National Park Service - Alaska Region
Inventory & Monitoring Program

ECOLOGICAL SUBSECTIONS OF LAKE CLARK NATIONAL PARK & PRESERVE

Mapping and Delineation by:
Page Spencer, National Park Service

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Photographs by:
Page Spencer

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

Page Spencer
Biological Resources Team
National Park Service

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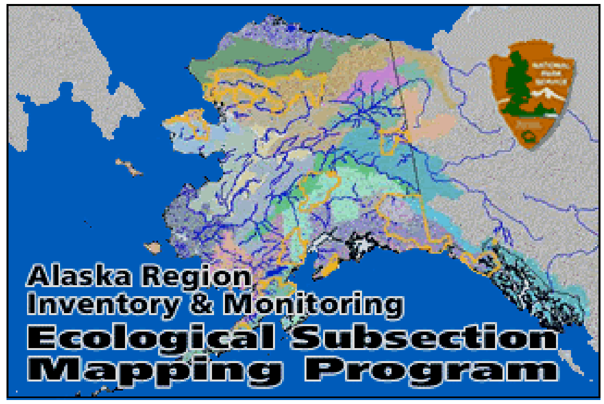

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Introduction

What is an ecosystem? The classic definition is often given as set of living organisms and physical processes that interact with each other to form a functional system. This definition is usually followed with examples such as an ecosystem can be a drop of pond water or a continental desert. Clearly, these ecosystems function at different spatial scales under different controlling parameters.

Several authors have developed ecological frameworks in an attempt to classify ecosystems into levels that are useful for human understanding, study and management applications. Natural systems can then be mapped using these criteria at increasing detailed spatial scales. The ECOMAP Hierarchial Framework of Ecological Units developed primarily by the USDA Forest Service (USFS ECOMAP 1993) offers a useful structure for mapping environmental units across the globe. Its highest levels are defined by global climate patterns and span millions of square miles. As the levels become increasingly detailed, the criteria include local weather patterns, topography, geomorphic processes, lithography, vegetation patterns and soils. The Unified Ecoregions of Alaska (Nowacki et al 2002) maps landscapes of Alaska and nearby countries at the Province level of the Bailey hierarchy.

This effort represents ecological mapping at the Section, Subsection and (partially) the Landtype Association levels of the ECOMAP heierarchy. Each of these levels is a further refinement of the Ecoregions. They have greater spatial detail, smaller units, shorter time frames, and increasingly local environmental parameters as defining factors. The National Park Service has mapped all Alaska park units to the subsection level as part of the national inventory program. These data will be used in this effort to stratify sampling designs for field inventories of vascular plants, small mammals, fish and birds. The US Forest Service has completed subsection mapping for both the Chugach and Tongass Forests in Alaska (Nowacki et al 2001).

Methods

Subsection units were mapped for Lake Clark National Park and Preserve through manual interpretation and synthesis of several information sources. The mapping base is a custom enhanced color infrared composite (Fleming 2000) of a Landsat TM scene acquired Sept 6, 1999. The mapping scale is 1:250,000. Additional information came from invaluable discussions with Ric Wilson, USGS geologist, interpretation of the TM image itself, landcover map of the park (NPS and PMR 1998), coastal resources mapping (Tande and Bennett 1996), bedrock geology datasets (USGS 2001), many discussions with Lake Clark park staff, and extensive field work in the area by the author.

Major subsection units were delineated based primarily on bedrock and surficial geologic features and processes, with refinements from vegetation and weather patterns. Most subsection units are over 5000 acres in size. An exception to this minimum mapping unit was made throughout the entire project for floodplains and coastal units. These detailed subsection units were deemed likely to be biologically diverse and important areas to concentrate inventory work, so were mapped in greater detail. Detailed subsections correspond to the Landtype Association level in the ECOMAP hierarchy.

The region encompassing Lake Clark National Park and Preserve spans the Alaska Range between Cook Inlet and the northern Bristol Bay country. The entire park and surrounding country were probably once part of a volcanic island arc formed at latitudes like those of present day Baja. The unit traveled north, docking at its current location (maybe) 120 million years before present (BP). Four major ecosystems are formed by this junction of topography and major climatic regimes. The northwest section around the Stony River is a boreal system, very like the interior of Alaska with permafrost soils and frequent wildfire. South of the Stony Rive valley there is a region of large lakes and intervening ridges remaining from multiple Pleistocene glacial advances. The Alaska Range forms the spine of the park, formed of an extremely rugged old pluton which has been surmounted in spots by recent volcanoes, and has been carved by continental and local alpine glaciations. The easternmost boundary supports a fringe of deltas, bays and estuaries on the Cook Inlet Coast. These four major ecosystems, which are reflected by the Ecoregions of Alaska map, were mapped in more detail at the Section and subsection levels for this effort. Fifteen ecological subsection units were mapped for the park (Plate 1). An additional 19 detailed subsection units were mapped to show floodplains and coastal units. Table 1 shows the relationship of the levels and ecological units to each other.

Lake Clark Ecological Subsection Descriptions

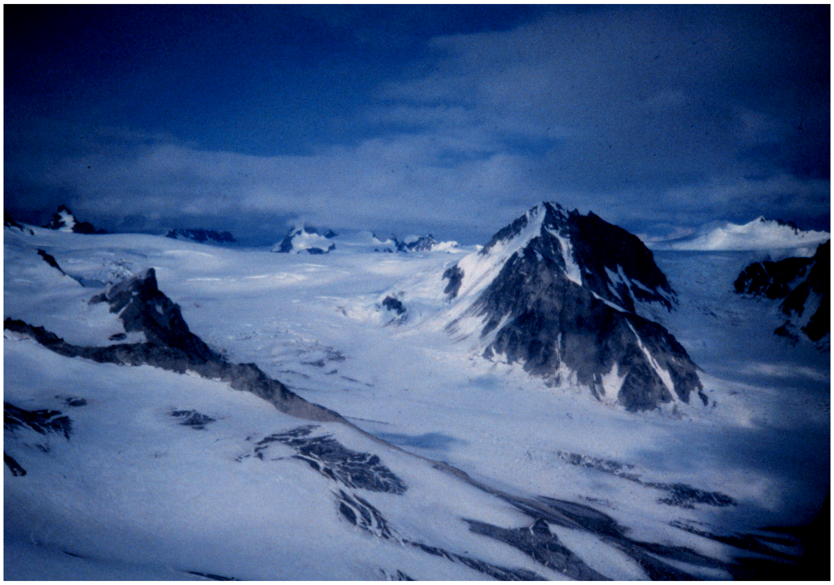

Figure 1. Chigmit Mountains and Icefields. Note rugged nunataks rising from alpine icefield. This photo is from the area between Chakachamna Lake and Lake Clark Pass.

The units of the Chigmit Mountains and Icefields subsection form the backbone of Lake Clark National Park and Preserve. The bedrock is composed of a ridge of old plutonic rocks which were intruded into sedimentary and volcanic country rock approximately 150-250 million years BP. Subsequently, these mountains were eroded, pierced by volcanos, and heavily glaciated.

This unit includes several active volcanoes: Redoubt, Iliamna (and would include Spurr if the unit extended further outside the park). The mountains are very rugged and draped with alpine glaciers. The valleys are all U-shaped remnants of extensive valley glaciation with complex moraines along the sides and throughout the bottoms.

Figure 2. Chigmit Mountains and Icefields. These rugged, glacially carved mountains are east of Turquoise Lake.

Generally, the lower slopes up to the lateral moraine lines are blanketed in impenetrable alder that gives way to open alder and grassy meadows at higher elevations. Alpine tundra is a sparse band below polished bedrock summits.

LCPM *Lake Clark Pass and Moraines*

Figure 3. Lake Clark Pass, with pass running from lower right to center left of photo. Glacier in center is at the summit of the pass, near the eastern end.

Lake Clark Pass follows a large fault running from the Cook Inlet Basin to the southwest, under Lake Clark itself. This unit is mapped as one subsection, even though it spans two ecoregions. This is due to its importance as an ecological corridor at this scale. Large valley glaciers have filled this pass many times, pushing out west into the area occupied by Lake Clark, southwest to Iliamna Lake and west up the Chulitna River. In the early 1960's ice still blocked the head of the pass from two side valley glaciers. Moraines and till cover the sides and floor of the pass and associated valleys. Ground till, morainal remnants and outwash deltas cover the terrestrial portions of the subsection south and west of Lake Clark.

Lake Clark Pass itself is vegetated with alder above the spruce line, and white spruce with some cottonwood in the valley bottom. Around Lake Clark, white spruce and birch forests blanket the hillsides, grading into black spruce woodlands and wetlands on the northeast shore in the Chulitna basin. Between Lakes Clark and Iliamna, the primary vegetation communities are sparse white spruce, dwarf birch and ericaceous shrubs, and lichens, due to the well drained Newhalen outwash. The river and lake systems of this subsection are major spawning and rearing grounds for the Bristol Bay sockeye

Figure 4. Lake Clark, view to the east. Lake Clark is approximately 50 miles long, and lies in a glacially carved basin aligned with the Lake Clark fault.

salmon. Spruce bark beetle are slowly moving through the pass from the eastern end, and have infested trees down to Lake Clark.

RVH Rounded Volcanic Hills

Figure 5. Rounded Volcanic Hills. This valley is at the headwaters of the Tazimina Lakes. The relatively rounded hills are remnants of old volcanic plutons eroded by water, gravity and ice. The U shaped valleys are typical of valley glaciation.

This subsection is a series of isolated outcrops surrounded by glacial debris, located in the southwest quadrant of Lake Clark National Park and Preserve. The bedrock is made

Figure 6. These eroding hills are the headwaters of several drainages for the upper Little Mulchatna River, north of Lake Clark. The trails across the fall lines are from migrating caribou.

up of volcanic material erupted here 40 to 70 million years BP. These have been eroded by glaciers and weather into gently rounded, moderate relief hills. Some of the hills are steep sided, with unstable talus woven by caribou trails. Generally they have alder and willow thickets on the lower slopes, grading up into alpine tundra and exposed bedrock on the higher exposed ridges. The lowest valleys support mixed forest of white spruce, birch and cottonwood. It is likely that some of the upper ends of the valleys (ex. Upper Kontrashibuana and Tazimina) were not glaciated during the most recent advance approximately 12 to 14 thousands years ago, serving as refugia during the last ice advances out of the Alaska Range.

WLTP *Western Lake and Till Plains*

Figure 7. Western Lake till and moraine plains. This view to the northwest of the outlet of lower Twin Lake shows the small terminal moraines and gentle plains covered with ground moraine from earlier glaciations.

The western lake and till plains subsection is an area of subdued relief and lakes between the Stony River and Lake Clark. This area is covered with ground moraine and small scale glacial features like eskers, pothole lakes, and lateral moraines. The last main glacial advance may have pushed as far west as Mary's Mountains and nearly to the Mulchatna River. More recently, small glaciers have probably advanced out of the valleys of Twin and Turquoise Lakes, leaving terminal moraines near the western ends of these lake systems. There was a likely ice-free corridor in the upper Kijik River and Fishtrap Lake country during the late glacial periods. The vegetation of this unit is primarily low shrub and ericaceous/lichen tundra, with scattered white spruce and wetlands. Near the eastern edge, the unit rises to the Chigmit Mountains, and supports alpine tundra with rich berry patches. Recent research indicates that this subsection is a nesting and rearing area for many species of shorebirds.

WSH Whitefish Sedimentary Hills

Figure 8. Snipe Lake and surrounding country of the moraines and till plains. This area may have been unglaciated during the most recent advance from the Alaska Range. The gentle terrain has ground moraine and eskers with scattered small lakes.

See Figure 10, which includes a portion of the Whitefish Sedimentary Hills on the left hand horizon.

These bedrock exposures are similar to the units of the Rounded Volcanic Hills subsection, but the bedrock is thought to be sedimentary rather than volcanic. These units rise up from a sea of till and morainal material brought to the region by massive valley glaciations out the Alaska Range.

TH Telaquana Highlands

Figure 9. Overview of the Telaquana Highlands. The foreground is sedge dominated wet tundra. The rough, dark area to right center is a portion of the Turquoise lateral moraine which lapped up onto the Telaquana Highlands.

The Telaquana highlands are a gentle ridge that has not been recently glaciated. Glaciers from the Telaquana and Turquoise valleys along the sides leaving prominent lateral moraines on both sides of the ridge. Several types of peri-glacial features such as patterned ground and tussocks are spread over the shallow basins forming the headwaters of the Mulchatna River. The unit is mostly vegetated with sedge dominated tundras. This unit may have served as a refugium during several of the most recent glacial advances, and is further unique due its location where the marine influence of the Bristol Bay and the continental boreal ecosystems merge. Preliminary surveys indicate a rich and unique vascular flora in the unit.

SRMV *Stony River Morainal Valley*

Figure 10. View downstream of the Stony River. Note the meandering rivercourse, and boreal forests on the valley floor. White spruce line the river where permafrost is deeper, with black spruce and muskeg further from the river in areas of shallower permafrost. This subsection is prone to natural wildfires. The hill rising on the left side of the horizon is part of the Whitefish Sedimentary Hills unit.

The Stony River flows through a broad valley partially shaped by large valley glaciers flowing west from the Alaska Range. The drainages originate in the Alaska Range and Merrill Pass country to the east and run through old terminal moraines delineating the western border of this subsection. This valley is blanketed with ground moraine and has numerous small shallow lakes and abandoned sloughs along the meandering rivers. As Lake Clark's boreal representative, the valley has discontinuous permafrost and associated thermokarsting. The vegetation is reflective of the continental climate, with black spruce/low shrub woodlands, wetlands and frequent lightening-caused wildfires. These fires yield a mosaiced pattern of successional vegetation communities, beginning with herbaceous and shrub communities that are replaced by aspen and birch stands and eventually become black spruce muskeg. These black spruce communities are vulnerable to wildfire, beginning the cycle again.

SKH Skwentna/Kuskokwim Headwaters

Figure 11. The rugged and glacially carved mountains north of Telaquana Pass have only small alpine glaciers. However, the U shaped valleys show previous glacial advances.

This unit is a vague stretch of the Alaska Range north of Telaquana Pass. It is geologically similar to the Chigmit Mountains, with the addition of of units of unstable sedimentary rocks of the Kahilitna Terrane which have been extensively folded, contorted and fractured. Two major river systems rise in these mountains; the south Fork of the Kuskokwim flowing to the Bering Sea and the Skwentna River flowing to Cook Inlet via the Susitna River. This region is composed of rugged mountains with glacially carved valleys and small alpine glaciers. It does not have the extensive ice fields of the Chigmits to the south. The mountains are raked by avalanches and debris falls, creating barren unstable slopes that support patchy alpine vegetation. Fast and flashy streams flow through the valleys with riparian shrub communities along their banks. Not much is known about this subsection, and access is challenging.

CMTV Chakachamna moraines and till valleys

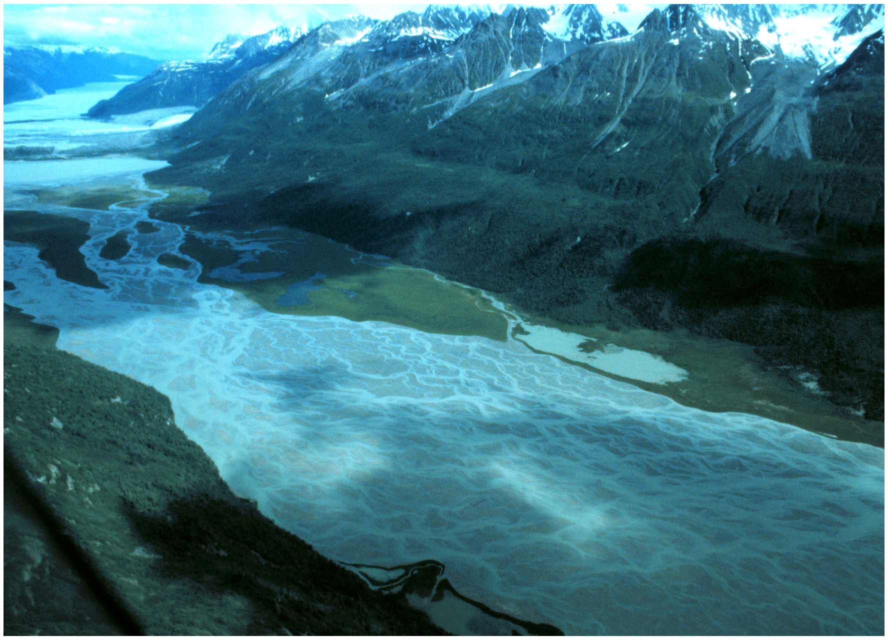

Figure 12. Neacola river with Chakachamna Lake at upper left. This broad valley has been carved by large valley glaciers. The wetlands which have developed along the shallow river and lakes support a rich diversity of wildlife and waterfowl.

The Chakachamna unit consists of the glacial valleys of Chakachamna Lake and valleys of its inflow streams. The unit has been heavily glaciated, and till and remnant moraines cover the valley floors. Active avalanche chutes and the termini of valley glaciers push into this unit from the surrounding mountain units. This unit continues to be a major depositional site from streams and glaciers. The Neacola River floodplain covers the valley from side to side with sandbars and shallow braided channels, and forms an extensive wetland where it flows into Kenibuna Lake. It provides rich habitat for wildlife and nesting waterfowl. The Chilligan river valley has been scraped to bedrock in many places, creating opportunities for waterfalls. White spruce forest covers the lower valley, with alder on areas of continuous disturbance above the forests. Chakachamna Lake itself is extremely silty from all the glacial streams pouring into it and Mt Spurr ashfalls. The Shamrock glacier pretty much blocks the western end of the lake. The valley of the Nagishlamina and Skwetna rivers runs north from Chakachamna behind Mt Spurr. Alpine tundra types and debris flows/moraines cover the upper valley, with mixed forest on lower elevations.

SBU String Bog Uplands

Figure 13. The string bog in the center of this photo is similar to those of the String Bog Uplands subsection. However, the Uplands are vegetated with alder and scattered white spruce on the drier sites, rather than the forest shown here.

This subsection is the furthest south unit of a complex of string bogs which extend to the north as far as Mount Susitna. The park boundary only nicks the unit on the west side, but it may be worthy of investigation due to the uniqueness of string bogs and the opportunity for diverse plant species. It is likely that this area was not covered with moving glaciers during the Pleistocene events in Cook Inlet, although stagnant ice may have been present. String bogs tend to be old surfaces where very slowly flowing water gradually accumulates organic material in little ridges perpendicular to the flow. In time, these stabilize with sedges, moss and low shrubs into a mosaic of ponds and wetlands. The String Bog subsection has extensive areas of such bogs, with alder in the larger drainages and scattered white spruce on the drier areas.

CIMT Cook Inlet Moraines and till plains

No Photo

Bedrock in this area is a combination of sedimentary and old volcanics. These units are remnants of till and lateral moraines left by various retreating Cook Inlet glaciers. The soil thickness varies over bedrock knobs, which are further smothered with alder, with scattered white spruce and wetland patches.

CIOV Cook Inlet Old Volcanics

Figure 14. Long ridges of old Cook Inlet volcanics reaching east from the Alaska Range. Redoubt volcano in the Chigmit subsection, rises in the background.

Several units of this subsection are a long stretch of the oldest rocks in the region from the Talkeetna Formation. They are an old belt of eroded igneous rocks that have metamorphosed into a mixture of volcanic and sedimentary rock, lying between the eroded plutons to the west, and more recent sedimentary formations along the Cook Inlet coast. This subsection forms the long ridges reaching east from the Alaska Range and skirts several active volcanos. The vegetation is primarily dense alder up to about 3000', and scattered alpine tundra and bare rock at higher elevations. Lower elevations in Crescent River support dense stands of white spruce and cottonwood. Spruce bark beetle swept through this area in the late 1990's, killing most large white spruce.

ISH Iliamna Sedimentary Hills

Figure 15. Slope Mountains on the western coast of Cook Inlet illustrates the tilted beds of the Iliamna Sedimentary Hills.

This subsection is a patch of dramatic tilted sedimentary beds on the eastern slopes of Mt Iliamna. These rocks are one of the best exposures of Jurassic (120-180 million years BP) sedimentary rocks in the world. The beds are unmetamorphosed and rich in fossils. This unit is important for understanding and describing Jurassic ecosystems. The bedrock is easily eroded, creating massive till and moraines on the Red Glacier, and unstable surfaces on the ridges reaching east from Iliamna. Additional instability comes from repeated eruptions and ash/rock falls from Iliamna volcano and multiple advances of valley glaciers off Iliamna. White and Sitka spruce form dense conifer forests with cottonwood along streams, and serious alder at lower elevations throughout the unit. Sparse alpine tundra occupies the ridgetops. This unit represents the furthest north extension of Sitka spruce forests on the western side of Cook Inlet. Spruce bark beetle have moved through the unit in the late 1990's, killing many of the mature white spruce.

CIMI Cook Inlet Marine Influence

Figure 16. Extensive sedge marshes and tidal mudflats at the head of Tuxedni Bay are rich spring habitat for brown bears.

The Cook Inlet Marine Influence subsection consists of several coastal units at the heads of large bays and lagoons. These units are primarily deposits of sand and silt from Cook Inlet and the glaciers and rivers of the Alaska Range. These large silt flats are vegetated with a mosaic of sedges and herbs resistant to frequent to occasional salt water innundation. This unit provides excellent brown bear habitat with lush sedge meadows and rich salmon runs, and on the seaward margins, razor clam beds.

References:

Fleming, M. 2000. Lake Clark National Park Satellite Image Map. 1:250,000 Custom Enhancement of Landsat TM data acquired 9/6/99. 1 imagemap.

National Park Service and Pacific Meridian Resources. 1998. Lake Clark National Park and Preserve Land Cover Mapping Project. Written Users Guide and digital dataset. (Hard copy report) NPS Alaska Support Office, GIS Team, 2525 Gambell St. Anch. Ak. 99503. (Digital data) www.nps.gov/akso/gis/

Nowacki, G.P., M. Shephard, W Pawuk, G. Fisher, J. Baichtal, D. Brew, E. Kissinger and T. Brock. 2001. Ecological Subsections of Southeast Alaska and Neighboring Areas of Canada. USDA Forest Service, Ak Region. Tech Pub No. R10-TP-75. Oct 2001. 306 pgs + map.

Nowacki, G., P. Spencer, M. Fleming, T. Brock and T. Jorgenson. 2002. Unified Ecoregions of Alaska: 2001. Map and digital dataset. (Map) USGS I series. (Digital data) www.adgc.usgs.gov/data/projects/fhm/

Tande, G.F. and A. Bennett. 1996. Mapping and Classification of Coastal Marshes, Lake Clark National Park and Preserve. Written report and digital dataset. (Hard copy report) NPS Alaska Support Office, GIS Team, 2525 Gambell St. Anch. Ak. 99503. 56 pgs. (Digital data) www.nps.gov/akso/gis/

USFS ECOMAP. 1993. National Hierarchal Framework of Ecological Units. Washington DC. USDA Forest Service. 20 pgs.

USGS 2001. UNPUBLISHED DRAFT DIGITAL DATA: Bedrock Geology of Iliamna, Lake Clark, Lime Hills, Kenai, Seldovia and Tyonek quadrangles. Digital data sets. This CD includes digital data of the references listed below:

Detterman, R.L., and B.L. Reed. 1980. Stratigraphy, structure, and economic geology of the Iliamna quadrangle, Alaska: U.S. Geological Survey Bulletin 1368-B, 86p., 1 sheet, scale 1:250,000.

Magoon, L.B., W.L. Adkison, and R.M. Egbert. 1967. Map showing geology, wildcat wells, Tertiary plant localities, K-Ar age dates, and petroleum operations, Cook Inlet area, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-1019, scale 1:250,000, 3 sheets.

Nelson, W.H., C. Carlson and J.E. Case. 1978. Geologic map of the Lake Clark Quad, Alaska. U.S. Geological Survey Miscellaneous Field Studies Map MF-1114A, scale 1:250,000.

Gamble, B.M. 1996. Compilation of Geologic Map of east half of Lime Hills Quad, Alaska. In Wilson, F.H., J.H. Dover, D.C. Bradley, F.R. Weber, T.K. Bundtzen and P.J. Haeussler. 1998. Geologic Map of Central (Interior) Alaska. U.S. Geological Survey Open File Report 98-133-A. Digital files published as CD.

Bradley, D.C. and others. 2000. Geology of the Seldovia Quadrangle: U.S. Geological Survey Open File Report. Scale 1:250,000

Wilson, Ric. Pers. Comm. 2001. Multiple discussions on bedrock and surficial geology of the Lake Clark region. March, April and December, 2001.

Table 1. Hierarchal levels of ecosystem mapping, with units for Lake Clark NP&P.

Ecoregion	Section	Subsection	Detailed Subsection (Landtype Association)
Alaska Range	Alaska Range Glacial Terrains	Chakachamna Moraines and Till Valleys	Neacola River Floodplain
		Cook Inlet Moraines and Till Plains	
		Lake Clark Pass & Moraines	North Fork Big River Floodplain
	Alaska Range Plutons	Chigmit Mountains and Icefields	Turquoise River Floodplain
			Tuxedni River Floodplain
		Cook Inlet Old Volcanics	Crescent River Floodplain
			Drift River Floodplain
			West Fk Glacier Ck Floodplain
		Skwentna/Kuskokwim Headwaters	
	Alaska Range Sedimentary	Iliamna Sedimentary Hills	Johnson River Floodplain
			Red River Floodplain
	Alaska Range Rounded Hills	Rounded Volcanic Hills	
Cook Inlet Basin	Cook Inlet Basin	Cook Inlet Marine Influence	Horsefly Slough Tidal Flats
			Silver Salmon Tidal Flats
			Chitintna Bay Tidal Flats
			South Tuxedni Tidal Flats
		String Bog Uplands	
Lime Hills	Lime Hills Glacial Terrains	Stony River Morainal Valley	Necons River Floodplain
			Stony River Floodplain
		Western Lake Moraines and Till Plains	
	Lime Rounded Hills	Rounded Volcanic Hills	
		Telquana Highlands	
		Whitefish Sedimentary Hills	

Plate 1. Ecological Subsections on Landsat TM image of Lake Clark NP&P area.

See full dataset for additional detail and unit names.