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Salmon Assessment

Tongass National Forest Plan Revision



Forest
Service

Alaska
Region

Tongass
National Forest

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Salmon Resource Assessment

Tongass National Forest Plan Revision

Forest Service, Alaska Region

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Introduction

Salmon are integral to the biogeography of Southeast Alaska and integral to the way of life and the economy of the region. Tlingit, Haida, and Tsimshian people have been living with salmon in Southeast Alaska for thousands of years. Today, the communities of Southeast Alaska continue their dependence on salmon for food, culture, social and ecological health, and the local economy.

The Tongass is considered a ‘salmon forest’ due to the ecological interconnectedness between salmon, watersheds, trees, and people. The diverse mosaic of aquatic habitat on Tongass National Forest has been vital to sustaining productive salmon stocks. The complex lifecycle of salmon requires access to both freshwater and marine environments. Salmon begin their lives in freshwater streams and lakes, migrate to saltwater, then return to their natal freshwater habitat to spawn. Many of these coastal, freshwater streams and lakes are located within the Tongass National Forest. As a key resource to the sustainability of people in Southeast Alaska, and a major contributor to local economies, it remains critical to maintain high-quality aquatic and riparian habitats necessary to support healthy salmon populations on the Tongass National Forest.

This assessment discusses the key ecosystem characteristics of salmon habitat, the natural processes that influence salmon, and the management actions affecting salmon. This assessment references numerous other assessment sections in an effort to highlight the interdependent significance of salmon to ecological, cultural/social, and economics of Southeast Alaska.

While this assessment focuses solely on salmon, there are other anadromous and resident fish that are also important to the ecology, economy and culture of Southeast Alaska. Other anadromous fish include rainbow trout, steelhead, eulachon, Dolly Varden, and coastal cutthroat trout. While habitat requirements and trends for each species are different, much of the forest management direction developed to benefit salmon species also benefits these other fish species.

Contribution of use to cultural, social and economic sustainability

One cannot speak about Southeast Alaska, nor the Tongass National Forest, without recognizing the role of salmon. The salmon, and the salmon lifecycle, are intimately intertwined with the people and the economies of the region. All five species of Pacific salmon: chinook, coho, chum, pink, and sockeye occupy streams in the area. While salmon are important across all of Alaska, the Southeast region supports a greater abundance of salmon than any other region of Alaska (Clark & Thiessen-Bock 2019). Salmon utilizing Tongass National Forest watersheds support commercial, sport, personal-use, and subsistence fisheries that are critical to nutritional, cultural and economic well-being of communities.

Cultural/Social/Food Security

Alaska indigenous people have a strong cultural connection to salmon which is well documented in the [Tongass: An Indigenous Place](#) Assessment. It speaks to the cultural connection and the wild food source that indigenous people have shared and depended on for many generations. In their customary ways, certain streams were stewarded by certain families, and the abundance was shared once individual family's gathering needs were met. Stories about salmon were shared across generations communicating the harvest methods, the high level of respect for the salmon, and sharing the ways to steward the lands to protect the fish and their habitats. The seasonal return of salmon, and the continuation of its abundance for generations, is critical to the future of the Tlingit, Haida, and Tsimshian people of Southeast Alaska.

The return of salmon on an annual basis provides wild food and sustenance for people in Southeast Alaska. An average of 843 metric tons of salmon are harvested on an annual basis from National Forest

Lands (J.R Belmore and E. Whitney 2025, in progress) accounting for an estimated 75 million (single person) servings. Salmon harvested by local residents in personal-use and subsistence fisheries are critical to the food security of rural communities where wild food harvest accounts for 25% of annual caloric requirements (Fall and Kostick 2018).

Ecology

Salmon contribute to the interconnectedness of ecosystems and are considered a ‘keystone’ species because they transfer marine-derived nutrients into the terrestrial and freshwater ecosystems. The distribution, abundance, diversity and function of salmon to the overall ecology of Southeast Alaska is unique in the National Forest system with few other national forests supporting anadromous fish at this scale. Managing the Tongass to maintain this diversity and abundance is important for long term sustainability.

Nutrients delivered by returning salmon contribute to increased growth rates of young salmon in freshwater ecosystems (Wipfli et al. 2003, Fitzgerald et al. 2024) resulting in better survival of those fish in both freshwater and marine ecosystems. Increased survival in turn results in greater chances of adult returns and sustainability of salmon populations over time. Maintaining access to diverse and complex freshwater habitats will support healthy populations and continued return of these marine derived nutrients over time.

As discussed in the [Aquatic Ecosystem](#) Assessment, many terrestrial and freshwater animals are inextricably connected to salmon (Willson and Halupka 1995). Over 50 animal species directly depend on salmon on the Tongass National Forest. Salmon-derived nitrogen has been found over ¼ mile away from salmon streams, indirectly feeding vegetation as well as animals. Maintaining effective corridors for wildlife access to riparian areas, and sustaining healthy salmon returns, will continue to support overall ecological function and an abundance and diversity of wildlife.

The ecological contribution of salmon to riparian soils, and indirectly to trees and riparian vegetation, is another example of the complex interconnectedness between salmon and the ecosystem. D’amore et al. (2020) showed increased levels of nitrogen and phosphorus in riparian soils along salmon streams compared to riparian areas without salmon. The degree of nutrient contribution, and the rate of nutrient flushing is variable across the landscape; however, the evidence for the ecological connection between salmon, soils, and the ability for trees and riparian vegetation to uptake nutrients is represented by the known signature phrase of ‘salmon in the trees’ (Quinn et al. 2018).

Economy

Harvest and Fishery Economics on the Tongass National Forest

In addition to government and healthcare, dominant industries across Southeast Alaska include mining, seafood harvest and processing, construction, and commercial tourism. The seafood industry ranks in the top three non-governmental industries in terms of total employment and total earnings across the region. Seafood values (to commercial fisherman), from 2008 to 2023, ranged from \$179,000,000 to \$486,000,000 with salmon species representing 82% of the regional seafood catch and 54% of the overall value in 2023. Across the region, the seafood industry supports nearly \$225,000,000 in total earnings from a workforce of 3,604 jobs (Southeast Conference 2024). Uniquely, a very high proportion (2,151) of those jobs are estimated as self-employed and presumably represent the highest number of independent owner-operator fishermen and custom processors working in diverse coastal communities.

Economic value of salmon can be estimated in many ways. The overall value of salmon as more than a commercial commodity, and across the varied fisheries in Southeast Alaska, is difficult to quantify. One

report, prepared for Trout Unlimited, compiled the economic contributions of salmonid resources in Southeast Alaska and estimated the total economic output (including multipliers) associated with commercial, sport, and personal use and subsistence fisheries, including hatchery operations, at \$986.1 million in 2007 (TCW Economics 2010). This significant economic value relates both directly and indirectly to Tongass National Forest aquatic habitat management.

Recent research led by the Pacific Northwest Research Station, Juneau Forestry Sciences Lab estimated the proportion of commercially caught salmon originating from the National Forest in Alaska, termed “forest fish” and estimated the commercial dockside value of those salmon. Of the total salmon harvest in Southeast Alaska, 75% were estimated to have originated from streams and lakes draining the Tongass National Forest between 2007-2016 with approximately 21% of hatchery origin and the remaining proportion being non-hatchery stock. The annual dockside value of these ‘forest fish’ ranged from \$50 million to \$150 million, with an average value of about \$69 million. Pink salmon comprised the greatest value during that time (Johnson et al., 2019).

Commercial Fisheries

Commercial fisheries have been a part of the Alaskan economy for generations, shaping cultural structure cultural and community identity, and are an active part of the market economy. While the non-commercial and commercial fisheries can sometimes be in conflict, they are also intertwined, and the same individuals may participate in various commercial, sport, and subsistence or other personal use fisheries. Therefore, the economic value is tied in with social and cultural stability, as well as economic stability across the spectrum of rural Southeast Alaska communities from Metlakatla to Yakutat.

Commercial salmon harvest (by species), in the marine waters across Southeast Alaska and Yakutat commercial fishery districts, is shown in Figure 1. Commercial harvest, including salmon of hatchery origin, is robust and has ranged from less than 20 million, to over 100 million over the past 40 years.

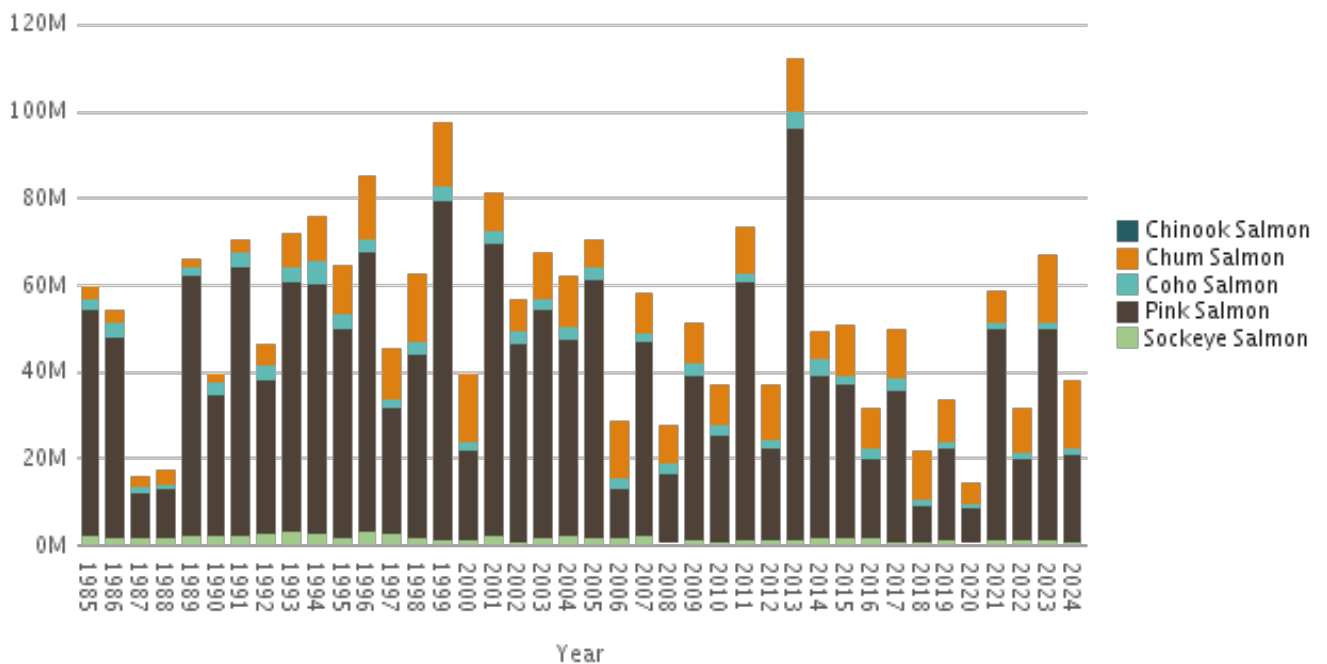


Figure 1. Southeast and Yakutat Regions commercial salmon fishery landings by species, as reported to Alaska Department of Fish and Game, 1985-2023. From Conrad and Thynes 2024. https://www.adfg.alaska.gov/index.cfm?adfg=commercialbyfisherysalmon.salmon_landings

While commercial dockside salmon fishery value is reported annually by Alaska Department of Fish and Game (ADFG), that does not account for the full economic value or impact of salmon in the region. Gross earnings in the commercial salmon fisheries are highly variable, fluctuate with abundance, price, regulation, fishery participation, and global market economics (Figure 2).

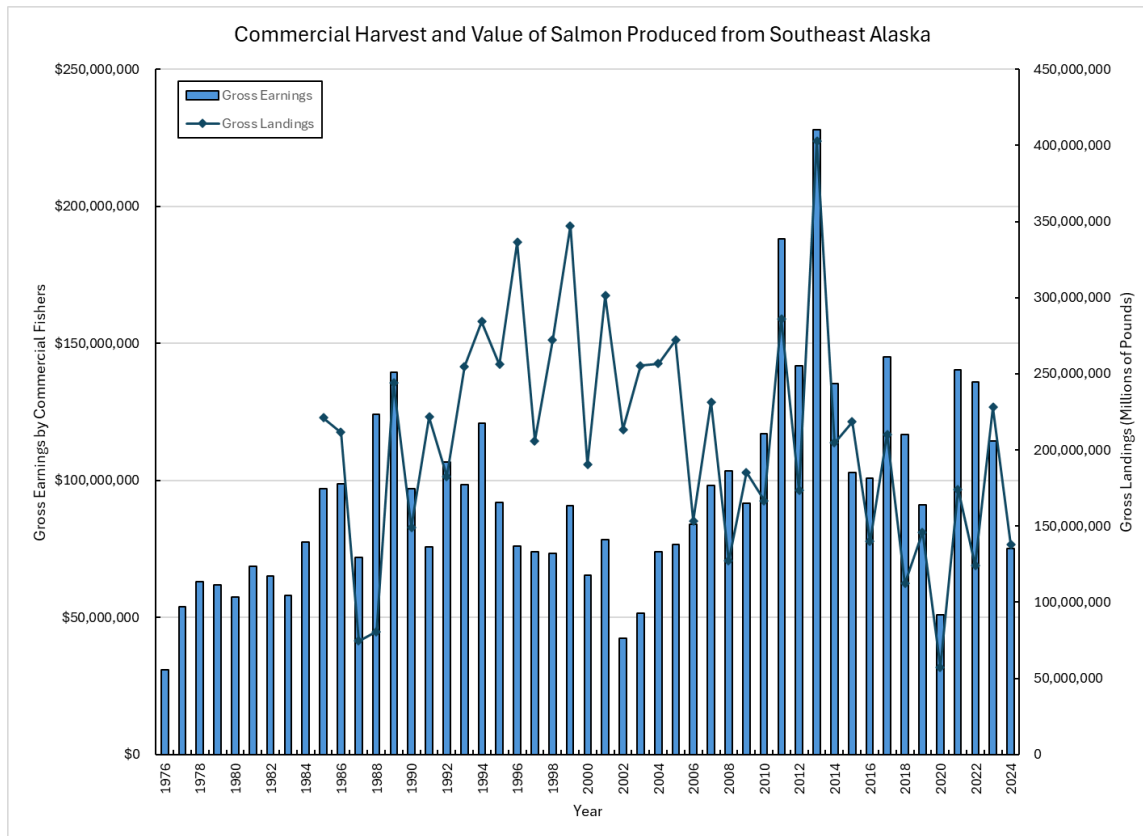


Figure 2. Commercial value of salmon produced in Southeast Alaska 1976-2024 (Conrad and Thynes, 2025).

Hatchery production has contributed substantially to Southeast Alaska’s commercial fisheries averaging about 10.4 million total salmon annually (including cost recovery, which are fish harvested to pay for private non-profit hatchery operations) in recent years (2015-2024) (Wilson 2025). The total 2024 commercial salmon harvest for Southeast Alaska, including hatchery produced, was about 36.1 million salmon with a value of \$79.8 million. Forty-two percent of the contribution, or 15.2 million salmon, were hatchery produced fish. The total value of the 2024 hatchery harvest, including cost recovery and commercial common property harvest is about \$43.8 million or 55% of the total commercial salmon fishery ex-vessel value (the value of the first purchase of raw fish) (Wilson 2025). Chum salmon have been the dominant contributor to the value of hatchery produced salmon and are the primary source of cost recovery for most hatchery operations (Pryor 2024.) In 2024, hatcheries produced 91% of the chum salmon caught in the common property harvest followed by coho (26%), chinook (17%), sockeye (7%), and pink salmon (1%) (Wilson 2025). Releases of hatchery reared juvenile salmon in Southeast Alaska totaled about 726 million fish with chum comprising 86% of the release (Wilson 2025).

It is also important to note that about 69,000 hatchery salmon were harvested in the sport, personal use, and subsistence fisheries in 2024. Coho salmon comprise the greatest part of the harvest followed by chinook, chum, sockeye, and pink (Wilson 2025).

Sport Fisheries

Sport fisheries also comprise significant contributions to communities and local economies across Southeast Alaska. In 2023, ADFG estimated 519,000 angler-days fished across the region, with Juneau, Prince of Wales, Ketchikan, Sitka and Yakutat survey districts reporting the highest fishing effort. Freshwater harvest for all salmon species topped 59,000 fish and saltwater harvest tallied 451,076 fish retained by an estimated 155,584 anglers, the highest angler estimate for the 2014-2023 reporting period. (Alaska Department of Fish and Game 2024). The estimated average number of “Forest Fish” harvested in the sport fishery between 2011 and 2020 is 279,406 per year (Bellmore et al. in prep).

When operating on the Tongass National Forest, outfitters and guides are managed by the Forest Service via special use permits. Freshwater guided sport fish outfitter and guided user days for clients on the Tongass National Forest totaled 3,668 in 2024, just above the average of 3,655 over the last 10 years. The number of fishing guide permit holders was 87 for 2024, below the average 91 for the last 10 years. The average annual number of visitors participating in freshwater fishing activities on the Tongass with a guide, from 2013-2023 (excluding 2020 and 2021 pandemic years) was 5,963 (Internal Natural Resource Manager special uses data). See the [Recreation and Tourism](#) assessment for more information on outfitter and guide activity.

Subsistence Fisheries

The function of the Tongass National Forest in support of provisioning households and maintaining rural identity and traditions from forest-derived foods is unique in the National Forest system. These themes and management responsibilities are discussed in [Tongass: an Indigenous Place](#) and [Subsistence and Other Non-commercial Harvest](#) assessments.

Subsistence is the take of wild and renewable resources for direct, personal or family consumption as food, shelter, fuel, clothing, tools, or transportation as well as for the making and selling of handicraft articles and for the customary trade, barter, or sharing for personal or family consumption (Alaska Statutes Title 16 2020). This use is not only a way of life for rural residents, but it is a constitutional right for citizens (Chamberlain et al. 2025). Because 80% of the Southeast Alaska Region is Tongass National Forest, the long-term sustainability of salmon habitats on the Tongass, and access to them, is critical to supporting subsistence use.

A recent article estimated 2055 tons of wild food harvested through subsistence by households in rural Alaska communities per year (Chamberlain et al. 2025). Using data from Alaska Department of Fish and Game Community Subsistence Information System the authors estimated that 582 tons of salmon are harvested annual by rural residents living in 33 communities across southeast Alaska, which equates to an estimated 153 annual meal servings per capita (<https://www.adfg.alaska.gov/sb/CSIS/>). This use is important for cultural, social and economic well-being of Southeast Alaska communities.

While salmon stocks have generally been healthy, effort and harvest in subsistence salmon fisheries has been slowly declining. The State of Alaska reports the number of state subsistence salmon permits it issues, and the reported catch from those permits. While these data do not represent all Federally qualified subsistence users, they are still useful for illustrating salmon harvest trends. The State of Alaska reported, between 1985 and 2004, an average of 3,480 household permits were issued each year. The average number of Sockeye Salmon reported to the State of Alaska harvested during that same time period was 40,233 per year. From 2005 to 2016, the average number of State of Alaska issued subsistence salmon permits fell to 3,146, with a harvest of 35,354 Sockeye Salmon per year (Conrad and Thynes 2024). The reasons for this decline are varied and complex, and include declining populations in rural communities, as well as loss of capacity and equipment to engage in harvesting activities (boats, nets, etc.).

Freshwater Salmon Habitat

Southeast Alaska has some of the most intact and highly functioning salmon watersheds in the world. There are over 13,000 miles of stream that directly support salmon habitat and another 40,000 miles of stream and about 213,000 acres of lakes and ponds that support other aquatic life on the Tongass. These various habitats include large mainland rivers and streams, smaller isolated island streams, and lakes, wetlands, and caves and karst, comprising some of the unique habitats in the region. These different habitats are discussed in detail in the [Aquatic Ecosystem](#) assessment including the relative function of the varying stream types and their influence on salmon habitats. The known number of salmon species for all watersheds in Southeast Alaska is shown in Figure 3.

All salmon species, and the other anadromous fish species on the Tongass National Forest, including steelhead, eulachon, and some Dolly Varden and cutthroat trout, spawn in freshwater, and spend varying life stages in salt water. The varying salmon species have different life cycles and utilize different freshwater habitat before migrating into the marine environment. When salmon return to spawn, they migrate back to their natal streams which are generally low gradient, free flowing, floodplain type alluvial habitats.

Tongass streams are categorized by stream class based on fish values, and process groups depending upon stream geomorphology. There are four categories of stream class including Class I for anadromous fish or adfluvial (migrating to a lake) fish, Class II for resident fish or fish habitat, Class III for perennial or intermittent stream without fish, and Class IV for smaller intermittent and ephemeral streams. The Alaska Region Channel Type Classification System, discussed in the [Aquatic Ecosystem](#) assessment, defines the various process groups. High gradient contained process group source and transport sediments, and invertebrates for food, while the lower gradient floodplain streams are more depositional in nature and provide habitat for spawning adult and rearing habitat for juvenile salmon. Of the 53,000 miles of streams on the Tongass, nearly 60% are high gradient contained process group (HC) and about 9% are high value salmon habitat floodplain (FP) streams (USDA 2016a).

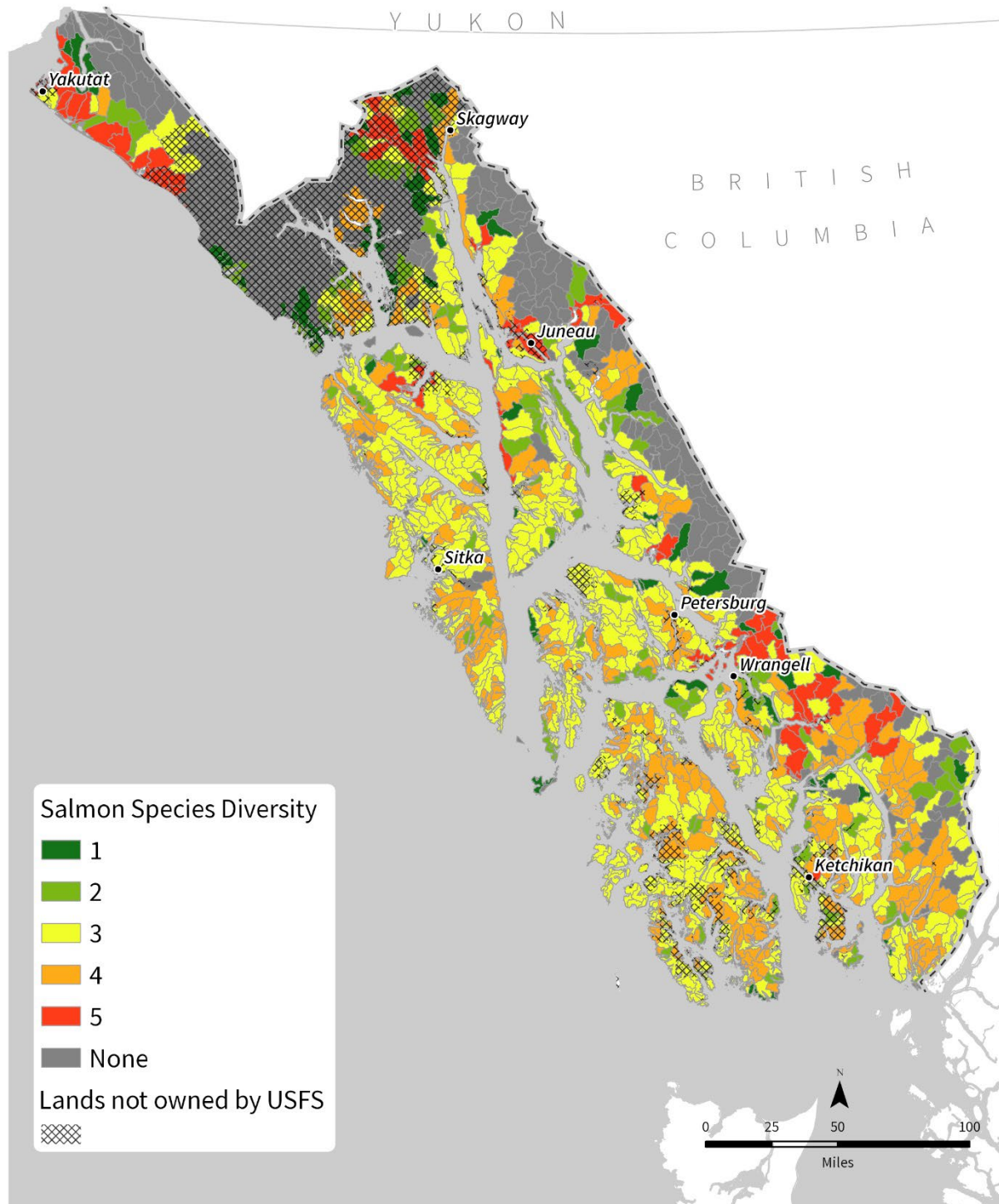


Figure 3. Diversity (count) of unique salmon species documented in watersheds across Southeast Alaska. Species include Chinook, chum, pink, coho and sockeye salmon. Data from Alaska Department of Fish and Game Anadromous Waters Catalog (ADF&G 2025a). Note that these reflect where salmon species have been observed and reported; other stream reaches that have not been surveyed may also be used by these species

Lakes offer high quality spawning, rearing and refugia for a variety of salmonid species and other aquatic organisms. While some of the lake systems are alpine areas and inaccessible to fish, other areas include wetland ponds and lower elevation lake systems which anadromous fish can access. Approximately 3,000 lakes and ponds are defined as anadromous or high-value resident fish habitat. Lakes accessible to salmon are classified as essential fish habitat. Large anadromous lake systems accessible to communities in Southeast Alaska are especially important for subsistence, personal use, and cultural harvesting of salmon.

Karst landscapes, dominated by limestone bedrock, also support salmon habitat and are associated with higher numbers of juvenile salmon. Karst landscapes dominate the northern end of Prince of Wales Island, portions of Kuiu and Chichagof Island, and smaller areas throughout the region. Because karst areas evolve from limestone or other carbonate type bedrock, they process water differently than other geologic types. In karst areas, solution chemistry results in subsurface flow through sinks, cracks, and caves. The geochemistry associated with karst development contribute a high primary productivity aquatic environment through its carbonate buffering capacity that reduces water acidity to create more productive waters (Wissmar et al. 1997 and Bryant et al. 1998). Karst associated streams on Prince of Wales Island are associated with the higher number of juvenile salmon (Bryant et al. 2011), unique niches of invertebrate habitats and high value fish habitats (Groves and Hendrickson 2011).

Estuaries are a mixing area between freshwater and saltwater and function for both spawning and rearing habitats for salmon. The shape and size of an estuary is a function of watershed size, stream gradient, geologic history, and daily tidal fluctuation. Large estuaries, such as the Bradfield River occur at the outlet of large mainland streams and smaller estuaries occur at the outlets of smaller watersheds on the coastal islands like Stoney Creek or 12 Mile River on Prince of Wales Island.

Estuary habitats change when sea-level changes. Southeast Alaska sea level change is extremely complex due to the influence of both large-scale continental icesheets and smaller scale more isolated glaciers. This variation in glacial extent has resulted in varying degrees of glacial rebound (land level rise and relative sea level lowering) or subsidence (land level lowering and relative sea level rise) (Baicthal et al. 2021). The habitat changes associated with sea-level rise or fall are outside the effects of forest management, but can be considered in creating an adaptive plan that acknowledges needs to address future changes.

Palustrine type channels with few streamside trees generally develop in upper portions of estuary areas making riparian area timber harvest less available. Since estuaries are generally wetter than uplands, it is also generally less desirable to build roads in these areas. While standards and guidelines provide guidance for estuaries through beach buffers, there are few current guidelines specific to estuary function protection.

Salmon Species Habitat and Lifecycles

Salmon start their lives as eggs in freshwater stream gravels or lakeshore margins, moving to the estuaries in their early life stages, living in marine ecosystems for 1-5 years, and finally returning to their natal freshwater habitats at the end of their lives, where they die after spawning, and deliver vital marine-derived nutrients to the water and adjacent riparian areas and forests.

All Pacific salmon need cold, moderate-to-fastmoving freshwater, at sufficient depths to spawn and migrate to and from their stream of origin. In systems with lakes, some salmon species can rear for one or more years in the lakes, particularly coho and sockeye. Some species and individual populations spawn in lakes, while others spawn miles upstream from the ocean, and others spawn at the mouth or lower sections of rivers. All species in Alaska migrate into salt water to mature. Because their lifecycle spans

many different aquatic habitats, conditions in streams, rivers, lakes and the marine environment can affect their survival and fitness. The known distribution of each salmon species, by watershed, is shown in Figure 4.

Chinook salmon have the most limited range of the salmon species on the Tongass National Forest. Because they are a larger species, they often select for larger spawning gravel and therefore larger rivers. Most runs in Southeast Alaska are found in mainland rivers with headwaters in Canada. There are more than 85 identified stocks of Chinook in Southeast Alaska (Halupka et al. 2000). Many of these populations are small, with only three rivers (Stikine, Taku and Alsek River systems) supporting runs greater than 10,000 fish, and nine others receiving runs greater than 1,500 fish (Pahlke 2010). The King Salmon River, Wheeler Creek and Greens Creek on Admiralty Island are the only wild stocks found in island drainages (Armstrong and Hermans 2004, Guthrie and Wilmot 2004).

Sockeye salmon are associated with watersheds containing lakes, and are generally found in fewer systems than coho, chum, and pink salmon. Sockeye salmon are highly used in subsistence and personal use fisheries. Sockeye salmon abundance in some watersheds has been variable due to a variety of factors including shifts in freshwater and marine conditions and interception in mixed-stock fisheries. A mixed stock fishery is a fishing area or practice where multiple fish populations, differing in age, size, geographic origin, or genetic makeup, are caught together. This presents challenges for fisheries management, as it becomes difficult to target specific populations and ensure their sustainability.

Coho salmon are among the most widely distributed salmon across Southeast Alaska and are important contributions to both recreational, sport and commercial fisheries. As juveniles, coho salmon are highly migratory, utilizing diverse habitats throughout the year, and rearing in small, first-order tributaries to large, forested floodplains and side-channels. Coho most frequently encounter habitat stressors from past forest management activities and roads. Coho are considered a 'design species' for in-stream restoration in historically disturbed watersheds as well as fish passage improvement projects at road/stream crossings.

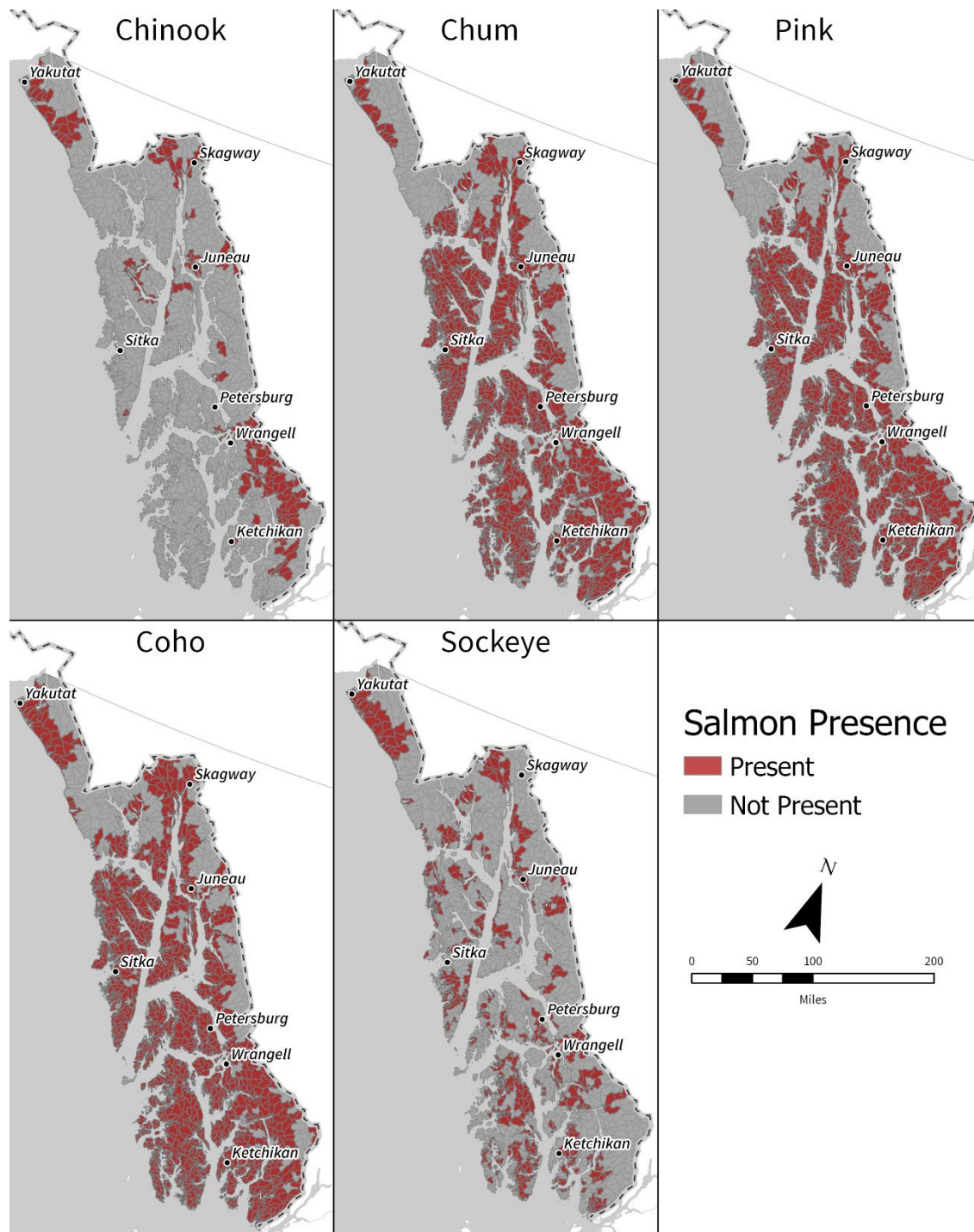


Figure 4. The known freshwater presence of each of the five salmon species in Southeast Alaska, by watershed. Note that these reflect minimum presence, where salmon species have been observed and reported; other stream reaches that have not been surveyed may also be used by these species. Data from the Alaska Department of Fish and Game Anadromous Waters Catalog (ADF&G 2025a).

Pink salmon, the most abundant of the five salmon species in Alaska, commonly spawn in lower reaches of streams and upper intertidal areas and are less reliant on freshwater habitat (Alaska Sustainable

Fisheries Trust 2024). Young pink salmon migrate directly to the ocean after emerging from the gravel. They have the shortest life span of the Pacific salmon with a 2-year life cycle resulting in even-year and odd-year runs (Meehan and Bjornn, 1991). Once they migrate to saltwater, pink salmon school and remain near estuaries and beaches until they move to deeper offshore waters (ADF&G 2025b). Prince of Wales Island has the most spawning habitat in the region. Pink salmon have comprised 64% of Southeast Alaska’s total salmon harvest in the last 10 years (Conrad and Thynes 2025). Pink salmon numbers declined in the late 2010s, likely due to drought conditions and a marine heat wave but have rebounded since. The 2023 harvest of about 48 million fish was well over the 19 million forecast (Alaska Sustainable Fisheries Trust 2024).

Chum salmon typically spawn in in the lower reaches of streams and within the tidal zone. They prefer small to medium slow flowing, spring fed side channels but can also be found in a wide variety of other habitats. After emergence, fry spend a few days to several weeks in the stream before migrating to nearshore habitats of the ocean. Juvenile chum salmon remain in the nearshore for several months before moving to the open ocean. During this time, they rely on estuaries for rearing and growth (Alaska Sustainable Fisheries Trust 2024). While in the near shore, shallow eelgrass beds are particularly important feeding grounds for juvenile chum salmon (ADF&G 2025c). Chum salmon populations hit a low in the 1960’s and 1970’s but following the start of Alaska’s hatchery program, chum numbers have rebounded. Chum salmon made up 41% percent of the 2024 commercial salmon harvest with most being hatchery produced fish (Conrad and Thynes 2025).

Threats to chum salmon include climate change, over-fishing, competition from hatchery fish, and habitat loss (ADF&G 2025c). Runs were poor in 2020 when chum entered the ocean during the end of the 2014-2016 marine heatwave. Wild chum escapements have improved since 2020 for most stocks with peak escapements for many stocks occurring in 2023 (Alaska Sustainable Fisheries Trust 2024).

Status and Trends

Drivers and Stressors

Climate

Climate factors, such as rainfall rates and temperature, have direct influence on the function and condition of salmon habitats. As climate conditions change through time, there can be associated changes in the habitats (Edwards et. al. 2013, Bellmore et. al. 2023, and Dunkle et. al. 2023). As mentioned in the [Drivers, Stressors and Climate Change](#) assessment, Southeast Alaska climate is trending towards warmer and wetter climate, and changes in precipitation intensities which influence peak and low flows. Higher and more frequent peak flows may increase erosion and result in excessive sedimentation in salmon habitats. Increased rainfall intensity and peak flows may also result in more landslides. Landslides are a natural disturbance which can contribute large wood to stream for salmon habitat, but landslides can also contribute sediment impacting salmon habitat.

As mentioned in the [Geology and Geologic Hazards](#) assessment, increased frequency and intensity of extreme weather events have resulted in increased frequency of landslides (Thoman and Mcfarland 2024) and increased the impacts to people in Southeast Alaska. Increased landslide frequencies may push a stream beyond its ability to function with excessive inputs. While landslides are part of the natural process in Southeast Alaska, they can be influenced by poor road drainage. To minimize road contributions to landslides, it is critical to maintain sufficient drainage along and across roads and

minimize road densities where possible. Regular assessment and road drainage maintenance could reduce road-related impacts to salmon from landslides and other associated erosion.

Warmer summer temperatures and decreased summer rainfall may lead to increased salmon die-offs. Salmon die-offs have been documented in Southeast Alaska streams and recent studies suggest die-offs related to hypoxia may be increasing (Seargent et al. 2023). Hypoxia is a water quality condition where dissolved oxygen, which salmon depend on, is depleted. These conditions generally occur during low streamflow periods when high numbers of fish are instream (often during summer months). Using modelling approaches, Seargent et al (2017;2023) found highest potential for hypoxia in low gradient stream reaches, with low reaeration rates, regardless of stream temperature.

Researchers in Southeast Alaska have been using climate scenarios to evaluate ecological interactions and potential success of salmon (Sloat et al. 2017, Bellmore et al. 2022, 2023; Dunkle et al. 2023, 2025). Using an aquatic modelling approach Bellmore et al. (2023) considered projected changes in climatic extremes on Coho Salmon, including high and low flows events, and warm water. Their results show that salmon populations in rain-fed watersheds may be highly sensitive to extreme climate conditions, especially high flow events that scour salmon redds (nest for fish eggs, built in stream bed gravel) (Sloat et al. 2017), whereas salmon populations in glacier- and snow-fed watersheds may be more resistant to the effects of climate extremes. Sloat et al. (2017) reported negligible effects of scour on salmon habitats from projected increased high flows on lower gradient salmon habitats in Southeast Alaska; however, higher gradient, coho habitats, may experience increased scour and altered conditions for spawning and rearing salmon. That said, high flows are also associated with high fluxes of food resources, which have been shown to contribute to greater juvenile salmon food consumption and growth (Fitzgerald et al. 2023). Other research indicated that the diversity of glacier-, snow-, and rain-fed streams in the region supports a diversity of aquatic habitats and food webs (Dunkle et al. 2023, 2025) that contribute to the stability of salmon returns through time (Bellmore et al. 2022). However, meltwater contributions to surface water runoff are declining rapidly with retreating glacier and ice/snow fields, potentially homogenizing the habitats and food webs that salmon rely on (Bellmore et al. 2022).

Continued modeling and verification will improve the understanding of the changing conditions and provide insight into critical habitats for climate refuge. Considering the spatial variation of potential climate effects on salmon habitats will assist in prioritizing areas for conservation and restoration. Stream temperature monitoring is critical to better understand the stream temperature effects of warming air temperature.

Hatcheries

Hatchery fish may lend additional stress to natural habitats. Increased numbers of fish in freshwater streams can increase biological oxygen demand beyond the potential for replacement via reaeration with the atmosphere. Seargeant et. al. 2023 used a modelling approach to determine potential effects of hatchery fish on mortality of adult spawning salmon. The authors used GIS spatial analysis and mechanistic modelling of dissolved oxygen to show approximately 17,000 km of stream reaches in Southeast Alaska which may be more vulnerable to hypoxia due to their proximity to hatcheries.

Timber Harvest

Removal of trees in riparian areas can also impact the natural habitat that salmon depend on. In a study of fish populations and stream habitats on the Tongass, researchers found the amount of old growth trees, in the habitat can potentially buffer impacts to the salmon. The study found that fish may have greater opportunities for refuge from late summer, low flow conditions in watershed with greater than 42% old growth (Flitcroft et. al. 2022). Timber harvest along streams has been buffered on the Tongass since the

implementation of Tongass Timber Reform Act (TTRA) in 1992; however, effects of harvest practices prior to TTRA have altered forest ecosystems. Historical timber management resulted in selection and removal of trees specifically in riparian areas. Streamside trees in the riparian areas are important for recruitment of large woody debris to the stream, for the maintenance of stream bank integrity and salmon habitat features such as pools. Recent publications suggest key large wood is decreasing in all streams, regardless of management history (Flitcroft et al. 2022). Maintaining the existing buffer strategy in the forest plan and further developing guidelines for windfirm buffers in upstream contributing areas, will maintain existing habitats and help support streams where pre-TTRA regulations resulted in loss of streamside trees.

Current forest management buffers timber harvest from areas adjacent to salmon streams but some of these areas become subject to windthrow. Windthrow is a natural disturbance process that can contribute large wood to salmon habitats when it occurs adjacent to streams. Historic patterns of windthrow are tied to landscape exposure to storm events, though small scale (single to several tree) blowdown can occur even in less wind prone areas. Windthrow patterns can be altered when climate conditions lead to changes in wind patterns. Windthrow patterns can also be influenced by timber harvest. While windthrow occurs commonly adjacent to harvested areas, the effects in riparian areas are most pronounced in steep areas where harvest occurred on both size of a stream, where a strip of trees is left along the stream but trees are cleared on the outside of that buffer (USDA, 2021). See the [Aquatic Ecosystem](#) assessment for further information about buffers.

Personal Use

While current riparian buffer requirements prevent commercial timber harvest adjacent to salmon streams, the removal of trees for personal use in riparian areas is not restricted. The removal of these trees from the riparian area decreases the wood recruitment opportunities for salmon habitats. While individual tree removal may be inconsequential to the overall wood budget, continual reduction in riparian trees adjacent to salmon streams may have compounding effects. There is a need to consider whether personal use timber harvest should follow TTRA riparian area buffer requirements, to increase consistency of riparian area buffers. Considerations include the potential effects of personal use timber harvest to salmon and other aquatic habitats over the long term.

Infrastructure

Roads can affect salmon habitat by reducing access to areas upstream and altering the condition of existing habitats. The Tongass National Forest maintains approximately 5,000 miles of forest roads with 3,743 known road/stream crossings with fish present. As of 2024 approximately \$41.8 million has been spent replacing and removing culverts that act as fish barriers. The level of road maintenance and road improvements is variable across the forest depending upon management priorities and funding. The [Infrastructure](#) assessment details road management on the Tongass.

Road use and stream crossings can also lead to erosion and sedimentation into water bodies. The degree of impact is relative to the proximity of roads to streams. Stream crossings, and roads adjacent to streams have the highest direct influence on sedimentation in streams. Roads on steep hillslopes with poor drainage can have indirect influence on sedimentation when landslides or hillslope failure occur. Maintaining road drainage is critical to minimizing sediment contribution and effects to salmon habitat. The [Watershed Condition and Water Resources](#) assessment includes more discussion of impacts on roads and timber harvest to water quality and stream morphology.

Dams can also have an impact on salmon as they can alter the flow of water and devoid salmonid habitats of critical substrate. By altering streamflow and the movement of sediment, dams can also interrupt the

movement of nutrients. Large dams which are generally developed for water sources or sources of energy are discussed in the [Energy and Minerals](#) assessment. Removing dams that are no longer needed can improve salmon habitat, and new dam proposals are weighed for benefits to communities and possible major effects to salmon in the dammed stream.

Mining

Salmon habitats can be affected by the physical and chemical influences associated with mining. There are several large-scale mines on the Tongass National Forest and many other smaller scale mining operations. Mining by-products, such as tailing and waste rock storage, have the potential to leach toxic chemicals into surface waters and impact salmon and other aquatic habitats. Mines authorized by the USFS have active water quality, biotic and abiotic monitoring programs, required by the State of Alaska and the Forest Service. Despite mitigations and robust monitoring programs by mine operators, there have been two recent spills at Kensington mine, one of which resulted in a fish kill in the lower reaches of a stream.

Wetland impacts associated with mines have largely been avoided through planning or mitigated for offsetting direct impacts. Mitigation opportunities from local mines have resulted in some stream and wetland restoration activities through mitigation banking and other mechanisms.

Salmon Habitat Trends

Salmon habitats affected by Tongass National Forest management are largely trending towards improved function and condition due to active and passive restoration efforts. The trend of salmon habitats related to changes in climate are more difficult to determine and effects of glacier retreat and resulting isostatic rebound on portions of the forest are variable with respect to quantity, availability and utilization of aquatic habitats. Maintaining watershed function, including surface water connectivity, fish passage across roads, and creating both spatial and temporal diversity in upland and riparian vegetation treatment design, are active management tools that help to support salmon habitats through natural changes in climate.

The Tongass National Forest uses a variety of methods to track aquatic habitat conditions. Project level monitoring is established on a sub-set of projects to ensure project objectives and best management practices have been met. Forest-level monitoring is done to evaluate the implementation and effectiveness of Forest Plan Standards and Guidelines, and the watershed condition framework tracks watershed condition over time (see [Watershed Condition and Water Resources assessment](#)). Additional monitoring and research have been done to address specific questions (such as wind firmness along riparian areas) or assess large datasets to support long term research for sustainable habitats.

The Watershed Condition Framework is a process used to track physical and biological conditions of the aquatic environment and identify priority areas for watershed restoration. As detailed in the [Watershed Condition and Water Resources](#) assessment, all of the 921 watersheds on the Tongass are ‘Properly Functioning’ using the parameters of the Framework; however, there are physical and biological attributes in some of the watersheds that are causing specific habitat impacts, even though the watersheds as a whole are rated properly functioning.

The watersheds that were most impacted included Stoney Creek, Eagle Creek, Twelvemile Creek and Skanaxheen (formerly Saginaw) Creek where dense large conifer stands and wide valley-bottom floodplain areas provided easy harvest access to high value timber stands. These same watersheds were also some of the highest value fisheries watersheds in the region. The impacts are mostly legacy from before the 1990 TTRA. These historically highly impacted riparian areas within high value salmon

watersheds have been a priority for restoration by the Tongass National Forest, along with communities, tribes, and non-governmental organizations.

Salmon Species Trends

In general, salmon populations throughout the Tongass National Forest are stable, though subject to considerable annual and geographical variations. The notable exception to stability is Chinook Salmon, which have experienced poor productivity throughout the region in recent years. Chinook salmon spawn in a limited number of river systems, most of which are large transboundary watersheds. These populations are intensively monitored, and fisheries on Alaska-origin stocks have been severely curtailed as a conservation measure. A petition was filed to list Gulf of Alaska Chinook salmon as threatened or endangered under the Endangered Species Act. National Oceanic and Atmospheric Administration Fisheries found the petition presents information indicating the listing may be warranted, initiating a formal status review (see also [Federally Recognized Species](#) assessment).

Most streams that do not have natural or anthropogenic physical barriers support at least one species of salmon (Armstrong et al. 2016). Due to the diverse life histories and broad geographic distribution of all species of salmon across Southeast Alaska, Forest Service land management activities have the potential to maintain, increase, or negatively impact salmon distribution and abundance at a variety of scales. Habitat quality is strongly correlated to salmon productivity. However, salmon escapement trends are not always a direct index for habitat suitability due to confounding factors such as commercial salmon interception, hatchery input and hatchery strays, and changes in ocean conditions.

The most common metric used for the health of salmon stocks is escapement, or the number of salmon that survive and return to freshwater to spawn. The sheer number of spawning streams in the Tongass National Forest precludes monitoring each stream individually, so managers typically concentrate data collection efforts on major systems or use smaller systems as indicators of wider regional trends. The escapement can be measured using a variety of tools, such as weirs, mark-recapture projects, spawning grounds surveys, or aerial surveys. Weirs provide the most accurate escapement data, but are expensive to operate, while spawning grounds and aerial surveys can be used over wider areas or to monitor more systems. Alaska Department of Fish and Game aerial surveys are used to monitor pink salmon escapements in over 700 streams across southeast Alaska (Piston & Heintz 2021).

Many salmon stocks in southeast Alaska have established escapement goals, which reflect the number of spawning salmon needed to provide a salmon population that can support a sustainable fishery. Escapement goals are calculated using historical salmon escapements and the resulting number of returning adult salmon (Munro 2023). These goals are developed by ADF&G and approved by the Board of Fish. Currently, there are escapement goals for 11 Chinook salmon stocks, 8 chum salmon stocks, 13 coho salmon stocks, 12 sockeye salmon stocks, and 3 pink salmon stocks in Southeast Alaska. While most of these goals are for an individual system, several are for aggregate spawning populations in a region. For example, the escapement goal for Southern Southeast Subregion Pink Salmon includes 366 index streams throughout the islands and mainland of southern southeast Alaska, which are monitored as a unit (Piston and Heintz 2021). Most populations are meeting escapement goals in most years, with some exceptions. For example, of the 12 Sockeye Salmon stocks with escapement goals, 9 met or exceeded their goals in 2023.

Another metric used to assess the health of salmon stocks is fishery performance, or the number of salmon caught in fisheries. Fishery performance is especially crucial for in-season management of salmon fisheries, when managers can use it to adjust management during the fishing season. Typically, managers use the catch per unit effort, such as the number of salmon caught per boat, as a measure of salmon

abundance. Fishery performance measures can be used on a range of time and geographical scales. For example, commercial fisheries managers may monitor the number of fish per boat caught, during a single day of commercial opening, to assess run strength over a wide area, while subsistence fisheries managers often use the number of fish caught per harvester at a particular stream over number of years to monitor a run in a single stream.

Tongass National Forest Management

The current Forest Plan includes extensive direction for salmon habitat maintenance and improvement. The management direction is spread throughout the plan, including the forestwide direction for fish, riparian, soil and water, timber, transportation, and young growth, and also included in management area specific plan components. Beyond plan components, the 2016 Record of Decision identified conservation priority areas including high value salmon habitats. Numerous partners including Audubon Alaska, The Nature Conservancy, and Trout Unlimited contributed to the collaborative effort and recommendations.

Many of the stressors to salmon are related to marine conditions and not under control of the Tongass National Forest land management plan. The current Forest Plan contributed to improving trends and generally contains adequate direction to continue improving trends for aquatic ecosystem conditions. Below are salmon-related management actions on which the Tongass management currently focuses on.

Watershed Inventory and Restoration

The watersheds most impacted by past timber harvest and road building have been the focus for restoration since the 1997 Forest Plan. Restoration actions, such as road storage, culvert improvements, riparian area thinning, and instream wood additions have led to salmon habitat improvement. Watershed Restoration Action Plans have been completed for 6 watersheds on the Tongass including Staney Creek, Sitkoh River, Sitkoh Lake, Iris Creek Meadows, Harris River and Twelvemile Creek. An additional four watersheds are near completion (Margaret Lake, Spasski Creek, Shaheen Creek, and Eagle /Luck Watersheds). There are currently 8 active Watershed Restoration Action Plans with ongoing instream, riparian area, and road improvements planned. Rates of restoration have largely been governed by availability of habitat assessments validating the need for restoration, staff availability and expertise, and funding.

Fish habitat collaboratives such as the Southeast Alaska Fish Habitat Partnership provide an avenue for strategic planning and partnership development in support of salmon habitat inventory and restoration. Forest Partnerships have also been established across the Tongass to work cooperatively with tribes, other stakeholders, and adjacent landowners, to build capacity and effectively meet the goals of the forest and the communities which rely on its fish, wildlife, plants, and locally-sourced wood resources. Restoration across the forest would not have been possible without the tremendous contribution from restoration partners. The Southeast Alaska Sustainability Strategy (SASS) has been established to increase capacity of partnerships and integrate workforce capacity at a local level to meet restoration, recreation, resilience and other forest management objectives. To continue restoration that meets the needs for salmon habitat improvement and community priorities, it is important that the revised Forest Plan emphasizes or provides direction that encourages continuation and expansion of such partnerships.

Road-Stream Crossings

Identifying, prioritizing, and restoring fish passage barriers at road crossings is essential to improving salmon and other anadromous fish habitat. Fish passage inventory and analysis has been a priority for the Tongass since the early 1990's when formal Road Condition Surveys (RCS) began, and the resultant information created the water crossing database. Road crossings that are blocking, or otherwise inhibiting

fish passage, are considered ‘red’ crossings. There are currently 1,170 red crossings (classified as partial or full fish passage barriers) accounting for 31% of the total inventoried fish crossings. While most of these barriers exist along resident Class II fish streams, 175 of the crossings, or 15% of the identified red crossings, are along Class I anadromous salmon streams. These remaining Class I ‘red’ crossings are estimated to impact fish access to approximately 40 miles of upstream salmon habitat.

Since 1998, approximately 702 culverts, 227 of which are anadromous crossings, have been removed, replaced, or retrofitted to restore access to approximately 100 miles of anadromous and 119 miles of resident fish habitats. Prioritization of road crossing improvements is based on the extent to which the crossing is affecting passage ‘barrierity’ (an estimate of barrier severity of the crossing) and the quantity and quality of upstream habitat. Failing structures at the end of their service life are replaced based on access needs regardless of quantity and quality of fish habitat. Continued maintenance of road drainage, and improvements to road crossings will retain access to fish habitats and support properly functioning ecosystems. Improperly located, installed, or maintained stream crossing structures can restrict migration of salmon to upstream habitats. Obstacles include vertical barriers, debris blockages, and undersized structures that constrict the channel. Most of the problematic stream crossings on the Tongass were installed prior to the implementation of the 1997 Forest Plan standards and guidelines for culvert installation. Current road construction regulations require fish passage at all salmon and resident fish crossings. Most fish passage is attained through stream simulation, geomorphic, or no –slope design approaches depending on site conditions to promote long term fish passage. These improvements in road design result in more resilient crossings that better attain clean water and fish habitat objectives, and reduce plugging, debris flows, and landslide potential.

It is essential to continue road improvements to maintain and restore both access to, and condition of, the habitats supporting salmon and other species. Integrating road maintenance requirements and minimum standards for emergency repairs into the forest plan would better maintain fish habitats and provide fish passage across roads for the long term. Adequately funding road maintenance budgets that align with use, size, and extent of road systems, and risks posed by increasing extreme weather events, would further support the long-term sustainability of roads and salmon.

Water Quality at Mines

Most monitoring completed adjacent to and downstream of mines shows compliance with water quality standards (Kanouse and Fritz 2020, Lindgren and King 2023). Some results have shown increases in metal concentrations in sediment and fish downstream of mining activities, relative to areas without known mining, but the majority of samples meet water quality standards.

Monitoring at Greens Creek Mine on Admiralty Island has shown a downward trend in water quality in associated salmon habitat at Tributary Creek. The recent downward trend has resulted in a Category 4b listing of Tributary Creek by Alaska Department of Environmental Conservation. The mine is implementing source control and other activities to minimize fugitive dust as an attempt to meet attainment goals for improved water quality and habitat conditions. The Forest Service is increasing its capacity to actively engage with State of Alaska and industry to refine monitoring programs and identify remaining risks to water quality and fish.

Habitat Trend Monitoring and Timber Harvest

Salmon habitats on the Tongass were impacted in the early days of large-scale logging from the late 1950’s-1992 (1992 being when the TTRA was enacted). Since that time, riparian area harvest buffers have largely resulted in sufficient riparian stands to support habitat integrity in those areas, with improving trends for salmon habitat. Monitoring and research into effects of past management, restoration, and

current management to salmon stream habitat conditions is ongoing and important to inform future management. Recent forest plan monitoring and research is suggesting minimal differences between the broad management types of managed, restored, and old growth dominant riparian habitats in the Tongass Watershed Restoration Effectiveness Monitoring (WREM) project. This lack of significant difference between management types could be explained by successful decision making on the use of passive or active restoration. The research shows that buffers and active restoration have been successful, though may need some review and updates to apply monitoring results.

The revised Forest plan should continue the use of buffer protections, encourage frequent road maintenance, and support ongoing stream restoration where riparian areas have been compromised. These types of management approaches will further the persistence of productive salmon habitats on the Tongass.

Key Findings

- Salmon represent significant economic, ecosystem, and cultural functions and values on the Tongass. Their self-sustaining diversity and abundance in Alaska is unique in the National Forest System.
- Existing Forest Plan standards and guidelines associated with streams and riparian areas have been successful in maintaining the integrity of existing habitats and supports the resilience of previously harvested riparian areas, with some possible exceptions. The Forest Plan revision presents an opportunity to review and clarify standards and guidelines to ensure they meet changing conditions and consider current scientific information.
- Standards and guidelines limit commercial timber harvest from riparian areas to maintain flood resilience and retain salmon habitats. Other riparian harvest opportunities, such as personal or cultural use, result in fewer riparian trees and potential impacts to salmon habitat and those effects can be considered as part of the revised Forest Plan.
- Road maintenance is critical to providing access to timber, recreation and food resources. A more consistently inventoried and better funded road maintenance program would more effectively support access and minimize resource risk.
- Continued research would be necessary to evaluate stream hypoxia associated with summer low flows, warmer stream temperatures, and hatchery fish influences. Additional research would also be needed to evaluate projected climate conditions and the ability for salmon to adapt to these changes in freshwater environments.
- Impacts from over-escapement, straying, redd superimposition, and other direct and indirect effects from hatchery fish may impact wild salmon. These tradeoffs may be considered when administering/approving special use permits for hatchery operations and associated release sites.
- While the effects of commercial fishing, sportfishing, and changing ocean conditions are outside the realm of forest and land management planning, these harvest patterns and environmental conditions may have direct impacts on the numbers of salmon returning to their natal streams and contributing to the people of the region. Habitat conservation measures on the Forest are intended to buffer these effects to the extent practicable.
- Expansion of mining extent and duration may trigger a need to ensure there is monitoring, adaptive management, and active mitigations to maintain water quality.

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