Enclosure D
Study FWS-2
Juvenile Chinook Salmon Survival Study
Submitted by the U. S. Fish and Wildlife Service
September 8, 2016

Introduction

The Applicant, South Sutter Water District (SSWD) operates the Camp Far West Hydroelectric Project on the Bear River (Project, FERC No. P-2297). Project operations are such that juvenile salmonid rearing habitat may be compromised downstream of the Project due to: (1) impacts to natural hydro-geomorphic processes that mobilize sediment, tumble (clean) spawning gravels, attract salmonid upstream migration, and provide downstream migration cues to steelhead trout (*Oncorhynchus mykiss*) and Chinook salmon (*O. tshawytscha*); (2) creation of warm water conditions that support predators that make it difficult for juvenile salmonids to safely migrate downstream; (3) limited floodplain rearing habitat caused by river channelization and regulated flows; (4) poor riparian conditions due to lack of floodplain connectivity, low input of marine derived nutrients (Zhang 2003) (Scheuerell et al 2005), and very low levels of littoral drift because woody material is held back by the Project and afterbay; (5) the narrow strip of existing riparian habitat that does not provide optimal juvenile rearing habitat or the wide, slow flow-conditions that would maximize retained woody debris in the floodplain.

This is the first step in the FERC Traditional Licensing Process where it would be appropriate for the U. S. Fish and Wildlife Service (USFWS) to make a study request.

Study Goals and Objectives

The goal of this study is to gather essential and fundamental information on Project effects on the survival of juvenile Chinook salmon and other anadromous fishes in the Bear River. This study will obtain the necessary information needed to evaluate the Project effects on survival of outmigrating Chinook salmon, and it will also gather information on Central Valley steelhead trout and green sturgeon (*Acipenser medirostris*). Resource agencies can use this information to develop license recommendations to conserve these species.

The objectives of the study are:

- to characterize the relative magnitude and timing of fry and juvenile salmonid outmigration in the lower Bear River and identify potential factors influencing outmigration;
- to estimate survival rates and condition changes in the juvenile salmonids outmigrating from the Bear River;
- to relate juvenile salmonid survival and movement behavior to habitat conditions;
- to estimate timing and use of the lower Bear River by juvenile salmonids and sturgeon, including non-natal rearing in the lower Bear River;

- to characterize use of the lower Bear River by juvenile salmonids and sturgeon in the context of flow, particularly spill events and the cessation of spill events.

Resource Agency Management Goals

The USFWS goals for the Camp Far West Hydroelectric Project include, but are not limited to, the following:

- Restoring disturbed or altered habitat for all life stages of native fish species, including fish spawning and fish passage habitat and including adult immigration and juvenile outmigration corridor habitat;
- Protecting, conserving, enhancing, and recovering native anadromous fish and their habitats by providing access to suitable habitats and by restoring fully functioning habitat conditions;
- Maintaining, enhancing and restoring all life stages of native aquatic species by ensuring connectivity within the Bear River and between the Bear River and Project-affected stream reaches;
- Maintaining, recovering and restoring streamflow regimes sufficient to sustain desired conditions of native riparian and aquatic habitats in Project-affected stream reaches;
- Identifying and implementing measures to protect, mitigate or minimize direct, indirect and cumulative impacts to, and enhance native anadromous fish resources, including related spawning, rearing, and migration habitats and adjoining riparian habitats;
- Maintaining, recovering, and restoring riparian resources, channel condition, connectivity, and aquatic habitat;
- Maintaining, recovering, and restoring streamflow regime sufficient to sustain desired conditions of native riparian, aquatic, wetland, and meadow habitats; and
- Protecting aquatic systems to which species are uniquely adapted.

Existing Information and Need for Additional Information

There is no information available on juvenile Chinook salmon outmigration on the Bear River; therefore, additional information is needed to better understand the Project effects on juvenile Chinook salmon survival and to determine the optimum flow timing and magnitude for outmigrating juvenile Chinook salmon and other anadromous fishes.

Project Nexus

The primary Project facilities include the: (1) Camp Far West Dam and spillway; (2) Camp Far West Reservoir (impoundment); (3) 6.8 MW capacity Camp Far West powerhouse; (4) powerhouse afterbay; and (5) recreational development. Continued operation and maintenance of the Project contributes to direct, indirect, and cumulative effects on the quantity of water, flow, and timing in the lower Bear River.

The Project directly affects the amount of juvenile Chinook salmon floodplain rearing habitat by attenuating the frequency and timing of flows during the wet-season runoff period of the hydrograph. Floodplain rearing and off-channel habitats are very important because they increase both the growth and survival of juvenile salmonids (*e.g.*, Sommer *et al.* 2001; Jeffres 2006). The current license's Article 29 instream flow releases are not adequate to sustain activated floodplain habitat, which is essential for the survival of juvenile salmonids (FERC 1981). The Article 29 instream flow releases are also not adequate to protect the designated beneficial uses of cold freshwater habitat and migration of aquatic organisms for the Bear River.

The Project cumulatively impacts juvenile Chinook salmon floodplain rearing habitat and outmigration survival because the Project holds back water, and SSWD and Camp Far West Irrigation District divert water that would otherwise engage with the floodplain downstream of the Camp Far West Diversion Dam.

The Bear River downstream of the Project currently is occupied by the anadromous Central Valley fall-run Chinook salmon, a subspecies with declining and unstable populations, the threatened Central Valley steelhead (*Oncorhynchus mykiss*) distinct population segment, and the threatened Central Valley spring-run Chinook salmon Evolutionarily Significant Unit. Critical habitat for steelhead within the Bear River extends from Camp Far West Dam to the mouth of the Feather River. Spring-run Chinook salmon critical habitat is in the downstream reach between Dry Creek and the Feather River. Any potential adverse impacts caused by the Project to Central Valley steelhead designated critical habitat or Central Valley spring-run Chinook salmon critical habitat need to be further evaluated.

The Bear River downstream of the Project is occupied by sturgeon. Little is known about their life-history uses of the River, but Project operations may lead to stranding. This study will not address all of the effects of the Project on green sturgeon, but is expected to collect data on juvenile outmigration timing and occurrence in the lower Bear River. See Enclosure A, Sturgeon Study Plan for additional data collection for sturgeon.

Scientific studies evaluating the relationship between flows and effects of Project operations on juvenile Chinook salmon and steelhead outmigration in the Bear River must be conducted to provide federal and state resource agencies necessary information to develop license conditions, protection, mitigation, and enhancement measures that will protect the anadromous fish resources of this watershed that are consistent with federal and state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by a project (§10(a)(2) of the Federal Power Act, 16 U.S.C. section 803(a)(2)(A)). Information from this specific new study would inform all parties of the Project's particular effects on juvenile survival of anadromous fish and whether the designated beneficial use of migration of aquatic organisms (MGR) is being protected (CVRWQCB 1998). The study results will inform the development of license requirements such as water operation modifications to provide instream flow downstream of the SSWD Diversion Dam to support floodplain connectivity and protect the native anadromous fish resources in the Bear River.

Description of Study Methods and Analysis

Study Area

The study area includes the Bear River from the SSWD Diversion Dam at RM 16.9 to the confluence with the Feather River.

General Concepts

The following general concepts apply to this study:

- Personal safety is an important consideration of each fieldwork team. If Licensees determine the information cannot be collected in a safe manner, Licensees will notify FERC and USFWS as soon as possible via email to discuss alternative approaches to perform the study.

- Applicant will need to obtain permits from appropriate federal and/or state agencies to capture and handle salmon, steelhead, and sturgeon.

- Licensee shall make a good faith effort to obtain permission to access private property where needed well in advance of performance of the study. If access is not granted or river access is not feasible or safe, Licensees will notify FERC and USFWS as soon as possible via email to determine if USFWS can assist in gaining access or to discuss alternative approaches to perform the study.

- The schedule for each proposed study is reasonably flexible to accommodate unforeseen problems that may affect the schedule. If a schedule changes, Licensees will notify FERC and USFWS as soon as possible via email to discuss alternative approaches to perform the study.

- Field crews may make minor modifications to the study proposal in the field to accommodate actual field conditions and unforeseen problems. If modifications are made, Licensees will provide a detailed description of the conditions that led to the decision to modify the study to FERC and USFWS as soon as possible via email.

- Licensees' performance of the study does not presume Licensees are responsible in whole or in part for resource management measures that may arise from that study.

- The estimated level of effort and cost is not a firm commitment by Licensees to expend all the funds. If the study costs more, Licensees are committed to completing the study. If the study costs less, Licensees are not committed to expending the remaining funds on other Relicensing studies or resource management measures.

- All special-status species observations will be submitted to the California Natural Diversity Database.

Study Methods

Fish Trapping—SSWD shall deploy two rotary screw traps (RSTs) following the methodology described in the Comprehensive Assessment and Monitoring Program (CAMP) *American River rotary screw trap protocol.*(Enclosure G to letter). The USFWS is available to answer any questions that SSWD may have regarding details of the CAMP protocol.

SSWD shall deploy one RST at or near Pleasant Grove Road at RM 6.7. Figure 3.2.1-8 in the PAD indicates that this location is near the most downstream extent of traditional riverine habitat. The goal of placement at this site is to allow capture of fish at a downstream location of spawning areas while still having good operability. The precise location should be selected in collaboration with fishery agencies, and may be adjusted for functionality.

Downstream of Pleasant Grove Road, the lower Bear River channel appears to lose complexity and may lack sufficient velocity at low flow to allow effective RST operation. The section of the lower Bear River downstream of Pleasant Grove Road is likely of greatest interest during high flow events, during which time it may serve as effective floodplain rearing habitat for juvenile salmonids and possibly sturgeon. The second RST should be deployed in this downstream section, with the goal of capturing juvenile fish that use the river at high flow. It is possible that an RST in this section may trap fish effectively only on an episodic basis. If that is the case, guide nets may be warranted. Regardless of the potential variations in efficiency of this downstream trap, the value of the data collected warrants placing a trap in this area.

For highest efficiency RSTs shall be placed : (1) where a relatively high percentage of the total river discharge flows through the trap cone; (2) where they can operate effectively over the entire range of discharge conditions (including floods) that may exist during a sampling season; (3) directly downstream of a riffle, as opposed to the downstream end of a pool; and (4) in the thalweg of the river or stream channel, unless high discharge or flood conditions dictates the trap should be moved to a position with lower water velocities. To the extent possible, SSWD should place the RSTs where water velocities at the trap site are at least 0.67 meters/second (m/s) at the lowest discharge that will be sampled and the water velocities at a trap site are 1.5 m/s under optimal conditions (USFWS 2008).

The SSWD shall install the RSTs with mechanical counters to record the number of revolutions the RSTs made between each servicing and calculate the revolutions per minute (RPM). Following the CAMP protocol, RPMs should be between 0.9 and 1.5. Fish refuge devices and debris separators should be provided in the live boxes to provide juvenile salmonids and sturgeon refuge from high water velocities and predation. The fish refuge devices and debris separators should be continually monitored to assure they do not result in size-selective mortality of juvenile Chinook salmon.

Fish Collection and Assessment of Trap Reliability—During each trap service, SSWD personnel should retrieve debris and fish inside the livebox using long-handled nets. SSWD should place separated fish in buckets of fresh water for processing. During fish processing, SSWD should anaesthetize fish using Tricaine-S (MS-222, TMS, tricaine methanesulfonate). After processing, SSWD should allow fish to recover in fresh water. SSWD personnel should count all captured fish, examine them for clips or marks, and classify them according to

species and development, or life stage, which for salmonids should distinguish them as follows:

- Yolk-sac fry are newly-emerged fish with a visible yolk sac ("unzipped").
- Fry are recently-emerged fish whose yolk is absorbed ("zipped-up"), and whose pigmentation is largely undeveloped.
- Parr are darkly pigmented fish with characteristic dark, oval-to-round shaped parr marks on their sides, no silvery coloration, and whose scales are firmly set.
- Silvery parr have visible but faded parr marks and a sufficient accumulation of purines to produce an intermediate degree of silvering.
- Smolts have highly faded parr marks or lack them altogether, a bright silver or nearly white coloration, a more slender body shape (i.e., lower condition), a black trailing edge on the caudal fin, and easily shed (deciduous) scales.

SSWD should measure and record the length of fish to the nearest millimeter (mm) of at least 50 randomly selected Chinook salmon, trout, or sturgeon per trap each time the traps are serviced; if fewer than 50 fish are captured during one service, SSWD should measure and record lengths of all of them. SSWD should measure and record the lengths of all captured sturgeon. For non-salmonid and non-sturgeon species, SSWD should measure and record the lengths of a random subsample of up to 20 individuals per service day**.**

In addition to collecting data from captured fish, SSWD should record each of the following variables during each servicing: (1) orientation of the trap to stream flow; (2) instantaneous rotation rate of the trap cone; (3) total number of rotations the trap cone makes each 12- or 24-hour period; (4) velocity of water moving into the trap cone; and (5) amount of debris collected by the trap. SSWD should measure the instantaneous rotation rate of the trap cone each time it processes fish at the trap, both before and after cleaning the trap. SSWD should also measure the instantaneous rotation rate of the trap cone as the average amount of time it takes the trap cone to make three revolutions. SSWD should also quantify the total number of rotations the trap cone makes during a 12- or 24-hour period using a mechanical counter mounted on the RST and reset the counter each time SSWD processes fish. SSWD should measure the velocity of water moving into the trap cone using a mechanical meter, measuring that velocity in the center of the trap cone just below the water surface.

Each day,SSWD should qualitatively and quantitatively document the amount of debris collected by the trap.

SSWD shall use the standardized data sheets developed by USFWS to document trap reliability (Appendix D of USFWS 2008).

Fish Marking for Survival Estimates—SSWD shall follow the fish marking and data collection protocol in the attached Pacific States Marine Fisheries Commission (PSMFC)(2016) including the fish marking. SSWD shall use the data sheets developed by the PSMFC (Appendix A of PSMFC 2016, attached), but change the river identification to the lower Bear River.

Data Collection—SSWD should collect environmental data at the trap sites including flow, water temperature, dissolved oxygen, and turbidity. SSWD should collect river discharge data using the Bear River at Wheatland gauge (USGS 11424000). SSWD should take instantaneous water temperature measurements at the trap sites using a handheld thermometer at least once each day. Data from recording thermographs situated near the trap sites were also acquired to define temperatures on a continuous basis. SSWD should measure turbidity and dissolved oxygen each time it processes a trap.

Reporting—SSWD will prepare a report that includes the following sections: (1) Study Goals and Objectives; (2) Methods; (3) Results; (4) Discussion; and (5) Description of Variances from the Study plan, if any, including consultation with resource agencies regarding variances. A number of report attachments will include, but not be limited to, additional data such as representative site photographs and entry logs with recorded screw trap data.

Products

- Data will be used to determine changes in juvenile fish condition as they migrate downriver, and may be used to determine the level of juvenile production necessary to sustain Chinook salmon and steelhead trout in the lower Bear River.
- Calculations of salmonid survival rates, estimate travel times, and growth rates.
- Inferences of fish condition, growth, and outmigration timing related to habitat conditions of flow and temperature.

Consultation and Communication

SSWD shall file with FERC and post on its Relicensing Website periodic reports (annual and semiannual reports) as required by the FERC in the Study Plan Determination. The Licensees will collaborate with the USFWS on the following items:

- Detailed study methods;
- Site selection;
- Obtaining proper scientific collecting permits from federal and state agencies; and
- Data analysis methods.

Schedule

SSWD should plan and complete the study as follows:
Planning and permitting.....January 2017 – December 2017
Collect Data .....January 2018 – May 2018
Study Report Preparation.....June 2018 – November 2018

If during January through May, 2018, there are not two consecutive weeks of flows in the lower Bear River with a magnitude greater than 500 cfs, SSWD will repeat data collection in January through May, 2019, and produce a report no later than November, 2019.

SSWD will include the study report in SSWD's DLA and FLA. If SSWD completes the Study report before preparation of the DLA, SSWD will post the report on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the report is available.

Consistency of Methodology with Generally Accepted Scientific Practices

The study methods discussed above are consistent with the established protocol for assessing juvenile survivorship in the major rivers of California's Central Valley (USFWS 2008, USFWS 2010, USFWS 2016). The methodology has been used in 16 major rivers in the Central Valley, with refined CAMP protocol being used on the Tuolumne, Stanislaus, Feather, American, and Sacramento rivers.

Level of Effort

As addressed above, existing information is not sufficient for developing protection, mitigation, and enhancement measures because the existing information does not specifically evaluate juvenile Chinook survival in the Bear River. SSWD should coordinate closely with California Department of Fish and Wildlife to ensure that no duplicative effort occurs on the Bear River and to potentially reduce costs.

References Cited

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