ECOLOGICAL SUBSECTIONS OF KENAI FJORDS NATIONAL PARK

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Ecological Subsections of Kenai Fjords National Park, Alaska

Final Report

Prepared For:

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October 2001
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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:


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 delineation 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 km²). 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:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARK_CODE</td>
<td>Four-character NPS abbreviation for the park unit</td>
</tr>
<tr>
<td>ECOREGION</td>
<td>From Nowacki <em>et al.</em> (2000)</td>
</tr>
<tr>
<td>SECTION</td>
<td>Full name for tentative Ecological Section</td>
</tr>
<tr>
<td>SUBSEC_NA</td>
<td>Full name of the Ecological Subsection</td>
</tr>
<tr>
<td>SUBSEC_CO</td>
<td>Symbol for the Ecological Subsection</td>
</tr>
<tr>
<td>DETSUB_NA</td>
<td>Full name of Detailed Ecological Subsection</td>
</tr>
<tr>
<td>DETSUB_CO</td>
<td>Symbol for Detailed Ecological Subsection</td>
</tr>
<tr>
<td>DS_LITHOL</td>
<td>General lithology if bedrock, or otherwise general surficial category</td>
</tr>
<tr>
<td>ACRES</td>
<td>Total acre amount for individual mapped polygons</td>
</tr>
<tr>
<td>SS_RATION</td>
<td>A short statement on the rationale for the unit</td>
</tr>
</tbody>
</table>

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


Tables

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

<table>
<thead>
<tr>
<th>Ecoregion Ecological Section</th>
<th>Ecological Subsection</th>
<th>Detailed Ecological Subsection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chugach-St. Elias Mountains</td>
<td>Kenai Mountains</td>
<td>Harding Icefield</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Gulf of Alaska Coast</td>
<td>Northern Gulf Fjordlands</td>
<td>KJL1 Peninsula and Island Granitics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KJL2 Fjordland Undifferentiated Sedimentary Rocks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KJL3 Coastal Lowland-Valley</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Ecoregion Ecological Section</th>
<th>Ecological Subsection</th>
<th>Subsection Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chugach-St. Elias Mountains</td>
<td>Kenai Mountains</td>
<td>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.</td>
</tr>
<tr>
<td>Gulf of Alaska Coast</td>
<td>Northern Gulf Fjordlands</td>
<td>Rugged coastal mountains comprised of an intricate system of fjords and drowned cirques forming spectacular &quot;biscuit board&quot; topography. Geomorphological features carved in massive Cretaceous-aged undifferentiated sedimentary rocks and Holocene granites by</td>
</tr>
</tbody>
</table>
Table 3. The landcover area and number for polygons of Subsections and Detailed Subsections associated with Kenai Fjords National Park.

<table>
<thead>
<tr>
<th>Ecological Subsection</th>
<th>Code</th>
<th>No. of Polygons</th>
<th>Acreage</th>
<th>Detailed Subsection</th>
<th>Code</th>
<th>No. of Polygons</th>
<th>Acreage</th>
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<tr>
<td>Harding Icefield</td>
<td>HIF</td>
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<td>335676</td>
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<tr>
<td>Kenai Fjordlands</td>
<td>KJL</td>
<td>12</td>
<td>270157</td>
<td>Peninsula and Island Granitics</td>
<td>KJL1</td>
<td>2</td>
<td>32330</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Fjordland Undifferentiated Sedimentary Rocks</td>
<td>KJL2</td>
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<td>13124</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Coastal Lowland - Valley</td>
<td>KJL3</td>
<td>5</td>
<td>224703</td>
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<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>14</strong></td>
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<td><strong>12</strong></td>
<td><strong>270157</strong></td>
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Table 4. A summary of the ecological units and criteria used to delineate Ecological Subsections of Kenai Fjords National Park

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Ecological Section</th>
<th>Code</th>
<th>Name</th>
<th>Subsection Physiography</th>
<th>Subsection Rationale</th>
<th>Detailed Ecological Subsection</th>
<th>Representative Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chu-ach-St. Ei- las</td>
<td>Mountains</td>
<td>HIF</td>
<td>Harding</td>
<td>Icefields</td>
<td>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. Some glaciers run.</td>
<td>Underlain by Undifferentiated Sedimentary Rocks</td>
<td><img src="image1" alt="Icefields" /></td>
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<td></td>
</tr>
<tr>
<td>Gulf of Alaska Coast</td>
<td>Northern</td>
<td>KJL</td>
<td>Kenai</td>
<td>Rugged coastal mountains comprised of an intricate system of fjords and drowned cirques forming spectacular &quot;biscuit board&quot; topography. Geomorphological features carved in massive Cretaceous-aged undifferentiated sedimentary rocks and Holocene granites by</td>
<td>Peninsula and Island Granitics</td>
<td><img src="image2" alt="Rugged coastal mountains" /></td>
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</tr>
<tr>
<td></td>
<td>Gulf Fjordlands</td>
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<td>Fjordlands</td>
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</tbody>
</table>

KJL1 Peninsula and Island Granitics

KJL2 Fjordland 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.