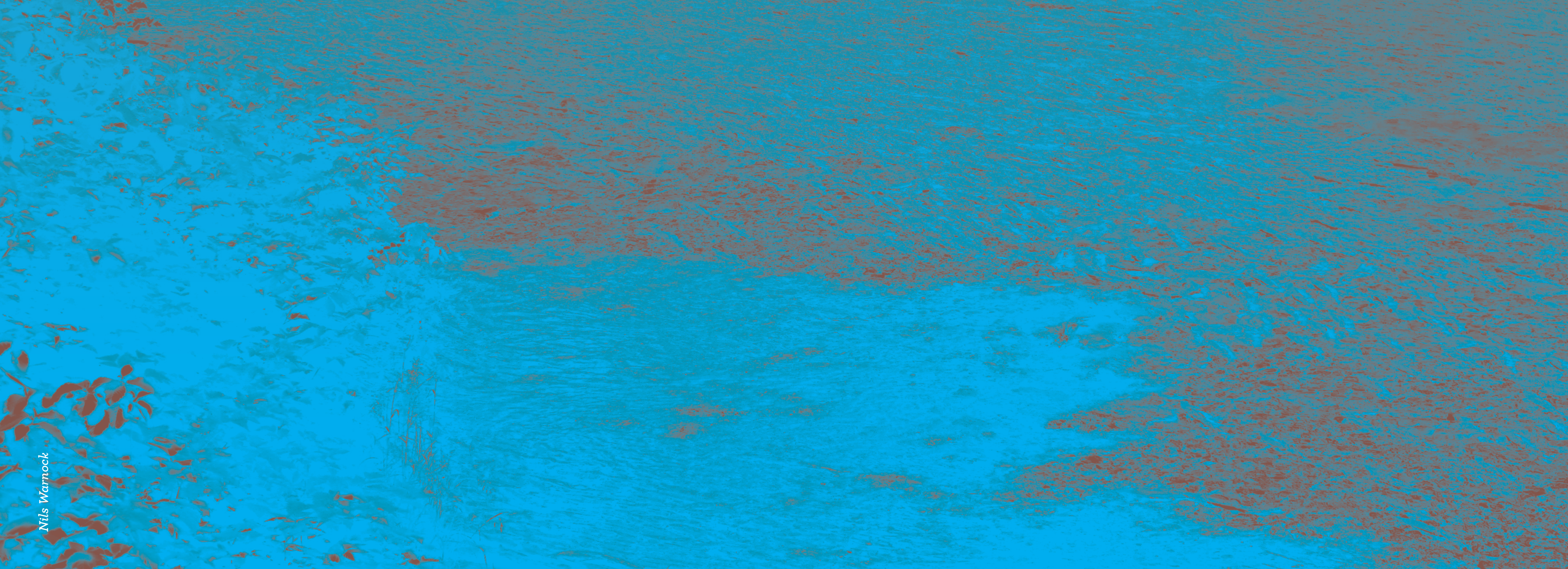
ANADROMOUS FISH

Many fishes migrate on time scales ranging from daily to annually or longer, and on spatial sales ranging from a few yards to thousands of miles. Many marine fish migrate long distances between areas where they spawn and areas where they feed and grow. Most prime spawning areas are coastal shallow waters where eggs cannot sink to great depths. Many freshwater fishes undergo short migrations from the lakes where they feed to nearby rivers where they spawn. Anadromous fishes feed and grow in the sea but migrate into freshwater to spawn. Catadromous fishes live in freshwater but migrate to the sea to spawn. The best known anadromous fishes are the species of North Pacific salmon. Anadromous fishes predominate at temperate latitudes where oceans are more productive than freshwaters. Catadromous fishes are found primarily in tropical regions were freshwater productivity typically exceeds that of the oceans (Gross et al. 1988).

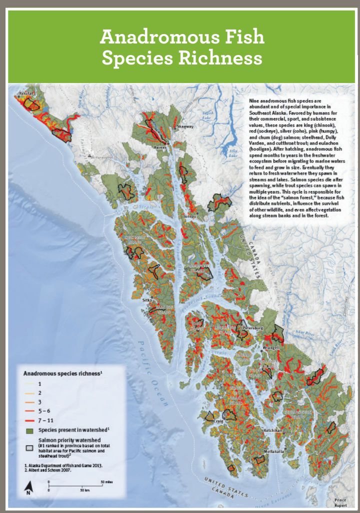
Anadromous fishes are prominent components of Alaska's freshwater fish fauna owing to the region's isolation from the major North American river drainages. Most of Alaska's freshwater fishes are recent colonists that arrived only after the massive glaciers that covered much the region melted away. Most came from the Pacific Ocean but a few entered from the interior. All of Southeast Alaska's freshwater fishes are anadromous. They vary in how far upstream they migrate, how long they stay in freshwater, and how long they live in the ocean before returning to freshwater to spawn. They are major transporters of marine nutrients to freshwaters and adjacent riparian vegetation. Their decaying bodies feed a variety of terrestrial mammals and birds. While at sea they are important sources of food for seals, sea lions, porpoises, whales, and seabirds. In Southeast Alaska, anadromous fishes are major integrators of terrestrial, freshwater, and marine ecosystems.

~ Gordon Orians



Nils Warnock

ANADROMOUS FISH MAPS INDEX



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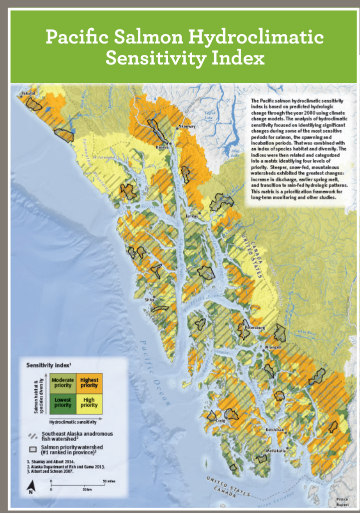

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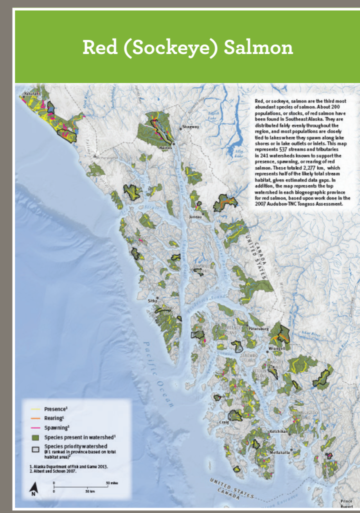

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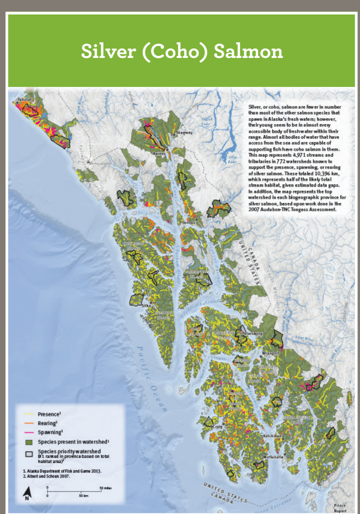

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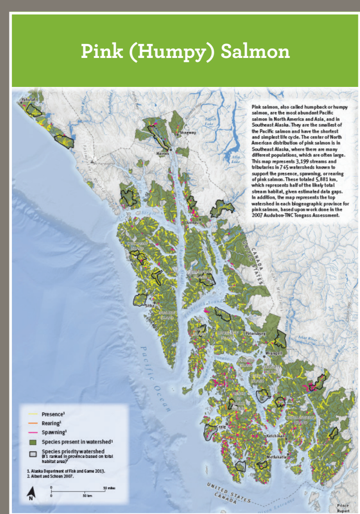

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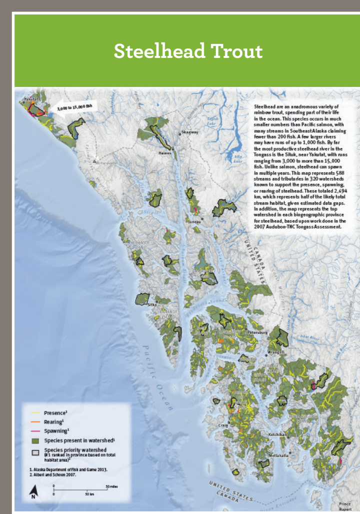

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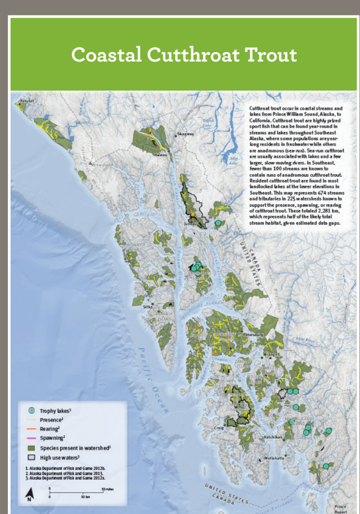

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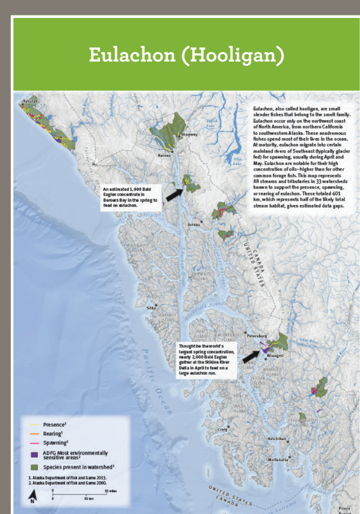

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ANADROMOUS FISH HABITAT

Bob Armstrong, Marge Osborn, Melanie Smith, and Nathan Walker

Anadromous fish are an essential part of Southeast Alaska's ecology and economy. Nine anadromous fish species are abundant in Southeast: king (Chinook; *Onchorhynchus tshawytscha*), red (sockeye; *O. nerka*), silver (coho; *O. kisutch*), pink (humpy; *O. gorbuscha*), and chum (dog; *O. keta*) salmon; steelhead (*O. mykiss*), Dolly Varden (*Salvelinus malma*), and cutthroat trout (*O. clarki*); and eulachon (hooligan; *Thaleichthys pacificus*) (Mecklenberg et al. 2002). A single river system in the region, the Chilkoot, is also known to support Pacific lamprey and an unspecified species of whitefish (Alaska Department of Fish and Game 2013). Bull trout may also be present in the Taku and Stikine, but are likely limited to the Canadian portions of those rivers (COSEWIC 2012).

After hatching, anadromous fish spend months or sometimes years in fresh water before migrating to marine waters to feed and grow in size. Eventually they return to fresh water where they spawn in streams and lakes. Pacific salmon species are semelparous, meaning that they die after spawning, whereas trout species are typically iteroparous (spawn in multiple years), although approximately 75% of steelhead trout die after a single spawning cycle (Alaska Department of Fish and Game 2014g). The cycle is responsible for the idea of the "salmon forest," because fish distribute nutrients, influence the survival of other wildlife, and even affect vegetation along stream banks and in the forest.

Pacific salmon in particular are a major vector for the transport of marine and freshwater nutrients to the forest ecosystem. Millions of salmon carcasses left behind in the forest by wildlife (such as bears) nourish the Sitka spruce-hemlock forests of Southeast Alaska (Willson and Halupka 1995). Following spawning, salmon carcasses release nutrients into the region's rivers and streams, and these nutrients are taken up by aquatic and terrestrial life (Cederholm et al. 1999). Salmon have been termed a keystone species within Southeast Alaska because they provide a resource base that supports much of the coastal ecosystem, including wildlife such as brown and black bears (*Ursus arctos* and *U. americanus*, respectively), Bald Eagles (*Haliaeetus leucocephalus*), and wolves (*Canis lupus*) (Willson et al. 1998). These predators eat anadromous fish eggs, juveniles, live adults, and carcasses. In all, salmon provide forage for more than 40 different species of mammals and birds in fresh waters of Southeast (Willson and Halupka 1995). Salmon also feed saltwater predators such as seabirds, seals, sea lions, porpoises, and orcas.

John Schoen

Pacific salmon are a critical food resource for Alaska's coastal black and brown bear populations. All five species are used wherever they are accessible to bears. Individual bears display many different fishing techniques. Bears are highly selective of fresh salmon and specific fish parts such as eggs and brains which have the highest nutritional value. Bears with access to salmon are larger, more productive, and have smaller home ranges and higher densities than bears without access to salmon.

Anadromous fish have played a major role in the history and economy of Alaska and its commercial, sport, and subsistence fisheries. Commercial harvest of Southeast Alaska salmon began in the late 1870s. In Southeast, harvests of all species except Chinook salmon have increased dramatically since the 1970s. The record total commercial harvest in Southeast was 112.4 million salmon in 2013 (Conrad and Gray 2014). In 2012, the total commercial harvest in Southeast Alaska and Yakutat was 37 million salmon with an estimated ex-vessel value of $157 million. Southeast Alaska salmon are an important subsistence species for Alaskans and are part of the Southeast Alaskan fishing industry worth $1 billion per year.

Despite historic success, fish stocks in Southeast are vulnerable to potential future impacts. The species face an uncertain future from climate change, and increases in human population and development. The numbers of some anadromous fish have decreased in parts of the region because of increasing pressure from anglers. These declines prompted the Alaska Board of Fisheries to reduce bag limits, completely close some systems to harvest, and establish catch-and-release-only fisheries on other streams (Larson 1990, Harding and Jones 1992;1993).

Aside from recent declines in Chinook salmon abundance (Alaska Department of Fish and Game 2015b), most Southeast salmon populations are healthy, as indicated by systematic surveys (Baker et al. 1996, Halupka et al. 2000) and fishery harvest reports (Conrad and Gray 2014). Maintaining intact watersheds is a critical factor in sustaining healthy salmon runs in Southeast (Bryant and Everest 1998). Factors associated with high levels of productivity and abundance include: (1) relatively pristine and undeveloped habitats (since much of the region is inaccessible); (2) successful habitat and salmon management policies within Alaska; (3) enhancement by hatcheries; and (4) favorable environmental conditions (Royce 1989, Meacham and Clark 1994). Marine conditions favorable to high survival of Alaska salmon have contributed to record returns (Beamish and Bouillon 1993, Francis and Hare 1994).

Anadromous fish depend on healthy freshwater habitat for spawning, rearing, and wintering. Because the landscape of Southeast is predominantly forest, the ability to maintain healthy freshwater habitats for anadromous fish is inextricably tied to the health of the forests and watersheds around them. Many of the areas most important to anadromous fish are also those most valued as sources of timber, however, and those forests and watersheds have been or could be exposed to impacts from timber harvest on a large scale. Maintaining a balance between the value and contribution of timber to the regional economy and the value and contribution of anadromous fish, especially salmon, is a major challenge to resource management and political decision-making.

As part of the 2007 Conservation Assessment and Resource Synthesis (Schoen and Dovichin 2007), Audubon Alaska and The Nature Conservancy worked together to develop a science-based process for ranking the ecological values of watersheds within biogeographic provinces across Southeast Alaska. The ability to assess and rank ecological values provides resource managers and conservationists with a tool for setting conservation priorities and evaluating and refining reserve networks.

The condition and management status of floodplain forests associated with anadromous fish streams were evaluated among 22 biogeographic provinces in Southeast Alaska. Based on the assessment, North Prince of Wales Island contained the most anadromous freshwater habitat, followed by Yakutat Forelands, East Chichagof Island, Kupreanof/Mitkof Islands and the Stikine River/Mainland. Anadromous habitat in transboundary watersheds outside of Alaska were not accounted for in the analysis.

MAPS ON PAGES 71,72

An estimated 20% of the approximately 500,000 ac (202,343 ha) of floodplain forests associated with anadromous fish have been logged since 1954 (Albert and Schoen 2007). The highest proportion of logging of flood plain forests occurred on Baranof Island, North Prince of Wales, the Chilkat River and East Chichagof Island. Regionwide, approximately 52% of anadromous floodplain forests are within non-development designations, with 38% in watershed-scale reserves. Provinces with the lowest representation in watershed-scale reserves include the Chilkat River (0%), North Prince of Wales (9%), Kupreanof/Mitkof (17%), and Dall Island Complex (19%). Provinces with highest levels of watershed-scale protection include Fairweather, Misty Fiords, West Chichagof Island, and Admiralty Island.

Fish are facing and will continue to face additional stresses due to a changing climate. Both an increase and a decrease in flow patterns can negatively affect anadromous fish populations. Warm temperatures in winter result in decreased snowpack as more precipitation falls as rain rather than snow; overall this causes reduced stream flows and thereby elevated stream temperatures (Service 2015). Another aspect of climate change is a shift in the timing of peak flows due to an earlier spring melt, and periods of increased stream flows from faster melting, as well as an increase of rain-fed events (not collecting in the form of slow-melting snow pack). Increased peak discharge can scour streams of eggs and fry which appear to be an important limiting factor for Pacific salmon populations (Shanley and Albert 2014).

Considering the benefits of anadromous fish to the economy and to the lifestyle of Southeast Alaskans, the importance of anadromous fish as food for a diverse assemblage of wildlife, and the indirect benefits of anadromous fish to Southeast ecosystems as a whole, safeguarding fish habitat is an investment worth making.

CONSERVATION ISSUES

Logging can have myriad impacts on anadromous fish habitat, as described by Murphy (1995):

"Salmonid habitat is a product of interactions among the stream, flood-plain, riparian area, and uplands—in short, the entire watershed. Effects of timber harvest, road construction, and other activities anywhere in the watershed can be transmitted through changes in hydrologic and erosional processes to modify habitat for salmonids."

In this report, Murphy (1995) also presented the following recommendations:

- Design buffer zones to protect fish habitat while enabling economic timber production
- Implement effective Best Management Practices (BMPs) to prevent nonpoint-source pollution
- Develop watershed-level procedures across property boundaries to prevent cumulative impacts
- Develop restoration procedures to contribute to recovery of ecosystem processes
- Enlist support of private landowners in watershed planning, protection, and restoration.

Rapid declines of salmon populations in Washington, Oregon, and California were brought about in part by loss of freshwater habitat from dams and watershed damage. A panel of fisheries experts assessed the levels of risk to fish habitat from timber harvest and other activities associated with management alternatives in the 1997 Tongass Land Management Plan revision. Panel evaluators identified Prince of Wales Island, Kupreanof Island, Kuiu Island, and Chichagof Island as currently having road densities high enough to warrant concern for maintaining adequate fish habitat. The panel stated in conclusion that, "A reduction of road development in any alternative reduces risks to fish habitat." The panel expressed five primary issues of concern (Dunlap 1997):

1. Roads may have negative effects on fish habitat. These effects could come from sedimentation when roads are constructed on slopes that are too steep. Stream-crossing structures, especially culverts, may block movement of juvenile fish and result in a long-term reduction of available fish habitat. In addition, the panel expressed concern about an increased risk of overharvests of fish, especially sockeye salmon and steelhead and cutthroat trout, because fishermen would have improved access from roads.

   The amount of timber harvested under any alternative was the second highest risk to fish habitat. This risk increased as the number of acres harvested increased.

Pink salmon in a Southeast Alaskan stream.

Nils Warnock

MAPS ON PAGES 71,72

2. Allocation of reserves free of timber harvest reduce the risk to fish stocks. The panel recommended that the most effective protection of fish habitat would be reserves that included entire watersheds rather than only parts of watersheds.
3. Results of watershed analysis may affect management decisions. The panel recommended that a watershed analysis be conducted before decisions are made on how management activities would be applied on the ground.
4. Timber harvest activities in the upper reaches of watersheds where fish do not occur may affect habitat. The panel pointed out that protection of these areas would help maintain and protect fish habitat farther downstream. Timber harvest in these areas is especially important in affecting the rate and amount of wood and sediment delivery.

The addition of millions of salmon from hatcheries has potential to change the genetic composition of local populations. The precise mechanisms driving salmon homing ability (when sexually mature salmon return to their natal site for spawning) are still not well understood, but hatchery-reared fish likely have elevated straying rates or impaired homing ability (Hard and Heard 1999, Candy and Beacham 2000). Although they may be poorly adapted to a new site, captive-reared salmon often hybridize with wild salmon when straying to a new spawning site, producing less viable offspring that can ultimately destabilize a wild salmon run (Bailey et al. 2010). Thus, an unintended consequence of hatchery production is the weakening of local adaptations and reduction of biodiversity (Willson 2007).

Climate change adds additional stress to fish due to changes in hydrology and stream temperatures. Some of the ways in which climate change is expected to affect streams utilized by anadromous fish populations include:

- Faster glacial melt and increased meltwater output (Motyka et al. 2002)
- An elevational shift in the snowline, and a change in precipitation from snow to rain below that line (Edwards et al. 2013)
- Reduction in snowpack (Mote et al. 2003) and an increase in rain-on-snow events (Rennert et al. 2009)
- Hydrologic changes including changes in peak and base flows, seasonal low flows, peak output, timing, and flooding (Mantua et al. 2010)
- General reduction in productivity due to hydrologic changes during spawning and incubation periods (Shanley and Albert 2014)
- Changes in lake temperatures, which would shift trophic relationships and alter food availability for juvenile salmon (Bryant 2009).

Conserving existing habitat and restoring degraded habitat are even more important as they increase watershed resiliency and potential for species adaptation to changing conditions.

MAPPING METHODS

Anadromous Waters

The Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes (Anadromous Waters Catalog) is maintained by the Alaska Department of Fish and Game (ADFG), with annual updates to incorporate nominations of new streams to the database or revisions of old ones. To be entered into this catalog, each waterbody must have documentation verifying the presence of an anadromous fish species. Statewide, this catalog currently contains over 18,000 waterbodies; however, more thorough surveys of localized areas suggest that this represents less than half of the total, with an additional 20,000 or more anadromous streams, rivers, and lakes not yet documented in this catalog. This map represents 5,614 streams and tributaries in 842 watersheds known to support the presence, spawning, or rearing of anadromous fish species (Alaska Department of Fish and Game 2013). These totaled 6,936 mi (11,163 km), or 50% of the model-estimated anadromous stream length.

The map features the total number (richness) of anadromous species known to occur in each stream segment, including streams where chum salmon, silver salmon, cutthroat trout, Dolly Varden, king salmon, eulachon, pink salmon, red salmon, and/or steelhead trout are either spawning, rearing, or present.

Top-ranked Watersheds

In addition, this map represents the top-ranked watersheds for salmonids in each biogeographic province based upon work done in the 2007 Audubon-TNC Conservation Assessment. The assessment of top-ranked watersheds included consideration of six species of salmonids: king salmon, chum salmon, silver salmon, red salmon, pink salmon, and steelhead trout. Available data on distribution and abundance of each species as well as populations with unique life history, timing of spawning runs, and genetics were reviewed. In addition, the limitations in existing data on salmon distribution and habitats were recognized. To improve the ability to identify areas of likely salmon habitat in unmapped stream channels, a landscape model was developed to identify floodplain habitats associated with documented anadromous fish streams.

The presence of salmon was estimated using the Anadromous Waters Catalog. This database is recognized to underrepresent the total distribution of salmon because of its (1) strict criteria for listing and (2) lack of complete stream surveys. The alternative database is the US Forest Service (USFS) Stream Inventory, which attributes stream segments by potential for anadromous fish based on channel characteristics (Paustian et al. 1992). The USFS database is sensitive to two types of bias: (1) it does not account for stream barriers that limit the actual distribution of salmon; and (2) mapping effort was more intensive in areas where timber sales have occurred. In general, side channels that provide important habitat for salmon tend to be underrepresented in both the USFS and ADFG datasets. The USFS database is beneficial because it provides information on fluvial processes, which determine how streams function in the life histories of salmon, as well as the interactions of salmon with other species (for example, availability to bears).

A floodplain model was developed to associate Class I streams (potential anadromous) in the USFS database with occupied streams in the ADFG database. This model was a function of slope and distance from the stream. Class I streams within this anadromous floodplain are likely to be used by salmon, and provide a better estimate of total freshwater habitat than the Anadromous Waters Catalog alone. Planning units were evaluated both on the number of species present as well as the estimated amount of habitat available.

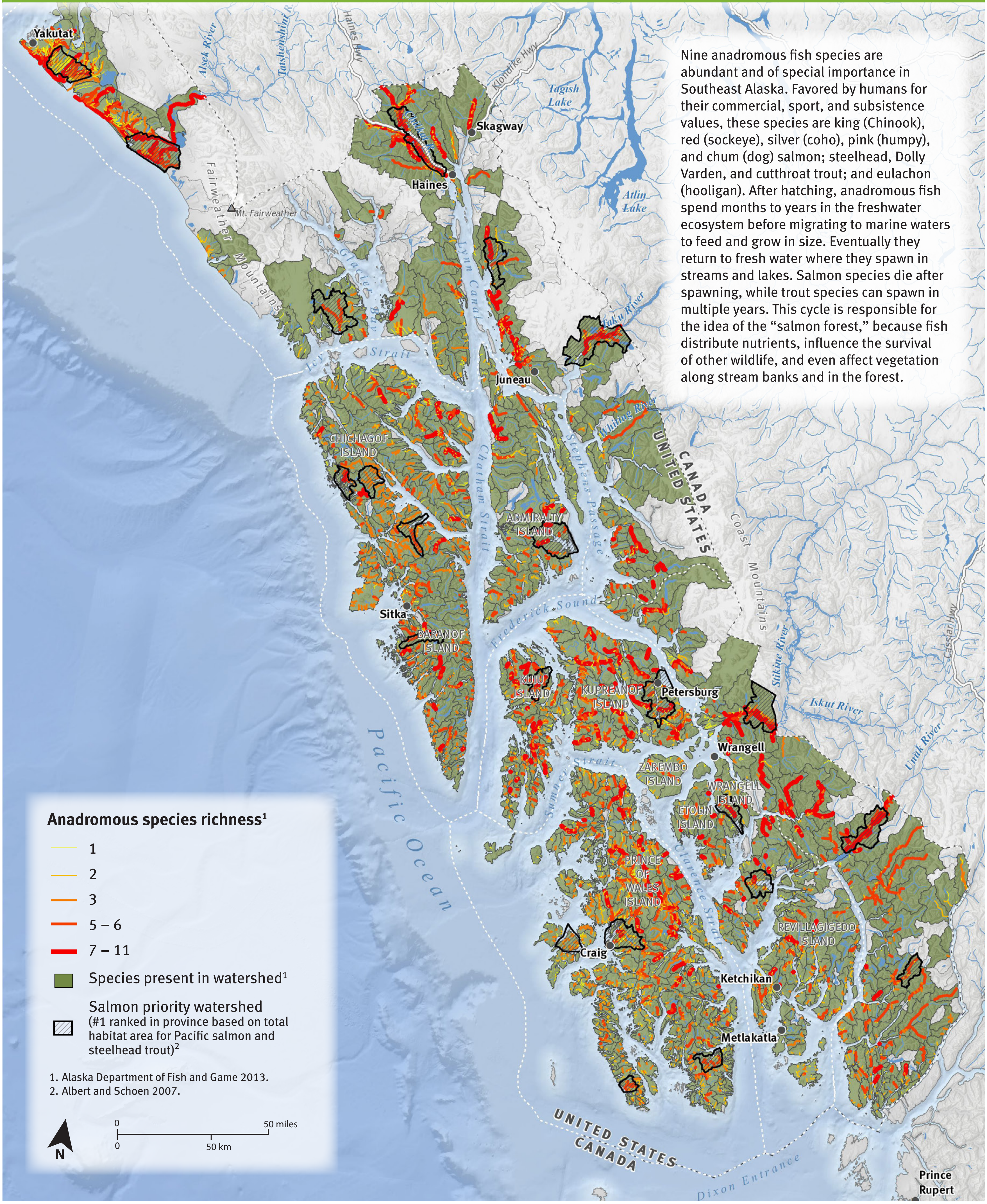
We utilized the salmon distribution data to rank watersheds. First, the total acreage of modeled habitat was calculated for each watershed, then watersheds were ranked from most to least salmon habitat acreage within each biogeographic province for each of the six species and for the total sum of habitat for all six species combined. Shown here is the top-ranked watershed in each province for the six species combined. In total, approximately 13,750 mi (22,000 km) of anadromous or potentially anadromous fish habitat were identified in Southeast, which is considered an underestimate of actual habitat (e.g. omission of anadromous lake habitat, limited knowledge total distribution). Coho or silver salmon was the species most widely distributed, followed by pink salmon, chum salmon, steelhead trout, red, and finally king salmon.

Data on Pacific salmon climate change sensitivity was provided by TNC from their recent publication in PLoS One (Shanley and Albert 2014).

MAP DATA SOURCES

- Anadromous streams: Alaska Department of Fish and Game (2013)
- Top-ranked watersheds: Albert and Schoen (2007).
- Pacific salmon hydroclimatic sensitivity index: Shanley and Albert 2014

Anadromous Fish Species Richness



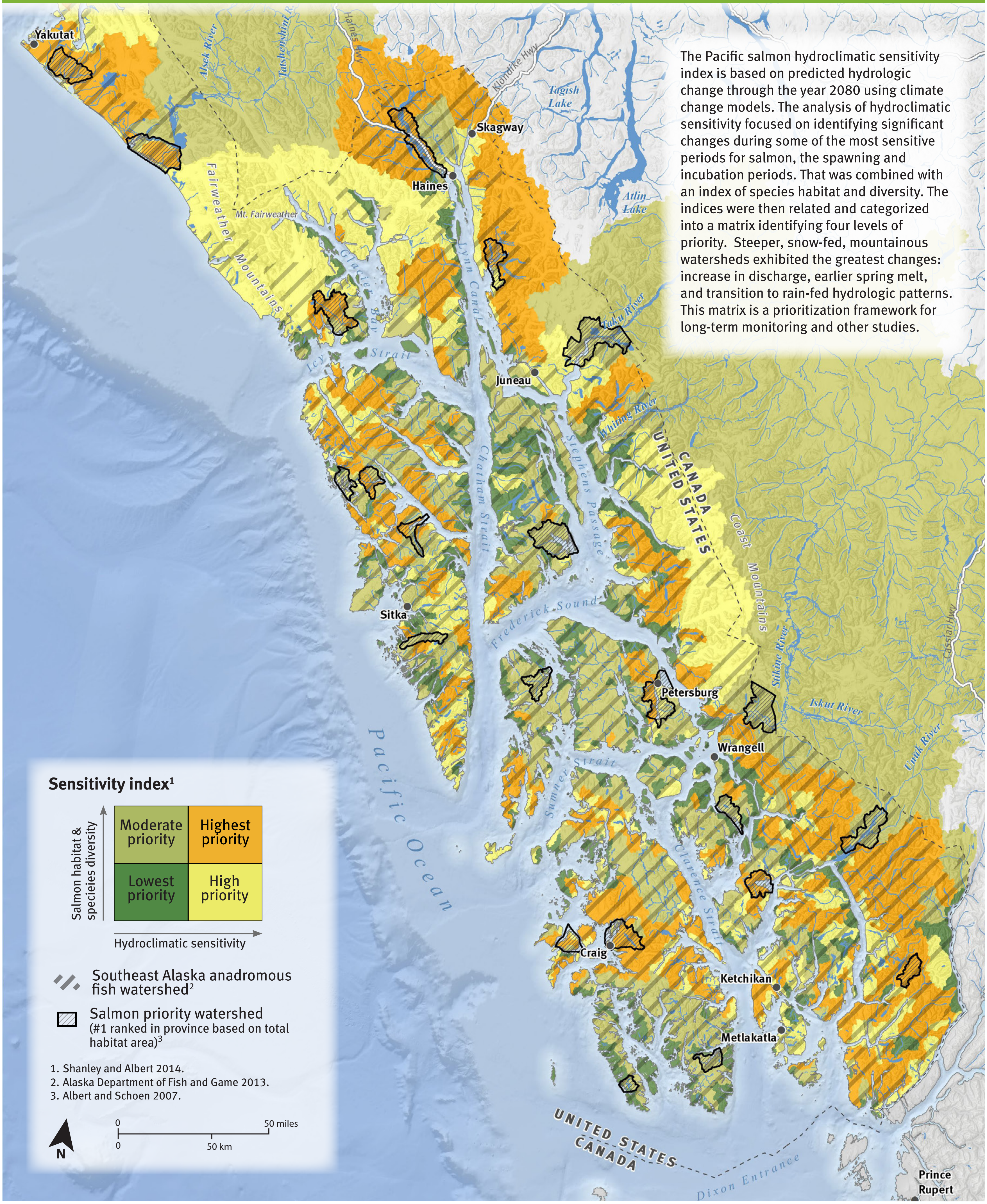
Nine anadromous fish species are abundant and of special importance in Southeast Alaska. Favored by humans for their commercial, sport, and subsistence values, these species are king (Chinook), red (sockeye), silver (coho), pink (humpy), and chum (dog) salmon; steelhead, Dolly Varden, and cutthroat trout; and eulachon (hooligan). After hatching, anadromous fish spend months to years in the freshwater ecosystem before migrating to marine waters to feed and grow in size. Eventually they return to fresh water where they spawn in streams and lakes. Salmon species die after spawning, while trout species can spawn in multiple years. This cycle is responsible for the idea of the “salmon forest,” because fish distribute nutrients, influence the survival of other wildlife, and even affect vegetation along stream banks and in the forest.

Map 4.1: Anadromous Fish Species Richness

Pacific Salmon Hydroclimatic Sensitivity Index

Audubon ALASKA
The Nature Conservancy

The Pacific salmon hydroclimatic sensitivity index is based on predicted hydrologic change through the year 2080 using climate change models. The analysis of hydroclimatic sensitivity focused on identifying significant changes during some of the most sensitive periods for salmon, the spawning and incubation periods. That was combined with an index of species habitat and diversity. The indices were then related and categorized into a matrix identifying four levels of priority. Steeper, snow-fed, mountainous watersheds exhibited the greatest changes: increase in discharge, earlier spring melt, and transition to rain-fed hydrologic patterns. This matrix is a prioritization framework for long-term monitoring and other studies.



Map 4.2: Pacific Salmon Hydroclimatic Sensitivity Index

MAP ON PAGE 75

KING (CHINOOK) SALMON

Bob Armstrong and Marge Osborn
Revised by Kathy Wells

Ocean phase.

Spawning phase.

Alaska Department of Fish & Game

King, or Chinook, salmon (*Oncorhynchus tshawytscha*) are largest of the Pacific salmon, averaging about 15 lbs (6.8 kg) (Alaska Department of Fish and Game 2014a), but commonly weigh over 30 lbs (14 kg) (Alaska Department of Fish and Game 2014b). Spawning stocks of king salmon are found on the east coast of Asia from northern Hokkaido in Japan to the Anadyr River in Russia, and on the west coast of North America from central California to Kotzebue Sound, Alaska (Healey 1991). Most king salmon harvested in Southeast marine waters come from rivers in British Columbia, Washington, and Oregon (Orsi and Jaenicke 1996). Chinook that frequent Alaska marine waters outside of Southeast, especially in the very northern part of the Pacific Ocean and the Bering Sea, are primarily of Alaskan origin, though some salmon deriving from British Columbia and the west coast U.S. stocks are also present (Armstrong 1996, Guthrie III et al. 2012).

Compared with other salmon, kings spawn in a limited number of the streams and rivers that empty into marine waters of Southeast. There are 34 documented watersheds in Southeast that support spawning populations of king salmon (Pahlke 2009), and most of these fish have spawned in the Canadian portions of the rivers (Heard et al. 1995).

Most king salmon stocks in Southeast are referred to as "stream-type" (age 1) because they spend one year in fresh water before migrating to sea. Most king salmon from the Situk River near Yakutat are "ocean-type" or "zero-check" (age 0)—fish that migrate to sea during their first year without spending a winter in fresh water (Thedinga et al. 1998). Unlike kings in other Alaskan rivers, those in the Situk River attain sufficient size in their first summer to migrate to sea as age-0 smolts (Johnson et al. 1992, Thedinga et al. 1998).

Because of its large size, eating quality, and fighting capabilities, kings are the salmon most sought after and prized by sportfishers. A 57-kg (126-lb) king salmon taken in a fish trap near Petersburg, Alaska, in 1949 is the largest on record. The largest sport-caught king salmon was a 44-kg (97-lb) fish taken in the Kenai River in 1986. Chinook salmon are very similar to silver salmon in appearance while at sea (blue-green back with silver flanks), except for their large size, small black spots on both lobes of the tail, and black gums. At spawning, kings turn red to copper to almost black.

Among the watersheds that support spawning populations of kings in Southeast, the largest populations are found in the Taku, Stikine, and Alsek rivers (Heard et al. 1995). These rivers originate in the Canadian provinces of British Columbia and the Yukon Territory, where the subarctic climate is drier and colder than the temperate maritime climate of Southeast; in these rivers king salmon spawn exclusively in Canada. The other mainland coast streams supporting spawning king populations are generally shorter and less productive. Only three naturally occurring stocks of king salmon have been found on islands in Southeast, all on Admiralty Island (Armstrong 2004).

Annual spawning escapements (the number of fish that escape a fishery to spawn) of king salmon in all systems in Southeast averaged 76,271 fish during 1991 to 1993 (Heard et al. 1995). Major systems (greater than 10,000 spawners) were the Alsek, Taku, and Stikine rivers. Medium systems (between 1,500 and 10,000 spawners) included Andrew Creek and Blossom, Chickamin, Keta, Situk, Chilkat, and Unuk rivers. Minor systems (fewer than 1,500 spawners) included systems such as King Salmon River on Admiralty Island.

Because salmon abundance fluctuates according to complex, site-specific cycles (Drake and Naiman 2007), it is difficult to assess region-wide population status. If salmon habitat is compromised through timber harvest or mining activities, individual runs and eventually entire populations may be extirpated (Jennings et al. 2008, USEPA 2014). In general, most Southeast watersheds that support king salmon have been spared significant human disturbance. However, anecdotal reports suggest that as many as four historic small king stocks in Southeast may have been extirpated, and that logging in the Bradfield River drainage during the 1950s likely contributed to a temporary decline in the river's king stocks (Halupka et al. 2000).

Commercial harvest of Southeast Alaska salmon began in the late 1870s. Patterns of king salmon productivity and abundance generally have varied over time and among different areas of Alaska. However, recent declines in productivity, abundance, and inshore harvests appear widespread and persistent throughout Alaska, prompting the ADFG to publish the King Salmon Stock Assessment and Research Plan in 2013. This report assessed the downturns in king salmon stocks, including the Southeast stocks of the Unuk, Stikine, Taku, and Chilkat rivers. As productivity and run abundances trended downward statewide, management of fisheries became more restrictive to achieve established escapement goals. As a result, average annual inshore harvest of king salmon in all Alaska fisheries have decreased during both the 13-year period prior to downturns in run abundance (1994–2006) and the 5-year period afterward (2007–2011). Specifically, subsistence and personal use is down from 175,000 to 154,000 fish (about a 12% reduction); commercial harvest is down from 584,000 to 425,000 fish (about a 27% reduction); and sport take is down from 178,000 to 141,000 fish (about a 21% reduction). These decreases in inshore commercial harvest of king salmon occurred in all management areas of Alaska (ADFG Chinook Salmon Research Team 2013). In 2014 and 2015, the commercial and sport harvest of Chinook increased significantly (Alaska Department of Fish and Game 2015a), with an influx from salmon production in the Columbia River and southern US states (Ed Jones, ADFG, personal communication 2015).

Compared with other species of Pacific salmon, king salmon have a slightly different set of spawning habitat preferences. Almost all salmon tend to spawn only in areas that have a good flow of subsurface water through a bed of gravel, but because spawning king salmon are larger than most other salmon, they select rivers with larger gravel, faster stream flow, and a good supply of dissolved oxygen for their larger eggs (Alaska Department of Fish and Game 2002).

Orsi and Jaenicke (1996) identified the importance of marine waters of Southeast as a nursery and feeding area for king salmon stocks originating between Oregon and Southeast, a range of 1,125 mi (1,800 km). These marine waters are also important to residents of Southeast because king are the only salmon caught in inside waters during the winter.

MAP ON PAGE 75

Because most of the Chinook salmon in Southeast spawn in the Canadian portions of the larger transboundary Alsek, Taku, and Stikine Rivers, there is concern that activities outside of Alaska could significantly impact local fisheries. For example, acid mine-drainage from the former Tulsequah Chief mine in British Columbia flows into the transboundary Taku River and its tributary, the Tulsequah River. Proposed reopening of the mine, if done without proper environmental safeguards, threatens king salmon in the Taku River and the multimillion-dollar Taku River fishery near Juneau. Twenty-one mining projects in Northwest British Columbia are active or in various stages of exploration and threaten fisheries on Stikine, Taku, and Unuk rivers (Southeast Alaska Conservation Council 2014).

There is some risk that the release of hatchery-reared king into Southeast waters could disrupt or alter native stocks. Although they may be poorly adapted to a new site, captive-reared salmon often hybridize with wild salmon when straying to a new spawning site, producing less viable offspring that can ultimately destabilize a wild salmon run (Bailey et al. 2010).

CONSERVATION ISSUES

Deterioration and loss of natural habitats due to industrialization, urbanization, other land-use practices, and especially the damming of rivers in southern parts of the range (i.e., the Pacific Northwest) are thought to be the main factors in the coastwide decline of many stocks (Heard et al. 1995). Conserving healthy Southeast king salmon populations will depend on the following considerations:

- Maintaining and enhancing protection of freshwater habitat in the limited number of watersheds suitable for king salmon runs
- Controlling logging, mining, and other human impacts on habitat
- Continuing to develop international cooperation on habitat for transboundary river stocks
- Monitoring of straying patterns in Southeast hatchery king salmon to (1) document interactions with wild populations and (2) identify aquacultural practices that reduce risks to natural salmon populations posed by straying
- Recognizing that king salmon originating from other US states and Canada rely on the marine waters of Southeast Alaska for nursery and feeding areas.

MAPPING METHODS

This map represents 226 streams and tributaries in 87 watersheds known to support the presence, spawning, or rearing of king salmon (Alaska Department of Fish and Game 2013). These totaled 940 mi (1,510 km), which is likely only 50% of the model-estimated anadromous stream length. In addition, this map represents the top watershed in each biogeographic province for king salmon, based upon work done in the 2007 Audubon-TNC Tongass Assessment. For more information on mapping methods see the Anadromous Fish Habitat methods section.

MAP DATA SOURCES

- Anadromous streams: Alaska Department of Fish and Game (2013)
- Top-ranked watersheds: Albert and Schoen (2007)

USFWS

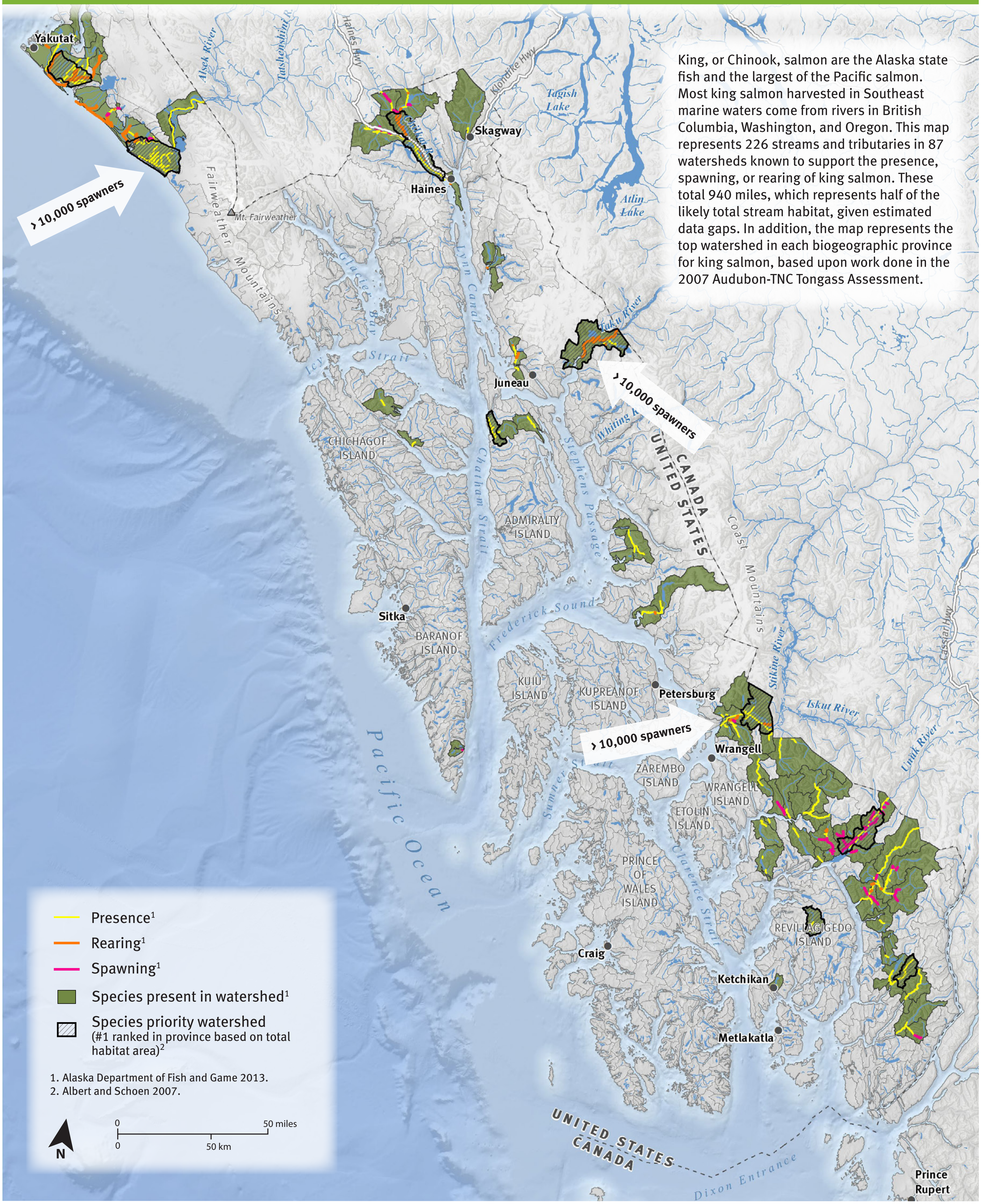
King (Chinook) salmon.

Audubon ALASKA

The Nature Conservancy

King (Chinook) Salmon

King, or Chinook, salmon are the Alaska state fish and the largest of the Pacific salmon. Most king salmon harvested in Southeast marine waters come from rivers in British Columbia, Washington, and Oregon. This map represents 226 streams and tributaries in 87 watersheds known to support the presence, spawning, or rearing of king salmon. These total 940 miles, which represents half of the likely total stream habitat, given estimated data gaps. In addition, the map represents the top watershed in each biogeographic province for king salmon, based upon work done in the 2007 Audubon-TNC Tongass Assessment.



Map 4.3: King (Chinook) Salmon

MAP ON PAGE 78

RED (SOCKEYE) SALMON

Bob Armstrong and Marge Osborn
Revised by Kathy Wells

Ocean phase.

Spawning phase.

Alaska Department of Fish & Game

Sockeye, or red salmon (*Oncorhynchus nerka*), are the second most abundant species of salmon (Heard 2002). While at sea they have iridescent silver flanks, a white belly, and a metallic green-blue top. There may be some fine black speckling that can occur on the back, but they are absent of the large spots of other Pacific salmon. When reds return to freshwater to spawn, their heads turn green and their bodies turn bright red, hence their common name, red salmon. Breeding males develop a humped back and hooked jaws filled with tiny teeth.

Sockeyes are one of the smaller species of Pacific salmon, weighing in at 4 to 15 lbs (2 to 6 kg), and have a lifespan of 3 to 7 years. Globally, reds range from the Klamath River in Oregon to the Chukchi Sea in northwestern Alaska (and potentially as far as Bathurst Inlet, Canada) and from the Anadyr River of Siberia south to Hokkaido, Japan. The largest red was caught in 1974 at the Kenai River and weighed 16 lbs (7.3 kg).

About 200 populations, or stocks, of red salmon have been found in Southeast Alaska and are distributed fairly evenly throughout the region (Halupka et al. 2000). Most populations are closely connected to lakes, which provide spawning habitat (Armstrong 1996) and which, in turn, receive significant nutrient subsidies from returned red salmon (Kline Jr et al. 1993). Lakes in Southeast that are accessible from the sea are important to the region's red salmon, especially for the rearing of young before their migration to sea. In this aspect, the red salmon differs from the other Pacific salmon species in Southeast, which normally do not depend on lake rearing during the juvenile stage (Burgner 1991). Red salmon are the only salmon species to spawn extensively in shoal beach areas along lake shores, typically in areas of upwelling groundwater that provides circulation through the nest (Burgner 1991). Interestingly, Halupka et al. (2000) describe some anecdotal reports of sockeye salmon spawning in the caves of Kook Lake.

Bob Armstrong

Black bear with a red (sockeye) salmon.

MAP ON PAGE 78

Young red salmon typically spend up to three years in these nursery lakes before migrating to sea. While in lakes, they usually stay near shore during the day and move offshore at night, where they feed on aquatic insects and zooplankton that migrate from the lake depths to the surface at night. Sockeye acquire their brilliant orange flesh-color from eating orange krill while in the ocean and filtering the zooplankton and small fish they eat through "gill rakers." Sockeye that migrate to the sea spend one to four years in salt water before returning to fresh water to spawn. Salmon die after spawning is complete. Over geologic time, some reds have become land-locked and are called "kokanee." These freshwater kokanee reds rarely exceed 14 in (0.4 m) in length compared to the anadromous sea-going sockeye that measure 16 to 30 in (0.5 to 0.8 m).

Some populations, or a portion of some populations, do not use lakes as nursery areas and instead migrate to sea at age 0, the same year as hatching (Heifetz et al. 1989, Thedinga 1993, Rice et al. 1994). Also, some populations rear in rivers, rather than lakes, for one year (Rice et al. 1994, Murphy et al. 1997). At least two systems in Southeast Alaska, the Taku and Stikine rivers, produce all three types of red salmon: lake type, 0-age stream type, and stream-rearing type (Rice et al. 1994).

In the Pacific region, sockeye were the first salmon species to be commercially harvested, and because of their color, rich oil content, flavor, and superior flesh quality they are the most sought after of all the Pacific salmon. Sockeyes are the most economically important species in Alaska, and in Southeast they are the salmon most harvested by personal use and subsistence fishers. Bristol Bay in Southwest Alaska has the largest harvest of sockeye salmon in the world, with 10 million to more than 30 million caught each year. In Southeast Alaska in 2012, the total harvest in commercial, personal use, and subsistence salmon fisheries was 0.9 million sockeye, below the long-term average of 1.3 million (Conrad and Davidson 2013), but in 2014 the commercial take alone was nearly 1.6 million fish.

A recent study of sockeye salmon in Bristol Bay found that maintaining population diversity has a "portfolio effect" in which the genetic diversity among the hundreds of smaller sub-populations stabilizes the overall population to ensure healthy returns and lower risks from exploitation (Schindler et al. 2010). Guthrie (1994) observed substantial divergence among red salmon collected from 52 Southeast stocks, which is consistent with what is known about the accurate homing of red salmon. They identified three geographic groupings that differed genetically. These groups corresponded to the southern inside waters; the far southeastern islands—including Prince of Wales Island; and inside waters of northern and central Southeast.

CONSERVATION ISSUES

Habitat loss, habitat degradation, climate change, and overfishing are potential future threats for red salmon throughout Alaska. The status of sockeye populations in Southeast is currently stable, but Halupka et al. (2000) identify several potential risks:

- Increased demand for this commercially valuable species
- Over-exploitation of small, artificially enhanced, or weak stocks in mixed-stock fisheries
- Heavy and poorly monitored subsistence harvests
- Lack of adequate information about small populations
- Human-caused and natural habitat alterations.

The following considerations seem most important for conserving healthy populations of red salmon in Southeast:

- Recognize the importance of genetic diversity in red populations (Schindler et al. 2010).
- Ensure proper management of key sockeye watersheds, especially the highest ranked sockeye watershed within each biogeographic province
- Identify and protect individual lakes that support populations of red salmon and kokanee
- Identify and protect the few red salmon populations that do not use lakes as nursery areas.
- Prevent the transmission of diseases from hatchery-reared sockeye to wild stocks.

MAPPING METHODS

This map represents 537 streams and tributaries in 241 watersheds known to support the presence, spawning, or rearing of red salmon (Alaska Department of Fish and Game 2013). These totaled 1,415 mi (2,277 km), which is likely only 50% of the model-estimated anadromous stream length. In addition, this map represents the top watershed in each biogeographic province for red salmon, based upon work done in the 2007 Audubon-TNC Tongass Assessment. For more information on mapping methods see the Anadromous Fish Habitat methods section.

MAP DATA SOURCES

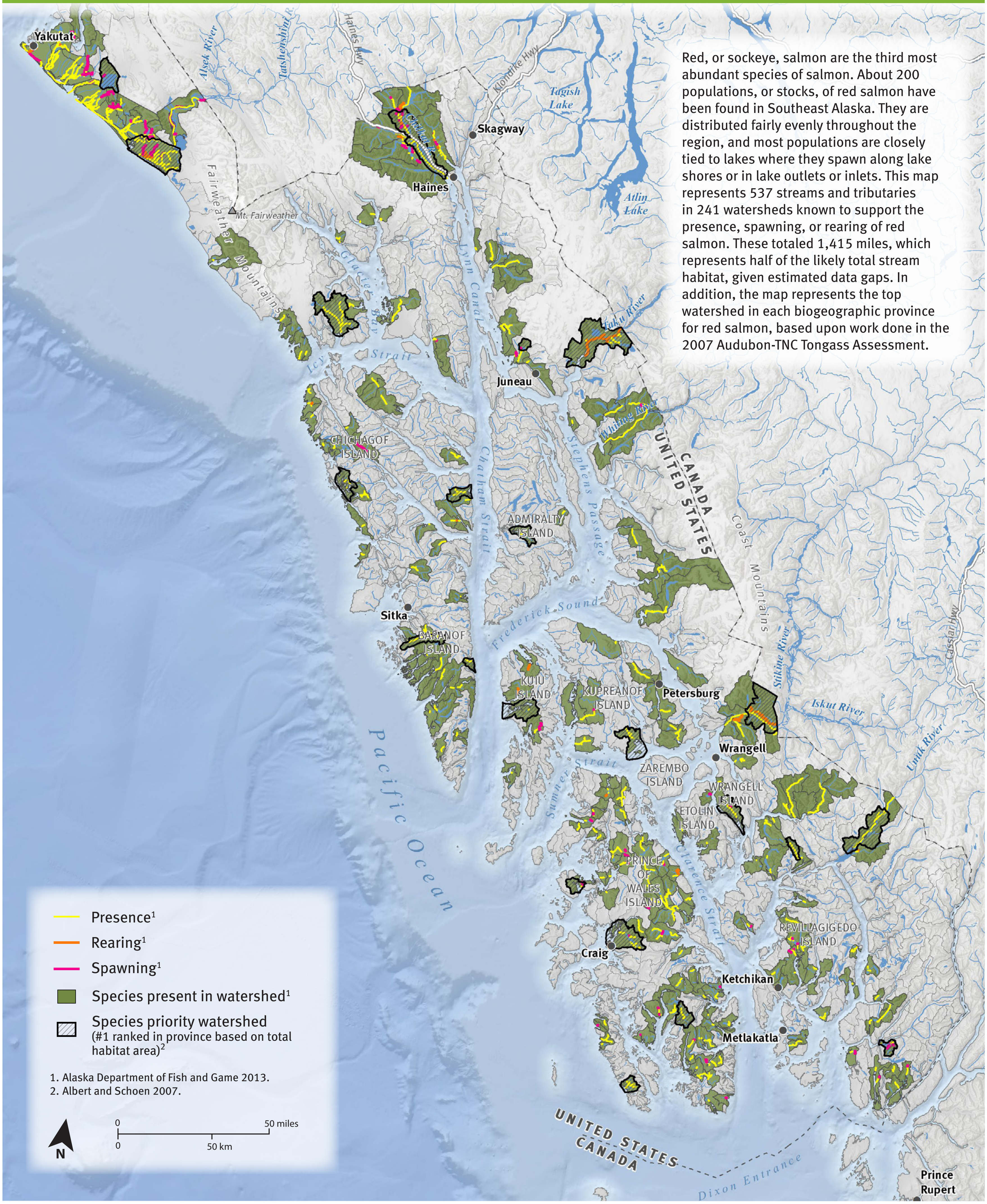
- Anadromous streams: Alaska Department of Fish and Game (2013)
- Top-ranked watersheds: Albert and Schoen (2007)

Red (Sockeye) Salmon

Audubon ALASKA

The Nature Conservancy

Red, or sockeye, salmon are the third most abundant species of salmon. About 200 populations, or stocks, of red salmon have been found in Southeast Alaska. They are distributed fairly evenly throughout the region, and most populations are closely tied to lakes where they spawn along lake shores or in lake outlets or inlets. This map represents 537 streams and tributaries in 241 watersheds known to support the presence, spawning, or rearing of red salmon. These totaled 1,415 miles, which represents half of the likely total stream habitat, given estimated data gaps. In addition, the map represents the top watershed in each biogeographic province for red salmon, based upon work done in the 2007 Audubon-TNC Tongass Assessment.



Map 4.4: Red (Sockeye) Salmon

MAP ON PAGE 81

SILVER (COHO) SALMON

Bob Armstrong and Marge Osborn
Revised by Kathy Wells

Ocean phase.

Spawning phase.

Alaska Department of Fish & Game

Silver, or coho salmon (*Oncorhynchus kisutch*), have dark metallic blue or geenish backs with silver sides and a light belly with small black spots on the back and upper lobe of the the tail while in the ocean. Their gumline in the lower jaw has lighter pigment than king salmon. They weigh in at an average 8 lbs (3.6 kg). The state angling record was a 26 lb (12 kg) fish caught in 1976 in Icy Strait.

Silver salmon are the third most abundant salmon species in Alaska (Heard 2002); however, their young seem to be in almost every accessible body of fresh water within their range. Adult silvers can leap vertically more than 6 ft (1.8 m) and migrate during fall floods when water levels are higher and most other species have ceased spawning.

At spawning, males have green backs and red on the sides while females are bronze to reddish on the sides. Juvenile coho have white on the leading edge of the dorsal and anal fins, and all fins may be tinted orange. Adults return to their stream of origin to spawn and die, usually at around three years old, although some males return as two-year-old spawners (known as "jacks"). Spawning males develop a strongly hooked snout and large teeth. Females prepare several redds (nests), where the eggs will remain for six to seven weeks until they hatch. Coho smolt migrate to sea usually after one to four years in freshwater streams and lakes. In streams, they prefer glides and pool habitats with cover and generally avoid fast riffles. Good winter habitat with deep pools, log jams, and undercut banks with woody debris are essential for silver salmon. In salt water, they gradually move offshore and travel within major current systems (Mecklenberg et al. 2002). About 85% return to their natal streams.

In Alaska, silver salmon occur in coastal salt water from Southeast to Point Hope on the Chukchi Sea, and in the Yukon River to the Alaska-Yukon border in streams and rivers of all sizes as well as in lakes and beaver ponds. In Southeast Alaska, silver salmon typically spawn in short, coastal streams. Some travel more than 1,200 mi (1,920 km) up the Yukon River (Armstrong 1996). In Southeast, silver salmon spawn in nearly 4,000 watercourses, including the headwaters of transboundary rivers in British Columbia and the Yukon Territory (Alaska Department of Fish and Game 1994). Silver salmon can be found in almost every body of water capable of supporting fish that is accessible from the sea.

Coho salmon typically spawn later than other species of salmon. They enter fresh water in September and October, and most spawning takes place in late October and November (Halupka et al. 2000). Therefore, these late-running stocks are available to feed other animals after fish from earlier stocks have disappeared (Armstrong 1996). Those few coho that do return to freshwater earlier, in late July and August, exhibit a smaller body size, presumably a trade off between missing the extra two months of marine feeding, but take advantage of higher water flow rates, which allows easier passage across barriers (Halupka et al. 2000). Good water quality is critical for rearing and sustaining silver salmon during the one-to-four-year period when they are in coastal streams. Road building and timber harvests exacerbate erosion, sedimentation, and poor water quality.

Adult coho salmon.

Alaska Department of Fish & Game

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In 2012, the total commercial, personal use, and subsistence harvest of coho was 2.1 million fish, well below the 10-year average harvest of 2.6 million. (Conrad and Davidson 2013), but in 2014 the commercial harvest alone was over 3.6 million (Alaska Department of Fish and Game 2015a). Although the ADFG currently identifies no stocks of concern, there are areas in previously logged watersheds that are impacted and losing their stream structure. In the North Pacific region, recent climate patterns which have both freshwater and marine effects are causing some fluctuations in runs. Lower coho production is occuring in more northern stream systems but there are strong returns in southern streams.

CONSERVATION ISSUES

Halupka et al. (2000) suggest three focal issues that seem most important for conserving healthy stocks of silver salmon in Southeast:

- Lack of sufficient information to make management decisions
- Adverse effects from hatchery fish through introduction of genes from hatchery stock to wild coho runs
- Silver salmon habitat degradation from clearcut logging and road building.

The single most important thing that can be done to protect silver salmon habitat is to establish and maintain adequate buffer strips along streams during clearcut logging and other types of development. Buffer strips are important to protect the riparian habitat that silver salmon need. However, buffers can be difficult to maintain since coho use most of the small tributaries and streams in the watersheds of Southeast. Coho may therefore especially benefit from watershed-scale protection, which addresses the protection of both major and lower-order waterways.

MAPPING METHODS

This map represents 4,971 streams and tributaries in 772 watersheds known to support the presence, spawning, or rearing of silver salmon (Alaska Department of Fish and Game 2013). These totaled 6,460 mi (10,396 km), which is likely only 50% of the model-estimated anadromous stream length. In addition, this map represents the top watershed in each biogeographic province for silver salmon, based upon work done in the 2007 Audubon-TNC Tongass Assessment. For more information on mapping methods see the Anadromous Fish Habitat methods section.

MAP DATA SOURCES

- Anadromous streams: Alaska Department of Fish and Game (2013)
- Top-ranked watersheds: Albert and Schoen (2007)

Upper Tenakee estuary, typical silver salmon rearing habitat.

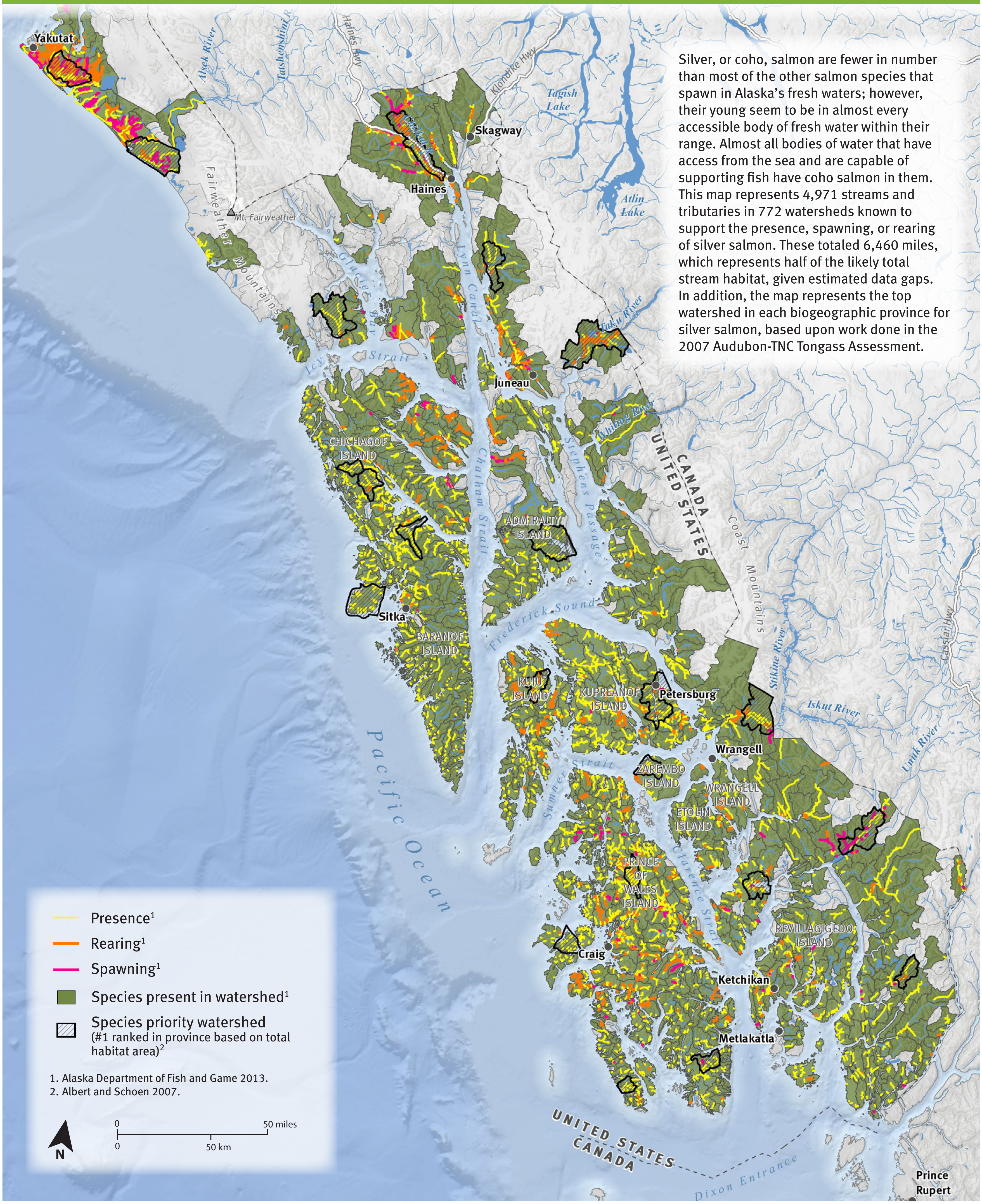
John Schoen

Audubon ALASKA

The Nature Conservancy

Silver (Coho) Salmon

Silver, or coho, salmon are fewer in number than most of the other salmon species that spawn in Alaska's fresh waters; however, their young seem to be in almost every accessible body of fresh water within their range. Almost all bodies of water that have access from the sea and are capable of supporting fish have coho salmon in them. This map represents 4,971 streams and tributaries in 772 watersheds known to support the presence, spawning, or rearing of silver salmon. These totaled 6,460 miles, which represents half of the likely total stream habitat, given estimated data gaps. In addition, the map represents the top watershed in each biogeographic province for silver salmon, based upon work done in the 2007 Audubon-TNC Tongass Assessment.



Map 4.5: Silver (Coho) Salmon

MAP ON PAGE 84

PINK (HUMPY) SALMON

Bob Armstrong and Marge Osborn
Revised by Kathy Wells

Ocean phase.

Spawning phase.

Alaska Department of Fish & Game

Pink salmon, also called humpback or humpy salmon (*Oncorhynchus gorbuscha*), are the most abundant Pacific salmon in North America and Asia (Heard 2002). They are found throughout the North Pacific including the Bering Sea, and in the southern Chukchi and Beaufort seas in the Arctic Ocean, as well as from the Lena River in Siberia to the south to Korea and Kyushu, Japan. Pink salmon are the smallest of the Pacific salmon and have the shortest and simplest life cycle.

Pink salmon are a bright greenish-blue on top with silvery sides when at sea. When they are ready to return to freshwater to spawn they develop large black spots on their back and tail. Males are brown to black above with a white belly, large hump, and a hooked jaw called a kype, and the females are olive green with dusky patches above and a light-colored belly. Adults weigh an average of 4 lbs (1.8 kg) and are 18 to 25 in (0.5 to 0.6 m) long. The state angling record was a 13 lb (6 kg) fish caught on the Moose River on the Kenai Peninsula in 1974.

Young pink salmon go to sea almost immediately after emerging from the gravel, so the condition and type of spawning beds are the most important requirements in their freshwater habitat (Heard 1991). Pink salmon prefer uniform gravel in both small and large streams when spawning and avoid quiet deep water, pools, areas with a slow current, and heavily silted or muddy streambeds. For a short time, pinks may be abundant in estuarine tidal channels, although pinks typically spend minimal time in estuaries.

Juvenile pinks use specific nursery areas for feeding in their first few weeks in salt water. The nurseries are located along irregular shorelines with complex eddies; ideally, the nursery is constantly replenished with zooplankton while offering shelter from wind-generated waves and strong tidal currents. Pink salmon feed on small crustaceans, zooplankton, squid, and small fish. Young pink salmon are also a food source for other fish. Examples are silver salmon (*O. kisutch*) smolts, Dolly Varden (*Salvelinus malma*), at least three species of sculpin (Mortensen et al. 2000), and cutthroat trout. (*O. clarki*)

After about 18 months at sea, pinks return to their natal streams to spawn. Their entire life cycle is completed in two years. Pink salmon are unusual in that they have even-year and odd-year populations that may differ considerably in numbers. These even- and odd-year runs are genetically separated with observable though minor morphological differences (Mecklenberg et al. 2002). Extreme northern and southern pink salmon stocks also can be distinguished by genetic differences (Gharrett and Smoker 1993).

The center of North American distribution of pink salmon is in Southeast Alaska where populations are numerous and often large. Pink salmon occupy more than 3,000 Southeast streams and tend to spawn in short coastal streams although some rivers in Southeast also have large numbers of pinks (Heard 1991, Noll et al. 2001). Positive trends in pink salmon escapements may be a result of factors such as

Earl Harper

Pink (humpy) salmon.

state efforts to rebuild pink salmon stocks, previous years of favorable ocean conditions, and the generally good quality of spawning habitat in Southeast (Halupka et al. 2000). Lower harvests can be attributed in some years to their two-year life cycle rather than declining populations.

In the early 1990s, the annual commercial catches of pink salmon exceeded 30 million fish (Hofmeister 1994). Commercial salmon harvests began in the late 1870s, catching mainly red salmon until the early 1900s, when pink salmon began to dominate. In the past 10 years, pink salmon comprised 74% of Southeast's total salmon harvest. Although the 2012 pink salmon harvest (21.3 million) was below the 10-year average, 2013 brought in a record harvest of 89.2 million (Conrad and Davidson 2013, Alaska Department of Fish and Game 2015a). During 2014 and 2015, commercial harvest averaged around 35 million fish. The economic contribution of this harvest is immense, as commercial pink salmon harvest in 2012 was valued at more than $101.1 million (Conrad and Davidson 2013).

For the past several years, the Southeast Alaska Coastal Monitoring project at the National Oceanic and Atmospheric Administration's (NOAA) Alaska Fisheries Science Center has measured juvenile pink salmon abundance at sea as part of their study of the marine ecosystem of Southeast Alaska and the adjacent Gulf of Alaska. As a result, scientists and managers have been able to improve their forecasts of pink salmon harvests (NOAA 2014); in Alaska, pink salmon populations are well managed and stable at this time (NOAA 2014).

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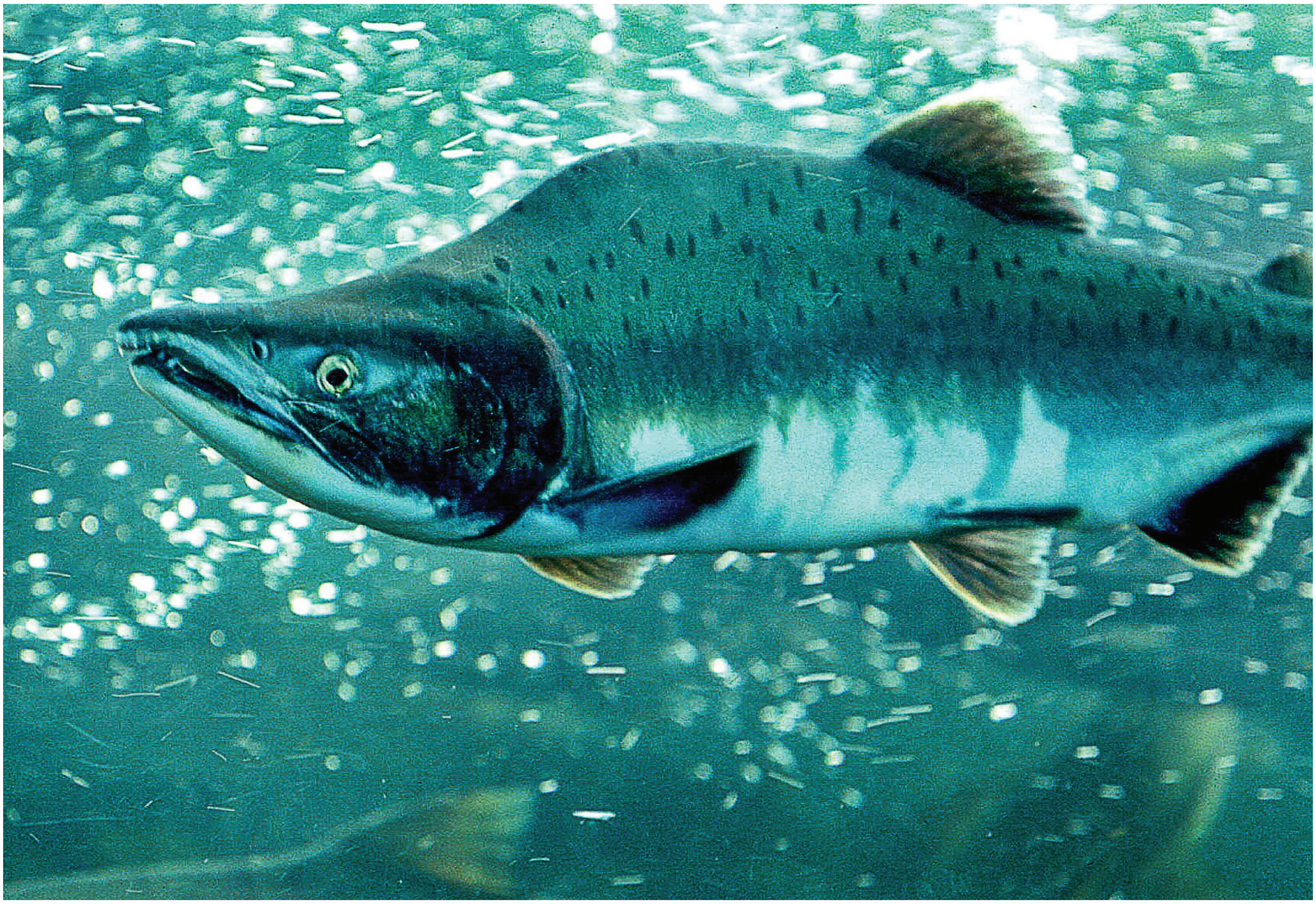


John Schoen

Adult male pink salmon in spawning condition in Southeast Alaska.

CONSERVATION ISSUES

Although pink salmon populations are currently stable, there are some factors to consider that could threaten pink runs in the future (Halupka et al. 2000):

- Sex-biased catches that lead to a predominance of males in escapements
- Pre-spawning mortality
- Egg and alevin mortality associated with changed hydrologic and thermal regimes of streams in logged watersheds
- An ongoing decline in pink salmon body size that could reduce productivity.

The five most important considerations for maintaining healthy pink salmon populations in Southeast are (Halupka et al. 2000):

- Protect spawning areas from disruption or pollution
- Maintain adequate buffer strips along streams during logging activity
- Identify and protect nearshore salt water nursery areas, where the young fish feed during their first weeks at sea
- Determine and monitor the effects of large-scale releases of hatchery fish on wild pink salmon populations
- Recognize the importance of size variation to population fitness, especially in wild stocks.

MAPPING METHODS

This map represents 3,199 streams and tributaries in 765 watersheds known to support the presence, spawning, or rearing of pink salmon (Alaska Department of Fish and Game 2013). These totaled 3,654 mi (5,881 km), which is likely only 50% of the model-estimated anadromous stream length. In addition, this map represents the top watershed in each biogeographic province for pink salmon, based upon work done in the 2007 Audubon-TNC Tongass Assessment. For more information on mapping methods see the Anadromous Fish Habitat methods section.

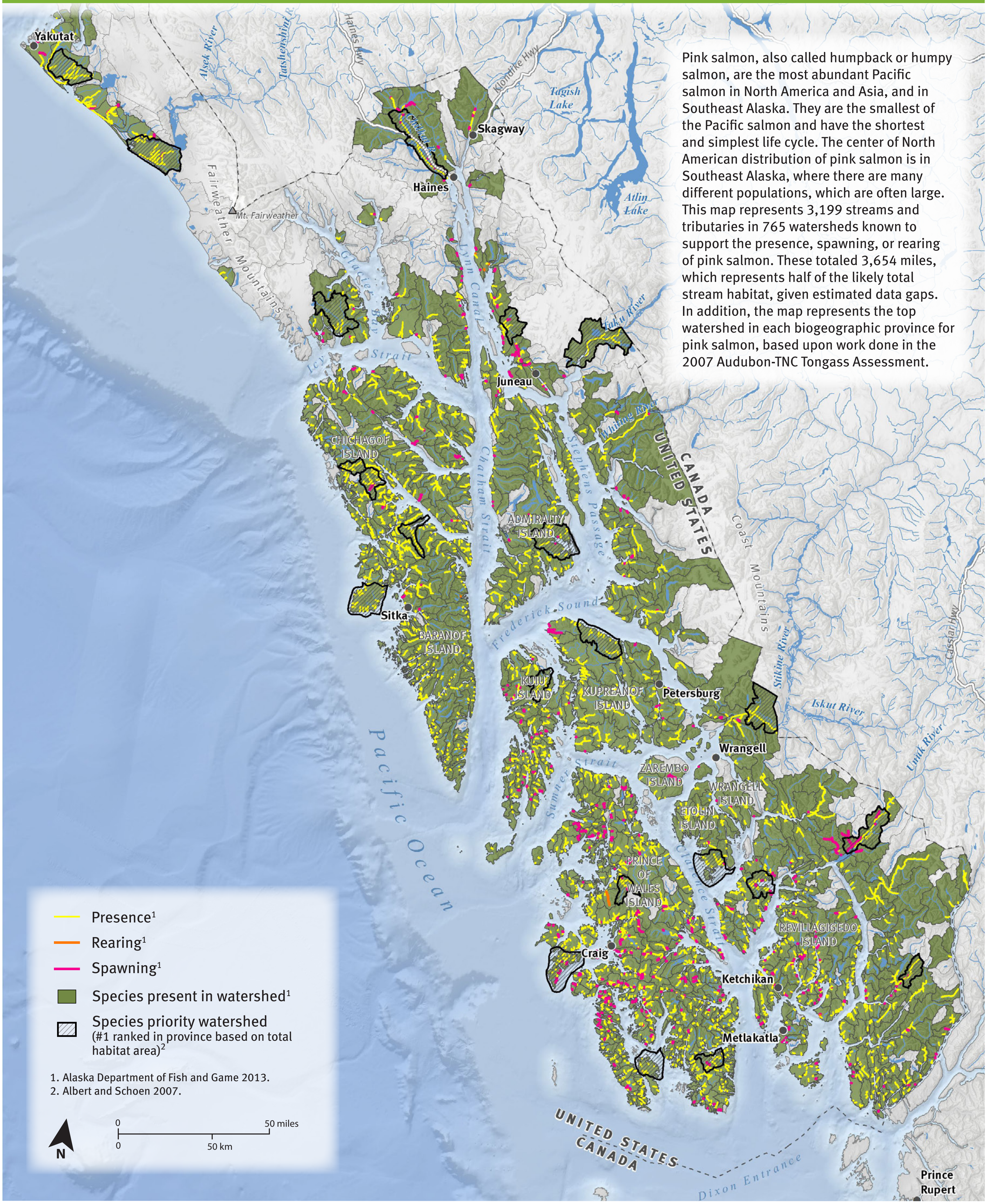
MAP DATA SOURCES

- Anadromous streams: Alaska Department of Fish and Game (2013)
- Top-ranked watersheds: Albert and Schoen (2007)

Pink (Humpy) Salmon

Audubon ALASKA The Nature Conservancy

Pink salmon, also called humpback or humpy salmon, are the most abundant Pacific salmon in North America and Asia, and in Southeast Alaska. They are the smallest of the Pacific salmon and have the shortest and simplest life cycle. The center of North American distribution of pink salmon is in Southeast Alaska, where there are many different populations, which are often large. This map represents 3,199 streams and tributaries in 765 watersheds known to support the presence, spawning, or rearing of pink salmon. These totaled 3,654 miles, which represents half of the likely total stream habitat, given estimated data gaps. In addition, the map represents the top watershed in each biogeographic province for pink salmon, based upon work done in the 2007 Audubon-TNC Tongass Assessment.



Map 4.6: Pink (Humpy) Salmon

MAP ON PAGE 87

CHUM (DOG) SALMON

Bob Armstrong and Marge Osborn
Revised by Kathy Wells

Ocean phase.

Spawning phase.

Alaska Department of Fish & Game

Chum, or dog salmon (*Oncorhynchus keta*), are the most widely distributed of all the Pacific salmon species. The name dog salmon comes from the sharp dog-like teeth of spawning males and because these fish have often been used to feed sled dogs. Females also have canine-like teeth, but less noticeable than those of males. While in the ocean, chum salmon are metallic bluish-green with silver streaks along the rays of their tail fin and some black speckling on the back. Spawning chum have a dark horizontal strip down their sides and calico coloration.

Chums are up to 3.6 ft (1.1 m) long and weigh on average 8 to 15 lbs (4 to 7 kg), although the state record chum salmon, caught in 1985 near Ketchikan, weighed 32 lbs (14.5 kg). Chum salmon are found throughout Alaska, but scarce north of Kotzebue Sound. They are also found along the east and west coasts of the North Pacific Ocean from northern California to Kyushu, Japan. Most of Alaska's chum salmon spend their life at sea in the eastern Chukchi and Bering seas and the Gulf of Alaska.

Chum salmon are abundant and widespread in Southeast. They reside in more than 3,000 streams and have two population types: those that spawn primarily in mainland or northern-island drainages are called summer populations; those that spawn in ground-water fed streams mostly in southern-island drainages are referred to as fall populations. Stocks of chum are more evenly and densely distributed in southern Southeast than in northern Southeast (Halupka et al. 2000).

Their large size and abundance make chum valuable food for a variety of animals and are important for subsistence harvest. Chum salmon are a traditional dried winter food for humans and dogs in Arctic, Western, and Interior Alaska.

Chum salmon return to spawn in their natal streams after three to five years at sea. They typically spawn in the lower 125 mi (200 km) of rivers and occasionally use the intertidal zone (Halupka et al. 2000). Chum salmon are considered poor jumpers compared to the rest of the Pacific salmon, and waterfalls can impede their travel to spawning grounds. Because chums are reluctant or unable to jump barriers, this limits their stream habitat (Hale 1985).

Young chum salmon head out to sea after spending several months close to shore in river and stream estuaries. While upriver, they feed on insect larvae and while in nearshore estuaries, chum salmon eat crustaceans, terrestrial insects, and young herring. In the ocean, they grow rapidly, feeding on copepods, tunicates, mollusks, and some fish. Landlocked or entirely freshwater chum salmon have not been found.

Chum salmon is a major food source for bears in Southeast because of their large size and abundance, and chum fry in fresh water are a valuable food for young silver salmon (*O. kisutch*), Dolly Varden (*Salvelinus malma*), cutthroat trout (*O. clarki*), rainbow trout (*O. mykiss*), sculpins, mergansers (*Mergus spp.*), and belted kingfishers (*Megaceryle alcyon*) (Armstrong 1996).

Bob Armstrong

In October and November, a late run of chum salmon provides food for a large gathering of Bald Eagles, numbering up to 3,500 at a time along the Chilkat River north of Haines.

MAP ON PAGE 87

There are a few rivers in Southeast where chum escapements have been large throughout the years. The Chilkat River has the largest run of chum, usually averaging more than 54,000 fish (Halupka et al. 2000). With an unusual and famous late run of chum salmon in October and November, the Chilkat provides food for a large gathering of Bald Eagles (Haliaeetus leucocephalus) numbering up to 3,500 at a time (Armstrong 1996). Reproductive success of Bald Eagles may be influenced by the late chum run (Hansen 1987). The State of Alaska acknowledged the importance of the area to eagles, salmon, and surrounding habitat, and established the 48,000 ac (19,425 ha) Alaska Chilkat Bald Eagle Preserve in 1982.

Escapements of more than 60,000 chum in some years have occurred at Fish Creek near Hyder (Armstrong 2004). The chum salmon from Fish Creek are thought to be the largest in North America, weighing more than 30 lbs (14 kg), and are designated as a sensitive species by the USFS because of their size (Armstrong 2004).

Most chum production comes from hatcheries in the region (Conrad and Gray 2014). Commercial harvest of Southeast Alaska salmon began in the late 1870s. Due largely to the establishment of the state hatchery program in 1971, the population of chum salmon has more than doubled since the 1980s. According to Conrad and Davidson (2013), “the recent 10-year average chum harvest is six times pre-hatchery production and the 2012 fishery was nearly eight times that amount.” In 2012, the total harvest of chums in commercial, personal use, and subsistence was 12.4 million.

Logging that results in increased sediment deposition into spawning streams could lead to the decline of chum stocks, and, accordingly, areas of intensive timber harvest have caused declines in chum salmon populations in the past. However, several other chum salmon stocks in Southeast declined without apparent cause (Halupka et al. 2000).

CONSERVATION ISSUES

Habitat degradation and loss from logging, climate change, overfishing, and competition from hatchery fish are potential future threats to chum salmon in Alaska. Considerations for conserving healthy populations of Southeast chum salmon are:

- Develop research to establish baseline data on habitat condition and spawner abundance to determine status of populations and changes in size of fish at maturity
- Employ conservative management practices for known threats such as logging and large-scale hatchery production activities.

MAPPING METHODS

This map represents 2,032 streams and tributaries in 658 watersheds known to support the presence, spawning, or rearing of chum salmon (Alaska Department of Fish and Game 2013). These totaled 3,047 mi (4,903 km), which is likely only 50% of the model-estimated anadromous stream length. In addition, this map represents the top watershed in each biogeographic province for chum salmon, based upon work done in the 2007 Audubon-TNC Tongass Assessment. For more information on mapping methods see the Anadromous Fish Habitat methods section.

MAP DATA SOURCES

- Anadromous streams: Alaska Department of Fish and Game (2013)
- Top-ranked watersheds: Albert and Schoen (2007)

John Schoen

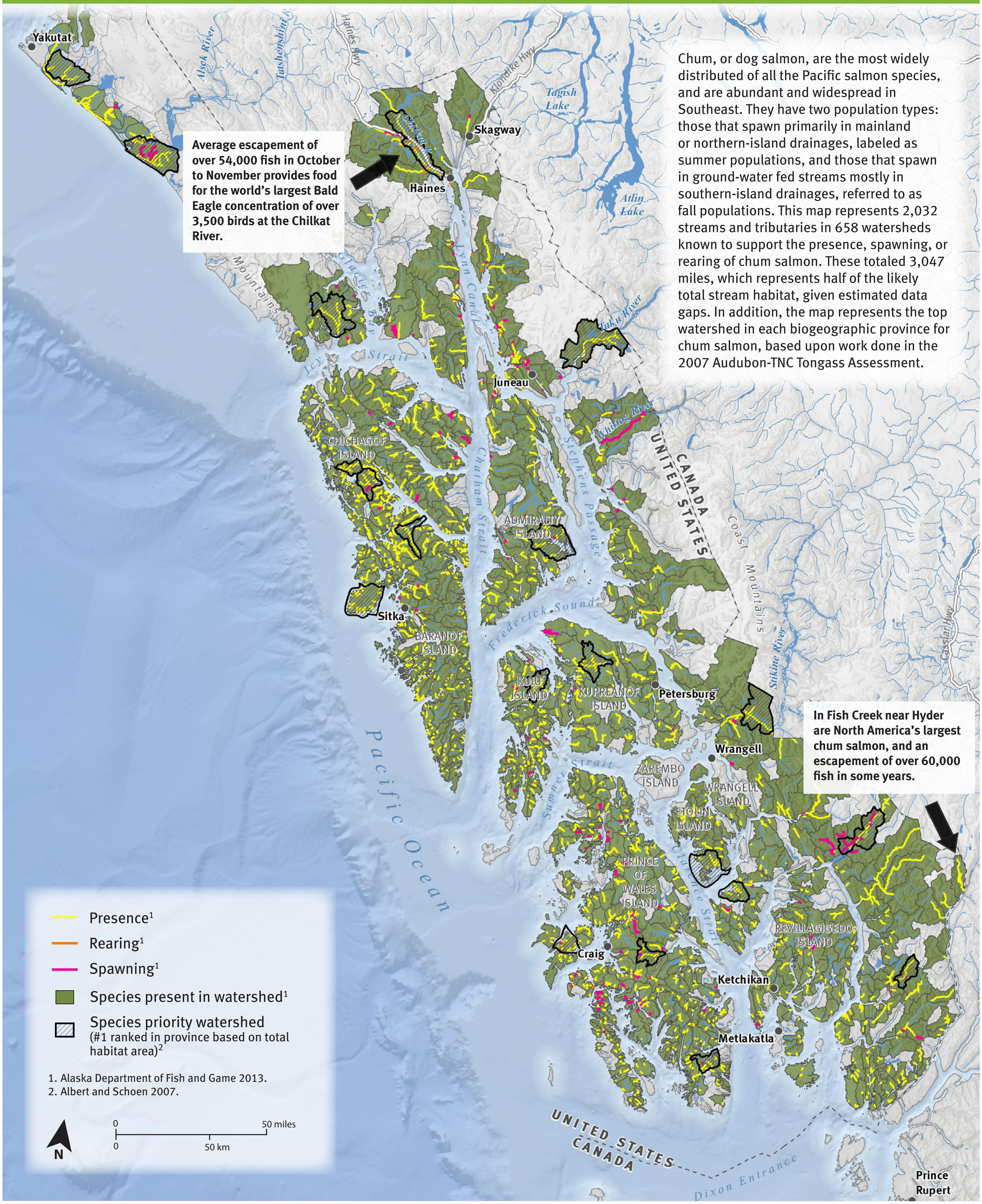
Spawning adult male chum salmon.

Audubon ALASKA

The Nature Conservancy

Chum (Dog) Salmon

Chum, or dog salmon, are the most widely distributed of all the Pacific salmon species, and are abundant and widespread in Southeast. They have two population types: those that spawn primarily in mainland or northern-island drainages, labeled as summer populations, and those that spawn in ground-water fed streams mostly in southern-island drainages, referred to as fall populations. This map represents 2,032 streams and tributaries in 658 watersheds known to support the presence, spawning, or rearing of chum salmon. These totaled 3,047 miles, which represents half of the likely total stream habitat, given estimated data gaps. In addition, the map represents the top watershed in each biogeographic province for chum salmon, based upon work done in the 2007 Audubon-TNC Tongass Assessment.



Map 4.7: Chum (Dog) Salmon

MAP ON PAGE 90

STEELHEAD TROUT

Beth Peluso

Steelhead (*Oncorhynchus mykiss*) are an anadromous variety of rainbow trout, spending part of their life in the ocean. Unlike their freshwater counterparts, they sport a silvery sheen while in the ocean. They range from Southern California to the Kamchatka Peninsula. In Alaska, steelhead inhabit coastal streams from Dixon Entrance up through the Gulf of Alaska to the Cold Bay area on the Alaska Peninsula (Harding and Coyle 2011). Although more than 500 streams in Southeast Alaska are known to support steelhead, this species occurs in much smaller numbers than Pacific salmon, with many streams in Southeast Alaska containing less than 200 fish. A few larger rivers may have runs of up to 1,000 fish. By far the most productive steelhead river in the Tongass is the Situk, near Yakutat, with runs ranging from 3,000 to more than 15,000 fish (Harding and Coyle 2011).

Depending on water temperature, the young steelhead hatch from between a few weeks to four months after the spawning season. The small fry hide in the safety of the gravel for a few more weeks, then emerge to feed (Alaska Department of Fish and Game 2014g). Steelhead spend their first several years (usually three) in their natal stream before traveling to the ocean. They feed in saltwater for two to three years, then return to freshwater to spawn (Harding and Coyle 2011). Steelhead mortality is high in the ocean—only about 5 to 10 out of 100 young steelheads that reach the ocean survive to spawn (Alaska Department of Fish and Game 2008a). The abundance of food in the ocean allows the fish to grow rapidly, sometimes up to an inch per month (Alaska Department of Fish and Game 2014g).

Unlike salmon, steelhead can spawn multiple years. Some fish may spawn as many as five times, although they may take a spawning season off to recover before returning (Alaska Department of Fish and Game 2014g). Adults that survive the spawning season are called “kelts.” Usually about one-third of a run may be returning fish. Males fight vigorously for females, resulting in a much lower survival rate, with 65 to 80% of returnees being female versus a 50/50 split between the sexes for first-time spawners (Harding and Coyle 2011).

The timing of steelhead runs varies widely, with runs occuring in spring (about mid-April through May), summer (July), and fall (September through November and sometimes through the rest of the winter). In Southeast Alaska, most steelhead runs occur in spring, with very few summer runs. About 36 fall runs occur in Southeast, but it is thought that spring runs in those areas are still higher. West of Yakutat, fall runs are dominant, including on the Kenai Peninsula, Kodiak Island, and Alaska Peninsula (Alaska Department of Fish and Game 2014g). Regardless of which run brings them back to freshwater, all steelhead spawn from mid-April through early June, when water temperatures reach 6° to 9°C (43° to 48°F) (Harding and Coyle 2011).

Steelhead are prized by sport anglers for their fighting abilities. They are also managed as a subsistence resource through a combination of federal and state management. The state angling record for steelhead/rainbow trout was a 42 lb (19 kg) fish caught in 1970 at Bell Island near Sitka.

Melanie Smith / Nick Jans

Releasing a steelhead trout.

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Steelhead populations decreased sharply enough in the mid-1980s that ADFG and the public became concerned about abundance. At the time, there was a limit of one steelhead per day, with a limit of two in possession. There were no size limits. Although there was not much information about the number of sport anglers fishing for steelhead, by the early 1990s the escapement (fish that pass upriver before harvest is allowed) levels on the Situk, the largest steelhead fishery, were declining alarmingly (Harding and Coyle 2011). In 1994, ADFG changed the regulations. Steelhead could no longer be sold commercially, although steelhead caught unintentionally (bycatch) could be kept for personal use as long as they were reported (Harding and Coyle 2011). As of 2014, state sportfishing regulations allow anglers to keep steelhead that are a minimum of 36 in (0.9 m) and have set the daily allowable bag limit to one steelhead, with an annual limit of two. Anglers are required to report the steelhead they keep (Alaska Department of Fish and Game 2014e). A series of international and national legal agreements banning the use of high seas drift nets with regard to salmon may have also played a role in recent steelhead population recovery (see also National Marine Fisheries Service 2013).

Until 1999, the State of Alaska handled the regulations for subsistence steelhead fisheries in Southeast Alaska. Except for an annual subsistence harvest of a maximum of 300 steelhead in the Situk and Ahrnklin rivers (near Yakutat), other subsistence harvest was limited to steelhead bycatch under subsistence salmon permits. In 2003, the Federal Subsistence Board expanded subsistence steelhead fishing substantially. Currently, there is some tension between state-managed and federally managed subsistence steelhead fisheries. The ADFG, which is responsible for managing state waters and sport fisheries, has tried (unsuccessfully) to oppose increases in harvest limits, citing concern for the impacts on steelhead population levels in Southeast Alaska (Harding and Coyle 2011).

CONSERVATION ISSUES

To avoid overharvest, conservation recommendations include continuation of harvest restrictions, monitoring of steelhead populations and the number of fish taken in all fisheries (including incidental take) for both federal and state subsistence fisheries. Based on limited stock information, Southeast Alaska steelhead stocks are relatively stable, having increased from 2003 to 2007 before decreasing more recently. Some systems have not rebounded from depressed abundance levels in the 1980s to 1990s (Alaska Department of Fish and Game 2014f).

NOAA

Steelhead trout.

Climate change may impact conditions in the North Pacific, which in turn affect survival of juvenile steelhead. The biggest threat to steelhead, as well as to rainbow trout, is habitat degradation (Alaska Department of Fish and Game 2014f) caused by urbanization, road building, hydroelectric power, logging, mining, and wetland loss.

MAPPING METHODS

This map represents 588 streams and tributaries in 320 watersheds known to support the presence, spawning, or rearing of steelhead (Alaska Department of Fish and Game 2013). These totaled 1,674 mi (2,694 km), which is likely only 50% of the model-estimated anadromous stream length. In addition, this map represents the top watershed in each biogeographic province for steelhead, based upon work done in the 2007 Audubon-TNC Tongass Assessment. For more information on mapping methods see the Anadromous Fish Habitat methods section.

MAP DATA SOURCES

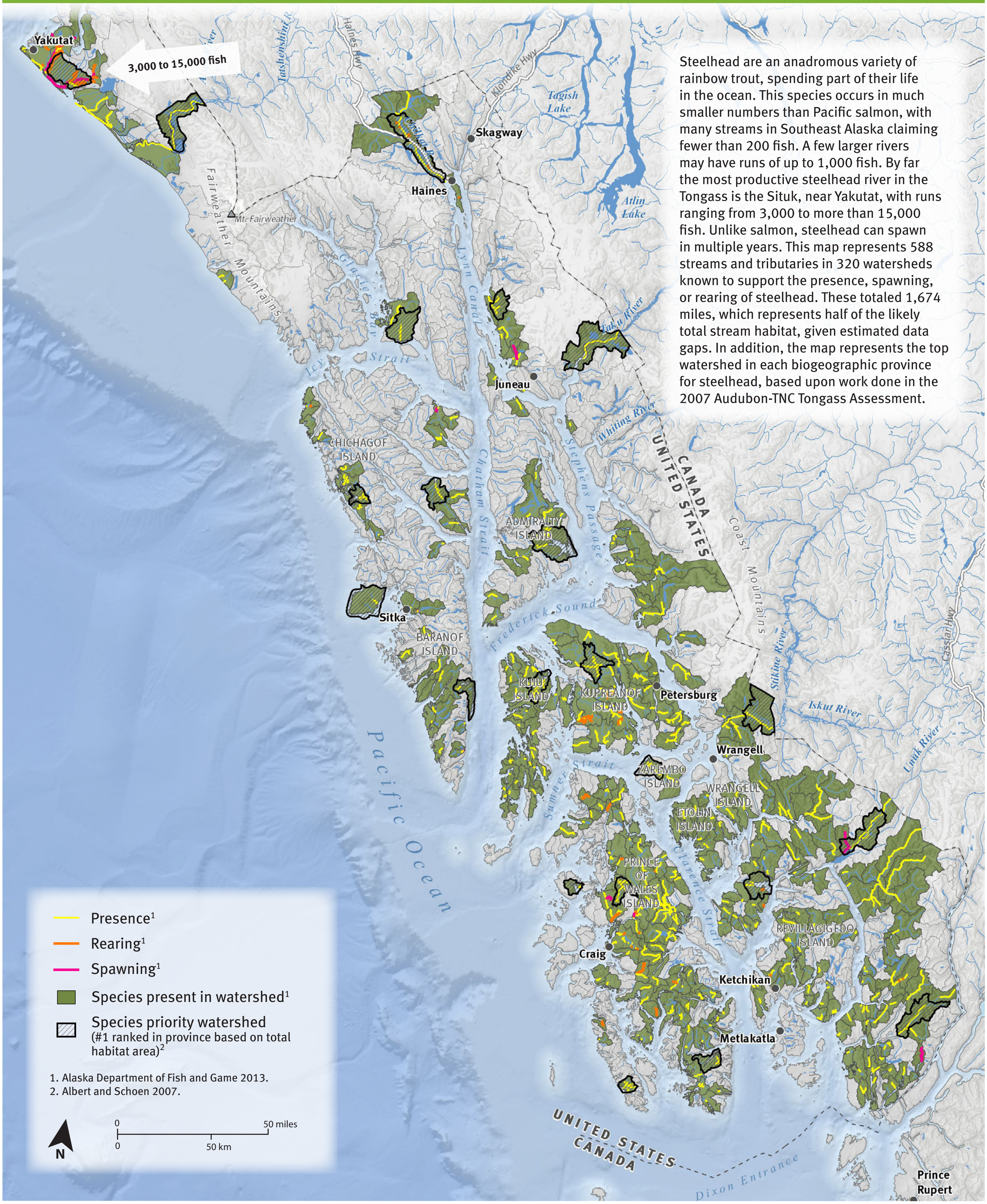
- Anadromous streams: Alaska Department of Fish and Game (2013)
- Top-ranked watersheds: Albert and Schoen (2007)

A Southeast Alaska fisherman reels in a steelhead trout.

Melanie Smith / Nick Jans

Steelhead Trout

Steelhead are an anadromous variety of rainbow trout, spending part of their life in the ocean. This species occurs in much smaller numbers than Pacific salmon, with many streams in Southeast Alaska claiming fewer than 200 fish. A few larger rivers may have runs of up to 1,000 fish. By far the most productive steelhead river in the Tongass is the Situk, near Yakutat, with runs ranging from 3,000 to more than 15,000 fish. Unlike salmon, steelhead can spawn in multiple years. This map represents 588 streams and tributaries in 320 watersheds known to support the presence, spawning, or rearing of steelhead. These totaled 1,674 miles, which represents half of the likely total stream habitat, given estimated data gaps. In addition, the map represents the top watershed in each biogeographic province for steelhead, based upon work done in the 2007 Audubon-TNC Tongass Assessment.



Map 4.8: Steelhead Trout

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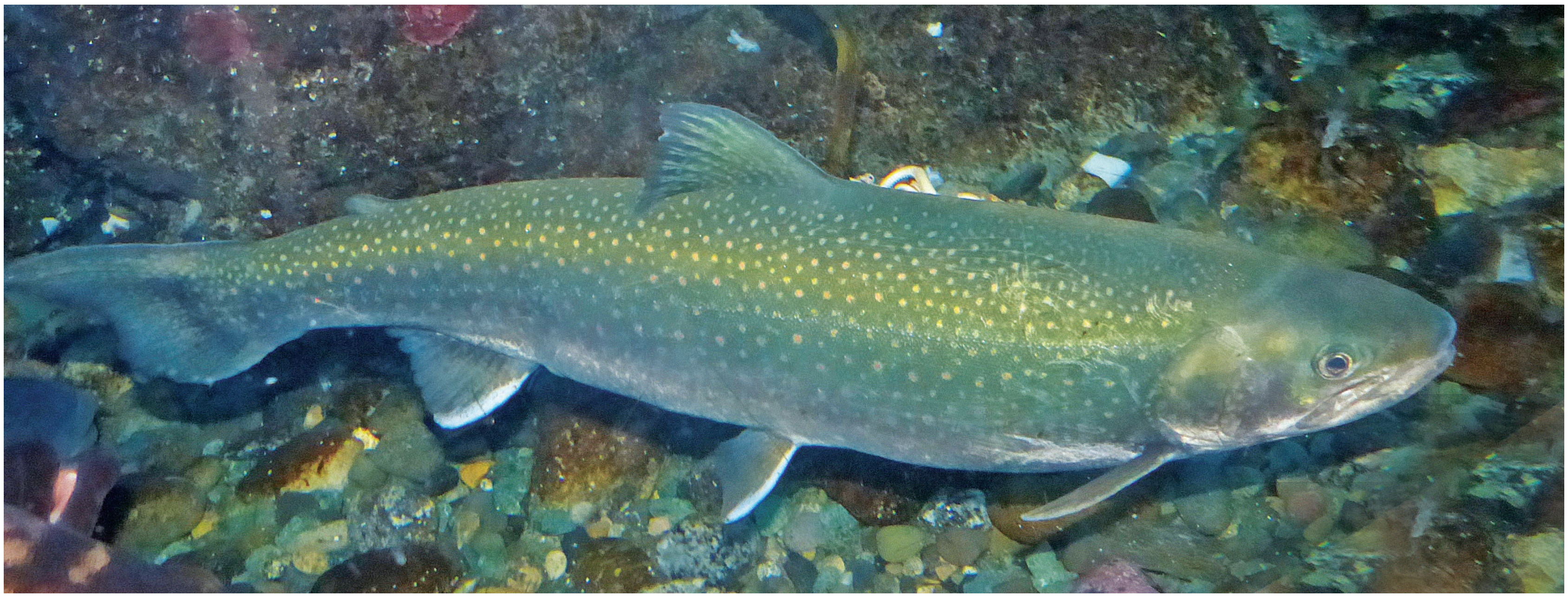
DOLLY VARDEN

Bob Armstrong and Marge Osborn
Revised by Kathy Wells



Adult Dolly Varden.

Dolly Varden (*Salvelinus malma*), a type of char, are found from northern Washington to the Mackenzie River in Arctic Canada, and from Eastern Russia to Japan and Korea. Dolly Varden are widely distributed in western North America and are particularly abundant throughout Southeast Alaska.

This species is prized by some anglers as a sport fish and for eating. Dolly Varden are a traditional subsistence food in Southeast Alaska. The sea-run Dolly Varden has an overall silvery appearance with olive-green to brown on its dorsal surface and numerous red to orange spots on its sides. At maturity the lower body of the breeding male turns brilliant red. The name Dolly Varden originated from a character in Charles Dickens' novel, *Barnaby Rudge*, noted for her vividly colored dresses (Alaska Department of Fish and Game 2008a).

The taxonomic status of Dolly Varden has been debated for years. Originally identified by Johann Walbaum in 1792 from specimens found in Kamchatka, Russia, the Dolly Varden has been variously considered a valid, independent species, a subspecies of the arctic char (*Salvelinus alpinus*), or the same species as arctic char (Armstrong and Morrow 1980). Today, there are two subspecies recognized in Alaska—a northern and a southern form. Only the southern Dolly Varden is found throughout Southeast. The two forms differ both genetically (the southern fish have 82 chromosomes, four more than the northern variety) and morphologically (the southern fish have fewer vertebrae than the northern fish). Both varieties have ocean-run and resident freshwater types. The southern variety lives thoughout Southeast Alaska up through the Gulf of Alaska and to the southern side of the Alaska Peninsula, Kodiak Island, and the Aleutian Islands (Alaska Department of Fish and Game 2014c).

The Dolly Varden in Southeast Alaska may grow up to 10 lbs (4.5 kg) and about 28 in (71 cm) long. They seldom live more than eight to ten years and spend their first five to six years maturing. In Southeast, Dolly Varden can be found in a wide variety of habitats, including lakes of all sizes with and without access to the sea; tiny, isolated ponds; large rivers; small streams; sections of water both above and below barriers to anadromous fish; and even intermittent rivulets (Armstrong 1991). From at least September to May, Dolly Varden can be found in glacial lakes that fish can access from the sea, and glacial lake outlets are often used for rearing young. Some Dolly Varden are present in salt water almost year-round, although populations are highest during late spring and early summer before they begin to enter streams. Dolly Varden inhabit both offshore and inshore saltwater areas but prefer inshore.

Resident Dolly Varden, which live their entire lives in streams or small lakes and ponds, are small. They seldom grow longer than 10 in (26 cm). Those that inhabit larger lakes often grow to 12 in (30 cm) or more, but they still generally weigh less than 1 lb (0.5 kg). Sea-run Dolly Varden, fish that spend part of their lives in salt water, usually grow from 15 to 22 in (38 to 56 cm) long and weigh 1 to 3 lb (0.5 to 1.4 kg). Occasionally, large fish weighing more than 10 lb (5 kg) are hauled from large mainland rivers such as the Taku River near Juneau. The state Dolly Varden/arctic char angling record was a 27 lb (12 kg) fish caught in 2002 on the Wulik River at Kivalina, Alaska.

Unlike salmon, Dolly Varden can spawn multiple seasons, although they do not often return more than three times (Alaska Department of Fish and Game 2014c). It is thought that less than half of the fish survive to spawn a second season. They spawn from September and November, returning to the headwater streams or sometimes larger stretches of river where they hatched. A single female can lay up to 6,000 eggs in the gravel bed (redd) she prepares (Alaska Department of Fish and Game 2014c). Dolly Varden are selective when choosing sites to spawn, concentrating in areas near stream headwaters rather than scattering in pairs throughout a stream.

Rearing areas are also especially important for the young of sea-run Dolly Varden. The eggs hatch within four to five months. The hatchlings hide in the gravel for another month, living off the remaining yolk sack. The alevins emerge from the gravel in May, and juveniles remain on the stream for two to four years (Armstrong 1970). During this period, before fish leave the streams as smolt, they appear to use a variety of habitats and can be found in most accessible portions of the streams (Armstrong and Morrow 1980). Young-of-the-year are found in small pools and in eddies along stream banks where the flow is reduced (Blackett 1968). In early summer, they can also be found in very small rivulets with depths of 0.5 to 1.5 in (1 to 3 cm) and widths less than 3 ft (1 m) (Armstrong and Elliott 1972).

At first, juvenile Dolly Varden stay close to the shore, feeding along the bottom on insects and larvae. After their first year of life, the juveniles use a variety of habitats ranging from still to moving water, gravel to muddy substrate, and dense vegetation to open water with no vegetation (Heiser 1966). Favored habitats appear to be undercut bank areas along the stream (Armstrong and Elliott 1972). As they grow bigger, they shift to deeper waters where they add small fish, salmon eggs, and crustaceans to their diet (Alaska Department of Fish and Game 2014c).

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After several years, the young fish reach a length of about 5 in (13 cm) and the next stage of their lives begin. Their bodies change color to silver and their physiology changes to adapt to life in saltwater. Dollies mainly head out to sea in May or June, although a portion of them move in September or October (Alaska Department of Fish and Game 2008a). They feed voraciously over the summer, growing rapidly, then return to freshwater to spawn for the first time in the fall (Alaska Department of Fish and Game 2014c).

In Southeast Alaska, after spawning, adult Dolly Varden migrate to freshwater lakes where they overwinter, perhaps from as far as 100 mi (160 km) away (Armstrong and Morrow 1980). Their migrations are more complicated than those of salmon. The Dollies often go out to sea to feed in the summer, traveling along the coastline, occasionally moving up into freshwater to feed. If a Dolly Varden hatched in a stream system with a lake, it returns to that lake for the winter. If not, it seeks out a lake where it can overwinter.

In the spring, as the Dollies head to the sea, they opportunistically feed on salmon fry, mainly pinks. Once in the ocean, they range from coastal waters to open ocean, eating amphipods, juvenile salmon, sand lance, and other small fish. Dolly Varden may also follow salmon into rivers to feed on salmon eggs (Alaska Department of Fish and Game 2008a;2014c). Generally, they seem to scavenge drifting salmon eggs that would not hatch (Alaska Department of Fish and Game 2014c).

Large amounts of Dolly Varden were historically caught as bycatch from commercial salmon harvest, sometimes as much as 190,000 lb (86,000 kg), but the amount has dropped in recent years (Alaska Department of Fish and Game 2014c).

The role of Dolly Varden in the food web of Southeast has not been well studied. The species may be important in the diet of Bald Eagles (*Haliaeetus leucocephalus*), river otters (*Lutra canadensis*), black and brown bears (*Ursus americanus* and *Ursus arctos*, respectively), mink (*Neovison vison*), harbor seals (*Phoca vitulina*), and Steller sea lions (*Eumetopias jubatas*). In addition, belted kingfishers (*Megaceryle alcyon*) have been observed bringing young Dolly Varden to their nestlings. Young sea-run Dolly Varden in coastal streams during the first two to four years of their lives are consumed by American dippers (*Cinclus mexicanus*), mergansers (*Mergus spp.*), and great blue herons (*Ardea herodias*).

For nearly two decades, from 1921 to 1939, there was a bounty of up to five cents for a Dolly tail. Because they feed on juvenile fish of other species, the idea was to boost salmon populations by decimating the Dolly Varden. People submitted nearly 6 million tails. The program halted abruptly when closer examination revealed that of the 20,000 tails submitted in 1939, more than half were actually from silver salmon (Alaska Department of Fish and Game 2008a;2014c). Research has since shown that the Dollies are not avid enough predators to affect salmon populations (Alaska Department of Fish and Game 2008a).

To the contrary, Dolly Varden may benefit salmon because in lakes they feed heavily on freshwater snails (Armstrong 1965), which are intermediate hosts of a parasite that infects the eyes of silver and red salmon young and eventually causes blindness. By controlling the population of these snails, the Dolly Varden may help reduce prevalance of the parasite and its impact on juvenile salmon (Armstrong 1991). Another possible benefit is that Dolly Varden compete for space with cutthroat trout in lakes (Andrusak and Northcote 1971). Because cutthroat trout prey heavily on sockeye in lakes (Armstrong 1971), this competition for space may play a role in reducing overall predation of the salmon young in lakes.

CONSERVATION ISSUES

Threats to local populations include urbanization, barriers to migration, fishing, mining, timber harvest, and climate change (Alaska Department of Fish and Game 2014c).

Because Dolly Varden are not as abundant as they appear to be in Southeast, they could be more easily overharvested than other species of fish. Their habit of moving from one freshwater system to another means that many of the fish seen in one stream at one time could be the same fish seen in another stream. Successful management of Dolly Varden depends on recognition of their complex migration patterns (Armstrong 1984).

Bob Armstrong

Young Dolly Varden mixed with cutthroat trout and silver salmon.

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Overharvest by sport fishermen has caused severe declines of Dolly Varden in some areas of Alaska. Over the last several decades, ADFG has instituted and removed various local limits on sportfishing, mainly in the Juneau area and Chilkoot River drainage. Based on strong declines in sportfish catch, in 1978 the allowable limit dropped to five fish per day in the Juneau area. In 1980, the agency lowered the limit to only two per day. These limits were reinforced by seasonal closures in freshwater from September through May and in nearshore ocean waters in April and May. By 1983, most of the seasonal limits were removed, except for a few specific locations. Mendenhall and Auke lakes are catch-and-release only. More recently, limits in the Chilkoot River were dropped from ten fish to two fish in 1994; further research merited raising the limit to four fish in 2003.

Although its effects have not been well studied, environmental degradation certainly has reduced the numbers of Dolly Varden in Southeast. Clearcut logging, stream channelization, and urban development have all caused obvious damage to streams where Dolly Varden live. Fortunately, Dolly Varden are widespread in the region and occur in almost all fresh waters capable of supporting fish; therefore, the current risk of widespread loss of populations is low.

Because numerous populations migrate to a relatively few lakes and larger rivers for the winter, harm to these overwintering areas could result in extensive loss of Dolly Varden. Identification and protection of Dolly Varden overwintering lakes and rivers is important to maintaining their populations in Southeast. Identification of many of these areas could be easy if one considers that any lake with access to and from the sea would be important to Dolly Varden. Lake Eva and Windfall Lake are two such major overwintering lakes which are identified for protection by the T77 proposal (see the Human Uses chapter).

Further study could reveal populations of Dolly Varden that might warrant special consideration. In particular, special consideration may be warranted for populations in isolated ponds or springs and some stream-resident populations that have been isolated from other populations for decades. Also, sea-run Dolly Varden exhibit strong homing tendencies for spawning, and some of these populations may reveal characteristics quite different from those of other sea-run populations.

Three considerations seem most important for conserving healthy populations of Dolly Varden in Southeast:

- Recognizing the complex nature of Dolly Varden migration patterns in management decisions
- Realizing that land-use activities that harm one stream, or overharvest in a single stream, could affect Dolly Varden populations in other systems
- Paying particular attention to the protection and preservation of major Dolly Varden wintering areas.

MAPPING METHODS

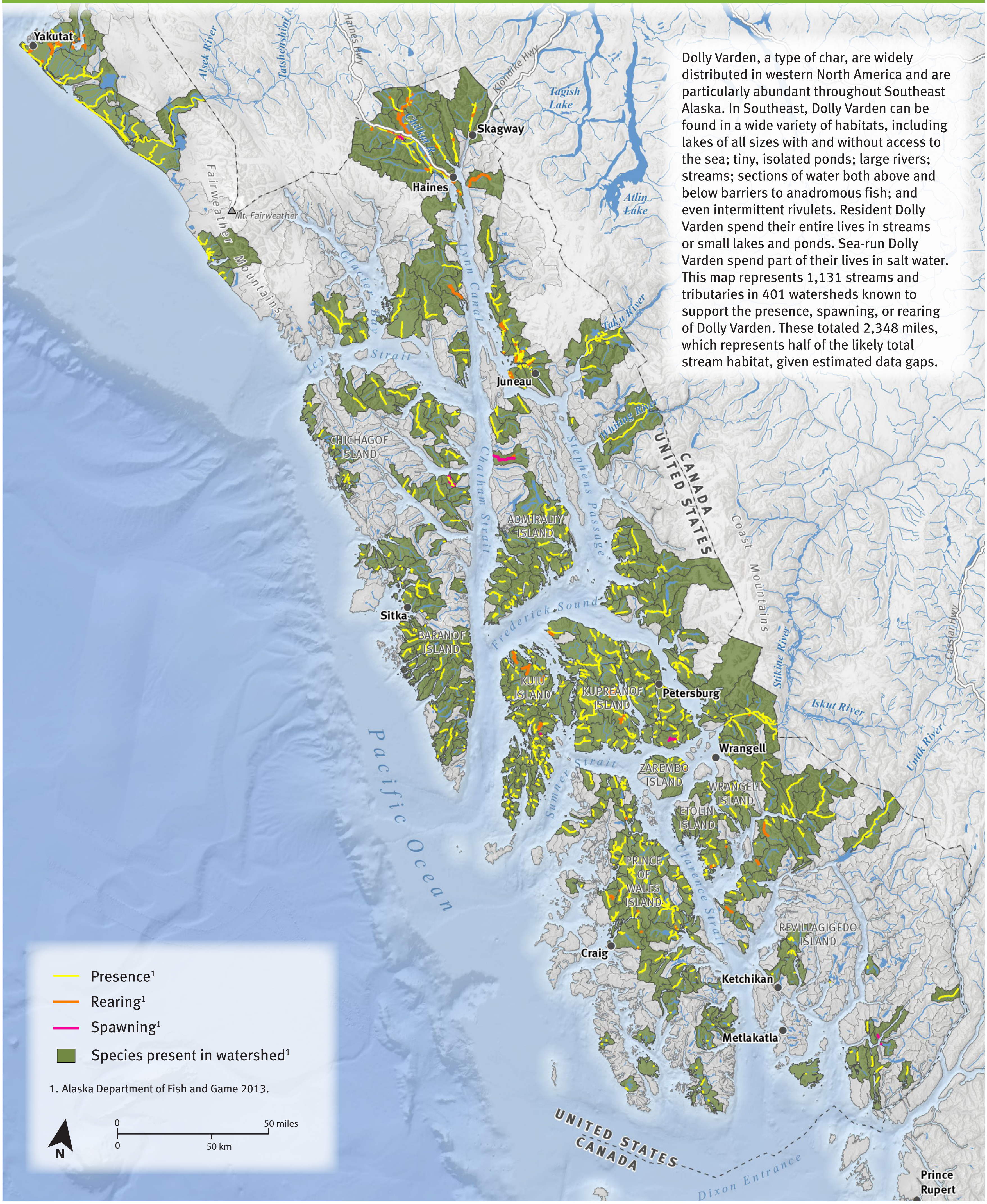
This map represents 1,131 streams and tributaries in 401 watersheds known to support the presence, spawning, or rearing of Dolly Varden (Alaska Department of Fish and Game 2013). These totaled 2,348 mi (3,779 km), which is likely only 50% of the model-estimated anadromous stream length (see Anadromous Fish Habitat methods section).

MAP DATA SOURCES

- Anadromous streams: Alaska Department of Fish and Game (2013)

Dolly Varden

Dolly Varden, a type of char, are widely distributed in western North America and are particularly abundant throughout Southeast Alaska. In Southeast, Dolly Varden can be found in a wide variety of habitats, including lakes of all sizes with and without access to the sea; tiny, isolated ponds; large rivers; streams; sections of water both above and below barriers to anadromous fish; and even intermittent rivulets. Resident Dolly Varden spend their entire lives in streams or small lakes and ponds. Sea-run Dolly Varden spend part of their lives in salt water. This map represents 1,131 streams and tributaries in 401 watersheds known to support the presence, spawning, or rearing of Dolly Varden. These totaled 2,348 miles, which represents half of the likely total stream habitat, given estimated data gaps.



Map 4.9: Dolly Varden

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COASTAL CUTTHROAT TROUT

Bob Armstrong and Marge Osborn
Revised by Nils Warnock and Ben Sullender

There are 14 subspecies of cutthroat trout (*Oncorhynchus clarkii*) in North America. Coastal cutthroat trout (*O. clarkii clarkii*) occur in coastal streams and lakes from Prince William Sound in Alaska to the Eel River in California (Behnke 1979). These cutthroat trout are highly prized sport fish that can be found in streams and lakes throughout Southeast Alaska, where some populations are anadromous (sea-run) and others are permanent residents in freshwater (Bangs and Harding 2008, Harding 2013). Sea-run cutthroat are generally uniform silver with numerous black spots and lake residents can be golden-yellow with numerous black spots. Sea-run cutthroat can weigh from 1 to 2 lb (0.5 to 0.9 kg) and some lake residents weigh up to 6 lb (2.7 kg). These fish can live to be over 15 years old (Roger Harding, ADFG, personal communication 2015). Usually cutthroat trout have a distinct red or orange streak on the underside of the lower jaw (hence its name), although the streak may be absent or inconspicuous in fish in the sea or fresh from the sea. A cutthroat is best distinguished from a rainbow trout by the presence of a patch of small teeth behind its tongue between the gills (Mecklenburg et al. 2002).

Southeast has many streams, rivers, and lakes with good cutthroat habitat (Bangs and Harding 2008, Harding and Coyle 2011). More than 200 lakes and associated stream systems are home to the resident coastal cutthroat trout and nearly 100 streams are known to contain runs of anadromous cutthroat trout (Armstrong 1996). Small streams harboring resident populations of cutthroat trout are widespread, although the exact number of these systems is unknown.

Sea-run cutthroat are usually associated with lakes and a few larger, slow-moving rivers. Most of these anadromous populations are found south of Frederick Sound in Southeast (Armstrong 1996). Each year, the fish go to sea in May and June and return to freshwater in September and October.

Resident cutthroat trout are found in most landlocked lakes at lower elevations in Southeast. Large, trophy-sized cutthroat may be found in a few of these systems. Some lake-resident cutthroat trout feed on small landlocked sockeye kokanee salmon (*Oncorhynchus nerka*). Resident cutthroat typically live longer than sea-run individuals (Alaska Department of Fish and Game 2008b). Other resident cutthroat have adapted to live in small streams by spawning at an early age and growing to only a few inches long.

Cutthroat trout are of particular conservation concern, as abundance in Southeast is relatively low (Harding and Coyle 2011); they can be vulnerable to depletion through overharvest, and they have a wide range of sizes and ages at maturity, making management difficult (Harding 2013). To compound these factors, cutthroat are very sensitive to habitat alteration, as indicated by the major declines in *O. clarkii* populations in the Lower 48 states as a result of anthropogenic activities (Hilderbrand 2003, Colyer et al. 2005).

Smaller streams in Southeast may be especially important as spawning and rearing areas for cutthroat (Bryant et al. 2009). In a study of the coastal cutthroat trout in British Columbia, Hartman and Gill (1968) found that large streams, with drainage areas of more than 50 mi^2 (130 km^2), were occupied predominantly by steelhead/rainbow trout. Small streams, with drainage areas of less than 5 mi^2 (13 km^2), were occupied predominantly by cutthroat. Where both species occurred, the predominant species was cutthroat in the small tributaries and headwaters and steelhead in the lower reaches of the main stream (see also Johnston 1981).

Anadromous cutthroat trout may also utilize different watersheds to provide spawning, feeding, and overwintering habitat. Cutthroat tagged at Petersburg Creek were recaptured by sport fishers in a total of 14 streams in the Petersburg area from 0.5 to 44 mi (0.8 to 71 km) away from the initial capture site (Jones 1977). Tagged cutthroat tended to follow the shorelines on their migrations and were reluctant to cross large open bodies of water. This behavior could mean that spawning fish home to specific tributaries and non-maturing fish do not always return to a home stream on a feeding run or when seeking overwintering habitat (Johnston 1981).

Numbers of cutthroat trout have been counted or estimated in various systems across Southeast known as good for cutthroat fishing (Bangs and Harding 2008, Harding and Coyle 2011).

There are only two populations of anadromous cutthroat in Southeast that have been adequately sampled for trend data, both using streams near urbanized areas around Juneau. At Auke and Jordan creeks, numbers of sea-run trout have declined (Bangs and Harding 2008, Harding and Coyle 2011), likely because of urbanization resulting in reduced water and habitat quality (e.g. see Host and Neal 2004).

Perhaps the largest population of lake-bound cutthroat in Southeast occurs on Admiralty Island at Hasselborg Lake with an estimated 10,839 trout in 1991 (Laker 1994, cited in Bangs and Harding 2008). At Turner Lake near the Taku River, ADFG estimated a population of 1,526 resident cutthroat trout. Other lakes checked for resident cutthroat in Southeast included Jims Lake (2,816), Mirror Lake (5,633), Harvey Lake

Cutthroat trout.

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John Schoen

Honker Divide on Prince of Wales Island is a popular fishing area for coastal cutthroat trout and other anadromous species.

(669), and Virginia Lake (5,631) (Jones et al. 1990, see more recent data in Bangs and Harding 2008, Harding and Coyle 2011). Several of these estimates reflect the number of cutthroat within the 4 to 16 in (100 to 400 mm) size range, the size sampled by the gear used.

Trend data on populations of freshwater cutthroat in Southeast are known for two lakes: Baranof and Auke lakes, both of which appear to be stable but highly variable (Bangs and Harding 2008). Abundance of stream-resident cutthroat is largely unknown but expected to be quite small.

Because of concerns about overfishing, state management of cutthroat in Southeast changed significantly in 1994 when the ADFG published new regulations with more restrictive bait, bag, and size limits, depending on whether areas were determined to be high or low use by anglers (Harding and Coyle 2011, Harding 2013). In most areas of Southeast, sport fishers have a bag limit of two trout (Bangs and Harding 2008).

Surveyed anglers said that the opportunity to catch trophy-size cutthroat trout is important to them, and ADFG's research shows that cutthroat do not reach trophy size for about 12 years (Alaska Department of Fish and Game 2012b). Thirteen lakes in Southeast have been designated as trophy cutthroat lakes and are under special management designations designed to maintain large cutthroat trout. The sport fish regulations covering these waters allow one cutthroat per day and in possession, 25 in (64 cm) or more. One lake, Turner, allows only catch-and-release fishing for cutthroat trout. The trophy cutthroat lakes are Distin, Hasselborg, and Jims lakes, as well as Lake Guerin—all on Admiralty Island; Turner Lake on the mainland near the Taku River; Eagle Lake off West Behm Canal; and Ella, Humpback, Manzanita, Orchard, Patching, Wilson, and Reflection lakes in the Ketchikan area. These lakes are known to have produced cutthroat trout greater than 3 lbs (1.4 kg) or 20 in (51 cm) (Alaska Department of Fish and Game 2012b).

Florence Lake and Hasselborg Lake are two of the most popular lakes in Southeast for fly-in fishing for cutthroat trout. Access to both lakes is mostly by small plane from Juneau or Sitka. Florence and Hasselborg lakes are designated "High Quality" or "Important" watersheds by both the ADFG and the USFS. The number of reported visitor days to these lakes nearly doubled during a 15-year period to more than 4,000 at Florence Lake and 3,000 at Hasselborg Lake as of 1991 (Jones et al. 1992). Following clearcutting at Florence Lake, the number of anglers declined (Harding 2013).

In the Petersburg/Wrangell area, only Eagle Lake off West Behm Canal has been designated a trophy cutthroat trout lake. In the Ketchikan area, the trophy cutthroat trout lakes are Ella, Humpback, Manzanita, Orchard, Patching, Wilson, and Reflection lakes.

In 2000, the Federal Subsistence Board liberalized the subsistence take of cutthroat and rainbow trout to a daily bag limit of six trout, with some exceptions (Bangs and Harding 2008). Statewide, numbers of cutthroat caught by sport fishers vary among years (1993 to 2003), from 30,825 to 75,067; most of these trout are caught in Southeast. At the same time, because of state restrictions imposed in 1994 and overall declines in cutthroat populations, harvest rates of cutthroat have decreased significantly (Bangs and Harding 2008, Harding and Coyle 2011). For the few years with data, the federal subsistence fishery in Southeast reports very low harvest rates (0 to 25 fish per year) (Bangs and Harding 2008).

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CONSERVATION ISSUES

The role of cutthroat trout in the food web of Southeast has not yet been widely studied, but because of the year-round presence of the species in lakes and streams, cutthroat likely provide food for American dippers (*Cinclus mexicanus*), mink (*Neovison vison*), river otters (*Lutra canadensis*), and fish-eating birds such as belted kingfishers (*Ceryle alcyon*), common mergansers (*Mergus spp.*), and great blue herons (*Ardea herodius*).

Within North America, the coastal cutthroat trout is the most abundant of the cutthroat trout subspecies (Behnke 1979, Johnston 1981), but serious declines in numbers have been reported since 1960, at least among anadromous populations. The reasons cited for these declines include loss of stream habitat from logging and forest road building, mines, oil spills, hydroelectric projects, over-fishing, and, in more populated regions, increased urbanization (Trotter 1989, Bangs and Harding 2008).

Populations of various subspecies of cutthroat trout have been considerably diminished in the Lower 48 (Colyer et al. 2005). Of the 13 subspecies of interior cutthroat trout, two are extinct and most of the rest occur at only a small fraction of their original distribution and abundance (Behnke 1991). Some of these subspecies are now listed as threatened in Nevada, California, and Colorado, and many western states have adopted wild fish management policies and management plans tailored to promote recovery of cutthroat trout subspecies (Trotter 1991).

Anadromous populations of coastal cutthroat trout outside of Alaska have declined sharply through time, and many are now listed as at risk. The declines have been attributed to anthropogenic factors such as landscape alteration from logging and urbanization, conscription of habitat for rearing millions of stocked salmon and steelhead in places that historically did not support them, and over-exploitation by anglers (Trotter 1991, Hilderbrand 2003). Indiscriminate mixing of various subspecies of cutthroat trout and hybridization with rainbow trout from hatcheries also appear to have been a major cause of the rapid decline of native subspecies in the Lower 48 (Behnke 1979).

Because anadromous cutthroat spend three to four years maturing in fresh water, these fish are particularly susceptible to habitat alteration from logging (Armstrong 1971, Giger 1972), and some populations of cutthroat trout have even been extirpated from small tributaries as a result of logging operations (Wustenberg 1953) Large woody debris creates productive habitat for salmonids by forming pools, meanders, secondary channels, and undercut banks (Bisson et al. 1987), and as the debris decomposes or is transported downstream, it is gradually replaced with new material from the riparian, or streamside, zone. This natural regeneration of salmonid habitat within forested streams is precluded by clearcut logging, which removes all streamside vegetation and depletes potential new debris for the stream channel (Crispin et al. 1993).

Because sunlight increases water temperature and stream productivity, canopy removal may initially trigger a rise in salmonid population size and biomass. However, the loss of debris eventually leads to habitat changes undesirable for salmonids, as loss of cover may reduce over-winter survival (Lowry 1966), increased siltation impairs spawning and rearing habitat (Bustard and Narver 1975). Over time, usually several decades, trout populations fall to well below pre-logging levels unless provisions are made for the addition of new, large woody structures to streams (Trotter 1989). Habitat preferred by rearing cutthroat is not as diverse as that of other salmonids and is usually limited within a given system. Alteration of this preferred habitat because of land-use activities could seriously affect the cutthroat population.

Beyond habitat degradation and impacts associated with logging, cutthroat trout are also especially vulnerable to insecticides (Whitney and Spindler 1959, Cope 1961), which may indicate they are sensitive to other pollutants as well. In a study on the effects of forest insecticide spray on salmon streams in Southeast, Reed (1963) found DDT and DDE in cutthroat from all four streams sampled.

Cutthroat trout may be susceptible to contracting viruses from stocked hatchery fish. The Turner Lake sockeye stocking project, for example, was canceled in May 1990 because of concerns related to the potential for introduction of Infectious Hematopoietic Necrosis Virus (IHNV). There was concern for both the kokanee and cutthroat trout in Turner Lake because both species are IHNV susceptible (Jones et al. 1990).

Mining in Southeast may also be impacting cutthroat. Cutthroat numbers in Tributary Creek on Admiralty Island, downstream from the underground polymetallic Hecla Mine, fell between 1981 and 2011 in all three reaches of the creek where numbers were estimated (Kanouse 2011).

In light of current knowledge about coastal cutthroat trout in Southeast, the following actions merit consideration:

- Maintaining the genetic purity of Southeast cutthroats, which are among the few pure stocks remaining in the United States
- Protecting the small headwater streams important for cutthroat spawning and rearing
- Taking into account the special sensitivity of cutthroat to pollutants whenever spraying of herbicides or insecticides or creation of by-products from mining are being considered
- Recognizing and learning more about the dependency of specific cutthroat stocks on different watersheds for spawning
- Protecting the Trophy Fish Waters identified by the ADFG and the High Quality and Important watersheds designated by USFS.

After a 10-year study of anadromous cutthroat trout in Southeast, Jones (1976) recommended:

- Establishing selected cutthroat systems in Southeast as roadless, dispersed recreation, or natural areas
- Giving special consideration to identified cutthroat spawning and rearing areas during road-building and logging operations.

Finally, predicted alterations based on climate change could negatively impact cutthroats in Southeast (Bryant 2009).

MAPPING METHODS

This map represents 674 streams and tributaries in 225 watersheds known to support the presence, spawning, or rearing of cutthroat trout (Alaska Department of Fish and Game 2013). These totaled 1,417 mi (2,281 km), which is likely only 50% of the model-estimated anadromous stream length (see Anadromous Fish Habitat methods section).

This map shows high-use cutthroat trout waters within Southeast Alaska. "These high-use waters are defined as areas with either developed access (road or trail from road), a USFS recreational cabin, and/or intensive fisheries, i.e., 'high-use'. Twenty-one lakes and six drainages including the Juneau roadside waters are classified into this category across Southeast Alaska" (Alaska Department of Fish and Game 2012a).

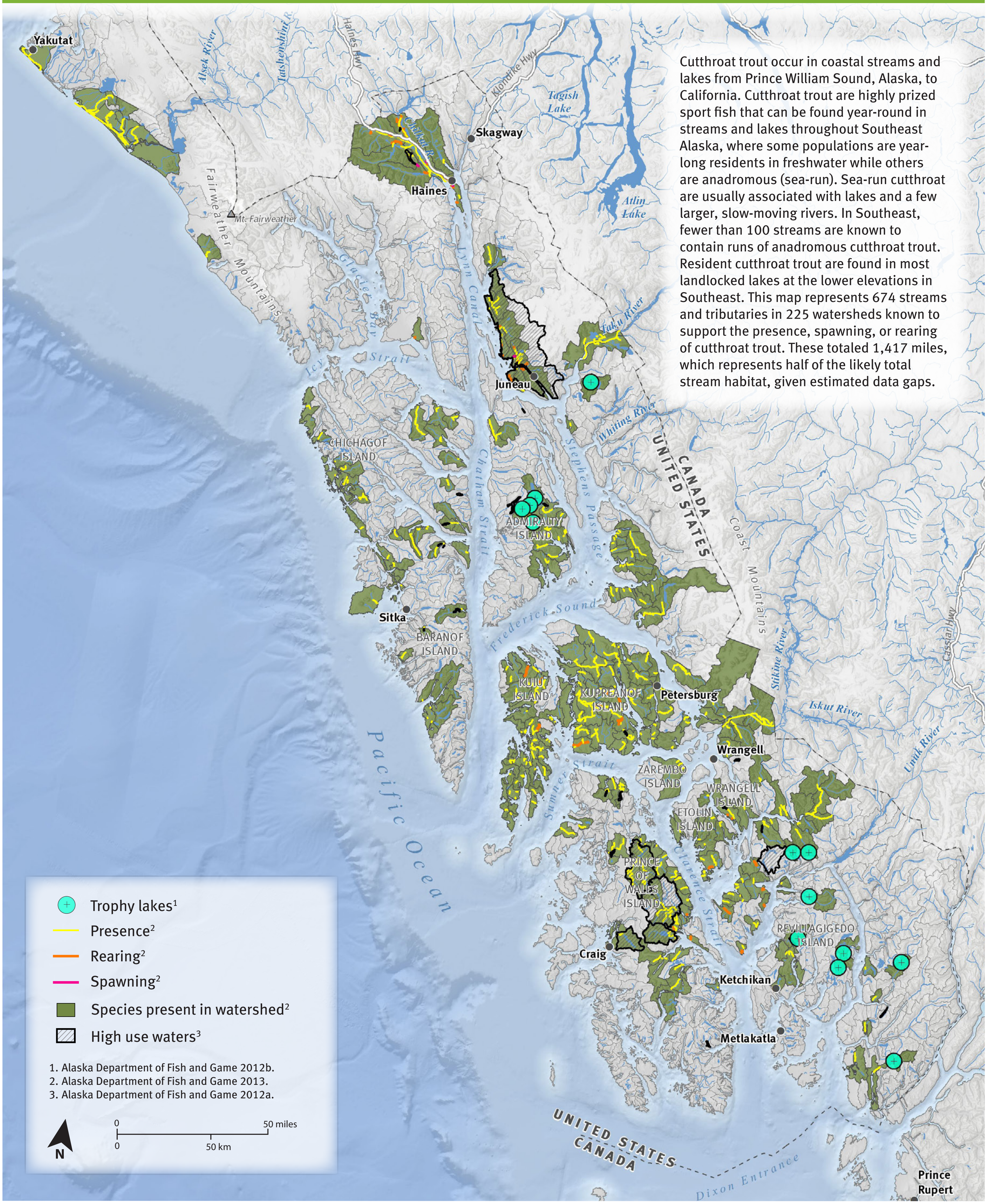
Also shown are the 13 trophy cutthroat trout lakes in Southeast. These are lakes "that have produced cutthroat trout that qualified for entry in the [ADFG] Trophy Fish Program... 12 of these lakes are managed with a minimum size limit of 25 inches, with only 1 per day/1 in possession and no bait allowed; Turner Lake is managed as a catch-and-release only lake with no bait allowed" (Alaska Department of Fish and Game 2012b).

MAP DATA SOURCES

- Anadromous streams: Alaska Department of Fish and Game (2013)
- High use cutthroat waters: Alaska Department of Fish and Game (2012a)
- Trophy lakes: Alaska Department of Fish and Game (2012b).

Coastal Cutthroat Trout

Cutthroat trout occur in coastal streams and lakes from Prince William Sound, Alaska, to California. Cutthroat trout are highly prized sport fish that can be found year-round in streams and lakes throughout Southeast Alaska, where some populations are year-long residents in freshwater while others are anadromous (sea-run). Sea-run cutthroat are usually associated with lakes and a few larger, slow-moving rivers. In Southeast, fewer than 100 streams are known to contain runs of anadromous cutthroat trout. Resident cutthroat trout are found in most landlocked lakes at the lower elevations in Southeast. This map represents 674 streams and tributaries in 225 watersheds known to support the presence, spawning, or rearing of cutthroat trout. These totaled 1,417 miles, which represents half of the likely total stream habitat, given estimated data gaps.

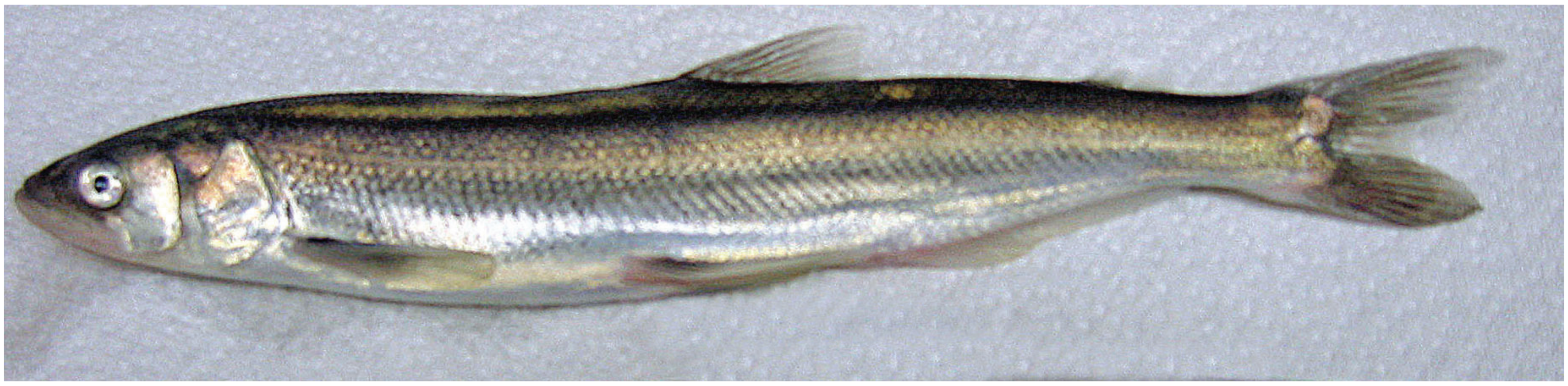


Map 4.10: Coastal Cutthroat Trout

MAP ON PAGE 102

EULACHON (HOOLIGAN)

Bob Armstrong and Marge Osborn
Revised by Nils Warnock



James Crippen / Wiki Commons

Eulachon (hooligan).

Eulachon, also called hooligan (*Thaleichthys pacificus*), are small slender fishes up to 25 cm (10 in) long that belong to the smelt family (*Osmeridae*). Eulachon occur only on the northwest coast of North America, from northern California to southwestern Alaska (Moody 2008). These anadromous fishes spend most of their lives in the ocean (Clarke et al. 2007). At maturity, eulachon migrate into certain mainland rivers of Southeast (typically glacier fed) for spawning, usually during April and May (but sometimes in the fall). Features distinguishing eulachon from other smelt in Alaska are obvious circular grooves on their gill covers and dorsal fins that begin well behind the pelvic fins (Mecklenburg et al. 2002).

Eulachon are notable for their high concentration of oils (mostly mono-unsaturated fatty acids such as oleic acid). Samples of eulachon obtained from February to June in the Gulf of Alaska contained 18 to 20% oil, a value higher than that for other common forage fishes, such as sand lance (*Ammodytes hexapterus*) (3 to 6%) or capelin (*Mallotus villosus*) (2 to 10%), during the same time frame (Payne et al. 1999).

For native communities in the Pacific Northwest and Southeast Alaska, eulachon have long been important food fish, sometimes referred to as "salvation fish" due to their early arrival in the spring when they provide fresh food and oil after long winters (Stewart 1977 cited in Alaska Department of Fish and Game 2003). Commercially, the eulachon has been of relatively little importance; therefore, less is known about this species than other fishes such as salmon. The role of eulachon as food for many animals, including some of conservation significance such as Steller sea lions (*Eumetopias jubatus*), is prompting greater interest in understanding the biology and ecology of this small fish (Womble et al. 2005, Willson et al. 2006).

Because of abundance and ease of capture during spawning runs, eulachon are common forage fish for Bald Eagles (*Haliaeetus leucocephalus*), harbor seals (*Phoca vitulina*), Steller sea lions, gulls, and other animals (Drew and Lepp 1996, Marston et al. 2002, Womble 2003, Womble et al. 2005). Eulachon have a very high resource value, as they provide a higher amount of energy than other forage fish such as Pacific herring (*Clupea barengus*), Pacific sand lance, capelin, and walleye pollock (*Theragra chalcogramma*) (Perez 1994, Payne et al. 1999, Kuhnlein 2000). In addition, they are available to animals that feed on them during a season when energy costs for animals are high and when food sources, such as spawning salmon, are not available.

Other animals that feed on eulachon, include fish (spiny dogfish [*Squalus acanthias*], sablefish [*Anoplopoma fimbria*], arrowtooth flounder [*Atheresthes stomias*], salmon (*Oncorhynchus spp.*), Dolly Varden (*Salvelinus malma*), Pacific halibut [*Hippoglossus stenolepis*], and Pacific cod [*Gadus macrocephalus*]); marine birds (harlequin ducks [*Histrionicus histrionicus*], pigeon guillemots [*Cepphus columba*], common murres [*Uria aalge*], mergansers [*Mergus spp.*], cormorants [*Phalacrocorax spp.*], and gulls) (Scott 1973); marine mammals (baleen whales, orcas [*Orcinus Orca*], dolphins, pinnipeds) (Kajimura et al. 1980, Speckman and Piatt 2000, Huntington 2002) ; and terrestrial mammals (brown bears [*Ursus actos*], wolves [*Canis lupus*]).

Throughout their range, eulachon runs tend to be erratic, appearing in some years but not others, and only rarely in some river systems (Willson et al. 2006, Ormseth and Vollenweider 2007). In the ocean, eulachon appear to live near the bottom, on the shelf, usually at moderate depths of about 60 to 650 ft (20 to 500 m), but they may occur at depths greater than 2,000 ft (610 m) (Allen and Smith 1988, Eulachon Research Council 2000, Hay and McCarter 2000). In the Gulf of Alaska, eulachon have been captured in trawl samples as deep as 1,640 ft (500 m), with considerable variation among portions of the Gulf (Mueter and Norcross 2002). In northern Southeast, they have often been captured in trawl samples in the coastal fjords (Carlson et al. 1977).

Eulachon spawn only in certain mainland rivers in Southeast (Willson et al. 2006, Moody 2008). Spawning rivers may be turbid or clear, but all are thought to have spring high-water periods caused by heavy rains, characteristic of rivers draining large snowpacks or glaciers (Hay and McCarter 2000). In many rivers, spawning is more or less limited to the part of the river influenced by tides (Lewis et al. 2002). In the Berners Bay system, the greatest abundance of eulachon was observed in tidally influenced areas, but some fish ascended well beyond the tidal influence. Eulachon are reported to go as far as 50 mi (80 km) up the Susitna River in Southcentral Alaska (Barrett et al. 1984, Vincent-Lang and Queral 1984), possibly because of a low gradient (Lewis et al. 2002). Eulachon once ascended more than 100 mi (160 km) in the Columbia River system in the Pacific Northwest. Some evidence indicates that water velocity can limit upstream movements (Lewis et al. 2002)

Spawning substrates can range from silt, sand, or gravel to cobble and detritus (Smith and Saalfeld 1955, Barrett et al. 1984, Vincent-Lang and Queral 1984), but sand appears to be most common (Langer et al. 1977, Lewis et al. 2002). Egg survival of eulachon is greatly influenced by salinity. Exposure to salt water can be lethal (Farara 1996). Major temperature changes can also affect survival (Lewis et al. 2002).

Recent biological data suggests that eulachon populations are geographically structured, contrary to early studies which indicated that eulachon in general constitute a single evolutionarily significant unit throughout their entire range (McLean et al. 1999). Eulachon stocks in individual rivers may differ in characteristics such as size and spawning times (Hay and McCarter 2000), and there is significant genetic variation among different populations in the Columbia River and the Cook Inlet of Alaska, so eulachon management plans should be

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Barbara and Jack Donancy

Eulachon (hooligan).

delineated by river drainage rather than one range-wide unit (Beacham et al. 2005). Further work in Alaska recommends that northern Alaskan populations (Yakutat Forelands, Prince William Sound, and Cook Inlet) of eulachon be managed separately from southern Alaskan populations (upper Lynn Canal, Berners Bay, Stikine Strait, and Behm Canal) since they are demographically independent (Flannery et al. 2009, Flannery et al. 2013).

Population estimates of eulachon in Southeast rivers are generally lacking, but the species is often observed in tremendous numbers in certain rivers, where large congregations of birds and mammals feed on them (for example, in the Alsek, Stikine, and Chilkat rivers and in Berners Bay). Eulachon have been abundant enough in Southeast to support small commercial harvests. Commercial harvests have occurred in the Stikine, Unuk and Chickamin, and Bradfield river systems, at least in some years (Alaska Department of Fish and Game 2000, Ormseth and Vollenweider 2007), while in other years no fish have been harvested, and sometimes the runs appear to have failed completely (Miller and Moffit 1999, Walker 2001) or greatly declined (Ormseth and Vollenweider 2007).

Eulachon also support subsistence and personal use fisheries in the Chilkat and Chilkoot rivers near Haines (Mills 1982, Magdanz 1988, Betts 1994, Reeves 2001), the Berners Bay system near Juneau (Mary Willson, ecologist, personal communication 2004) and the Situk near Yakutat (Alaska Department of Fish and Game 2014d). Alaska Natives traditionally harvested eulachon to be eaten fresh, smoked or dried, or rendered into oil as a dietary supplement or condiment (Alaska Department of Fish and Game 2003, Willson et al. 2006, Moody 2008). According to Betts (1994), the contemporary eulachon subsistence fishery in Southeast is conducted primarily by the Chilkat (Jilka'at) and Chilkoot (Lkoot) Tlingits of Klukwan and Haines, with locations of fishing and processing organized by clan affiliation. The name "eulachon" comes from the Chinook Indian word ulakan, which means "candlefish" and refers to the unusually large amount of oil in the fish.

CONSERVATION ISSUES

Considering their oil content and food value, their early run timing (before salmon arrival), and the number and variety of animals that feed on them, eulachon can be considered one of the most important forage fish in Southeast.

There are a variety of threats to eulachon, some of which are relevant to the Tongass, including climate change, timber harvest and related activities, dredging and habitat alteration in spawning areas, pollution of spawning rivers, targeted commercial fisheries, and by-catch in offshore trawl fisheries (Hay and McCarter 2000).

Eulachon are especially important to Steller sea lions in Southeast. Seasonal pulses of high-energy food resources are critical to the reproductive success of Steller sea lions (Womble 2003), as energy demands are high for sea lions during spring when females are pregnant and lactating as well as when males are preparing for extended fasting prior to the breeding season. Many sea lions concentrate during the eulachon runs in Berners Bay (Womble 2003) and in Dry Bay near Yakutat (Catterson and Lucey 2002). Because Steller sea lions are listed as a threatened species under the US Endangered Species Act, eulachon conservation is particularly important.

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In some instances, eulachon appear to be extremely important in the diet of Bald Eagles (Drew and Lepp 1996). Almost 2,000 eagles are attracted to the Stikine Delta spring run of eulachon. In addition, an estimated 1,000 Bald Eagles concentrate in Berners Bay in the spring to feed on eulachon (Mary Willson, ecologist, personal communication 2004).

In the last 20 years, especially since the mid-1990s, nearly all eulachon spawning runs—from California to Southeast Alaska—have declined (Hay and McCarter 2000). Federal agency biologists determined that the southern populations (those spawning in rivers from south of the Nass River in British Columbia, Canada, down to and including the Mad River in California) were discrete from northern populations of eulachon (Department of Commerce 2009). In March 2010, the National Marine Fisheries Service listed the southern population of eulachon as threatened under the Endangered Species Act. The eulachon has been recommended by some scientists for listing as an indicator species in the North Pacific (Hay et al. 1997) . Nevertheless, although runs there have collapsed in some areas, there are no special designations for eulachon in Southeast Alaska (Ormseth et al. 2008).

Eulachon are sensitive to pollutants in their spawning rivers. The accumulation of pollutants occurs even though the fish do not feed in freshwater and remain there only a few weeks (Rogers et al. 1990, Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife 2001). For example, eulachon returning to the lower Fraser River contained contaminants from wood-treatment processes (Rogers et al. 1990), and apparently acquired them after river entry (Birtwell et al. 1988, Rogers et al. 1990). Industrial effluent into the Kitimat River has spoiled eulachon that would otherwise be edible (Pedersen et al. 1995, Mikkelson et al. 1996), and Nass River eulachon acquired detectable levels of metals derived from mine tailings (Futer and Nassichuk 1983).

Four major eulachon spawning areas in Southeast are at risk from proposed mining activities. In the Taku River, proposed reopening of the Tulsequah Mine could affect water quality. As noted by the Environmental Mining Council of British Columbia:

Re-opening this old acid and heavy metal polluting mine will also involve siting a new tailings pond in the floodplain of the Tulsequah River. While the new mine plan calls for clean-up of the old mine waste, it will introduce new toxic waste problems to the watershed (Environmental Mining Council of British Columbia 2004).

Berners Bay eulachon may be impacted by developments at the Kensington Gold Mine. Current concerns center on the newly constructed tailings facility in Lower Slate Lake or pollution from increased barge and ferry traffic (Bluemink 2004). The Stikine and Unuk watersheds also have several mines proposed or under development across the Canadian border, which will have likely downstream effects on Eulachon spawing habitat.

Three considerations seem to be most important for conserving healthy populations of eulachon in Southeast:

- Providing special attention and protection for all systems supporting eulachon, because the number of systems supporting eulachon are relatively few and these fish are an important forage resource
- Mitigating the potential of activities such as mining, other industrial development, and urban development to pollute the waters that eulachon use, because eulachon easily accumulate pollutants and pass them up the food chain
- Recognizing the traditional value of eulachon to the Native people of Southeast and supporting both eulachon habitat and harvest access.

MAPPING METHODS

This map represents 88 streams and tributaries in 33 watersheds known to support the presence, spawning, or rearing of eulachon (Alaska Department of Fish and Game 2013). These totaled 373 mi (601 km), which is likely only 50% of the model-estimated anadromous stream length (see Anadromous Fish Habitat methods section). The map also shows most environmentally sensitive areas (MESAs) for eulachon designated by ADFG.

MAP DATA SOURCES

- Anadromous streams: Alaska Department of Fish and Game (2013)
- Most environmentally sensitive areas: Alaska Department of Fish and Game Habitat and Restoration Division (2000).

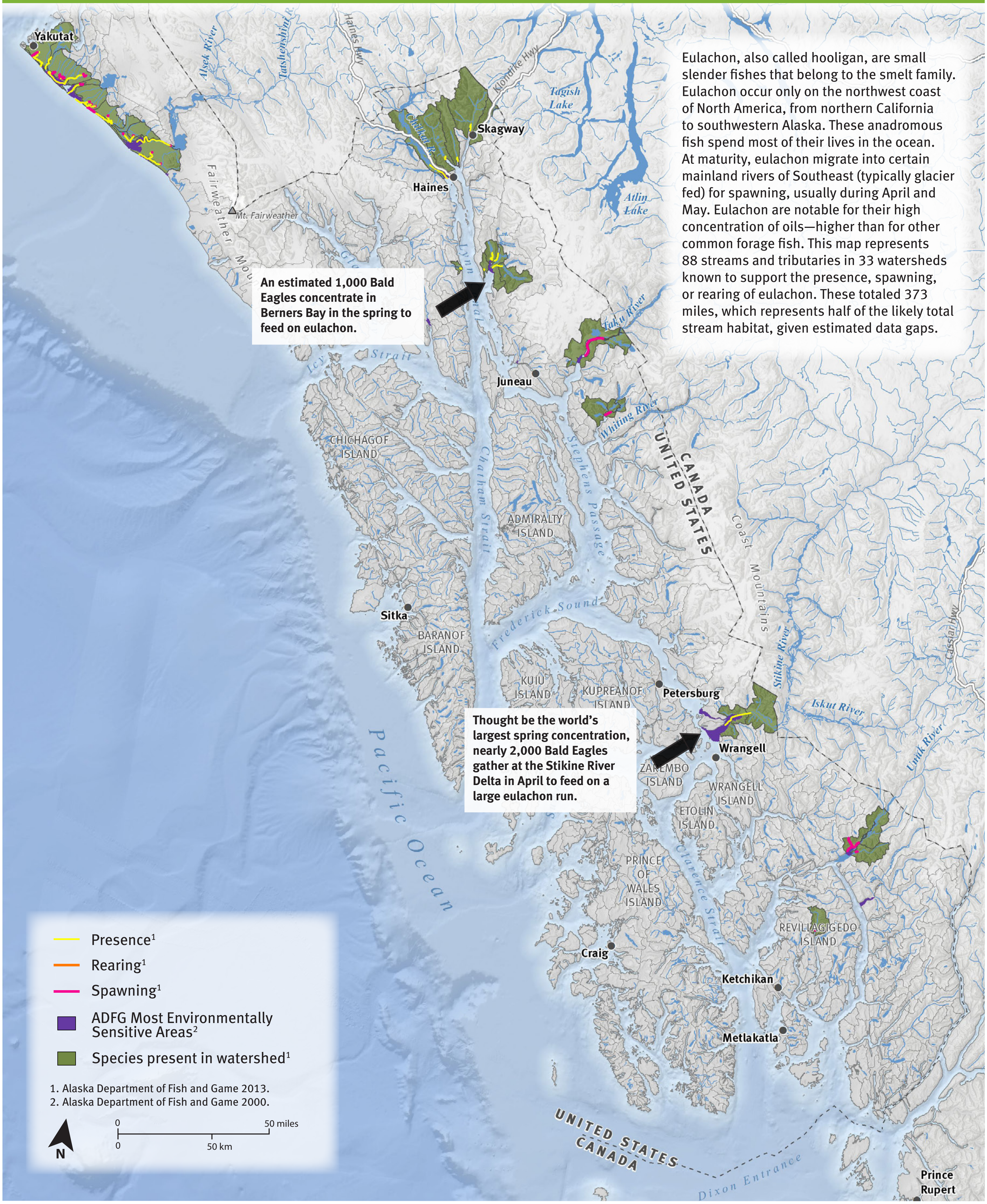
The Stikine River has a large run of eulachon each spring.

John Schoen

Eulachon (Hooligan)

Audubon ALASKA

Eulachon, also called hooligan, are small slender fishes that belong to the smelt family. Eulachon occur only on the northwest coast of North America, from northern California to southwestern Alaska. These anadromous fish spend most of their lives in the ocean. At maturity, eulachon migrate into certain mainland rivers of Southeast (typically glacier fed) for spawning, usually during April and May. Eulachon are notable for their high concentration of oils—higher than for other common forage fish. This map represents 88 streams and tributaries in 33 watersheds known to support the presence, spawning, or rearing of eulachon. These totaled 373 miles, which represents half of the likely total stream habitat, given estimated data gaps.



Map 4.11: Eulachon (Hooligan)

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