

A Thousand Tiny Wounds

The crisis in California's salmon population can be described as the result of a perfect storm

Story by Harry Morse and Neil Manji



A salmon seeking a suitable spawning bed for her roe. Freshwater streams and estuaries provide important habitat for salmon. They feed on terrestrial and aquatic insects, amphipods and other crustaceans while young and on other fish when older.



DFG File Photo

An aerial shot of the mouth of the Klamath River. American Indians relied on the Klamath for its abundance of salmon and trout. The Gold Rush brought miners searching for minerals and their massive operations caused terrible disruptions to the area by damming and diverting water.

The perfect storm of natural and man-made events decimated California's Central Valley Chinook salmon population in 2008 and 2009. Once considered the icon of wild and free rivers, these salmon all but disappeared from waters throughout the state. Businesses were lost, traditions broken and anglers left mystified. Californians asked, "What happened?" Each time experts found one answer for the collapse, another question arose. While poor open ocean conditions that deprived young salmon of abundant food were identified as the main theme in the story of rapid decline, this issue highlighted only one chapter in the story. Drought, low river flows, water diversions, pollution, predation, hatchery practices, poaching and harvest management were all factors in the storm of events that culminated in the crash. The shockwaves it created rippled through California and the Pacific Northwest.

The story of the Chinook decline starts with irreversible changes in the mighty rivers of California where salmon live and die. When dams were built on the Sacramento, Feather, American, Mokelumne, Merced and San Joaquin rivers, man redirected the future of water use, water flows of entire rivers and the locations of places the Central Valley Chinook salmon would and could live. Dams closed off thousands of miles of spawning and rearing waters, not only in the Central Valley but also on the Eel, Klamath and Trinity rivers. For centuries, millions of young salmon had been nurtured in these waters. No salmon ladders or channels were constructed to allow salmon to bypass the major dams

and continue their journey upriver.

The needs of people—agriculture and business—demanded that waters of the great rivers be diverted, stored and rationed. Naturally occurring flood events were neutralized and salmon spawning and rearing areas were lost. Salmon swimming up these rivers were blocked from returning to ancestral spawning areas. Thus the salmon began to edge toward trouble.

Historical records estimate the Central Valley fall-run Chinook alone once easily exceeded a million returning adult salmon. In 2008 only 66,000 returned. A century ago, the spring and winter runs of Central Valley salmon together made up the largest of the returning salmon

runs. Today, both stocks are listed under the Endangered Species Act.

It would be inaccurate to say that salmon were completely forgotten by the dam builders, water users, regulators and anglers. Hatcheries were built to replace the lost runs of salmon, and today, water users and regulators pay millions annually to replace the losses of salmon stocks through the funding of hatchery operations, management and water allocations. Congress passed legislation and state government passed laws to ensure the survival of the salmon runs.

The crash of 2008 and 2009 prompted numerous court rulings creating strict guidelines on how much water could be pumped out south of the Delta for urban and agricultural use. The guidelines fluctuate throughout the year based on needs of salmon and other species of fish. The final rulings caught the attention of the general public at last, bringing the conflict between man and fish back into the public arena.

Still, most Californians do not understand the role and effect of dams on salmon; in fact, many Californians do not even know these dams exist. The dams provide flood protection, manage water supplies and help ensure the availability of food for millions of Californians. As

long as water problems were averted, people could water their lawns and salmon fishing and salmon steaks remained

Dams on the Sacramento, Feather, American, Mokelumne, Merced and San Joaquin rivers re-wrote the future of water use, water flows of entire rivers, and where Chinook salmon would and could live.

available, the dams were generally seen as a positive contribution to urban society. After all, only 6 percent of Californians fish, but all use water every day.

Half-Billion Dollar Loss

In 2008, the collapse of the Sacramento River fall-run Chinook salmon population cost the California economy more than \$255 million and 2,263 jobs. The following year brought the same bad news, but at an even higher cost: \$279 million and 2,690 jobs. The majority of the ocean and inland salmon seasons were closed for the first time in state history in 2008, and the same closure continued in 2009. Boat owners and commercial salmon fishermen were put out of business. Recreational anglers were stunned. Tackle shops, bait and boat dealers, motels and restaurant owners found their businesses floundering during one of the worst recessions on record. Newspapers and television newscasts asked why ... and whether the salmon dinner was a thing of the past.

Scientists from the National Oceanic and Atmospheric Administration (NOAA) were charged with finding answers. They investigated the ocean

Different Varieties in California

There are several species of Pacific salmon but only two occur in California rivers and streams with enough consistency to allow a fishery. Salmon are easily recognized by their streamlined, torpedo-shaped bodies, forked tails and a small adipose fin. The body shape allows efficient swimming in river currents and at cruising speed in open ocean waters.

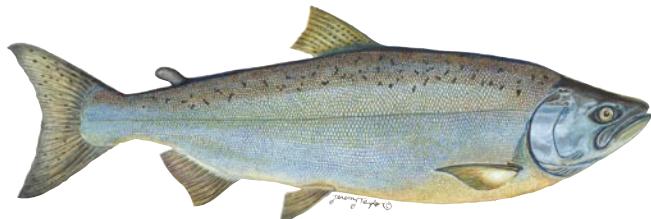


Illustration © Jeremy Taylor

Chinook salmon, also known as king salmon, are the biggest salmon and can weigh more than 100 pounds. They are "anadromous" fish, migrating upstream as adults to spawn in freshwater streams, and migrating as juveniles downstream to the ocean to grow and mature. The time spent in the ocean and freshwater varies greatly among the various runs.



Illustration © Tim Knepp

Coho salmon, also known as silver salmon, enter fresh water from September through January in order to spawn. In California's short coastal streams, migration usually begins between mid-November and mid-January. On the Klamath River, coho begin entering in early to mid-September and reach a peak in late September to early October. On the Eel River, adult coho return four to six weeks later than on the Klamath River. Arrival in the upper reaches of these streams generally peaks in November and December. Timing varies by stream and/or flow.



Illustration © Tim Knepp

Sockeye salmon is also known as red salmon. It is also known as Kokanee salmon and is stocked by the Department of Fish and Game in 24 reservoirs.



Photo © Joe Ferreira

waters where salmon, marine mammals and seabirds fed, and found significant changes in open ocean conditions that limited available food sources. This resulted in the loss of seabirds and fish stocks ranging from sardines to salmon. NOAA concluded that many young salmon faced food shortages at a critical point in their life and were dying without having a chance to return to their birth waters to spawn.

Pacific Fishery Management Council (PFMC), the federal commission charged with managing ocean fisheries off the West Coast, assembled a panel of scientists to produce its own report on the decline. This report also cited open ocean conditions as a major contributor, along with 40 other possible contributing factors.

A new University of California, Davis report on the overall decline of salmon, steelhead and trout in California predicted extinction of some species within the century.

Yet another report by the University of California, Davis examined the overall decline of salmon, steelhead and trout. Water use, quality and flow regimes were placed under a microscope and Delta studies by various agencies and groups were revisited. These researchers came to the direst conclusion yet: extinction of some species within the century.

Meanwhile, an investigation by the Sacramento Bee found millions of gallons of untreated ammonia were being pumped into the Sacramento River annually, further damaging the river and Delta ecosystems where



In order for a female adult to lay her roe, she uses her tail fin to exhume gravel and produce a shallow depression, called a redd. The female will lay thousands of eggs within the redd, which can cover as much as 30 square feet. Male salmon will approach the female in her redd, leaving his sperm over the roe. The female covers the eggs by disturbing the gravel at the upstream edge of the redd before moving on. Females make several redds before their supply of eggs are exhausted. Because of the exhausting effort it takes to reach the spawning area and complete their function, adults die usually within a few days.

salmon live, migrate and spawn.

NOAA questioned existing hatchery practices, specifically the rearing and releasing of millions of young salmon in a very short time period and in locations in close proximity to each other. Some likened this practice to putting all of the eggs in one basket. Other studies raised questions about the genetic integrity of salmon runs where the fish had been subjected to decades of hatchery production. Concerns arose regarding the fitness of hatchery reared salmon as compared to native or wild salmon. Salmon's complex life cycle in both fresh and saltwater exposes them to a wide range of deadly threats, and hatchery fish seemed to lack the resilience to survive.

Additional studies by the Department of Fish and Game and other agencies found that some young migrating salmon lost their way at diversion sites and

when flow conditions were adverse. DFG and its federal partners consistently release 32 million young salmon each spring in the Central Valley to replace salmon lost to the dams.

The Legislature considered a bill to remove all limits on striped bass, blaming them for decimating the salmon runs because they eat young salmon.

In the midst of all these studies and opinions, one clear picture emerged: salmon were falling victim to a thousand tiny wounds. They faced death at every turn of their life cycle. The hatchery fix of releasing millions of young fish annually was not ensuring large—or even minimum—returns of salmon. The problem had grown too large.

None of the studies or scientists were able to identify simple fixes. Salmon are not like goldfish that live in one bowl where the water can be changed. Their extremely complicated and vulnerable life cycle exposes them to myriad threats, ranging from drought to floods, predators and pollution, management and mismanagement, ocean changes and global warming. In light of all these factors, survival is nothing short of a miracle.

Ironically, California salmon are on the southern-most range of Pacific salmon stocks, geographically placing them on the edge of the best salmon habitat and favorable ocean conditions on the West Coast. From fish to fowl, the story is the same: species born into better habitats are more likely to survive adverse conditions. Those on the edge struggle for survival when things go bad.

The way the California salmon seasons are set only complicates the available harvest. Once they reach the ocean, salmon that originated in the Central Valley intermingle with salmon from the Klamath River and coastal stocks. To protect weak stocks of salmon, such as the 2008 returning Central Valley fall-run Chinook, all fishing in the ocean was closed, even though the Klamath fall-run Chinook salmon was large enough to support limited ocean angling. This approach, called weak stock management, is intended to protect the weakest link in the salmon chain.

What is the Department of Fish and Game Doing to Bring Back Salmon?

To get a time-sensitive snapshot of DFG salmon efforts, a Salmon Summit was called at DFG headquarters. Fisheries managers, scientists, water managers, harvest experts, enforcement chiefs, hatchery managers and habitat biologists met to address what mitigation measures DFG had taken so far, and what could be done in the future.

Hatchery managers knew only too well the success of spawning, rearing and releasing generations of salmon from California hatcheries. Their efforts went far beyond just releasing the fish into the river. In 2008, 20.2 million young salmon got a free ride to the ocean in specially designed DFG tanker trucks. Why the ride? Because

Common Questions About Salmon



Why was the salmon season closed?

This year, 122,000 Sacramento River fall-run Chinook salmon adults are projected to return. When subtracting for incidental losses, the number does not allow for any harvests and the actual return may not meet the minimum conservation goal for returning adults to the river system. In 2008, less than 66,000 Sacramento River fall-run Chinook adults returned to spawn in the Sacramento River Basin. It was the lowest escapement of Sacramento River fall-run Chinook on record. It is well below the annual conservation objective of between 122,000 and 180,000 adult spawners required by the Pacific Fisheries Management Council's (PFMC) salmon fishery annual goals for the stock.

What are the possible factors in the decline of the salmon?

A PFMC study considered the life history, range and needs of salmon. The study indicated that poor open ocean conditions and the lack of adequate food was the primary cause, but other factors were involved. Their study examined hatchery management practices, escapement numbers, predation, open ocean conditions, harvest management, water diversion and water management. In all more than 40 factors were considered part of the reason in the crash.

What is the cost of lost salmon seasons?

DFG assessed the potential damage from the closure of the salmon season and determined the loss to be \$279 million and 2,690 California jobs for 2009.

Will there be any compensation for lost jobs and wages?

Yes. The governors of California and Oregon sent a letter requesting the U.S. Commerce Secretary to declare a fishery resource disaster under the Inter-jurisdictional Fisheries Act of 1986, and a commercial fishery failure under the Magnuson-Stevens Fishery Conservation and Management Act of 1976. A disaster was declared in 2008 and 2009.

Who sets the seasons?

California Fish and Game Commissioners vote to conform to standards recommended by the PFMC. The recommendation called for closure of the ocean recreational salmon fisheries south of Horse Point in California for the 2009 season. The PFMC voted to close both commercial and recreational salmon fishing (except for 10 days in the Klamath Management zone) in federal waters. The state commercial regulations are auto-conforming; the commission adopts recreational regulations for state waters.

navigating downstream in these rivers is incredibly dangerous for young salmon. Some years, a majority of the young salmon—called smolts—never reaches the ocean. Studies by DFG and information collected by the Fishery Foundation of California show that, compared to smolts released at state hatcheries, the smolts trucked upriver and held in acclimation pens had a much higher return rate.

The summit meeting also highlighted efforts and measures implemented at Battle and Butte creeks. These are two examples of cooperative salmon and steelhead habitat. Butte Creek restoration efforts are intended to ensure the survival of the endangered spring-run of Chinook salmon in the Sacramento River system. Battle Creek efforts help anchor the giant fall-run in the system and, through continuing restoration efforts, aims to restore the listed winter and spring runs. More than \$90 million is being invested in restoring future spawning habitat in these two systems by state and federal fish managers working closely with landowners and power companies.

Grants managers have funneled million of dollars into coastal stream and inland waterway restoration projects in priority watersheds. The Fisheries and Restoration Grant Program is nearing the \$200 million mark in support of vital habitat related projects.

DFG's Water Branch, which consists of habitat specialists, undertook key water negotiations to ensure future generations of young salmon have consistent flows to support their migration to the ocean. In the fall of 2008, adult salmon on the American River needed an extra release of cool water from the lower levels of Folsom Dam to trigger up-river migration and entry into Nimbus Hatchery. Water negotiations made this water release possible. In the maze of water negotiations, controversies and contentious issues, unfortunately, many of the water specialists' achievements simply go unnoticed.

New research is underway regarding genetic salmon stock identification techniques. Also, a massive marking project of 8 million young salmon is in its third year. These efforts will ultimately produce better information on how many salmon return each year and which hatcheries they came from, and will help pinpoint the waters where they originated. This information comes into play when the state sets seasons, evaluates the success of threatened or endangered salmon stocks and monitors the outcome of habitat improvements.

PFMC is charged with setting ocean salmon seasons on the West Coast. Harvest management is a science which utilizes complex formulas to predict sizes of salmon populations. Through the use of computerized models and new salmon marking projects, PFMC is able to better predict salmon survival and return. It was their estimations predicting a low number of returning adult salmon that triggered a second year of closed salmon seasons on Central Valley salmon stocks in 2009.

The annual numbers of returning salmon serve



DFG Historical Records File

Even at its best in the late 19th century, early commercial salmon fishermen couldn't compete against today's technology for harvesting salmon. However, early commercial fishermen didn't suffer the collapse of the Pacific Coast salmon fishery. The state's economy lost \$255 million in 2008 as well as losing 2,263 jobs. This year the economy suffers a \$279 million loss and the loss of 2,690.

as the basis for both federal recommendations for ocean fisheries and state recommendations for river salmon seasons. Both federal and state analysts use a weak stock management policy to meet conservation goals.

Enforcement of state laws affecting salmon is a key piece of the puzzle. Wardens issue citations for illegal fishing, but their efforts stretch far beyond. They protect fisheries from over harvest, work with biologists to identify riverbed and stream alterations that violate state laws and reduce salmon's chances for survival, and they serve as a critical link in efforts to educate the public on salmon issues and laws.

The Salmon Summit was a success because it produced a clearer picture of the varied DFG efforts. It showcased successful programs and provided a blueprint for better cross-management and information sharing.

Solving the Salmon Puzzle Affects Us All

Has the perfect storm that devastated Central Valley Chinook salmon blown over or is it a harbinger of still more bad news to come? The question has galvanized a wide range of salmon advocates, scientists, managers and members of the public.

The toughest part of the salmon crisis is getting a grip on all the pieces in the puzzle. Critics focus on individual issues, but DFG works with a wide range

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of partners and engages all areas over which it has jurisdiction.

Though dams play a vital role in California's economy and water supply system, they also limit salmon populations. Fisheries managers have learned to work within these limitations. Salmon hatcheries are ready to take a scientific leap forward. New techniques and computerized advances are on the horizon.

Habitat restoration and stewardship of the Delta are particularly controversial issues. Solutions must come from state, federal and private nonprofit groups in a collaborative effort. Court rulings establish guidelines for water use and fish rehabilitation and health.

The perfect storm that brought the Pacific Coast the salmon crisis was brewing for decades before it broke. It may have started with the first dam and hydraulic dredge used to find gold. But one thing we know for sure: the salmon crisis didn't happen overnight, and it will not be solved overnight. It is DFG's responsibility to help salmon continue along their magnificent journey. 

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