

Pacific Salmon: King of California Fish

A Challenge to Restore Our Salmon Resources of the Future

FOR HUNDREDS OF YEARS, PACIFIC SALMON have been a part of California's natural landscape. Magnificent, resilient and ever-determined, they face incredible odds to travel from their inland birthplace to the open ocean, where they mature for several years before making the perilous journey back home to spawn at the end of their lives. These amazing fish serve as an icon of the state's wild and free rivers, reflecting the spirit and tenacity of California's earliest inhabitants.

But over the past 100 years, the numbers of salmon have been dropping. In 2008 and 2009, the population of California's Central Valley Chinook salmon was so low that the state had to close salmon fisheries for the first time in history. Businesses failed, traditions were lost and anglers were mystified.

In an attempt to decipher the reasons for this decline—as well as to collaborate on ways to reverse the trend—many state and federal agencies, universities, consulting groups and non-governmental organizations banded together. The California Department of Fish and Game (DFG) plays a lead role in these efforts to restore salmon populations.

The cost and the effort required to initiate change are enormous, calling for a pooling of effort, intellect and financial resources. Only cooperative and innovative fisheries management coupled with habitat restoration and public education about our natural resources can reverse the downward trend in California's salmon populations.



Classifications of Salmon

The term *Pacific salmon* comprises several species, but two types in particular are declining in number in California: Chinook (also known as king salmon) and coho.

Chinook salmon migrate into the Sacramento–San Joaquin river system, the Klamath-Trinity river system and several north coast rivers, including the Mattole, Eel, Mad and Smith rivers and Redwood Creek. Coho salmon are found predominately in central and northern California coastal streams and the Klamath-Trinity river basin.



Because different segments of the population (called *stocks*) migrate with the seasons, there are fall, late-fall, winter and spring Chinook salmon runs and a fall coho run. The winter-run Chinook are listed as endangered by the federal government under the Endangered Species Act (ESA); the spring-run Chinook are listed as threatened.

Under the ESA, salmon stocks can also be classified according to their geographical area of origin. The California coastal Chinook is listed as threatened; the central California coast coho and the southern Oregon/northern California coho are listed as endangered.

The most important stocks to sports anglers and commercial fishermen are the Central Valley fall- and late-fall Chinook salmon runs. Currently, they are designated as a “species of special concern,” which means they are being closely watched and monitored to determine whether there is a continuing long-term decline in the population.

Pacific Salmon Life Cycle

Salmon are *anadromous*, meaning they live in both freshwater and saltwater at different points in their lives. Salmon hatch in freshwater, migrate to the ocean to mature in food-rich saltwater and eventually complete the life cycle by returning to freshwater to spawn.

They do not feed during the spawning period, surviving on the stored fat and oil reserves in their bodies. Once they return

to their birthplace—which they find by following “chemical cues” in the water—they seek out clean gravel areas with good water quality to lay their eggs. The female salmon constructs a nest (or *redd*) in the gravel with her tail fin and may spawn as many as 2,500 to 7,500 eggs, depending on the species and the size of the individual salmon. These eggs hatch in 60 to 90 days. Both the male and the female salmon die after spawning.

A juvenile Chinook salmon emerges from the gravel and immediately begins its migratory journey to the ocean, where it will spend two to five years before returning to its freshwater birthplace. Juvenile coho salmon, on the other hand, may spend up to two years in freshwater before migrating to the open seas and will return to spawn after another three years.



An adult female salmon uses her tail fin to construct a redd, a shallow depression in the streambed gravel, where she will lay her eggs.

A History of Salmon Fishing: A California Tradition

All along the western coast of North America, salmon are an important historic, social, cultural, economic and aesthetic resource.

Pacific Coast American Indians created legends and ceremonies to celebrate the importance of the salmon to their culture and survival, and European settlers trapped and fished for salmon for food and sport. As early as 1870, the Commissioners of Fisheries for the State of California recognized the significance of the species:

The salmon is the most important visitor to our rivers. It has appropriately been called the “king of fish.” The richness of its flesh, its large size, the certainty of its annual return from the ocean, the rapidity with which, under favorable conditions, it is multiplied, all render it an important article of human food. It has probably been the chief source of subsistence to more people than any other fish.*

Commercial salmon fishing began in California inland waters in 1864 and expanded to the ocean near Monterey in 1893. Sport angling for salmon became popular in the early 1900s. Between 1900 and 1950, the Central Valley fall-run Chinook salmon—typically the most abundant of the runs—numbered more than a million fish returning annually to the Sacramento–San Joaquin river



At left, commercial fishermen reap a bounty of salmon with a Larco drag net off Santa Cruz Island in 1934. The decline in salmon threatens not only commercial fishing but also recreational fishing and its related enterprises.

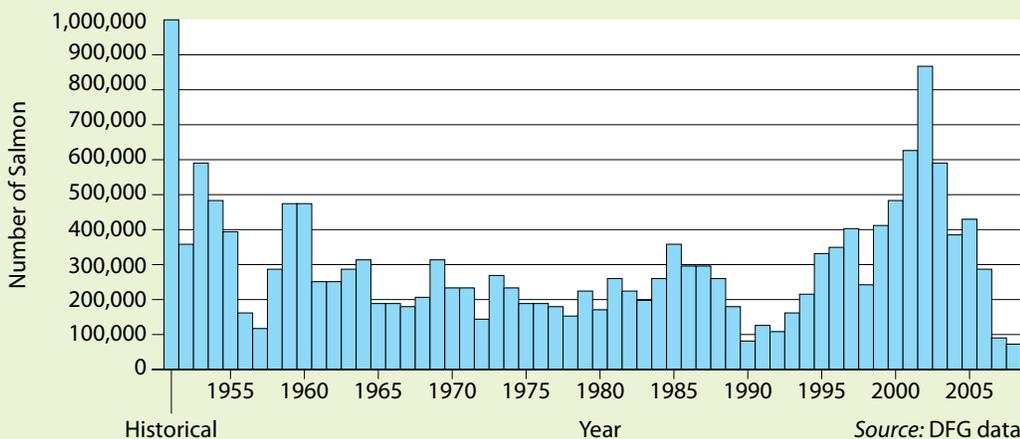
system. But after 1950 a declining pattern became clear. In 1957 the California State Legislature closed commercial salmon fishing in inland waters.

Central Valley fall- and late-fall-run Chinook salmon are still the most important part of California’s fishing industry, but they continue to vanish from our waters. In 2002 scientists counted 880,000 returning adults in the fall run.

Just six years later, in 2008, only 66,000 salmon returned.

To ensure future generations of salmon, in 2008 all ocean salmon fisheries were closed for the first time in history. Salmon season restrictions continued into 2009, resulting in statewide economic losses of more than \$279 million and 2,670 jobs. California can no longer afford to postpone action.

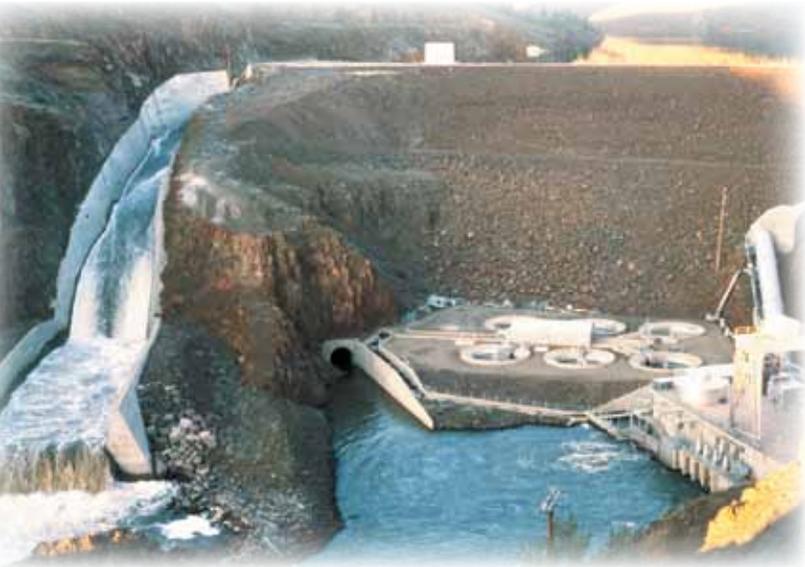
Estimates of Returning Central Valley Fall-run Chinook Salmon
Historical Through 2008



*California Fish Commission. 1872. Report of the Commissioners of Fisheries of the State of California for the Years 1870 and 1871. As reprinted in *California Fish and Game* (1933) Vol. 19, No. 1, pp. 41-56.

What's Causing Salmon Declines, and What Can We Do About It?

Scientists blamed the dramatic 2008 decline of California's salmon populations on a "perfect storm" of events caused by weather conditions that limited food sources at critical times for young salmon.



Whether massive structures like the Iron Gate Dam on California's Klamath River or minor diversions on smaller streams, dams prevent salmon from returning to their historic spawning habitat. Contamination of streams by polluted runoff is another threat to the salmon's fragile environment and complex life cycle.

Other contributing factors include over-harvesting, pollution, dams and water diversions, logging, reduced flow, urbanization, agricultural and industrial development, and other land changes.

The National Oceanic and Atmospheric Administration (NOAA) found that food shortages in the ocean were responsible for the deaths of many of California's young salmon in 2004 and 2005. The Pacific Fisheries Management Council (PFMC) reviewed 40 factors affecting survival of salmon during this period and also concluded that open-ocean conditions were key to the significant decline in salmon stocks. Water quality, habitat, predation and hatchery practices were identified as contributing factors.

Climate change is another concern. California's fertile Central Valley and river systems are on the extreme southern

end of the Pacific salmon habitat, and the salmon in this area are exposed to long-term weather events such as drought and intense rains. Decreased snowpack and changes in the timing of meltwater release negatively affect traditional migration patterns, spawning behavior and the timing of the spring flows that carry young salmon to the ocean.

DFG and other state, federal and private agencies have worked to reverse the trend since the 1950s. Efforts have included extensive habitat restoration, dam removal, screening and other projects intended to stabilize and increase salmon populations and restore habitat.

Today, DFG and its partners are increasing monitoring efforts, implementing adaptive management practices to protect core habitats and maintain genetic diversity

and undertaking restoration work that addresses entire watersheds.

Suggested practices that could benefit salmon in light of habitat and climate changes in the coming years include:

- Maintaining and increasing genetic diversity
- Protecting cold-water resources
- Maintaining habitat complexity
- Connecting rivers/streams and floodplains
- Protecting alpine meadows, springs and riparian areas
- Limiting interaction between wild and hatchery fish
- Tempering unusual high and low flows
- Restoring estuaries, sloughs and marshes

Key Legislation and Broad-scale Ecosystem Restorations Efforts and Acts

California has a history of working to protect its natural resources. Here is a run-down of major legislative actions.

1957 The **California Water Plan** creates a framework for legislators, water managers and the public as they make decisions regarding California's water future. The plan, which is updated every five years, presents data and information about California's water supply, including assessments of agricultural, urban and environmental water uses.

1981 The DFG **Fisheries Restoration Grant Program** is established by a coalition of government agencies, tribes, fisheries and watershed organizations, the California Conservation Corps, AmeriCorps and private landowners in response to rapidly declining populations of coastal wild salmon and steelhead trout. To date, the program has invested more than \$180 million in restoration projects and watershed education throughout coastal California.

1986 The **Klamath River Basin Fishery Resources Restoration Act** earmarks more than \$20 million to restore and maintain anadromous fish populations. The program ended in 2006, but planning and implementation of fisheries and habitat improvements, scientific investigations, and public outreach and education continue today.

1992 Congress passes the **Central Valley Project Improvement Act**, dedicating 800,000 acre-feet of water for environmental use and ecosystem restoration efforts in the Sacramento and San Joaquin rivers. The same year the U.S. Fish and Wildlife Service's Anadromous Fish Restoration Program (AFRP) is tasked with doubling natural production of anadromous fish in California's Central Valley streams on a long-term, sustainable basis. AFRP has provided millions of dollars for habitat projects to help restore Central Valley salmon and steelhead populations.

1994 The **Delta Accord** is signed by water interests, environmental groups, and state and federal agencies, with the intent of establishing interim protection for listed fish species, including Chinook salmon, steelhead and Delta smelt. This leads to the establishment of the California Bay-Delta Program (CALFED) in 2000, a cooperative effort of 25 state and federal agencies to improve the quality and the reliability of California's water supplies while restoring the Bay-Delta ecosystem. DFG administers the CALFED **Ecosystem Restoration Program** and has awarded 530 grants totaling more than \$500 million to restore habitat, install screen diversions, remove fish barriers and fund research.

2006 The **Bay Delta Conservation Plan** is initiated to provide for the conservation of Delta fisheries while supplying water to 25 million Californians. Seventeen federal and state agencies, environmental groups, water agencies and other organizations work together on developing the plan.

Modern Salmon Research and Information-gathering Techniques

DFG and its partners conduct extensive research and information-gathering efforts to learn more about California's salmon population. DFG carefully monitors the catch of salmon in all California fisheries and works with other state, federal and non-governmental organizations to provide annual estimates of salmon returning to various California rivers and streams.

In 2007, DFG began using coded wire tags to track 25 percent of all juvenile fall-run Chinook salmon released from California hatcheries. This technology allows the state to determine the contribution and the distribution of salmon in ocean and river fisheries and the success of hatchery mitigation programs.

On the South Delta portion of the San Joaquin river system, scientists track migrating fish by following the sounds emitted by acoustic tags implanted inside their bodies. By tracking the salmon's travels, the scientists can determine and better troubleshoot the path ahead.

At the Warm Springs Hatchery, DFG scientists are researching ways to re-establish endangered wild coho salmon in the Russian River basin. Based on their findings, a captive rearing and broodstock program has been established at the hatchery, and now thousands of fingerling coho salmon are being released into historic coho waters each year.



Barely visible wire tags are used to monitor salmon released from hatcheries.

DFG and NOAA fisheries are also collaborating on a plan to monitor coastal populations of anadromous fish species and their habitats from San Diego to Del Norte counties. The first phase of the program is to conduct status and trend monitoring of fish populations, focusing on adults returning to spawn and out-migrating juveniles.

Ultimately, the program will include the monitoring of coastal restoration efforts, watershed health and fisheries management activities.

Salmon Hatcheries

California's eight salmon hatcheries are operated as mitigation for water projects. These hatcheries release more than 40 million juvenile salmon annually in the Klamath-Trinity, Sacramento-San Joaquin and Russian river systems. The hatcheries ensure genetic diversity among the different salmon stocks.

- **Coleman National Fish Hatchery** Built in 1942 on Battle Creek, a tributary to the Sacramento River; releases up to 15 million juvenile Chinook salmon annually
- **Feather River Hatchery** Built in 1967 on the Feather River; releases up to 8 million juvenile Chinook salmon annually
- **Iron Gate Hatchery** Built in 1966 on the Klamath River; releases up to 5.1 million juvenile and 0.9 million yearling Chinook salmon annually
- **Merced River Fish Facility** Built in 1964 on the Merced River; releases up



At left, a hatchery worker milks eggs from a female salmon. Millions of fingerlings like those below are released each year.



- to 1.3 million juvenile Chinook salmon annually
- **Mokelumne River Fish Hatchery** Built in 1964 on the Mokelumne River; releases up to 5.4 million juvenile Chinook salmon annually
- **Nimbus Fish Hatchery** Built in 1955 on the American River; releases up to 4 million juvenile Chinook salmon annually

- **Trinity River Hatchery** Built in 1964 on the Trinity River; releases up to 3 million juvenile and 1.3 million yearling Chinook salmon annually
- **Warm Springs Hatchery (The Congressman Don Clausen Fish Hatchery)** Built in 1980 on Dry Creek, a tributary to the Russian River; releases up to 0.2 million juvenile coho salmon annually



Recreational and commercial fishing are regulated to ensure that enough salmon survive to produce future populations.

Fishing Regulations

Anglers look to fishing regulations to find out how many salmon they can catch as well as when and where. Fishing regulations are set by the California Fish and Game Commission for sport and commercial fisheries, including coastal waters extending three miles offshore. The commercial salmon industry is also closely regulated by the setting of fishing seasons and fishing limits.

The PFMC and the National Marine Fisheries Service determine the salmon season for sport and commercial fisheries in ocean waters from three to 200 miles offshore. Because ocean salmon fisheries harvest a mixture of salmon stocks, fishery managers take a precautionary approach to reduce ocean harvest rates to levels that will not have an impact on ESA-listed salmon.

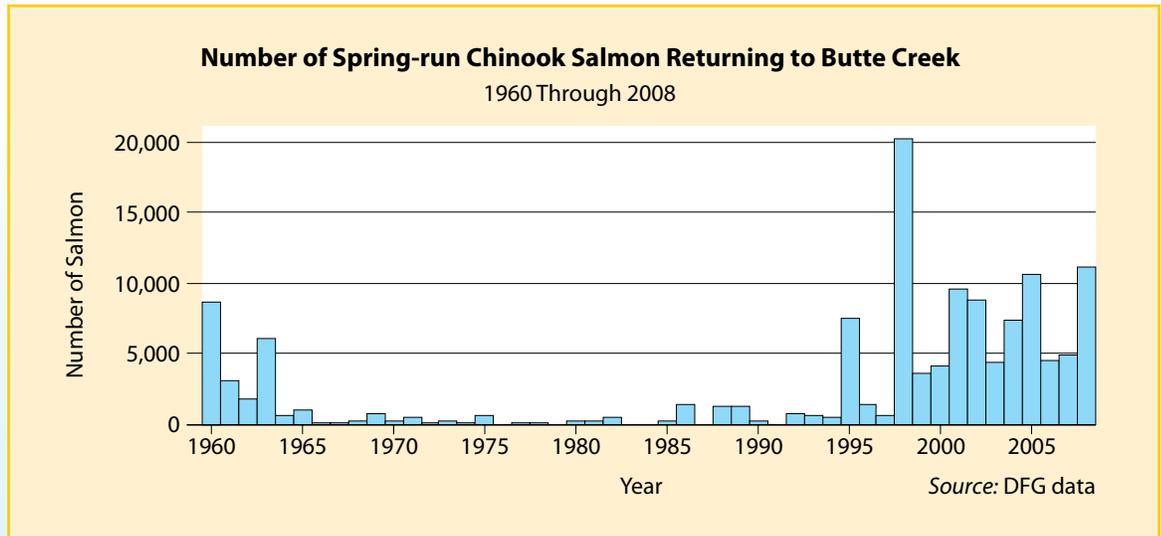


Each spring both the California Fish and Game Commission and the PFMC adopt regulations that meet the conservation objectives for California salmon. In 2008 sport and commercial salmon fishermen were stunned when all ocean salmon seasons were closed for the first time in California history because not enough adult salmon were returning to spawn.

Successful Salmon Recovery Efforts in California

Millions of dollars have been expended on efforts to increase salmon populations throughout the state. In the Sacramento–San Joaquin river system, Butte Creek and Battle Creek stand out as examples of how humans can make a positive difference, as does the Russian River on the north central coast.

Butte Creek today supports the largest spring run of wild Chinook salmon in the Central Valley. Restoration efforts have included the removal of four diversion dams, placement of five juvenile fish screens, installation of 11 fish ladders, acquisition of additional waters to increase instream flow and acquisition of riparian areas.



Above, graphic evidence of the success of the Butte Creek restoration. At far left, a record-sized Chinook found in Battle Creek during a 2008 DFG spawning survey. Near right, the restored salmon habitat above Mumford Dam on the Russian River.

Since 1993 more than \$35 million has been spent on these successful efforts. The number of returning salmon has increased from less than a thousand fish to several thousand annually.

Battle Creek is one of the most important tributaries of the Sacramento River. DFG and its partners have committed \$67 million to re-establishing endangered and threatened winter-run Chinook and steelhead in these waters. Plans call for the restoration of 42 miles of habitat along Battle Creek and the removal of several hydroelectric diversion dams, which will increase the flow of the creek while protecting fish and creating passages. This

will be the biggest watershed restoration and dam removal project in the state.

On the **Russian River**, the Sonoma County Water Agency and DFG implemented the Mumford Dam Fish Passage and Riparian Restoration Project, which restored salmon and steelhead fish passage to nearly 50 miles of spawning and rearing habitat above Mumford Dam.

More than 560 feet of the channel's bed was elevated to improve migration conditions. Riverbanks were regraded, and riparian canopy was restored, using large boulders and willow sprigs and planting native trees and shrubs on the banks.

Migrating adult Chinook and steelhead were observed navigating the new dam passage, and the following year young Chinook smolts and steelhead smolts migrated out. This successful restoration project continues to provide Chinook salmon and steelhead with access to the headwaters of the Russian River.

DFG is only one of many players uniting in the effort to rebuild California salmon stocks. Californians are enacting their stewardship of salmon resources now and in the future. Each restoration effort is another step leading to healthy salmon populations.

Educating Californians About Salmon

California salmon have endured 150 years of floods, dams, unregulated harvest, urbanization, agriculture and industrialization. Our challenge is to ensure that they remain a part of our future.

DFG recognizes the importance of educating Californians—especially our youth—about the history and the uncertain fate of our salmon. DFG's Classroom Aquarium Education Program teaches students about our state's natural resources and the factors that influence our salmon population. The program touches about 10,000 students in 400 northern California classrooms each year. These students are our state's next decision-makers.

Cities like Fort Bragg, Oroville and Rancho Cordova host annual salmon festivals that bring together community members young and old to feast and celebrate the historical and cultural values of salmon to our state. Festivals also provide an opportunity for residents to learn about restoration efforts currently under way.

All these efforts take time, planning and financing. By providing the public with the big picture in a way that is easy to understand, we ensure that tomorrow's industry, community and agricultural interests will continue to work together on projects to better the future of California's salmon.

Through the DFG's educational activities, students learn the value of aquatic environments, the need to preserve California's fisheries and aquatic habitats and how their personal actions affect these valuable resources.



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