Photographic examples of different wetland types on the Kenai Peninsula lowlands

Blue rows are peat-dominated freshwater wetland ecosystem types on the Kenai Peninsula lowlands

D: Depression wetlands are common as peatlands in ice-block depressions on large moraine complexes. They are also found on smaller moraines scattered throughout the lowlands. Depressions are "ice block depressions." Large blocks of glacial ice were entrained in glacial till deposited by receding glaciers. When ice blocks melted, they left deep depressions on the surface, some more isolated than others. Depressions are surrounded by uplands and lack a stream or wetland connection to Cook Inlet. http://www.kenaiwetlands.net/EcosystemDescriptions/Depression.htm

A segregated, concentric D1-3 depression with a central pool ringed by sedge, then shrub plant communities, near Kasilof (polygon 9757). www.kenaiwetlands.net/MapUnitDescriptions/D13.htm

Segregated, concentric D1-4: central pool (D1) is ringed by a sweetgale – sedge community (D2), then sphagnum moss – round sedge community (D3), and black spruce forest (background, D4), near Soldotna (polygon 623). www.kenaiwetlands.net/MapUnitDescriptions/D14.htm

Segregated, concentric D2-4 depression with central sedge area, then shrub communities, then black spruce forest, near Sterling (polygon 861). www.kenaiwetlands.net/MapUnitDescriptions/D24.htm

A D34 Depression near the coast, north of Nikiski (polygon 1196). www.kenaiwetlands.net/MapUnitDescriptions/D34.htm

DW: Relict Glacial Drainageway wetlands are peatlands formed in relict, sometimes abandoned, drainageway features. These are linear features that once drained more extensive glaciers. Some may have formed along glacier margins. Some support modern streams, but these streams are underfit (meaning their streamflows are too small to have eroded the valleys in which their channels now run). These are fen peatlands, with a stable high water table supported by ample groundwater throughflow that has had recent contact with mineral substrates. http://cookinletwetlands.info/Ecosystems/Drainageway.html

A segregated DW1-3 wetland southeast of Kenai (polygon 901). www.kenaiwetlands.net/MapUnitDescriptions/DW1-3.htm

A segregated DW21 wetland north of Kenai, near Salamatof Lake (polygon 1941). http://www.kenaiwetlands.net/MapUnitDescriptions/DW12.htm

Polygon 8137, a DW23 wetland northeast of Kenai. www.kenaiwetlands.net/MapUnitDescriptions/DW23.htm

Segregated DW35A wetland in Soldotna Creek watershed (polygon 555). A central shrubby band is flanked by bands of wet spruce forest. www.kenaiwetlands.net/MapUnitDescriptions/DW35A.htm

Floating Island wetlands are rare, human-generated ecosystems on Kenai lowland lakes. They are literally islands floating on lakes. Soils are entirely organic. On Beluga Lake in Homer, a lake dammed by human activity, occasional small mats of bluejoint grass are broken off from floating mats along the lake margin during high water events. These 25 square meter (~270 square feet) "islands" float quickly with the wind, eventually lodging against the causeway that created the lake (Lake Street), where they are removed. Nearby measurements suggest these mats are probably up to about 3 meters (~10 ft) thick. www.kenaiwetlands.net/EcosystemDescriptions/FloatingIs.htm

Floating islands shown above formed when the outlet of a peatland was dammed by road construction. The peatland flooded, forming Suneva Lake, and leaving several vegetation mats floating on its surface. These islands are about a hectare (2.47 ac) in size; one was observed drifting 1 km over the course of 3 hrs with a breeze of less than 5 mph. www.kenaiwetlands.net/EcosystemDescriptions/FloatingIs.htm

A floating island close up. www.kenaiwetlands.net/EcosystemDescriptions/ FloatingIs.htm

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HF: Headwater Fen wetlands are peatlands formed in small cirques or at drainage divides at or near treeline at the headwaters of first-order streams. These fens often support diverse plant communities, especially in the Caribou Hills, where most of the currently mapped HF wetlands are located. Headwater Fens may be a particularly important energy source at the center of stream food webs. Insects obtain part of their food from the micro-organisms that process carbon exported from Headwater Fens. Larger organisms, such as anadromous fish, then feed on the insects. http://www.kenaiwetlands.net/EcosystemDescriptions/Headwater.htm HF wetlands lie in flat, low spots at headwater basins of streams draining Late Snow Plateaus (see non-peatland wetlands below or http://www.kenaiwetlands.net/EcosystemDescriptions/lateSnow.htm).

A segregated H1-3 fen in the upper Anchor River watershed (polygon 19763). Open water occupies the center, sedges surround the pool, then shrubs border the upland. www.kenaiwet lands.net/MapUnit Descriptions/H13.htm

A stream emerging from beneath peat in a Headwater Fen at the headwaters of the Anchor River. www.kenaiwetlands.net/ EcosystemDescriptions/Headwater.htm

An H32 fen with elephant-head lousewort (*Pedicularis groenlandica*)—a rare plant (listed as G5S2 by the Alaska Natural Heritage Program)—in upper Anchor River watershed (polygon 10295). www.kenai wetlands.net/MapUnitDescrip tions/H23.htm

An H43 wetland in the upper Stariski Creek watershed (polygon 2949). www.kenai wetlands.net/MapUnitDescriptions/H43.htm

K: Kettle wetlands are peatlands occupying depressions created when ice-blocks carried within glacial till melted at the end of the last glacial advance. Kettles have deeply fluctuating water tables, and K2 and K3 wetlands can be flooded at the surface. Much late-season water storage becomes available in these wetlands as the water table draws down during summer dry periods. Kettles have a wetland or stream connection to Cook Inlet, unlike Depression wetlands, which also formed in ice-block depressions. Kettles with more than 20 acres of open water are mapped as lakes http://cookinletwetlands.info/ecosystems/kettle.html.

A K13 wetland near the Boxcar Hills, 20 mi northeast of Homer (polygon 30730). www.kenaiwetlands.net/MapUnitDescriptions/K1-3.htm

Segregated K2-4 wetland near Kasliof (polygon 9478). Central sedge-dominated area (not visible) is ringed by shrubby peatland (left foreground) and forest (right). www.kenaiwetlands.net/MapUnit Descriptions/K2-4.htm

A K31 wetland near Mackey Lakes. The shrubby sweetgale component shown above can occupy a K2 or K3 position (polygon 712). www.kenaiwetlands.net/ MapUnitDescriptions/K1-3.htm

A wetland mapped as K4 north of Kasilof (polygon 8783). www.kenaiwetlands.net/ MapUnitDescriptions/K4.htm

LB: Relict Glacial Lakebed wetlands are extensive peatlands occurring on expansive flat surfaces formerly occupied by large proglacial lakes. Peatlands develop on these surfaces through a process known as "primary peat formation," which occurs where a marshy area gradually fills with peat. Relict Lakebed peatlands are mostly fens, often with patterning. The patterns consist of low-lying pools, which can dry up seasonally to form mud-bottoms (flarks) and intervening strangs (low shrubby ridges). Tree islands often form. http://cookinletwetlands.info/ecosystems/lakebed.html

A wetland polygon mapped as LB1-3 in the large fen complex east of Anchor Point (polygon 48). www.kenaiwetlands.net/ MapUnitDescriptions/LB1-3.htm

LB26 in the large fen complex east of Anchor Point (polygon 70). Foreground is dominated by very wet sweetgale – dwarf birch/water sedge – water horsetail community; a stunted Lutz spruce woodland is in background. www.kenaiwetlands.net/ MapUnitDescriptions/LB26.htm

LB3: An ericaceous shrub layer covers a sphagnum carpet. www.kenaiwetlands. net/MapUnitDescriptions/LB3.htm

A sparse open woodland with a shrubby understory, mapped as LB64, near Clam Creek (polygon 2118). www.kenaiwet lands.net/MapUnitDescriptions/LB46.htm

Photographic examples of different wetland types on the Kenai Peninsula lowlands

Green rows are Kenai Peninsula freshwater wetland ecosystems with mineral OR organic (peat) soils

S: **Discharge Slope** wetlands occur over hydric mineral or organic soils where shallow groundwater discharges at or near the surface. This is the most extensive wetland ecosystem on the Kenai Peninsula, and a Discharge Slope dominated by Lutz spruce (*Picea* X *Lutzii*) is the most common component. Discharge slopes typically occur at margins of other wetlands where the upland boundary is indistinct. These wetlands often support only seasonally high water tables and, therefore, can be difficult to identify. http://cookinletwetlands.info/ecosystems/DischargeSlope.html

An SL wetland (S = Discharge Slope, L = Lutz) with a rusty menziesia dominated understory, near Nikolaevsk (polygon 6969). (Many trees in this stand have been killed by spruce bark beetle.) SL is the single most common and extensive wetland type mapped on the Kenai lowlands. SL wetlands are Lutz spruce forests at foot- and toeslope landscape positions receiving groundwater discharging to near the surface. SL is the most common hydrologic component mapped by itself, but it also frequently occurs with other hydrologic components, especially Barclay's willow (SS). South of Clam Gulch, SL wetlands occur on virtually all foot- and toeslopes underlain by deposits of the last glacial maximum. On these surfaces,S wetlands often form a transition zone between wetter LB or DW wetlands and drier uplands. Lutz spruce Discharge Slopes also occur on slope breaks of terraces formed in deposits of the last glacial maximum.

The most common SL understory plants are rusty menziesia (*Menziesia ferruginea*), thinleaf alder (*Alnus incana* ssp *tenuifolia*), Barclay's willow (*Salix barclayi*), and bluejoint grass (*Calamagrostis canadensis*). The presence of field horsetail (*Equisetum arvense*) in the understory along with any of these plants is good evidence for the presence of a seasonally high water table (e.g. redoximorphic features within 30 cm (1 ft) of the surface). These sites generally meet jurisdictional wetland criteria. That means that any "dredge or fill" activities in these wetlands require a "404 wetland permit" from the US Army Corps of Engineers. www.kenaiwetlands.net/MapUnitDescrip tions/SL.htm

An SLS wetland (S= Discharge Slope, L = Lutz, S = Salix) along a tributary to the North Fork of the Anchor River (polygon 6670). Wetlands mapped as SLS and SSL are where willow shrubs (usually Barclay willow, *Salix barclayii*) mix with Lutz spruce over mineral substrates along slopes receiving groundwater discharge to near the surface. If spruce is more abundant, the unit is designated SLS, and if willow predominates, SSL. These wetlands are common along foot- and toeslopes south of Clam Gulch. They occur along slope breaks on a variety of landforms including: stream-valley walls, terraced moraines, the bases of knobs in kettle-and-knob topography, and where the peat layer thins at the margins of large and small LB or DW peatlands.

Where these wetlands occur along stream valley walls, they are usually found on more southerly facing slopes. More northerly facing slopes typically support a hummocky plant community composed of crowberry (*Empetrum nigum*), sphagnum moss, scattered willow, and stunted spruce. Willow is usually more abundant at higher elevations, but it can also dominate on valley walls that receive a steady supply of discharging groundwater. The water table is seasonally variable but often maintained near the surface by a constant supply of groundwater discharge. www.kenaiwetlands.net/MapUnit Descriptions/SLS.htm

An SM wetland (S = Discharge Slope, M = *mariana*) with a black spruce (*Picea mariana*) overstory and an ericaceous shrub understory, near Clam Gulch (polygon 11633). SM wetlands are most common north of Clam Gulch where narrow bands of shallow groundwater discharge tend to occur on footslopes between peatlands and glacial features such as moraines, knobs, and terraces. Many of these bands are too narrow to delineate at the mapping scale, and SM wetlands probably occur at every peatland margin north of Clam Gulch, whether mapped there or not. Black spruce is less common further south on the peninsula. SM wetlands rarely occur with other S hydrologic components, however, wetlands designated SLM—where mixed forests of black and Lutz spruce occur on a foot- or toeslope—are common. www.kenaiwetlands.net/MapUnitDescrip tions/SM.htm

An SS wetland (S = Discharge Slope, S = Salix) in the upper Anchor River watershed (polygon 10280). The wetland is a broad willow thicket (*Salix* spp.) at the toeslope margin of a DW. Wetlands mapped as SS are willow shrublands over mineral soil at foot- and toeslope landscape positions receiving shallow groundwater discharge. Barclay willow (*Salix barclayi*) is the most common willow species found in these wetlands. SS wetlands are usually saturated to near the surface throughout the growing season, and are found adjacent to many peatlands, especially at higher elevations, or along south-facing stream valley walls, often in a mosaic with forests of Lutz spruce (SL). SS wetlands are a particularly important winter food source for moose, especially when found at lower elevations near the coast, where winter snowpack is not as deep. www.kenaiwetlands.net/MapUnitDescrip tions/SS.htm

Photographic examples of different wetland types on the Kenai Peninsula lowlands

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R: Riparian or **Riverine** wetlands lie adjacent to rivers and streams. On the Kenai lowlands, Riparian wetlands are of two types, glacially fed (and associated with large flow-buffering lakes except in the Seward area), and those not fed by glaciers. Riparian wetlands not fed by glaciers frequently occur as underfit streams that flow in valleys carved by much larger rivers that were once fed by glacial meltwater. Those fed by modern glaciers (e.g., along the Kenai and Kasilof Rivers) shift from rivers with stable channels and low meander-width ratios that cross moraines, to rivers that meander across large, flat relict lakebed/ estuarine terraces near their mouths. Kenai lowlands R wetlands are named using a modified version of Rosgen and Silvey's classification (1996) (see also http://www.epa.gov/owow/watershed/wacademy/acad2000/stream_class/index.htm). The modified version of Rosgen Level I has seven classes, four of which are common on the lowlands: **B reaches** are moderately entrenched, riffle-dominated reaches with narrow fringing wetlands; **C reaches** possess riffle/pool morphology with cutbanks, point bars, and broad fringing wetlands on floodplains; **E reaches** are slightly entrenched, stable, pool-dominated channels within relict channels (underfit) supporting wide stream fringe wetlands; and **D reaches** are braided glacial rivers (which are found in the Seward area and at the head of Kachemak Bay). A fifth type, **DA,** represents small streams with multiple channels and associated wetlands (mostly peat). http://cookinletwetlands.info/ ecosystems/Riverine.html

A steep, entrenched stream mapped as **RA** flowing into Fox River near the head of Kachemak Bay (polygon 32145). These are entrenched, steep gradient (4-10%), cascading, step-and-pool reaches, with cataracts and waterfalls. Only a few RA reaches were mapped on the Kenai lowlands. Examples are found along McNeil and Falls Creeks, which drain southward across a steep, high bluff into Kachemak Bay. Reaches mapped as RA support wetlands along only a very narrow margin adjacent to the channel. Occasionally, RA reaches include short stream segments with wide, relatively flat valley bottoms where shallow groundwater discharging from adjacent slopes supports more extensive wetlands along the margins of the stream, such as where Jones Road crosses Eastland Creek in Kachemak Bay State Park. These wide, flat valley bottoms are where streams traverse narrow terrace treads formed during the last glacial maximum. The narrow treads often support small peatlands. www.kenai wetlands.net/ MapUnitDescriptions/ra.htm

A reach mapped as **RB** in upper portion of the Anchor River watershed (polygon 895). B streams are moderately entrenched, of moderate gradient (2-4%), and dominated by riffles. At nearly 5% of the total wetland area, RB reaches are the third most abundant and extensive wetland type mapped on the Kenai lowlands. These reaches are usually found in upper portions of most watersheds, in headwater positions, although exceptions are common, especially along the Kenai River between Sterling and Soldotna and where streams traverse the steep risers of terraced moraines along the western slope of the Caribou Hills.

Along RB reaches, narrow fringing wetlands usually support Barclay's willow (*Salix barclayi*) or diverse bluejoint grass (*Calamagrostis canadensis*) communities, although many RB reaches flow through forests. Streambed materials are typically gravels and cobbles. The floodplains of RB reaches are narrow, therefore wetland criteria are often met only very close to the streambed, although many RB reaches may be mapped wider in order to connect adjacent reaches. The diagnostic wetland criterion is often the depth to redoximorphic features. Occasionally, the hyporheic zone —where stream water and groundwater mix along stream courses—may be shallow and extensive, supporting a wide fringing wetland. For example, the hyporheic zone along B reaches of the Kenai River can extend 100 meters or more from the edge of the channel. www.kenaiwetlands.net/Map UnitDescriptions/rb.htm

An **Rel** stream in the upper Anchor River watershed flowing across a former beaver pond breached during the autumn floods of 2002 (polygon 10133). Rel units are common and widespread, often occurring as streams flowing across peatlands on relict glacial lakebeds (LB). Streambed materials are typically cobbles or gravels. Rel streams are slightly entrenched (E), sluggish, pool-dominated, linear channels with thickly vegetated banks. They occur on surfaces deposited by glacial processes during the last major glacial advance, which left behind LB, DW, and K landscapes and related R wetlands. Rel units typically have channel sinuosities less than 1.3 (usually around 1.1). Rel streams frequently have an extensive wetland fringe, as they often occupy relict lakebed surfaces that support large peatland complexes.

After the flooding that occurred in October and November 2002, many E streams changed character. Their beds were scoured, creating more riffles and exposing cobbles and gravels. Beaver dams were breached, so E streams that were dammed became freeflowing, resulting in the development of some B and C stream traits. Many E steams should be reexamined to determine whether they: 1) changed during 2002 flooding, 2) have returned to their former character, or 3) have begun to evolve into a different stream type. The 2002 floods may have been one of the first big episodes in the longterm evolution of these streams.

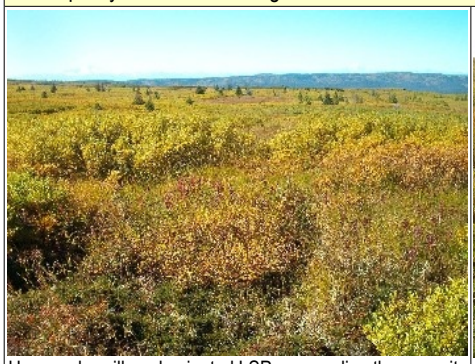
Glacial till across which these streams now flow will over time be left as terraces as stream valleys are entrenched into underlying bedrock. Then the till terraces will erode into the streams, forming a deep V-shaped valley. Eventually glaciers may return and reset the process. www.kenai wetlands.net/Map UnitDescriptions/rel.htm

The **RC** reach of Deep Creek. This is the largest wetland polygon mapped on the Kenai lowlands (polygon 26548). A large cutbank can be seen on the left in the middle distance, with a point bar across from it on the inside river bend. Reaches mapped as RC produce cutbanks and point bars, support channels with alternating riffles and pools, and have well-developed floodplains. RC reaches on the Kenai lowlands form along larger streams, such as Stariski Creek, Deep Creek, and the Anchor River. Bed materials are typically gravels and cobbles (which can be critical for salmon spawning). The entire valley bottom of these reaches is included in the mapping, although significant areas of upland often lie between the valley walls. For example, at nearly 1400 ha (~3460 ac), the RC reach of middle and lower Deep Creek is the largest single wetland polygon mapped on the Kenai lowlands; however, within this large polygon, side channels, cutbanks, meander scrolls, and accreting terraces all support different plant communities and water regimes. At a finer scale, these features could be mapped as separate wetland types interspersed with uplands. Although many areas of upland are included within the C reaches mapped on peninsula lowlands, it should be recognized that C reaches are dynamic systems, and areas that are upland today may later become wet as stream channels migrate across their floodplains. Important variables that identify areas that may meet wetland criteria within C reaches are both flooding frequency and depth to redoximorphic features in the soil profile. www.kenaiwet lands.net/MapUnit Descriptions/rc.htm

Photographic examples of different wetland types on the Kenai Peninsula lowlands

This row shows the Kenai Peninsula freshwater wetland ecosystem found only on mineral (non-peat) soil.

LSP: Late Snow Plateau wetlands (also called "Late Snow Ecosystem) are restricted to elevations above about 500 meters (1600 ft) in the Kenai lowlands. Above 500 meters, the snow-free season is short. A mantle of wind-carried sediment and volcanic ash lies over a thin layer of poorly sorted glacial till. The flat, till-covered landscape in combination with late-lying snow perches the water table. Snowmelt from late-lying patches keeps the ground saturated near the surface throughout the growing season. These gentle slopes occur with poorly drained soils and late-melting snow patches south of Clam Gulch. They are extensive on the plateaus of Bald Mountain and near the USGS "Eagle Lake" monument. Late Snow Plateaus are headwater sources for most lower peninsula streams. LSP wetlands support a diverse Barclay's willow community on a wet mineral soil (almost always of the hydric Snowdance series). Headwater sources are important in maintaining streamflow during droughts, in recharging groundwater, and they are essential in maintaining downstream water quality. Pollution entering a headwater source can affect the entire stream. www.kenaiwetlands.net/EcosystemDescriptions/ lateSnow.htm



Hummocky willow-dominated LSP surrounding the summit of Bald Mountain (polygon 7217). A small peatland is in the middle distance. www.kenaiwetlands.net/MapUnitDescriptions/lsp.htm

A hummocky diverse Barclay's willow plant community on an LSP in the upper Anchor River watershed. www.kenaiwetlands.net/EcosystemDescriptions/lateSnow.htm

Lutz spruce (*Picea* X *lutzii*) invades a willow-dominated LSP in the upper Anchor River watershed (polygon 10363). www.kenaiwetlands.net/MapUnit Descriptions/lsp.htm