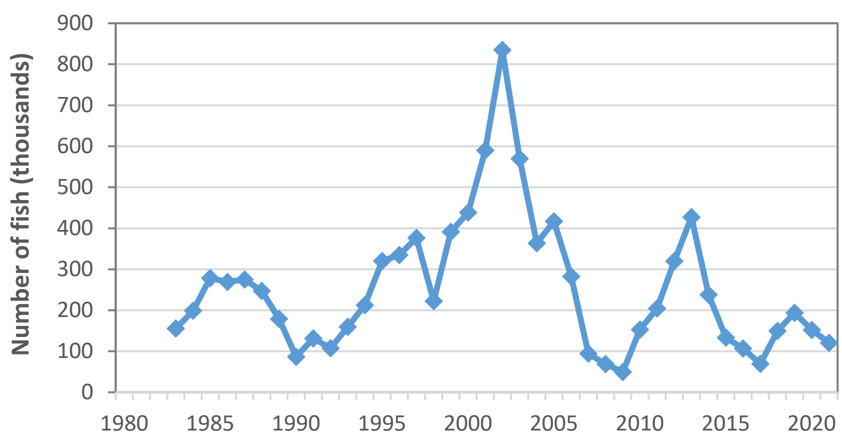
CHINOOK SALMON ABUNDANCE

California Chinook salmon (Oncorhynchus tshawytscha) populations are threatened by warming temperatures and changing conditions in freshwater, estuarine, and ocean habitats. While Sacramento River Chinook salmon abundance has been variable, winter-run abundance has seen low numbers over most of the past four decades. Salmon River spring-run Chinook salmon abundance, while also variable, dramatically declined after 2011, and has remained extremely low over the past five years.

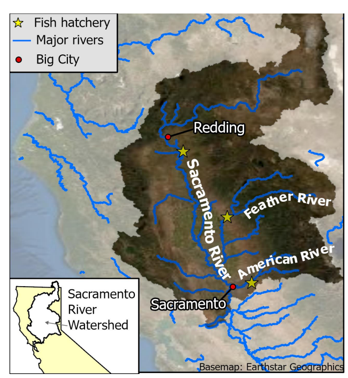
Figure 1. Sacramento River Chinook Salmon Abundance: Fall-Run (Number of adult Salmon*)



Source: Azat (CDFW), 2022

** These counts reflect adult Chinook salmon returning to their spawning grounds in the fall after having spent 3 to 4 years maturing in the ocean. This number is also known as annual escapement, since it estimates the number of salmon that have escaped harvesting by fisheries.*

Source: US Fish and Wildlife Service



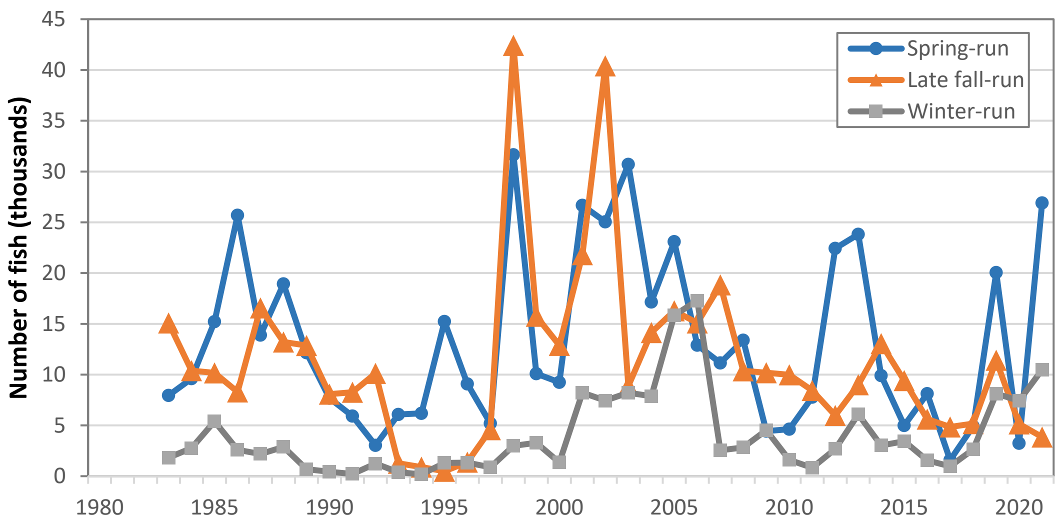
Source: USGS, 2019

Central Valley Chinook salmon rear in the fresh waters of interior California, migrate as juveniles to feeding grounds in the Pacific Ocean, and return to fresh water from July to December to spawn. Four distinct runs ("ecotypes") spawn in the Sacramento-San Joaquin River system (map on the right), named for the season when the majority of the run enters freshwater as adults. Spawning adult Chinook salmon change color from blue-green with silvery sides to olive brown, red or purple (image, left).

What does the indicator show?

Figure 1 shows the number of adult Sacramento River fall-run Chinook salmon returning from the ocean to their freshwater spawning habitat. This number is also known as annual *escapement*, since it estimates the number of salmon that have escaped harvesting by fisheries. The most abundant of the four Sacramento River runs, fall-run Chinook salmon abundance fluctuated from 1983 to 2021. Relatively constant prior to 1995, the numbers peaked in 2002 followed by seven years of mostly declining numbers. The drop in 2007 was followed by two years of record lows. Salmon numbers increased in 2012 and 2013 to levels above the 39-year average (about 260,000 fish) before declining again in 2014 through 2017. Escapement numbers started to recover in 2018 and 2019 but began declining again in 2020 and 2021.

Figure 2. Sacramento River Chinook Salmon Abundance: Winter-, Spring-, Late-fall- Runs (Number of adult fish*)



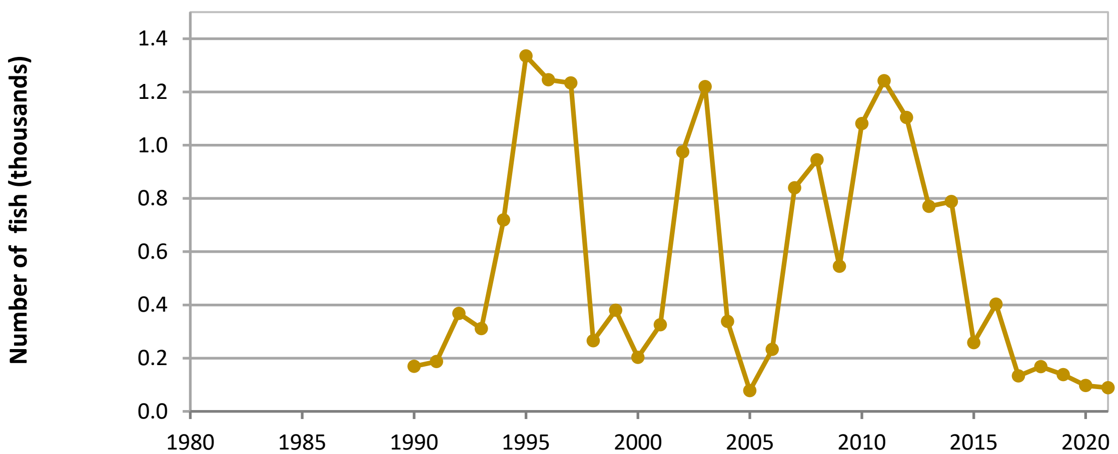
Source: Azat (CDFW), 2022

** Counts reflect adult salmon returning to their spawning grounds after spending 1 to 3 years (winter-run), 3 to 5 years (spring-run), and 3 to 4 years (late-fall) maturing in the ocean.*

Figure 2 shows Sacramento River Chinook salmon abundance for the spring, late-fall, and winter runs, which are much smaller than the fall-run population. These runs represent three distinct populations of fish with different migration patterns (described below). The staggered runs have historically allowed Chinook populations to spread risk across seasons and changing habitats. For all three runs, salmon abundance fluctuated considerably over the approximately four-decade period shown.

Spring-run abundance shows steep highs and lows but peak abundance numbers over the last decade are not reaching those seen between 1998 and 2003. The late-fall run was precipitously low from 1993 to 1996, but rebounded and reached two of its highest numbers in 1998 and 2002. Winter-run abundance is low (under 5,000 fish) in most years, dipping to extremely low numbers from 1989 to 1997, but showing an overall increase until 2006. In the late 2000s, abundance numbers again dipped for the late-fall and winter runs, and have generally remained below average since. Average fish counts over the past four decades are 11,000, 4,000 and 13,000 for the late-fall, winter- and spring-runs, respectively. Abundance numbers for all runs have been below their respective long-term averages in at least 10 of the last 15 years.

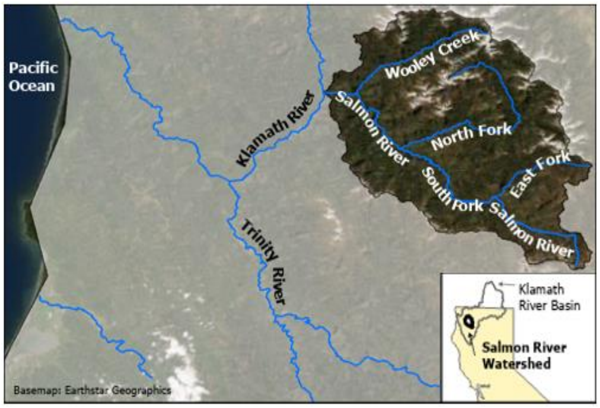
Figure 3. Salmon River Spring-Run Chinook Salmon Abundance (Number of adult fish*)



Source: CDFW, 2022a; SRRC, 2021

** These counts reflect adult Chinook salmon returning to their spawning grounds after having spent 3 to 4 years maturing in the ocean. Fish surveys in 2006 were not conducted due to regional wildfires; instead, the value for 2006 is an estimate based on the historic average (see Technical Considerations).*

Source: Michael Bravo, SRRC



Source: USGS, 2019

The Salmon River in northern California has the largest remaining wild run of spring Chinook salmon in the Klamath River watershed (map, right). As adults, spring-run Chinook (pictured, left) migrate upstream from the ocean in late spring/early summer and seek refuge in cool pools during the summer months before spawning in early fall. Juvenile fish reside in the river until the following summer and then outmigrate to the ocean.

Figure 3 shows spring-run Chinook salmon abundance in the Salmon River, from 1990 to 2021. Spring-run Chinook abundance has fluctuated with an average annual number of 568 fish over the 32-year period. A record low count of 78 fish in 2005 was attributed to extremely low flows and high prevalence of disease in 2001-2002 that limited both juvenile and adult salmon survival during their migration through the Klamath River. Numbers have been declining since 2011, and despite an increase in 2016, abundance has generally plummeted over the last decade. The salmon count of only 89 in 2021 was the fifth year in a row with population levels far below average.

Why is the indicator important?

Salmon are among California's most valued natural resources (CDFW, 2013; Moyle et al., 2017). The Chinook salmon is the largest Pacific salmon species. This iconic fish is legendary for its migration from the streams in which it is hatched to the Pacific Ocean, where it can travel as far as a thousand miles, only to return to its natal stream to spawn and die. California marks the southern end of the range of all salmon on the Pacific coast, and has two large basins that support most of the state's Chinook salmon runs: the Central Valley, which contains the Sacramento and San Joaquin River basins, and the Klamath Basin, which contains the Klamath and Trinity Rivers and their respective tributaries (including the Salmon River).

Highly valued for its flavor and nutritional benefits, salmon are an important source of revenue for the commercial fishing industry, and a prized catch for both ocean and freshwater sport fishers. In 2021, Chinook salmon commercial fisheries in California took in about $17.5 million in revenue (CDFW, 2022b). In 2008 and 2009, when escapement in the Sacramento River was extremely low, commercial and recreational fisheries were heavily impacted by closures.

Salmon are celebrated in many aspects of Tribal culture, not only as a food source, but also as 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, 2022; also see *Impacts on California Tribes* section of this report). 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).

Salmon play a key role in marine and inland ecosystems and thus can serve as an indicator of the health of both ecosystems (CDFW, 2013; Naiman et al., 2002). While at sea, Chinook salmon accumulate nitrogen, phosphorous and other nutrients in their bodies as they feed and grow to adulthood. When fish return to their spawning ground, their carcasses contribute to nutrient cycling and productivity of riparian systems.

Naturally-spawning Chinook salmon populations are at historically low levels despite regulatory and management efforts, restoration work, and sizable federal and state hatchery programs (Herbold et al., 2018). Scientists suggest that nearly all of California's salmon face extinction within 50 to 100 years, with about 45 percent of the population at risk of extinction within 50 years, if current trends in climate change and other anthropogenic stressors persist (Moyle et al., 2017; UC Davis, 2017).

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 reproducing adults is important in defining population viability, as a measure of both demographic and genetic risks. It is equally important to managing harvest in the fishery, which typically aims at meeting escapement goals such that the population remains viable (for Endangered Species Act-listed populations) or near the biomass that produces maximum recruitment (for stocks covered by a fisheries management plan).

Sacramento River Chinook Salmon

Sacramento River Chinook salmon winter-, fall-, late-fall and spring-runs demonstrate different migratory approaches that exploit varying landscapes and seasons. As noted above, the staggered runs have allowed Chinook populations to spread risk across seasons and changing habitats, stabilizing their numbers. However, beginning in the 1930s, mining, water diversions and other human activities have threatened their survival. In recent decades, climate-related disturbances have since placed additional stresses on the salmon populations (Munsch et al., 2022).

- Sacramento River ***fall-run*** Chinook salmon have been the largest contributor to ocean salmon harvest off California and Oregon for decades (O'Farrell et al., 2013). This historically large run is now the dominant fish population in the Central Valley due to declining spring and winter runs and the naturally small size of the late-fall run (Yoshiyama et al., 1998). It is designated as the indicator stock for guiding Central Valley salmon population management and habitat restoration plans. Unfavorable climate conditions and other anthropogenic impacts have led to the fall-run Chinook salmon's designation as a s*pecies of special concern* by the California Department of Fish and Wildlife (CDFW) (CDFW, 2022c).

- The ***late–fall*** Chinook salmon have been eliminated from most of their native spawning habitat and for the most part are now dependent upon cold water releases from reservoirs and habitat mitigation efforts (CalTrout, 2022a). Additionally, since 2000 hatchery fish have made up at least half the adult fish returning to spawn. Because late-fall run Chinook salmon spend more time feeding in the ocean than the other salmon runs, they tend to be larger fish and highly coveted by sport fishers. Central Valley fall-run Chinook salmon are designated by CDFW as a *species of special concern* (CDFW, 2022c).

- The Sacramento River system is home to the only ***winter-run*** Chinook salmon in the world (US NMFS, 2019). Winter–run Chinook salmon are especially vulnerable because they spawn during the summer months when temperatures are their warmest. This run has persisted largely due to managed cold water releases from Shasta Reservoir during the summer and artificial propagation from a fish hatchery (NOAA, 2022a). Ironically, the dam above the reservoir has blocked access to high elevation cold waters and is largely why the winter-run has suffered huge declines. Winter-run Chinook was the first Pacific salmon to be state and federally listed as *endangered* in 1989 and 1994, respectively (Phillis et al., 2018).

- ***Spring-run*** Chinook salmon were a historically abundant salmon stock in the Central Valley prior to habitat degradation and the construction of dams which blocked access to their native habitats. Now only remnant runs remain in the main-stem Sacramento River and three of its tributaries. Central Valley spring-run Chinook salmon were state and federally listed as *threatened* in 1999 (CDFW, 2022d).

<u>Salmon River Chinook Salmon</u>
The Salmon River is the second largest tributary to the much larger Klamath River system (SRRC, 2020). 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. 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 refugia 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).

Because spring-run Chinook salmon stage in cold water pools throughout the summer when stream flows are reduced and temperatures approach their upper tolerance, their abundance is a good indicator of ecosystem health (CalTrout, 2022b). Spring-run Chinook salmon were declared *threatened* in the Upper Klamath-Trinity River by the State of California in January 2022 (California Fish and Game Commission, 2022) and are currently being considered for listing by the federal government (NMFS, 2021).

The Salmon River also supports fall-run Chinook salmon, the most abundant salmon population in the Klamath watershed (SRRC, 2022). Fall-run Chinook salmon enter the river in the late summer and early fall, making them less vulnerable to warm summertime water temperatures and drought conditions. However, diminished water quality and flow in the Klamath River may be tied to fall-run numbers well below average for five of the past seven years (Meneks, 2022).

What factors influence this indicator?

The multi-year life history of Chinook salmon is essential to understanding how climate change can impact salmon in different habitats and during all life stages, including escapement. California Chinook salmon spawn and rear in fresh water bodies and migrate to the ocean to feed for three to four years on average until they become adults. Changes in climate can alter freshwater, estuarine, and marine habitats, putting salmon populations at risk. Studies have identified warm temperatures and low flows as harmful to salmon in the Central Valley (Herbold et al., 2018; Moyle et al, 2017; Munsch et al., 2019). As noted above, anthropogenic influences such as dams and fish hatcheries can also affect salmon population abundance. These stressors amplify the impacts of climate change; for example, dams block access to higher elevations where water temperatures are cooler, water withdrawals reduce stream and river flow, and warmer water temperatures render juvenile fish more vulnerable to predators.

This section describes factors influencing Sacramento River Chinook salmon runs and Salmon River spring-run Chinook salmon in fresh water and marine environments.

Fresh water environment

California salmon abundance in fresh water streams and rivers 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 runoff, dams, water diversion for agricultural and domestic uses, and mining (Moyle et al., 2013; Wells et al., 2014). Land and water use changes over the past century have eliminated or blocked access to important habitats, limited habitat diversity, and constrained salmon distribution (Herbold et al., 2018; Munsch et al., 2022).

California Chinook salmon now encounter more stressful climatic conditions 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. With warming temperatures, more precipitation falls as rain instead of snow in the mountains (see *Precipitation*, *Snowmelt runoff* and *Snow-water content* indicators), reducing the amount of snowmelt that provides cold water year-round to rivers and streams. During drought periods, wetlands habitat availability and connections between salmon habitat areas are reduced and water quality is compromised (Crozier et al., 2019).

Streamflow is an important determinant of water temperature (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 (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. 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).

<u>Sacramento River Chinook salmon</u>
Historically, the Central Valley was characterized by a diversity of landscape features that allowed for salmon populations to develop resilience to climate change (Munsch et al., 2022). The four Chinook salmon subpopulations encounter different climate conditions due to differing life history patterns (set of events and traits that define the life cycle) and area-specific environmental conditions, as discussed above (CDFW, 2013). For example, while fall- and late-fall run Chinook salmon migrate upstream and spawn in the river during the cooler months, spring- and winter-run Chinook salmon enter the river and spawn during the warmer months and for longer periods of time. Before the building of dams, the spring- and winter- runs adapted to natural habitats at higher elevations with access to colder summertime waters. The winter-run's reliance on dam releases for cold water make them especially vulnerable to warming freshwater temperatures.

Chinook salmon populations were much more abundant across the Central Valley before anthropogenic influences described above caused severe population declines. (Wells et al., 2014; Yoshiyama et al., 1988). The trends shown in Figures 1 and 2 reflect data since 1983, a time when populations had stabilized at lower abundance levels, largely sustained by hatchery programs.

The Sacramento River and its tributaries rely on Sierra Nevada snowpack to provide cold waters for Chinook salmon habitat. When water is cold and flows are high, egg survival increases; juveniles use habitats for longer time periods--they grow larger, survive better, and can better avoid predators (CCIEA, 2022). Scientists have shown that Sacramento fall-run Chinook salmon adult returns in a given year are correlated with snowpack levels from two years prior because high snowpack indicates cold, wet conditions in the watershed. Because the Sacramento River Basin has suffered from loss of salmon habitat and life history diversity, salmon abundance is expected to increasingly track snowpack (Munsch et al., 2022). It is predicted that adult returns will decline in 2022 and 2023 relative to 2021 based on below average snowpack in 2020 and 2021.

A severe and prolonged drought from 2012-2016 resulted in reduced winter and spring flows in the Sacramento River watershed, increased fish energy expenditure during outmigration due to slow water velocities, elevated temperatures within outmigration corridors, decreased food availability, and increased risk of predation and disease

(Herbold et al., 2018; PFMC/NMFS, 2020). As shown in Figure 1, the impacts of drought conditions and exceptionally warm air temperatures on fall-run Chinook salmon population abundance were evident for four years beginning in 2014. For winter-run Chinook salmon, very low abundance numbers in the 1990s due to anthropogenic stressors prompted habitat enhancements and cold water releases from the Shasta Reservoir to manage water temperatures. The lack of cold water behind Shasta Dam during the drought led to unsuitable stream temperatures in spawning grounds and 95 percent mortality of eggs and fry in 2014 and 2015 (Voss and Poytress, 2017). Consequently, winter-run abundance was alarmingly low in 2016 and 2017 as shown in Figure 2 (Meyers, 2021). During the drought years, young spring-run Chinook salmon had low out-migration survival rates; once flows were restored escapement numbers began to rebound beginning in 2018 (Cordoleani et al., 2021; Notch et al., 2020).

The year 2021 was one of the warmest and driest years on record (see *Air temperature and Precipitation* indicators). During the summer, scientists estimated that about 75 percent of winter-run salmon eggs died in the Sacramento River due to high temperatures driven by extreme drought conditions and historically low reservoirs (NOAA, 2022b). The 2021 freshwater conditions likely limited survival of the 2021 brood year and is expected to impact winter-run escapement numbers in 2023 and 2024.

Fish hatcheries in the Sacramento River watershed sustain salmon populations for the four runs by promoting increased juvenile survival to adulthood during periods of poor freshwater and ocean conditions (Herbold, 2018). Hatcheries release artificially propagated juvenile salmon into freshwater, estuary or marine habitats to supplement natural-origin salmon production. The number of hatchery fish released in the Central Valley has remained fairly stable over the past decades; however the need to transport hatchery fish downstream has increased in recent years to reduce outmigration mortality in increasingly hot, degraded waterways (Huber et al., 2015; Sturrock et al., 2019). Emergency downstream trucking of salmon in 2014-2015 was implemented to improve survival rates during this extreme drought period.

Future reductions in stream flow and increases in stream temperature are expected in the Sacramento River and its tributaries, fed by the northern Sierra Nevada (its lower elevation makes this region more vulnerable to warming than the southern Sierra Nevada) (Moyle et al., 2017). Management strategies that aim to mimic historic diverse habitats and conditions under which the salmon runs evolved could promote climate resilience for salmon populations in the years to come (Munsch et al., 2022; PFMC/NMFS, 2020).

<u>Salmon River spring Chinook</u>

Starting at the turn of the 20th century, the spring-run Chinook population in the Salmon River suffered precipitous declines due to habitat degradation from mining, over-fishing, logging, diversions and dams in the Klamath River Basin. The construction of dams in other rivers in the basin blocked access to much of their historical spawning grounds. The Salmon River itself, however, has no dams or hatcheries, a rugged terrain preventing the introduction of infrastructure and relatively little water diverted for human uses due to the area's low population density (SRRC, 2020). Few anthropogenic influences allow scientists to better assess how climate change may be impacting wild spring-run Chinook salmon on this river.

Water temperatures in the Salmon River and its tributaries are warming due to increases in air temperatures and decreases in snowpack and river flow (see *Salmon River Water Temperature* indicator). During the period 1995-2017, mean August water temperatures warmed at a rate of 0.38°F per decade and mean daily maximum August water temperatures warmed at a rate of 0.70°F per decade. Spring-run Chinook salmon live in these habitats through the entire summer, and under current conditions peak summer temperatures in portions of the river and its tributaries are likely at or exceeding thermal suitability for this species (Strange, 2010).

As noted above, years of low snowpack and snow water runoff tend to yield decreases in stream and river flow in watersheds. Low August flow rates in the Salmon River coincided with warmer stream temperatures in 2014 and 2015 (Asarian et al., 2019), which likely impacted juvenile Chinook salmon survival and adult escapement numbers three to four years later. Conversely, higher flow rates in 2010 and 2011 corresponded with much cooler stream temperatures and high salmon abundance.

An indicator of warmer temperatures and less snow in the region is the dramatic melting in recent decades of glaciers in the Trinity Alps at the headwaters of the Salmon River's South Fork (Garwood et al., 2020; see also *Glacier change* indicator). These glaciers historically fed cold water to streams during the summer. Declining glacial ice and snowpack in the Trinity Alps foretell how climate change threatens the unique distributions and resiliency of fish in the Klamath River watershed.

Marine environment

Changes in physical, chemical and biological components and processes in the ocean affect the viability of young salmon as they feed and grow to adulthood. Salmon survival during the initial months of ocean life depends on available prey (largely krill, forage fish and crab larvae) (Wells et al., 2014; 2017). Increasing ocean temperatures can negatively alter the food web on which salmon depend, changing the range of predators, competitors, and prey species. In addition, water temperature affects fish metabolism, development, behavior, and distribution. Overall, warming ocean temperatures are expected to result in range changes for California salmon, a phenomenon that is already occurring with other fishes (Crozier et al., 2019; Wells et al., 2014).

Along the California coast, the timing and intensity of "coastal upwelling" — a wind-driven motion of dense, cooler, and usually nutrient-rich water towards the surface — also affect salmon (Crozier et al., 2019; Wells et al., 2016). Salmon feed on krill, phytoplankton and other prey in upwelled waters and have suffered population declines during years of weak upwelling conditions. Warming surface waters can increase water column thermal stratification and reduce upwelling of cold nutrient-rich water. Evidence suggests that warm sea surface temperatures, weak upwelling, and low prey densities in 2005 and 2006 resulted in unusually poor survival of juvenile Sacramento River fall-run Chinook (Lindley et al., 2009). During this time, warm water temperatures compressed salmon prey species towards the coast where out-migrating juvenile salmon are foraging (Well et al., 2017). This concentration of forage species also attracted salmon predators (e.g., common murre), and likely impacted juvenile salmon survival. The steep decline in fall-run salmon abundance in 2007 (see Figure 1) may have been in part a response to these ocean conditions.

Another ocean condition that may threaten Chinook salmon is the acidification of coastal waters as a consequence of increasing atmospheric carbon dioxide (Wells et al., 2014; Crozier et al., 2019). Although acidification will likely have little direct effect on salmon, increasing ocean acidity may have a significant impact on invertebrate prey species such as squid, crabs and krill that are important to the salmon diet (see *Acidification of coastal waters* indicator).

Along the Pacific coast, rising sea levels can lead to inundation of low-lying lands and increases in salinity, transforming estuary 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 is very important.

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, 2022). 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, 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).

Salmon return counts lack precision because the numbers are generated by combining data from multiple sources (e.g., red counts, carcass counts, hatchery returns). Although salmon return data do not provide estimates of variance, the data are still useful for trend analysis.

Escapement estimates can be underestimated when fish returning to spawn stray into other rivers that are outside the sampling area.

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. A crew of 80 trained divers from state and federal agencies and local tribes work together to swim the entire Salmon River to survey the fish population. 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 about 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, making possible an actual count 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 with the exception of 2006 and 2020. 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 with the exception of two lower priority reaches and was not expected to significantly affect the count (Personal communication, Sophie Price, SRRC, April 2022).

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