Fish Salvage Mock Release Site Study

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Introduction

The California Department of Water Resources (DWR) has conducted an investigation into the release aspect of the Collection, Handling, Transport, Release (CHTR) process at the John E. Skinner Delta Fish Protective Facility. Results of this investigation provide the necessary scientific and engineering foundation for design of improved fish handling facilities as part of the long-term fish protection solution to Delta water export operations.

This study investigates two focal points of the release process: (1) release from the truck and (2) travel through the release pipe.

Based on observation, the physical features identified that may cause stress in the fish release process include:

- The truck tank outlet.
- The 90° bend in the release pipe.
- The hydraulic jump in the pipe where the release flow meets the receiving water.
- The interaction of salvaged fish and debris.
- Four water jets discharging into the center of the release pipe designed to flush. fish and debris down the pipe (auxiliary flow).

Objectives

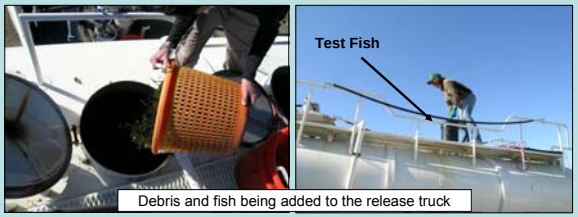
The results of this experiment will be used to:

1. Provide data to make informed decisions regarding recommendations for new technologies; these technologies can be in the form of new facilities, modifications to existing facilities, and alterations to operating procedures for releasing fish.

2. To develop criteria for the amount of debris to be removed throughout the fish salvage facilities and in the CHTR process; debris, coupled with the release hydraulic conditions, could be detrimental to fish survival.

Methods

- A mock release site mimicking the existing State Water Project release pipe at Horseshoe Bend was constructed at the Skinner Fish Protective Facility. The mock site consisted of a 95 foot long 12 inch diameter clear plastic pipe installed at a 16 percent slope, and equipped with hydraulic instrumentation. The pipe discharges into a fiberglass tank approximately 8-feet wide by 30-feet long and 9-feet deep (42,910 L). Above the water line, the model was a full scale representation of the actual release facilities.



Debris and fish being added to the release truck

- Fish (cultured delta smelt or chinook salmon) and varying levels of debris (0X- no debris, 1x- average debris, or 4x-heavy debris) were inserted into a release truck parked at the top of the hill prior to each experiment (treatment group). Additional control groups of fish were also inserted either into the receiving pool (control group) or immediately into post-test holding tank (baseline group).

Fish and Debris Recovery | 48-hr Health Assessment

- After each release, the receiving pool was drained and all fish and debris were recovered. Fish were held for 48 hours post test and all mortalities recorded.

- After 48 hours, a subset of fish was examined for various types of injury.

- For statistical testing purposes, all injury and mortality observations were converted to adjusted response effect values by the following formula:

  Release pipe effect size=(treatment-control proportions) $+C_T$

  were C_T is the largest effect value in the test for each variable.

The existing State Water Project release pipe at Horseshoe Bend near Rio Vista

The experimental release site constructed at the Skinner Fish Facility

Results

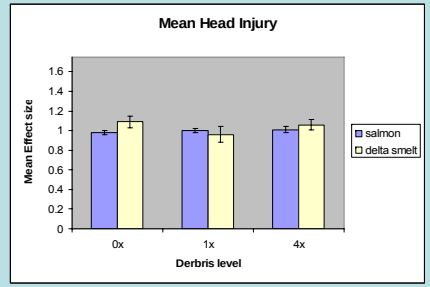
Fish survival and injury:

- Low mortality for both species post experiment and after 48 hours.
- Low injury rates for both species after 48 hours.
- No significant differences in mortality or injury between all debris treatments for both species.

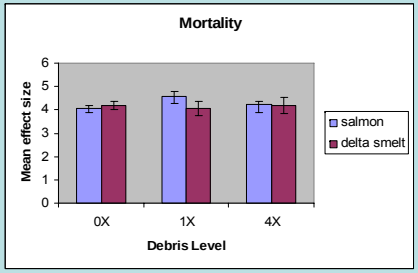
Percent mortality of Chinook salmon and delta smelt for baseline, control, and treatment groups

Species	Baseline 0x	Baseline 1x	Baseline 4x	Control 0x	Control 1x	Control 4x	Treatment 0x	Treatment 1x	Treatment 4x
Chinook salmon	0%	0.2%	0%	0.6%	0%	0.8%	0.8%	2.6%	1.6%
Delta smelt	0%	0.3%	0.3%	0.5%	2.7%	4.0%	1.3%	2.9%	4.8%

Results continued



Head injury serves as an example of a health assessment parameter with no difference between treatment groups



No differences in mortality were observed for either species at each debris level

Hydraulics and Debris:

- Maximum velocity encountered in the pipe was 25 ft/s.

- Maximum rate of fluid strain (shear) of 428 in/s/in. Rate of fluid strain is defined as the change in velocity magnitude divided by distance normal to the flow direction.

- The auxiliary flow, which measured 0.185 cfs, was insufficient to effectively flush the pipe, a minimum of 3.5 cfs for at least five minutes is needed to effectively flush the existing fish release pipe.

- Debris had no effect on hydraulics except for occasional clogging of the truck tank outlet or elbow under the 4x debris load.

Discussion

Our results show very low mortality for Chinook salmon and delta smelt associated with simulated fish release and varying debris loads. These results are comparable to similar fish handling or passage research. Helfrich and others (2001) also found no significant mortality of Chinook salmon in a Hidrostal Pump with survival rates ranging from 98.7% to 100% after 96 hours. A Department of Energy (DOE) study (2000) found that exposing fish to excessively strong shear flows may result in scale loss, bruising, or mortality. The maximum rate of fluid strain in a hydraulic jump can be approximated by high velocity flow entering a pool. Rate of fluid strain is defined as the change in velocity magnitude divided by distance normal to the flow direction (Δy). In the DOE study, shear effects on multiple salmonid fingerlength and juvenile age classes and yearling American shad were tested. All strain rates were based on a Δy of 0.7 inches, the approximate width of a juvenile salmonid fish. The study found no significant injuries to fish occurred at strain rates < 517 in/s/in. Maximum velocity in our model reached about 25 ft/s or a maximum rate of strain of 428 in/s/in, which does not meet the threshold determined by DOE 2000 to cause injury.

Given the results in this study where no significant injuries or mortality were found in the release phase for either Chinook salmon nor delta smelt, it is difficult to recommend changes to release protocols or modifications to the release pipe. However, we do recommend that some changes be made to the release pipe for the purposes of debris handling. These changes include the addition of an air venting valve to prevent blowback, removal of the 90° elbow on the release pipe to prevent clogging, consistently operating gate actuators, and augmenting the auxiliary flushing flow to 3.5 cfs to fully flush the pipe following a release.