Session 7: Juvenile Chinook salmon

"De Minimus": What does this mean for the San Joaquin River Restoration Program and the Reintroduction of Spring-run Chinook Salmon?

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The Federal Implementing legislation for the San Joaquin Restoration Program is the San Joaquin River Restoration Settlement Act (Act) (Pub. L. 111-11, 123 Stat. 1349 (2009)). Among other things, the Settlement Act requires the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) to prepare a rule pursuant to section 4(d) of the Endangered Species Act (ESA) so that spring-run Chinook salmon reintroduction will not impose more than "*de minimus* water supply reductions, additional storage releases, or bypass flows on unwilling third parties." This rule entitled "Designation of a Nonessential Experimental Population of Central Valley Spring-run Chinook Salmon Below Friant Dam in the San Joaquin River California" was published December 31, 2013 (78 FR 251, December 31, 2013). This rule requires that a technical memorandum is prepared and released annually by NMFS. The annual technical memorandum is produced to calculate and document the proportionate contribution of Central Valley (CV) spring-run Chinook salmon originating from the SJRRP and describe how take of these fish will be deducted or adjusted for when applying the operational triggers and incidental take statements associated with the NMFS 2009 Biological Opinion or future biological opinions for the Long-term Operations of the Central Valley Project (CVP) and State Water Project (SWP), or section 10 ESA permits. A series of workshops were held in the summer of 2014 to explore the possible methods we could employ to make these adjustments. The information gathered during these workshops, as well as other background and supporting information, is being collated into a Guidance Document. This Guidance Document will be used to inform implementation of suitable methodologies to address the "de minimus" requirement of the Act. These methodologies will rely heavily on monitoring conducted by the San Joaquin River Restoration Program.

Juvenile Chinook salmon Trap and Transport

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Outmigration of juvenile Chinook salmon to the Pacific Ocean is critical for survival to adulthood in California rivers. Factors determining successful outmigration include suitable water temperatures, adequate and timely flow for downstream movement, and a passable watercourse, none of which are available downriver of Reach 1of the San Joaquin River Restoration Program during a low hydrologic water-year type and when Restoration pulse flows are absent. Low water conditions and water temperatures exceeding salmon thermal tolerance limits create physical, environmental, and physiological barriers to downstream migration and result in lower salmon survival if no management actions are taken. Due to poor hydrologic conditions and elevated water temperatures in the spring of 2014 and 2015, Reclamation conducted a trap and haul effort to capture and move juvenile fall-run Chinook salmon from rearing habitats in Reach 1, past dry river sections, to a downstream release location in Reach 5 where they could continue their migration. The purpose of the proposed action was to support the Settlement Restoration Goal by taking adaptive management actions to respond to unsuitable environmental and passage conditions in years when fish will not be able to emigrate on their own volition and to evaluate the feasibility of implementing similar temporary capture and relocation actions in the future.

To capture fish, temporary fence weirs were installed at four locations on the San Joaquin River between the Highway 41 and Highway 99 Bridges. The fence weirs were constructed from bank to bank, using wire mesh panels and supporting metal posts leading to a collection box. Fish would enter the collection box through a V-shaped passageway that inhibits exit. Restrictive bars at the collection box entrance would allow smaller fish to enter and block larger fish (i.e., predators). In addition to weirs, temporary fish collection nets were installed at a location downstream of Highway 99 Bridge and a rotary screw trap was temporarily installed near Ledger Island in 2013. Collection boxes were checked for fish and weirs cleaned of debris at least once daily. A total of 2,393 and upwards of 1,000 (study currently underway) salmon were captured during the 2014 and 2015 juvenile salmon trap and haul, respectively. Fish were collected from all sites and transported to the downstream release site daily. This effort will help to establish acceptable practices for capturing and transporting fish in subsequent low flow years when the San Joaquin River may not be contiguous throughout the Restoration Area. Monitoring fish movements and behavior in the San Joaquin River during a "Critical High and Low" hydrologic water-year, as defined by the Restoration Settlement, where no flow pulses are available to cue juvenile salmon to downstream migration is important for management of future salmon populations. In addition, genetic samples were taken to assist in determining parentage and successful redds along with stomach samples to determine food type and availability.

San Joaquin River Restoration: Floodplain Production in a Severe Drought

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A goal of the San Joaquin River Restoration Program (Program) is to restore suitable rearing habitat for juvenile salmonids, including seasonal floodplains that will support re-introduced fall and spring-run Chinook salmon (*Oncorhynchus tschawytscha*). Unfortunately, much of the historic Central Valley floodplain of the Sacramento San Joaquin River System was decoupled or converted long before monitoring was instigated and significant study must be undertaken to identify how and where floodplain restoration must occur for the Program to be successful. However, two years of severe drought have greatly impacted flow available to the lower San Joaquin and the ability to reconnect and study seasonal floodplains. Even so, artificial flooding of off channel habitat for waterfowl provides a unique opportunity to augment study of juvenile Chinook salmon growth associated with seasonally inundated habitat. From February through March 2015, we released Chinook fry into five off-channel habitats along the restoration reach. We collected water temperature by data logger and sub-sampled juvenile salmon every 2 weeks to track growth and diets related to different habitats. This study provides a unique opportunity to evaluate multiple use benefits of severely limited water supply. In this presentation we will discuss preliminary results and future direction for study.

Juvenile Chinook salmon growth and diet patterns in SJR mainstem habitats

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San Joaquin River restoration challenges include reduced discharge through drought and water diversions. The resulting 'Critical Low' discharge levels are insufficient to create floodplain habitat for juvenile Chinook salmon (JCS). However, this allows us to test a prevailing paradigm that juvenile Chinook salmon (JCS) require floodplain habitat for high rates of survival and growth. In this study we examine variation in JCS growth rates and diets over time and site through examination of otolith circuli and C & N stable isotope signatures of prey items and JCS liver and muscle tissue. Liver tissue reflects more recent (~7 days) C and N sources compared to muscle tissue which integrates a longer feeding history. Juvenile liver tissue was depleted in ^{13}C and ^{15}N relative to muscle. Liver ^{13}C was highly variable among individuals but did not vary over time or with fish size. Liver ^{15}N was less variable and decreased with fish size. Invertebrate delC and delN varied greatly among taxa and sample sites. Stable isotope modeling in MixSIAR produced Bayesian diet probabilities which demonstrated benthic foraging and trophic ontogeny as juveniles grew. Analysis of JCS otoliths for growth trajectories demonstrated that despite conventional theory, JCS growth rates in mainstem habitats were at or exceeded that of other populations in the western U.S. We address these relatively high growth rates compared to predictions for JCS growth in the inSTREAM v5.0 model. Under low discharge conditions, the San Joaquin River mainstem could comparably function as a floodplain habitat, with relatively high temperatures and reduced water velocities and turbidity.

*Salmon feeding strategies and the bioenergetic modeling of Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) growth during a drought in the San Joaquin River, California*

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Salmon fisheries managers often use models to determine the growth of individuals for a variety of objectives. Most models of salmon prey use only incorporate activity costs for one feeding strategy: ambushing, also known as drift foraging, when making growth assessments or predictions. This ignores a second foraging strategy, actively searching for food, because it is believed to be inefficient or biologically irrelevant. We propose that fish may need to include an active foraging strategy to meet their energy needs under certain situations, such as when prey is scarce, difficult to find, or if low water velocities do not promote high drift delivery. To investigate this we will test how the growth observed in a cohort of wild juvenile Chinook salmon in the San Joaquin River during a drought compares to predictions of growth derived from models of the two feeding strategies. This study will seek to provide evidence that current fisheries models need to become more sophisticated to properly estimate the growth of individuals and habitat production potential especially during less than optimal environmental conditions. The more accurate model can also then be used with future prey and environmental data from the San Joaquin River to more accurately predict juvenile salmon growth.