National Park Service - Alaska Region

Inventory & Monitoring Program

ECOLOGICAL SUBSECTIONS OF KENAI FJORDS NATIONAL PARK

Mapping and Delineation by:

Gerald F. Tande; Julie Michaelson, AK Natural Heritage Program

Photographs by:

USGS and Page Spencer, NPS

Alaska Region

Inventory and Monitoring Program

2525 Gambell

Anchorage, Alaska 99503

Alaska Region Inventory & Monitoring Program

2525 Gambell Street, Anchorage, Alaska 99503

(907) 257-2488 Fax (907) 264-5428

Ecological Subsections of Kenai Fjords National Park, Alaska

Final Report

Prepared For:

U. S. National Park Service
2525 Gambell Street
Anchorage, Alaska 99503-2892

Prepared By:

Gerald F. Tande
Vegetation Ecologist

Julie Michaelson
Program Data Manager

Alaska Natural Heritage Program
Environment and Natural Resources Institute
University of Alaska Anchorage
707 A Street
Anchorage AK 99501

October 2001

Table of Contents

Introduction

Ecological land classifications are important for evaluating land resources and refining research and management strategies for specific areas. Landscape-level stratification can be used to more efficiently allocate inventory and monitoring efforts; improve landcover classifications developed from remote sensing; partition ecological information for analysis of ecological relationships and development of predictive models; and improve recommendations for ecological restoration (Jorgenson *et al.* 1999, 2000). Accordingly, the National Park Service (NPS) has elected to use landscape-level maps as the basis for stratifying their biological inventory and monitoring programs to insure that their field sampling is distributed across a wide range of environmental gradients.

Ecological land classifications involve organizing ecosystem components at various scales based on the recognition that ecological components and features operate within a hierarchy of differing spatial and temporal scales (ECOMAP 1993, Bailey 1996). This hierarchically linked structure reveals that smaller-scale features, such as vegetation and soils, are related to and nest within larger-scale components such as climate and physiography. Climatic factors, particularly temperature and precipitation, typically account for the largest amount of variation in ecosystem structure and function globally (Walter 1979). Physiography, or broad-scale landforms with a characteristic substrate, surface shape, and relief, are the terrain conditions that control the spatial arrangement and rate of geomorphic processes. These processes, in turn, affect material and energy flows and, ultimately, ecosystem development (Swanson *et al.* 1988, Bailey 1996).

Under the National Hierarchical Framework (ECOMAP 1993), these small-scale regional factors of climate, physiography, and geology can be used as differentiating criteria for delineating Sections defined as physiographic regions with similar geology and regional climate, and Subsections, more narrowly defined geology with repeating associations of geomorphic units.

The U.S. National Park Service is currently undertaking landscape-level mapping at the Subsection level of the National Hierarchical Framework (ECOMAP 1993) for all its parks in Alaska. Landscape-level maps have already been produced for Bering Land Bridge National Preserve (Jorgenson 2000), Cape Krusenstern National Monument (Swanson 2001), Denali National Park and Preserve (Clark 1998), Katmai National Park and Preserve (Shephard 2000), Kobuk Valley National Park (Swanson 2000), and Yukon-Charley Rivers National Preserve (Swanson 1999).
Similar landscape-level mapping in Alaska has been completed outside of the national park system for the Chugach (Davidson 1996, Davidson and DeVelice 2000) and Tongass National Forests (Nowacki *et al.* 2001); the central Arctic coastal plain (Jorgenson *et al.* 1997); and Fort Wainwright and Fort Greely Military Reservations in central Alaska (Jorgenson *et al.* 1997, 2000).

This report presents the results of the mapping of Ecological Subsections for Kenai Fjords National Park (KEFJ), an area encompassing 245,970 ha (607,805 acres) in southcentral Alaska (Figure 1) that was set aside to protect the unique and dynamic glacial environment represented by the park. The specific objective of this study was the compilation and review of existing information to identify, map and describe these Ecological Subsections according to the National Hierarchical Framework (ECOMAP 1993).

Ecological Subsection mapping is intended to be used to further understand the coarse-scale ecological units within the park for park planning; as a stratification layer for use for species-level inventory and monitoring, and vegetation and cover-type mapping; and to assist with an ongoing water inventory program. Subsection classification was to be constructed in a manner that would lend itself to aggregation upward for the refinement of ongoing efforts to map Ecoregions at the state level (Nowacki *et al.* 2000).

Methods

Data compilation involved reviewing existing field studies for relevant information on the characteristics of the various landscape components; compiling information on the distribution of the various components from hard copy maps; interpreting and mapping ecological units; and integrating digitized map data into a georeferenced GIS database. Multiple factors are used to delineate ecological landscape units in the discipline of ecosystem geography (Cleland *et al.* 1997, Bailey 1996, ECOMAP 1993). For KEFJ, these multiple factors included:

Bedrock and surficial geology maps and reports (Beikman *et al.* 1977a, 1977b, Bradley *et al.* 1999, Karlstrom *et al.* 1964, Kelley 1985, Magoon *et al.* 1976, Mann 1998, Nelson *et al.* 1985, Nelson and Hamilton 1989, Nelson *et al.* 1999, Selkregg 1975, Tysdal *et al.* 1976, Tysdal and Case 1979);

Composite Landsat thematic mapping imagery of the park at various scales (produced by Jess Grunblatt, National Park Service, Alaska Support Office, Anchorage, AK);

USGS 1:250,000 topographic maps for the region (Blying Sound, Cordova, Kenai, Seward);

Digital map data provided by the NPS in GIS databases on CD-ROM. The databases included data at various scales from a variety of sources including: an Ecoregion map of Alaska (1:2.5 million scale, Nowacki *et al.* 2000), digital elevation models developed from 1:250,000-scale USGS quadrangles, digital raster graphics of the USGS topographic maps (1:250,000- and 1:63,360-scale), hydrography from USGS maps (1:63,360 scale), park, preserve, and wilderness boundaries (1:63,360 scale), bedrock geology (1:2,500,000 scale, Beikman *et al.* 1980); and a composite Landsat thematic landcover map (Ducks Unlimited 1999).

Color infrared aerial photography where available.

Kenai Fjords National Park Subsection mapping utilized the NPS composite thematic mapping imagery and geologic information listed above. Landform and landcover mapping information normally employed to assist Ecological Subsection mapping is nearly nonexistent for the Kenai Fjords region.

The Ducks Unlimited (1999) landcover map, although useful in a general sense, has not been ground-truthed, and was recommended by park personnel to be viewed conservatively in this Subsection mapping project (Jess Grunblatt, pers. comm.). The map was used extensively for noting major Subsection breaks; however, a more

thorough analysis of this digital database was beyond the scope of the current project, though may be of use in park planning as NPS moves toward KEFJ species inventories and landcover mapping in the future.

Most vegetation landcover research has been generally limited to the Exit Glacier area of the Resurrection River valley. We supplemented our investigations with coastal geomorphological studies (Mann 1993); paleoecological studies (e.g., Ager 2000, Mann *et al.* 1998); early geological surveys of the region (e.g., Davidson 1869, Grant 1915, Grant and Higgins 1909); historic resource studies (Cook and Norris 1998); archeological investigations (e.g., Crowell *et al.* 1998, Yarborough and Yarborough 1998); and various park guides (e.g., Miller 1987, Nelson and Hamilton 1989, Pfeiffenberger 1995, Sisson 1985).

Southcentral Alaska Ecoregion mapping at the Ecoregion-level (Nowacki *et al.* 2000), and Subsection-level mapping previously completed for the neighboring Chugach National Forest (Davidson(1996), Davidson and DeVelice 2000) were reviewed and compared to our interpretations for KEFJ. The Gulf of Alaska Coast, Chugach-St. Elias Mountains, and Southcentral Ecoregions (Nowacki *et al.* 2000), and the Kenai Fjordlands Subsection of the North Gulf Fjordlands Section (Davidson and DeVelice 2000) were successfully applied and extended to the park.

The Landsat thematic imagery of the park was used as a base layer in conjunction with USGS topographic maps for the area. Ecological units were recognized by qualitative interpretation and synthesis of the available data for the study area; the authors used their experience in southcentral Alaska and the disciplines of geology, plant ecology and landscape ecology to determine what was deemed to be ecologically important. Surficial and bedrock geology maps were carefully examined and interpreted, and the various bedrock and surficial geology reports were reviewed. Boundaries were drawn by mentally synthesizing the base map information and delineating units on a draft 'concept-level' map over the Landsat imagery.

The basis for final line placement was based on interpretation of the thematic mapper imagery or one of the geology theme maps, whichever best reflected the primary delineating criteria for each line or polygon delineation. When one or more of the principle delineation factors (gross physiography, lithology, and surficial geology) changed dramatically so that there was a sharp ecotonal boundary, we used the boundary as the delineation between ecological units.

Following the ECOMAP (1993) framework, Sections were defined as physiographic units with similar geology and regional climate that possessed repeating associations of a limited set of closely related geomorphic deposits. Subsections provided further partitioning of geomorphic or lithologic variability, such as differentiating between icefields and granitic and sedimentary rocks, or various surficial deposits.

Although a minimum mapping unit size was not defined for this project, the ECOMAP (1993) recommended size range for Subsection mapping was generally adhered to (between 10's and 1,000's of square miles; 6,000-10,000 A; 40.5 km^2). In response to the potential needs of the anticipated users of the maps, ecological units were delineated as finely as the methods would allow. The coastal Subsection of KEFJ could be readily subdivided into more detailed units. However, not all of these more detailed units are fine enough to qualify as the next level down in the National Hierarchical Framework of Ecological Units, the Landtype Association (Cleland *et al.* 1997, ECOMAP 1993). Furthermore, field sampling would be needed to verify the composition of any Landtype Associations. Thus, the finer units are here referred to simply as "Detailed Subsections".

To ensure consistency in NPS's statewide effort, mapping investigators for other park and preserve units convened at workshops in Anchorage on September 26, 2000 and April 17, 2001 to develop a consensus on mapping criteria (Page Spencer, NPS pers. com.). At these meetings, various criteria were discussed and developed including: minimum mapping unit size; differentiating coastal (salt affected) ecosystems and floodplain ecosystems; not differentiating alpine ecosystems (they are problematic because they are part of a continuous toposequence, and are highly patchy and disjunct on mountaintops, which is a pattern that is inconsistent with the principle of broad regionalization (Jorgenson 2000)); colluvial deposit hillslope position; and the standardization of ArcView GIS attribute-table field names.

Nomenclature for classes of the various landscape components followed names used by the individual authors of geological reports; an engineering geology mapping classification system for geomorphic units (ADDGS 1983); a standardized hierarchical arrangement of Subsection names for terrain and physiographic and geologic classes previously developed for southeast Alaska (Nowacki *et al.* 2001); and the Chugach National Forest, the only previously mapped area and nearest to KEFJ in southcentral Alaska (Davidson 1996, Davidson and DeVelice 2000).

Subsections and Detailed Subsections that occurred in KEFJ were extended beyond the park boundary to their natural limits. Placement of these boundaries outside of the park should be considered tentative.

Following a review by AKNHP and NPS staff, the 'concept-level' map was refined and a final map was prepared on mylar over the mylar 1:250,000 quadrangle maps for the area. Mylar overlay linework was scanned by a contractor, and all lines were edge-matched and smoothed across USGS quadrangle boundaries, and merged into a single, seamless, georeferenced coverage in ARC/INFO (Alaska Albers with NAD27 datum).

The ARC/INFO map polygons were then attributed with the following:

PARK_CODE	Four-character NPS abbreviation for the park unit
ECOREGION	From Nowacki *et al.* (2000)
SECTION	Full name for tentative Ecological Section
SUBSEC_NA	Full name of the Ecological Subsection
SUBSEC_CO	Symbol for the Ecological Subsection
DETSUB_NA	Full name of Detailed Ecological Subsection
DETSUB_CO	Symbol for Detailed Ecological Subsection
SS_PHYSIOG	Hierarchical classification for Alaskan Subsections (Nowacki *et al.* 2001, Shephard 2000)
DS_LITHOL	General lithology if bedrock, or otherwise general surficial category
ACRES	Total acre amount for individual mapped polygons
SS_RATION	A short statement on the rationale for the unit

Digital metadata meeting Federal Geographic Data Committee standards were prepared for all spatial data products using the metadata generation tools in ARCVIEW 3.2. All final products meet the spatial accuracy of the National Data Information Infrastructure Metadata Standards (NDII).

The total aerial extent of Ecological Subsections and Detailed Subsections were generated using the Arcview AK_Pac module and incorporated into the acreage table provided in this report (Table 3).

A field reconnaissance was attempted on four separate occasions during July 2001 to become familiar with the KEFJ landscape and evaluate preliminary concepts of landscape units, and to acquire large-scale photography of Subsections for reference and presentation. Unfortunately, flights could not be completed in the allocated field time due to poor weather. July was reportedly one of the wettest months on record for the State of Alaska and this affected travel from Seward down the Gulf of Alaska coast and across the Harding Icefield. Oblique photography representative of the park was gathered from other sources including park staff (Page Spencer) and researchers or past visitors, and occasionally documents depicting characteristic physiography from known locations.

Ecological Unit Descriptions

Kenai Fjords National Park occurs within the Kenai Mountains Section of the Chugach-St.Elias Mountains Ecoregion, and the Northern Gulf Fjordlands Section of the Gulf of Alaska Coast Ecoregion (Nowacki *et al.* 2000; Davidson and DeVelice 2000).

The map legend for Ecological Subsections of Kenai Fjords National Park is given in Table 1; criteria used to delineate these Subsections are summarized in Table 2.

Table 3 provides a summary for the total landcover area of each Subsection and Detailed Subsection. A synoptic summary of ecological units, lithology, physiography, rationale and a representative photo of the unit are provided in Table 4.

Simplified maps of Subsections and Detailed Subsections of Kenai Fjords National Park are provided in Figures 2 and 3. Representative photos of the ecological mapping units can be found in Figure 4. All units and their respective attributes are also provided in the ARC/INFO coverage that accompanies this report.

Chugach-St. Elias Mountains Ecoregion

(Nowacki *et al.* 2000)

Kenai Mountains Section

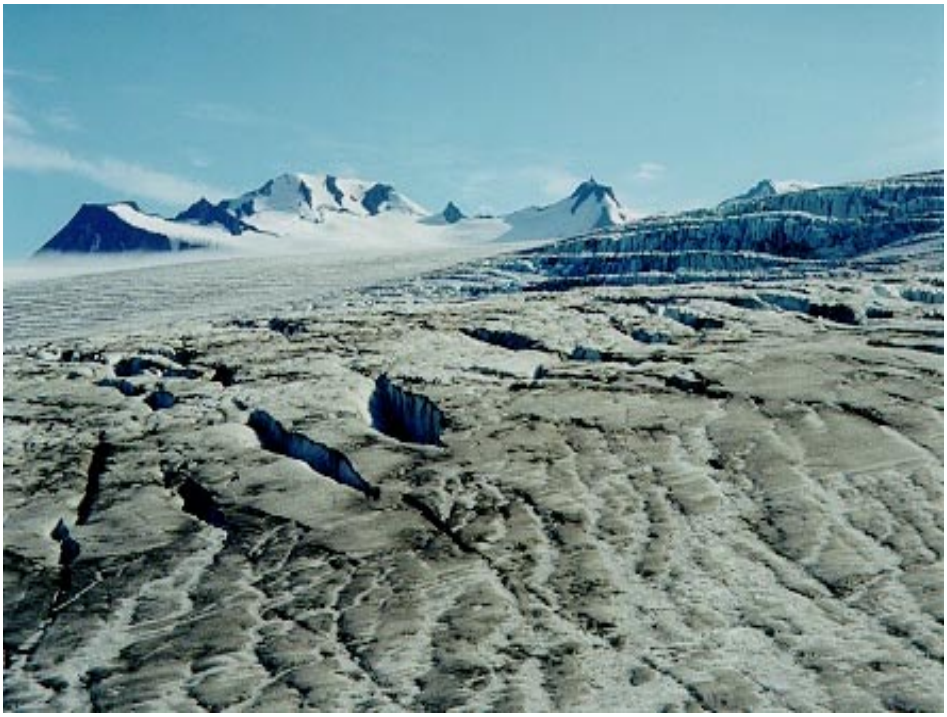
(Davidson and DeVelice 2000)

HIF Harding Icefield Subsection

HIF - Harding Icefield Subsection

Geology and Physiography: Broad, gently sloping icefield with snowfields and numerous smaller glaciers that mantle steep, angular and cliffy peaks of Cretaceous Undifferentiated Sedimentary Rock. Isolated small peaks called nunataks sporadically protrude in the middle of the icefields. A number of glaciers run easterly all the way to tidewater; westerly, a number run to large glacial lakes. Numerous hanging glaciers are present. The Subsection includes portions of glaciers below the firn line where ice and rock rubble are exposed by seasonal melt, and barren rock exposed by longer-term deglaciation.

Elevation: Approximately 305 m (1000 feet) ESL to the tops of Nunataks at more than 1524 m (5000 feet)



Vegetation/Landcover: Mostly snow and ice, bedrock, talus and scree with minimal or disjunct patches of vegetation. Lower slopes have discontinuous patches of shrubby vegetation.

Gulf of Alaska Coast Ecoregion

(Nowacki *et al.* 2000)

Northern Gulf Fjordlands Section

(Davidson and DeVelice 2000)

FJL Kenai Fjordlands Subsection

(Davidson and DeVelice 2000)

FJL1 - Peninsula and Island Granitics Detailed Subsection

Geology and Physiography: Rugged low mountains, islands and sea stacks resulting from an intricate system of fjords and drowned cirques forming a spectacular "biscuit board" topography. Geomorphological features have been carved from massive Holocene granite and granodiorite by glacial action and erosion. Recent deposit features such as sand and gravel floodplains, beaches, river mouth deltas, tidal flats, and salt marsh systems are uncommon except in protected areas. Three major disjunct areas include: Aialik Peninsula-Chiswell Islands; the Harris Peninsula; and McCarthy Peninsula-Pi Islands.

Elevation: 0- 920 m

Vegetation/Landcover: Unvegetated, steep, rocky walls rise off the ocean to a discontinuous narrow band of conifer forest and dense alder shrub thickets and avalanche paths with occasional bogs or small ponds. Higher elevations to 305 m support low shrubland of willows and alder; sparse vegetation occurs on barren rock at higher elevations.

FJL2 - Fjordland Undifferentiated Sedimentary Rocks Detailed Subsection

Geology and Physiography: Rugged coastal mountains comprised of an intricate system

of recently deglaciated fjords. Generally extends from the ocean shoreline to the barren, recently deglaciated areas below the Harding Icefield and associated glaciers. Geomorphological features have been carved from extensive Cretaceous-aged undifferentiated sedimentary rocks by glacial action and erosion. Recent deposit features such as sand and gravel floodplains, beaches, river mouth deltas, tidal flats, and salt marsh systems are uncommon except in protected areas.

Elevation: 0-1,525 m

Vegetation/Landcover: Unvegetated, steep, rocky walls rise off the ocean and fjords to a discontinuous narrow band of conifer forest and dense alder shrub thickets and avalanche paths with occasional bogs or small ponds. Elevation of upper treeline varies considerably based on localized weather and terrain features. Higher elevations to 305 m support low shrubs of alder and willow; sparse alpine vegetation occurs on barren rock at higher elevations and at the heads of the fjords.

FJL3 - Coastal Lowland-Valley Detailed Subsection

Geology and Physiography: Recently deglaciated valleys including floodplain and low-lying areas of braided glacial rivers, fluvial valley bottoms, glacial moraines and outwash plains, depositional slopes and high relief terraces, and coastal landscapes such as

beaches and river mouth deltas. Composed of or underlain by Holocene and Pleistocene surficial deposits of unconsolidated alluvium, alluvial fans, and glacial and landslide deposits near the mountains. Mainly silt, sand, gravel and reworked rock fragments. Three major disjunct areas include: the Resurrection River Valley; Bear Glacier; Beauty Bay-Nuka River Valley; and the Yalik- Peter-Glacier valleys.

Elevation: 0-100 m

Vegetation/Landcover: Variable, from unvegetated barren cobble and sand and morainal debris, to sparse colonizing lichen/moss-herb; dense alder shrub thickets and closed conifer forests in valley bottoms and on valley slopes.

References

ADGGS (Alaska Division of Geology and Geophysical Surveys). 1983. Engineering geology mapping classification system. Alaska Division of Geology and Geophysical Surveys. Fairbanks, AK.76 p.

Ager, T.A. 2000. Postglacial vegetation history of the Kachemak Bay area, Cook Inlet, south-central Alaska. U.S. Geol. Surv. Prof. Pap. 1615. Scale 1:746,000.

Bailey, R. G. 1996. Ecosystem geography. Springer-Verlag, New York, 204 p.

Bailey, R. G. 1997. Ecoregions of North America. U.S. Department of Agriculture, Forest Service, Washington, D. C., Scale 1:15,000,000.

Beikman, H.M., C.D. Holloway and E.M. MacKevett. 1977a. Generalized geologic map of the eastern part of southern Alaska: U.S. Geol. Surv. Open File Rep. OF-77-169-B. Scale 1:1,000,000.

Beikman, H.M., C.D. Holloway and E.M. MacKevett. 1977b. Generalized geologic map of the western part of southern Alaska: U.S. Geol. Surv. Open File Rep. OF-77-169-G. Scale 1:1,000,000.

Bradley, D.C., T.M. Kusky, P.J. Haeussler, S.M. Karland and D.T. Donley. 1999. Geologic map of the Seldovia quadrangle, south-central Alaska: U.S. Geol. Surv. Open File Rep. OF-99-18. Scale 1:250000.

Beikman, H.M. 1980. Geologic map of Alaska. US Geol. Survey, Scale 1:2,500,000.

Clark, M. 1998. Hierarchical framework of ecological units to the subsection level for Denali National Park and Preserve. Unpubl. Rep. Prep. for U.S. National Park Service, Anchorage, AK.

Cleland, D.T., P.E. Avers, W.H. McNab , M.E. Jensen, R.G. Bailey, T. King, and W.E. Russell. 1997. National hierarchical framework of ecological units. Pp. 181-200. *In*: M. S. Boyce and A. Haney (eds.). Ecosystem management . Yale University, New Haven, CT. 361 p.

Cook, L.A. and Norris. 1998. A stern and rock-bound coast: Kenai Fjords National Park historic resource study. National Park Service, Alaska Support Office, Anchorage, AK. 405 p.

Crowell, A. L., D. H. Mann, L. Cook and L. F. Yarborough. 1998. Archaeology and coastal dynamics of Kenai Fjords National Park, Alaska. Research/Resources Manage. Rep. ARRCR/CRR-98/34 U.S. National Park Service, Alaska Support Office, Anchorage, AK.

Davidson, D. 1996. Draft ecological hierarchy of the Kenai Peninsula. Draft Manuscript. U.S. Forest Service, Chugach National Forest, Anchorage, AK. 6 p.

Davidson, D. and R. DeVelice. 2000. Ecological subsections of Chugach National Forest, Alaska. Unpubl. Rep. U.S. Forest Service, Chugach National Forest, Anchorage, AK.

Davidson, G. 1869. Coast pilot of Alaska; southern boundary to Cook's Inlet. U.S. Coast and Geodetic Survey, Washington, DC. 246 p.

Ducks Unlimited, Inc. 1999. Kenai Fjords National Park landcover. Digital database and user's guide. Prep. for U.S. National Park Service, Anchorage, AK by Ducks Unlimited, Inc., Rancho Cordova, CA.

ECOMAP. 1993. National Hierarchical framework of ecological units. Washington, DC: U.S. Forest Service. 20 p.

Gallant, A.L., E.F. Binnian, J.M. Omernik and M.B. Shasby. 1995. Ecoregions of Alaska. U.S. Geol. Surv. Prof. Paper 1. 73 p. plus map.

Grant, U.S. 1915. The southeastern coast of Kenai Peninsula. U.S. Geol. Surv. Bull. 587: 209-238.

Grant, U.S. and D.F. Higgins. 1909. Notes on the geology and mineral prospects in the vicinity of Seward, Kenai Peninsula. U.S. Geol. Surv. Bull. 379: 98-107.

Jorgenson, M. T., J. E. Roth, E.R. Pullman, R.M. Burgess, M. Raynolds, A.A. Stickney, M.D. Smith and T. Zimmer. 1997. An ecological land survey for the Colville River Delta, Alaska, 1996. Unpubl. Rep., Prep. for ARCO Alaska, Inc., Anchorage, AK, by ABR, Inc., Fairbanks, AK. 160 p.

Jorgenson, M. T., J. E. Roth, M. Raynolds, M.D. Smith, W. Lentz, A. Zusi-Cobb and C.H. Racine. 1999. An ecological land survey for Fort Wainwright, Alaska. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH. CRREL Rep. 99-9. 83 p.

Jorgenson, M. T., J. E. Roth, M.D. Smith, S. Schlentner, W. Lentz, and E.R. Pullman. 2000. An ecological land survey for Fort Greely, Alaska. U.S. Army Cold Regions Research and Engineering Laboratory. In press.

Jorgenson, M.T. 2000. Landscape-level mapping of ecological units for the Bering Land Bridge National Preserve. Draft Rep. Prep. for U.S. National Park Service, 2525 Gambell St., Anchorage, AK. 42 p.

Karlstrom, T.N., H.W. Coulter, A.T. Fernald, J.R. Williams, D.M. Hopkins , T.L. Pewe, H. Drewes, E.H. Muller and W.H. Condon. 1964. Surficial geology of Alaska: U.S. Geol. Surv. Misc. Geologic Investigations Map I-357. Scale 1:1,584,000.

Kelley, J.S. 1985. Geology of the southwestern tip of the Kenai Peninsula. pp. 50-68 *In:* Sisson, A. (*ed.*). Guide to the geology of the Kenai Peninsula. Alaska Geological Society Guidebook. Anchorage, AK.

Magoon, L. B., W. L. Adkison and R. M. Egbert. 1976. Map showing geology, wildcat wells, Tertiary plant fossil localities, K-Ar age dates, and petroleum operations, Cook Inlet area, Alaska. U.S. Geol. Surv. Misc. Investigations Series, Map I-1019. Scale 1: 250,000.

Mann, D.H. 1993. Shoreline geomorphology classification-Kenai Fjords National Park. Digital database. Prep. for U.S. National Park Service, Alaska Support Office, Anchorage, AK. by Geology and Geophysics Department, University of Alaska, Fairbanks, AK.

Mann 1998. Geology and natural history. Pp. 13-30. *In:* Crowell, A. L., D. H. Mann, L. Cook and L. F. Yarborough. 1998. Archaeology and coastal dynamics of Kenai Fjords National Park, Alaska. Research/Resources Manage. Rep. ARRCR/CRR-98/34. U.S. National Park Service, Alaska Support Office, Anchorage, AK.

Mann, D.H., A.L. Crowell, A.D. Hamilton and B.P. Finney. 1998. Holocene geologic and climatic history around the Gulf of Alaska. Arctic Anthropology 35(1): 112-131.

Miller, D. W. 1987. A Guide to Alaska's Kenai Fjords. Wilderness Images, Cordova, AK.

Nelson, S.W. , J.A. Dumoulin and M.L. Miller.1985. Geologic map of the Chugach National Forest, Alaska. U.S. Geol. Surv. Misc. Field Studies Map MF-1645-B. Scale 1:250,000.

Nelson, S.W. and T.D. Hamilton. 1989. Guide to the geology of the Resurrection Bay-eastern Kenai Fjords area. U.S. Geol. Surv. Field Trip Guide. Alaska Geological Society. Anchorage, AK.

Nelson, S.W., M.L. Miller, P.J. Haeussler, L.W. Snee, P.J. Phillips and C. Huber. 1999. Preliminary geologic map of the Chugach National Forest special study area, Alaska. Open File Rep. 99-362.Version 1.1.

Nowacki, G., P. Spencer, T. Brock, M. Fleming and T. Jorgenson. 2000. Narrative descriptions and map for the Ecoregions of Alaska and Neighboring Territories. Draft 6-1-00; Final rep. in Prep. 16 p. plus map.

Nowacki, G., M. Shephard, P. Krosse, W. Pawuk, G. Fisher, J. Baichtal, D. Brew, E.. Kissinger and T. Brock. 2001. Ecological Subsections of southeast Alaska and neighboring areas of Canada. Draft Rep. U.S. Forest Service, Tongass National Forest, Juneau, AK. 160 p.

Pfeiffenberger, J. 1995. The Complete Guide to Kenai Fjords National Park, Alaska. Greatland Graphics, Anchorage, AK.

Selkregg, L.L. 1975. Alaska regional profiles: southcentral region. Vol. 1. Univ. of Alaska, Arctic Environmental Information and Data Center, Anchorage, AK. 265 p.

Shephard, M. 2000. Ecological units of Katmai National Park and Preserve, Alaska. Limited Copy Report. U.S. National Park Service, Regional Office, Anchorage, AK. 30 p.

Sisson, A. (*ed.*) 1985. Guide to the geology of the Kenai Peninsula, Alaska. Alaska Geological Society, P.O. Box 101288, Anchorage, AK 99510.

Swanson, D.K. 1999. Ecological units of Yukon-Charley Rivers National Preserve, Alaska. U.S. National Park Service, Limited Copy Rep. YUCH-99-001. Yukon-Charley Rivers National Preserve Office, 201 1st Ave, Doyon Bldg., Fairbanks, AK 99701. 29 p.

Swanson, D.K. 2000. Ecological units of Kobuk Valley National Park, Alaska. Draft Rep. Prep. for U.S. National Park Service, 201 1st Ave, Doyon Bldg., Fairbanks, AK 99701. 31 p.

Swanson, D.K. 2001. Ecological units of Cape Krusenstern National Monument, Alaska. Unpubl. Draft Rep. Prep. for U.S. National Park Service, Regional Office, Anchorage, AK. 20 p.

Swanson, F.J., T.K. Kratz, N. Caine and R.G. Woodmansee. 1988. Landform effects of ecosystem patterns and processes. Bioscience 38:92-98.

Tysdal, R.G. and J. E. Case. 1979. Geologic map of the Seward and Blying Sound quadrangles, Alaska. U.S. Geol. Surv. Misc. Geol. Investigations Map I-1150. Scale 1:250,000.

Tysdal, R. G., T. Hudson and G. Plafker. 1976. Geologic map of the Cordova B-2 quadrangle and northern part of the Cordova A-2 quadrangle, south-central Alaska. U.S. Geol. Surv. Misc. Field Studies Map MF-783.

Viereck, L.A., C.T. Dyrness, A.R. Batten and K.J. Wenzlick. 1992. The Alaska vegetation classification. Gen. Tech. Rep. PNW-GTR-286. Pacific Northwest Research Station, U.S. Forest Service, Portland, OR. 278 p.

Walter, H. 1999. Vegetation of the Earth, and Ecological Systems of the Geobiosphere. Springer-Verlag, New York. 274 p.

Wahrhaftig, C. 1965. Physiographic divisions of Alaska: U.S. Geol. Surv. Prof. Paper 482. 52 p. plus map.

Yarborough, M.R. and L.F. Yarborough. 1998. Prehistoric maritime adaptations of Prince William Sound and the Pacific coast of the Kenai Peninsula. Arctic Anthropology 35(10: 132-145.

Tables

Table 1. Index to the ecological units of Kenai Fjords National Park.

Ecoregion	Ecological Section	Ecological Subsection		Detailed Ecological Subsection	
		Code	Name	Code	Name
Chugach-St. Elias Mountains	Kenai Mountains	HIF	Harding Icefield		N/A
Gulf of Alaska Coast	Northern Gulf Fjordlands	KJL	Kenai Fjordlands	KJL1	Peninsula and Island Granitics
				KJL2	Fjordland Undifferentiated Sedimentary Rocks
				KJL3	Coastal Lowland-Valley

Table 2. Summary of criteria used to delineate Ecological Subsections in Aniakchak National Monument and Preserve.

Ecoregion	Ecological Section		Ecological Subsection	Subsection Rationale
	Name	Code	Name	
Chugach-St. Elias Mountains	Kenai Mountains	HIF	Harding Icefield	Icefields, snowfields, and numerous smaller glaciers, mantling steep, angular and cliffy peaks of Cretaceous undifferentiated sedimentary rock. Isolated small peaks called nunataks poke up sporadically in the middle of the broad icefields.
Gulf of Alaska Coast	Northern Gulf Fjordlands	KJL	Kenai Fjordlands	Rugged coastal mountains comprised of an intricate system of fjords and drowned cirques forming spectacular "biscuit board" topography. Geomorphological features carved in massive Cretaceous-aged undifferentiated sedimentary rocks and Holocene granites by

Table 3. The landcover area and number for polygons of Subsections and Detailed Subsections associated with Kenai Fjords National Park.

Ecological Subsection				Detailed Subsection			
Name	**Code**	**No. of Polygons**	**Acreage**	**Name**	**Code**	**No. of Polygons**	**Acreage**
Harding Icefield	HIF	2	335676				
Kenai Fjordlands	KJL	12	270157	Peninsula and Island Granitics	KJL1	2	32330
				Fjordland Undifferentiated Sedimentary Rocks	KJL2	5	13124
				Coastal Lowland - Valley	KJL3	5	224703
TOTAL		14	605833			12	270157

Table 4. A summary of the ecological units and criteria used to delineate Ecological Subsections of Kenai Fjords National Park.

Ecoregion	Ecological Section	Ecological Subsection				Detailed Ecological Subsection			Representative Photo
		Code	Name	Subsection Physiography	Subsection Rationale	Code	Name	Detailed Subsection Lithology	
Chugach-St. Elias Mountains	Kenai Mountains	HIF	Harding Icefield	Icefields	Ice¼elds, snow¼elds, and numerous smaller glaciers, mantling steep, angular and cliffy peaks of Cretaceous Undifferentiated Sedimentary Rock. Isolated small peaks called nunataks poke up sporadically in the middle of the broad ice¼elds. Some glaciers run			Underlain by Undifferentiated Sedimentary Rocks	
Gulf of Alaska Coast	Northern Gulf Fjordlands	KJL	Kenai Fjordlands	Angular Mountains	Rugged coastal mountains comprised of an intricate system of fjords and drowned cirques forming spectacular "biscuit board" topography. Geomorphological features carved in massive Cretaceous-aged undifferentiated sedimentary rocks and Holocene granites by	KJL1	Peninsula and Island Granitics	Eocene Granite and Granodiorite	
						KJL2	Fjordland Undifferentiated Sedimentary Rocks	Upper Cretaceous Undifferentiated Sedimentary Rocks	
						KJL3	Coastal Lowland and Valley	Holocene Alluvial Deposits	

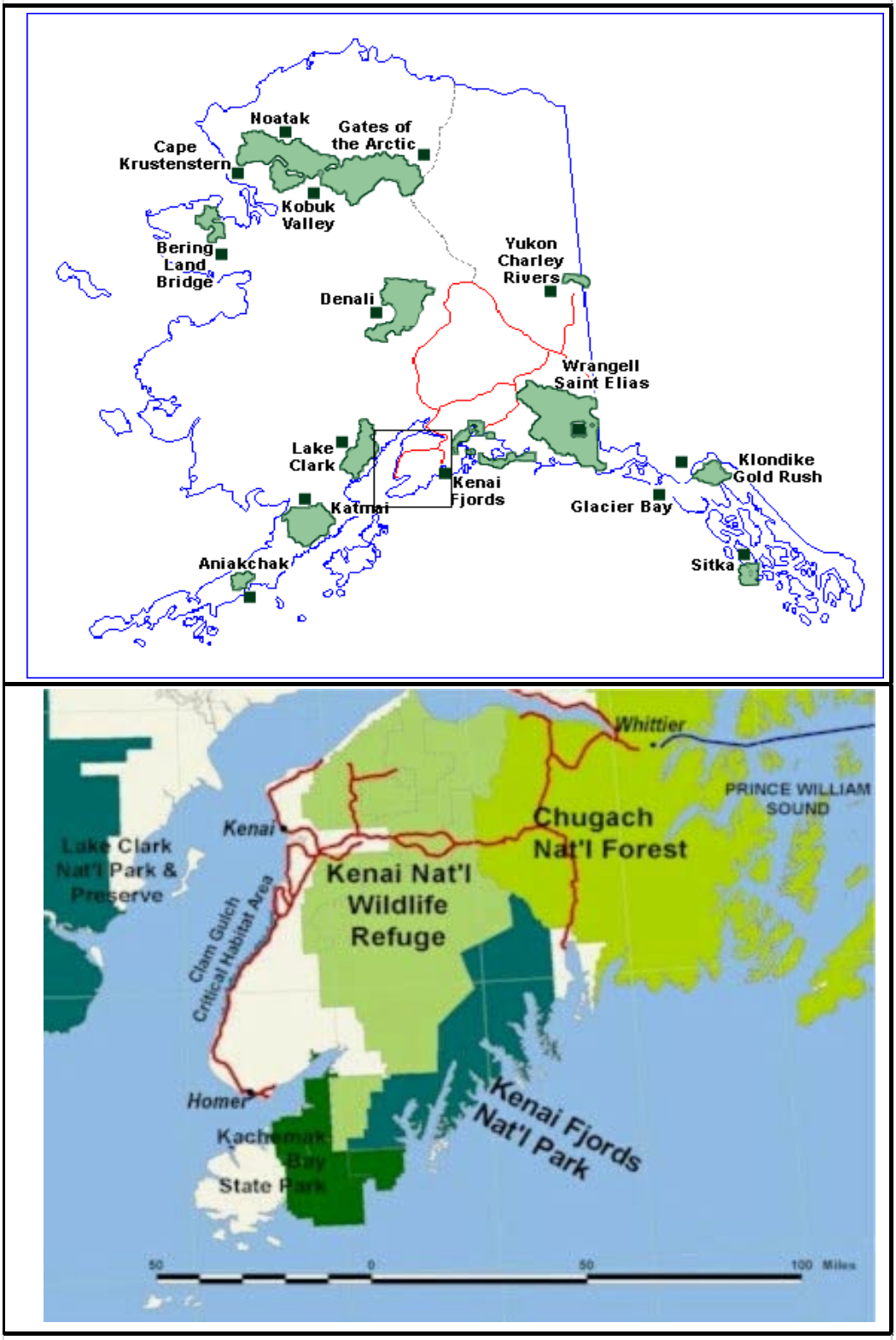


Figure 1. Map of southcentral Alaska showing the location of Kenai Fjords National Park.

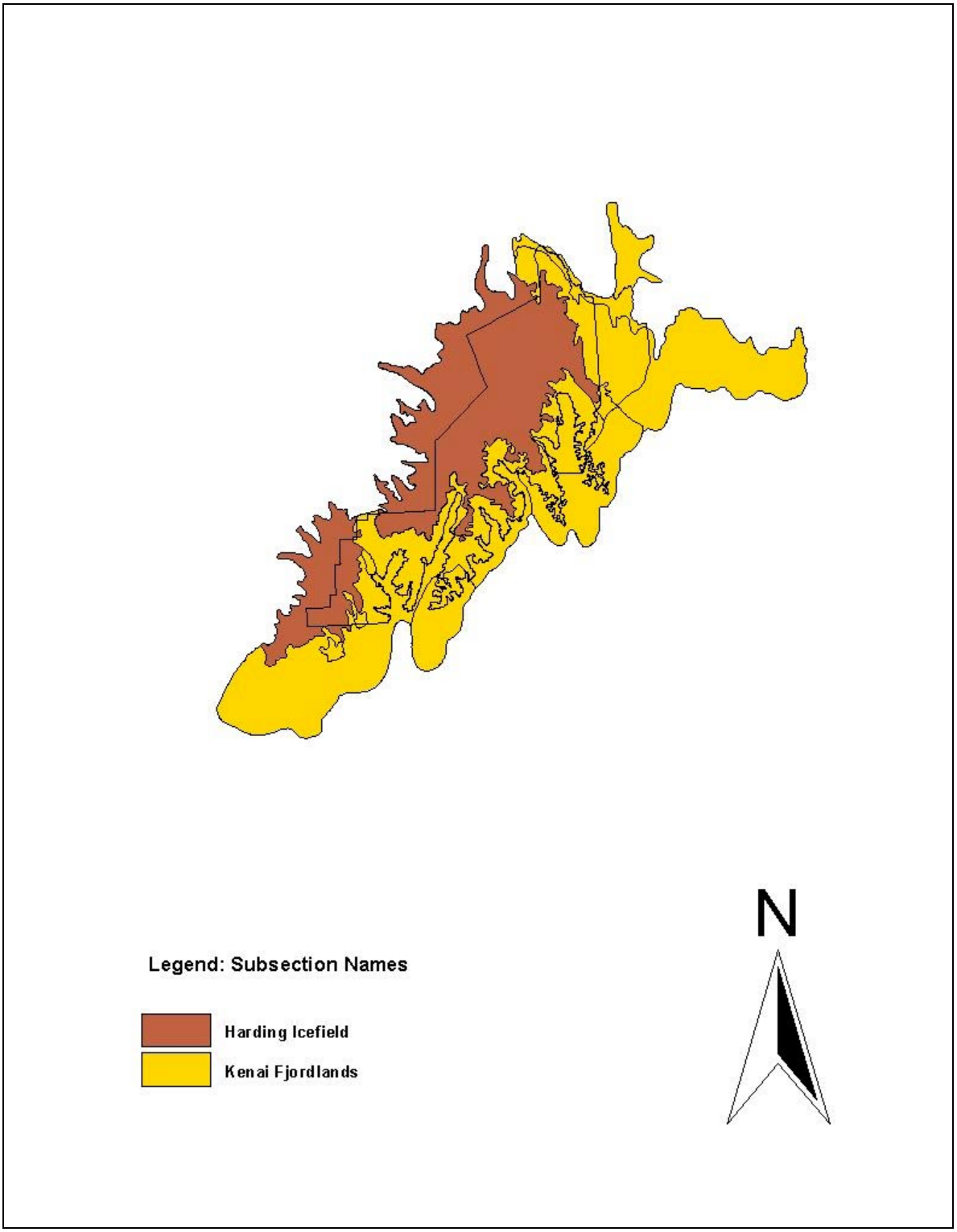


Figure 2. Map of Subsections within Kenai National Park.

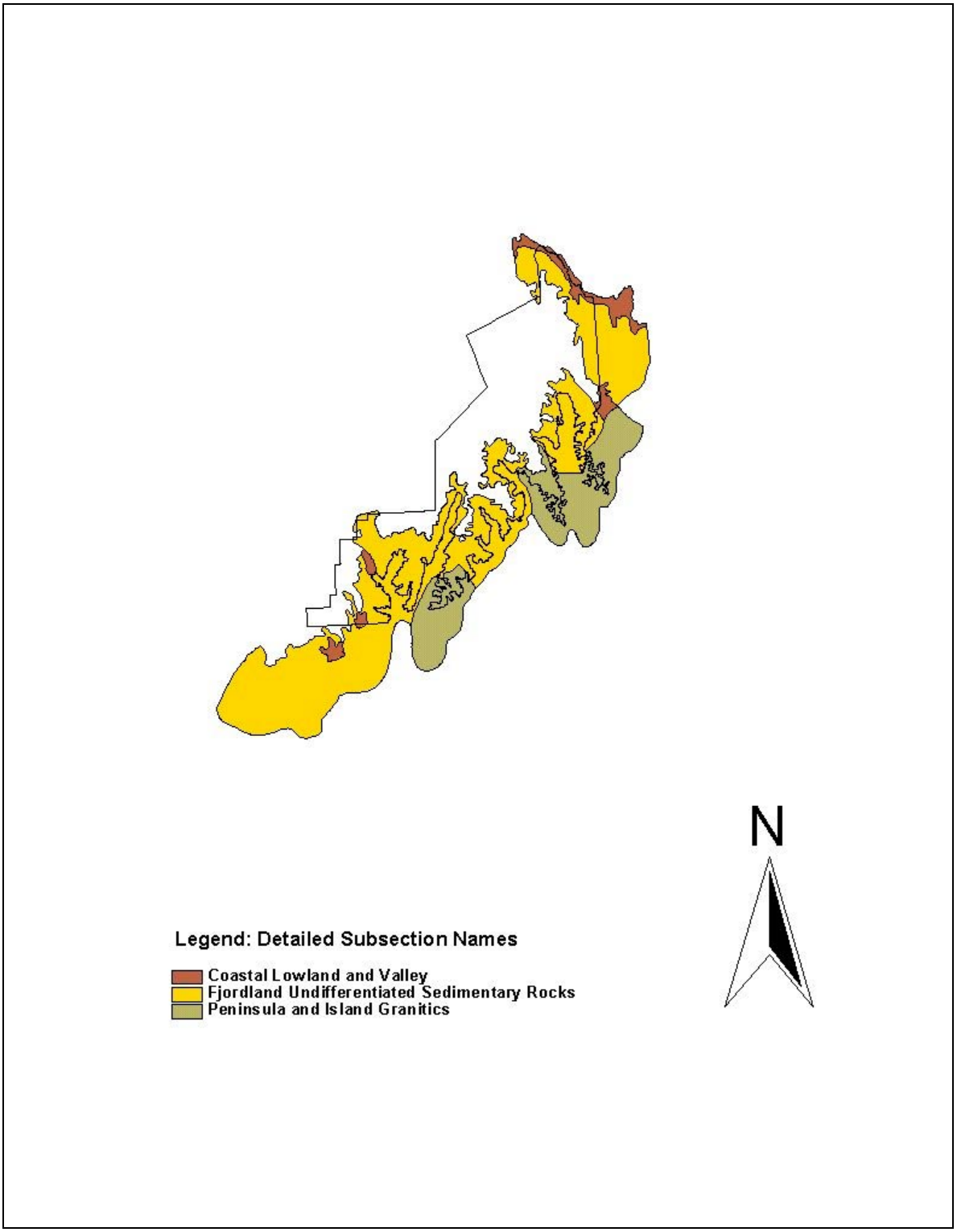


Figure 3. Map of Detailed Subsections Kenai National Park.