

## **Skinner Evaluation and Improvement Study Summary**

The Skinner Evaluation and Improvement (SEIS) study was initiated to comply with the requirements of the National Marine Fisheries Service (NMFS) 2009 Biological Opinion (BiOp) Reasonable and Prudent Alternative (RPA) IV.4.2, NMFS BiOp Term and Condition 2a, and the California Department of Fish and Wildlife's (CDFW) Incidental Take Permit Conditions of Approval 6.2.1 and 8.5. The objectives of the Skinner Evaluation and Improvement Study (SEIS) are to:

1. Evaluate pre-screen loss in Clifton Court Forebay (CCF) to measure the effectiveness of predator management actions including predator relocations efforts.
2. Evaluate Whole Facility Efficiency (WFE) at the John E. Skinner Delta Fish Protective Facility (SDFPF) for salmonids including losses through the louvers, screens, and other physical components of the facility, and to measure the hydraulic conditions at the facility.
3. Evaluate the effectiveness of juvenile Longfin Smelt salvage at the SDFPF.
4. Recommend improvements to the physical structures and/or operation of the SDFPF, CCF, and Banks Pumping Plant to improve the salvage of salmonids and Longfin Smelt.

From 2016 through 2018, DWR completed the SEIS study from January through June with the specific intent of measuring any reduction in pre-screen losses achieved as part of the concurrent Predator Reduction Electrofishing Study (PRES) in CCF. Similarly, in 2019, continuation of the SEIS study is ongoing concurrently with the Predatory Fish Relocation Study (PFRS), and DWR intends to continue the SEIS study while any further predation management actions are implemented in CCF.

### **Methods**

The SEIS project principally utilizes mark-recapture methods to evaluate direct losses of salmonids. To assess juvenile salmon survival from the CCF radial gate inlet through salvage, PIT tagged fall and late-fall Chinook Salmon are tagged and released at the radial gates and at the SDFPF behind the trashrack structure directly into the primary louver bays. Tagged fish are released from January through June or until water temperatures in CCF exceed lethal limits for salmonids. Except in 2016, a subset of salmon tagged with acoustic transmitters were also released at the radial gates. Detection of PIT tagged salmon occurs at the terminal stage of the salvage process at the salvaged fish release sites. Acoustic tags are detected with an array of receivers deployed at key locations within CCF and at the SDFPF.

To assess the effectiveness of juvenile Longfin Smelt salvage, DWR in collaboration with UC Davis, is attempting to develop a captive-spawned source of juvenile Longfin Smelt for use in a mark-recapture study. Phase One of the study is ongoing and is focused on developing culture and marking methods, while Phase Two is a planned series of releases of marked fish (likely dyed) released at the SDFPF headworks and recovered during salvage census at the SDFPF.

In tandem with the mark-recapture studies, DWR is also evaluating hydraulic conditions within the SDFPF as fish collection efficiencies are known to be influenced by the hydraulic performance of the louvers and bypass intakes. In general, for this study component, Acoustic

Doppler Current Profilers (ADCP) and Acoustic Doppler Velocimeters (ADV) are deployed in each bay of the SDFPF. In each bay, water velocity profiles are collected at set transect points within each louver bay.

## **Mark-Recapture Study Findings**

### **WY 2016**

To measure losses, a total of 66 releases of 20 PIT tagged fish each were made at the CCF radial gates from January through May utilizing late-fall run Chinook Salmon (January through March) and fall run Chinook Salmon (April through May). From April 20 through May 18 of this period, the PRES study conducted electrofishing and predator relocation from CCF.

Estimates of Total SWP Loss (TLswp) and Pre-Screen Loss (PSL) were calculated using the equations from Clark and others (2009). TLswp is defined as the proportion of fish released at the CCF radial gates that are lost prior to successful salvage at the SDFPF and is inclusive of pre-screen and screening losses. In these calculations, PSL is defined as an indirectly measured estimation of the proportion of fish released at the CCF radial gates that survive to the SDFPF trashrack. A value of 78% WFE at the SDFPF was utilized for these analyses (DWR 2015).

TLswp for WY 2016 was estimated as  $93 \pm 3\%$  (mean  $\pm$  C.I.) and ranged from 39% to 100%. TLswp was lowest during January (80%) but was more than 90% in all other months. Total PSL for WY 2016 was estimated as  $91 \pm 4\%$  (mean  $\pm$  C.I.) and ranged from 22% to 100%.

Time to Salvage (TTS), defined as the duration of time from release at the CCF radial gates to detection at the SDFPF, was also measured in WY 2016. Mean TTS was estimated as  $1.9 \pm 0.4$  days (Mean  $\pm$  SD), however since detections occurred post salvage, fish may have entered the SDFPF and been salvaged from 1-24 hours prior to the time of detection.

Results of the 2016 study were consistent with the results of prior studies evaluating losses of salmonids in the Forebay (Gingras 1997, Clark et al 2009). There were no detectable effects from the 11-day predator relocation effort in CCF.

### **WY 2017**

To assess juvenile salmon survival from the Radial Gates through salvage in 2017, from January to March, late-fall run Chinook Salmon were PIT-tagged and released in groups of 108-111 fish over eight discrete releases. From late April to June, eight groups of smaller fall run Chinook were similarly tagged and released in groups ranging from 168-169 fish. Four groups of 25-27 of the late-fall run Chinook Salmon also received both a PIT and an acoustic tag. Three of these acoustic tag releases occurred in February and one occurred in March. In addition, six groups of 30 fish each were released directly into the primary louver bays at the SDFPF trashrack to directly estimate SDFPF WFE, and to indirectly estimate PSL. During this time, predator relocation as part of the PRES study occurred on 39 days between January 23<sup>rd</sup> and June 15.

PSL was estimated as 77.16% for all races combined using tag detections and modeled results from the 16 releases of PIT tagged Chinook Salmon. PSL was estimated as 56.07% (range=26.1% to 88.5%) and 92.1% (range=92.1% to 98.5%) for late-fall and fall run Chinook Salmon, respectively. SDFPF WFE was modeled as 81.7% (77.9% to 86.2%) and 55.0% (54.3% to 55.7%) using tag detections from six releases of PIT tagged Chinook Salmon at the SDFPF trashrack during “Salmon” and “Striped Bass” operating criteria, respectively.

The limited acoustic tag data collected in 2018 showed similar results for total survival but had point estimates of pre-screen survival in excess of 90%. These results, which were based on direct measurement and different tag detection locations, indicated that significant loss occurred in the area around the SDFPF trashrack.

Survival of PIT-tagged juvenile Chinook Salmon was also modeled in a multi-state Bayesian mark-recapture framework as a function of environmental covariates (downstream and upstream head level at the Radial Gates, flow at the Radial Gates, pumping rate, temperature, turbidity, wind speed, fork length, predator biomass removed and predator CPUE). Neither predator biomass removed nor predator CPUE were found to be predictors of release-specific survival, suggesting that predator relocation efforts in 2017 were ineffective at reducing pre-screen loss.

### **WY 2018—\*Preliminary Results, Subject to Change\***

To assess juvenile salmon survival from the radial gates through salvage from January to March, late fall-run Chinook Salmon were PIT-tagged and released in groups of 99-120 fish over 20 discrete releases. From late April to June, 15 groups of smaller fall-run Chinook Salmon were similarly tagged and released in groups ranging from 167-189 fish. On sixteen occasions, salmon received both a PIT and acoustic tags. In addition, seven groups of 20-30 fish each were released directly into the primary louver bays at the SDFPF trash rack to directly estimate SDFPF WFE and to indirectly estimate PSL. During this time, predator relocation as part of the PRES study occurred in CCF on 54 days between January 8<sup>th</sup> and May 3<sup>rd</sup>.

In 2018, TLswp from the radial gates to the salvage release sites of PIT-tagged fall run juveniles was 89% and for late-fall juveniles was 93%. As in 2017, predator relocation efforts did not appear to have had a significant effect on survival.

Compared to 2017, preliminary acoustic tag analysis revealed spatial differences where mortality occurred between fall run and late-fall run Chinook Salmon. Late-fall run salmon experienced double the mortality between radial gates and intake canal.

### **Listed Species Take**

Federal Endangered Species Act “Take” of listed species has not occurred during implementation of the SEIS study to date. Use of hatchery origin late-fall and fall run Chinook Salmon for the mark recapture studies and autonomous detection of tagged fish negates any incidental take required to collect data.

The Longfin Smelt component of the study has not proceeded beyond laboratory-based study components, and thus no take has occurred. Field implementation of a Longfin Smelt mark-

recapture study would utilize several short (24-48 hr) periods of full salvage census (i.e. 120-minute counts) during March through May. During these periods, any non-experimental fish salvaged at the SDFPF could be subject to the additional handling associated with 120-minute fish counts, but lethal take is not expected.

There is no incidental take associated with hydraulic monitoring at the SDFPF.

## **References**

Clark, K.W., M.D. Bowen, R.B. Mayfield, K.P. Zehfuss, J.D. Taplin, and C.H. Hanson. 2009. Quantification of Pre-Screen Loss of Juvenile Steelhead in Clifton Court Forebay. March. Sacramento, CA: California Department of Water Resources, Bay-Delta Office.

California Department of Water Resources. 2015. Clifton Court Forebay Predation Study: 2013 Annual Progress Report. California Department of Water Resources, Bay-Delta Office, Sacramento, CA.

California Department of Water Resources (DWR). 2016. Preliminary SWP Chinook Salmon Survival Estimates for WY 2016. Technical Memorandum. California Department of Water Resources, Bay-Delta Office, Sacramento, CA.

California Department of Water Resources (DWR). 2019. Skinner Evaluation and Improvement Study 2017 Annual Report. California Department of Water Resources, Bay-Delta Office, Sacramento, CA.

Gingras, M. 1997. Mark/Recapture Experiments at Clifton Court Forebay to Estimate Pre-Screening Loss to juvenile Fishes: 1976-1993. IEP Technical Report 55. September.