

Summary, Review and Analyses, and Recommendations

State of the Science Workshop on Fish Predation on Central Valley Salmonids in the Bay-Delta Watershed - 7/22-23/2013

Sponsors: California Department of Fish and Wildlife, Delta Science Program, NOAA's National Marine Fisheries Service

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Workshop Purpose

"The purpose of the workshop was to have an independent panel of experts summarize the current state of knowledge on predation of Central Valley salmonids by other fish. This information will clarify the understanding of the role of fish predation on salmonids and associated factors in salmonid life history for policy decisions focused on improving Central Valley salmonid populations."

Questions for Panel to Address

"o What is the ecological context of predation by fish on Central Valley salmonids, and what can be learned from other systems that could inform our understanding of predation on anadromous salmonids?

o What do the available data and analyses tell us about the rates and population level effects of fish predation on Central Valley salmonids? Specifically:

- Are there appropriate methods for estimation of predation rates and population level effects from the existing data?*
- What biological and physical factors are likely to affect the impacts of predation on salmonids? Have these factors changed over time, and do they vary between the major basins (i.e., San Joaquin and Sacramento)? Do these factors vary among the major reaches of the system (e.g., spawning areas, riverine reaches, delta, bay, ocean)?*
- What is understood about the interactions among major factors influencing predation on salmonids (e.g., interactions among predators, hydrology and temperature, etc.)?*
 - o What related science is generally agreed upon; what are the key disagreements or uncertainties?*
 - o What future work (e.g., feasible scientific studies, modeling, and pilot experiments) should be done to address key knowledge gaps by testing clearly stated hypotheses to substantially reduce scientific uncertainties that lead to disagreement? Please provide guidance on appropriate study design and methods for estimating predation rates and population level effects."*

Problem Statement

"By the mid-1980's the population of winter-run Chinook salmon had collapsed such that the spawning escapement in 1994 was estimated to be fewer than 200 fish. These numbers increased to 17,153 in 2006, but then declined to 1,596 in 2010 and continued downward to just 824 in 2011. Escapement of spring-run Chinook (from several Central Valley streams) has declined precipitously over the last few decades as well. From the mid-1970's through the mid-1990's numbers had increased to nearly 15,000 in 2005. Then, numbers fell sharply to only 1,904 fish in 2010 for Butte, Deer, and Mill Creeks combined. For 2011, spring-run Chinook numbers rose to 2,767 for these important tributaries and were recorded at 3,064 for the Sacramento River system."

Initial Panel Conclusion

Does fish predation comprise a significant portion of salmonid mortality in the Delta? Based on available information the panel is uncertain as to the role of predators, but will get back to us in September.

Workshop Summary

Presentations on July 22 focused on the available science on Central Valley salmon and their predators. Some highlights:

- The main theme from presentations of recent studies of predation by striped bass and largemouth bass was these predators do not eat a lot of salmon. (Note: there was no info presented on historic studies from upper Sacramento River, especially those conducted at the Red Bluff Diversion Dam where predation rates on salmon were high.)
- Tagged winter-run chinook smolt studies indicate poorest survival in passage through San Francisco Bay, with Delta survival next lowest. River survival was highest. Overall survival was 15% in wetter years and 5% survival in drier years.
- San Joaquin fall-run smolt survival was low with high predation in Delta and Clifton Court Forebay. Steelhead yearling smolt survival rates were much higher (larger and faster). Salmon smolts trucked from salvaged facilities had higher survival than "natural" migrants.

July 23 was a shortened agenda with Panel's initial thoughts and comments of attendees.

My Comments

My thoughts from the workshop were that the presentations skirted much of the available information on the salmon that are vulnerable to predators and on the full array of predators the salmon face. Nearly all the information presented to the panel was on hatchery smolt predation.

"The Central Valley hatcheries (Feather River Hatchery and its Thermalito Annex, Nimbus Hatchery, Mokelumne River Hatchery, and Merced River Hatchery) have released fish in the past five years into a number of environments, including: rivers adjacent to the hatcheries, rivers in other parts of the Central Valley, farther downstream in the Sacramento–San Joaquin River Delta (Delta), and San Pablo and San Francisco Bays. Small numbers of fish (51,600 to 437,700 annually) have been released from the Mokelumne River Hatchery through an enhancement program that involves trucking fish to ocean or bay environments (Avila, Monterey, Santa Cruz and Tiburon) and then placing the fish in net pens prior to release. Transporting hatchery fish downstream of the Delta improves their survival. However, off-site release can also increase the rate at which returning salmon stray from the stream of their origin. This straying can result in salmon returning to streams that previously only supported steelhead runs or streams supporting other populations of Chinook salmon."

<https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=15293>

Information Missing from Presentations

1. There are nearly 30 million salmon and steelhead smolts released each year into Central Valley rivers from state and federal hatcheries.
2. These fish are subject to a gauntlet of predators in the tributaries, mainstem rivers, Delta, and Bay before passing through the Golden Gate.
3. These hatchery smolts contribute 60-80% of the salmon and steelhead runs.
4. Despite trucking and pen acclimation increasing smolt survival nearly 8-fold there is a move to reduce or eliminate this program because of straying problems.
5. No mention was made of the pilot barging program undertaken in the past two years.
6. No mention was made of the on-going trucking and pen acclimation program.
7. No mention was made of salmon salvage at export facilities or salvage fish trucking program protocols.
8. Wild salmon spawn in selected small tailwater reaches of tributaries and mainstem rivers making them highly vulnerable to a large number and array of predators.
9. Most of FWS and DFG's salmon and steelhead hatcheries are designed primarily to mitigate for the loss of fish habitat and blocked access to upstream spawning areas caused by dam construction. These hatcheries are located immediately below dams and draw their brood stock from returning hatchery fish and wild fish.

Columbia River

Information from Columbia River is relevant to Central Valley predation issue. There was no discussion of bird predation in the Central Valley and Bay.

"Caspian tern and double crested cormorant predation is a major cause of juvenile salmon mortality in the Columbia River Basin. The largest concentration of these birds – and where most of the juvenile fish are consumed – is in the Columbia River estuary below the federal dams. The birds are protected under the Migratory Bird Treaty Act, so management actions must consider these protections.

The Corps has constructed several alternative habitats for terns, attracting more than 1,000 mating pairs away from East Sand Island in the estuary, where the tern population is 9,000 to 10,000 pairs. The Corps has also reduced the size the East Sand Island nesting site by two thirds since 2009. When the redistribution project is complete, it will protect an estimated 2.4 million to 3.1 million additional juvenile salmon each year.

Cormorant predation has increased in recent years. In 2011, cormorants on East Sand Island consumed an estimated 20.5 million juvenile salmonids as they migrated to the Pacific Ocean – approximately 18 percent of the entire Columbia River out-migrating salmon population. The Corps is scoping an Environmental Impact Statement to identify alternatives to manage cormorant predation. The EIS is expected to be complete in 2014 so that management actions can be pursued.

Avian predation wires installed at dams are an effective deterrent to gulls and other birds that hunt near the tailraces of dams to prey on the juveniles as they pass. Wires installed at John Day Dam in 2010 reduced gull predation by an estimated 76 percent."

<http://www.salmonrecovery.gov/Home/LinksMapsResources/FAQS.aspx#q14>



Double-Crested Cormorant



Predator Management: Four main predator species are a major cause of mortality of ESA-listed fish in the Columbia River system. Populations of Caspian terns and double-crested cormorants, which eat large numbers of migrating juvenile fish, have increased over the last two decades in the Columbia River Estuary. These two species are also present in the mid-Columbia region. Among fish, northern pikeminnow are voracious consumers of juvenile salmon and steelhead. California sea lions are known to consume substantial numbers of adult spring Chinook salmon and winter steelhead below Bonneville Dam. Predation by bass is also a concern. Federal and state agencies are cooperating in efforts to reduce predation on listed species. Programs to redistribute Caspian terns currently nesting in the estuary, deter and block sea lions from Bonneville Dam fish ladders, and reduce the northern pikeminnow population through a sport- reward program have been successful in decreasing the loss of adult and juvenile salmon to predation. In 2009, the Action Agencies continued efforts to control specific predators and improve survival of juvenile fish. Caspian terns and double-crested cormorants consumed an estimated 17.5 million, or about 15 percent of all, juvenile Chinook and steelhead estimated to reach the estuary during the 2009 outmigration. <http://www.salmonrecovery.gov/Files/BiologicalOpinions/2009/2009%20FCRPS%20Progress%20Report%20-%20Section>

<http://www.birdresearchnw.org/Feature-Story/421687.aspx>

Columbia River Hatchery Program

Approximately 85 million hatchery-reared chinook salmon smolts are released into the Columbia River each year (as compared to 30 million in Central Valley).

(<http://wdfw.wa.gov/hatcheries/overview.html>)

"Historically, 10-16 million wild salmon and steelhead used to return to the Columbia/Snake river basins, now (2002-2011 average) we see about 1.3 million hatchery fish and about 320,000 wild fish return each year. Wild salmon and steelhead only makeup 20 percent of the annual returns in the Columbia/Snake river basins."

<http://www.fws.gov/pacific/Fisheries/Hatcheryreview/Reports/leavenworth/MC--024Huntington2007TUFinalReport.pdf>



Columbia River Barging Program

Hatchery and wild fish are barged below Bonneville Dam on the Columbia River. There is a general conflict between barging and spill as management tools.
<http://www.cbbulletin.com/426309.aspx>

Juvenile fish transportation is an ongoing program that collects fish from juvenile bypass facilities at Lower Granite, Little Goose, Lower Monumental, and McNary dams and transports them primarily by barge to release sites below Bonneville Dam. Approximately 16.7 million juvenile salmon and steelhead were collected at transport locations in 2009, with about 8.7 million fish being transported to below Bonneville Dam. The timing and conditions for fish transportation are determined based on annual research comparing adult returns to the spawning grounds of transported fish versus fish that migrated in-river. In general, fish survive better migrating in-river in early April, but they survive better when transported during lower- flow conditions in mid to late May. Also, steelhead generally exhibit higher survival, compared to Chinook salmon, when transported during the spring migration.
<http://www.salmonrecovery.gov/Files/BiologicalOpinions/2009/2009%20FCRPS%20Progress%20Report%20-%20Section%201%20-%20FINAL.pdf>

"The number of fish barged by the Corps grew steadily over the years, eventually to 20 million fish per year or more. Research indicates a mixed degree of success. Some stocks did well, and others did not. Barging appears to work best for steelhead and spring Chinook, which spend a year in their birth habitat before migrating to the ocean, and less well for fall Chinook, which begin their migration within a few months of their birth. The effectiveness of barging, then, may have something to do with length of time in the birth habitat and size of the fish. Barging or trucking (far more fish are barged than trucked) is effective but creates an unnatural environment and an unnatural migration experience for the fish, and some transported fish either lose their homing instinct or fail to return for reasons that are not clearly understood. Research shows that more transported fish survive to the release points below Bonneville Dam than fish that migrate in the river, but that fish that migrate downstream in the river return in greater numbers as adults than transported fish. The "delayed mortality" of transported fish is a subject of ongoing research."
<http://www.nwccouncil.org/history/fishtransportation/>

The question of transport versus spill is a complicated issue, particularly in low-water years and NOAA is conducting studies to provide additional information on barging.
(<https://www.fbo.gov/index?s=opportunity&mode=form&id=46b233a703d208594d8f274c7e09a743&tab=core&cvie w=0>)

To improve survival of juvenile migrants the 2008 BiOp, relying on the best available scientific information, calls for maximized transportation beginning on April 3 in exceptionally low water years when the seasonal regulated flow is ≤ 65 kcfs at Lower Granite Dam. This is accomplished by stopping spill at the three collector projects, Lower Granite, Little Goose, and Lower Monumental dams and diverting fish through the bypass facilities for collection and transport. [http://www.salmonrecovery.gov/Files/BiologicalOpinions/2010/Ex%201%202010%20Spring%20Fish%20Operations%20Plan%20\(3-26\).pdf](http://www.salmonrecovery.gov/Files/BiologicalOpinions/2010/Ex%201%202010%20Spring%20Fish%20Operations%20Plan%20(3-26).pdf)

NOAA Fisheries analysis of data from previous operations shows that barging federally protected juvenile steelhead and chinook in dry years produces significantly better adult returns, though there are limitations in the data. The Independent Scientific Advisory Board reviewed the current information, including information for species not listed under the Endangered Species Act, and recommends that spill combined with barging spreads the risk more broadly across those and other species, including sockeye and lamprey, and provides for additional data collection to help future decision makers. After considering all of the information and views, the agencies propose to operate the Columbia Basin hydropower system this spring with a combination of spill and barging to help juvenile salmon and steelhead reach the ocean in low water. The agencies coordinated the plan with states and tribes. Today the Justice Department filed the plan with federal court in Portland. The plan will be implemented with the start of the migration of juvenile salmon this month." Nmfs 2010 <http://www.salmonrecovery.gov/Files/BiologicalOpinions/2010/Spring%20Fish%20Ops%20Statement%202010%20Final.pdf>

Recommendations

A major factor in Central Valley salmon predation is the large hatchery program that was established as mitigation for the habitat lost by construction of the rim dams. The release of tens of millions of hatchery salmon smolts in upstream reaches of streams not only encourages predation but it also enhances the populations of predators. It's a self-perpetuating cycle that creates large numbers of predators that prey on the smaller populations of wild salmon and steelhead that are forced to rear and migrate through the degraded habitats of the Central Valley.

At the workshop, NMFS compared the 50% salmon smolt survival in the Columbia River system with the dismal 5% survival rate in the Central Valley. Unfortunately, NMFS failed to describe the different management strategies of the two systems.

The Columbia River system has two programs: spring spills in wetter years and barging wild and hatchery smolts in dry years, when spills are too costly to hydropower and water supplies.

Spring spills may be more difficult to arrange in the Central Valley but barging, at least under drier year conditions, should be seriously considered. Barging hatchery fish from

Verona and Discovery Park on the Sacramento River, after some trucking, would likely increase survival of 30 million hatchery smolts from the present 5% to potentially near 100%.

Wild salmon would no longer have to compete with hatchery salmon and, as wild salmon are likely more adept at avoiding predators, the predators would hopefully leave or decline because of the reduced artificial food supply. We might also consider initially barging the million or so wild fish collected at the fish salvage facilities of irrigation diversions and export project pumps.

It will still be essential to address the significant predation that occurs at predation hot spots created by water diversion and export projects, especially the Central Valley Project and State Water Project export facilities. For example, reconfiguring Clifton Court Forebay and upgrading fish screens and salvage facilities to state-of-the-art standards, as recommended in the CalFed ROD, would save enormous numbers of listed species, including salmon.

There are a number of other measures that should be considered. For example, providing January/February flows in the San Joaquin River tributaries would enable salmon fry to migrate while temperatures are low and before predators in those streams become active.