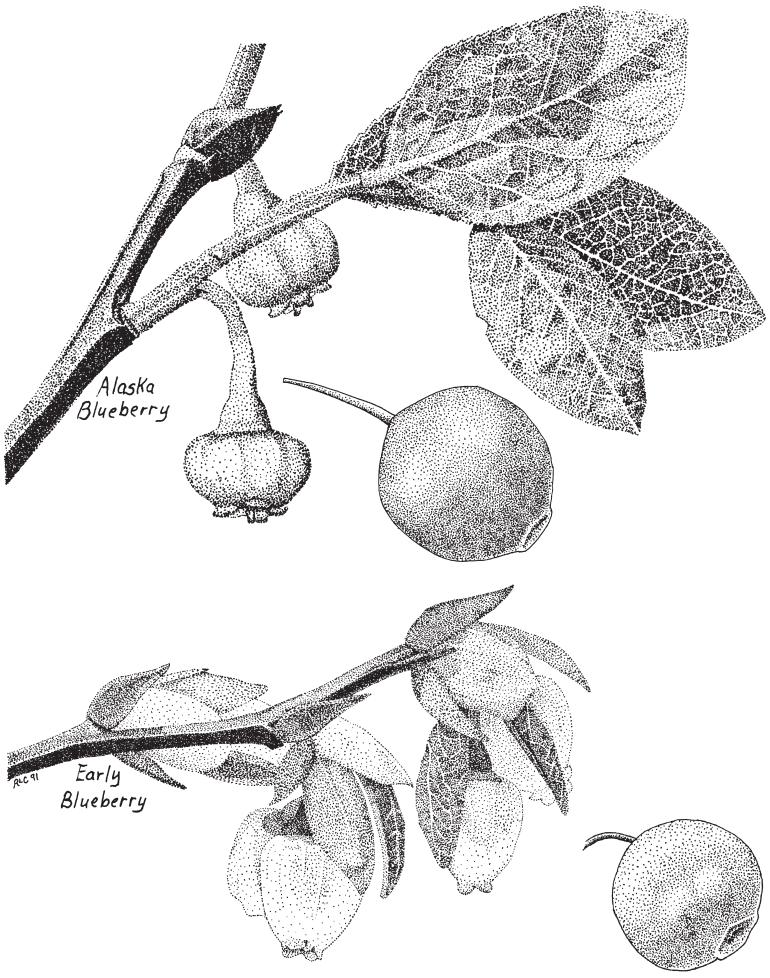
A NATURALIST'S LOOK AT SOUTHEAST ALASKA



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CARSTENSEN ILLUSTRATIONS

DISCOVERY FOUNDATION 1993*

** subsequently re-named Discovery Southeast*

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Postscript, 2012: Almost 2 decades have passed since Greg Streveler and I assembled this synopsis as a handout for teacher workshops in northern and central Southeast Alaska. While much has since been learned about Tongass natural history, *some* works are timeless. One such is the way "Strev"—my friend and mentor in matters ecological—whipped out this 16-page ode to the Archipelago.

In 1992 and 93, Greg and I hit the road in the puke-green 1969 Ford camper we called the *Naturemobile*, delivering teacher workshops to Haines, Hoonah, Angoon, Sitka and Petersburg. It was just after *The Nature of Southeast Alaska* came out, a book I'd written with Rita O'Clair and Bob Armstrong.

Nice job, Greg acknowledged. But a little weak in geology, glacial history, island biogeography, and marine ecology. Let's fill in some of those neglected disciplines, in a handout to field-worthy educators of the rebounding North Pacific.

Making handouts with Strev is like holding palettes for Picasso. Then a journeyman naturalist, what I mostly contributed was cut-&-paste craftmanship and a drawing or two. Reviewing Greg's prescient terrane-poem from a 20-year vantage, it's pretty obvious I need to resurrect this booklet.

The occasion for re-delivery was a gift from Michael Blackwell, who told me to radically enhance the Discovery Southeast website, and send him the bill. Those welcome marching orders directed me to the roots of our organization, when we were still called *Discovery Foundation*. What is most *foundational* to our mission—the connection of people to this rainy land?

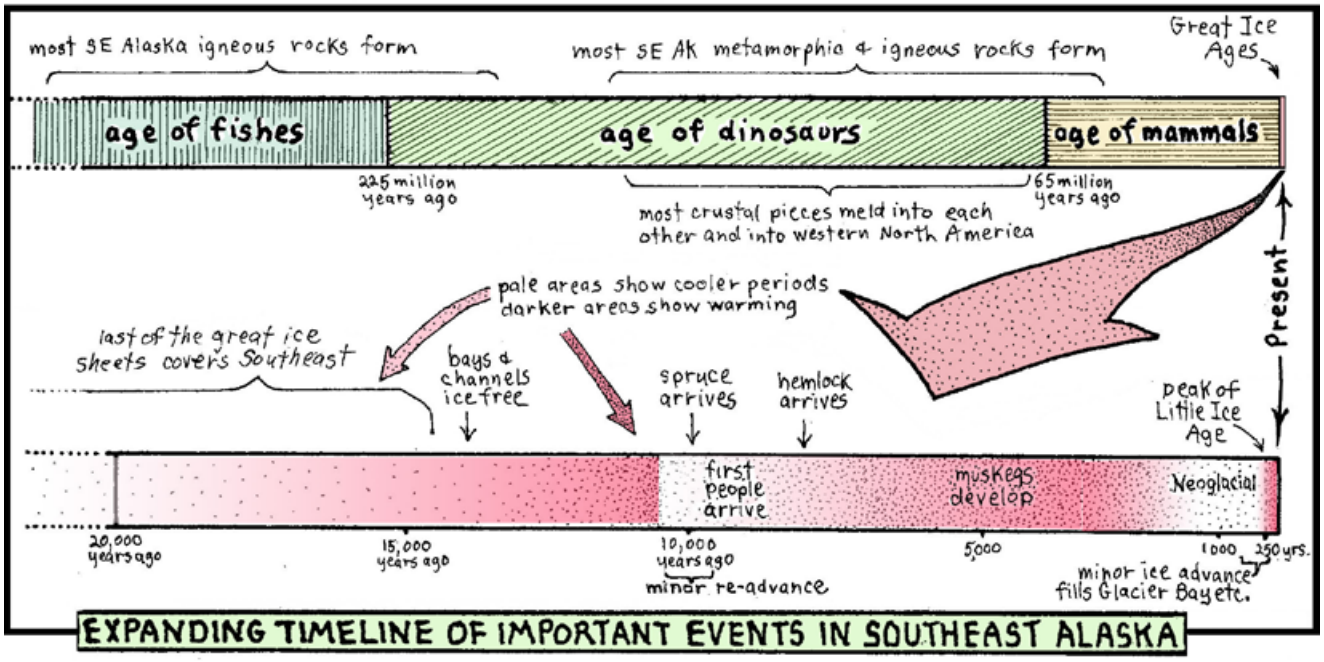
Maybe this naturalist's *look*. Four eyes: one rocky, fishy, spruce-enfolded shatter zone. One collaborative tribute to icemelt re-establishment. Richard Carstensen

Front cover: Comparison of our shrub-sized blueberries (*Vaccinium alaskaense* & *ovalifolium*)
Back cover: Alpine azalea, arctic willow and reindeer lichen colonize crack in exposed alpine outcrop.

Introduction

Westward of the Canadian Coast Range, the margin of North America stoops abruptly to interfinger with the Pacific in a maze of fjords, valleys, beaches, straits and islands, creating a landscape where no point of land or sea is more than 30 miles from a shore.

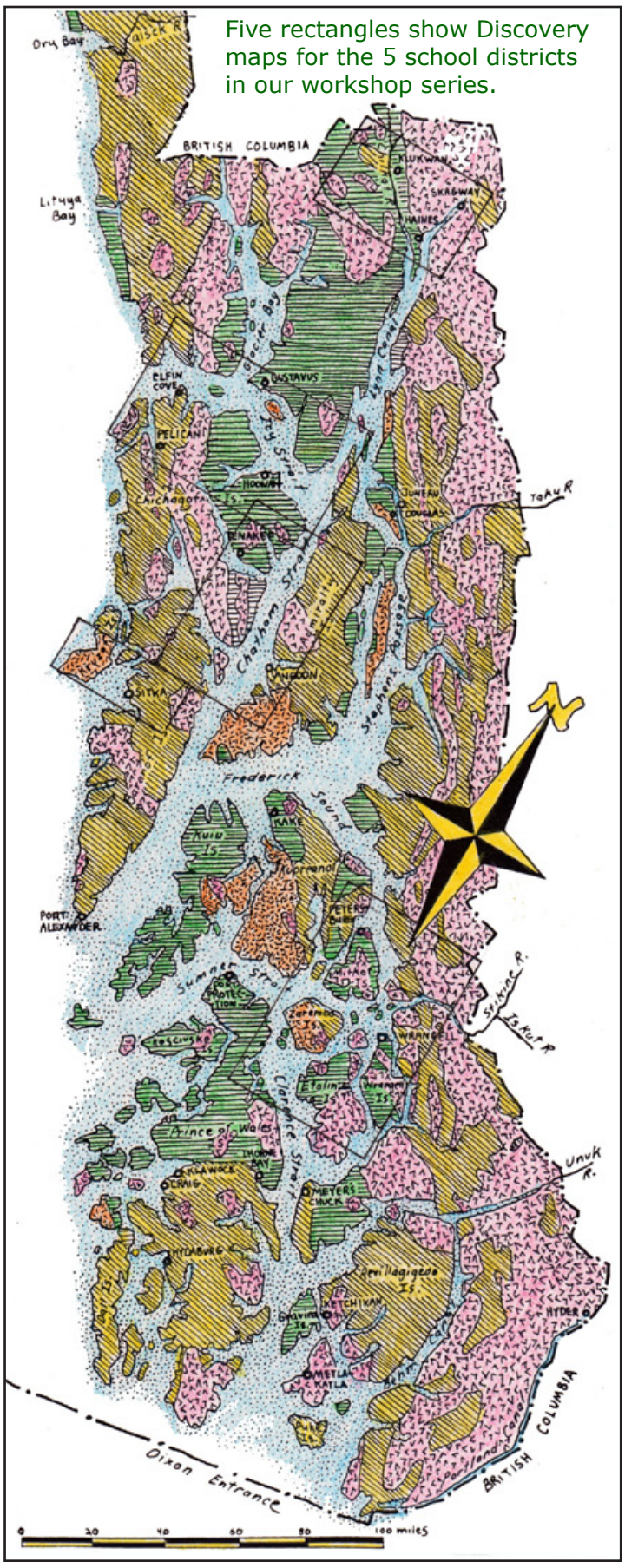
It's an austere place of big tides, strong currents, fall gales and frequent earthquakes, a landscape of great peaks and profound deeps, of somber blues, greens and grays occasionally relieved by pastels of grassy meadows or sunset skies. Yet there's verdance born of moisture, moderate temperature, nutrient abundance, profusion of life. The world's greatest temperate rain forest cloaks the land. Salmon abound in streams. Seas teem with halibut, crab, seal, diving birds. All presided over by large predators: orcas, brown bears, bald eagles, and wolves.



Geology

Southeast Alaska's extreme topography witnesses immense energies deriving from a position astride the active suture between the North American and Pacific crustal plates. Since the Age of Dinosaurs, North America has been plowing obliquely into the Pacific plate at several centimeters per year. Generally this plate has dived under North America. But occasional bits—island arcs, pieces of sea floor, fragments of continental margin—are scraped off and smeared along the leading edge. These scrapings accumulated in a NW-SE pattern reflecting shatter zones created as rocks accretted.

Frequent earthquakes suggest plate motions continue to this day. All the while, rocks are compressed. Some are forced upward to form mountain chains. Others are buckled



IGNEOUS
(once molten)

formed at depth
granite, diorite, gabbro, etc.

formed near surface
basalt, rhyolite, etc.

METAMORPHIC
(strongly altered by heat and pressure)

schist, gneiss, marble, hornfels, etc.

SEDIMENTARY
(less altered)

limestone, shale, sandstone, etc.

downward and melted. Molten rock then moves volcanically through the shatter zone, cooling and welding one of the world's most complex geological jigsaw puzzles.

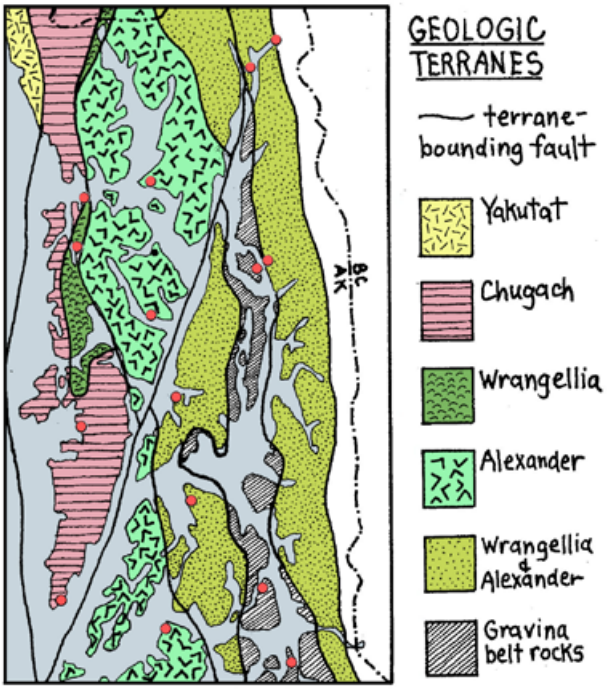
Highlands formed by this process intercept predominantly onshore flow of Pacific air, wringing moisture as rain and snow. For several million years snows accumulated in uplands as glacial ice, repeatedly invading lowlands as climate periodically cooled.

During the height of the most recent of these Great Ice Ages about 20,000 years ago, an ice sheet covered all of Southeast except the highest peaks and certain headlands. Then one could have walked from present Sitka to Cape Cod, never leaving ice. Life was excluded. Aspect was reminiscent of modern-day Greenland or Antarctica.

Post ice-age history

By 13,000 years ago, retreating ice bared a landscape of rounded hills and deep, U-shaped valleys or fjords, presided over by precipitous peaks,

From Brew (1988). Terranes are wandering crustal fragments, each with its own geologic history.

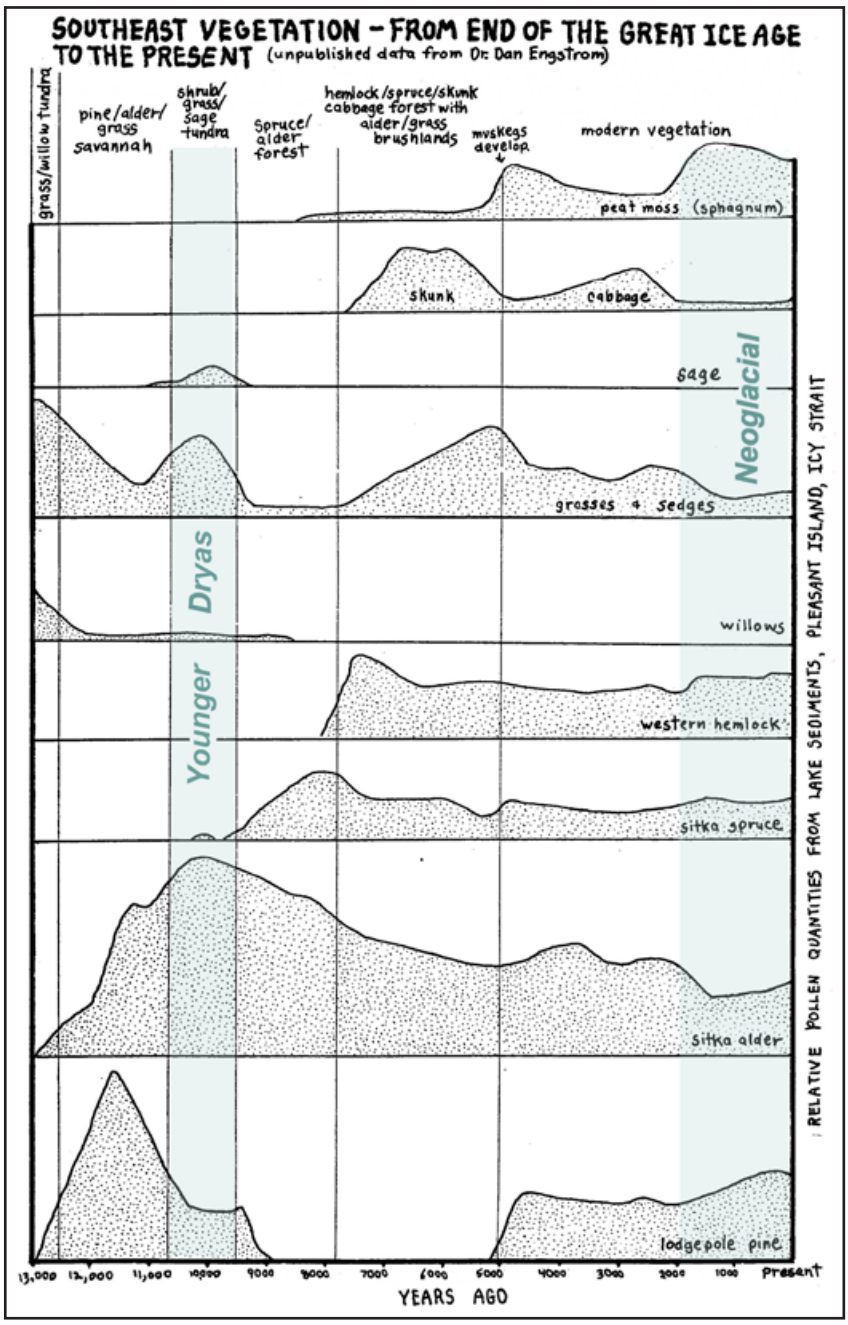


projecting above the ice and escaping its erosion. Although sea level was 300 feet lower world-wide because of water still locked in ice, Southeast's crust was pressed down much farther under weight of ice. Several thousand years passed before land rebounded to earlier, pre-ice-age position. The ocean stood up to 500 feet higher than today, especially in Lynn Canal where ice was thickest. The archipelago was more insular than today, since higher sea divided what is now one island into several. But life returned, slowly surmounting physical barriers of saltwater, mountains and ice fields, and ecological barriers posed by still-harsh living conditions.

Pollen in lake-bottom and bog sediment records return of plants after ice. For several millennia, tundra and pine-alder scrub dominated the post-glacial landscape. By 8,000 years ago, spruce-hemlock forest predominated, suggesting climate was approaching today's wet and mild conditions. By 5,000 years ago peat bogs were forming. Foundations for modern vegetation were laid. A few thousand years later, climate worsened—a period called the Neoglacial, culminating in the Little Ice Age 2 centuries ago. Glaciers depressed the land again, especially around Glacier Bay. Snow-line descended, shifting vegetational belts. But conditions weren't severe enough to bring tundra back to the lowlands.

Post-glacial rebound and sediment brought down from mountains turned fjords into valley bottoms and connected islands to mainland. Streams etched glacially scoured hillsides, dumping fans at toe-slopes, where seas worked them into beaches. Land- and freshwater animals immigrated. Breeding sites for colonial birds and marine mammals probably became fewer. Salmon returned to streams. Deer and black bear increased, while puffins and sea lions diminished.

This story remains sketchy. But recently-discovered caves in southern Southeast have rich deposits of animal bones dating to the end of the last Great Ice Age. These will ultimately yield detailed records of mammal and bird re-occupation.



Climate

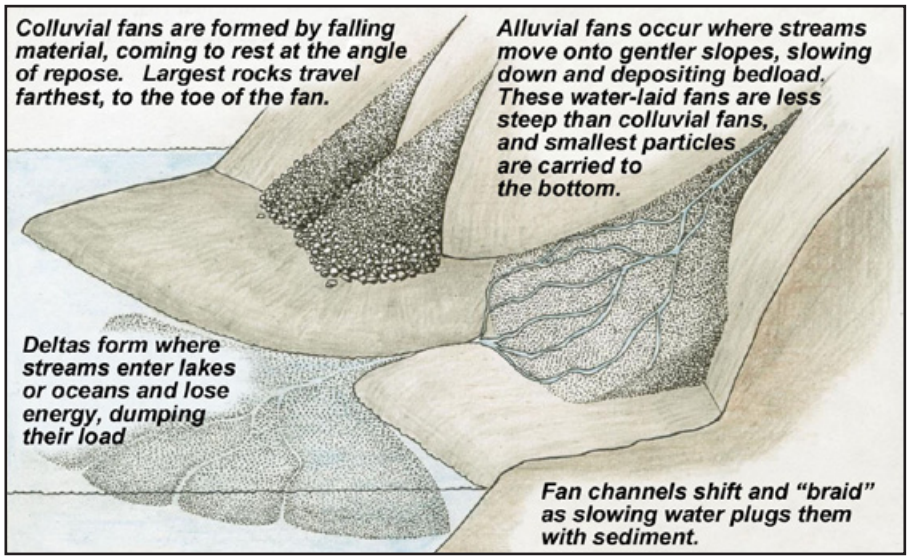
Glaciers spawn severe climate, but also reflect heat, generating cold high-pressure cells that hold warm oceanic air at bay. We live in a milder-than-average period compared to the last few million years. With glacial ice at a minimum, the great *lows* sweeping off the Gulf dominate our climate, bringing abundant moisture. Since the Gulf's oceanic currents are mostly from the south, we're bathed by warmer waters for our lattitude. Our temperatures are mild.

The sea pervades into every interstice, but especially along the outer coast. On the mainland, most obviously by interior passes, periodic incursions of continental air reduce average rainfall and bring more extreme seasonal temperature variations. Average annual temperatures are highest in the south.

Plants

(Common names follow O'Clair, Armstrong & Carstensen, 1992)
Plant communities reflect climate. Pine-birch and spruce-cottonwood forests near Skagway differ from hemlock-spruce-cedar forests near Ketchikan. Yellow-cedar, so pervasive in maritime lowlands around Sitka, is scarce at Juneau. High elevation tundra differs from low elevation bog, forest and brushland.

Modern Southeast vegetation is arrayed along a vertical gradient. At the shore, a few salt-tolerant species form productive salt marshes just below high tide. Above extreme



high water is a lush, diverse beach meadow dominated by grasses and large umbels such as cow parsnip. Uplift meadow abounds in northern Southeast, where high rates of post-glacial rebound cause the sea to recede faster than forest advances. Lowland forests host Sitka spruce, western hemlock, and cedars. Moss, ferns, evergreen herbs and brushy species such as blueberry, menziesia and devil's club cloak the ground, except where even-aged forest admits too little light to support undergrowth. With increasing elevation, mountain hemlock supplants western hemlock.

Forest generally forms an unbroken cloak on Southeast Alaskan landscapes unless interrupted by disturbance, wetness or altitude. Disturbance takes many forms: avalanche, snow creep. flooding, windthrow, disease, insect infestation, or logging. Infrequent or small scale disturbance doesn't erase the forest, but increases diversity by creating a mosaic of several different ages, admitting light to the forest floor, making some of our best wildlife habitat.

But trees take time to re-establish. Forest can't persist if disturbance is too frequent and severe. It's replaced by brush. which stands more punishment and bounces back faster if erased. Alder, salmonberry and copper bush withstand deep subalpine snow, and extend far downhill in avalanche chutes, joined by elderberry. devil's club and currant. Willow and alder are prominent in flooded river valleys.

On wet soil, forest gives way to bog. Poor drainage favors hardpan soils, keeping trees from rooting deeply enough to resist windthrow. It also favors peat moss, whose water retention and acid production further retards healthy tree growth, resulting in stunted trees and sparse heath shrubs on an ever-thickening mantle of peat. On more sloped terrain with high water table, sedge-dominated peatlands called fens may form.

With increasing altitude, tree growth is first impeded then halted by low summer temperatures. Often a zone of brush interposes, but sometimes forest gives way directly to lush subalpine meadows much like those just above the tide. Farther up, where

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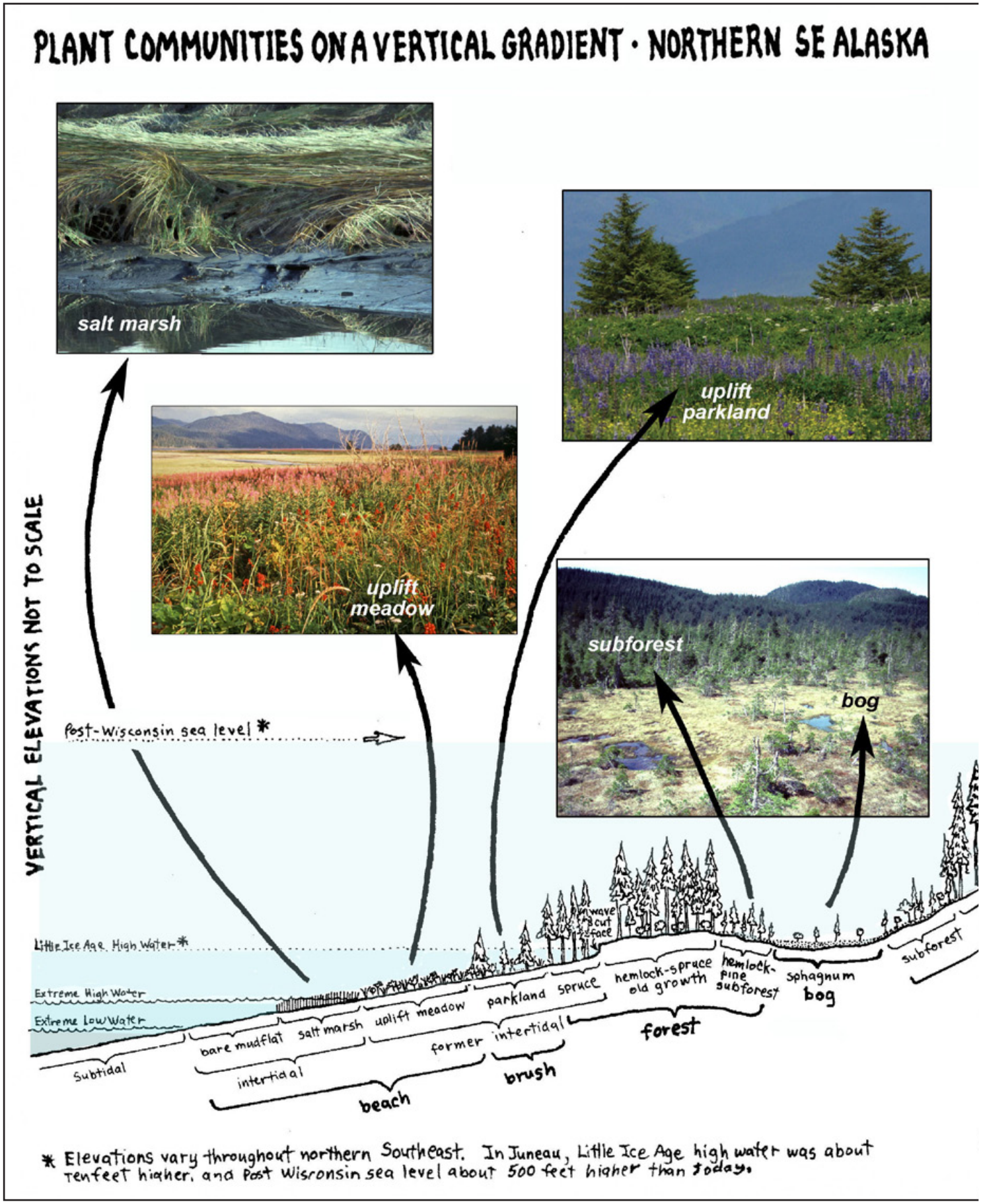
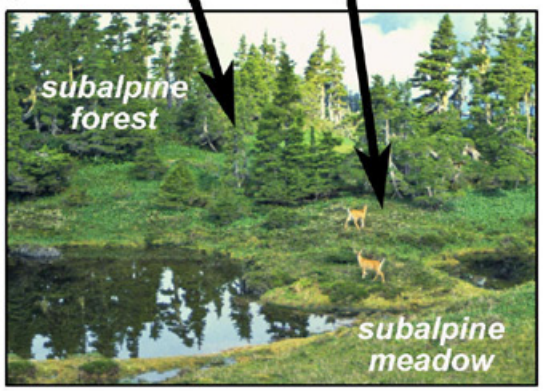
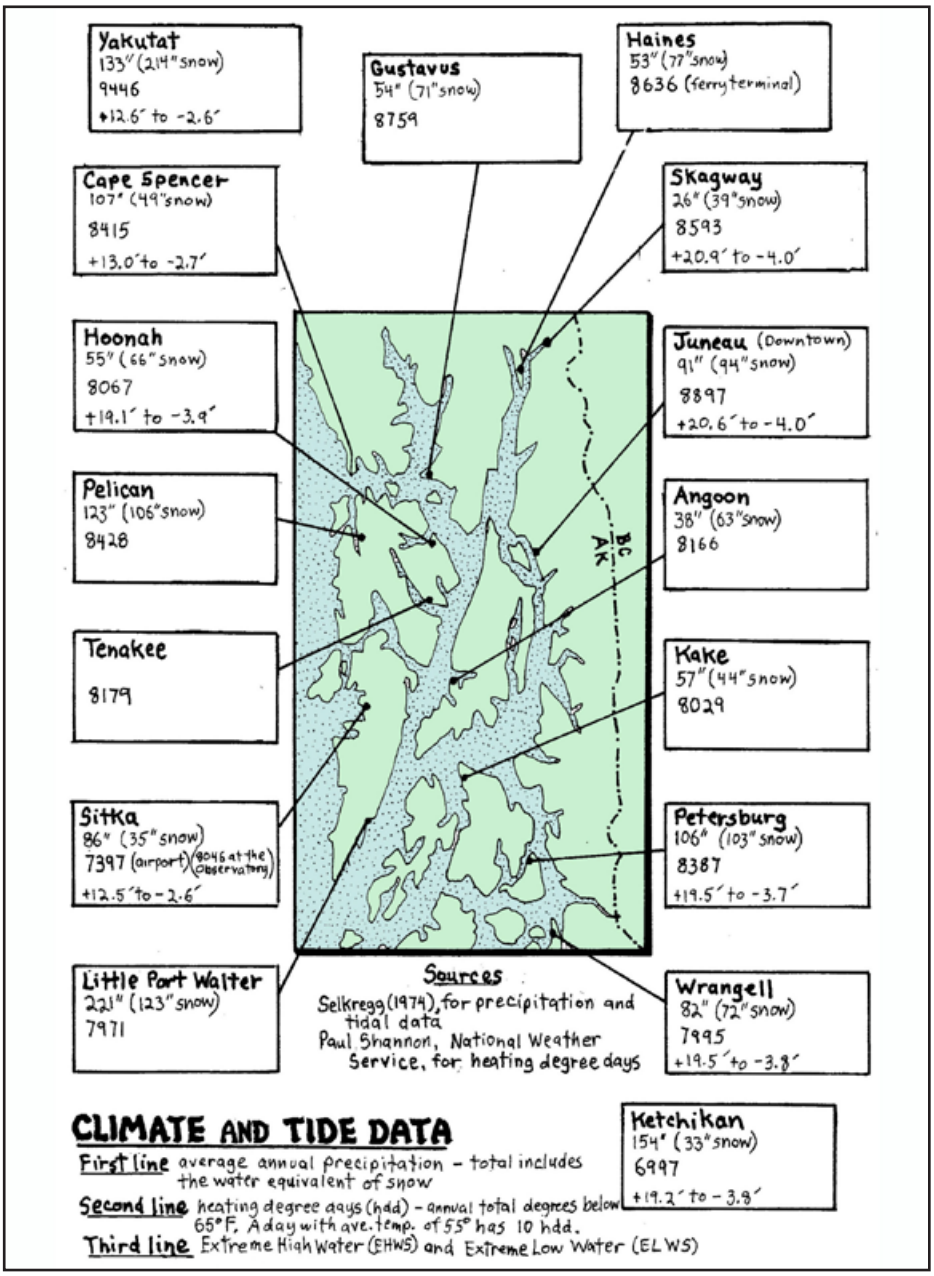
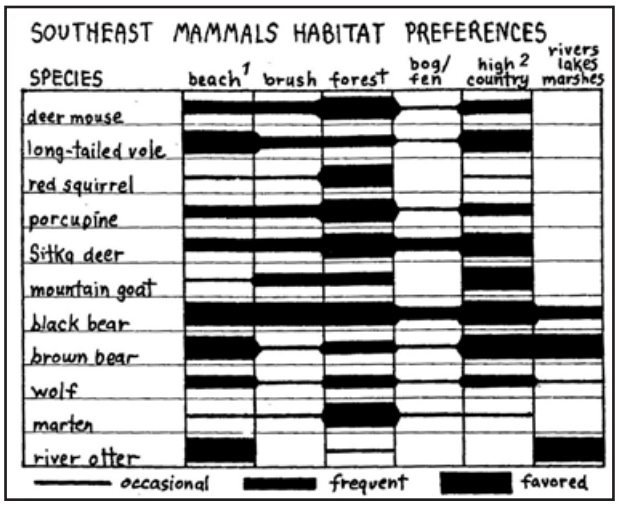

PLANT COMMUNITIES ON A VERTICAL GRADIENT · NORTHERN SE ALASKA
salt marsh
uplift parkland
uplift meadow
subforest
bog
VERTICAL ELEVATIONS NOT TO SCALE
Post-Wisconsin sea level *
Little Ice Age High Water *
Extreme High Water
Extreme Low Water
wave cut face
bare mudflat
salt marsh
uplift meadow
parkland spruce
hemlock-spruce old growth
hemlock-pine subforest
sphagnum bog
subforest
Subtidal
intertidal
former intertidal
forest
beach
brush
* Elevations vary throughout northern Southeast. In Juneau, Little Ice Age high water was about ten feet higher, and Post Wisronsin sea level about 500 feet higher than today.

PS 2012: For comprehensive descriptions of these communities visit: *http://home.gci.net/~tnc/HTML/Resource_synthesis.html*







summers are brief and winter wind blows away protective snow mantle, alpine tundra mats of prostrate shrubs, tiny herbs, mosses and lichens predominate. Even higher, bare rock and ice reign.

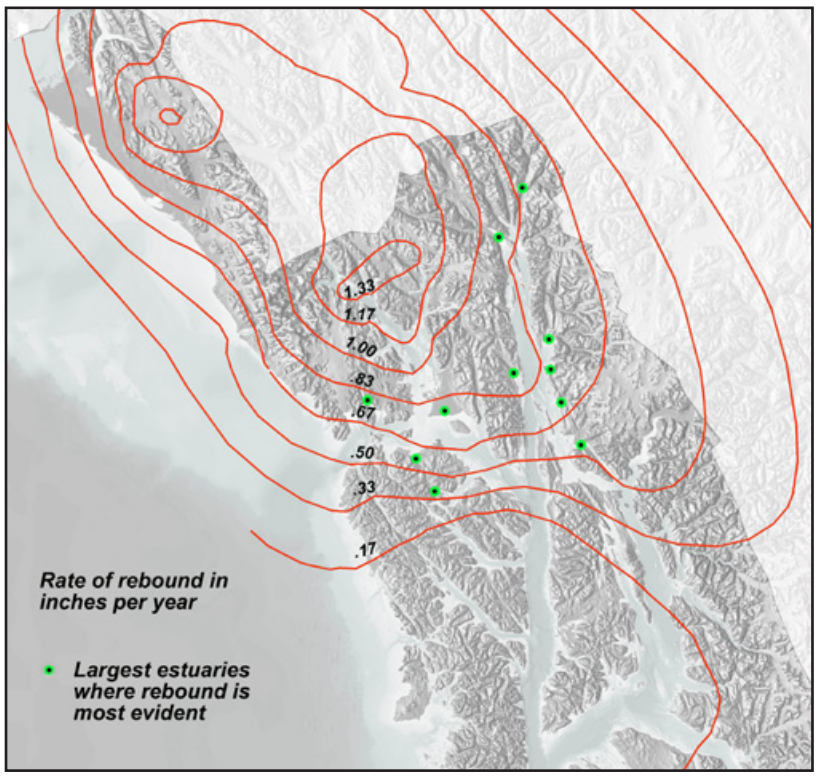
Animals

Distribution of land animals is more complex than that of plants. Birds and many flying insects are especially mobile, able to overcome most physical barriers. But they're choosey about habitat; most associate with a particular group of plant communities. Animals of this type are widely distributed, but are found in specific habitats.

The opposite is true for mammals. Especially the largest—bears, moose—use a variety of habitats from beach to alpine. Yet because many lack a dispersal phase in life history comparable to the mobile seeds or spores of plants, or the winged migrations of birds, their distribution is relatively incomplete.

1 "Beach" includes rocky intertidal, mudflats, and young meadows uplifted by glacial rebound.
2 "High country" includes alpine tundra, subalpine meadows, and elfinwood at tree limit.

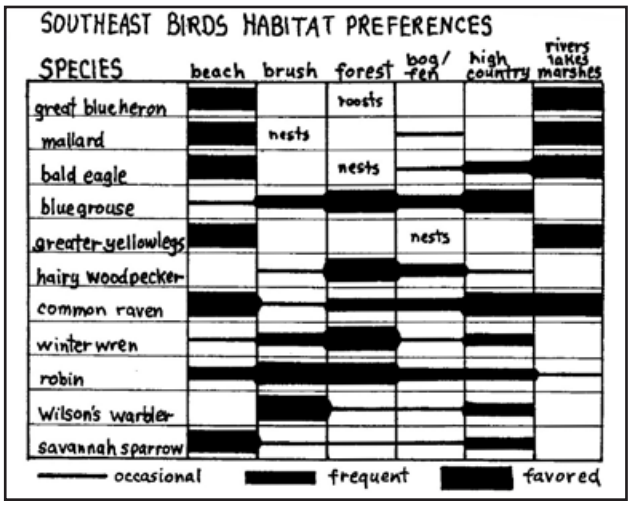
Most rapid uplift is in Glacier Bay where land was most depressed during the Little Ice Age, and where mountain-building is great. Rate declines away from major ice fields and uplifting mountains.



For instance, of the 48 species living in the interior of British Columbia with ranges bordering on our region, only 37 have made it across the mountain passes to mainland Southeast Alaska, and only about 10 of these—little brown bat, short-tailed weasel, mink, otter, brown bear, deer, deer mouse, tundra vole, dusky shrew, masked shrew—are known to have made it without the aid of people past the water barriers to Baranof Island.

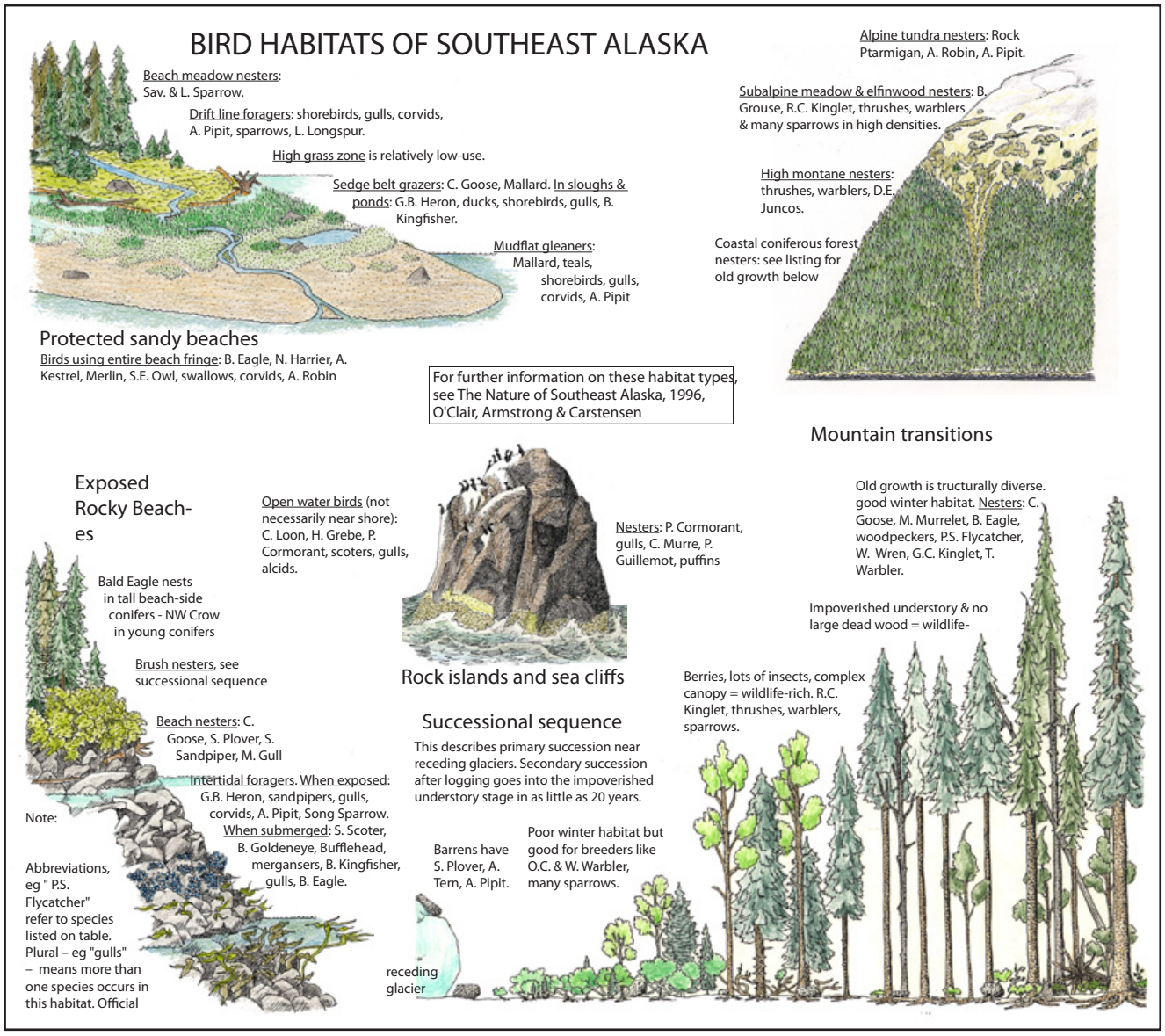
Relatively few freshwater fishes have made it to Southeast Alaska. The bulk of these are salmon and char, which spend parts of their life cycles in salt water, and so can get past the mountains and marine channels that limit the distribution of strictly freshwater animals. Except for introduced species like grayling or brook trout, only 2 fishes with no connection to salt water—round whitefish in Chilkat Lake, northern pike in the pike lakes near Yakutat—have made it to the fringes of our region.

The relatively few land-based animals able to colonize our islands have have often attained large numbers. Among these are brown and black bears, Sitka black-tailed deer, mink, otter, bald eagle, blue grouse and salmon. Wildlife surveys show that most species reach maximum densities near marine shores. There's hardly an animal species in the region that has no direct connection to the sea.



The sea

A fortunate combination of characteristics makes Southeast Alaskan seas immensely

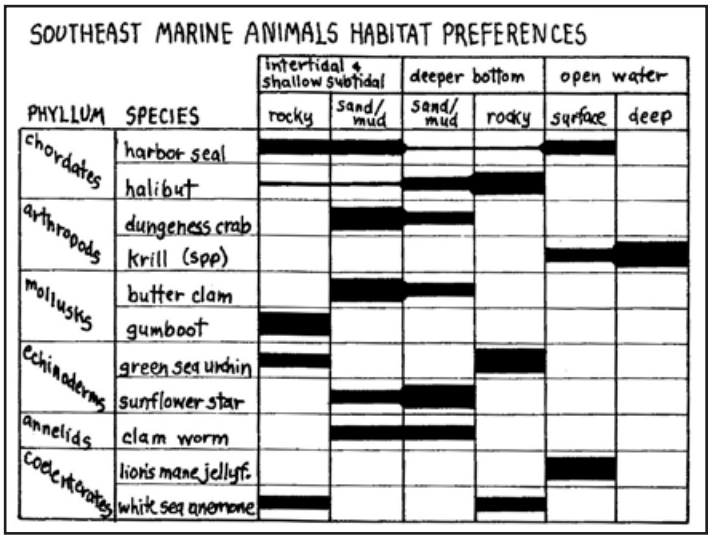


PS, 2012: This is an updated, color version of the b&w original that appeared in A Naturalist's Look in 1993. It's now available in a 3-fold Discovery field laminate.

productive. The waters are warmed and enriched by the adjacent Pacific Ocean. Complicated shoreline and bottom topogaphy combine with exceptionally high tidal energy to produce strong currents that stir nutrients to the surface. Two other factors are necessary to translate nutrients into productivity—enough light for phytoplankton (plant plankton) to photosynthesize rapidly, and enough water-column stability to allow these tiny organisms to stay in the "photic zone" near the surface. All these factors come together in spring and early summer.

Then, for a few weeks, the concentrations of phytoplankton reach astronomical proportions. Many animal plankton (krill, copepods etc.), and bottom-dwelling invertebrates (starfish, sea urchins, worms, and clams), time their reproduction to coincide with this brief time of plenty. Vast shoals of small fishes such as herring, capelin and sand lance in turn feed upon this animal plankton. Salmon, sea lions, porpoises, cormorants, and

murrelets forage on the fishes, while humpback whales come from Hawaii and Baja to harvest them, and the plankton, by the ton. Seaweed and salt-marsh vegetation also begins to grow again in early spring. These plants support an abundant crop of grazers, and upon decomposing produce detritus for bottom-dwelling worms and sand fleas. Moreover, they provide a substrate for microscopic algae, which are grazed by snails and other mollusks.



Summer in the upper waters is a brief but exuberant season. Most marine birds and mammals raise their young and then put on fat while the bounty lasts. Fishes exhibit a variety of reproductive strategies. Herring and cod release small (yolk-poor) eggs that fend for themselves as they hatch in the rich plankton soup. Skates produce large yolk-rich eggs produced from stored energy from the previous season. Ling cod males use stored energy reserves to defend their brood of eggs from predation.

As snows and gales of winter come, and the sun moves ever lower in the noon sky, much of the marine world goes “on hold”. Many species leave for the south; a lot of the rest curtail their activity. Salmon eggs rest in creek gravels. Herring and rockfish school in a rocky deep to await the coming of spring when the drama will be replayed.

But the marine ecosystem does not grind to a halt over winter. A portion of the living matter from upper waters makes its way to the bottom in the form of detritus, where it is eaten by filter feeders like barnacles, anemones and clams. That which they miss is incorporated in sediment to be eaten through the year by tiny crustaceans and worms, which in turn feed flounders, crabs, cod and diving birds like scoters. Seals, sea otters and halibut provide the next link in this benthic food chain, which fluctuates much less through the seasons than that of the open waters, and thus becomes disproportionately important during winter.

Marine productivity comes ashore in numerous ways. Salmon carry it to the far corners of the region when they spawn; the young of some species remain in ponds and streams, where they are important food for mergansers and kingfishers. Predators such as eagles, otters and mink hunt at sea and carry their catch to land.

Most important, Southeast Alaskan shores provide hundreds of miles of interface between land and sea. Shores provide thoroughfares and den-sites; carcasses wash up on them; and they grow lush intertidal communities that are dry land when the tide is out A large array of predators and scavengers from bears to shrews and ravens patrol the beaches, eating flotsam and some of the intertidal invertebrates. Herbivores such as deer, moose, mountain goat, porcupine and voles graze on plants of the upper intertidal zone or eat kelp for salt. And have you noticed where most Southeast Alaskan towns are?

People

The list of Southeast Alaskan species has included people for at least 9000 years. In recent millennia our region has been home to the Tlingit, Haida and Tsimshian peoples, whose great villages and high culture bore testimony to the abundance of both natural and spiritual resources. These people were encountered (but not defeated) by the Russians during the 18th and 19th centuries, who pursued the sea otter and traded from their enclave in Sitka, then sold what they perhaps did not own to the United States in 1867.

Into this "last frontier" have come people drawn from more crowded lands. Yet Southeast Alaska's rugged terrain and difficult climate have conspired to hold the human population thus far to relatively modest levels. The natural fabric of our region remains largely intact.

Though our population is small, modern times have seen dramatic increases in the rates of resource harvest and landscape alteration. As people expect more from the natural world, wise stewardship will depend increasingly on our awareness of Southeast Alaska's particular natural fabric: how it came to be, its present components and interactions, and where the future would take it. Ultimately, stewardship demands willingness to live within the land's limits.

GPS
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References

Alaback, P. 1982. *Dynamics of understory biomass in Sitka spruce-western hemlock forest of southeast Alaska*. Ecology 63:1932-1948.

Alaska Dept of Fish & Game. 1989 *Wildlife notebook series*. ADFG, Juneau.

Barr, L. and N. Barr. 1983. *Under Alaskan seas: the shallow water marine invertebrates*. Alaska Northwest Books. Anchorage, AK.

Beikman, H.M., 1980, *Geologic map of Alaska*. U.S. Geological Survey Special Map, 1:250,000 scale, 2 sheets.

Brew, D., 1988. *Plate-tectonic setting of Glacier Bay National Park and Preserve and of Admiralty Island National Monument, Southeastern Alaska.* In *Proceedings of the Second Glacier Bay Science Symposium*.

Carefoot, T. 1977. *Pacific seashores: A guide to intertidal ecology*. University of Washington Press. Seattle.

Cowan, I. and C. Guiguet. 1978. *The mammals of British Columbia*. BC Provincial Museum, Handbook #11.

Engstrom, D., B. Hansen, and H. Wright. 1990. *A possible Younger Dryas record in southeastern Alaska*. Science. vol 250. pp. 1383-1385.

Franklin, J., K Cromack, W. Denison, A. McKee, C. Maser, J. Dedell, F. Swanson and G. Juday. 1981. *Ecological characteristics of old-growth Douglas fir forests*. USDA Forest Service General Technical Report. PNW-118.

Harris, A. 1989. *Wind in the forests of southeast Alaska and guide for reducing damage*. USDA Forest Service General Technical Report PNW-GTR-244. 63 p.

Hart, J. 1980. *Pacific Fishes of Canada*. Fisheries Research Board of Canada. Ottawa.

Harthill, M. and I. O'Connor. 1975. *Common mosses of the Pacific coast*. Naturegraph Publishers, Healdsburg, California.

Heller, C. 1966. *Wild edible and poisonous plants of Alaska*. Cooperative Extension Service. U. of Alaska, No. 28.

Heusser, Calvin. 1960. *Late Pliestocene Environments of North Pacific North America*. American Geographical Society Special Publication 35.

Hicks, S., and W. Shofnos. 1965. *Determination of land emergence from sea level observations in Southeast Alaska*. Journal of Geophysical Research. 70(14): 3315-20.

Hodge, J. 1976. *Reptiles and amphibians in Alaska, the Yukon and neighboring territories*. Alaska Northwest Publishing Company, Anchorage, Alaska.

Holsten, E., P. Hennon, and R. Werner. 1985. *Insects and diseases of Alaskan forests*. USFS Alaska Region Report No. 181.

Howe, D. 1984 *Bibliograph of research and exploration of Glacier Bay, Alaska. 1798 to 1984*. US Dept of Interior, National Park Service. Science Publications Office. Atlanta, Georgia.

Hulten, E. 1967. *Flora of Alaska and neighboring territories*. Stanford University Press.

Isleib, P., R. Armstrong, R. Gordon and F. Glass. 1987. *Birds of Southeast Alaska: A checklist*. Alaska Natural History Association. US Forest Service Alaska Region. Audubon Society Juneau Chapter, and the Alaska Dept of Fish and Game.

Kessler, W. 1979. *Bird population responses to clearcutting in the Tongass National Forest of southeast Alaska*. USDA Forest Service, Alaska Region. Report No. 71.

Ketchum, R. and C. Ketchum. 1987. *The Tongass: Alaska's vanishing rain forest*. Farrar, Strauss and Giroux. New York.

Kirchhoff, M. and K. Pitcher. 1988. *Deer pellet-group surveys in Southeast Alaska*. 1981-1987. ADF&G Research Final Report, Project W-22-6.

Kozloff, E. 1983. *Seashore life of the Northern Pacific coast: An illustrated guide to northern California, Oregon, Washington, and British Columbia*. U Washington Press.

Lawrence, D. 1958. *Glaciers and vegetation in southeastern Alaska*. American Scientist 46: 89-122.

Lawrence, D. 1979. *Primary versus secondary succession at Glacier Bay National Monument, Southeastern Alaska*. pages 213-224 in Linn, R. ed. Proceedings of the first conference on scientific research in the National Parks, New Orleans, 1976. USDI, National Park Service, Transactions and Proceedings Series, no. 5, 2 vols.

Manville, R., and S. Young. 1965. *Distribution of Alaska mammals*. Bureau of Sport Fish and Wildlife. Circular no. 211.

Maser, C., and J. Trappe, eds. 1984. *The seen and unseen world of the fallen tree*. USDA Forest Service General Technical Report. PNW-GTR-164.

Milner, A. and J. Wood. 1988. *Proceedings of the second Glacier Bay science symposium*. US Dept of Interior, Alaska Regional Office, Anchorage.

Muller, M. 1991. *Field guide to rare vascular plants of the National Forests in Alaska*. USFS. R10-MB-128.

Neiland, B. 1971. *The forest-bog complex of Southeast Alaska*. Vegetatio. 22:1-64.

Noble, M., D. Lawrence and G. Streveler. 1984. *Sphagnum invasion beneath an evergreen forest canopy in Southeastern Alaska*. Bryologist. 87(2): 119-127.

O'Clair, R.., R.. Armstrong, and R. Carstensen. 1992. *The nature of Southeast Alaska*. Alaska Northwest Books. Seattle WA. 254 p.

Paige, B. 1979. *Birds of Glacier Bay National Monument: a checklist*. NPS.

Reardon, J. 1981. *Mammals of Alaska*. Alaska Northwest Publishing Company. Anchorage. Alaska Geographic 8(2).

Reiners, W., I. Worely, and D. Lawrence, 1971. *Plant diversity in a chronosequence at Glacier Bay, Alaska*. Ecology 52:55-69

Robuck, O.W. 1989. *Comon alpine plants of Southeast Alaska*. US Forest Service. Pacific Northwest Research Station, Miscellaneous Publication.

Robuck, O.W. 1985. *The comon plants of the muskegs of Southeast Alaska*. US Forest Service. Pacific Northwest Research Station, Miscellaneous Publication.

Ruth, R. and A. Harris. 1979. *Management of western hemlock-Sitka spruce forests for timber production*. USDA Forest Service General Technical Report, PNW-88.

Scagel, R. 1967. *A guide to common seaweeds of British Columbia*. BC Provincial Museum Handbook No. 27.

Schoen, J.,and L. Beier. 1990. B*rown bear habitat preferences and brown bear logging and mining relationships in Southeast Alaska*. Federal Aid in Wildlife Restoration. Final report. Grant W-22. Alaska Department of Fish and Game, Juneau, AK.

Schoen, J., M. Kirchhoff, and J. Hughes. 1988. *Wildlife and old-growth forests in southeastern Alaska*. Natural Areas Journal 8:138-145.

Schofield, N. 1989. *Discovering wild plants: Alaska, western Canada, the Northwest*. Alaska Northwest Books.

Selkregg. L. 1974. *Alaska Regional Profiles: Southeast region*. University of Alaska. Arctic Environmental Information and Data Center, Anchorage.

Stephens, F., and R. Billings. 1967. *Plant communities of a tide-influence meadow in Chichagof Island, Alaska*. Northwest Science. 44(2) 123-130.

Stephens, F., C. Gass and R. Billings. 1970. *The muskegs of Southeast Alaska and their diminished extent*. Northwest Science, Vol 44, No. 2.

Streveler, G. and B. Paige. 1971. *The natural history of Glacier Bay National Monument, Alaska: a survey of past research and suggestions for the future*. US National Park Service, Juneau.

Streveler, G. and I. Worley, eds. 1977. *Dixon Harbor biological survey. Final report for the summer phase of 1975 research*. US National Park Service, Juneau.

Streveler, G., I. Worley, and B. Molnia, eds. 1980. *Lituya Bay environmental survey*. US National Park Service, Juneau.

Tipper, H. 1981. *Tectonic assemblage map of the Canadian Cordillera and adjacent parts of the US*. Map 1505A. Geological Survey of Canada. Vancouver, BC.

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

Vitt, D., J. Marsh, and R. Bovey. 1988. *Mosses Lichens and ferns of Northwest North America*. Lone Pine Publishing.

Wallmo, O. 1981. *Mule and black-tailed deer of North America*. U. Nebraska Press.

Welsh, S. 1974. *Anderson's flora of Alaska and adjacent parts of Canada*. Brigham Young University Press. Provo, Utah.

Wood, J. M. Gladziszewski, I. Worley and G. Vequist, eds. 1984. *Proceedings of the first Glacier Bay science symposium*. US Dept of Interior. Science Publications Office, Atlanta.