Home is Where the Habitat is

An Ecosystem Foundation for Wildlife Distribution and Behavior

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The lands and near-shore waters of Alaska stretch from 48° to 68° north latitude and from 130° west to 175° east longitude. The immense size of Alaska is frequently portrayed through its superimposition on the continental U.S., stretching from Georgia to California and from Minnesota to Texas. Within Alaska's broad geographic extent there are widely diverse ecosystems, including Arctic deserts, rainforests, boreal forests, alpine tundra, and impenetrable shrub thickets. This land is shaped by storms and waves driven across 8000 miles of the Pacific Ocean, by huge river systems, by wildfire and permafrost, by volcanoes in the Ring of Fire where the Pacific plate dives beneath the North American plate, by frequent earthquakes lifting mountains and shifting faults, and by glaciers retreating up to a thousand feet per year or surging hundreds of feet in a day.

This incredibly beautiful, but constantly shifting, land is home for many species of plants and animals. Some animals come only for the summer months, to breed, raise young, and retreat to warmer climes before freeze-up, when the cold, dark winter sets in. Other species are year-round residents, hibernating through the hungry winter or hunkering down with insulating fat, fur, or feathers or with high metabolism to survive until spring.

During 1999–2001 a group of scientists used old resource and environmental maps of Alaska and new digital datasets to derive a map illustrating the major ecosystems of Alaska. Extensive discussions among 40–50 scientists from many disciplines, representing hundreds of years of field experience in the north, helped refine the final data set. Thirty-two ecoregions were delineated and described, encompassing the landscapes and ecological processes of Alaska and nearby Canada and Russia. These are large ecosystems primarily defined by climate and topography, with refinements from vegetation patterns, disturbance regimes, bedrock geology, and surficial deposits remaining from recent geomorphic activities such as glaciers, floods, and volcanic eruptions.*

Ecosystems in Alaska are spread out along three major bioclimatic gradients, represented by the factors of climate (temperature and precipitation), vegetation (forested to non-forested), and disturbance regime. When the 32 ecoregions are arrayed along these gradients, eight large groupings, or ecological divisions, emerge. In this paper we describe the eight ecological divisions, with details from their component ecoregions and representative photos.

Ecosystem structures and environmental processes largely dictate the distribution and behavior of wildlife species. For example, the numerous shallow ponds and wetlands of the Arctic coastal plain and the Yukon–Kuskokwim Delta provide nesting and rearing habitat for millions of waterfowl that migrate north every summer. However, cold, windy winters freeze the ponds, and snow blankets the tundra, turning a lush landscape into a frozen barren land. As ice fingers reach across the water, the birds fatten up, then swing into the sky and migrate back to their wintering grounds.

Farther south, coastal brown bears spend the summer and fall months gorging on nutrient-rich sedges, salmon, and berries. As the early snowline moves down the mountains, the bears scavenge the final carcasses and head into snug dens to hibernate for the winter. Metabolism rates drop, allowing a bear to survive four to six months on fat reserves. For pregnant sows, this survival extends to nursing cubs that are born during the winter.

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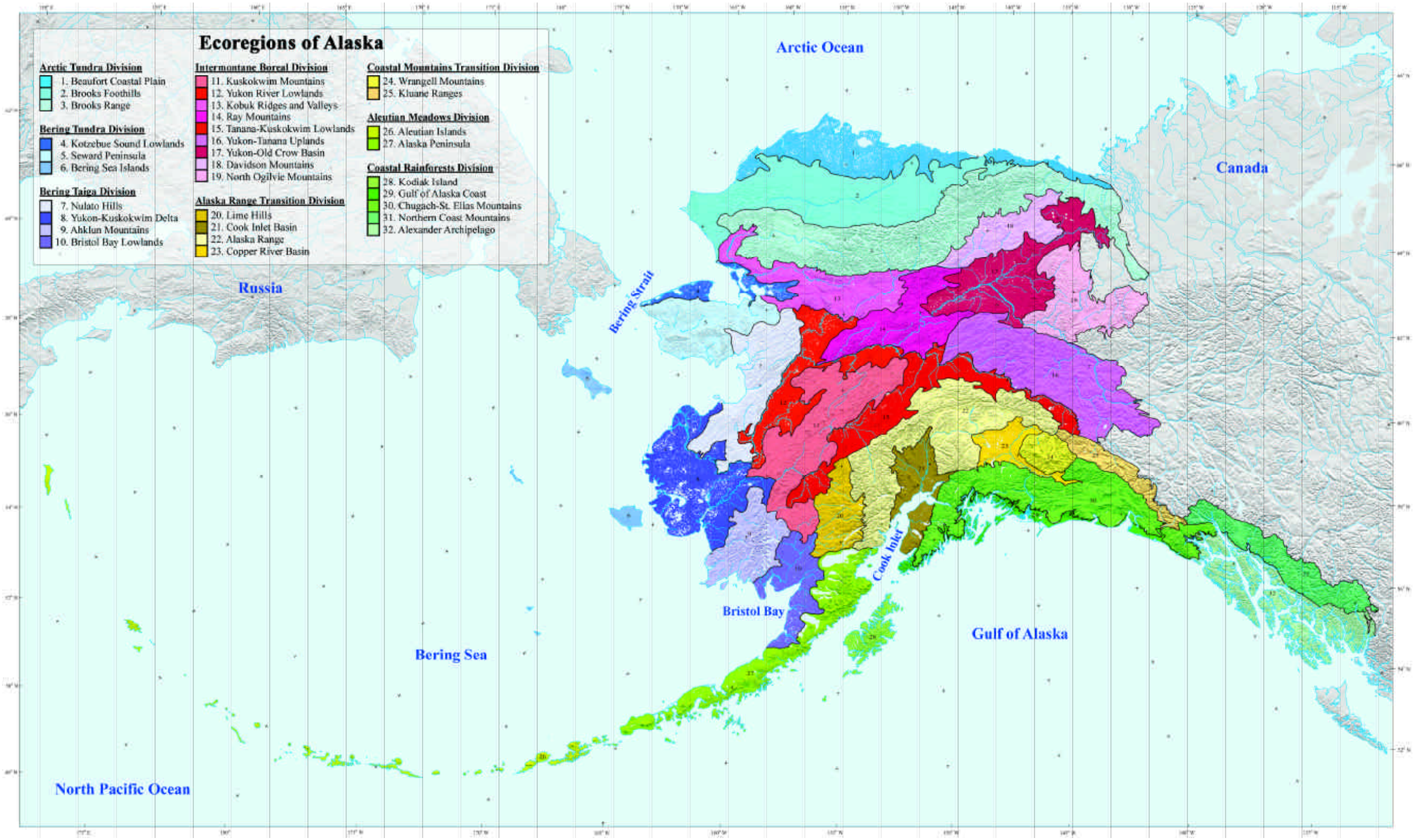
* Full ecoregion descriptions with photos and compilation tables of environmental variables are available in the original publication [Nowacki, G., P. Spencer, M. Fleming, T. Brock, and T. Jorgenson (2002) Unified Ecoregions of Alaska: 2001. USGS Open File Report 02-297. 1 map.] Digital files of the Unified Ecoregions of Alaska are available at http://agdc.usgs.gov/data/projects/fhm.



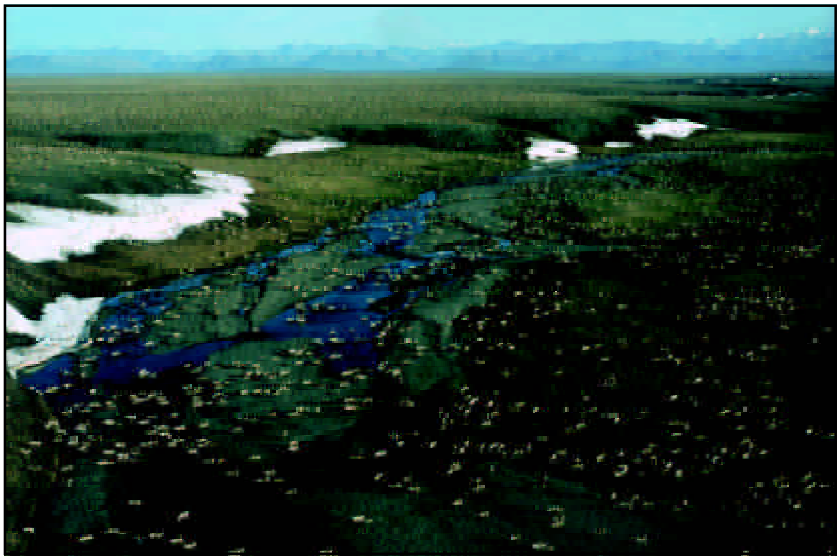
Several map versions were generated over a period of one year incorporating suggestions received from various ecologists, biologists, soil scientists, pilots, and geologists from across the state and adjacent Canadian lands. In areas where data were lacking or pattern changes on the land were indistinct, the advice of local experts was used extensively for line placement. The final data set represents the combined wisdom of 40–50 scientists from many disciplines with hundreds of years of experience in Alaska and nearby country.

The primary map contributors included Lee Anne Ayers, Chris Dau, Jonathon Hall, Janet Jorgenson, Fran Mauer, Ken Rice, Susan Savage, Lisa Sapperstein, and Mike Vivion of the U.S. Fish and Wildlife Service; Blain Anderson, Mary Beth Cook, Bill Eichenlaub, Rich Harris, Penny Knuckles, Lois Dalle-Molle, Bud Rice, Danny Rosenkrans, Patty Rost, Shelli Swanson, and Sara Wesser of the U.S. National Park Service; Dean Davidson, Rob DeVelice, Gary Fisher (GIS work), Rex Friend, Connie Hubbard, Beth Schulz, Michael Shephard, Ken Winterberger, and Kari Youkey (GIS work) of the U.S. Forest Service; Mark Clark and Darrell Kautz of the U.S. Natural Resources Conservation Service; David Brew, Alisa Gallant, and Mark Shasby of the U.S. Geological Survey; Keith Boggs and Carolyn Parker of the University of Alaska; David Banks of The Nature Conservancy; Bob Ritchie of Alaska Biological Resources, Inc.; Tony Button and Dennis Demarchi of the British Columbia Ministry of the Environment, Land and Parks; John Meikle and Jack Schick of the Government of the Yukon; Charles Roots of the Geological Survey of Canada; and Scott Smith of Agriculture and Agri-Food Canada.

Moose spend their summers feeding on lush wetland vegetation and new shrub growth, especially in early successional vegetation communities. During winter, however, snow severely limits food availability, forcing moose to wade through deep snow to browse on shrubs. If the energy gained from browsing willow twigs is greater than the energy expended reaching them, the moose have a good chance of surviving until spring.

The animal species discussed in this issue have each developed adaptations that have enabled them to survive and persist in the various ecosystems in Alaska.

The **Arctic Tundra Division** stretches along the Arctic Ocean and sweeps inland to include the Beaufort Coastal Plain, the Brooks Foothills, and the Brooks Range ecoregions. These open, wind-swept lands are gripped by polar conditions throughout the year. Cold air off the permanent ice pack of the Beaufort Sea has low moisture-holding capacity, and precipitation in this region is less than 20 inches per year. Summer temperatures average less than 50°F within this division, effectively limiting tree growth to the southern fringe of the Brooks Range. Permafrost is nearly continuous throughout the region, contributing to saturated organic soils in the summer and a variety of freeze–thaw ground features. Repeated freezing and thawing of soils create unique features such as pingos (ice-cored peat mounds), ice-wedge polygons (a repeating pattern of hexagons in the tundra vegetation), oriented thaw lakes (linear lakes shaped by prevailing winds), and solifluction lobes and stone stripes (ground loops and vertical stripes on gentle hills caused by slumping of the thawed active layer or by frost pushing larger rocks to the soil surface).



Migrating caribou swarm across a braided floodplain in the Brooks Foothills, with the peaks of the Brooks Range in the background. Late snowbanks and aufeis deposits provide a refuge from biting insects. On either side of the river, tussock tundra and willows stretch for hundreds of miles across the foothills and into the lower Brooks Range.

The Brooks Range represents the northern extension of the Rocky Mountains and is built up by accreted terranes (fault-bounded rock units with a unique geologic history) originating from the Arctic Ocean. The high central portion of the range possesses steep angular summits of sedimentary and metamorphic rock draped with rubble and scree. Mountain glaciers covered the higher peaks during the Pleistocene, leaving remnant glaciers in the high cirques (steep-walled semicircular hollows created by glacial scouring). These glaciers flowed out of the Brooks Range, carving wide valleys, which serve as corridors for human and wildlife migrations, and leaving terminal moraines looped across the Brooks Foothills. The Brooks Foothills are gently rolling hills and broad exposed ridges flowing out from the northern flank of the Brooks Range. Narrow valleys, glacial moraines, and outwash are interspersed among long linear ridges, buttes, and mesas composed of tightly folded sedimentary rocks. The foothills flatten out into the Beaufort Coastal Plain, a vast undulating surface underlain by unconsolidated deposits of marine, fluvial (carried by streams), glaciofluvial (carried by glacial ice and meltwater), and eolian (carried by wind) origin and covered with a mosaic of lakes, braided rivers, and wetlands.

River systems arising in the Brooks Range flow south into the boreal zone or north to the Arctic Ocean. High-energy stream systems cut narrow ravines in the mountainous Brooks Range, etching a deeply incised dendritic pattern. Streams coalesce into large braided rivers in the foothills. Some of these streams freeze solid to their bottoms, causing large deposits of frozen overflow, or aufeis, that last well into summer and provide refuge for caribou from voracious flies. Break-up and snowmelt in the southern Brooks Range often cause spring flood waters to flow out over still-frozen river channels on the Coastal Plain and flood onto the near-shore ice of the Arctic Ocean.

Tundra and low shrub communities predominate throughout the Arctic Tundra zone. Saturated soils and numerous thaw lakes on the Beaufort Coastal Plain support wet sedge tundra in drained lake basins, swales, and floodplains and tussock tundra and alpine tundra dominated by sedges and *Dryas* (mountain avens) on gentle ridges. Vegetation of the foothills and lower mountain slopes of the Brooks Range is dominated by vast expanses of mixed shrub–sedge tussock tundra,

Wetlands, oriented lakes, and saturated organic soils are characteristic of the Beaufort Coastal Plain near Milne Point. Lakes are still ice-covered in early spring but will soon break up and resound to countless calls of courting and nesting waterfowl.

interspersed with willow thickets along rivers and small drainages and *Dryas* tundra on ridges. Alpine tundra and barrens dominate at higher elevations along the entire crest of the range. On the south side, lower mountain slopes and valleys are covered with sedge tussocks and shrubs. The Arctic treeline skirts across the Brooks Range in Canada and is restricted to the south side of the range in Alaska. Here, sparse spruce and birch forests and tall shrublands occur in larger valleys.

Fish species and populations are sparse in the swift shallow streams of the Brooks Range. As streams become larger and slower, their clear waters teem with arctic char and arctic grayling. Arctic cisco, broad whitefish, least cisco, and Dolly Varden char overwinter in deep holes of the larger rivers of the coastal plain and migrate to near-shore marine waters for the summer. This region has been called the "Arctic Serengeti" because of the huge herds of caribou that migrate across the Brooks Range annually—north to the coastal plain for calving and summer grazing, south for the winter months. Wolves, arctic foxes, and grizzly bears follow and prey on caribou herds, subsisting on voles, lemmings, arctic ground squirrels, or vegetation when caribou are not available. Muskoxen were heavily hunted on the coastal plain during the whaling era and are re-establishing themselves from introduced animals (see p. 74). Dall's sheep occupy the high country of the Brooks Range (see p. 68). Several species of whales migrate into the Arctic Ocean in summer, and seals and polar bears are year-round residents. The coastal plain is important for breeding birds, including a wide variety of shorebirds, ducks, geese, swans, and songbirds.

The **Bering Tundra Division** includes lands and nearby waters in and near the Bering Sea. The Bering Sea is mostly ice-covered for many months each year and cold and stormy the remaining months. The Bering Sea has limited warming effects on the climate, so the adjacent lands are predominately cold, wind-swept, and treeless. The Bering Tundra Division includes the Kotzebue Sound Lowlands, the Seward Peninsula, and the Bearing Sea Islands ecoregions. The northern Bering Sea covers a large shallow shelf less than 250 feet deep, reaching well north in the Chukchi Sea, through the Bering Strait, and south to the Pribilof Islands. During several glacial maxima, this shelf has been above sea level and vegetated with tundra and steppe communities. This plain served as a migration route between North America and Eurasia for plants, animals, and humans (see p. 55).

Scattered volcanic hills rise above large expanses of marine sediments, outwash plains, and sedimentary bedrock. These hills form the exposed Bering Sea Islands and hills of the Seward Peninsula. Several recent lava flows, cinder cones, and hot springs on the Seward Peninsula indicate ongoing volcanism. The Kotzebue Sound Lowlands are primarily depositional features from materials washed and blown off nearby hills and outwash plains. The Seward Peninsula is gently rolling hills and rounded valleys with a few more rugged mountains in the south. Continuous permafrost of varying thickness underlies the thick wet soils of the Kotzebue Sound rim and the thin rocky soils of the Seward Peninsula and Bering Sea Islands.

The cold soils and bitter climate support moist or wet tundra communities of sedges, grasses, low shrubs, and lichens interspersed with rocky cliffs

The winter sun rises briefly over low mountains and frozen tundra on the Seward Peninsula. Subdued terrain and harsh weather off the Bering Sea are typical of the Bering Tundra Division.

The clear waters of the South River in the Nulato Hills are spawning habitat for hordes of pink (or humpy) salmon that provide fall food for hungry bears. Sparse taiga forests grow on river terraces, grading upward into low shrubs, shrub tundra, and rocky alpine tundra.

and shorelines. Drier ridgetops on the Seward Peninsula and the islands have alpine *Dryas*–lichen tundra and barrens with low shrub tundra on hillsides and willows along streams. Scattered forest patches of balsam poplar and white spruce grow along the rivers in protected valleys of the easternmost Seward Peninsula and the Kotzebue lowlands. Strong ecological affinities to Asia remain to this day, with the presence of Eurasian birds (gray-headed chickadees, yellow and white wagtails, and bluethroats), fishes (Alaska blackfish), and flora. Whales, walruses, and polar bears funnel through the Bering Strait as they migrate between the Bering Sea and the Arctic Ocean. Dense concentrations of lakes and ponds support many species of nesting birds, including the rare arctic loon. Bears, caribou, snowy owls, arctic foxes, and hares are common on the mainland. Millions of seabirds (cormorants, kittiwakes, murres, puffins, and auklets) and marine mammals (northern fur seals, ribbon seals, and sea lions) inhabit the rocky outposts of St. Lawrence, St. Matthew, and the Pribilof Islands during the summer. Wintering flocks of rare spectacled eiders congregate in small polynyas (openings) in the sea ice south of St. Lawrence Island. Muskoxen and domestic reindeer have been introduced to Nunivak Island and the Seward Peninsula.

The ecoregions of the **Bering Taiga Division** spread along the eastern coast of the Bering Sea from Norton Sound south to Bristol Bay. Although the area is dominated by a moist sub-polar climate, the southern Bering Sea is not as covered by ice during the winter as north of St. Lawrence Island. Summers are sufficiently long and warm to allow patches of stunted trees (taiga) to grow, primarily along rivers and streams. However, summer warming is tempered by the cold prevailing winds off the Bering Sea, which in some years result in patchy ice as far south as Bristol Bay. The ecoregions of the Bering Taiga are the Nulato Hills, the Yukon–Kuskokwim Delta (often called the Y–K Delta), the Ahklun Mountains, and the Bristol Bay Lowlands.

The Bering Taiga Division is made up of two units of old weathered mountains: the Nulato Hills and the Ahklun Mountains, with intervening depositional lowlands: the Y–K Delta and the Bristol Bay lowlands. The Nulato Hills are rolling waves of regular northeast–southwest-trending mountains, with beautiful clear rivers in the valleys. The Nulato Hills and Y–K Delta were largely ice-free during the Pleistocene, while the Ahklun Mountains spawned mountain glaciers that left U-shaped valleys throughout the unit and spread terminal moraines across the northwest corner of the Bristol Bay lowlands. These lowlands have been shaped by multiple huge glaciations out of the eastern side the Alaska Range, which left concentric terminal moraines and large outwash plains across the unit and into Bristol Bay. The valleys of the Ahklun Mountains are filled with large “finger

lakes" that have filled the glacial basins as the ice retreated. The Y–K Delta and the Bristol Bay lowlands have been formed by the dance of fluctuating sea levels during glacial periods and alluvial deposition from huge river systems draining central Alaska. The resulting layers of glacial, alluvial, and marine sediments form low-lying saturated soils and an incredible mosaic of ponds, sloughs, and wandering streams. Permafrost is nearly continuous on the Y–K Delta, opening to patchy farther south in Bristol Bay. The mountain units have thin rocky soils with sporadic permafrost in the valleys.

The vegetation patterns of the Bering Taiga generally follow the terrain. White spruce and balsam poplar grow in sinuous stands along most river systems in the region. Gently rolling side slopes support black spruce and paper birch forests and tall shrub communities of dwarf birch and alder. The higher elevations are covered with shrub tundra and lichens or barrens on the wind-scoured summits. Lowlands are covered with a rich and productive mix of emergent wetlands and sedge–tussock and sedge–moss bogs, with willows along small streams. Slight rises support low shrublands and scattered spruce.

The river systems of this division are incredibly productive for various fisheries. The Bristol Bay sockeye (red salmon) run is the largest in the world, and huge pink salmon runs ascend the Unalakleet River every summer. Rural residents throughout the region and upstream into Canada depend on king (chinook), red, and chum salmon for winter supplies and dog food. These salmon runs feed coastal brown bears, especially in the Bristol Bay region. The rapidly rotting spawned-out carcasses bring vast quantities of marine nutrients to the terrestrial and aquatic ecosystems, where they nourish the next generation of salmon fingerlings. Likewise, the lake and wetland systems, particularly of the Y–K Delta, support millions of staging and nesting waterfowl and shorebirds. Great numbers of gregarious walruses and sea lions haul out on rocky beaches, while seabirds patrol the skies. Moose and beaver thrive along the rivers, while caribou, wolves, and black and grizzly bears roam the uplands.

The lower Yukon River Delta is typical of depositional wetlands of the Bering Taiga Division. This maze of lakes, creeks, and wetlands will soon host millions of nesting waterfowl and shorebirds during the summer months.

The **Intermontane Boreal Division** in Alaska is a portion of the largest coniferous forest in the world. The boreal forest stretches across the northern circumpolar regions, including Canada, Alaska, Siberia, and Scandinavia. This intermontane terrain, sandwiched between the Brooks and Alaska Ranges, remained largely ice-free during the last ice age, forming part of the "Beringia Corridor" that provided a route for animals and humans moving between Asia and southern parts of North America (see p. 55).

The boreal region is characterized by a continental climate, with extreme weather conditions ranging from long, cold winters to short, warm summers. The continental climate is fairly dry throughout the year, and forest fires rage during summer droughts. The resulting vegetation pattern is a constantly shifting mosaic of successional communities in response to wildfire and river changes. Most of the soils are underlain by ice-rich permafrost and are subject to thermokarsting where ice lenses melt out or form under insulating moss mats. The boreal forests of Alaska, also called taiga from the Russian term meaning "land of little sticks," is vegetated with black spruce, tamarack, and paper birch woodlands; shrubby muskeg on permafrost-rich areas; white spruce and balsam poplar on floodplains where permafrost is missing or very deep; and aspen and shrub on upland areas of recent fires and discontinuous permafrost.

Alaska ecoregions in the Boreal Division are a combination of large river valleys and old mountains. The river valleys include the Yukon–Old Crow Basin, the Tanana–Kuskokwim Lowlands and the Yukon River Lowlands. Units of old, largely unglaciated mountains are the Kobuk Ridges and Valleys, the Ray Mountains, the Davidson Mountains, the North Ogilvie Mountains, the Yukon–Tanana Uplands, and the Kuskokwim Mountains.

The boreal lowlands are drained by several large river systems, including the Yukon (the

The broad valley of the Kobuk River shows the mosaic of conifer and deciduous forests shifting in response to multiple changes in the river channel.

fourth longest in North America), Porcupine, Tanana, Koyukuk, and Kuskokwim. The climate becomes progressively more continental the farther east one travels, as the temperature ranges become greater and precipitation decreases. These river valleys were largely unglaciated during the Pleistocene. However, most of these areas are blanketed in thick loess (fine-grained silt), blown off the glaciated areas of the Alaska Range, and alluvial deposits from side streams in the hills and mountains. The Yukon Flats and Old Crow Basins are gently sloping basins composed of depositional fans, terraces, and mountain toeslopes with deep colluvial (deposited by gravity), alluvial, and eolian deposits underlain by continuous masses of permafrost. The lowlands of the Yukon, Tanana, and Kuskokwim Rivers have deep alluvial sediments overlain by eolian loess. Ice-rich permafrost permeates organic soils with varying patterns of thickness and continuity. The resultant floodplains and wetlands support intricate wetlands, old river sloughs, and subtle hills.

The highly productive vegetation along the major rivers supports vigorous stands of white spruce and balsam poplar. Robust wet sedge meadows and aquatic vegetation are invading sloughs and oxbow ponds. The adjacent permafrost-dominated lowlands support black spruce woodlands, dwarf birch and low-growing ericaceous shrubs of the heath family, and sedge–tussock bogs. The rich aquatic habitats support tremendous concentrations of nesting waterfowl (in the millions!) and other migratory birds and an abundance of moose, bears, furbearers, northern pike, and salmon. Large rivers support important runs of chinook, chum, and coho salmon, while clear tributary streams support dolly varden and grayling. Flat areas are pockmarked with lakes and ponds. These areas support large populations of moose and black bear; the oxbow sloughs and thaw ponds support abundant waterfowl during breeding season; and the lowland forests are important to furbearers, including beavers, muskrats, and martins. Cliffs along the rivers are excellent nesting habitat for ravens and raptors such as peregrine falcons. Yellow-cheeked voles are found in early successional riparian and recently burned areas throughout the Alaskan and Canadian boreal forests (see p. 48).

Boreal uplands are characterized by low- to mid-height hills and mountains, with subtle topography from long-term weathering without the impacts of glaciers. Again, many of the upland units, especially the Kuskokwim Mountains and the Yukon–Tanana Uplands on the southern side of the intermontane valley, are cloaked with loess blown north from the Alaska Range glaciers during the Pleistocene. The Kobuk Ridges and Valley and the Davidson Mountains on the northern side of the boreal division were subject to partial glaciations during the Pleistocene, with morainal remnants strewn along classic U-shaped valley walls. The North Ogilvie Mountains are

Lightening-caused wildfires are constantly burning patches of the boreal forest, creating a mosaic of successional vegetation communities that provide habitat for many wildlife and bird species.

Fall colors drape the lowlands of the Kenai Peninsula in the Cook Inlet Basin. Lakes were created from remnant blocks of ice abandoned by retreating glaciers, and the mixed forests and wetlands are habitat for moose, bears, waterfowl, and beavers.

the oldest portion of Alaska, representing the western extent of the North America stable platform, where terranes rafting from the Pacific and Arctic Oceans finally came to rest and docked. Several of these boreal mountain units are host to hot springs. Vegetation is dominated by white spruce, birch, and aspen on south-facing slopes, black spruce on north-facing slopes, and black spruce woodlands and tussock and scrub bogs in valley bottoms. Floodplains of headwater streams support white spruce, balsam poplar, alder, and willows. Above treeline, dwarf birch and ericaceous shrubs and *Dryas*–lichen tundra dominate. Lightning from frequent summer thunderstorms starts many wildfires each year. These fires contribute to the spectacular mosaic of forest successional stages that provide a wide range of habitats. Caribou, moose, snowshoe hares, martens, lynx, and black and grizzly bears are plentiful (see p. 63). The clear headwater streams are important spawning areas for chinook, chum, and coho salmon.

The **Alaska Range Transition Division** literally rises between the continental boreal interior of Alaska and the marine rainforest coastlands along the Gulf of Alaska. The climate of this division has shorter winters than the continental interior and warmer, drier summers than the marine-influenced coastal rainforests. However, the Alaska Range, including Mt. McKinley (Denali) at over 20,000 feet, generates its own weather, as moisture-laden air rises over the massif and releases heavy snowfalls on the upper elevations. Pleistocene glaciers heavily influenced the entire area, and remnants of glaciers and many glacial features still define the landscape. Boreal forests are distributed in the valleys and lowlands of the division, but wildfire and permafrost have much less influence on vegetation succession and distribution. The ecoregions of the Alaska Range Transition are the Lime Hills, the Alaska Range, the Cook Inlet Basin, and the Copper River Basin.

The Alaska Range is a long arcing wall of accreted terranes that have fused into a complex mix of folded, fractured, and deformed sedimentary and metamorphic rocks with intrusions of granite. The Denali Fault runs parallel to and within the Alaska Range for the easternmost 350 miles,

The Alaska Range rises abruptly from nearby river basins, creating its own climate, which is a transition between the continental conditions of interior Alaska and the marine systems along the north Gulf of Alaska coast. Sparse taiga forests and wetlands are common in the Susitna and Copper River Basins of the Alaska Range Transition Division.

A grizzly sow and her cub forage for blueberries and mossberries in the brilliant fall colors of subalpine ericaceous shrub tundra. This pair was photographed in early September on the north slopes of the Alaska Range.

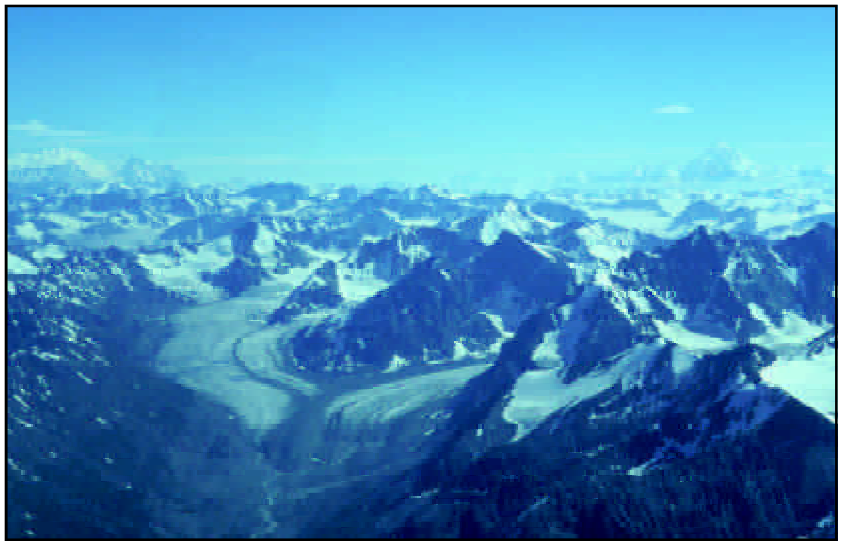
before the range takes a turn to the south and the Denali Fault continues southwesterly into the Kuskokwim Basin. The Alaska Range was the origin for much of the Pleistocene ice that flowed out of the mountains in all directions and substantially formed the landscape. Large valley glaciers and ice caps still flow off the peaks of the Alaska Range. The Lime Hills area immediately west of the Alaska Range is a series of east–west-trending ridges and intervening valleys. This area was repeatedly scoured by huge valley glaciers flowing out of the Alaska Range and, like the Cook Inlet and Copper River Basins, is covered with glacial moraines, lacustrine sediments deposited in lakes, and outwash plains. The Copper River Basin was the location of Great Lake Ahtna, a large proglacial lake dammed by glaciers blocking the Chugach Range to the south. The Cook Inlet and Susitna valleys are a large trough between the Alaska and Kenai Mountains that has been subject to repeated glacial advances. Some of these glaciations also formed large lakes over the current Kenai Peninsula. The region is covered with a subdued pattern of low ridges and lakes or wetlands.

This division forms the headwaters for rivers flowing into all the oceans surrounding Alaska except the Arctic Ocean. Glacial rivers are silty and braided, with broad, gravelly floodplains. Clear streams are generally smaller with narrower floodplains and lose their clear identity as soon as they flow into a glacial stream. Arctic grayling are common in clear mountain streams, and all five species of Pacific salmon migrate into rivers of the Alaska Range Transition.

Soils in the mountainous units of the Alaska Range and Lime Hills are generally thin, rocky, and cold, with scattered pockets of permafrost. The Copper River Basin floor is formed of interleaved lacustrine deposits, glacial material, and volcanic debris that forms fine-grained saturated soils with ice-rich permafrost. Soils of the Cook Inlet Basin are a complex mixture of alluvial, glacial, volcanic, and lacustrine materials with occasional patches of permafrost. Both basins support boreal vegetation patterns, with white spruce and birch on higher ground and black spruce, low shrubs, sedges, and mosses growing in the wetlands. White spruce and balsam poplar form successional stands along the rivers. The lower slopes of the Alaska Range and Talkeetna Mountains are covered with dense thickets of alder that transition to low shrubs in the subalpine and blueberry-rich alpine tundra. Vegetation of all types succumbs to the harsh conditions at about 4000 feet, leaving the higher arena to bare rock, talus (broken loose bedrock), and ice.

The wide variety of habitats, ranging from sea level to several thousand feet, in a transitional climate support many species of mammals and resident and migratory birds. Moose, grizzly and black bears, wolves, foxes, beavers, and various small mammals are fairly common in the Cook Inlet Basin and lower reaches of the Alaska Range (see p. 18). Caribou herds roam the Alaska Range, Lime Hills, and Copper River Basin (see p. 63). Waterfowl nest in the wetlands of the basins, although not in the concentrations found in the Y–K Delta or Yukon Flats. Golden eagles nest in the mountains and disperse farther south for the winter months (see p. 22). Ptarmigan spend the winters in willow thickets with a white coat of double feathers all the way down their feet, and ravens haunt urban dumpsters looking for high-calorie treats and roadkill.

The **Coast Mountains Transition Division** is similar to the Alaska Range Transition in that a range of very high mountains is thrust up between a dry continental climate of the upper Yukon River drainage and the maritime-driven climate of the



Valley glaciers flow between nameless peaks in the towering Wrangell Mountains. Moisture-laden clouds sweeping inland from the Gulf of Alaska are cooled as they rise over the mountains, and the resulting prodigious snowfalls create the largest icefield outside the Arctic and Antarctic latitudes.

Chugach and St. Elias Ranges. Because of their sheer height, these mountains capture ocean-derived moisture as it passes inland. Yet, their proximity to Interior Alaska gives these mountains a fair degree of seasonal temperature change similar to a continental climate. Climatic influences change with elevation, with maritime conditions on mountaintops (feeding ice caps and glaciers) grading to continental conditions at their base (boreal forests). The Wrangell Mountains and the Kluane Ranges ecoregions comprise the Coast Mountains Transition.

The Wrangell Mountains are a compact layer cake of volcanic and deformed sedimentary materials, stacked up for thousands of feet, topped by recent volcanic lava and ash, and etched by massive glaciers. The abundant maritime snows feed extensive icefields and glaciers interspersed by dull gray ridges draped with rock shard slopes and patches of alpine meadows. The Kluane Ranges reach east into Canada in the rain shadow of the St. Elias Mountains along the steep slopes of the fault line scarp in the Shakwak Valley. Occasional glaciers flow onto the Kluane Ranges from the St. Elias icefields, but the unit is generally ice-free.

Continental climates around the toeslopes of the Wrangell Mountains support permafrost soils and boreal forests of black spruce and birch, grading up into drier shrublands, and typical alpine communities of low ericaceous shrubs, lichens, and barrens. The Kluane Ranges have thin rocky soils with discontinuous permafrost. The unstable materials are constantly moving downslope as talus, stream erosion, or solifluction. The dry climate supports white spruce woodlands with balsam poplar and aspen stands, grading upward into willow shrubland and typical low and dwarf shrub communities in the alpine areas. Snowshoe hares and lynx exhibit cyclic fluctuations in abundance, with lynx numbers dropping shortly after the peak in hare population. Dall's sheep roam throughout the area, along with mountain goats, brown bears, caribou, wolverines, and gray wolves.

The **Coastal Rainforest Division** includes the great arc of mountains and the forested fringe that swing around the north and east shores of the Gulf of Alaska. Terranes that originated beneath the Pacific Ocean have been rafted into place and accreted in ridges. Frequent earthquakes along the dip of the Pacific Plate under the North American Plate result from continuing uplifting and faulting of the sedimentary and volcanic materials.

Dominant storm tracks from late summer through early spring curl east from the Aleutians into the Gulf. Upon hitting shore, the moisture-laden air rises over the mountains, dropping copious rain at lower elevations and snow at the higher altitudes. The Gulf of Alaska current flows east to west along the coast, bringing relatively warm temperatures throughout the year. The warm, wet climate supports lush conifer rainforests along the coast and large icefields and glaciers at higher elevations. All of the division has been heavily glaciated several times during the Pleistocene.

The coastlands reflect their glacial heritage, with steep bedrock fjords, tidewater glaciers, and numerous rocky islands. The Coastal Rainforest Division includes the mountainous units of the Chugach–St. Elias Mountains and the Boundary Ranges and the island and fjord lands of the Alexander Archipelago, the Gulf of Alaska Coast, and Kodiak Island.

Mountains tower behind the Gulf Coast to altitudes over 19,000 feet. The largest icecap outside of the polar regions drapes the folded sedimentary rocks of the Chugach and St. Elias Mountains. Huge valley glaciers flow out of this icecap, many to tidewater. The Bering Glacier, at more than 2000 square miles, spreads out over the lowlands of the Gulf Coast. The Hubbard Glacier surged during the summers of 1986 and 2002, blocking off Russell Fjord for several weeks each time. The Boundary Ranges, located farther south and lower in elevation, hold only mountain glaciers. The Alexander Archipelago, the Gulf of Alaska Coast, and the Kodiak Archipelago all face the Gulf of Alaska, with intricate glacier-carved coastlines. Long,

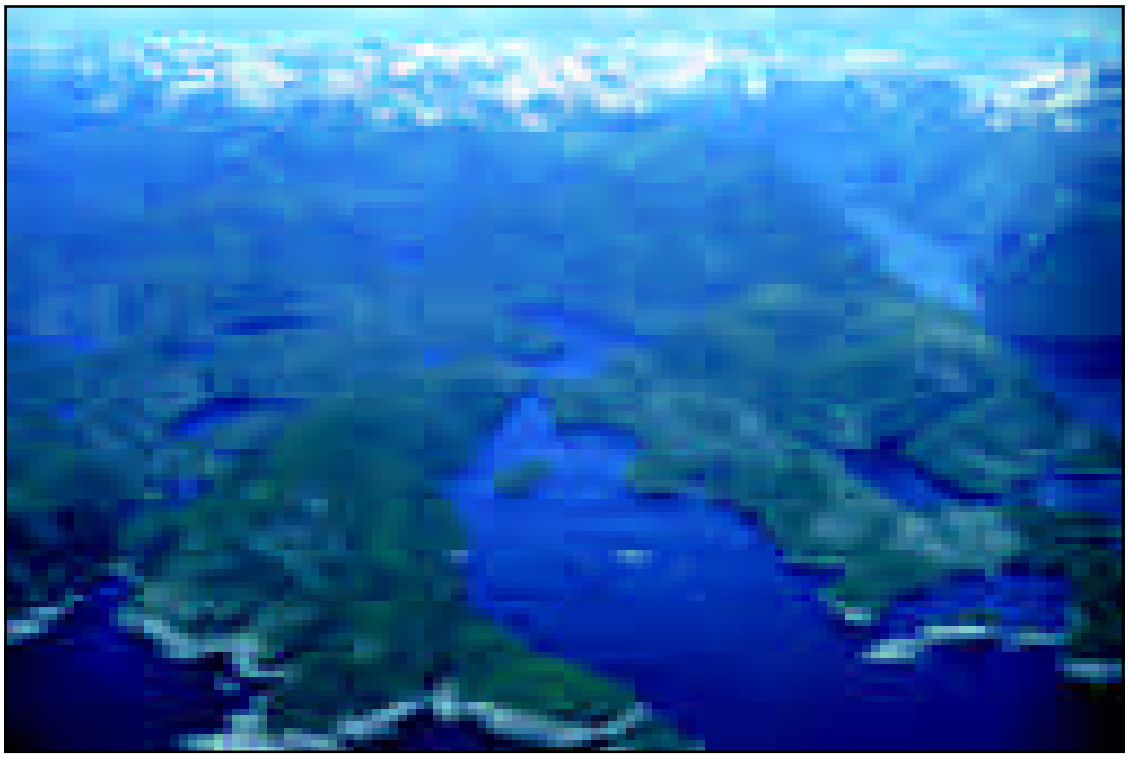
deep fjords formed where glacier-carved terrain filled with seawater after deglaciation. Thousands of islands, islets, and rocks indicate the summits of submerged mountain ranges and present both a challenge and a delight to mariners.

A few areas along this coast remained ice-free during one or more glacial advances, providing refugia for plant and animal species to survive the Pleistocene advances. Humans may have also migrated along the coast from one ice-free toehold to another. Movements of the earth's crust continue to raise and lower portions of the coast, creating and deleting coastal lagoons, beaches, and tideflats. Soils are exceptionally thin except in riparian zones. Relatively warm winters preclude permafrost.

Short rivers flow out of glaciers in braided floodplains or tumble off rocky mountainsides in barely contained waterfalls. Five species of Pacific salmon migrate into these fast-flowing streams to spawn. Dolly Varden char and steelhead (ocean-going rainbow) trout live in larger clear-water streams along the coast and on Kodiak Island. The land and sea are intimately connected, as spawning salmon return to their native streams and, in the process, cycle tremendous amounts of nutrients back to the freshwater and terrestrial systems that bore them life. Streams become increasingly littered with spawned-out carcasses as brown and black bears, bald eagles, and gulls feast on returning salmon from late spring to early fall.

The warm maritime environment encourages lush moss-draped conifer forests along the coast. Old-growth forests of Sitka spruce, hemlock, and cedar blanket the lower slopes of the Alexander Archipelago. Toward the west, cedar drops out in Prince William Sound, and hemlock reaches to the end of the Kenai Peninsula. On Kodiak, Sitka spruce is expanding south across the island into new habitats. Pockets of wetlands have formed on shallow, poorly drained soils on bedrock throughout the division. The stunted trees, tiny ponds, and bedrock outcrops give the appearance of a giant bonsai garden. Hidden coves and rocky islands are fringed with intertidal communities of kelps, eelgrass, and barnacles. Upper forests give way to a narrow subalpine zone of alder and herbaceous meadows and then alpine tundra and bedrock or ice.

Common forest animals include black and brown bears and Sitka black-tailed deer. Offshore waters are rich with deepwater fish, such as halibut and cod. Grey whales migrate along the coast, following the warm Gulf current as far as the Arctic Ocean for summer, returning to the Gulf of Mexico for the winter months. Humpback whales migrate annually between winter calving grounds near the Hawaiian Islands and summer feeding grounds near Glacier Bay (see p. 42). Bald eagles, common



The fjord-studded Alexander Archipelago was carved by massive glaciers rising in the background Boundary Ranges of southeast Alaska. The retreating glaciers left an intricate coastline with dense conifer forests on the lower mountain slopes, rising to alpine tundra and barrens.

Bear Glacier, one of the largest concentrations of tidewater glaciers in the northern hemisphere, meets the sea along the Gulf of Alaska coastline. The glacially formed lagoons and fjords are habitat for seals, whales, sea otters, and terrestrial mammals.

murres, Bonaparte's gulls, Steller sea lions, harbor seals, and sea otters teem along its endless shorelines (see p. 31 and 36).

The **Aleutian Meadow Division** stretches nearly 2000 miles, reaching from Iliamna Lake west to the Komandorskiye Islands near the Kamchatka Peninsula in Russia. The fog-shrouded Aleutian Islands and storm-pounded coasts of the Alaska Peninsula make up this exposed division, set between the cold Bering Sea and the stormy North Pacific Ocean. This division is defined by cool, moist, and harsh weather, which limits tree growth to a few Sitka spruce perched on rocky promontories on the Shelikof Strait coast. The division is formed by the Pacific Plate Subduction Zone, where the Pacific Plate dives beneath the North American Plate, forming one of the most seismically and volcanically active areas in the world. The area hosts 80% of the active volcanoes in the United States, and many of the gently steaming cones may erupt at any time.

Glaciers have also played a role in shaping this land of fire and ice. Thick ice sheets from the Alaska Range and lower Cook Inlet overrode the mountains near Iliamna and Katmai, rounding off lower mountains and leaving large basins filled with freshwater lakes along the western slopes of the Alaska Peninsula ecoregion. Glaciers also formed on the wetter, southern side of Aniakchak, Veniaminof, and Pavlof volcanoes, expanding south onto the narrow shelf at the edge of the North Pacific. The Aleutian Islands are predominately volcanic features rising above the turbulent seas.

Permafrost is absent from this division, reflecting the relatively warm climate dominated by oceanic influences. Soils are a mixture of volcanic materials, often reworked by glacial and alluvial agents. Areas of recent glaciations and volcanic activity such as Katmai and Aniakchak are largely barren cinder plains. Other parts of the region, well watered by Pacific storms and fertilized by nesting seabirds, support lush meadow and heath vegetation communities, with willows along streams. The flora is a blend of species from two continents, grading from Asian to North American affinities from west to east.

This division is the domain of seabirds, waterfowl, and marine mammals. Sea otter populations have rebounded since near extirpation by Russian and American fur traders and are now distributed through most of their former range along the Aleutian and Gulf of Alaska coasts (see p. 31). Stellar sea lions use low rocky shelves as haulouts and pupping areas, although their numbers have dropped dramatically within the past several decades (see p. 36). Several species of whales reside here or migrate through en route to the Arctic Ocean. Onshore, coastal brown bears feed on lush sedge meadows and salmon runs, moose

are expanding gradually down the peninsula, and caribou are native on the peninsula and Unimak Island and have been introduced to several Aleutian Islands. Foxes, introduced to many islands for fox farming, and rats, introduced accidentally from ships, have nearly decimated ground-nesting waterfowl, including the Aleutian Canada goose. Fox eradication and careful reintroduction of the Aleutian goose on several islands have recently resulted in its removal from the endangered species listing.

Suggestions for Further Reading

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Mt. Peulik, a dormant volcano, rises on the shores of Becharof Lake. The low shrubs and sedge tundra are characteristic of the Aleutian Meadow Division.