*San Joaquin River PIT tag monitoring program: survival and travel speed of juvenile emigrating Fall-Run Chinook salmon (*Oncorhynchus tshawytscha*)*

Charles D. Hueth, USBR chueth@usbr.gov
Zachary Sutphin, USBR; Donald E. Portz, USBR

Historically, California's upper San Joaquin River (SJR) supported stable populations of fall- and spring-run Chinook salmon (*Oncorhynchus tshawytscha*). However, both populations were extirpated from the system in the mid-nineteenth century following the construction of Friant Dam. In response to the San Joaquin River litigation Settlement, the San Joaquin River Restoration Program (SJRRP) has implemented an objective to restore a naturally reproducing and self-sustaining population of Chinook salmon, as well as other fishes, in the system. Because the anadromous life-cycle of SJR Chinook salmon requires conveyance of juvenile smolts from a riverine system to the Pacific Ocean, to support the return of spawning adults, meeting this objective requires the consideration of environmental conditions most likely to promote survivability of emigrating Chinook salmon smolts. Though there are likely a multitude of environmental parameters that impact emigrating juvenile salmon, flow regime and predation are often cited as having a significant effect on travel speed and survivability. Flows in California's San Joaquin River are highly regulated as means to support agricultural production, and non-native piscivorous fish in the restoration reach tend to occur more frequently downstream of Reach 1 (Gravelly Ford to confluence of Merced River) and in off-channel areas. Anecdotal evidence collected during SJRRP fish inventory and monitoring efforts suggests many of the non-native piscivores tend to reside in anthropogenic altered habitats (e.g., mine pits, altered channels, etc), which may pose a challenge to emigrating salmon smolts. To ascertain effects of environmental conditions, PIT tag antenna systems (6 sites per year) were constructed to evaluate mortality and migration rate of tagged juvenile fall-run Chinook salmon through the Restoration Area under a variety of flow conditions in 2012 (n = 3; 355, 505, and 709 cfs), 2013 (n = 3; 392, 600, and 1059 cfs), and 2014 (n = 4; 148, 157, 130, and 189 cfs). Results of our 2012 and 2013 data indicate at lower flows mean travel speed tended to decrease between sites moving downstream, but at higher flows fish apparently refuged between certain sites while moving rapidly through others. Percent survival data suggests decreasing survival with increasing flow. However, effects of flows > 400cfs on survival are likely invalid, as increasing flows promoted elevated water depths and rapid fish passage, which was assumed to contribute to decreasing PIT tag antennae detection efficiency. Therefore, evaluation of fish survival focused primarily releases when flows were < 400cfs, as antennas were constructed and calibrated at these flow conditions.

Juvenile Chinook Salmon survival and migration using acoustic tags

Jerrad Goodell, USFWS jerrad_goodell@fws.gov
Michelle Workman, East Bay MUD; Zachary Jackson, USFWS; Joseph Kirsch, USFWS

The San Joaquin River Restoration Program (Program) established Chinook Salmon (*Oncorhynchus tshwaytscha*) population targets to guide restoration and achieve salmon viability within the Restoration Area. A critical component to assessing population viability and guiding restoration is knowing the survivorship of individuals within a population and understanding why it varies, respectively. Currently, the survival rates of juvenile Chinook Salmon within the Restoration Area are unknown and not well understood. Consequently, the Program's population targets, prioritization of restoration actions, and the design of restoration projects may not be optimally informed. We evaluated the survival of hatchery reared juvenile fall-run Chinook Salmon released into the Restoration Area during four consecutive years (2011-2014) to help assess the effect of water operations, predation, and degraded habitats or anthropogenic structures on the survival of juvenile salmon. We released groups (n=28) of 22-199 individuals implanted with acoustic tags during the spring in reaches 1 and 2 of the Restoration Area in 2011, and within reaches 1 and 5 in 2012 to 2014 based on a lack of river connectivity. Each group of acoustically tagged fish was released with untagged individuals to emulate natural schooling behavior. We monitored the survival and movement of tagged fish using stationary acoustic receivers distributed throughout wetted reaches within the Restoration Area. In general, we found that survival, on average, was highest in 2011 and lowest in 2014 presumably based on the influence of drought and water operations. Further, survival estimates varied considerably within and among river reaches. For example, survival was higher in Reach 1 relative to Reach 5, but survival sharply decreased within Reach 1 as individuals migrated past Sycamore Island in most years. In addition, we observed that older and larger fish had greater survival than younger and smaller fish. We believe that our results can inform programmatic decisions concerning both near-term and long-term management actions. However, we recommend that more sampling be conducted with larger release groups and more replicates to better elucidate the relative importance of environmental factors, operating at local and regional scales, on juvenile Chinook Salmon survival and thereby viability within the Restoration Area.

Assessment of non-native predator movements, diets, and consumption rates: a threat to Chinook salmon reintroduction?

Steve Blumenshine, CSU Fresno sblumens@csufresno.edu
Kyle Griffiths, CSU Fresno; Michelle Workman, East Bay MUD; Zachary Jackson, USFWS

The upper reaches of the San Joaquin River include dozens of gravel mine ponds adjacent to and within the river mainstem, which support 11 mostly warm-water and non-native piscivore species. A collaborative effort sought to determine the predation risk to juvenile Chinook Salmon (JCS) from non-native piscivores through sampling monthly (February-June) from 2013-2014 at 32 sites. Evidence from mark-recaptures, assemblage structures over time, and stable isotope ratios of deuterium and oxygen in water and fish tissues suggest high site fidelity among piscivores. We analyzed over 500 diet samples from predators but focused our analyses on Largemouth Bass (LMB), which comprised the majority of predator numbers and biomass. Diet samples and bioenergetics models show that although 77% of LMB diet samples included fish, the rates of piscivory are not evenly distributed, not related to habitat depth or volume, and were related to water temperature. Although fish prey were numerous, only four out of ca. 4,000 diet items in 2014 were JCS, and crayfish were the main energy source for LMB across both study years. In 2015, weir and rotary screw traps captured far fewer JCS compared to 2014, and LMB in and around weirs consumed many JCS suggesting habituation to JCS as prey. We ran bioenergetic simulations addressing diet shifts of LMB to diets of 50% and 100% of energy from JCS during February-May, and found that LMB alone would be capable of consuming a very large fraction of JCS cohorts observed in recent trap and haul efforts.

Fish assemblage inventory and monitoring study

Jaron Hutcherson, USBR jhutcherson@usbr.gov
Jerrad Goodell, USFWS; Michelle Workman, USFWS; Joseph Kirsch, USFWS; Shaun Root, USBR; Donald E. Portz, USBR

A primary goal of the San Joaquin River Restoration Program is to restore and maintain fish populations in "good condition" in the mainstem San Joaquin River below Friant Dam to the confluence with the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish. As a means to quantify success of any restoration effort, it is necessary to first define baseline biotic and abiotic conditions for post-treatment comparison. To quantify baseline conditions, and develop standard procedures and methodology to support a long-term fish and water quality monitoring program, a Fish Assemblage Inventory and Monitoring Study (I&M) was conducted 2012-14. The I&M was an interagency effort (U.S. Fish and Wildlife Service and Bureau of Reclamation), and consisted of sampling multiple sites (typically 1 – 19 sites) seasonally (October, January, March/April, June) within all reaches of the Restoration Area. A diverse multi-technique sampling approach, intended to promote capture of multiple species and life-stages with varying habitat preferences, included boat and backpack electrofishing, seining, and trammel netting. In addition, water quality (dissolved oxygen, temperature, conductivity, and turbidity) was recorded during sampling occasions, and additional data was obtained from the California Data Exchange Center website from sensors within the Restoration Area. Results of fish sampling suggest native fish were generally more restricted in distribution than nonnative fish, and catch-per-unit-effort (CPUE) was lower, in most cases, for native fish than nonnative fish throughout all reaches. Water quality results indicate temperature, conductivity, and turbidity tend to increase upstream to downstream, whereas dissolved oxygen tended to remain consistent, though increasingly variable with distance downstream. Detecting moderate changes in CPUE, in response to future restoration efforts, using the current data as a baseline may prove difficult because of the level of variance measured. Additionally, data was collected during drought years and may not accurately reflect fish assemblages across varying conditions. Therefore, future efforts should focus on refining current methods to better detect these changes (e.g., increasing sample sites in Reaches that are under-represented) and/or incorporating additional methods which could provide information to detect changes in fish distribution. Additional baseline sampling may also be required to incorporate other water year types.