Glacier Bay

Official National Park Handbook

Handbook 123

Glacier Bay

A Guide to
Glacier Bay National Park
And Preserve, Alaska

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Using This Handbook
The major attractions at Glacier Bay National Park and Preserve are the bay and its tidewater glaciers; the whales and other wildlife of land, sea, and air; the abrupt and massive Fairweather Range; and the vast unspoiled outer coast. Part 1 of this handbook briefly introduces the park and its history; Part 2 takes a close look at the dynamics of tidewater glaciers and the natural history of both bay and landscape; and Part 3 presents concise travel guide and reference materials.

National Park Handbooks, compact introductions to the great natural and historic places administered by the National Park Service, are published to support the National Park Service's management programs at the parks and to promote understanding and enjoyment of the parks. Each is intended to be informative reading and a useful guide before, during, and after a park visit. More than 100 titles are in print. This is Handbook 123.

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Part 1


Welcome to Glacier Bay

The Gem of Alaska's Inside Passage

A hiker packs through a lush meadow high above Tidal Inlet, about halfway up Glacier Bay. Since John Muir's day, the bay has attracted thousands of travelers, most of them waterborne. Part 1 of this handbook recounts the Glacier Bay travel tradition, from early explorations and scientific expeditions to the first tourists on steamships. Great cruise ships today ply the bay, introducing its wonders to travelers. Others come by air and by private water craft.

Pages 4-5: *The serene bay surface may burst open to emit a 35-ton acrobatic humpback whale, or a towering wall of glacier ice may calve off stupendous icebergs. The unexpected pleasures of Glacier Bay and Southeast Alaska are nearly limitless.*

Alaska's Glacier Bay confronts us with a mad jumble of paradoxes. Attempts to describe it juxtapose references to thunderous booming of ice and overwhelming silence. The landscape rests both brashly new and bedrock old, at once eternal and transitory, everlasting and ephemeral. The ice sheets lock up climatic history while rewriting today's topography. The crushing magnitude contrasts with the uncanny finesse of staged plant recovery. It is as though two worlds were unrolling like the ends of a scroll—ice receding and vegetation advancing. Might there not be a seam between these two worlds, one wonders, some extra-dimensional passage? No. Both are but landscapes and timescapes of our own one world.

John Muir came here in 1879 pursuing the reality of what he had earlier tracked as a mere ghost throughout California's High Sierra. He had trekked the California highcountry to find telltale etchings of massive glaciation, wishing to demonstrate the then novel and religiously disruptive glaciation theories of Swiss scientist Louis Agassiz. In Glacier Bay country, just below the shoulder of Alaska's south-reaching coastal arm, Muir trekked the real thing in action. He contemplated landscapes newly emerged from the Little Ice Age, a geologically recent winter's night that had lasted some ten centuries. Muir knew: At Glacier Bay you can get lost both in space and in time.

Muir's letters to the San Francisco *Bulletin* newspaper attracted Eliza Ruhamah Scidmore to Glacier Bay. "Steaming slowly up the inlet, the bold, cliff-like front of the glacier grew in height as we approached it," she wrote on her second trip in 1885, "and there was a sense of awe as the ship drew near enough for us to hear the strange, continual rumbling of the subterranean or subglacial waters, and see the avalanches of ice that, breaking from the front, rushed down into the sea with tremendous

What color are black bears? The question is not a riddle. They have three color phases: black, brown, and cinnamon. Black bears frequent forests of the lower bay. The much larger brown/grizzly bears are more common in inlets up bay.

Pages 8-9: *Kayakers contemplate the spray-strewn aftermath of a monumental calving spree at Muir Glacier. Taken with a telephoto lens, this photo makes it look like the kayakers are closer to the glacier than they are. Never approach one of these glaciers closer than a half mile.*

Pages 10-11: *Margerie Glacier, in the Fairweather Range, carries a massive debris load gathered from its tributary glaciers.*

crashes and roars." Despite the whales, despite the seals, despite the stupendous coastal mountain scenery, it is first and foremost the stark drama of tidewater glaciers that makes Glacier Bay the gem of southeastern Alaska's protected coastal sea lane known as the Inside Passage. "Words and dry figures can give one little idea of this glacial torrent," Scidmore wrote, " . . . the beauty of the fantastic ice front, shimmering with all the prismatic hues, is beyond imagery or description." Her first glimpse of Muir Glacier had reduced her to silence. Today, thousands of people visit Glacier Bay each summer. Most come by cruise ship, others fly into nearby Gustavus, or directly to the park in charter aircraft. The park's Fairweather and other mountain ranges are perhaps the world's most spectacularly glaciated. The bay itself is home to seals, porpoises, whales, and countless species of fish and invertebrates. Its shores are dotted with birdlife, with bears, and with mountain goats.

Recorded history as we generally credit it had begun for the Glacier Bay area nearly 150 years before Muir's coming. The log of the Russian packet boat *St. Paul*, commanded by Alexis Tchirikov, records for July 15, 1741: "This must be America, judging by the latitude and longitude." Tchirikov had sighted the Fairweather Range. The next day his compatriot Vitus Bering sighted land north of here and named Mt. St. Elias. Bering's name survives as a sea, a strait, and as a former land bridge between Russia and what is now Alaska. Tchirikov's log book survived the voyage; Tchirikov did not.

Actually, the Fairweather Range of mountains was not so named until 1778, when James Cook, commanding His Majesty's sloop, *Resolution,* sailed into the area. For the next several years, assorted Russians and Aleuts lured by sea otters visited, but no records survive. Then in 1786 Frenchman Jean Francois de Galaup, comte de La Pérouse, put into what is now Lituya Bay. Tlingit Indian legend records La Pérouse's visit, calling him Yealth. He managed to "purchase" Cenotaph Island from one Tlingit chief, leaving a medallion and records to that effect stashed in rocks there; these either remain undiscovered or were destroyed by later Russian or other visitors. He spent 27 days in Lituya Bay, and his log book describes in detail both Tlingits and the

surrounding gigantic wilderness. Not least, he describes a calving berg: "A fragment of ice, which fell into the water near half a mile off, occasioned such a swell along the shore, that my boat was upset, and thrown to some distance on the border of the glacier. This accident was soon repaired, and we returned on board. . . ." Mt. La Perouse and the magnificent La Perouse Glacier on the park's outer coast inscribe this Frenchman's name here.

By the time of La Pérouse and Cook, explorers were plying the American Northwest Coast fueled by a rich mixture of greed and geographic misinformation. They sought the mythic Northwest Passage, that supposed navigable route across North America to a lucrative China trade. Imagine then their disappointment to confront staggering glacial blockades walling off progress inland so immediately after they quit the open Pacific.

The number of discrete tidewater glaciers has increased significantly since Lieutenant Whidbey from Capt. George Vancouver's ship *Discovery* spied what would become Glacier Bay from Icy Strait on Vancouver's expedition in 1794. Simply put, the entire bay was at that time one mighty ice sheet almost to its mouth.

If Eliza Scidmore was one of Glacier Bay's first tourists, she was soon succeeded by more tourists and glaciologists and plant ecologists, too. Spectacles of nature abound throughout most of Alaska, but in Glacier Bay you can still step right off the Little Ice Age and walk across nearly two centuries of plant succession, seeing how ice-scoured land recovers by stages to mature coastal forest. Glacier Bay offered glaciologists and plant ecologists a compact natural laboratory of time and space too good to pass up. "Discovered" in 1879, prominent by 1884, world famous by 1886, the Muir Glacier that Scidmore saw would next be unattainable by tourists. An earthquake rocked the Alaskan coast at 12:20 p.m. on September 10, 1899. Within hours, Glacier Bay was a mass of impenetrable floating ice. The glacier's terminus was devastated by the quake and went into rapid retreat. For the next few years ships could generally get within only 8 kilometers (5 miles) of the Muir Ice front. This cataclysmic change marked the end of the era of description for Glacier Bay. The era of explanation then began, and contin-

ues today, as Ruth Kirk testifies in Part 2 of this handbook.

Several Glacier Bay facts amply demonstrate the rapid, massive changes here: Tchirikov could not have entered Glacier Bay in 1741 because it was a vast ice sheet. Captain Vancouver found Icy Strait much choked with ice in 1794, and Glacier Bay was a mere dent in the shoreline then. Yet by 1879 John Muir found that the sometimes 1,200-meter- (4,000-foot) thick mantle of ice had retreated 77 kilometers (48 miles) up the bay. By 1916 the Grand Pacific Glacier stood 105 kilometers (65 miles) from the mouth of Glacier Bay. This rapid pace of glacial retreat on this large scale is known nowhere else in the world. This central fact, plus its exemplification of plant succession, great natural beauty, and value to marine mammals and other wildlife, inspired the move to protect Glacier Bay.

The Ecological Society of America, with the impetus of William S. Cooper who had studied the plant succession and relict forests, in 1923 recommended that a national monument be established at Glacier Bay. Five reasons were enumerated: the tidewater glaciers; other scientific features, including ancient forest remnants; the coastal forests; the historical associations since Vancouver's time; and the relative accessibility to travel, compared with other tidewater glacier areas. The Society recommended a national monument because such areas could be established by Presidential proclamation, whereas national parks could be created only by Congress. In 1924, President Calvin Coolidge ordered the temporary withdrawal of one million hectares (2.5 million acres), and in 1925 he proclaimed the Glacier Bay National Monument. All seemed well.

Local agitation for opening the area to mining followed, however, and in 1936 a bill to do just this was quickly approved by Congress two days before its adjournment for the Democratic National Convention. President Franklin Delano Roosevelt signed it three days later. Conservationists who had worked two years for the monument's establishment with mining excluded were shocked.

With support from the U.S. Department of Agriculture, the monument boundary was enlarged significantly in 1939. Again because of local pressure

Pages 16-17: *The Fairweather Range's Mount Bertha wears soft hues of morning light. The Fairweathers rise abruptly from tidewater, walling the bay's western shore.*

Pages 18-19: *A big humpback whale outweighs eight African elephants. Curious, friendly, and playful, this mysteriously intelligent and talkative whale is an endangered species.*

however, the boundary was reduced somewhat in 1955. Another large addition to the monument was made in 1978. In 1980, Congress redesignated the area Glacier Bay National Park and Preserve. The national park now includes some 1.3 million hectares (3.2 million acres) and the national preserve some 23,000 hectares (57,000 acres). The national park portion is closed to mining, of course, and much of it is further protected as part of the National Wilderness Preservation System. These management distinctions are explained in Part 3 of this handbook.

The 1930s mining flap unwittingly centered about an indefatigable prospector named Joe Ibach. He put ashore at Ptarmigan Creek, northwest of Reid Glacier, in the early summer of 1925. Nearby Ibach hit gold-bearing veins and staked them, registering them later that summer. So began a three-decade association with Reid Inlet for Joe and his wife, Muz, just as, on the other side of the continent, the fight for establishing the monument was just grinding toward resolution.

The Ibachs' gold operations, in association first with Capt. Tom Smith and later with novelist Rex Beach, never amounted to anything. One season's yield was enough to cover the smelting work in Juneau, but not the freight, for which the smelter billed Ibach and Smith! The next year was more profitable. After all was said and done, Joe and Muz netted $13 and Smith netted $13. At that, the latter threw in his pick and sledge. Beach never realized anything from mining here.

The cabin that still stands at the entrance to Reid Inlet was built by the Ibachs about 1940 and Muz soon put in the vegetable garden with dirt hauled in ore sacks from Lemesurier Island. Three spruces, also imports, were planted there far ahead of their ecological time, since the Reid Glacier was then less than 5 kilometers (3 miles) away. Captain Smith recounts that Joe and Muz had agreed that if one of the couple died while they were in the wilds together, the other would die right away. "I think I would feel the same way," Smith reflected, "if I had lived out there all that time with a wife." The Ibachs' last year together at Reid Inlet was 1956. Muz died in Juneau's St. Ann's Hospital in 1959. Joe died in 1960, still planning to visit Reid Inlet. The morning after planning his return, Joe shot himself. At the bottom

of his will, written on brown wrapping paper, Joe had added: "There's a time to live and a time to die. This is the time." The unconscious ambiguity somehow sits well in this terrain of paradoxes.

Of all Glacier Bay's extremely few residents since Indian days, perhaps only Joe and Muz Ibach and Jim Huscroft stand out. Huscroft lived alone on Cenotaph Island in Lituya Bay from 1915 or 1917 to 1939, when he died there, still alone. He was the only outer coast resident for a 240-kilometer (150-mile) stretch. Once a year he went to Juneau for supplies and to pick up the past year's stack of newspapers, saved for him at the Elks Club. Back home on the island, he read one paper a day, a year late, never cheating by reading ahead one day. Huscroft's biggest yearly event was Christmas dinner. He sat down to it alone with 14 kinds of homemade pie!

The paucity of human neighbors for Huscroft suggests how vast this untrammeled landscape is. The designated wilderness *inside* the park and preserve is larger than Yellowstone National Park. Since 1986, Glacier Bay has been part of a far larger international Biosphere Reserve, and, since 1992, part of the larger still Wrangell-St. Elias National Park and Kluane National Park (Canada) World Heritage Site—now at 24 million acres the world's largest internationally protected area. One glacier in it is larger than Rhode Island. The scale of wildness suffices to nurture unfettered the dynamics of the more-than-human world and to preserve intact these landscapes of our continent's human origins. Wilderness and culture are but parts of a larger grammar here.

There must be profound satisfaction in venturing, as Eliza Scidmore did, to such an area as Glacier Bay so early in its tourist history. Indeed, after describing the Muir ice front and "the crack of the rending ice, the crash of the falling fragments" with their steady undertone like the boom of Yosemite Falls, Scidmore adds this note: "There was something, too, in the consciousness that so few had ever gazed upon the scene before us, and there were neither guides nor guide books to tell us which way to go, and what emotions to feel." Those words appear, paradoxically, in her illustrated guidebook, *Journeys in Alaska*, issued the very next summer. We hope this Glacier Bay handbook serves you as well as hers served a generation of Alaskan travelers.

Part 2


Of Time and Ice


110
US GEOLOGICAL SURVEY
GROWLER

Tidewater Glaciers

Ice research vessel Growler *rests in Johns Hopkins Inlet. Author Ruth Kirk traveled aboard with glaciologists for one of her many Glacier Bay trips. In Part 2 of this handbook she recounts her travels, the dynamics of tidewater glaciers, and the park's natural history. Depth readings made aboard* Growler *and* Bergy-bit*—hanging astern on davits—are interpreted for you by the illustration on pages 46 and 47.*

Pages 22-23: *Pan ice simmers golden in low sun on Johns Hopkins Inlet.*

In a small way, I once touched time. It was July and my husband, Louis, and I were camped in Reid Inlet, an exquisite fjord fingering off Glacier Bay's main, upper waterway. Our tent was pitched near a 1940s gold miner's shack, which that summer was serving as headquarters for park ranger Ole Wik and his wife, Manya. Rock peaks and ridges walled our horizon. At the inlet's head a glacier tongue calved icebergs directly into saltwater. From basketball to Detroit limousine size, these ice chunks rode the currents and stranded ashore on each outgoing tide, making the beach a sculpture garden. Manya lugged small stranded bergs home in pails hung from a shoulder yoke. The ice turned a pit dug in the coarse upper beach gravel into an icebox.

One evening, the Wiks and Louis and I decided to make ice cream in an old hand-crank freezer. Out from the pit came fresh eggs, which Manya mixed with powdered milk dissolved in creek water and sweetened with honey. Ole and Louis chipped salvaged bergs and packed the ice fragments into the freezer. We turned the crank till it would turn no more and then spooned out the ice cream.

Icebergs floated on the tide just offshore. We sat reveling in the 11 p.m. sunset and feasting on the ice cream. A cormorant, its sleek body and upright neck a dark silhouette against the water's pink tint, rode one berg. New bergs sporadically broke from the glacier, their birthing thunder a syncopation for the evening's hush. Ole mused aloud on our having used the iceberg's cold to freeze our ice cream. Indeed, for the ice this concluded unknown decades of an existence begun as fluffy snow that was then compressed to ice, owing to the sheer weight of snow accumulating above it.

By the Grand Pacific Glacier: Reid Inlet ice cream comes to mind now, four Julys later, as I cook breakfast aboard *R.V. Growler*, a U.S. Geological Survey ice research boat. Oatmeal bubbles on the

galley's oil range as I set out the corn muffins I've baked. The big galley table is at once workbench, library desk, and center for food preparation, eating, and socializing.

Five of us are aboard. In charge is glaciologist Austin Post—tall, strong, with a grizzled beard that hangs to his chest and gentle eyes that laugh. His assistants, college-age, capable, enthusiastic, are David Janka, Emily Chase, and Austin's son Charles Post. My role is as observer and photographer.

For two hours we've been taking depth readings in front of Tarr Inlet's Grand Pacific Glacier. Its ice, along with that of the Margerie Glacier, blocks the extreme upper end of Glacier Bay. Data recorded by *Growler's* electronic sounder will make it possible to chart the bottom contours here. The contours will help in understanding tidewater ice, which responds to various factors aside from climate. Why, for example, is the Grand Pacific Glacier advancing, while just to the east, the Muir Glacier has been rapidly retreating for a century? What accounts for such diverse behavior in the same area?

Glacier ice today whitens a tenth of the world's land surface, as much as is now farmed. A few thousand years ago glaciers covered triple this area, as they someday surely will again. Boston's Bunker Hill is a drumlin left behind by glacier ice. Erratic boulders dot Manhattan's Central Park, transported from Canada by glacier ice. Duck hunters in Minnesota set decoys on pothole lakes formed by melting ice remnants. Plains farmers grow wheat in loess, windblown glacial sediment. French vineyards are also in loess. Drink French wine and you toast the Ice Age. Yet despite the magnitude and recurrence of glaciers, knowledge of them is little more than well begun. Glacier Bay is one of the widely recognized field laboratories for glaciology.

Growler is in Glacier Bay as part of a continuing study of tidewater ice. Austin Post can visualize these ice tongues and how they behave. For 20 years he has been making aerial photographs of glaciers from the Andes to the Aleutians and painstakingly mapping their changes. Austin does not merely rejoice to know that the world is not only blue and green but also white. He *prefers* the white. When I came aboard *Growler*, he asked me about the weather in Seattle. "Sunny and hot," I said. "That's awfully

hard on the ice," Austin muttered in reply.

At the wheel Austin is now maneuvering *Growler* through floating icebergs. They aren't packed solid this morning and we can work to within one-third kilometer (1,000 feet) of the Grand Pacific's ice face. We won't go closer because of danger from falling ice, but we'll send a small, radio-controlled skiff to bump against the glacier snout and read the water depth there. The glacier front is not floating. It rests on a rubble ridge of its own making. Emily, Dave, and Chuck are with Austin in the wheelhouse, correlating *Growler's* precise position with the depth-sounder record and with Polaroid pictures of the radar scope. I can be spared to cook, but everyone else is needed for the readings. It's 0800 now. We've been underway since 0630, and we will soon cut the engine to drift with the floating ice and eat breakfast.

A moment ago we were swept off course by a melt torrent draining from under the glacier. No depth reading registered until we worked free of its flow, because the stream disgorges so much suspended mineral material that the signal from our depth sounder dispersed instead of striking bottom and bouncing back. Even the water surface is gray with glacial flour, bedrock ground to powder by the pressure of moving ice. Away from the ice front the gray becomes turquoise as the silt mutes but no longer dominates the clear, deep blue of open water. Often distinct color bands persist, their moiré pattern maintained by the water's different temperatures and salinities. Such banding may reach all the way to Icy Strait, 70 kilometers (43 miles) from the nearest tidewater glaciers. We terrestrials think of seawater as homogeneous. It's not.

Nor is a glacier just a mass of frozen water. It is ice, plus flowing water, plus a vast amount of rock debris scoured, rasped, and plucked from the mountains where glaciers are born and from the valley walls and bottoms they inch across en route downslope. In the color banding of a fjord's water surface you witness the sedimentation process that in time fills in enormous submarine troughs and turns waterways into valleys with freshwater streams and wildflowers.

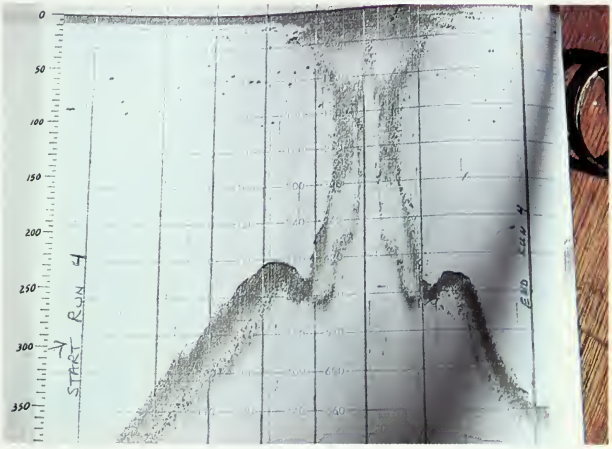
Out *Growler's* porthole the far side of the Margerie Glacier is so blackened with rubble that it looks like rock. Only a melt sheen identifies it from this

distance as glacier ice. Directly ahead of us, moraines of rock debris streak the length of the Grand Pacific Glacier like ribbons. At the sides of the ice face they show as tilted layers dipping into the water. Moraines form as rock tumbles and slides from steepened slopes onto the glacier surface, there to ride the ice and eventually break free as part of an iceberg, or to be released by melt. Moraines are among the legacies of glaciation. They form abrupt ridges of loose rock, gravel, and sand often several-score meters high and extending for long distances. Though in time moraines may become upholstered with plants, their origin remains easily recognizable.

When mineral debris is dropped directly beneath a glacier it may form hills and short ridges known as kames and drumlins, or, if deposited by a subglacial stream, as eskers. Last evening we anchored *Growler* a half-hour's run south of the Margerie ice front, then hiked up a side drainage and sat at dusk watching a loon paddle across a small lake impounded by an esker. Slices of time seemed separated from eternity's flow and laid before us. We had walked through a carpet of dryas plants shaggy with seedheads. Dryas can pioneer poor soil and so can quickly form a green aftermath of glacier ice. We had hoped to find glacio-marine clay—lumps dropped, usually, from floating icebergs—remnants from millennia ago when seawater covered where we sat watching the loon.

Floating bergs, the white peaks, and the processes of mineral transport and deposit, have all repeatedly characterized the Glacier Bay scene. Until recently, geologists believed that the last million years had brought four major ice ages. Now they see these as composite glacier advances, retreats, and re-advances. The number of such pulses was closer to 40 than to four, with one series often hard to discern from another.

Expanding glaciers clear virtually everything movable from their paths, so nothing more than traces of early glaciations are likely to remain. One such trace lies along the outer coast of Glacier Bay National Park. Marine tillite, glacial debris deposited in seawater, is there interbedded with layers of siltstone and sandstone for a total thickness of nearly 2,000 meters (6,500 feet). The ancient tillite formed by the same mineral dumping process I've been



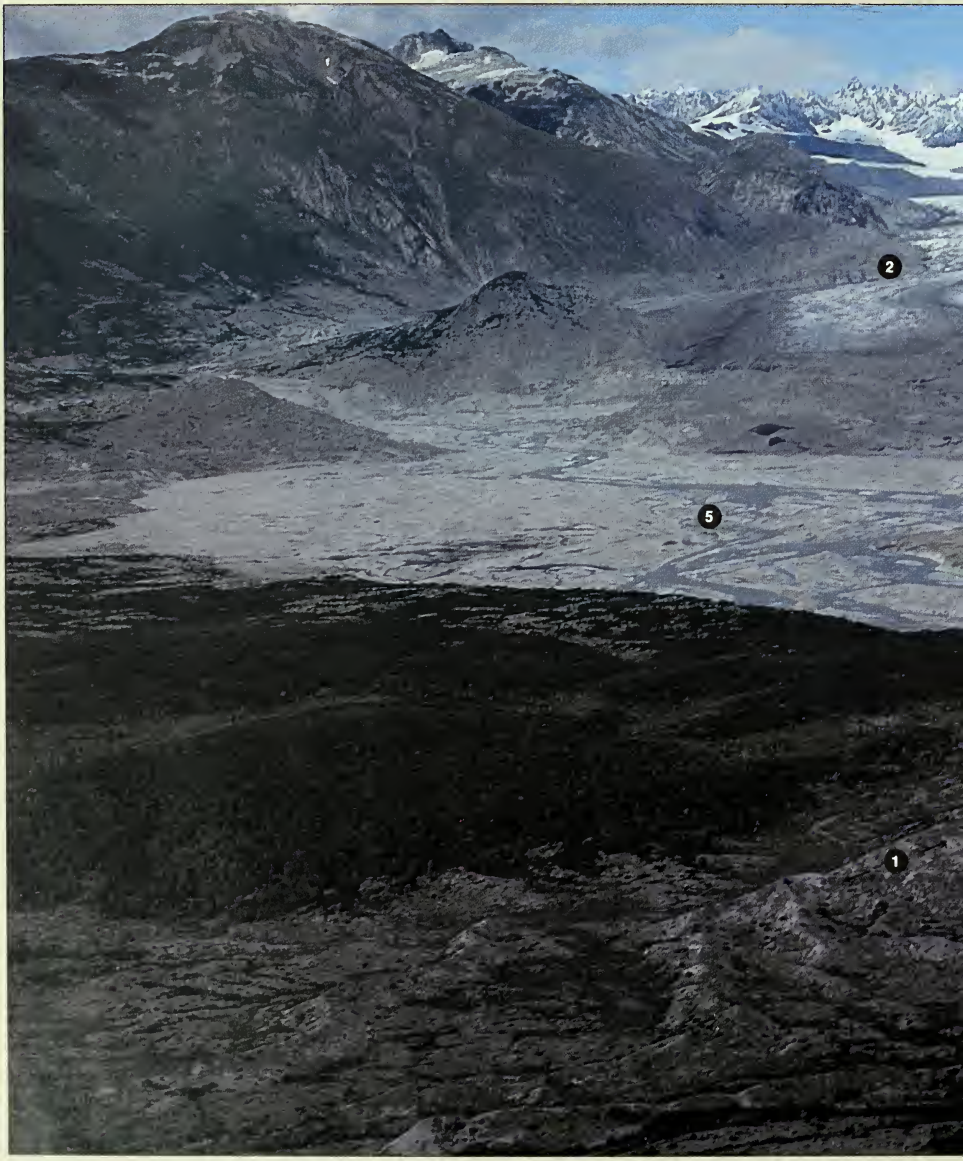
Researchers ready depth-recording instruments inside Bergy-bit's *covered hull (top). Glaciologist Austin Post (middle) plots bathymetric contours aboard* Growler. Bergy-bit's *chart (bottom) shows the Gilman Glacier ice front. On the author's trip aboard* Growler, Bergy-bit *charted an underwater canyon at the Johns Hopkins Glacier ice front.*

Post-Glacial Land Features

Retreating glaciers leave behind characteristic land features, some shaped by the ice, others by meltwater. In your travelogue, impress your friends with the technical term: glacio-geomorphological features.

❶Eskers form as a stream tunnel beneath a glacier fills in with rubble. Eskers look like inverted streams winding snake-like across today's landscape.

Moraines form in various ways. ❷Lateral moraines form where the sides of a glacier shove up mounds or ridges. ❸End moraines, glacial dumps at the snout of retreating ice, trend perpendicular to its flow. Ground



moraines are deposited under moving ice. ❹ The dark stripes on Casement Glacier (below) are medial moraines. They were once the lateral moraines of the tributary glaciers squeezed together to form this glacier.

❺ Outwash plains are meltwater features. The broad, flat riverbed and braided stream are typical. At times during the Ice Ages, the Mississippi River probably looked like this scene—on a grander scale.

❻ Revegetation flourishes on higher ground. The outwash plain must fix its river channel before revegetation takes hold. Burdened by glacial silt, this streambed wanders over the valley, its changing course stymieing revegetation.

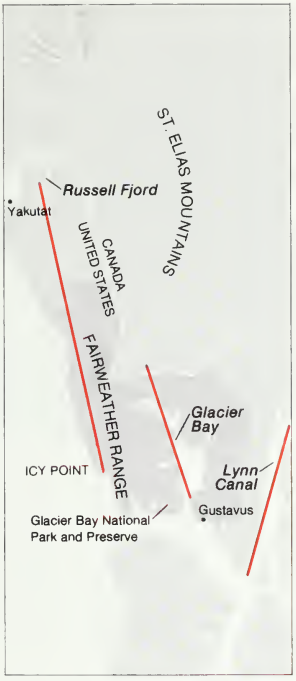
watching this morning. It comes complete with the rafted lumps such as we sought without success last evening—the sort that ride the icebergs I see out the porthole now.

Shells date the layered outer-coast sediments to about 15 million years B.P. (before present.) A park research biologist once told me he found a fossil beech leaf in the deposits. It must have been blown or washed seaward to settle in the ocean-bottom ooze. To have endured for 15 million years seems extraordinary; to be a beech leaf even more so. For that testifies to a scene far different than today's. Glacier ice was then juxtaposed with deciduous forest. Nowhere does such a situation exist today except in Chile where a relative of beech thrives close to ice.

For most of southeast Alaska, the signs of early glaciation are not deposition but erosion. Sharply sculpted high peaks are those plucked by ice. Lower, rounded contours were overridden. You can see this shift from craggy horn peaks to rounded and polished bedrock and so pinpoint the level of a former glacier. In lower Glacier Bay this line comes at about 1,300 meters (4,200 feet).

The period from about 30,000 to 10,000 B.P. brought the most recent worldwide glaciation, known in America as the Wisconsinan because the southern edge or terminus of a vast ice sheet sculpted much of that state's current topography. The Glacier Bay region—and practically all high latitudes and elevations—surrendered to ice during this time. Juneau lay beneath a white shroud 1,500 meters (5,000 feet) thick. At Cape Spencer on the park's outer coast the ice was still at least 900 meters (3,000 feet) thick, with its leading edge somewhere far beyond today's coastline.

Oddly, however, parts of the shore were not veneered by this ice. It may be they escaped because a geologic fault at the western base of the Fairweather mountains acted as a gutter and shunted off encroaching ice. Faults are cracks in the Earth's surface; this one marks where a large sliver or terrane of the Earth's crust slides against another, near the much larger Pacific and North American crustal plates' boundary. California's San Andreas Fault is similar. The Fairweather rift splits off land from Icy Point to Russell Fjord north of Yakutat.



During the Wisconsinan advance the Glacier Bay region surrendered to a vast ice sheet, but part of the Outer Coast escaped this icy veneer. Scientists hypothesize that a geologic fault at the Fairweather Range's western base acted as a gutter, shunting off the encroaching ice. Faults show as red lines on this map.

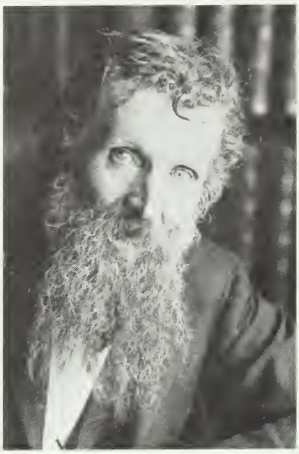
Bedrock is out of alignment along opposite sides of the fault. In fact, whole provinces have slid northward as the oceanic plate collides with the continental plate and heaves up the mountains. Certain rock found at sea level south of Icy Point stands north of the Point at an elevation of more than 3,000 meters (10,000 feet). Less active faults underlie both Glacier Bay and Lynn Canal.

Above Tarr Inlet: It is afternoon and Dave and Emily and I have climbed onto the highest terrace of the slope above the Grand Pacific snout. Dave's altimeter shows our elevation as 269 meters (882 feet). A multi-decked cruise ship drifting among icebergs near the glacier face looks from here like an inconsequential dot. People on deck to watch bergs calve off must see the glacier front as immense. At 60 to 80 meters (200 to 260 feet) high and 6 kilometers (3.75 miles) across, it is.

From our vantage point you see how much more glacier there really is than shows from the water. Grand Pacific flows as an infinity of ice coming from far back in the mountains. Except for crevasses near the snout, its surface looks like a broad white highway, which is how several coastal Alaskan glaciers served Indians and prospectors traveling to and from the interior. Using Grand Pacific as a conduit, wolves and bears have extended their range onto Glacier Bay lands recently melted free of ice and beginning to host life again.

From where we sit it's easy to imagine Tarr Inlet stripped of today's ice, seeing instead either a continuation of today's waterway or a broad terrestrial valley bottom. As recently as the 1920s the Grand Pacific melted its way out of the United States and 2 kilometers (1.2 miles) into Canada. That gave Canada a potential site for her northwesternmost seaport. But by 1948 ice again moved forward as far as the border.

The Glacier Bay bedrock trough is tremendously deep, dropping to 550 meters (1,800 feet) near Gilbert Island. Muir Inlet reaches about 375 meters (1,200 feet), a considerable depth, yet the inlet completely filled with gravel following withdrawal of the Wisconsinan ice! This fill stood higher than present sea level, developing soil and a spruce-and-hemlock forest. Side valleys, dammed by the gravel, seem to have held lakes, because traces of glacial



The theory of worldwide glaciation, published in 1840, only slowly supplanted the Biblical flood in explaining contemporary landforms. Naturalist John Muir championed this glacial theory in the United States. Muir canoed into Glacier Bay with Tlingit paddlers in 1879 from Fort Wrangell to see first-hand the massive glacier now named for him.

outwash gravels cling 250 meters (820 feet) above today's saltwater shores, and lakebed sediments are still in place. Dr. Richard Goldthwait, former professor at Ohio State University, believed that the fill in Muir, Wachusett, and Adams Inlets probably averaged 150 meters (500 feet) deep and 5 kilometers (3 miles) wide for a cumulative 80 kilometers (50 miles) of length. Except for mere whispers, this stupendous volume of gravel fill is now gone. Readvancing ice swept it into the Beartrack Cove area and on southward. The broad Gustavus flatlands are partly old Muir gravel fill.

Wisconsinan glaciers melted back perhaps 11,000 years ago and probably stayed back until about 3,500 years ago, when harsh climatic conditions again favored glacier expansion. Worldwide this Little Ice Age was not dramatic. At Glacier Bay, however, snowfall produced ice more than 1,000 meters (3,200 feet) thick and pushed the glaciers far forward. A tongue of ice once more filled the entire Glacier Bay fjord and bulged out into Icy Strait. This dammed Muir Valley and backed up an enormous lake there that drowned the forest.

About a thousand years after the glaciers' encroachment into the main Glacier Bay fjord, an ice tongue began to advance down Muir Valley. At the outlet it was blocked by the glacier already there. Unable to thrust farther forward, this new ice ponded and flowed back on itself, filling depressions along lower Muir Inlet to such depths that remnants still haven't melted today. They are popular destinations for hikers and give geologists a look at how melting glacier ice has produced much of today's northern-latitudes topography.

The often exuberant, knowledgeable, and renowned John Muir was an early proponent of the continental glaciation theory in North America. Muir canoed north from Fort Wrangell in October 1879, coaxing his Tlingit Indian paddlers onward against their judgment. Fall struck them as a foolish season for venturing among icebergs, but, for Muir, ice was the reason for the journey. Aged 41, acclaimed champion of all nature, specifically fascinated by glaciation, Muir became the first Glacier Bay sightseer to write extensively and glowingly about the wonders of what now is the national park. His first trip was brief, but in the summer of 1880 and again in

Harry Fielding Reid first lugged his theodolite and plane table about Glacier Bay in 1890. So began the accurate plotting of ice positions that is critical to relating glacier behavior to climate change and other factors.

1890, Muir returned. By the time of his third trip, tourists were visiting Glacier Bay aboard side-wheel excursion steamers. Eliza Ruhamah Scidmore wrote in a *National Geographic* article of "stopping, backing, and going at half speed to avoid the floating ice all around . . . [which] occasionally was ground and crunched up by the paddle wheels with a most uncomfortable sound."

The Muir Glacier—newly named for the famed naturalist—had scarcely begun its retreat at that time, though the ice filling Glacier Bay proper had drawn back 60 kilometers (37 miles) in the century since British Captain George Vancouver had noted its presence in 1794. This glacial retreat of this scale is the fastest known anywhere, anytime.

Fortunately for the understanding of Glacier Bay's chronology, Harry Fielding Reid, a pioneering glaciologist, arrived here in 1890, about 30 years after the Glacier Bay recession had exposed the Muir Glacier for the first time. Through the summer of 1890 and again two summers later, Reid explored by rowboat and on foot, lugging a cumbersome theodolite and plane table for mapping glacier positions. "We once approached to within a quarter mile of the ice cliffs of Muir Glacier, which towered impressively above us," Reid wrote. "Suddenly a large berg broke off, followed immediately by a second, and then several arose from below. Great breakers which must have been 30 feet high, rushed forward, but fortunately subsided into an even swell before reaching us. The fragments of ice spread out with great rapidity and in a few minutes quite surrounded our boat."

The Grand Pacific Glacier was then fused with the Margerie, their joint terminus barely separated from the Johns Hopkins Glacier. Reid wrote that the continual calving of that great ice cliff, nearly 10 kilometers (6 miles) long, was "keeping the inlet well covered with floating ice and the air pulsating with the thunder of its fall."

No wonder the Tlingits thought John Muir reckless, though he gloried in the calving bergs' "awful roaring, tons of water streaming like hair down the sides, while they heave and plunge again and again before they settle in poise and sail away as blue-crystal islands, free at last. . . ." John Muir, too, had touched time.

Galloping, Calving, Advancing, Retreating

Mad wreckage of the retreating Muir Glacier ice front chokes adjacent waters. The glacier retreated about 5 kilometers (3 miles) between 1972 and 1982. It has retreated more than 25 kilometers (15 miles) in this century, at widely varying rates.

Johns Hopkins: All morning we have been charting in upper Johns Hopkins Inlet. The high peaks of the Fairweather Range thrust like white fangs above us. Beside us rise gray, bare, abrupt rock walls. We arrived here aboard *Growler* about 2100 last evening. Sunlight still flooded the upper walls but the water already stood in twilight, lending an eerie quality to this cathedral-like fjord. Eager to see whether the Tyeen Glacier had surged forward since last summer, we barely noticed, however. Austin, Dave, Emily, Charles, and I all crowded into the wheelhouse, with last year's aerial photograph on the chart table for comparison with what we hoped to see ahead, a glacier that galloped. Alas, no drama greeted us. The ice still hung near the top of the cliff, poised to surge, perhaps, but far from having done so.

Two hundred surging glaciers are known in Alaska and northwestern Canada, with some occasionally surging several kilometers in a single year. These extraordinary advances occur only on certain glaciers. No glaciers overlying granitic bedrock are given to surging. Many that do surge are associated with geologic faults, but not all. Water beneath the ice has been advanced as an explanation for surging glaciers, but this may not be the whole answer.

A mountain glacier is usually rushing if it moves a meter or two (4 to 7 feet) a day. Deformation permits the ice to bend and slide around obstacles, and the enormous pressure against any such protrusion produces enough heat to melt a fraction of the glacier's undersurface. Lubricated by this minute film of meltwater, the ice jerks forward. That relieves the pressure and the melt-film refreezes. The process starts anew.

I once watched this happen where University of Washington researchers had dug a 25-meter (85-foot) tunnel to bedrock beneath the Blue Glacier in Washington's Olympic Mountains. Gauges imbedded in the tunnel walls measured the pressure the ice

exerted against irregularities in its bed and the rate of its jerky flow over and around them. Dials dispassionately registered what was happening, but you could see it without them. A knob of bedrock might have ice pressed against it. Then a momentary wetness would darken the rock and an additional fraction of the knob would be engulfed. The process was silent and, but for the glaciologists' lights, would have taken place in utter blackness.

While it is not very likely that you would get to witness the surging of a glacier during your stay in the park, most people who visit Glacier Bay do get to see the park's glaciers perform what is unquestionably their most stupendous scenic spectacle: the calving of icebergs off their tidewater snouts. When the glacier ice comes in contact with saltwater, it melts at a much more rapid rate than does ice that is exposed only to the open air. This increased rate of melting produces an undercutting of the front of the glacier and therefore reduces the amount of support for the ice above it, which is exposed only to the air. The amount of their ice that is exposed to the sea water, along with the speed of their forward movement, are the factors which help explain why some glaciers calve so actively, and others do not.

Icebergs themselves are far from uniform. Those that look white hold myriad trapped air bubbles. Blue means denser ice. Greenish-black ice is from the bottom, or sole, of a glacier and such bergs may also be grooved where bedrock knobs have gouged the glacier. Morainal rubble stripes some icebergs with brown, or totally darkens them. Rocks ride atop bergs and plop into the water from their sides.

Stranding icebergs leave tracks as they half float, half drag along the beach. And they grind, squash, and rip seaweeds and mussels pioneering rocky shores. Floating bergs offer perches favored by bald eagles, cormorants, and gulls. For eagles the bergs seem to serve as movable vantage points for spotting opportunities to prey or scavenge. Cormorants often hold out their wings to dry while they ride. Most gulls just rest. Kittiwakes—gulls that come ashore only to nest—briefly ride Glacier Bay icebergs during their August transition from nesting colonies to life at sea. Guillemots and puffins never ride the bergs, perhaps because of difficulties landing on ice. Their legs, set far back and fine for swimming, are

awkward out of water. Land birds, except for eagles, generally ignore icebergs.

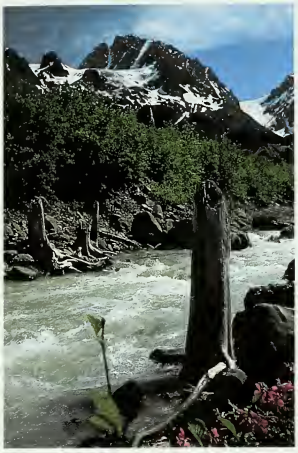
As you kayak among bergs, paddling silently, you hear melt take its toll. Water drops and cascades. Air bubbles pop and ice cracks constantly as it adjusts to changing pressures and temperatures. Even with your eyes closed, you can tell icebergs are close. How high bergs float depends on their size and ice density and on the density of the water. Where runoff or rainwater floats atop saltwater, bergs sink lower than if freshwater is absent. The burden of rock and sediment in the ice sometimes weighs a small berg below the surface. A faint shadowy presence is all that gives it away.

Huge bergs, recognizable by distinctive shape or patterning, may last a week or more, though they split or turn over as reshaping melt affects balance. What had seemed a modest floating crag may, when rolling over, suddenly loom as an enormous hazard if you've paddled too near.

Studying a beached iceberg reveals its fabric and susceptibility to melt. Ice crystals that measure a centimeter (0.4 inches) or more across interlock as in a three-dimensional puzzle. Along such interfaces sun warmth and saltwater attack. Grasp a projection and wiggle it. You will hear a squeaking as the crystals rub one another along these junctions.

Last evening Dave stood near *Growler's* bow as we approached the upper end of Johns Hopkins Inlet. Net in hand, he scooped up icebergs for the refrigerator. We had run close to the Johns Hopkins and Gilman glacier faces to take bottom readings. For these, Austin used *Bergy-bit*, the little radio-controlled boat which amounts to a sleek hull fitted with a tight lid. Only its three-horsepower electric motor projects vulnerably. We placed one of *Growler's* depth sounders inside *Bergy-bit*.

Mid channel approaching the Johns Hopkins snout, *Growler* consistently recorded a water depth of 400 meters (1,300 feet) and a flat bottom, the sort of uniform contour expected of fine-grained sediments deposited in deep water. The water is so deep that there is no anchorage in this inlet. The bottom lies far beyond an anchor's reach even along the sidewalls. To our surprise, however, about one kilometer (1.5 miles) from the glacier face we measured water "only" 150 meters (500 feet) deep. The glacier is



Stumps are all that remain of ancient forests that flourished between the major ice advances. Some such silent park sentinels lived when Egypt's great pyramids were under construction.

Pages 40-41: *Icebergs are not uniform. White ones hold myriad trapped air bubbles. Blue indicates denser ice. Greenish-black ice comes from the glacier bottom. Brown stripes denote morainal rubble. The sighings and creakings of an iceberg's slow demise are—with the percussive drip of meltwater—quite musical.*

pushing a steep-sided submarine moraine far out ahead of its front—and thereby creating a situation that Austin was seeing for the first time.

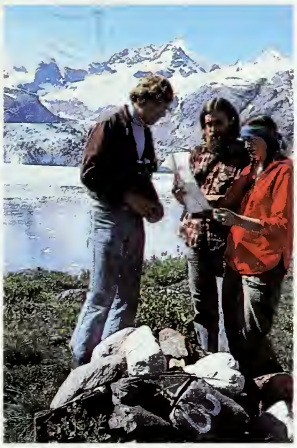
We sent *Bergy-bit* along the east side of the Johns Hopkins ice front, and the entire front of the Gilman Glacier, and then, barely before midnight, quit for dinner. For the past two hours I had supposed we would stop, so I kept spinach noodles hot on the stove, and they turned into a startling green goo. Rather than admit culinary defeat I topped the mass with Parmesan cheese and croutons and baked it. Camaraderie and hunger sufficed to prompt praise for my baked goo. By the time we finished dinner it was technically already morning.

We drifted all night. With the water too deep for anchorage, we had to depend on pack ice to hold us safely away from the fjord wall. We took turns standing watch, a long boat hook in hand for pushing off bergs that might cause trouble. At one point Emily roused Austin to start the engine and work free of encircling ice that brought with it an iceberg towering higher than *Growler's* rail.

Mostly it was a night of ethereal peace. There was no moon but the floating ice reflected enough light so that on watch you could make out closeby bergs and the seals circling us like dark phantoms. Occasionally a seal would signal the sudden end of its curiosity and slap the water with its hind flippers, then dive. Otherwise, the only sounds were a faint roar from distant waterfalls, the sporadic grinding of ice against *Growler's* hull, and once the splash of an iceberg rolling over.

This morning we resumed readings with *Bergy-bit*. I sit out of the way atop the wheelhouse while Dave controls the skiff with the radio transmitter and Emily watches with binoculars, telling him which way to turn so as to steer *Bergy* through leads in the ice pack. Falling ice strikes the little boat with a loud *clonk* and for a while *Bergy* vanishes from sight amid a welter of falling and surging bergs. Then we see the dot of its brilliant red hull and know it has survived. Bottom readings are clear. They show a depth of 350 meters (1,100 feet) close to the west side of the Johns Hopkins ice front. We have just charted an underwater canyon.

The Johns Hopkins Glacier started advancing more than 50 years ago. South of here the Brady



Ashore at Photo Station 3, marked by a cairn, Growler *crew members try to ascertain changes in glacier positions.*

Icefield and Glacier extends a full 70 kilometers (43 miles) through the Fairweather Range to Taylor Bay. Indeed, the Reid Glacier and the Lamplugh, near the mouth of this inlet, are lobes of the Brady. It is an ice mass today choking a fjord, much as ice a few centuries ago sealed the Glacier Bay fjord, forcing out the Chookaneidi' Tlingits and denying entrance to Captain Vancouver. Why the asynchrony? Among the national park's current tidewater glaciers, that is, why are some advancing, some retreating, and most simply holding their own?

Photo Station 3: We have rowed ashore on the west side of Johns Hopkins Inlet to photograph the glaciers from a position first used decades ago by Dr. William O. Field, of the American Geographical Society. This station is simply a rounded, glacier-polished outcrop of white rock partly veneered by a mat of dryas runners rooted nearby. A low stone cairn holds a jar with a registry of those who have made official photographs here. It requests anyone who takes unofficial pictures to send copies to the Society to enhance the record. There are only four entries, beginning with 1958. The position is stunning. We see the Johns Hopkins and Gilman Glaciers clearly and half a dozen high peaks, including Mount Crillon, almost 4,000 meters (13,000 feet) high.

I once talked with the late Dr. Field in New York City. White haired, the epitome of a gentleman-scholar, he was dean of those who had studied the Alaskan glaciers. From memory he recited which glaciers were advancing, which retreating, and in what years. As a young geographer he had pondered the small amount of ice left in the United States compared to its dominant role in shaping the land. "That's when I got hooked," he told me.

In 1926 on his first trip to Glacier Bay he noticed immense changes in the ice positions documented by pioneering glaciologists beginning in the late 1800s. Harry Reid, for example, had written about "changes expected in the next 50 years." Where Reid's map showed solid ice, Field watched whales and seals. The ice was gone.

"You need continuity in a record," he told me. "Otherwise there's no way to see what's happening. The Johns Hopkins Glacier, for example, has advanced a mile since I first saw it in 1926 and it's still coming. Small glaciers show change more quickly

These pictures taken by William O. Field from Photo Station 3 document the advancing position of the Johns Hopkins Glacier in (top to bottom) August of 1941, 1950, and 1976. This glacier began its current advance about 50 years ago. Use the mountain peaks as reference points to verify the advance for yourself. Nearby Gilman Glacier, and a small hanging glacier on Mt. Abbe, above the Johns Hopkins, have hardly changed since the 1930s.

Professor Field sets up for theodolite readings from a survey station near Muir Glacier in 1976.

than vast icefields can. Greater accumulation than normal, or more melting, and they respond almost right away. Yet glaciers aren't simply barometers of climate. There's more to it, especially with tidewater glaciers."

The lack of glacier documentation had launched Field's career. Getting data takes remarkable persistence, partly because of the mammoth compilation needed and partly because of isolated and difficult working conditions.

"You need triangulation to keep track of what an ice front is doing, but maintaining usable triangulation points gets tough at times," Dr. Field reminisced. "You may go back and find a station worthless because alder has grown so much you can't see out, let alone do any surveying or even take a picture.

"Or if the ice is advancing, you have to move the station out of its way. If it's receding, you still have to move so as to stay close enough to do any good. In the 1940s we watched the Grand Pacific Glacier advance from Canada back into the U.S. We'd set up a station and it'd be obliterated before we could get back on another trip. Access was a problem, too, even if the station was still there. We had a real battle getting to the photo point between the Margerie and the Grand Pacific. The beach we needed to land on often was completely blocked by floating icebergs. And the calving of new ones set up shock waves that kept us alert the times we did go ashore."

Field said that tidewater glaciers "confuse the whole picture" in measuring past climates. As an oversimplification, assume the steady nourishing of a glacier by yearly snowfall. Once equilibrium is reached, this ice should neither thicken nor thin, advance nor retreat. Given present climate, this fairly well describes most ice tongues in Glacier Bay National Park and Preserve except for those that reach saltwater. These cause the confusion, but research aboard *Growler* has contributed to understanding them. Receding tidewater glaciers reach into deep water. Advancing or stable tongues end either on marine shoals or where the heads of inlets rise above sea level.

If deep water spells retreat, what's the depth where tidal glaciers are advancing? Shallow. Usually less than 80 meters (260 feet).

Why? The glaciers themselves make it so. They

Tidewater Glaciers

A tidewater glacier is one whose snout touches tidal water, such as Glacier Bay. Nine glaciers actively calve icebergs into tidal water in the park. This painting—based on the Johns Hopkins Glacier—shows you the dynamics and effects of such a mammoth tongue of ice from near its mountain origins to the submarine sole of its snout. The submerged fjord walls and floor are interpreted from contour lines plotted from bathymetric readings taken aboard the research vessel *Growler* (see

photos on pages 24 and 29). An advancing glacier is like a combined bulldozer and conveyor belt. It cuts and shoves material around, and conveys it forward from the mountains; Johns Hopkins Glacier began its current advance some 65 years ago. To support its advance, a tidewater glacier builds a protective shoal at its snout by dumping rock debris. Plucking material from the up-slope of this ridge and depositing it on the down-slope enable the glacier to advance in deep water. This balance is precarious. The least retreat may back it off the shoal. Rapid retreat then sets in until the glacier reaches shallow water, where it may rebuild its protective shoal.

Climbers sometimes find the Fairweather Range, with its quixotic and severe weather, misnamed. This immense land seems to triple in size immediately when you get in a tight spot.

advance only if they've built a protective shoal at the snout, by dumping rock debris. This forms an underwater terminal moraine and provides a partial barrier between the ice and the erosive action of sea water. By plucking material from the up-slope of this ridge and redepositing it on the down-slope, a glacier can keep advancing along even a very deep waterway.

How fast? Perhaps one to three kilometers (0.5 to 2 miles) per century. Eventually the ice may become so extended that the amount lost from the surface melt and calving matches the snowfall feeding the upper glacier. At this stage, balance is so precarious that even a slight retreat causes the snout to back off its shoal and re-enter deep water. Irreversible retreat then continues until the glacier reaches shallow water, usually at the head of tidewater. There it stabilizes, at least until it builds enough shoal to begin a new, slow advance.

Sometimes I resent the name Johns Hopkins for this inlet. It comes from an early-day university expedition here. It struck me as audacious to make an institutional trophy of such scenic magnificence. Bob Howe, park superintendent when I first visited here, clamped a moratorium on further naming of peaks, valleys, waterfalls—or anything. He felt there should be places where humans experience the pristine without presuming to label. The gift shop manager of a cruise ship told me she put up a *closed* sign during her first trip into Johns Hopkins Inlet. "Come to the upper deck if you need film," her note read. "The shop will reopen after we leave Johns Hopkins." It's that beautiful.

Reid Inlet: We anchored *Growler* about 0200 this morning. We'd eaten another midnight dinner after finishing the Johns Hopkins depth readings and hiking across the Topeka Glacier outwash, looking for inter-glacial wood. We debated: stay in Johns Hopkins or run to Reid Inlet? Austin decided to run because we might be too tired to stand effective watch through the night. There was too little pack ice in Johns Hopkins Inlet to hold *Growler* safely free of the sidewalls as we drifted. Two other vessels also were running, their distant lights ghostly companions for this late and weary hour. One could only speculate who these boats might be, drifting off the pack ice off the Margerie Glacier. Perhaps one was a sailboat awaiting the winds to take it home, and the

other was a tourboat standing idle hoping for one last icefall before the onset of darkness.

Harry Reid's 1890 map of this inlet now bearing his name shows nothing but ice here. No land at all. Even in the 1940s, when Joe and Muz Ibach built a distinctive little cabin and began mining pockets of gold ore high on the cliffs, the Reid Glacier had drawn back no farther than the toe of their beach. Now, however, you can boat some 3 kilometers (2 miles) into the inlet.

After breakfast this morning we motored *Growler's* dory across from our anchorage, following as close as is prudent to the bulging ice face. "The glacier must be advancing," Austin said. "Look at the push moraines." He pointed out low ridges of rock and gravel slightly ahead of where ice is pressing against the inlet's sidewall. Circular mats of dryas are half swallowed by the advance. Sheer crevasses split the ice where its leading edge has thrust across the land. They form 50-meter (164-foot) slits clearly visible against the sky.

Aboard *Growler* I have been seeing advancing or stable glaciers, yet other glaciers in the park are rapidly withdrawing. Muir Glacier has gone back 40 kilometers (25 miles) since 1890 when Reid mapped its terminus barely above the inlet's junction with Glacier Bay. In the years my husband, Louis, and I have been coming to the park we have seen the Muir front separate from the Riggs Glacier and retreat far up the inlet. As of 1994, this glacier has been essentially grounded, no longer a true tidewater glacier.

Elevation may partly explain why some glaciers are now advancing while others are withdrawing. Tarr, Johns Hopkins, and Reid inlets all finger from high peaks. Plateaus feeding their ice typically stand 2,000 meters (6,500 feet) high and are subject to prodigious snowfall. The park's retreating glaciers, on the other hand, derive from elevations averaging about half that high. The uplands near Glacier Bay's mouth, where ice is gone, rise little more than 350 meters (1,100 feet) overall. This difference in park elevations separates northwestern advancing ice from eastern receding ice. And the Brady Icefield's immensity seems to influence its own weather. The icefield chills moisture-laden clouds from the Pacific and triggers their glacier-nourishing release.

Surprisingly small temperature differences account

for radically varying glacial effects. The Wisconsinan Ice Age was only 5 to 6 degrees Celsius cooler than today. The following warm period averaged perhaps one degree warmer than today. During the Little Ice Age here, the elevation above which more snow fell in winter than melted in summer was about 830 meters (2,700 feet). Today this point stands at 1,600 meters (5,200 feet)—except for the Brady Icefield, where it is half that.

No wonder the glaciers that are more likely to advance now are those with their heads high in the mountains. The dice are loaded against the others, aside from the peculiarities of tidewater ice. Viewed on a time scale of millennia, all glaciers are responding to climate. They are asynchronous only in terms of centuries and decades, time scales more comprehensible because they better match our lifespan. What we view as significant events may be minute fluctuations on the millennial scale, which is, for glaciers, the more true scale.

Post-Glacier Plant Succession

Harebells (front) and fireweed push up their colors from streamside rock rubble tumbled like fist-sized gems by past torrents of glacial meltwater.

In Muir Inlet: A photograph taken in the 1890s shows an excursion steamer at the Muir ice front and, perched closeby on a completely barren moraine, the one-room cabin where John Muir hosted Harry Reid's research party. Today the cabin is just an overgrown heap of chimney stones and from the place where the photo was taken you can't even see out through the alder and spruce. As for the glacier snout, it's now 40 kilometers (25 miles) away. Just as glaciologists find these inlets ideal for pinpointing the coming and going of ice, botanists revel in the chance to document the plants' green conquest of denuded landscapes retreating glaciers leave behind.

My husband, Louis, and I were at the Muir snout this afternoon with Chess Lyons, aboard our small sloop, *Taku*. At 7 meters (23 feet) long, *Taku* is outclassed by some icebergs we sailed among. We brought the sloop to Juneau by ferry and then sailed and motored to Glacier Bay. Louis is a skilled sailor so enamored of the sea that I suspect saltwater, not blood, flows in his veins. Our friend Chess has no sailing background but his career as naturalist with British Columbia Provincial Parks—he is now retired—and maker of nature films has given him abundant outdoor experience. I am adept in the galley, less so in the cockpit, yet enthusiastic about life afloat, whether aboard *Growler* last month or now *Taku*. We ate today's lunch while sailing up the inlet, wind flicking salad from our bowls. Even without sails raised, *Taku* heeled ten degrees. With sails, we traveled faster than *Taku's* rated hull speed of seven knots.

Yesterday we motored to the head of Wachusett Inlet, a Muir tributary. The lower part of Wachusett Inlet, longest free of glacier ice, is green with vegetation while utter barrenness still characterizes the newly ice-free upper reaches. At the head of the inlet we hiked to the divide separating Wachusett from Queen Inlet. This took us backward through

vegetation's green chronology: The lower the slope, the more recent the plants. Hiking at first was like crossing a desert alluvial fan except that we found *no* plants. Even in Death Valley you can't take a dozen steps without coming on greenery. Here was nothing but sand and rock. The land is virgin, newly released from the ice.

A bit higher I finally noticed a plant, a single fireweed half a finger high. Soon other fireweed plants and equally tiny willows were present. Upslope the plants gradually got taller and the willow even had branches. We added scouring rush to the species list we were keeping, then dryas. The dryas stood a centimeter (0.4 inches) high, each plant having six leaves. I kept the lens cap on my camera because the plants were so widespread and puny that footsteps kicked up dust.

The vegetation changed abruptly as we reached a high terrace that had been free of ice substantially longer than the slopes below. The willow now reached halfway to our knees. Leathery-leafed dryas plants formed circular mats, and cushions of dark, dry moss padded spaces between alders growing as high as my shoulder. At the divide we found Christmas-tree spruce and carpets of heather. We had walked backward through plant succession, beaching our dinghy on land born just two years ago and climbing to a surface now green, but new a century ago when Harry Reid made his glacier map and John Muir explored the inlet that bears his name.

Plant beginnings may be no more than "black crust," a cohesive feltlike nap believed to be mostly algae. This helps stabilize silt and hold in moisture. Moss adds thicker, more conspicuous tufts to the covering, and windblown spores and seeds of plants from scouring rush to fireweed and willow, spruce, and alder arrive and root. Along beaches, seeds such as those of ryegrass ride ashore on extreme high tides. Blueberry and crowberry seeds get deposited in bird feces, the seedlings thereby benefitting from minute dots of fertilizer. Bears and wolves and mountain goats, shaking water from their pelts, may shake out clinging seeds picked up where they last fed. Campers sweeping out tents may also contribute. By such means, vegetation's green conquest makes its start.

Successful growth depends in part on where the

In raw landscapes dryas builds soil and adds enriching nitrogen. Fossil and pollen studies show that this matting plant pioneered much of Europe and North America when the last Ice Age ended.

seeds happen to land. Glacier till and outwash are notoriously deficient in nitrogen and at first produce stunted, yellowish plant growth. Green exceptions to this rule are alder and dryas. Both solve the problem by associating with micro-organisms that draw nitrogen directly from the air. Alder relies on molds living on its roots in nodules about the size of grain kernels or sometimes as big as walnuts. Dryas roots apparently interrelate with mycorrhizae, minute fungi that sheathe the roots of many plant species and stimulate growth in ways not fully understood. The process seems to involve enzyme and nitrogen production.

Fossil leaves, seed hairs, and pollen recovered in bogs and excavations indicate that dryas pioneered much of northern Europe and America at the close of the last Ice Age. Their first year the plants produce single rosettes of tiny leaves. The next year this growth triples; the third year it quadruples. Mats well over a meter (a yard) across develop after five years. At this stage, lateral shoots rapidly fuse individual mats into massive carpets.

Hardy and flexible, Sitka alder begins to dominate suitable sites within a couple of decades following glacier retreat. It eventually forms dense stands that are abominably tangled—and disliked by humans who are afoot. At this stage trees are about 3 meters (10 feet) high, the limbs of individual alders growing low and wickedly interlocked. Hike through such thickets and you find arms, legs, shoulders, eyeglasses, bracelet, and backpack each caught separately and pulled in differing directions. You can't see out. Holding to a course is largely luck without a compass. Brown/grizzly bear tracks thread what openings there are, then vanish. The more you try to see where the tracks lead, the more certain it is that your noisy bashing about will startle a ptarmigan, the explosive whirr of its wings all but stopping your heart until its gravelly *tobacco-tobacco-tobacco* call registers an all-clear: bird, not bear.

"Two of us after three hours of thrashing through this dreaded shrub, emerged at the point where we had set out!" lamented a recent British researcher. But alder has its good side. It stimulates the growth of other plants. Its fallen leaves put as much nitrogen into the soil as alfalfa would. Dryas similarly enriches the soil. Alder and dryas are such successful plant pioneers and become so dominant that you'd expect

Post-Glacial Plant Succession

After glacial retreat, vegetation recolonizes bare, nutrient-poor land in successive stages. Algal plant associations stabilize silt. Moss tufts follow. Then come horsetail and dryas, a matting plant that pioneered post-Ice Age Europe and North America. Willow, alder, and spruce next gain footholds. The climax stage is the mature spruce-hemlock forest found at Bartlett Cove.

Ryegrass (large photo) may pioneer beaches. Inset photos (clockwise from upper left) show: alder, cottonwood, hemlock, and spruce.

Plants Recover the Landscape

For two centuries glacial ice has been melting back in retreat up this fjord we know as Glacier Bay. This means that none of the plant life seen here today is more than 200 years old. Most of it is indeed far younger.

At Bartlett Cove, the full 200 years have allowed development of mature spruce forest. Within this forest more than one generation of trees has had time to grow, many old veterans have died, and fungi and molds have become established in the special habitat of decaying wood. Further up the fjord the number of plants decreases. Living conditions loom more severe and habitats are fewer. At the fjord's farthest reaches, at the ice margins themselves, are only mosses, lichens, and primitive plants struggling to reclaim raw land for coming stages of revegetation.

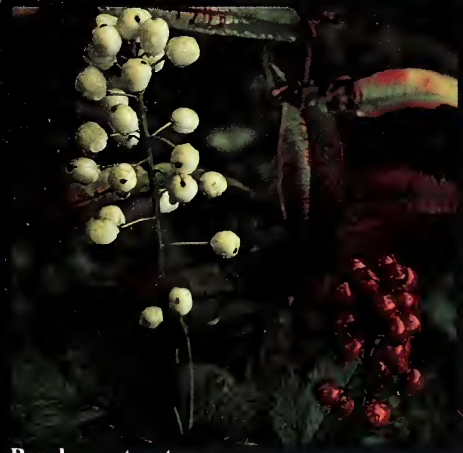
It is difficult to imagine that the landscape of richly forested Barlett Cove was so recently similar to the glacier rubble of the stream-cut terminal moraine shown at right. However, the setting of this stream, issuing from a nearby retreating glacier, repeats the scene that has been marching up-bay for two centuries.

Red columbine

Moss

Blueberry

Terminal moraine succession



Baneberry, two types

Fungus

Bitter cress

Skunk cabbage

them to last forever. Their growth is so dense, however, that their own progeny can't make headway. Their role is to stabilize and enrich the soil. That done, they die out and a comparative explosion of plant diversity ensues.

Overall, this successional drama is similar along the shorelands of all up-bay country. First come the scattered pioneers, succeeded by a low-growing mat stage and then a thicket stage. The two major arms of the Glacier Bay waterway differ, however, in their rates of development within these stages and in the species playing key roles. In Muir Inlet and its tributaries alder is ubiquitous. In the upper Tarr Inlet drainage alder thrives only in swales and draws. Soapberry and willow approximate a thicket stage, one you can easily hike through.

These geographic differences are surprisingly clear cut. In Muir Inlet a land surface that has been free of ice nearly a century will host a formidable tangle of alder—or be well along toward spruce forest. But in Tarr Inlet, dryas and willow still will dominate a surface of comparable age. Why should Muir Inlet be ahead in its plant sequences? Probably because it opens toward the prevailing southerly wind. This may simplify the arrival of seeds and spores, and moderate temperatures. Harsh Tarr Inlet conditions contrast markedly. Ocean-born moist winds are blocked by the Fairweather mountains, which send cold, dry air draining downslope from the high peaks.

From *Growler*, we regularly rowed ashore so that Emily Chase could core trees for a study, counting annual rings to find out how long it takes for a surface freed of ice to become upholstered by full forest. In the park, Bartlett Cove, which is edged by a Little Ice Age terminal moraine, has been evolving toward forest the longest. It melted out a bit before Captain Vancouver arrived offshore. Its forest now is a stately mix of Sitka spruce and western hemlock. The forest floor is thickly padded by moss and clubmoss and is studded with fern, blueberry, devil's club, and twayblade.

On Young Island, only a few kilometers up the bay from Bartlett Cove and therefore free of ice only about two centuries, we sank ankle deep into chartreuse moss which extended from the forest floor onto the stubby lower branches of spruce. The

trunks of these trees were bigger than one person alone could encircle with outstretched arms. The only hemlock we happened to find had a diameter less than half that of most of the spruce. On Francis Island, spruce were mere dark pyramids barely beginning to overtop thick cottonwoods, and we saw no hemlock. There, we pulled ourselves up steep slopes by alder and willow branches. We had moved 30 kilometers (19 miles) up-bay from Bartlett Cove, sampling forests separated by about seven decades of growth opportunity.

If a seed source is nearby, spruce can arrive and sprout early in Glacier Bay's plant sequence, but they may grow slowly at first. If it is shaded beneath an alder thicket, a 30 to 40-year-old tree may stand only knee high. Eventually spruce may overtake the alder, and then spruce will dominate for a century or two but then be outnumbered by hemlock. On the outer coast, however, not all spruce forests even wait for the ice to melt. The forest actually grows like a green rug atop the stagnant Fairweather Glacier tongue and on remnants of the Lituya Glacier, flourishing because lowland glaciers characteristically carry heavy mineral loads. Spruce and even good-sized hemlock stand rooted in thick soil and duff. But they tilt drunkenly because pits form in the underlying ice and meltwater grottoes collapse.

Muskeg is the final stage of plants' green conquest in Southeast Alaska, although little, if any, muskeg exists along the waterways of Glacier Bay proper. Sufficient time has not elapsed since withdrawal of the Little Ice Age glaciers. Muskeg represents a wondrous coming full circle, a return to openness though not to barrenness. It develops as forest soil deteriorates after 500 to 1,000 years, building a hardpan layer that blocks drainage and prevents roots from anchoring securely. Mature trees consequently topple readily during wind storms, creating openings which encourage other plants. Saturated conditions preclude most bacteria and fungi, retarding decay. Instead, sufficient organic litter accumulates to hold year-round moisture even without the hardpan layer, which slowly disintegrates. Acid conditions prevail and vegetation changes from forest to muskeg.

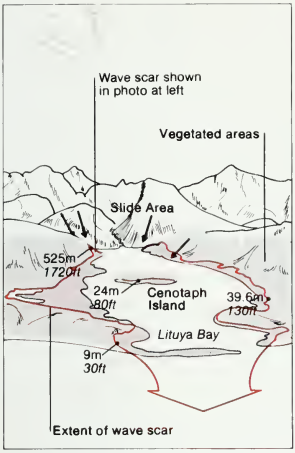
Along the park's outer coast are lowlands that escaped being covered by ice during the last glacier

Plant succession will culminate in spruce-hemlock forest in most of the park. The forest floor near park headquarters at Bartlett Cove still shelters glacial clues, however. Hollows betray where abandoned ice blocks took years and years to melt. Moss-covered hummocks disguise sandy glacial outwash.

advance. They have been muskeg for at least 8,000 years, changing very little through most of this time. New species continually arrive and vie for optimum position during the two or three centuries that lead up to the spruce-hemlock stage. But once muskeg takes over, little changes. Spruce and western hemlock continue, but grow scattered and dwarfed and with a look of great age and adversity. Mountain hemlock, lodgepole pine, and in places yellow cedar, come in. Beneath them a variety of soggy and leathery-leaved species forms a rough upholstery. Overall, I find the mood of muskeg to be quite elfin and most mysterious.

Just east of Glacier Bay, muskeg grows in profusion at Point Couverden, where I encountered its great mysteries and even greater blueberries. En route from Juneau Louis, Chess, and I anchored *Taku* overnight in the point's lee and I rowed ashore. Walking inland I passed first through beachside ryegrass and head-high cow parsnip flower stalks left from last season. Then I passed through a band of spruce-hemlock forest rich with fern. Ahead I could see the rounded tops of lodgepole pine, a clear contrast to the sharp spires of spruce and the pointed-but-drooping tops of hemlock. Abruptly, the forest gave way to open, mossy, soggy muskeg. Pines grew scattered and interspersed with a few stunted mountain hemlock. Deer fern replaced the lady fern and wood fern I'd noticed in the forest, and hip-high bushes of bog laurel and Labrador tea mixed with enormous blueberry bushes laden with fruit the size of giant peas. I could pick five or six powdery-blue berries at a time without moving my hand. For the first time I can remember it didn't matter if a berry dropped. We had blueberry pancakes for breakfast.

Tidal Inlet: The wind has died. Louis and Chess and I are motoring up Tidal Inlet in *Taku*, savoring the last of the daylight. Waterfall Fjord would be an appropriate name here. Every few minutes we come to another falls. Most spill over the cliffs, unnamed and rarely seen. Ribbons of white, cascades, plumes. One as lacy as Yosemite's Bridal Veil Falls, deep-set in a rock vee. Another showy only at the bottom, where it splashes from six separate ledges. A third hits so hard it spurts up and out. From the side you see only an odd, gravity-defying spout of white water.



A 1958 earthquake triggered a landslide at Lituya Bay's upper end. The slide created a wave that denuded the promontory facing it (shown at the left in the photo of Lituya Glacier) to an altitude of 525 meters (1,720 feet). Three boats were in the bay. The island protected one. A second washed over the sandspit at the bay's mouth and into the ocean. The third was destroyed. The drawing shows the extent of denuded shorelines.

High above us, the fjord wall is gashed by a raw arc, the scar of a gigantic landslide, that stretches for more than 2 kilometers (1 mile) and looks as high as a six- or eight-story building. It is ten times that.

Austin Post once told me the scar formed as ice choking the inlet retreated, withdrawing support and leaving an over-steepened slope. This probably happened around 1860-70. Parts of the scar have stabilized enough for alders to grow, but the whole slope looks poised to slide more—and it probably does slide a little whenever there's an earthquake.

We cruise along aboard *Taku* and contemplate earth forces that could be capable of so suddenly resetting the clock of life's sequences. Were this slide to let go and crash into saltwater, a stupendous wave would strip vegetation far beyond reach of the slide itself. That happened at Lituya Bay in July 1958. A quake along the Fairweather Fault, at the upper end of the bay, dislodged rain-soaked rubble from a steep headwall. This material sheared off ice at the snout of the Lituya Glacier, then, riding an air cushion, shot across the toe of an adjacent cliff to an elevation of 525 meters (1,700 feet). The force hurled icebergs and seals onto high ledges and violently uprooted mature spruce. Displaced water rose as an incredible wave that ravaged shores even at the mouth of the bay, 11 kilometers (7 miles) from the headwall. The wave lifted a fishing boat, swept it across the moraine guarding Lituya Bay's entrance, and smacked it down in the ocean so forcefully the seams burst and the boat disassembled, fortunately not before the couple aboard could leap into their skiff and row off.

From the air the devastated Lituya Bay cliff scar is astonishing. Uprooted trees litter every beach of the bay. Seen from a boat, the destruction appears even more dramatic. Its full magnitude is immediate, without the detachment a plane affords. The soil, forest, glacial till, rock, and ice that slid into the water is estimated at nearly 400 million cubic meters (1.3 billion cubic feet). This appalling mass sent a wave racing down-bay probably 250 kilometers (155 miles) per hour and exerting sufficient pressure to splinter trees and rip mussels and barnacles from their holds. Lituya Bay shorelands for a kilometer (half mile) inland still have recovered only to the alder stage.

Four earlier giant waves—1936, 1899, 1874, 1854—can still be traced by tree damage. Heights ranged from some 20 meters (65 feet) to about 130 meters (425 feet)—gentle foretastes of July 1958. Doubtless there have been others, and giant waves remain certain for the bay's future, perhaps soon. Slopes where the 1958 slide broke loose are still unstable and a separate huge inverted vee of unconsolidated earth hangs on a cliff near the North Crillon Glacier. This new headwall slippage already seems to defy gravity. Bedrock geology is responsible for slippage. The 1958 quake, eight on the Richter scale, produced a 7-meter (23-foot) horizontal displacement along the Fairweather Fault. With the edge of the oceanic plate slipping beneath the continental plate offshore and wrinkling the edge into mountain ranges—and the lateral slippage of two crustal terranes—earthquakes are inevitable. Given the walled-in nature of fjords, so are the consequent devastating waves. The shifting along the junction of the oceanic and continental plates is a tectonic ("building") process. The Earth's crust is built of adjoining plates which float on a molten core. Uplift of the coast comes in jerks. Barnacles still cling where bellflowers and Indian paintbrushes bloom. The change from tidepool to cliff garden can be abrupt.

The coming and going of glaciers can also directly raise and lower both the ocean volume and the land surface. Worldwide sea level during the Wisconsinan Ice Age stood about 100 meters (325 feet) lower than it does today. It rose as the glaciers melted and released water to the oceans. If Earth's ice were all to melt, sea level would rise far more. Fish would swim Tokyo's Ginza. Sea anemones would wave from Manhattan's World Trade Center.

Evidence of sea-level fluctuation along the park's outer coast includes a wave-cut terrace 30 meters (100 feet) above present tide line. Because the terrace is recognizable on both sides of the Fairweather Fault, tectonic force cannot explain its origin. Most likely it formed during sea-level changes produced by glacier ice. Ice a kilometer or two (0.5 or 1.3 miles) thick is enough to depress bedrock. Melting releases this weight, and the land slowly rebounds, or rises.

In Glacier Bay, the rate of rebound is greater than

anywhere else in southeast Alaska, and even by worldwide standards it is spectacular. At Bartlett Cove rebound and tectonic mountain-building processes produce a 4-centimeter (1.5-inch) yearly rise. On the nature trail near park headquarters, dropping down the stairs from mature spruce-hemlock forest to a zone of young spruce and beach meadow, you step onto land newly out of the sea. The stairs' base marks the old high tide line. Count a sapling's growth rings, then add time for salt to wash from the beach and for spruce to germinate, and you can know about how long ago the surface changed from sea bottom to dry land. Up-bay, release from the weight of the ice is more recent than at Bartlett Cove and present rebound is even more rapid. The shorelands rising fastest now are those close to the mouth of Muir Inlet, where glacier retreat began only about a century ago.

With rebound, islands expand noticeably, decade by decade, and shoal water shifts, quickly rendering inshore marine charts useless. Tide zones and beach meadows are constantly born anew. And humans experience certain dilemmas. For example, the land has risen so decidedly that National Park Service employees now can get their boats to and from the headquarters dock only when full high tide floods the channel. At Gustavus, the politics grow tangled, for who owns virgin land? Once the sand and mud of these flatlands formed the fill in Muir Inlet. Swept southward, that material lay beneath the sea for millennia. Now the land has risen and we humans puzzle over its ownership.

"So Far As Known"

This personable harbor seal pup has hauled out on an iceberg. Why not? It was probably born on one.

Field notebooks of summers in the 1970s document hour-by-hour seal behavior in Johns Hopkins and Muir Inlets. Summer park biologist John McConnell:

"*16 June, 2:14 p.m.* Earthquake tremor! Two-second duration. Ground shook. Rocks fell off north side of Inlet. Seals calling all over now. Not much diving in. Just up, looking around. Pretty loud boom that echoes. No calving on either Muir or Riggs.

"*2:34 p.m.* Lost pup has been swimming around calling for about 10 minutes. Hauls out. Back in, and goes on swimming and calling frantically. No one seems to care.... One really LOUD call, almost scream.

"*2:42 p.m.* Pup really frantic. One single adult in water about 60 yards away looking around and raising out of water to look. Could this be the negligent mother?

"*2:45 p.m.* Lost pup comes up to mother-pup pair on berg, calling. Looks. They don't even wake up.

"*2:48 p.m.* Single adult swimming in direction of lost pup.

"*2:50 p.m.* Come together, bump noses, pup shuts up and they dive, come up, now swimming off to north. Crisis ended.

"*17 June, 4:20 p.m.* Mother and two pups playing; they all ball up and roll over and over, then dive, come up, and do it again. Both pups alternate hitching rides on her back till she rolls them off. Mother goes to each and bumps noses.

"*4:24 p.m.* Here comes a single adult toward the threesome. Goes to one pup, touches noses. Now swims off with that pup. Other female and pup go in different direction. Was it a Muir Inlet baby sitting service I watched a moment ago?"

Former park biologist Greg Streveler one summer counted 3,500 seals in Johns Hopkins Inlet. Nearly a third that many used to ride the floating ice of upper Muir Inlet when East Arm glaciers were still

discharging bergs into the bay. Seal pupping took place there as well, but the pupping went out with the ice. Current park biologist Beth Matthews now counts nearly 5,000 harbor seals in the Johns Hopkins Inlet, and there the Park Service has created a seal pupping sanctuary, off limits to cruise ships, boaters, and kayakers alike. Until July 1 each year the seals are not intruded upon, free to give birth in peace. Throughout the rest of the summer, vessels must remain 400 meters (a quarter mile) away from seals on icebergs.

Harbor seal pups gain 100 pounds in their first month of life. The pups are then weaned off their 50-percent milkfat diet (compare that with 2-percent milkfat for human babies) and left alone to fish for themselves. But that early feeding period is critical. When approached the skittish seals may scatter, and a nursing mother and her pup may not find each other again. "It's being startled that has grave implications," Greg Streveler once told me. "That's what leads to separation."

One is not likely to find a killer whale in the Johns Hopkins Inlet, even with such a high concentration of possible prey. The orca avoids this extreme habitat near the powerful Johns Hopkins Glacier. It is thought that the silt-laden waters and ice interfere with the orca's ability to hunt.

"Protecting the seal's habitat here in the bay is important," claims Beth Matthews. Although we tend to think of Alaska as a pristine place where animals flourish, harbor seal populations have been in a dramatic and unexplainable decline in the northern part of the state. The Johns Hopkins Inlet is home to the largest known concentration of these animals.

Geike Inlet: We've anchored at Shag Cove, just inside Geike Inlet, where Chess immediately rigged his pole and cast from *Taku's* cockpit. He said he'd add this spot to his world map of places he's caught no fish. I've just rowed back from watching salmon by the thousands struggle up the creek to spawn in freshwater. They rarely feed while spawning.

Salmon spawning is a spectacle: Carcasses line the creek banks, heads a sepulchral white, hooked jaws still full of needle teeth, eye sockets empty. Live fish thrash against the water's flow, backs above the surface, wriggling like snakes, forcing passage over cobbles. Sometimes they turn on their sides and slither up shallow riffles. Pale underbellies show.

Yellow eyes seem strained and desperate.

Once a sudden movement and a loud splash made me pivot to look. A huge male had wedged head-down between two rocks, caught by water pouring forcefully over a log. I watched his struggle, then looked away. When I turned back, he'd broken free. I counted 33 fish in a 3-meter (10-foot) radius. This entire cove was deep beneath ice 150 years ago. When the glacier began to wane, runoff streams must have carried more silt than fish tolerate. When did the salmon arrive?

Once Louis and I joined Ole Wik in checking on whether Dolly Varden had returned to a stream at the head of Geike Inlet, not far from Shag Cove. My journal of that trip with Ole records:

"We sit in the dinghy halfway to shore, attention riveted on a half-grown wolf pup that trots from where it was feeding. It watches us from the willows, secure within their protective screen although keeping ears cocked like twin radars.

"After a while, the pup moves on, then returns with a second pup. Both are black, typical of wolves in Glacier Bay—and not an unexpected color, for wolves as a whole vary from sand-colored, through almost red, to this decided black. The two pups stand curious, but unconcerned. For once, there is time to focus binoculars and fix a sight indelibly in mind.

"While the wolves stare at us, a whale rolls barely astern of our anchored boat. It blows, smacks the water with a flipper so long it's like a wing; then the whale submerges. The sudden slap against the water startles 200 to 300 crows into circling as a ragged black cloud, cawing wildly. Their racket prompts a bald eagle into lifting off from somewhere so far back in the spruce that we wouldn't have noticed it if it hadn't flown.

"Where but Glacier Bay can you swivel binoculars and find such a three-minute sequence of land, sea, and air life as prelude for a stream check? We find no Dolly Varden, however. Maybe conditions aren't yet right. Maybe our seasonal timing is off."

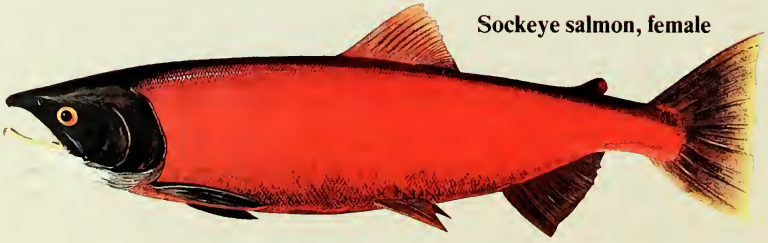
Glacier streams raging across raw outwash plains attract no salmon. But in time as stream conditions mature, fish find their way. With them a whole chain of life is fostered. Eagles, ravens, and coyotes feed on spawned-out salmon carcasses littering the banks.

The Salmon Economy

Salmon annually succumb to a bizarre frenzy approximating the behavior they routinely incite in anglers. Natural predators catch this short-lived fever, too. For the brief season of the salmon spawning run, birds and mammals line the banks and plunge into streams to gorge on live fish or spawned-out carcasses. A stable and diverse ecology seems to convert overnight to a one-crop marketplace, the protein-rich salmon economy. Silver, chum, sockeye, and pink salmon spawn in the park streams. Poised to pounce and peck, or to pluck them from streams and banks, are bald eagles (inset), ravens, coyotes, wolves, minks, otters, seals, black bears, and brown/grizzly bears. Some predators and their prey even seem to observe a tacit truce

Silver (coho) salmon

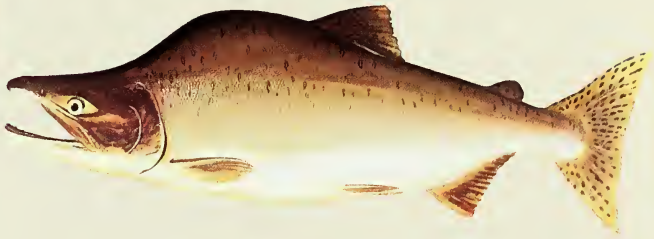
Chum salmon, female



Sockeye salmon, female

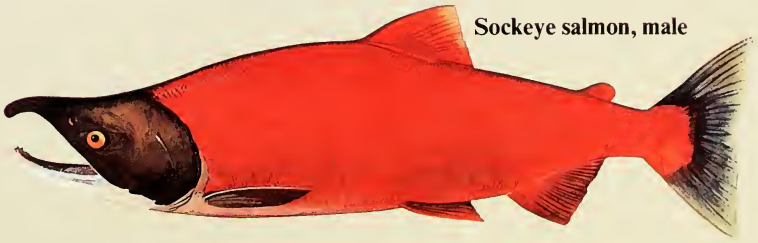
during the run. In close quarters they grab what they can from this small end of an ephemeral gourmet funnel. Pragmatically seen, nature would appear to transfer food wealth from the oceans into a protein-starved terrestrial food chain. The uncanny homing ability of salmon—after years at sea they find the same stream gravels in which they were born—remains one of nature's great intrigues.

Pink (humpback) salmon



Chum salmon, male

Sockeye salmon, male



Mink and otter, wolves, black bears and brown/grizzly bears take live fish. Seals foray into stream mouths to feed on spawners newly arrived at homewater.

Four Pacific salmon species spawn here: silver, chum, sockeye, and pink. Dolly Varden, steelhead, cutthroat, and three-spined stickleback also spawn in Glacier Bay's freshwater. King salmon frequent Bartlett Cove, Berg Bay, and Dundas Bay, but do not yet enter streams to spawn, s.f.a.k.—"so far as known," as field naturalists a century ago acknowledged the limits of their knowledge.

Details can prove fascinating. In some Glacier Bay streams snails and bivalves are few because the water is too low in dissolved minerals for the making of shells. Shells are mostly calcium carbonate. On the other hand, tiny shrimplike creatures thrive in ephemeral ponds fed by melt from glacier remnants. Their eggs don't dry out readily and will pass unscathed through the guts of fish or birds. In fact, viable eggs have been found in the feces of fish-eating birds. This means the eggs have endured a double dose of gut acids, first the fish's, then the bird's!

Birds bring crustaceans to newly formed ponds. Insects come on their own, to streams as well as ponds. The aquatic nymphs of mayflies, stoneflies, and caddisflies are equipped with bristles, hooks, and suckers for clinging to rocks, so rushing water is no problem. Various biting flies are equally able to survive immature stream conditions. Even close to melting ice in water too cold, rushing, and silt laden for other species, blackfly larvae secure themselves to rocks by hooking their tails into specially secreted silken pads. "No-see-ums," perpetrators of painful bites in their adult stage, also flourish in glacial torrents. Ashore in summer, you scarcely escape their swarming attack anywhere. Afloat you are safe.

"A sinuous strip a quarter of a mile wide on the landward side of the beach and double that to the sea is where the action is," Greg Streveler says. We owe the variety and abundance of wildlife in the park to this shoreland strip. The shore is the land mammal's larder because it links the sea's riches to life on land. On the outer coast, red foxes feed along the beach on ducks, dead fish, strawberries, gooseneck barnacles, and beached whales. Coyotes crunch open sea urchins and mussels. Greg once

watched a brown/grizzly bear dig clams on the outer coast, "sand and rocks really flying, its butt sticking up out of the hole." Black bears squish open barnacles to eat. Shrews feast on barnacles, mussels, and squashed snails. Mountain goats and porcupines eat seaweed. Deer do too, but they can't digest it; deer have starved to death here, their stomachs full of seaweed. Sedges and grasses, available even in winter, bring the deer and goats to the shore. Seaweed is just a salty sidedish.

Shorebirds join the beach community while retreating glacier fronts are still close by and floating bergs a constant presence. Oystercatchers—the size of northern crows, black with naked pink legs like stilts, and with bright orange, chopstick bills—are my favorites. They eat not oysters, but snails and mussels. Louis and I camped at Reid Inlet once and filmed oystercatcher hide-and-seek among small, stranded icebergs.

It was a gray June week with the mists clamped to the water. Sky and sea, equally wet, differed only in texture: the water polished, the clouds dull. For brief periods when the murk thinned we could make out a vee of scoters flying low to the water in one direction. Glaucous-winged gulls, higher, moved in the opposite direction. Or a fleet of pigeon guillemots might be bobbing as if at anchor, each bird a solid black fore and aft but with white wing patches separating end from end. When the guillemots dove after fish, their red legs and feet flashed a momentary finale to the upending.

Mew gulls and arctic terns nested on the foreshore, their eggs laid in saucer-shaped scrapings ungraced by grass, down, or other softening material. Gulls returning to brood duty often first landed on an iceberg to look around, their touchdowns like the uncontrolled skids of neophyte ice skaters. Arctic terns defended nests by dive-bombing and cursing intruders. Their targets included Louis and me, mew gulls, and the oystercatchers, which cringe comically when a tern zeroes in.

Louis and I knew that a pair of oystercatchers nested near the gulls and terns, but where? Both male and female stalked about glancing back to be sure we were fooled about where their nest was. Satisfied we were still watching, they then crouched and squirmed as though settling onto eggs.

The unmistakably marked oystercatcher looks like a designer shorebird. Come too near its nest and it breaks into paroxysms of conflicting body and verbal language. Its absurd performance simultaneously combines studied stealth with wildly raucous screaming. Turns out it doesn't catch oysters, either.

One morning I chanced upon the two oystercatchers apparently at their real nest, well back from the highest strand line. They saw me see them. Looking chagrined and uncertain of what to do, they just shrieked and flew off. I retreated, stepping only on large flat stones to avoid crushing eggs I couldn't see. Their spotted shells blend perfectly with the rock mosaic left by a retreating glacier.

Arctic terns commute from Antarctic wintering grounds to Glacier Bay, arriving in May while snow still covers the ground. They are gone again by mid-August. To disrupt such hurried nesting and fledging would be unconscionable. The National Park Service grew concerned when the present large cruise ships began entering the bay. Excursion steamers of the late 1800s were much smaller. When the 33,000-ton *Arcadia* first arrived in 1970, rangers watched beaches to see what the ship's wake might do. A single errant wave could destroy nests and nullify the terns' 32,000-kilometer (20,000-mile) round-trip journey.

Fortunately, a ship moving slowly did no harm—probably less than our human presence ashore, no matter how carefully we stepped and stayed back photographing with long lenses. People are decidedly disturbing to wildlife. Wolves seem reluctant to trot their accustomed paths while people are around, though their scat shows they're still about. Mountain goats will abandon the whole side of a ridge facing a camp far below them.

That same summer of oystercatcher hide-and-seek Louis and I filmed at the Ohio State University research camp in Wachusett Inlet. Camp was a moonscape with ice. Tents sprouted from a bare moraine, icebergs floated past, and a kilometer (half mile) behind camp the stagnant Burroughs Glacier melted into oblivion. It shrank scores of meters (hundreds of feet) per year, its ice so brown with rock and silt that it hardly looked like a glacier. But terrestrial life had already begun staking a claim.

Snow buntings, trim white-bellied finches, came mornings to feed on iceworms, which look like wriggling bits of black thread. These distant relatives of earthworms live their whole lives in ice. There they feed on algae and bacteria, and on organic matter and minerals washed along by glacier-melt and borne by air currents. The first such worms

Birds of Sea and Shore

More than 200 species of birds have been recorded in the park. Many are best seen in or near marine environments, which offer them abundant and varied food. At bay mouths and in narrow waters, turbulence stirs up plankton, shrimp, and fish to the surface. For birds a feeding frenzy ensues. Critical protein sources come within diving and skimming distance of the water's surface. Large flocks of murrelets, kittiwakes, gulls, and northern phalaropes gather. Phalaropes are feminist: males wear the dull plumage and incubate the eggs. Phalaropes commute yearly far down into South America. Arctic terns commute up to 32,000 kilometers (20,000 miles) round trip each year.

Tufted and horned puffins

Horned grebe

Old squaw duck

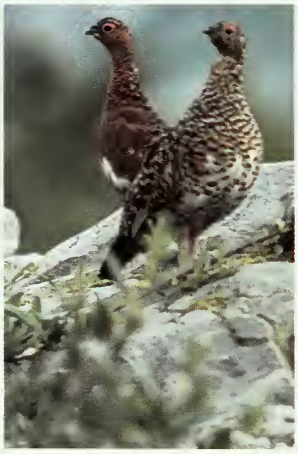
Glaucous-winged gulls

Pigeon guillemot

Least sandpiper

Arctic terns

Kittiwake colony



Willow ptarmigan know camouflage. Both winter and summer, these birds blend so well with their surroundings that you may miss spotting them at arm's length. How many do you see in each picture?

reported anywhere—in 1887—came from the Muir Glacier. We now know iceworms occur widely in the coast mountains from Washington northward. A few years ago, Ohio State researchers flew iceworms home with them from Glacier Bay and maintained them in the laboratory for more than a year. In the esophagi of several, they found cylindrical micro-organisms which may secrete an enzyme that helps them digest algae. You never know where you'll find the base of a food chain.

One of the glaciologists found a dead shrew beneath the Burroughs Glacier when he roped down a cavernous melthole to trace water channels. Far out on the glacier taking measurements, two men were buzzed by a rufous hummingbird and several times saw bumblebees. Deer mice plagued the Wachusett camp at night. A tundra vole sampled every candy bar in one particular sack.

How can tiny rodents, hummingbirds, or bees brave the glacier barrens? Resilience and adaptations. Hummingbird metabolism permits a sustained energy output impossible among mammals. Bumblebees, far from hapless victims of environment, can control body temperature. Hike across a glacial outwash such as the one that spills from the Casement Glacier and at the ice face you find buntings pouring out territorial song from the sharp crests of eskers. Ptarmigan droppings are evident too. The birds blend so perfectly with rocks and moss tufts that you rarely see them unless and until they move.

Redpolls and rosy finches may be raiding willow catkins for seed and picking insects from where scattered fireweed and alder pioneer the gravel. Where dryas has started forming mats, Savannah sparrows and least sandpipers nest. In alder and willow thickets, hatchlings of orange-crown warblers, fox sparrows, and even occasional hermit thrushes and Oregon juncos harass parents to supply what must seem like endless food. Feathers and flight muscles are made of mosquitoes, blackflies, midges, plant lice, and water beetles.

Glacier Bay's bird list boasts more than 200 entries. Included are species more typical of Arctic tundras and Aleutian grasslands than of southeast Alaska. They are here because of the glaciers. As vegetation sequences progress to the hemlock stage, these birds of the barrens largely forsake the park, replaced by

forest species. On the Bartlett Cove trails you hear the plaintive, minor call of varied thrushes and the musical notes of Swainson's and hermit thrushes, birds common throughout Northwest rain forests. Robins are present, their singing—to my ear—like that of a cheerful amateur determined to learn to carry a tune. Kinglets and siskins flit through tree tops in loose, lisping flocks. Three-toed woodpeckers and blue grouse sound their territorial claims, the woodpecker by pounding a dead tree, the grouse by releasing air from throat sacs.

Spring and fall migrations bring birds in, out, and through the park in the ebb and flow of an avian tide. Loons by the thousands stream north along the outer coast in spring. Squadrons of red-necked phalaropes fly low to the sea in early and late summer, dropping to feed in tide rips. With winter, old squaw ducks and common murres by the tens of thousands arrive in Glacier Bay, much of their food needs supplied by seabottom dwellers. The shore's mingled sea-and-land resources are crucial for birds as well as land mammals.

One misty Reid Inlet morning Louis and I noticed a small dark dot swimming our way from the far shore. At first we supposed it a seabird, then a seal. On it came, purposefully, straight toward our tent. Within minutes we watched a black bear step onto the beach, shake half dry, and amble from view.

Land animals are not commonly found going about their business so close to the ice, but neither do they wholly avoid the glaciers. Near where Margerie and Grand Pacific glaciers converge, hikers have found brown/grizzly bear and lynx tracks. In Johns Hopkins Inlet, Greg once found evidence of a wolf. For a while there were mice close to the glacier front, probably stowaways in campers' gear. Marmots eke out an existence near Reid Inlet's entrance, their shrill whistle a surprise coming from near sea level because these plump woodchuck-cousins are highcountry characters throughout the West. The elevation seems wrong, but the biome is right.

Land mammals face their own problems in moving back to newly ice-free shores and lowlands. They can't come by air, as the first plants do with windblown seeds and spores, or as the first insects do, arriving as winged adults or in bird gullets. Mammals must walk or swim. Even for large animals, extensive

Pages 82-83: *Alaska moose are the largest of their species. Sporting broad, flat, and lobed antlers, males weigh 450 to 720 kilograms (1,000 to 1,600 pounds). Both bull and cow have a curious skin tab—called a bell—below the neck.*

ice or water or mountains may be a formidable barrier.

The two sides of Muir Inlet exemplify the land mammals' disadvantage. Plant succession shows no real difference between sides of the inlet, nor do insect or bird populations. However, the east side hosts several more species than the west. From the east side a low pass connects from Adams Inlet to Lynn Canal and so to the interior. But the west side of Muir Inlet has no such conduit outside. Bounded by ice, mountains, and more saltwater, it is, from the standpoint of life, an island hard to reach.

No true successional stages characterize mammals' pursuit of waning ice. No pioneer species regularly prepare the way for replacements, as with plants. Large mammal firstcomers usually draw on the resources of ecologically young terrain part of the year, moving elsewhere the rest of the year. Gradually, resident populations will build. Moose were first seen in the lowlands east of Muir Inlet in the 1950s, probably having come over Endicott Gap from Lynn Canal. Now you often see moose, or moose sign. Moose have begun to round Tlingit Point into lower Tarr Inlet and have spread throughout the western park, recently to Dundas Bay.

This is also a barrier: mammals haven't had time since the Wisconsinan Ice Age to complete their dispersal throughout southeastern Alaska. The white shroud of the glacial maximum covered most of the region below 600 to 700 meters (2,000 to 2,300 feet) elevation, but it left refugia—green arks of continuing life—north and south of the ice sheet. Brown/grizzly bears, moose, muskrats, and snowshoe hares have repopulated southeastern Alaska from such northern refugia—so far as known. Black bears, wolves, coyotes, deer, and mountain goats have come from refugia to the south. Mountain slopes in the Glacier Bay region also provided sky islands of livable habitat for small creatures during the Ice Age. And minor refugia along the park's outer coast escaped getting swallowed by ice during the whole of the Wisconsinan glacier advance. Today 40 mammal species are listed for the park.

Greg Streveler speculated that one or more coastal refugia may have been large enough for the so-called glacier bears to develop as a distinct race of black bears. Their coats took on a distinctive steely blue

color. Indians and 19th-century settlers describe these bears as different from black bears and brown/grizzly bears both in looks and behavior. They stayed apart from the other bears, preferring the glacier barrens they probably grew accustomed to during the Ice Age. Glacier bears never became a species of their own, however, and now they've bred back into the black bear population. Even the blue-gray coat appears less and less often.

It's said that only iceworms and glaciologists suffer when the ice sheets disappear. We should add glacier bears to the list. The surest place to see one now is the Alaska State Museum.

The Only Constant Is Change

Mountain goats are superbly adapted for scrambling atop rocky crags that would give fits to climbers. Their hooves have cushioned, skidproof pads and their psyches are unflappable. Mountain goats don't panic under pressure; they retreat deliberately, with cool dignity. This pensive critter, on Van Horn Ridge in mid-June, still must shed some winter coat. Those foreleg guard hairs grow 18 centimeters (7 inches) long.

Winter: I came to Glacier Bay in late January once. Perhaps that would be the ideal time for anyone's first trip here. White flakes from white clouds muffle the world. Low peaks seem handsomely tall compared with summer when they're only patched with snow. Spruce and hemlock rim the lower bay as giant, white feather plumes. Up-bay, pan ice skims the water. It gives way with a quiet rasp as your boat cuts through and sends small pieces skittering across the unbroken ice.

The white heads of bald eagles, so conspicuous at other seasons, in winter become camouflage. They look like additional lumps of snow caught on high branches where the birds perch. Occasional blood spots and scattered feathers dot the frozen sea, left from seabirds that became eagle dinners. Cormorants fly low, wings whirring as though the birds were trying to catch up to their own heads. The goldeneye ducks, old-squaws, and murres that have arrived for the winter continually up-end themselves to feed beneath the surface. Seals rise to stare with brown eyes incredibly soft. The seals in winter number only about half the bay's summer population and most now stay away from the ice. Their probable diet is fish, shrimp, and crabs.

That January I traveled up-bay aboard the National Park Service supply boat *Nunatak*, joining a group led by Greg Streveler, to make a winter wildlife census in Adams Inlet. It didn't take long to begin the count. As we motored ashore from *Nunatak* the first morning, a river otter streaked through slabs of pan ice that lay on the lowtide shore like oversized almond bark candy. Above the jumbled slabs we found three crab shells, apparently the otter's dinner midden. Rock sandpipers made a close-packed cluster of 80 to 90 black dots where a river emptied into the inlet. While strapping on skis, I noticed a midge the size and form of a mosquito. It was tiptoeing across the snow, wings held straight up over its back.

Such insects are suited to winter because they spend most of their lives as aquatic larvae and need only a day or so out of water to mate and lay eggs and die. For that bit of time they can cope with almost any weather. Spiders also stalked the snow as we set off. The hardy spiders apparently have a built-in antifreeze to pump through their bodies to keep them from freezing. Not long after we had strode out on our skis we heard the birdlike trill of a red squirrel, a familiar call to people in many latitudes.

Our plan was to check for animal tracks along beaches, creeks, and at the junctions between slopes and adjoining flats, chief winter routes of animals. Fresh snow skimmed a firm crust. Mountains rimmed a white world. Brown traceries of alder and cottonwood branches rose out of snow perhaps 40 centimeters (16 inches) deep.

Wolverine tracks laced the edge of a thicket—hiding place for ptarmigan—and farther on we spotted the wolverine loping along the beach. Wolf tracks were frequent. We found one shallow depression in the snow where a lone wolf had rested, protected from wind by a low bank. Greg guessed it came a long distance or it wouldn't have lain down. This wasn't a bedding ground because no urine yellowed the snow. Out on the flat three sets of tracks overlapped and braided as they followed the river bank. Turning onto a high moraine, they vanished in the alder. All the wolf scat we found held mountain goat hair.

Just seven winters before, Greg had counted more than 200 of the goats in the Adams Inlet area. But on this trip we saw none, despite the fact that we knew what we were looking for and had spotted and watched the superbly adapted mountain denizens elsewhere. Two successive winters of deep snow brought trouble for the animals. Browse was buried. Even beach salt grass and sedge were covered. Getting around was equally troublesome, because sharp hooves and deep snow make a poor combination.

Wolves found the severe conditions less crucially difficult. Their broad feet upholstered with stiff hair facilitate snow travel. And potential food for the wolves was ample that winter because the mountain goats were conveniently forced down to the shore. Predators don't, as biologists formerly believed, necessarily rely exclusively on weak animals. In this

case the wolves might take animals in any state of health, eating only choice parts—there's more where that came from. Predator numbers go up; prey numbers drop. Then the pendulum swings and predator numbers drop, maintaining balance over time. Populations and species seem to be what matter, not individuals.

Summer Aboard *Ginjur:* My journal from the research boat *Ginjur* notes: "Charles Jurasz greeted Austin Post saying, 'You're the bottom man and I'm the whale man.' Biologist and glaciologist then disappeared into the wheelhouse to pencil notations onto marine charts." The *Ginjur* is a converted 15-meter (50-foot) Navy ship-to-shore transport aboard which biologist-owner Chuck Jurasz is researching acoustics, which is why he wanted *Growler's* depth information for Glacier Bay's underwater basins. Additional work will show details: where is the bottom soft and sound-absorbing and where does bare bedrock reflect sound back into the water, perhaps echoing it, or—for a whale—accentuating it painfully?

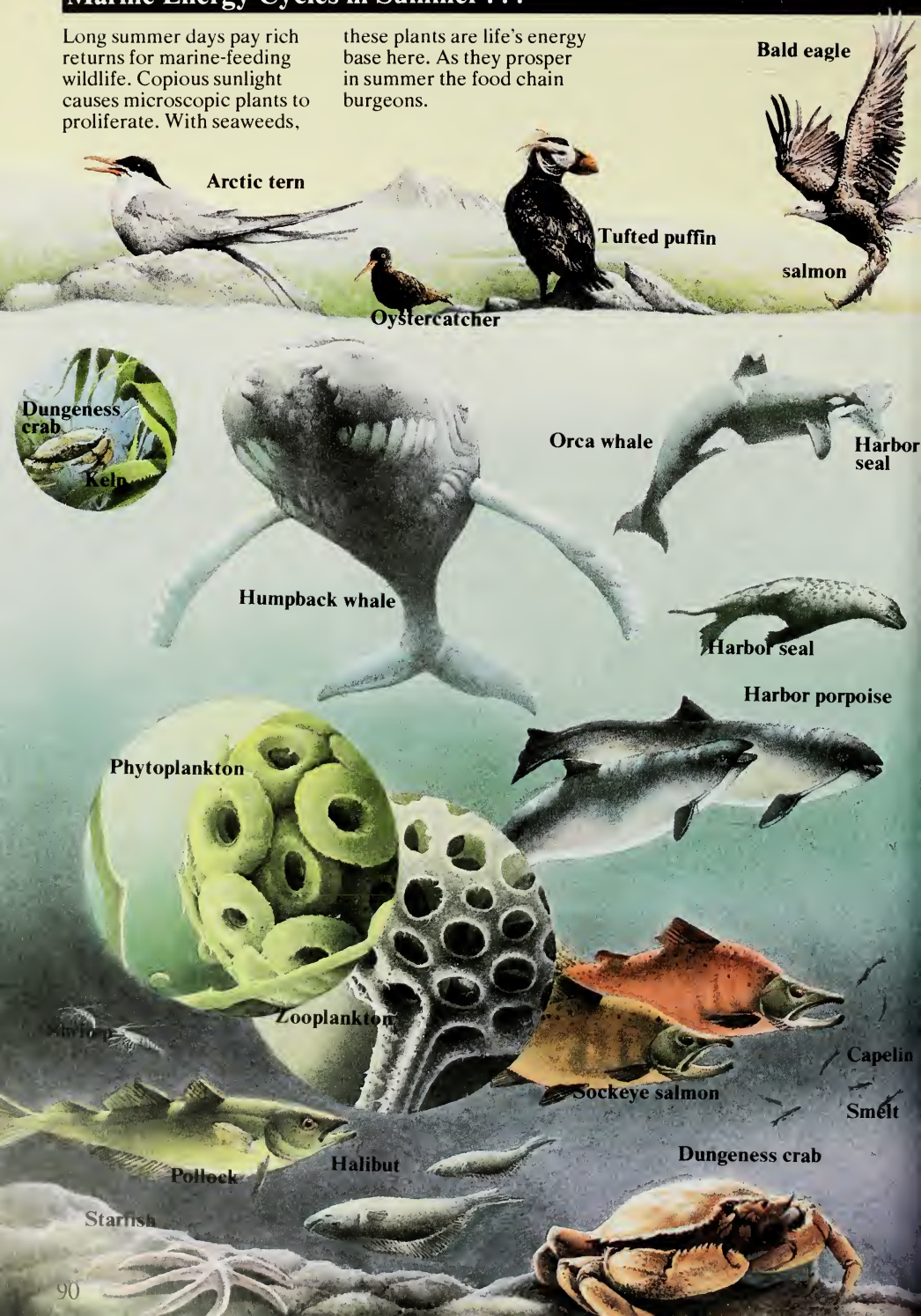
Beyond *Ginjur's* fantail I watched chunky little murrelets flip themselves below the surface, then bob back up, each with a silver fish dangling from its bill. Humpback whales also feed on these capelin: 45-ton monarchs swallowing 84-gram (3-ounce) prey. Humpbacks sometimes lunge to the surface with their mouths agape, scooping in a ton of water and capelin or krill, and opening out their accordian-pleated undersides. Powerful throat muscles then force the water through curtains of baleen, catching prey as though in a sieve. The pleats fold shut.

Chuck has seen three whales working together, rising with the dark sides of their flippers uppermost, only to suddenly turn them over, flashing the white undersides. Perhaps the light color of the humpbacks' extraordinary flippers, far longer than those of any other whale, helps to concentrate the feed. He has also watched the whales flick their great tails forward, whooshing the chowderlike water toward their open mouths. Chuck has seen this scores of times but—and this he emphasizes—only by two individuals: Garfunkle and Gertrude.

"Garf is innovative," says Chuck, who recognizes these individuals by the distinctive color patterns of flippers and flukes. "Garf's always coming up with something the other whales aren't doing. He started

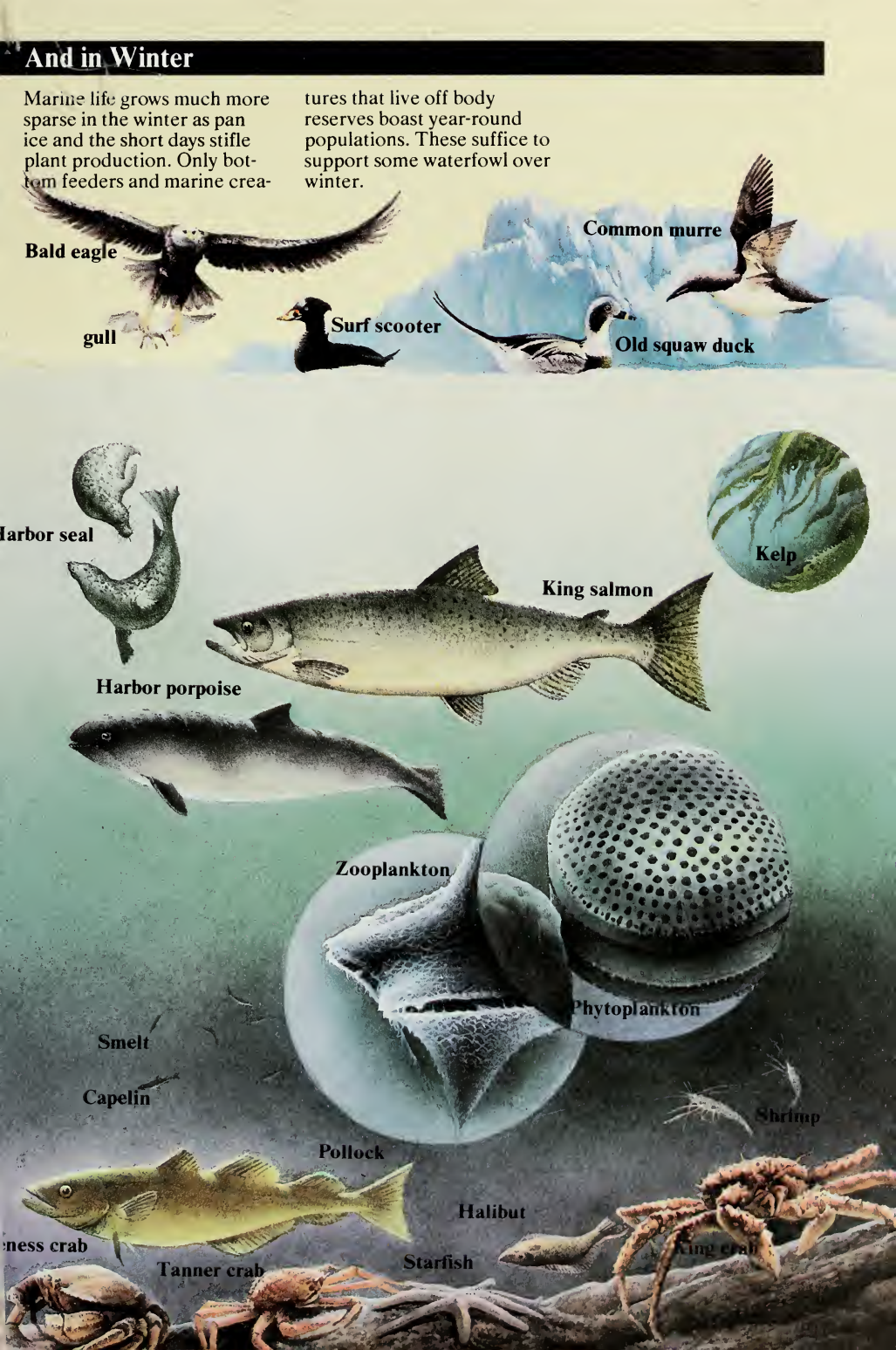
Marine Energy Cycles in Summer . . .

Long summer days pay rich returns for marine-feeding wildlife. Copious sunlight causes microscopic plants to proliferate. With seaweeds, these plants are life's energy base here. As they prosper in summer the food chain burgeons.



And in Winter

Marine life grows much more sparse in the winter as pan ice and the short days stifle plant production. Only bottom feeders and marine creatures that live off body reserves boast year-round populations. These suffice to support some waterfowl over winter.



Humpback and Minke Whales

Whales are grouped as either baleen or toothed. The humpback and minke are baleen whales. They have no teeth. They feed by filtering their food from seawater with comb-like, paired rows of horny baleen plates, the whalebone of Victorian corsets. Humpbacks (below) in Glacier Bay feed mostly on krill (below left) and small schooling fish, such as capelin—at about 600 liters (150 gallons) per mouthful, one ton per bellyful.

Minkes (below right) prefer fish in these waters. Adult humpbacks average 12 to 15 meters (40 to 50 feet) long and weigh about 2.5 tons per meter (about three quarters of a ton per foot). Decimated by whaling, these coast-loving creatures are now protected under the Endangered Species Act and international agreements. Minke whales grow to about 10 meters (33 feet) long in northern waters. Among the large whales they are fast swimmers—up to 32 kilometers per hour (20 mph). Minkes are the most heavily hunted baleen whales, since taking others has been more restricted.

The Orca (or Killer) Whale

Orca whales are also known as killer whales. These toothed whales can hunt in packs, called pods, and have been dubbed wolves of the sea. They eat fish, sea lions, seals, porpoises, sharks, squid, and other whales. Orcas have even killed blue whales, the largest creatures—at 100 tons, or the weight of about 2,250 men—that the world has ever known. Orca adults average about 7 meters (23 feet) long and can sustain speeds up to 45 kilometers per hour (29 mph). The largely triangular dorsal fin may reach nearly 2 meters (6 feet) high on old males. Its prominence and their black-and-white markings on belly, flanks, and head make the orca unmistakable. Orcas eat a staggering variety of ma-

rine animals, including warm-blooded species. The range of foods available to them is greatly enhanced by their diving ability. Orcas can dive to nearly 1,000 meters (3,400 feet); Glacier Bay isn't that deep, however. When whales dive, blood is forced from their muscles into the brain and the buildup of carbon dioxide in their lungs does not force them to breathe, as it would humans. Killer-whale attacks on boats are both rare and largely undocumented. One killing—unsubstantiated—of a fisherman off Baja California was reported in 1977. The orca's rapacity is exaggerated in whaling literature from unscientific samplings of one specimen's stomach contents. Docile in captivity and keenly intelligent, orca whales are star aquarium performers.

feeding this way one summer off Johns Hopkins and the next year, while following him, Gertrude began doing it too."

Bubble-net feeding? Chuck first noted this in 1968. He saw bubbles rising in a ring where he knew a submerged whale was. "Hey, it's letting out air underwater instead of at the surface," he thought. Then he saw the water come alive with herring and the whale rising through the fish, jaws open. The whale was working like men do in a hatchery, using bubbles to shunt fish to where they're wanted. The bubble net worked nicely to concentrate the fish in position to swallow! All previous whale records—s.f.a.k.—mention this feeding method only once. This is in a French report written years ago by a Norwegian whaler in the Antarctic.

The paucity of written records is a problem. "We know about whales from chasing and killing them," Chuck explains. "You can read a lot about anatomy and the measurements taken from carcasses. But until very recently you couldn't read much about the living animals. What we're getting aboard *Ginjur* is basic data on how humpbacks feed in Alaska: what they go after, how they capture it, and where they have to go to find it." From the late 1960s to '70s, 20 to 24 humpbacks summered here. But in 1978 and on into the '80s, fewer whales came. In the past few years, numbers are back up to historic levels. Why? Despite research, nobody knows.

Investigators find that an enormous quantity of humpback food is available in Glacier Bay waters, but it quite likely varies at times. Also, park waters may be somewhat noisier than those nearby.

Noise from ship engines and small boat motors seems more noticeable here than nearby, and vessel traffic here is greater.

Understanding has barely begun. Consequently, park regulations require staying at least 400 meters (0.25 mile) away from whales; and courses for water travel are at times restricted. Today's humpback whales have few havens. Extinction threatens—and extinction lasts forever.

Disrupted balances inevitably domino. Take sea otters as an example. La Pérouse, remarking on their beauty and abundance along Glacier Bay's outer coast, estimated that a Lituya Bay factory could take 10,000 skins per year from the coast. Only a few

years after La Pérouse's visit, a Russian vessel arrived bringing Aleut hunters and 450 of their baidarkas, fleet skin boats much like Eskimo kayaks. Within mere days, men stowed 1,800 sea otter skins into the ship's hold. Most were from the Aleuts' kills, but many were from trade with resident Tlingits. Lituya Bay was a prime sea otter hunting ground.

Sea otters were killed off along this coast by the dawn of the 20th century, and the effects of such a loss are only now beginning to be understood. The entire marine community is involved, with repercussions of implicit change rippling all throughout it. Sea otters feed on sea urchins, which in turn feed on kelp. Eliminate the otters and urchins increase, eating far more kelp. A plethora of plants and animals next are affected, because kelp beds are the great nearshore nurseries of many ocean species. Eventually seabirds, eagles, seals, bears, and even people are bound to feel the change.

Dundas Bay, aboard *Taku*: Rain during the night. *Taku* bobbed considerably, especially at the turn of the tide. Yesterday we went ashore to explore, wearing every bit of rain gear we possess. Today will be the same. Checking the long abandoned salmon cannery here in Dundas Bay, we found the pilings deeply worn at the base, etched by saltwater and time. Some of the pilings associated with the old cannery have already fallen down. Those that still remain standing look uncannily like trees that have been gnawed by a beaver. Nearby, other timbers mark what once had been a shipway, and there is a wrecked barge lying stranded at the hightide line.

Near the forest edge is a cabin with a sign reading "Government Property." The door is unlocked but a note asks you to close the cabin carefully when leaving, to keep out mice. Inside, there's an oil-barrel stove and a pencilled invitation to "Have a warm time." Old magazines include *Quest* with an article on whale watching promoted on the cover but missing inside. A guest log requests "Please sign in," but names from the last five years take up less than a page. Earlier pages have been torn out. A note addressed "Dear *Nunatak*" and dated three years ago asks that the cabin's mattress be taken to Bartlett Cove. The mattress still is here.

Dave Bohn writes in *Glacier Bay, the Land and the Silence* that this cannery started in 1898. Sixty-

Tlingit Indians

Tlingit Indians living in Hoonah, a village diagonally across Icy Strait from Glacier Bay, have proud family songs and stories about advancing ice that drove their ancestors from *Tcukanedi*, the Valley of the River of Grass. This was probably on former shorelines in lower Glacier Bay. There stood a village. And there a young girl, ritually confined during her first menses, violated cultural dictates and in her loneliness called to glaciers on the slope above. Her cries brought them down. Ice overrode the people's lands and waters. It obliterated the seal hunting grounds and the meadows and muskegs rich with berries and fleshy roots. It covered the streams ideal for summer and fall salmon fishing. Gone were the beaches and sea cliffs where

Artist Belmore Browne served as a guide in the Glacier Bay area. He painted from nature. Here he depicts a Tlingit bidarka in modern time, outfitted with oarlocks and oars.

the spring egg gathering was so easy that Tlingits today still speak of "picking" eggs, not hunting them. The Tlingit Clan fled first to the Home Shore, east of today's Excursion Inlet. Then in time they fled across Icy Strait to Hoonah. It was the Little Ice Age glacier advance that had driven these peoples from Glacier Bay. Before their ancestral shores had melted free again, their aboriginal days collided with the arrival of Europeans, and life began a new and radically different era.

Joe and Muz Ibach (above) built their cabin (left) about 1940 at Reid Inlet. Their gold operations, supplemented with gardening and foraging, kept them alive, but that's all. Some years they went in the hole for freight and processing. One year they netted $13.

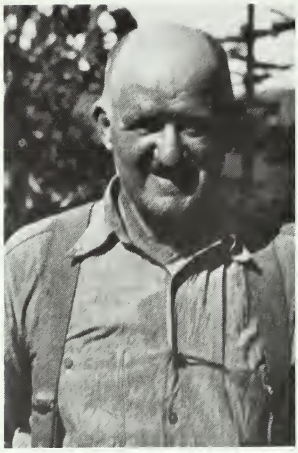
one men worked here, half of them Chinese, the others Caucasian and Tlingit fishermen who supplied salmon. A 1912 photo shows about 40 houses along the beach north of the cabin. Now none is discernible.

From our anchorage we have two objectives ashore: Buck Harbeson's place and the old Tlingit cemetery up the river. Harbeson, a prospector, died here in 1964 alone in his cabin. He had come 33 years earlier to work on Doc Silvers' claim. Silvers had arrived with his wife in 1928. The rain and the silence of our few days in Dundas Bay were theirs year-round, although canneries, salteries (the predecessors of canneries), small mines, and fox farms then accounted for a human population here far greater than today's. A farflung neighborliness must have prevailed as an antidote for the cabin's poignant isolation or, perhaps, as an irritant for any hardcore recluse. Before the arrival of miners and cannery men, fox farmers and squatters, the Tlingits lived here.

The remnants of Harbeson's cabin remind me of Reid Inlet and the Ibachs' little barn-red cabin. When Louis and I stayed there squares of wallpaper samples covered the walls of the Ibachs' back room. Halves of a Mother's Day card were tacked over the two bunks, the cover picture—roses—above one bunk, the inside message over the other. Dave Bohn's book includes a snapshot of the Ibachs (above). They have that gentle expression frequent among people living alone in the wilds. You expect a grizzled, weary, hard look. Instead there's this incredible innocence. Jim Huscroft had that look. He raised foxes on Cenotaph Island in Lituya Bay from around World War I until his death, alone, in 1939.

The 1936 Lituya Bay wave damaged Huscroft's cabin. The 1958 wave demolished it. Pieces of stovewood and scraps of plumbing scattered through the alder are all that tell of its presence now. Human marks have never been great in this country.

Gales today are reported on the outer coast. Winds to 60 knots and 4.5-meter (15-foot) seas. Louis is ashore with the water cans at a stream that flows over granite boulders in an idyllic, mossy, rain-forest setting. Chess stands in the cockpit fishing. We've decided against going ashore to look for the Harbeson cabin. Nor will we chance taking the



Jim Huscroft raised foxes on Cenotaph Island in Lituya Bay from about World War I until he died there alone in 1939. The 1958 wave in Lituya Bay wiped out his cabin.

dinghy up-river to the Tlingit cemetery. This anchorage is too poor and too windy for all of us to leave *Taku*. We thought about holing up and waiting, but have decided to head out.

Gray sky, gray sea. The shore shows only as a low blue-black streak. No mountains, no detail. We failed to explore either cabin or cemetery but the day's mood and the unseen traces of humanity beyond the porthole now merge into remembrance of having once rowed to a grave island opposite today's Tlingit village of Hoonah. You walk across the beach there, climb a bank, and step into the dripping hemlock forest. Headstones are decorated with marble cherubs and crosses that include Russian Orthodox crosses with a second, dipped crossbar. Indian clan crests mingle with the Christian symbols. A marble grizzly drapes over one headstone. A wolf head tops another, jaws open, teeth and tongue realistically carved. There are marble salmon, dogfish, eagles, ravens, and a stone chief's hat embellished with a wolf's face which is outlined with abalone shell.

Step among such graves and you feel a shiver of time and of intersecting cultures. Talk with Indian villagers and you feel it even more. The mother of one of our Hoonah friends watched the Russian flag come down and the 35-star American flag go up in 1865 at Sitka. The entire English-speaking era in Alaska spans just two generations.

Go further back in human time and you come to the tale of ice forcing the Chookaneidi' people out of Glacier Bay. Further still, and you're reading archeology reports. Near Point Couverden—where I found the best huckleberry picking of my life—Dr. Robert Ackerman of Washington State University excavated a site that radiocarbon dates as 10,000 years old. The Ground Hog Bay site is one of only two comparably old sites known so far in Alaska. The other is on nearby Admiralty Island.

Bits of charcoal give the date. With them lay stone choppers, gravers, scrapers, and tiny blades technically called microblades, significant because they represent a distinct, and sophisticated, tool manufacturing technique found on both the Russian and American sides of Bering Strait. A paint stone was also found at Ground Hog Bay: part of a woman's cosmetic kit? a shaman's medicine kit? the palette

an artist used in painting hide?

The Ground Hog Bay site now stands 13.3 meters (44 feet) above sea level, or it did in 1965 when Ackerman and his crew first tested their discovery. Now it must be minutely higher, rebounding as the ice continues to retreat. When the fires of early peoples flickered there the site was at beach level, for artifacts and charcoal lay in beach gravel. Beneath the beach gravel are glacial deposits. Layers of time.

Taku's voyage is ending. Two porpoises are close off the starboard bow. A distant storm petrel flies low to the water, utterly controlled. We're heading for Elfin Cove and from there to Juneau to reboard the ferry. Are we returning to reality or are we leaving it?

Part 3

Guide and Adviser


ARCTIC OCEAN
USSR
UNITED STATES
Cape Krusenstern National Monument
Bering Land Bridge National Preserve
Noatak National Preserve
Kobuk Valley National Park
Gates of the Arctic National Park and Preserve
ALASKA
Denali National Park and Preserve
Fairbanks
Lake Clark National Park and Preserve
Katmai National Park and Preserve
Yukon-Charley Rivers National Preserve
Anchorage
Kenai Fjords National Park
Aniakchak National Monument and Preserve
UNITED STATES
CANADA
Arctic Circle
GULF OF ALASKA
Wrangell-St. Elias National Park and Preserve
Whitehorse
Skagway
Klondike Gold Rush National Historical Park
Glacier Bay National Park and Preserve
Haines
Gustavus
Hoonah
Juneau
Sitka National Historical Park
Sitka
Ketchikan
INSIDE PASSAGE
Prince Rupert
PACIFIC OCEAN
Vancouver
Klondike Gold Rush National Historical Park
Seattle
CANADA
UNITED STATES
WASHINGTON
Portland
MONTANA
OREGON
IDAHO
CALIFORNIA
WYOMING
0 250 500 Kilometers
0 250 500 Miles

Getting to Glacier Bay

Glacier Bay National Park and Preserve lies west of Juneau and can be reached only by plane or boat. The only road merely connects Gustavus and its airfield to park headquarters at Bartlett Cove (11 kilometers/7 miles). There is no link with the Alaska highway system.

Alaska Airlines provides daily jet service from Juneau to Gustavus (about 30 minutes) in the summer season from mid-May to mid-September. Passengers are transported between Gustavus and Bartlett Cove by bus or taxi. Year-round air service to Gustavus is also available by small plane. Scenic flights, charters, and air taxi service, including floatplane service, are offered in summer by a concessioner at Glacier Bay Lodge, and year-round out of Gustavus, Hoonah, and Juneau. Write to the park superintendent—address at right—for a list of operators.

By Boat or Ship Boat transportation from Juneau to Gustavus and limited tour boat service from Juneau to Glacier Bay may be available from May until early fall, but you must inquire before making plans. Charter boat arrangements are sometimes possible out of Juneau or Gustavus. Write to the Juneau Chamber of Commerce, or Gustavus Visitors Association, P.O. Box 167, Gustavus, AK 99826. Private boats are welcome, but a free vessel permit is required from June through August. Write ahead to the park for special regulations. (For boat service at Glacier Bay see Trips Up the Bay.)

Write to the park for a list of ship and tour boat companies that offer Alaska cruises featuring a day in Glacier Bay. On such cruises you will want sun, wind, and rain protection gear so that you can enjoy being on deck, and binoculars for scenery and wildlife.

Topical Reference

For More Information Contact:
Superintendent, Glacier Bay National Park and Preserve, P.O. Box 140, Gustavus, AK 99826-0140; www.nps.gov/glba; or glba_administration@nps.gov by e-mail.

Pages 104-105: *At 1:30 a.m. on May 23 at this campsite on Brady Glacier, only the tent fabric glows warm red.*

Pages 108-109: *Some management regulations for the preserve area—at upper left on your map—may differ from those normally associated with National Park Service areas. For information check with a ranger or write the superintendent.*


YAKUTAT GLACIER
NOVATAK GLACIER
Harlequin Lake
BRABAZON RANGE
Alsek River
Tatshenshini River
TATSHENSHINI-ALSEK PARK
BRITISH COLUMBIA
ALASKA
SAINT ELIAS MOUNTAINS
MELBURN GLACIER
Alsek River
Airstrip
Ranger Station
Dry Bay
East Alsek River
Cabin
GLACIER BAY NATIONAL PRESERVE
Alsek Glacier
Grand Plateau Glacier
GRAND PACIFIC GLACIER
1925
Mount Lodge
10,530ft
3210m
CANADA
USA
Margerie Glacier
Mount Root
12,860ft
3920m
Mount Fairweather
15,300ft
4670m
Mount Quincy Adams
13,650ft
4161m
FAIRWEATHER RANGE
Mount Salisbury
12,000ft
3658m
1966
1929
Johns Hopkins Glacier
Cape Fairweather
Fairweather Glacier
Lituya Mountain
11,750ft
3582m
Mount Abbe
8750ft
2667m
Lituya Glacier
Mount Bertha
10,204ft
3110m
N. Crillon Glacier
Mount Crillon
12,736ft
3883m
Lituya Bay
PACIFIC OCEAN
GLACIER NATIONA
Mount La Perou
10,728ft
3270m
La Perouse Glacier
GULF OF ALASKA
Icy Point
North
0
10 Kilometers
0
10 Miles
1966
Historic extent of glaciation


To Haines Junction and Whitehorse, Yukon Territory and Fairbanks, Alaska
3
Mount McDonnell
5481ft
1671m
BRITISH COLUMBIA
ALASKA
Chilkat
Chilkoot Trail
White Pass and Yukon Railroad
Skagway
CANADA
USA
Klukwan
Chilkat River
Tsirku River
Takhin River
7
Haines
TAKHINSHA MOUNTAINS
MUIR GLACIER
Riggs Glacier
McBride Glacier
Davidson Glacier
CARROLL GLACIER
1960
1966
Wolf Point
Interglacial forest stumps
Casement Glacier
1929
1907
Queen Inlet
1880
GLACIER
Tidal Inlet
MUIR INLET
Adams Inlet
1892
Muir Point
Mount Wright
5139ft
1566m
LYNN CANAL
Blue Mouse Cove
Hugh Miller Inlet
BAY
1860
CHILKAT RANGE
Drake Island
North Marble Island
Francis Island
South Marble Island
Gelkie Inlet
Interglacial forest stumps
Willoughby Island
Finger Bay
Berg Bay
Beardslee Islands
Bartlett River
Glacier Bay Lodge
Visitor Center
Park Headquarters
1794
Campground
9.3mi
15km
Airport
Gustavus
Dundas River
BRADY GLACIER
1961
1750-1780
Excursion Inlet
Pleasant Island
ICY STRAIT
Lemesurier Island
Inian Islands
CROSS SOUND
Cape Spencer
Elfin Cove
CHICHAGOF ISLAND
Hoonah

This is a land of glaciers. Clouds make and perpetuate glaciers, so, for weeks at a stretch, so-called "good" weather may mean a day of only scant rain. Clear days rate as blue-sky days, and most agree such weather is best. But don't despair on gray days. Distant views are blocked, but mist hangs above the water, first swaddling, then releasing, nearby peaks. The bay seems to brood, to be mysterious. Gray days are typical, although rain usually is light and intermittent. May and June usually bring the most sunshine and the least rain, but never trust statistics here. The visitor season runs from mid-May through mid-September.

Generally, weather runs cool in summer and surprisingly mild in winter, with abundant rainfall all year. Rainfall generally increases as the summer progresses into early fall. Bring clothing for possible below-freezing temperatures, no matter the month. Carry full rain protection even aboard ship—for head, torso, legs, and feet—so you can be on deck in all weather.

Layer your clothing: several lightweight shirts and sweaters worn under a windproof, rainproof parka or jacket offer a range of temperature readiness outdoors. Protect wrists, throat, and head against heat loss with cap, high turtlenecks, and sleeve cuffs. (Hikers and kayakers please read clothing and gear advice under Enjoying the Backcountry.) The maritime climate moderates and mutes differences in the change of seasons. In April bears come out of hibernation. Waterfowl begin coming through. Seabirds arrive to nest, and hummingbirds return. Seals give birth beginning in late May. The first whales usually arrive in mid-May to begin foraging on the krill and small fish that will sustain them, as stored fat, through the winter.

Waves of color along the shore tell you what's happening to the calendar. Green leaves burst from lowland willow and alder in May. Alpine meadows turn green in July. Fireweed blossoms paint the upper beach rose-purple from July to mid-August. By late August, cottonwoods glow golden. In late summer and early fall the snow is gone from the ridges and low peaks. Berries ripen in abundance, and salmon migrate into the rivers. Whales and summer birds begin to leave. During starry nights the aurora borealis or northern lights appear.

Insects, Insects, Insects Alaska is notorious for the ferocity of its biting insects. Gnats and flies are worse than mosquitoes here. Aboard ship you'll probably not be troubled. But ashore . . . you may see mountain goats with their muzzles buried in snow to escape getting bitten. Or you may see a cloud of insects encircling a bear.

Higher country is generally worse for bugs than the low country. Some years are plain awful—mosquitoes, deerflies, horseflies, white sox, and no-see-ums are all out for blood. Most years aren't that bad. But bring insect repellant. Beaches often have enough breeze to hold biting insects to a minimum. Bushes can fairly swarm with them.

Backpackers hike along a crevasse, a deep fissure in the ice, on Geikie Glacier in mid-August. This former tidewater glacier has retreated high above its inlet on the bay's west shore.

Naturalist Programs

Park ranger/naturalists lead hikes daily in summer from Glacier Bay Lodge, and they board cruise ships and tour boats to answer your questions and interpret the scenery and wildlife. Exhibits housed in the visitor center portray the park's glacier story, the return of life as ice retreats, and the marine energy cycle. Exhibits on the dock treat whales and marine life.

Films about Glacier Bay are shown daily in summer at the visitor center. Naturalists give presentations in the evenings. Both events take place in the auditorium. Schedules are posted in the visitor center. Rangers can be found in the visitor center—upstairs level of Glacier Bay Lodge—and can suggest the best areas to visit during your stay or answer questions.

Up-bay, rangers are stationed at Blue Mouse Cove in summer and offer information and help in emergencies.

Free literature from the Park Service and various publications sold through the nonprofit Alaska Natural History Association are available. They deal with such topics as the humpback whales, bear safety, and intertidal life at Bartlett Cove. The free park newspaper tells you where to get information about the day's events and provides general Glacier Bay information, including safety precautions and important management regulations.

Accommodations and Services

Glacier Bay Lodge, a concession and the only hostelry in the park, operates from about mid-May to mid-September. The rooms are motel-style. Make room reservations well in advance. The central unit offers lobby, dining room, and bar. Full meal and bar services are open to all, not just to the lodge's guests. Less expensive dorm rooms are also available. For reservations write: Glacier Bay Park Concession, Inc., 226 2nd Avenue West, Seattle, WA 98119-4204. Several family-operated bed and breakfasts and inns in Gustavus offer rooms and meals.

Campground The National Park Service maintains a campground at Bartlett Cove (no reservation or fees required). Facilities include bearproof food caches, outhouses, and fire wood. Campground stays are limited to 14 days maximum. Bring all equipment and supplies. Gustavus has only one small general store and grocery. Juneau is the nearest full-supply point. Glacier Bay Lodge usually sells white gas but no other campstove fuels. Pets must be leashed at Bartlett Cove and are prohibited in the backcountry.

Bartlett Cove Concession A dock facility at Bartlett Cove sells No. 2 diesel fuel and gasoline for boats. Limited time tie-up space is available. Anchorage is good. A tidal grid facilitates hull inspection and repair. Limited snack-type groceries are sold at the lodge. The lodge's showers, laundromat, public phone, dining room, bar, and gift shop are open to all, not just to lodge guests.

Bartlett Cove Activities Be sure to take in the daily naturalist programs at the visitor center. Schedules are posted. You can also hike the trails. A short trail leads through the forest and along

the beaches to the dock. The other trail meanders by a tidal lagoon and into the forest to the Bartlett River estuary (7.2 kilometers/4.5 miles round trip). In May and June birdsong is everywhere, as bird migrations are at their peak. In June and July forest and beach flowers bloom, and berries start to ripen. Take your pick of strawberries, blueberries, salmonberries, and several others. But don't pick the poisonous baneberry! In late summer you can watch salmon enter the Bartlett River to spawn, one of the world's great natural events. August and September bring the onset of fall colors. Ducks, geese, and other waterfowl concentrate in the lagoon for fall migration.

Fishing An Alaska fishing license is required in the park. Licenses are sold in Juneau and Gustavus, at Glacier Bay Lodge, or by mail. Halibut and salmon are the chief sport fish. Some freshwater streams and lakes harbor Dolly Varden and cutthroat trout.

Margerie Glacier's ice front (top) looms high above the serene waters of Tarr Inlet. In a boat this big, this may be as close as you can get to Canada—see map—only to be stopped short by ice, the Grand Pacific Glacier.

Strawberries thrive in this moist, marine climate, and they are not averse to disturbed land and sandy soils.

Trips Up the Bay

Do take an excursion up-bay. The nearest tidewater glacier is about 70 kilometers (43 miles) from Bartlett Cove. Cruise ships and tour boats generally spend a leisurely day traveling to at least one glacier front so passengers can watch the birth of icebergs. A concessioner-operated tour boat departs the lodge every morning for a nine-hour trip up the bay for looks at icebergs, glaciers, and wildlife. Park ranger/naturalists accompany both cruise ships and tour boats. Some concessioners offer overnight boat trips in summer. These are often heavily booked, so inquire way ahead if possible.

Backcountry hikers, campers, and kayakers can be let off by boat and picked up again at designated points up-bay. Make reservations in advance. Floatplane taxi service often can be arranged, but rigid kayaks cannot be transported by floatplane.

Guided kayak trips and kayak rentals are available at Bartlett Cove. Contact the park for current information.

Whale and Seal Watching Comparatively few people have ever seen a whale in the wild. And while nobody guarantees you will see humpback whales, chances are good in June, July, and August. Please remember: whales need peace more than you need a close look. Don't pursue whales. Let binoculars and long lenses close the gap. Minke whales occasionally enter Glacier Bay. So do orcas (killer whales), and porpoises are common. Boaters mostly see humpback whales, which usually just flash their arched backs capped with a small fin. Occasionally, however, humpbacks display their full, prodigious dimensions in leaps from the water, called "breaching." Whales react to boats in various ways. They sometimes slap the water with their side flippers, called "finning," or with their flukes, called "tail lobbing." Humpbacks may also react simply by moving away from the boat or even abandoning the area. The North Pacific Ocean population of humpback whales now stands at only about 2,000 individuals. They are so scarce worldwide they are protected under the Federal Endangered Species Act. They arrive here from their calving grounds near Hawaii with a purpose: to eat enough to store the fat needed to see them through the winter. Humpbacks do not feed year round.

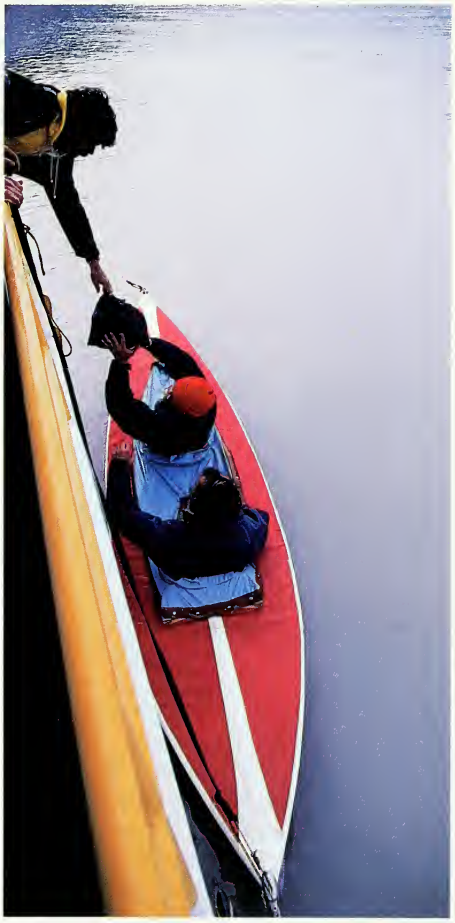
Glacier Bay's harbor porpoises are considered one of the world's few untrammeled populations. More than a hundred have been counted feeding together in Sitakaday Narrows where tide rips bring nutrient-rich bottom water to the surface. You may see Dall porpoises in Icy Strait or in the lower bay playing in your vessel's bow wake. Harbor seals are seen almost anywhere in Glacier Bay waters. Great throngs ride pack ice in upper tidewater-glacier inlets during early summer's pupping season. Don't approach them during mid-May to mid-June, the crucial weeks of mother-pup bond formation. Disturbance may cause a mother to abandon her young permanently. Certain death ensues for the hapless pup.

Camper orientations, provided at least twice daily by rangers, are required if you are planning to camp in the park. Bear-resistant food canisters are provided free of charge at your camper orientation. Plan carefully so you are well supplied but not overburdened with gear. You will meet wilderness on its terms, not yours. Count on rain: May and June average the least, August and September grow steadily wetter. Most years, snow lingers well into June in the low country and blankets meadows into July or even August.

Bring good raingear, a tent with waterproof fly, a rain cover for your pack, waterproof matches, and dry bags if you are kayaking. Then expect to be wet part of the time anyway. Wool clothing or synthetic pile is advisable, because it retains warmth while wet. Cotton and many synthetics do not. However, synthetic-fill sleeping bags and jackets provide more insulation when wet and can be wrung half dry. By contrast, down bags and clothing lose most insulation value when wet. Protect down garments zealously during wet conditions. And remember that the wet from sweat is just as wet—and chilling—as rain.

So-called "waterproof but breathable" fabrics often soak through in constant downpour conditions that sometimes exist. Be sure you're equipped either with clothing that stays warm while wet or with clothing carefully kept dry until needed and feasible to wear. Hypothermia—critical loss of body heat—is serious and can strike any time of year here. Hypothermia can cause death, even when the temperature is well above freezing.

You must be prepared for wet and cold but also bring lightweight clothing, in case of hot weather, and sunburn protection.



Kayakers transfer the last bit of gear as they get dropped off for paddling and backpacking in the upper bay. Both kayakers and their kayaks can book passage up the bay with Glacier Bay Lodge's daily tour boat service.

Extensive hiking, especially with a heavy pack, requires sturdy boots. Rubber boots are almost a necessity for getting in and out of kayaks. Carry moleskin or something similar even if you are not prone to blisters. Wet feet can develop sore spots. A sleeping pad will afford comfort and insulate you from the cold ground. A mosquito head net can be helpful when the insects are numerous.

Where to Go? No trails exist in Glacier Bay National Park and Preserve except at Bartlett Cove. Carry a compass and topographic map—maps are sold in the visitor center, backcountry ranger station, or by mail—and know how to use them before you begin your trip. Solo travel is inherently more risky than group travel. Only the more experienced wilderness travelers should consider solo trips. A permit from the Park Service is required for all overnight backcountry travel. Be prepared for steep, rocky slopes, maddening tangles of alder and devil's club, vast barrens, and rivers rising treacherously in heavy rain or becoming torrents on hot afternoons when ice melt is greatest. Also expect beauty that will stretch your soul and likely haunt you forever.

To be close to tidewater ice, go to upper Muir Inlet on the bay's east side, or Reid, Johns Hopkins, or Tarr Inlets on the west side. Lituya Bay and the La Perouse Glacier, on the outer coast, are also close to ice, but approach by air taxi is all but required.

Delightful coves, inlets, and islands offering wildlife and plants in varying stages of colonization are available by the score as destinations, many with valleys or slopes that lead to high ridges and over into adjoining drainages. Put a pin on the map while blindfolded, and you probably will pick well! But to fit interest and energies to available time and experience, you do best to talk over options with a ranger. And read about backcountry access and transport in Trips Up the Bay.

Making Your Camp Avoid camping on beaches bordered by bluffs or plant thickets where animals—from mountain goats to wolverines, moose, wolves, and bears—have established thoroughfares. Also respect the territory of nesting birds. South Marble Island and other islands are closed to camping, or even to going ashore, from May 1 to September 1. This is to protect nesting birds. Ask a park ranger about any other restrictions on camp locations. Naturally disturbed places, such as outwash areas, are recommended as campsites. Stay *well* above high tide line, preferably above the ryegrass zone.

Firewood is not available in the upper bay. The only wood there is interglacial wood, sometimes several thousand years old, killed by previous glaciation. This wood should not be burned. Bring a stove and fuel bottle. White gas is sold at Glacier Bay Lodge or in Gustavus, but alcohol, butane, propane, and Sterno are not. Commercial airline safety regulations prohibit carrying flammable or explosive materials, which includes all campstove fuels. So bring a fuel bottle for filling here and be prepared to use only white gas.

Finding water is no problem except on islands and some ridges and high slopes, but water for drinking should be boiled, treated, or filtered. Glacial streams may run brown with silt. Let silt-bearing water stand overnight to settle out and then treat it for drinking.

Leave No Trace Respect other travelers by choosing subdued colors for your tent and clothing. Greens and

grays are best. Where possible place your camp out of sight of waterways and other travel corridors. Pack out everything you pack in. This includes empty cans, jars, and plastic bags. Human waste should be left in the lower intertidal zone. This is where it breaks down the fastest. Campfires are to be built only in the intertidal zone. The key is: camp without leaving a trace.

Mountain and Glacier Climbing Specialized equipment and experience are requisite to safe mountain climbing or to venturing out onto glacier ice. It is highly recommended that you register your climb with a ranger if your plans include the high peaks or glacier travel. The Fairweather Range stretches nearly 5,000 meters (16,000 feet) above sea level, and scores of glaciers whiten various elevations. Spectacular climbs are assured the prepared, but you need to bring full equipment and knowledge with you. This includes rescue knowledge and gear. (See page 107 and Trips Up the Bay for logistics information.) Radio communication in the Fairweather Range is unreliable. Expect to be totally on your own and make your own support-party arrangements. The terrain here is exceedingly remote. Rangers help if they can, but even making contact is unlikely in emergency situations. (See Precautions.)

Kayaking and Boating In general, kayaks are preferable to canoes in these waters. Kayaks are lighter to handle and, because they ride lower in the water, less affected by wind. This can be important. A general lack of wind may frustrate sailors here, but there is enough wind to menace paddlers. Strong gusts may blow up at any time, so stay within 500 meters (a quarter mile) of shore and at the first hint of storm, head in. The routine scheduling of city living can be a booby trap here. Setting time goals and sticking to them may interfere with your trip rather than enhance it. Do not stubbornly buck wind and waves. Do not challenge fate. Go ashore, hole up, and wait. Once you have idled back your sense of urgency to fit reality here, you will find a peculiar emancipation—like returning to a time that predates and transcends the clock.

All those afloat in no matter what type of craft should bring lifejackets, at least one extra paddle per craft, basic repair parts and equipment, and a Juneau tide table. Tide range approaches 8 meters (25 feet). This produces strong currents that drastically affect itinerary and timing. You can get a free ride by going with the tidal current but be thwarted or swept back by going against it. Plan accordingly.

When ashore, carry your craft up well above the highest seaweed and barnacles, then tie the bowline to a rock or tree trunk. Do this automatically—even on the outgoing tide—and you will never return to find your kayak or dinghy drifted off, with potentially dire consequences.

Do not pursue seals, whales, or seabirds in the water. Respect seal mother-and-pup pairs hauled out on floating ice. If you panic them into diving off, they may become helplessly separated, and the pup will die. By Federal regulation whales may not be approached closer than 500 meters (1,500 feet). This is to assure that park waters remain a protected haven for their summer feeding, but the regulation also protects you. Even without intending harm, a whale could easily capsize a kayak, skiff, or dinghy and could severely damage a larger boat.

Seawater temperatures here are much

too cold for falling overboard even in summer. Know how to handle your craft before venturing onto these waters on your own. Kayaks may be rented at Bartlett Cove. Guided trips are offered as well.

Private boaters need an up-to-date Glacier Bay chart sold at the backcountry office or visitor center. All boaters are reminded that a permit, available up to 60 days in advance, is required for entry into the park from June 1 to August 31. Boaters should also stop in at the backcountry office by the dock for an orientation upon entering Bartlett Cove. Rangers can advise you somewhat about anchorages and courses. Extensive, specific information may be hard to come by.

Classic up-bay anchorages are Reid Inlet, Shag Cove, Blue Mouse Cove, and South Sandy Cove. Wolf Point in Lower Muir Inlet is beautiful but exposed to winds and drifting icebergs. For additional anchorages, or for Dundas or Taylor Bay or outer-coast destinations, you will have to find someone who can pinpoint protected locations on your chart.

Inside Glacier Bay extreme water depth, tide range, and rocky bottoms can complicate anchoring. There are no docks or mooring buoys. Icebergs may be a real threat, as well as a joy to behold (see Precautions). Beware, too, of silty deltas reaching considerable distances offshore from active glacial outwashes. Depth readings may be misleading because such submarine deposits can have an abrupt leading edge. Running aground is the only way to find them!

Prevailing winds off the ocean and Cross Sound are southwesterly. They may be fairly strong in lower Glacier Bay while upper reaches are flat calm. Intermittent winds coming off the high

Day hikers, backpackers (top photo), and kayakers can be let off the daily tour boat and picked up again for the tour fee plus drop-off and pickup charges. Arrangements must be made ahead: only three dropoffs and pickups are planned per day.

Page 118: *An angler proudly shows off his catch of a silver salmon beside the Dundas River.*

Author Ruth Kirk confirms itineraries with the charter pilot after she and her party unloaded their gear at Reid Glacier.

A raft party floats the Tatshenshini River. It joins the Alsek River in the national preserve and provides exciting float trip adventures.

peaks characterize the upper bay. These are not uniform in direction, strength, or duration.

Getting water is no problem, providing you have containers and a means of going ashore, but all water should be treated before drinking.

The National Park Service monitors Channel 16 daily from 8:00 a.m. to 7:00 p.m. during the summer season. Bartlett Cove park headquarters call letters are KWM-20. The ranger station at Blue Mouse Cove can be called directly by location name. Rangers are here intermittently, so do not be confident of making contact. Line-of-sight is necessary for most VHF transmission, obviously a stacked deck in fjord country whose high cliffs wall and seal off inlets.

Self-sufficiency is the hallmark of Glacier Bay boating. Bring all gear and supplies, including those for emergency repairs, and an extra anchor.

River Float Trips Where the Tatshenshini and Alsek Rivers join, the water flow becomes triple that of the Colorado River through its Grand Canyon. This makes for one of our continent's major float trips. The Tatshenshini-Alsek river corridor comprises the only break in the coast mountains from Cape Spencer to the Copper River. Both guided and private trips are strictly limited in number. Several guides offer float trips under permit in summer. Private trips also require a permit. Write to the park for more information. The trip takes a week or more. Total distance is about 200 kilometers (125 miles). High peaks, closeby glaciers, and wildlife assure superb scenery. You end up at Dry Bay, on the park's northern outer coast, where prearranged air service meets you.

Armchair Explorations

Selected books, maps, charts, guides, and other publications are available through the Alaska Natural History Association. The Association is a nonprofit organization founded in 1959 to enhance the public's understanding and conservation of Alaska's natural, cultural, and historical resources. To accomplish its mission, the Association works in cooperation with Alaska Public Lands Information Centers, Alaska State Parks, Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, U.S. Forest Service, and other educational organizations throughout Alaska. The Association donated money to help produce this handbook.

If you would like a pricelist of publications or information about membership in the Association, please contact the Alaska Natural History Association, P.O. Box 140, Glacier Bay National Park, Gustavus, AK 99826, or telephone (907) 697-2635.

Precautions

Wilderness seems wilder here than in many regions where that term is used. And some potential hazards here are rare elsewhere. If you and your party are inexperienced, don't start out on your own here. Join a cruise or tourboat party, or a guided kayak or float trip instead. Those with previous experience, however, can expect an absolute high point in backpacking, kayaking, or boating—or a combination of these.

About Bears Both black bears and brown/grizzly bears can be dangerous, although aggressive encounters are extremely rare. You cannot outrun either. Don't squander energy trying. The best thing to do is to avoid a confrontation. Never go deliberately close. Use a telephoto lens for pictures. When hiking, be noisy, especially when going through brush where visibility is limited. Talk, sing, whistle, or tie a jingling bell on your pack. This gives the bears fair warning, and they will usually avoid you, given the option. Stay out in open country whenever possible, especially if you have noticed bear tracks, droppings, or diggings. And avoid bear food sources such as salmon streams, animal carcasses, and berry patches. Cook and eat in the intertidal zone and store your food (always in a bear-resistant canister) in an area well separated from where you sleep. Be scrupulously clean about your camp to minimize odors.

Near certain trouble will result if you get between a sow and her cubs. If a bear charges you, most experts advise that you first try out-psyching it. Call in a loud but calm and authoritative voice, not a hysterical screech. The words don't matter. "Stop" and your favorite epithets are probably as good as anything.

If a bear clearly is going to attack, not just charge in bluff, your best hope of survival seems to be curling into the fetal position with your fingers clasped over the back of your neck. If there are several of you, try linking arms and looking like a huge adversary while ordering the bear to stop. If you spot a bear, make plenty of noise and cross upwind so that it can get your scent. Surprise encounters are to be avoided if at all possible. A bear information brochure is available free at Bartlett Cove, or by mail from the park. Get one and study it.

Icebergs and Glaciers Despite their beauty floating icebergs can be dangerous if approached too closely. They may turn over quickly or break up without warning. Added danger—for kayak or dinghy—comes from the waves set in motion by a rolling berg.

Ice falling from tidewater glacier fronts sets off enormous waves sweeping for considerable distances. This is the most common danger from getting too close to a tidewater ice cliff. The National Park Service recommends staying at least 800 meters (a half mile) away. The waves set up may also race along the shore, threatening kayakers or hikers who thought they were prudently removed from the glacier front. Even a mostly grounded ice tongue, such as the Reid Glacier, may calve off enormous slabs and bergs. People have been killed in Southeast Alaska when walking close to such ice fronts.

Venturing out onto a glacier is best left to the experienced and equipped. Ice remnants such as what is left of Burroughs Glacier are a partial exception to this because they have mostly dwindled into reasonable stability. Even so, what looks like gravel may be just a thin veneer over slick ice. Last winter's snow may be hiding crevasses, great cracks like canyons, and moulins, melt holes that drop clear through the ice. If you hear the muffled roar of water, beware. The ice covering a melt stream is often thin.

Ice caves along the edge of a glacier are always dangerous. Rocks embedded in the ceiling can drop, ice slabs give way, and melt streams somewhere upslope suddenly break loose and send a torrent sluicing through the cave. Seracs—ice pinnacles—may melt out of balance and crash down.

When Afoot Meltwater rivers are turbulent. If they come from a glacier they may be so silty you can't see bottom. Cross such rivers with care. Use a stout stick for balance. Wide sections of river, usually the most shallow, are often the best crossing points. Angle slightly downstream as you wade. Early morning crossings are best: lower melt rates then mean shallower water.

In tidal areas or near glaciers, watch out for quickmud, sediment so newly deposited it is still goop. The surface looks okay but put weight on it, and the deposit liquifies. Poke ahead with a staff if you have any doubt about what you're getting into. Move as quickly as possible if you feel yourself sinking in.

Hold to a compass course if you are bashing through alder thickets. You can't see out, and otherwise you may waste hours going in unhappy circles. Devil's club is an additional terror. If your necessary route leads through this thorny hell, don your sturdiest long-sleeved, long-legged clothing.

When Afloat Floating icebergs and tidewater glacier tongues are the greatest hazards afloat, as described above. If you anchor in iceberg waters, such as Reid Inlet or at Wolf Point, consider

your emergency action if a large iceberg should bear down on your boat or anchor line. Know how to cut and run if your boat hook won't fend off the ice. It is better to lose an anchor and line than to contend with a big iceberg. Otherwise, do not anchor where tidal currents could bring a stream of bergs near you.

With tides ranging up to 8 meters (25 feet), you must carry dinghies and kayaks truly high on the beach when going ashore. Then secure them well by tying. Similarly, allow ample scope on the anchor line and remember that adequate water depth at high tide may be unacceptable at low tide. You will go aground.

Firearms Warning Firearms are not permitted in the park. If you have brought one, check with a ranger, who will store it until the end of your trip.

Nearby Attractions

Excursion Inlet An active salmon cannery operates adjacent to ruins of a long-defunct predecessor. The massive timber frameworks of now-outlawed fish traps lie beached at the inlet's head. No tourist services are available. The inlet's western shore is in the park.

Hoonah A Tlingit Indian village, Hoonah offers motels and stores, limited dock tie-up space and fuel, scheduled flights connecting to Juneau, and charter flights anywhere. There is a public telephone and a clinic that accepts emergency patients. A cannery in the outer harbor buys salmon and crabs from commercial fishermen.

Elfin Cove On Cross Sound, Elfin Cove is a roadless fishing village of cantilevered walkways and houses tucked along the inner reaches of a steep-sided, deep cove. A more picturesque layout is hard to imagine. Dock tie-up space generally equals demand on a first-come, first-served basis (no charge). Fuel, groceries, ice, marine supplies, and limited service are available. So are rooms, meals, liquor, hot showers, and sauna.

Juneau If you're in Juneau on a blue-sky day, consider chartering an hour's flight over the ice field. Tour buses run from downtown Juneau to the Mendenhall Glacier snout. This pleasant drive ends at a Forest Service visitor center with exhibits and a nature trail. Allow a half day for this trip. In downtown Juneau the State Museum offers outstanding displays about natural history and human culture here. (Open daily in summer; small fee.) The Juneau Chamber of Commerce, on Franklin Street, provides a downtown walking tour leaflet. Highlights are St. Nicholas Russian Orthodox Church and the im-

Skagway's historic Arctic Brotherhood Hall must have one of this nation's most intriguing facades. Here at Klondike Gold Rush National Historical Park restored structures give a picture of life in 1898 and after. Bottom photo shows, from left, Mascot Saloon, Pacific Clipper Line office, and the Boas Tailor and Furrier shop.

posing Governor's Mansion. Juneau has been Alaska's capital since territorial days. There is a joint National Park Service-U.S. Forest Service Information Center in Centennial Hall downtown. Ask there for information on Admiralty Island National Monument. There are Forest Service campgrounds some distance north of Juneau. City bus service connects from Auke Bay and the airport to downtown Juneau.

Haines Principal Haines area attractions include Fort William H. Seward, Sheldon Museum and Cultural Center, Alaska Indian Arts, and the Chilkat Center for the Arts, where the Chilkat Dancers perform. Along the river, north of town, bald eagles congregate in late summer and fall to feed on spawned-out salmon. There are private and state park campgrounds surrounding Haines. A road leads into the interior, joining with the Alaska Highway at Haines Junction north of Whitehorse in Yukon Territory, Canada. Haines occupies a traditional Tlingit village site. Recent history dates from the establishment of a trading post in 1878, followed by a mission in 1881.

Skagway The Alaska Marine Highway, the state ferry system, has its northern end at Skagway, at the head of Lynn Canal. Many cruise ships and tour boats stop here as well. The present town was born during Klondike Gold Rush days in 1898, when 20,000 eager stampeders made it their staging area—and the largest Alaskan town of that day. From Skagway, gold seekers climbed famed Chilkoot Pass, bound for Lake Bennett and a water route to the gold fields. Klondike Gold Rush National Historical Park today preserves the scene of their struggles. You can climb the same trail they did, nearly

straight up via Chilkoot Pass. (Allow several days for this hike.) Scheduled bus tours operate on the new road connecting Skagway and Whitehorse. There is a National Park Service visitor center in Skagway's historic railroad depot building. The Trail of '98 Museum is inside City Hall. A city campground and private campground are virtually downtown. A small state park lies about 7 kilometers (4.5 miles) from the ferry terminal.

Sitka Sitka is reached by air or aboard certain state ferries and cruise ships but not all. Russian traders established this first white settlement in Southeast Alaska in 1799. Here Russia transferred title to Alaska into American hands following Secretary of State William H. Seward's land purchase in 1817. Today Sitka's economy is based on tourism, fishing, and a cold storage plant. Campgrounds and a range of accommodations and services are available. Points of interest include the Tlingit Cultural Center, Sheldon Jackson Museum, St. Michaels Cathedral, and Sitka National Historical Park. The park features a totem pole collection, demonstrations of native crafts, and a Russian bishop's restored house. Ask in Sitka about the new Archangel Dancers performance schedule.

Index

Numbers in italics refer to photographs, illustrations, or maps

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Handbook 123

The National Park Service expresses its appreciation to all those persons who made the preparation and production of this handbook possible.

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R.H. Armstrong 79 sandpiper and terns
Tom Bean 4-5, 6, 8-9, 12, 16-17, 40-41, 77, 78 puffins, 82-83, 86, 104-105, 111, 118, 119
Bruce Black 101
William Boehm 18-19, 58 moss
Belmore Browne, Courtesy of Glenbow Museum, Calgary, Alberta 98-99
Donald D. Chase 120 raft
John Cossick 42
Richard Ellis 92-95 whales
John Field 45
William O. Field, American Geographical Society 44
Gary M. Hasty 57 spruce bud
James G. Hauck 52, 57 cottonwood
W.S. Home 58 columbine
Robert Hynes 90-91
John Hopkins University, Ferdinand Hamburger, Jr. Archives 34
Mark Kelley cover
Ruth and Louis Kirk 24, 29, 36, 43, 49, 56-57, 100, 113 ship, 120 plane
Penny Knuckles 58 blueberry, 59 baneberry
David Nemeth 59 fungus
Michael J. Nigro 59 cress
Rollie Ostermick 59 skunk cabbage
Bruce Paige 10-11, 22-23, 30-31, 78 duck, 79 guillemot
Jaime Quintero 46-47
R.R. Donnelley & Sons 106, 108-109
William Rodarmore 55, 57 alder, 58 moraine
Greg Streveler 62, 79, kittiwakes, 80 top
Clarence Summers 57 spruce/hemlock
U.S. Fish and Wildlife Service 72-73 salmon, 73 eagle (Ron Singer)
Bradford Washburn 102
Manya Wik 68, 79 gulls

National Park Service
U.S. Department of the Interior

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

Glacier Bay