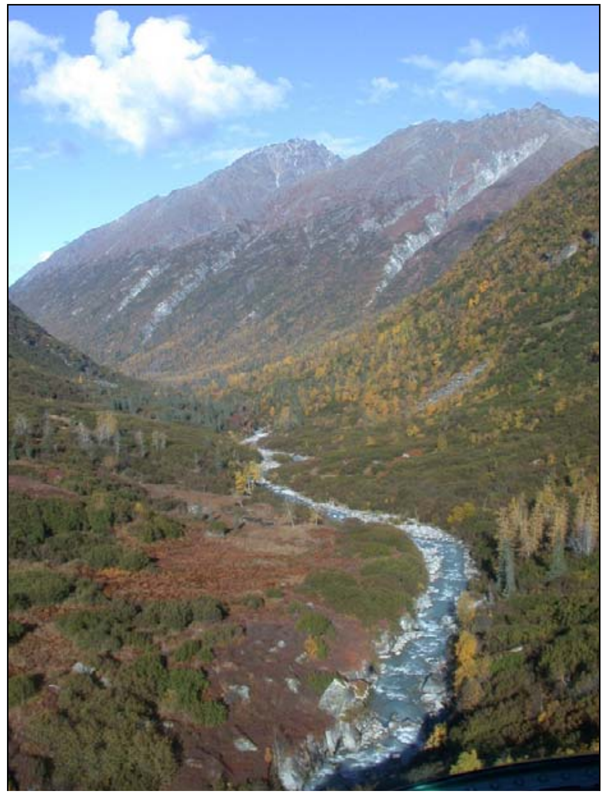
Appendix 5.7 Aquatic Habitats

Featured Species-associated Freshwater Aquatic Habitats: Glacial Waters, Clear Waters, and Riparian Zones



Kashwitna River D. Ryland, ADF&G

Alaska has more than 40% of the entire nation's surface water resources. Approximately three-fourths of all freshwater resources in Alaska are stored as glacial ice covering about 5% of the state. Alaska has more than 3 million lakes greater than 5 acres (Harle et al. 1993), over 12,000 rivers, thousands of streams and creeks, and an estimated 100,000 glaciers. Alpine glaciers, lakes, groundwater, glacial and clearwater rivers, streams, springs and ice fields connect the uplands to Alaska’s estuarine ecosystem.

Alaska’s largest rivers include the Yukon, Kuskokwim, Susitna, and the Copper. The state’s longest river is the Yukon. At over 2000 miles long it is the third longest river in North America. It flows for 1280 miles through Alaska and drains a 204,000- mi^2 area. Alaska’s rivers support many aquatic species including both anadromous and resident fish, and serve as migratory corridors to the many smaller tributaries and waterways that support spawning, rearing, and overwintering habitats. These same tributaries provide protective vegetative cover, a significant source of detritus, and terrestrial wildlife riparian migration corridors.

Lake Iliamna is Alaska’s largest lake covering an area of approximately 1000 mi^2. It is 75 mi long and 20 mi wide. Other lakes of size include Lake Clark and Becharof, Naknek, Ugashik, Teshekpuk, Tustumena and Kenai lakes. The Wood-Tikchik Lakes system in Southwest Alaska consists of 13 lakes that range in length from 15 to 45 mi.

Alaska’s freshwater ecosystems are found across the state from the temperate coastal rain forest of the Southeast region with maritime climate and dense riparian vegetation, to the boreal forest of Interior Alaska, with continental climate and modest riparian vegetation, to the Arctic tundra of the North Slope, with sparse riparian vegetation (Reynolds 1997). In terms of elevation, freshwater habitats are found from the highest alpine glacier and cirque lakes down to sea level, and flowing waters effectively connect the mountains to the sea.

Alaska freshwater resources are distributed throughout the state, from the mountains to the coastal plain, and they provide a wide variety of habitats. Aquatic habitats are complex and range from small, ephemeral streams to large, braided glacial systems that flow across entire regions of the state. Still water habitats range from tiny ponds to some of the very large lakes mentioned above. Headwater streams include pool, riffle, side channel, isolated pool and stream margin and backwater habitats. Floodplain characteristics include main channel, side channel, oxbow lake, backwater lake, meander, scroll depression, and backwater wetlands habitats. Lake and pond habitats include typical shoreline, pelagic and benthic areas.

Flow regime

The flow regimes of Alaska's rivers and lakes include those influenced by glacial melt, snowmelt, precipitation, and ground water, including springs and upwelling areas. Three common types of streams occur in Alaska: ephemeral, intermittent and perennial streams. Directly correlated with precipitation, ephemeral streamflow is limited to short periods of a few hours or days immediately after storms and floods. In intermittent streams, flow occurs for several weeks or months each year when precipitation and ground water input is relatively high. Perennial streams have a well-defined channel that contains water at least 90 percent of the time. They receive substantial ground water input and generally flow continuously throughout the year. Annual flows can vary widely and streams may be dry during periods of low precipitation, although ground water is generally near the surface. Water supply to Alaska's ponds and lakes is governed by the same types of flow regimes as for these 3 stream types.

Substrate and Morphology

Spawning gravels, Susitna Basin M. LaCroix, DNR

The type and ratio of substrate materials offered by a waterway determines the habitat suitability for associated aquatic species. This is particularly true for aquatic species during differing life stages. Stream and riverbed substrates vary from large boulders to glacial silt or flour, clay, and mud. Large boulders provide resting areas for fish, while smaller cobbles and gravels allow for the required aeration and subsequent development of eggs buried in the streambed. Larger substrates provide greater surface area for aquatic invertebrate concentration and for the establishment of algae and mosses. Boulder and cobble bed streams are usually found in the upper portion of a watershed. These streams often have pockets of gravel and fines in the pools, behind large rocks, and on the inside of bends and other areas of reduced velocity. Mud, silt, or clay substrates are often represented in shallower and slower waters, or at the terminus of a waterway.

Large boulders, Little Willow Creek D. Ryland, ADF&G

Many other physical factors contribute to the complexity of aquatic habitats, and channel morphology characteristics provide additional habitat diversity for aquatic species. Straight and meandering channels are both common, with extent of meandering largely determined by the stream gradient and underlying soils. Meandering waterways typically contain deeper areas of swift flow near the eroding outer edge of the meander, and areas of deposition and shallower water on the opposite bank. In broad valleys of major rivers, extensive meanders create oxbow lakes in abandoned channels. Braided channels are formed as a result of erosional and depositional processes, and are typical of large glacial rivers. Morphologic complexity, along with substrate material that provides channel roughness, contributes substantially to the habitat quality and quantity of a system for aquatic species.

River meanders and abandoned channels
M. LaCroix, DNR

Lake and pond habitats also vary with substrate, bathymetry, and shoreline contour. Flow regimes and depth contours are also important influences on nutrient cycling, hydraulic retention time and biological productivity in the relatively still waters of lakes and ponds. As with flowing waters, the origin of a lake basin determines its contour and morphometry.

Microhabitat

Differing hydrologic energy dissipation as a result of substrate conditions causes specialized microhabitats to develop in waterways. For example, riffles form in river and stream reaches where flow is slowed by rocks, gravel, or sand bars. In a healthy system, these features are interspersed with pools of deeper, slower water. Intermediate runs of moderate current are often found in larger streams and rivers. In the lower stream reaches, deep pools near undercut banks, and large woody debris are common. The representative biota residing in pool and riffles often contrasts sharply due to differing habitat niches offered by each. In lower elevation areas, backwater sloughs and their associated floodplains and wetlands provide some of the most physically protected and biologically productive freshwater aquatic habitats.

Large woody debris (LWD) is an important component of rivers and streams that helps to stabilize banks and substrate material, and provide cover from terrestrial predators. It also fosters formation of pool habitats and provides spawning bed integrity and habitat for aquatic invertebrates, elevating in-stream productivity. In large rivers, LWD groundings often lead to formation of downstream islands, bars and slough habitats. In smaller streams, lakes, and ponds, LWD plays an important role in habitat creation immediately adjacent to the point of input. Decaying terrestrial debris also tends to accumulate near LWD, providing a food source for aquatic invertebrates. In Alaska, nutrient input from both allochonthous (originating outside the system) and autochonthous (originating within the system) sources contributes significantly to fresh waters, whether flowing or still (e.g., lake and pond habitats).

Cumulatively, stream- or riverbed material, channel morphology, and microhabitat characteristics increase the quantity of available aquatic habitat and the diversity of the aquatic environment. Similarly, pond and lake habitat are further diversified by the occurrence of differing substrates, depths, and contours.

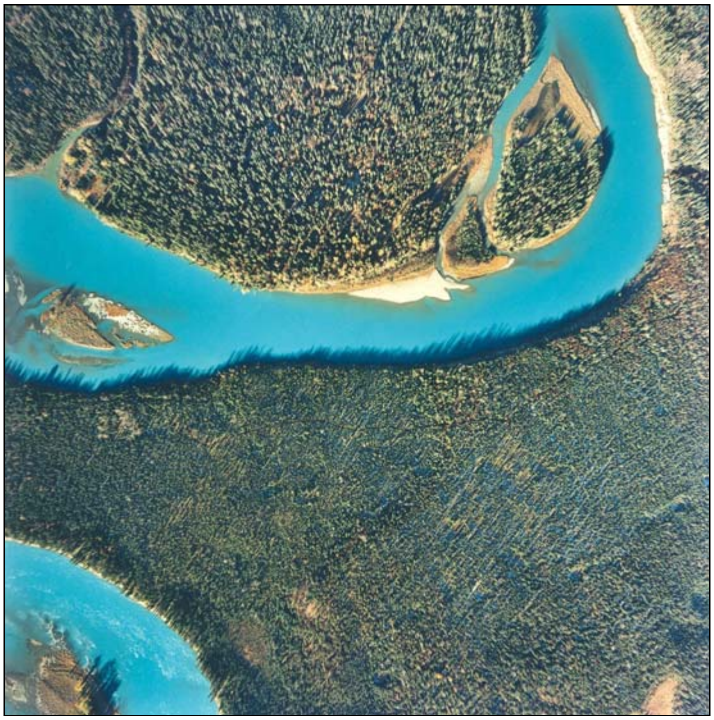
GLACIAL WATERS

Glacially influenced rivers and streams

The extent to which Alaska is covered with glaciers significantly influences its freshwater habitats. The area of glacier coverage in other states is less than 200 mi^2, and the glacier ice in the rest of the United States combined totals less than the area of a single large Alaska glacier (Molnia 2001). In Alaska, glaciers develop in high mountainous areas and often flow out of ice fields that span several peaks or an entire mountain range. Alaska’s 300 mi^2 Harding Icefield, located in the mountains of the Kenai Peninsula, is the largest in North America and one of only four remaining ice fields in the United States. Thirty-five of Alaska’s glaciers, some among the largest mountain glaciers in the world, stem from the Harding Icefield.

Glacially influenced waterways are those where glacial input is the dominant channel- or floodplain-forming mechanism, dictating the chemical and physical hydrology of the water itself. Glaciers feed and influence nearly all major rivers in Alaska and provide the headwaters to some of the state’s largest rivers, including the Copper, Susitna and Tanana.

Alaska's glacially driven rivers exhibit high and variable rates of fluvial activity and channel adjustments from erosional and depositional processes (Wooster 2002). Rivers originating from glaciers tend to have high discharges, and generally have pronounced daily and seasonal stream flow fluctuations near the glacier and large year-to-year fluctuations in stream flow. Peak glacial river flows occur during the warmest months of the year, typically May through August. However, even during summer, water temperatures are measurably lower near a glacier than farther downstream. Glacial rivers tend to transport large volumes of fine-grained sediment and have steep channel slopes. In response to these conditions, braided river channels may develop containing multiple channels separated by bars or islands. During the colder winter temperatures, when base flow is derived entirely from ground water, glacial rivers generally run clear and low.



Glacial waters of the Kenai River with sandbars, islands and side channel habitats Kenai River Center

Depending on the channel slope and bed composition, glacial systems may show pronounced accumulation of deposited materials (i.e., aggradation) in their streambeds and valleys. Large, unstable, braided channels occur where the rate of aggradation is high (e.g., Matanuska glacier/ Matanuska River), and single channels occur were rates are low (e.g., Mint glacier/ Little Susitna River). Where they are associated with rivers, glacier-dominated lakes regulate the flow moving downstream and reduce the amount of sediment transported to the river's lower reaches.

Alaska's glacial hydrologic systems differ from clearwater systems in terms of runoff, water quality, and volume. The volume of flow from glacial rivers can be 10 times as much as that from clearwater rivers. The water quality difference between these streams is mainly expressed as turbidity: Glacial rivers and streams carry a large sediment load of clay and silt, giving the waters a cloudy-gray opaque color. Other glacially influenced rivers and lake waters appear turquoise blue-green in color. This is due to their absorption of all the colors of the spectrum except blue, which is reflected off the glacial sediments in the upper reaches of the system. Kenai Lake and the upper Kenai River demonstrate this phenomenon. Dissolved oxygen, conductivity, and pH of glacial versus clearwater systems are roughly equal.

Glacial River and Stream-associated Species

Rainbow smelt, *Osmerus mordax*
Eulachon, *Thaleichthys pacificus*
Longfin smelt, *Spirinchus thaleichthys*
Pygmy whitefish, *Prosopium coulteri*

Glacially Influenced Lakes and Ponds

Lakes form in glacier-dominated watersheds as a result of glacial advance and subsequent retreat. Most of the state's larger lakes, particularly those in Southwest and Southcentral Alaska, resulted from glaciation and are important to both resident and anadromous fish species for overwintering. Kenai Lake has glacial tributaries, while Iliamna Lake has clearwater tributaries. Both of these lakes are connected to rivers that support large and valuable runs of salmonids.

Crescent Lake M. Wiedmer, ADF&G

Two types of floods are common in Alaska's glacial waters, yet rarely occur in the rest of the United States. These are floods caused by the release of water from glacier-dammed lakes and by ice jams on rivers. Approximately 750 glacier-dammed lakes have been identified in Alaska. These lakes are formed in areas where glaciers flow across tributary valleys and trap runoff. Catastrophic flooding occurs when the ice dams fail. In some places, the dams fail predictably and/or annually. Others fail unexpectedly due to geomorphic glacial changes, with sudden outbursts resulting in floods (Snyder 1993). An ice jam is an accumulation of broken river ice in a narrow, shallow, or blocked part of the river channel. Backwater pooling from an ice jam can cause flooding upstream. When an ice jam suddenly releases, river discharge increases rapidly and causes downstream flooding.

Glacially Influenced Lake and Pond-associated Species

Pygmy whitefish, *Prosopium coulteri*

CLEAR WATERS
Clearwater Rivers and Streams

Clearwater rivers and streams are also common throughout Alaska. In contrast to glacial systems, these waterways exhibit low turbidity, high clarity and flow derived primarily from ground water and precipitation. Clear waters maintain less dynamic annual flows than glacial waters.

Clearwater systems have relatively narrower channel widths, stable well-defined beds and banks, relatively low sediment loads, and increased habitat complexity in the form of pools, riffles and LWD. Relative to glacial waters, clear waters generally are narrower, as a result, freeze up earlier in the winter months.

Overwintering

Katalla River M. LaCroix, DNR

Aquatic overwintering habitats in Alaska are often limited. Many lakes and streams often freeze to the bottom during winter. As the temperatures decrease in the fall, Alaska's freshwater fish usually move from summer habitats to overwintering areas. In winter, fish and other aquatic species may become concentrated in small areas of rivers and at the bottoms of lakes. In clearwater streams, overwintering habitat can be reduced due to the smaller volume of water available in contrast to glacial river systems. Often a river's edge or floodplain offers some of the best available overwintering habitat. Upwelling areas in groundwater-fed streams and perennial spring pools also provide some of the most important winter habitats for freshwater aquatic species in Alaska. This is particularly true in the Arctic areas where groundwater sources are dominant throughout the year. Spring-fed streams, deep pools of large rivers, and deeper lakes connected to rivers offer additional winter habitats for freshwater aquatic species in Alaska. Winter habitat in upper stream reaches is limited to sites of groundwater discharge or springs; otherwise these areas freeze solid (Reynolds 1997).

In addition to the reduced presence of water in winter months, water quality is an important limiting factor and can further reduce survival success of overwintering fish in an already limited habitat (Morris 2000).

Clearwater River and Stream-associated Species

Stoneflies (Plecoptera)
Mayflies (Ephemeroptera), *Rhithrogena n.* sp.
Caddisflies (Trichoptera)
Freshwater clams (Pelecypoda):
Western pearlshell, *Margaritifera falcata*
Yukon floater, *Anodonta beringiana*
Western floater, *Anondonta kennerlyi*
Arctic Tern, *Sterna paradisaea*
Aleutian Tern, *Sterna aleutica*
Rusty Blackbird, *Euphagus carolinus*
Tule White-fronted Goose, *Anser albifrons gambeli*
Osprey, *Pandion halieatus*
Alaska blackfish, *Dallia pectoralis*
Pacific lamprey, *Etosphenus tridentatus*
Arctic lamprey, *Lampetra camtschatica*
River lamprey, *Lampetra ayresi*
Western brook lamprey, *Lampetra richardsoni*
Alaskan brook lamprey, *Lampetra alaskense*
Siberian brook lamprey, *Lethentron kessleri*
Broad whitefish, *Coregonus nasus*
Bering cisco, *Coregonus laurettae*
Threespine stickleback, *Gasterostius aculeatus*
Ninespine stickleback, *Pungitius pungitius*
Western Toad, *Bufo boreas*
Wood Frog, *Rana sylvatica*
Columbia Spotted Frog, *Rana pretosia*

Yukon River Endemic Species

Trout-perch, *Percopsis omiscomaycus*

Clearwater Lakes and Ponds

As with flowing waters, the amount and quality of available habitat for biota in and around lakes depends on connections of the lake with surface and/or ground waters. Lake water level is related to the flow regime and can be perennial, with surface waters present year-round, or intermittent with water present seasonally. Lake level, thermal regime, and chemical composition may fluctuate depending on the groundwater source and connectivity.

Clearwater Lake and Pond-associated Species

Dragonflies, Suborder *Anisoptera*
Damselflies, Suborder *Zygoptera*
Mayflies (Ephemeroptera), *Rhithrogena n.* sp.
Water fleas - *Daphnia* spp. (Copepoda)
Arctic Tern, *Sterna paradisaea*
Red-throated Loon, *G. stellata*
Pacific Loon, *G. pacifica*
Arctic Loon, *G. arctica*
Common Loon, *G. immer*
Red-necked Grebe, *Podiceps grisegena*
Horned Grebe, *Podiceps auritus*
Surf Scoter, *Melanitta perspicillata*
White-winged Scoter, *Melanitta fusca deglandi*
Black Scoter, *Melanitta nigra Americana*
Tule White-fronted Goose, *Anser albifrons gambeli*
Osprey, *Pandion halieatus*
Yukon floater, *Anodonta beringiana*
Western floater, *Anondonta kennerlyi*
Alaska blackfish, *Dallia pectoralis*
Threespine stickleback, *Gasterostius aculeatus*
Ninespine stickleback, *Pungitius pungitius*
Western Toad, *Bufeo boreas*
Wood Frog, *Rana sylvatica*
Northwestern Salamander, *Ambystoma gracile*
Rough-skinned Newt, *Taricha granulose*
Long-toed Salamander, *Ambystoma macrodactylum*
Columbia Spotted Frog, *Rana luteiventris*

Isolated Lakes and Ponds

Many lakes in Alaska are not connected to a river or stream via an inlet or outlet. For example, lakes and ponds of thermokarst, fluvial, and volcanic origin generally lack connecting tributaries. Isolated or landlocked lakes can also be extremely shallow during the winter.

Although landlocked ponds and lakes may appear to lack connections to surface waters, many “isolated” waterbodies are hydrologically connected to other lakes, wetlands, streams, or rivers by subsurface flows. For example, the state’s Arctic region is dotted with shallow ponds and lakes that were created during deglaciation of the area. These ponds are hydrologically linked via the underlying permafrost.

Because of their relative isolation, lakes and ponds with no surface connection to another water body are more likely to contain unique biota due to temporal isolation. A lake or pond may have either been originally connected to a river or stream, or created during deglaciation with no surface connection to other water bodies. Other lakes, such as isolated oxbow lakes on former floodplains, were once inundated by seasonal river flows but due to changes in river courses may be isolated beyond the active floodplain.

Isolated ponds M. LaCroix, DNR

RIPARIAN ZONES

The riparian zone is the area adjacent to the bank of a water body where terrestrial processes influence the aquatic environment. With few exceptions, mostly related to altitude and/or recent deglaciation, the banks of Alaska's lakes, rivers, and streams are vegetated, and the term riparian zone is most commonly used to refer to the vegetated corridor adjacent to a water body. Riparian zones provide the interface between terrestrial and aquatic habitats, and like all "edge" habitats, they support a wide diversity of wildlife. In spite of the large quantity and diversity of aquatic resources in our state, these important habitats make up only a small percentage of the total landscape. Although the majority of riparian areas in Alaska are in their natural condition, many areas of core development and resource extraction have compromised riparian zones.

In 1999 the National Research Council (NRC) developed the following definition of riparian area (NRC 2002).

> Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes and estuarine-marine shorelines.

Riparian zone with stream pool, riffle, waterfall habitat, and LWD in unnamed tributary, Little Susitna River drainage. D. Ryland, ADF&G

Riparian zones provide several functions directly related to aquatic habitats. They contribute LWD, provide leaf litter for primary consumer production, filter sediments and pollution, reduce wind, and regulate water temperature through shading and heat retention. They also provide streambank and floodplain integrity and stability via vegetative root systems. Although the functional boundary of a riparian area adjacent to a waterbody varies in relation to local flow regime, elevation, soils and vegetation, the overall importance of riparian zones for fish and wildlife is undisputed.

In Alaska, the distribution and abundance of plant species in riparian zones is dictated by geographic location, elevation, and soil characteristics. Generally speaking, emergent vegetation occurs in the hydric (wet) soils along relatively slow-flowing open water of streams or lakes. Shrubs, willows, grasses, and sedges dominate hydric-mesic (wet) soils and seasonally moist mesic (damp, moist) soils where water levels fluctuate. Mesic-xeric (drier) soils in uplands support species such as spruce, birch, dwarf dogwood, highbush cranberry, and lingonberry.

Riparian-associated Species

Rusty Blackbird, *Euphagus carolinus*
Blackpoll Warbler, *Dendroica striata*
Tule White-fronted Goose, *Anser albifrons gambeli*
Barn Swallow, *Hirundo rustica*
Bank Swallow, *Riparia riparia*
Cliff Swallow, *Petrochelidon pyrrhonota*

Southeast Endemic Species

Glacier Bay water shrew, *Sorex alaskanus*
Keen's mouse, *Peromyscus keeni* complex
Dusky shrew, *Sorex monticolus* complex

Ecological Role of Freshwater Aquatic Habitats

Alaska's waterways, riparian zones, and their resources sustain large and diverse populations of fish and wildlife. For aquatic species water provides migratory routes, spawning and rearing habitats, overwintering habitat, and refugia. Terrestrial wildlife also derive numerous benefits from freshwater aquatic habitats and riparian areas, including water itself, shelter, nesting and breeding areas, and important seasonal or daily transportation/migration corridors.

Rivers, Streams, Lakes and Ponds

The importance of quality fresh water to obligate aquatic species, such as fish, is apparent. However, the value of quality microhabitats or niches within the aquatic environment is central to the water's integrity, function, and purpose for other biota as well. For example, niche habitats provided by the streambed substrate and gradient are key in determining the types of organisms present and their distribution and abundance.

Alaska's resident and anadromous fish use distinct microhabitats and often move between them with regular periodicity. This movement can occur seasonally, annually, or be associated with different life stages. For example, depending on species and life stage, fish use different habitats as juveniles (i.e., for rearing) than they do as adults for spawning (Schlosser 1991). Shifts in use can also be related to water temperature, water level and photoperiod. As temperatures decrease in the fall, for example, Alaska's freshwater fish usually move from summer habitats to overwintering areas offering different habitats.

The size and stability of bed material usually dictates the presence or absence of benthic invertebrate communities. For example, boulder, cobble, and gravel beds support a high diversity of benthic organisms. In streams, aquatic invertebrates drift downstream with the current. Most of these drifting organisms are immature aquatic stages of insects that later metamorphose into winged terrestrial adults, the main groups being mayflies, stoneflies, caddisflies, and midges. Immature mayflies spend from a few months to several years in streams before they metamorphose and emerge as terrestrial adult insects. During a brief few days the adults mate in swarms near the stream, lay eggs in the water, and die (Stolz et al. 1991).

Many of the small invertebrates found in lakes and ponds differ from those found in streams. Aquatic insects or benthic invertebrates that live in the bottom sediments or on aquatic plants are the dominant species in lakes and ponds, and they provide a main food source for fish. Cladocera ("water fleas") are the dominant plankton found in freshwater habitats and are also an important food source for fish and predatory insects.

Cobble and gravel substrate provides spawning habitat for fish species that construct redds and for broadcast spawners as well. Fish species foraging in cobble-boulder substrates either use isolated pockets of gravel for spawning, or they spawn in tributaries or reaches that have spawning gravels. Redd-building females generally select a site at the tail-out of a pool or head of a riffle area where there is good circulation of oxygenated water through gravel substrate. Pockets of relatively stable gravels help protect the redds from the scouring effects of high flows. Upon their emergence from the gravel, juveniles may move into the boulder-cobble reaches to seek refuge. Large woody debris and boulders provide streambank structure that decreases sediment input to redds, and offer additional refugia for juveniles and smaller species. Sand and gravel bars and secondary channels provide additional specialized habitats to the aquatic environment.

Anadromous species such as eulachon, rainbow smelt, and longfin smelt exhibit a somewhat unique developmental egg stage whereby the female’s recently released eggs fall to the stream bottom and immediately adhere to the substrate. The outer cover of the egg subsequently ruptures and turns inside out, forming a short stalk that holds the egg fast to the bottom substrate. These smelt species prefer spawning in substrate composed of coarse sand and gravel. In addition to spawning in stream habitats, rainbow smelt are also known to spawn in the shallows of lakeshores.

Lamprey species depend on muddy bottoms, backwaters, and low gradient areas during juvenile life stages. Substrate material is particularly important in the life cycle of juvenile lamprey as they stay burrowed in the mud for 4–6 years, moving only rarely to new areas. Larval lamprey occupy a special niche in the stream system, filtering microscopic plants and animals from mud on the bottom. However, adult lamprey spawn in gravelly substrates, similar to those required by Pacific salmon. Because lamprey species exhibit freshwater, anadromous and marine forms, they are important forage fish for marine mammals, birds, and freshwater fish.

Alaskan blackfish prefer muddy substrates in quiet waters in densely vegetated areas of wetlands, ponds, rivers, and lakes. They are spring spawners whose eggs are demersal and stick to available vegetation. Blackfish have a unique modified esophagus capable of gas absorption, which allows them to breathe air. This ability enables them to live in small, stagnant tundra pools that are almost devoid of oxygen in summer and to survive in moist tundra mosses during extended dry periods.

The trout-perch (*Percopsis omiscomaycus*), Alaska’s sole percopsid species, occurs only in the mainstem of the state’s longest waterway, the Yukon River. Trout-perch typically reside in deep lakes or in long deep pools of streams and are an important forage fish for larger species. They move into shallower waters to spawn where their eggs sink and stick to substrate, woody debris, or vegetation.

Sticklebacks often dominate lower elevation ponds, lakes, and streams in Alaska. They are an important forage fish for other fish species and for piscivorous birds, such as loons, terns, and gulls. Besides other zooplankton and insects, cladocera are an important food source of stickleback. Stickleback are represented by freshwater, anadromous, and marine forms, the ninespine stickleback being a freshwater inhabitant while the threespine stickleback is found in both marine and fresh waters. The presence of aquatic vegetation plays an important role in this fish’s selection of spawning habitat because the male builds a nest of sand and vegetation to house the fertilized eggs. Freshwater stickleback spawn in shallow well-oxygenated waters, including isolated ponds. Most isolated ponds and lakes provide the same functions as ponds with hydrologic connectivity to other waters, i.e., providing breeding grounds for aquatic insects, invertebrates, amphibians, and waterfowl. However, they restrict fish passage and limit distribution, setting the stage for population endemism due to geographic isolation. Because of this, many populations of stickleback in the Cook Inlet area are considered to be different subpopulations that have evolved over time.

Invertebrate species, including bivalve mollusks, are often associated with ponds and lakes, whether isoloated or not. The western floater and the Yukon floater, 2 types of mollusks, are associated with sand and gravel substrates of lakes, ponds, and slow-moving streams. Another invertebrate species of concern, the western pearlshell, prefers gravel substrates in rivers.

Many avian species overwinter in other areas of the country or in other habitats within the state, yet spend their summers in ponds and lakes across Alaska. Loons, grebes, waterfowl, and shorebirds are all found throughout lake and pond habitats during the summer mating, nesting, and rearing season. Although loons spend their winters offshore, they spend summers inland in close proximity to the ponds and lakes where they nest and rear their young. In summer, waterbirds such as grebes prefer secluded habitats in ponds and lakes. During winter and on their migration journeys grebes prefer large lakes, coastal bays, and estuaries. Many gulls and terns nest in the coniferous tree tops surrounding isolated ponds, eating insects and forage fish. Summer breeding areas for Aleutian Terns, however, include the matted dry grass near riverine habitat. Black Scoters and Surf Scoters nest in the riparian zone of lakes, ponds, or rivers in tundra or forests, while the White-winged Scoter prefers breeding grounds near streams and lakes.

Glacial Systems

Glacial rivers are important migratory corridors for both aquatic and terrestrial wildlife. They provide access to the clearwater systems elsewhere in a drainage that are ideal for spawning and rearing. In addition, many glacial river drainages contain associated large lake systems. Mainstem spawning does occur in some glacial rivers in Alaska. Onset of migratory movements in fish is induced by water temperature and level. Consequently, migratory and spawning timing in glacial waters can be significantly impacted in years of high glacial melt and can result in flooding and destruction of spawning beds. Regulated primarily by ground water, clearwater systems exhibit less dynamic annual flows.

Glacially influenced and clearwater lakes   Alaska USGS

Significant eulachon runs are associated with some of Alaska's glacial rivers, including the 20 Mile River in the Turnagain Arm area, the Susitna River, the Kenai River on the Kenai Peninsula, and the Eyak River in the Copper River Delta of Prince William Sound. Pygmy whitefish are generally associated with postglacial lakes and are largely considered a glacial relict species. Streams they inhabit are of moderate to swift current and may be silty or clear. Pygmy whitefish are frequently found in deep, unproductive lake waters.

Glacial advances formed 2 large glacial lakes within the Kenai River watershed, Kenai and Skilak Lakes. These lakes provide important overwintering habitat for aquatic species and improve downstream habitats by trapping coarse sediment, increasing water temperatures, and regulating downstream flow (Dorava 1998). These lakes significantly influence the downstream habitats of the watershed.

Riparian Zone

The riparian zone adjacent to rivers, streams, lakes, and ponds plays a critical role in nutrient cycling between terrestrial and aquatic habitats. Nutrient and organic-matter input from the riparian zone has a direct influence on food availability and growth rates of fish in both upstream and floodplain habitats (Schlosser 1991). The influence of the riparian zone vegetation is greater in headwater streams due to the high ratio of shoreline to stream bottom area. Riparian vegetation along rivers, streams, and lakes is a critical food source to primary producers, such as invertebrates, including filter feeders, shredders, scrapers, and predators. Riparian vegetation provides shade that limits in-water plant growth, but it provides substantial organic inputs, such as leaves, needles, twigs, nuts, and flowers. This dead plant material is the dominant detritus that constitutes up to 90 percent of the organic matter supporting headwater stream communities (Cummins et al. 1978), including insect larvae, such as caddisflies, stoneflies, mayflies and black flies. It also provides substrates for emerging adult insects, such as stoneflies and mayflies.

The riparian zone influences fish habitat by regulating water temperature through shading effects, by providing inputs of food supply and large woody debris, by providing channel structure through maintaining bank stability, and by preventing sedimentation and erosion (NRCC 2002). Riparian zone variables, such as width, density of vegetation, and season, regulate inputs and effectiveness. For example, diversity and density of aquatic invertebrates available as fish food is higher in streams (Newbold et al. 1980) and lakes (Christiansen et al. 1996) with wider riparian zones. In upstream habitats, seasonal variations exist related to detritus input in the fall, leaf processing in the winter and spring, and reduced organic inputs during the summer. Similarly, the growth rate of fish in large river floodplain habitats is linked to food availability provided by headwaters associated with seasonal water fluctuations.

The varied structural integrity and diversity of plant species present in the riparian zone also provide habitat for other wildlife. Amphibians, such as the Wood Frog and the Columbia Spotted Frog, require water to complete their life cycles and are closely linked to riparian areas year-round. Wood Frog eggs are found either free floating or attached to vegetation in shallow areas of ponds, lakes, and/or slow-moving streams. Juveniles disperse to surrounding uplands but return annually at adulthood to these aquatic breeding areas. The Northwestern Salamander lives under logs and rocks of the coastal forests next to freshwater ponds or lakes. Its eggs are found attached to vegetation or submerged trees in slow-moving streams, ponds, or lakes. Rough-skinned Newts are found in the coastal forest around permanent ponds and lakes or in slow-moving streams with large amounts of vegetation. They attach their eggs to vegetation or between pieces of vegetation, making them difficult to spot. Both the Rough-skinned Newt and the Northwestern Salamander have extended periods of metamorphosis within the aquatic environment taking approximately 2 years.

Small terrestrial rodents such as the Glacier Bay water shrew and Keen’s mouse preferentially use riparian zones. Small mammals may be year-round residents of riparian floodplain forest (Hanley 1999). Water shrews can dive to the bottom of a water body. Air trapped in the small mammal’s fur pops it to the water’s surface like a cork. This trapped air also allows the water shrew to float on the surface. Water shrews eat mayfly and caddisfly nymphs, as well as terrestrial invertebrates (National Wildlife Federation 2003). In addition to providing food resources, riparian vegetation provides shrews with cover from predators, while providing easy access to water.

Riparian vegetation also provides feeding, breeding, and nesting areas for all types of birds. Many of the nation’s migratory birds depend on riparian areas of lakes, ponds, rivers, and streams to supply food resources such as insects, nuts, and berries, as well as protective sites and materials for nesting. Bird density, species richness, biodiversity, number of rare species, and number of breeding pairs are often elevated within riparian habitat.

Large terrestrial mammals also benefit from intact riparian zones by using them as protected corridors for daily or seasonal movements, and as a means to facilitate gene flow (seek out mates in new areas).

The riparian zone provides connectivity to the multitude of habitat types required to maintain species productivity, sustainability, and biodiversity. As a whole, the riparian zone typically becomes wider as one moves from a water body’s headwaters to the floodplain. The width of the riparian zone may be the most important feature for species dynamics, with connectivity, sinuosity, and network pattern also playing a role (Malanson 1993). Mammals that search the waters for fish often bring their catch inland to consume. Leftover carcasses decompose and feed terrestrial plants that are the mainstay of the riparian habitat, providing shade, sediment filtration, and woody debris. Fallen leaves and large woody debris enter the waters, providing both food for primary producers and enhancing fish spawning habitat. Spawned-out fish carcasses provide food sources for juvenile fish and for scavenging birds and mammals. These activities provide inputs to the aquatic system that contribute to its health and maintain its cyclic nature.

Conservation Status

Alaska's freshwater habitat is generally healthy. Localized development impacts will likely continue to result in habitat alteration. Opportunities should be sought that alleviate negative impacts and maintain connectivity and quality habitat important to the sustainability of species.

Threats to freshwater habitat include point and nonpoint source pollution, development and associated sediment erosion and removal of riparian vegetation, blockages, diversions, channelization, dams, unmonitored water withdrawals, natural resources extraction, mixing zones, ice export, invasive species, and global warming.

Regulatory responsibilities over fresh waters in Alaska involve both state and federal agencies. DNR is the state agency responsible for water data collection and for planning and administering the appropriation of water. The Water Resources Section of DNR's Division of Mining, Land, and Water regulates water withdrawals and adjudicates water right applications. As the state's land manager, DNR holds land and water under the public trust doctrine and is responsible for maintaining these resources in an unimpaired state for the use of future generations. Alaska's laws guarantee the public's access to and use of state waters.

Water withdrawals may also be jurisdictional to DNR's Office of Habitat Management and Permitting (OHMP), which regulates activities that result in the physical alteration of, or have the potential to adversely affect, anadromous waterbodies. The OHMP also regulates activities in resident fish streams that might block fish passage.

The OHMP holds the state's regulatory authority over anadromous and resident fish and aquatic insect streams. Effective May 1, 2003, fish habitat permitting, Forest Resource and Practices Act review, and other project review functions were transferred from the Habitat and Restoration Division of ADF&G to the Alaska Department of Natural Resources' OHMP. Specifically, the OHMP's statutory responsibilities are to protect freshwater anadromous fish habitat under the Anadromous Fish Act (AS 41.14.870) and to provide free passage of anadromous and resident fish in freshwater bodies (AS 41.14.840).

ADF&G regulates activities within the state's refuges, critical habitat areas, and sanctuaries. ADF&G also reviews proposed water withdrawals and appropriations, and works to determine appropriate instream flow reservations important to aquatic and riparian habitat functions. In addition, ADF&G also reviews projects under federal jurisdiction requiring a Federal Energy Regulatory License (FERC) for protection of fisheries resources. OHMP and ADF&G's Sport Fish Division work jointly to produce the State's Anadromous Waters Catalog.

DEC implements the State's Water Quality Standards and programs to address both point source discharges and nonpoint source pollution. Under section 401 of the Clean Water Act, the DEC also issues certifications for activities authorized by the COE. The COE regulates structures in navigable waters and the placement of fill within waters of the United States.

In addition to DEC's programs, most point source discharges to surface waters are also regulated by the EPA, which administers the National Pollution Discharge Elimination System (NPDES) program. The state is currently seeking to receive primacy in the administration of this program to the federal government.

Activities within the state's designated Coastal Zone that require state or federal authorizations are reviewed by state agencies for consistency with the standards of the Alaska Coastal Management Program (ACMP).

The state's ACMP standard for habitats, 11 AAC 112.300, requires that rivers, streams, and lakes shall be managed to avoid, minimize, or mitigate significant adverse impacts to: (A) natural water flow, (B) active floodplains, and (C) natural vegetation within riparian management areas.

According to the definitions found in 11 AAC 112.300, a riparian management area means:

(A) along the braided portions of rivers and streams, 500 feet on either side of the waterbody;

(B) for split channel portions of rivers and streams, 200 feet on either side of the waterbody;

(C) for single channel portions of rivers and streams, 100 feet on either side of the waterbody;

(D) for lakes 100 feet of the waterbody; distances in this paragraph are measured from the outermost extent of the ordinary high water mark.

This definition applies to water bodies located within the state's coastal zone, but the state does not have a legal definition of riparian zone that is consistently applied statewide. The Forest Practices Act, implemented by DNR, requires riparian buffers of varying size depending on land ownership and region of timber harvest. The definition of riparian zone developed by the NRC, referenced earlier in this appendix, is not a definition that is consistently applied by federal agencies. This hinders the ability of state and federal programs to best protect riparian areas. Alaska has a unique opportunity to study and protect river corridors uninterrupted over the whole of the river continuum from headwaters to mouth.

Specific recommended conservation actions for freshwater aquatic habitats include developing and integrating biodiversity conservation and sustainable use objectives into water and land use and natural resource use management plans. The conservation and management of existing freshwater ecosystems should be a priority. Maintaining aquatic systems and natural hydrologic functions is preferred over the need for costly restoration through engineered solutions. For example, specific conservation actions directed at maintaining hydrological regimes that sustain suitable spawning and rearing habitats for aquatic species in quality and quantity are in the state's best interests. Government agencies with water rights jurisdiction should strive to set minimum flow rates and levels for streams and lakes that maintain ecologically viable aquatic systems, including wetlands. Recent GIS capability of the National Hydrography Dataset (NHD) will facilitate water management and aquatic conservation goals. The NHD is a comprehensive set of digital, spatial data that contains information about surface water features, such as lakes, ponds, streams, rivers, springs, and wells. The NHD allows analysis and display of these water-related data in upstream and downstream order (USGS 2005). In Alaska, the USGS topographic maps were used to develop the NHD dataset at a scale of 1:63,360. Hydrologic processes regulate the quality and quantity of available habitat for aquatic species. Understanding these processes within a given system may help identify critical habitats necessary for overwintering and egg survival success of obligate aquatic species. Tools such as an appropriate aquatic habitat classification and GIS mapping would enhance efforts to identify and conserve important areas.

Additional recommended conservation actions include studies directed at identifying links between landscape processes, such as geological and climatic history; the habitat process, such as the development and dynamics of riparian areas and their vegetation; and the ecology and population dynamics of the dominant fish species that occur in the different ecoregions of Alaska. This will further our understanding of how human-induced changes affect the species composition and population dynamics of each species.

Other steps toward conservation include land planning and platting efforts that protect riparian areas adjacent to important aquatic habitats. Implementation of conservation efforts should focus initially on core areas of development around the state, such as in Fairbanks, Anchorage, and the Matanuska-Susitna Borough. Effective incentives to minimize habitat fragmentation, encroachment, and pollution to aquatic ecosystems, as well as establishing long-term cost recovery mechanisms and financial assistance for sustainable use, should be implemented. Incentive-based approaches that encourage private landowners to protect Alaska's water and riparian areas and provide for their sustainable use should be developed. These may include resources such as farm bills, cost-share programs, tax incentives, conservation easements, and restoration programs. Although these types of approaches are costly, they are also cost effective; it is much cheaper to protect and sustain than to restore.

Continued cooperating efforts among state and federal agencies, NGOs, and local watershed groups on existing water resources programs that protect water quality through incorporating point and nonpoint source pollution prevention strategies should be encouraged and strengthened. These same groups should develop and/or improve mitigation policies that address negative impacts to aquatic resources with the goal of maintaining connectivity and productivity of habitats.

Lastly, cooperative relationships with local watershed and citizen monitoring groups, including outreach and education opportunities, should be fostered. This should include long-term projects and long-term partnerships with local communities. Grass-roots efforts have great potential to improve the quality of local freshwater habitats by advocating awareness and enlisting volunteers.

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