Study 12

Fall-run Captive Rearing Study – Year 3

Public Draft
2013 Monitoring and Analysis Plan

SAN JOAQUIN RIVER
RESTORATION PROGRAM

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San Joaquin River Restoration Program

2013 Monitoring and Analysis Plan

Fall-run Captive Rearing Study - Year 3

California Department of Fish and Game
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Proposed Staff: 1 permanent staff and 3 temporary staff from CDFG as needed, 1 temp from USFWS as needed.
County(ies) affected by Study: Fresno County

I. Study Management

A. Study Description

1. History or Background
   a. General project background discussion.

The Fall-run Captive Rearing Study is the third year of a multi-year study from salmon that were originally spawned in 2010. In the fall/winter of 2010/2011, a pilot-scale Interim Conservation Facility (Interim Facility) was developed adjacent to the San Joaquin Fish Hatchery (Friant, CA), and a small group of fall-run Chinook salmon was introduced to begin captive rearing investigations. During the 2010 fall-run Chinook spawning season, 55 pairs were mated at CDFG's Merced River Hatchery (MRH). Tissue samples from each adult were collected and sent to the CDFG's Anadromous Resources Tissue Archive in Rancho Cordova, California and then to the Genomic Variation Laboratory at University of California-Davis. After approximately 30 days when eggs developed a strong eye, 10 eggs from each cross (550 eggs total) were collected and transferred to the CDFG Silverado Fisheries Base (Yountville, CA) for hatching and quarantine. Of these, 60 juveniles were sacrificed for fish health assessment by CDFG's Fish Health Laboratory in Rancho Cordova. In March, 2011, following clearance from the Fish Health Lab, fish were transferred to the Interim Facility. Fish weights and lengths were measured monthly or

bimonthly and each fish was implanted with a Passive Integrated Transponder (PIT) tag (Biomark, Boise, ID). In August, 2011, fish were tissue sampled and sex was determined genetically by the Genomic Variation Laboratory at UC Davis. On October 21, 2011, the gender data were used to segregate fish according to sex to allow customized feed rations to modulate growth rates. At that time, approximately 15% of the male fish were identified as precocious and segregated. Gonadal development was then confirmed by ultrasound (SonoSite MicroMaxx 3.4.1 high resolution digital ultrasound, Wallingford, CT). Semen was expressed from each precocious male, tested for motility and cryopreserved. A strict feed regime was instituted in effort to modulate growth rates to control precocity using GROW, a Microsoft Excel based program developed for the Oregon Department of Fish and Wildlife. Females were fed a standard full ration and all males were offered a half ration.

c. Why is the study necessary (context of settlement requirements, reintroduction efforts, interim flow information needs, etc.)?

Captive rearing has been successfully used to increase depleted numbers of salmon nationwide, including wild sockeye salmon in the Redfish Lake Recovery Program (Hebdon et al. 2004) and the USFWS Winter-run Chinook Salmon Program at Livingston Stone National Fish Hatchery (Shasta Lake, CA), and it is currently being used by California Department of Fish and Game's (CDFG) Russian River Coho Recovery Program at Warm Springs Hatchery (Geyserville, CA).

Due to the technical challenges experienced by these programs and the time required to establish new hatchery facilities, a pilot-scale interim facility was proposed to captive rear non-listed salmon to refine rearing techniques and protocols prior to handling ESA-listed fish. The facility would also provide a staging location for other studies and be used for rearing spring-run Chinook while full-scale hatchery facilities are under construction.

2. Site Description

a. Location of the study (include maps, geographic data, etc.).

San Joaquin Hatchery is located along the San Joaquin River in the town of Friant, approximately 1 mile down stream of Friant Dam. The Interim Facility is located adjacent to the hatchery along the western edge, between staff housing and the hatchery's waste treatment ponds. The location provides a physical separation from the main hatchery complex for purposes of disease control. The water supply originates from Millerton Lake and is conveyed through a gravity-fed pipeline from Friant Dam and through a hydropower unit that is operated by Orange Cove Irrigation District (OCID). The Interim Facility currently operates on approximately 40 gallons per minute, which is sourced from SJH's water allotment. The Program is in the process of securing a total of

2 cubic feet per second (cfs) for the Interim Facility and will eventually secure approximately 20 cfs for the full-scale hatchery operations.

Figure 1. Interim Facility, Friant, California

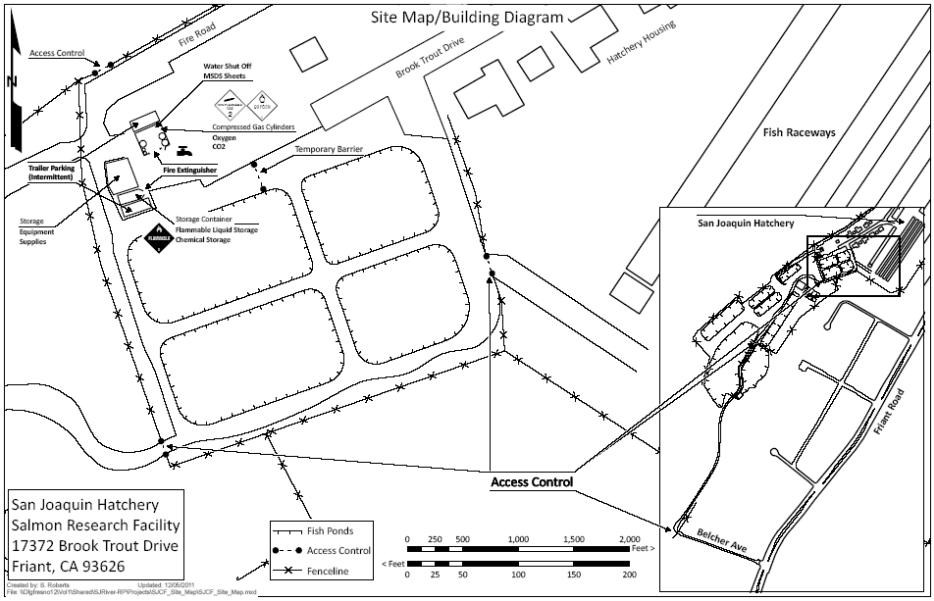

Figure 2. View of Interim Facility and Adjacent Buildings

2. Study purpose
    a. Statement of study goals.

The goal of the project is to continue to investigate methods for the captive rearing of Chinook salmon from spawning through adulthood in an effort to be fully prepared to work with threatened

spring-run Chinook and to increase the chances for successfully developing a self-sustaining, self-reproducing population of spring-run Chinook salmon in the San Joaquin River.

b. List the objectives of the study

The objectives of the study change annually, depending on the life stage of the fish:

Year 1: Develop Interim Facility and Initiate Captive Rearing Study - Test new equipment, practice egg collections, husbandry, PIT tagging, tissue collections, and growth tracking.

Year 2: Practice determination of sperm motility, cryopreservation, growth rate modulation, and continue facility development.

Year 3: Continue facility development, practice tracking ova development, continue to practice growth rate modulation, and cryopreserve semen from Jacks. Introduce a second group of either spring- or fall-run Chinook.

Year 4: Develop and implement mating matrix, practice spawning and egg incubation, use gonadotropins to stimulate ovulation, and practice release strategies for captive reared smolts. Introduce a third group of either spring- or fall-run Chinook.

3. What are the management or policy implications of the study?

The Fisheries Management Plan of the San Joaquin River Restoration Program (Program) (SJRRP 2010a) sets population goals for Chinook salmon (*Oncorhynchus tshawytscha*) to achieve the Restoration Goal of restoring self-sustaining populations of wild spring- and fall-run Chinook salmon to the San Joaquin River. The Program's Fisheries Implementation Plan (SJRRP 2010b) prioritized studies to address information needs for fish restoration and identified the Fall-run Captive Rearing Study as a high priority prior to the reintroduction of spring-run Chinook salmon, which is required by the Stipulation of Settlement by December 31, 2012 (NRDC vs. Rodgers 2006). The study is also identified as instrumental in the Program's Hatchery and Genetic Management Plan (SJRRP 2010c), which was submitted to NOAA Fisheries as an Appendix to the 10(a)1(A) Enhancement of Species permit application (USFWS 2011).

B. Study Organization and Responsibilities

Principal Investigator – Paul Adelizi

Responsible for study design and implementation, procurement, construction coordination, staffing, and draft and final report preparation.

Temporary Staff – (3)

Responsible for husbandry, water quality monitoring and data collection.

C. Study Design

The 2010 brood year fish will continue to be reared for an additional year at the Interim Facility, provided that the Program is able to secure additional water that will be required as fish space requirements increase. Depending on water availability, a second group of 2012 brood year Chinook will also be introduced to the facility. If all required permits are issued for the take of spring-run Chinook salmon, spring-run will be collected from Feather River Fish Hatchery for broodstock. If permits are not issued, it is likely that fall-run Chinook salmon will be used.

2010 Brood Year

Husbandry

When sufficient water is available, fish will be transferred from the two 6-ft circular rearing tanks to two 16-ft circular tanks. Fish will be weighed and measured every 2 to 3 months, and condition factors will be calculated. During weighing, fish will be anaesthetized with 75-100 mg/L tricaine methanesulfonate (MS-222). Males and females will be reared separately through December 2012. Males will be fed a restricted diet to reduce the incidence of precocity, while females will be fed a full or near-full ration to maintain high fecundity. Beginning January 2013 (i.e. during year 3 of rearing), males and females will be combined and fed 80-100% of a full ration supplemented with frozen krill to maximize the nutritional condition prior to spawning as 3-year-old fish. Ration requirements will be based on GROW, a Microsoft Excel® based fish feed program developed for the Oregon Department of Fish and Wildlife. The program uses Average Growth Rate (AGR) for Chinook salmon, temperature, average body weight, and feed conversion to estimate the ration amounts.

Gamete Development and Spawning

Approximately one month prior to spawning season, fish will be examined for sexual development using visual inspection and ultrasound (SonoSite MicroMaxx 3.4.1 high resolution digital ultrasound, Wallingford, CT). Two-year-old precocious fish will be segregated and semen will be cryopreserved based on Negus 2008. The frozen semen will be made available for crosses with three-year old fish the following year depending on the recommendations of the Program's Hatchery Technical Team. Two-year-old precocious females that are identified (if any) may be spawned, again depending on the recommendations of the Hatchery Technical Team. Spawning procedures will be similar to the guidelines outlined in the Program's HGMP (SJRRP 2010).

Briefly, males and females with developed gonads will be examined weekly during the spawning season to determine ripeness. Potential spawners will be genetically analyzed and a relatedness estimate (e.g., Queller and Goodnight 1989, Mxy, Blouin et al. 1996) will be developed for all pairs of broodstock fish (Kozfkay et al. 2008, Sturm et al. 2009). Based on the molecular relatedness estimate, a spawning matrix will be constructed following Sturm et al. (2009). Eggs from each female will be divided into 4 to 5 groups of roughly equal size and each will be fertilized by a different male. Eggs and fry from each cross will be kept separately until the major period of in-hatchery mortality is passed to allow for evaluation of the success of the cross.

2012 Brood Year

Stock Selection

If additional water supplies are secured and all required permits are issued, spring-run Chinook will be collected from Feather River Hatchery in accordance with the Program's December 2011 Enhancement of the Species 10(a)(1)(A) permit application for the collection of spring-run Chinook salmon for broodstock. If the Program is unable to collect spring-run Chinook salmon eggs in fall 2012, but sufficient water is available, the Program will likely pursue the collection of fall-run Chinook salmon. Fall-run Chinook salmon will be collected from either Merced River Hatchery, Feather River Hatchery, or possibly from fish that circumvent the Hills Ferry Barrier in Reach 5 on the San Joaquin River. The final stock selection will be determined by the Program's Fisheries Management Workgroup and will comply with appropriate State and Federal Permit requirements. The donor source that is selected for this study should not affect the procedures of this study as follows:

A maximum of 560 eyed eggs will be collected from the selected source stock for captive rearing and transferred to the CDFG Silverado Fisheries Base (Yountville, CA) for hatching and quarantine. Approximately 30 days prior to transfer, 60 juveniles will be sacrificed for fish health assessment by CDFG's Fish Health Laboratory in Rancho Cordova. Between February and March of 2013, fish will be transferred to the Interim Facility using a 500-gallon double-walled insulated aluminum tank (Aquaneering INC, San Diego, CA) equipped with two mechanical aerators (Fresh-flo Corporation, Sheboygan, WI) and pure oxygen gas supplied from pressurized cylinders through a coarse oxygen diffuser (Bioweave Diffuser, Aquatic Ecosystems, Apopka, FL). Oxygen levels will be maintained between 80-150% of saturation during transport. At the Interim Facility, fish will be reared in 6-ft diameter circular fiberglass tanks during the first year. Dissolved oxygen (DO), temperature, and feed quantity will be measured daily. Oxygen will be maintained above 80% of saturation, and temperatures will be maintained below 58 F.

Growth Rate Monitoring

Fish weights, lengths, and condition factors will be measured every 2-3 months. During weighings, fish will be anaesthetized with 50-75 mg/L tricaine methanesulfonate (MS-222). Fish will be tissue sampled and tagged by intraperitoneal injection (IP) using a 12 mm preloaded Passive Integrated Transponder (PIT) tags (Biomark, Boise, ID) when they have reached an average fork length of 60 mm. A secondary Visual Implant (VI) tag will also be used to maintain identity in the event that a PIT tag is lost. Tissue samples will be taken and correlated with the corresponding PIT and VI tag number. Using clean scissors, a small piece of caudal fin tissue (~ 2 mm x 2 mm) will be removed and transferred to a 2-mL cryopreservation vial filled with 95% denatured ethanol and labeled with PIT tag number, date, brood year, and river origin. Between clippings, scissors will be wiped, rinsed in 10% bleach solution, rinsed in distilled water and then 95% ethanol. Vials will be stored at room temperature and later transferred to the CDFG Tissue Archive (Sacramento, CA) for sub-sampling and transferred to the Genomic Variation Laboratory at University of California-Davis for sex identification using the process described by Brunelli et al. (2008). This technique identifies sex according to the presence of one (female) or two (male) bands from amplification of the OtY3 genetic marker.

Fish will be fed a quality commercial salmon feed, and the amount of the daily ration will be determined using GROW. Before sexual identity is know, fish will be fed 60-70% of the full ration in effort to reduce the incidence of precocity in the first year. Once sexual identity has be determined (preferably by May 2013), sexes will be placed in separate tanks and fed separate rations. Males will be provided a restricted diet (40-50% of the full ration) until they are approximately 24 months old to prevent early maturity. Female will be fed 80-110% of the calculated full ration in effort to maintain high fecundity and good egg quality. After 24 months, sexes will be combined and both fed 80-110% of the calculated full ration.

2. Describe the contingency plans to assure the question is resolved and uncertainties are addressed:

Contingency plans are discussed above and are based on the availability of water supplies the Interim Facility and the completion of environmental permitting.

D. Study Resource Needs

1. Detailed budget

The project will be fully funded by the CDFG with the exception of in-kind staffing contributions by the USFWS.

4. Coordination needs

   For stock collection, coordination will occur between the CDFG, USFWS, NMFS, Feather River Hatchery, Silverado Fisheries Base, the CDFG Tissue Archive, the Genomic Variation Laboratory at University of California-Davis, CDFG Fish Health Laboratory and the Hatchery Technical Team.

   For source water sourcing, coordination will occur between CDFG, USBR, Orange Cover Irrigation District and Friant Power Authority.

5. Has access to study site(s) been arranged?

Yes

E. Compliance Considerations

1. Route study through FRRT for compliance considerations

F. Invasive Species: What measures will be taken to ensure field staff does not spread invasive plants or animals to new sites during the study? (HACCP plans)

The Interim Facility is developing an HACCP plan for biosecurity and invasive species control.

G. Due Dates and Products

A draft report to the mid-year ATR will provide information

H. References

Negus, Mary T. 2008. SALMONID SPERM CRYOPRESERVATION TECHNIQUES. Minnesota Department of Natural Resources Special Publication 167, March 2008.