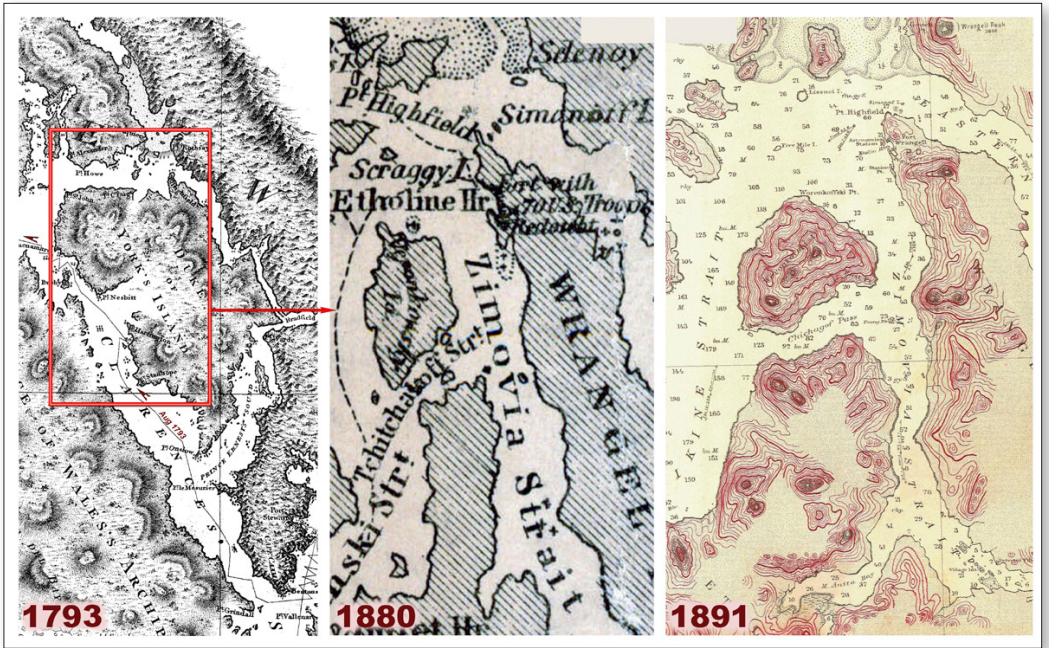
Cartography

Pre-digital dark ages

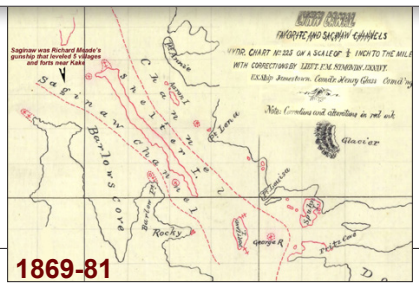
To interpret maps and orthophotos [1] we'll use throughout this course, let's review how they were made. A semester course could be taught, devoted solely to the unpredictable evolution of Lingít Aaní cartography, starting in 1869 with the 3-day masterpiece of Kohklux and his wives who'd never used pencils, sequentially plotting from memory the passes, corridors and summit landmarks of a vast network of Jilk̲áat greasetrails to interior.

Imposed on, and contemporaneous with, this Davidson-commissioned indigenous masterpiece was a tradition of sail-&-steam-ship cartography using scarcely more calibrated techniques. Yes, chart-drafters pinned down their sketchmaps every few days via celestial observation to real lat-longs, but in-between those anchor-points, impressionistic scribblings from the deck, embellished by baroque scalloping from engravers back home, was all the rage. This 4-panel series shows a progression in understanding and communication that didn't really



1 An orthophoto, or orthomosaic, is a nadir (downward-facing) air photo or stitched mosaic that has been georeferenced to serve as a map in programs such as ArcGIS Pro.

1793 "Vancouver" map (actually the work of Joseph Baker), from August passage along labeled track. Today's Wrangell & Woronkofski Islands [1] were lumped as Duke of York's Island. ● **1869-81** Áak'w Aaní blacklines in '69 by Richard Meade, corrected in red by Lt. Symonds on *Jamestown*. These were dressed up by urban engravers into . . ● **1880** . . . beautiful charts, as in detail above. Calligraphic lettering, hachures & faux-shoreline-detail belied



the enormity of speculation. Although a century of exploration—now by steam—had filled in many broad-scale features, cartographic technology had advanced slowly, scarcely differing from Baker's methods. ● **1891** Just one decade saw sudden advances over steamer-deck sketching. It required solid, shore-based triangulation with plane-table and alidade. Surveyors measured vertical angles & bearings to summit points and other prominences. Red contours in this draft were then sketched around those control points..

1 Strangely, no Lingít names were recorded (?), for these or other dominant landscape features such as Zarembo Island, not recognised by earliest euro-invaders as distinct from Tàan, *sea lion* (POW)

Searching online for pics of glass plate cartographic cameras 'in action' I find only shots like these, with sighting devices—alidade, theodolite—on tripod-mounted planetables. Finally, I realized you need a camera to photograph a camera, and who wants to lug **2** of those massive mahogony boxes to a mountain top!

take a quantum leap toward topographic reality until the 1890s. By that time, especially around our explosively growing gold town, surveyors like ironman Canadian William Ogilvie were plotting every hill and valley, bushwacking through fresh, d7 [2] 1883 blowdown with uncollapsable tripods and 5x7-inch glass-plate box cameras.

Much of this was fueled by international escalation toward the US-BC boundary survey. Equipment consisted of 3-inch transit theodolite, tripod, aneroid barometer, sidereal chronometer; field glass, box compass and cartographic camera. An article by Otto Klotz, also Canadian, described the camera, which . . .

> *". . . has no focusing adjustment, as all views taken are distant. The box is rigid, of well seasoned mahogany and brass bound, attaching to a brass foot with levelling screws. The foot fits onto the transit tripod, the latter serving for both instruments [*ie, camera alternating with theodolite as on inset above*]. In middle of each side is fixed a narrow brass comb, photographed on each view for drawing horizon and principal lines on the photograph . . . Each camera*

2 d=difficulty, on scale of 1 to 10, from Carstensen-Christensen bushwack-ranking system.

Fair enough. But NSIDC's "*unknown glacier.*" doesn't even show; it's just off bottom left, albeit in 1750 would've reached out to that farthest, terminal moraine. Recognise the shoreline? And can you place the photopoint, on a mountain unnamed on topo maps but well known to out-the-roaders? On the joint-commission map, next page, what's the number of Ogilvie's Δtriangulation station?

I've rubberstamped-away dozens of these irritating toothy-black margin thingies. Figured they must've been tape, maybe to hold glass plates in place? But Klotz quote explains their real function. Brass combs guided "*horizon & principal line*" drawn back in the office, and in the field, along with bubble levels(?) maybe helped photographers compose their view. Explains, too, why they forfeited a more informative downward oblique and 'wasted' half their image on empty sky. Not a fan of "*white space,*" I've redeemed that waste by captionizing it. **:)**

Klotz (1896): "*Principal [*vertical*] line gives relative azimuth of any point. Horizon line between lateral comb marks determines elevation or depression of any point above or below level of camera.*"

Not sure I did it correctly, but have added principal and horizon red-lines to this example.

has 6 double holders, carrying a dozen 43/4 x 61/2", isochromatic glass plates, generally sufficient for a day's climb." Klotz, (1896) [3]

Klotz further explained office workflow:

*"To each point thus determined [*from cartographic photos*] is written its height above the sea. When a terrene is filled with a sufficient number of established points, contour lines, 250 feet apart, are drawn. This requires skill, for, with photograph in hand, the expert topographer sketches in details not indicated by the plotted points."*

First decades of the 1900s saw expansion of

3 "Canada's Surveyor General, Édouard Deville, believed the camera might overcome obstacles involved in surveying. He combined triangulation with a series of 360° panoramic rings of oblique photos of nearby mountain peaks taken from peaks of known location & elevation. Precise orientation of each photo relative to a survey station was measured with transit or theodolite. Each feature was photographed and triangulated from at least 2 camera angles. Back in the office, surveyors plotted camera stations, orienting photos relative to transit angles, then drew lines from that station to each significant feature in the photo. Intersection from 2 or more camera stations gave the point's position. Canada's first photo-topographic survey was by James McArthur in the Rockies in 1887" McMaster University archives.

Right: Summit triangulations, from NOAA's Historical map&chart collection downloaded when researching adventures of William Ogilvie who took the cartographic images on previous page and below. Unlike the mostly low-elevation red-circled Camera Stations, numbering for loftier ΔTriangulation Stations shifted by the time of this 1895 draft. So, which point was William on when taking the preceding image he labeled 55-O? •

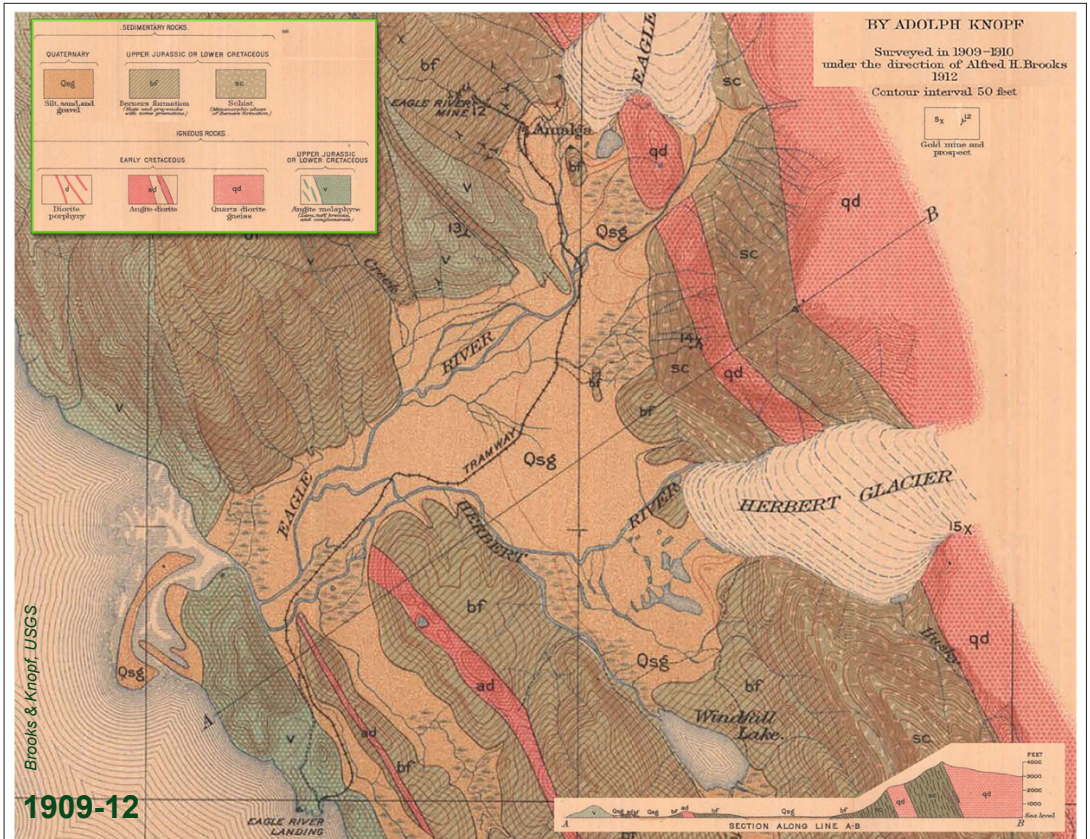
Below: Excerpt from annotated Ogilvie image, north over Norris-Taku to Devil's Paw. Numbered Δpoints became spot elevations for 250-ft contour interpolation. *Hmmm*, I guess in 1895 Canada had not yet succumbed to metrification.

this mountaintop-triangulation method, pioneered by the Canadians under Deville. This Knopf map overlaid that masterful topography. Then, in the late 1920s & 1940s, first airborne surveys followed cartographic advances spurred by each World War. [4]

Above link details the Navy's 1929 and 1948 Southeast Alaskan missions. As a naturalist focused on succession and connections between landform/substrate and the biotic community, I rely on this historical imagery for almost every project and location. In 2011, on receipt of the full, digitized collection of 1948 Southeast aerials, I narrated a 35-minute slideshow, comparing the 30-or-so Southeast communities, in 1948 versus 2005.

Rapid acquisition of thousands of nadir (downward facing) aerials in 1948, and automation of stereoscopy—3D modeling from overlapping images—led ultimately to complete mapping of Lingít Aaní at 1:63,000, (inch-to-the-mile) with 100-foot contours. An example underlies the surficial geology map on next page.

4 There's nothing like a war, or threat thereof, to motivate and fund rapid evolution of new mapping technologies. *Aerospace.org* attributes GPS origins to the US-Russian space race



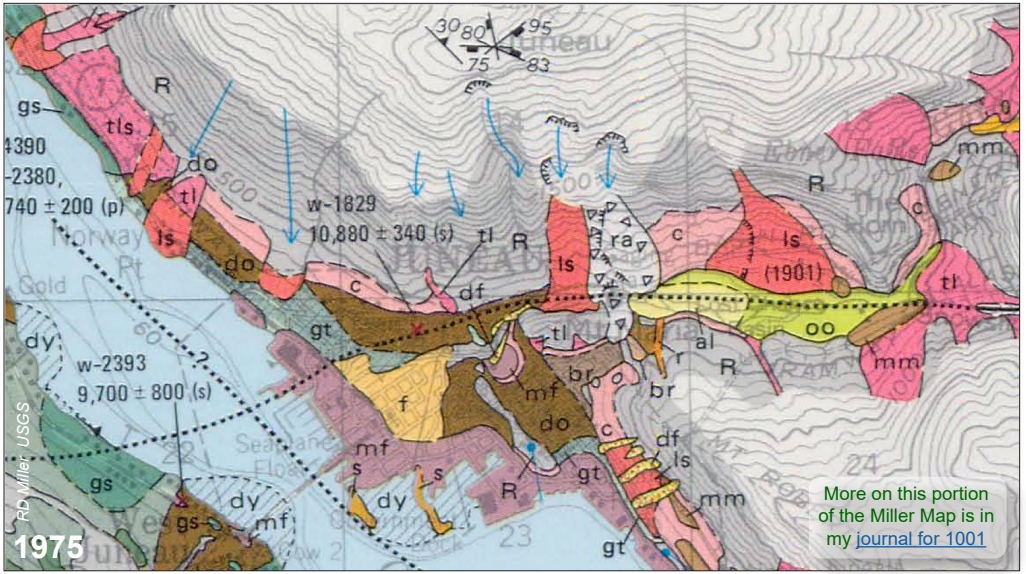
Widely referred to as the Knopf map, geologist Adolph merely draped these geo-colors onto extraordinarily detailed topography (50 ft contours!) from surveyors like Ogilvie, Klotz, Peters & Brooks. Not published until 1912, this map probably reflects glacial positions of about 1910. Although humans (and cameras) were flying over Kitty Hawk by 1903, no pilot or cartographer saw this scene from the air until the Navy's first mission in 1926.

Miller Map

Like Adolph Knopf 65 years earlier, R.D. Miller was a visiting geologist whose mapping overlaid USGS topography, which in our area showed development, ice-positions, etc, dating to 1948 Navy imagery. [5] In the wake of the great 1964 earthquake, Miller, along with colleagues Lemke & Yehle, traveled throughout Lingít Aaní's principle communities, assessing surficial landforms. The Geological Survey clearly needed better predictive ability, should more quakes, landslides or tsunamis occur in these places.

Along with Knopf (1910), Miller (1975) is my most frequently consulted map of Áak'w and T'aakú Aaní. But while I study Knopf for historical insights, nobody to date has done a better job than RD of mapping our surficial geology. His map can seem 'busy' and kaleidoscopic at first. But once accustomed to the symbology, you come to admire his unmatched ability to see the landforms through the trees. Clearly, RD loved his work, giving us a level of detail far exceeding the needs of hazards assessment. His 1972 open-file report is a gold mine of site-specific descriptions.

What fun it'd be to pore over the 2013 LiDAR hillshade with Miller, tweaking the map to reflect features even he couldn't detect half a century ago from careful fieldwork. In a sense, that's what I do for maps like we used in our first-day Avenza tour. In my constantly evolving 'surfgeo' layer, I rarely change Miller's coarse-scale diagnosis, but routinely zoom in to adjust boundaries, between, say, marine sediment and bedrock outcropping, or tracing a thin floodplain RD couldn't plot, even through 1962 stereoimagery, too overhung by conifers.



GIS

Most maps today are made in some form of Geographic Information Systems (GIS). Pioneered by ESRI in the late 1990s, GIS is a hairpullingly counterintuitive (& expensive) graphics program. But it interfaces between maps, imagery, and databases, allowing quantitative analysis of spatial patterns, revolutionizing the way we measure, portray and query landscapes. I use ArcPro every day.

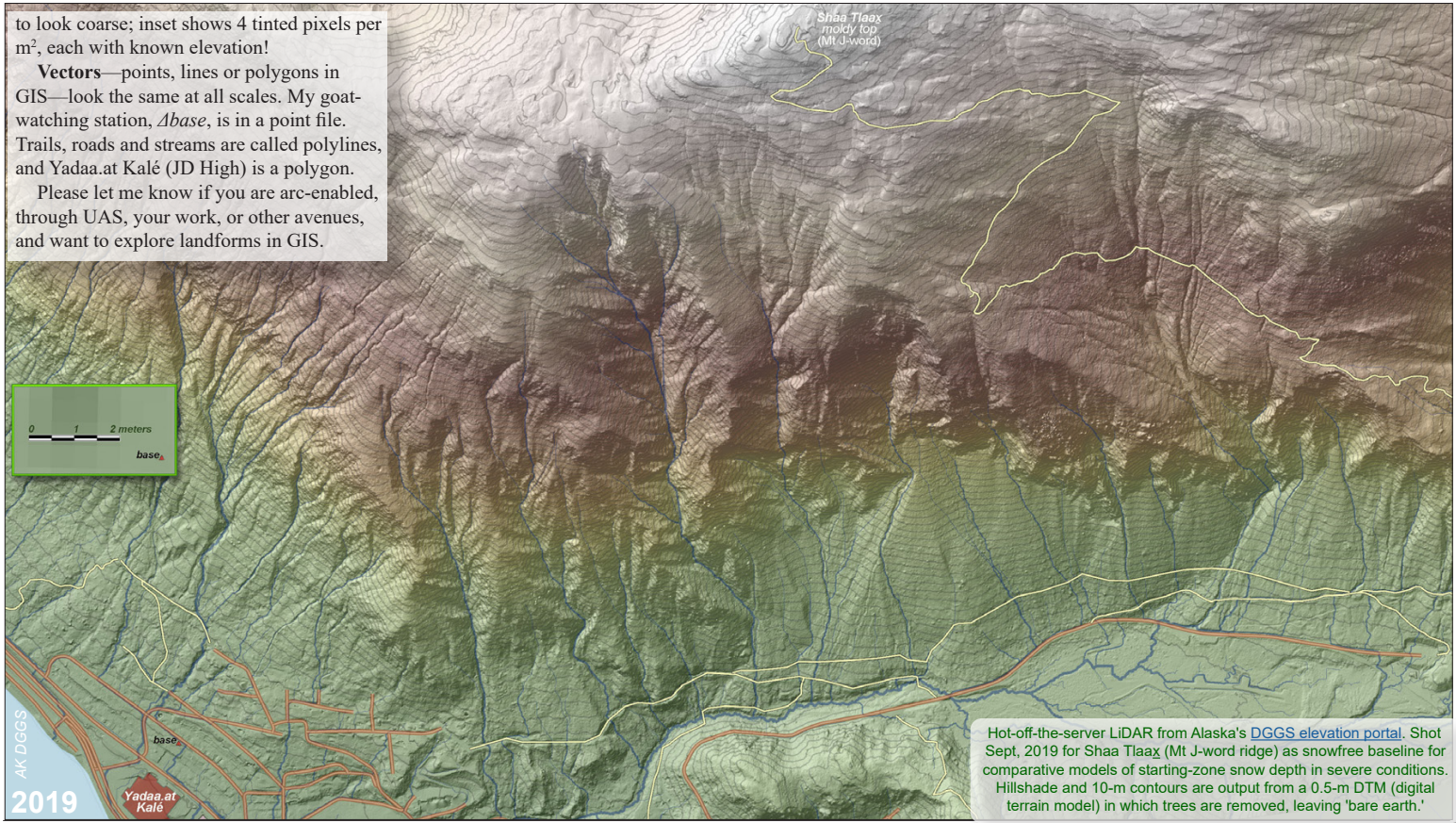
Rasters vs vectors We'll try not to overwhelm you with carto-esoterica, but these terms are important to understanding basic layer types in GIS. A **raster** is an image composed of pixels, such as the map above, or hillshade on next page. Zooming in, it'll eventually begin

5 Lapse of 2 decades between 1948 and Miller's field work in the late 1960s didn't matter much at the scale of his mapping. For example, Egan Drive hadn't yet been constructed, and Áak'w Táak, *inland from little lake* (M-word Valley) was still largely undeveloped. Áak'w Ḵwáan Sit'í, *Auk people's glacier*, was just 160 yards from the site of our future visitor center in 1948, and *still* only 360 yards when construction began in 1962..

to look coarse; inset shows 4 tinted pixels per m^2, each with known elevation!

Vectors—points, lines or polygons in GIS—look the same at all scales. My goat-watching station, *Δbase*, is in a point file. Trails, roads and streams are called polylines, and Yadaa.at Kalé (JD High) is a polygon.

Please let me know if you are arc-enabled, through UAS, your work, or other avenues, and want to explore landforms in GIS.



Hot-off-the-server LiDAR from Alaska's DGGS elevation portal. Shot Sept, 2019 for Shaa Tlaax (Mt J-word ridge) as snowfree baseline for comparative models of starting-zone snow depth in severe conditions. Hillshade and 10-m contours are output from a 0.5-m DTM (digital terrain model) in which trees are removed, leaving 'bare earth.'

LiDAR (& IfSAR)

Until about a decade ago, DEMs, or digital elevation models, were based on the same stereographic terrain modeling from which USGS topographic maps were made. Resolution was typically 30-meter-pixel. This delivered a satisfying hillshade when zoomed out to, say, all of Sayéik, *spirit helper* (Douglas Island). We could make out the suddenly gentler perimeter of raised marine terraces, or scan for U-shaped cirque valleys.

But most of the subtler features we'll be exploring in this class—especially if overgrown by forest or scrub—could only be mapped in the field. To some degree, of course, 'veg' itself is an indicator. For example, a stand of tall spruce enclosed by shorter, gappy, hemlock old growth is often on an alluvial fan or floodplain. But in the dark ages before LiDAR, a map such as Miller's 1975 surficial geology required a *lot* of bushwacking and shovel-time.

In 2013 CBJ commissioned one of the state's first extensive LiDAR missions. [1] It revolutionized the way my friends and I conducted prefield scoping and planning, field navigation, and postfield measurements, analysis and reporting.

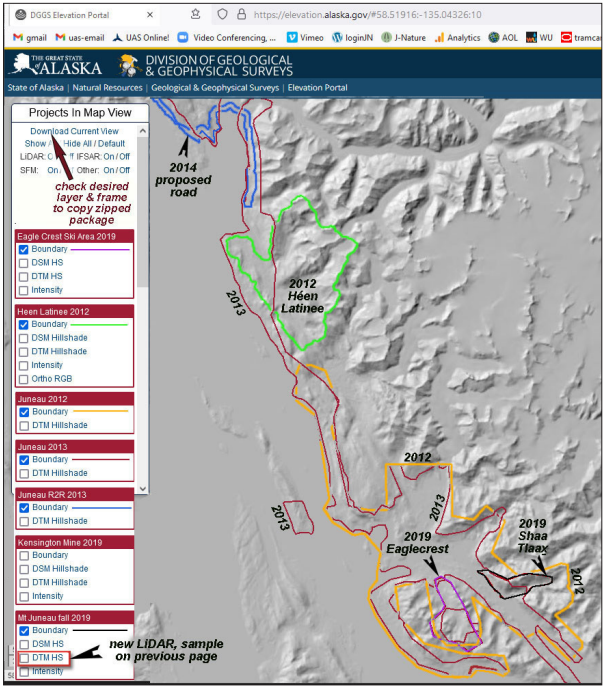
With the advent of LiDAR, cartographers began to label digital elevation models or DEMs as either DSMs or DTMs: [2]

- **Digital Surface Models** (DSMs) give elevation of highest surface including vegetation and buildings.
- **Digital Terrain Models** (DTMs) give elevation of underlying terrain or 'bare earth' with vegetation and human structures removed.

From the LiDAR 'point cloud,' we measure and display vegetation structure, extremely valuable for my work in forestry and habitat mapping. But most of the point cloud's 'high hits'—Maynard Miller's "*green scum*"—need to be stripped away for our current focus on landforms. Maynard would've loved the scum-dissolving DTM!

IfSAR Compared to LiDAR's 1-meter pixel or better resolution, IfSAR is coarse, at 5-m-pixel. Its big advantage is that we have it in one seamless mission for all of Alaska. Obviously, for midscale landforms mapping, it's a big improvement over previous 30m-pixel DEMs.

Although IfSAR purports to deliver either DSM or DTM, most cartographers I know have been underimpressed its supposed terrain model. This technology, unlike LiDAR, can't penetrate canopy to give a believable picture of the ground. I therefore use exclusively DSMs from IfSAR, recognising that it's showing me



Alaska's DGGS site (Division of Geologic & Geophysical Surveys) has evolved into a primary portal for Alaskan raster layers from all sources. I've color-coded just the LiDAR missions for our area.

In *table of contents* bar on left, only mission outlines are checked. Zooming in, and checking, say, the 2019 DTM at bottom, you'll see the hillshade bare earth in all its glory. Nice not only for downloads, but as hillshade viewer for non arc-users

1 LiDAR stands for Light Detection And Ranging. LiDAR aerial surveys use pulsed laser light to measure terrain and vegetation.

Bruce Simonson, now in our class, was CBJ GIS Manager in 2013, overseeing delivery, organization and distribution of this massive dataset. It is largely thanks to his initiative and prescience that we are so deeply immersed in LiDAR today. For JWMP (Juneau Wetland Management Plan) surveys, 2014-15, Koren Bosworth, Cathy Pohl and I were probably the first field team in Southeast to employ LiDAR for daily field navigation, landscape/habitat metrics and summary cartography. My 512-page report includes many examples of this new mapping capability (Carstensen, 2016).

2 At the earlier, coarser, 30-m-pixel scale, nobody expected to distinguish bare ground from veg-surface, so the distinction was unnecessary..

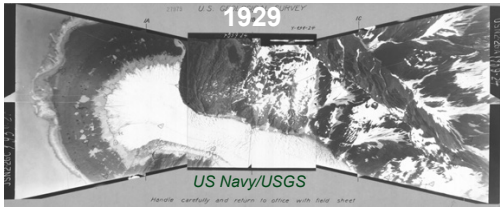
vegetation surface, sometimes more than a hundred feet above actual ground.

Keepers, tossers, new toys

Cathy and I have been around the block a few times in the realms of geologizing, landform-reading, fieldwork, and ways of sharing all this stuff. So we probably have useful perspectives on what to purge and what to hang on to. Let's close out this section on *Cartography* with a few thoughts on best of the old and most promising of the new. I'm mostly just flagging these topics, with links to *JuneauNature*, this document's *Appendices*, and other sources

Northern Lingít Aaní is one of the most exciting places a landform-reader could live. Sure, lots of it's hidden under the green scum, but that's what newfangled LiDAR and lowtech shovels are for. And where else is landform generation so active and ongoing? Who else has receding glaciers, rebounding shorelines, and powerline-toppling slidepaths so close at hand?

Tracking glaciers, isostacy and gravity-burps, professionals from agencies and industries employ new and mostly expensive tools for measuring rates and recurrences. Some of it's even trickled into the public domain. Who could've foreseen, back around Y2K, that I could sit at my desk and measure any tree on the hillside above me to the nearest foot, by dragging a spiffy ruler-tool through the point cloud. That's what I meant, back at the start of this *Cartography* retrospective, by its evolution being "*unpredictable*." Advent of LiDAR—maybe not superman's x-ray vision but getting there—feeds optimism that all barriers (even climate change? ***:)*** will eventually fall before the march of human ingenuity.



But try as I might, nothing in my clouded crystal ball suggests there's a time-machine in there.

So, let's assume our future is a black box, and that only rearview experience holds any clue to what lies ahead. [3] What tools at our private-sector disposal best illuminate the past, enabling measurement and prediction? One has been around since about 1839. It's called the photograph.

Historical imagery/Repeat photography I first became aware that not everyone shared my reverence for ancient photos in the late 1980s, when trying to relocate moldy, 'butterfly-bandage' paste-ups from the 1929 Navy mission. A USFS senior staffer told me he'd rescued them from the dumpster, where a new hire had deposited them, wondering no doubt why someone hadn't done that decades prior, on receipt of the more up-to-date 1948s.

I am generally well disposed toward purging. But old maps and photos ***do not qualify!*** They anchor the art and science of repeat photography, which I practised intensively in 2004-05 with Kathy Hocker. On the presentation end, these make wonderful long-dissolves in a slideshow. For user-engagement, I'm currently fondest of '*pageflippers*,' which are scattered through this document.

Stereo Pairing images for 3-dimensional viewing dates back almost to the beginnings of photography. Used to be, every forester and geologist was trained in 3D landscape interpretation. With advent of GIS, that perspective was backseated. We (RC&CC) do not concur that stereo is a 'tosser.' We'll have a viewing session at some point, so you can judge for yourself. And I'm happy to help any of you learn to make your own.

I've tried to migrate digital stereo to tablet and phone. Stereopairs for many of our field destinations will be grouped in *Appendix 3*.

Drones Up there with LiDAR in the '*who could've guessed*' category is our ability to launch featherweight cameras 399 feet into the sky (not more, says FAA). For me, definitely coolest new toy of the decade. Make that toys plural, cause they crash. I'm on my third since 2014.

For reading the mostly-forested landscapes of Lingít Aaní, greatest potential of drones is still unrealized. Yes, we already make inspirational raven's-eye movies. And for raw terrain—wave-washed beach, alpine fellfield, first 20 years of postglacial succession—even the hobbyist droneflier can make a high-res SFM (structure from motion) terrain model. These are generated from the same stereoscopic parallax that gave us topo contours in the

3 I recognize that writing about time, fore-&-aft, is stylistically fraught terrain. Talking about it (*sans* editor or bleeper) is even riskier. Two years ago, at the beginning of COVID, I started a list of ***most-irritating & overworked words and expressions***. It was precipitated by listening helplessly to KTOO, while dear friends and neighbors earnestly contaminated the English language with buzzwords and largely-unconscious dogwhistles. The phrase that pushed me over the edge was "***going forward***."

So help me, if I hear one more politician or business leader or radio interviewer "***unpack this narrative going forward***," I may have to ***reach out and pivot their modality.*** Just sayin . . .

Mission had 9 flight lines, predicted 4.5 minutes. Took much longer but still finished with 60% battery.

1940s. Only now, every ground point is seen from >12 positions, and pixels in this Seawalk example are about 1cm^2, delivering 10,000 times more information than the City's outstanding 1-m-pixel LiDAR model.

Obviously, for small aerial projects, drones are cheaper and safer than planes. But SFM models can't reach bare ground through coniferous canopy. The real breakthrough awaits affordable, ultralight LiDAR sensors, and user-friendly post-processing cloud-apps. That'll resemble the 1900 debut of Kodak's *Brownie*, a box roll-film camera that suddenly emancipated photography from portrait studios and the purview of mountaineer-geometricians. Suddenly any student or naturalist will be making drone-based 3D models of last-hit boulderpatch runouts under 3-layer canopies, or mapping gravel size through heavy herbaceous meadow, or (groan), orbiting their heads for hair-off, rotateable selfies.

artifacts from water refraction and movement

Background: AOL, 201906

Translucent hillshade over coded DEM, with 2-ft contours from same. Stats on delivery page:

Process Full 3D Yes
Collected Sept. 5, 2020, 7:56 a.m.
Images Uploaded 78
Input GP 0.936000
Output Size 12711x11395
Resolution 0.68"/pixel
Average AGL Alt 127.99 ft
Area 5.25 acres
Elevation Range -11.3 to 41.0 ft
Georeferenced with EXIF tags Yes

2019

2020

N

0 100 200 feet

contours 2 feet from SFM DEM

seawalk20200905-COLOR.jpg

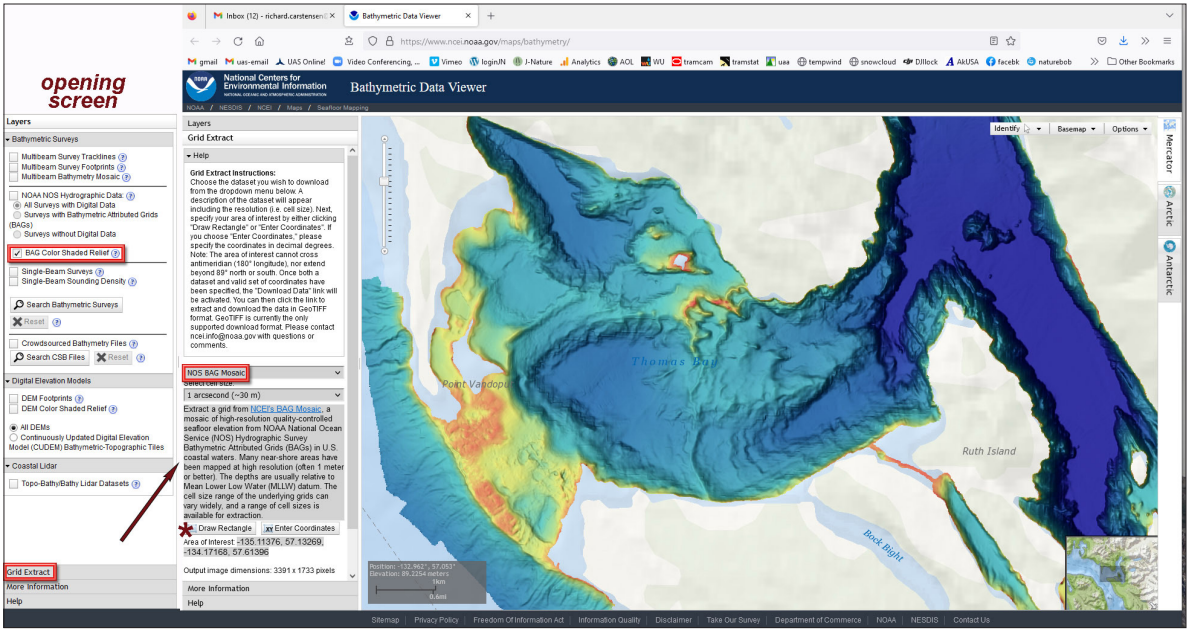
USGS, GeoEye, Microsoft

Bathymetry

Until diving into this course on *Reading the landscape*, I'd made only cursory use of bathymetric rasters in GIS. But preparing for the cruise to S'awdáan, *dungie town* (Holkham Bay), I noticed fascinating submarine features presumably dating back to Younger Dryas times. They're only faintly recognizable on the 40-meter DEM that until recently was our best available seafloor raster.

For ArcMap users, (I'm using pro) add the layer from *Living Atlas* called *World_Ocean_Base*. (WOB) While much of Lingít Aaní is still pretty coarsely mapped, in a few places like S'awdáan, the variable-scale WOB pulls in much higher res DEMs for areas with BAG-surveys (Bathymetric Attributed Grids)

During our Chilkat tour, Bruce Simonson did some digital bottom-trolling and discovered the source of these BAG hotspots. In this example from Taalḵú, (Thomas Bay), the DEM is way higher res than WOB. BAGs can be individually downloaded from NOAA's Bathymetric Data Viewer. Zoom in to your area of interest, then follow these steps, as shown on my screengrab:



- On opening TOC, uncheck everything but *BAG color-shaded-relief*
- click *Grid Extract* on bottom
- When new TOC opens, pulldown NOS BAG mosaic and default scale
- Check *Draw Rectangle* and drag over desired area with your mouse.

The download screen will send a raster .tiff to your specified destination.

My current interest in BAG detail is sorting out ancient from recent terminal and recessional moraines, and understanding why they seem to be shaped so differently than moraines who form on land.

Taalḵú, *widemouth basket* (Thomas Bay) on NOAA's Bathymetric Data Viewer. Default color spectrum makes depth easy to recognise, and hillshade elucidates topographic subtleties invisible on simple sounding-charts, such as **'plough-furrows' and frontal 'kick-ups.'** I've selected this example to show that similar features at S'awdáan, *dungie town* (Holkham Bay) are not unique to that glaciated inlet. More frontal kickups in *Geology>marine landforms*, & 2023 Summary thoughts

Journaling

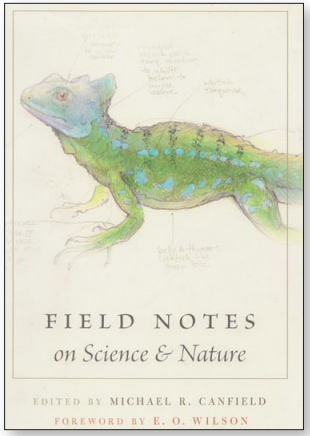
"This much is clear from this poll: in general, lab scientists working in biochemistry, cell, and molecular biology tend to keep much better notebooks documenting their science than field biologists working in the areas of ecology, behavior, and conservation biology."
Erick Greene, Chapter 12 in *Field notes on science & nature* (2011)

Old school

A strong contender for my all-time favorite book is *Field notes on science & nature* (2011). Of its 14 authors, none could be called luddites, yet nearly all remained staunch advocates of pencil and paper.[1]

Granted, that book is already (in 2022) more than a decade old. Its senior author, E.O. Wilson, has passed. Every year we move farther from pencils and physically archived journals. If *Field notes* were written today, there'd be more chapters about start-to-finish digital journaling, and fewer advisors nostalgic about HB2 pencils or (can you believe it?!) print-in-the-field polaroid cameras.

But whether high-or-low tech, few would disagree that journals are enormously valuable. Done well, they're "*letters to the future*"—title of another chapter in *Field notes*. Declines in journaling have more to do with perceived efficiencies ("*who has time?*"), and, to some degree, a shift in opinions about hard-science vs soft-arts. [2]



The tech-enhanced observer

My mentor in most aspects of digital and cartographic technology—Bob Christensen—is almost young enough to be my son. This relationship is probably not as 'flipped' as it seems. Indeed, in the world of cellphones, apps, online communications, etc, Cathy and I will surely learn more from you, our "students," than we might hope to teach. As a devotee of the long-view, this is part of the appeal for me of my forté, natural history. There are teenaged concert pianists, and 20-something Silicon Valley CEOs, but there's probably no master naturalist under 40. [3]

So, it must follow that tech-enhanced observation is a collaboration, of elders most experienced at seeing forests (or in this case rocks?) through trees, with youngsters most proficient and creative in design of new perceptual and disseminational tools. I hope this class embodies the best of that two-way instruction.

I try to periodically document and update my entire ground-truthing protocol, from prep to field to summary. Such updates typically follow get-togethers with Bob Christensen, who's always several jumps ahead of me, technologically, and recommends app or device replacements. That unfortunately hasn't happened since (wow) . . . 2012.

So I have a call in to Baikarkabob, who is possibly the most remote-living and hard-to-reach techno-meister on the planet. If he gets back to me, I'll have some more timely advice to pass along. Otherwise, please note that the following tips&tricks are about 10 years out-of-date. (PS: no word from The Master ***:)***

20220919: Just back from the amazing trip to Jilḵáat/Jilḵoot Aani. Now that we've traveled together, hopefully you're starting to consider the digital portion of your journaling workflow. On Saturday evening in the heliski lodge I projected the day's drone movies, and some examples of named-panostitched-&-numbered still photos from the trip-to-date. Often, in the heat of multiday field trips, that—and a few scribbled notes—are all I can finish before sleep overcomes.

But these are just the first steps. Before pdf-ing the daily journal out of Indesign, here are the steps, roughly in order. Again, I'm not recommending this as a hard&fast journaling

1 The sole dissenter, Piotr Naskrecki, titled his chapter *Note-taking for pencilophobes*, concluding: "*There is no denying it, the era of paper is fading fast, and I can easily imagine a time when students will be perplexed by the strange, primitive instrument known as the pencil. As far as I am concerned, this time cannot come soon enough."*

2 Greene's students are initially "*chilly*" toward his journaling requirement: *"I am interested in science, not creative writing." "This is so lame—I already did my 'expressive arts' requirement." "Do you want us to meditate and write about that too?"* Fortunately, these skeptics almost universally "*thaw*" as they discover how illuminating and focusing the practise can be. Your "journal" may look nothing like any of the examples in *Field notes* (2011) or my geeky (and hugely labor intensive) documentation. The point is—are you okay with learning and research as an *in-one-ear-out-the-other* process? Because no matter how good your memory, it **really will** evaporate. If you find that unacceptable, start thinking about what journaling—in whatever form—could look like for you.

3 Not that I mind being upstaged by a teenager. It's reassuring, actually, for those of us old-timers concerned about how things will play out in the coming century.

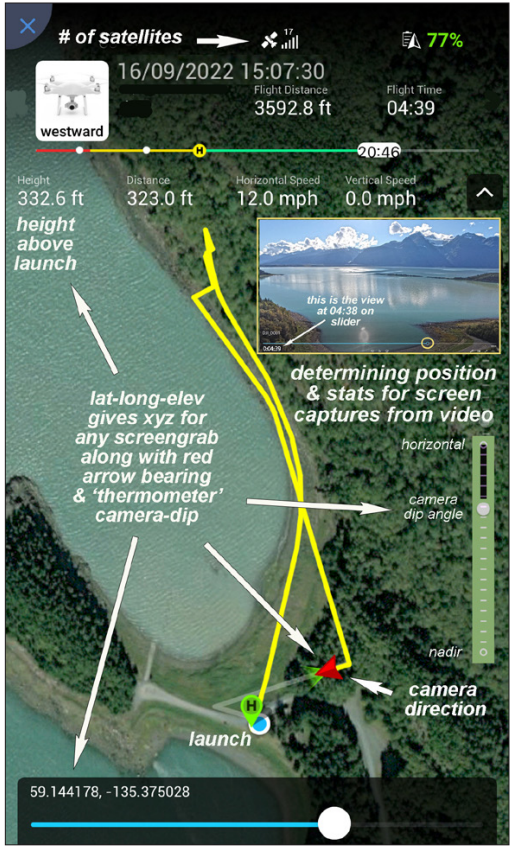
recipe, but merely an example from which you can pick and choose: [4]

- **downloads** to laptop from field devices: .jpgs, mp4s from telecam, iphone, drone (also 4k mp4s), badelf, (for me, Avenza only if not bad-elfing)
- **convert** .gpx tracks to Arc shapefile. Drop it into the *.aprx* Arc project—in this case my my master-file for the *GCW Atlas* (greater chilkat watershed). Nice to do this first because, even before the photos get linked, many steps down, having a track on hillshade or orthoimagery may help in giving meaningful names to photos. On our weekend Chilkat jaunt, I didn't have the bandwidth to even *open* Arcmap, so deferred this until post-trip.
- **drone-vid** The 4K video [5] gets processed into multiple products: **1)** best clips assembled into annotated and/or voice narrated movies **2)** screengrabs exported with prefix # adjacent to any ground-pics **3)** Microsoft ICE stitches from nadir-pass, slow pan or sideways crab **4)** stereopairs from nadir or crabbing flight, generally with screengrabs just a few seconds apart.
- **process & name ground-pics** Load phone & telephoto camera .jpgs to one folder & sort chronologically. [6] Cull duds, adjust color, brightness, shadows etc, especially for pics in suboptimal light (backlit, dim, etc). If you took overlapping photos for panoramas, stitch em now. [7] (I took 280 jpgs on day-3. after culls and stitching, compressed to 'only' 93 keepers *:)*

Give each photo a meaningful name—especially when you may have to defer journaling for days, or when you take a ton of em.

After culling duds, processing photos, renumber, to keep them in chronological order—especially helpful if

Above: Devices used on the 20220916-18 Chilkat trip. Not shown cause I didn't digiscope: Kowa 88mm 60x spotscope. Some took goat pics through this with cellphones. ***PS 202409****: For a check on tech-replacement rates, I have a new phone and new drone but still use the Nikon and Bad Elf* • **Right**: Cloudbased day-1 flightlog over Tléikw Xágu, *berry sand beach* (Lehunua Island). Screengrab inset was taken at 4:39 on the slider. Dragging this flightlog slider to that position gives exact 'xyz' position of the drone. (lat longs on bottom, and height of 333 feet in upper left.)



4 Unless this is the only course you're taking, you simply won't have time to invest as heavily in journaling as I do.

5 I almost never pause to shoot stills because screengrabs from 4K video, running launch-to-retrieval, look just as good. Not true for newer, high-end consumer drones that take very high-res stills.

6 Phones (& gps track) will always have the correct time, but most cameras won't, and should be periodically adjusted to match your phone-time. That way, mixed-batch jpgs from 2 or more cameras will sort properly.

7 Cellphones have simplified panorama-taking with the sideways-sweeping method. But I still take a lot of overlapping panos with my Nikon ultrazoom. I call them 'midzoom' panos. You can 'step them up' along a mountain skyline, but of course it creates a jagged mosaic. Example from our 8-mile stop is on next page.

combining pics from several cameras.

- **'anchor' your pics spatially** There are several ways to mark photopoints. We've been using Avenza so far. Of course all cellphones these days collect lat-long for each shot from their internal GPS, as long as you've enabled location services. So you can map your photopoints whether or not you're collecting an Avenza track. [8]

For maybe 8 years I've been using a tiny bluetooth aviator's GPS called Bad Elf gps pro+ to record high-resolution tracks. It's early as good under canopy as ridiculously overpriced Trimbles, & dispenses with laborious postprocessing. Not all cameras have internal gps, and if they do, lat-longs won't be as accurate as Bad Elf.

Once the day's photos have been suitably enhanced, named and organized, it's time to tie them to this detailed track. I'm still using Robogeo for this, but that's a 'ghost app,' no longer serviced. Baidarkabob tells me he's switched to Adobe Lightroom for this, and I'll probably migrate eventually. Here's a how-to that looks useful. If you have access to Adobe Suite (and Arc stuff, below) through UAS, I recommend diving into these programs. Maybe you'll lose access on matriculation, but odds are you'll regain it, moving into careers with agencies or—as in my case—nonprofits.

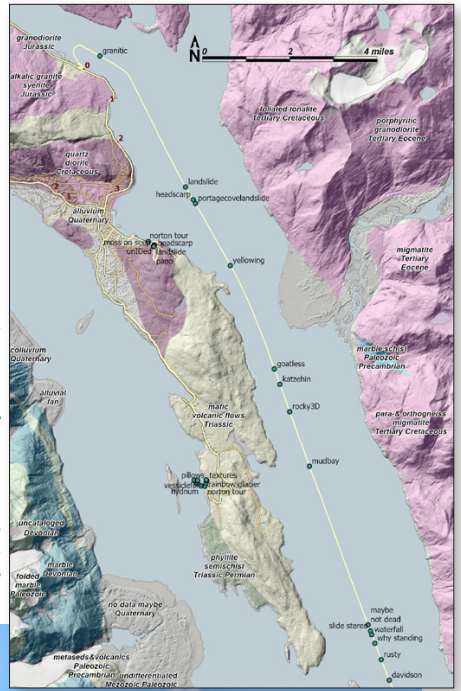
Bad Elf and Garmin gpx tracks are usually exported as .gpx files, through cable or email. For me that requires translating to shapefile for use in ESRI's ArcGIS Pro. Lots of ways to do that.

- **export a route&pics map** Now we're getting into rather expensive and tech-heavy solutions. Map on right is an export from my *chilkat.aprx* project, with badelf track, hi-res named photopoints, and geo-units.
- **sweeping it together with Indesign** I rarely use Word because it sucks at page layout. And being a visually oriented human, I demand lots of integration between graphics, captions and text.

8 Nothing wrong with using your camera's software to map photopoints, especially if there's just a few. In my work & play, I like to be able to 'backtrack' my entire walk with a gps track. Avenza's just one handy way to integrate that track with photopoints to 'tell a story.'

Route&pics map for our arrival on *MV ~~LeConte~~* at Wooshkakanté, *quarreling rocks* (Lutak terminal)

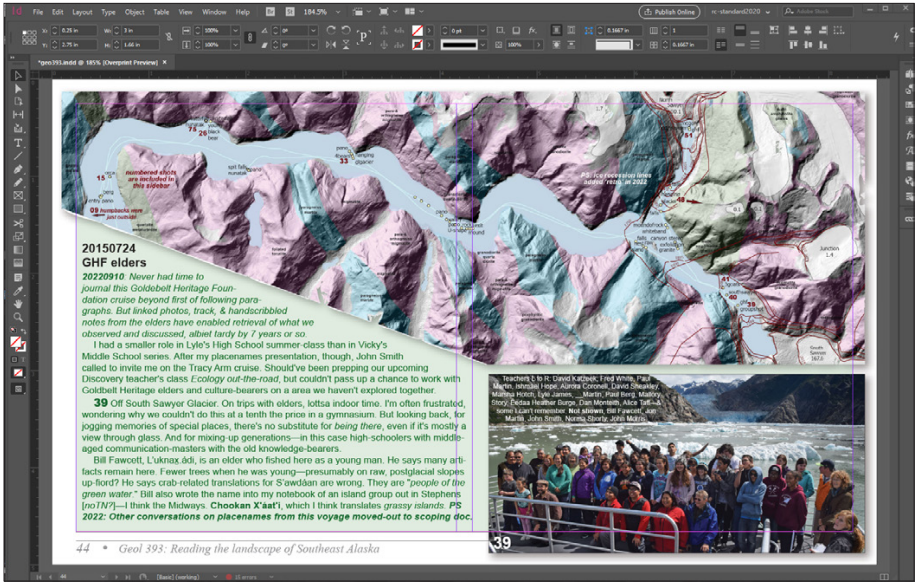
BTW, are you okay with commemorating a racist every time you reference our beloved ferry? Joseph L-word found *"Reconstruction intolerable. He referred to 'a carpet-bag governor, scalawag officials, and a negro legislature controlled by rascals' and stated that the 'sudden enfranchisement of the negro without qualification was the greatest political crime ever perpetrated by any people.' "*



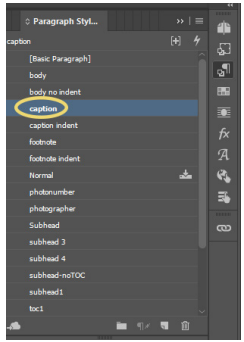
Top of stitch was correspondingly 'stepped' but I just cloned-in sky-blue to even it out.

2022

From our penultimate stop at 8.3 mile. 'Steps' across the bottom of this ~10-shot mosaic result from following the skyline with my Nikon P1000, set to mid-zoom range—impolite to chop the heads off sacred mountains—sometimes handheld but usually panning from tripod. At 86MB, this composite is high enough resolution to pick up mountain goats, 5 miles away across the river.



Left: sample Indesign page, from my last visit to Sít'ja.eeti aaní, *handiwork of the glacier.* (Tracy Arm). Such excerpts and 'spin-off' addenda are carried into this *Geol393* scoping-&-journal as sidebars, segregated from regular text in green boxes, in this case running for 4 pages. They're further distinguished from regular text by use of caption font. • **Right**: Green 7pt Arial is my caption font. Layout professionals recommend you choose a strongly differing font from your text (*body*, and *body-no-indent* here). I use not only a *sans-serif* to set apart from the text *serif*, but also a different color. Since most of my pictures—as a treehugging naturalist greenie—have lots of green in them, I use this green to further meld photos with the written word . . .



Imagine trying to lay out the above journal page in *Word*—you'd soon be screaming at your computer, which is a waste of time since computers can't hear. (hmmm, actually i guess they can, but let's not think about that . . .)

• **share it!** My article called *Field journaling as Raven goes global* concludes with thoughts about sharing experiences in nature, now that we don't sit round the fire much with our sister-&-fellow gatherer-hunter-fishers. My old handwritten journals were ok for personal use but inconvenient to pass along to friends or colleagues.

For me, today, Indesign-to-PDF-to-website-upload (or simple email attachment for more directed communications) is a satisfying solution. I'll bet many of you can find more efficient and creative alternatives.

Cathy and I hope you will think about this, during and after our time together. Find a process that's so fun and rewarding that it *beckons,* not intrudes. Build and protect a legacy, for landscape-trackers still unborn.

***PS, post-course note to students**: I was thoroughly impressed by the technical mastery and content of your last-day presentations—and wish we could have had more interactions around that aspect of geologizing-documenting-communicating.*

I've also been humbled by how much you're juggling, with multiclass, nonstop schedules. That doesn't leave time for much of the journaling work-flow outlined here. But I hope, at some less-accelerated time in your lives, you'll come back to these ideas and practises. We'd love to hear more from you about the evolution of journaling in your work and play.

***PPS, 2024**: Reviewing this 2 years later with intent to final upload to JuneauNature (yeah! sorry folks, kinda tardy, eh?), I realize that—partly in the interests of UAS privacy policies—I've said very little about **who the students actually were**. You'd think from the above sign-off of sorts that they were all young. While most enrolled UAS students in our course were environmental science majors, we were also 'audited' by some grey-haired friends, astute observers all: Dick Farnell, Bruce Simonson, Pat Harris, Sue Baxter, Dave Sturdevant, Brien Daugherty, and Laura Stats.*

This mix of old and young was one of Geo-393's most memorable features. During the class, most questions and discussion were from the oldsters—who Cathy called The Classics. We worried a bit about that at first. Were our enrolled students intimidated by the seniors' much deeper experience?

But we gradually realized they weren't shy; this was just a particularly quiet (and hard-working) bunch of Env Sci majors. Their homework contributions were impressive, their final presentations delightful, and all clearly thrived on the Landforms class. From day-one I don't think we had a single drop out.