Proposal for the 2009 VAMP Study

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4/2009

Background: The VAMP Technical Committee formulated a plan for the 2008 study using a network of acoustic receivers deployed in the Delta to detect passage of acoustic-tagged juvenile Chinook salmon and estimate fish survival (Figure 1). USGS installed and operated the dual-array four-port receivers shown in Figure 1 at Mallard Island (Chipps Island) and Jersey Point. The VAMP Technical Committee had been working on preparations to continue the same study in 2009. However, on January 8, 2009, USGS announced that due to staffing problems, they would not be able to install and operate the four-port systems at Mallard Island and Jersey Point. Without acoustic receivers at those locations, overall fish survival to Mallard Island cannot be estimated. Two other contractors were contacted to determine their ability to install and operate the four-port receivers, but due to time constraints associated with contracting and the specialized nature of installing, maintaining, and retrieving several miles of cables on the riverbed the receivers at Mallard Island and Jersey Point will not be in place for the 2009 study.

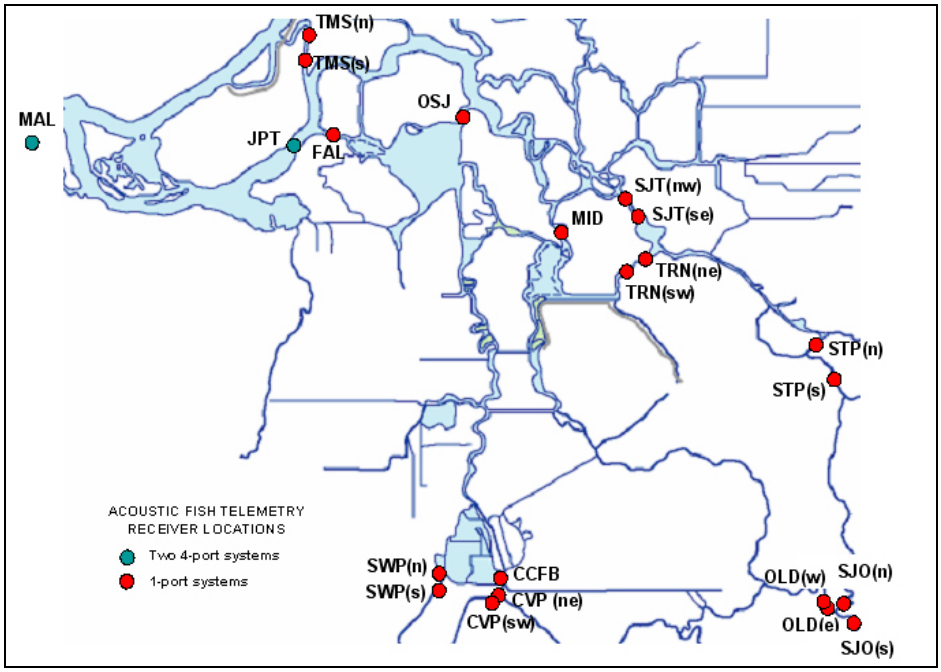

Figure 1. Locations of acoustic receivers deployed in the Delta during the 2008 VAMP Study.

Initially the technical team evaluated implementing a plan B which incorporated all of the same receivers in 2008, with the exception of Mallard Island and Jersey Point. However, after further discussion it was determined that four sites incorporated in 2008 would have little biological relevance because fish survival cannot be estimated to those locations (i.e., northern Middle (MID) and Old Rivers (OSJ), False River (FAL), and Three-Mile Slough (TMS(s) and (n)) without receivers at Mallard Island and Jersey Point, thus the plan was further scaled back for 2009. Although the 2009 proposed plan would not provide estimates of overall fish survival to Mallard Island, it would provide fish survival estimates in some key reaches of the Delta and fish route "selection" probabilities at critical flow splits (i.e., head of Old River and Turner Cut).

Also, this plan would enable continued testing of the acoustic receiver network and equipment, refining logistical approaches to field implementation, and other potential improvements should a study of this nature continue in future years.

In addition, DWR is planning to conduct a study of the effects of south Delta temporary barriers on juvenile salmon by installing acoustic receivers at the unlabeled, green, sites shown in Figure 2. Furthermore, DWR would like to test the ability of a behavioral barrier at the head of Old River to reduce the number of juvenile salmon that enter Old River. As part of this effort a four port hydrophone will be placed in the junction of upper Old River and San Joaquin River to do 2-D tracking of acoustic fish passing by the junction. The exact placement of the hydrophones to accomplish 2-D tracking is still under development although Figure 3 shows an approximation of how they will be placed for the study.

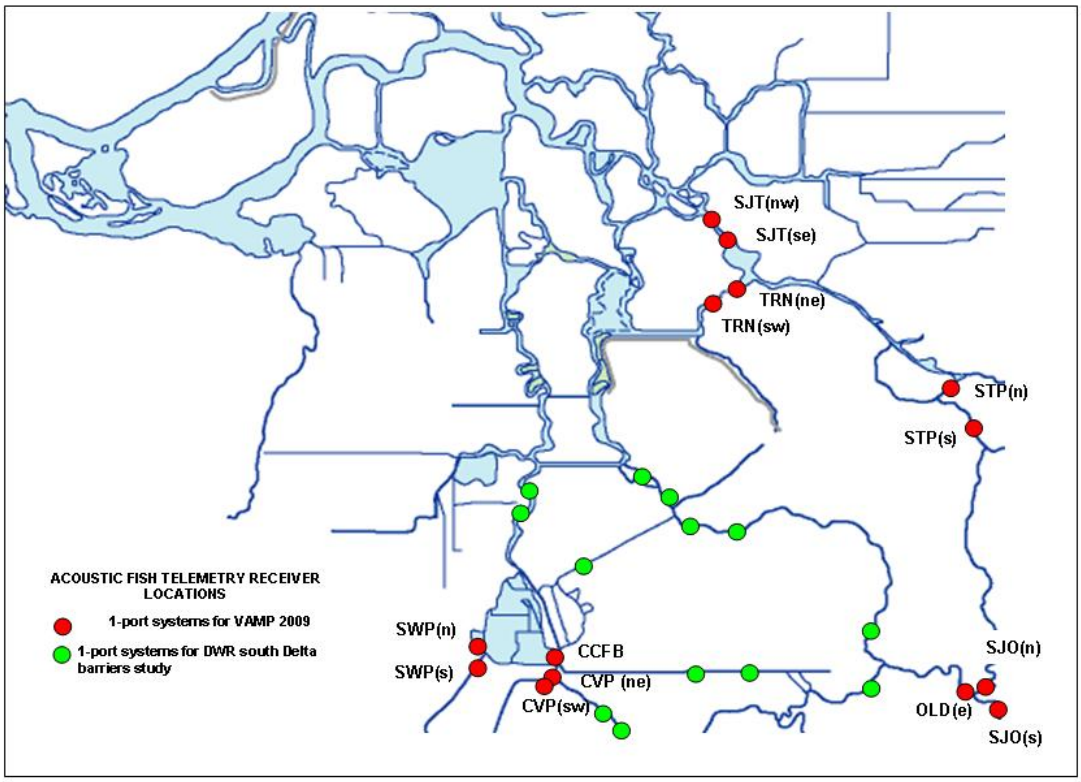

Figure 2. Locations of acoustic receivers for the 2009 VAMP study (revised Plan "B") including locations of acoustic receivers DWR plans to deploy for the south Delta temporary barriers study.

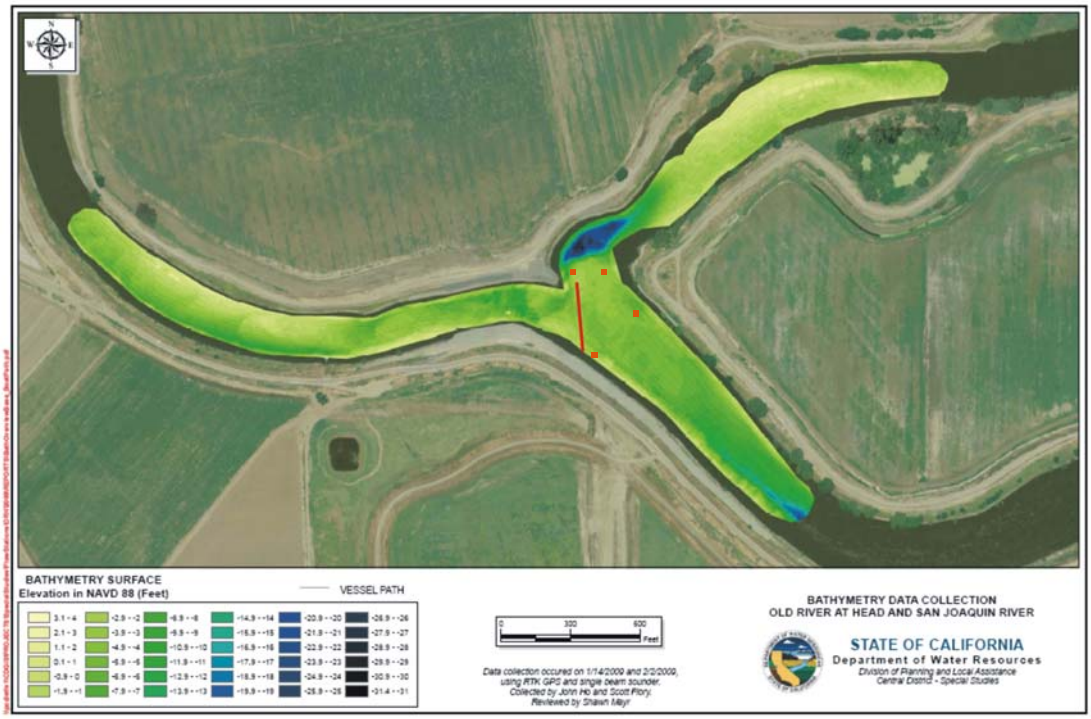

Figure 3: Potential location of hydrophones associated with 2-D tracking of acoustically tagged salmon released as part of VAMP and "bubble curtain" barrier proposed for installation in 2009.

It has been suggested that with the four port hydrophone at the upper Old River junction, that it is not necessary to have a receiver at Mossdale. Although, this may be true, it would be beneficial to retain the receiver planned for Mossdale in the plan to better document any potential loss between Durham Ferry and Mossdale and as a back up incase the 2-D tracking does not occur or has technical problems.

Kevin Clark of DWR has discussed with the technical team some of the potential limitations associated with one of the receivers placed near the trash-rack at the State Fish Facility (SWP (n)). Kevin found in his studies on steelhead use of Clifton Court Forebay that some steelhead detected at the trash-rack were later detected in Clifton Court Forebay and even into Old River. Thus Kevin recommended that the receiver at the State Fish Facility trash-rack be moved to the holding tanks or the release sites. It is unlikely the State Fish Facility management would allow receivers to be placed in the holding tanks due to safety concerns. The technical team could not easily accommodate Kevin's suggestion for additional receivers at Horseshoe Bend on the Sacramento River and Curtis Landing (or is it Antioch Bridge) on the San Joaquin River. The technical team realizes there may be some limitations associated with estimating survival across Clifton Court Forebay based on using data from the receiver at the trash-racks at the State Fish Facility. A second receiver is planned to be installed by DWR in Clifton Court Forebay just inside the radial gates.

Model:

John Skalski, Rebecca Buchanan and Russ Perry (modelers) from the University of Washington have recently recommended a model structure for the proposed 2009 VAMP study. The modelers' recommendations on the layout of telemetry stations (Figure 4) is a slight modification of that described in Figure 2. It is important to engage modelers in determining placement of receivers to insure estimability of requested movement and survival parameters through the study area. However, due to the numerous issues described in the VAMP technical committee meetings, time and logistical constraints in the 2009 study limit the ability to fully explore those potential opportunities and may constrain our abilities to estimate survival.

If the project is successful, a spatial, branching release-recapture model will be used to estimate: (1) migration route probabilities (i.e., route entrainment probabilities), (2) route-specific survival probabilities, and (3) the overall survival of outmigrating smolts to the six exit points in the model (A6, F1, C2, B3, D1, and E1). Both the statistical model used to analyze the telemetry data and the estimable parameters will depend on the precise layout of the telemetry receiver stations. Importantly, the inference area for the survival estimates will depend on the location of both the "entrance" and "exit" telemetry stations. Also, the ability to estimate both migration route probabilities and route-specific survival probabilities will depend on the precise location of the telemetry stations. Therefore, it is essential that tight coordination exists between the hydrophone layout, release design, and statistical analysis. Usually, this process occurs over many months well in advance of such a study. However, given the short time available this year, attempts have been made to refine the study using the modelers' recommendations.

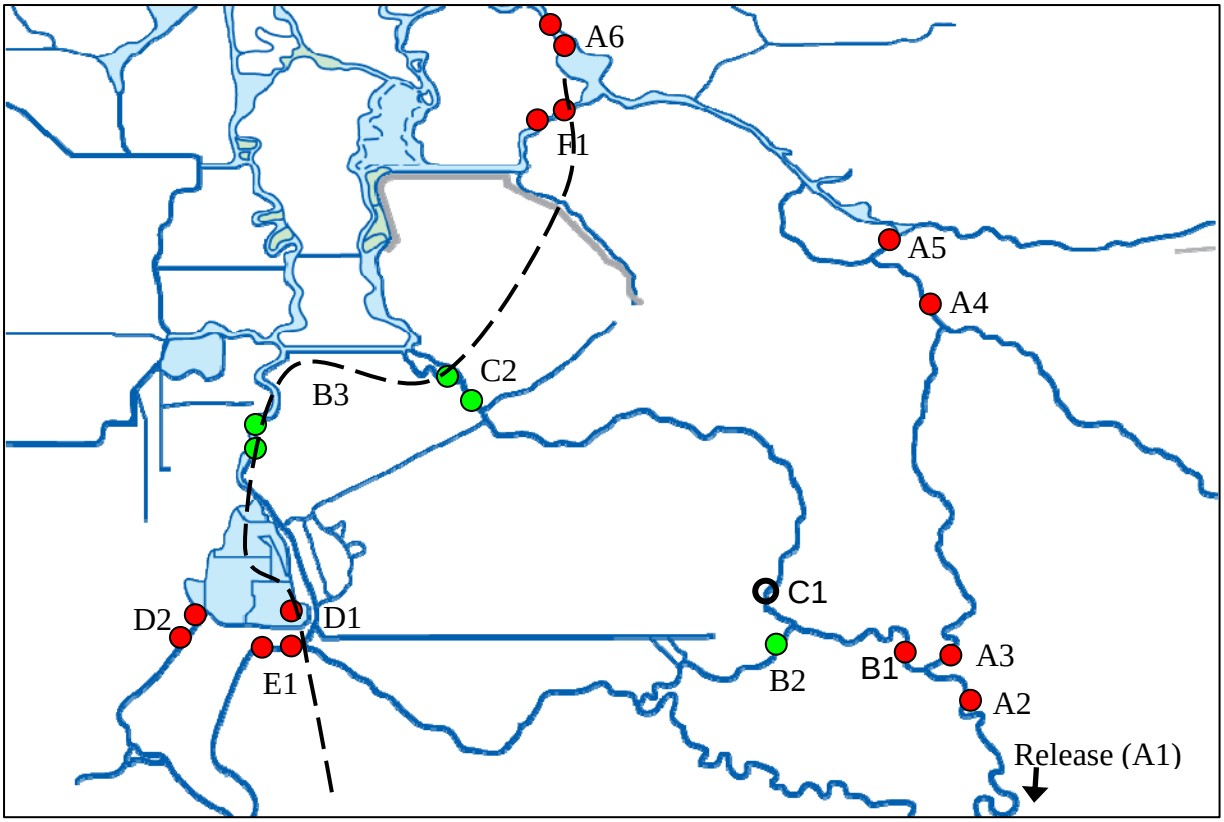

Figure 4. Map showing recommended locations of telemetry stations. Red sites are those being implemented specifically for VAMP. The green sites show those being implemented for the DWR study. Double arrays are shown as two-closely spaced dots with a single label. The dashed line bounds the study area and shows the six exit locations from the study area. The receiver at the SWP project near the trashracks (D2) may need to be moved as steelhead have been documented moving from the trashracks back into Clifton Court Forebay in previous experiments. As of 3/15/09, C1 can no longer be deployed due to lack of suitable site at that location.

A schematic is provided in Figure 5 of the release-recapture model corresponding to the layout in Figure 4. This design layout and model will provide estimation of migration route parameters and route-specific survival parameters through various reaches, as well as "total survival" from entry into the system at station A2 through exit from the system at stations B3, C2, D1, E1, A6, or F1. A brief overview of the model parameters and the estimable measures follows. Changes to the layout of the telemetry stations from that shown in Figure 4 will result in reduced estimability; some parameters may not be estimable from a different layout. The various routes and exit points are defined as follows:

A = San Joaquin River: survival and exit point
B = Old River: survival and exit point
C = Middle River: survival and exit point
D = State Water Project: survival and exit point
E = Central Valley Project: exit point
F = Turner Cut: exit point

Furthermore, define the following model parameters:

P_{hi} = detection probability: probability of detection at telemetry station *i* within route *h*.

S_{hi} = survival probability: probability of surviving from telemetry station *i* to *i*+1 within route *h*, conditional on surviving to station *i*.

ψ_{hl} = route entrainment probability: probability of a fish entering route *h* at junction *l* (*l* = 1, 2, or 3), conditional on fish surviving to junction *l*.

$\phi_{hi,kj}$ = joint probability of survival and route entrainment: probability of surviving and moving from station *i* in route *h* to station *j* in route *k*.

Fish emigrating from the San Joaquin River enter the Delta at Station A2 (SJO(s) in Figure 2. From this point, survival and migration route probabilities can be estimated separately for three different migration routes, using the layout depicted in Figure 4: The San Joaquin River (Route A), Old River (Route B), and Middle River (Route C). The probability of migrating through each unique route is the product of route entrainment probabilities at each river junction within a migration route:

$$\psi_A = \psi_{A1}$$
$$\psi_B = \psi_{B1}\psi_{B2}$$
$$\psi_C = \psi_{B1}\psi_{C2}$$

The probability of surviving from the entrance of the Delta (A2) through an entire migration pathway is estimated as the product of survival probabilities that trace each pathway:

$$S_A = S_{A2}S_{A3}S_{A4}S_{A5}$$
$$S_B = S_{A2}S_{B1}S_{B2}$$
$$S_C = S_{A2}S_{B1}S_{C1}$$

Survival probabilities S_{B2} and S_{C1} above represent survival of fish that remain in the Old River at B2, or enter the Middle River at C1, respectively. These fish may subsequently exit the next "reach" at four possible locations: the State Water Project (D1), Central Valley Project (E1), Old River (B3), or Middle River (C2; see Figures 4 and 5). Because there are many unmonitored river junctions within this reach, it is impossible to separate the probability of taking a specific pathway from the probability of surviving to a given exit point. Thus, only the joint probability of movement and survival can be estimated to any given exit location (the $\phi_{hi,kj}$ parameters defined above and in Figure 5). However, over all possible pathways and exit points, survival from C1 (S_{C1}) or B2 (S_{B2}) to all possible exit locations can be estimated from the $\phi_{hi,kj}$ parameters as:

$$S_{C1} = \phi_{C1,B3} + \phi_{C1,C2} + \phi_{C1,D1} + \phi_{C1,E1}$$
$$S_{B2} = \phi_{B2,B3} + \phi_{B2,C2} + \phi_{B2,D1} + \phi_{B2,E1}$$

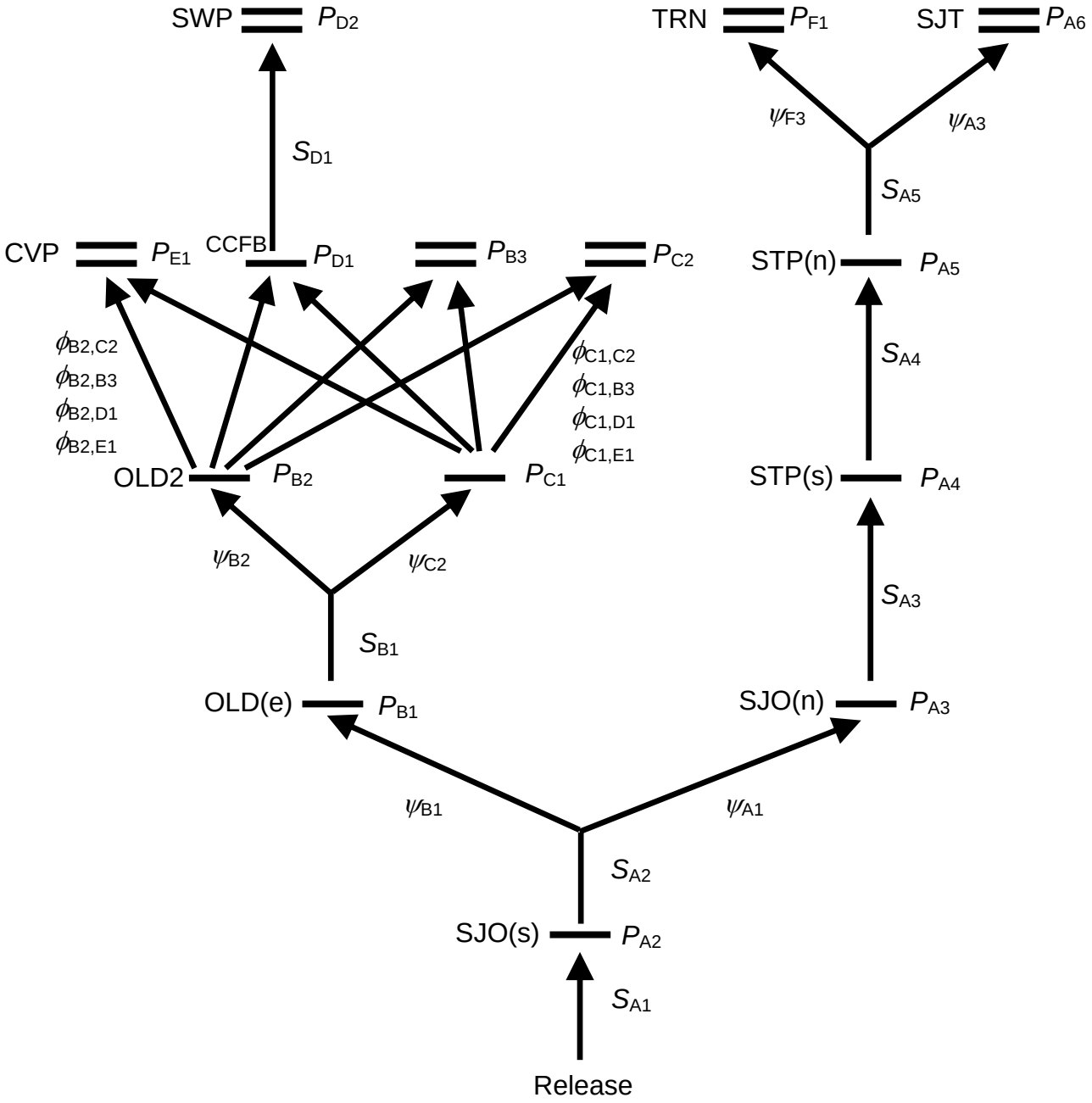

Figure 5. Schematic of mark-recapture model showing estimable parameters given the layout of telemetry stations in Figure 4. Single lines denote single-array telemetry stations whereas double-lines denote double-array telemetry stations that would be needed to estimate all the parameters shown. Names of telemetry stations corresponding to Figure 2 are shown on the left of each telemetry station in the schematic. Subscripts of detection probabilities (P_{hi}) correspond to telemetry station labels in Figure 4.

Given migration-route probabilities and route-specific survival for these three routes, survival of the population from A2 to the six possible exit locations from the study area will be estimated as:

$$S_{total} = \psi_A S_A + \psi_B S_B + \psi_C S_C .$$

The above model is a variation on the branching models used by Perry et al. (2009) to estimate movement dynamics of salmonid smolts through the Sacramento River Delta.

A likelihood model for the above tagging design will be developed and maximum likelihood estimates of the parameters obtained numerically. Standard errors for the model parameters will be obtained numerically from the inverse Hessian matrix. Variances for functions of the parameter estimates (e.g., S_{total}) will be derived using the delta method (Seber 1982:7-9).

Stations C1 and B2 are of lesser importance to DWR and may not be installed. If this is the case, it will not be possible to estimate the entrainment probabilities ψ_{B2} and ψ_{C2}, i.e., the probabilities of remaining in the Old River or entering the Middle River, respectively, upon reaching the head of the Middle River. Instead, the Old River migration pathway will encompass the Middle River pathway (Route C), and survival will be estimated from B1 to the four exit points B3, C2, D1, and E1:

$$S_{B1} = \phi_{B1,B3} + \phi_{B1,C2} + \phi_{B1,D1} + \phi_{B1,E1} .$$

Total survival from A2 to the six exit points (A6, B3, C2, D1, E1, and F1) will be estimated as:

$$S_{total} = \psi_A S_A + \psi_B S_B ,$$

where $\psi_B = \psi_{B1}$, and $S_B = S_{A2} S_{B1}$.

As discussed in the VAMP technical committee meetings in early 2009, it may not be possible to implement the previously described model and acoustic receiver network due to the numerous delays in project implementation and significant issues yet to be resolved prior to conducting the study this year. Therefore, the VAMP committee has acknowledged that due to necessity the downstream receivers in Turner Cut and the Deep Water Ship Channel may need to be a lower priority than those receivers placed at upstream locations. Given such a circumstance, it will not be possible to estimate fish survival from Durham Ferry to the Turner Cut and Deep Water Ship Channel, but it should still be possible to estimate survival in the reaches to STP(s) on the San Joaquin River portion of the network.

Sample size: To estimate the number of fish within a release and the number of releases simulations were done to best allocate the 950 fish available for use in the 2009 VAMP. Different numbers in each release group were simulated to identify the minimum number for release to allow the parameters within the model to be estimated. The minimum number of individuals within the release was estimated to be 135 in the simulations, assuming that the "bubble curtain" would be on approximately 50% of the time, with the San Joaquin entrainment probability ranging from 0.4 to 0.5 when the barrier is off, and from 0.7 to 0.9 when the barrier is on. Simulations were done with low/high survival from release to the head of Old River (survival = 0.85 - 0.95), from the head of Old River to the Turner Cut split (stations A6/F1) in

the San Joaquin (Route A: survival = 0.4 - 0.6), and from the head of Old River to stations B3/C2/D1/E1 in the Old River route (Route B; survival = 0.15 - 0.35); and low/high detection probability at the head of Old River (stations A3 and B1: 0.7 - 0.9 at each). The recommendation is based on high detection probability (0.9) at A3 and B1.

In most cases, a release size of 118 was sufficient even with the barrier on and highly effective, but in two cases, a release size of 135 was required. This occurred when survival to Old River was low (0.85), survival in the Old River route was low (0.15), and the proportion staying in the San Joaquin was high both with the barrier on (0.9) and with the barrier off (0.5). Cases where the barrier-off probability of staying the San Joaquin was 0.6 were also simulated; these scenarios generally required a higher release size (135 - 157). With lower detection probabilities at stations A3 and B1 (i.e., at the head of Old River), higher release sizes are required. None of the simulations included natural variability. If natural variability were included, the required release size would likely go up.

If survival is low in Old River and a low proportion of fish use it, survival will be hard to estimate even with a large release and we may not achieve enough power to detect a statistically significant difference in survival between the Old River route and the main stem San Joaquin River. A sample size of 135 individuals should be sufficient to allow estimation of survival in both routes at reasonable precision if detection on the arrays at the head of Old River is high (0.9+) and the survival and entrainment probabilities are in the ranges considered in the simulations.

In addition, the estimated "entrainment probability" (i.e., the probability of remaining in SJR at the head of Old River) will be the average over the release group, that is, the average probability of remaining in SJR over all conditions (on/off) of the barrier.

Additional simulations were conducted to estimate the number of releases needed to detect a 15% difference in survival between fish that take the San Joaquin River (Route A) versus those that migrate through Old River (Route B), with power at 80% with high and low variability. Estimates of the number of groups suggested from the simulations ranged between 3 and 10. Thus, 7 groups of 135 individuals were selected to achieve the goals of VAMP for 2009: to be able to statistically differentiate a 15 -25% difference in survival between Route A and B, with intermediate to large levels of variability with 75 to 80% power.

Tag life study: An in-tank tag life study will be conducted by FISHBIO to quantify the rate of tag extinction under the operating parameters used for the study (i.e., encoding, range, and pulse width), and following similar methods employed by the CRRL during 2008. Fifty tags will be randomly selected across the 1,000 model 795 Lm tags purchased from HTI. The tag life study will begin as soon as possible after all tags have been delivered with the goal of collecting at least several days of data prior to tagging. Tags will be programmed according to the same procedures used in the field study, and the date and time of initialization will be recorded. Tags will be secured to a stand with hook and loop closure and placed into the study tank immediately after programming.

Two independent detection systems (HTI model 295 receiver and hydrophone) will be used to continuously monitor the tags, and files will be processed daily to determine whether tags are

still functioning. Tags will be considered dead when they are not detected during any single one hour period. The date and time of the last transmission will be recorded for each tag and will be used in conjunction with the time of initialization to determine the active life of each tag.

Water temperatures in the tank will be maintained according to a one day lag of observed average daily water temperatures at Jersey Point. A recording thermograph will be placed in the tank prior to tag initialization and will log temperature readings every 30 minutes for the duration of the study.

Study Fish – 3500 fall/spring hybrids from Feather River Hatchery will be used for this study. Two thousand of the 3500 available will be used for training at the Tracy Fish Facility. Fish will be picked up at Merced River Hatchery and transported to the Federal Fish Facility a couple of days before training starts and the day before each tagging session. Fish should be delivered to the Tracy Fish Facility from Merced Fish Facility on 4/10 (1,000), 4/20 (225), 4/23 (225), 4/27 (225), 4/30 (225), 5/4 (225), 5/7(225) and 5/11(225). Fish must be sorted at the hatchery to assure that the fish being transported are a minimum size of $\geq$105 mm (and 12.1 grams). Fish not used for training or tagging operations will be euthanized after all tagging has been completed. We are minimizing the time each of the groups of fish are held at the Tracy Fish Facility to decrease the chances of the fish becoming diseased while being held at that location.

Training: Tagging training will occur during April 13-17th and will be led by FISHBIO. Equipment will be set up at the Tracy Fish Facility on April 9 and 10. Four individuals previously trained for tagging will be given a refresher course on April 13 and 14th. After the refresher course, eight assistants will join those trained for tagging for 3 additional days of training on April 15-17. Training will occur at the Tracy Fish Facility, and will follow the same general process as in 2007 and 2008. Relative to previous training, returning taggers will practice on a greater number of fish prior to tagging study fish during 2009.

Tag Programming: Tags will be programmed according to modified guidelines developed during the 2008 study in response to problems identified with tag activation. Tags will be soaked for approximately 24 hours prior to programming. After programming, tags will be sniffed in a cup of water using an HTI sniffer and monitored through at least three transmission cycles. At least 5 attempts will be made to program each tag. During 2008 we encountered some tags that passed activation and sniffing, but then could not be heard. To address this, we will briefly listen to activated tags prior to surgical implantation in study fish to confirm tag function and programming.

Tagging: Tagging will occur on Tuesdays and Fridays between 4/21 and 5/12 (4/21, 4/24, 4/28, 5/1, 5/5, 5/8, and 5/12) between the hours of 8:00 am and noon for the day releases and noon to 4:00 pm for the night releases. An HTI model 291 (four-port) receiver will be used at the Tracy Fish Facility to verify that tags are working correctly prior to release. Three fish will be held in each 5 gallon bucket after tagging and held for approximately 26 hours prior to transport to the release site. Releases will occur on Wednesday and Saturdays either during the day (5:00 pm) or at night (9:00 pm) releases.

Five additional fish, over the course of the experiment will be implanted with a working tag and subsequently killed and released with the live fish containing working tags. The identity of each

intentionally sacrificed fish will be determined prior to transporting study fish to the release site and this fish will be isolated from others to avoid potential confusion with unintentional mortalities. This aspect of the project is conducted to better understand the behavior of dead fish with working tags.

Use of dummy tagged fish: Each release group (7) will include an additional 10 fish that will be tagged with dummy tags during each tagging session, and held and transported with the groups with live tags. An additional four groups of 10 dummy tagged fish will be held in net pens near the Stockton WWTP. Methods for randomly distributing dummy tags within the pool of live tags for each group will be consistent with methods used during 2007 and 2008.

Fish loading: Three tagged fish will be placed in each bucket after they have been tagged. For each release there will be 45 buckets of release fish and 3 buckets with dummy tagged fish (3 in 2 buckets and 4 in 1 bucket). An additional 3 buckets will be used to transport 10 dummy tagged fish to Stockton on four of the releases (each Wednesday). The buckets will be held in tanks at the Tracy Fish Facility for approximately 24 hours, prior to loading them into the transport tanks fixed to a rented flat-bed truck. Temperature and DO will be taken at Tracy Fish Facility after loading and before leaving for the release site and at the release site prior to release.

Release strategy: Seven groups of (135 tagged fish) will be released near Durham Ferry. Groups would be released both during the day (5:00 pm) and at night (9:00 pm), within a week. . Fish are generally smaller than anticipated so the timing of VAMP will pushed back by a week – and is proposed to occur from 4/20 to 5/20.. Releases are scheduled on 4/22 day, 4/25 night, 4/29 night, 5/2 day, 5/6 night, 5/9 day, 5/13 night. Once at the release site, buckets of fish implanted with live tags, will be moved downstream by boat to assure fish are released away from the near-by agricultural pump. Since fish will have been held and tagged at the Federal Fish Facility, where temperatures will be similar to those in the river, there will be no acclimation of the fish prior to release. Each group of dummy tagged fish will be held at the release site (Durham Ferry) in a garbage can or net pen for 48 hours and evaluated for condition and mortality at the end of the 48 hours.

Fish Health: Due to proposed changes in the origin of the study fish, holding facilities, and tagging location of VAMP study fish, the fish health part of the proposal is focused on health monitoring to detect pathological or physiological problems which may affect fish performance. External parasite and bacterial infections have been a problem at the Byron Delta smelt hatchery at the State facility. A pathology sampling will be performed on 20 fish per week for 3 weeks (60 total fish). A subsample of fish tagged on Fridays (4/24, 5/1 and 5/8) will be reserved and held for pathology sampling. The fish for these samples should come from the same population as the tagged group, preferably a random sample of the tagged fish, but could be the fish which have been rejected for tagging due to size (minimum FL 75 mm for pathology sampling). The fish health center would be available to perform diagnostic sampling during the holding period in case a fish health problem occurs.

Pathology and physiology sampling summary:

Assay	**Fish/week**	**Weeks**	**Total fish**
Bacteriology	20	3	60

Virology	20	3	60
Rs DFAT	20	3	60
Histology	10	3	30
Gill ATPase	10	3	30
Diagnostic Sampling		As needed	

Receiver maintenance and data downloading: Field crews will visit sites daily to determine if the receivers are functioning. Batteries will be swapped Monday, Wednesday and Fridays. The Stockton FWS will be responsible for maintaining the 6 sites on the San Joaquin River between Stockton and downstream of Turner Cut (A4, A5, A6 (2), F1 (2)). DWR (Kevin Clark) will be responsible for maintaining those receivers at the State (D1 and D2) as well as those at B3, C2 (Figure 4), and B2 and others directly associated with the south Delta temporary barriers program. Brandon Wu of the USBR will be responsible for maintaining and downloading data from receivers at the Tracy Fish Facility (E1). Mark Bowen and Dave Vogel will be responsible for the 2-D array at the head of Old River barrier while DFG will be responsible for the receivers at A2, A3 and B1. Laptops and cross-over cables will be used to download the data from the receivers and to check that the receivers are working.

Water Quality Assessment using Net pen fish at Stockton Wastewater Treatment Plant:

To assess potential acute water quality affects in the Stockton area, a separate bioassay will be conducted with dummy tagged fish held in live cages.

A bioassay would be performed each week at two sites, the Durham Ferry release site (control) and near the Stockton Wastewater Treatment Plant (SWTP). Each Wednesday, a live cage containing 10 fish will be placed at the control and SWTP sites (10 fish x 2 sites x 4 weeks = 80 fish). The fish health center will recover and sample the fish 36-48 h later on Friday. Bioassay fish should undergo handling and surgery similar to the study fish, but no tag is required. The fish health center will provide live cages and anchoring system for the study.

Bioassay sampling summary:

Assay	**# Fish/site**	**# Sites/week**	**# weeks**	**Total fish**
Histology	10	2	4	80
Condition	10	2	4	80

Water Temperature Monitoring:

Water temperature will be monitored during the VAMP 2009 study using individual computerized temperature recorders (e.g., Onset Stowaway Temperature Monitoring/Data Loggers). Hanson Environmental will be in charge of preparing, deploying, maintaining, and retrieving temperature loggers, as well as downloading and providing graphical analyses of the data. Water temperatures will be measured at locations along the longitudinal gradient of the San Joaquin River and interior Delta channels – locations along the migratory pathway for the juvenile Chinook salmon released as part of the VAMP study. Locations of temperature loggers

will be similar to those in the 2008 VAMP study. Temperature loggers will be deployed in late March/early April, and will run until mid June/early July. As part of the 2009 VAMP monitoring program, additional temperature recorders will be deployed in the south and central Delta to provide geographic coverage for characterizing water temperature conditions while juvenile salmon emigrate from the lower San Joaquin River through the Delta. Water temperature will be recorded at 24-minute intervals throughout the period of the VAMP 2009 investigations. Water temperatures will also be recorded within the holding facilities at the SWP site where juvenile Chinook salmon will be tagged and held. Temperature recording here will take place while juvenile Chinook salmon are present.

Mobile Monitoring: Mobile telemetry in past telemetry studies has proven to be highly effective in locating areas of high fish mortality in the Delta. For example, in the 2007 VAMP study, 116 motionless acoustic transmitters were located in a very small site near the City of Stockton. Additionally, other areas in the Delta where high losses of acoustic-tagged juvenile salmon occur have been documented (e.g., near Tracy). Due to the importance in fish restoration efforts and proposed changes in Delta operations, mobile telemetry was conducting in the recent large-scale north Delta study and will be conducted in the 2009 VAMP study. Mobile telemetry will be conducted in channels within the proposed acoustic receiver array after receivers have been placed and fish have been released. Priority will be placed on the river reach between Mossdale and the Deep-Water Ship Channel. Other locations will be surveyed based on availability of FWS and DFG staff.

Predator Tagging: During the 2009 VAMP study, 30 striped bass (and possibly black bass) will be tagged with Hydroacoustic Technology, Inc. acoustic transmitters to monitor fish movements and behavior during April and May. Fish will be captured, tagged, and released at a variety of locations in the lower San Joaquin River and interior Delta. Sites may include scour holes, near bridges, pump stations, and in front of the trash racks at the federal Tracy fish facilities. If the relative abundance of black bass is high at these locations, some black bass will also be tagged with transmitters. The acoustic transmitters would be similar, but larger, than the 0.65-gram transmitters implanted in salmon smolts released during the VAMP study. The bass transmitter batteries will last for the duration of the one-month study. Each transmitter will be individually identifiable and not overlap with the smolt transmitters. Movements of tagged striped bass will be monitored with the same fixed-station acoustic receiver (data logger) network deployed during the VAMP study and with mobile telemetry receivers during the study. Acoustic-tagged bass passing each fixed-station receiver will record the tag ID and date/time. If acoustic-tagged salmon are consumed by an untagged predator and the predator swims past a receiver prior to tag defecation, data collected by the receivers could be misinterpreted as live salmon passing fixed stations; data are needed on predator movements to assist in interpretation of study results. This information is necessary to minimize or avoid bias in smolt survival estimates. Data are anticipated to provide information on striped bass movements within the study area and possible affinity to specific locales during spring 2009. Results would be reported in the annual report for the 2009 VAMP program.