MUD BAY SURVEY

Richard Carstensen *Discovery Southeast*
Koren Bosworth *Bosworth Botanical Consulting*
for **SEAL Trust, June, 2013**

CONTENTS

To Haines residents: In the journal and summary sections, I've tried to distinguish between observation and speculation. Certainly, though, Mud Bay aficionados will find much that is missing or misinterpreted in this quick look at their home ground. I welcome critique and contributions, and would be happy to incorporate such information into a revision of this report. Contact me through the email on the header, or at (909) 586-1272.

Richard Carstensen

Navigating this digital journal

- ArcMap convention for dates is YYYYMMDD: for example, 20130605 = June 5, 2013.
- This pdf is "bookmarked," allowing quick navigation from either the *bookmarks* tab (left side of Acrobat window) or *Contents*. Acrobat's left-arrow button (or *alt+backarrow*) returns you to your previous position.
- Parts of the journal have 2-page panoramas and are best viewed in facing-pages mode. To correctly display these pages, pull down *view>page display>show cover page during two-up*.
- If these tools are missing from your Acrobat header, pull down *tools>customize toolbars*, and check them. Another useful Acrobat tool opens the contextual search window. Custom-load the binocular icon, showing search-word in context of its sentences.
- Animals or sign thereof are noted in **bold**.
- Common names for plants are generally used. However, I occasionally give lists, using the 4-letter genus-species codes. For these, see Part 4; *Species codes*.
- Air-photo stereograms are present in Part 4. These are best viewed on an Ipad or android tablet, placed flat, under a pocket stereoscope. (most computer screens are lower resolution, so pixels become visible at 2x magnification.

A note on place names Since publication of *Haa L'éelk'w Hás Aani Saax'ú: Our grandparents' names on the land*—Tom Thornton, *ed*—in spring, 2012, I've used Tlingit names in all of my writing, followed by the english translations *in italics*, and the IWGNs (important white guy names) where they belong, (in parentheses).

This convention feels to me like a key step in repatriating (or is it rematriating?) the country's real names. It goes beyond simple remediation to something much more exciting. These names were spoken in watersheds who *owned people*, rather than the other way around. Learning them invites us, too, into that owned relationship.

At the scale of our Nelson homestead surveys, Thornton gives no names, so I default here to the IWGNs. But Chilkat Peninsula is rich with Tlingit names. At that broader scale, I've used them in my text and cartography. For a map of the names, see Part 2: *Tlingit place names*. *RC*

Preface 20130605 In May, Diane Mayer asked Koren Bosworth to survey and describe wetlands and other habitats on a property at Mud Bay called the Nelson Homestead. SEAL Trust, Clay Frick and Carol Tuynman are working toward a conservation easement for this parcel, and more broadly on a conservation vision for the Mud Bay community. On Koren's suggestion, Diane invited me along, to help characterize the property's natural and cultural history, and its strategic significance in the broader context of Chilkat Peninsula. We'll spend a couple days mapping the 129 acres, and talking to folks in Haines who are knowledgable about the country.

Angie Hoffard at SEAL Trust has a comprehensive GIS project for the Haines area. To complement hers, I prepared for this trip with an arcmap project including georeferenced historical imagery, shorezone oblique aerials, geology, Tlingit place names, etc. This will be the base that Koren and I use to organize our tracks, wetland observations, linked photos, etc. Exports from the Mud Bay arc project are used throughout the following journal and site description.

This report is in 4 parts:

1) daily journal detailing surveys on June 5th & 6th

2) more systematic natural history of the project area

3) vegetation mapping & description by Koren

4) historical aerials & retakes; references, etc.

Our field protocol involves linking sequentially numbered-&-named photographs to a GPS track. In the following journal text, numbers correspond to these photo ID#s.

Cover photo *View NW into Mud Bay, 20130605, on our flight to Haines. All text, photos and maps by*


65

1 FIELD JOURNAL

20130605 Flight to Haines

At the airport it was raining, and ceiling was low. There were 5 of us on an Alaska Seaplanes charter to Haines: Diane Mayer, Angie Hoffard, Clay Frick, Koren Bosworth, and me. On the chance that clearing weather farther north would be conducive to photography, Diane asked pilot William if we could deviate from the normal flight path to shoot Mud Bay.

On my tablet, for quick reference in the plane, I also loaded 1929 obliques in need of replication. Diane gave me the last seat, where I could unbuckle and shoot out either side, clear of interference from the wing (**125**). William zig-zagged obligingly up Lynn Canal, to Endicott estuary on the west side, and Point Sherman on the east. By this time, ceiling was lifting. Then he looped us over Mud Bay (**65**), and circled in front of Haines to retake an old Navy shot upriver. Finally, we descended over marshes and cottonwood stringers on the SW side of Chilkat River, almost as far as Kicking Horse.

Except for that final retake scene up Chilkat River, this repeat-photography venture was fairly peripheral to the study at hand, so I've deferred the 8 photo pairs and their interpretation to Part 4 of this report (*Flight from Juneau to Haines*). Thanks, Diane, for allowing this exciting detour! I hope you and others at SEAL Trust enjoy the results.

20130605 Day 1 survey

Carol Tuynman—from whose family Clay purchased the Nelson Homestead—met us at the airport and drove us to her place above the shore of Mud Bay.

Carol is part of a community of conservation-minded residents in Mud Bay. It includes many folks I already know, like Clay, Ben&Irene, Tim Shields, Rob&Donna, Deb Marshall, and Joe Ordonez across the bay. (*PS: Carol is also putting me in touch by email with other folks I didn't know, or didn't have a chance to check in with, during our whirlwind visit.*)

We made sandwiches and suited up for a day of bushwacking. With 4 GPSes running side-by-side, we were pretty sure not to get lost. Angie navigated with SEAL Trust's new Trimble, loaded with high-res 2006 base imagery and a parcel boundary to keep us mostly within the homestead survey lines.[1]

1 Since this is a new tool for SEAL Trust, with a steep learning curve, and since Koren & I wanted to maximize


125

127

129

132

127 Panorama of land cleared by Carol's father, who homesteaded in the 1970s. He planted it in barley. This shot is on Carol's land, heading west onto the conservation piece.

129 First of many Douglas maples, seen throughout our survey, even in the subcanopy of old-growth forest.

132 Koren's first soil pit. Compacted silt-clay mix with no visible grains. This proved to be widespread throughout the pass.

135 Two low bushes in bottom foreground are serviceberry, *Amelanchier*, the only ones we noticed on the property. Otherwise, a pretty typical assemblage on the cleared land, with high % exotics: dandelion, clover, creeping buttercup (& nearby, reed canary grass). Aggressive natives include: cow parsnip (which by mid-summer will grow as tall as the devil's club on forest edge), meadow horsetail, moose-stubbled alder, and sweet cicely.

136 **Moose-**browsed menziesia. Only on highest-density range, such as outer Chichagof, do deer stoop to eating much of

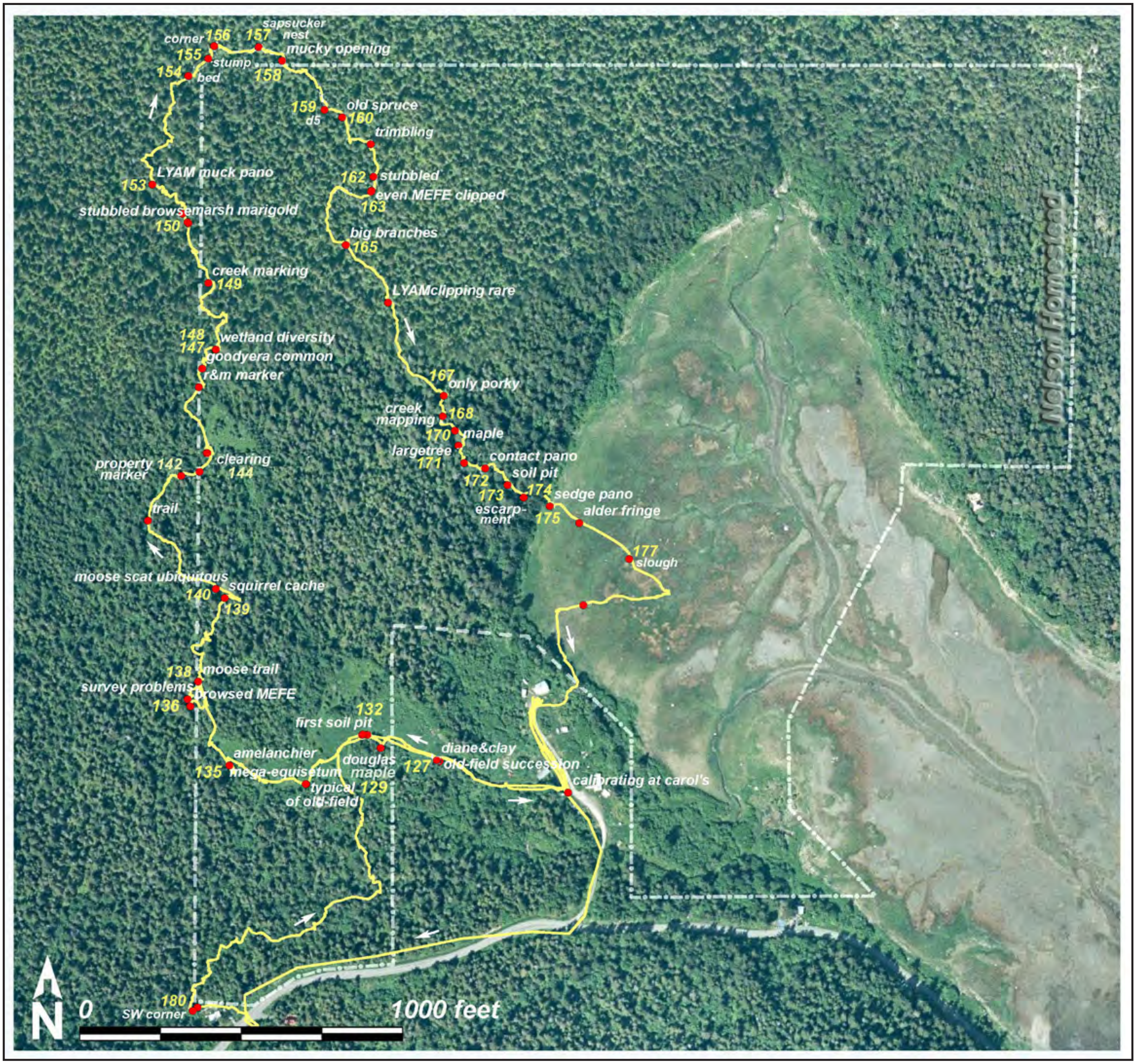
---

our 2 field days, we decided to stick with our standard rino-camera combinations. I hope to learn more from Angie about project creation on the Trimble, post-field processing, etc.

135

Shorezone captured this great oblique of Carol's place on the shore of Mud Bay on July 20th, 2005. Steady breezes through the Mud-Bay-Letnikof-Cove pass are conducive to wind power.

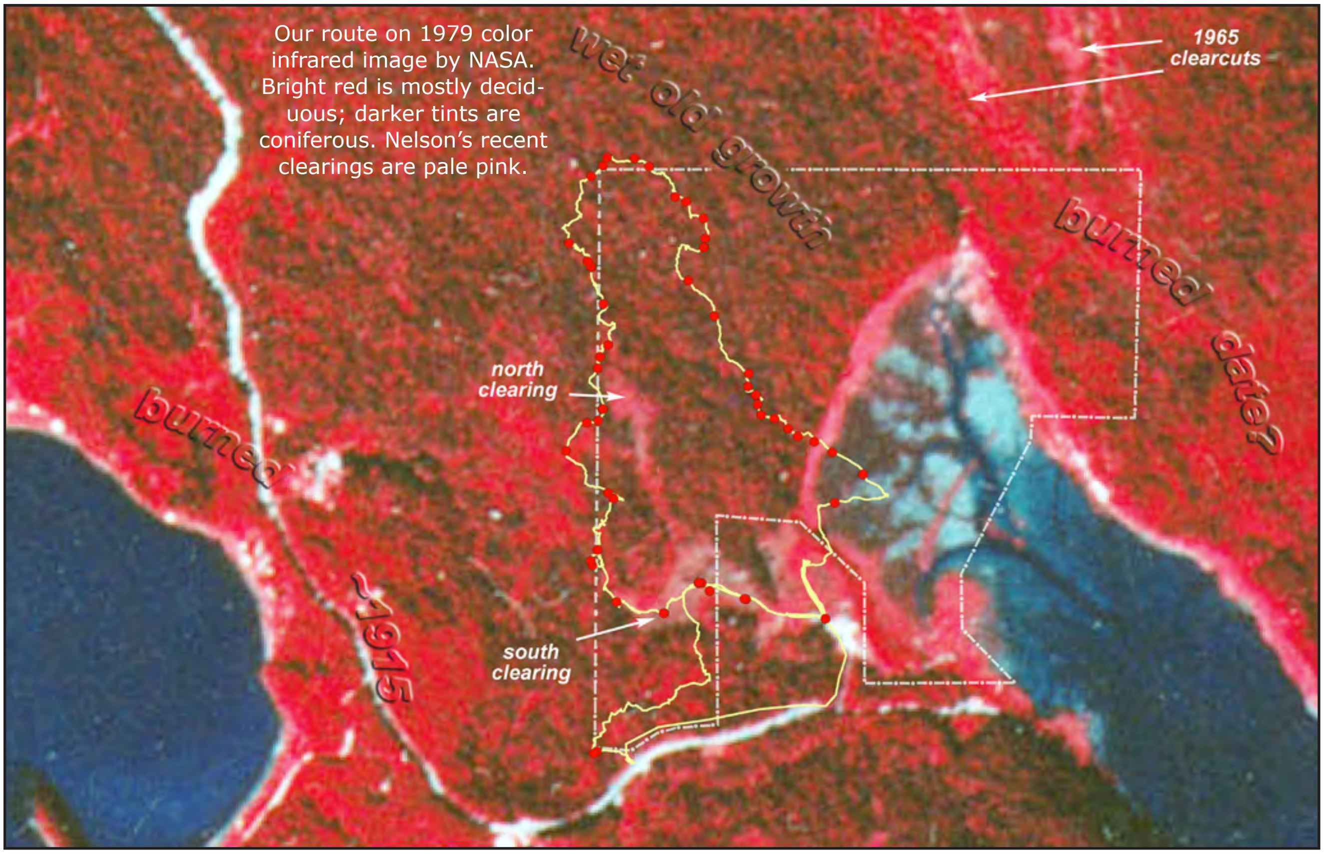
Alaska Shorezone Project, 20050720



Export from *Arc* project. Base is from the 2006 census imagery, at 1-meter pixel resolution. Yellow line is my rino track (typically 10-to15-ft confidence) and red dots are my photos, linked to the track in *Robogeo*. All photos are named here, but only those included in this journal are numbered in yellow.

this chemically-defended, high-lignin blueberry relative. I don't imagine moose like it any better than deer do, so use of menziesia suggests a considerable winter population here.

138 Pano of moose trail running along a N-S ridge on the west boundary of the property. We speculated about geomorphic origins of this landform, but never found a satisfying answer. No obvious bedrock outcrops, but I think that's a better explanation for the ridge than surficial landforms such as moraine or esker or kame mound. Lacking fine lidar contours, the best I can do is scrutinize topography on the stereograms, Part 4. Forest canopy obscures subtle ridges such as these, with generally



Our route on 1979 color infrared image by NASA. Bright red is mostly deciduous; darker tints are coniferous. Nelson's recent clearings are pale pink.

less than 30 feet of relief. Underlying bedrock is probably more rugose, but mellowed by a cap of fine marine sediment. I didn't think to put a compass on our moose-trail ridge, but it may actually have pointed NNW, in line with the bedrock strike, and Mud-Letnikof pass.

My Arc project has georeferenced 1948 and 1979 aerials. While these are much lower resolution than the 2006 meter-pixel orthophotography, the color-infrared is better for picking up differences in conifer and deciduous canopy.

Reviewing my journal from Discovery's *Repeat Photography* project (Carstensen & Hocker, 2005, p 39), I remembered the conversation with Rob Goldberg, who has investigated wildfire history on the peninsula. We should ask him for historical sources on the fire:

> *Rob counted rings on a felled hemlock that had blackened fire scars formed in 1915, confirming what we'd heard about the year of the big Haines fire. He showed us on our orthophotos*

While we walked this upland ridge, Koren looped eastward along the base of it, mapping the upland-wetland contact.


139


140

where he thinks the boundaries of that fire occured on the Chilkat Peninsula. For example, in the damp-soiled lowlands between his house and Mud Bay there are older stands that apparently did not burn.

Most of the forest in the Nelson Homestead is comprised of this rich, old-growth forest on marine sediment. I've mapped it as "wet old growth" in Part 2 (*Context, peninsula vegetation*).

139 Red squirrel caches were surprisingly common in the wet old growth. Generally I find peak squirrel concentrations in younger, spruce-dominated stands. Maybe their abundance here has to do with the limbiness and climbability of these old, slow-growing spruces, atypical of most Southeast old growth.

140 Moose pellets in ungrazed ground dogwood. These winter pellet groups were abundant throughout the wet lowlands. While shrubs were heavily browsed (mostly *Vaccinium* but even *Menziesia*—136, 163) I saw no evidence moose were taking the low winter forbs so important to deer (*Cornus-Coptis-Rubus-Tiarella*)


144

Switch to facing-pages mode in Acrobat to view this panorama.

142 Marker about halfway up the western property line. Studying the preceding 2006 census imagery before our trip did not prepare me for how open the canopy is in this wet old growth. Result is plentiful light to the understory, and high shrub & forb production.

144 Carol said her father created this north clearing in the 1970s, as well as the larger south clearing (127) we explored at the beginning of our circuit. This north clearing and a connecting road shows well on the preceding 1979 CIR imagery. Species are similar to those in the south clearing: RUSP, OPHO, HELA, TAOF, RARE, EQAR, ALCR[2]

2 4-letter abbreviations are in Part 4, *Species codes*.


142


Leader growth shows most of these spruces growing >18-inches per year.

144


148


147

147 *Goodyera oblongifolia* Along with *Pyrola* and *Equisetum*, this is a plant I'm not accustomed to seeing in old growth elsewhere in Southeast.

148 Panorama of one of the wetter forested portions of our survey. Even in red boots we often had to pick our way through these muck pits by teetering over logs. Species: LYAM, CAPA, EQAR, STRO, VAOV, MEFE, GYDR. Note small % of the skunk cabbages nipped in spring by **moose**, as in the inset, lower right.

149 Angie and Koren mapping an intermittent stream channel at the west property boundary. We didn't trace this toward the beach, but


149

153

it probably connects with the intermittent channel mapped in Koren's Part 3.

Hummocky nature of the terrain shows well in this pano. Although flat overall, the pass is rough on a microscale, more so than can be attributed to pit-mound development from windthrow and uprooting.

150 Most blueberries we passed in the Mud-Letnikov pass were heavily browsed by **moose**. In theory it could have been done by **deer**. Clay did tell us that Ben Kirkpatrick has been seeing more deer around his place, but we never saw deer pellets in the pass, yet were rarely out of sight of moose pellets.

153 Old, mostly infilled **moose** tracks in a mucky swale. I don't remember seeing such frequent raw exposures of organic mud in other old-growth forests, and began to attribute this to frequent moose disturbance. Looking at them, you wonder why moose don't regularly plunge in up to their bellies, creating a great deal *more* disturbance. I think Koren's soil pits provide the explanation. She rarely went down far before encountering firmly compacted marine fines, which easily support the weight of moose.

154 **Moose** bed. There were lots of these on the better-drained convexities we passed. Many had winter hairs in them, up to 6 inches long.

In addition to the ubiquitous winter pellet clusters that moose deliver when eating mostly woody browse, we saw a few massive greenish plops, larger versions of the scat deer leave when shifting to skunk cabbage spears in the spring. There weren't many of these, which to me fits the observation that only a few of the ~foot-tall unrolling LYAM plants had been nipped off a month or so ago. That's the time when overwintering herbivores seem most interested in the irritating (gum-burning) but high-biomass forage. Aside from LYAM, there isn't a lot of new green stuff available in the forest in April. I've seen many forests where deer bite off almost every tip, year after year. Are moose mostly gone from the Mud Bay old growth by April?

Later, at dinner, I speculated that moose may use the Mud-Letnikof old growth as a wintering area in fairly large numbers, but mostly exit in summer, probably north to the Chilkat deciduous lowlands where

150

154


VAOV & MEFE all browsed below knee height. Does moose disturbance have anything to do with the unusual amount of EQAR for an old-growth forest?
156


155

Streveler on moose & old growth

Back home, I called naturalist Greg Streveler in Gustavus to find out if he'd observed similar concentrations of wintering moose in conifer forests. He has a great deal more experience in moose country than I do, and enjoys thinking about successional change, seasonal and decadal critter movements, and big-picture landscape ecology.

Greg's impression is that in the Park and on the Gustavus forelands, moose *are* making more use of spruce-hemlock forest in recent decades. In fact, low levels of moose activity are now evident almost everywhere, in part because such a heavy-footed animal can't pass even once through a forest without tracking it up pretty blatantly. But in Greg's area, moose rarely stubble blueberries, leading him to conclude they really don't like it much compared to willow. Like me, Greg has never seen an old-growth forest used by moose in the same way that an exceptionally high concentration of deer will use it.

So the Mud-Letnikof wintering area may be a pretty unique phenomenon. Greg's questions, which I couldn't answer:

1) How many animals contributed to the sign we saw? He reminded me a moose eats 40 pounds a day. Does the Nelson tract support 2 moose, or 20? You'd need to do some winter tracking on snow to find out.

2) How representative was our little piece of the Mud-Letnikof lowland old growth? We had a pretty good look at about 40 acres. In ArcMap, I estimate the pass contains maybe 220 acres of similar habitat, far enough from houses to provide an attractive winter yard.

I'll return to these moose musings in Part 2, *Wildlife*.

pulse of primary production is greater than in coniferous forest. Carol wasn't impressed with that hypothesis, because cows with calves continue bedding in her yard. Obviously, moose are present year-round on Chilkat Peninsula. Because aerial census is difficult in conifer forest, I doubt ADF&G has data on "herd" movements between the peninsula and Chilkat River flood plain. That would require telemetry.

155 Cut stump, probably less than decade ago judging by lack of moss cap or rot. From here, it's 1900 feet straight west to the highway, and 1200 feet SW to the nearest residence. These are likelier destinations for the log than the head of Mud Bay, 1500 feet SE. Does anyone know who's been logging in here?

156 Crew at the northwest property corner. Angie's Trimble will have a more accurate position than mine (N 59.1637824755; W-135.3676966368). Note on my preceding photopoints ortho that the monument is about 70 feet off from my crudely traced border.

157 Active **sapsucker** nests can be distinguished from unused ones by fresh brown scuffing around the edges of the entry. Adults traded off as we watched. Turning SE toward the beach, we saw more sapsuckers in flight, visiting another cavity tree, but don't know if it was a separate pair of birds, or the


158

same pair at a “backup nest.” Do they do that? This is close to the northern limit of sapsucker range.

158 Section of d5 bushwacking—about the densest brush we encountered. This pano shows the low hills (<30 feet relief) common in Mud-Letnikof pass. Because the forest is generally open-canopied like this, *most* of it would be this brushy if not for moose browsing.

160 Descending from the same ridge shown in pano 158. Large spruce above Diane could be many centuries old. Witches-broom deformity on hemlock branch at right side of photo. The hemlocks in this forest have a high level of dwarf mistletoe infection (compare 165).

163 Even the menziesia is hit pretty hard by **moose**. Compare photo 136.

162 Pano in scrubby, open-canopied hemlock forest. Ephemeral creek gully diagonals through. Before moose

157


163


160

162

165

167

lowered the brush down to knee-height, this opening probably had chest-high, d5+ shrubs. How long ago did that happen, and can the current population keep wintering here, or will it become less productive?

165 Massive branches indicate a very old hemlock. Witches broom on left is also very old, so the tree has put up with its parasite load for a long time.

167 The only **porcupine** sign we saw on Nelson Homestead. Probably more than 20 years old. I had to look close to see the faint, weathered tracks of incisors. Carol says she's never seen a porky on the peninsula, and has never heard of anyone's dog getting into one—pretty good indication of very low population.

I'm beginning to think we Juneauites have a distorted idea of what a "natural" porky abundance should look like. In other mainland areas I've surveyed in the past few years (Soule River, Gilbert Bay), you can walk all day and often not pass obvious porky sign. As in those places, the level of sign at Mud Bay is so extremely low that it's hard to understand how porkies persist at all; how do they find each other to reproduce?[3]

168 Koren mapping in a twisty, deeply incised ephemeral creek bed. This channel shows on our vegetation map in Part 3. Incision may be a recent response to major glacial rebound, evident in the escarpments above the beach (174). But see comments on photo 66, day-2. Have these streams had that much erosive power lately?

An unusual feature of these currently-dry stream beds is fluffy deposits of mixed silt and organic fines, flushed downstream and left in little pockets under root pads and in dewatered back eddies. In a setting such as Mud-Letnikof pass, covered with old growth and

3 At Juneau, I've heard porky abundance attributed to preference for second growth forest. While they do seem to winter more successfully in such stands than do other wildlife, I also see plenty of sign in old growth, where you're rarely out of sight of a porky-scarred hemlock trunk. One could also hypothesize that at Juneau, porkies were temporarily released from wolf predation. But predator sign at Soule and Gilbert is extremely low. In fact, Juneau lately has a lot more wolf activity in peoples' backyards than do the remote mainland watersheds I've surveyed.

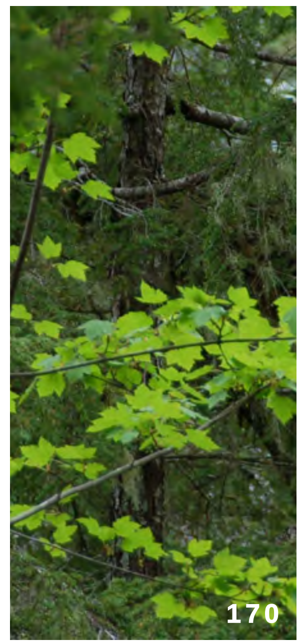

168

lacking enough catchment to flush down high-energy storm flows, it's hard to understand where this fluffy sediment comes from. Most ephemeral streams this size I've examined are sediment-*starved*, with clear or tannin-stained, but *not* turbid water. Could this be one more impact of the high wintering **moose** populations? Pano 153 raises that possibility.

170 Telephoto of Douglas maple foliage about 50 feet up. Earlier shot 129 shows another, but that one was on the edge of a young growth forest. I don't believe I've ever seen tall maples in the subcanopy of a Southeast old-growth forest. Once we trained our search images (there were also lots of large, old birches and alders), we realized these maples were quite common.

171 Pano in probably the most majestic, large-tree forest we saw on the property. Not very tall, but a moderately vigorous, middle-aged spruce stand.

172 Pano looking north along the contact of old growth (left) and even-aged young growth (right). This shot spans about 180^{o}. Mud Bay is visible in center distance. Foreground hemlocks on right are unrepresentative; the young growth is mostly spruce, as with almost every uplift forest I've seen in Southeast. (But *is it* uplift forest? See notes on photo 174.) Moving into the shadier young growth, understory diversity and lushness declines.


170


171


172

174

173

173 Koren's soil pit near top of the escarpment (174) exposed shallow organics over the same compacted marine fines we encountered everywhere else on our survey. Trees haven't claimed this surface long enough for much soil development.

174 Pano facing south along the edge of the wave-cut face, which drops off along the left. On neither of our field days did I think to take a photo showing the full escarpment, top to bottom. I remember it as being more than 15 feet high, not including the more gentle slope above current extreme high water at the base.

As this pano shows, there are limby young spruces even on the top of the wave-cut face, and these extend back from the edge about 50 yards in this location (distance from photopoint 172 to 174). Judging from reconstruction of uplift rate and total rise in Larsen et al (2005), it seems impossible that all of this terrain could have been covered by high tides 250 years ago (Part 2, *Glacial rebound*). Some other disturbance has to be invoked for the young age of trees here. Early, undocumented clearcut

175 Switch to facing-pages mode in Acrobat to view this panorama.

(So long ago that stumps have rotted?) Jilkáat cultural site?

175 Panorama where we emerged onto the sedge flat spans almost 180º. Entry to Mud Bay is SE, just right of center distance. Koren (orange&yellow) can barely be seen out there, botanizing. In the foreground are many flowering grasses, but this high-marsh belt doesn't reach very far out into the marsh—one of many unusual features of Mud Bay vegetation.

177 One of the slough channels we later mapped. Although we didn't have time to GPS them, they're easy to trace on the 2006 census imagery. That's unfortunately *not* the case upslope, under forest canopy. There, our streams map only shows channels we were able to ground-truth.

Comparing the alignment of salt marsh sloughs on the 2006, 1979 & 1948 imagery shows no evidence of migration. In almost all salt marshes I've studied, meanders have been stable over the past half century.[4] That's interesting considering the tidal velocities that regularly sweep them. It suggests the rhizome mat of both high-marsh grasses and the low-marsh sedge belt is very resistent. They also support bank overhangs offering great fish cover.

179 Just before dinner at Carol's, Koren and Angie and I made a brief visit to pin down

4 Exceptions are in marshes influenced by deposition and erosion from major glacial rivers.


177


175

179

180

the SW property corner and see how wet the forest was. Our track shows as a separate, clockwise loop, starting down the road and hooking back northeastward through the forest.

Compared to old growth stands we traversed earlier, the terrain is more dissected here by incised channels. Maple is common in the subcanopy. This feels like great bird habitat. You'd probably find songbirds breeding here that are unusual elsewhere in Southeast.[5]

180 Angie GPSing the SW corner. From here, we bushwacked NE, paralleling a stream that exits through "the boot"—the Italy-shaped southern lobe of Nelson Tract (labelled on following photopoint map for Day 2 surveys). Koren and I later GPSed the lower meanders of that stream. Compared to forest channels in the NW quarter of the property, which we mapped as intermittent, this one is perennial.

Post field Carol fed us red snapper for dinner. Ben Kirkpatrick and Irene Alsexikos came by, and also Deb Marshall. Deb put Koren up for the night, and I went home with Clay. I forgot to bring an SD card reader, and couldn't download my 250+ pictures from the Nikon. Just as well, though; it would have distracted me from the evening conversations. Even as it was, I never had time to check in with great local observers like Tim S, Rob G, Judy H, Dan E and Joe O.

A geologist told Carol her well is keyed to a fault running through the Mud-Letnikof pass. I think she said the well was a couple hundred feet deep, through fines into coarser sand and gravel. The consequent artesian effect is such that she never has to pump. I dropped the *faults.shp* layer onto my *Arc* project but this subsidiary Mud-Letnikof fault is not mapped; only the state-spanning Denali-Chatham fault, and a smaller one running up Chilkat Inlet along the western base of Chilkat Peninsula (Part 2: *Geology*).

5 Since the late-1990s, I've been unable to hear high notes of Southeast songbirds—which renders me pretty useless for bird surveys. Koren occasionally alerts me to canopy singers like Townsend's warblers. I think she said she heard her first Pacific-slope flycatcher of the year on this trip (usually the latest arrival among our common breeders). Our Southeast conifer-forest breeders are a pretty small guild, but the addition of maple, alder and birch to the Peninsula old growth might be inviting to such additional species as Hammond's flycatcher, western tanager, etc.

20130606 Day 2 survey

Another beautiful day! All of yesterday's crew—Diane, Carol, Angie, Clay, Koren & I—started out together. In late morning, Ben took Diane & Angie on a tour of Haines properties and mitigation possibilities. Clay stayed a bit longer but also had to leave in early afternoon. Koren & I finished up on our own with a second loop after lunch. These tracks all show on the photopoint map, following page.

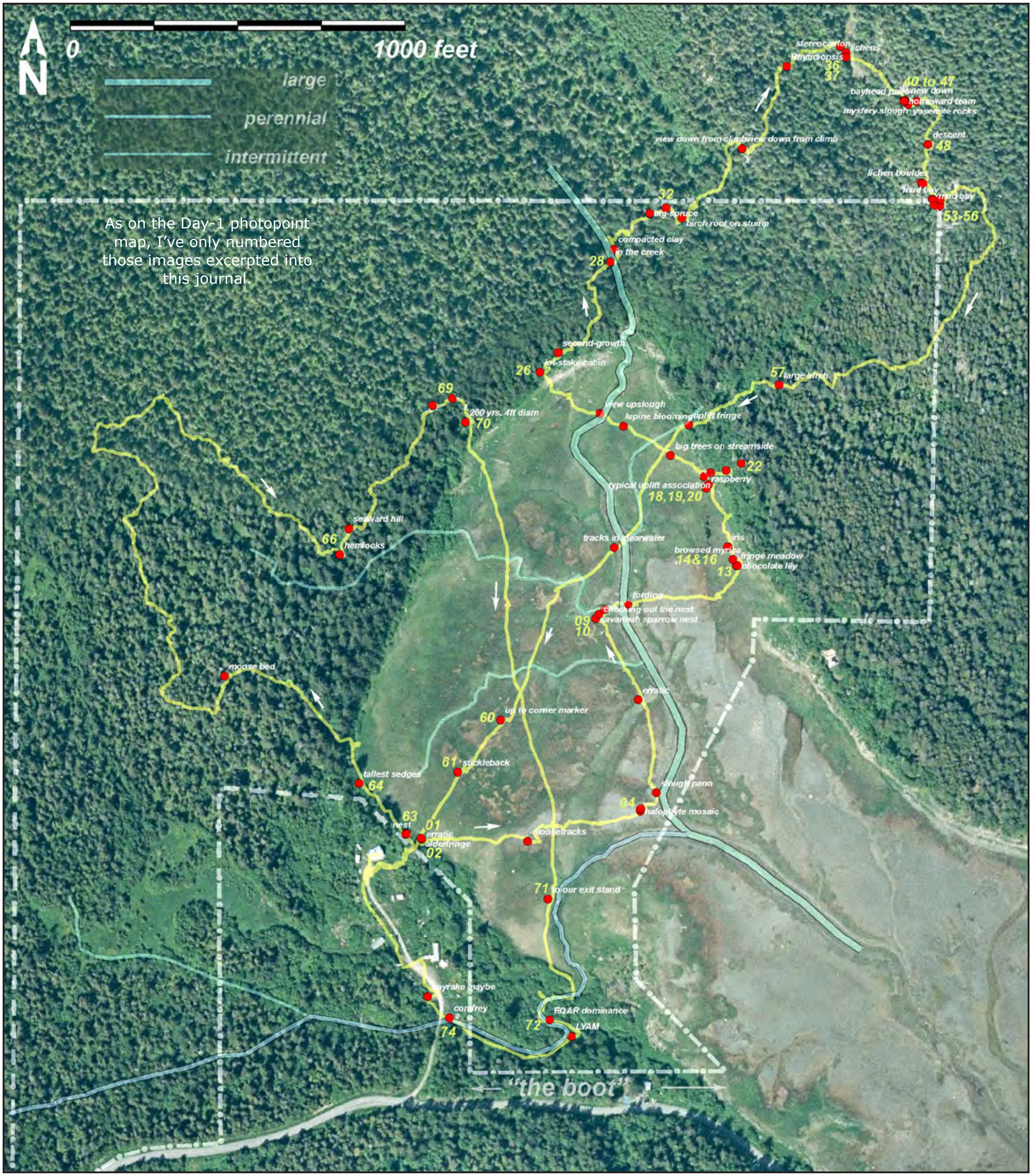
01 Tabletop erratic at edge of the marsh, just below Carol's place. More of these granitic boulders show on my cover photo, and in the Shorezone image on page 5. I don't know of a better term than "erratic" for these ice-delivered boulders. But they probably were not let down directly from the surface or interior of a wasting, late-Wisconsin or Younger-Dryas glacier. Instead, they rest *atop* subsequent marine deposits from a period of higher sea level.

So did they raft in on Little Ice Age bergs? That's dubious because we don't know of nearby tidewater advances, and also because a berg gigantic enough to float such erratics would have stranded long before drifting this far into Mud Bay.

That leaves me with the conclusion that—fresh and "newly-perched" as they seem, these rocks were dropped to the bottom from bergs the size of city blocks at the close of the Younger Dryas, more than 10,000 years ago, when Mud-Letnikof pass was under several hundred feet of water. That pass must have emerged soon afterward, or else the erratics would be buried under more Chilkat River sediment. Isostacy then delivered them from submarine into intertidal ranges over ensuing millennia.

02 View NE to head of Mud Bay. Morning light and early-summer leaf-colors are great for accentuating many different forest types on upland slopes and lower marine landforms. Clay and I later looped through the right uplands on our climb to the NE

My track (yellow) & photopoints (red) on Day 2 (20130606) is composed of 2 separate outings. Streams added back in Juneau. The morning loop thorugh the flats was with everyone. Clay & I then climbed to the NE property corner. In the afternoon, Koren & I did another clockwise loop through old growth in the western half of Nelson Tract.



corner. We neared but did not detour into the 1965 clearcut. Clay knew of this logging, and speculated the cuts were accessed by road from the Letnikof side. Only back in Juneau, dropping a "harvest depletion" layer onto the arc project, did I learn the date and extent of the cutting units. One covered 19 acres and the other one 6 acres.

04 View NE along "Mud Bay Creek," the largest of the streams entering the bay head. Joe Ordonez home in right distance. Koren mapped most of the larger ryegrass clones, which show well on the 2006 imagery. Although relief is minimal on the flats, these appear to favor "levee" deposits along the channel margins, where overbank deposits are slightly higher and, maybe more important, sandier and better drained.

09 First of 2 sparrow nests we found today on the flats. In both cases females flushed underfoot (males don't share incubation), giving away location of otherwise exquisitely camouflaged ground nests. At the time, I assumed these were **savannah sparrows**, but can't absolutely rule out **Lincoln's**. Egg illustrations are from Baicich & Harrison (1997). Here's their description for savannah:

> *"**Nest**: hollow scratched out in soft soil, nest rim level with the ground.* Lined with coarser grasses, sedges or Salicornia, sometimes with hair. [Harrison (1979) adds: usually concealed under last year's straw layer]. **Eggs**: usually 4-5, blotched brown or chestnut, often concentrated at larger end, 19x15mm."*

And for Lincoln's sparrow:

> *"**Nest**: Cup of dry stems and blades of grass, lined with finer grasses and a little hair. **Eggs**: usually 4-5, finely speckled, 19x14mm."*

Although the egg illustrations are almost identical, descriptions plus habitat favor savannah sparrow.

10 Carol standing over the nest. Who would guess that a bird could fledge chicks from such an exposed, often flooded location? I've often wondered if these birds nesting just below extreme high water manage to incubate and fledge their broods in between spring-tide

* True for this nest but compare photo 63.


13


14


16

floods. According to Baichich & Harrison, incubation takes 8-12 days, and first flight is at 8 to 14 days. Even assuming minimums for these periods, 8 plus 8 = 16 days. Half a month from laying to fledging doesn't compute, as far as squeezing off broods in between twice-monthly spring tides.

If this reasoning is correct, I can think of only 2 outcomes:

1) these high-marsh nesters get *Darwin Awards*, selecting themselves out of the gene pool. Only those savannahs at or above extreme high water reproduce successfully.

2) high marsh eggs survive brief submersion. In this scenario, it would sure help if freshwater dilution kept the salinity down, as seems to be the case in the upper Mud Bay salt marsh. More on this below.

13 Uplift meadow is just a narrow fringe. With succession we can expect more of this valuable habitat (Part 2; *Glacial rebound*). In this shot are sweetgrass, silverweed, field horsetail, chocolate lily and dandelion (invasive)

14 FRCA, EQAR, COPA, POAN

16 Heavily browsed sweet gale. This is a common woody shrub in poorly drained (and often heavily grazed) uplift meadows at Juneau and on the Yakutat forelands. Wetlands ecologist John Thilenius determined it fixes nitrogen. He told me that even though **moose** typically avoided it, *Myrica gale* improved their habitat by enhancing growth of willows that they *did* overbrowse. I've seen **deer**-browsed *Myrica* on Admiralty (where it's rare), so wasn't too shocked to see moose hammering it here at Mud Bay. I recommended to Carol that she bruise and smell the leaves, to experience the unmistakeable aroma, apparently part of *Myrica's* defense against herbivory. But when I tried this myself, odor was relatively muted. Are these Mud Bay plants perhaps chemically underendowed, setting them up for moose-stubbling?

18 **Brown bear** diggings for umbel-family species: here mostly likely *Conioselinum, Ligusticum* and *Angelica*. The leavings—purplish stem bases—have often puzzled me. Seems like they take both the roots and leafy tops but ignore these bases. Are they too fibrous? Too bitter?

We didn't find much of this sign, but Carol says a few brownies are routinely seen working the fringes of Mud Bay. Folks we talked to seemed to agree **brown** bears were more common than **black** on the peninsula, which surprises me (lack of big fish runs; minimal sedge except here in the bay head). Tracks I later photographed (59) in the slough were of a small to medium-sized bear.


18


19

19 We don't have this native interior raspberry (*Rubus idaeus*) in Juneau. Stems are much bristlier than its cousin salmonberry (*R. spectabilis*). (PS post trip: Koren agrees with my impression that *Rubus* shrubs in forest were mostly RUSP, and that these raspberries are more restricted to the uplift meadows.)

20 Typical assemblage in the uplift meadow: HELA, EQAR, TAOF, RARE (creeping buttercup) and RUSP. Other species of interest, not shown, are iris, lupine and baneberry. All are toxic to some degree and presumably defended from grazing. At least I can say that cattle seemed to ignore them during the dairy era at Juneau, leading to proliferation in


20

22

26

today's meadow communities.

22 Before continuing to the head of Mud Bay, I poked uphill here to the upper influence of Little Ice Age high water, to get a sense of successional development. As indicated on my profile cartoon in Part 2: *Glacial rebound*, it's difficult to distinguish between upper reach of tides and the never-flooded surfaces oversteepened by storm waves, which were equally raw at peak LIA, and have similar-aged trees and understory.

Again, I was impressed by the breadth and vertical relief of this belt, compared to uplift features I'm accustomed to at Juneau. This is uplift succession on steroids! There's a stronger and more integrated (i.e. less linear) deciduous component (alder, birch), and a rich understory of OPHO, MADI, EQAR and ferns. At the bottom of the belt it's marshy and diverse.

26 Carol took us into second growth forest to see a little cabin her dad was required to build to prove up on this subunit of the homestead. I guess it was never used much. Clay is thinking of repairing it for use by folks wanting to overnight in the bay. Carol recalls her dad saying that the logging here occurred in the 1920s or 30s. I didn't core any trees to confirm that, but they look about right for a clearcut of that era. It's a pretty even mix of spruce and hemlock. Hard to guess what the logging was for. Remaining stumps are pretty small. Maybe a piling-log project?

28 From the cabin we traversed NE out of the second growth toward what the orthophoto suggested should be the largest trees on the property. Carol had seen a very large spruce back here on one visit but failed to


28

relocate it on return trips. At low flow this is a sedate little stream with nice overhanging banks and exposed cobble-gravel bars.

I cut into one particularly pure-looking exposure of marine fines beneath a root pad and discovered it had the finest sediment of anything we'd yet encountered. It felt slick and greasy, and rolled into a coherent tube. Placed on the teeth, you could hardly detect grittyness—almost pottery-quality clay.

32 Carol says the spruce she remembers is even larger than this one.

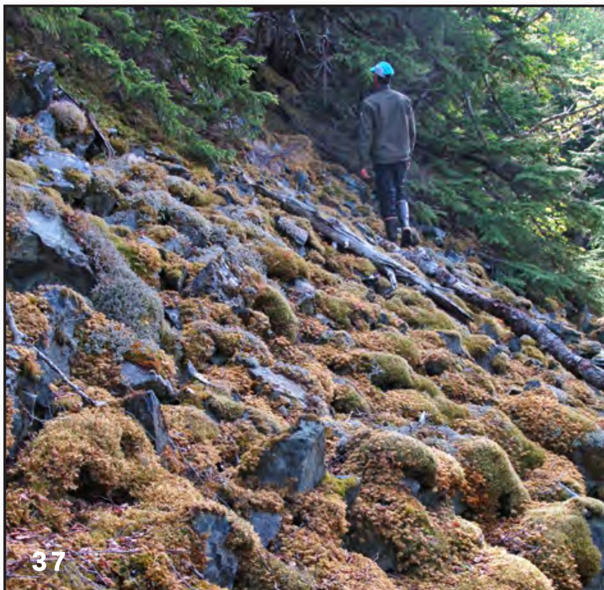
KB 1556 Koren's photo of a birch root from a tree perched atop an old hand-logged spruce stump.

When the others turned back to Carol's place, Clay and I climbed to the NE property corner. Clay had been there before. I wanted to compare forest types on steep upland slopes to old growth we'd begun to document on wet lowlands in


KB 1556


32

36



37

Mud-Letnikof pass, and also to get some photos of Mud Bay from a high vantage.

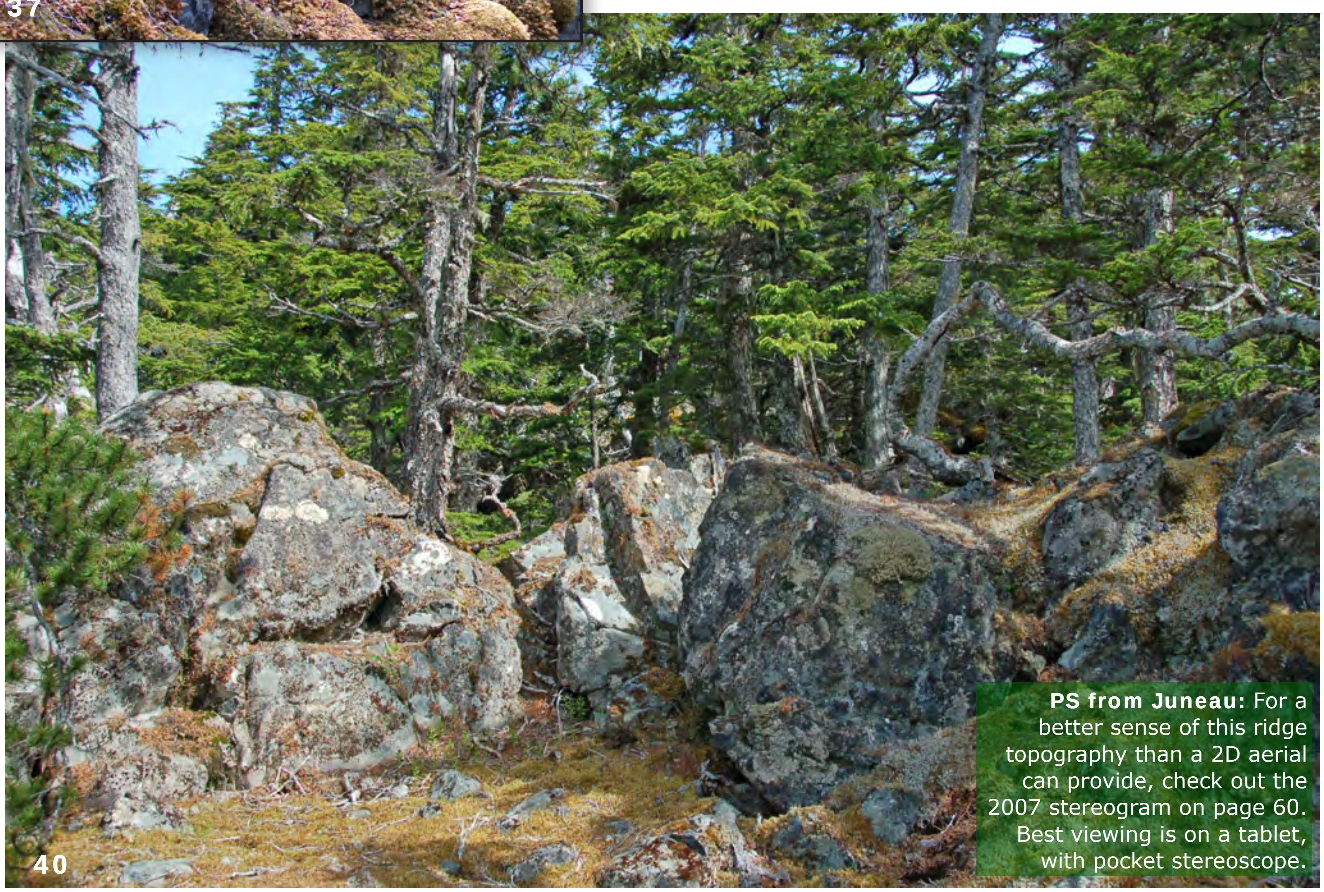
36 Pipecleaner moss, *Rhytidiopsis robusta*. I've seen this mostly in the alpine, but rarely in old-growth understory. Pojar & MacKinnon 1999 say:

> *"characteristic of subalpine forests where it can form large, pure mats on the forest floor; sporadic and becoming rare at lower elevations, where it sometimes occurs in bogs."*

37 Southeast outdoorspeople rarely speak of "talus," a nearly ubiquitous colluvial substrate known (if not loved) by every mountaineer in the drier Rockies. It's not that we don't have it. But in rainy Southeast, talus is generally covered by such dense vegetation that we don't distinguish it from other steep-slope substrates. These boulders had little vascular cover but were lushly upholstered with *Racomitrium* mosses and *Stereocaulon* lichens.

40 Dwarf forest on outcropping metavolcanics at the high point of our climb, 485 feet elevation and about 100 yards north of the property. Very little soil has accumulated in these rocks, making me wonder if periodic fire has a retarding effect. Small pine on left. Farther NW up the Chilkat River, the framing upland forests are even drier than this, with much less moss cover and forests of almost pure lodgepole and/or birch.

Which subspecies of pine is this? I forgot to take a closeup of the cones and foliage for ID. It's an intriguing



40

PS from Juneau: For a better sense of this ridge topography than a 2D aerial can provide, check out the 2007 stereogram on page 60. Best viewing is on a tablet, with pocket stereoscope.

question because of the transitional nature of Chilkat Peninsula in regard to wildfire and succession.

There are 2 very different subspecies of *Pinus contorta* in Alaska. Our coastal, peatland tree is *P. c. contorta*, often called shore pine. The more widespread subspecies of boreal interior, and western mountain forests of the west as far south as Baja is *P. c. latifolia*, the soldierly form more deserving of the name "lodgepole." This latter subspecies has serotinous cones, sealed by pitch, that often don't open until seared by fire. Here's how Viereck & Little (1972) differentiated them:

> ***Shore pine**: "cones pointing backward, opening at maturity, generally low spreading tree of muskegs. . . **Lodgepole pine**: cones pointing outward, mostly remaining closed many years, tree often tall and narrow of inner fiord forests at head of Lynn Canal, Skagway to Haines."*

All of the cones we examined on low pine branches were open and had already shed their seeds. The few that show in my photos appear to point backwards. So while this relatively xeric hillside undoubtedly has a fire history, we've apparently not yet left behind the *contorta* pine.

43 View down to oddly shaped lagoon at bay-head. Looks like maybe an embedded tree got ripped out of the mud here?

46 Throughout the North American taiga and arctic tundra, the reindeer lichen *Cladina stellaris* is the most-sought caribou forage (more even than C. rangiferina, according to Brodo *et al*, 2001). The fact that **moose** droppings share this scene may be coincidence; we saw little evidence moose have used any plants this close to the ground. On the other hand I imagine it *is* an attractant here to . . .

47 **Mountain goats**? Clay had told me about finding apparent goat scat on previous explorations of this ridge top. He hasn't seen hair on the bushes to confirm this, nor could I find any this time to confirm the sign as goat. The dimpled end occurs on some **deer** scats but is more characteristic of goat. Also, on Clay's earlier visits, he found tracks in snow that looked blockier than deer.

If our ID is correct, it raises questions about access and seasonal movements. Mount Riley, the high point of the peninsula, is only 1760 feet high, and has little escape cover, or for that matter *anything* I'd consider normal goat habitat. I doubt the peninsula could support an autonomous breeding population. So does this represent the wanderings of a stray from Ripinsky ridge, not to be repeated, or an annual movement of one or several animals out onto the peninsula?

Or is this actually a couple **blacktails** with caprinid aspirations?

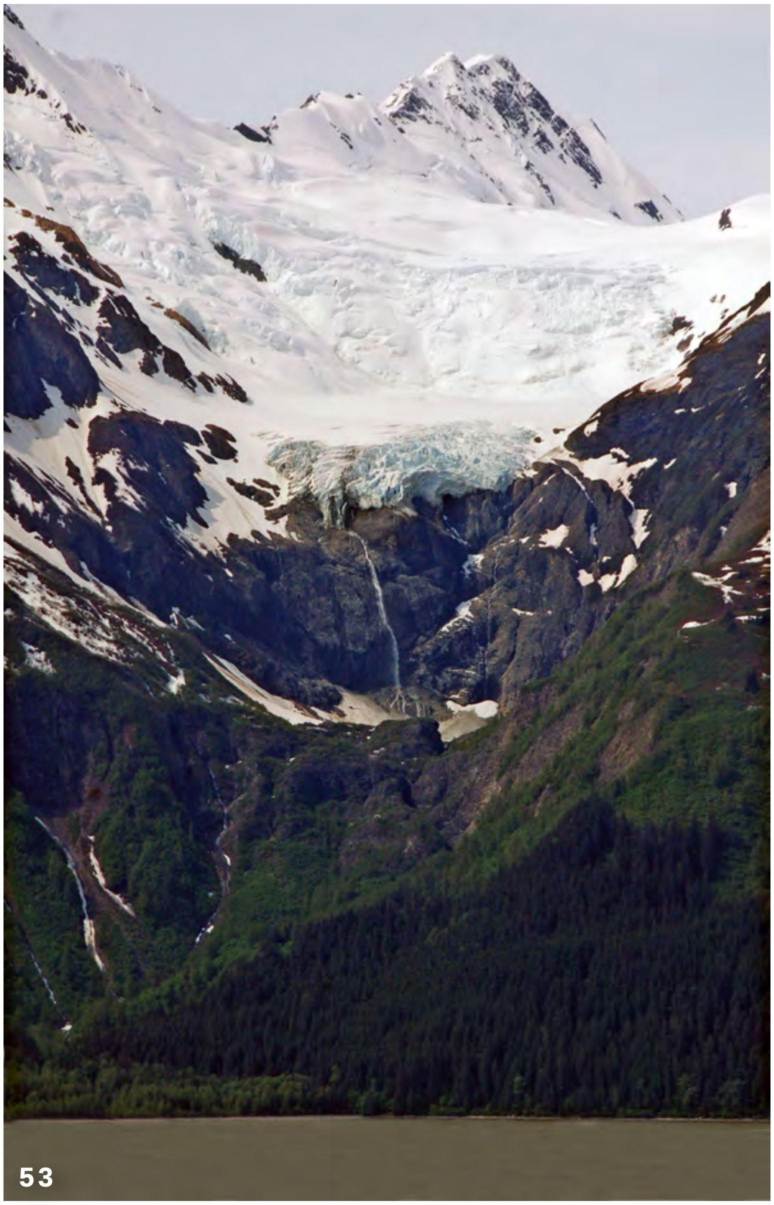
48 Still on the ridge top, descending from our high point at 485 to the property corner at 435, I remembered to take a "typical habitat" picture. Often I photograph only unique scenes that catch my eye as somehow different. This forest shot, on the other hand, is almost the only scene I recorded

43

46

47

48



53

Switch to facing-pages mode in Acrobat to view this panorama.

54

in 2 days that could have been taken on say, Kuiu Island, or a hill above Ketchikan. There's nothing that says "Haines."

In general, I expect the peninsula's upland old growth will have more of this "generic Southeast" component than the wet old growth on raised marine fines. Also, we saw way less sign of winter **moose** activity on these upland slopes than in the wet old growth of Mud-Letnikof pass. ***But***, my experience on the peninsula is extremely limited. It would be useful to hear feedback from the resident naturalists.

53 View SW to Lkoodaséits'k (Rainbow Glacier) and the precipitous stream that drains it, which managed to retain at least a fair approximation of its Tlingit name on USGS topos: "Ludaseska Creek." Thornton (2012) explains that Lkoodaséits'k is the name of a giant. I find it interesting that a mountain of the same name on Taku River figures in a battle of giants. Taku Lkoodaséits'k was the loser, and his bodily remains were ripped apart

and strewn by the victor over the landscape, explaining much of the topography of the lower Taku. Is this Jilk̲áat giant a player in the same transplanted story? And if so, which is the "original" landscape?

54 Panorama SSE over Mud Bay to Davidson and Rainbow Glaciers across Chilkat Inlet. Pines in foreground grade downward into hemlock-spruce old growth.

56 Clay on *Stereocaulon* lichens. Browsed blueberries.

57 Most of the way back down to the


57


58

beach, we stopped by this large birch. Because the surrounding conifers are not particularly tall, this tree shares the high canopy

58 Once again I remembered to take a boring, "tangle-of-green" typical shot. This is in the final ~d5 thrash through a wet, toeslope uplift thicket with ALCR, OPHO, SARA, VAOV and RUSP out to the flats.

59 Crossing the slough, we noticed these **brown bear** tracks under clear water about 4 inches deep.

60 View from the flats back up to marker at the NE property corner. The orange-red triangular marker, barely visible, is indicated with white arrow.

61 Clay caught this **stickleback** in the slough. I think we also saw juvenile staghorn sculpins, but no starry flounder.

We had lunch in Carol's yard, and then Clay headed off on errands while Koren and I started our last loop through the Nelson property. I didn't take pictures as often on this loop because, lacking an SD card reader to download yesterday's nearly 300 photos, my Nikon was almost full.

63 In the upper ryegrass belt, Koren flushed another **sparrow** from almost directly underfoot, and peeled back the dried grasses to find another 5 eggs. I'm not absolutely positive, but it sure looks like the inner lining is of **moose** hair. At any rate, it looks quite different from the obvious grass lining of our first nest (photo 09), which was 160 yards away from the nearest brush fringe. In contrast, this one was quite close to the game trail descending through thickets where we saw moose hair clinging to branches. Recall that the Baichich nest descriptions suggest Lincoln's sparrows more routinely use hair. But **savannahs** do also, and the eggs are very similar.

Koren noted this nest was suspended in grasses over a very damp surface. Close to the toe slope, on impermeable fines, water must sweep under the nest as sheet flow in hard rains.

64 These are the same Lyngbye sedges that appear in


59

60

61


63


64

earlier photos—177, 175, 01, 10—but at only ankle- to knee-height. For some reason they grow taller here at the upper edge of the marsh.

Koren wanted to fill in some gaps in our coverage of the forest yesterday. We used yesterday's track, which she hadn't cleared from her rino, to walk a non-redundant clockwise loop about 400 yards inland.

66 Returning SE toward the beach, we approached this deeply incised channel, running diagonally NE to an emergence point that's marked by a lobe of brush extending out into the marsh. We mapped it as intermittent. Considering the compacted silt-clay substrate and small catchment with probably pretty wimpy storm flows in terms of erosion potential, I wonder if these deep gullies pre-date the Little Ice Age—maybe even originating in the early Holocene. Certainly, the 14 feet or so of uplift documented by Larsen *et al* (2005) should result in *some* compensatory incision, but maybe not this much?

As we traversed NE through mostly even-aged


66


69

uplift forest parallel to the beach, a large subadult **goshawk** —probably female—darted through the subcanopy and landed ahead of us about 30 feet up. I couldn't focus on her in time because my camera metered on some intervening branches. She was pretty tame, and I got the impression she was following us in hopes of capturing distracted or flushed birds. **Varied thrushes** began chattering as she departed.

Presence of this apex predator—albeit a probably naive killer-in-training—is a pretty good indicator of strong populations of **grouse** and/or nesting passerines. Compared to the game-poor Gilbert Bay area, where we've spent a lot of time lately, I get the impression this diverse wet old-growth is pretty good accipiter hunting grounds.

69 On the border of uplift spruce and ~1920s second growth is a fresh, half-acre opening with maybe 30 trees felled by Carol's brother. It doesn't show on the 2007 stereo (Part 4), so is less than 6 years old. We descended through this clearcut.

70 The largest stump is about 4 feet in diameter. Based on typical ring widths of open-grown spruce at Juneau, I'd have guessed the tree was about 120 years old. A quick ring count on this stump indicated it was closer to 200 years. That averages about 10 rings per inch, getting tighter toward the outside. If this slow growth is typical also of spruces back in the old growth, some might be quite old.

71 View south along the perennial stream into "the boot" (see property outline on day-2 photopoint


70

map). Over time, the stream has deposited a lobe of higher ground, now partially colonized by Sitka alder. Arrow identifies the boulder discussed in notes on following Shorezone photo. Mud Bay Road skirts inland of of this deltaic thicket, and a residence stands just beyond the boot property line. Because this is exceptional wildlife habitat, it would be useful to know if these neighbors have dogs.

72 Tracing the meanders upstream through framing alders, we found this lovely inner terrace. Not much current moose activity, which would show plainly in the fragile horsetails.

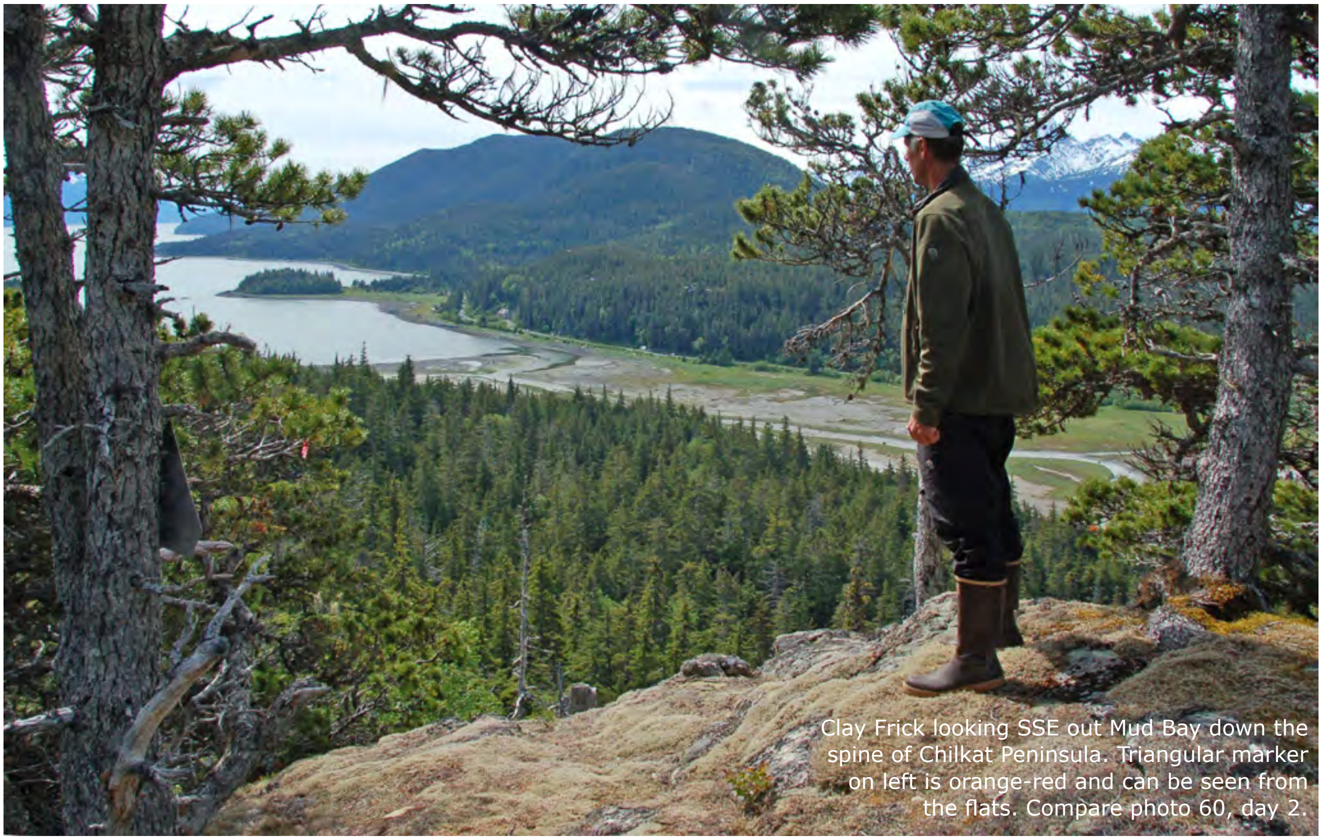
Alaska Shorezone Project, 20050720

AK-S 723 Excerpt from a Shorezone oblique aerial shows the brush delta of the perennial stream. Compared to compacted marine fines underlying Mud Bay and the Mud-Letnikof pass, this delta lobe is a recent deposit that was probably augmented considerably during the Little Ice Age. Note the large erratic boulder on the right side; also indicated by an arrow on preceding photo 71. You could probably learn something about the antiquity of Mud Bay's erratics by excavating the base of this boulder. If a great deal of alluvium has built up around it, the erratics may have been here for many millennia. If on the other hand it appears to rest mostly on top of the delta, all the erratics are potentially recent.

73 Comfrey on Carol's land. This is an aggressive species in gardens, but so far, Koren hasn't seen it move into "wild" habitats.

Post field Carol took us to the ferry terminal, where we learned Clay Good would be traveling with us. Halfway down Lynn Canal, we re-entered the Juneau rain.

***Thanks, Carol**, for hosting us at Mud Bay, and for all you do for this wonderful country!*



Clay Frick looking SSE out Mud Bay down the spine of Chilkat Peninsula. Triangular marker on left is orange-red and can be seen from the flats. Compare photo 60, day 2.

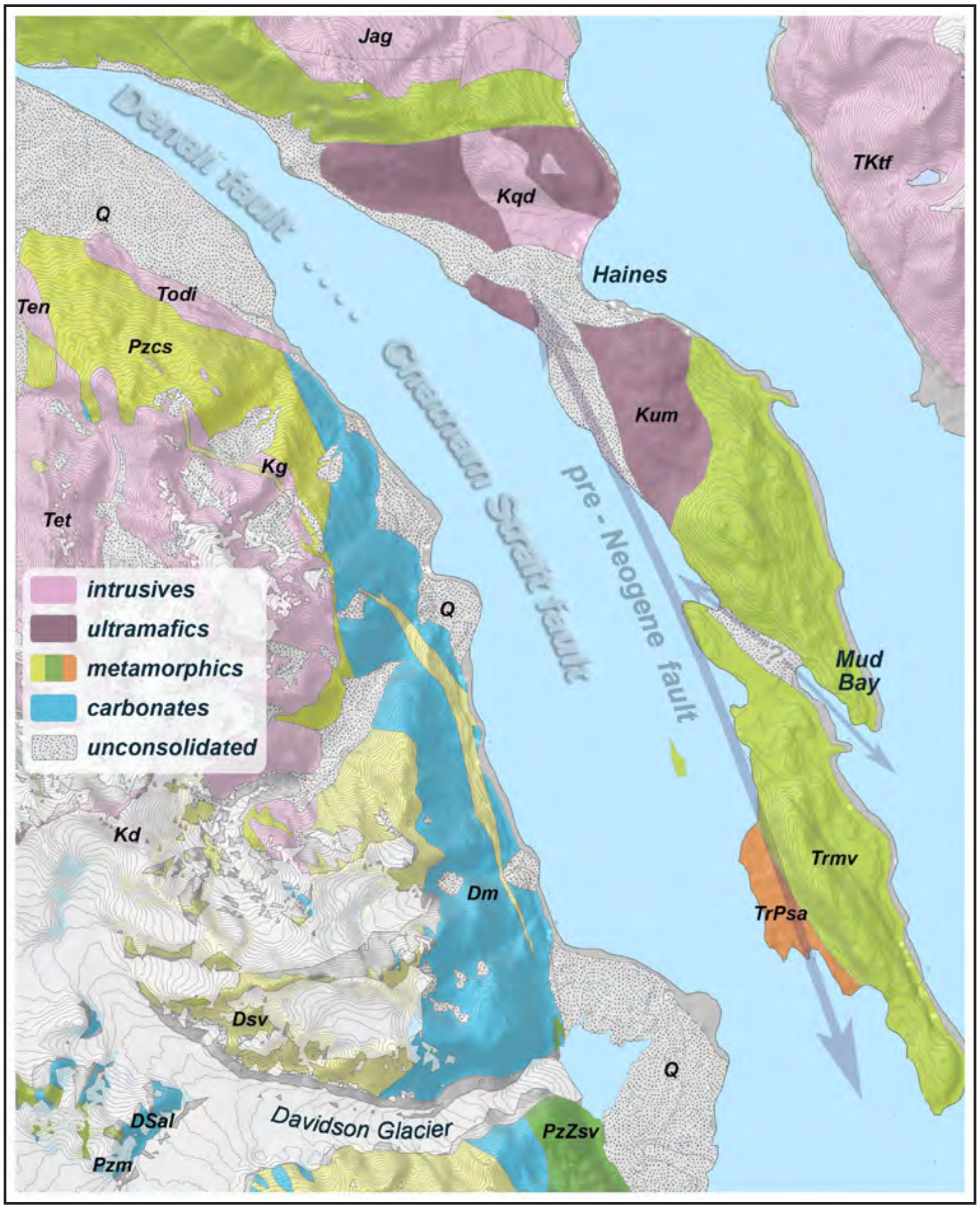
2 MUD BAY & CHILKAT PENINSULA

Natural & cultural history

Having begun with a walk through the Nelson Homestead (Part 1), let's scale out to consider this parcel's spatial and temporal context. What is its ecological and cultural role in relation to the greater Chilkat Peninsula? And how has that changed over time?

Following the typical sequence of "disciplines" used by naturalists and ecologists to describe places, let's begin with bedrock geology, then consider glacial history, isostacy, vegetation and succession, wildlife, and finally human history.

View NW up Chilkat Valley from vicinity of Sinclair Mountain in 1894. I don't recognise the initials but other mountaintop views in 1894 were attributed to a J. McArthur. It would be fun to have higher-res copies of these glass-plate images, no doubt quite sharp. This perspective highlights significance of Mud-Letnikof pass for migratory birds, and as a pinch-point for wildlife connectivity. Davidson Glacier (no Tlingit name in Thornton, 2012) drained southward.



I assembled this geology map from several sources, mainly a draft GIS layer from USGS. Three faults are indicated: a minor one running up the base of Chilkat Peninsula, and the state-spanning Chatham-Denali fault that runs all the way into interior Alaska. A third fault apparently controls the Mud-Letnikof pass, as shown by "?".

Some of the text below is adapted from descriptions by Greg Streveler, who wrote the geology section of a guide for teachers that we prepared during *Discovery Southeast* workshops in 1993. Other information on rock units comes from the draft key by USGS.

Although many different metamorphic and intrusive rock units are shown, I've lumped them in the color scheme to elucidate rock "families." One pattern emerging is that ***Chilkat Peninsula is essentially the northernmost bastion of semi-productive, mellow upland topography supporting "classic" Southeast coniferous old growth.*** Moving farther northward toward Skagway, precipitous, sterile granitics prevail (Shorezone #74, following). Moving NW into Chilkat Valley, you leave Southeast coniferous old growth for drier forest types transitional to interior taiga.

Geology

Chatham Strait Fault transects most of Southeast Alaska, from Port Alexander to northern Lynn Canal. At Haines, fault-controlled valleys radiate like fingers in a hand, but the dominant branch crosses the Canadian border on the NW-trending Kelsall-Chilkat, where it becomes known as the Denali fault.

Rocks on the SW side of the Chatham-Denali fault moved NW prior to 50 million years ago, while rocks on the other side of the fault were already welded securely to North America. As a result, rocks bounding the fault don't match up well.

All of the area's rocks are metamorphic or igneous, showing they were once deeply buried. Those northeast of the fault show evidence of deepest burial. Metamorphics are highly varied, derived from many sorts of sedimentary and volcanic rocks mostly laid down 300 to 400 million years ago. These are mainly marble, slate and argillite SW of the fault, while schist and gneiss are common across the fault to the NE.

A great belt of igneous rock dominates northern Lynn Canal. It includes what geologists call the Mount Kashagnak pluton, named for a peak on the ridge extending up-valley from Mt Ripinski. Plutons are immense bodies of once-molten rock injected into the earth's crust at times when crustal fragments to the westward banged into the edge of North America and arranged themselves into their present configurations. Most of this belt is granite, except for a band of dense, locally highly mineralized diorites and gabbros stretching from Haines into the upper Chilkat Valley.

View NW over point enclosing Mud Bay on the east gives best view of *Trmv* unit (Triassic metavolcanics) underlying southern two-thirds of Chilkat Peninsula. Red arrows show eastward dip.

Alaska Shorezone Project, 20050720

Recent, unconsolidated surficial deposits (“Q” for Quaternary) are indicated by stipple on what is otherwise a bedrock geology map. I haven’t divided them by origin type, but in general, those to the SW of Chilkat River are alluvial fan and flood-plain deposits. Those on the less river-dominated NE side are primarily raised marine deposits. The USGS draft layer did not map the Mud-Letnikof pass as “Q”, so I added that, after Koren’s test pits clearly demonstrated a raised marine landform.

Condensed descriptions of some of our study area’s key rock units:

UNCONSOLIDATED:
Q *Quaternary* Unconsolidated deposits. Here, a mix of early Holocene raised marine deposits, and more recent Neoglacial alluvial fan, flood-plain and till. The marine deposits we examined are compacted and very poorly drained. Much younger fan and flood-plain deposits are more variable, hosting soggy wetlands SE of the Kicking Horse confluence, and more productive spruce and cottonwood forest on better-drained sandy stringers and fans.

Much of the bulge below Davidson Glacier is Little-Ice-Age terminal and recessional moraine.

INTRUSIVES:
Kqd *Cretaceous* Quartz diorite, monzonite, quartz monzonite.

Jag *Jurassic* Alkalic granitic rocks including granite and syenite

TKtf *Tertiary & Cretaceous* Foliated tonalite: hornblende-biotite granodiorite and tonalite, with related hornblende diorite to biotite quartz monzonite. ***Magnetite is common***. Correlated with tonalitic plutons that form thick sills extending for at least 800 km along the west margin of the Coast Mountains plutonic metamorphic complex.

METAMORPHICS:
Trmv *Triassic*: Metamorphosed intermediate to mafic volcanic flows, pillowed flows, tuff, and agglomerate. Retains primary depositional textures. N and E of Chilkat River near Haines and on Chilkat Peninsula, includes massive, flow-banded, and locally pillowed or amygdaloidal metabasalt. ***Contains magnetite***.[1] Metamorphosed to low greenschist facies and intruded by the Mt. Kashagnak pluton. Up to 3.4 km thick. Dark green and black metabasalt and metaandesite. Flow units and intercalated metasedimentary rocks strike NW and dip steeply east. These rocks were previously mapped with Wrangellia in the Haines area, but lack the thick limestone component that would be correlative with all other Wrangellian localities.

TrPsa *Triassic & Permian* Sedimentary rocks undivided. Phyllite and semischist derived from pelitic and semipelitic flysch gradationally interbedded with minor andesitic or basaltic volcanic or volcaniclastic rocks.

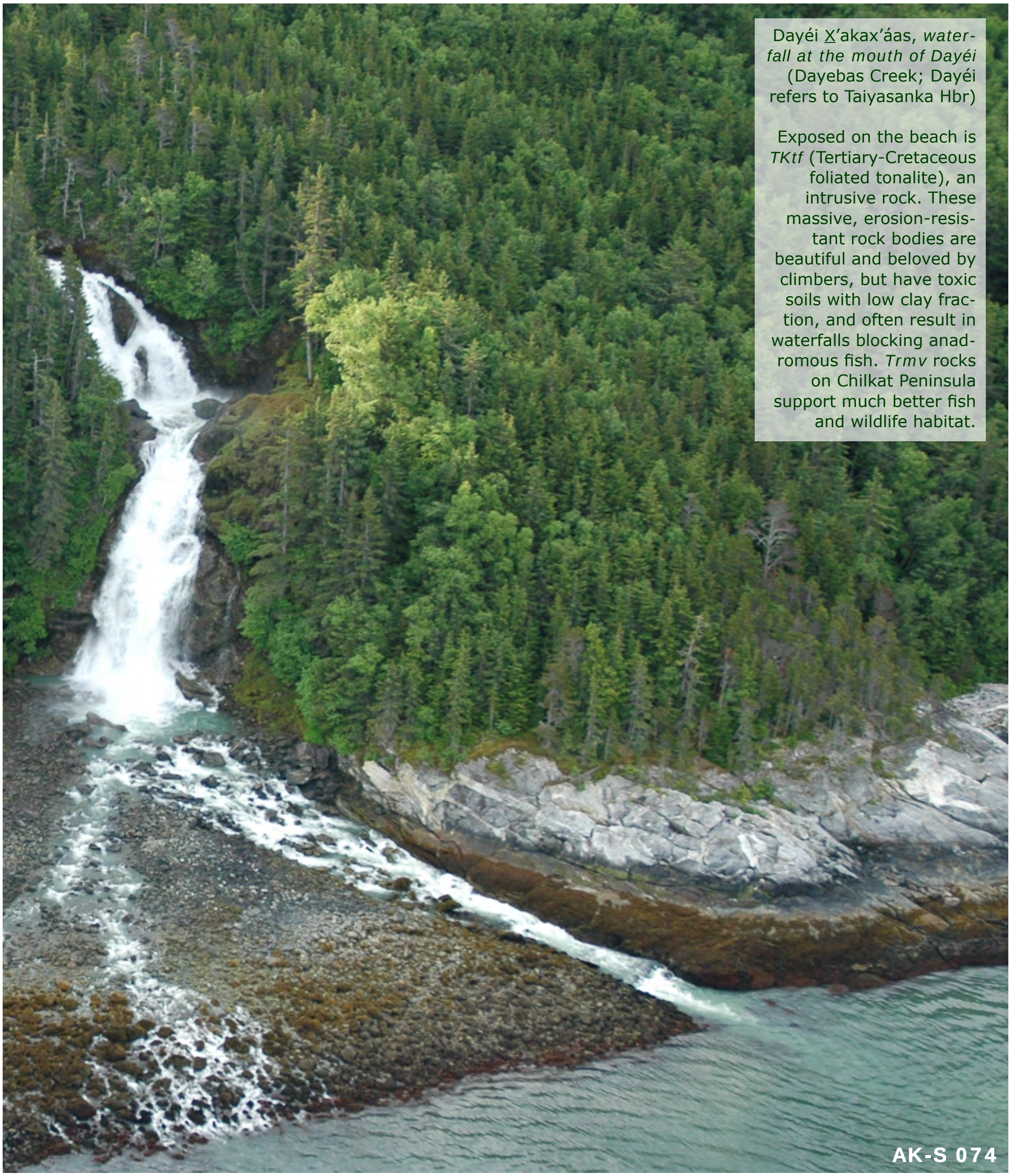
CARBONATES:
Dm *Devonian* marble. In Davidson and Rainbow glacier areas, includes light gray, very argillaceous schistose marble, and buff-weathering, tan calc-schist and calc-phyllite. Contains schist, argillaceous marble, and black phyllite in intervals up to 3 m thick.

DSal *Devonian & Silurian* Calcareous mudstone and siltstone turbidites, with subordinate graywacke turbidites, siliceous turbidites, and limestone. Siliceous

1 Several times during our survey, the magnetic compasses in our rinos gave hard-to-believe bearings, or simply took a long time to respond. Have others experienced this on Chilkat Peninsula?

argillite interbedded with light gray to black marble, with alternating bands 1 mm to 10 cm thick.

ULTRAMAFICS:
Kum *Cretaceous* Ultramafic and associated mafic intrusive rocks At Klukwan, fine- to very coarse-grained pyroxenite and hornblendite with inhomogenous distribution of ***up to 10% magnetite***.[*RC: No specific description in foregoing of the Haines-area unit, but I remember strong magnetic interference when surveying on Chilkat Lake with Dan Bishop in the late 1980s.*]



Dayéi X̲'akax'áas, *waterfall at the mouth of Dayéi* (Dayebas Creek; Dayéi refers to Taiyasanka Hbr)

Exposed on the beach is *TKtf* (Tertiary-Cretaceous foliated tonalite), an intrusive rock. These massive, erosion-resistant rock bodies are beautiful and beloved by climbers, but have toxic soils with low clay fraction, and often result in waterfalls blocking anadromous fish. *Trmv* rocks on Chilkat Peninsula support much better fish and wildlife habitat.

Alaska Shorezone Project, 20050720

Alaska Shorezone Project, 20050720

Above: Shorezone oblique of the head of Mud Bay. Band of young spruces on raised former beach are much taller than old growth beyond, distinguishable by greyer green color and pale snags. **Right**: Uplift rates in inches, based on Larsen *et al* (2005) Mud Bay is rising ~0.83 inches per year (red contour).

Glacial rebound

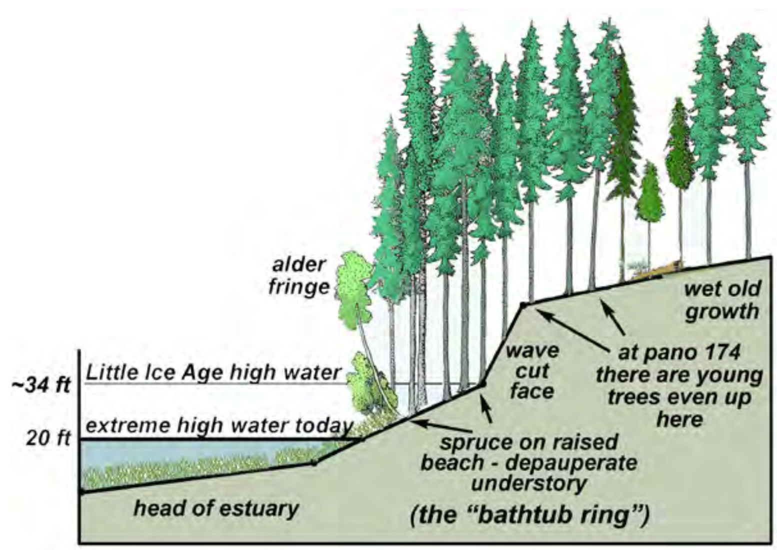
Larsen *et al* (2005) report evidence for 13.8 feet of uplift in Mud Bay. (For comparison, their estimate of total uplift on Mendenhall Wetlands is 10.2 feet.) While they state that rebound appears to have commenced in Southeast Alaska around 1770 AD, I doubt that uplift rate was rapid until well into the 1800s.[1]

Time elapsed since 1770 is 243 years. If uplift had been consistent throughout that time span, it would work out to 0.68 inches per year. It's in fact more than that, supporting the expectation that rate was slower in early decades after Little Ice Age maximum advances.

Larsen *et al's* contour map of uplift rate indicates current rebound at Mud Bay of about 0.83 inches per year.

Compared to wave-cut faces and reforestation of raised beaches at Juneau, analogous features at Mud Bay are impressive. Escarpments seem *twice* as high, not just 25% higher, as expected from the Larsen *et al* data. The head of Mud Bay must have experienced powerful storm waves during southeasterly gales, funneling into the cove and inflicting serious erosion upon soft marine sediments above the flats.

Below: Cartoon of typical beach profile and successional sequence on uplifting beaches. Little Ice Age high water reached about 14 feet higher in the early 1800s. Spruce have colonized both the raised beach and the undermined escarpment face. Nutrient enrichment and better drainage supports taller trees than in the old growth.

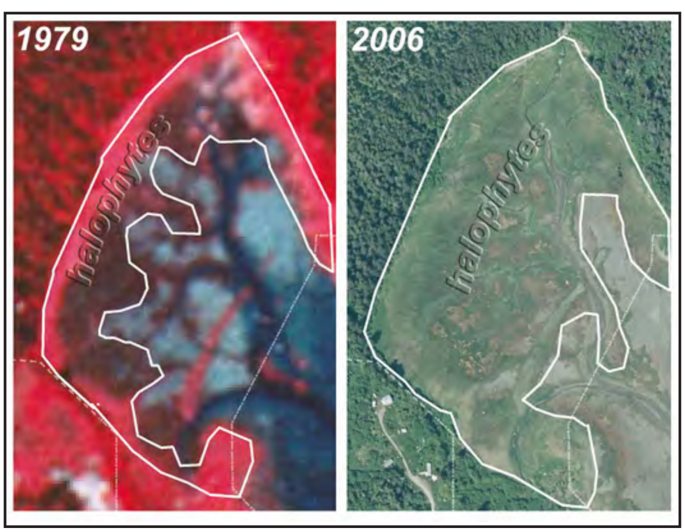


1 As late as 1794, George Vancouver described coves rimmed with drowned trees. This suggests to me there was a lag between the time of maximum glacial advance (~1770) and the time when land began to rebound.

Mud Bay lacks the wide belts of high-marsh grasses characterizing more typical salt marshes such as Mendenhall Wetlands.

In addition to driving succession on supratidal landforms *above* the active beach, glacial rebound is a factor in succession *on* the Mud Bay tidelands.

Since the 1979 color infrared aerials by NASA, assuming 0.83 inches per year uplift, the land has risen 28 inches. On Juneau's Mendenhall Wetlands, that's about the elevational scope of the entire low-marsh Lyngbye sedge belt (spanning roughly from 15 to 17 feet above MLLW). Gradient is imperceptible at the head of Mud Bay. An uplift of more than 2 feet could in theory move the entire Nelson tract tidelands out of one major halophyte belt into another. Clearly we should expect migration of this critical habitat.

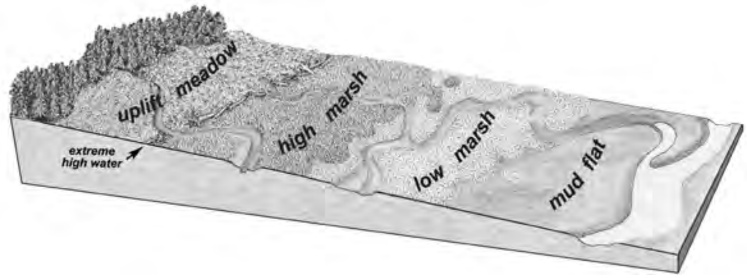


My white outline on the 1979-vs-2006 aerials is a crude attempt to encompass the vegetated tidelands (halophytes are salt-adapted plants) For more detail, see Koren's map in Part 3. This outline suggests halophyte cover has roughly doubled in the past 34 years.

I asked Carol if there was a history of livestock grazing in Mud Bay, as we were told the Sawmill Wetlands experienced.[2] She hadn't heard of any. If my interpretation of historical imagery and estimated uplift rates is correct, there *wasn't any* Lyngbye sedge in Mud Bay during the dairy era.

And what about the future? Will the sedge be evicted by grasses, 34 years from now? Or is there something about the Mud Bay combination of freshwater dilution and extremely impermeable substrate that slows down invasion of high-marsh grasses here?

2 During our work on the taxiway extension assessment in the late 1980s, Charles Brouillette told us cattle grazed "salt grass" on Sawmill Wetlands. We figured out this refered to Lyngbye sedge—also reportedly the key forage plant for Juneau's dairies (pers comm, Mary Lou King, Marie Darlin).

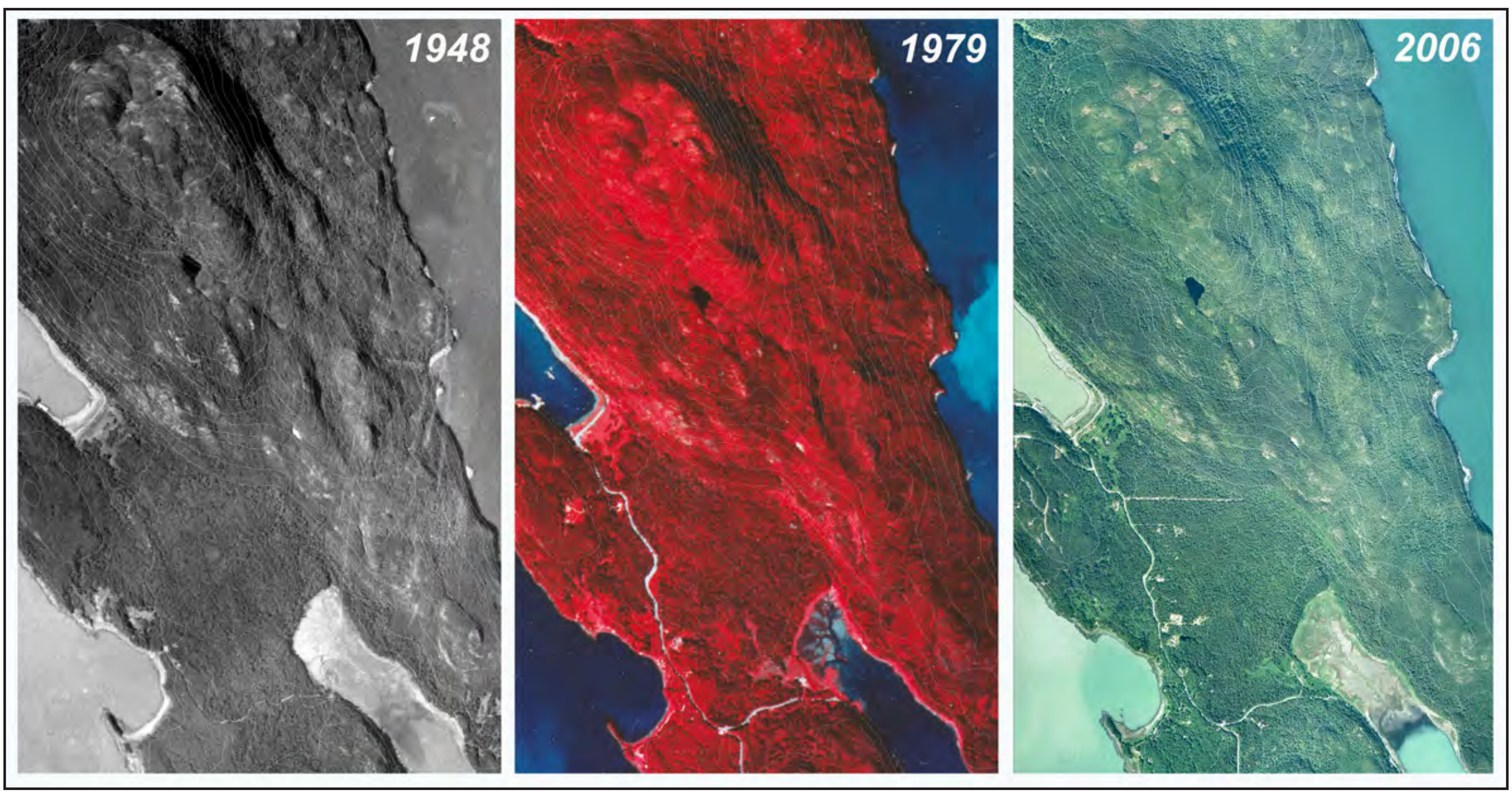


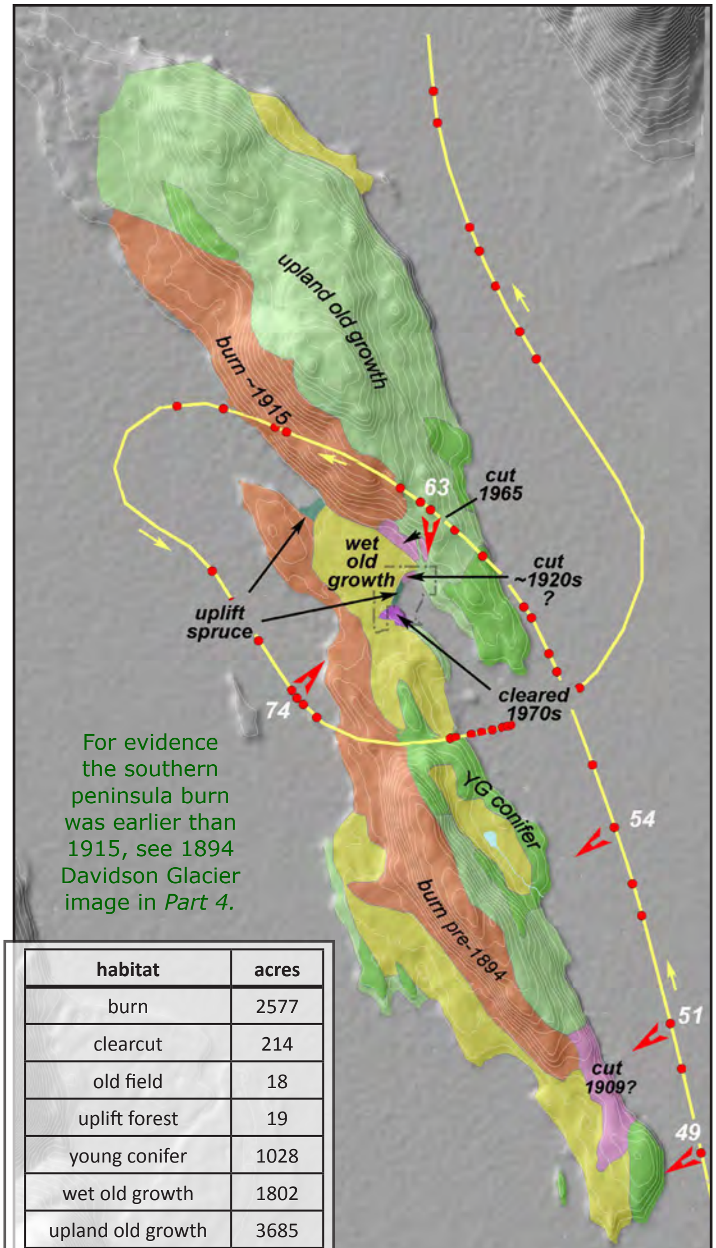
Another habitat of major importance to wildlife in estuaries such as Mendenhall Wetlands is **uplift meadow** (photos 13 & 20, day 2). At Mud Bay these are currently crowded into narrow belts just above extreme high water. On the Mendenhall Refuge, uplift meadow and high-marsh grasses will increase at the expense of low-marsh sedges, because enclosed topography leaves insufficient room for sedge advance downward into the intertidal with glacial rebound. At Mud Bay, it looks to me like there's plenty of room for gain of meadow and high marsh, without loss of low-marsh sedge habitat. It *is* possible, however, that the high-value sedge belt could migrate completely out of the Nelson tract in coming decades.

Succession on historical imagery

I georeferenced 2 historic aerial photos in my Arc project: 1948 and 1979. Below are exports, framed and aligned identically, with 100-foot contours overlaid. The preceeding page has a closeup comparison for 1979-vs-2006 for just the upper marsh area. This series allows scanning for change across the broader geographic context. A few things I notice:

- Apparent fresh clearcuts in extreme lower right of 1948 imagery. These aren't mapped in the State's *harvest depletion* layer. They're still obvious on the 1979 CIRs, but undetectable by 2006
- Canopy texture of low, wet old growth in Mud-Letnikof pass remains unchanged throughout the series. Is soil dampness part of the reason this forest survived the 1915 fire?
- Mud Bay Road dead-ended just below "the boot" in 1948 but was present by 1979. Land was cleared but not developed in Paradise Cove in 1948.
- In 1948, steep slopes NE of Mud Bay appear to have no tall trees. This can be confirmed by examining them in stereo (Part 4). Did the 1915 burn sweep almost all the way down to the Bay entry? I'm not confident enough to have shown it that way on the following vegetation context map. Instead I chose a non-committal "YG conifer" classification.





habitat	acres
burn	2577
clearcut	214
old field	18
uplift forest	19
young conifer	1028
wet old growth	1802
upland old growth	3685

Context: peninsula vegetation

When Koren maps and describes wetlands, she uses locally-attuned structural/functional/seral classifications that we've individually and collaboratively customized for Southeast Alaska over the course of our respective careers. They link both "downward" to geologic substrate, and "upward" to wildlife habitat. To my mind, this approach is more useful than nationally standardized systems—usually parsed according to species or taxonomic groups—that either lump, or, alternatively, split beyond thresholds of airborne believability, thereby glossing or over-exploding locally relevant connections.

In creating a context map of vegetation for Chilkat Peninsula, I've taken this structural/functional/seral approach. The USFS *existing_veg.shp* stops short of the peninsula, and wouldn't have been much use to us anyway. Other systems, such as recent ANH and TNC mosaics, include a few informative polygons, but in projects like these, I generally find it more useful to let the country suggest its own categories, rather than shoe-horning habitats into into predetermined cubbyholes.[1]

My acreage table lists 7 forest categories. Five are early- to mid-seral, and the last 2 are late-seral, true old-growth types. In my past visits to Haines I've spent little time examining forests on Chilkat Peninsula. Our 2 days of ground-truthing this June were restricted to Nelson Homestead and immediate surroundings. Given this minimal ground-time on the peninsula, I mapped according to:

1) aerial imagery at several scales, B&W, true color, color infrared, and satellite multiband

2) historical aerials for assessing successional change

3) low-elevation aerial obliques by Alaska Shorezone, July, 2005

4) mid-elevation obliques, taken June 5th, 2013, on our approach to Haines.[2]

Photopoints for these last images are linked to my GPS flight line. I've selected 5 of them—identified on the map by white photo numbers—to illustrate the range of forest types.

Mapped habitats:

Burn In 1915, a fire at the sawmill torched the lower slopes of Mt Ripinski, then jumped Haines and raged southward down the inside (west) of Chilkat Peninsula. Our *Repeat Photography* report (Carstensen & Hocker, 2005) includes information and imagery for this >1500-acre fire.

Clearcut The Alaska State spatial database shows only 3 "harvest depletion" units on the peninsula. No doubt there are more, such as the above-mentioned pre-1948 cuts at Mud Bay's mouth. I mapped a fourth patch in the head of

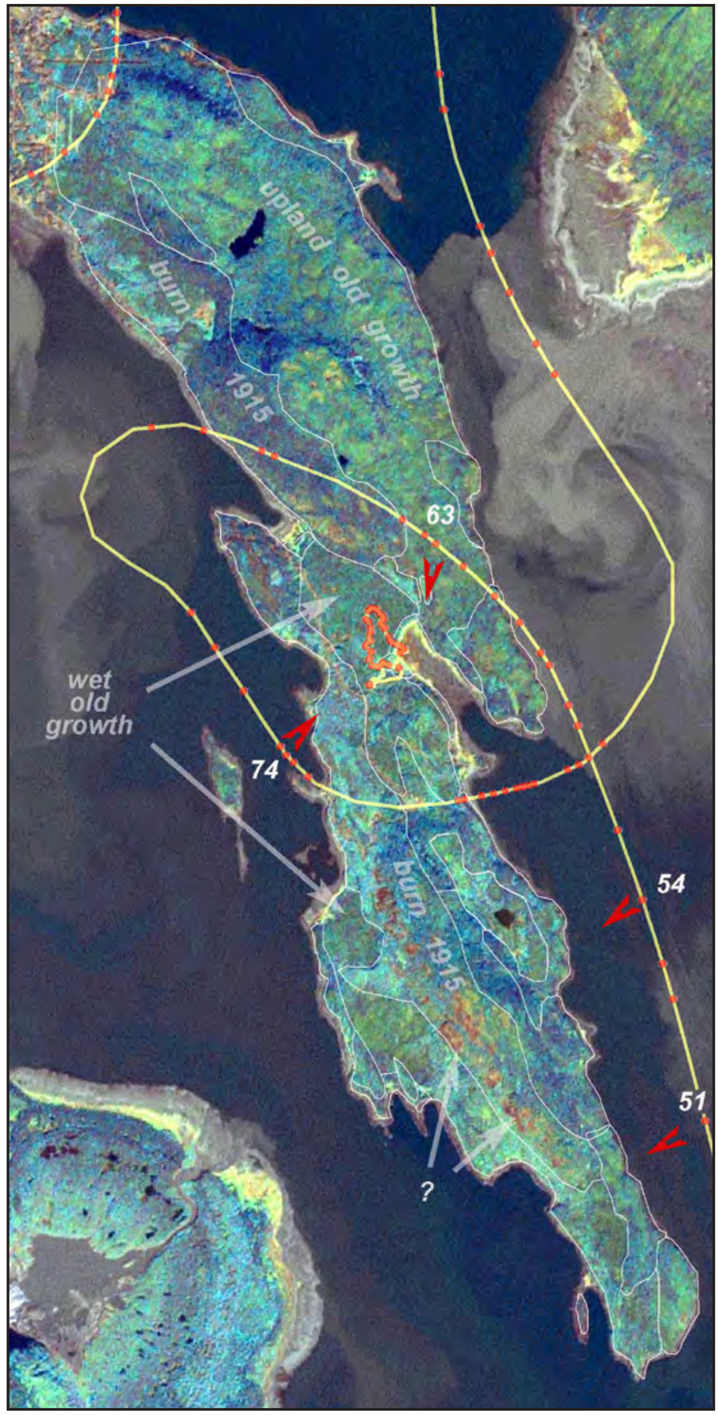
1 Obviously, the standardized systems have their uses in jurisdictional arenas; so Koren typically crosswalks her custom classifications with NWI/Cowardin, etc. The draft Adamus classification will prove more useful than broadly-encompassing systems to date, thanks in part to Koren's involvement, and Paul's coordination of input from many local experts.

2 PS 0628: I didn't have access to the 2007 USFS stereo imagery (Part 4) when creating this veg map.

Satellite image mosaic created by the *National Park Service Alaska Landcover Mapping Program* for Glacier Bay NP to the southwest. Source imagery was generated by USGS EROS for NPS in UTM—NAD 27 projection. The TM7 mosaic was acquired August 1, 1999, using 30-meter visible bands (3,2,1) merged with a 15-meter panchromatic band. The resulting image has 15m pixel size, and contains infrared information that enhances the true color image.

Although resolution is low compared to other imagery in this report, I love this satellite view for vegetation mapping at broad spatial scales (useful down to ~1:40,000). Haines can be grateful to NPS for extending boundaries of coverage to include most of the greater Chilkat River watershed.

On this clip for Chilkat Peninsula, I've outlined my forest-type units in white, but removed my color-codes to allow the panchromatic-&-true-color combination to show through. I expect that forest aficionados with a lot more ground-time on the peninsula than me—such as Rob Goldberg, Tim Shields and Ben Kirkpatrick—will spot subtleties of color signature that elude me. For example, what are the rusty-brown patches in the southern part of the burn, that I indicated with a question mark?



Mud Bay, based upon Carol's information from her father.

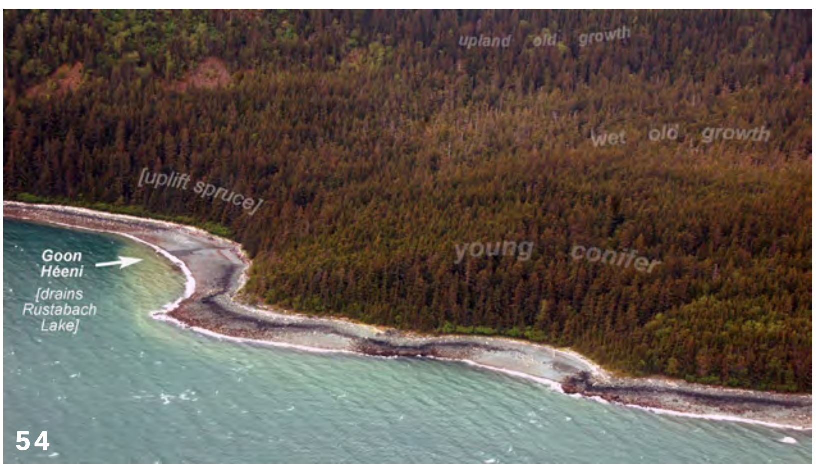
Old field Abandoned fields returning to forest are today the principal successional pattern throughout the eastern U.S. but are rare types in SE Alaska. In the 1970s, Carol's dad cleared a total of about 18 acres for agriculture and residential development. These clearings are now coming back in a combination of native and exotic species.

Uplift spruce I only mapped a few examples of this type, at either end of Mud-Letnikof pass. There's at least a narrow band of uplift forest above all but the steepest, most exposed shorelines on the peninsula. So a complete mapping would probably multiply my ~19 acres at least tenfold.

Young conifer This is sort of a catch-all category for smooth-canopy stands lacking strong deciduous component, that I can't assign positively to fire, logging or blowdown. Many little patches of these fine-textured, even-aged stands are scattered throughout the other mapped units, so my acreage total is a considerable underestimate.

Wet old growth Level or gently rolling benches up to a few hundred feet above sea level appear to be capped with a layer of fine marine silt and clay. We only ground-truthed this substrate within the Nelson homestead, so my extrapolations to similar surfaces on the peninsula should be considered speculative. Koren and I were impressed with the species richness and structural diversity of this gappy forest, and with its unexpected importance to wintering moose.

Upland old growth Most of our forest surveys were in low, wet forests, so I can say little about steeper old forests on bedrock and glacial till that comprise about 40% of Chilkat Peninsula. I've mapped this as "old growth" wherever a gappy, complex canopy prevails. So far, my impression is that the upland old growth is less diverse, and maybe



less valuable to game such as **moose**, than the low, wet, old-growth type. See for example photo 48, day 2 survey.

Interpretation for numbered oblique aerials:

49 View SW over Ayiklutú, *you gotta get ready* (Seduction point). In reference to a similar shallow bight near Point Retreat, fluent Shangukeidí speaker Fred White told me that lutú means nostril, and indeed this indentation just north of the point could be seen as a nostril to the nose of the peninsula's southernmost point.

Most of the foreground is smooth-textured forest suggesting same-aged hemlock and spruce responding to some stand-replacing disturbance—probably wind. In the lower right, a lot of brighter green deciduous trees are intermixed. These occur on too fine a scale to have been mapped. On the far shore beyond the point, canopy is gappier, suggesting old growth. Because terrain is gentle, I mapped it, speculatively, as wet old growth.

51 About a mile north from Ayiklutú, the state database shows a 133-acre clearcut, with "9" (=1909?) in the *year_harvest* field. Studying this patch in my oblique aerial, an extremely uniform, almost pure-conifer stand occupies much of the mapped unit. Tree growth appears to have been slow on convex topography and faster in the gullies with deeper, richer soils.

If the state forest layer is correct about date and extent, this clearcut is remarkable and puzzling. Chainsaws didn't appear until the 1940s, and when forests were logged by handsaw, trees were generally taken selectively, not in 100+ acre swaths. There's no sheltered cove on either side of the peninsula where logs could have been staged.

As for why they were cut, the location suggests a hemlock "wind-forest" as the original forest type. Hemlock was the prefered species for piling, and a great deal of that was needed for canneries and fish traps.

54 Goon Héen means *springfed stream*, a spiritually significant feature to the Tlingit. Combined with the inviting-looking canoe beach in a southeast-facing crescent, with excellent defensive views, we can be almost certain this was a strategically important camp or satellite-village site for the Lukaax̱.ádi.[3]

Three distinct forest types recede into the distance across the right half of this scene: even-aged young-growth conifer in the foreground, backed by wet old growth on fairly level terrain with marine sediments, and steeper,

3 Compare the Rustabach Lake historic series, following in Part 4.

better drained upland old growth on the hillside. The darkest and tallest of the young growth in center foreground is mostly spruce, while the paler green, smooth-canopied stands bracketting it on left and right are mostly hemlock.

The Goon Héeni crescent is backed by vigorous young uplift spruces on a raised beach (I didn't map this; thus the brackets). This mid-seral forest probably extends as far back as the tallest of these trees. Haines has had about double the amount of vertical rise as I'm used to in the coastal forests around Juneau. Along with springfed (ultimately, lake-source) drinking water, good canoe access and great views, this smooth, well-drained living surface would have been a prized feature in selection of camp and village sites for the Lukaax̱.ádi.

63 View straight south over Mud Bay. Light was challenging and this was a pretty drab photo but I managed to bring up the color contrast in photoshop.

Ground-truthing allowed finer-scale delineation here. In foreground are old but small hemlocks on bedrock and till. These grade downslope to a narrow belt of darker, taller, younger spruce that frames all but logged-&-developed shorelines of Mud Bay. Much of this spruce belt is on land removed from tides by glacial rebound or steepened by waves.

Spanning center distance is low, wet old growth, probably similar to the stands we surveyed in Mud-Letnikof pass. Compare the mottled, olive-green tints on preceding NPS satellite image. On the eastern peninsula is the 1915 burn.

74 View NE over Tlek̲wxágu, *berry sand beach*, into Léix̲'w Noow, *ochre fort* (Paradise Cove). Mud Bay is in right middle distance. In our *Repeat Photography* report (2005) we have a 1905 historical photo and retake of the cannery below Tim Shields' house, which shows the pure coniferous forest that grew here 10 years before the great Haines fire.

In my oblique aerial #74, remains of the cannery pilings are still visible in the cove. The strong deciduous component of forests recolonizing the 1915 burn is still apparent, almost exactly a century later. (Does this long-lasting deciduous legacy suggest that the previous, purely coniferous forest had *not* burned in well over a century? That would make since, considering we were just emerging from the colder, wetter Little Ice Age in the early 1900s.)

Tallest trees above Paradise Cove, with yellowish crowns, are cottonwoods. Vulnerable to **moose**

Photo we scanned at the Sheldon Museum in 2005, dated 1940. Taken from the Ripinski trail at about 2500 feet, looking Southeast over Chilkat Peninsula, only 25 years after the 1915 fire.

browsing, these probably couldn't have survived without human protection in sapling phases.[4] I didn't ground-truth the 1915 burn on this visit, but in 2005, here and at Skagway, we noted primarily birch and lodgepole pine in the fire forests, along with the considerably less fire-worthy spruce and hemlock, present probably by virtue of prolific nearby seed source. Willow is also present, but judging by what I saw at Mud Bay, is rather suppressed by moose.

Which brings us to wildlife . . .

Wildlife; some musings

I don't presume to know enough about Haines to give anything like a balanced summary of the peninsula's importance to wildlife. There are a lot of observant local naturalists who could do a better job of that. Here, I'll just mention a few of the puzzlers and speculations that rise to the top for me, as I put together this report.

Moose The whole question of moose impact on the peninsula forest communities is worthy of focused study:

• How many are there? On the peninsula? In Mud-Letnikof pass? What are their seasonal movements?

• When did they get here? Impacts to the wet old-growth forest type are superficially obvious, but whether they're positive (nutrient enrichment, productivity stimulation) or negative (erosion?) is less clear. How long did these impacts take to develop? And how long can moose sustain current or increasing levels of use?

• Moose are obviously mucking up many organic mires in the wet old growth (day-1; 153). Is that "bad?" Does this affect hydrology downstream in problematic ways?

• Have moose suppressed reproduction of favored browse like willow and cottonwood. Is there a refuge height and diameter for these species, and is there a consequent age discontinuity of "moose trees" dating to the decade moose arrived?

• Moose seem to be ignoring the standard winter forbs so important to **deer**: COCA/RUPE/COAS/TITR. If more deer continue to colonize and survive with warming climate, will this allow sharing of winter grounds between these ungulates—one mostly a browser and the other mostly a grazer?

• Am I correct that moose make less use of upland slopes? Why?

Deer I saw no definite sign, but Clay says that he, Ben and Irene are all seeing a definite increase in recent years.

Could any of the peninsula naturalists draw us an off-the-top-of-the head map of winter snow depths? This would help a lot in predicting areas where deer can winter on the peninsula.

As I noted in my caption to the preceding geology map, the peninsula is basically the northernmost bastion of "typical" Southeast coniferous old growth. For geologic reasons, we can predict that will not change, even with warming climate. The peninsula may therefore become a "final" destination in northward colonization of Sitka blacktails into the archipelago. Will it support huntable populations, or always remain marginal, in the way of edge-of-range locations?

Goat This was a real surprise to me (day-2; 47). Are goats "permanent residents" on the peninsula? Did we just see the leavings of a couple strays? Or are there in fact zero goats on the peninsula, and we mistook deer sign for goat?

4 Of course, moose didn't arrive in the Haines area until about the 1930s (?) and probably much later out here on the peninsula.

Brown bear I'm surprised that residents see more brown than black bear on the peninsula, which offers none of the habitats or resources (salmon, sedge flats, avalanche chutes, lush subalpine meadows, etc.) characterizing high-density brown bear populations.

Given regional scarcity of high-quality forage plants, sedges and other halophytes at the head of Mud Bay should in theory be a hotspot for brown bears in May and June. Does Joe Ordonez or any other resident have direct observations, or clues from track sizes as to numbers of individuals?

Water birds Our visit was too late to get a sense of migration through the Mud-Letnikof pass. Even on Mendenhall Wetlands, June can be a pretty slack month for bird observations, so it may not be significant that we saw almost no waterbirds in Mud Bay during our 2 days there: zero shorebirds, almost no waterfowl or gulls, and few corvids.

Do geese overwinter in Mud Bay? Around Juneau and in other Southeast salt marshes, sedge flats of this size typically support resident Vancouver Canada geese. Jim King and Jack Hodges point out, however, that icing can be an issue, placing otherwise suitable estuaries off limits to wintering geese and mallards.

Overall, my impression is that the Mud Bay salt marsh is a ***rich but ecologically under-utilized*** salad bowl. I could be wrong; it's quite a reach to generalize based upon 2 days' observations. But I put this idea down for others more grounded to react to. Does it confirm or run counter to experiences of resident observers?

Tlingit place names

With the 2012 publication of *Haa L'éelk'w Hás Aani Saax'ú: Our grandparents' names on the land*—Tom Thornton (ed), we no longer have any excuse for suppressing the country's real place names. Tlingit names are so much more interesting, respectful and tenured than IWGNs (important white guy names), that I'm beginning to use them whenever possible, followed by the english translation *in italics*, and the IWGNs where they belong, (in parentheses).[1]

How much cooler or intriguing to daisy-pickers could you get than "*place where frogs drift in bunches*"—the cove below Katzehin estuary? Before the chytrid plague, western toads bred prolifically on big-river flood plains, and probably flushed when overbank floods swept their nurseries. All this is speculation, anathema to hard science, but irresistable to a 21st-century naturalist.

When George Emmons came to Alaska, the Jilkáat were the most powerful of Tlingit kwáans. What geographies promoted that dominance, and how was it defended? In such bellicose days, the Peninsula, by my way of thinking, would be less about resource than armament, or maybe seduction.

Léix'w Noow, *ochre fort*, guarded the river mouth. But what about the outside? Goldschmidt & Haas (1998) map a fort at Battery Point. I suspect others stood at Goon Héeni and Ayiklutú. I'd also check out that point enclosing Mud Bay (AK-S 730, *Geology* section), bracketted by nifty canoe beaches.

Thornton gives no Tlingit name for Mud Bay. What was its significance in the time of pass-climbers and canoe-traders whose livelihoods arose from local, nearby, and a few distant, startled watersheds?

1 In future smart-pdf versions of these digital journals for tablet, tapping Tlingit name launches audio of an elder pronouncing the word. If available & authorized, further taps link to story behind the name.

Plate 48 from Moser's report on the Albatross expedition of 1898.

People on the peninsula

As with wildlife, my understanding of human history of northern Lynn Canal is too haphazard to attempt an overview. I'll simply close this natural and cultural history with a vignette distilled from the turn-of-century visit by fisheries research vessel *Albatross* (Moser, 1898):

> *"The Chilkat River valley is wide, but water at ordinary stages is confined to a few channels, which flow around sand banks and marshy and wooded islands. Most redfish are taken by cannery fishermen with drift gill nets between Glacier Point and McClellan Flats, a range of about 7 miles. Columbia river boats are used, each manned by 2 white men, or 1 white man and 1 native. Average seasonal catch during the past 4 years has been 300,000 redflsh, The fishermen receive $100 for working the ship to Alaska and return to San Francisco, and 3 cents is paid the boat outfit for each king salmon, redfish, or coho taken; the men are boarded by the cannery. The cannery, besides obtaining fish from this source under its own supervision, purchases fish from the Chilkat and Chilkoot Indians.*
>
> *The Indians fish from canoes moored to posts, or from platforms built over the streams. They use a large gaff, consisting of an unbarbed hook about 4 inches across the bend, secured to a pole 10 or 12 feet long. This is thrust into the water, and when the Indian feels or sees a fish, he impales it and drags it ashore. When fish are plentiful the hook is simply dragged through the water.*
>
> *In 1880, when it appeared that the salmon of the Columbia were becoming scarcer, Mr. M. J. Kinney, one of the large packers on the Columbia, started inquiries elsewhere. . . . In 1882 he had the Chilkat territory prospected, built a hut at Pyramid Harbor, and in 1883 he erected a cannery, under the name of the Chilkat Packing Company, on the eastern shore of the inlet, about a mile below the site now occupied [*i.e. 1898*] by the cannery of the Chilkat Canning Company. The cannery burned in 1892.*
>
> *The Chilkat Canning Company was built in 1889 by Hugh Murray and David Morgan* ***at Chilkat Village, on the eastern side of the inlet, and inside of Pyramid Island****.* [RC emphasis][1] *It sold to the Alaska Packers'Associatiou and closed in 1893.*
>
> *Pyramid Harbor is a small cove in which 2 or 3 vessels may find anchorage. The cannery was built in 1883 by the Northwest Trading Company, at the time that company was established at Killisnoo. It burned in 1889 but was rebuilt at once. In 1893 it joined the Alaska Packers' Association [*building to*] a capacity of 1,600 cases a day. In 1896 14 whites and 87 Chinese were employed in the cannery. The company employed 60 white fishermen, and received fish from about 200 natives.*
>
> *After the gold excitement reached Pyramid Harbor many white fishermen left for the Klondike and many Indiaus left to freight across the passes.The Chinese contract price was 40 cents per case. The fish obtained for [*the Haines-area canneries*] all came from the Taku, Chilkat, and Chilkoot rivers."*

For his time, Commander Jefferson Moser was an exceptionally objective observer, sympathetic to Tlingit land rights:

> *"[*Conflict*] usually results in the survival of the most powerful corporation, and the Indian goes to the wall."*

Still, you'd never guess from the foregoing description how close the canneries came to pushing the Jilkáat sea-raiders beyond the limits of tolerance. Pyramid Cannery's fish trap drew Tlingit ire only a decade before Moser's visit. In 1890 Jilkáat dissidents subdued the armed trap guards and tore down their fish-run extinguisher (Goldschmidt & Haas, 1998).

In the watershed of Kohklux, destroyer of the Pelly River Hudson's Bay post of 1852, and Elizabeth Peratrovich (Lukaax.ádi of Yandeist'akyé, *where everything from afar drifts on shore*), invaders are not suffered quietly. Those canneries got off easy.

1 Goldschmidt & Haas (1998) mapped and described only 3 Jilkáat villages on the lower river: Yindastuki (airport area), Deishú (today's Haines) and Tanani (near today's ferry terminal). So this 1898 mention of a "Chilkat Village" inside Pyramid Island is intriguing. Thornton (2012) does give the place name Laxách' T'áak for this beach, but with no associated translation or story. So what's behind the name "Chilkat" in exactly this spot on the 1:63,000 USGS topographic map?!

3 WETLANDS AT MUD BAY HOMESTEAD

Koren Bosworth

Tidal and uplifted tidal communities

A broad band of the mid to upper intertidal in Mud Bay, is dominated by Lyngby's sedge. **E2EM1N**

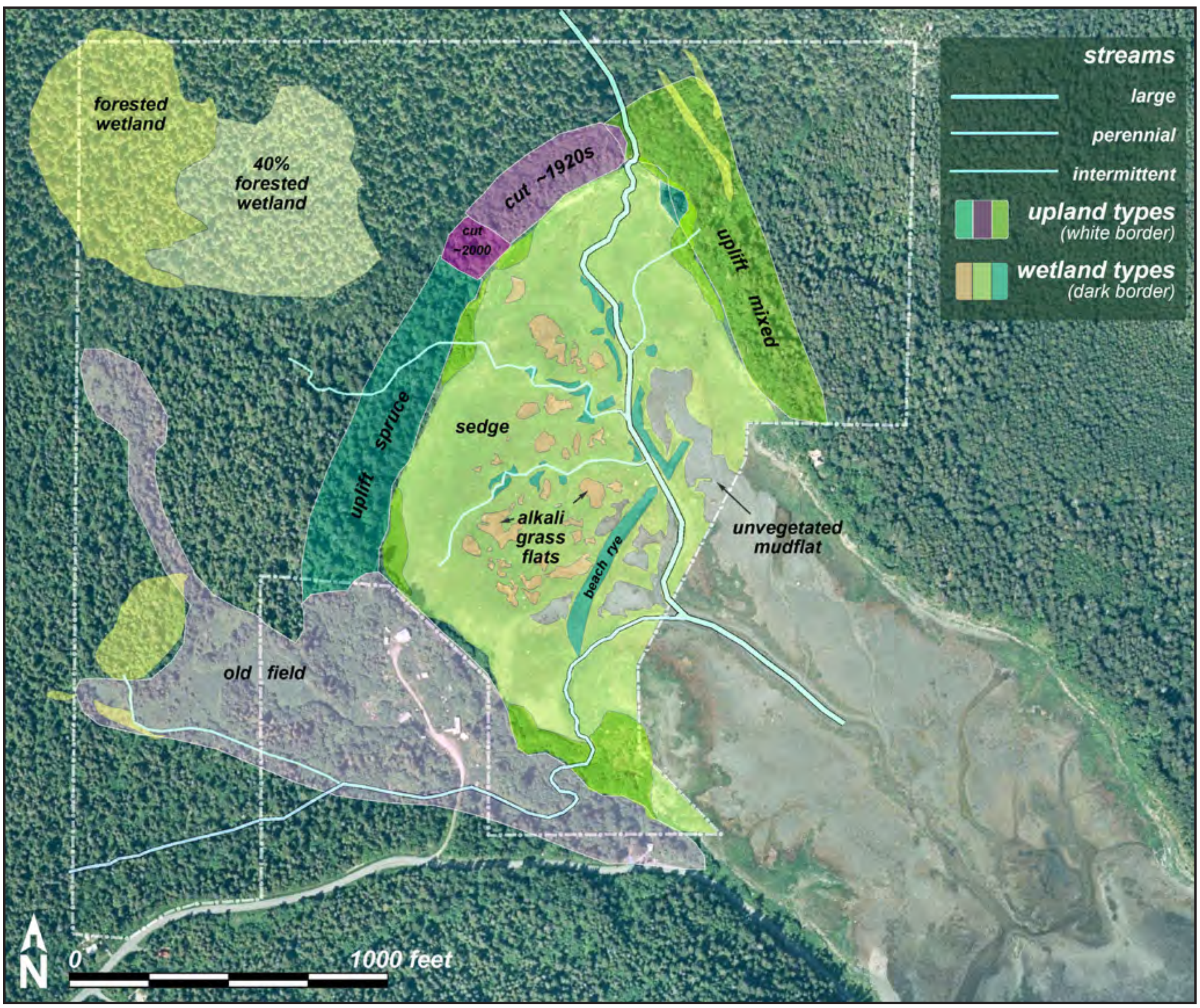
Carex lyngbyei
Potentilla anserina (silverweed)
Rumex occidentalis (western dock)
Festuca rubra (red fescue)
Carex glareosa (lesser saltmarsh sedge)
Plantago maritima (goosetongue)
Glaux maritima (sea milkwort)
Sagina maxima (coastal pearlwort)
Stellaria humifusa (saltmarsh starwort)

Within the *Carex lyngbyei* band are circular patches bare of *Carex* and dominated by two species of alkali grass and goosetongue. The smaller species of grass is *Puccinellia phryganodes* and it forms a tight short stoleniferous mat over these circular patches. **E2EM1N**

Plantago maritima (goosetongue)
Puccinellia phryganodes (goose grass)
Puccinellia nutkaensis (Alaska alkali grass)
Triglochin maritima (sea arrowgrass)

There is a slightly raised sandy berm across the middle of the intertidal area[1] and a few small bands along the slough that are dominated by *Leymus*

1 RC: We puzzled over the origins of this berm. Alignment parallel with bay-head suggests a natural feature. It was clearly present in the 1979 NASA photography, already transected by sloughs, but can't be detected in the 1948s. Sediment is coarser than the silty matrix up and down-bay. Was this topographically subtle but vegetationally distinctive bar deposited by waves breaking along this line, when sea level was several feet higher?



mollis (beach rye). **E2EM1P**

Leymus mollis (beach rye)
Lathyrus maritima (beach pea)
Ligustichum scoticum (beach lovage)
Achillea borealis (yarrow)
Deschampsia beringensis (Bering hair grass)
Cochlearia officinalis (scurvy grass)

The narrow band of uplift meadow between the *Carex lyngbyei* band and the forest has a wide variety of meadow species. **E2EM1P**

Angelica lucida (sea watch)
Picea sitchensis (Sitka spruce) seedlings
Myrica gale (sweet gale)
Potentilla anserina (silverweed)
Fritillaria camschatcensis (chocolate lily)
Iris setosa (iris)
Hierochloe oderata (common sweetgrass)
Equisetum arvense (field horsetail)
Lathyrus palustris (marsh pea)
Festuca rubra (red fescue)
Juncus arcticus (arctic rush)
Poa eminens (eminent bluegrass)
Conioselinum pacificum (Pacific hemlock parsley)
Lupinus nootkatensis (Nootka lupine)
Rubus idaeus (raspberry)
**Ranunculus repens* (creeping buttercup)
Maianthemum dilatatum (deer berry)
Geum macrophyllum (large-leafed avens)
Actea rubra (bane berry)
Heracleum lanatum (cow parsnip)

In the areas where small upland intermittent streams come out onto the impermeable intertidal silts there are marsh/swamp communities dominated by Sitka alder at the upper edge and lush *Carex lyngbyei* at the lower edge. **E2EM1P**

Carex lyngbyei
Alnus sinutata (Sitka alder)
Caltha palustris (marsh marigold)
Comarum palustre (marsh five finger)
Equisetum arvense (field horsetail)
Equisetum fluviatile (swamp horsetail)
Epilobium luteum (yellow willow-herb)

Forested wetlands

The NW quarter of the project area is flat and is underlain by relatively impermeable glaciomarine deposits resulting in a forested wetland community dominated by western hemlock and skunk cabbage. There are upland hummocks and gullies throughout the area and those upland areas increase downhill and to the southeast. **PFO4**

Tsuga heterophylla (western hemlock)
Picea sitchensis (Sitka spruce)
Lysichiton americanum (skunk cabbage)
Equisetum arvense (field horsetail)
Oplopanax horridus (devils club)
Athyrium felix-femina (lady fern)
Vaccinium ovalifolium (early blueberry)
Menziesia ferruginea (false azalea)
Caltha palustris (marsh marigold)
Gymnocarpium dryopteris (oak fern)
Cornus canadensis (dwarf dogwood)

* introduced species

Wetland classification & amounts

KB type	Cowardin	acres
forested wetland	PFO4	8.50
40% forested wetland	PFO4	7.84
marsh/alder	PEM1/PSS1	3.33
alkali grass flats	E2EM1N	1.66
beach rye	E2EM1N	1.49
sedge	E2EM1N	26.59
unvegetated mudflat	*special aquatic site	2.28

* Special Aquatic Sites are geographic areas, large or small, possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values. These areas are generally recognized as significantly influencing or positively contributing to the general overall environmental health or vitality of the entire ecosystem of a region. They are a subset of areas identified as "Waters of the United States". Activities that affect waters of the U.S. are regulated under the Clean Water Act (CWA). Under the 404(b)(1) guidelines, Special Aquatic Sites are subject to greater protection than other waters of the U.S. because of their significant contribution to the overall environment.

Mapped stream lengths

size	feet
large	2894
perennial	2804
intermittent	3816

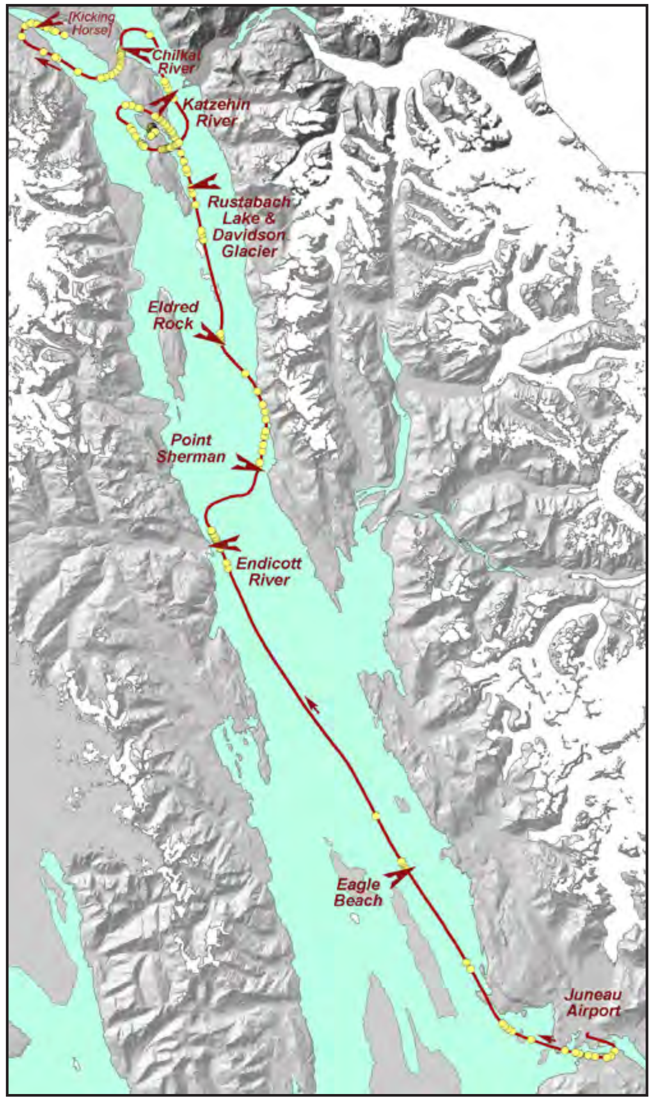
4 RETAKES, REFERENCES

Flight from Juneau to Haines

As explained in Part 1*: 20130605 Flight to Haines*, we took the opportunity of the Juneau-Haines charter to replicate several oblique air photos in Lynn Canal, mostly taken by the US Navy in 1929. For more background on the Navy aerials and the process of retaking them, see Carstensen & Hocker (2005).

Our culminating loops over Mud Bay and Chilkat River have already been described in Part 3: *Context, peninsula vegetation*. Since these more southerly retakes aren't related to the Nelson Homestead project, I've placed them here at the end of the report.

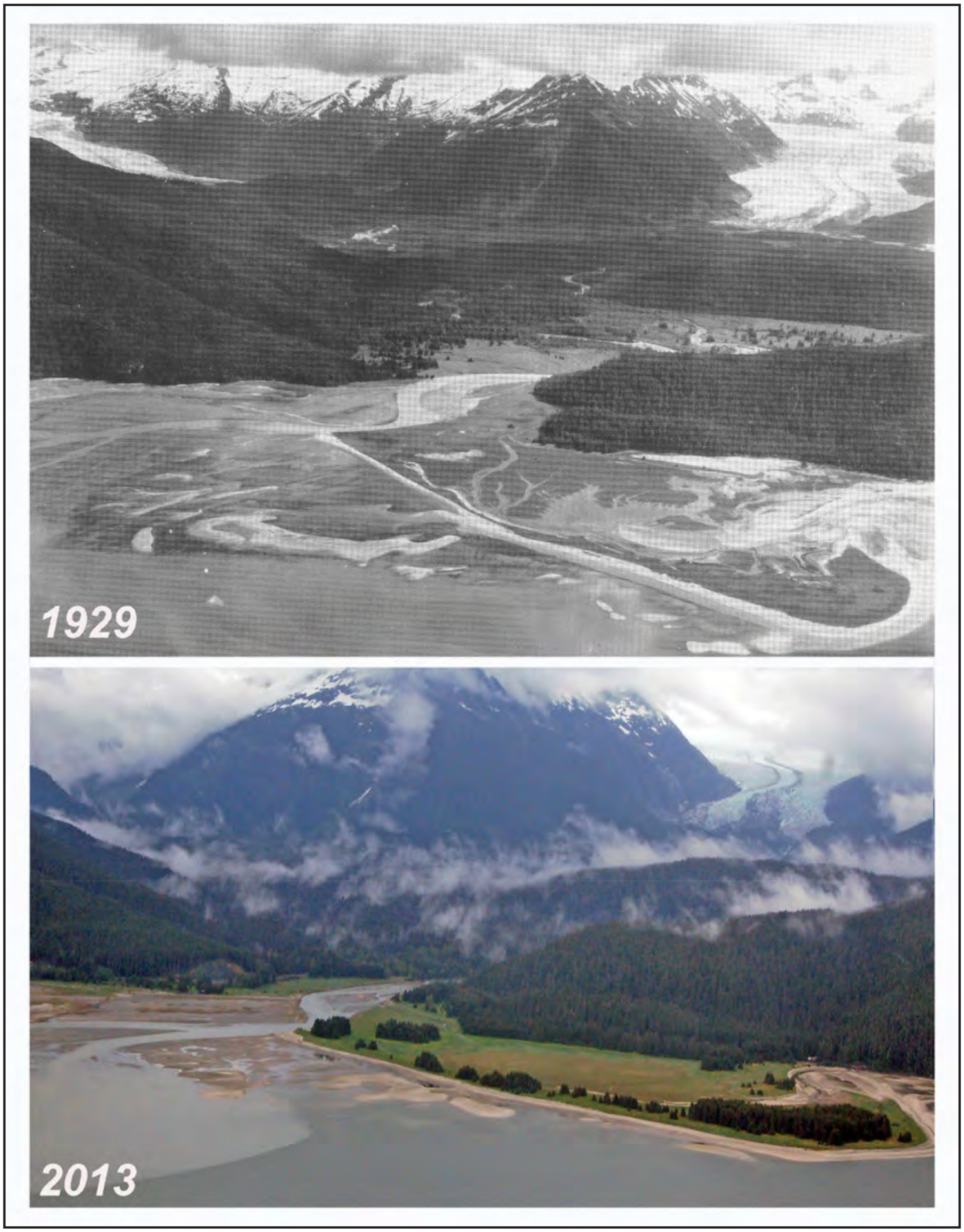
On dedicated repeat-photography flights, I make a more concerted effort to position the plane as close as possible to original elevation and photo-bearing. That wasn't possible for most of these retakes, but I include them anyway because much can be learned from comparison of landforms and successional status, regardless of photo angle.



Below: On our final loop toward Haines airport, we got a look at the flats below Kaltsex̲x'i Héen, *kicking river*, (Kicking Horse River), site of historic hooligan camps.

In Part 3*: Wildlife, some musings*, I commented that Chilkat Peninsula is suboptimal for both **moose** and **brown bear**. This photo shows superior upriver alternatives for herbivorous and omnivorous megafauna: vast freshwater wetlands; willow/cottonwood browse on river levees; mixed spruce/cottonwood and a maze salmon-spawning tribs on the vast Kaltsex̲x'i Héen fan.

US Navy, June 22, 1929



Eagle Beach

Asx’ée, *twisted tree* (Eagle River) is the square mile where I became a naturalist in the 1980s, and is probably the reason for my obsession with detecting change. In the 1929 original, no spruces were yet visible on the outer ridge. Today they’re beginning to close ranks into a solid line, but meadow-capture may retard final closure into the 22nd century.

Of relevance to the Mud Bay project is slough migration here, or lack thereof. Asx’ée rebounded about 5 feet in the interval between these photos. But while river-influenced sloughs on the left migrated like a whipped rope, those within the goosetonge flats have remained remarkably stable. The same has been true in the head of Mud Bay (Part 2*: Succession on historical imagery*). This can probably be attributed to the tenacious and often deep rhizome mat of salt-marsh halophytes, which binds the banks and “locks-in” the lacing channels.

US Navy, June 22, 1929

Endicott River

This was Jilkáat Kaagwaantaan country, trapped all the way to the headwaters (Goldschmidt & Haas, 1998); however, Thornton (2012) gives no Tlingit name. My retake is at lower elevation and farther to the north than the original.

Former USFS forester Tom Pence told me back in the 1980s that cottonwoods were growing 5 feet per year on the Endicott delta, and in logged karst on the upland point enclosing its north end (not shown in retake). In addition to forest advance in the foreground fan and beach ridges, there's been dramatic colonization by cottonwoods on the distant flood plain. At Endicott Gap, ~15 miles west on the border with Glacier Bay National Park, the Adams Inlet glacier once spilled over into Endicott River. The largely barren flood plain in 1929 was probably a legacy of this glacial dominance, healing over during the subsquent 8 decades.

US Navy, June 22, 1929

Point Sherman

We didn't pull in against the east shore of Lynn Canal until somewhat north of Point Sherman, so my retake is at about 90° to the 1929 original. Arrows point to a large, pale erratic (probably ice rafted) that makes a good point of reference.

Point Sherman Lighthouse opened in 1904. A keeper's dwelling and boathouse show in the upper inset. The first keeper, Andrew Jackson, was an avid horticulturalist who grew 5-foot tall potato plants in the favorable soils and southwest aspect.

In distance, beyond the erratic, were dock pilings and worker residences for the Comet Mine, developed in the 1880s and 90s. Today, the Kensington mine (lower inset) has coastal facilities here.

Today, the forest inboard from Sherman reef is scrubby and fine textured, suggesting regeneration after windthrow. In 1929 this stand was short and gappy, and had not yet closed canopy. That would be about right for recovery from the 1883 windstorm that leveled so many forests around Juneau.

US Navy, June 22, 1929

Eldred Rock

As with the Pt Sherman retake, I couldn't shoot the Eldred lighthouse until we'd passed over.

The Sheldon Museum website says:

> *Eldred Rock is the oldest original Alaskan lighthouse building. The octagonal building is constructed of huge timbers brought to the island by the US Government in 1905.[1] The light was 91 feet above sea level. . . built after some disastrous ship-wrecks in the vicinity, especially during the 1898 Gold Rush . . . According to Krause, Eldred Rock was known by the Tlingits as "Nechraje."* [Eldred] *was decommissioned in 1973 and has been operated remotely since then.*

Comparing 8 decades of succession at Eldred and Sherman lighthouses the latter has grown in so densely that ruins of the keeper house can no longer be detected in my retake. In contrast, only a handful of spruces have established on Eldred Rock. Why the difference? How much can be attributed to trampling and perhaps intentional clearance by residents and visitors at Eldred, and how much is due to violent storms sweeping this much more exposed location?

1 If the preceding date of 1904 for the Sherman light is correct (*http://www.lighthousefriends.com/light.asp?ID=876*) this claim for Eldred would be incorrect.

USFS photo archives

Rustabach Lake

Historian Jim Mackovjak found this unnamed, undated image in a box of DVDs in the basement of the Federal Building, containing scans from early prints and thousands of 35mm slides. I'd never have recognised the location, except that the upper part of this cropped view shows Davidson Glacier (next photo series).

My retake is from lower elevation, and several hundred feet south of the original. White arrows on both photos show outer edge of a distinctive patch of even-aged spruce. Using this stand for orientation, note the many spruce crowns that have emerged through the deciduous (birch?) canopy in the half decade between photos. You can just barely detect the tops of these conifers in the original image.

US Navy
US Navy
Google Earth

C.W. Wright
USFS photo archives

Davidson Glacier

Oddly, Thornton (2012) gives no Tlingit name for the Davidson—one of the most photographed glaciers in Southeast Alaska. My retake is considerably south of the 1906 and ~1960 views, but serves to show how much the terminus has receded since its Little-Ice-Age march to tidewater. On the 1906 photo by Wright I've added dotted lines on the right-side trimline. When ice reached this elevation, it also extended out to the farthest moraine visible in the 1948 vertical photo. Because land was depressed several feet at that time, high tides probably lapped the ice on the northeastern front. The radial lines running like spokes through recessional moraines are puzzling. I don't see these on similar expanded-toe glaciers near Juneau.

Considerable reforestation has occurred not only on deglaciated ground, but on raised former tideland. The outwash channel shifted north between 1948 and 1960. In the 1894 image by McArthur, ice had receded only a little from the LIA maximum. The same pattern prevailed in Juneau-area glacial retreat—slow at first, then accelerating ~1910.

J McArthur

US Navy

US Forest Service

Katzehin River

Wulix'áasi Héen, *cascading river*, is fed by Meade Glacier[1]—like the Davidson a major ice feature for which, unfortunately, I can find no Tlingit name. The Lukaax̱.ádi must have been intimately familiar with this northernmost ice-river draining the Juneau Icefield, because it advanced about to the corner visible in the distance on the 1929 oblique. Hiking up valley for trapping and goat-hunting would have been easy on the barren river bars, at least during low flow.

My retake lines up the opposing points fairly well, but was at lower elevation. Although considerable recession has occurred, this is still an active glacial river, with a mostly-barren flood plain. To best appreciate this, the vertical aerials on right are more useful than obliques. Only in a few protected side pockets and on some point bars has substantial reforestation occurred. An example is the cottonwood stand marked in middle distance. Compare this on the vertical aerials on the right. It's still a mosaic, but about 70 acres of deciduous forest has colonized the higher ground here. Between these patches are lacing overflow channels

In contrast, the glacially rebounding estuary has seen about 400 acres of more uniform forest advance. Unlike the river bars, this uplifted delta is now entirely free of water-related disturbance.

It does appear that as Meade Glacier recedes, parts of the Wulix'áasi Héen flood plain are downgrading, or at least shifting away from certain marginal terraces. In the upper right of the 1948 verticals there's a braided overflow channel that almost completely filled in with deciduous forest and scrub by 2007.

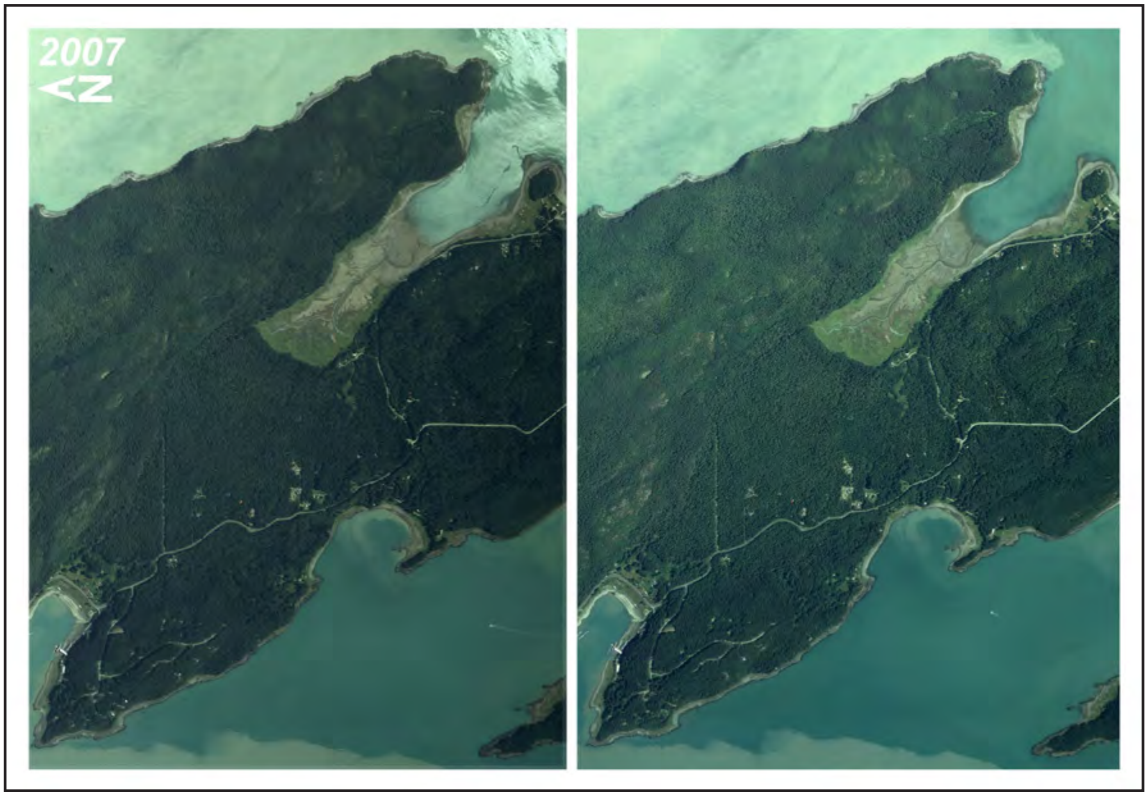
1 Richard Meade was the naval commander who bombarded and leveled 2 Kake villages on northern Kuiu. His name should be wiped off all maps. At least Davidson deserves credit, if not IWGNs, for commissioning the Kohklux map of trade routes into the interior.

US Navy, June 22, 1929

Chilkat River

My retake of this classic early Haines scene is just slightly south of the original. The most dynamic area is Sawmill Wetland, site of today's airport, visible way upriver. In 1929 there was apparently little vegetation anywhere on the flats, which were all swept by Chilkat River during high flows. What was then an overflow channel became Sawmill Creek, heading near the Lukaax̱.ádi village of Yandeist'ak̲yé.

Dan and Gretchen Bishop and I studied succession on this wetland in the early 1990s, in relation to proposed taxiway construction. I'd love a chance to go back and revisit those sudies.

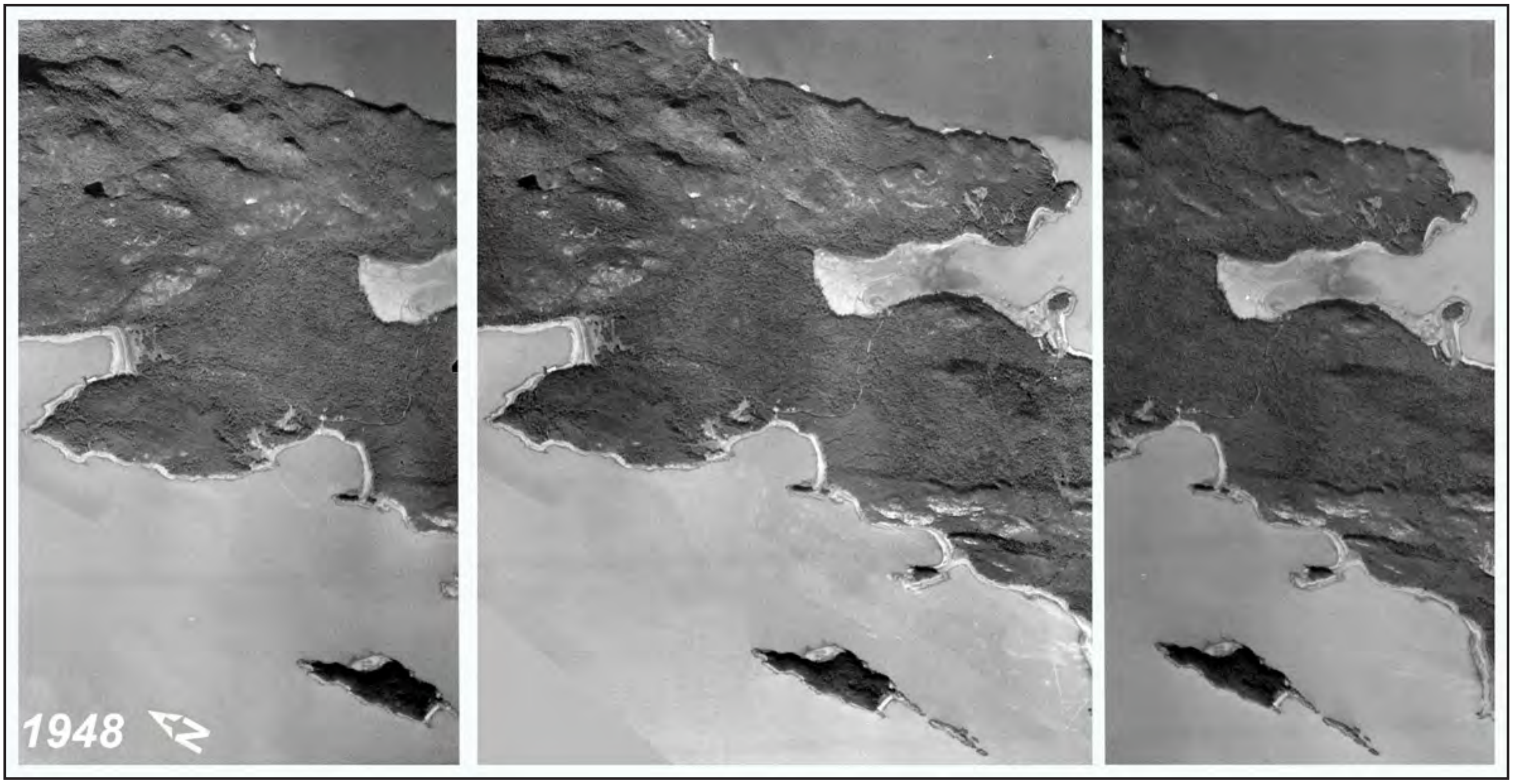


Stereograms

Photos of the same object or landscape taken from different positions can be viewed under a pocket or mirror stereoscope to produce a 3D image. Lately, I've been appreciating my tablet for this purpose, for 2 reasons.

First, resolution is higher, so images don't pixelate under 2x magnification as they do on computer monitors. Secondly, you can lay the tablet flat and rest the legs of the viewer on it, just as with a paper print-out, but with more vibrant color and finer resolution.

Since return from Haines, I acquired from Mark Riley (remote sensing specialist at USFS) a complete set of raw digital (scanned) imagery from which the newer generation of orthophography has been produced. These raw aerials overlap in coverage, which allows stereo presentation not available from the processed, non-overlapping orthos. Although Mud Bay is off the Tongass, we lucked out; it



appears at the edge of a flight line covering the east side of Lynn Canal.

I've prepared 2007 stereograms for Mud Bay at 2 scales. The upper pair gives the broader context of Mud-Letnikof pass. The lower pair shows the Nelson Homestead in greater detail.

These stereopairs (and the earlier 1948s) allow examination of topographic subtleties in Mud-Letnikof pass. It appears level (or slightly domed in center?) on a coarse scale but hummocky at a finer scale. That of course can be misleading due to variable tree heights. On the ground, we were puzzled by occasional low ridges (day-1: 138) and mounds

We could make better-educated guesses about landform origin if we had 5-foot lidar contours.

Mud Bay 1948 On these early black&white stereograms, note that north is oriented differently than in the 2007s.[1]

This imagery was acquired by the US Navy on July 5th, 1948. In order to encompass all Mud Bay and Letnikof Cove, I had to include 3 overlapping images, providing 2 different stereo-scenes. For Letnikof, set up the viewer centered over the left&center images; for the entirety of Mud Bay, set up over the center&right pair.

These photos were taken only 3 decades after the great fire of 1915, so its extent on moderate topography is made apparent by extreme canopy smoothness. Of course, the burn was not limited to these smooth patches, but also extended up onto steep slopes that had delayed recolonization in 1948 (and even today). On some of those rocky hillsides, fire burned the duff right down to bedrock, and such places may take centuries to regain their soils. I'm still a little vague on how far the 1915 fire extended along the hills NE of Mud-Letnikof pass. (Recall that on the preceding 1894 mountaintop view down onto Davidson Glacier, a burn already showed on the hills of the southern Chilkat Peninsula)

1 In viewing stereo imagery, presentation is dictated by flight line; we don't have the option of following the standard north-up convention unless the plane was traveling east-west.

Species codes

CODE	COMMON NAME	*SCIENTIFIC NAME*
trees		
ALCR	sitka alder	*Alnus crispa*
ALRU	red alder	*Alnus rubra*
PICO	lodgepole pine	*Pinus contorta*
POTR	black cottonwood	*Populus tricocarpa*
PISI	spruce	*Picea sitchensis*
TSHE	western hemlock	*Tsuga heterophylla*
TSME	mountain hemlock	*Tsuga mertensiana*
shrubs		
MEFE	rusty menziesia	*Menziesia ferruginea*
OPHO	devil's club	*Oplopanax horridum*
RUSP	salmonberry	*Rubus spectabilis*
RUID	raspberry	*Rubus idaeus*
SARA	elderberry	*Sambucus racemosa*
SASI	sitka willow	*Salix sitchensis*
VAAL	alaska blueberry	*V. alaskense*
VAPA	red huckleberry	*V. parvifolium*
VAspp	blueberry spp	*Vaccinium spp*
VAOV	early blueberry	*Vaccinium ovalifolium*
herbs		
ANLU	sea watch	*Angelica lucida*
BORO	ground cone	*Bochnyakia rossica*
CALY	lyngbye sedge	*Carex lyngbyei*
CAPA	marsh marigold	*Caltha palustris*
CIDO	poison hemlock	*Cicuta douglasii*
COPA	hemlock parsley	*Conioselinum pacificum*
COAS	fern-leaved goldthread	*Coptis asplenifolia*
COCA	ground dogwood *present?*	*Cornus canadensis*
ELMO	ryegrass	*Elymus mollis*
HELA	cow parsnip	*Heracleum lanata*
LYAM	skunk cabbage	*Lysichiton americanum*
POAN	silverweed	*Potentilla anserina*
PYAS	pink wintergreen	*Pyrola asarifolia*
RUPE	5-leaved bramble	*Rubus pedatus*
TITR	foamflower	*Tiarella trifoliata*
TAOF	dandelion	*Taraxacum officinale*
mosses		
HYSP	step moss	*Hylocomium splendens*
RHLO	lanky moss	*Rhytidiadelphus loreus*
FIGR		*Fissidens granifrons*
FOAN	common water moss	*Fontinalis antipyretica*
ferns		
ATFE	lady fern	*Athyrium felix-femina*
DREX	shield fern	*Dryopteris expansa*
GYDR	oak fern	*Gymnocarpium dryopteris*
THPH	beech fern	*Thelypteris phegoptera*

Bushwacking difficulty scale

This is something Bob Christensen and I first began using in 2005, our first year of the Ground-truthing Project. I find it to a useful parameter of wildlife habitat, particularly for bigger creatures such as deer and bear who—like us humans—don't necessarily prefer thrashing around in brush tangles. If they do seek out tangles, it's often for their utility as cover from things they like even less.

The scale is a ranking, from d1 to d10, with "d" standing for difficulty: d1 is sidewalk; d10 is suicidal. The ranking ignores factors that vary temporally. A given piece of terrain should have the same rating in summer and winter, rain or shine, leafed-out or leafless, buggy or bugless, and whether the traveller is going uphill or down. It should also be as independent as possible of subjective factors: whether the bushwhacker is feeling grumpy, exhausted, allergic, etc.

d1 is level and mostly brush free. Most trails are d1 or d2. Hikers needn't look at their feet while walking. If you look up at the canopy while walking and trip over a root, you're in d2.

d2 Visually, this habitat is unobstructed. You can see 50 yards in d2 understory. Terrain can be rolling, but uphill portions should not cause strain compared to level hiking.

d3 Many mature second-growth forests, and some fairly closed-canopy old-growth forests with sparse understory are d3 bushwhacking. Bushes are mostly waist hieght or less; it's easy to weave your way without thrashing. Same goes for down logs; you rarely have to climb over or under if you choose a good route.

d4 At this stage, some brush thrashing is unavoidable, and down logs are common enough that minor gymnastics are involved.

d5 By this stage, visibility is restricted by brush. Often, you can't see hiking partners 10 yards away. Log obstructions are common, but you rarely have to go down on hands and knees. With good raingear, you should be able to stay dry all day in d5.

d6 If the day's bushwack averages d6 or d7, it becomes impossible even with the best raingear to keep shirt collar and forearms dry; frequent contorted poses let rain drip inside your hood & up your sleeves—not to mention that by day's end your clothing is saturated with sweat from strenuous exertions. After a day of d6, there are usually at least 3 hemlock needles in your underwear.

d7 Uninitiated hikers begin to grunt and whimper, and to question the leader's sanity. A good portion of travel is on top of slippery or bouncy logs, with little to cling to for support other than thorny devil's club and salmonberry.

d8 You can't travel 100 yards through d8 without bleeding. Sometimes brush is so dense the only way to continue forward momentum is to fall. Much of the time you can't see your feet. D8 usually entails radical terrain as well as blowdown tangle and dense brush. Each step is a logistical consideration. Many recently-thinned 25-to-35- year-old clearcuts are d8.

d9 No rational human would spend more than a few moments in d9. These supremely brushy places are often wonderful songbird and small mammal habitat, but deer-sized critters find easier places to forage. Their only incentive for penetrating d8-d9 is predator avoidance.

d10 I'm alive, therefore I've never been in d10. I may have seen it once or twice, but tried not to think about it. Southeast Alaska actually has little d9 and d10 habitat compared to other ecoregions, such as coastal Mexican thornscrub.

The bushwacking difficulty scale is a good way to evaluate successional trends. Each disturbance sets off its own unique trajectory. For example, after logging of a d5 upland hemlock old-growth stand, years 1-to-25 are typically d7 to d8. With canopy closure and settling of slash at 40 to 50 years, difficulty typically declines to d2-d4. After several centuries, with tree fall and increased canopy gaps, the brush mosaic re-establishes, and average difficulty returns slowly to d5. Note in this example, the higher the difficulty, the better the summer wildlife habitat. In winter, however, the d5 old growth is by far the most valuable habitat for resident birds, mammals and fish.

References

Baicich, P. and C. Harrison. 1997. A guide to the nests, eggs and nestlings of North American birds. Academic Press.

Brodo, I. S, Sharnoff, and S. Sharnoff. 2001. Lichens of North America. Yale University Press.

Carstensen, R. 2007a. Terrestrial ecological systems. Chapter 5,Section 2 in: Schoen, J. and E. Dovichin, eds. ibid. *http://home.gci.net/~tnc/HTML/Resource_synthesis.html*

Carstensen, R. 2007b. Coastal ecological systems. Chapter 5, Section 3 in: Schoen, J. and E. Dovichin, eds. ibid. *http://home.gci.net/~tnc/HTML/Resource_synthesis.html*

Carstensen, R. 2007c. Freshwater ecological systems. Chapter 5, Section 4 in: Schoen, J. and E. Dovichin, eds. ibid. *http://home.gci.net/~tnc/HTML/Resource_synthesis.html*

Carstensen, R, J. Schoen, and D. Albert. 2007. Biogeographic provinces of Southeastern Alaska. Chapter 4 in: Schoen, J. and E. Dovichin, eds. http://home.gci.net/~tnc/HTML/Consv_assessment.html.

Carstensen, R., M. Willson, R. Armstrong. 2003. Habitat use of amphibians in northern Southeast Alaska. Discovery Southeast for Alaska Department of Fish and Game.

Carstensen, R. & K. Hocker. 2005. Repeat photography field journals. Discovery Southeast for USFS/State & Private Forestry. (*Many of these retakes can be viewed on the FS website*: *http://www.fs.fed.us/r10/spf/fhp/repeat_photo_se/index.php*

Carstensen, R. 2010. Coming home: the land of old trees. in. Gulick, A. 2010. Salmon in the trees: Life in Alaska's Tongass rain forest. Braided River.

Connor, C, G Streveler, A Post, D Monteith, & W Howell. 2009. The neoglacial landscape and human history of Glacier Bay National Park & Preserve, southeast Alaska, USA. The Holocene 19, 3.

Cook, J. et al. 2001. A phylogeographic perspective on endemism in the Alexander Archipelago of southeast Alaska. Biological Conservation 97 215-22.

Dauenhauer, N., and R. Dauenhauer, eds. 1987. Haa Shuká; Our ancestors. SeaAlaska Heritage Foundation.

Dauenhauer, N., and R. Dauenhauer, eds. 1994. Haa Kusteeyí, Our culture: Tlingit life stories. SeaAlaska Heritage Foundation.

Deur, D and N. Turner, 2006. Keeping it living: traditions of plant use and cultivation on the Northwest Coast of North America. University of Washington Press.

Edwards, K. 2009. Dictionary of Tlingit. Sealaska Heritage Institute, Juneau, Alaska

Emmons, G. 1991. The Tlingit Indians. Edited with editions by F. de Laguna. U Washington Press.

Goldschmidt and Haas. 1946. Haa Aani. Our Land: Tlingit and Haida land rights and use. U. Washington Press. Revised 1998.

Harrison 1979. A field guide to western birds' nests. Peterson field guide series. Houghton Mifflin Co. Boston

Hope, A and T. Thornton, eds. 2000. Will the time ever come? A Tlingit source book. Alaska Native Knowledge Network. Center for Cross-cultural Studies.

Hope, A et al. 2003. Traditional Tlingit country: Tlingit tribes, clans and clan houses. Map by SeaAlaska Heritage Foundation and other groups.

Karl, S. 2004. Unit descriptions for digital map of southeast Alaska. USGS. 20040524 update

Kruckeberg, A. 2002. Geology and plant life: the effects of landforms and rock types on plants. University of Washington Press, Seattle, WA.

Larsen, C., R. Motyka, J. Freymueller, K. Echelmeyer, E. Ivins. 2005. Rapid viscoelastic uplift in southeast Alaska caused by post-Little Ice Age glacial retreat. Earth and Planetary Science Letters. 237. 548–560.

MacDonald, S. and J. Cook. 2007. Mammals and Amphibians of Southeast Alaska. Special Publication No 8. Museum of Southwestern Biology.

Moser, J. 1899. The salmon and salmon fisheries of Alaska. Bulletin of the U.S. Fish Commission, Washington, 178 p.

Moser, J. 1902. Alaska salmon investigations in 1900 and 1901. Bulletin of the U.S. Fish Commission, Washington Vol. XXI, 398 p.

Nowacki, G. et. al. 2001. Ecological Subsections of Southeast Alaska and neighboring areas of Canada. USDA Forest Service. Technical Publication No. R10-TP-75.

O'Clair, R., R. Armstrong and R. Carstensen. 1997. The nature of Southeast Alaska. Alaska Northwest Books. Seattle WA.

Olson, W. 1993. The Alaska travel journals of Archibald Menzies, 1793-1794. U. Alaska Press, Fairbanks.

Pojar, J. and A. MacKinnon, eds. 1994. Plants of the Pacific northwest coast: Washington, Oregon, British Columbia and Alaska. Lone Pine Publishing, Redmond, WA.

Schoen, J., and E. Dovichin, eds. 2007. A conservation assessment and resource synthesis for the coastal forests and mtns ecoregion in southeastern Alaska and the Tongass National Forest. The Nature Conservancy and Audubon Alaska. *http://home.gci.net/~tnc/*

Schoonmaker, P., B. von Hagen, and E. Wolf, eds. 1997. The Rain forests of home: profile of a North American bioregion. Island Press, Washington D.C.

Swanton, J. 1909. Tlingit Myths and Texts. Bureau of American Ethnology Bulletin 39

Thornton, T. 2012. Haa L'éelk'w Hás Aani Saax'ú. Our grandparents' names on the land. University of Washington Press, Seattle & London.

Turner, N. 1975. Food plants of the British Columbia Indians. British Columbia Provincial Muserm. Handbook 34

US Senate. 1904. Proceedings of the Alaska Boundary Tribunal, Volume 2. 58th Congress, 2nd session. Document 162.

Vancouver, G. 1984. George Vancouver: A voyage of discovery to the North Pacific Ocean and round the world. 1791-1795. W. K. Lamb, ed. London: The Hakluyt Society.

Viereck, L. and E. Little. 1972. Alaska trees and shrubs. USDA Forest Service. Agriculture Handbook. No. 410.

Wright, C. 1906. A reconnaissance of Admiralty Island, Alaska. Bulletin #287, USGS. (*See Spencer above; this is actually 2 publications wrapped into one by USGS, and usually cited under Spencer.*)

Young, S. 1927. Hall Young of Alaska: "the mushing parson:" The autobiography of S. Hall Young. Fleming H. Revell, NY.