin maritimum* (Quimby 1972, Rosenberg 1986, Vince and Snow 1984). *Puccinellia phryganodes-Salicornia europaea* (Hanson 1951). *Puccinellia phryganodes-Cochlearia officinalis* (Thomas 1951). *Puccinellia andersonii* (Meyers 1985).

III.A.3.i. Halophytic Sedge Wet Meadow

Description- These communities generally form the main body of coastal marshes around the State (fig. 67). They can be grouped into two main phases: (1) monotypic stands of coarse sedges near the seaward edges of coastal marshes, and (2) more diverse stands dominated by more delicate sedges farther inland. Communities of the first phase are composed of dense swards of sedges. *Carex lyngbyaei* generally dominates in southern Alaska, and *Carex ramenskii* and *C. subspathacea* are characteristic dominants of northern sites. Woody plants, mosses, and lichens are absent. Plant cover is often complete (100 percent) and is usually over 50 percent, though sparse stands do occur. Reported aerial standing crops range from 466 grams per square meter (4,150 lb/acre) for *Carex* lyngbyaei communities at Cook Inlet (Vince and Snow 1984) to 94 grams per square meter (838 lb/acre) for *C. subspathacea* at Barrow (Jefferies 1977). The dominant sedges range in height from over 1 meter (3 ft) in *Carex* lyngbyaei communities of southern Alaska to a few centimeters in northern Alaska.

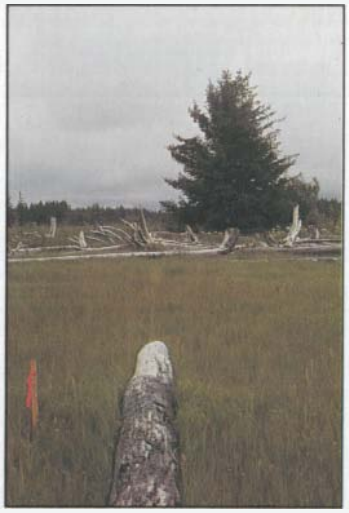

Figure 67-Halophytic sedge wet meadow of *Carex lyngbyaei* in the tidal zone in south-central Alaska.

Communities of the second phase are commonly dominated by Carex *pluriflora* in the south and *C. rariflora* in the north. Low shrubs may be present, but mosses and lichens are absent. Plant cover is usually complete or nearly so and plant height is generally 20 to 40 centimeters (8 to 16 in).

Distribution and site characteristics- The coarse sedge communities of the first phase are common throughout the State along borders of brackish ponds, drainage-ways, and tidal flats. Areas tend to be quite small in northern Alaska, where tidal fluctuation is small and coastal erosion is intense. Frequency of tidal inundation ranges from several times per month to once per summer. Soils consist of silts and clays, without microtopography, that often overlay sand or gravel. Water quickly runs off most of the seaward sites after flooding, which allows the surface centimeter or two of soil to dry. Soil salinity ranges from 6 to 12 parts per thousand. Soil reaction is circumneutral to slightly acid.

Communities of the second phase occur inland from those of the first phase and form a broad ecotone with freshwater wetlands. The substrate is a saturated hummocky peat, often with a few centimeters of water in the depressions. Soil salinity is generally between 0 and 6 parts per thousand; soil reaction ranges from slightly acid to as low as pH 4.4.

Successional status- Succession depends primarily on whether the coastline is prograding (as on deltas), subsiding, or stable. The successional trend on a prograding marsh would be from halophytic forb or halophytic grass to halophytic sedge phase one to halophytic sedge phase two to various freshwater wetland types. Where the coastline is subsiding, the successional trend would be reversed.

Closely **related** types-Seaward edges of communities of the first phase commonly border abruptly on halophytic grass wet meadow communities. The sedge communities are substantially taller and denser than the grass communities. Communities of the second phase frequently grade inland into fresh wet meadows or bogs. They are especially similar to subarctic lowland sedge-bog meadows, but the latter are farther from the sea (never tidally inundated) and support mosses and a greater diversity of sedges. With increasing shrubs, these inland halophytic sedge meadows may grade inland into sweetgale, willow fen, or shrubby bog communities. Communities dominated by *Eleocharis palustris* are similar to certain fresh sedge marshes but are exposed to periodic flooding by tidewater.

Photographs- Batten and others 1978, figure 9; Neiland 1971b, figures 12 and 13; Racine and Anderson 1979, figure 22; figure 67, this publication.

Primary references-- del Moral and Watson 1978, Frohne 1953, Jefferies 1977, Meyers 1985, Stephens and Billings 1967, Vince and Snow 1984.

Communities- Carex *subspathacea* (Hanson 1951, 1953; Meyers 1985). *Carex subspathacea-Puccinellia phryganodes* (Bergman and others 1977, Byrd and Ronsse 1983, Nodler and others 1978, Webber and others 1978). *Carex ursina* (Jefferies 1977). *Carex* mackenziei (Byrd and Ronsse 1983, Ritchie and others 1981). *Carex ramenskii* (Batten and others 1978, Hanson 1951, Jefferies 1977, Neiland 1971b, Quimby 1972, Vince and Snow 1984). *Carex ramenskii-Potentilla egedii* (Byrd and Ronsse 1983, George and others 1977, Rosenberg 1986). *Carex ramenskii-Triglochin maritimum-Potentilla egedii* (Hanson 1951, Ritchie and others 1981). *Carex lyngbyaei* (Batten and others 1978; Craighead and others 1988; Crow 1968, 1977b; Crow and

Koppen 1977; del Moral and Watson 1978; Friedman 1982; Frohne 1953; Hanson 1951; Klein 1965; McCormick and Pichon 1978; Neiland 1971b; Racine and Anderson 1979; Ritchie and others 1981; Rosenberg 1986; Stephens and Billings 1967; Streveler and others 1973; Vince and Snow 1984; Wibbenmeyer and others 1982). *CareX lyngbyaei-Poa eminens-Potentilla egedii* (Rosenberg *1986). Carex lyngbyaei-Triglochin maritimum* (Crow 1968, Crow and Koppen 1977, Ritchie and others 1981). *Carex lyngbyaei-Porentilla egedii* (Crow 1977b). *Carex lyngbyaei-Eleocharis palustris (Crow* 1968, 1977b). *Carex lyngbyaei-Hippuris tetraphylla* (Crow 1968). *Carex lyngbyaei-Polygonum amphibium* (Thomas *1957). Carey pluriflora* (Vince and Snow 1984). *Carex pluriflora-C. lyngbyaei* (Hanson 1951, Ritchie and others 1981, Rosenberg 1986). *CareX pluriflora-Triglochin palustris* (Crow 1977b). *Carex pluriflora-Deschampsia beringensis* (Crow 1977b). *Carex rariflora-Salix ovalifolia-Empetrum nigrum* (Byrd and Ronsse 1983, Hanson 1951). *Eleocharis palustris* (Crow 1977b, del Moral and Watson 1978). *Scirpus paludosus* (McCormick and Pichon 1978, Neiland 1971b, Quimby 1972).

III.A.3.j. Subarctic Lowland Sedge-Bog Meadow

Description- These communities are dominated by low peat-forming sedges growing on bog peats. Common sedges include *Eriophorum russeolum,* Carex *limosa, C. pluriflora, C. chordorrhiza, C. livida, C. magellanica,* and *Trichophorum caespitosum.* These species are much smaller and more delicate than the coarse robust species that dominate sedge wet meadows. Shrubs, mosses (including sphagnum), and lichens may be common or absent but are not dominant. *Andromeda polifolia* is commonly present in minor quantities. Plant cover is complete or nearly so.

Distribution and site characteristics- Sedge-bog meadows are found throughout the nonarctic part of the State, (including the Aleutian islands) in filled-in sloughs, boggy pond margins, and other topographic depressions. These are among the wettest bog communities with saturated peaty soils often forming quaking mats. The peat, composed primarily of sedge material, is generally at least 30 centimeters (12 in) thick and usually much thicker. It often is marked with small pools or sometimes may be shallowly flooded. Permafrost is generally absent, though isolated pockets of ice may occur under hummocks in interior Alaska. Reported soil reactions range from pH 5.4 to 6.4.

Successional status- Floating mats of these communities may actively extend into shallow lakes and replace marsh or aquatic communities there. Likewise, peat accumulation in wet meadows can lead to their gradual transformation into sedge-bog meadows. Continued bog development may cause these communities to be replaced by mossier and shrubbier bog communities.

Closely related types-Sedge-bog meadows are similar to sedge wet meadows, but the former are dominated by low slender sedges and occur on well-preserved peats. They are also similar to sedge-moss bogs but lack a dominant moss component. As broad-leaved herbs increase at the expense of sedges, these communities grade into subarctic lowland herb bog meadows.

Photographs- Calmes 1976, figures 2, 8, 9, and 17.

Primary references- Calmes 1976, Drury 1956, Shacklette 1961.

Communities- *Eriophorum russeolum-E* scheuchzeri (Wilson and Underwood 1979). *Eriophorum* spp.-Menyanthes trifoliata (Dachnowski-Stokes 1941). *Eriophorum russeolum-Carex kelloggii-Calamagrostis* canadensis (Heusser 1960). *Eriophorum russeolum-Carex limosa-Calamagrostis* canadensis (Cooper 1939, Streveler and others 1973). *Carex limosa-C. chordorrhiza* (Calmes 1976, Drury 1956). *Carex limosa-C. capillaris* (Viereck 1970b). *Carex pluriflora* (Hultén 1960). *Carex pluriflora-Eriophorum russeolum* (Bank 1951). *Carex kelloggii-C. canescens* (Shacklette 1961a). *Carex livida-Menyanthes trifoliata* (Hogan and Tande 1983).

III.A.3.k. Subarctic Lowland Sedge-Moss Bog Meadow

Description- These communities are dominated by mosses, principally *Sphagnum* spp. (fig. 68). Low sedges, such as those listed above for sedge-bog meadows, are generally present and usually codominant. The aspect is of low slender sedges and other herbs growing out of a matrix of sphagnum mosses. Low shrubs and lichens may be present or absent but are not dominant. *Andromeda polifolia* and *Vaccinium* oxycoccos are low, delicate shrubs that are commonly present, though they provide little cover. Widely scattered stunted trees may be present. Plant cover is complete or nearly so.

Distribution and site characteristics- The subarctic lowland sedge-moss bogs occur throughout the nonarctic parts of the State on peat in filled-in lakes and other depressions or on slopes where precipitation is adequate (Aleutian Islands, southeastern Alaska, and parts of south-central Alaska) and may form floating mats. The substrate is wet acidic peat at least 30 centimeters (12 in) thick and frequently is dotted with small pools. The reaction of the peat is generally pH 4.0 to 5.5, though values as high as 6.2 have been reported. The pH of the water in the pools is usually slightly higher than that of the associated peat. Permafrost is generally absent, but isolated pockets may be present under moss hummocks in interior Alaska.

Successional status- Floating mats of these communities may advance into shallow lakes to replace marsh or aquatic vegetation. Continued peat accumulation in sedge-bog meadows combined with invasion of sphagnum mosses also can result in establishment of these sedge-moss bogs. Continued bog development may yield surface conditions resulting eventually in shrub or forest invasion of the bog.

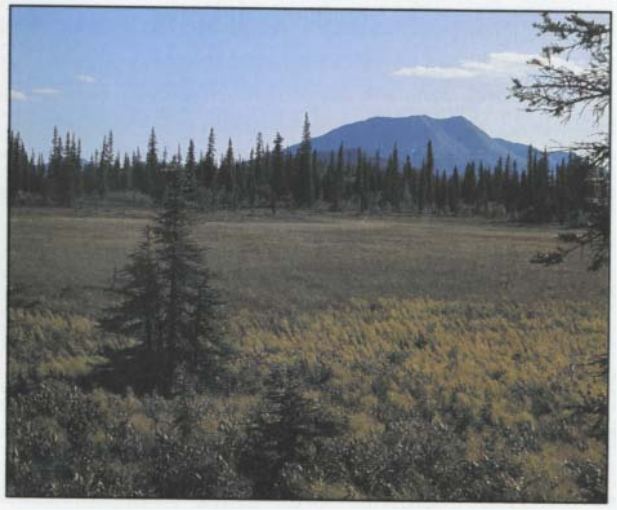

Figure 68-Subarctic lowland sedge-moss bog meadow dominated by the sphagnum mosses *Sphagnum fuscum* and *S. warnstorfii.* the sedges *Carex pauciflora,* C. *limosa,* and *Eriophorum angustifolium,* and the low shrubs *Andromeda polifolia. Betula nana,* and *Vaccinium oxycoccos* in southwest Alaska.

Closely related types- These communities are similar to sedge-bog meadows, though the latter lack a dominant moss component. They also are similar to herb-bog meadows, where broad-leaved herbs have increased their influence at the expense of sedges.

Photographs- Calmes 1976, figures 3 and 17; Cooper 1942, figure 4; figure 68, this publication.

Primary references- Calmes 1976, Cooper 1942, Dachnowski-Stokes 1941, Drury 1956.

Communities- *Carex aquatilis-Menyanthes trifoliataSphagnum* spp. (Scheierl and Meyer 1977). *Carex aquatilis/Sphagnum riparium* (Luken and Billings 1983). *Carex nigricans-C. limosa/Sphagnum recurvum* (Cooper 1942). *Carex limosa-C. chordorrhiza/Sphagnum* spp. (Calmes 1976; Drury 1956; Hanson 1953, 1958). *Carex limosa-Eriophorum russeolum/Sphagnum fuscum-S. papillosum* (Dachnowski-Stokes 1941). *Carex pluriflora-Calamagrostis spp./Sphagnum* spp. (Thomas 1957; also see footnote *3). Carex chordorrhiza-Menyanthes trifoliata/Sphagnum* spp. (Scheierl and Meyer 1977). *Carex canescens-C. magellanica/Sphagnum teres* (Calmes 1976, Drury *1956). Eriophorum russeolum-Equisetum fluviatile/Sphagnum* spp. (Racine 1978b). *Eriophorum russeolum-Carex rotundata/Sphagnum* spp. (Rosenberg 1986). *Eriophorum russeolum-Carex pluriflora/Sphagnum* spp. (Rosenberg *1986). Eriophotum russeolum-Carex limosa/Sphagnum squarrosum* (Hogan and Tande 1983). *Eriophorum scheuchzeri-Menyanthes trifolia/Sphagnum* spp. (Heusser *1960). Trichophorum caespitosum-Eriophorum* spp. *-Rhynchospora alba/Sphagnum* spp. (Dachnowski-Stokes 1941, Streveler and others 1973). *Rhynchospora alba-Drosera anglica/Sphagnum lindbergii-S. tenellum* (Neiland 1971b). *Carex pluriflora-Eriophorum russeolum/Sphagnum teres-S. magellanicum* (Shacklette and others 1969).

III.B. Forb Herbaceous

Included are communities dominated by forbs (broad-leaved herbs), rushes (Juncaceae), horsetails (Equisetaceae), and ferns. Graminoids may be present but are not dominant. Shrubs may be present but provide less than 25 percent cover.

lll.B.1. Dry Forb Herbaceous

This includes forb communities on dry sites. Most of these are sparsely vegetated pioneer communities.

Ill.B.1.a. Seral Herbs

Description- These are open communities of herbs colonizing previously unvegetated landscapes (fig. 69). A wide variety of herbs may be present. Some of the most common are *Epilobium latifolium, Artemisia tilesii, Crepis nana, Hedysarum mackenzii,* and *Oxyria digyna.* Grasses may be present but usually are widely scattered. Woody plants and small patches of mosses may be present but provide little cover. Lichens are scarce. Cover is often low and varying amounts of bare ground are exposed.

Distribution and site characteristics- Seral herb communities are found throughout the State, primarily on unstable sites such as flood plains, riverbanks, and eroding bluffs. Though biomass and cover are low, diversity often is high. The substrate usually is coarse and excessively drained.

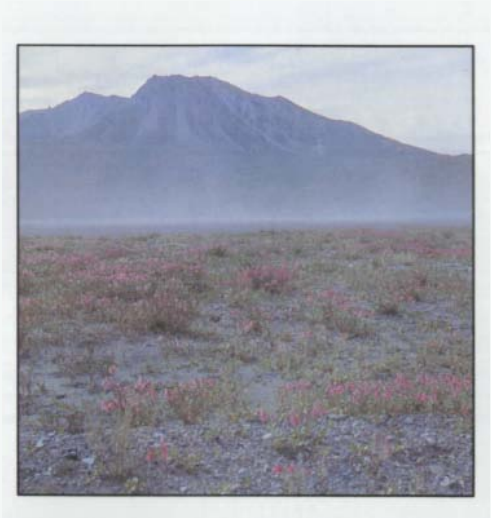

Figure 69-Seral herb stand dominated by *Epilobium latifolium* with scattered *Artemisia tilesii, Crepis nana, Astragalus nutzotinensis,* and several other herb species on the gravel bar of a glacial river in the Alaska Range in interior Alaska.

Successional status- These are early successional communities colonizing recently exposed surfaces. If disturbance is not renewed, many will develop into grass or scrub communities depending on locality and climate.

Closely related types- Seral herb communities are similar to alpine herb communities, but the former usually are on lowlands (including mountain flood plains) recently or periodically disturbed by a catastrophic agent, commonly moving water (floods on flood plains or storm surges on coastal bluffs). Alpine herb communities are typical of talus slopes and rock outcrops, where soil development is minimal and disturbance comes in the form of frost action or rockfall.

Photographs- Figure 69, this publication.

Primary references- Johnson and others 1966, Spetzman 1959.

Communities- *Epilobium latifolium (Scott* 1974a, Webber and others 1978). Epilobium latifolium-Artemisia tilesii (Batten 1977, Bliss and Cantlon 1957, Johnson and others 1966, Spetzman 1959). *Epilobium latifolium-Crepis nana* (Young 1974b). *Hedysarum alpinum-Artemisia arctica* (Webber and others 1978). *Cochlearia officinalis-Oxyria digyna-Saxifraga rivularis* (Potter 1972). *Cochlearia officinalis-Phippsia algida-Stellaria humifusa* (Webber 1978). *Artemisia arctica* ssp. *comata* (Meyers 1985). *Wilhelmsia physodes-Artemisia arctica-Chrysanthemum arcticurn* (Thomas 1951). *Equisetum variegatum* (Helm and others 1984, Young 1974b). *Dryas drummondii-Epilobium latifolium* (Talbot and others 1984).

III.B.1.b. Alpine Herb-Sedge (Snowbed)

Description- This unit includes a wide variety of vegetation types below late-lying snowbanks in mountainous areas throughout the State. Dominant species may be herbs (such as *Oxyria digyna, Koenigia islandica, Saxifraga rivularis, Cardamine bellidifolia, Poa arctica, Carex lachenalii,* and *Claytonia sarmentosa),* mosses, and lichens, commonly *Cetraria delisei.* Woody plants are absent. Cover is sparse, and much bare ground generally is present.

Distribution and site characteristics- Snowbed communities occur below outcrops and in depressions, streambeds, or other topographic features that break the wind and allow substantial snowdrifts to accumulate. Soils are well drained, often stony, and may be dry late in the season. These sites are irrigated, at least seasonally, by water from late-melting snowdrifts upslope.

The sites themselves are covered with snow through part or most of the summer. Species present must adapt to a short growing season.

Successional status- These specialized communities are not likely to change as long as winter precipitation and wind patterns do not change significantly.

Closely related types- These communities may resemble mesic sedge-herb meadow tundra but have a more open vegetative cover and less sedge cover and are located in snowbeds. In some cases, these snowbed communities may grade into alpine herb communities on adjacent talus, but a topographic break and changes in species usually separate the two. Open dwarf scrub snowbed communities are dominated by prostrate mat-forming shrubs, are usually more densely vegetated than alpine herb-sedge snowbeds, and occur on sites with long growing seasons.

Primary references- Johnson and others 1966, Scott 1974a.

Communities- Cetraria *delisei-Oxyria digyna-Koenigia islandica-Saxifraga rivularis* (Johnson and others 1966). *Carex lachenalii-Oxyria digyna-Claytonia sarmentosa (Scott* 1974a). *Rhacomitrium canescens-Dicranoweisia cirrata-Oxyria digyna* (Scott 1974a). *Anthelia julacea-Scapania paludosa-Saxifraga, hirculus-Leptarrhena pyrolifolia* (Shacklette and others 1969). *Rubus arcticus-Sedum rosea-Polygonum bistorta-Saxifraga hirculus* (Racine and Young *1978). Carex nigricans* (Jaques 1973).

1II.B.l.c. Alpine Herbs

Description- Alpine herb communities consist of sparse vegetation on talus and blockfields. A wide variety of herbs may be present, often with no particular species dominating. Species commonly present include Draba spp., *Saxifraga* spp., *Festuca brachyphylla, Potentilla* spp., *Diapensia lapponica, Oxyria digyna, Androsace* spp., *Epilobium latifolium,* and *Smelowskia* spp. Woody plants are absent or nearly so. Small patches of mosses such as *Andreaea* spp. may be present between rocks. Lichens, especially crustose lichens, may be common. These communities are open with much bare rock between individual plants.

Distribution and site characteristics- Alpine herb communities occur on talus, rock outcrops, and blockfields throughout the State. These are sites too steep or too windblown for soil development. The substrate consists of lithosols or regosols between rocks.

Successional status- These are early successional communities colonizing stony, unvegetated surfaces. They persist at these sites indefinitely because soil formation is slow and fine materials are either blown away or moved downslope as soon as they are formed.

Closely related types- Alpine herb communities are very similar to seral herb communities, but seral communities occur primarily on flood plains, cutbanks, and other sites where succession to other communities will occur fairly rapidly after disturbance ceases. Alpine herb communities are maintained in a successional state indefinitely by steep slopes and wind erosion. Some species are common in both communities (notably *Epilobium latifolium).* Others, such as *Artemisia tilesii* and *Hedysarum mackenzii,* are more typical of seral herb communities. Still others, such as *Draba* spp. and *Smelowskia* spp., are more typical of alpine herb communities.

Alpine herb communities also may be similar to alpine herb-sedge (snowbed) communities, but the latter occur in depressions below snowbeds lasting late in the spring and usually are quite distinctive. Mesic mixed herb communities are on well-developed soils and have much denser (usually closed) vegetation. Very open dwarf scrub communities may resemble alpine herb communities, but in the latter the plants are primarily woody mat-formers, such as dryas, crowberry, or prostrate willows.

Very open alpine herb communities with lichens present may resemble lichen communities (lll.C.2.), but herbs are almost completely absent from lichen communities.

Photographs- Johnson and others 1966, figure 5; Racine and Anderson 1979, figure 17; Shacklette and others 1969, figures 6, 7, 18, 30, 32, and 33.

Primary references- Griggs 1936, Johnson and others 1966, Racine and Anderson 1979, Shacklette and others 1969, Spetzman 1959.

Communities- Saxifraga *tricuspidata-Draba caesia* (Batten 1977, Johnson and others 1966). *Saxifraga oppositifolia* (Griggs 1936). *Saxifraga oppositifolia-Epilobium latifolium* (Viereck 1963). *Saxifraga tricuspidata-Artemisia arctica* (Webber and others 1978). *Potentilla hyparctica-Cerastium aleuticum-Draba aleutica* (Shacklette and others 1969). *Potentilla villosa-Draba hyperborea-Saxifraga bracteata* (Shacklette and others 1969). *Artemisia arctica-Potentilla hyparctica-Hierochloë alpina* (Heusser 1954, *1960). Diapensia lapponica-Saxifraga bronchialis-Sibbaldia procumbens-Trisetum spicatum* (Griggs *1936). Saxifraga* spp.-Festuca *brachyphylla-Poa glauca-Luzula confusa-Minuartia* spp. (Spetzman *1959). Oxyria digyna-Saxifraga punctata-Sedum rosea-Primula tschuktschorum* (Fries *1977). Veronica stelleri-Cassiope lycopodioides-Tofieldia coccinea-Salix rotundifolia* (Shacklette and others *1969). Carex circinnata-Umbilicaria proboscidea-Agrostis borealis* (Shacklette and others 1969). *Geum rossii-Silene acaulis-Oxyria digyna* (Friedman. *1982). Hierochlolë alpina-Luzula tundricola-Potentilla elegans* (Racine and Anderson 1979).

III.8.2. Mesic Forb Herbaceous

These forb communities primarily occur on rich, sheltered, well-drained sites with deep soils.

Ill.B.2.a. Mixed Herbs

Description- These communities are dominated by herbs and have complete or nearly complete vegetative cover (fig. 70). Locally common herbs include *Campanula* spp., *Angelica* spp., *Lupinus* spp., *Artemisia* spp., *Lathyrus* spp., *Anemone* spp, *Delphinium* spp., and *Aconitum delphinifolium.* Sedges, grasses, ferns, and mosses (especially feathermosses) also are common at many sites. Lichens may be present; woody plants are rare.

Figure 70-A mesic forb herbaceous community dominated by Fauria *crista-galli* and *Luetkia pectinata* near the coast in south-central Alaska.

Distribution and site characteristics- Mixed herb communities are found in small, local patches on deep, loamy, fairly well-drained soils along streambanks, on stabilized dunes, on ancient beach ridges, and in sheltered pockets on subalpine slopes. These communities have been reported from southeastern and south-central Alaska and the Aleutian Islands; they probably are present throughout the State. Snow generally accumulates on these sites throughout winter but melts early in spring. Permafrost has not been reported, but communities of this type on relatively thick active layers may exist over permafrost in northern and western Alaska.

Successional status- Successional relations are largely unknown and probably differ considerably by individual location and site characteristics. In general, it seems likely that mixed herb communities would tend to develop toward scrub or forest types or, occasionally, bogs in the forested parts of the State and toward sedge or tussock communities elsewhere.

Closely related types- Mesic mixed herb communities with *Heracleum lanatum* or *Angelica* spp. are similar to large umbel types but differ in having less Umbelliferae cover. Other mesic mixed herb communities are similar to mesic sedge-herb meadow tundra, but have fewer sedges. They also can be similar to alpine herb and seral herb communities but grow much more densely and occur on much more mesic sites with deeper soils. Still other mesic mixed herb communities can resemble some of the dry or mesic grass types (elymus, bluejoint, fescue, or other medium-height grasses) but have more herbs and fewer grasses.

Photographs- Shacklette and others 1969, figure 13; figure 70, this publication.

Primary references- Anderson 1974, Bank 1951, Hanson 1951, Klein 1965, Shacklette and others 1969.

Communities- Fauria *crista-galli* (Shacklette 1965). *Fauria crista-galli-Caltha biflora* (Fox 1983, Klein *1965). Achillea borealis-Arnica unalaschcensis-Claytonia sibirica-Geum calthifolium* (Shacklette and others 1969). *Polygonurn viviparum-Campanula lasiocarpa-Primula cuneifolia-Cardamine umbellata* (Bank 1951). *Epilobium latifolium-Mertensia paniculata-Arctagrostis latifolia* (Anderson 1974). *Aconitum delphinifolium-Aquilegia formosa-Sanguisorba stipulata-Geranium erianthum* (Cooper 1942). *Streptopus amplexifolius-Linnaea borealis-Juncus arcticus* (Bank 1951). *Platanthera spp.-Fritillaria camschatcensis-Polygonum viviparum-Erigeron peregrinus* (Bank 1951). *Athyrium filix-femina-Carex lyngbyaei-Heracleum lanatum-Geum macrophyllum* (Shacklette and others 1969). *Lupinus arcticus-Aconitum delphinifolium-Anemone narcissiflora* (Brock and Burke *1980). Fritillaria camschatcensis-Aconitum maximum-Angelica lucida* (Friedman *1982). Iris setosa-Dodecatheon pulchellum* (Frohne 1953). *Hedysarum alpinum-Equisetum variegatum* (Crow *1968). Lupinus nootkatensis-Lathyrus maritimus-Achilles borealis* (Hanson 1951).

Ill.B.2.b. Fireweed

Description- These communities are dominated by fireweed *(Epilobium angustifolium).* Grasses, sedges, mosses, lichens, and woody plants may be present but are inconspicuous.

Distribution and site characteristics-Fireweed communities are common on disturbed sites in south-central Alaska and on recent burns in interior Alaska, though none has been reported in the literature.

Successional status- If disturbance is not renewed, most of these communities probably will be invaded by bluejoint *(Calamagrostis canadensis)* fairly quickly. They then may persist for several years as bluejoint or bluejoint-herb communities before yielding to scrub and eventually forest communities. Alternatively, fireweed communities may be replaced rapidly by shrubs or trees sprouting from roots and rhizomes that survived the original disturbance.

***Closely related* types-** Fireweed communities can be similar to some bluejoint-herb communities but have less bluejoint and a stronger dominance of fireweed.

Primary references-None.

Communities- Epilobium *angustifolium* (undescribed).

Ill.B.2.c. Large Umbel

Description- These communities are dominated by tall herbs (0.5 to 1.5 meters [20 in to 5 ft]) of the family Umbelliferae, most commonly of the genera *Heracleum* and *Angelica.* Other broadleaved herbs, grasses, and sedges may be common, but it is the large umbellifers that are most conspicuous in these communities. Woody plants are absent or rare; nonsphagnaceous mosses often are abundant; lichens may be present. Cover is complete or nearly so.

Distribution and site characteristics-Small stands are common on relatively deep soils of sheltered subalpine mesic slopes and streambanks in south-central and southeastern Alaska and the Aleutian Islands. These sites usually are protected by snow in winter but become snow-free in early summer. Permafrost is absent.

Successional status-Successional relations are unknown. Stands in the Aleutian Islands may be quite stable. Those in south-central Alaska eventually may be replaced by scrub or forest communities.

Closely related types-- These communities are closely related to the mixed herb and fern types but have more cover of *Heracleum lanatum* or *Angelica* spp. Communities containing *Elymus arenarius* are closely related to some of the elymus (dry graminoid herbaceous) types but have more umbels and less elymus.

Primary reference- Byrd 1984.

Communities- Heracleum *lanaturn-Veratrum viride-Senecio triangularis* (Cooper *1942,* Fox *1983). Heracleum lanatum-Athyrium filix-femina-Angelica lucida* (Byrd 1984, Friedman 1982). *Artemisia tilesii-Heracleum lanatum-Elymus arenarius* (Byrd 1984).

Ill.B.2.d. Ferns

Description- These communities are characterized by a lush growth of ferns, often *Athyrium filix-femina* or *Dryopteris* spp. Herbs, grasses, and sedges may be common but are inconspicuous. Woody plants are absent or rare, mosses may be common, and lichens may be present. Cover is complete or nearly so.

Distribution and site characteristics- Fern communities usually are found at low elevation in localized patches in relatively deep, well-drained, moist soils in southeastern and south-central Alaska and the Aleutian Islands. These sites are snow covered in winter but become snow free early in spring. Permafrost is absent. The single community reported is at the bases of rock cliffs at low elevations in the Aleutian Islands.

Successional status- Successional relations are unknown.

Closely related types- Fern communities can be similar to large umbel communities and mesic mixed herb communities but are strongly dominated by ferns.

***Primary* reference--** Bank 1951.

Communities- Athyrium *filix-femina-Cystopteris fragilis-Botrychium* spp. - *Gymnocarpium dryopteris* (Bank 1951).

111.B.3. Wet Forb Herbaceous

These wet forb communities occur on soils saturated with water or semipermanently flooded.

Ill.B.3.a. Fresh Herb Marsh

Description- Fresh herb marsh communities are dominated by emergent herbs in deep water (15 centimeters [6 in] or more). Characteristically, the dominant or codominant emergent is *Equisetum fluviatile;* although it is not really an herb, it is included with true herbs on the basis of being nongraminoid and nonwoody. Common associated emergent herbs (sometimes codominant) include *Menyanthes trifoliata* and *Potentilla palustris.* Floating-leaved or submerged aquatic plants, such as *Potamogeton* spp., *Hippuris vulgaris,* and *Myriophyllum spicatum,* may be present or even abundant. Aquatic mosses often are common. Woody plants and lichens are absent. Plant cover is open.

Distribution and site characteristics- Fresh herb marshes occur in permanently flooded sites (usually with 15 to 100 centimeters [6 to 40 in] of water), including sloughs, oxbow lakes, sluggish rivers, and lake margins, in and near the forested parts of the State. Soils may be mineral silts or sands or well-decomposed organic mucks.

Successional status- These are early successional communities in aquatic seres; they replace open water or aquatic communities. As sedimentation and organic matter accumulation gradually build up the soil to near the water level, these communities probably will be replaced by graminoid wet meadows. They also can be replaced by laterally expanding floating bog mats.

Closely related types-Fresh herb marshes are similar to graminoid marshes in that they consist of tall emergent plants in deep water. The former are dominated, however, by nongraminoid emergents, typically *Equisetum fluviatile.*

Fresh herb marshes also are similar to subarctic lowland herb wet meadows and bog meadows. Many of the common secondary species of marshes are codominant in herb wet meadows or herb bog meadows. Wet meadows are flooded with much less water than marshes or have no standing water at all. Herb bog meadows often occur in shallower water than herb marshes but sometimes are in fairly deep water or on floating mats submerged slightly below the surface that sink when walked on. The substrate of the bog meadows is peat, in contrast to the mineral or well-decomposed organic substrate of marshes. Neither herb wet meadows nor herb bog meadows are dominated by *Equisetum fluviatile.*

Primary references- Racine 1976, Ritchie and others 1981.

Communities- Equisetum *fluviatile* (Craighead and others 1988, Racine 1976, Ritchie and others 1981). *Equisetum fluviatile-Menyanthes trifoliata* (Hultén 1966, Racine 1978b, Ritchie and others 1981, Rosenberg 1986). *Equisetum fluviatile-Polygonum amphibium* (Young and Racine 1976).

III.B.3.b. Subarctic Lowland Herb Wet Meadow

Description- Herb wet meadows are dominated by herbs or nonwoody plants other than grasses and sedges, commonly *Equisetum arvense, E. variegatum, Caltha palustris,* and *Juncus arcticus.* Scattered grasses and sedges may be present. Nonsphagnaceous mosses may be common or absent. Lichens and woody plants are rare or absent. Cover usually is less than complete.

Distribution and site characteristics- Herb wet meadows are found in seepage areas, pools, pond margins, and marsh edges throughout most of the State, especially the southern two-thirds. Stands usually are quite small and widely scattered. They occur on saturated or shallowly flooded soils. If standing water is present, it usually is less than 15 centimeters (6 in) deep. Soils usually are mineral silts or sometimes sands; often they have a few centimeters of well-decomposed organic muck at the surface. Soil reaction is circumneutral to acid but not extremely acid; pH values of 6.1 to 7.0 have been reported, but some herb meadows probably occur on more acidic substrates.

Successional status- As soil development proceeds, adjacent wet sedge meadows may expand into and overwhelm many of these communities, which eventually evolve to bog or scrub communities.

Closely related types- Herb wet meadows are similar to fresh herb marshes but are not as wet and are not dominated by *Equisetum fluviatile.* They also are similar to herb bog meadows but occupy essentially mineral substrates instead of peats. They also resemble wet sedge-herb tundra and subarctic lowland wet sedge meadows, but sedges are absent or scarce.

Photographs- Batten and others 1978, figure 26; Racine and Anderson 1979, figure 25.

Primary references- Cooper 1939, Hanson 1951, Shacklette and others 1969.

Communities- *Equisetum* arvense (Craighead and others 1988, Hultén 1960). Equisetum *arvense-E variegatum* (Batten and others 1978). *Equisetum arvense-* E. *variegatum/Philonotis fontana* (Cooper 1939). *Caltha* palustris (Murray 1974). *Caltha palustris-Claytonia sibirica* (Shacklette and others 1969). *Caltha palustris-Sparganium hyperboreum* (Amundsen 1977, Amundsen and Clebsch 1971). *Caltha palustris-Angelica lucida-Platanthera* spp. (Friedman 1982). *Juncus arcticus* (del Moral and Watson 1978, Hanson 1951). *Senecio congestus* (Racine and Anderson 1979). *Parnassia kotzebuei/Phlonotis fontana* (Shacklette and others 1969).

III.B.3.c. Subarctic Lowland Herb Bog Meadow

Description- Herb bog meadows are dominated by broad-leaved herbs, commonly *Menyanthes trifoliata* (fig. 71). Other common herbs include *Potentilla palustris* and *Caltha palustris.* Aquatic plants such as *Hippuris vulgaris* and *Sparganium* spp. may be present. Mosses, sometimes including sphagnum, usually are present. Graminoids, woody plants, and lichens are absent or scarce. Plant cover is usually open.

Distribution **and site characteristics-Small** stands of herb bog meadows are found on the wettest parts of floating peat mats, in shallow bog pools, and on boggy pond margins throughout the southern two-thirds of the State. The substrate is peat, often a floating peat mat, and may be strongly acidic. Standing water usually is present. The peat mat is often shallowly submerged and sinks 20 to 50 centimeters (8 to 20 in) or more when walked on.

Figure 71-Subarctic lowland herb bog meadow of Menyanthes *trifoliata, Potentilla palustris,* and *Caltha palustris* near the coast in south-central Alaska.

Successional status- In some cases, these communities extend into ponds, replacing aquatic or emergent (marsh) communities. In other cases, they occupy bog pools brought into existence by various bog processes. As the peat mat thickens, many herb bog meadow communities gradually will be replaced by sedge bog or sedge-moss bog communities.

Closely related types- Herb bog meadows are similar to herb wet meadows but occur on peat substrates and are usually dominated by different species (commonly *Menyanthes trifoliata).* They also are similar to herb marshes but have a peat substrate and are never dominated by *Equisetum fluviatile.* Herb bog meadows are similar to sedge bog meadows and sedge-moss bog meadows but have few sedges.

Photographs- Dachnowski-Stokes 1941, figure 10; Tande 1983, plate 23; figure 71, this publication.

Primary references- Dachnowski-Stokes 1941, Griggs 1936, Racine 1978b, Ritchie and others 1981, Tande 1983.

Communities- *Menyanthes trifoliata* (Dachnowski-Stokes 1941, Griggs 1936, Palmer 1942, Ritchie and others 1981, Rosenberg 1986, Young and Racine 1976). *Menyanthes trifoliata/Sphagnum* spp. (Racine 1978b, Scheierl and Meyer 1977, Seguin *1977). Menyanthes trifoliata-Ranunculus pallasii* (Webber and others 1978). *Menyanthes trifoliata-Potentilla palustris* (Griggs 1936, Tande *1983). Hippuris vulgaris-Menyanthes trifoliata* (Cooper 1942). *Viola Iangsdorffii/Sphagnum girgensohnii-Rhytidiadelphus triquetrus* (Bank 1951).

lll.B.3.d. Halophytic Herb Wet Meadow

Description- These communities are dominated by halophytic herbs such as *Triglochin maritimum, Plantago maritima, Honckenya peploides, Mertensia maritima, Atriplex* spp., and *Cochlearia officinalis* (fig. 72). Scattered halophytic grasses (usually *Puccinellia* spp.) or sedges may be present. Woody plants, mosses, and lichens generally are absent. Scattered shrubs may be present in some slough levee halophytic herb communities, along with scattered representatives of other less halophytic species such as *Poa eminens, Festuca rubra,* and *Elymus arenarius.*

Plant cover often is open. A relatively dense stand of *Triglochin maritimum* and *Potentilla egedii* in upper Cook Inlet had a peak standing crop of 412 $\pm$ 63 grams per square meter (3,675 $\pm$ 560 lb/acre) (Vince and Snow 1984).

Distribution and site characteristics- Halophytic herb communities occur throughout the State at the seaward edges of beaches and coastal marshes, on gentle swales and backslopes within coastal marshes, and on coastal slough levees. The substrate consists of tidally deposited silts, sands, or pebbles and is inundated at least a few times per month by high tides. As the tides recede, water runs rapidly off the surface leaving it firm, but silt substrates remain saturated below the upper 1 or 2 centimeters (0.5 to 1 in). Measured substrate salinity and pH range from 6 to 13 parts per thousand and pH 6.4 to 8.6, respectively.

Successional status-These are early successional communities; on prograding beaches and marshes, most will be replaced gradually on marshes by halophytic sedge meadows (usually *Carex lyngbyaei, C. subspathacea,* or *C. ramenskii)* and on beaches by *Elymus* arenarius communities.

Figure 72-Halophytic herb wet meadow of *Triglochin maritimum* in upper tidal area in south-central Alaska.

Closely related types- Halophytic herb communities occupy habitats similar to halophytic grass wet meadows *(Puccinellia* spp.) and often intergrade with the latter but have few grasses and many herbs. They sometimes intergrade in a similar way with halophytic sedge wet meadows *(Carex ramenskii,* C. subspathacea, or C. lyngbyaei). Again, the boundary between communities must sometimes be arbitrary, but halophytic herb communities have few sedges and relatively abundant herbs.

Halophytic herb communities on slough levees can resemble some midgrass-herb communities *(Deschampsia beringensis, Festuca rubra,* or *Poa eminens),* but grasses are widely scattered and herbs are much more conspicuous in the former.

Photographs- Neiland 1971 b, figure 9; Racine 1978b, figure 38; figure 72, this publication.

Primary references- Batten and others 1978, Frohne 1953, Hanson 1951, Neiland 1971 b, Ritchie and others 1981, Vince and Snow 1984.

Communities- Triglochin *maritimum* (Frohne 1953, Quimby 1972, Ritchie and others 1981). *Triglochin maritimum-Potentilla egedii* (Hanson 1951, Vince and Snow 1984). *Triglochin maritimum-Plantago maritima* (Batten and others 1978, Vince and Snow 1984, Ritchie and others 1981). *Triglochin maritimum-Puccinellia* spp. (Racine 1978b). *Triglochin palustris-Atriplex gmelini* (Neiland 1971 b). *Honckenya peploides* (Batten and others *1978,* Crow 1977b, Meyers *1985). Mertensia maritima-Honckenya peploides* (Amundsen and Clebsch 1971, Batten and others 1978, Britton 1967, Griggs 1936, Hanson 1953, Potter 1972, Spetzman 1959, Streveler and others 1973, Thomas 1951). *Cochlearia officinalis* (Wiggins and Thomas *1962). Cochlearia officinalis-lathyrus maritimus* (Bank 1951). *Cochlearia officinalis-Puccinellia phryganodes* (Webber and others *1978). Honckenya peploides-Senecio pseudo-amica* (Shacklette and others 1969, Young 1971). *Cochlearia officinalis-Fucus distichus* (Batten and others *1978). Cochlearia officinalis-Achilles borealis* (Byrd 1984). *Plantago maritima-Puccinellia* spp. (Hanson 1951). *Stellaria humifusa* (Meyers 1985).

III.C. Bryoid

This unit includes communities dominated by bryophytes and lichens. Bryophytes and lichens also may be abundant in graminoid and forb communities and some shrubby communities, but here they occur to the near-exclusion of vascular plants.

111.C.1. Bryophyte

These are communities dominated by mosses or hepatics

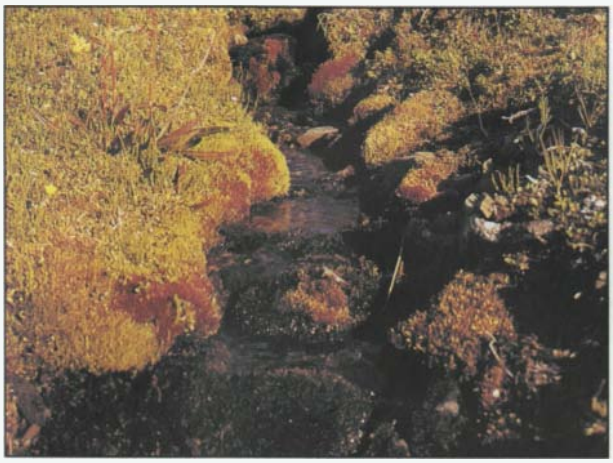

Figure 73-A wet bryophyte community along a small stream in arctic Alaska

III.C.1.a. Wet Bryophyte

Description- These are communities of bryophytes, including mosses and hepatics (fig. 73). Common dominants include Gymnocolea *acutiloba, Scapania paludosa,* and *Nardia* spp. Vascular plants and lichens are absent or nearly *so. Sphagnum* spp. have not been reported. Plant cover is usually nearly 100 percent.

Distribution and site characteristics- Wet bryophyte communities have been reported from the southern (high precipitation) part of the State. They are always of small extent and widely scattered and often are associated with peculiar substrate conditions (for example, copper concentrations on Latouche Island [Shacklette 1961a]). Substrates are varied but often consist of 10 to 60 centimeters (4 to 24 in) of wet to mesic organic material (moss or liverwort peat) overlying mineral soil. Permafrost is absent from all sites reported.

Successional status- Successional relations are various and many are unknown. Some communities maintained by mineral concentrations, such as the *Gymnocolea acutiloba* community on Latouche Island, appear to have remained stable over a long period (Shacklette 1961a). The *Scapania-Nardia* community on Yakobi Island colonized mountain rivulets, thereby providing a substrate for invasion by *Fauria* herb meadows and, later, copperbush thickets (Shacklette 1965).

Closely related types-Wet bryophyte communities are similar to dry bryophyte communities but are dominated by different species and occupy wetter substrates. They also are similar to some subarctic lowland sedge-moss bog communities, and the distinction between them is sometimes arbitrary. Sphagnum communities generally are included with the sedge-moss bog types even if sedges are very sparse or locally absent from small areas. Wet bryophyte communities have virtually no vascular plants and are defined arbitrarily not to be parts of bogs or other broad landscape features.

Photographs-- Figure 73, this publication.

Primary references- Shacklette 1961a, 1965.

Communities- Gymnocolea *acutiloba* (Shacklette 1961a). *Scapania paludosa-Nardia compressa* (Shacklette 1965). *Nardia scalaris-Bryum stenotrichum* (Shacklette 1961a). *Pleuroclada albescens* (Shacklette 1961a). *Scapania paludosa-Nardia scalaris-Marsupella emarginata* (Shacklette and others 1969).

Figure 74-A dry btyophyte community of *Rhacomitrium* lanuginosum on coarse gravel outwash in a coastal area of south-central Alaska.

III.C.1.b. Dry Bryophyte

Description- These are communities dominated by bryophytes, usually mosses such as *Rhacomitrium* spp., *Grimmia apocarpum,* and *Andreaea rupestris* (fig. 74). Lichens may be common. Vascular plants are rare or absent. Cover usually is sparse.

Distribution and site characteristics- Dry bryophyte communities are fairly rare and have been reported primarily from the Aleutian Islands, though they probably are more widespread. They are most common on windswept coarse mineral substrates, including sand dunes and gravelly slopes. These are sparsely vegetated types with much exposed substrate.

Moss mound communities also are included within this unit. These well-vegetated microcommunities occupy a substrate of dead mosses. Some mounds consist of mosses throughout, others have rock cores. Substrates are generally acidic (pH 5 to 7).

Successional status- The windswept barren dry bryophyte communities are an early successional stage but may persist indefinitely because of wind deflation of soil materials. Moss mounds are temporary features; eventually growth ceases and the mounds start to break apart, finally becoming indistinguishable from the surrounding vegetation.

Closely related types- Dry bryophyte communities are similar to wet bryophyte communities but are dominated by different species and occupy drier sites. The dry windswept bryophyte types also are similar to some lichen communities but are dominated by bryophytes instead of lichens. Both resemble some of the most sparsely vegetated open dwarf shrub (mat and cushion) communities, but the latter have more vascular plants, particularly shrubs or subshrubs.

Photographs- Shacklette and others 1969, figure 10; figure 74, this publication.

Primary reference- Shacklette and others 1969.

Communities- Rhacomitrium *lanuginosum-Dicranum* spp. (Shacklette and others *1969). Rhacomitrium lanuginosum-Grimmia apocarpa-Ulota phyllantha* (Shacklette and others 1969). *Andreaea rupestris-Grimmia apocatpa-Rhacomitrium lanuginosum* (Shacklette and others 1969).

Figure 75-A community of crustose and foliose lichens on a granite boulder in the Alaska Range in interior Alaska.

III.C.2. Lichen

These are communities dominated by lichens.

III.C.2.a. Crustose Lichen

Description- These communities are dominated by crustose lichens, such as Rhizocarpon spp. and Lecanora spp. (fig. 75). Xerophytic saxicolous (rock inhabiting) foliose lichens, especially Umbilicaria spp., Xanthoria spp., and Parmelia saxatilis, also may be abundant. Fruticose lichens, mosses and vascular plants are absent or rare. Plant cover always is sparse.

Distribution and site characteristics- These communities grow on rocks on extremely xeric, windblown, soilless sites such as rockfields, outcrops, and recent lava flows where nothing but saxicolous lichens can grow. They are common in alpine regions throughout the State.

Successional status- Crustose lichen communities are probably the earliest successional stage of many xeric seres but are likely to persist indefinitely because of severe environmental conditions at the sites they inhabit.

Closely related types- Crustose lichen communities are similar to foliose and fruticose lichen communities but are even more xeric and consist entirely of saxicolous lichens. They also may be similar to some very open dwarf scrub (mat and cushion) communities, but the latter have more vascular plants.

Photographs- Racine and Anderson 1979, figure 18; Shacklette and others 1969, figure 7; figure 75, this publication.

Primary reference- Racine and Anderson 1979.

Communities- *Umbilicaria* spp. (Rausch and Rausch 1968). *Umbilicaria* spp.-*Rhizocarpon* spp. (Anderson 1974, Hanson 1953, Kessel and Schaller 1960, Klein 1959, Pegau 1968, Rausch and Rausch 1968, Webber and others 1978). *Umbilicaria* spp.-Parmelia spp. (Webber and others 1978). *Umbilicaria* spp.-Cetraria spp.-*Cornicularia* spp.-Pseudephebe spp. (Talbot and others 1984). *Xanthorea candelaria-Ramalina scoparia-R. almquistii* (Shacklette and others 1969). *Lecanora* spp.-*Parmelia saxatilis-Xanthorea candelaria* (Racine and Anderson 1979).

Figure 76-A community of fruticose lichens, primarily *Cetraria nivalis* and *Thamnolia vermicularis,* on rock scree in arctic Alaska.

III.C.2.b. Foliose and Fruticose Lichen

Description- Foliose and fruticose lichen communities are dominated by foliose and fruticose lichens, such as species of *Cladonia, Cladina,* and *Stereocaulon* (fig. 76). Crustose lichens may be common. Mosses are uncommon. Vascular plants are absent or nearly so. This unit is reserved for communities where lichens are common and other life forms are absent or nearly so.

Distribution and site characteristics- Foliose and fruticose lichen communities are most important in southwestern and northwestern Alaska, where they occur on fellfields and exposed ridges. These sites are slightly more amenable to plant growth than are those occupied by crustose lichen communities, but the sites are still too severe for vascular plant growth.

Successional status- Successional relations are unknown.

Closely related types- Foliose and fruticose lichen communities are similar to crustose lichen communities but are dominated by foliose and at least some fruticose lichens. They also are similar to some lichen-rich open dwarf shrub types, but vascular plants are absent or very scarce. Dwarf shrubs or sedges, or both, have been common in all the fruticose lichen-rich communities reported to date. Communities with a dense cover of lichens but with some shrub or herbaceous cover have been placed in dwarf scrub or graminoid herbaceous tundra types in this classification.

Photographs- Figure 76, this publication.

Primary references-None known.

Communities- *Cladina stellaris-Sphaerophorus fragilis* (Klein 1959). *Cladonia* spp.-Cetraria spp. (Johnson and others 1966). *Cladonia* spp.-Cladina spp. (Brock and Burke 1980). *Alectoria* spp.-Stereocaulon spp. (Brock and Burke 1980).

III.D. Aquatic Herbaceous

These are communities dominated by plants with leaves that float on the water surface or grow entirely below the surface of the water.

III.D.1. Freshwater Aquatic Herbaceous

This unit includes aquatic communities in fresh water.

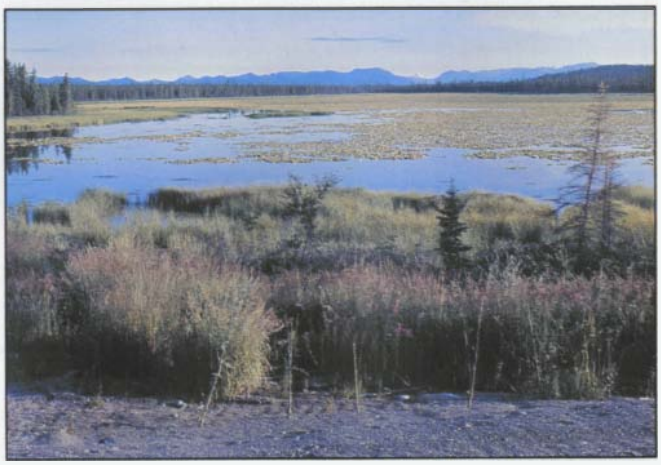

Figure 77-A freshwater aquatic pondlily community of *Nuphar polysepalum* in a shallow lake in south-central Alaska.

III.D.1.a. Pondlily

Description- These are aquatic communities dominated by pondlilies (Nuphar polysepalum or Nymphaea tetragona) (fig. 77). Other aquatic plants, such as *Callitriche* spp., *Potamogeton* spp., *Sparganium* spp., *Hippuris vulgaris, Myriophyllum spicatum,* or aquatic mosses, also may be common. Emergent species such as *Scirpus* spp. and *Carex* spp. may be scattered but usually are absent.

Distribution and site characteristics- Pondlily communities are common in ponds, bog pools, and shallow lake embayments throughout the forested parts of the State and extend somewhat beyond the trees in the western part of the State. Water depth generally ranges from 3.0 to 9.5 meters (10 to 30 ft). The substrate is usually a well-decomposed organic-rich muck, but pondlilies also grow in peat-bottomed pools.

Successional status- These are early stages of aquatic seres and most will be replaced by emergent sedges or floating bog mat communities as the ponds fill in.

Closely related types- Pondlily communities are distinctive. Pondlilies are large, conspicuous, and tend to dominate aquatic communities wherever they are present.

Photographs- Cooper 1942, figure 4; Hogan and Tande 1983, plate 28; Shacklette 1961b, figure 355.1; Tande 1983, plate 26; figure 77, this publication.

Primary references- Cooper 1942, Hogan and Tande 1983, Ritchie and others 1981, Shacklette 1961b.

Communities- Nuphar polysepalum (Dachnowski-Stokes 1941; Griggs 1936; Hogan and Tande 1983; Heusser 1960; Johnson and Vogel 1966; Palmer 1942; Porsild 1939; Racine 1976, 1978b; Ritchie and others 1981; Tande 1983). *Nuphar polysepalum-Callitriche verna* (Streveler and others 1973). *Nuphar polysepalum-Sparganium angustifolium* (Cooper 1942). *Nuphar polysepalum-Isoëtes muricata* (Shacklette 1961b). *Nuphar polysepalum-Hippuris vulgaris* (Drury 1956, Isleib and Kessel 1973). *Nuphar polysepalum-Potamogeton gramineus* (Rosenberg 1986). *Nuphar polysepalum-Potamogeton* spp. (Talbot and others 1984).

Figure 78- A freshwater aquatic common marestail community of *Hippuris vulgaris* in a shallow pond in arctic Alaska.

III.D.1.b. Common Marestail

Description- These aquatic communities are dominated by common marestail (Hippuris vulgaris) (fig. 78). This species may occur in pure, usually small, stands or may be associated with other aquatic species, commonly *Sparganium* spp. and *Myriophyllum spicatum.* Emergent plants are absent or rare.

Distribution and site characteristics- Common marestail communities occur throughout the State in shallow freshwater pools and flooded depressions, usually in 5 to 30 centimeters (2 to 12 in) of water. In some localities, the water occasionally dries to leave the marestail in wet mud for a few days or even weeks of the growing season. The substrate is mineral soil or organic-rich muck. Marestail stands are usually small in area but quite common.

Successional status- Like most aquatic communities, these are early successional and probably will be replaced by wet sedge meadows or sedge bogs as the organic substrate builds up.

Closely related types- These communities are similar to other aquatic communities but have common marestail as a dominant component. They are especially similar to four-leaf marestail communities (which grow in brackish ponds) but are dominated by common marestail instead of four-leaf marestail.

Some marshes *(Scripus* spp., *Equisetum fluviatile,* and *Arctophila fulva* communities) and wet sedge meadows have abundant marestail. Emergents are common in all those communities but are absent or nearly so from common marestail communities.

Photographs- Figure 78, this publication.

Primary references- Ritchie and others 1981, Webber and others 1978.

Communities- Hippuris *vulgaris* (Potter 1972, Racine 1976, Ritchie and others 1981). *Hippuris vulgaris-Potamogeton gramineus* (Webber and others 1978). *Hippuris vulgaris-Sparganium hyperboreum* (Hultén 1966, Porsild 1939, Streveler and others 1973). *Hippuris vulgaris-Potentilla palustris* (Spetzman 1959).

1ll.D.1.c. Aquatic Buttercup

Description- These communities are dominated or codominated by aquatic buttercups, including *Ranunculus trichophyllus, R. gmelini, R. hyperboreus,* and *R. pallasii.* Common associated aquatic plants include *Hippuris vulgaris, Myriophyllum spicatum* and *Potamogeton* spp. and, in streams, the aquatic moss *Fontinalis neomexicana.* Emergent plants are absent or rare.

Distribution and site characteristics- Aquatic buttercup communities are common in several habitats throughout the State. They occur in ponds, sloughs, oxbow lakes, sluggish rivers, swift streams, beaded drainages, and wet polygon centers. Water depths range from a few centimeters to a meter or more. *Ranunculus* hyperboreus and, to a lesser degree, *R. gmelini are* facultative aquatics and can live for a time in wet mud during periods of low water. Substrates are usually mineral soils or organic-rich mucks.

Successional status- Like all aquatic communities, these are early successional and most will be replaced eventually by marshes or wet meadows.

Closely related types- These communities are similar to other aquatic communities but have aquatic buttercups as major components. Again, they may be similar to some marsh or wet meadow communities but lack emergent plants.

Primary references- Johnson and others 1966, Shacklette and others 1969.

Communities- Ranunculus *trichophyllus-Hippuris vulgaris* (Friedman 1982, Hanson 1953, Shacklette and others 1969). *Ranunculus trichophyllus-Potamogeton natans* (Seguin 1977). *Ranunculus hyperboreus-R. gmelini-R. trichophyllus* (Johnson and others *1966). Ranunculus hyperboreus-R. trichophyllus* (Griggs *1936). Fontinalis neomexicana-Ranunculs trichophyllus* (Bank 1951, Shacklette and others 1969). *Ranunculus trichophyllus* (Streveler and others 1973).

111.D.1.d. Burreed

Description- These communities are dominated by burreed *(Sparganium* spp.) (fig. 79). These species often form pure stands or commonly mix with other aquatic species including *Potamogeton* spp, *Hippuris vulgaris, Ranunculus pallasii,* and aquatic mosses such as *Calliergon sarmentosum.* Emergent plants are absent or rare. The leaves of most burreed species lie flat on the surface of the water, but the central portion of the leaves of some species *(Sparganium angustifolium* and *S. multipedunculatum)* commonly arch out of the water, with only the tips floating on the surface.

Distribution and site characteristics- Burreed communities occupy small areas, but are widely distributed throughout the State. They are found in freshwater ponds, sloughs, oxbow lakes, shallow embayments, and sluggish rivers, usually in 10 to 50 centimeters (4-20 in) of water. The substrate is usually mineral silts or organic-rich mucks.

Successional status- Many of these early successional aquatic communities probably will be replaced by marshes or wet meadows.

Closely related types- Burreed communities are similar to other aquatic communities but have burreed as a major component. They also may be similar to some marsh or wet meadow communities but lack emergent species.

Figure 79-A freshwater aquatic burreed community of Sparganium *hyperboreum* in a shallow pool in south-central Alaska.

Photographs- Figure 79, this publication.

Primary references- Racine 1976, 1978b; Racine and Anderson 1979; Spetzman 1959.

Communities- Sparganium hyperboreum (Heusser 1960, Johnson and others 1966, Murray 1974, Spetzman 1959). Sparganium hyperboreum-Potamogeton *perfoliatus* (Hultén 1966). *Sparganium hyperboreum-Potamogeton pectinatus* (Racine 1978b, Young 1974b). *Sparganium hyperboreum-Ranunculus pallasii* (Racine 1976, Racine and Anderson 1979, Wiggins and Thomas 1962, Young 1974b).

III.D.1.e. Water Milfoil

Description- These communities are dominated by water miifoil *(Myriophyllum spicatum).* Common associated or codominant aquatic species include *Potamogeton* spp., *Sparganium* spp., and *Callitriche* spp. Emergent plants are absent or rare.

Distribution and site characteristics- Water milfoil communities are common as small stands in freshwater ponds, sloughs, oxbow lakes, and flooded depressions throughout interior, south-central, and western Alaska. They usually occur in shallow water about 10 to 100 centimeters (4 to 40 in) deep. Substrates include mud, organic-rich muck, and peat.

Successional status- Most of these communities probably will be replaced by marshes or wet meadows as succession advances.

Closely related types- Water milfoil communities are similar to other aquatic communities but have a dominant component of water milfoil. This species also is common in the understory of some marshes (dominated by *Scirpus validus* or *Equisetum fluviatile)* and the wetter parts of some wet meadows (dominated by *Menyanthes trifoliata* or various sedges), but water milfoil communities have few or no emergents.

Photographs-- Batten and others 1978, figure 16; Dachnowski-Stokes 1941, figure 17.

Primary references- Racine and Anderson 1979, Ritchie and others 1981.

Communities- Myriophyllum *spicatum-Potamogeton perfoliatus* (Batten and others 1978, Racine 1976). *Myriophyllum spicatum-Potamogeton* spp. (Dachnowski-Stokes 1941, Ritchie and others 1981, Young 1974b). *Myriophyllum spicatum-Utricularia vulgaris* (Porsild 1939, Racine and Anderson 1979).

III.D.1.f. Fresh Pondweed

Description- These communities are dominated by pondweeds *(Potamogeton* spp.). Some species grow mostly submerged *(Potamogeton pectinatus),* and others extend to the water surface and have some floating leaves *(P. gramineus).* Common associated aquatic plants include *Myriophyllum spicatum, Hippuris vulgaris, Sparganium* spp., and *Callitriche* spp. *Chara* spp. may be common on mineral substrates at the bottom of clear water bodies. Emergent plants are absent or rare.

Distribution and site characteristics--Pondweed communities are common in freshwater lakes, ponds, and sluggish rivers throughout Alaska, except for the littoral fringe of the arctic coastal plain. They occur in 10 centimeters (4 in) to at least 3 meters (10 ft) of water and are rooted in a substrate of mud or organic-rich muck.

Successional status- Communities in shallow water will probably be replaced by marshes or wet meadows. Those in deep water may eventually suffer the same fate but after a much longer time.

Closely related types- These communities are similar to other aquatic communities, but have a dominant component of pondweeds. They are especially similar to brackish pondweed communities and sometimes contain the same species, but the brackish pondweed types are restricted to shallow ponds on the coast periodically inundated by tides. Some pondweeds are found occasionally in the understories of marsh communities, but pondweed communities contain few or no emergents.

Primary reference- Ritchie and others 1981.

Communities- Potamogeton *gramineus-P. alpinus* (Porsild 1939). *Potamogeton berchtoldi-P. alpinus* (Porsild 1939). *Potamogeton pectinatus* (Spetzman 1959). *Potamogeton filiformis-Ruppia spiralis* (Cooper 1939). *Potamogeton perfoliatus* (Ritchie and others 1981).

III.D.1.g. Water Star-Wort

Description- These communities are dominated or codominated by water star-wort *(Callitriche* spp.). Other aquatic plants may be associated with the star-won, but the only one reported is *Subularia aquatica.* Emergent plants are rare or absent.

Distribution and site characteristics- water star-wort communities have been reported only from Amchitka Island, but small communities are probably scattered in freshwater ponds, bog pools, and shallow lake embayments throughout the State, except for the arctic coastal plain. These communities have been reported only from rock-bottomed seasonal pools, but they probably also exist in perennial water bodies with various substrates and 1 or 2 meters (3 to 6 ft) of water.

Successional status- Most of these communities probably are eventually replaced by marshes or wet meadows.

Closely related types- These communities are similar to other aquatic communities but have a dominant component of water star-wort.

Primary reference- Shacklette and others 1969.

Communities- Subularia *aquatica-Callitriche anceps* (Shacklette and others 1969).

III.D.1.h. Aquatic Cryptogam

Description- These are aquatic communities dominated by cryptogams. Reported dominants include the mosses *Fontinalis* spp., the liverwort *Scapania paludosa,* the lichen *Siphula ceratites,* and the vascular cryptogam *Isoëtes muricata.* Other species, such as *Scorpidium scorpioides, Drepanocladus* spp., and *Calliergon* spp., undoubtedly also dominate certain aquatic habitats. Various aquatic vascular plants may be scattered among the cryptogamic dominants. Emergent plants are absent or rare.

Distribution and site characteristics- Aquatic cryptogam communities are infrequently reported, but small stands of them are common in freshwater ponds, sloughs, slow-flowing streams, and bog pools throughout the State. Substrates range from rocks to peats. Many cryptogams are facultative aquatics and can thrive for a time if the water body dries up.

Successional status- Many of these communities eventually will be replaced by wet meadows or bog meadows.

Closely related types- These may be similar to other aquatic types but are dominated by cryptogams and lack a dominant vascular element. Aquatic cryptogams also may be present or abundant in marshes, some wet meadows, and vascular aquatic plant communities.

Primary references- Shacklette and others 1969, Worley 1972.

Communities- Fontinalis *antipyretica* (Worley 1972). *Siphula ceratites-Scapania paludosa* (Shacklette and others *1969). Isoëtes Muricata-Ranunculus reptans-Limosella aquatica* (Shacklette and others 1969).

III.D.2. Brackish Water Aquatic Herbaceous

This unit includes aquatic communities of brackish water ponds near the sea coast.

III.D.2.a. Four-Leaf Marestail

Description- These communities are dominated by four-leaf marestail *(Hippuris tetraphylla).* Other aquatic species that tolerate brackish water, such as *Potamogeton pectinatus, Ruppia spiralis,* or *Zannichellia palustris,* may be present or common. Cryptogams are absent. Emergent plants are absent or scarce.

Distribution and site characteristics- Four-leaf marestail communities are common in brackish ponds in coastal marshes throughout the State. They occur in tidally deposited mineral silts and clays in 5 to 50 centimeters (2 to 20 in) of water. The water generally is slightly brackish (1 to 10 parts per thousand salinity). These ponds are inundated periodically by tides, but many are only inundated a few times each growing season.

Successional status-Most of these communities eventually will be replaced by halophytic wet sedge meadows.

Closely related types- These communities are similar to other aquatic communities but are dominated by four-leaf marestail. They are especially similar to common marestail communities, which occur exclusively in fresh water,, but are dominated by four-leaf marestail instead of common marestail and occur in brackish, coastal settings. Four-leaf marestail may be common in the understory of the wetter parts of some halophytic sedge wet meadow communities, but emergent plants are lacking from four-leaf marestail communities.

Primary references- Batten and others 1978, del Moral and Watson 1978.

Communities- Hippuris *tetraphylla* (Potter *1972). Hippuris tetraphylla-Potamogeton pectinatus* (Batten and others 1978). *Hippuris tetraphylla-Potamogeton filiformis-Myriophyllum spicatum* (Crow 1968, lsleib and Kessel 1973). *Hippuris tetraphylla-Potamogeton filiformis* (del Moral and Watson 1978, Thomas 1957).

III.D.2.b. Brackish Pondweed

Description- These communities are dominated by species of pondweed that tolerate brackish water, primarily *Potamogeton pectinatus* and *P. filiformis.* Wigeongrass *(Ruppia* spiralis) and horned pondweed (Zannichellia palustris) communities also are included. *Hippuris tetraphylla* may be present. Emergent plants are absent or rare.

Distribution and site characteristics-Brackish pondweed communities occupy shallow (10 to 50 centimeters [4 to 20 in] deep) brackish ponds in coastal marshes throughout Alaska, except for the Chukchi and Beaufort seacoasts. These ponds are tidally inundated several times each summer and have salinities of roughly 1 to 10 parts per thousand. The substrate consists of tidally deposited silts and clays.

Successional status- Most ponds containing brackish pondweed communities are replaced eventually by halophytic sedge wet meadows.

Closely related types- These communities are similar to fresh pondweed communities, and most of the dominant species also grow in fresh water. The brackish pondweed communities occur, however, only within or at the edges of coastal marshes and may include *Hippuris tetraphylla* or other salt-tolerant species as minor constituents. Pondweed species with broad leaves (such as *Potamogeton gramineus* and *P. perfoliatus)* never dominate brackish communities.

Primary references- Neiland 1971b, Palmer 1942.

Communities- Myriophyllum *spicatum-Potamogeton filiformis* (Crow 1968). *Potamogeton filiformis* (Crow *1968). Potamogeton* spp. (Neiland 1971b, Palmer *1942). Potamogeton* spp. *-Zannichellia palustris* (Rosenberg 1986).

III.D.3. Marine Aquatic Herbaceous

This unit includes communities in the ocean.

Figure 8O(left)-A marine aquatic eelgrass community of *Zostera marina* in a lagoon In southwest Alaska. (Photograph courtesy Joanna Roth.)

Figure 81(right)-A marine algae community of Fucus spp. in coastal south-central Alaska. (Photograph courtesy Glenn Juday.)

lll.D.3.a. Eelgrass

Description- These communities are dominated by eelgrass (Zostera marina) and normally occur as pure stands of this species (fig. 80).

Distribution and site characteristics- Eelgrass communities occur in protected bays, inlets, and lagoons with clear water along the Alaska coast as far north as the north shore of the Seward Peninsula. They occur in the subtidal and lower intertidal zones. The substrate usually is marine silts and clays but sometimes is cobbles.

Successional status- These communities probably would be considered climax in most instances.

Closely related types- Eelgrass communities are distinctive and unlikely to be mistaken for another type except, perhaps, certain communities of marine algae. Surfgrass *(Phyllospadix* scouleri) communities occur occasionally on rocks exposed to surf in southeastern Alaska.

Photographs- Figure 80, this publication.

Primary references- Batten and others 1978, McRoy 1968, Roth 1986.

Communities- Zostera marina (Batten and others 1978, McRoy 1968, Palmer 1942, Roth 1986).

lll.D.3.b. Marine Algae

Description- These communities are dominated by various species of marine algae, including species of fucus, Laminaria, *Gigartina, Porphyra, Alaria,* and *Ulva* (fig. 81). Plants other than algae are not present.

Distribution and site characteristics- Marine algae communities are widespread on subtidal and intertidal rocky shores along the Pacific coast and the Aleutian Islands.

Successional status- Successional relations are unknown to us.

Closely related types-- These communities are quite distinctive. Rarely, Fucus communities will border on and intergrade with halophytic herb communities on gravels near river mouths, but even then they usually are distinct.

Photographs- Lebednik and Palmisano 1977, several figures; figure 81, this publication.

Primary references- Batten and others 1978, Lebednik and Palmisano 1977.

Communities- Many communities occur, but a review of marine ecological literature is beyond the scope of this vegetation classification, which is terrestrially oriented. Species of *Fucus, Gigartina, Porphyra,* and *Ulva* are important along Alaska coasts (Batten and others 1978, Druehl 1970, Palmer 1942, Stevens 1965).

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Table 3-List of scientific and common names used In the text

Scientific names	Common name
Trees:[a]	
Abies amabilis (Dougl.) Forbes	Pacific silver fir
Abies lasiocarpa (Hook.) Nutt.	Subalpine fir
Alnus rubra Bong.	Red alder
Betula papyrifera Marsh. var. *humilis* (Reg.) Fern. & Raup	Alaska paper birch
Chamaecyparis nootkatensis (D. Don) Spach	Alaska-cedar
Larix laricina (Du Roi) K. Koch	Tamarack, larch
Picea glauca (Moench) Voss	White spruce
Picea mariana (Mill.) B.S.P.	Black spruce
Picea sitchensis (Bong.) Carr.	Sitka spruce
Pinus cuntorta Dougl.	Lodgepole pine
Populus balsamifera L.	Balsam poplar
Populus tremuloides Michx.	Quaking aspen
Populus trichocarpa Torr. & Gray	Black cottonwood
Taxus brevifolia Nutt.	Pacific yew
Thuja plicata Donn	Western redcedar
Tsuga heterophylla (Raf.) Sarg.	Western hemlock
Tsuga mertensiana (Bong.) Carr.	Mountain hemlock
Shrub and subshrubs:[a]	
Alnus crispa (Ait.) Pursh	American green alder
Alnus sinuata (Reg.) Rydb.	Sitka alder
Alnus tenuifolia Nutt.	Thinleaf alder
Andromeda polifolia L.	Bog-rosemary
Arctostaphylos alpina (L.) Spreng.	Alpine bearberry
Arctostaphylos rubra (Rehd.& Wilson) Fern.	Red-fruit bearberry
Arctostaphylos uva-ursi (L.) Spreng.	Bearberry, kinnikinnik
Arfemisia alaskana Rydb.	Alaska sagebrush
Artemisia frigida Willd.	Fringed sagebrush
Betula glandulosa Michx.	Resin birch, bog birch
Betula nana L.	Dwarf arctic birch
Cassiope lycopodioides (Pall.) D. Don	Alaska cassiope
Cassiope mertensiana (Bong.) D. Don	Mertens cassiope
Cassiope stelleriana (Pall.) DC.	Starry cassiope
Cassiope tetragona (L.) D. Don	Four-angled cassiope
Chamaedaphne calyculata (L.) Moench	Leatherleaf
Cladothamnus pyrolaeflorus Bong.	Copperbush
Cornus stolonifera Michx.	Red-osier dogwood
Diapensia lapponica L.	Diapensia
Dryas drummondii Richards.	Drummond mountain-avens
Dryas integrifolia Vahl	Entire-leaf mountain-avens
Dryas octopetala L.	White mountain-avens
Elaeagnus commutata Bernh.	Silverberry
Empetrum nigrum L.	Crowberry
Gaultheria shallon Pursh	Salal
Kalmia polifolia Wang.	Bog kalmia
Ledum decumbens (Ait.) Small (= *Ledum* palustre L. ssp. *decumbens* (Ait.) Hult.)	Narrow-leaf Labrador-tea

Footnote on page 253.

Table 3-List of scientific and common names used in the text (continued)

Scientific names	Common name
Ledum groenlandicum Oeder (= *Ledum palustre* L. ssp. *groenlandicum* (Oeder) Hult.)	Labrador-tea
Linnaea borealis. L.	Twinflower
Loiseleuria procumbens (L.) Desv.	Alpine-azalea
Menziesia ferruginea Sm.	Rusty menziesia
Myriiza gale L.	Sweetgale
Oplopanax horridus (Sm.) Miq.	Devilsclub
Phyllodoce aleutica (Spreng.) Heller	Aleutian mountain-heath
Phyllodoce aleutica ssp. *glanduliflora* (Hook.): Hult.	Glandular Aleutian mountain-heath
Phyllodoce coerulea (L.) Bab.	Blue mountain-heath
Potentilla fruticosa L.	Bush cinquefoil
Rhododendron camtschaticum Pall.	Kamchatka rhododendron
Rhododendron lapponicum (L.) Wahlenb.	Lapland rosebay
Ribes triste Pall.	American red currant
Rosa. acicularis Lindl.	Prickly rose
Rubus idaeus L. var. *strigosus* (Michx.) Maxim.	American red raspberry
Rubus spectabilis Pursh	Salmonberry
Salix alaxensis (Anderss.) Cov.	Feltleaf willow
Salix arbusculoides Anderss.	Littletree willow
Salii arctica Pall.	Arctic willow
Salix barclayi Anderss.	Barclay willow
Salix bebbiana Sarg.	Bebb willow
Salix brachycarpa Nutt. ssp. *niphoclada* (Rydb.) Argus	Barren-ground willow
Salix commutata Bebb	Undergreen willow
Salix fuscescens Anderss.	Alaska bog willow
Salix *glauca* L.	Grayleaf willow
Salix hastata L.	Halberd willow
Salix interior Rowlee	Sandbar willow
Salix lanata L. ssp. richardsonii (Hook.) A. Skwortz.	Richardson willow
Salix lasiandra Benth.	Pacific willow
Salix novae-angliae Anderss.	Tall blueberry willow
Salix ovalifolia Trautv.	Ovalleaf willow
Salixphlebophylla Anderss.	Skeletonleaf willow
Salix planifolia Pursh ssp. *pulchra* (Cham.) Argus	Diamondleaf willow
Salixpolaris Wahlenb. ssp. *pseudopolaris* (Flod.) Hult.	Polar willow
Salix *reticulata* L.	Netleaf willow
Salix rotundifolia Trautv.	Least willow
Salix sitchensis Sanson	Sitka willow
Sambucus callicarpa Greene	Pacific red elder
Shepherdia canadensis (L.) Nutt.	Buffaloberry
Sorbus sitchensis Roem.	Sitka mountain-ash
Spiraea douglasii Hook.	Douglas spirea
Spiraea beauverdiana Schneid.	Beauverd spirea
Vaccinium alaskaense Howell	Alaska blueberry
Vaccinium caespitosum Michx.	Dwarf blueberry

Table 3-List of scientific and common names used in the text (continued)

Scientific names	Common name
Vaccinium ovalifolium Sm.	Early blueberry
Vaccinium oxycoccos L.	Bog cranberry
Vaccinium parvifolium Sm .	Red huckleberry
Vaccinium uliginosum L.	Bog blueberry
Vaccinium vitis-idaea L.	Mountain-cranberry
Viburnum edule (Michx.) Raf.	High bushcranberry
Herbs:[b]	
Achillea borealis Bong.	Northern yarrow
Aconitum delphinifolium DC.	Monkshood
Aconitum maximum Pall.	Kamchatka aconite
Agropyron boreale (Turcz.) Drobov (= *Agropyron latiglume* (Scribn. & Sm.) Rydb.)	Northern wheatgrass
Agropyron pauciflorum (Schwein.) Hitchc.	Few-flowered wheatgrass
Agropyron spicatum (Pursh) Scribn. & Sm.	Bluebunch wheatgrass
Agropyron subsecundum (Link) Hitchc.	Wheatgrass
Agrostis borealis Hartm.	Red bentgrass
Alopecurus alpinus Sm.	Alpine/foxtail
Androsace L.	No common name
Anemone narcissiflora L.	Narcissus-flowered anemone
Angelica genuflexa Nutt.	Bent-leaved angelica
Angelica lucida L.	Sea coast angelica
Antennaria rosea Greene	Pussytoe
Aquilegia formosa Fisch.	Western columbine
Arabis holboellii Hornem.	No common name
Arctagrostis latifolia (R.Br.) Griseb.	Polar grass
Arctophila fulva (Trin.) Anderss.	Pendent grass
Arnica unalaschcensis Less.	No common name
Artemisia arctica Less.	Arctic wormwood
Artemisia arctica Less. ssp. comata (Rydb.) Hult.	No common name
Artemisia borealis Pall.	Northern wormwood
Artemisia tilesii Ledeb.	No common name
Astragalus alpinus L.	Alpine milk vetch
Astragalus nutzotinensis Rousseau	Sickle pod
Athyrium filix-femina (L.) Roth	Lady fern
Atriplex gmelini C.A. Mey.	Orach, spearscale
Blechnum spicant (L.) Roth	Deer fern
Botrychium L.	Moonwort
Bromus pumpellianus Scribn.	Brome grass
Bupleurum triradiatum Adams	Thorough-won
Calamagrostis canadensis (Michx.) Beauv.	Bluejoint
Calamagrostis deschampsioides Trin.	No common name
Calamagrostis nutkaënsis (Presl) Steud.	Pacific reed-grass
Calamagrostis purpurascens R. Br.	Purple reed-grass
Callitriche anceps Fern.	Water star-wart
Callitriche verna L. emend. Lönnr.	Vernal water star-won
Caltha biflora DC.	Broad-leaf marsh-marigold
Caltha palustris L.	Yellow marsh-marigold

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Table 3-List of scientific and common names used in the text (continued)

Scientific names	Common name
Campanula lasiocarpa Cham.	Bellflower
Cardamine bellidifolia L.	Alpine bittercress
Cardamine umbellata Greene	Bittercress
Carex L.	Sedge
Carex anthoxanthea Presl	No common name
Carex aquatilis Wahlenb.	Water sedge
Carex bigelowii Torr.	Bigelow sedge
Carex canescens L.	Silvery sedge
Carex capillaris L.	Hair-like sedge
Carex chordorrhiza Ehrh.	Creeping sedge
Carex circinnata CA. Mey.	Coiled sedge
Carex franklinii Boott	No common name
Carex glacialis Mack.	Glacier sedge
Carex glareosa Wahlenb.	Weak cluster sedge
Carex *kelloggii* W. Boott	Kellogg sedge
Carex Iachenalii Schkuhr	Arctic hares-foot sedge
Carex lasiocarpa Ehrh.	No common name
Carex limosa L.	Shore sedge
Carex livida (Wahlenb.) Willd.	Livid sedge
Carex lyngbyaei Hornem.	Lyngbye sedge
Carex mackenziei Krecz.	Mackenzie sedge
Carex macrochaeta C.A. Mey.	Alaska long-awned sedge
Carex magellanica Lam.	Bog sedge
Carex membranacea Hook.	Fragile sedge
Carex microchaeta Holm	No common name
Carex microglochin Wahlenb.	False uncinia
Carex misandra R. Br.	Short-leaved sedge
Carex nardina E. Fries	Hepburn sedge
Carex nesophila Holm	Bering Sea sedge
Carex nigricans C.A. Mey.	Blackish sedge
Carex pauciflora Lightf.	Few-flowered sedge
Carex pluriflora H u lt.	Many-flowered sedge
Carex podocarpa R.Br.	Short-stalk sedge
Carex ramenskii Kom.	Ramenski sedge
Carex rariflora (Wahlenb.) J.E. Sm.	Loose-flowered alpine sedge
Carex rostrata Stokes	Beaked sedge
Carex rotundata Wahlenb.	Round-fruited sedge
Carex rupestris All.	Rock sedge
Carex saxatilis L.	No common name
Carex scirpoidea Michx.	Northern single-spike sedge
Carex sitchensis Prescott	Sitka sedge
Carex subspathacea Wormsk.	Hoppner sedge
Carex supina Willd.	No common name
Carex ursina Dew.	No common name
Carex vaginata Tausch	Sheathed sedge
Cerastium aleuticum Hult.	Aleutian chickweed
Chrysanthemum arcticum L.	Arctic daisy
Cicuta mackenzieana Raup	Water hemlock
Circaea alpina L.	Enchanter's nightshade
Claytonia sarmentosa C.A. Mey.	Spring beauty
Claytonia sibirica L.	Siberian spring beauty

Table 3-List of scientific and common names used in the text (continued)

Scientific names	Common name
Cochlearia officinalis L.	Scurvy grass
Coptis aspleniifolia Salisb.	Goldthread
Coptis trifolia (L.) Salisb.	Goldthread
Cornus canadensis L.	Bunchberry, dwarf dogwood
Crepis nana Richards.	Dwarf hawks-beard
Cystopteris fragilis (L.) Bernh.	Fragile fern
Delphinium glaucum S.Wats.	Glaucous larkspur
Deschampsia beringensis Hult.	Bering hair-grass
Deschampsia caespitosa (L.) Beauv.	Tufted 'hair-grass
Dodecatheon jeffreyi Van Houtte	Jeffrey'shooting star
Dodecatheon pulchellum (Raf.) Merr.	Pretty shooting star
Draba aleutica Ekman	Aleutian draba
Draba caesia Adams	No common name
Draba hyperborea (L.) Desv.	No common name
Drosera anglica Huds.	Long-leaved sundew
Drosera rotundifolia L.	Round leaved sundew
Dryopteris dilatata (Hoff m.) Gray	Spinulose shield-fern
Dupontia fischeri R. Br.	Tundra grass, dupontia
Eleocharis palustris (L.) Roem. & Schult.	Spike rush
E/ymus arenarius L.	Dunegrass
E/ymus innovatus Beal	Downy ryegrass
Epilobium adenocaulon Haussk.	Northern willow-herb
Epilobium angustifolium L.	Fireweed
Epilobium latifolium L.	Dwarf fireweed
Equisetum arvense L.	Meabow horsetail
Equisetum fluviatile L. ampl. Ehrh.	Swamp horsetail
Equisetum palustre L.	Marsh horsetail
Equisetum pratense Ehrh.	Meadow horsetail
Equisetum sylvaticum L.	Woodland horsetail
Equisetum variegatum Schleich.	Variegated scouring-rush
Erigeron peregrinus (Pursh) Greene	Coastal fleabane
Eriogonum flavum Nutt.	Umbrella plant
Eriophorum angustifolium Honck.	Tall cottongrass
Eriophorum brachyantherum Trautv. & Mey.	No common name
Eriophorum russeolum E. Fries	Russett cottongrass
Eriophorum scheuchzeri Hoppe	White cottongrass
Eriophorum vaginatum L.	Tussock cottongrass
Fauria crista-galli (Menzies) Makino	Deer cabbage
Festuca altaica Trin.	Fescue grass
Festuca brachyphylla Schult.	Sheep fescue
Festuca rubra L.	Red fescue
Fritillaria camschatcensis (L.) Ker-Gawl.	Black lily, indian rice
Galium boreale L.	Northern bedstraw
Galium trifidum L.	Small bedstraw
Gentiana douglasiana Bong.	Swamp gentian
Geocaulon lividurn (Richards.) Fern.	Northern commandra
Geranium erianthum DC.	Northern geranium
Geum calthifolium Menzies	Caltha-leafed avens
Geum glaciale Adams	Glacier avens
Geum macrophylum Willd.	Large-leaved avens
Geum rossii (R. Br.) Ser.	Ross avens

Table 3-List of scientificand common names used in the text (continued)

Scientific names	Common name
Glaux maritima L.	Sea milkwort
Glyceria borealis (Nash) Batchelder	Northern manna grass
Goodyera repens (L.) R. Br.	Rattlesnake plantain
Gymnocarpium dryopteris (L.) Newm.	Oak fern
Hedvsarum alpinum L.	Alpine sweet-vetch
Hedysarum mackenzii Richards.	Northern sweet-vetch
Heracleum lanatum Michx.	Cow parsnip
Hierochloë alpina (Sw.) Roem. & Schult.	Alpine holygrass
Hippuris tetraphylla L.	Four-leaf marestail
Hippuris vulgaris L.	Common marestail
Honckenya peploides (L.) Ehrh:	Seabeach sandwort
Hordeum brachyantherum Nevski	Meadow barley
Iris setosa Pall.	Wild Iris
Isoëtes muricata Dur.	Quillwort
Juncus arcticus Willd.	Arctic rush
Kobresia myosuroides (Vill.) Fiori & Paol.	No common name
Kobresia simpliciuscula (Whalenb.) Mack.	No common name
Koenigia islandica L.	Koenigia
Lathyrus maritimus L.	Beach pea
Lathyrus palustris L.	Wild-pea
Leptarrhena pyrolifolia (D. Don) Ser.	Leatherleaved saxifrage
Ligusticum scoticum L.	Beach lovage
Limosella aquatica L.	Mudwort
Luetkea pectinata (Pursh) Kuntze	Luetkea
Lupinus arcticus S. Wats.	Arctic lupine
Lupinus nootkatensis Donn	Nootka lupine
Luzula confusa Lindeb.	Wood rush
Luzula tundricola Gorodk.	Tundra woodrush
Lycopodium alpinum L.	Alpine club moss
Lycopodium complanatum L.	Ground-cedar
Lysichiton americanum Hult. & St. John	Yellow skunk cabbage
Maianthemum dilatatum (How.) Nels. & Macbr.	False lily-of-the-valley
Menyanthes trifoliata L.	Buckbean
Mertensia maritima (L.).S.F. Gray	Oysterleaf
Mertensia paniculata (Ait.) G. Don	Bluebell
Minuartia arctica (Stev.) Aschers. & Graebn.	Arctic sandwort
Myriophyllum spicatum L.	Water milfoil
Nuphar polysepalum Engelm.	Yellow pondlily
Nymphaea tetragona Georgi	Dwarf waterlily
Oxyria digyna (L.) Hill	Mountain sorrel
Oxytropis borealis. DC:	Boreal oxytrope
Oxytropis deflexa (Pall.) DC.	Deflexed oxytrope
Oxytropis nigrescens (Pall.) Fisch.	Blackish oxytrope
Parnassia kotzebuei Cham. & Schlecht.	Kotzebue grass-of-parnassus
Pedicularis labradorica Wirsing	Labrador lousewort
Petasites frigidus (L.) Franch..	Arctic sweet coltsfoot
Phippsia algida (Soland.) R. Br.	Snow grass
Phyllospadix scouleri Hook.	Scouler's surfgrass
Plantago maritima L.	Goose-tonque
Platanthera L.C. Rich.	Bog orchid
Poa arctica R. Br.	Arctic bluegrass

Table 3-List of scientific and common names used in the text (continued)

Scientific names	Common name
Poa eminens Presl	Coastal bluegrass
Poa glauca M.Vahl	Glaucous bluegrass
Poiemonium acutiflorum Willd.	Blue Jacob's ladder
Polemonium boreale Adams	Northern Jacob's ladder
Polygonum amphibium L.	Water smartweed
Polygonum bistoria L.	Meadow bistort
Polygonum viviparum L.	Alpine bistort
Polystichum munitum (Kaulf.) Presl.	Sword fern
Potamogeton alpinus Balb.	Northern pondweed
Potamogeton berchtoldi Fieb.	Berchtold pondweed
Pdtamogeton filiformis Pers.	Filiform pondweed
Potamogeton gramineus L.	Grasslike pondweed
Potamogeton natans L.	Floating pondweed
Potamogeton pectinatus L.	Fennel-leaf pondweed
Potamogeton perfoliatus L.	Clasping-leaf pondweed
Potentilla biflora Willd.	Two-flowered cinquefoil
Potentilla egedii Wormsk.	Common silverweed
Potenitilla elegans Cham.,& Schlecht.	Elegant cinquefoil
Potentilla hyparctica Malte	Arctic cinquefoil
Potentilla palustris (L.) Scop.	Marsh fivefinger
Potentilla pennsylvanica L.	Pennsylvania cinquefoil
Potentilla vahliana Lehm.	One-flowered cinquefoil
Potentilla villosa- Pall.	Villous cinquefoil
Prenanthes alata (Hook.) Dietr.	Rattlesnake root
Primula cuneifolia Ledeb.	Wedge-leaf primrose
Primula tschuktschorum Kjellm.	Chukch primrose
Puccinellia andersonii Swallen	Anderson alkali grass
Puccinellia borealis Swallen	Northern alkali grass
Puccinellia glabra Swallen	Glabrous alkali grass
Puccinellia grandis Swallen	-Large alkali grass
Puccinellia phryganodes (Trin.) Scribn. & Merr.	Creeping alkali grass
Puccinellia nutkaënsis (Presl) Fern. & Weath.	Pacific alkali grass
Pulsatilla patens (L.) Mill.	Pasqueflower
Pyrola asarifolia Michx.	Liverleaf wintergreen
Pyrola grandiflora Radius	Large-flowered wintergreen
Pyrola secunda L.	One-sided wintergreen
Ranunculus gmelini DC.	No common name
Ranunculus hyperboreus Rottb.	Arctic buttercup
Ranunculus pallasii Schlecht.	Pallas buttercup
Ranunculus reptans L.	Creeping buttercup
Ranunculus trichophyllus Chaix.	White water crowfoot
Rhynchospora alba (L.) M. Vahl	Beak rush
Rubus arcticus L.	Nagoon-berry
Rubus chamaemorus L.	Cloudberry
Rubus pedatus Sm.	Five-leaf bramble
Ruppia spiralis L.	Ditch grass
Salicornia europaea L.	Glasswort
Sanguisorba stipulata Raf.	Sitka burnet
Saxifraga bracteata D. Don	No common name

Table 3-List of scientific and common names used in the text (continued)

Scientific names	Common name
Saxifraga bronchialis L.	Spotted saxifrage
Saxifraga hirculus L.	Bog saxifrage
Saxifraga oppositifolia L.	Purple mountain saxifrage
Saxifraga punctata L.	Cordate-leaved saxifrage
Saxifraga rivularis L.	Brook saxifrage
Saxifraga tricuspidata Rottb.	Prickly saxifrage
Scirpus microcarpus Presl.	Small-fruit bullrush
Scripus paludosus Nels.	Bayonet-grass
Scirpus validus M. Vahl	Great bulrush
Sedum rosea (L.) Scop.	Roseroot
Senecio congestus (R. Br.) DC.	Marsh fleabane
Senecio pseudo-arnica Less.	No common name
Senecio triangularis Hook.	No common name
Sibbaldia procumbens L.	Sibbaldia
Silene acaulis L.	Moss campion
Silene menziesii Hook.	No common name
Smelowskia C.A. Mey.	No common name
Solidago multiradiata Ait.	Goldenrod
Sparganium angustifolium Michx.	Narrow-leaved burreed
Sparganium hyperboreum Laest.	Northern burreed
Sparganium multipedunculatum (Morong) Rydb.	Emersed burreed
Spergularia canadensis (Pers.) G. Don	Canada sand-spurry
Stellaria humifusa Rottb.	Low chickweed
Streptopus amplexifolius (L.) DC.	Twisted-stalk
Suaeda depressa (Pursh) S. Wats.	Sea blite
Subularia aquatica L.	Awlwort
Thalictrum minus L.	Meadow rue
Tiarella trifoliata L.	Lace flower
Tofieldia coccinea Richards.	Northern asphodel
Trichophorum caespitosum (L.) Hartm. (= *Scirpus caespitosus* L.)	Tufted clubrush
Trientalis europaea L.	Starflower
Triglochin maritimum L.	Maritime arrow grass
Triglochin palustris L.	Marsh arrow grass
Trisetum spicatum (L.) Richter	Downy oatgrass
Utricularia vulgaris L.	Common bladderwort
Vahlodea atropurpurea (Wahlenb.) E. Fries (= *Deschampsia atropurpurea* (Wahlenb.) Scheele)	Mountain hair-grass
Valeriana sitchensis Bong.	Sitka valerian
Veratrum viride Ait.	False hellebore
Veronica stelleri Pall.	Alpine speedwell
Viola *langsdorffii* Fisch.	Langsdorff violet
Wilhelmsia physodes (Fisch.) McNeill	Merckia
Zannichellia palustris L.	Horned pondweed
Zostera marina L.	Eelgrass

Table 3-Llst of scientific and common names used In the text (continued)

Scientific names	Common name
Brophytes:[c]	
Andreaea rupestris Hedw.	No common name
Anthelia juiacea (L.) Dum.	No common name
Aulacomnium palustre (Hedw.) Schwaegr.	No common name
Aulacomnium turgidum (Wahlenb.) Schwaegr.	No common name
Brachythecium albicans (Hedw.) B.S.G.	No common name
Bryum stenotrichum C. Muell.	No common name
Calliergon giganteum (Schimp.) Kindb.	No common name
Calliergon sarmentosum (Wahlenb.) Kindb.	No common name
Campylium stellatum (Hedw.) C. Jens.	No common name
Dicranoweisia cirrata (Hedw.) Lindb. ex Milde	No common name
Dicranum scoparium Hedw.	No common name
Distichium capillaceum (Hedw.) B.S.G.	No common name
Drepanocladus lycopodioides (Brid.) Warnst.	No common name
Drepanocladus revolvens (Sw.) Warnst.	No common name
Drepanociadus uncinatus (Hedw.) Warnst.	No common name
Fontinalis antipyretica Hedw.	No common name
Fontinalis neomexicana Sull. & Lesq.	No common name
Grimmia apocarpa Hedw. (= *Schistidium apocarpum)*	No common name
Gymnocolea acutiloba (Schiffn.) K. Müll	No common name
Hylocomium splendens (Hedw.) B.S.G.	Feathermoss
Marsupella emarginata (Ehrh.) Dum.	No common name
Mnium Hedw.	No common name
Nardia compressa (Hook.) S. Gray	No common name
Nardia scalaris S. Gray	No common name
Oncophorus wahlenbergii Brid	No common name
Philonotis fontana (Hedw.) Brid.	No common name
Plagiothecium undulatum (Hedw.) B.S.G.	No common name
Pleuroclada albescens (Hook.) Spruce	No common name
Pleurozium schreberi (Brid.) Mitt.	Feathermoss
Polytrichum juniperinum Hedw.	No common name
Ptilium crista-castrensis (Hedw.) De Not.	No common name
Rhacomitrium canescens (Hedw.) Brid.	No common name
Rhacomitrium lanuginosum (Hedw.) Brid.	No common name
Rhytidiadelphus loreus (Hedw.) Warnst.	No common name
Rhytidiadelphus triquetrus (Hedw.) Warnst.	Feathermoss
Rhytidium rugosum (Hedw.) Kindb.	No common name
Scapania paludosa (K. Mull) K. Mull	No common name
Scorpidium scorpioides (Hedw.) Limpr.	No common name
Sphagnum L.	Sphagnum moss
Sphagnum fuscum (Schimp.) Klinggr.	Sphagnum moss
Sphagnum girgensohnii Russ.	Sphagnum moss
Sphagnum lindbergii Schimp. ex Lindb.	Sphagnum moss
Sphagnum mageilanicum Brid.	Sphagnum moss
Sphagnum papillosum Lindb.	Sphagnum moss
Sphagnum riparium Angstr.	Sphagnum moss

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Table 3-List of scientific and common names used in the text (continued)

(Scientific 'names	Common name
Sphagnum recurvum P.-Beauv.	Sphagnum moss
Sphagnum squarrosum Crome	Sphagnum moss
Sphagnum tenellum Ehrh. ex Hoffm.	Sphagnum moss
Sphagnum teres (Schimp.) Angstr. ex C. Hartm.	Sphagnum moss
Sphagnum warnstorfii Russ.	Sphagnum moss
Tomenthypnum nitens (Hedw.) Loeske	No common, name
Ulota phyllantha Brid.	No comm.on name
Lichens:[d]	
Alectoria nigricans (Ach.) Nyl.	No common name
Cetraria cuctillata (Bellardi) Ach.	No common name
Cetraria delisei (Bory ex. Schaerer) Nyl.	No common name
Cetraria islandica (L.) Ach.	No common name
Cetraria nivalis (L.) Ach.	No common name
Cladina arbuscula (Wallr.) Hale & Culb.	No common name
Cladina portentosa (Dufour) Follm. (= *Cladina impexa* B. de Lesd.)	No common name
Cladina rangiferina (L.) Nyl. (= *Cladonia rangiferina* (L.) Rabenh.)	Reindeer lichen
Cladina stellaris (Opiz) Brodo (= *Cladina alpestris.* (L.) Nyl.) (=, *Cladonia alpestris* (L.) Rabenh.)	No common name
Cladonia Hill ex Browne	No common name
Cladonia pyxidata,(L.) Hoffm.	'No common name
Cornicularia (Schreber) Hoffm.	No common name
Dactylina arctica (Richardson) Nyl.	No common name
Lecanora Ach. *in* Luyken	No common name
Masonhalea richardsonii (Hook.) Kärnef. (= *Cetraria richardsonii* Hook.)	No common name
Nephroma arcticum (L.) Torss.	No common name
Parmelia ***saxatilis*** (L.) Ach.	No common name
Peltigera Willd.	No common name
Peltigera aphthosa (L.) Willd.	No common name
Peltigera canina (L.) Willd.	Dog lichen
Pseudephebe M. Choisy	No common name
Ramalina almquistii Vainio	No common name
Ramalina scoparia Vainio	No common name
Rhizocarpon Ramond ex DC.	No common name
Siphula ceratites (Wahlenb.) Fr.	No common name
Sphaerophorus fragilis (L.) Pers.	No common name
Sphaerophorus globosus (Huds.) Vainio	No common name
Stereocaulon tomentosum Fr.	No common name
Thamnolia subuliformis (Ehrh.) Culb.	No common name
Thamnolia vermicularis (Swartz) Ach. ex Schaerer	Worm lichen
Umbilicaria proboscidea (L.) Schrader	No common. name
Xanthoria candelaria (L.) Th.. Fr.	No common name

Table 3-List of scientific and common names used in the text (continued)

Scientific names	Common name
Algae:[e]	
Alaria Grev.	No common name
Chara Valliant	No common name
Fucus distichus L.	No. common name
Gigartina Stackh.	No common name
Laminaria Lamour.	No common name
Pophyra C.A.	No common name
Ulva L.	No common name

[a] Nomenclature from Viereck and Little (1972).
[b] Nomenclature from Hulten (1968): some common names from Welsh (1974).
[c] Nomenclature from Crum and others (1973) for mosses and Stotler and Crandall-Stotler (1977) for hepatics.
[d] Nomenclature from Egan (1987).
[e] Nomenclature-for marine algae from Smith (1969) and for freshwater algae Smith (1950).

Glossary[1]

Abundance- (l) The total number of individuals of a species in an area, population, or community; (2) total number of individuals in a sample divided by the number of occupied sampling units gives relative abundance; (3) also may be expressed subjectively on a five-part scale as very rare, rare, infrequent, abundant, and very abundant.

Active layer- The layer of soil above the permafrost that thaws and freezes annually.

Age distribution- The classification of individuals of a population according to age classes or periods, such as prereproductive, reproductive, and postreproductive, or into numerical intervals such as 10-year age classes

All-aged- Applied to a stand of trees in which trees of all ages are found.

Alluvial- Refers to material transported and deposited by running water.

Alluvial soil- Soil that has developed from transported and relatively recently deposited material (alluvium), characterized by little or no modification of the original material by soil-forming processes.

Alluvium- A general term for all detrital material deposited or in transit by streams, including gravel, sand, silt, clay, and all variations and mixtures of these.

Alpine- (1) Refers to those portions of mountain landscapes above tree growth, or the organisms living there; (2) that vegetation 'occurring between the upper limit of trees (tree line) and the lower limit of snow (snowline) on mountains high enough to possess both of these features; (3) implies high elevation, particularly above tree line, and a cold climate.

Alpine meadow- (l) A dense, low, meadowlike type of herbaceous plant cover found above tree line; (2) low herbaceous vegetation dominated by grasses, sedges, and other herbs in the alpine zone; (3) nearly synonymous with alpine grassland.

Alpine tundra- That portion of the landscape above the upper limit of tree growth that supports a plant cover of dwarf shrubs and herbs.

Annual plant- A plant completing its life cycle and dying in 1 year or less; for example, *Bromus tectorum.*

Aquatic plant, emerged or emersed- A plant adapted to life with its lower parts submerged in water, its upper parts raised out of water.

Aquatic plant, immersed- A plant adapted for life submerged or almost submerged in water; for example, Myriophyllum spp.

Aquatic sites- Sites permanently or at least characteristically flooded where all dominant plants are aquatics with floating or submerged leaves; for example, species of *Potamogeton, Hippuris, Myriophyllum,* and several others. Depth of water is not significant but its persistence is.

Arctic- High-latitude region where tree growth usually is absent because of unfavorable environmental conditions (low temperatures, short growing season) and more or less following the 10 ^{o}C mean daily isotherm for the warmest month of the year. In general, north of 67° N. latitude; sometimes defined in Alaska as north of the "P-Y-K Line," or north of the Porcupine, Yukon, and Kuskokwim Rivers.

[1] Definitions for terms are from Gabriel and Talbot (1984).

Association, plant- A stand or group of stands made up of plants characterized by a definite floristic composition consisting of uniformity in physiognomy and structure and uniform habitat conditions. The term generally is reserved for a climax community.

Avalanche track- The central, channellike corridor along which an av alanche has moved; it may take the form of an open path in a forest, with bent and broken trees, or an eroded surface marked by pits, scratches, and grooves.

Barren- (l) An area devoid of trees or tall shrubs, as in the Canadian "barren ground" terminology for tundra; (2) an area devoid of vegetation or nearly so.

Beach- Depositional area at the shore of an ocean or lake covered by silt, sand, gravel or larger rock fragments and extending into the water for some distance. The zone of demarcation between land and water.

Bedrock- The solid rock underlying the soil and other unconsolidated material or that is exposed at the surface.

Biennial plant- A plant requiring 2 years to complete its life cycle; for example, raspberries.

Biomass- (l) The total amount of living material present in a particular area or habitat (community biomass) at any given time on a per-unit-area basis expressed in terms of either mass (g/m^2, kg/ha) or energy (cal/m^2); (2) an expression of the total weight of matter incorporated into a population of organisms (species biomass).

Biome- A continental-scale ecosystem characterized by similarities in plant life-form and environment (for example, tundra or coniferous forest) but including all plants and animals in the area.

Bog- (l) A peat-forming ecosystem influenced solely by water falling directly onto it as rain or snow and generally dominated by sphagnum mosses; (2) a peat-covered or peat-filled area, generally with a high water table dommated by mosses, especially sphagnum-although the water table is near the surface, there is little standing water except in ponds; (3) in Alaska, bog vegetation may be predominantly herbs, shrubs, or trees with *Sphagnum* spp. usually present and often dominating the moss layer; substrate is composed of very wet sedge peat or sphagnum peat with depth of peat ranging from 30 centimeters (12 in) to several meters.

Basin bog- A bog that has built up to the water level in a lake or an old river channel, and the upper surface of the peat is either horizontal or gently sloping.

Blanket bog- Term used in Britain for bog covering undulating semiuplands: (1) bogs of cool temperate regions formed under a maritime rainfall at lower elevations; (2) bogs that have developed on hills under high rainfall and low temperatures as in southeastern Alaska.

Ericaceous shrub bog- Sites in Alaska on wet, peaty soils on which ericaceous shrubs are codominant with sedges, mosses, other shrubs, or trees. Trees, when present, provide less than 25 percent of the cover. Peats may be either sedge or sphagnum, and accumulations range from 15 centimeters (6 in) to 12 meters (39 ft).

Flat raised bog- A bog having a tendency for peat growth to extend up the sloping valley sides, thereby leaving the boundary between bog and valley side poorly marked.

Lacustrine bog- The transitional stage in which some mineral water is still a major influence in the development of the bog.

Paludification- A bog formed over previously dry land where a rise in the water table saturates the soil without forming a lake.

Quaking bog- (l) Bog that has developed on a mat of Carex or *Sphagnum* growing over a wafer surface; (2) a carpet of bog vegetation that is floating and sinks and quivers when walked on. Often called a floating bog.

Raised bog- Bog with an elevated central area caused by peat accumulation. This central zone is generally isolated from the local water table and chiefly dependent on precipitation for water and minerals.

String bog- **A** common taiga landscape consisting of alternating low bog ridges (German: strange) and wet, sedgy hollows (Swedish: *flarke,* English: flarks). The ridges and hollows are oriented across the major slope of the peatland at right angles to water movement. Synonym of *strangmoor* (German) and more properly termed a "fen" because if usually is fed by wafers from outside the mire.

Treed bog- A type of ericaceous shrub bog with 10 to 25 percent of the cover in trees at least 135 centimeters (53 in) tall. See *muskeg.*

Bog ridge- A ridge of peat moss supporting shrubs or trees and superimposed on a matrix composed primarily of sedges. The ridges are narrow, usually with their long axes across the slope, and may form into net patterns. Synonyms are *strange* (German), *strangar* (Swedish), and *pounu* (Finnish).

Boreal- (l) Northern, or having to do with northern regions; (2) one of three transcontinental regions, extending from the northern polar seas south to southern Canada.

Boulders- Rock fragments larger than 60 centimeters (2 ft) in diameter.

Brackish water- Slightly salty water with a saline content intermediate between those of fresh water and sea wafer.

Breast height- A standard height for measurement of tree diameters 1.37 meters (4.5 ft) above average ground level in the United States; in Europe and most Commonwealth countries, 1.3 meters (4.25 ft).

Broad-leafed- With leaves other than linear in outline as opposed to grasslike or graminoid.

Broadleaf- (adj.) A conventional term applied to trees and shrubs of the Angiospermae, in loose contrast to the generally needle-leaved Gymnospermae. *See hardwood.*

Browse- (n.) Twigs or shoots, with or without Iattached leaves, of shrubs or trees that are available for forage for wild or domestic animals. (v.) To eat such plant material.

Bryoid- (1) A moss, liverwort, or hornwort; (2) in the Alaska vegetation classification, a herbaceous vegetation class including both bryoid communities and lichen communities.

Bryophyte- A plant of the phylum Bryophyta, which includes mosses, liverworts, and hornworts.

Burn- An area over which fire has run.

Caespitose (cespitose)- Plants with short stems and branches usually covered with leaves and forming dense tufts or cushions; for example, Silene *acaulis. See cushion plant.*

Canopy- (l) More or less continuous cover of branches and foliage formed collectively by crowns of adjacent trees, shrubs, or herbs, depending on the type of vegetation; (2) the cover of leaves and branches formed by the tops or crowns of plants as viewed from above.

Canopy closure- In a stand, the progressive reduction of space between crowns as they grow and spread laterally. A canopy in which the individual crowns are nearing general contact is termed a "close canopy"; and having achieved contact, a "closed canopy."

Canopy cover- See *cover.*

Character (characteristic) species- A plant species nearly always found in a community type regardless of its abundance or influence.

Circumboreal- Occurring simultaneously in the northern parts of North America, Asia, and Europe. The zoological equivalent of this botanical term is holarctic.

Circumpolar- Occurring around the North or South Pole.

Classification- (l) A "bottom-up" synthesis in which units are grouped by similarities to form a first category of classes; classification proceeds upward through synthesizing of new categories until all classes are included in one superclass; (2) the orderly arrangement of objects by their differences and similarities.

Clay- As a soil separate, mineral soil particles less than 0.002 millimeter (0.0005 in) in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Climax- That state of a biotic community that is attained when population structures of all its species fluctuate rather than exhibit unidirectional change. Such a community will remain in a self-perpetuating state so long as present climatic, edaphic, and biotic conditions continue.

Climatic climax- The ultimate phase of ecological development of plant communities permitted by the climate of a region.

Edaphic climax- Any distinctive type of stable community that develops on soils different from those supporting a climatic climax.

Fire climax- Any type of apparently stable vegetation whose distinctiveness depends on being burned at regular intervals.

Zootic climax- Any type of stable vegetation whose continued existence depends on continuous stress from heavy use by animals.

Climax species- A species that is self-perpetuating in the absence of disturbance, with no evidence of replacement by other plant species.

Climax vegetation- (l) The pattern or complex of climax communities (associations) in a landscape corresponding to the pattern of environmental gradients or habitats; (2) the stabilized plant community of a particular site, where the plant cover reproduces itself and does not change so long as the environment remains the same; (3) the final, stable community in an ecological succession that is able to reproduce itself indefinitely under existing environmental conditions.

Codominant- One of several species dominating a plant community, no one to the exclusion of the others.

Colluvial- (1) In soils, material that has been transported downhill and has accumulated on lower slopes or at the bottom of the hill; (2) pertaining to material transported and deposited by mass-wasting and local unconcentrated runoff on and at the base of steep slopes.

Community- A general term for an assemblage of plants living together and interacting among themselves in a specific location with no particular ecological status being implied. The basic unit of vegetation.

Community-type- An abstract community, or a group or class of similar abstract communities, that is relatively stable and recurs in similar habitats. Successional status is uncertain.

Competltion- The influence of one plant on another that results when both draw from one or more resources in short supply.

Conifer- (n.) A plant belonging to Coniferales that bears cones and needlelike or scalelike leaves. Sometimes misleadingly referred to as a softwood.

Coniferous- (adj.) Bearing cones.

Constancy- The relative consistency of occurrence of **a** species in stands of equal size located in a community-type, expressed as a percentage of the stands in which the species occurs.

Cover- (l) Any vegetation producing a protecting mat on or just above the soil surface; (2) the area of ground covered by the vertical projection of the aerial parts of plants of one or more species; (3) the entire canopy of all plants of all sizes and species found in an area.

Canopy cover- The proportion of the ground area covered by the vertical projection of the canopy. Expressed as a percentage of area.

Crown cover- The ground area covered by the crown of a tree or shrub, as delimited by the vertical projection of its outermost perimeter.

Crown- The upper portion of a tree or shrub including the branches and foliage.

Crown closure- (l) The closing together of the crowns of trees in a forest as they age and grow; (2) by extension of the term, the proportion of the ground area covered by the aggregate vertical projection of all the tree crowns in a crown cover. Expressed as a percentage of area.

Cryaquepts- Gray or olive soils with a high water table during all or most of the summer. They generally are strongly mottled. These soils have many textures and may have substratum of gravelly sand below 30 centimeters (12 in). Only thin accumulations of organic matter occur on the soil surface, and only thin dark upper horizons occur in the mineral soil.

Cryochrepts- Soils in which small or moderate amounts of organic matter have been incorporated into the upper portion of the mineral soil. Usually are well drained and support forest vegetation. Textures are most often loam or silt loam but may be gravelly. Many of these soils contain permafrost.

Cryptogam- (1) Any plant reproducing sexually without forming seeds; (2) collective term for the Thallophytes, Bryophytes, and Pteridophytes.

Cushion plant- An herbaceous or low woody plant so densely branched that it forms a dense, resilient mat or cushion; for example, *Silene acaulis.*

Diameter at breast height (d.b.h.)- The diameter of a tree, measured outside the bark, at 1.37 meters (4.5 ft) above ground level. See *breast height.*

Decadent- Declining or decaying.

Deciduous- Woody plants, or pertaining to woody plants, that seasonally lose all their leaves and temporarily become bare-stemmed.

Density, stand- The number of plants per unit of area at a given time. Expressed as number per square meter or stems per acre.

Depauperate- Describing an unusually sparse growth of undergrowth plants.

Disjunct- Pertaining to discontinuous range having two or more potentially inter-breeding populations separated by a distance precluding genetic exchange by pollination or dissemination.

Distribution- (l) The geographic range of a species at any one time; (2) the pattern of occurrence of individuals of a taxon in an area.

Disturbance- Any mechanism limiting plant biomass by causing its partial or total destruction.

Diversity- An expression of the variety of species that exist in a community, or of the variety of communities in a landscape.

Dominance- The degree of influence that a plant species exerts over a community as measured by its mass or basal area per unit area of the ground surface, or by the proportion it forms of the total cover, mass, or basal area of the community.

Dominant- (l) The plant species having the greatest canopy coverage; (2) the most numerous or vigorous species in a stand; (3) a taxon or group of taxa characterizing the community in its larger aspects, usually preponderant either numerically or in mass.

Drainage (hydrology)- Process of downward removal of water from soil, particularly by surface and subsurface runoff and artificially by ditching and other measures for hastening removal.

Drainage (pedology)- Frequency and duration of the periods when the soil is free of saturation or partial saturation. Commonly expressed in terms of seven subjective drainage classes extending from very poorly drained to excessively drained.

Very poorly drained- Drainage class where water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season.

Poorly drained- Drainage class where water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods.

Somewhat poorly drained- Drainage class where water is removed slowly enough that the soil is wet for significant periods during the growing season.

Moderate/y well drained- *Drainage* class where water is removed from the soil somewhat slowly during some periods. These soils are wet for only a short time during the growing season.

Well drained- Drainage class where water is removed from the soil readily, but not rapidly. Water is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods.

Somewhat excessively drained- Drainage class where water is removed from the soil rapidly. Many somewhat excessively drained soils are sand textured and rapidly permeable.

Excessively drained- Drainage class where water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, stony, or shallow.

Drift- (l) Any rock material such as boulders, till, gravel, sand, or silt and clay transported by a glacier and deposited by or from the ice or by water derived from melting of the ice: (2) snow lodged on the lee of a surface irregularity under the influence of wind.

Duff- Forest litter and other organic debris in various stages of decomposition on top of the mineral soil; typical of conifer forests in cool climates where the rate of decomposition is slow and litter accumulation exceeds decay.

Dwarf scrub- Vegetation made up of dwarf shrubs and averaging less than 0.2 meter (8 in) tall.

Dwarf shrub- A shrub or woody plant usually less than 0.2 meter (8 in) tall.

Dwarf tree forest- In Alaska, vegetation with 10 percent or more crown cover in dwarf trees that will not achieve heights of 3 meters (10 ft) or more at maturity; for example, some black spruce bogs.

Ecosystem- (l) Totality of an environment plus its included organisms, or habitat and community as an interacting unit; (2) a community, including all component organisms, together with the environment forming an interacting system. The fundamental unit in ecology.

Ecotone- A transition zone between two well-defined plant communities or units of vegetation.

Ecotype- Within a species, a race that is genetically adapted to a local habitat different from the habitat of other races of that species:

Edaphic- (adj.) Pertaining to the soil and particularly the influence of soil on organisms.

Edge- The more or less well-defined boundary between two or more elements in a landscape; for example, forest and grassland.

Emergent- Aquatic plant, usually rooted, that during part of its life cycle has portions above water; for example, cattail and bulrush.

Endemic- A taxon confined to a particular region and having a comparatively restricted distribution (usually a relatively small geographic area or an unusual or rare type of habitat).

Eolian soil material- Material accumulated through wind action. Commonly refers to sandy deposits in dunes or to silt (loess) in blankets on the surface.

Ephemeral- Short-lived existence, or occupying a site for a brief period.

Epiphyte- A plant using another living plant as a substratum (that is, growing upon another plant but deriving no sustenance from the supporting structure); for example, many mosses and lichens growing on trees.

Ericaceous- Refers to the heath family, Ericaceae; for example, blueberry.

Eutrophic- Literally, "well fed." Refers to habitats, particularly soils and water, rich in nutrients.

Even aged- A stand of trees with individuals that originated at nearly the same time and thus have essentially the same age. The maximum difference in age in an even-aged stand is usually 10 to 20 years.

Evergreen- Plants, or pertaining to plants, that remain green the year round, either by retaining at least some of their leaves at all times or by having green stems that carry on the principal photosynthetic functions.

Exotic- A plant or species not native to the region it is growing in; for example, clover in alpine tundra.

Exposure- (1) The openness of a site to weather conditions, particularly sun and wind; (2) the direction a slope faces.

Fauna- (l) The sum total of all species of animals living in a defined area at one time; (2) a collective term for all animal species in the same way that "vegetation" is a collective term for all plant communities.

Feathermoss- Common name for some species of mosses; for example, *Hylocomium splendens, Pltiurozium schreberi, Ptilium crista-castrensis,* and *Rhytidiadelphus trique trus.*

Fellfield- From the Danish *fjoeldmark,* or rock desert. A type of tundra ecosystem characterized by rather flat relief, very stony soil, and low, widely spaced vascular plants.

Fen- A general term for a mire (peat-forming ecosystem) with little or no *Sphagnum* spp. and with a source of water and minerals outside the limits of the mire. Fens, in comparison with bogs, are less acidic or even alkaline and mineral rich. Fens generally support a more varied vegetation, composed of: grasses, sedges, or reeds, than bogs do.

Eutrophic fen- Nutrient-rich fen with green sedges predominate and *Sphagnum* spp. are absent. Usually on sites with nutrient-rich ground water.

Forested fen-See swamp.

Mesotrophic fen- A moderately nutrient-poor fen where greyish-green sedges are predominant and *Sphagnum* spp. occur. With an increase in *Sphagnum* spp., it would become a bog.

Patterned fen- *A* mire (peat-forming ecosystem) characterized by low peat ridges alternating with parallel wet hollows, the pattern developing parallel to the contour (at right angles to water movement) on gentle slopes.

String fen- A patterned fen with long strings and flarks. (see bog, string bog).

Shrub fell- A type of mire (peat-forming ecosystem) usually flooded with slowly flowing water. Vegetated with low (less than 1.5 meters [5 ft] tall) erect shrubs and a generally open canopy. Trees may be present or absent. Sedge peat often is present.

Fertility, soil- The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, soil physical conditions, and other growth factors are favorable.

Fire cycle- The length of time necessary for an area equal to the entire area of interest to burn. The size of the area of interest must be clearly specified. Expressed as years per area. Synonym of fire rotation.

Fire effect- Any consequence, neutral, detrimental, or beneficial, resulting from a fire.

Fire frequency- The number of fires per unit of time in some designated area (which may be as small as a single point). The size of the area must be specified. Expressed as number of fires per unit of time per unit of area.

Fire interval- The number of years between two successive fires documented in a designated area (that is, the interval between two successive fire occurrences). The size of the area must be clearly specified. Unit of measurement is years. Synonym of fire-free interval and fire-return interval.

Fire regime- The type, intensity, size, and frequency of fires typical for a specific land area. The fire regime determines the scale of fire effects and the way fire influences an ecosystem.

Floating aquatic plant- Plant adapted to a floating aquatic existence, not rooted in soil; for example, duckweed and some algae.

Flood plain- A nearly level alluvial plain bordering a stream and subject to periodic flooding unless protected artificially.

Flooding- The temporary covering of the soil with water from overflowing streams, runoff from adjacent slopes, and exceptionally high tides.

Flora- A collective term for all plant species in the same way that “vegetation” is a collective term for all plant communities. Flora indicates what species are present; not abundance or spatial arrangement.

Floristic- Pertaining to the species composition of vegetation.

Foliage cover- See *cover.*

Foot slope- The inclined surface at the base of a hill; also, the toe of a hill.

Forb- An herbaceous plant other than a grass, sedge, or other grasslike plant.

Forest- (l) Plant community predominately of trees and other woody plants, growing more or less closely together; (2) in the Alaska vegetation classification, vegetation with at least 10 percent of the crown cover by trees (that is, single stemmed woody plants at least 3 meters [10 ft] in height at maturity).

Broadleaf forest- In the Alaska vegetation classification, forest vegetation in which 75 percent or more of the forest canopy is made up of broadleaf trees.

Closed forest- *A* community completely dominated by the tree stratum because of the closure of the crowns. In the Alaska vegetation classification, defined as having over 60 percent tree canopy coverage.

Conifer forest-- See *forest, needleleaf.*

Hardwood forest- *See forest, broadleaf.*

Mixed forest-- *(l)* A forest composed of two or more species of trees; (2) according the the Alaska vegetation classification, a forest composed of both needleleaf and broadleaf trees.

Needleleaf forest- **In** the Alaska vegetation classification, forest vegetation in which 75 percent or more of the forest canopy is made up of needleleaf trees.

Open boreal forest- The widespread forest within the subarctic zone between the tree line and closed boreal forest. Synonym of subarctic woodland, open woodland, and lichen-woodland.

Forest cover-All trees and other woody plants occupying the ground in a forest.

Forest floor- An inclusive term for deposited dead plant matter on the mineral soil surface in a forest. Includes lifter and unincorporated humus. *See duff.*

Forest type- A forest stand, community, or association essentially similar throughout its extent in composition and development under essentially similar conditions. Usually used in an abstract sense to mean both climax and seral species.

Forest-tundra- Characterized by a mosaic of forest communities, krummholz, tree islands, or trees growing along river and lake shores or in sheltered positions and a tundra vegetation on exposed ridges between the rivers and in xeric habitats.

Forest-tundra ecotone- A transition belt between the dense conifer forest and alpine or arctic tundra.

Formation- A continental-scale vegetation unit comprising all plant communities that resemble each other in appearance and in major features of their environment; for example, northern coniferous forest and tropical rain forest.

Frequency- (l) Number of recurring events in unit time (for example, forest fires per year); (2) the degree of uniformity with which individuals of a species are distributed in an area and, more specifically, a stand. Expressed as a percentage of plots (quadrats) of equal size in which a species occurs in a stand.

Fruticose- Shrubby, as in fruticose lichens; for example, *Cladonia rangiferina.*

Fuel- (l) Any combustible material that will support a forest or range fire; (2) dead and down woody material in a forest.

Glacial drift- Rock debris transported by a glacier and deposited either directly from the ice or from the melt water.

Glacial outwash- Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Glacial till- Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and stones transported and deposited by glacial ice.

Gradient- A more or less continuous change of some property in space. Gradients of environmental properties are ordinarily reflected in gradients of biota.

Graminoid- Grasslike in appearance with leaves mostly very narrow or linear.

Grass- A member of the family Gramineae and characterized by hollow stems that are circular in cross section and bladelike leaves arranged on the culm or stem in two ranks.

Grassland- A landscape in which the existing plant cover is dominated by grasses.

Gravel- Rounded or angular fragments of rock 2 millimeters to 7.5 centimeters (0.08-3 in) in diameter.

Groundwater- Water that moves downward from the upper soil layers into permanently saturated soil and geologic zones.

Growth form- The characteristic shape or appearance of a plant as a result of its development in response to environmental conditions within its genetic constitution.

Habitat- The natural abode of a plant or animal; refers to the kind of environment a plant or animal normally lives in as opposed to the range or geographical distribution.

Half-shrub- A perennial plant with a woody base whose annually produced stems die back each year; for example, *Artemisia frigida.*

Halophyte- A plant adapted to existence in a saline environment and more or less restricted to saline or alkaline soils or to sites influenced by salt water.

Halophytic- Refers to halophyte.

Hardwood- Generally, a colloquial term for trees having broad leaves, in contrast to the needleleaf conifers. Inaccurate, in that the wood of many conifers is harder than that of many "hardwoods."

Heath- Community of grasslike plants and shrubs of one or more of the heath families Ericaceae, Empetraceae, or Diapensiaceae found on infertile sites. Frequently found on bogs in Alaska.

Heathland- Landscape dominated by evergreen sclerophyllous shrubs growing on soils very low in plant nutrients. The vegetation always contains members of the heath families-Ericaceae, Empetraceae, and Diapensiaceae.

Herb- Flowering plant with no significant woody tissue above the ground; includes forbs and grasses.

Herbaceous-- In the Alaska vegetation classification, vegetation with 2 percent or more of the crown cover in vascular and nonvascular (mosses and lichens) plants and less than 10 percent of crown cover of woody plants.

Aquatic herbaceous- In the Alaska vegetation classification, vegetation in which there is a predominance of cover of floating or submerged plants growing in wafer. Can include mosses and algae as well as vascular plants. In this classification, emergent plants are not included in aquatic vegetation but are placed in the wet forb herbaceous and graminoid herbaceous units.

Bryoid herbaceous- In the Alaska vegetation classification, a category of vegetation in which the predominance of cover is in mosses or lichens.

Forb herbaceous- In the Alaska vegetation classification, herbaceous vegetation in which the predominance of cover in nongrasslike plants. This includes forbs, rushes, ferns, and horsetails.

Graminoid herbaceous- In the Alaska vegetation classification, herbaceous vegetation with the predominance of cover in grasses or sedges.

Herbland- Any landscape on which herbaceous species dominate the vegetation.

Holarctic- Occurring simultaneously in the northern parts of North America, Asia, and Europe. The botanical equivalent of this zoological term is circumboreal.

Horizon, soil-- A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes.

Humification- The process of decomposition whereby organic material is humified and becomes humus.

Hummock- A microtopographic elevated area on a raised bog, composed principally of hummock-forming species such as *Sphagnum fuscum, S. imbricatum,* and S. *flavicomans.*

Hummocky- Refers to a landscape of hillocks, separated by low sags, having sharply rounded tops and steep sides. Hummocky relief resembles rolling or undulating relief, but the tops of ridges are narrower and the sides are shorter and less even.

Hydrophyte- A plant usually found growing in wafer or in soil containing water well in excess of field capacity most of the time.

Hygrophyte- A plant that is more or less restricted to moist sites; for example, *Drosera rotundifolia.*

Ice lenses- segregated ground ice oriented more or less parallel to the ground surface.

Ice wedges- wedge-shaped vertical or inclined sheets of foliar ground ice that form in thermal contraction cracks in permafrost. Formation and active growth of wedges requires temperatures of -40 to -45°C (-40 to -50 ^{o}F) for creation of contraction cracks.

Importance- Density, basal area, cover, or frequency each could be interpreted as an “importance value” depending on the values the investigator considers most important for a particular species or community.

Indicator- A plant whose presence, abundance, or vigor is indicative of certain site conditions; for example, *Cassiope tetragona* on sites with late-melting snowbeds.

Indigenous-Native to the area; not introduced by man.

Karst- A limestone plateau marked by sinks, or karst holes, and solution channels interspersed with abrupt ridges. Not a single feature but a landscape.

Krummholz- Scrubby, stunted trees often forming a characteristic zone at the limit of tree growth in mountains.

Lacustrine deposit-Mineral material deposited in lake water and exposed when the water level lowers or the land raises.

Landscape- All the natural features, such as hills, forest, and water, that distinguish one part of Earth's surface from another.

Landslide- The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated.

Layer (vegetation)- A stuctural component of a community consisting of plants of about the same stature or height; for example, tree layer, shrub layer, herb layer, and moss layer.

Lichen-woodland- Subarctic forest in which the open ground between trees is covered with light-colored fruticose lichens; for example, *Cladonia rangiferina.*

Linear leaf- A leaf many times as long as wide and with essentially parallel sides at least in the middle portions.

Lithophyte- A plant growing on a rock; for example, lichens and mosses.

Lithosol- A young soil consisting mainly of partly weathered rock fragments or of nearly bare rock.

Litter- A surface layer on the forest floor of loose organic debris consisting of freshly fallen or slightly decomposed plant parts.

Littoral- That portion of the sea shore subject to alternate submergence and emergence by abnormal tides.

Liverwort-A small plant in the class Hepaticae, phylum Bryophyta, usually growing in moist places; for example, *Marchantia.*

Loam- Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt panicles, and less than 52 percent sand panicles.

Loess- Soil material transported and deposited by wind and consisting of predominantly silt-sized panicles.

Low moor- Type of fen composed of peat or muck soil, formed in eutrophic or mesotrophic waters (commonly a former lake) and, therefore, relatively rich in minerals and supporting a rich vegetation.

Lowland- A relative term for land lying along streams and flood plains.

Marine aquatic- Aquatic plant community types in ocean settings, either subtidal or intertidal, but low enough to be inundated at least once daily by high tides.

Marsh- (l) A periodically wet or continually flooded nonpeat-forming ecosystem where the surface is not deeply submerged and supports sedges, cattails, and rushes or other hygrophytic plants. Subclasses include freshwater and saltwater marshes. Less acid and less continuously flooded than a bog, often only intermittently flooded. (2) In Alaska, sites are characteristically flooded with 15 centimeters (6 in) or more of water; may have no standing water late in the summer but soils remain saturated. Vegetation usually is dominated by emergent herbaceous plants. Typical species are *Arctophila fulva, Scirpus* spp., *Equisetum fluviatile,* and *Eleocharis palustris.* Woody plants, lichens, and sphagnum are absent or rare.

Salt marsh-- Similar to a fresh marsh, but adjacent to the sea and inundated periodically (tidally or seasonally) with saline water.

Tidal marsh-- *low* marsh lands traversed by interlacing channels and sloughs and subject to tidal inundation. Usually the vegetation is composed of salt-tolerant (halophytic) grasses and sedges.

Meadow- Closed herbaceous vegetation, commonly in stands of limited extent. Often used to denote stands of grasses and sedges.

Brackish marsh meadow- Coastal flats and lower beach habitats regularly inundated by tides. Soils are mineral, sometimes overlain by a tough sod of roots and rhizomes or by shallow (up to 20 centimeters [8 in]) peat.

Fresh marsh meadow- Fresh or essentially fresh community types predominately on mineral soils or less than 30 centimeters (12 in) of peat. Where peat is present, it usually is sedge peat.

Sedge meadow- *A* vegetation unit (usually in wet situations) consisting of low grasslike plants belonging to Cyperaceae; for example, cottongrass.

***Wet* meadow-** In Alaska, sites characterized by saturated soils or by flooding to depths of less than 15 centimeters (6 in) and vegetation dominated by herbaceous species, usually graminoids. Moss cover varies but generally is low. Soils are mineral but may be overlain by a shallow organic layer.

Mesic- Refers to sites of habitats characterized by intermediate moisture conditions; that is, neither decidedly wet (hygric) nor decidedly dry (xeric).

Mesophyte- A plant whose normal habitat is neither very wet nor very dry; for example, paper birch.

Metamorphic rock- Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat and pressure. Nearly all such rocks are crystalline.

Microrelief- Small-scale local differences in topography, including mounds, swales, and pits that are only a few feet in diameter and height.

Microsere- A time sequence of communities, of small areal extent, that may be observed even in climax stands. Microseres involve such processes as the replacement of a large individual plant after it dies, the sequence of decomposers that follow each other in a unit of litter, and the development of vegetation on an abandoned ant nest.

Mineral soil- Soil that is mainly mineral material and low in organic material (usually less than 20 percent). Its bulk density is greater than that of organic soil.

Mire- General term embracing all peat-forming ecosystems described in English by other terms such as bog, fen, carr, muskeg, moor, and peatland. Does not include marshes because they are, by definition, nonpeat-forming and seasonally flooded. Mires are subdivided into fens and bogs by origin and chemistry of their respective water supplies.

Moisture, soil- The relative amount of moisture in the soil, usually applied to the A- and B-horizons and occasionally to the humic material.

Moor- (l) A term applied to any area of deep peat whether acid or alkaline (bog or fen); (2) in England, the term is applied to high-lying country covered with heather and other ericaceous dwarf shrubs, mainly *Vaccinium.*

Moor, string- See *fen, string* and *bog, string.*

Moraine- An accumulation of glacial drift built within a glaciated region by the direct action of glacial ice. Examples are lateral, terminal, and recessional moraines.

Moss- A plant in the class Musci of the phylum Bryophyta; usually, but not always, occurring in a wet habitat.

Moss peat- Peats composed generally of *Sphagnum* spp. It also includes peats having a high percentage of other constituents, such as sedge-moss peat, woodmoss peat, and moss-sedge peat.

Mottling, soil- Irregular spots of different soil colors that differ in number and size. Mottling generally indicates poor aeration and impeded drainage.

Muck- Black, well-decomposed organic material accumulated under conditions of imperfect drainage. Contains more mineral matter and is usually darker than peat, and the original plant parts are not recognizable.

Muskeg- A wet area usually moss-floored, characterized chiefly by an organic soil. Muskeg most often refers to a black spruce woodland with a thick mat of mosses (generally *Sphagnum* spp.) underlain by peat.

Needleleaf- Plant bearing stiff, linear, needlelike leaves, or vegetation composed of needleleaf plants; for example, *Picea glauca.*

Needleleaf deciduous- Needleleaf plant that loses its leaves and has bare stems seasonally; for example, *Larix laricina.*

Nets, nonsorted- Patterned ground with a mesh intermediate between that of a nonsorted circle and a nonsorted polygon, and with a nonsorted appearance due to absence of a border of stones, such as characterize a sorted net.

Nets, polygonal- Honeycomb patterns in the soils of arctic and alpine regions, with borders formed of relatively large stones or boulders and centers consisting of finer particles sorted by solifluction processes.

Nets, sorted- Patterned ground with a mesh intermediate between that of a sorted circle and a sorted polygon, and with a sot-fed appearance commonly due to a border of stones surrounding finer material.

Neutral soil- A soil having a pH value between 6.6 and 7.3.

Old-growth stand- Not synonymous with old-aged forest and must be recognized on the basis of stand characteristics rather than age of trees. Old-growth stands contain trees of wide range of sizes and ages and have a deep, multilayered canopy. They contain large standing dead snags and large down dead trees and other coarse woody debris.

Oligotrophic- (1) Describing bog formed of plants growing in waters poor in nutrients, as in a raised bog; (2) pertaining to water poorly supplied with the basic nutrients needed by plants.

Organic matter- The more or less decomposed material of the soil derived from organic sources, usually from plant remains. The term covers matter in all stages of decay.

Organic terrain- Tract of land having a surficial layer of living plant material (vegetation) and a sublayer of peat or fossilized plant detritus of any depth existing in association with various hydrological conditions and underlying mineral formations. Term used somewhat interchangeably with muskeg in Canada.

Outwash, glacial- Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by water originating mainly from the melting of glacial ice.

Outwash fan- Material deposited by fast-flowing, heavily loaded water whose velocity is suddenly reduced; for example, at the mouth of a gorge or ravine.

Outwash plain- A land form of mainly sandy- or coarse-textured material of glaciofluvial origin deposited gradually. An outwash plain commonly is smooth; where pitted, it generally is low in relief.

Overstory- The portion of the trees forming the upper canopy in a forest stand of more than one story.

Paludification- Literally, "swamping." Process of mire (peat-forming ecosystem) formation over previously forested land or grassland due to climatic or autogenic processes leading to waterlogging and anaeroby.

Parent material- (l) The great variety of unconsolidated, more or less chemically weathered organic and mineral material from which soil forms. Consolidated bedrock is not yet parent material by this definition. (2) The C-horizon of the soil.

Patterned ground- A collective term for the more or less symmetrical forms such as circles, polygons, nets, steps, and stripes that are characteristic of but not necessarily confined to ground that is subject to intensive frost action. Circles, polygons, and nets are most typically formed on level ground, and stripes and steps are found on slopes.

Peat- Layer consisting largely of organic residues originating under more or less water-saturated conditions through the incomplete decomposition of plant and animal constituents; results from anaerobic conditions, low temperatures, and other complex causes.

Amorphous granular peat- Descriptive term applied to one of the primary macroscopic elements of peat that is granular in nature but has no particular shape.

***Sedge* peat-** Peat composed of sedge species, primarily *Carex,* with *Juncus, Eriophorum,* and *Scirpus.* In some instances, sedge peat is so-termed because a unit proportion of peat is more than 50 percent sedge.

Sphagnum peat-Peat that develops from sphagnum mosses.

Peatland- A generic term including all types of peat-covered terrain. Many peatlands are a complex of bogs and fens, sometimes called a "mire complex." A loose synonym of muskeg and organic terrain.

Perennial- A plant that lives for 3 or more years.

Pergelic- A soil temperature regime that has mean annual soil temperatures of less than 0 ^{o}C (32 ^{o}F). Permafrost is present.

Periglacial- Refers to areas, conditions, processes, and deposits adjacent to the margin of a glacier.

Permafrost- Perennially frozen ground, or ground in which a temperature below 0 ^{o}C (32 ^{o}F) has existed continuously for 2 or more years. Permafrost is defined exclusively by temperature, and no moisture or ice need be present.

Active layer- The layer of ground above the permafrost that freezes and thaws each year.

Continuous permafrost- *A* zone of perennially frozen ground in which permafrost is present everywhere except under lakes and rivers that do not freeze to the bottom.

Discontinuous permafrost- *A* zone including numerous permafrost-free areas that progressively increase in size and area from north to south until the permafrost-free zone is reached.

Permafrost table- The upper surface of permafrost.

pH value-- A numerical designation of acidity and alkalinity in the soil, the negative logarithm of hydrogen-ion concentration. pH 7.0 is neutral; values above 7.0 indicate alkalinity and those below 7.0 indicate acidity.

Phase- Subdivision of a unit of vegetation representing a characteristic variation in species composition or abundance as caused by a change in environmental conditions.

Phenology- The study of the time of appearance of characteristic periodic events in the life cycle of organisms in nature and how these events are influenced by environmental factors, such as temperature, latitude, and elevation; for example, flowering and leaf-fall in plants.

Physiognomy-The general outward appearance of a plant community, determined by the life-form of the dominant species; for example, forest or scrub.

Physiography- Branch of physical science dealing with the physical features of Earth's surface and the description of the landscape.

Pingo- An Eskimo term for a perennial, conical-shaped ice-cored mound as much as 65 meters (213 ft) high and 1000 meters (3280 ft) in diameter. Generally found on the arctic slope, but open-system pingos also occur south of the Brooks Range.

Pioneer- Plant capable of invading bare sites and persisting there (that is, colonizing, until replaced by other species as succession proceeds); for example, *Stereocaulon* spp. and *Epilobium* spp.

Pleistocene- The geological epoch preceding the Recent in the Quaternary period of the Cenozoic era; began about 1 million years ago and lasted for about 1 million years.

Polygons- One of the forms of patterned ground caused by intensive frost action.

High-centered polygons- Polygons bordered by eroding ice wedges that have permitted the polygon margin to collapse info thermal contraction cracks. Generally, a later developmental stage of ice-wedge polygon that is associated with improved drainage.

Ice wedge polygons- Large-scale polygonal features commonly outlined by shallow trenches underlain by ice wedges.

Low-centered polygons- Polygons bordered by active ice wedges, which are covered by low ridges of peat that cause the margins 'of the polygon to be higher than the surface of the center.

Population- A group of individual plants of the same species in a common location or habitat. ,

Presence- The occurrence of a taxon in a vegetation (association or stand) table. Plots do not have to be of equal size.

Profile, soil- A vertical section of the soil extending through all its horizons and info the parent material.

Prominence- The degree to which a species characterizes or dominates the community, or conspicuously impresses the observer, regardless of any numerical abundance.

Quadrat- A small, clearly demarcated plot or sample area of known size where ecological observations are made. Quadrats may be square, rectangular, or circular.

Quaternary- The latest geologic period of the Cenozoic era, which began about 1 million years ago and includes the Recent and Pleistocene epoch.

Range- That portion of Earth's surface enclosed by a line drawn about the outermost limits of the distribution of a taxon. A species does not occupy all the area within ifs range owing to differences in soil, topography, and so forth.

Raw humus- A loose term for any appreciable accumulation of slightly to moderately decomposed organic matter on the surface of a mineral soil.

Regeneration- Renewal of a tree crop, whether by natural or artificial means; also the young crop itself.

Regolith- The unconsolidated mantle of weathered rock and soil material overlying the solid rock of the earth.

Regosol- Young soils located on deep, unconsolidated soft mineral deposits; for example, sand dunes and loess.

Relief- Variations in elevation of Earth's surface.

Revegetation- The reestablishment or improvement of a plant cover. May take place naturally through reproductive processes of the existing flora or be induced by humans through seeding or transplanting.

Riparian- Pertaining to streamside environment.

Saline- Pertaining to soil or water containing, sufficient soluble salts to interfere with normal plant growth.

Sand- As a soil separate, individual rock or mineral fragments from 0.05 to 2.0 millimeters (0.002 to 0.08 in) in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and no more than 10 percent clay.

Sandstone- Sedimentary rock containing dominantly sand-size particles.

Saprophyte- A plant incapable of synthesizing its nutrient requirements from inorganic sources and that obtains food from dead or decaying organic material.

Scree- Sheet of coarse rock debris mantling a mountain slope. Whereas talus is an accumulation of rock material at the base of a cliff, scree includes loose material lying on slopes without cliffs.

Scrub- (l) Woody vegetation predominantly of shrubs, ranging between 0.2 meter (8 in) and 3 meters (10 ft) in height; (2) in the Alaska vegetation classification, treeless vegetation (or with. less than 10 percent tree crowns) and with shrubs comprising 25 percent or more of the absolute crown cover.

Dwarf shrub scrub- In the Alaska vegetation classification, scrub vegetation that is less than 20 centimeters (8 in) tall and with 25 percent or more crown cover in dwarf shrubs. If tall or low shrubs are present, their combined cover should be less than
25 percent.

Dwarf free scrub- *In* the Alaska vegetation classification, vegetation with 10 percent or more crown cover in dwarf trees that will not achieve heights of 3 meters (10 ft) at maturity on those sites.

Low shrub scrub- In the Alaska vegetation classification, scrub vegetation less than 1.5 meters (5 ft) in height and with 25 percent or more crown cover in shrubs.

Scrubland- In the Alaska vegetation classification, landscape occupied by scrub vegetation or capable of growing shrubs.

Sedge- A plant in Cyperaceae, grasslike in appearance, but with solid stems that are triangular in cross section.

Sedimentary rock-Rock made of panicles deposited from suspension in water. The chief types of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate.

Seral- Nonclimax; that is, a species or a community demonstrably susceptible to replacement by another species or community, usually within a few decades or a few centuries at most.

Sere- A sequence of plant communities that follow one another in an ecological succession on the same habitat from a pioneer stage to, and terminate in, a particular kind of stable (climax) association.

Series- Term for a group of habitat types having the same tree species dominant at climax; for example, white spruce series or black spruce series.

Shrub-A woody perennial plant differing from a tree by its low stature and by generally producing several basal stems instead of a single bole, and from a perennial herb by its persistent and woody stem(s).

Dwarf shrub- shrub less than 20 centimeters (8 in) tall.

Low shrub- In the Alaska vegetation classification, a shrub between 20 centimeters (8 in) and 1.5 meters (5 ft) in height.

Tall shrub- *A* shrub more than 1.5 meters (5 ft) in height.

Shrubland- A landscape occupied by a scrub vegetation and probably not capable of growing trees.

Silt- As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter [0.0005 in]) to the lower limit of very fine sand (0.05 millimeter [0.002 in]). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site- An area considered in terms of its environment and ecological factors with reference to capacity to produce a particular vegetation; the combination of biotic, climatic, and soil conditions of an area.

Slough- A former stream channel now containing standing water, at least seasonally.

Snag- Standing dead tree from which the leaves and most of the branches have fallen.

Snowbed- Area where snow accumulates each winter and melts late each growing season; for example, cornice on the lee of a ridge.

Snowfield- An area or mass of snow that remains throughout much of the summer.

Softwood- In common usage, the wood of a coniferous tree. Inaccurate, in that the wood of many conifers is harder than that of many “hardwoods”; for example, spruce is harder than aspen.

Soil- The unconsolidated mineral and organic material on the immediate surface of Earth that serves as a natural medium for the growth of land plants.

Soil reaction- The degree of acidity or alkalinity of a soil expressed in pH values.

Soil texture- A property defined by particle size distribution and thus dependent on relative proportions of sand, silt, and clay panicles in a mass of soil.

Coarse-textured soil- Sand or loamy sand.

Moderately coarse-textured soil- Sandy loam and fine sandy loam.

Medium-textured soil- Very fine sandy loam, loam, silt loam, or silt.

Moderately fine-textured soil- Clay loam, sandy clay loam, and silty clay loam.

Fine-textured soil- Sandy clay, silty clay, and clay.

Solifluction- Downslope movement ("flowing soil") of earth materials resulting from frost action characteristic of areas with cold arctic or alpine climate.

Solum- The upper and most weathered part of a soil profile, above the parent material, in which processes of soil formation are active. The solum in mature soils consists of the A- and B-horizons.

Sphagnum moss- Moss plants of the genus *Sphagnum.*

Spruce bog- A loosely applied term describing confined areas of organic terrain where coniferous trees are a prominent feature of the vegetational cover.

Stand- A concrete (vs. abstract) aggregation of plants of more or less similar uniformity in physiognomy, species composition, spatial arrangement, and condition to distinguish it from adjacent communities. Concrete stands, which we sample or measure, are aggregated into abstract communities, and communities are further abstracted into a general vegetation.

Steppe- Temperate zone vegetation dominated by grasses and occurring in climates where zonal soils are too dry to support trees. Open grass or other herbaceous vegetation, the plants or tufts discrete but averaging less than their diameters apart.

Stones- Rock fragments 25 to 60 centimeters (10 to 24 in) in diameter.

Stone stripes-Patterned ground with bands of fine rock debris that alternate with channels filled with coarse rock fragments and are oriented parallel to the direction of the steepest slopes.

Stony- Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Strand- That portion of the shore between high and low water on beaches, spits, reefs, and so forth.

Stratum (vegetation)- A horizontal layer in a community in which the plants are about the same height.

Structure (soil)- The arrangement of primary soil particles into compound panicles or aggregates that are separated from adjoining aggregates.

Structure (vegetation)- (l) The spatial distribution pattern of life forms in a plant community, especially with regard to their height, abundance, or coverage within the individual layers; (2) the three components of vegetation structure are (a) vertical structure (stratification into layers), (b) horizontal structure (spatial distribution of individuals and species populations), and (c) quantitative structure (abundance of each species).

Subalpine- The first distinctive type of vegetation, usually open forest, below the alpine tundra.

Subarctic- Pertaining to regions immediately outside the Arctic Circle. Often interpreted as constituting a biotic transition belt (the forest-tundra ecotone) between the treeless arctic zone and the forested boreal zone.

Subarctic forest- The northern part of the boreal forest, characterized by open stands of small conifers, chiefly black spruce, with abundant lichens on the ground.

Subarctic woodland- See *forest, open boreal.*

Submerged aquatic plant- Plant adapted to totally submerged aquatic existence or with only leaves floating.

Subsoil- Technically, the B-horizon; roughly, the part of the solum below plow depth.

Substratum- The soil or other material that plants are rooted in or attached to.

Succession- The gradual replacement of one community of plants by another; the sequence of communities being termed a sere and each community a seral (successional) stage. The endpoint of succession is a stable, climax community.

Primary succession- Plant succession on newly formed soils or on surfaces exposed for the first time that have never borne vegetation.

Secondary succession- Plant succession subsequent to the destruction of all or part of the original vegetation on a site.

Succulent- Having the stems or leaves conspicuously fleshy.

Surface soil- Commonly refers to the top horizon in the soil profile (generally the A-horizon).

Swale- A moist or marshy depression, particularly in a grassland or prairie.

Swamp- In the Alaska vegetation classification, wetland sites dominated by tall shrubs and occasional trees. Standing or flowing water usually is present. Although peat generally is absent, soils may be high in organic matter content. A wooded fen.

Synecology- The study of plant communities and their environmental relations.

Taiga- A Russian term meaning “land of little sticks,” and originally applied to the open conifer lichen woodland between the boreal conifer forest and the tundra. This term often is used more broadly to denote the northern portion of the boreal forest.

Talus- In polar and arid temperate climates, the debris from rock falls accumulates at the foot of cliffs and steep slopes. The sloping heap of rock fragments is termed “talus,” from the French term for slope.

Taxon- A neutral term for a taxonomic group of any rank, such as subspecies, species, or genus.

Temperate- Climates with regular winter seasons of freezing weather, alternating with summer seasons that either are hot or are warm but of long duration.

Terrace- An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is infrequently subject to overflow.

Thermokarst- A permafrost-related landscape characterized by a peculiar topography of pits, hummocks, depressions, and small ponds caused by the melting of ground ice and the settling or caving of the ground surface.

Tidal- Refers to plants or vegetation within reach of the influence of tides.

Tidal marsh- Low marshlands traversed by interlacing channels and sloughs and subject to tidal inundation. Usually the vegetation is composed of salt-tolerant grasses and sedges.

Till- An unstratified, nonsorted deposit of gravel, boulders, sand and finer materials that has been transported and laid down by glacial ice with little or no transportation or sorting by water.

Till plain- An extensive flat-to-undulating area underlain by glacial till.

Timberline- Some consider the upper edge of continuous forest to be timberline; others recognize timberline as the altitude of the highest tree or a midpoint between these extremes.

Tolerance- The relative ability of a plant species to survive and develop under a deficiency of an essential growth requirement, such as light, moisture, or nutrient supply.

Tree- A woody perennial plant, typically large (a mature height of at least 3 meters [10 feet]) and with a single well-defined stem and a definite crown shape.

Tree line- A loose term for the limit beyond which trees cannot or do not occur. Tree line is more generally used to refer to the altitudinal boundary, and the term "tree limit" is used for the latitudinal boundary.

Tree, dwarf- In the Alaska vegetation classification, a plant species that would, under normal conditions, be a tree 'but which will not achieve a height of 3 meters (10 ft) on the site where found; for example black spruce on bogs or near treeline.

Tundra- A cold-climate landscape having a vegetation without trees. The absence of trees is caused by a complex of conditions that ultimately is related to regional climate. This regional aspect distinguishes tundra from treeless bogs where low edaphic extremes prevent tree growth in areas within a generally forested region.

Alpine tundra- That portion of the landscape above the upper limit of tree growth in the higher mountain regions that supports a plant cover of dwarf shrubs and herbs.

Dwarf shrub scrub tundra- *A* tundra landscape (beyond the limits of tree growth) with a dwarf shrub scrub vegetation.

Herbaceous tundra- *A* tundra landscape (beyond the limits of tree growth) with an herbaceous vegetation.

Mat and cushion tundra- *A* tundra landscape (beyond the limits of tree growth) with a vegetation composed of mat and cushion plants.

Sedge-grass tundra- *A* tundra landscape (beyond the limits of tree growth) with an herbaceous vegetation of nontussock-forming sedges and grasses.

Shrub tundra- A tundra landscape (beyond the limits of tree growth) with a scrub vegetation.

Tussock tundra- A tundra landscape (beyond the limits of tree growth) with an herbaceous vegetation of tussock-forming plants, particularly *Eriophorum* spp.

Tussock- A plant form that is tufted and bears many stems arising as a large, dense cluster from the crown.

Type- A kind of vegetation; for example, cover type, community-type, or forest type.

Cover type- A descriptive term used to group stands similar in composition and development, by which they may be differentiated from other groups of stands. It suggests repetition of the same character under similar conditions.

Undergrowth- A loose term generally meaning shrubs and herbs growing under a forest canopy.

Understory- That portion of the trees in a stand below the upper crown cover or overstory. Also commonly applied to shrubs and herbs growing under a forest or shrub canopy.

Uneven-aged- A stand of trees in which the individuals are of considerably different ages but are not all ages.

Upland- Land at higher elevation, in general, than the. alluvial plain or stream terrace; land above the lowlands along streams.

Vascular plant- Ferh or seed plant having an internal system of vascular tissue for transport of food (via phloem) and water (via xylem).

Vegetation- (l) The mosaic of plant communities in the landscape; (2) plants in general, or the sum total of plant life in an area.

Actual vegetation- The currently existing vegetation mosaic of an area; the vegetation actually, existing at the time of observation, regardless of the character, condition, and stability of its component communities.

Climax vegetation- The final, stable community in an ecological succession that is able to reproduce itself indefinitely under existing climatic conditions.

Original vegetation- Exists in a landscape before European influence affects it significantly.

Potential natural vegetation- The climax vegetation, that would develop if human influence were removed.

Vegetation type- A kind of vegetation, or the kind of community of any size, rank, or stage of succession.

Vegetation zone- The vegetation cover found in a specified geographic region or zone having a uniform macroclimate.

Vegetative cover- More properly called plant cover, vegetal cover, or vegetational cover.

Water table- The upper limit of the soil or underlying rock material that is wholly saturated with water.

Perched water table- The surface of a local zone of saturation held above the main body of ground water by an impermeable layer or stratum (for example, clay or permafrost) and separated from the main body of ground water by an unsaturated zone.

Waterlogged- Saturated with water. Replacement of most of the soil air by water.

Watershed- An entire drainage basin including all living and nonliving components of the system.

Wetland- Lands where saturation with water is the dominant factor in determining the nature of soil development and the types of plant and animal communities living in the area.

Wet meadow- These sites are characterized by saturated soils or by flooding to depths of less than 15 centimeters (6 in). The vegetation is dominated by herbaceous species, usually by graminoids. Moss cover varies but generally is low. Soils are mineral but may be overlain by a shallow organic layer.

Woodland- In the Alaska vegetation classification, forest vegetation with 10 to 25 percent crown cover by the tree crowns.

Broadleaf woodand- In the Alaska vegetation classification, a broadleaf forest vegetation with 10 to 25 percent crown cover of the tree crowns.

Conifer woodland- *See woodland, needleleaf.*

Lichen woodland- *See forest, open boreal.*

Mixed woodland- In the Alaska vegetation classification, a mixed broadleaf and needleleaf forest vegetation with 10 to 25 percent crown cover by the tree crowns.

Needleleaf woodland- In the Alaska vegetation classification, a needleleaf vegetation with 10 to 25 percent crown cover by the tree crowns.

Xeric- Refers to a dry habitat or site

Xerophyte- A plant capable of surviving periods of prolonged moisture deficiency. A plant that grows on dry sites.

Zonal- In Russian geobotany, term applied to vegetation unit that reflects a close relation to current climatic conditions of a large region on soils with nonextreme properties. Zonal plant community corresponds more or less to climatic climax community.

Zone- An area characterized by similar flora or fauna; a belt or area that certain species are limited to.

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The Alaska vegetation classification presented here is a comprehensive, statewide system that has been under development since 1976. The classification is based, as much as possible, on the characteristics of the vegetation itself and is designed to categorize existing vegetation, not potential vegetation. A hierarchical system with five levels of resolution is used for classifying Alaska vegetation. The system, an agglomerative one, starts with 888 known Alaska plant communities, which are listed and referenced. At the broadest level of resolution, the system contains three formations-forest, scrub, and herbaceous vegetation. In addition to the classification, this report contains a key to levels I, II, and Ill; complete descriptions of all level IV units: and a glossary of terms used.

Keywords: Vegetation, classification, Alaska, tundra, boreal forest, coastal forest, plant communities.

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