North Delta Conveyance Issues

DRAFT Fish Facilities and Fisheries Study Plan to Investigate a Hood Diversion - Phase 1

Send Comments to Darryl Hayes (dhayes@ch2m.com) or Ron Ott (ronott@water.ca.gov)

Introduction

Presented below is a discussion of North Delta fisheries and facilities related studies and evaluations that could be implemented during Phase I of the CALFED Bay-Delta Program. These studies would be designed to address the issues and impacts of a new screened diversion near Hood between the Sacramento and Mokelumne Rivers.

Policy Guidance on staging/planning a North Delta diversion

The CALFED Preferred Alternative includes future North Delta actions with a possible connection channel between the Sacramento and Mokelumne Rivers to address water quality degradation. Construction of this conveyance for water quality mitigation would only be considered if fisheries protection can be maintained or improved. Other North Delta water management strategies to improve water quality include the evaluation of various cross channel closures and EWA operations.

The June 1999 *Revised Phase II Report* stated that, "A screened diversion at Hood will be evaluated and may be implemented if necessary." The required action is the evaluation and not the implementation. In very general terms, the report describes the nature of the evaluation and the conditions which must be met. The evaluation must confirm a water quality problem, and show that a 0-4000 cfs diversion can reduce or eliminate the water quality problem without adverse impacts on fish. Only then can consideration be given to a pilot project and only after operation of a pilot facility can consideration be given to a production facility.

A fully developed North Delta diversion facility could include a fish screen, upstream fish passage facilities (locks, ladders, screen openings, etc.), fish bypass facilities (including fish lifts), fish return facilities, channel diversion pumps, and various configurations of control structures to control the volume of water entering the conveyance channel. The operating rules for these facilities would depend on the requirements for both upstream and downstream migrating fish, and on their impacts on habitat shifts resulting from increased flows in the eastern Delta on Delta species.

In general, initial assessments and studies would include modeling and analyzing the impacts of a various configured diversions. Much of the evaluation will draw from information either already being gathered (or that will be underway shortly). One of these focused efforts could include the construction of a test facility at the Delta Cross Channel. These and other efforts are described below.

Specific Facility Components and Fishery Issues

To develop adequate studies and evaluations, we must first identify the criteria to be used and the range of proposed facilities or features we are considering. Any proposed facility would have to be designed with the following criteria in mind:

- Survival goals for juvenile fish (including screen and fish lift if applicable): 95% or greater survival (not including indirect losses) of salmon (all runs) and steelhead. The facility will be designed with delta smelt, splittail, American shad, and sturgeon in mind, but due to their limited presence and our uncertain ability to protect or pass them efficiently, criteria should not be set. Incidental protection of other species will be provided using the criteria set for these species.
- Eggs and Larvae Entrainment: Design of screen facilities for E&L will not be considered. Diversion may be reduced or shut off during E&L pulses if necessary. For a through-Delta alternative, this may is not a significant issue unless E&L are damaged as a result of passage through the screen (or pumping plant if applicable).
- Upstream Passage Goals: "Insignificant" delay to migrating salmon, steelhead, shad, sturgeon. Possible screen opening passage for these and other fish based on "real-time" monitoring (for instance, delta smelt may not pass a ladder well so pass them operationally). Fish passing to the "wrong side" of screen structure may have a difficult time getting back to their stream of origin. Possible passage opportunities back to their stream of origin should be investigated or considered.

Listed below in no particular order of importance are a number of issues or project features that will need to be investigated:

- A North Delta diversion may have to operationally deal with significant seasonal pulses of eggs and larvae. However, entrainment may not be a significant issue if the larvae are not damaged by passage through the facility (since this is a "through-Delta" option).
- Salmon and steelhead fry will have to be protected, but these fish should pass the area quickly since there is little rearing habitat available on the Sacramento River near Hood and flows are generally good.
- The facility must include upstream passage facilities for adult fish including salmon, steelhead, delta smelt, splittail, sturgeon, and American shad. A variety of options are necessary including fish lifts, false weir ladders and permanent or periodic screen openings. The performance of these facilities, however, is largely unknown for most of the species of concern (especially delta smelt that might be there in dry years and splittail). Also of concern is the additional risk of fish wandering the Central Delta and resisting passage through the conveyance facility or straying as a result of this facility is largely unknown.
- On-river screens will be considered if the maximum diversion is no larger than 4000 cfs and is operated according to established hydraulic criteria and flows in the Sacramento River. The screens shall have uniform hydraulic flows under all possible river and diversion conditions.

- Off-River screens with juvenile collection facilities may be considered for options that include permanent screen openings for upstream migrants.
- A low head canal pumping plant behind the screened diversion might be considered to control the diversion and screen hydraulics. Operations will need to be defined in the initial assessment process. Without a pumping plant, operation of the channel may be significantly constrained during periods of diminished or reversed flows due to tidal action.
- A flow control structure in the channel may have to be considered if the diversion will be limited to 4000 cfs and there is no pumping plant to control flows.
- Maintenance access to screen units will be provided under all river conditions if screened diversion is required.
- Wedgewire screens will be used.
- Surface booms (with underwater deflectors) to deflect floating debris (and possibly even juvenile fish) away from the screen will be considered.
- Screen brush cleaners or comparable cleaning devices will be provided.
- Sediment removal and/or resuspension systems will be considered for all facilities.

<u>Specific Action Plans to Investigate Fisheries/Facilities Impacts</u>

This is the section that needs to be more fully developed and commented on.

<u>Planning Studies that can or should begin immediately - (and are actually feasible to quickly initiated):</u>

Collect Site Specific Data near Hood (see other section for fisheries studies)

- Survey the river bathemetry (needed for modeling)
- Analyze historic hydraulic data (needed for modeling and boundary conditions)
- Set up additional water quality and hydrfaulic monitoring stations on the Sacramento River at Hood or on the lower Mokelumne River if necessary
- Collect suspended sediment and bed load information

Conduct Delta Operations (and System) Modeling with a Proposed Diversion Facility

- DSM2 and CALSIM modeling
- Investigate Flood Control Issues (Flooding of Interior Delta Area?)
- Conduct particle tracking analysis
- Investigate various flow splits (diversion conveyance)
- Investigate operations scenarios (flow restrictions/channel control with gates or pumps/water quality triggers/fish triggers/etc.)

- Look at tide phasing changes in the Delta
- Look at modeled water quality changes
- Investigate head available to possibly drive a bypass system (if needed)

Conduct 2-D Numerical Hydraulic Modeling

- Look at alternative facility configurations and function under various flow conditions
- Analyze range of flows, velocities, and head differentials around the proposed facility that might be occur
- Investigate potential sediment transport/deposition issues
- Investigate River Hydraulic Degradation Potential

Conduct Physical Modeling

- Using boundary conditions and operations scenarios from the numerical models, set up model of the Sacramento River diversion

Conduct site specific fisheries monitoring of the North Delta and Mokelumne area:

- Analyze existing database and old studies in the North Delta area.
- Conduct sampling to investigate the temporal distribution of fish in the North Delta area.
- Conduct fisheries sampling in the Hood area to investigate vertical and horizontal distributions of adult and juvenile (down and up) migrating fish that may be in the area to help in planning facility layouts.
- Investigate timing and spawning/movement triggers of downstream migrating egg and larval in the Hood area (including delta smelt, striped bass, American shad, splittail, and sturgeon).
- Investigate the potential damage to migrating fish and greater exposure to predators, poor water quality, and pumping plants in central and southern Delta by doing more control studies of marked and released fish.
- Compare habitat conditions for juveniles and adult fish and evaluate threats of the possible new fish routes for various flows and residence times for various hydrology.
- Radio tag or monitor juvenile fish movements in the North Delta more intensively to investigate potential fish residence in Delta, downstream migration, and potential for recirculation of fish around or near a fish screen.
- Control experiments using CWT or radio tagged fish to look at the effect of lower net downstream flows below Hood on migration, timing, and success.
- Conduct some pilot studies of delta smelt spawning habitat enhancement in the eastern Delta area (on the Mokelumne side of the proposed diversion channel) in

anticipation of having to mitigate for not being able to pass these fish upstream around a screen.

- Expand fisheries sampling at the Delta Cross Channel to better understand gate operations.

Complete Fish Screen Criteria Development for Juvenile Fish – Analyze fish movement and survival along long screens:

- Evaluate studies underway to address salmon and steelhead passage along long screens being conducted at GCID starting in summer 2000.
- Evaluate data from the UC Davis Treadmill studies. This already being done.
- Coordinate studies at the TFTF for application to the North Delta. This should not require much of a change in work scope.
- Consider additional testing for juvenile sturgeon if they may be potentially listed. Consider lab tests at UC Davis Treadmill
- Investigate potential damage to entrained larval and juvenile fish passing through a screen system - mesh size considerations. This should be done in a lab environment and with the TFTF studies.

Initiate Fish Passage and Ladder Investigations

- Analyze (research) various locks and ladders around the world that are designed to pass fish species similar to Delta species.
- Conduct scaled model lab experiments to look at various ladder configurations and velocity profiles of various ladder options that may be considered for Delta Species.

Fish Release Studies - If fish bypass pipes are considered at Hood, various release strategies must be considered. Hood would use a long pipe, instead of a truck or barge, and release directly into river downstream.

- Lab studies could investigate passage problems in long pipes for Delta species
- Expand studies at GCID and the TCCA Red Bluff screens focusing on salmon passage in pipes.
- Expand TFTF release site study to look at predation, fish accumulation at various release sites and possible release pipe configurations

Fish Bypass Lift Evaluations – If salvage/collection facilities are necessary

- Evaluate data from Red Bluff Research Pumping Plant and proposed TFTF studies on fish lifts. Include data on larval fish survival. Data needs are similar so not much change in work scope is anticipated.
- Install new fish lift in Bay #4 at Red Bluff RPP to investigate long term pump reliability issues.

- Investigate passage of adult fish through the fish lifts including salmon, sturgeon, splittail, and delta smelt (since they could get into bypasses) since they could be entrained. This could be accomplished at the RBRPP or the TFTF.
- Evaluate proposed facilities and operations under a range of flows

"Pre-Hood" Diversion Studies Designed to Investigate Upstream Attraction/Paggage Issues

Initial studies could be implemented without constructing a new Hood channel, but these investigations might require construction of monitoring facilities and reoperation of the Delta Cross Channel. These changes might require additional environmental documentation and operations agreements before implementation or studies.

Possible attraction issue studies could include:

- **Delta Cross Channel Investigations** - This facility might give the best insight into Delta fish migration issues and incremental water quality changes. The DXC is close in proximity to the proposed Hood Diversion. Although this channel is considered a navigation channel, the study and corresponding facilities could be developed and operated when the gates might otherwise be closed.
  - Construct large fish trap downstream of the Delta Cross Channel gates. Control flows into the DCC from 1000 to 4000 cfs (net daily) by cracking the gates and investigate the numbers of salmon that might be attracted into the fish traps during and following a change in flow. It might be appropriate to investigate different configurations of fish trap entrances. These insights might help in channeling adults into a future ladder, lock, or simple passage through a screen opening.
  - Investigations might also include tagging adult salmon caught above Hood or in Mokelumne, then transported back to Chipps Island and released. These fish could then be followed to look at their passage back upstream through the Delta (with Cross Channel open to some degree). These studies would investigate the potential delay or the inadvertent passage of non-Sacramento fish over the barrier (DCC). (Do Sacramento Fish only go up the Sacramento River, or do they wander through the Delta channels? Do Mokelumne fish travel up the Sacramento, then cut across?)
- **Sacramento Deep Water Ship Channel Ladder** - Evaluate passage/attraction at the SDWSC Locks adjacent to Sacramento. There is already a known attraction issue there due to lock leakage. Construction of a pilot facility here could be beneficial to that areas water quality and fish attraction problem. I would also be relative to the Delta attraction issue. Allowing some water to enter the channel might help determine the influence of various flows into the channel.
- **Radio Tagging of Adult Salmon** - Conduct an extensive fish tagging effort that will look at passage of adult fish through the Delta. Fish could be tagged in the Suisun Bay area.

Ladder and Lock Investigations in the Field

- Install pilot lock or ladder facility in the Delta using various attraction flows. This could be constructed at the Delta Cross Channel after some initial study on the attraction issue. An alternate location for a pilot facility would be at the SDWSC locks.

Appendix A

Conceptual Designs of a Proposed Hood Diversion

The proposed facility description below identifies and describes conceptual designs and operations issues associated with a Hood diversion facility. These concept facilities are presented for discussion purposes only. Concept test facilities needed for the DCC, SDWSC (Ship channel), and other studies will be developed over time.

Below is a brief summary of the feasibility and approaches for safely passing upstream-migrating fish around a screened "diversion" which would pass Sacramento River water into the central Delta near Hood. Two methods of delivering water have been discussed over time in the CALFED process: "passive" and "active". The "passive" approach involves excavating a conveyance from Hood to the North Fork Molelumne via Snodgrass Slough, and allowing water to flow by gravity, driven by (usually) relatively higher stage in the Sacramento. The "active" approach involves a similar conveyance, but with a low-head pumping plant to enhance water flow. These two conveyance schemes dictate different approaches for upstream fish passage. Furthermore, any upstream passage approach will need to be compatible with the downstream screening approach; it is important to view the facility as an integrated system. Maximum conveyance of 4,000 cfs is assumed. Each of these approaches has relative advantages and disadvantages. It is also possible to implement a hybrid "active + passive" system, which would operate passively during certain river stage conditions and actively during others. The hybrid system is more complex and expensive, but could realize most of the relative advantages and avoid most of the relative disadvantages.

Passive Conveyance

Two approaches to downstream screening and upstream passage of a passive conveyance are feasible, assuming a maximum 4,000 cfs conveyance; with greater capacity, one approach becomes impractical and drops out. The first approach is a "compound V" set of screens located near the head of the conveyance canal, similar to the system envisioned for the Isolated Facility alternative in the CalFed process. Downstream migrants entering the diversion canal are concentrated at the apices of the V's and shunted via fish pumps to sorters to be returned to the Sacramento River about a mile downstream (to avoid recycling fish due to tidal flow reversals under some stage conditions). Upstream migrants are concentrated to the opposite apices of the V's, each of which can be configured as a vertical slot or a vertical series of orifices. Upstream migrants could simply pass through these slots/orifices and continue upstream. The slots/orifices would occupy less than 1% of the cross-sectional area of the conveyance, so a very small percentage of downstream migrants would tend to pass through them to the Mokelumne side. Precise hydraulic control of the system could easily be achieved by means of both louvers and drop-gates on the *back* (downstream) sides of the screens. The system could be closed, if desired, during tidally-driven flow reversals which could occur under some river stage and tidal asynchrony conditions. This approach would pass upstream-migrating salmon, steelhead, splittail, striped bass, American shad and sturgeon with little or no significant delay; minimal fall-back problems are anticipated, but some would occur. Errant Mokelumne salmon could fall back and be returned to the back of the screen array to exercise voluntary behavior. This approach would not pass upstream-migrating delta smelt. Water velocities necessary to keep fine sediments in suspension (~2 fps) would present an impossible velocity barrier for this species. Mitigation by developing local spawning habitat would be necessary (feasible). Operational constraints during the (long) delta smelt migration season may help significantly.

The second approach to downstream screening and upstream migrant passage could employ a series of flat plate screens oriented parallel to the Sacramento River bank. These would need to be separated by some distance to keep exposure time of downstream migrants within acceptable limits. No salvage facilities would be required with this arrangement; downstream migrants would simply continue moving downstream past the screen. However, this system could not be operated under certain tidal conditions common at low river stage (when the conveyance is most needed) due to inadequate sweeping velocities. The overall design capacity of 4,000 cfs pushes the limit for this approach; any greater conveyance would foreclose this approach, and planning for the future should take this into account. Hydraulic conditions on the downstream side of the screens could be readily controlled to concentrate upstream migrants to the upstream end of the screen plate to a relatively small bypass canal, which would continue about 1/4 mi or more upstream. At this point the canal would have to extend into the river some distance offshore and daylight in the river, protected by pilings. This would be necessary to avoid entraining any shoreline-oriented and shallows-oriented downstream migrants. Accommodating variable river stage could be engineered into the terminus (feasible). This approach would pass upstream-migrating salmon, steelhead and American shad with little or no significant delay. Modest delays of striped bass and splittail may occur due to the canal approach; data for splittail entering a flume or canal are essentially non-existent. Sturgeon delays and rejection might be significant, but a trap-and-haul system could be retrofitted into the system if a problem was identified. Fall-back problems would not occur with this approach, since the screen system would not incorporate a salvage/bypass for downstream migrants. Errant Mokelumne River salmon could not "change their minds" and return. This approach would not pass upstream-migrating delta smelt for the same reason as the first approach; mitigation would be necessary.

Advantages of the passive conveyance approach include lower cost and relative simplicity of operation. Disadvantages include lack of ability to "boost" conveyance when river stage differential is insufficient to drive the desired amount of water into the central delta (typically at low river stage).

Active Conveyance

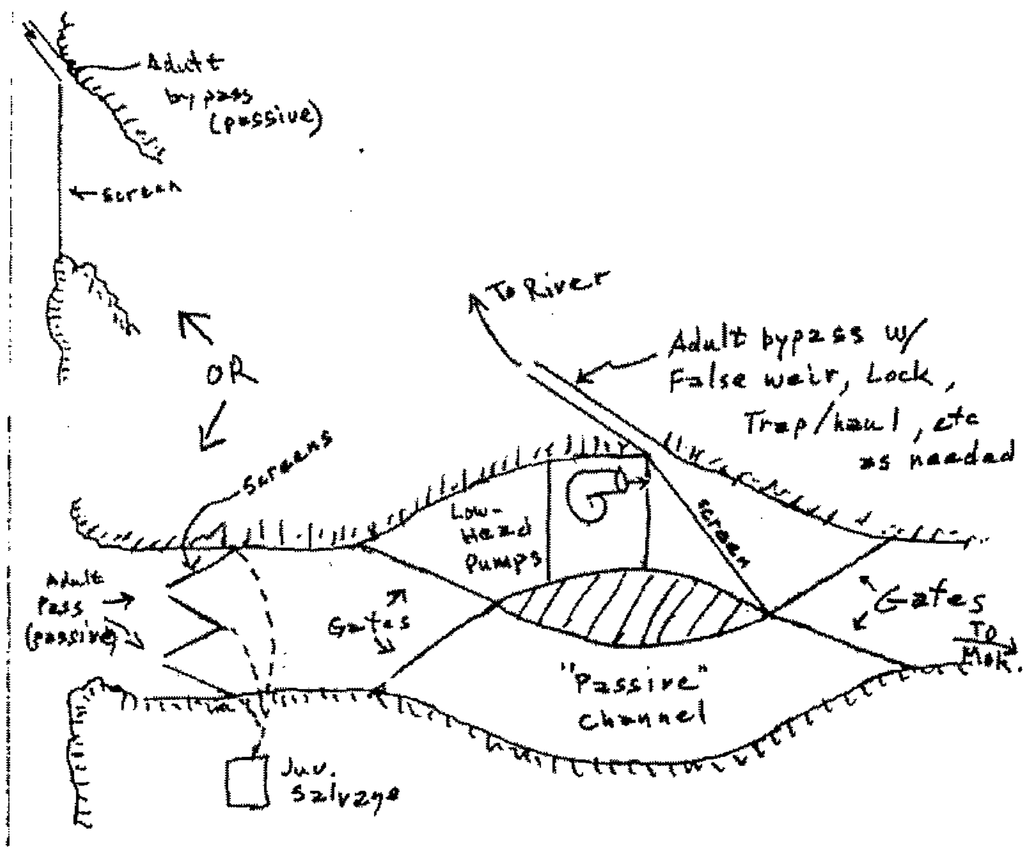
This conveyance approach would involve a low-head pumping station which would boost water from the Sacramento River about 4 ft above nominal river stage, resulting in much greater control over water flow into the central delta. This approach would require two sets of screens, one on the upstream side of the pumps for downstream migrants, and another on the downstream side of the pumps for upstream migrants. The two configurations for the downstream migrant screens, "compound V" and flat shoreline plate, would still be feasible, the first with salvage facilities and the second without. Passage of upstream migrants with active conveyance becomes more complicated, but could be achieved for most species. Fish must move from a higher water surface elevation to a lower one while swimming upstream. Several approaches are available, all with relative advantages and disadvantages; a hybrid system may be required. Salmon and steelhead, and to a limited extent American shad, can be concentrated into a canal (see above) and encouraged to pass over a "false weir", a flume section terminus with an upwelling diffuser floor grate. Once over the end plate, fish slide to a lower elevation and arrive in a canal much like that for the second passive conveyance configuration described above. No data are available on reactions of splittail to this approach, but it is likely that at least some would negotiate the route. Striped bass may experience delay or reject the false weir. Some sturgeon may negotiate the false weir, but delays are to be expected. For these species, either a lock or a trap-and-haul system may be required. An adaptive approach would be to develop a prototype facility at the existing Delta Cross-Channel and test various configurations. If the false weir appears satisfactory for these species, the full sized 4,000 cfs facility should be designed so that a lock or trap-and-haul system could be retrofitted at a later date if necessary. Due to higher velocities through the facility, it is unlikely that delta smelt can be passed upstream; mitigation and operational flexibility must be relied upon for this species.

Advantages of the active conveyance approach include much better control over the water diverted into the central delta. Disadvantages include significantly higher cost and more complex operation.

Hybrid Active / Passive Conveyance

This conveyance approach could incorporate elements of both active and passive conveyance systems and could realize the relative advantages of both systems while avoiding most of the relative liabilities. A hybrid system could incorporate either flat plate or "compound V" fish screens for downstream migrants, as described above. On the downstream side of these screens, the channel would be split, with one arm leading to a low-head pumping facility and the other bypassing this facility. These two channels would then re-converge. During operation, water would be shunted to one of the channel arms with the other arm isolated by flat gates at both ends, angled in the canal in a manner which would produce smooth flow lines no matter which approach is in operation.

The primary advantage of this hybrid approach is that it could be operated passively when Sacramento River stage is sufficient to drive the desired amount of water to the Mokelumne system. Typically, this condition exists during the migration season for most or all of the species capable of being passed upstream by any means. The need for the active mode of operation is typically during low Sacramento River stage, outside the migration window for species of interest. Thus, passive operation would dominate in periods when this mode is most appropriate for upstream passage because of its greater efficiency for passing more migrating species. The primary disadvantage of the hybrid approach is its significantly greater cost than either of the other two approaches.


Adult bypass (passive)
screen
OR
To River
Adult bypass w/ False weir, Lock, Trap/haul, etc as needed
Screens
Low-Head Pumps
screen
Adult Pass (passive)
Gates
Gates
To Mok.
"Passive" channel
Juv. Salvage