GLACIER BAY NATIONAL PARK AND PRESERVE
VASCULAR PLANT INVENTORY
FINAL TECHNICAL REPORT

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National Park Service Alaska Region
Inventory & Monitoring Program
NPS Report :

Revised September 2004

Cooperative Agreement No. 1443CA991000013

Funding Source: National Park Service, Inventory & Monitoring Program

ABSTRACT

In 2001 and 2003 the Alaska Natural Heritage Program (AKNHP) conducted vascular plant field inventories in Glacier Bay National Park and Preserve in accordance with a cooperative agreement with the National Park Service. The primary goal was to document greater than 90% of the vascular plant species expected to occur within the park and significantly improve our understanding of current species distributions. The inventory targeted diverse habitat types and poorly-sampled areas. The AKNHP staff visited eight diverse ecogeographic regions and sampled intensively within these regions from late June to mid-August, 2001 and late June to early July in 2003. A total of 555 specimens were collected, recorded, pressed, and curated. Of the 333 individual taxa, 172 are new records for the park and an additional 43 represent verifications of previously unverified reports. A number of finds were significant range extensions or taxa of conservation concern. Collections were made of four globally restricted species: *Botrychium ascendens* (G2G3-S2 AKNHP rank), *Platanthera chorisiana* (G3-S3), *Eleocharis kamtschatica* (G4-S2S3), and *Salix setchelliana* (G4-S3). A number of collections were made of species which are very rare in Alaska, but more widespread in western North America, such as *Agoseris aurantiaca*, *A. glauca*, *Carex interior*, *Cypripedium montanum*, *Piperia unalascensis*, and *Rorippa curvisiliqua*. Two species were significant range extensions; *Festuca saximontana* is a grass of northern Canada and eastern interior Alaska, which was located along the Alsek River, ca. 200 km to the south of its known distribution; *Artemisia furcata* is a wormwood of mountains in southern Yukon and central and northern Alaska that was collected in an alpine habitat along the Alsek River, ca. 200 km to the south of its known distribution. Two introduced exotic plants, *Taraxacum officinale* ssp. *officinale* and *Lupinus polyphyllus* were collected in Dry Bay.

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EXECUTIVE SUMMARY

The Inventory and Monitoring Program (I&M) of the National Park Service supported vascular plant inventories to document the occurrence, distribution, and relative abundance of plants occurring in the Southeast Alaska Park Network. The Southeast Alaska Park Network includes Sitka National Historical Park (SITK), Klondike Gold Rush National Historical Park (KLGO), and Glacier Bay National Park and Preserve (GLBA). The inventory was developed to provide baseline information for future monitoring and management of natural resources within the park network. In 2001, 2002, and 2003 the University of Alaska Anchorage (UAA), Alaska Natural Heritage Program (AKNHP) conducted field inventories in SITK, KLGO, and GLBA under Cooperative Agreement No. 1443CA991000013, Modifications 18 and 22. The primary goal was to document 90% or more of the vascular plant species expected to occur within the parks and significantly improve our understanding of current species distributions. The inventories targeted diverse habitat types and poorly sampled areas. This report covers inventories in Glacier Bay National Park and Preserve. Discussions of inventories in the other Southeast Alaska units are covered in separate reports (Carlson et al. 2004, Lipkin et al. in prep.).

Following an analysis of previous floristic surveys, we noted that most collections were from late seral stages at low elevations in Glacier Bay proper, nearest to Icy Strait, and extending to the more recently deglaciated Muir Inlet. Sporatic collections were noted from the West Arm, Dundas Bay/Cape Spencer, and the outer coast at Lituya Bay and Dry Bay. Large ecogeographic areas had not been inventoried, and after discussions with National Park Service personnel, private consultants, and the Alaska Plant Inventory Working Group, gaps were identified and florisitic sampling areas targeted. Floristic gaps included wetlands, alpine and subalpine communities, avalanche chutes, talus slopes, dry rocky cliffs, nunataks, the Alsek River corridor, the Dry Bay forelands, and periglacial communities. Increasing our understanding of plant communities receiving heavy impacts from backcountry use, exotic species, and potential threats to natural communities were also identified as priorities. This information was taken into account when identifying sites to inventory. Eight floristic regions were outlined for study prior to the 2001 field season. The sites included: coastal and alpine flora of the Fairweather Range, riverine and alpine flora of the Alsek River Valley, Cape Spencer, Dundas River flats, Salmon River Hills, Adams Inlet, Tarr Inlet, and the Dry Bay Forelands. In 2001, we visited these regions in a project combining vegetation landcover mapping and botanical survey initiatives (see Boggs et al. in prep). There were four regions where 2001 sampling was relatively weak, so supplemental floristic work in 2003 was directed towards filling in gaps in these locations or other locations where there was a high probability of encountering plant taxa new to the park. In 2003 we attempted to visit two areas that had high diversity of lithologies, elevations, and climates, but had been poorly sampled historically and in 2001; these were the Alsek River corridor and calcareous outcrops along Excursion Ridge. We were unable to access Excursion Ridge due to inclement weather.

While at the remote collection regions, techniques of inventory involved hiking to as many habitat types and geographic areas as possible and collecting specimens that were known to be new records or considered significant. Upon collection of specimens, data were gathered on site characteristics, including latitude and longitude to associated species and soil conditions. Plants were then pressed and dried and catalogued with the Alaska Natural Heritage Program. Final taxonomic determinations and herbarium mounting were conducted by the University of Alaska Fairbanks Museum.

A total of 555 specimens were collected, recorded, pressed, and curated. Duplicate or triplicate sheets exist for many of the specimens. Roughly 300 individual taxa are represented and 172 are new records for the park (an additional 43 are taxa that were previously reported but unverified). A number of finds were ecologically significant or taxa of conservation concern. Two species were significant range extensions; *Festuca saximontana* and *Artemisia furcata* are plants of northern Canada and eastern interior Alaska that were located along the Alsek River about 200 km to the south of their known ranges. Collections were made of a number of globally restricted species: *Botrychium ascendens* (G2G3-S2 AKNHP rank), *Platanthera chorisiana* (G3-S3), *Eleocharis kamtschatica* (G4-S2S3), and *Salix setchelliana* (G4-S3). Additionally, collections were made of species that are very rare in Alaska, but are more widespread in western North America. These include: *Agoseris aurantiaca*, *A. glauca*, *Carex interior*, *Cypripedium montanum*, *Piperia unalascensis*, and *Rorippa curvisiliqua*.

Key Words –
Glacier Bay National Park and Preserve, inventory, vascular plants, rare plants

INTRODUCTION

An Inventory and Monitoring (I&M) Program for the National Park Service (NPS) was established by the US Congress in 1992. The goal of NPS and the I&M program is to establish baseline information and long-term trends of natural resources in the parks. Biological inventories were conducted to establish data to be used in future monitoring programs, make management decisions, conduct research, and educate the public. To meet these objectives, NPS established three program goals:

- Document at least 90 percent of the species of vertebrates and vascular plants expected to occur in the park,
- Describe the distribution and abundance of species of special concern (e.g., rare species or exotics), and
- Provide information necessary to establish a monitoring strategy, with special reference to particular threats and resource issues within each park.

The Alaska Natural Heritage Program (AKNHP) was contracted to conduct the vascular plant inventory component of the I&M program of the Southeast Alaska Network (SEAN), which includes Sitka National Historical Park (SITK), Klondike Gold Rush National Historical Park (KLGO), and Glacier Bay National Park and Preserve (GLBA). In 2001 three AKNHP botanists and several NPS ecologists inventoried the vascular flora of Glacier Bay, and in 2002 AKNHP botanists inventoried the floras of Sitka and Klondike Gold Rush National Historical Parks. In 2003, one to two AKNHP botanists visited specific regions of Glacier Bay and Klondike Gold Rush to complete vascular plant inventories. NPS biologists and ecologists aided in all floristic inventories. The following report outlines pertinent information from the Glacier Bay National Park and Preserve inventory, including the regions inventoried, methods employed, the flora encountered, and a discussion of the importance of those finds.

Ecological and Geological Background

Glacier Bay National Park and Preserve is an extensive, geologically young and dynamic glacial fjord system backed by high coastal mountains in northern Southeast Alaska (see Nowacki et al. 2001 for a discussion of geology and ecological context). The park represents the most dramatic documented large-scale glacial retreat in the world and provides unparalleled opportunities for

scientific study of tidewater glaciers and ecosystem development. Originally established in 1925, today's 3.3 million-acre park encompasses the largest marine area managed by the NPS. Glacier Bay National Park and Preserve is designated an International Biosphere Reserve and is part of an International World Heritage Site that also includes Wrangell-St Elias National Park and Preserve, Yukon Territory's Kluane National Park, and British Columbia's Tatshenshini-Alsek Parks.

The park's highly complex and dynamic geologic foundation supports an extensive and diverse northern Pacific coastal biome that experiences a relatively moderate, wet climate. Steep, rugged mountain peaks up to 4,500 m elevation and scoured, rock-strewn valleys exemplify recent glacial activity. Surface ages range from zero years at the margins of retreating glaciers to many thousands of years in areas that escaped the Wisconsin glaciation. The ages of landscapes are also represented in various stages of biological community development (both terrestrial and aquatic). On land, these vary from periglacial barrens to mature spruce-hemlock forest and peatlands. The park has 2,000 km of marine coastline and 250,000 hectares of marine waters (20,000 of which are protected "inside" waters of Glacier Bay proper). A wide variety of habitat types supports pelagic and benthic biotic assemblages ranging from the intertidal to depths exceeding 420 m.

This diversity and dynamism of habitats is reflected in the park's fauna. Humpback whales, harbor seals, sea otters, and a number of other marine mammals inhabit the marine waters, along with hundreds of fish species and thousands of invertebrates. A diverse assemblage of migratory and resident seabirds, shorebirds, and waterfowl is present. The terrestrial avifauna represents a full array of northern southeast Alaska species. Trout, salmon, and char inhabit the park's streams and lakes. Bears, wolves, moose, mountain goats, porcupines, red squirrels, several weasel species, and a variety of shrews, microtine rodents, and other small mammals characterize the terrestrial mammalian fauna. The lands now encompassed in the park have been important subsistence and village sites of the Yakutat and Hoonah Tlingits for many centuries (for more discussion, see Catton 1997).

Management Efforts and Issues

Resource managers of SEAN units have had little opportunity to obtain baseline information due to the ruggedness of the units and large size and remoteness of GLBA. In addition, earlier scientific research has been stymied by the unavailability of landcover and habitat maps. Clear data gaps exist for vascular plants as well as other taxa. Thus, the I&M Program represents the first step to gather resource information on plant and animal species. These data will assist land managers in developing and improving their management activities and programs.

To determine the status of previously collected inventory data in SEAN units, the AKNHP was contracted to accumulate and verify historical and predicted species occurrences for each park. This involved synthesizing information from a broad range of sources. Ultimately, a list of species verified to occur in the units along with a list of species not verified but expected to occur.

In addition to documenting greater than 90% of vascular plants, the I&M Program attempts to obtain greater baseline information on the presence, absence, and distribution of species of special concern. For plants, the species of concern relate to threatened, endangered, rare, and exotic species.

METHODS AND MATERIALS

The AKNHP's vascular plant inventory in Glacier Bay National Park and Preserve occurred from late June to mid-August, 2001 and again in late June to early July 2003. Compilation of the expected taxa list, site selection, and sampling design proceeded field work and was initiated in January of 2001.

Expected and Known Taxa

To gauge progress toward achieving 90% documentation of the expected flora, an informed list of known and probable taxa was first required. Plant collections from the herbarium of the University of Alaska Museum (ALA) and from the herbaria of the various park units (ANCS+ database) were databased along with selected collections from other herbaria, observations, and floristic lists from published and unpublished literature. Collections from ALA were verified for both taxonomic identification and geographic location. Collections from ANCS+ were largely unverified by floristic experts for both taxon and geographic location. The records were used by AKNHP to develop lists of taxa known from or expected to occur in the park units. Taxa that were known only from unverified collections or from observations or literature citations were recorded as "Unconfirmed."

Compiling the expected species list for areas that are poorly known is replete with difficulties. We included documented taxa that occurred within 50 km of the park units. This is a very rough approximation of taxa actually present in the park. Even after revisions were made (based on likely habitats and geography) the list undoubtedly omits taxa in the units and includes taxa that are not present. Taxa known from within 50 km of the park boundary, or that were expected to occur in the park for other reasons, were recorded as "Probably Present." In the Recommendations section, we suggest the removal and addition of individual taxa. Using these criteria we initially determined that the percentage of the total expected flora known to be present in the park was 65%. This initial analysis did not factor in the presence of taxonomic synonyms.

For hundreds of years botanists have tried to create natural classifications that are stable. However, ideas about taxonomic relationships are continually being reevaluated and often the same biological entity is described by different authors and given different names. Thus, the biological names are in a constant state of flux. This nomenclatural confusion has been identified as a research priority that is fundamental to ecosystem management and biodiversity conservation. This primary need, noted by the White House on Biodiversity and Ecosystem Dynamics Subcommittee, requires improvements in the organization of, and access to, standardized nomenclature. ITIS (originally referred to as the Interagency Taxonomic Information System: http://www.itis.usda.gov/) was designed to fulfill these requirements.

We used the standardized nomenclature of ITIS to eliminate all taxa that were recorded more than once. For example, there is one currently accepted name for Sitka alder, *Alnus viridis* ssp. *sinuata*. However, the unaccepted synonyms *A. crispa* ssp. *sinuata* and *A. sinuata* were also present on the list, as well as *A. crispa* (*Alnus crispa* is a synonym for *A. viridis* ssp. *crispa*, a taxon restricted to eastern North America). We reanalyzed the list to remove the large number of synonyms that artificially inflate the diversity in the park. Synonyms were eliminated from the “probably present” list if found on the “unconfirmed” list. If synonyms were found on the “present” list, then synonyms were removed from both the “probably present” and “unconfirmed” lists.

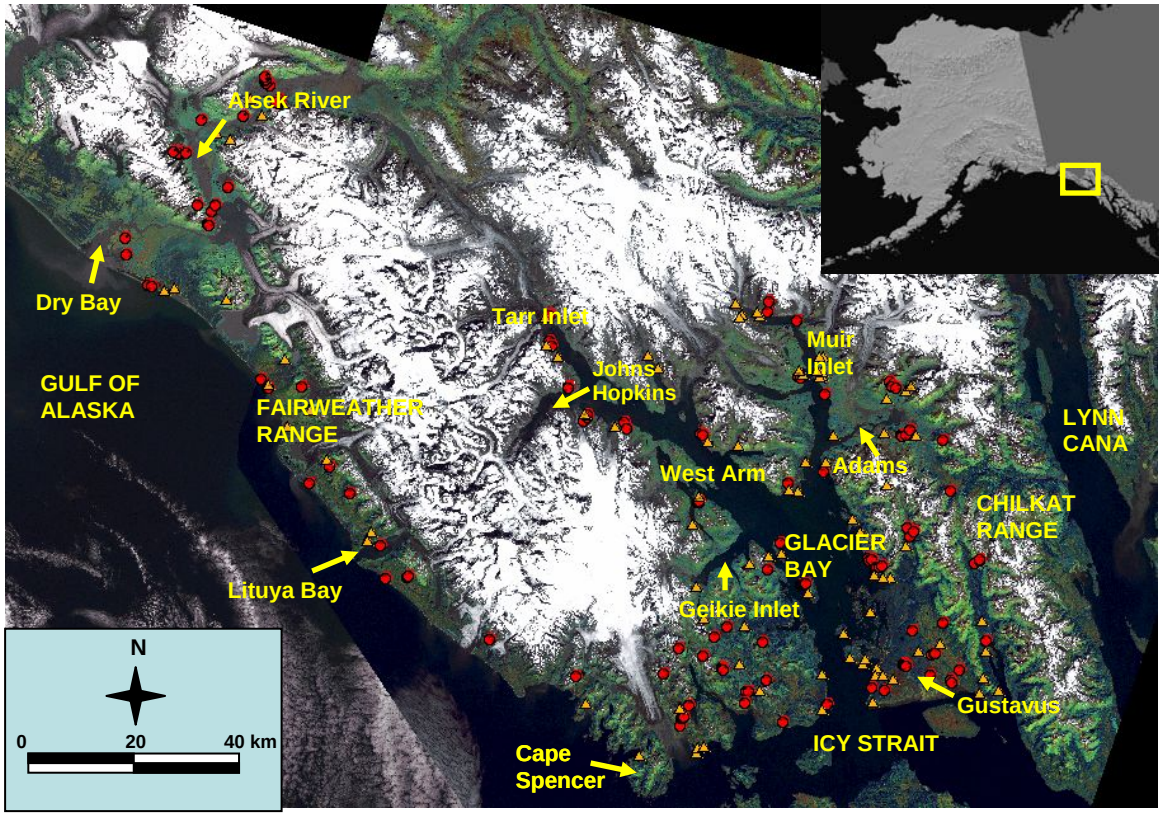
After synonym removal, the number of taxa expected to occur in GLBA dropped from 944 to 625. Of the 625 taxa, 266 were listed as "present." A total of 194 were listed as "probably present," and 165 were listed as "unconfirmed." This indicates that 69% of the expected flora was documented prior to AKNHP fieldwork. ITIS names are used in this document, with names used in Hultén (1968) included parenthetically for commonly encountered species.

Floristic History of Glacier Bay National Park and Preserve

Over 260 vascular plant taxa were reliably documented by collections from GLBA prior to this study. Additional taxa are known from unverified collections and observations in literature and field notes. The earliest botanical collections were made in 1874 by William H. Dall of the United States Coast Survey and Trevor Kincaid of the Harriman Expedition (Fig. 1). In the early to mid-1900s, more extensive collections were made by William S. Cooper, who was studying plant succession (Cooper 1923). Cooper's studies were continued in the 1930's and 1940's by Lawrence (1951a, 1951b, 1953, 1958, 1979), Anderson, and others. Since the 1950's, references that contain species information include: Bormann and Sidle (1990), Chapin and Walker (1990), Chapin et al. (1994, 1995), Fastie (1995), Heacox (1983), Hobbie (1994), Home (1977), Juday et al. (1991), Lawrence and Hulbert (1950), Lawrence (1951a, 1951b, 1953, 1958, 1979), Lawrence et al. (1967), Lentfer et al. (1991), Lilleskov (1990), Loewe (1966), Nobel and Sandgren (1976), Reiners et al. (1971), Schoenike (1957), Shepard (1990), Stephens (1968), Stephens (1991), Stephens et al. (1970), Streveler (1979), Streveler and Paige (1971), Streveler et al. (1980, 1995), Streveler and Worley (1975), Tanner (1979), Walker (1995), Welch (1965), and Worley (1975). The vast majority of collections are within Glacier Bay proper. Large areas of the park have had no botanical collecting. Figure 2 shows the collection sites within the park and surrounding areas.

Figure 1. Left: Naturalist William H. Dall third from the left, at a field camp along the Pacific Coast (ca. 1875) http://www.si.edu/archives/documents/dallphotos.html
Right: Naturalist Trevor Kincaid on the left, of the Harriman Expedition processing invertebrates (ca. 1900). http://www.washington.edu/research/pathbreakers/1901a.html

Figure 2. Glacier Bay National Park and Preserve. Plant collection locations by AKNHP botanists in 2001 and 2003 are shown as circles; approximate locations of previous collections are shown as triangles. Inset map shows GLBA relative to Alaska.



Sampling Design

In order to attain the goal of documenting 90% of the expected flora, we used two slight variations of the reconnaissance method of floristic survey. This method was recommended as the best approach for plant inventories in all Alaska parks by the wide group of botanists at the Alaska Plant Inventory Working Group September 2000 meeting; the general methodology is also supported by Catling and Reznicek (2003). The reconnaissance method involves identifying survey areas within landscape units via spatial analysis using the following key criteria:

- regionally unique geological or geomorphologic features
- communities or habitats of biological concern
- likely habitats of expected species, as indicated by regional floras and park collections
- under-represented plant communities in existing inventories
- logistical feasibility (e.g., access means, cost)
- potential of certain types of sites to maximize species and communities encountered (e.g., ecotones, high environmental gradient areas)

Site selection was somewhat different between 2001 and 2003. Collections in 2001 were designed to cover all ecoregional subsections and the majority of habitats within the sections. In 2003 collections were targeted to specific areas that were poorly sampled and were believed to harbor the largest number of taxa not recorded for the park.

In 2001 vascular plant collection sites (i.e., a location in which plants with the same specific latitude, longitude, habitat type, and collection date are collected) were selected based on a stratified random sampling design associated with the Glacier Bay Landcover Mapping Project (see Boggs et al. in prep. for a more detailed explanation of landcover/vascular plant inventory methods). Site selection represented the range in variability of ecoregional subsections (Shephard 2000), landcover types (Table 1), wetlands, plant associations, and vascular plant species diversity across GLBA. Post-stratification was used to refine the placement of each site and was based on a variety of factors. Some sites were moved in order to encompass samples within every ecoregional subsection. Age since deglaciation was used in post-stratification to ensure that all ranges of community development were represented. Additional landscapes such as rolling hills, piedmonts, and tidal marshes were targeted. Private in-holdings were avoided.

Transects ranging from ca. 2 km to 10 km were placed in such a way to maximize variation in habitat types (typically from ridge tops to valley bottoms). Opportunistic plant collection occurred adjacent to the transects when species were encountered that were new to the park, of conservation significance, or were unidentifiable in the field. A special effort was made to seek out habitats and areas that were identified as under-sampled by the GLBA botanical experts and the Alaska Plant Inventory Working Group. These were:

- Wetlands, all elevations, especially calcareous fens and aquatic species
- Subalpine
- Alpine
- Avalanche chutes
- Talus slopes
- Dry rocky cliffs
- Nunataks
- Alsek River corridor, especially alpine
- Dry Bay forelands

In 2003 all elevations within the Alsek River corridor and high elevation calcereous areas of Excursion Ridge (including avalanche chutes, talus slopes, and dry rocky cliffs) were targeted. To maximize species diversity we attempted to distribute sampling throughout both areas. Targeted sampling was incorporated into the study design to ensure that sampling occurred in unique sites or habitats where species that were expected, but not yet documented, may exist. Logistical feasibility and the potential of certain types of habitats/areas to encompass maximum species diversity and plant associations encountered were incorporated into the study design. The final site selection process for this study required detailed examination of aerial photographs, geology, and landcover maps. Further adjustments were made in the field, as access to previously identified sites was often impossible due to the terrain or time constraints.

This targeted, judgement-based approach is essential to identify potential habitat for species of special concern and attempt to locate additional populations based on known habitat preferences and patterns of distribution. As surveys progressed the list of species of special concern was refined as well as knowledge of their habitat and geography.

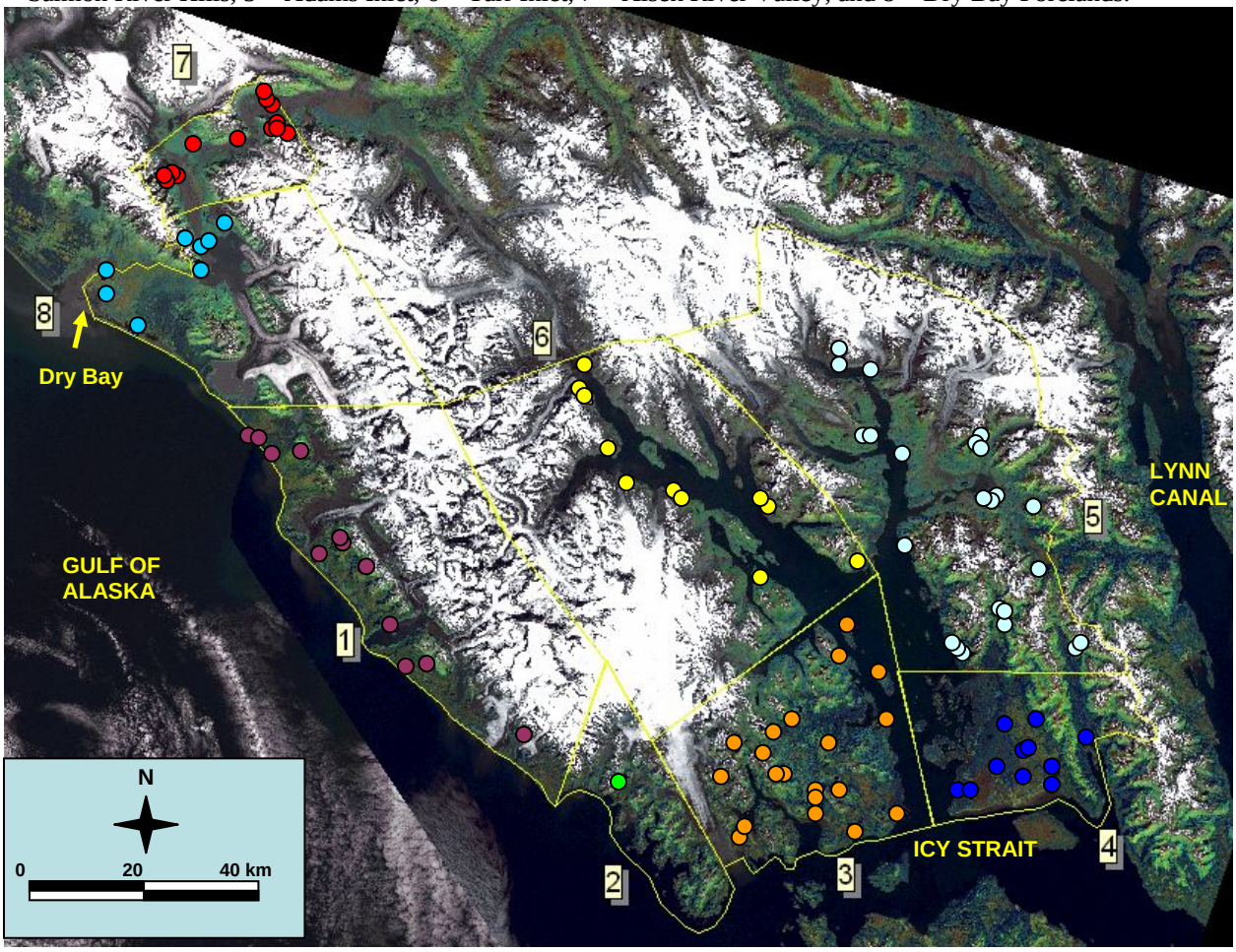
Table 1. Preliminary Land and cover classes of Glacier Bay, based on Viereck et al. (1992), for further discussion see Boggs et al. (in prep.).

Lifeform	**Landcover class**	**% Canopy cover**
Conifer	Spruce Closed	60-100%
	Hemlock Closed	60-100%
	Spruce-Hemlock Closed	60-100%
	Spruce Open	25-59%
	Hemlock Open	25-59%
	Spruce-Hemlock Open	25-59%
	Spruce Woodland	10-24%
Peatland	Lodgepole Pine, Woodland Stunted Peatland	10-24%
	Hemlock/Spruce, Woodland Stunted Peatland	10-24%
Krummholz	Krummholz	
Deciduous	Cottonwood, Closed	60-100%
	Cottonwood, Open	25-59%
	Cottonwood, Woodland	10-24%
Mixed Conifer-Deciduous	Spruce-Cottonwood, Closed	60-100%
	Spruce-Cottonwood, Open	25-59%
	Spruce-Cottonwood, Woodland	10-24%
Closed Tall Shrub	Closed Tall Alder	75-100%
	Closed Tall Willow	75-100%
	Closed Tall Alder-Willow	75-100%
Closed Low Shrub	Closed Low Willow	75-100%
Open Low Shrub	Open Low Willow	25-74%
	Open Low Willow-Herbaceous	25-74%
	Open Low Shrub	25-74%
Shrub Peatland	Open Low Shrub Peatland	25-74%
Open Tall Shrub	Open Tall Alder-Willow	25-74%
	Open Tall Willow	25-74%
Dwarf	Dryas Dwarf Shrub	25-100%
	Ericaceous Dwarf Shrub	25-100%
	Ericaceous Dwarf Shrub - Forb meadow	25-100%
Herbaceous	Beach rye meadow	75-100%
	Mesic Herbaceous	25-74%
	Uplifted Graminoid Forb	25-74%
	Wet Graminoid Forb	75-100%
	Halophytic Sedge Marsh	75-100%
	Aquatic	>25%
Non-vascular	Moss/Lichen	
Sparse/bare	Bare	<25% veg

Site Descriptions

Based on the sampling design criteria, we concentrated our inventory in each of the eight diverse ecogeographic regions of the park, incorporating very divergent habitat types (Fig. 3). The eight regions divide the park into areas of similar magnitude. Multiple collection sites were located within each region. The regions were the following: the Fairweather Range, Cape Spencer Fjords, Dundas River, Salmon River Hills, Adams Inlet, Tarr Inlet, Dry Bay Forelands, Alsek River Valley. Access to all regions was by helicopter, boat, or fixed-wing aircraft. Table 2 reports the collection regions, number of sites, number of collections made, and general habitat attributes.

Figure 3. Landsat image of GLBA, showing regions (yellow outlined polygons) and specific collection sites by AKNHP (circles). 1 = Fairweather Range, 2 = Cape Spencer Fjords, 3 = Dundas River, 4 = Salmon River Hills, 5 = Adams Inlet, 6 = Tarr Inlet, 7 = Alsek River Valley, and 8 = Dry Bay Forelands.



In 2001 we visited seven of the eight ecogeographic sampling regions (based on Shephard, 2000), and inventoried a number of different habitat types within the regions. The total number of collection sites within regions ranged from 1 to 33. It is impractical to discuss each of the nearly 120 collection sites from 2001, so we discuss collections associated with particular habitat types for each of the seven sampling regions.

Sampling in the remaining region was conducted in 2003 on a float trip through the long, broad Alsek Valley that is flanked by steep, rocky or alder-cloaked slopes. A number of discrete sampling areas were located along this unit as well as in Dry Bay and we present findings for each of these areas. Inventories in the Excursion Ridge area were cancelled due to inclement weather.

Table 2. Collection region descriptions. NW and SE Coordinates are corners of a rectangle encompassing all collection sites of the region. Appendix II gives a full description of habitats and associated species for each specific collection site.

Region	# of Sites	# of Collections	NW Coordinates (dd)	SE Coordinates (dd)	Elev. (m)	Topography	Habitats
Fairweather	13	26	58.929, 138.005	58.483, 137.194	0 to 722	Beach	Open sandy beaches
						Low forelands - coastal plain	Wet sedge and bluejoint meadows
						Stream edge, coastal plain	Sitka spruce-hemlock and red alder forests
						Mountain side slope	Alaska cedar forests and open Sitka spruce forests
						Upper hillside	Peatlands
						Upper mountain slope and ridge	Alpine heath-meadows
Cape Spencer Fjords	1	1	58.423, 136.898	58.423, 136.898	500	Upper mountain slope and ridge	Herbaceous -dwarf shrub tundra
Dundas River	33	105	58.692, 136.780	58.347, 136.038	-3 to 733	Beach	Beach rye meadows
						Low forelands - coastal plain	Peatlands/calcareous fens
						Low forelands - coastal plain	Mesic graminoid meadows
						River plain	Shrub and early seral river plain communities
						Mid-slope wetland	Wet sedge meadows
						Mountain side slope	Closed coniferous forests
						Cliff, upper mountain slope and ridge	*Dryas* -dwarf shrub
						Upper mountain slope and ridge	Alpine dwarf shrub
Salmon River Hills	20	54	58.604, 136.071	58.376, 135.481	-1 to 250	Intertidal-Beach	Intertidal forb-graminoid communities
						Outwash flats and foothills	Open pine woodlands and saturated peatlands
						Outwash flats and old river channel	Saturated forb-graminoid communities
						Mountain slope	Open hemlock-tall shrub forests
Adams Inlet	20	54	58.604, 136.071	58.376, 135.481	-1 to 250	Intertidal-Beach	Intertidal forb-graminoid community
						River plain	Riparian cottonwood forests
						Mountain side slope and steep drainage	Shrublands and shrub-meadow mosaics
						Mountain side slope	Closed spruce-hemlock forests
						Mountain slope	Subalpine wet sedge meadow
						Upper mountain slope and ridge	Alpine heath-meadows

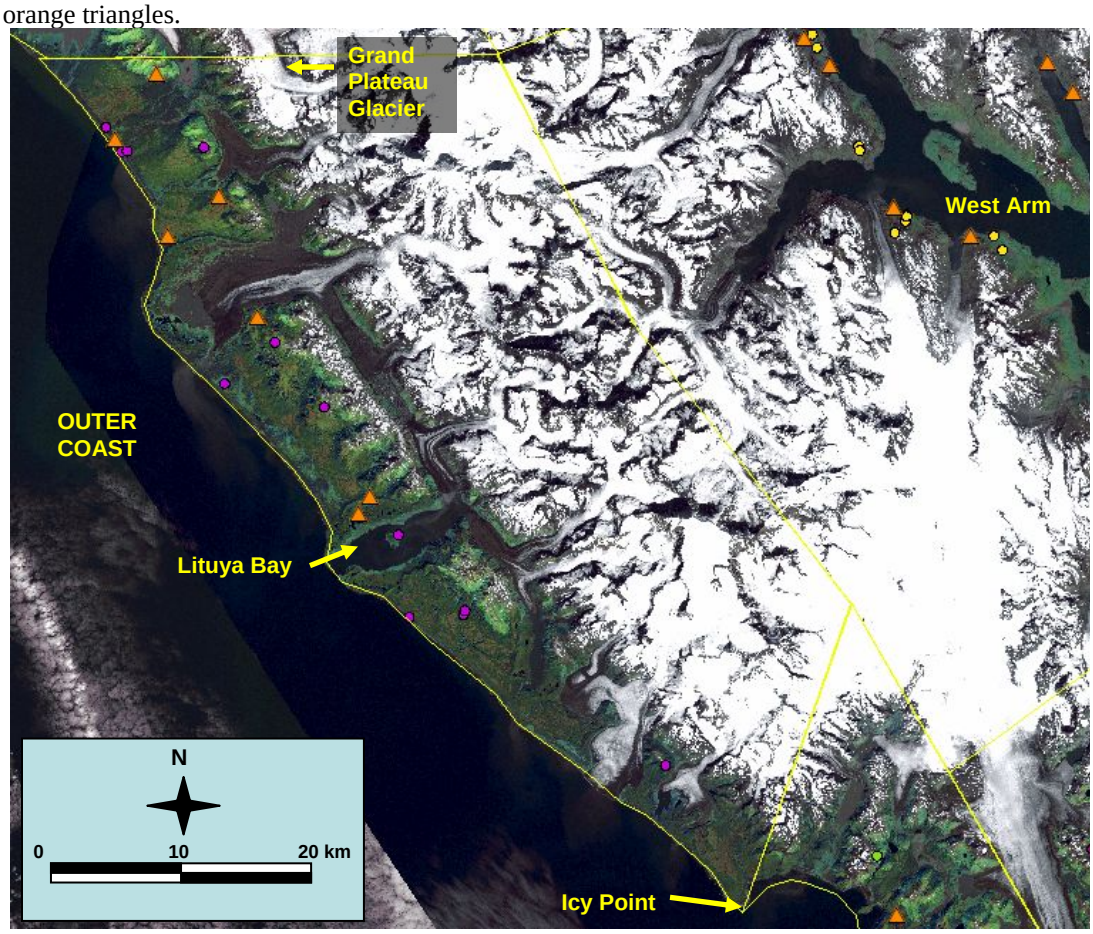
Table 2. Continued.

Region	# of Sites	# of Collections	NW Coordinates (dd)	SE Coordinates (dd)	Elev. (m)	Topography	Habitats
Tarr Inlet	19	55	59.074, 137.054	58.741, 136.178	4 to 690	Intertidal-Beach	Intertidal forb-graminoid community
						Uplifted beach	Uplifted tidal marsh
						Side slopes	Shrubland and shrub-meadow mosaics
						Floodplain	Riparian floodplain
						Barren slopes and cliffs	*Dryas*-dwarf shrub and rocky outcrops
						Upper mountain slope and ridge	Subalpine mesic shrubland
						Mountain ridge	Barren alpine shrub community
Alsek River Valley	23	157	59.493, 138.468	59.255, 137.632	44 to 825	Glacial lake margin	Alder scrub - pond margin
						River plain	Seral herb-scrub
						River terrace	Open poplar and alder grove
						Slope and cliff-face and avalanche gully	Forb-graminoid meadow
						Beaver pond	Sedge-wetland
						River terrace	Closed shrubland
						Sub-alpine slope	Sedge-ericaceous heath meadow
						Upper mountain slope	Alpine heath-meadows
						Upper mountain slope and ridge	Alpine heath and exposed fellfield
Dry Bay	11	38	59.304, 138.811	58.741, 137.846	0 to 760	Beach ridge	Graminoid-forb beach community
						Intertidal-Beach	Forb-graminoid mud flat
						Coastal plain	Wet meadow
						River terrace	Seral herb-scrub
						River terrace	Cottonwood, willow, forb meadow
						Mountain side slope	Shrubland
						Mountain slope	Alpine heath-meadows
						Mountain slope and ridge	Alpine graminoid-forb meadows

Fairweather Range Region

Areas from Grand Plateau Glacier south to Icy Point on the outer coast were inventoried between 18 to 21 August 2001 by six NPS and AKNHP botanists and ecologists. Very few collections were known from this region prior to 2001. We collected specimens from 13 sites throughout the unit. Figure 4 shows the region covered and specific locations of all collection sites, which were accessed by helicopter. The primary habitat types encountered at low elevations were beach and halophytic-sedge meadows, Sitka spruce forests, wet sedge meadows-fens, and alder-willow thickets. Alder-willow thickets, Alaska cedar forests, wet sedge meadows and fens, and ericaceous shrub/forb meadows extended into higher elevations. At the highest elevations (500 to 700 m), herbaceous-dwarf shrub tundra and exposed scree slopes were dominant. No collections were made on nunataks on the icefield. The primary landforms and communities in the Fairweather Range are discussed below.

Figure 4. Collection sites in the Fairweather Range (violet circles), Cape Spencer (green circles), and Tarr Inlet (yellow circles) Regions. 2001 Collection sites are shown as circles, previous collections are shown as orange triangles.



The topography and geology in the Fairweather region include extensive coastal forelands of unconsolidated glaciomarine deposits (see discussion in Nowacki et al. 2001), which span the length of the beach and approximately 5 km inland. Sand and gravel beaches and a series of older beach ridges as well as marshes and *Nuphar lutea ssp. polysepala* (= *Nuphar polysepala*) dominated ponds are found on this substrate. Shrub thickets as well as graminoid meadows occupy older beach ridges (Fig. 5) between strands of Sitka spruce and alder forests (Fig. 6).

Figure 5. Wet forb-graminoid meadow of the Coastal Forelands, Fairweather Region. *Carex* spp., *Cicuta douglasii*, *Alnus viridis* ssp. *sinuata*, and *Picea sitchensis* were dominant species of this area. The Front Range is visible in the background.

To the east of the coastal forelands a front range of fragmented mountains extends to 1,300 m. The Fairweather Front Range Complex is composed primarily of moderately metamorphosed graywacke and greenstone with small amounts of uplifted marine siltstones (Nowacki et al. 2001) and is incised by numerous small streams. Spruce, hemlock, and cedar forests give way to subalpine and alpine meadows as well as exposed

scree slopes sculpted by glaciation at the higher elevations. To the east of the front range a long ice-filled valley (Desolation Valley) marks the area where the Pacific and North American Plates make contact (Nowacki et al. 2001). The heavily glaciated Fairweather Range extends eastward.

In the Fairweather Region we made collections from the following habitats:

Figure 6. Alder-spruce forest, Fairweather Region. *Alnus rubra*, *Picea sitchensis*, and *Sambucus racemosa* were dominant species of this area.

- Open sandy beaches – A single specimen was collected on Cenotaph Island in Lituya Bay (58.643°N, 137.575°W), from a barren, sandy site. No other species were associated with the *Carex glareosa* collected.

- Wet sedge and Bluejoint grass meadows – At three sites, we made collections of wetland-associated species in saturated graminoid meadows (Fig. 5). One location was an uplifted beach swale of *Carex aquatilis* var. *dives* (= *C. sitchensis*) with small shallow ponds containing *Utricularia intermedia* and *Potamogeton gramineus*. Another collection was from a wet meadow in a more extensive western hemlock stand. Last, two taxa were collected from a wet sedge-willow scrub habitat near Fairweather Glacier. The associated species at this site were *Carex aquatilis* var. *dives*, *Calamagrostis canadensis*, *Equisetum arvense*, and *Salix commutata*.

- Sitka spruce-hemlock and red alder forests – Along the coastal plain we often encountered Sitka spruce-hemlock forests. Soils were moist and organic with a substantial layer of mosses. Species diversity was generally low. The dominant species associated with forested coastal forelands were *Tsuga heterophylla*, *Picea sitchensis*, *Alnus rubra* (= *A. oregona*), *Oplopanax horridus* (= *Echinopanax horridum*), *Carex aquatilis* var. *dives*, and *Calamagrostis canadensis*. *Alnus rubra* and *Sambucus racemosa* were the primary woody species near streams (Fig. 6). We made collections of *Cinna latifolia*, *Rhynchospora alba*, *Scheuchzeria palustris* adjacent to streams in red alder forests at sea-level.

- Alaska cedar forests – Above the spruce and hemlock trees the community transitioned to Alaska cedar (*Chamaecyparis nootkatensis*) forests at about 160 m elevation. These forests had a closed canopy and soils were moist to saturated with a deep organic layer. The associated species were *Lysichiton americanus*, *Vaccinium alaskaense* (= *V. alaskensis*) and various graminoid species.

- Peatlands – Mid-elevation (160 m) peatlands were sampled, and dominated by *Nephrophyllidium crista-galli* (= *Fauria crista-galli*), *Pinus contorta*, *Carex aquatilis* var. *dives*, and *Sanguisorba menziesii* (Fig. 7).

Figure 7. Mid-elevation peatland in the Fairweather Front Range.

Figure 8. High elevation herbaceous-dwarf shrub tundra in the Fairweather Front Range. The Gulf of Alaska is visible in the background.

- Alpine heath-meadows – High elevation alpine slopes from 500 to 720 m were surveyed at four locations in the Fairweather Range. These sites were generally steep, mesic ericaceous tundra composed of *Harrimanella stelleriana* (= *Cassiope stellariana*), *Cassiope mertensiana*, and *Luetkea pectinata* (Fig. 8). However, at one site the community was a rich assemblage of herbaceous and shrubby species: *Elliottia pyroliflorus* (= *Cladothamnus pyrolaeflorus*), *Athyrium filix-femina*, *Rubus spectabilis*, *Veratrum viride*, and *Arnica* sp.

Cape Spencer Fjords Region

Cape Spencer Fjords are a series of ice-free parallel ridges, composed primarily of metamorphic gneiss and shists. Glacial deposits are present in valley bottoms. Forests are a mixture of western hemlock, Sitka spruce, and Alaska cedar; however, tree growth is limited along the coast due to severe weather (see Nowacki et al. 2001 for a more complete discussion).

The region from Icy Point south to Cape Spencer on the outer coast was inventoried on 16 August 2001. Poor weather in the region hampered attempts to reach multiple sites and a single alpine site was inventoried. Figures 9 and 10 show the region and the specific location of the collection site, accessed by helicopter. The primary habitat type encountered was herbaceous-dwarf shrub tundra at 500 m. No collections were made on low-elevation coastal habitats, wetlands, or mid-elevation forests and meadows.

Figure 9. Cape Spencer Fjords and Dundas River Regions. AKNHP 2001 Collection locations are shown as circles (green = Cape Spencer Fjords, violet = Dundas River). Previous collections are shown as triangles.

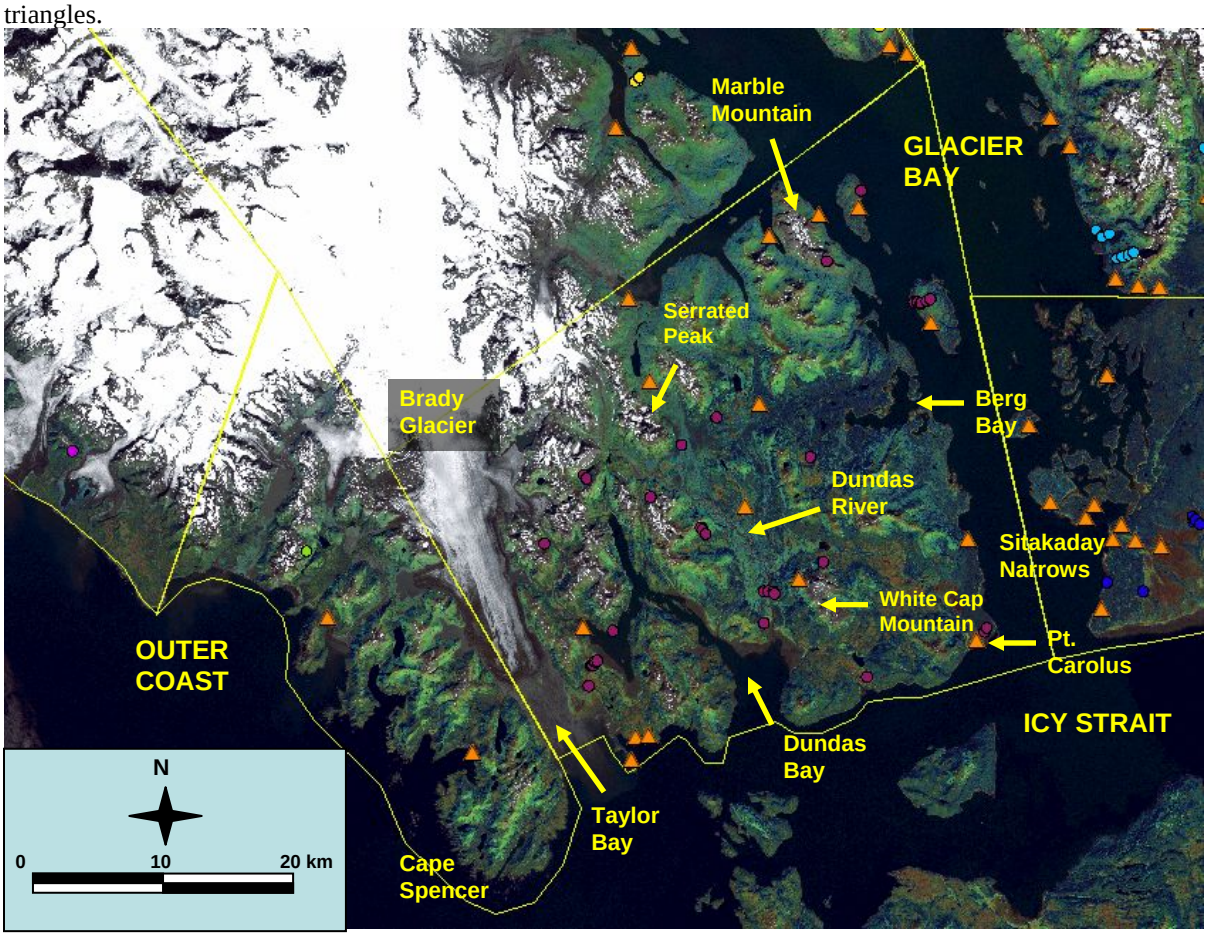


Figure 10. Herbaceous-dwarf shrub tundra at Cape Spencer Fjords. The plant community is dominated by ericaceous shrubs.

We investigated a mid- to high-elevation site on the east side of DeLangle Mountain (58.423°N, 136.898°W). This was a dwarf shrub tundra snowbed composed primarily of *Luetkea pectinata* (Fig. 10). Wet graminoid meadows and isolated patches of *Lupinus nootkatensis* bordered the snowbeds. Overall vascular plant diversity was low, which is very typical for such higher elevation acidic, ericaceous shrub-dominated sites.

Dundas River Region

The region stretching from Brady Glacier east to Glacier Bay proper was inventoried on 16-21 July and 10-11 August 2001. Over 100 specimens were collected from 33 sites throughout the unit, including low elevation and coastal sites as well as high elevation sites. Figure 9 shows the region covered and specific locations of all collection sites. The primary habitat types encountered at low elevations were beach and halophytic-sedge habitats, coniferous forests, alder and willow thickets, river floodplains, graminoid meadows, peatlands and calcareous fens, and limestone cliffs. At higher elevations (500 to 700 m) we encountered herbaceous-dwarf shrub tundra and exposed scree slopes.

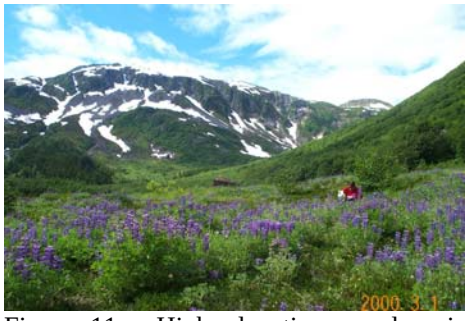


Figure 11. High elevation meadow in granitic mountains of the Dundas area.

The geology and topography of the Dundas region is quite diverse. Between Taylor and Dundas Bays a fractured ridge of steep granitic mountains runs north-south (Figs. 9 and 11). These mountains reach 1,000 m in elevation. At lower elevations, a series of moraines occurs between Taylor and Dundas Bays (Nowacki et al. 2001). According to Nowacki et al. (2001) this area, unlike much of Glacier Bay, was not overridden by neoglacial ice to any great extent. Sitka spruce, western hemlock, and Alaska cedar cover much of the Dundas region.

On the east side of the granitic mountains a broad outwash plain empties the Dundas Valley into Icy Strait. This valley was formed by large volumes of glacial waters filling the valleys with gravels and sandy deposits (Streveler and Paige 1971). The plant communities are characterized by sparse spruce, alder, and cottonwood forests and peatlands/calcareous fens and wet sedge and willow thickets. Unconsolidated sediments are also found at lower elevations on the coast from Berg Bay to Point Carolus. These landforms were created by repeated neoglacial iceflows depositing mixed sizes of materials that were colonized by vegetation relatively early for Glacier Bay (Nowacki et al. 2001).

A complex aggregation of geologies is found on the Sitakaday Narrows portion of this sampling region. A series of mountains of 500 to 1,000 m in elevation surrounds low, narrow valleys and rivers. The mountains are of mixed lithologies, including noncalcareous sediments as well as granitic bedrock (Nowacki et al. 2001). High pH, carbonate lithologies are found on Marble and White Cap Mountains.

Primary plant-community types sampled in this region were the following:

- Beach rye meadows – We inventoried communities at the western end of Dundas Bay (58.3559°N, 136.532°W), which had well-drained sandy substrates dominated by *Leymus mollis* (= *Elymus arenarius*), *Festuca rubra*, and *Argentina egedii* (= *Potentilla egedii*).

- Peatlands/calcareous fens – We investigated numerous peatlands at both low and mid-elevations. Saturated, basic calcareous substrates have been reported in the Dundas Valley; however, we did not encounter plant communities that appeared to be high-pH associates. Low elevation communites were composed of *Sphagnum* mosses, *Carex pluriflora*, *C. viridula ssp. viridula* (= *C. oederi*), *Myrica gale*, and *Eriophorum angustifolium*. At higher elevations the composition of species included *Pinus contorta*, *Dodecatheon pulchellum*, *Trichophorum caespitosum*, *Menyanthes trifoliata*, and *Sanguisorba* sp. (see Fig. 12). Soils were saturated and organic.

Figure 12. Wet sedge peatland, near White Cap Mountain.

- Mesic graminoid meadows – Three specimens were collected in a mesic *Calamagrostis canadensis* meadow near the mouth of Dundas River (58.402°N, 136.313°W). Other associated species were *Geum macrophyllum*, *Sanguisorba canadensis* (= *S. sitchensis*), and *Viola langsdorfii*.

- Shrub-early seral herbaceous river plain communities – Along the Dundas River headwaters near Serrated Peak and near the mouth of Dundas Bay (Fig. 9), we surveyed early seral herbaceous and shrub habitats. The habitats were generally barren sand with *Equisetum variegatum* and occasional thickets of *Salix sitchensis* (Fig. 13).

Figure 13. River plain community along the lower Dundas River.

- Wet sedge meadows – A considerable number of species was collected from this community type. Soils were organic and saturated and associated species were *Menyanthes trifoliata*, *Cicuta douglasii*, *Eriophorum russeolum*, and *Carex lyngbyei* (near the coast).

- Closed coniferous forests – A limited amount of collecting occurred in *Picea sitchensis* and *Tsuga mertensiana* forests at 58.376°N, 136.513°W. This community was low in vascular plant diversity.

- *Dryas*-dwarf shrub community – We inventoried habitats dominated by *Dryas integrifolia*, *Alnus viridis* ssp. *sinuata*, *Arctostaphylos uva-ursi*, and *Shepherdia canadensis* found on a limestone substrate (Fig. 14) at Marble Mountain and Drake Island. Additionally, limestone cliffs were surveyed on Willoughby Island.

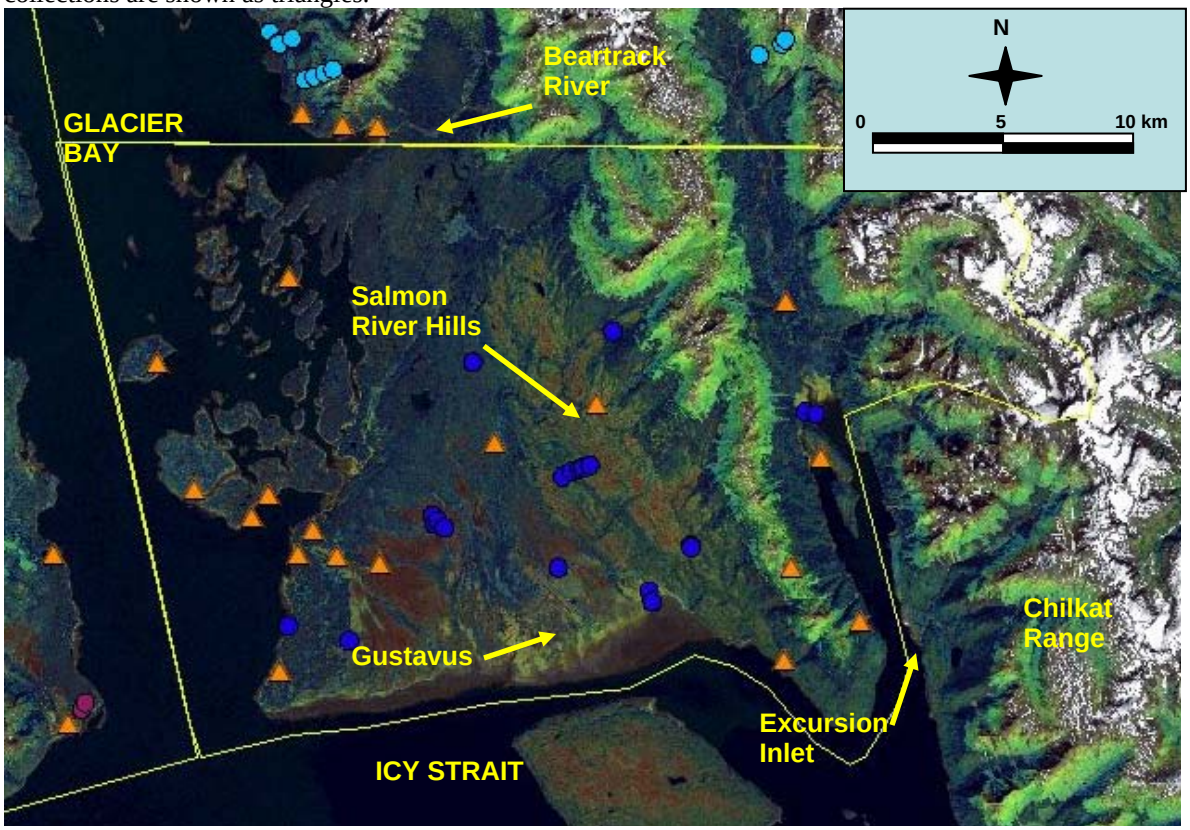
Figure 14. *Dryas*-dwarf shrub community on Marble Mountain. Willoughby Island is visible in the background.

- Alpine dwarf shrub communities – We surveyed seven sites on high granitic mountains near Brady Glacier. The communities were composed of *Loiseleuria procumbens*, *Empetrum nigrum*, *Vaccinium uliginosum*, *Carex* spp., *Cassiope* sp., *Luetkea pectinata*, *Geum calthifolium*, *Phyllodoce glanduliflora*, and *Tsuga mertensiana* (Fig. 11). These high-elevation sites were often sparsely vegetated and the substrates were composed of a thin layer of organics over bedrock or coarse talus.

Salmon River Hills Region

A moderate amount of collecting had previously occurred in the area from Point Gustavus east to the park boundary on the Chilkat Peninsula and north to Beartrack River. Most of the collections were at low elevations and in the vicinity of Bartlett Cove. From 18-23 July and again on 17 August 2001 NPS and AKNHP botanists and ecologists surveyed 29 sites scattered from Pt. Gustavus to Sawmill Bay (Fig. 15). We attempted to access high elevation calcareous outcrops along the eastern border of the park in 2003, but weather prevented this. The primary habitat types encountered at low elevations were halophytic sedge and marsh communities, pine woodlands, forb-sedge meadows, and saturated peatlands. Above 150 m we encountered forb-graminoid meadows and open mountain hemlock forests.

Figure 15. Salmon River Hills Regions. AKNHP 2001 Collection locations are shown as circles. Previous collections are shown as triangles.



The Salmon River Hills region has a mixed geology composed of unconsolidated sediments from Beartrack River south to Icy Strait. These lowlands were shaped by neoglacial activities, with a series of terminal and lateral moraines remaining. The Gustavus flats are the result of large meltwater discharges during neoglacial retreat (Nowacki et al. 2001). Low calcareous argillite foothills are found northeast of Gustavus. The steep, angular Chilkat Range rises just to the east of the foothills. Elevation in the sandstone and carbonate-derived mountains reach over 1,200 m.

The lowlands tend to have very nutrient poor, sandy soils and support only sparse forests of pine, cottonwood, and Sitka spruce. Fens supporting peatlands are numerous in the lowlands. The Salmon River Hills and Chilkat Range have denser spruce and hemlock forests as well as subalpine habitats. The higher elevations in the Chilkats also have barrens, scree slopes, and alpine meadows.

Primary plant community types encountered within the Salmon River Hills were the following:

- Intertidal forb-graminoid communities – We visited three sites at or below sea-level. These were dominated by a low density of the alkali grass, *Puccinellia nutkaensis* (Fig. 16). At the high tide zone the community shifted to a higher density of plants. These halophytic sedge and marsh communites were dominated by *Leymus mollis*, *Deschampsia beringensis*, *Argentina egedii*, and *Hordeum brachyantherum*. A single collection site was located east of Gustavus on an uplifted beach outwash - shrub wet meadow. The dominant species were *Salix barclayi*, *S. commutata*, *Carex lyngbyei*, *Lathyrus palustris*, and *Carex pluriflora*.

Figure 16. Intertidal *Puccinellia nutkaensis* community transitioning to halophytic sedge and marsh habitats. Sitka spruce and hemlock forest dominate above the zone of tidal influence.

- Open pine woodlands and saturated peatlands – Shore pines (*Pinus contorta*) of variable densities were associated with saturated acidic peatlands. This habitat was sampled heavily throughout the region. It was composed of *Sphagnum* mosses, *Pinus contorta*, *Carex* spp., *Trichophorum caespitosum*, *Vaccinium uliginosum*, *Empetrum nigrum*, and *Equisetum variegatum*. This habitat type was encountered at near sea-level to mid-elevations (250 m). Cover of pines was generally less than 10% and occasional muskeg ponds and streams were observed.

- Saturated forb-graminoid communities – A wet meadow habitat was inventoried at one location west of Gustavus near sea-level (58.408°N, 135.853°W). The plant community was composed of *Menyanthes trifoliata*, *Cicuta douglasii*, *Equisetum palustre*, and *Carex pluriflora*.

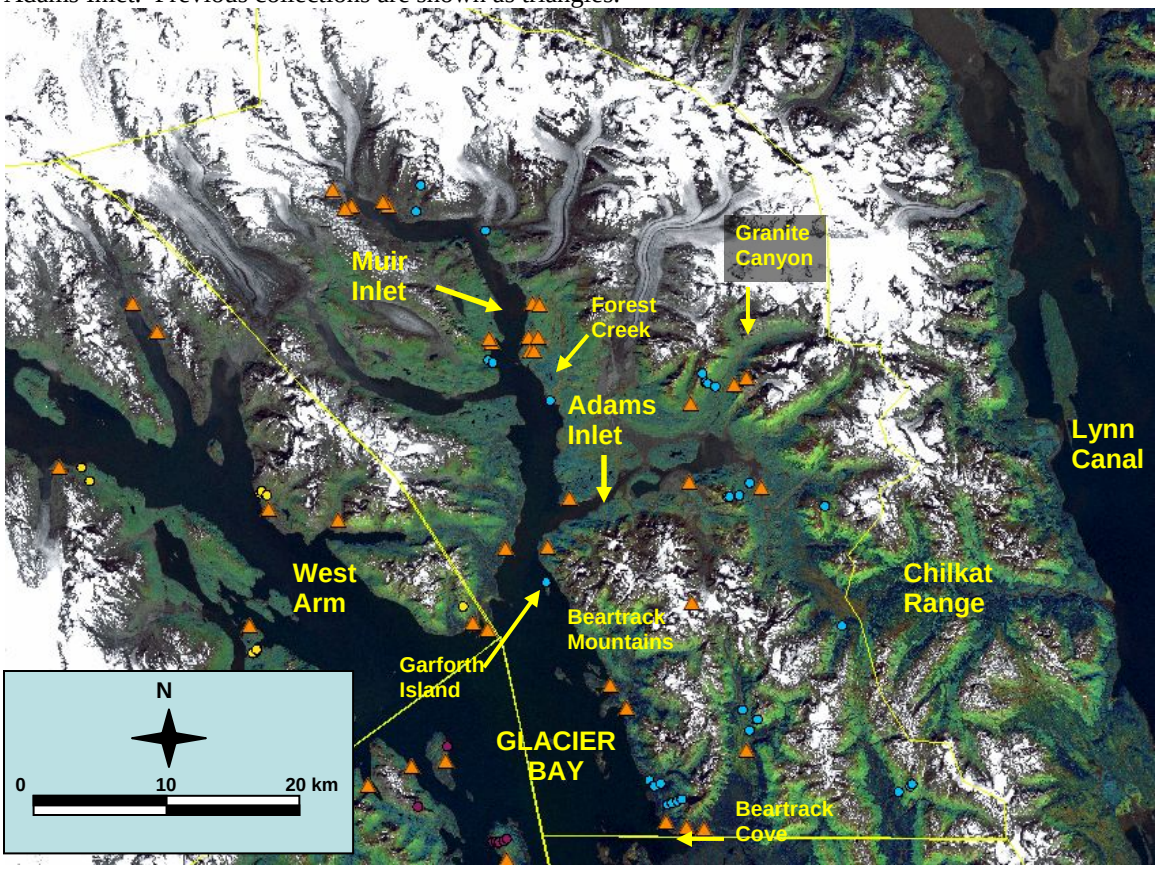
- Open hemlock-tall shrub forests – We inventoried open hemlock-tall shrub forests at four sites (between 100 and 250 m elev.) in the foothills of the Salmon River Hills. Nine specimens were collected from this habitat, which was dominated by *Tsuga heterophylla*, *Vaccinium ovalifolium*, *Menziesia ferruginea*, *Malus fusca*, and various species of bryophytes.

- High elevation alpine communities – We were unable to access high elevation sites in the Chilkat Range due to poor weather.

Adams Inlet Region

The northeast section of Glacier Bay Park was inventoried on 18 and 19 July and on 14-16 August 2001. Very little collecting had occurred at elevations above 100 m; we therefore concentrated the majority of our efforts on high elevation habitats. We visited a total of 32 separate sites (see Fig. 17), ranging from intertidal communities to closed mountain hemlock forests and alpine heath and forb meadows.

Figure 17. Adams Inlet Region. AKNHP 2001 Collection locations are shown as light blue circles in Adams Inlet. Previous collections are shown as triangles.



The Adams Inlet Region is characterized by its very recent emergence from melting neoglacial ice. Glacial associated deposits are the primary substrate, originating from ice-water-land interactions, such as lacustrine sediments in former Glacial Lake Adams, glaciofluvial outwash, and glaciomarine deposits (McKenzie and Goldthwait 1971, Nowacki et al. 2001). Thick layers of ice overrode most of the region creating a series of low rolling hills that radiate from surrounding mountains. Immediately south of Adams Inlet high, steep mountains rise to over 1,500 m. These Beartrack Mountains are part of the Chilkat Peninsula Carbonate Subsection (Nowacki et al. 2001) and have a mixture of lithologies, including granitics, and calcareous rocks of various ages. The vegetation of the southern portion of the region has well developed coniferous forests, in addition to well established alpine vegetation. The young age of the northern portion and geographic remoteness has resulted in poorly developed plant communities.

Alder and cottonwood dominate the lower portion of Muir Inlet and are restricted to low elevation valley bottoms in the upper portions of the region (Nowacki et al. 2001).

Plant communities inventoried in 2001 included:

- Intertidal forb-graminoid community – At the mouth of Forest Creek, across from Rowlee Point (58.932°N, 136.072°W) we surveyed an intertidal community with mostly bare, fine-grained and large beach cobble substrates. We also collected a few species from the high tide zone, where the community was dominated by *Leymus mollis* stands and flanked by alder and coniferous forests (Fig. 18) at Garforth Island (58.793°N, 136.074°W) and Beartrack Cove (58.643°N, 135.918°W).

Figure 18. Intertidal *Leymus mollis* and alder-coniferous forest communities at Beartrack Cove in the southern section of Adams Inlet Region.

- Riparian cottonwood forests - On 19 July 2001 we surveyed an open cottonwood forest along the Beartrack River (58.698°N, 135.784°W). The community was composed of *Populus balsamifera ssp. trichocarpa*, *Alnus viridis* ssp. *sinuata*, and *Salix alaxensis*. Adjacent to this location were wet sedge meadows and floodplain marshes of *Equisetum arvense* and *Carex* spp.

- Shrublands and shrub-meadow mosaics – Mid-elevation sites (ca. 600 m) at Granite Canyon (four sites) and Beartrack Cove (two sites) were sampled. These were tall alder thickets intermixed with herbaceous meadows. Soils were often coarse and unsorted. Collections were also made in steep drainages with large boulders. The dominant plants were *Alnus viridis* ssp. *sinuata*, *Artemisia arctica*, *Geranium erianthum*, and *Salix sitchensis*. A total of 16 specimens were collected from this habitat.

- Closed spruce-hemlock forest – We collected plants from a few well developed coniferous forests in the Beartrack Cove area (Fig. 19). Soils were moist humus, and gently to moderately sloping. Overall vascular plant diversity was low.

Figure 19. Closed western hemlock forest, Adams Inlet, near Beartrack Cove.

Figure 20. Subalpine forb meadow, Adams Inlet.

- Alpine and subalpine habitats – A range of alpine and subalpine habitats was surveyed throughout the Adams Inlet Region. Subalpine wet sedge meadows of *Eriophorum angustifolium*, *Carex pluriflora*, and *C. aquatilis* var. *dives* were encountered at 460 m elevation. Soils were saturated and highly organic at this location, and slopes were less than 10°. At 800-910 m we sampled forb meadows dominated by *Lupinus nootkatensis*, *Geranium erianthum*, *Artemisia arctica*, and *Phegopteris connectilis* (= *Thelypteris phegopteris*) at one site (Fig. 20), and by *Sanguisorba canadensis*, *Anemone narcissiflora*, *Lupinus nootkatensis*, and *Prenanthes alata* at another. Both of these sites were steep (ca. 30°) and had a thin organic layer over mostly exposed till or bedrock. Alpine heath dominated by *Cassiope mertensiana*, *Harrimanella stellariana* (= *Cassiope stellariana*), and *Phyllodoce glanduliflora* was encountered in moist catchment basins and snowbeds.

Tarr Inlet Region

The West Arm of GLBA was inventoried on 11-14 August 2001 by seven NPS, private, and AKNHP botanists and ecologists. Collection sites covered most of the area with the exception of nunataks, Johns Hopkins Inlet, and the north shore of Tarr Inlet (Fig. 21). A total of 19 collection sites was located in this region. The majority of AKNHP collections were from elevations under 100 m; however plants were collected from four high elevation (> 300 m) sites as well.

Figure 21. Tarr Inlet Region. AKNHP 2001 collection locations are shown as yellow circles in Tarr Inlet. Previous collections are shown as triangles.

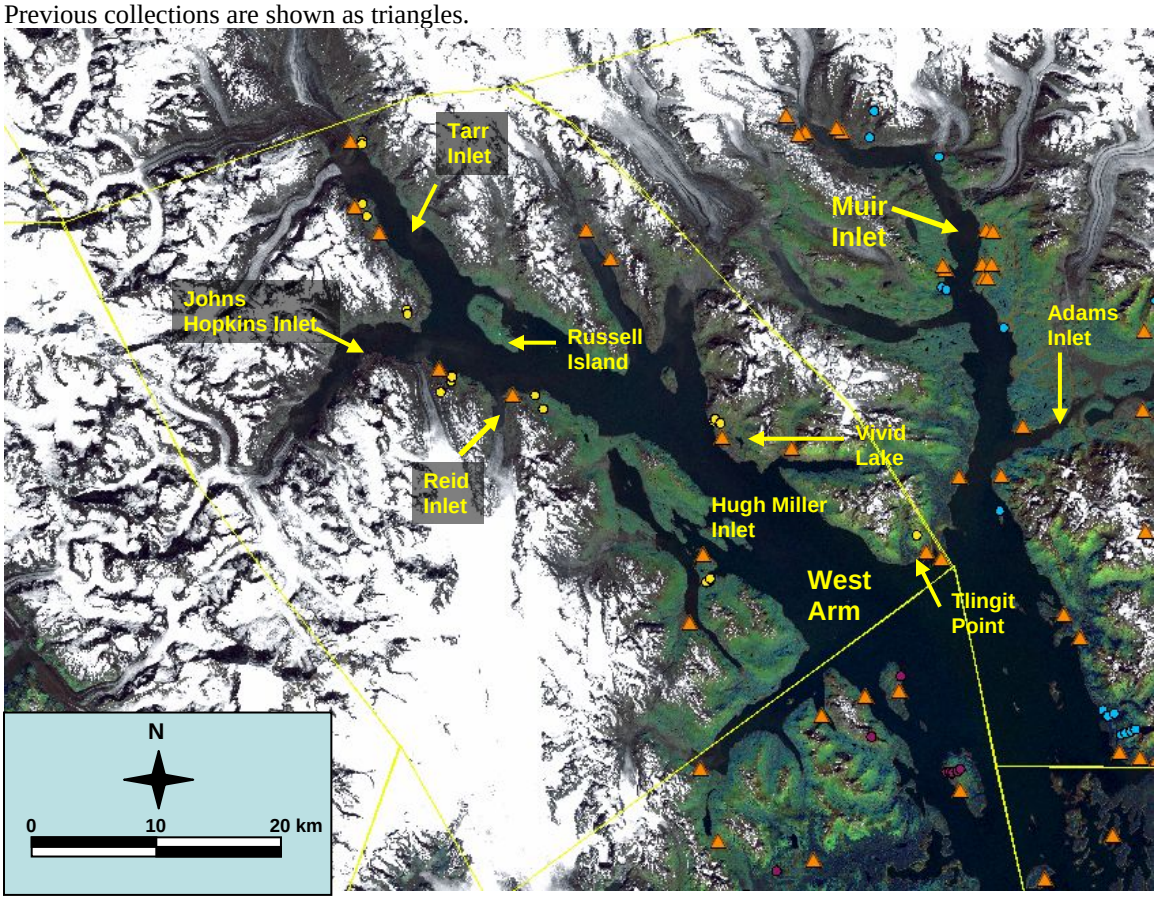


Figure 22. Upper Tarr Inlet Region. Johns Hopkins Inlet and Glacier are present in the center.

The geology of the West Arm is composed of rugged, steep-walled mountains and narrow fjords (see Fig. 22). According to Nowacki et al. (2001) the glacial retreat was slow and erratic with many tidewater glaciers still active in the region. Precipitation levels are quite high, which keep the granodiorite substrates free of sediments, and thus the vegetation is generally sparse. Moderate amounts of sedimentation are evident along shorelines and depressions, especially to the south and support stands of coniferous forests. From Russell Island southeast to Tlingit Point, on the north side of the West Arm, the substrates have granite inclusions, but are primarily a mixture of noncarbonate and carbonate sedimentary and metasedimentary rocks (Nowacki et al. 2001). The vegetation is also sparse in this area.

Habitats inventoried in the Tarr Inlet Region in 2001 included:

Figure 23. Upper beach habitat at Reid Inlet in the Tarr Inlet Region.

- Intertidal forb-graminoid community – Near Reid Inlet (58.874°N, 136.759°W) a sparsely vegetated community at the edge of tidal influence was inventoried (Fig. 23). Soils were moist and composed of a thin organic layer overlying mixed glacial till. Dominant plants were *Hieracium albiflorum* and *Poa eminens*.

- Uplifted tidal marsh – This community type was inventoried near Hugh Miller Inlet (58.735°N, 136.500°W). The marsh previously had a greater marine influence, but isostatic rebound has caused the area to lift and become freshwater dominated. The plant community was composed of the sedge species: *Carex lyngbyei*, *C. viridula* ssp. *viridula*, and *C. limosa*. Soils appeared to be often saturated, but were relatively dry at the time of sampling in mid-August.

- Shrublands and shrub-meadow mosaic – We encountered willow dominated shrublands at a number of sites in the upper reaches of the West Arm. Willow shrublands were inventoried at sites between 15 and 30 m in elevation, but they commonly extended to higher elevations. The communities were composed of thick stands of *Salix sitchensis, S. commutata*, and *Shepherdia canadensis* (Fig. 24).

- Riparian floodplain – Near Reid Inlet (58.863°N, 136.746°W) collections were made along a nearly unvegetated riparian community. Soils were sandy to silty. *Salix* spp., *Populus balsamifera* ssp. *trichocarpa*, and *Equisetum* spp. were found adjacent to the floodplain.

- <u>*Dryas*-dwarf shrub and exposed rocky outcrops</u> – A *Dryas drummondii* dominated community with exposed mineral soils was inventoried at the head of Tarr Inlet (59.061°N, 137.025°W, Fig 25). Additional dwarf shrub habitats with exposed rock were inventoried northwest of Vivid Lake (58.859°N, 136.494°W). The substrate at this location was limestone, with occasional areas of more developed organic soils.

Figure 24. Shrubland community, Reid Inlet.

Figure 25. *Dryas*-dwarf shrub habitat, upper Tarr Inlet.

- <u>Alpine and subalpine habitats</u> – High elevation habitats were surveyed at two locations on either side of Johns Hopkins Inlet. The site on the north side of the inlet was at 450 m and was a mesic snow basin composed of *Salix sitchensis* and *S. commutata*. On the south side of the inlet the habitat at 680 m was dominated by exposed mineral substrates and small patches of *Salix sitchensis* and the prostrate *S. arctica* (Fig. 26). The substrate at this site included a mixture of bedrock, cobbles, and gravel.

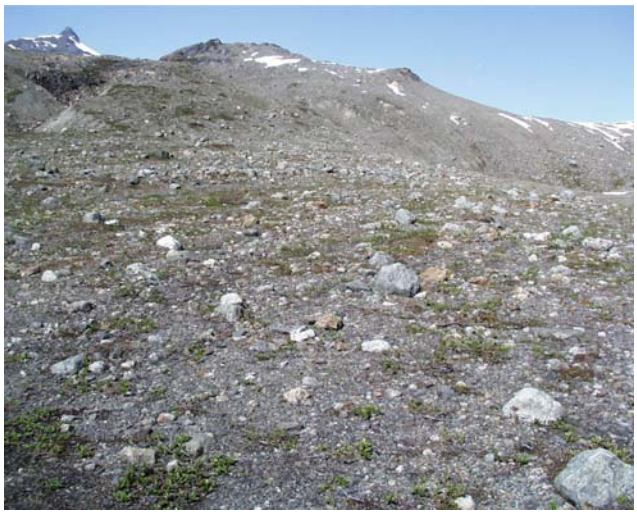
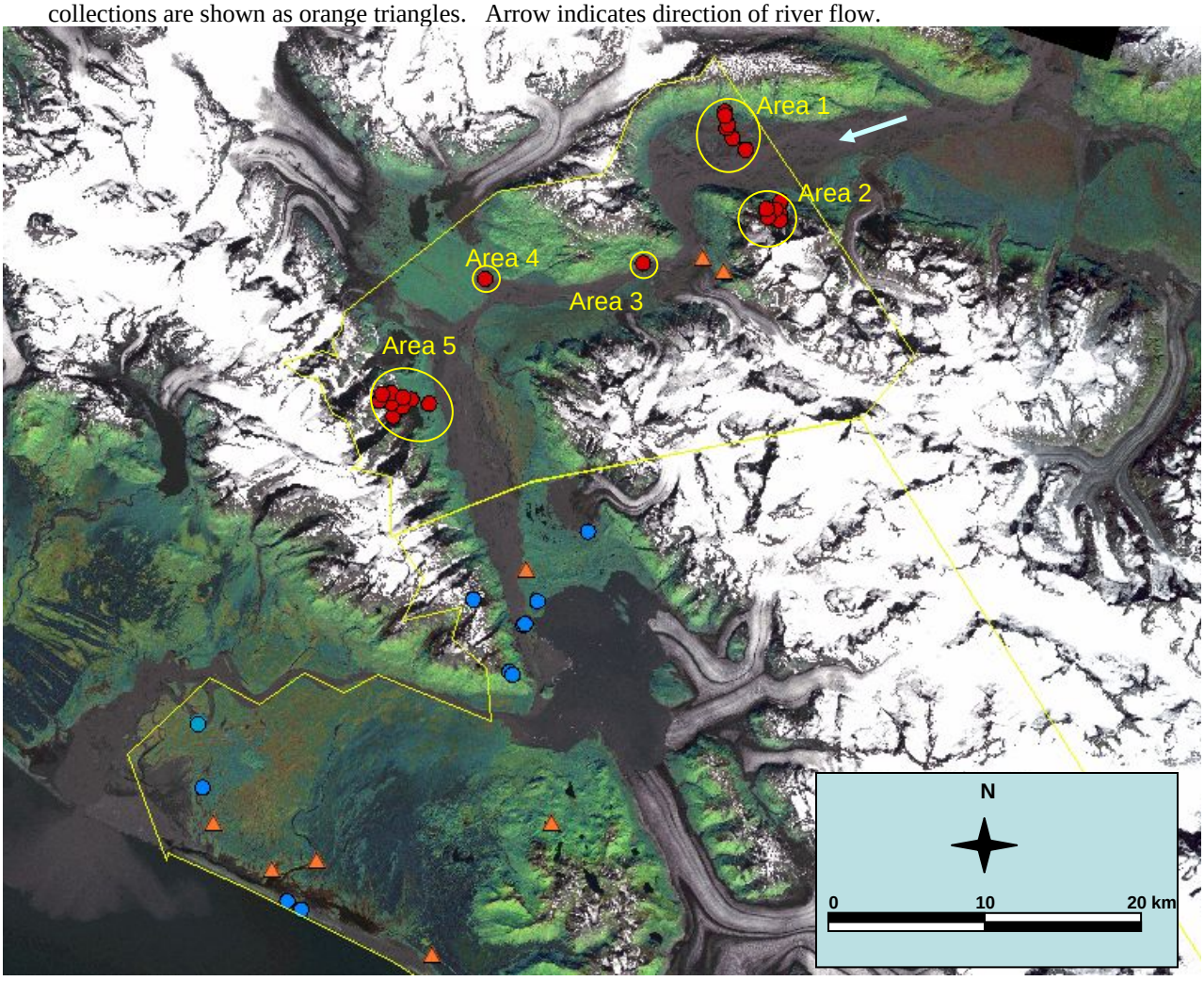


Figure 26. Alpine exposed arctic willow community, Johns Hopkins Inlet.

Alsek River Valley Region

The Alsek River Corridor was surveyed during a single float trip from the Alaska-British Columbia border to Dry Bay, a distance of roughly 65 km. Figure 27 shows the overall area inventoried. Surveys were conducted from 24 June to 1 July 2003 by an AKNHP botanist and volunteer botanist from the Oregon Plant Conservation Biology Program, Oregon Department of Agriculture. Six major collecting areas, which included from one to eight specific collection sites, were established along the river. Collections occurred at low elevations along the river as well as alpine areas in a number of locations. Additional collecting occurred sporadically. The geographic location, topography, and habitats of the areas are discussed below rather than in relation to community types (as in the suvey regions discussed above) since relatively few areas were sampled and a multitude of habitats were encountered at most of these areas.

Figure 27. Primary collection areas along the Alsek River, Dry Bay is in the lower left corner. Previous collections are shown as orange triangles. Arrow indicates direction of river flow.



The Alsek River Valley originates in the Canadian Interior, north of Haines Junction, Yukon Territory and bisects the St. Elias Range. This drainage has been subject to considerable alterations due to advances and retreats of glaciers; the Lowell Glacier has dammed the Alsek River at least four times in the last 500 years (Lindsey and McPhail 1986). Steep, angular mountains surrounding broad, flat-bottomed valleys with braided river channels characterize the topography of the region. Mineral soils predominate in the area. The Alsek River Valley is unusual in having a drier continental climate and a vegetation community that is more boreal than most other regions of GLBA.

Figure 28. Mid-seral river bar along the edge of the Alsek River at the AK-BC border. *Hedysarum boreale* ssp. *mackenziei* is present in the foreground.

Alsek Area 1

On 24 June 2003 two AKNHP botany crew members landed on a gravel bar on the north side of the Alsek River at the Alaska-British Columbia border. The following day the crew explored the nearby riverbars and wetlands along the toeslope, and scouted routes to the ridge on the extreme northern edge of the park. The location was 59.448º N and 138.020º W and 85 m elevation (Fig. 27). Due to poor visibility the second flight of equipment did not reach the crew for a few days, so the botany crew was restricted in the amount of exploration possible in this location. Habitats within the survey area were moderately diverse. Well drained river bars of various successional stages were the most common habitats sampled (Figs. 28, 29). Additionally, the field crew encountered well developed wetlands at the mountain toeslope, which were primarily drawn-down beaver ponds (Fig. 30.). The major associated species at this site were *Calamagrostis canadensis*, *Carex lenticularis*, *Carex utriculata*, *Eleocharis palustris*, *Alnus viridis* ssp. *sinuata*, and *Rubus spectabilis*. Investigation of the south-facing slope indicated that access to alpine habitats was not achievable.

Figure 29. Temporary camp along the Alsek River at the B.C. border (59.448º N, 138.020º W). Dominant species are *Populus balsamifera* ssp. *balsamifera*, *Salix setchelliana*, *Salix alaxensis*, *Hedysarum boreale* ssp. *mackenziei*, and *Oxytropis campestris* var. *varians*.

Figure 30. Drawn-down beaver pond wetland site along the Alsek River at the B.C. border. Dominant species are *Calamagrostis canadensis*, *Carex lenticularis*, *Carex utriculata*, *Eleocharis palustris*, *Alnus viridis* ssp. *sinuata*, and *Rubus spectabilis*.

Alsek Area 2

Figure 31. Botanist Steve Gisler lining the raft to the south side of the Alsek River.

The crew moved directly across the river (Figs. 31, 32) to the southern side of the river in an attempt to access alpine habitats via avalanche gullies. Collections on 26 and 27 June 2003 included alluvial-associated habitats, avalanche gullies, and alpine meadows to 550 m elevation in an area approximately 1.5 km downstream from the B.C. border (59.424º N, 138.000º W; Fig. 34). The habitat at the river's edge was quite similar to early seral staged communities on the north side of the river. On the sideslopes there was a few broad avalanche gullies that were inventoried. In the most active zone of the avalanche gullies there was almost no vegetation; along the edges of the gullies there were increasing numbers of vascular plants and increasing plant cover. At the extreme edge of the avalanche gully Sitka alder dominated and plant diversity once again dropped. The dominant species of the 12 specimens collected in the avalanche gully were *Alnus viridis* ssp. *sinuata*, *Aruncus dioicus*, *Chamerion latifolium* (= *Epilobium latifolium*), and *Cryptogramma crispa* (Fig. 33). In the alpine zone 27 species were collected from a diversity of microhabitats including; moist graminoid meadows, rocky outcrops, loose talus, and ericaceous alpine tundra (Fig. 34).

Figure 32. Collection areas along the Alsek River at the Alaska- B.C. border (shown in blue). Collection Areas 1 and 2 are shown as triangles. Areas traversed are indicated as the white dashed line. Arrow indicates the direction of water flow

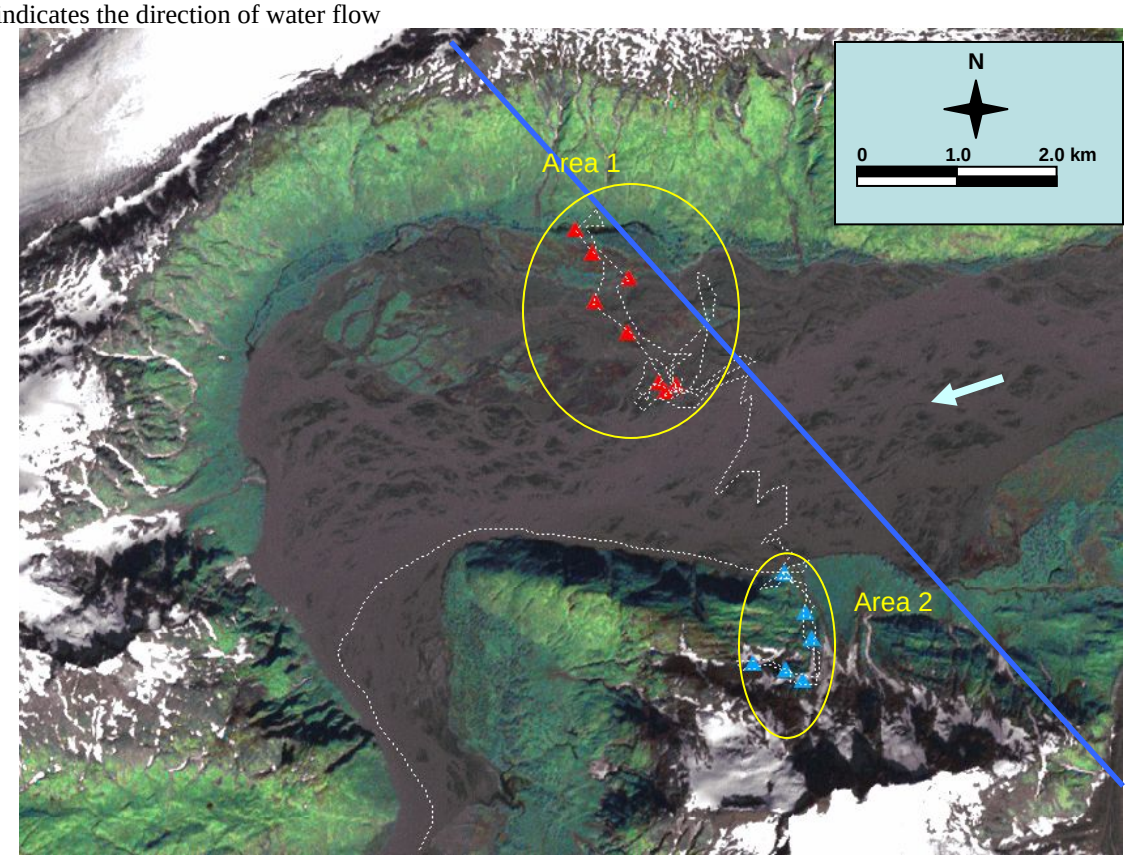


Figure 33. Avalanche gully along the Alsek River near the B.C. border. Dominant species are *Alnus viridis* ssp. *sinuata*, *Aruncus dioicus*, *Chamerion latifolium*, and *Cryptogramma crispa*.

Figure 34. Moist ericaceous heath-forb meadow dominated by *Luetkea pectinata*, *Phyllodoce glanduliflora*, *Valeriana sitchensis*, *Vaccinium uliginosum*, and *Carex macrochaeta*. The Alsek River is visible in the upper left.

Alsek Area 3

This area was just downstream from Walker Glacier on the north side of the river where a steep, narrow drainage cut through the alders (59.420ºN, 137.995ºW, Fig. 35); collections occurred on 27 June 2003. The elevation was 67-94 m. The plant habitat was a closed cottonwood-alder woodland with small forb-graminoid openings on an elevated river terrace. Soils were deep, moist sand with a very thin organic layer. Dominant associated species were *Populus balsamifera*, *Alnus viridis ssp. sinuata*, *Calamagrostis canadensis*, *Chamerion angustifolium* (= *Epilobium angustifolium*), *Heracleum maximum* (= *H. lanatum*), *Viburnum edule*, and *Salix glauca* (Figs. 36, 38). Twenty four species were collected from rock outcrops and steep, open graminoid meadows on either side of the narrow drainage above the river terrace. Mesic, organic soils surrounded dioritic rock-faces. Dominant species at the open graminoid-outcrop sites were: *Aruncus dioicus*, *Elymus glaucus*, *Sanguisorba canadensis*, *Achillea millefolium* var. *borealis* , and *Fritillaria camschatcensis* (see Fig. 37). On the south side of the drainage, the dominants were *Alnus viridis* ssp. *sinuata*, *Aruncus dioicus*, *Oplopanax horridus*, *Festuca altaica*, and *Saxifraga oppositifolia*.

Figure 35. Collection areas along the Alsek River near Walker Glacier. Specific collection sites are shown as triangles. Areas traversed are indicated as the white dashed line. Arrow indicates the direction of water flow.

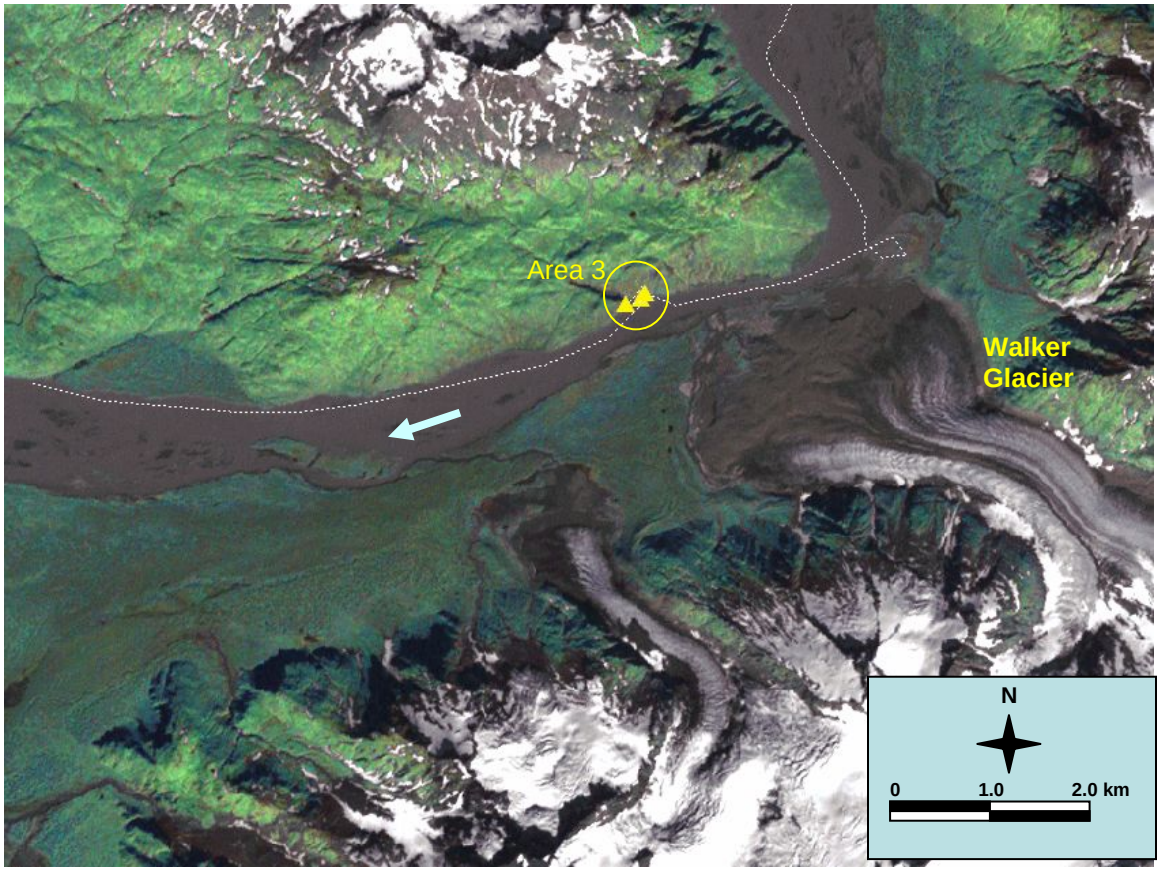


Figure 36. Narrow drainage and river terrace (to the left) running into the Alsek River below Walker Glacier, Area 3.

Figure 37. Open forb-graminoid slope and rock outcrop at Area 3. Dominant species are *Aruncus dioicus*, *Elymus glaucus*, *Sanguisorba canadensis*, and *Fritillaria camschatcensis*.

Alsek Area 4

A small number of specimens were collected from the broad Novatak outwash plain and adjacent river terraces at the confluence with the Alsek River (59.382ºN, 138.254ºW; elev. 66-89 m, Fig. 39). Sampling Area 4 included an open, early seral herbaceous community and a closed alder thicket on the river terrace. The area was inventoried on 28 June 2003. There was more than 90% bare ground at the early seral community and the few associated species were *Salix glauca, Chamerion latifolium, Calamagrostis canadensis,* and *Trisetum spicatum* (Fig. 40). *Alnus viridis* ssp. *sinuata, Salix glauca, Populus balsamifera, Calamagrostis canadensis,* and *Trisetum spicatum* were dominants in the alder scrub community (Fig. 41). Substrates were well-drained, sandy soils or a thin organic layer over river cobbles.

Figure 38. Closed cottonwood-alder woodland with small forb-graminoid openings on an elevated river terrace at Area 3.

Figure 39. Collection areas of the Alsek River near Novatak River. Specific collection sites are shown as triangles. Areas traversed are shown as the white dashed line. Blue arrow indicates the direction of water flow.

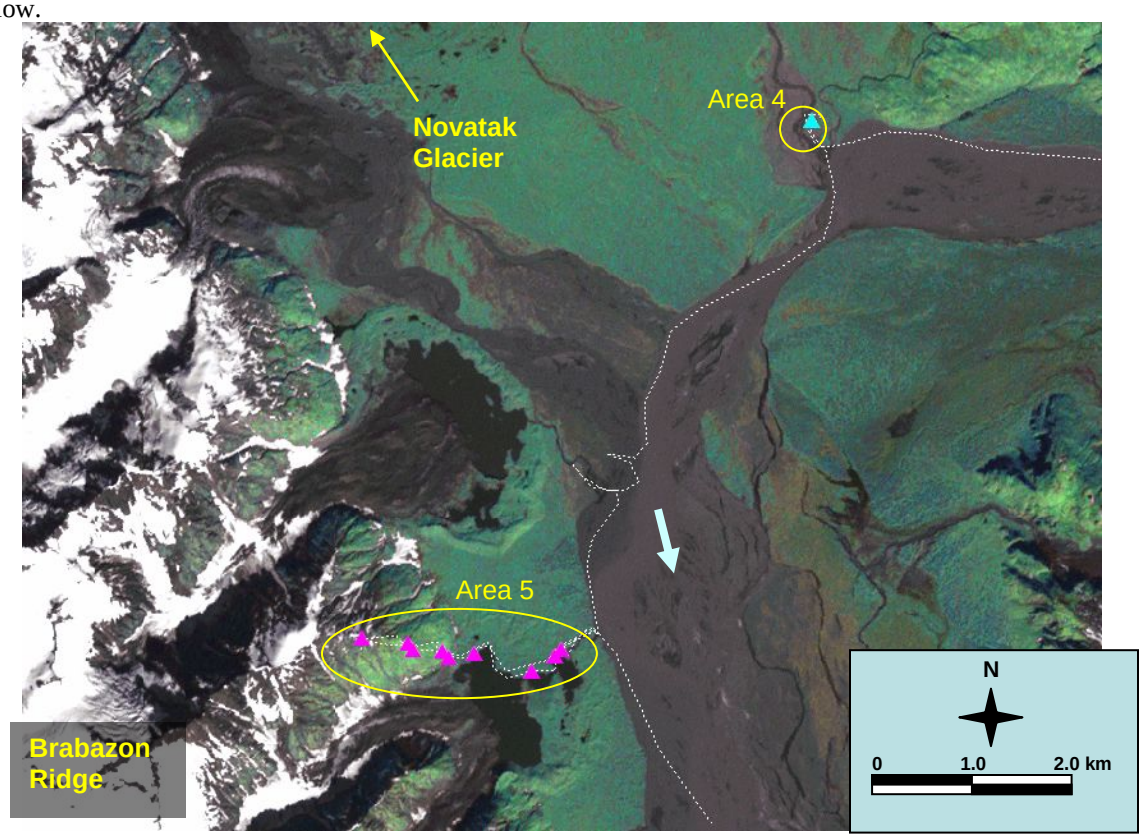


Figure 40. Open early seral community on the broad Novatak outwash plain at the confluence with the Alsek River (Area 4).

Alsek Area 5

Figure 41. Closed alder thicket on an elevated river terrace near the Alsek Novatak confluence.

After unsuccessful attempts to access high elevations southwest of Area 4, we drifted downstream to 59.326ºN, 138.295ºW on 29 July 2003, where a series of streams and avalanche gullies afforded a route to the alpine zone (Figs. 39, 42). This area had diverse habitat types and collections were made along the margins of glacial outwash ponds, alder thickets, rocky avalanche gullies, herbaceous alpine meadows, and alpine fellfields. Approximately ten specimens were collected from saturated muddy soils along the narrow margin between thick alder scrub and the glacial pond (Fig. 43). We made a few collections along the eroding side of a steep lateral moraine above the lake at 118 m. On the north side of the moraine the habitat transitioned to an alpine-heath meadow surrounded by alder and salmonberry scrub at 190 - 600 m. We made approximately ten collections from this habitat type, which was dominated by *Luetkea pectinata*, *Harrimanella stelleriana*, *Leptarrhena pyrolifolia*, *Elliottia pyroliflorus*, and *Geum calthifolium*. Above 700 m the slopes lessened and the habitat was alpine forb-graminoid meadows dominated by *Salix arctica*, *Lupinus nootkatensis*, *Geum calthifolium*, and *Carex macrochaeta* (Fig. 44). An additional eight collections were made from open, alpine fellfield habitats with less than 15% plant cover of *Harrimanella stelleriana*, *Empetrum nigrum*, *Sibbaldia procumbens*, and *Kumlienia cooleyae* (= *Ranunculus cooleyae*).

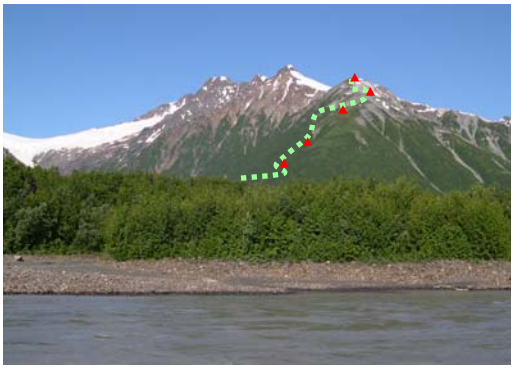


Figure 42. View of Area 5 from the Alsek River. Route (green) and collection sites (red triangles) are shown.

Figure 43. Collection site along a glacial pond at Area 5 (59.326ºN, 138.295ºW).

Dry Bay Forelands Region

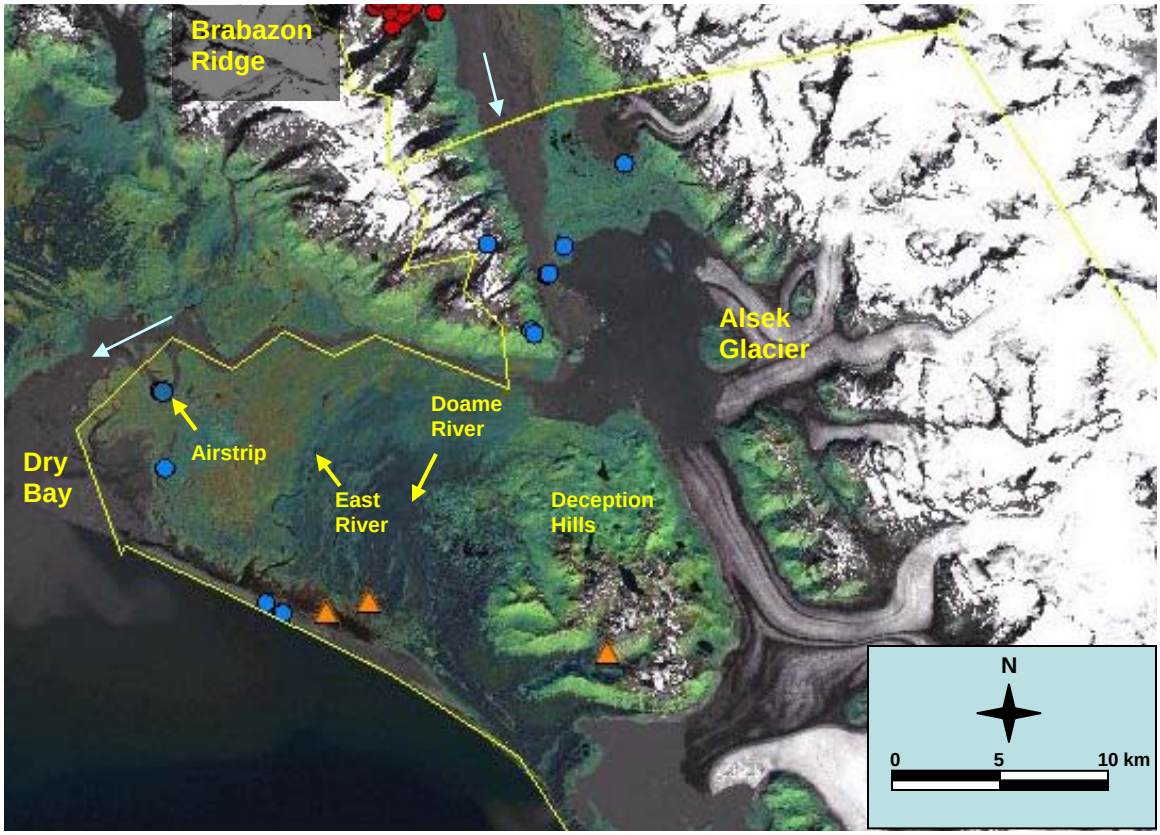
The landcover mapping project made collections from the region extending from lower Brabazon Ridge and Alsek Lake south to the Doame River and Deception Hills on the outer coast in 2001. In 2003 surveys were restricted to sand dunes near Alsek Lake and river terraces around the Dry Bay airstrip (Fig. 45).

Figure 44. Alpine forb-graminoid meadow above the Alsek River (left) at 700 m. The dominant species were *Salix arctica, Lupinus nootkatensis, Geum calthifolium,* and *Carex macrochaeta*. (The glacial pond from the above photo is visible on the left.)

The Dry Bay Forelands are characterized by a vast, gently sloping coastal plain juxtaposed with the steep, angular mountains of the Fairweather Complex (see Fairweather Region). The forelands are a combination of unconsolidated glacial, alluvial, and marine deposits that have been uplifted by isostatic rebound and plate tectonics (Nowacki et al. 2001). A series of ancient beach ridges is evident and run parallel to the coast. Precipitation is very high in this area and most soils are perpetually saturated. Wetland communities predominate, with spruce and hemlock forests occurring only on well-drained stream levees, uplifted beach ridges, and moraines. Braided glacial meltwater rivers are common in the Dry Bay Forelands. Intertidal communities and estuaries are extensive as well.

Eleven collection sites were visited in 2001 and five sites in 2003. Because the sites are clustered in distinct areas, we discuss topological, geological, and habitat characteristics of each area separately as in the Alsek Region.

Figure 45. Collection sites in the Dry Bay region. AKNHP-NPS 2001 and 2003 collections are shown as blue circles. Previous collections are shown as orange triangles. Arrows indicate the direction of water flow.

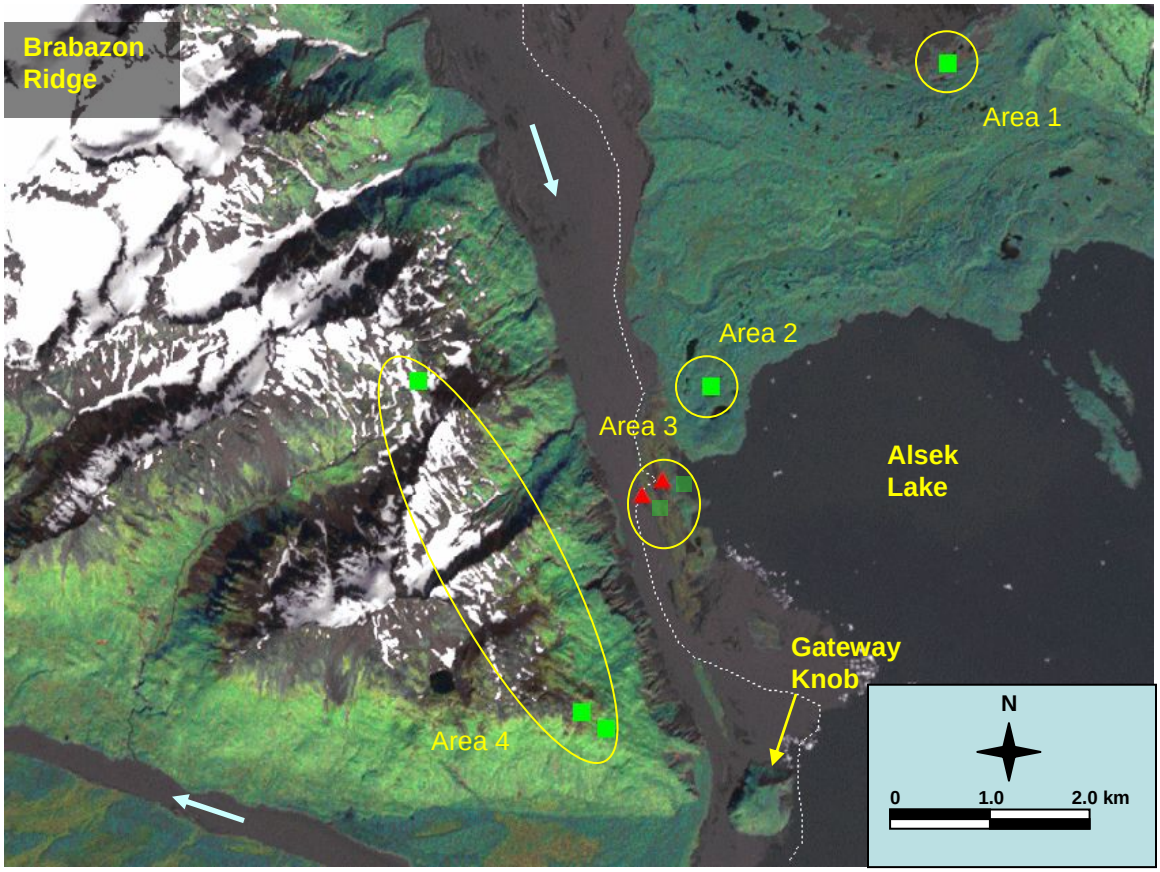


Dry Bay Area 1

AKNHP and NPS botanists collected 2 specimens from a relatively young alder scrub community on large morainal cobbles on 20 August 2001 (Fig. 46). The location was 2.5 km north of Alsek Lake, 59.266ºN, 138.149ºW at 73 m elevation (Fig. 47). Associated species were *Alnus viridis* ssp. *sinuata, Salix sitchensis, Chamerion latifolium,* and *Stellaria crassifolia*. Soils were composed of glacial tills overlain with a thin layer of organics.

Figure 46. Alder scrub-early seral forb community near Alsek Lake, Area 1.

Figure 47. Collection areas in the Dry Bay region along the lower Alsek River. Specific collection sites are shown as squares (2001) and triangles (2003). Areas traversed in 2003 are shown as the white dashed line. Blue arrows indicate the direction of water flow.



Dry Bay Area 2

Figure 48. Wetland community dominated by sedges and occasional willows (Dry Bay Area 2).

Brief sampling occurred in a small wetland on 20 August 2001. The edge of the small pond was surrounded by 2 m tall *Salix commutata*. The location was on the north spit of Alsek Lake (59.232ºN, 138.192ºW) at 46 m elevation (Fig. 47). Associated species were *Carex aquatilis* var. *aquatilis*, *Carex aquatilis* var. *dives* (= *C. sitchensis*), *C. rostrata*, *C. lenticularis* var. *lipocarpa* (= *C. kelloggii*), and *Equisetum variegatum* (Fig. 48).

Dry Bay Area 3

AKNHP and NPS botanists collected 20 specimens from extensive sand dunes of various seral stages on 20 August 2001 and 30 June 2003. The location was 2 km north of Alsek Lake (59.323ºN, 138.344ºW) at 44 m elevation (Fig. 47). Associated species of the younger, beach rye-forb communities were *Leymus mollis, Salix alaxensis, Aster sibiricus, Equisetum variegatum,* and *Hedysarum alpinum* (Fig. 49). Collections were also made in more stable habitats supporting small stands of cottonwoods. These communities were dominated by *Populus balsamifera* ssp. *trichocarpa, Salix alaxensis, Hedysarum alpinum, Astragalus alpinus*, and *Astragalus robbinsii*.

Figure 49. Beach rye-forb sand dunes of Dry Bay Area 3. Lower Brabazon Ridge is on the right.

Dry Bay Area 4

On 20 August 2001 high elevation communities on lower Brabazon Ridge were surveyed (59.198ºN, 138.214ºN; elev 520-760 m). The alpine habitats were moist, steep heath and graminoid meadows. Considerable amounts of exposed bedrock and scree were observed in this area (Fig. 50). The associated species included *Vahlodea atropurpurea*, *Calamagrostis canadensis*, and *Carex macrochaeta*. The heath-dominated collection sites were composed of *Phyllodoce glanduliflora*, *Luetkea pectinata*, and *Empetrum nigrum*, as well as forbs and grasses.

Figure 50. Alpine heath community on Brabazon Ridge, Dry Bay Area 4.

Figure 51. Dry Bay Area 5, a low river terrace near the Dry Bay airstrip, bordered by thickets of willows, alders, and cottonwoods.

Dry Bay Area 5

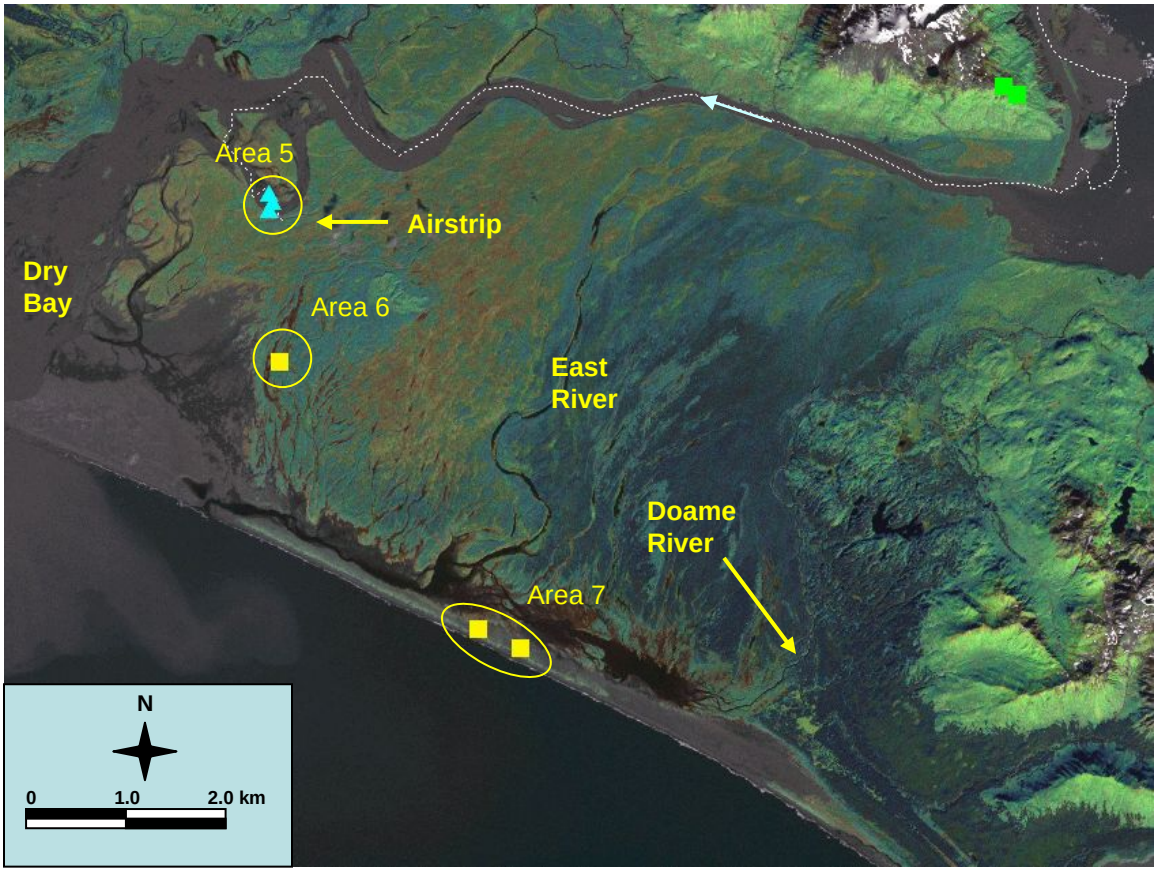
Seven collections were made on 1 July 2003 along river terraces at Dry Bay (59.167ºN, 138.500ºW) along the river at 11 m elevation (Fig. 52). The community was an early seral forb-

graminoid scrub (Fig. 51). Dominant plant species at this area included *Festuca rubra, Fragaria chiloensis, Deschampsia beringensis,* and *Salix setchelliana*. Substrates were dry, well-drained, and gravelly.

Dry Bay Area 6

A few specimens were collected on 20 August 2001 in wet meadow, near a tidal slough, (59.137ºN, 138.489ºW) at sea-level (Fig. 52). Dominant plant species at this area included *Eleocharis* spp., *Equisetum* spp., and mosses.

Figure 52. Collection areas of the Dry Bay survey region along the lower Alsek River. Specific collection sites are shown as squares from 2001 and triangles from 2003 (in the vicinity of Dry Bay airstrip). Areas traversed in 2003 are shown as the dashed white line. Arrow indicates the direction of water flow



Dry Bay Area 7

A few collections were made on 21 August 2001 along beach habitats and brackish marshes at 59.082ºN, 138.394ºW at sea-level (Fig. 52). At one site the geomorphology was comprised of stabilized sand dunes that were vegetated with sandloving species (psammophytic) with scattered alders. The associated species included *Fragaria chiloensis, Leymus mollis,* and *Castilleja unalaschcensis*. A

Figure 53. Dry Bay Area 7, a brackish marsh and mudflat along the East River estuary.

dried brackish marsh and mudflat were surveyed nearby on the lower East River. This community was dominated by *Alopecurus aequalis, Juncus bufonius, Poa eminens,* and *Sisyrinchium litorale* (Fig. 53).

Field Methods

During 2001 the field personnel consisted of three teams of two people. Transportation to the transects was by helicopter or by boat. The boat was the Fish and Wildlife Service "Surfbird" and was used only for visiting transects in Glacier Bay because helicopters were not permited in Glacier Bay proper.

A floristic inventory was completed at each landcover plot (see Boggs et al. in prep. for more details) and additional species were collected as the transect was walked.

A complete list of species was made for each 10 x 10 m plot. The following data were recorded for each vouchered specimen: date, unique collection number, latitude and longitude, slope, aspect, elevation, topographic position, vegetation classification (based on Viereck et al. 1992), plant association, substrate, parent material, cover, notes on characters not preserved well, associated photo number, and phenology.

The size of the population and area surveyed was included for species of concern.

Also, collections were made only if the population was large enough to support removal of individuals and followed the collecting protocol of Murray and Parker (1990) and Parker and Murray (1992). Rare plant sighting forms with maps were completed for species with an AKNHP state rank of less than 3 ("rare or uncommon," see Appendix IV for discussion of Heritage Program ranks).

Field data was collected during a 23 day field season in the summer of 2001 (16 July to 21 August). Between 12 June and 1 July 2003 an AKNHP botanist and a volunteer professional botanist conducted the fieldwork at the Alsek River Valley and Dry Bay regions.

These regions were accessed by fixed-wing aircraft and by raft. At each region we made a complete floristic inventory using the following methods. Each region was mapped on an aerial photo or USGS topographic map and a georeference point was recorded using global positioning system. The routes surveyed were also mapped. Representative photos were taken of each region including communities, unusual landforms, and notable plants. A description of each region was recorded and significant landforms and plant associations were described. As new communities were encountered the following data were recorded: vegetation type, slope, aspect, elevation, topographic position, moisture, soil types, parent material, cover classes of growth forms and bare ground, and dominant species by growth form. A complete species list was compiled for each region. Additional data were gathered specific to the location, habitat, etc. in which plants were collected (these collection localities are referred to as "collection sites"). The nature of data collected is discussed in the following section. Aerial-oblique photos of the region and photo of significant plant associations were often taken on departure. Vouchers were collected and curated as discussed below.

Vouchers and Curation

The following data were recorded with each vouchered specimen: date, unique collection number, latitude and longitude (NAD27, decimal degrees); slope, aspect, elevation, topographic position, associated landforms, associated species, vegetation class, substrate, soil moisture, soil type, drainage, parent material, cover class and frequency class, notes on characters not preserved well, associated photo number, phenology and ecological observations. A "collection site" is a location in which plants with the same specific latitude, longitude, habitat type, and collection date are collected. Collection sites can include from just a single vouchered specimen to over 20, and is confined to an area of less than 400 m^2 of similar habitat attributes.

The size of the population and area surveyed was included for species of concern.

The first set of collection sheets were archived at the Herbarium of the University of Alaska Museum (ALA) and the duplicate set were sent to NPS if enough material was present for a second sheet.

Specimens were given conditional names in the field by AKNHP and NPS staff. The plants were later sorted, examined and identified by AKNHP botanists and the collections were then sent to ALA where notable finds and difficult taxa were reviewed by the Museum staff. As needed, specimens were sent out to authorities by ALA for determination. Specimens to be archived at ALA and those to go to park herbaria were prepared at ALA.

RESULTS

Significant increases in the number of vascular plant species verified for GLBA were made in 2001 and 2003. Prior to 2001, 69% of the 625 expected taxa were known from GLBA. Following the 2001 field season, 145 collections were made of taxa considered “probably present” but not vouchered, 16 new taxa were collected that were not originally predicted to occur in the park, and 34 collections represented vouchered collections of previously “unconfirmed” taxa. Thus, the percentage of documented vascular plant taxa rose to 88% following the 2001 field season.

In 2003, the percentage of known taxa increased an additional 4.5% to 92.5%, reaching the park’s objectives in documenting greater than 90% of vascular plant taxa in GLBA. A total of 25 taxa were collected that were considered “probably present.” Eleven additional taxa were of plants not expected to occur in the park. Ten collections were of specimens that were documented, but not from verified voucher specimens. Because taxa were collected that were not on the list of 625 expected, the number of expected taxa should be adjusted to 652. Additional, targeted floristic inventories would likely reveal 10-20 new taxa to the park. The relevance and importance of the finds are discussed in sections following the general discussion of collections.

A list of confirmed and expected taxa in GLBA prior to 2001 fieldwork is presented in Appendix I. An annotated species list describing all taxa and the basic topographic and habitat attributes is presented in Appenedix II. Appendix III gives a list of rare species encountered. AKNHP rare plant ranks are given in Appendix IV and a user’s guide to the GIS product is given in Appendix V.

Regional Collections

Fairweather Range Region

A total of 26 specimens, representing 23 separate taxa, was collected from 13 sites in the Fairweather Range. Ten taxa were collected that were previously known from Glacier Bay. Eleven taxa were collected that were listed as "probably present," and two additional species were collected that were not expected to occur in the park. The taxa new to GLBA were the wetland species: *Platanthera chorisiana*, *Scheuchzeria palustris*, *Scirpus microcarpus*, and *Utricularia intermedia*. Mid-elevation species of meadows were *Cinna latifolia*, *Deschampsia caespitosa*, and *Luzula multiflora*. Subalpine-alpine species were *Anemone narcissiflora*, *Carex nigricans*, *Empetrum nigrum*, *Juncus mertensianus*, and *Salix stolonifera*. All of these species are quite widespread, with the exception of *Platanthera chorisiana*, in southern Alaska and have likely been overlooked because they occur in wetland or high-elevation areas that are difficult to access, or they were not collected because they are so common (e.g., *Empetrum nigrum*, *Deschampsia caespitosa*). *Platanthera chorisiana* is a rare orchid that is discussed in detail in the Discussion section. One taxon, *Scheuchzeria palustris* (rannoch rush), is uncommon north of Kupreanof Island in southeast Alaska, but is known from a few collection sites in southcentral Alaska. This species appears to be more common throughout boreal Canada (see Hultén 1968).

Carex glareosa ssp. *glareosa* and *Rhynchospora alba* were two species of the Cyperaceae family that were not expected to occur in the park. Collections of *C. glareosa* ssp. *glareosa* are known from upper Lynn Canal, and *R. alba* is a species of saturated peaty or sandy soils known primarily from the southern half of Southeast Alaska (Hultén 1968). Small populations of *Rhynchospora alba* are also found in southcentral Alaska and the collection in Glacier Bay represents an important addition to filling in the species' range.

Voucher specimens were collected for three additional species (*Carex gmelinii*, *Pedicularis oederi*, and *Potamogeton gramineus*) that were previously listed as "unconfirmed."

Cape Spencer Fjords Region

A single collection of *Juncus drummondii* was made in high elevation dwarf shrub tundra at DeLangle Mountain. According to the NPSpecies Database, this taxon is known from the park from two collections at high elevations: one on Excursion Ridge by Streveler in 1982 and the other from Red Mountain by Worley in 1969.

Dundas River Region

Collection intensisty and habitat diversity was high in this region; 83 species were collected, 61 were new park records. Many new records were of widespread graminoid taxa (*Carex* spp., *Eriophorum russeolum* var. *majus*, *Poa* spp., *Calamagrostis canadensis*, *Agrostis aequivalvis*, *Juncus* spp., and *Luzula* spp.) associated with mesic or wetland habitats. Two ferns were collected that were new to the park: *Blechnum spicant* and *Woodsia ilvensis*. Two dwarf ericaceous shrubs, which are widespread in mesic tundra throughout Alaska and the circumpolar region, were collected that were new to GLBA: *Andromeda polifolia* and *Loiseleuria procumbens*.

We collected four different genera of orchids that represent new species to the park. *Goodyera oblongifolia* is an evergreen species generally found growing on humus among mosses in closed coniferous forests. Our collection was from a mossy open limestone cliff on Drake Island. This

species is found throughout Southeast Alaska south to California. Northwestern twayblade, *Listera caurina* is another species of moist humus in closed forests with a northwestern Pacific Coast distribution. In an open, saturated herbaceous meadow near Dundas River, *Malaxis diphyllos* (= *M. monophyllos*) was collected. Last, the rare Alaskan orchid, *Piperia unalascensis* (= *Platanthera unalaschcensis*) was collected in a *Dryas integrifolia*-dwarf shrub habitat on Willoughby Island. This taxon is widespread throughout western North America, but is very rare north of Washington State; only a few isolated populations are known in Alaska, and this species was not expected to occur in the park. *Piperia unalascensis* is ranked G5-S2 by the Alaska Natural Heritage Program.

Four other taxa were collected that were not expected for the park. All of these were species of *Carex*. Two were collected from limestone substrates (*C. atratiformis* and *C. glacialis*). *Carex atratiformis* is a tall, North American sedge known mostly from the upper Tanana River and southern Yukon. *Carex glacialis* is a circumpolar species, restricted to calcareous lithologies, known from upper Lynn Canal (Hultén 1968). The other sedges were *C. canescens* and *C. glareosa* ssp. *glareosa* (also collected in Lituya Bay). *Carex canescens* is very widespread throughout the boreal northern hemisphere in fens and swamps, and has been collected widely in Southeast Alaska. *Carex glareosa* ssp. *glareosa* was discussed in the Fairweather Range Results section. The population collected in Dundas Bay was in a sandy substrate near the tideline like the Lituya Bay population.

Salmon River Hills Region

Many previous collections were known from this region due to the proximity to Gustavus and NPS facilities in Bartlett Cove. AKNHP and NPS made 54 collections representing 52 taxa. A total of 22 taxa were new to the park, most of which were expected to occur. The new species were *Agrostis aequivalvis* (= *Podagrostis aequivalvis*), *Agrostis exarata*, *Alopecurus pratensis*, *Anemone parviflora*, *Antennaria pulcherrima*, *Botrychium virginianum*, *Carex limosa*, *C. rostrata*, *C. saxatilis*, *Deschampsia caespitosa*, *Eriophorum viridicarinatum*, *Galium trifidum* ssp. *trifidum*, *Gentiana douglasiana*, *Juncus falcatus*, *Juncus mertensianus*, *Packera pauciflora* (= *Senecio pauciflorus*), *Prunella vulgaris*, *Pyrola chlorantha*, *Scheuchzeria palustris*, *Streptopus streptopoides*, and *Vaccinium vitis-idaea* . Many of these taxa were collected elsewhere in 2001 and 2003 by AKNHP and NPS botanists and are widespread in the park.

Six species were collected that represent confirmations of unconfirmed taxa. One species, *Calamagrostis lapponica*, was not expected to occur in GLBA. This is a circumpolar species, generally restricted to the interior of Alaska (except along the Bering Coast). According to Hultén (1968) it is found mostly in the mountains in dry places. However, our two collections were from low elevation peaty fens.

Adams Inlet Region

From the Beartrack Mountains to the upper reaches of Muir Inlet, including extensive areas around Adams Inlet, 121 specimens (99 separate taxa) were collected in 2001. Of the total, 49 were new park records and ten were confirmations of previously unconfirmed taxa.

Five of the new records were of species that were not expected to occur in GLBA. Most of these were graminoids: *Carex canescens*, *C. foenea* (= *C. foena*), and *Bromus ciliatus*. The other two species were *Botrychium lanceolatum* and *Agoseris glauca*. *Botrychium lanceolatum* (found at 1,000 m) and *C. canescens* are widely distributed across southern Alaska and it was not surprising to have collected them. However, *C. foenea* is not widely collected in Alaska. Its

distribution includes all Canadian provinces as well as the New England and mid-western states and extreme eastern Alaska (Mastrogiuseppe et al. 2002). This taxon was collected twice in the Adams Inlet region: once near the terminus of Muir Glacier (59.075°N, 136.275°W; 120 m elev.) in a small wetland between alder thickets, and another collection was nearby, but collected at 1,000 m elevation on an alpine ridge on Mt. Brock (59.095°N, 136.269°W). *Agoseris glauca* is primarily a Cordilleran species, barely reaching Alaska in upper Lynn Canal. This taxon is listed as globally widespread, but critically imperiled in the state of Alaska (G5-S1, AKNHP). The collection in GLBA was from the same Mt. Brock site as the *C. foenea* specimen.

Of the species found that were considered likely to occur, *Cypripedium montanum* (mountain ladyslipper) is a rare taxon in Alaska. The orchid has a distribution quite similar to *Agoseris glauca*, with populations known only from the northern edge of Southeast Alaska. *Cypripedium montanum* was collected twice in the mountains surrounding Adams Inlet. It was collected on the north side, from Granite Canyon (58.948°N, 135.844°W; 630 m elev.) in a brushy mid-slope and on the south side of Adams Inlet from Tree Mountain (58.862°N, 135.792°W; 900 m elev.). The AKNHP lists *C. montanum* as secure globally, but critically imperiled at the state level (G5G4-S1).

We also made a collection of *Rorippa curvisiliqua*, a widespread western North American mustard that is quite rare in Alaska. This taxon was collected north of Beartrack Cove at ca. 50 elevation in a fen dominated by *Carex lenticularis* var. *lipocarpa* (= *C. kelloggii*), *C. rostrata*, liverworts, and *Viola* sp.. Four unverified collections were already known from the park. These collections were located in wetland or beach rye habitats.

Tarr Inlet Region

Relatively few collections were known from the Tarr Inlet region prior to AKNHP-NPS collections in 2001. We collected 54 specimens, representing 46 separate taxa. Nineteen of these are new records for GLBA and an additional six are confirmations of previously unverified records.

The majority of new plants were species that were not unusual and were generally collected elsewhere in GLBA in 2001 or 2003, such as *Salix arctica, S. stolonifera*, and *Leptarrhena pyrolifolia*.

Two collections were of rare species, *Piperia unalascensis* (= *Platanthera unalaschcensis*) and *Eleocharis kamtschatica*. The orchid was found in an open, mixed shrubland with small Sitka spruce near Vivid Lake on limestone substrates (58.859°N, 136.494°W; 40 m elev.). This species was also collected on calcareous substrates of Willoughby Island in the Dundas River Region. It is listed as G5-S2 by AKNHP. The Kamtschatica spike rush was collected from an uplifted tidal marsh at Hugh Miller Inlet (58.735°N, 136.497°W) in a community dominated by wetland *Carex* species. This species is listed by AKNHP as G4-S2.

Alsek River Valley Region

Prior to this survey, only a handful of plant collections was known from the Alaskan portion of the Alsek River. Nearly all of the collections were from low elevations along the river bank. In a single drift trip from the B.C. border to Dry Bay, a distance of roughly 65 km, we collected 154 specimens. Of these, 35 were new records for the park. Nearly all of the species collected are relatively common in Alaska and adjacent provinces, and many are distributed throughout the holarctic region. Roughly one third of the species collected are generally restricted to the more

continental climates of interior Alaska and Yukon. Two species of conservation concern were encounterd and a moderate range extension to the south was documented.

Alsek Area 1

At the Alaska-British Columbia border, 25 specimens were collected from early seral river terraces and lower elevation wetlands. The location was 59.448º N and 138.020º W and 85 m elevation (Fig. 32). Common habitats were open gravel bars-early seral scrub, alder-willow thickets, and sedge wetlands (Figs. 28, 29, 30). Four taxa were new records.

On the open gravel bars and early seral scrub habitats we encountered a number of species with continental, interior distributions, which are rare for southeastern Alaska. These included *Hedysarum boreale* ssp. *mackenziei* (boreal sweetvetch), *Braya humilis* (low northern-rockcress: Fig. 54), *Listera borealis* (northern twayblade), and the globally rare *Salix setchelliana* (G4-S3). Near this border area, boreal sweetvetch was quite common, forming large, colorful patches (see Fig. 28). However, within a few kilometers downriver from the border this species was seldom seen. *Braya humilis* was found at just a single site, in a shallow depression along a former river channel (Fig. 54). The population of *Salix setchelliana* was estimated at 5,000 individuals. However, extensive underground connections were revealed from the few specimens collected, so the number of genetically distinct individuals is undoubtedly much fewer.

Figure 54. *Braya humilis* (inset) and *Salix setchelliana* site. The diminutive mustard was collected in the shallow depression around the backpack. Setchell's willow are the small shrubs (20 cm tall) more obvious to the lower right of the backpack.

In the wetland area we encountered a number of widespread graminoid species such as *Carex lenticularis*, *C. utriculata*, *Eleocharis palustris*, and *Alopecurus aequalis*. While most of the collections in this wetland were of species that had been collected in Glacier Bay before, none were known from this northwestern corner of the park, and very few other well-developed wetlands were encountered in the Alsek River Valley.

Alsek Area 2

In the alluvial-associated habitats, avalanche gullies, and alpine meadows, approximately 1.5 km downstream from the B.C. border (59.424º N, 138.000º W; Fig. 34), 40 specimens were collected. This included ten species new to Glacier Bay: *Cardamine bellidifolia*, *Carex pyrenaica* ssp. *micropoda*, *Kumlienia* (*Ranunculus*) *cooleyae*, *Oxytropis campestris* var. *varians*, *Poa glauca*, *Poa paucispicula*, *Primula cuneifolia*, *Saxifraga rivularis* (= *S. flexuosa*), *Taraxacum phymatocarpum* (= *T. alaskanum*), and *Vahlodea atropurpurea*. Many of these species are widespread grasses that can easily be overlooked. Quite a few additional alpine taxa were collected, which were previously collected outside of the Alsek River Valley, such as *Antennaria alpina*, *Carex macrochaeta*, *Salix arctica*, *S. stolonifera*, and *Sibbaldia procumbens*. No species encountered here represent significant range extensions or species of concern.

Alsek Area 3

This narrow drainage and river terrace (location: 59.420ºN, 137.995ºW; Fig. 35) with open rocky outcrops yielded a surprisingly high diversity of species, many of which were not found

elsewhere in the Alsek River Valley. A total of 35 taxa was collected from this location. Species that were new records for the area were *Aquilegia formosa, Allium schoenoprasum* var. *sibiricum, Elymus glaucus, Parnassia kotzebuei, Dasiphora floribunda* (= *Potentilla fruticosa*), *Platanthera obtusata, Poa pratensis* ssp. *alpigena, Saxifraga mertensiana,* and *Zigadenus elegans*. Additionally, species generally associated with higher elevations in southern Alaska, such as *Festuca altaica, Carex scirpoidea,* and *Saxifraga oppositifolia* were found near the level of the river (60-95 m elevation). These plants were likely carried down from higher elevations by loose rock. No collections were made of *Saxifraga oppositifolia* since it was not in flower or fruit. This is a species that is often associated with more basic substrates, and the overall diversity of Area 3 suggests that calcareous intrusions may be present. This location requires greater attention, especially at higher elevations.

Alsek Area 4

Corallorrhiza trifida, Streptopus amplexifolius, Phleum alpinum, Stellaria crispa, and *Epilobium hornemannii* were collected from a gravel bar and adjacent river terrace just downstream from Area 3 (59.382ºN, 138.254ºW; Fig. 39). Four of these five species have circumpolar distributions and were previously collected in GLBA.

Alsek Area 5

At this rocky outcrop and bluff on the south side of the river, we collected 36 taxa (location: 59.32ºN, 138.30ºW; Fig. 39). This was one of the higher elevation sites encountered (ranging from 60 m to 820 m). Of the 36 taxa, six were new park records and two were confirmations of previously unverified collections. The six new species were *Antennaria alpina, Carex macloviana, Mitella pentandra,* and *Pedicularis sudetica* (= *P. albolabiata*).

Dry Bay Forelands Region

Extensive collections were made in this region at all elevations. A total of 36 vouchers representing 34 separate taxa were collected. Fourteen of these were new park records, and ten are now vouchered records of formerly unconfirmed taxa.

Dry Bay Area 1

Agrostis mertensii (= *A. borealis*) and *Stellaria longipes* were collected from the young alder stand north of Alsek Lake and an uncosolidated moraine. Both of these species were known from unconfirmed records. *Agrostis mertensii* was likely collected by G. Streveler in 1969, but notes associated with the voucher suggest that it may also be *A. scabra*. Two collections of *Stellaria longipes* are attributed to W. S. Cooper in 1931 from Russell Island in the West Arm of Glacier Bay proper (NPSpecies Database).

Dry Bay Area 2

A single collection of the pondweed *Potamogeton perfoliatus* was made in 2001 from a small wetland pond on the spit separating Alsek River and Lake. This taxon was listed as "unconfirmed" by NPSpecies, based on a collection in 1968 by C. L. Estabrook in Adams Inlet.

Dry Bay Area 3

This was a series of sand dunes built up on the northern edge of Alsek Lake that varied in age, moisture, and exposure (location: 59.02ºN, 156.14ºW; Fig. 47). Twenty-one voucher species were collected, including the species new to the park: *Artemisia tilesii* ssp. *unalaschcensis*, *Aster sibiricus*, *Calamagrostis stricta*, *Carex saxatilis*, *Elymus alaskanus* ssp. *latiglumis* (= *E. trachycaulus* ssp. *violaceum*), *Salix setchelliana*, *Fragaria chiloensis*, and *Botrychium minganense*. These species are common over much of Alaska and boreal North America, with the notable exception of *Salix setchelliana*. This is a rare willow, endemic to Alaska, which was collected in the Alsek Region as well (see above). The collection of the *Botrychium minganense* is noteworthy; recent systematic studies of moonworts (*Botrychium* spp.) have suggested that many populations in Alaska are indistinguishable from Eurasian populations (Stensvold 2001). Additionally, two recently described and extremely rare moonworts are present in the Yakutat and Glacier Bay areas (Stensvold et al. 2002).

Dry Bay Area 4

Ten specimens were collected from two high elevation sites on lower Brabazon Ridge. Five of the collections were of species new to the park. *Carex lachenalii* and *C. nigricans* (collected in the Fairweather region and elsewhere in 2001) are alpine associated species that are relatively common in the northern portion of Southeast Alaska. *Carex lachenalii* is a circumboreal species that tends to have a more northern and interior distribution. Additional collections of new park records were of *Salix stolonifera* (also collected in the Fairweather Region) and the stunning *Rhododendron camtschaticum*. This prostrate shrub is a species generally associated with the Aleutian and Alaska Peninsula coastal foreland flora. It was collected from an alpine slope on Brabazon Ridge and has been observed in other high elevation slopes along the Alsek River (M. Shephard, pers. comm.). *Artemisia furcata* is a new park record, known in Alaska from spotty collections in the Brooks and Alaska Ranges as well as in northwestern Alaska. A few collections have been recorded from mountains near Whitehorse, Yukon. However, no other specimens have been collected in Southeast Alaska, to our knowledge; this collection represents a moderate range extension to the south.

Dry Bay Area 5

Near the Dry Bay Ranger Station seven taxa were collected, four of which are noteworthy. An additional collection site of the rare willow *Salix setchelliana* was made along a sandy river bar. Two species were collected that were not expected, based on known distributions: *Lupinus polyphyllus* and *Taraxacum officinale* ssp. *ceratophorum* (= *T. lacerum*). Large-leaf lupine (*Lupinus polyphyllus*) is generally regarded as an introduced species in Alaska, although native to the Pacific Northwest (Hultén 1968). We also collected the introduced common dandelion (*Taraxacum officinale* ssp. *officinale*) in a forb-graminoid meadow. Many individuals have established in the Dry Bay area, including populations on river terraces and along the landing strip. The native dandelion (*Taraxacum officinale* ssp. *ceratophorum*) was collected from an early seral herbaceous community loosely lined with alders and cottonwoods. This taxon is generally restricted to moist mountain meadows in central Alaska east through Canada. We also made a collection of the common introduced dandelion (*Taraxacum officinale* ssp. *officinale*), which was growing intermixed with the native species.

Dry Bay Area 6

Two collections were made near a stream remnant south of the airstrip. One was of a sedge (*Carex leptalea*) known in the park and the other (*Ribes bracteosum*) was a new record, according to NPSpecies. However, multiple (unverified) collections of stink current are present in the Glacier Bay Herbarium from many locations in the park.

Dry Bay Area 7

In a tidal community near the mouth of East Alsek River, eight taxa were collected. Seven collections were of species already known. One collection was apparently a new park record that was also a rare species: *Botrychium ascendens* (G2G3 – S2). However, three specimens were apparently collected from Glacier Bay by Smith in 1953 (Wagner 1996).

DISCUSSION

Range Extensions

Festuca saximontana Rydb.

Festuca saximontana (Mountain fescue, Fig. 55) is a North American boreal grass of dry mountain slopes. In Alaska it is found from the eastern interior southeast through the Yukon and eventually down into the Rocky Mountains (Fig. 55).

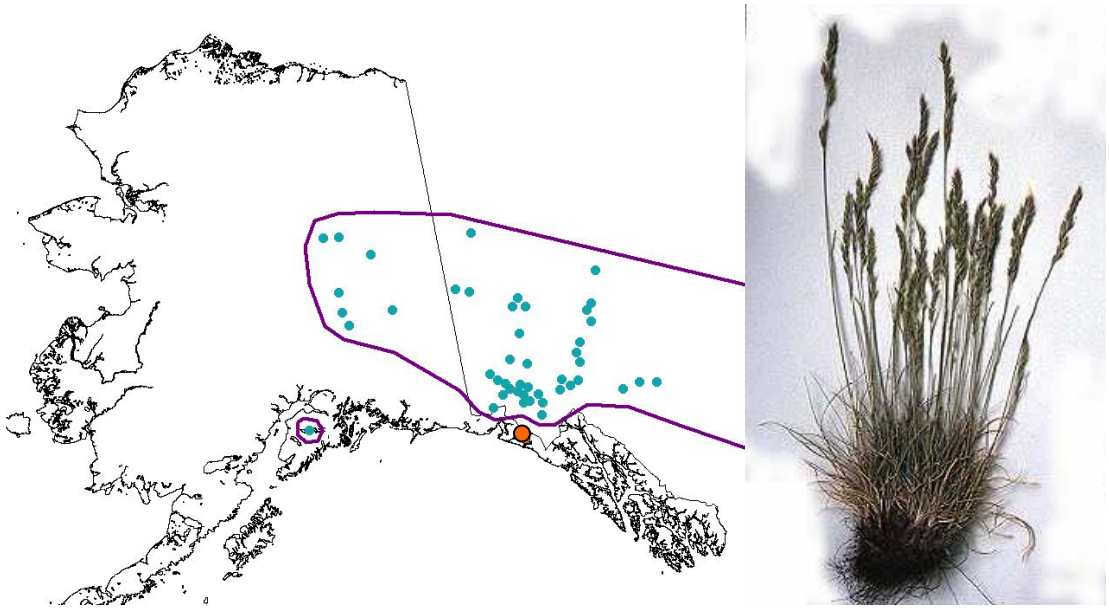


Figure 55. Distribution of *Festuca saximontana* in Alaska, Yukon, and northern B.C. Approximate locations of previous collections are shown as light blue circles (Hultén 1968, Cody 1996). The collection along the lower Alsek River is indicated as an orange circle. Right, photo of herbarium specimen from the Wisconsin State Herbarium, Emmet J. Judziewicz.

The population along the Alsek (Alsek Area 5) is a range extension to the south of approximately 150 km from the Haines Junction area and Tatshenshini River collections in Yukon Territory and northwestern B.C. (Hultén 1968, Pojar and McKeown 1993, Fig. 55). While the distance of the

range extension is not great, the presence of a species restricted to mountains of interior Alaska and Canada is notable. This is the first collection of the taxon on the coastal side of the St. Elias Range. Many of the populations in southwestern Yukon and northwestern B.C. are found within the same drainage (i.e., Tatshenshini-Alsek), and it is not surprising for plants to also be found downstream in Alaska.

Only a few individuals (less than ten) were observed on a mossy rock outcrop in a dense alder thicket along Brabazon Ridge (59.321º N, 138.326º W) at about 100 m elevation. It is likely that other populations are present along the length of the Alsek River, but small fescues are often overlooked. This species is quite similar to *F. brachyphylla* but is generally more than 30 cm tall, has a 3 cm long panicle, and has significantly longer anthers than *F. brachyphylla*.

***Artemisia furcata* Bieb.**

On an exposed alpine swales at 580 m on the east side of Brabazon Ridge (Dry Bay Area 4; Fig. 47) a collection was made of *Artemisia furcata*. This taxon has a spotty distribution, ranging from Mongolia, northeastern Siberia, and northern Japan to northwestern Alaska and the Beaufort Sea in Canada. In Alaska it is known from sites along the Bering Strait and Chukchi Sea as well as alpine locations in the Brooks and Alaska Ranges (Hultén 1968). Many collections have been made in the vicinity of Kluane Lake, Yukon Territory from alpine tundra and talus slopes (Cody 1996).

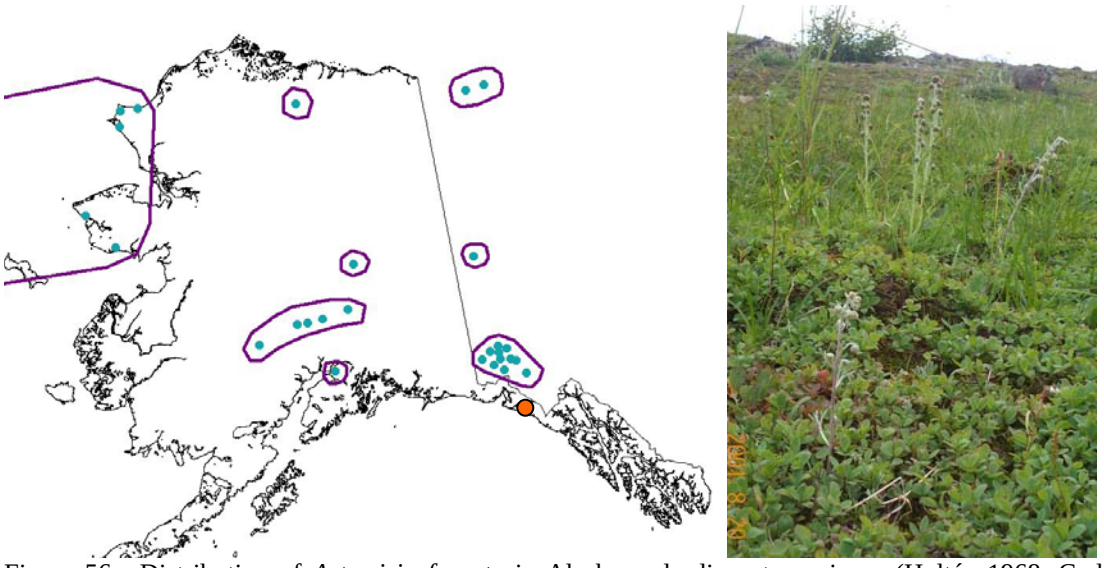


Figure 56. Distribution of *Artemisia furcata* in Alaska and adjacent provinces (Hultén 1968, Cody 1996). Approximate locations of previous collections are shown as blue circles. The collection along the lower Alsek River, Brabazon Ridge is indicated as an orange circle. Right, photo of *Artemisia furcata* at the collection site. The alpine habitat is dominated by *Vahlodea atropurpurea*, *Calamagrostis canadensis*, *Carex macrochaeta*, and dwarf ericaceous shrubs.

The substrate at the Brabazon Ridge site was mesic, acidic organics overlaying dioritic bedrock. The associated species were *Vahlodea atropurpurea*, *Calamagrostis canadensis*, *Carex macrochaeta*, and dwarf ericaceous shrubs such as *Vaccinium uliginosum* and *Arctostaphylos rubra*. This caespitose wormwood with entire to partially lobed cauline leaves (Fig. 56) was found in very limited numbers, perhaps less than 50 individuals were located. In general, this taxon is found on exposed, rocky or sandy slopes in arctic and alpine tundra.

The collection in GLBA represents a moderate range extension to the south (ca. 150 km), very similar to that of *Festuca saximontana* (Fig. 56). This is the first record of the taxon on the coastal side of the St. Elias or Coast Range we are aware of. The presence of forked wormwood this far down the Alsek River is not particularly surprising, and populations are likely along the length of the river corridor.

The occurrence of *Festuca saximontana* and *Artemisia furcata* in the Fairweather Range of GLBA highlights the importance of the Alsek Valley as a conduit for interchange between interior-boreal and coastal associated taxa. A number of other species were encountered along the Alsek River that are more typical of interior habitats and climates: *Hedysarum boreale* ssp. *mackenziei*, *Zigadenus elegans*, *Corallorrhiza trifida*, *Braya humilis*, *Listera borealis*, and *Pedicularis sudetica* (= *P. albolabiata*). It is most likely that these species are entering Alaska through the now ice-free corridor from refugial populations in Yukon.

A few species were collected that are most likely remnants from coastal, ice-free refugia. *Rhododendron camtschaticum* (Fig. 57) is largely an Aleutian-Alaska Peninsular taxon with a few outlying sites on the Kenai Peninsula and east to coastal mountain slopes in the Dry Bay Forelands and one site on Chichagof Island. This species' distribution was likely more continuous until extensive periods of glaciation isolated small populations at the eastern portion of its range. However, it is also possible the outlying eastern populations represent more recent long-distance dispersal events. We collected this species from an alpine site on Brabazon Ridge in 2001.

Figure 57. *Rhododendron camtschaticum*, Brabazon Ridge, Dry Bay Area 4.

Exotic Species

Two exotic vascular plant species were collected in the park. All appeared to have invaded intact communities.

***Taraxacum officinale* ssp. *officinale* Weber ex Wiggers**

The introduced common dandelion *Taraxacum officinale* ssp. *officinale* was confined to a single area in Dry Bay. The location was along river terraces and early seral forb meadows near the Ranger Station and airstrip. The highest densities of plants were in areas of greatest anthropogenic disturbance, but a significant number of plants (>1000) were observed in a native early seral forb meadow northwest of the airstrip on a sandbar island. The associated species were *Festuca rubra*, *Fragaria chiloensis*, and *Deschampsia beringensis*.

This species is most common in mesic, open habitats, and it is a common weed of roads and pastures. It is generally not considered a serious threat in National Parks in Alaska (Densmore et al. 2001) as it does not establish in areas with organic soils and tends to be found only along roadsides and areas of habitation despite its dispersal capabilities. Two other unverified collections of *T. officinale* ssp. *officinale* are known from GLBA; one on Excursion Ridge and the other on Sealers Island. It is possible that these collections are mis-identified native species.

Figure 58. *Lupinus polyphyllus* and *Taraxacum officinale* ssp. *officinale* site in Dry Bay.

Management of this population of introduced *Taraxacum* is probably not feasible, as a large seed source is present in developed areas of Dry Bay, and the population is large and does not seem to be causing serious alterations to the ecosystem.

Native dandelions (*Taraxacum officinale* ssp. *ceratophorum*) were found growing with the introduced species. The native species is distinguished by the presence of horns on the involucral bracts, shorter scapes, and narrower inflorescences (heads) in fruit.

***Lupinus polyphyllus* Lindl.**

At the same location in Dry Bay where *Taraxacum officinale* ssp. *officinale* was found, along undisturbed river terraces and disturbed areas along the airstrip and access roads, *Lupinus polyphyllus* was quite common. The population size for the Dry Bay area is likely over 5,000 individuals and appears to extend over a considerable area. It was growing on sandy substrates with *Festuca rubra*, *Fragaria chiloensis*, and *Deschampsia beringensis*. *Lupinus polyphyllus* is distinguished from native lupines by having ten or more leaflets rather than nine or less.

Lupinus polyphyllus is considered introduced in Alaska from its native range in the Pacific Northwest by many authors (e.g., Hultén 1968, Densmore et al. 2001); however, it is listed as native in Alaska by ITIS and the USDA PLANTS Databases (http://www.itis.usda.gov/ and http://plants.usda.gov/). In Alaska it is found on the Kenai Peninsula, Matanuska Valley, and Denali National Park as well as around Yakutat and has been reported to be spreading along roadsides (e.g., Hultén 1968, Densmore et al. 2001). In southcentral Alaskan sites this species integrates into the plant communit without obvious ecosystem or community alterations. In Denali National Park and outside Kenai Fjords National Park, the plant is restricted to disturbed roadsides (Densmore et al. 2001)

Because the populations in Dry Bay are so large and well established and the seeds are so long-lived (Baskin and Baskin 1998), removal of the population is probably not feasible. Additionally, because the nativity of this taxon is questionable and the taxon appears to not affect ecosystem processes, we suggest casual monitoring in the future rather than control.

Species of Conservation Concern

We collected four species that are uncommon globally and very rare in Alaska, as well as six species that are relatively common globally, but critically imperiled in Alaska.

***Botrychium ascendens* W.H. Wagner (G3G2-S2)**

A few individuals of the rare moonwort *Botrychium ascendens* were collected at a beach spit at the mouth of East River in the Dry Bay area (59.082°N, 138.394°W). The site was of stabilized sand dunes that were sparsely vegetated by grasses, *Fragaria chiloensis*, and *Castilleja unalaschcensis*. *Botrychium ascendens* is listed as rare to imperiled globally and imperiled within the state (G3G2 – S2 AKNHP rare plant tracking list, see Appendix IV).

Most *Botrychium* species are rather difficult to distinguish (this specimen was sent to the taxonomic specialist Mary Stensvold, USDA Forest Service, for identification). *Botrychium ascendens* is smaller than *B. lunaria* and has once pinnate leaf blades that are stalked. The blade segments are wedge-shaped to oblong and sharply dentate (Cody 1996). Its distribution includes western North America, but populations tend to be very small and isolated. There is a single collection known from the Yukon at Dawson in a grassy meadow (Cody 1996), and four collections in Alaska, two in the Brooks Range, one on the Alaska Peninsula, and one in the Yakutat forelands (UAM Herbarium Database 2004, http://arctos.database.museum/).

***Platanthera chorisiana* (Cham.) Reichenb. (G3-S3)**

We identified a small population of the rare bog orchid, *Platanthera chorisiana* (Fig. 59) at a mid-elevation wet sedge-forb meadow west of Topsy Creek in the Fairweather Area. The site was at 58.590ºN, 137.478ºW, and was dominated by *Nephrophyllidium crista-galli* (= *Fauria crista-galli*), *Carex aquatilits* var. *dives* (= *C. sitchensis*), *Sanguisorba menziesii*, and *Coptis aspleniifolia* (Fig. 60). This species is listed by the AKNHP as a G3 - S3 (rare globally and within the state).

Platanthera chorisiana is distinguishable from other bog orchids in being less than 20 cm tall and having two basal leaves, but lacking developed cauline leaves. Its distribution globally is amphi-Pacific, occurring in northern Japan, Kamchatka, and east to Alaska and British Columbia. It is known primarily from scattered sites in the Aleutians, Prince William Sound, and Southeast Alaska (Fig. 61). We found a single small population (ca. 50 individuals), despite surveying many other similar *Sphagnum* fens. Because of its rarity, small population sizes, and narrow habitat specificity, we recommend more targeted inventory for this taxon and casual monitoring of the Fairweather population.

Figure 59. *Platanthera chorisiana* photo of a plant in Japan (http://www5.ocn.ne.jp/~rebun-fl/zukan/z-ma/miyake.html).

Figure 60. *Platanthera chorisiana* site in the Fairweather Mountains.

***Eleocharis kamtschatica* (C.A. Mey.) Kamarov (G4-S2S3)**

Eleocharis kamtschatica is a coastal saline marsh species of northern Japan, Kamtchatka, Alaska, British Columbia, and disjunct to Hudson Bay and the Saint Lawrence River (Fig. 61). This species appears to be rare everywhere (Hultén 1941-1950) and is listed by the AKNHP as G4-S2S3.

Eleocharis kamtschatica is loosely stoloniferous. The culms are tufted and up to 30 cm tall. Spikes are terminal with a large basal scale that completely encircles the base of the spike. A turbercle nearly the size of the achene and bright purplish-brown stem bases separate *E. kamtschatica* from the more widespread *E. uniglumis*. A photo of the species is shown in Figure 62.

This species has been collected at a variety of locations in Alaska, from moist sedge meadows along the Norton Sound coast (near Unalakleet airport) to coastal marshes in southcentral Alaska (e.g., Kachemak Bay) and Southeast Alaska (Haines airport, Katzehin River delta, Dyea, near

Ketchikan) (AKNHP Database 2004, Carlson et al. 2004). Our collection in Hugh Miller Inlet was from a habitat similar to most *E. kamtschatica* sites; however, the Hugh Miller site had many freshwater rather than saltwater or esturine influence. The site was composed of halophytic sedges despite having been uplifted above tidal influence.

Figure 61. Distribution of *Platanthera chorisiana* (white lines), *Eleocharis kamtschatica* (orange lines) and, *Salix setchelliana* (green lines, adapted from Hultén 1968). Populations of *E. kamtschatica* near Hudson Bay and Nova Scotia are not shown.

It is difficult to explain why so few populations are present despite a wide geographic range. This is especially true considering that a recent collection by Parker (2001) was from a disturbed site adjacent to the Haines airport. The indication that this species can withstand environmental perturbation is counterintuitive to its rarity and suggests that more effort be placed on understanding the environmental and/or biotic factors limiting its distribution. One might think that a non-showy species such as this might merely be overlooked such that its rarity is a function of under collection. However, floristic inventory work has accelerated in Alaska in the last 30 years, and very few additional sites to those outlined in Hultén's 1968 flora are known.

Figure 62. *Eleocharis kamtschatica*. http://hos0.big.ous.ac.jp/~hoshino/Labo/colorzukan/harizk/kuroha/kuroha.htm

***Salix setchelliana* Ball (G4-S3)**

The endemic Alaskan willow, *Salix setchelliana*, was found throughout open sandy bars along the Alsek River, from the Alaska-British Columbia border to Dry Bay. Population sizes were estimated at 5,000 at each of three locations along the Alsek River. However, the species is rhizomatous and the number of genetically distinct individuals is likely much smaller. This species was generally growing on the most recently deposited sediments and very few other vascular plants were associated with it (Fig. 54). *Chamerion latifolium*, *Oxytropis campestris* var. *varians*, *Astragalus alpinus*, and *Equisetum variegatum* were occasionally found growing with Setchell's willow along the Alsek.

Salix setchelliana is found on gravel bars and sandy slopes along glacial meltwater rivers in central Alaska, such as the Knik and Copper Rivers, as well as one site in the Brooks Range (Anaktuvuk River), and the White and Donjek Rivers of southwestern Yukon (Fig. 61). It is

globally very restricted, yet population sizes appear to be large, stable, and dispersed throughout much of Alaska and the Yukon. This willow is very distinctive (Fig. 63), as it is the only one with fleshy leaves. It is a dwarf shrub with mostly unbranched stems; the ovaries are large and dark red to yellow at maturity. Because populations are large, continuous, and secure in the Alsek area, no monitoring is necessary. However, because this species is globally restricted and this is the furthest southeast it has been found, we would encourge informal surveys to estimate changes in population distributions and numbers.

Figure 63. *Salix setchelliana* growing on a cobble and sand substrate along the Alsek River.

***Agoseris aurantiaca* (Hook.) Greene. (G5-S1)**

Figure 64. *Agoseris aurantiaca* ©Gary A. Monroe. Rocky Mountain National Park, CO. (USDA-NRCS Plants Database 2003).

We made a collection of *Agoseris aurantiaca* (G5-S1, Fig. 64) on the west side of Willoughby Island in Sitakaday Narrows in the Dundas Bay Survey Region. The site was at 58.595°N, 136.130°W at 480 m elevation on a limestone, subalpine meadow. The associated species were *Arctostaphylos rubra*, *Salix arctica*, *Salix reticulata*, and *Astragalus alpinus*.

This species is found throughout the western states and provinces in the mountains (Fig. 65). It barely reaches into Alaska along the upper Lynn Canal area of Southeast Alaska, where only a handful of populations are known.

***Agoseris glauca* (Pursh.) Raf. (G5-S1)**

Along the terminus of Muir Glacier we made a collection of *Agoseris glauca*, from a colluvial side slope at 1,000 m, dominated by *Salix arctica*, *Chamerion angustifolium* ssp. *angustifolium*, *Poa alpina*, *Lupinus nootkatensis*, and *Trisetum spicatum* (59.952°N, 136.269°W).

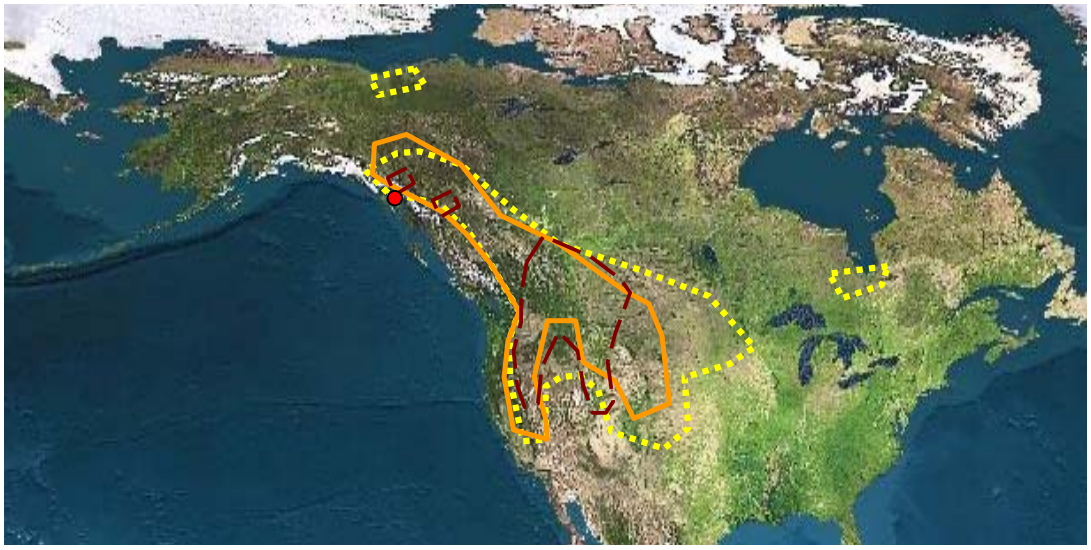


Figure 65. Global range of Cordilleran species collected in GLBA. *Agoseris aurantiaca* = orange line, *A. glauca* = yellow line, and *Cypripedium montanum* = brown line. Collection location in GLBA is shown as a red circle. Basemap is from Fourmilab.

This species has a distribution that is nearly identical to its close relative, *A. aurantiaca* (Fig. 65). A few populations are known from northern Yukon and Northwest Territories, however. Like *A. aurantiaca*, *A. glauca* enters Alaska only in the northern reaches of Southeast Alaska.

***Carex interior* Bailey. (G5-S1)**

Carex interior is sedge of wet meadows found across boreal North America that reaches Alaska along the Haines Highway and an additional, disjunct population farther west, near Anchorage. We collected this species along the Beartrack River in an open cottonwood forest, associated with *Alnus viridis* ssp. *sinuata* and *Salix alaxensis*.

***Cypripedium montanum* Dougl. ex Lindl. (G4G5-S1)**

The *Cypripedium montanum* (mountain lady slipper orchid, Fig. 66) is another Cordilleran species that is rare in Alaska, occurring only in the northern section of Southeast Alaska (Fig. 65). Other sites of this attractive orchid have been located in the GLBA: K. Bosworth has collected the taxon from a drainage near Tlingit Point, B. Paige collected it in South Tidal Inlet, G. Streveler has made collections near Cooper's Notch, and a number of early collections were made by Cooper in the 1930's.

Figure 66. *Cypripedium montanum* Photo by Jamie Notman. Northwest Orchid Society. http://www.nwos.org /Newsletters/july_02.html

AKNHP-NPS collected this taxon at two locations in the Adams Inlet Region, northwest of Granite Canyon and on the east side of Tree Mountain at 630 m and 900 m, respectively. This taxon was collected from alder and willow scrub and herbaceous meadow mosaic. Most populations of *Cypripedium montanum* in Alaska are associated with mesic, calcareous soils, and much of the lithology in the Adams Inlet is basic, calcareous rock.

***Piperia unalascensis* (Spreng.) Rydb. (G5-S2)**

The rare Alaskan orchid *Piperia unalascensis* (= *Platanthera unalaschcensis*) was collected in a *Dryas integrifolia*-dwarf shrub habitat on the limestone derived Willoughby Island. *Piperia unalascensis* is quite widespread throughout western North America, but is very rare north of Washington State; only a few isolated populations are known in Alaska. *Piperia unalascensis* is ranked G5-S2 by the Alaska Natural Heritage Program.

***Rorippa curvisiliqua* (Hook.) Bess. ex. Britt. (G5-S1)**

In a fen near the Beartrack River we collected the rare Alaskan mustard *Rorippa curvisiliqua*. This species is quite widespread in wetlands in western North America but has been collected only a few times in Southeast Alaska. Populations have been located along the Haines Highway, near Hyder, and at an unconfirmed location by Noble and Sandgren in a beach rye meadow at Muir Point in 1974 (NPSpecies). The majority of populations in southeastern Alaska are quite small and disjunct. This pattern appears to be the consistent with long-distance transport by waterfowl. It is unknown whether the *R. curvisiliqua* populations are capable of achieving their replacement rate such that recrutitment equals or exceeds mortality without the influx of propagules from outside the population.

Recommendations

To achieve a more complete list of species in GLBA, we recommend inventorying the following locations and habitats (Fig. 67):

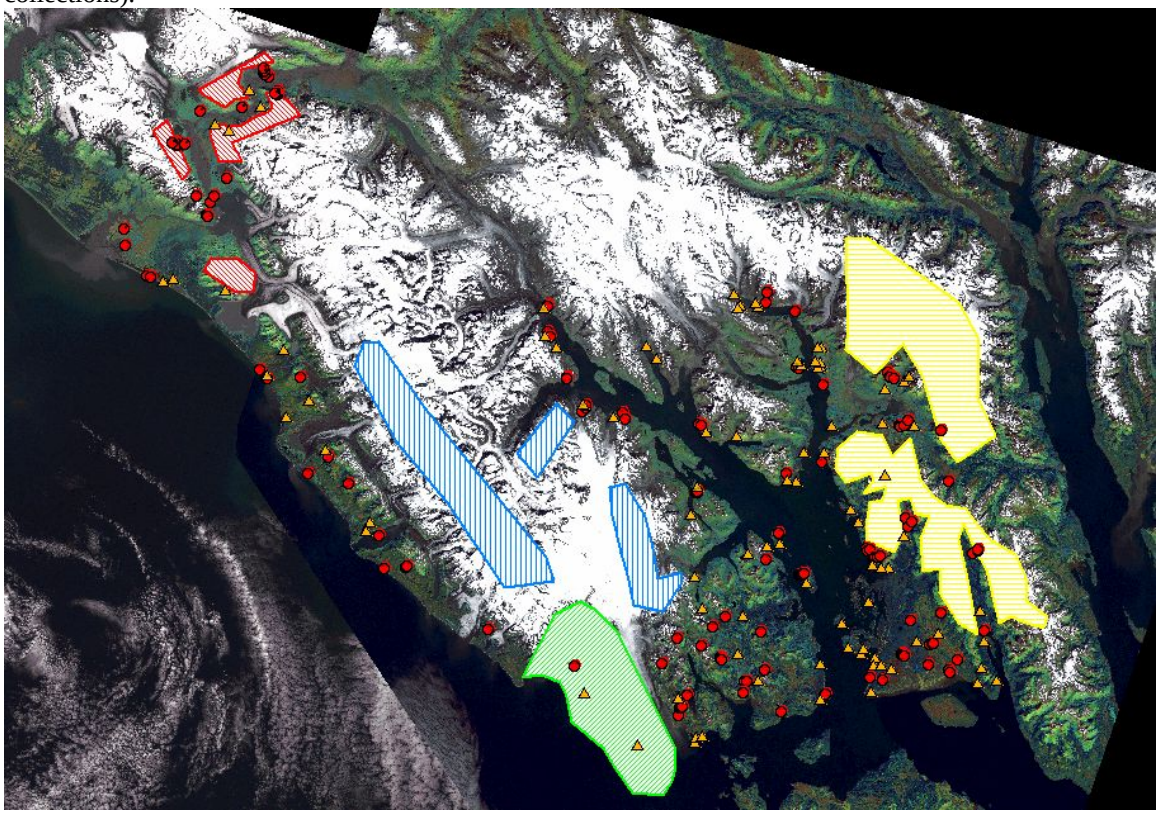
- ***High elevation calcareous regions of Excursion Ridge/Chilkat Range.*** The extreme eastern border of GLBA in the Chilkat Range has received only cursory visitation by botanists, and the large diversity of lithologies would likely harbor edaphic specialist taxa. For example, the rare sedge *Carex hoodii* (G4G5-S1) is a species requiring basic soils that was located on limestone and marble derived substrates southwest of Haines in the Chilkat Range (Parker 2001). This taxon may likely reach GLBA along the northeast border. It was evident that a large number of species that were collected as "new park records" were disproportionately collected from calcareous substrates. Parker collected *Sedum divergens* on the Takhin Ridge southwest of Haines, which may be found in the park. Anderson collected *Silene involucrata* ssp. *involucrata* (= *Melandrium affine*) along the Endicott River (Hultén 1941-1950) and it is likely that this circumpolar taxon might be located in the eastern portion of the park.

- ***Cape Spencer Fjords.*** Very little collecting has occurred in this area largely due to limited access because of stormy weather and often poor visibility. Habitats in this area are primarily heavily weathered spruce, hemlock, and Alaska cedar forests, which are generally poor in vascular plant diversity (G. Streveler pers. comm.). These habitats were visited in the adjacent Fairweather and Dundas regions and showed low plant diversity. The lithology of the area is primarily metamorphic gneiss and shists, which are unlikely to support uncollected edaphic specialists. However, it is possible that species of beaches, coastal headlands and forests, and high elevations that are expected but not known for the park (e.g., *Cakile edentula*, *Calamagrostis nutkaensis*, *R. uncinatus* var. *parviflorus*) may be found in the Cape Spencer Fjords region.

- ***High elevation areas of the Dry Bay Forelands and Alsek River Corridor.*** We were able to access high elevations in only a few locations, and because this area has been the source for a large number of species of conservation concern, range extensions, and new park records, greater sampling effort with the use of helicopters would be valuable. In particular, the ridge opposite Walker Glacier would likely have a number of interesting taxa. In 2003 we collected nine new park records from a steep drainage at low elevation that had a number of alpine associates. It is likely there more notable alpine taxa at the top of the drainage.

- ***Nunataks in the Fairweather Range.*** There are a significant number of outcrops that remained ice-free that should be surveyed for vascular plant taxa. In general, nunataks are quite species-poor, but these refugia can harbor very significant taxa (e.g., disjunct and rare taxa separated from other populations for thousands of years, which play a large role in determining the pattern of succession in nearby recently deglaciated areas). For example, one of the few collections of *Phyllodoce empetriformis* (G4-S1S2) in Alaska is from the Mendenhall Towers on the Juneau Icefield. While access would require helicopters, one or two days of sampling should be sufficient to inventory the primary nuntaks (Contact and Heather Nunataks).

Figure 67. Suggested future sampling sites in GLBA, shown as polygons. Yellow = Excursion Ridge and Chilkat Range, Green = Cape Spencer, Blue = Fairweather Nunataks, Red = Alpine areas of Alsek Corridor. Known plant collection sites are shown as circles (AKNHP 2001-2003) or triangles (previous collections).



Alterations to the expected species list

Taxa currently listed as "Probably Present" in NPSpecies that are unlikely to occur in GLBA and therefore should be removed –

- *Collinsia parviflora*, *Corydalis aurea*, *Erigeron compositus*, *Penstemon procerus*, *Phacelia mollis*, *Rosa acicularis*, and *Symphoricarpos albus* are species listed as "probably present," which are unlikely to occur in GLBA. Most of these species are known from only a few collections on open slopes and roadsides in the relatively dry Chilkat River Corridor and along the Tanana-Yukon Uplands in Alaska and Yukon Territory. Similar habitats were not located during surveys in 2001 and 2003.

- *Amsinckia menziesii* and *Cryptantha torreyana* would be unlikely to occur in the park, as the species are introduced borages (Boraginaceae) from California and Oregon and they have been found on dry, well drained waste places. A single collection of *C. torreyana* and two collections of *A. menziesii* are known from Skagway, but similarly dry and anthropogenically disturbed habitats are not present in Glacier Bay. *Plagiobothrys scouleri* var. *hispidulus* (= *P. cognatus*) is another borage that has been collected in disturbed sites in Skagway, and appears to be native in Alaska, despite being disjunct from the core distribution in Oregon and California.

- *Cnidium cnidiifolium* and *Glechoma hederacea* have been collected once in 1968 on flats near the Mendenhall Glacier in Juneau (UAM Herbarium). The *Cnidum* collection is disjunct hundreds of kilometers southeast of its central and northwestern Alaska distribution. This species is found in wet meadows and riverbanks. *Glechoma hederacea* is a weedy mint generally found at lower latitudes. *Papaver nudicaule* is a roadside weed that would be unlikely to exist in GLBA. It has escaped gardens and has been collected once in Juneau (Auke Bay roadside) in 1978 (NPSpecies).

- *Carex microchaeta* and *Diapensia lapponica* are generally restricted to alpine meadows and heaths in interior Alaska and Canada. *Diapensia lapponica* also occurs in western Alaska. Both species have been collected once in Southeast Alaska at high elevations along Dayebas Creek, across Chilkoot Inlet from Haines by A. Batten and G. Juday in 1988. These species are not known from the Chilkat Range or western side of the St. Elias Mountains.

- *Juncus biglumis* has been collected only once on a nunatak on the Juneau Icefield and is absent from coastal areas from Cook Inlet southwest through Southeast Alaska. It would be surprising to locate this taxon in the park.

Taxa currently not listed in NPSpecies that should be entered as "Present" –

- We collected the following specimens in GLBA: *Agoseris glauca, Artemisia furcata, Aster sibericus, Botrychium ascendens, Botrychium lanceolatum, Botychium minganense, Bromus ciliatus, Calamagrostis lapponica, Calamagrostis stricta, Carex atratiformis, Carex canescens, Carex gynocrates, Carex foenea, Carex glacialis, Carex glareosa* ssp. *glareosa, Festuca saximontana, Listera borealis, Lupinus polyphyllus, Osmorhiza depauperata, Piperia unalascensis, Platanthera obtusata, Rhynchospora alba, Rubus arcticus, Taraxacum officinale* ssp. *ceratophorum* (= *T. lacerum*), *Taraxacum phymatocarpum*, and *Zigadenus elegans*. Vouchers of these taxa are deposited at the University of Alaska Fairbanks Museum and duplicate sheets are present for many of the taxa at the Glacier Bay Park Herbarium.

- The rare lupine *Lupinus kuschei* (G3-S2) has been observed along the Alsek River near Walker Glacier and should be added to the list (R. Lipkin, pers. obs.).

Recommendations for monitoring or other action

- We recommend casual monitoring of the following rare taxa encountered: *Agoseris aurantiaca, A. glauca, Botrychium ascendens, Carex interior, Cypripedium montanum, Eleocharis kamtschatica, Piperia unalascensis, Platanthera chorisiana, Rorippa curvisiliqua*, and *Salix setchelliana*. These species were all located in apparently secure populations with no observable threats. However, NPS employees and botanists working in the park should pay special attention for these species in known and in other locations to determine the number, extent, and status of the populations.

- Exotic species - Management of the the weedy introduced species, *Taraxacum officinale* spp. *officinale* and of *Lupinus polyphyllus*, whose nativity is unknown does not seem feasible as they are fairly widespread in natural areas around Dundas Bay and do not appear to be influencing ecosystem or community processes.

ACKNOWLEDGEMENTS

The AKNHP is grateful for the logistical and financial support of the NPS, and in particular of the I&M and SEAN coordinators Sara Wesser and Lewis Sharman. Greg Streveler and the NPS staff at Glacier Bay, particularly Jim Capra, were invaluable in identification of appropriate collecting sites and general logistical support. NPS ecologists Beth Koltun, and Jess Grunblatt made numerous collections and identification. Chiska Derr and others at NPS made valuable comments on earlier versions of this manuscript. Botanical support and enthusiasm of Koren Bosworth and Lisa Stratford was greatly appreciated. Volunteer Steve Gisler (Oregon Department of Agriculture-Plant Conservation Biology Program) was an invaluable addition to the botany crew in 2003, with an excellent eye for new plant taxa, a strong back, and tireless work in the field.

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