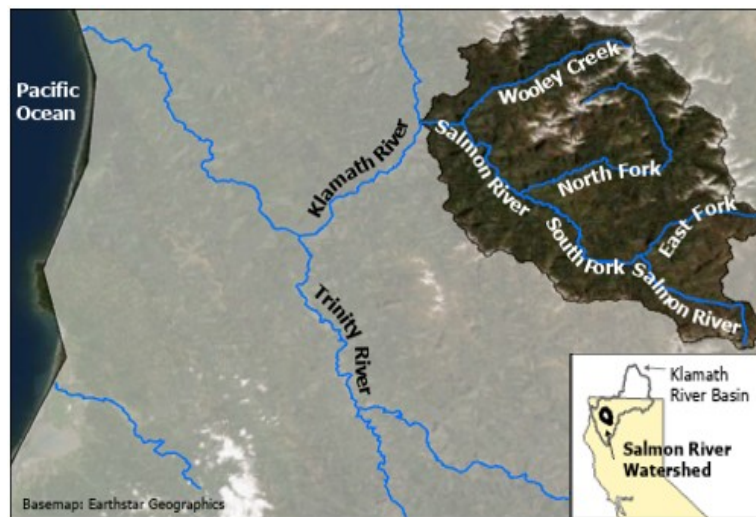
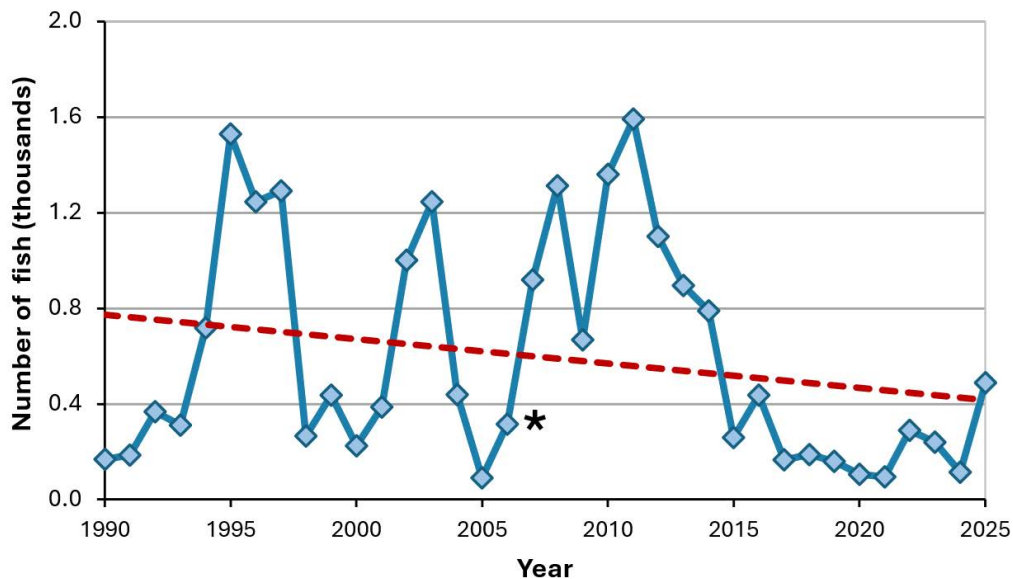


3.16 Chinook Salmon Abundance

Chinook salmon (*Oncorhynchus tshawytscha*) are born in freshwater, grow in the ocean and return to rivers to spawn. California populations, while resilient, are increasingly unable to withstand the combination of long-standing habitat degradation and the accelerating pressures of climate change. The population decline is underscored by the closure of the state's commercial salmon fishery in 2025 for the third consecutive year.

Figure 3.16.1. Salmon River Spring-Run Chinook Salmon.



The counts show annual counts from 1950 to 2025 of total returns of adult and grilse, which are precociously mature Chinook that are 2 years old, reported from spawner escapement surveys, river harvests, and run-size estimates. *Fish surveys in 2006 were not conducted due to regional wildfires; instead, the value for 2006 is an estimate based on the historic average. Source: Salmon River Water Council (2025, top graph) and USGS (2019, map)

What does the indicator show?

This indicator tracks returning adult Chinook salmon abundance in two key systems: the Salmon River in the Klamath Basin and the Sacramento River in the Central Valley, which contains the Sacramento River and San Joaquin River basins. Together, these basins support most of California's remaining Chinook salmon runs.

Tribal Connection 3.16.1

The Eel River in Northern California historically supported one of the largest salmon runs in the state (CalTrout, 2025). Salmon or *malhuk* are culturally significant species for the Wiyot Tribe who inhabit the Eel River or *Wiya't* watershed. According to the Tribe: *"In Wiyot oral history, there were so many salmon before colonization that one could cross the river by walking on their backs. It is likely that nearly a million salmon returned to the river in a good year (Yoshiyama and Moyle, 2010). Post-colonization damming, logging, agriculture, and over-harvesting reduced salmon populations by as much as 99%, significantly reducing their ability to respond or adapt to climate change-related events. [...]. The Wiya't, its tributaries, and the Baduwa't [Mad River] support ecologically distinct populations of California Coastal Chinook salmon (Oncorhynchus tshawytscha), which are currently listed as threatened under the Federal Endangered Species Act (ESA). Chinook counts have been below average for the past 6 years and the population shows no long-term trend for recovery, remaining at high risk of climate vulnerability"* (Wiyot Tribe, 2026).

Spring-run Chinook abundance in the Salmon River has declined sharply since 2011 (**Figure 3.16.1**), from almost 1,600 fish in 2011 to 489 fish in 2025. While 2025 count showed an uptick in abundance – the highest count since 2014 – the return remains below long-term average for the 11th consecutive year. The Salmon River supports the



largest remaining wild spring-run Chinook population in the Klamath Basin and is largely free of dams, hatcheries, and major water diversions. The Upper Klamath-Trinity Rivers spring-run Chinook are listed as threatened under the California Endangered Species Act (CESA).

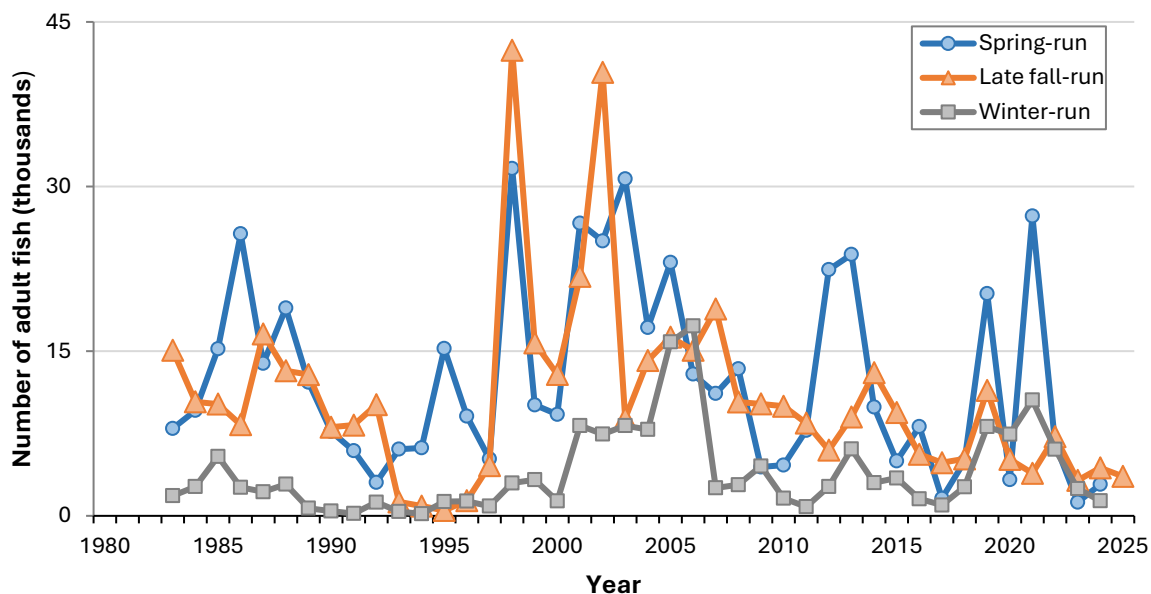
Unlike the Salmon River, Chinook populations in the Sacramento River are heavily influenced by dams, water diversions, and infrastructure (Michel et al., 2021). In the Sacramento River, all four Chinook runs—fall, late-fall, winter, and spring—have declined since about 2000 (**Figure 3.16.2** and **Figure 3.16.3**). The Sacramento River system supports the world's only winter-run Chinook salmon, which is listed as endangered at both the state and federal levels and frequently falls below 5,000 spawners annually, far below historical runs of 200,000 spawners per year. Winter-run Chinook salmon population had historical spawning habitat completely blocked with dam construction circa 1940 and now relies on managed cold-water releases from Shasta Reservoir for spawning and egg incubation. Fall-run Chinook, historically the most abundant run, peaked in the late 1990s and early 2000s but has declined and is now designated a Species of Special Concern by the California Department of Fish and Wildlife. The fall-run Chinook population is a fishery target, so the escapement numbers reported below in **Figure 3.16.3** represent only the fish that were not caught, except in years when the fishery was closed. Another factor to consider is that harvest levels tend to increase in years when larger runs are forecast. Spring-run Chinook, listed as threatened, shows high interannual variability but remains far below historical abundance.



Tribal Connection 3.16.2

Chinook salmon used to run from the Sacramento River up the Yuba River and were a central part of the diet of Nisenan people living in the Yuba watershed. In *Impacts of Climate Change on the Nevada City Rancheria Nisenan Tribe*, the author writes: “Populations were drastically reduced by mining, dam construction, and overfishing throughout California’s colonization and mining period, and now face additional threats from heat and drought. Chinook salmon [...] have access to less than a third of their historic spawning range in the Yuba River (The Nature Conservancy, 2025). The accessible portion is in the lowest and hottest part of the watershed and suffers from ongoing gravel loss and poor water quality. The numbers of Chinook returning to the Yuba River continue to decline” (Nisenan, 2026).

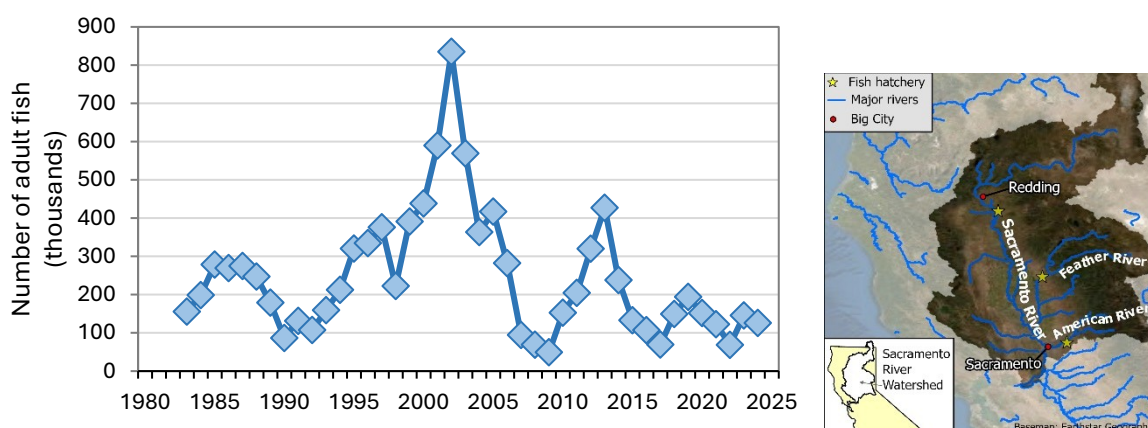
Figure 3.16.2. Sacramento River Chinook Salmon Abundance: Winter-, Spring-, Late-fall- Runs.



The figure above shows Sacramento River Chinook salmon abundance for the spring, late-fall, and winter runs, which are much smaller than the fall-run population. Source: CDFW (2025a)



Figure 3.16.3. Sacramento River Fall-Run Chinook Salmon Abundance.



The figure above shows the number of returning adult Sacramento River fall-run Chinook from 1983 to 2024. These data show returns, including hatchery returns, to the Sacramento River and its tributaries. The San Joaquin system, which meets the Sacramento River at the delta, is not included. Source: CDFW (2025) (left) and USGS (2019) (map, right)

Why is the indicator important?

California salmon populations are increasingly vulnerable to climate change.

Historically, millions of salmon returned annually to California rivers; today, populations are a fraction of those levels and increasingly dependent on hatcheries (CDFW, 2024a). If current climate trends and human stressors persist, nearly all of California's salmon populations face a high risk of extinction within the next century (Moyle et al., 2017; UC Davis, 2017). From 1995 to 2020, abundance trends across 28 distinct populations of Pacific salmon (*Oncorhynchus spp.*) that were listed under the US Endangered Species Act (ESA) showed that populations in California had lower median trends than those in the Pacific Northwest, likely due in part to climatic and hydrologic stressors such as extended drought, declining snowpack, increasing stream temperatures, decreasing minimum and maximum flows (Ford et al., 2025).

Salmon are among California's most valued natural resources. As a keystone species, they have a disproportionately large effect on the broader natural environment relative to their abundance. Salmon are one of nature's "force multipliers," super-charging



benefits across entire ecological communities (Schindler et al., 2003). Their health influences the whole ecosystem. They are food for other species. Their bodies enrich habitats through cycling of nutrients from ocean to rivers (CDFW, 2024a).

Chinook salmon historically supported healthy ecosystems and local economies and jobs in California. Chinook ocean fisheries generated approximately \$17.5 million in commercial revenue in 2021, declining to \$16.3 million in 2022 (CDFW, 2026) before closing from 2023–2025 due to extremely low adult returns (CDFW, 2025a). These closures have cascading economic impacts on fishing communities and related industries.

Tribal Connection 3.16.3

Salmon is celebrated in many aspects of Tribal culture, not only as a food source, but also as a species of cultural significance. For example, the Karuk Tribe's First Salmon Ceremony invokes the spring salmon run in the Klamath River; the Karuk also use the presence of salmon as an indicator of both riverine and forest habitat quality to guide traditional land management practices (Karuk Tribe, 2026). Prior to European contact, different runs of fish entering the Klamath River (of which the Salmon River is a tributary) provided for the needs of several tribes, including the Yurok, Karuk and Hoopa, with the spring-run Chinook as the only salmon available between late spring and early summer. Today, due to the greatly diminished abundance of the spring-run salmon, tribal harvest is limited in the Salmon River and sport fishing is prohibited (SRRC, 2022).

The Salmon River is the second largest tributary to the much larger Klamath River system (SRRC, 2020). The Salmon/Mid-Klamath watershed is considered one of the few salmon strongholds in the world, which means it resides within a major salmon ecoregion with historically high levels of wild salmon abundance, productivity, and diversity, and habitat quality capable of sustaining resilient wild salmon populations (Rahr III et al., 2025). Spring-run Chinook salmon were once widely dispersed throughout tributaries of the Klamath River upstream of the Trinity River confluence. Mining activities beginning in the late 1800s and dams built between 1918 and 1962



severely impacted the fish population in the Klamath region. The loss of beavers in California, including the Klamath watershed, due to hunting during the 1800s, has also impacted salmon populations. Beaver dams help create wetlands upstream of the structures which prevent silt from traveling downstream into the gravel streambeds where salmon spawn, create ponds of deeper, cooler water, and attract more insects for salmon to eat (Pollock et al., 2004). Beaver dams, unlike man-made dams, do not hinder the movement of salmon upstream (Pollock et al., 2022).

These fish are critical to the food security, cultural survival and well-being of indigenous people in the Klamath Basin including the Karuk Tribe (Karuk Tribe, 2016). The Salmon River does not have a hatchery, making this a unique refuge for wild salmon. Efforts to restore the Salmon River from mining, logging and other past land management practices have left it a remaining stronghold tributary in the Upper Klamath-Trinity River system for wild spring-run Chinook salmon. (Very low numbers of spring-run salmon are also found in the South Fork Trinity River and the New River, a tributary to the Trinity River).

Estimates of spawning escapement are extremely important to salmon management as an indication of the actual reproductive population size (Wells et al., 2014). The number of adults reproducing is important in defining population viability, as a measure of both demographic and genetic risks. It is equally important to manage harvest in the fisheries, which typically aims at meeting escapement goals such that the population remains viable (for ESA-listed populations) or near the biomass that produces maximum recruitment (for stocks covered by a fisheries management plan).

What factors influence this indicator?

Changes in climate can alter freshwater, estuarine, and marine habitats, putting salmon populations at risk. California Chinook salmon now encounters more stressful climatic conditions in freshwater bodies than those in which they evolved (Herbold et al., 2018; Moyle et al., 2013; Wells et al., 2014). As air temperatures rise, river and stream temperatures have increased and will likely continue to increase (see the *Salmon River Water Temperature chapter*). Warmer waters and lower flows increase juvenile salmon's exposure time to predators. Non-native predators in the Sacramento-San



Joaquin Delta consume more juvenile salmon when waters are warmer (Michel et al., 2021). High water temperatures can also increase Chinook salmon susceptibility to disease (Bergendorf, 2002). With warming air temperatures, more precipitation falls as rain instead of snow in the mountains (see the *Precipitation*, *Snowmelt Runoff* and *Snow-water Content* chapters), reducing the amount of snowmelt that provides cold water year-round to rivers and streams. During droughts, wetlands habitat availability and connections between salmon habitat areas are reduced and water quality is compromised (Crozier et al., 2019). Wildfires can also impact Chinook salmon in complex ways. In the short term, fires can cause deadly water temperatures spikes, reduce stream cover which further drives up water temperatures, increase runoff and erosion, and release toxic ash and fire retardants into the water. Over the long term, charred debris and fallen trees enrich river ecosystems, creating slow-water habitats that are beneficial for juvenile rearing (Becker, 2024; Flitcroft et al., 2016).

Streamflow is an important determinant of water temperature (Asarian et al., 2023; Moyle et al., 2017; Wells et al., 2014). River and stream temperatures are cooler when flows are high and warmer during years with diminished flows. Low summertime flows from lack of snowmelt together with warmer temperatures in salmon freshwater habitats can alter prey composition, riparian vegetation, and stream morphology. These changes in habitat affect salmon physiology and behavior in freshwater, which can in turn have consequences for growth and survival in the marine life stage. Significant reductions in cold-water river and stream flows in the summer may directly affect spawning, egg viability, rearing conditions and juvenile and adult migration (Martin et al., 2017, Munsch et al., 2019; Wells et al., 2014). Temperature and flow constraints on seaward migration timing may result in premature migrations when fish are small and vulnerable or before ocean conditions are favorable (Satterthwaite et al., 2014, Munsch et al., 2019, Goertler et al., 2024). Scientists have identified threshold levels of flow that are necessary for juvenile salmon survival and habitat use that could be used to assist in watershed restoration efforts (Michel et al., 2021; Munsch et al., 2020).

Ocean conditions strongly influence salmon survival. Because Chinook salmon spends two to three years in the ocean before returning to freshwater to spawn, the number of salmon observed in rivers in any given year partly reflects marine conditions in



preceding years (CCEIA, 2025). Ocean habitat compression and shifts in ocean forage have created difficult conditions for California's Chinook Salmon in recent years (CDFW, 2024b). Prey availability, driven by ocean temperature and upwelling strength, is a key determinant of juvenile growth and survival (Wells et al., 2014). Warm ocean temperatures, weak upwelling, and altered food webs have been linked to poor survival and sharp declines in Sacramento River fall-run Chinook (Lindley et al., 2009). Shifting food availability in the ocean has also led to anchovy-dominant diets for Chinook salmon. Anchovies carry an enzyme (thiaminase) that degrades thiamine, and Chinook dietary shift to anchovy has caused thiamine deficiency in spawning females' eggs. Offspring impacted by thiamine deficiency can have abnormal swimming patterns and low survival (Mantua et al., 2025).

Additional ocean stressors include increasing acidification, which threatens key invertebrate prey species, and sea-level rise, which may degrade estuarine habitats critical for salmon transitioning from freshwater to marine environments (Crozier et al., 2019). Along the Pacific coast, rising sea levels can lead to inundation of low-lying lands and increased salinity, thereby transforming estuarine habitats for migrating salmon (Wells et al., 2014). Because the success of salmon rearing in coastal estuaries strongly influences later survival in the ocean, the physical and biological conditions of estuaries are very important.

In freshwater streams and rivers, California salmon abundance is influenced by dynamic interactions between natural landscape features (e.g., climate and topography) and human activities. Anthropogenic influences on salmon populations include urban and agricultural runoffs, dams, water diversion for agricultural and domestic uses, and mining (Moyle et al., 2013; Wells et al., 2014; Moore et al., 2025). Land and water use changes over the past century have eliminated or blocked access to important habitats, limited habitat diversity, and constrained salmon distribution (CDFW, 2025b; Herbold et al., 2018; Munsch et al., 2022). Dams may contribute to water quality issues in freshwater such as the Klamath River (NOAA, 2024), which may impact fish during migration. Fishing also affects the abundances of adults that return to spawn. While the fishery targets the fall-run Chinook, it can incidentally capture protected stocks (Satterhwaite et al., 2023). State and federal water projects can also lead to declines in



salmon abundance. Juvenile winter-run Chinook entering the Delta can be entrained, or drawn into, the water export facilities that pump out large volumes of water for use in agriculture and municipalities. These facilities can also change hydrodynamics, delay salmon outmigration and consequently increase predation risk. In 2024 and 2025, the annual loss thresholds (maximum number of juvenile winter-run salmon that can be entrained by water projects) exceeded 100% by late March (Sturrock et al., 2026).

Technical considerations

Sacramento River Chinook Salmon Abundance

Data characteristics

Total spawning escapement values for the four salmon runs were taken from the California Central Valley Chinook Population Database Report (Azat and Killam, 2025). The report, also known as “GrandTab,” is a compilation of sources estimating the late-fall, winter, spring, and fall-run Chinook salmon total populations for streams surveyed. Estimates are provided by the California Department of Fish and Wildlife, the US Fish and Wildlife Service, the California Department of Water Resources, the East Bay Municipal Utilities District, the US Bureau of Reclamation, the Lower Yuba River Management Team, and the Fisheries Foundation of California.

The *Central Valley Chinook Salmon In-river Escapement Monitoring Plan* is used by fisheries resource managers across the basin for estimating numbers of adult Chinook salmon returning to spawn (Bergman et al., 2013). After completing the ocean stage, hatchery-origin fish generally return to tributaries concurrently with natural salmon and are part of abundance counts. Escapement estimates are based on counts of fish entering hatcheries and migrating past dams, carcass surveys, live fish counts (snorkel surveys and video monitoring), and ground and aerial redd counts. This comprehensive plan includes a spatially and temporally balanced sampling protocol that when implemented allows for statistically defensible estimates of population status.

Strengths and limitations of the data

Chinook salmon monitoring has been conducted on the Sacramento River since 1950; however, abundance data in the early decades were lacking in precision and consistency (Bergman et al., 2013). The National Oceanic and Atmospheric



Administration (NOAA) Northwest Fisheries Science Center in their salmon indicator report present Chinook salmon abundance trends beginning in 1985, citing lower data quality and consistency prior to this year (Wells et al., 2014).

While methodology varies by river/tributary, the escapement estimates are useful for trend analysis, particularly in the years we assessed.

Salmon River Spring-run Chinook Salmon Abundance

Data characteristics

Spring-run Chinook salmon estimates for the Salmon River are collected during an annual cooperative spawning survey. Since 1995, the Salmon River Restoration Council (SRRC) has helped coordinate with the US Forest Service the annual Spring Chinook and Summer Steelhead Cooperative Fish Dive. The dive event covers the upper mainstem and the North, South and East forks of the river in a single day. The lower mainstem and Wooley Creek (a large tributary) are surveyed separately in the same week. The survey area is approximately 89 miles measured in intervals or “reaches” of two to four miles. The dive takes place in late July when fish are holed up in deep pools and near cool side streams, allowing direct counts of individual fish (SRRC, 2022).

Strengths and limitations of the data

Both the methodology and effort made when conducting the summer dive events have been consistent over the years except for 2006, 2020, and 2025. Wildfire closures in 2006 prevented the mainstem Salmon River and Wooley Creek from being surveyed. An expansion equation was developed to estimate the number of spring-run Chinook salmon that would have been counted on those reaches based on the historic average. In 2020, the COVID-19 pandemic restricted divers to a core number of individuals and the survey was spread out over two days instead of one. The entire survey area was covered except for two lower priority reaches and was not expected to significantly affect the count (Personal communication, Sophie Price, SRRC, April 2022). In 2025, the survey team was limited to a smaller number of local fisheries professionals due to wildfire activity in the area, but survey procedures were otherwise relatively unchanged.



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