REVIEW OF FOUR JUVENILE SALMON CODED WIRE TAG EXPERIMENTS CONDUCTED IN THE DELTA

Patricia Brandes - US Fish and Wildlife Service

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Background Information: Four coded wire tag experiments/programs were designed to evaluate water project actions (effects of diversion into the interior Delta through the Delta Cross Channel and Georgiana Slough, CVP and SWP exports and flow in the San Joaquin River with a barrier in upper Old River) on juvenile salmon survival through the Delta. The experiments have been conducted over the last 20 years with the Interior Delta versus Mainstem, Delta Action 8 and VAMP experiments ongoing. The purpose of this project is to re-examine these historical and on-going studies involving the release and recovery of juvenile Chinook hatchery salmon in the Delta to determine what has been or can be learned about the impacts of water projects on salmon survival. The question being addressed is "How can one improve the science associated with protective measures to improve juvenile salmon survival in the Delta?" This question directly relates to the scientific topics and general CALFED Bay-Delta Program management questions identified in this solicitation by obtaining and applying information on the direct and indirect effects of the CVP and SWP Diversion on at-risk species (salmon). It also would identify weakness in the existing monitoring and assessment programs and identify how they could be improved.

Delta Cross Channel Experiments: The question being asked in these experiments are: Is survival through the Delta higher with the Delta Cross Channel Gates closed? Survival to Chipps Island has been estimated for paired fall run coded wire tagged hatchery juvenile salmon released upstream and downstream of the Delta Cross Channel and Georgiana Slough with the DCC gates open and closed. These experiments were conducted between 1983 and 1989. Four experiments were conducted with the DCC gates closed and nine were conducted with the DCC gates open. Survival indices were generated based on recoveries made at Chipps Island in the western Delta using a midwater trawl towed at the surface. Sampling was conducted at Chipps Island, daily for several weeks after the releases were made, with 10, twenty minute tows conducted per day. Survival indices were compared for the groups released upstream and downstream of the Delta Cross Channel and Georgiana Slough. In both cases, (using a paired t- test and a t test of the difference) survival indices were found to be significantly ($p<0.05$) greater when fish were released downstream. When survival indices are compared between the gates open and the gates closed cases, differences were not significantly different (Brandes and McLain, 2001). The results of these two studies appear to contradict each other indicating that confounding factors may be affecting our ability to detect differences in survival between the gates open versus gates closed cases.

The closure of the Delta Cross Channel is assumed to reduce the number of juvenile salmon diverted into the interior Delta because on average a lower percentage of the water at Walnut Grove is diverted when the gates are closed. More recent studies in the vicinity of the Delta Cross Channel indicate that tidal conditions affect the amount of water and juvenile salmon diverted into the interior Delta via the Delta Cross Channel and Georgiana Slough (D.Vogel, personal communication). On flood tides more flow and radio tagged salmon entered the Delta Cross Channel (D.Vogel, personal communication). Also on flood tides with the gates closed more flow and radio tagged salmon entered Georgiana Slough (D.Vogel, personal communication). At lower flows the relative force of the flood tide (in the vicinity of the Delta Cross Channel and Georgiana Slough) would be greater than at high flows. There are potentially times,

t-tests on the differences were done for smolt survival indices 1993-2003 (t= 4.59, n=13, P=0.0007) and for ocean recovery rates (t=3.40, n = 10, P=0.0078). These data infer that once fish are diverted into the Central Delta via the open Delta Cross Channel or Georgiana Slough, high relative mortality occurs for juvenile salmon migrating through the Delta in the fall, winter and spring months.

Delta Action 8 Experiments: The question being asked in this experiment is, "Is survival through the interior Delta related to project exports for late-fall run juvenile salmon?". Delta Action 8 refers to an original Anadromous Fish Restoration Action that was proposed to evaluate CVP and SWP pumping on the survival of juvenile salmon through the Delta. The experiment was originally designed to release two sets of marked fish into Georgiana Slough and at Ryde on the mainstem Sacramento River, one at high exports and one at low exports. The ratio of the survival index of the Georgiana Slough group to the Ryde group was used to index interior Delta survival. The experiment has been conducted since 1993 using late-fall Coleman NFH hatchery fish to better represent older and larger fish migrating through the Delta in the late-fall and winter months. Results to date indicate that the survival ratio is weakly correlated to CVP/SWP exports for the mean of the 3 days after the Georgiana Slough release using both the Chipps Island survival index ratios and the ocean recovery rate ratios. The data are more variable at the lower range of exports than it is at the higher export values. It has been suggested that exports may limit interior Delta survival at the higher export levels whereas at the lower export levels, other things sometimes limit survival.

Releases have also been made at Port Chicago to factor out influences downstream of Port Chicago using ocean recovery data. In some years, releases have also been made at Sacramento just prior to the releases made in Georgiana Slough and at Ryde. A further refinement to the design, starting in 2003 has been the added release at Sherman Island, which is designed to standardize trawl efficiency at Chipps Island to make year to year comparisons of the individual indices more valid.

In the last four years (and in 1993 and 1996) only one set of release groups have been used at Ryde and Georgiana Slough. The balance of the 290,000 hatchery fish available have been used for additional releases at Sacramento, Sherman Island, and at Vorden. These additional releases are being made to put the Ryde and Georgiana Slough releases into further context. The Sacramento release gives an estimate of survival through the Delta. TheVorden group which is released on the Sacramento River downstream of the junctions with Steamboat and Sutter Sloughs, provides some information on the benefits or detriments of some fish being diverted into Steamboat and Sutter Sloughs when it is compared to the Sacramento group. There are limited data from these other releases since they have only recently been incorporated or ocean recovery rates are not yet available. It is anticipated that more analyses will be done on these releases in the future with modeling of late-fall survival through the Delta being our main goal. One of the critical questions we will be asking the statisitican is "are these methods valid, but progress is slow because the Delta is complex, or is there a large amount of variation because the method needs improvement (larger release numbers or more trawling time)

STATEMENT OF WORK

UFWS would be the lead agency. Ms. Pat Brandes, Senior Fishery Biologist would be the Principal Investigator. Ms. Brandes is the lead biologist for all of the studies listed above. USFWS would select an appropriate technical expert - with expertise in evaluation of coded wire tagging experiments and applied statistics. Funding would support the technical expert's time.

The technical expert (statistician) would review the relevant literature, review the study designs, conduct power analyses, review data and results, evaluate statistical methods and interpretation and suggest alternatives if appropriate (and conduct them if possible) for the four projects listed above. The technical expert will meet regularly with Ms. Brandes. It is estimated that it will take the statistician 10 weeks - full time to thoroughly review these projects, suggest alternatives and write up a technical report on the findings. Each aspect of the program review will take approximately one to two weeks and include reviewing relevant literature (1 week), reviewing the study design and recovery methods (1 week), conducting power analyses (2 weeks), reviewing data and results (1 week), evaluating statistical methods (1 week), suggesting alternatives (2 weeks), and writing the report (2 weeks). The Service will contribute as a cost share approximately $3000: Ms. Brandes time of approximately 40 hours - 4 hours /per week for ten weeks. Ms. Brandes salary will be paid for through CVPIA B2 monitoring and USFWS (EWA/CALFED) funds.

Timeline:
The project start date will be September 1, 2006. This start date will allow ample time for the identification and selection of a qualified statistician. The project end date will be December 1, 2007 to provide time for review by three independent experts familiar with coded wire tag experiments and analyses. Although the project is estimated to only take 10 weeks of effort, it will be done over a 15 month period.

Deliverables:

- Presentations at conferences including the CALFED Science Conference;
- Semi-annual reports will be submitted to the CALFED Science Program contract manager (the technical liaison listed in this contract) every 6 months following the project start date;
- A Final report will be submitted 15 months from the project start date to the CALFED Science Program contract manager. It will include review from at least three independent experts familiar with coded wire tag analyses and their comments will be provided as an attachment to the final report.