State of California
Department of Fish and Game

M e m o r a n d u m

Date: September 11, 2007

To: John Kirlin, Ph.D.
Executive Director, Delta Vision
Resources Agency

From: John McCamman
Acting Director
Department of Fish and Game

Subject: DFG assessment of Delta Vision Stakeholder Coordination Group (SCG) Preliminary Recommendations Report, August 21, 2007

In response to your request for comments the Department is providing its preliminary review of the subject Report to the Delta Vision Blue Ribbon Task Force (BRTF). As noted numerous times in the document the recommendations are preliminary and all vision elements must be rigorously evaluated on their technical, biological, economic, social and financial merits before being considered for implementation. The report characterizes the emerging visions as promising possibilities for addressing the issues confronting the Delta. The Department concurs with this characterization. It is our position that these are ideas, which in whole or part, may aid in addressing the ecological crisis and issues of sustainability in the Delta.

As you are aware other planning efforts are currently underway on focused subsets of the broader range of issues being addressed as part of the Delta Vision process. These include the Bay Delta Conservation Plan, Delta Risk Management Strategy, Delta Regional Ecosystem Restoration Implementation Plan, Suisun Marsh Restoration and Management Plan, and the CALFED Ecosystem Restoration Program (ERP) Stage 2 Conservation Strategy. The Department is engaged in all of these efforts as a lead agency or participant. The emerging visions included in the Report incorporate a number of common elements emerging from those planning efforts which is encouraging in that there appears to be emerging consensus in a number of areas.

The Department’s comments are focused on the ecosystem elements of the visions since those are the primary concerns of the Department. Over the past months, the Department as the State implementing agency for the CALFED Ecosystem Restoration Program has shared with the Delta Vision SCG and BRTF the emerging ERP Conservation Strategy. The ERP strategy focuses on the types of habitat which should be restored in the Delta and where suitable conditions exist to support these habitats. The two primary habitat types recommended for protection, enhancement and restoration are intertidal and flood plain. Both SCG “Emerging Visions” share similar focus on the Cache Slough area for intertidal restoration and the Yolo Bypass and Consumnes-Mokelumne/Stone Lakes areas for flood plain restoration and enhancement. These are priority areas in the Delta for restoration and protection the

Department has also identified. The Department also supports the recommendations in Emerging Vision 2 for creation of tidal and flood plain habitats in the Stewart and Fabian Tract areas of the South Delta. The South Delta is an area of high potential for intertidal restoration and the Department would encourage consideration of more extensive restoration in this area consistent with a compatible conveyance option. Neither SCG Vision identifies intertidal restoration in the eastern Delta, which the Department believes is desirable. From a habitat perspective protection of transitional upland areas around the periphery of the Delta in the primary and secondary zones are particularly important to assure areas for intertidal habitats to expand into with expected sea level rise as well as to protect the existing wildlife values they provide.

With regard to recommendations for Suisun Marsh, the Department as a land manager in the marsh and a participant in the Suisun Marsh Restoration and Management Plan process appreciates the SCG Reports recognition and reliance on the products from that process as the basis of their recommendations for that area.

With regard to conveyance alternatives discussed in the Report the Department is looking to the BDCP process to conduct the analysis to determine the best approach which meets the ecological needs of the Delta while providing for water supply reliability and sustainability. We believe method of conveyance is key to solving ecological problems in the delta and historically our department has supported isolated conveyance as an important component of any long term solution. We continue to hold this view, but will review and consider any and all options that purport to resolve problems associated with conveyance related issues in the delta. The conveyance approaches in the emerging visions are similar to options 2, 3, and 4 being considered by BDCP. An uncertainty associated with the water conveyance along the South Fork of the Mokelumne River is the potential effects to salmonids using eastside tributaries. Further, we recommend that you review the CALFED Diversions Effects Team reports on issues associated with conveyance, if you have not already done so
http://www.delta.dfg.ca.gov/erp/docs/Diversion_Effects_on_Fish_1.pdf
http://www.delta.dfg.ca.gov/erp/docs/Diversion_Effects_on_Fish_2.pdf (copies attached).

The recommendations in Chapter 3 for an "action based decision making " process for implementing proposed alterations in the Delta is consistent with the CALFED adaptive management process which is incorporated into the ERP conservation strategy. The key in these processes is thoroughly vetting proposed actions to evaluate feasibility and implementing and monitoring in an experimental framework to determine if the action is meeting clearly identified criteria.

The Department through the ERP is completing development of the DRERIP conceptual models. This collection of community, species, physical, and ecological process models incorporate the state of scientific knowledge for the Delta. They are designed to be used to vet proposed actions to determine the degree to which they would achieve stated ecosystem benefits and will be useful in conducting further analysis of Delta Vision actions and those resulting form other processes such as the BDCP.

Attachments (2)

Diversion Effects on Fish

Issues and Impacts

Prepared by the

CALFED Diversion Effects on Fish Team

June 25, 1998

EXECUTIVE OVERVIEW

An interagency/stakeholder Diversion Effects on Fish Team (DEFT) was formed to address the technical issues related to diversion impacts on fisheries for each the CALFED alternatives. The primary issues addressed were:

- Which species, populations, and life stages are most sensitive to diversion effects under no action and alternatives 1, 2, and 3?
- What degree of benefit and impact will the common programs provide?
- What is the risk and chances of success of species recovery for each alternative?

To evaluate these issues, species teams were formed for salmon, striped bass, and delta smelt. These species were chosen because they represent a range of exposure periods and they are the objects of numerous management and regulatory concerns. There are species that may be affected by changes in delta conditions whose responses may differ from the species analyzed here. The species teams developed matrixes on the effects of a set of impact parameters on the life stages of each species by month for each alternative. The detailed matrixes are described in individual species reports appended, which the reader is strongly urged to review for the details of the evaluations. This report summaries the process, assumptions, modeling studies, information used, professional judgement and the conclusions reached by the teams.

This report and the results should be interpreted cautiously, recognizing the many informational and procedural limitations inherent in these work products. The short time frame provided for this work compelled the team to rely primarily on professional judgement to evaluate the degree to which each relevant factor affects each of the key species. Assumptions had to made that in some cases limited the teams ability to answer the primary issues and included: 1) evaluation of diversion effects on fish populations was confined to the legally defined Delta, Suisun Bay and Suisun Marsh, even thought the CALFED solution area is much larger; 2) evaluations were based on a single operations study for each scenario with no attempt to minimize impacts or maximize benefits, (The next phase of the teams efforts will be to optimize the alternatives.), 3) the common programs will provide benefits with some negative impacts to each of the evaluated species, but the quantification of these benefits is uncertain, and 4) the impacts of water quality and exotics issues have not been evaluated.

The following were consensus professional judgements of the species teams, based on system operations modeling studies and published and unpublished information on individual species biology. Although the team had consensus on a number of assumptions regarding delta species biology, opinions of other scientists on the validity of the assumptions will likely vary from consensus to strong disagreement. The outcome of the assessments is very dependent on these assumptions.

The **salmon** team evaluated relative survival in the Delta of chinook salmon from the Sacramento and San Joaquin basins; Sacramento River races were assessed in aggregate. Survival was estimated monthly in relation to impact parameters considered important to salmon survival in the Delta. For Sacramento River chinook, five composite parameters had the greatest effects on survival; 1) entrainment losses, 2) flows below a Hood diversion, 3) interior-Delta survival, 4) habitat restoration, food supply, and screening of small agricultural diversions, and 5) impacts on adult upstream migration. Common Programs, Alternative 1, and Alternative 3 had similar total impacts, but involved different tradeoffs among benefits and detriments to salmon survival. Alternative 2 was least favorable, largely due to anticipated increases in adult straying and migration delays. For all three Alternatives, Common Programs provided most of the benefit. For San Joaquin salmon, the key composite parameters were 1) entrainment losses, 2) flow at Vernalis, 3) interior-Delta survival, and 4) habitat restoration, food supply, and screening of small agricultural diversions. Alternative 3 offers the greatest benefits for San Joaquin salmon, exceeding the benefits of any alternative for Sacramento salmon. Benefits accrue through reduced entrainment and improved interior-Delta survival.

The **striped bass** team concluded that none of the alternatives are likely to restore the adult population to historic levels (i.e., population of 1.8-3 million). Alternative 3 provides the best potential for partial restoration of the population. Alternative 3 is likely to reduce the entrainment of juveniles at the south Delta export facilities and increase the salvage of those that are entrained. Alternative 3 will likely enhance the transport of eggs and larvae in the lower San Joaquin River by positive flows and also restore Delta nursery habitat. However, both Alternatives 2 and 3 may have negative impacts by decreasing egg and larva transport below the Hood intake. Alternative 2 also has high impacts because of passage problems created for adult fish using the Mokelumne River as a migration route to Sacramento River spawning grounds. Alternative 2 also subjects eggs and larvae to two diversion points. Alternative 1 is likely to increase the entrainment of eggs and larvae at the south Delta export facilities. The common programs have both potential benefits and detriments that were difficult to quantify but are likely to have some net benefit.

The **delta smelt** team concluded that Alternative 3 has the most potential to improve conditions for delta smelt; however, the uncertainty associated with this evaluation is extremely high. The delta smelt team made separate evaluations for wet years and dry years. The No Action Alternative results in a slight worsening of conditions in both year types because of increased diversions to meet increased demand. The Common Programs result in a moderate improvement in conditions in both year types because of hypothesized benefits associated with increases in shallow-water habitat. Alternatives 1 and 2 represented moderate improvements compared to existing conditions but the benefits are derived from the Common Programs rather than changes in conveyance associated with the alternatives. Alternative 1 resulted in a slight decline in value in relation to the Common Programs. Alternative 2 resulted in a moderate decline in the value in relation to the Common Programs. The hydrodynamic effects of Alternative 2 were believed to be a strong negative effect on delta smelt. Alternative 3 resulted in significant benefit to delta smelt because of the combination of the positive effects of the Common Programs and the Team’s assessment that the hydrodynamic effects would also be positive for the majority of the population. The degree of benefit from the three Alternatives is very dependent on the Common Programs; thus, different assumptions about benefits of the Common Programs could result in substantially different assessments.

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1. INTRODUCTION

An interagency/stakeholder Diversion Effects on Fish Team (DEFT) was formed to addressed the technical issues related to diversion impacts on fisheries for each the CALFED alternatives. The primary issues addressed were:

- Which species, populations, and life stages are most sensitive to diversion effects under no action and alternatives 1, 2, and 3? When and where are they most affected?
- What degree of benefit and impact will the common programs provide?
- What is the risk and chances of success of species recovery for each alternative?

To provide a base to evaluate the these issues, interagency/stakeholder species sub-teams were formed for salmon, striped Bass, and delta smelt. This report summaries the organization, process, assumptions, modeling studies, information used, professional judgement and the conclusions reached by these species teams and the full DEFT.

Team Organization

Members of the DEFT are listed below under the species team on which they primarily served. Some participated in several teams. Several people contributed to the species teams that are not on the DEFT. They are identified with an (*).

Salmon team
Patricia Brandes (co-chair), U.S. Fish and Wildlife Service
Shelia Greene (co-chair), Department of Water Resources
Serge Birk, Central Valley Project Water Association
Pete Chadwick, Department of Fish and Game
Karl Halupka, U.S. National Marine Fisheries Service
Jim White, Department of Fish and Game
*Jim Starr, Department of Fish and Game
Striped Bass Team
Lee Miller (chair), Department of Fish and Game
Elise Holland, Bay Institute
*Stephani Spaar, Department of Water Resources
*David Kohlhorst, Department of Fish and Game
Kevan Urquhart, Department of Fish and Game
*Don Stevens, Department of Fish and Game
Delta Smelt Team
Dale Sweetnam (co-chair), Department of Fish and Game
Larry Brown (co-chair), U.S. Bureau of Reclamation
Michael Thabault, U.S. Fish and Wildlife Service
*Chuck Hanson, State Water Contractors
DEFT members not on a specific species team
Bruce Herbold, U.S. Environmental Protection Agency

Pete Rhoads, Metropolitan Water District Southern California
Michael Fris, U.S. Fish and Wildlife Service
Jim Buell, Metropolitan Water District Southern California
Ron Ott, CALFED

Process

To guide the species teams and to provide a framework for addressing the issues the DEFT developed a list of impact parameters that have direct and indirect effects on the populations in the Delta. Each species team modified the impact parameters listed below to better assess the impacts on their particular specie. The general impact variables are:

- Entrainment
- Hydrodynamics
- Predation
- Handing
- Food Supply
- Shallow/near shore Habitat
- Water Quality (Contaminants)
- Water Quality (Temperature)
- Water Quality (Salinity)
- Agriculture Diversions
- Straying

Each species team evaluated the impacts and benefits on their species against the above parameters for each month of the year for:

- Exiting Conditions
- No Action
- Common Programs
- Alternative 1
- Alternative 2
- Alternative 3

These alternatives are described in the CALFED document, “Programmatic EIS/EIR, Technical Appendix-Phase II Report”, March 1998
Sacramento and San Joaquin salmon represent anadromous species with the shortest exposures to delta conditions. Striped bass, an anadromous species, and delta smelt, a resident species, represent species with greater exposure to delta conditions.

The species teams developed matrixes on the effects of the impact parameters on the life stages of each species by month for each alternative. These were used by the teams to address the primary listed above and other issues listed below. The detailed matrixes and interpretations are described in individual species reports in Appendices 1,2 & 3. Species teams reports were review by the DEFT and other stakeholders outside the DEFT.

Other Issues

This report focuses on primary issues 1, 7, and 5. In addressing these three primary issues the species teams also answered several other issues, numbered below. All others except issues 4 and 13 were addressed in the individual species report (Appendices 1,2&3). Issues 4 and 13 will be addressed in the next phase of this teams efforts. The issues are:

1. Which species, populations, and life stages are most sensitive to diversion effects under no action and alternatives 1, 2, and 3? When and where are they most affected?
2. Can diversion effects in the South Delta be offset by habitat improvements and other common program actions?
3. To what extent can alternatives 1, 2, and 3 offset diversions effects as presently configured?
4. To what extent can diversion effects be offset by modifications to the alternatives or by operational changes? (Will be addressed in biological operation criteria white paper.)
5. What is the risk and chances of success of species recovery for each alternative?
6. What increment of protection or improvement for fish species will be provided by other programs such as the Central Valley Project Improvement Act, biological opinions, etc.?
7. What degree of benefit and impact will the common programs provide?
8. What are the direct and indirect effects on fish populations resulting from each alternative and what is the expected response of the populations to these effects?
9. What Sacramento River flow is required below a Hood diversion to protect salmon, striped bass and delta smelt?
10. What survival rate can be expected for striped bass eggs and larvae and delta smelt passing through Sacramento River screen and pumps in Alternative 2?
11. Should there be a screen on the Sacramento River intake of Alternative 2?
12. What are the logical stages for a preferred alternative? (Will be address in biological operation criteria white paper.)
13. What is the range of biological criteria that should be considered in operations of the three alternatives? (Will be addressed in biological operation criteria white paper.)

2. ASSUMPTIONS AND LIMITATIONS

This report and the results should be interpreted cautiously, recognizing the many informational and procedural limitations inherent in these work products. The short time frame provided for this work compelled the team to rely primarily on professional judgement to evaluate the degree to which each relevant factor affects each of the key species. Assumptions had to made that in some cases limited the teams ability to answer the primary issues. The assumptions and limitations are summarized below.

Biological Scope

The team has analyzed the impacts of different CALFED scenarios using the three species that represent types of fish likely to be affected. Some species, such as those that live their entire lives upstream or downstream of the delta are unlikely to be affected by changes in point of diversion in the delta. Other species, such as tule perch or largemouth bass, have life history characteristics that make them much less sensitive to hydrodynamic conditions or entrainment were also excluded. The three species the team examined included Sacramento and San Joaquin salmon to represent anadromous species with the shortest exposure to delta conditions. Striped bass, an anadromous species, and delta smelt, a resident species, represent species with greater exposure to delta conditions. Other species that may be affected by changes in delta conditions, but whose responses may differ from the species analyzed here, include: green sturgeon, white sturgeon, longfin smelt, Sacramento splittail, and American shad. CALFED may need to develop a future analysis to address these species.

Geographic Scope

The geographic scope of the CALFED "solution area" encompasses all of the Central Valley, San Pablo and San Francisco bays, and the near-shore Pacific ocean. The team's evaluation of diversion effects on fish populations was confined to the legally defined Delta, Suisun Bay and Suisun Marsh. Consequently, the team did not incorporate into its evaluation the potential beneficial and adverse effects of actions outside that area. Fluctuations in ocean and bay conditions, salmon and striped bass harvest management, CALFED's Ecosystem Restoration and Water Quality programs that occur outside the delta, and actions associated with the Central Valley Project Improvement Act (CVPIA) are all likely to affect fish populations.

Restoration and recovery of these three species will also depend on CALFED actions outside of the "problem identification area" that the team has addressed. CALFED's actions must also address many issues of greater uncertainty than those addressed, such as offshore harvest. Therefore, the team was unable to assess the degree to which the effects of these delta-based scenarios contribute to overall restoration and recovery. A far more complex and time-consuming analysis would be necessary to integrate the Delta effects we identify, with the broader range of natural fluctuations and human activities that will determine recovery.

The team identified the principal mechanisms by which storage and conveyance will affect these species, when these species are in the Delta. The team assigned relative ranks to summarize it's assessments of the balance of impacts and benefits for each scenario.

Process

Evaluations were based on the team's best professional judgement to the degree of which each relevant parameter affects each key species. The judgements considered empirical relationships between parameters and survival, where such relationships were available. Evaluations were based on operations modeling studies and qualitative assessments of the degree to which water operations, water management facilities, and biological parameters affect the populations of each species. More rigorous quantitative analysis was not possible within the time constraints imposed on this process.

The evaluations recognized the many sources of uncertainty that derive from the limitations of our scientific knowledge about the species and Bay-Delta ecosystem. From an analytical perspective, monthly averaged hydrology was the primary hydrologic parameter used in the analysis. For example, the use of particle tracking model output, which is based on short time-steps, may help reduce this uncertainty.

Sources of uncertainty on biological processes takes a variety of forms and makes any predictions of actual results at the population level extremely problematic. For example, the benefits of shallow water habitat to Delta smelt are not yet well understood. With regard to striped bass, the continuation of historic relationships into the future is unclear due to the many changes in the system. For salmon, the sources of mortality in the Delta are poorly understood. The various sources of uncertainty were acknowledged, identified, and considered to the extent possible in the evaluation

Procedures and Inputs

Evaluations are based on a single operations study for each scenario. There has been no attempt to minimize impacts or maximize benefits. The next phase of the teams efforts will be to optimize the alternatives. The specific CALFED operations studies used for each scenario were: Existing Conditions-558, NoAction-516, Alternative 1 without storage-518, Alternative 1 with storage-609, Alternative 2 without storage-528, Alternative 2 with storage-532a, Alternative 3 without storage-595, and Alternative 3 with storage-567. These runs included meeting the flow requirements for the Vernalis Adaptive Management Plan (VAMP), meeting the 1995 WQCP, and the biological opinions for delta smelt and winter-run chinook salmon. Analyses were based on monthly flows at selected locations in the Delta averaged over all years and averaged over selected dry and critical years. No attempt was made to explore the full range of annual variability

Using the model runs above, each alternative was analyzed by the salmon team with no new storage and with maximum new storage. The delta smelt and striped bass teams analyzed the no new storage alternatives only. The range of storage represents the extremes of existing storage to an additional 6.2 MAF of new storage. Storage between these two extremes would have marked results on the outcome of these evaluations. There was no attempt to minimize impacts or maximize benefits by optimizing storage.

For each alternative, the model runs produced average monthly flows at locations throughout the Delta. Wet and dry year flow summaries were used in the evaluation of impacts of an alternative. In some cases , using average monthly flows and monthly summaries could minimize the actual impacts or benefits of an alternative. The team attempted to account for the model limitations in their evaluations.

Incorporation of Common Programs

The evaluation of the effects of the Common Programs posed particular challenges for this evaluation. For example, at the current programmatic level of development, the distribution of restored/rehabilitated wetland and riparian habitat has not been defined. Different distributions of habitat would benefit different species. However, even if the distribution were clearly defined, our current level of scientific knowledge limits the evaluation of the benefits that would accrue to each species.

There was a broad consensus among the team that the common programs will provide benefits to each of the evaluated species. The quantification of these benefits is, however, not possible at this time. Increasing the amount of habitat will almost certainly increase the potential for survival of each of the evaluated species, but the magnitude of the increase is uncertain. Some potential impacts of the water quality program on striped bass are considered.

Water Quality

Changes in point of diversion would effect a variety of water quality parameters in the Delta. San Joaquin River water carries a significant load of agricultural chemicals, selenium, and other contaminants and nutrients. Sacramento River water generally carries lower loads and carries different metals such as copper, mercury, cadmium and zinc. Delta water directly receives a variety of agricultural chemicals (including herbicides), salts and organic carbon. Contaminant loads and concentrations vary seasonally, vary with hydrology, and can be expected to vary with different points of diversion and changes in operating criteria. The availability and effects of these chemicals on fish populations, and the food web that supports them, are unknown but potentially significant. Impacts may occur through direct toxicity, but are more likely through chronic effects or trophic disruptions. Synergisms of chronic effects with other factors such as disease or reduced growth that prolongs exposure to predators may also result in effects on fish populations. Changes in the point of diversion could also affect the transport of ocean derived salts in the Delta. The DEFT has not attempted to incorporate any of these contaminant effects into the evaluations of fishery impacts , and recommends collaborative efforts of the ecosystem restoration and water quality program elements to address these concerns as part of the plan for implementing the first phase of the CALFED program. A small group of appropriate experts from the water quality team and the DEFT should meet to evaluate these factors and help the

DEFT revise the present report.

Exotics

The Bay/Delta is dominated by non-native species. Some introduced species have substantially altered the functioning of ecosystems they have invaded and the team has limited understanding of the new ecological relationships among species. New species will likely continue to arrive and disrupt the biological communities of the estuary in the future. All data and analyses, therefore, that rely on historical relationships may not predict the future but they are the only available basis for analysis. The almost certain arrival of new species in the future may alter the ability of the estuary to support these three species but the group feels it is unlikely that effects of new species introductions would change the performance of the alternatives relative to each other ,in that, species introductions would not fundamentally alter the response of a fish population to basic ecosystem properties such as spawning habitat, streamflow, or hydrodynamics.

3. PRIMARY QUESTIONS

Each of the species team addressed the primary and other issues in their species reports in Appendices 1, 2 and 3. Summary evaluations of the primary questions (1, 7, and 5) for each species follow.

Salmon

1) Which species, populations, and life stages are most sensitive to diversion effects under existing conditions No Action and Alternatives 1, 2, and 3? When and where are they most affected?

The salmon Team evaluated diversion effects in the Delta on San Joaquin basin chinook salmon and an aggregate of all races of Sacramento-basin chinook. All San Joaquin chinook migrate through the south Delta, where they experience direct entrainment, loss in Clifton Court Forebay, and reduced survival associated with unfavorable flow distributions. A much smaller portion of Sacramento chinook are affected by diversions from the south Delta.

Substantial negative effects exist for both groups under existing conditions, and those would persist under No Action and Alternative 1, although direct entrainment losses would be reduced by a small increment under Alternative 1. Under Alternatives 2 and 3, the entire population of Sacramento chinook would emigrate past a screened diversion at Hood, and would be exposed to flow reductions in the Sacramento River downstream of Hood. Adverse effects unique to Alternative 2 would be increased straying and migratory delay of adult salmon returning to the Sacramento basin, due to both attraction to the Mokelumne River portion of the Delta and exposure to a fish passage facility at the Hood diversion. Under Alternative 2, direct and indirect effects in the San Joaquin portion of the Delta would be less for salmon from both rivers. Those effects would be further reduced under Alternative 3.

Fry rearing in the Delta is important to salmon production, especially in wet years. Diversion effects are believed to be greater on actively migrating yearlings and smolts, whether rearing takes place in the Delta or in upstream areas.

7) What degree of benefit and impact will the Common Programs provide?

Much of the expected benefit for salmon would result from restoration of shallow water habitat. However, the actual effect on salmon populations is uncertain. Salmon pre-smolts are particularly likely to use restored habitats. Restored habitats would also be favorable for predators but in the opinion of most salmon biologists the increased cover and food supply should increase salmon survival and provide net benefits. If habitat restoration is successfully implemented along migration corridors for salmon, benefits should be greater than estimated in this analysis. Screening Delta diversions and improved Delta water quality are also expected to be beneficial. Increased spring flows would slightly improve chinook survival in the Delta, in addition to providing upstream benefits. The Water Use Efficiency and Water Transfer programs would increase flexibility in water supply operations, offering some opportunities to shift diversions to times less detrimental to salmon, but such shifts would probably increase impacts on other species. Overall, the Common Programs are unlikely to provide sufficient benefits in the Delta to offset diversion effects fully.

5) What are the risks and chances of success of species recovery for each alternative?

Recovery depends on conditions throughout the life history of salmon. Because the salmon team considered only needs of juveniles and adults in the Delta, the following answers are more appropriate for addressing risks of precluding recovery by significantly adversely impacting one lifestage, rather than addressing the chances of success of species recovery.

No Action - Substantial adverse impacts to San Joaquin chinook in the south Delta under Existing Conditions would increase under No Action due to the increased exports from the south Delta. Although a smaller proportion of the Sacramento chinook are impacted by south Delta exports, substantial negative effects exist for both groups under existing conditions, and those would persist under No Action. The operation studies provided for these analyses assume the Delta Cross Channel gates are closed between November and June to improve survival of salmon migrating down the Sacramento River. The validity of this assumption during November and December was questioned by the salmon team since water quality objectives often are in conflict during low flow periods. The ongoing efforts of the Ops Group to improve salmon survival under Existing Conditions in the face of limited operational flexibility, and the probable decrease in flexibility over time with the No Action scenario, indicate potential for precluding recovery.

Alternative 1- Delta Cross Channel gate closure to improve survival of salmon emigrating down the Sacramento River would continue to be in conflict with water quality objectives during low flow periods. Improved fish screens in the south Delta would provide additional protection, especially for San Joaquin salmon. These benefits would be tempered by the continued need for handling and trucking, but this is less of a risk for salmon than for many other species. Overall, reduced entrainment and benefits from the Common Programs probably would not be sufficient to cause major improvements in salmon production.

Alternative 2- The diversion at Hood would impose several new risks for salmon from the Sacramento system (see response to question 1 above). The salmon team believes that Alternative 2 would pose risks for salmon from the Sacramento system greater than any other alternative, potentially resulting in population declines relative to Existing Conditions. For salmon from the San Joaquin, the combination of improved flow distribution in the central Delta, and benefits from new screens in the south Delta (see Alternative 1), would make Alternative 2 superior to Alternative 1.

Alternative 3- For Sacramento salmon, Alternative 3 would not pose the same risk for upstream migrants as Alternative 2. Other risks of the Hood diversion would be essentially the same as those described for Alternative 2. These risks would result in overall benefits about the same as for the Common Programs. San Joaquin basin chinook have the greatest potential to benefit from Alternative 3. The benefit that would be most certain is the reduction in entrainment losses associated with the large reduction in diversions from the south Delta.

Striped Bass

1) Which species, populations, and life stages are most sensitive to diversion effects under existing conditions No Action and Alternatives 1, 2, and 3? When and where are they most affected?

No Action- Striped bass eggs, larvae, and juveniles are directly impacted by water diversions in the Delta during the first year of life from April through fall, and sometimes during winter. The impact on eggs and young fish occurs from April to July, with further impacts on larger juveniles through summer and fall. Under current conditions, the population is likely to continue to decline in the absence of a stocking program. In recent years, young striped bass abundance has remained low despite higher-than-average delta outflows and low export rates, both of which are conducive to strong year classes in the past.

Alternative 1- Entrainment of eggs, larvae, and juveniles in the south Delta will continue and increase with channel improvements and additional storage. Closure of the cross channel gates through the spawning season from April to June would reduce the diversion of Sacramento River striped bass eggs and larvae but may cause increased flow reversal in the lower San Joaquin River.

Alternative 2- Increased numbers of eggs and larvae could be diverted and entrained from the Sacramento River because fish screens at the Hood diversion would be inadequate to screen these stages. The magnitude of diversion of eggs and larvae from both the Sacramento and San Joaquin rivers, as well as juveniles from the San Joaquin, depends on operation of the facilities. For example, temporary reduction in diversion at Hood during the striped bass spawning season would reduce diversion of eggs and larva from the Sacramento River and provide transport flow to move young bass to the nursery areas downstream. At the Clifton Court diversion, eggs, larvae, and juveniles would be continue to be entrained; more juveniles would be salvaged.

Adults would be attracted by the high proportion of Sacramento water in the Mokelumne River and they would be trapped behind the fish screen at Hood. The feasibility of passing large numbers of striped bass around or over such structures is highly questionable. Adults trapped behind the Hood fish screen would be forced to spawn in the Mokelumne River and most of their progeny would be entrained in the flow to the export pumps. If flow diverted at Hood is a large proportion of the Sacramento flow, as might occur in dry years, more fish would be attracted to the Mokelumne as a corridor to the spawning grounds.

Alternative 3- Increased numbers of eggs and larvae could be diverted and entrained from the Sacramento River because fish screens at the Hood diversion would be inadequate to screen these stages. The magnitude of diversion of eggs and larvae from both the Sacramento and San Joaquin rivers, as well as juveniles from the San Joaquin, depends on operation of the facilities. For example, temporary reduction in diversion at Hood during the striped bass spawning season would reduce diversion of eggs and larva from the Sacramento River and provide transport flow to move young bass to the nursery areas downstream. If diversions are not curtailed entrainment of egg and larva will be high and transport flows will likely be inadequate. Adult migrations would not be affected as for Alternative 2 because the facility is isolated. Because QWEST flows would be improved over existing conditions and less water would be diverted from the south Delta, the team expects less entrainment of striped bass and improvement of nursery habitat in the Delta.

7) What degree of benefit and impact will the Common Programs provide?

The common programs will likely provide some benefits to young striped bass, but these are difficult to quantify. Screening of small Agricultural diversions would reduce mortality of young striped bass. Increasing the amount of marsh habitat for nursery areas adjacent to Suisun Bay and in San Pablo Bay would likely increase survival of young striped bass. Reducing point and non-point sources of toxic chemicals and metals could improve conditions for all life stages to some degree; however, present population impacts of toxicants have not been demonstrated. Reduction of organic input and decreasing turbidity may adversely affect striped bass production.

5) What are the risks and chances of success of species recovery for each alternative?

When and where are they most affected? The adult population is affected by reduced recruitment as a result of early life stage losses. Although there is evidence of density-dependent survival (compensation) it has not been sufficient to maintain the numbers of adults that were historically present. Recovery cannot occur under the No Action Alternative. Alternatives 1 and 2 appear to exacerbate present problems associated with using the Delta as a water export conduit. Alternative 3, while falling short of restoration to historic population levels, would, if operated in a manner which minimized entrainment of young striped bass and provided adequate transport flows, provide the best opportunity for partial restoration of the population.

Delta Smelt

1) Which species, populations, and life stages are most sensitive to diversion effects under existing conditions No Action and Alternatives 1, 2, and 3? When and where are they most affected?

No Action: Larvae and young juveniles are the most sensitive life stages. These life stages are present in the spring and early summer. The major effects occur in the central and south Delta where altered hydrodynamics and entrainment are important. As delta smelt become adults, they migrate downstream to brackish water areas in the fall and winter and are considered less vulnerable to diversion effects. Pre-spawning adults migrating back into freshwater to spawn in the late winter and early spring become vulnerable to entrainment effects once again.

Alternative 1: The same as No Action.

Alternative 2: Larvae and young juveniles are still the most sensitive stages and are still vulnerable at the same times. The major changes in hydrodynamics anticipated with Alternative 2 are believed to be a negative factor for all life stages of delta smelt, but especially these sensitive stages. These negative effects are expected to be most severe in the eastern Delta.

Alternative 3: Alternative 3 was given high benefit because of its positive effects on returning Delta hydrodynamics to a more "natural" condition, meaning the rivers and most channels maintain positive outflows at most times and places. Positive benefits for delta smelt may be high compared to other species because it is the only species to complete its entire life cycle in the estuary.

7. What degree of benefit and impact will the common programs provide?
The delta smelt team estimated that improvement would occur with the common programs. Much of the benefit predicted is due to the creation of additional shallow water habitat of several different types. The effect on delta smelt is uncertain. Much of this uncertainty stems from the scarcity of evidence of the effects of increasing such habitat. Delta smelt use such habitat for spawning but it seems to be of no special importance as rearing habitat. There is no evidence that spawning habitat is a limiting factor for the delta smelt population. While the habitat will also be favorable for predators, the increased spawning habitat and possible increases in Delta primary productivity and food supply were believed to be possible benefits and were assigned benefits even though this is an area of high uncertainty. Screening Delta diversions and improved Delta water quality are also expected to be beneficial.

5. What is the risk and chances of success of species recovery for each alternative?
For the delta smelt team recovery is defined in "The Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes" (Appendix 1). Alternative 1 is not a major change and probably has little influence on probability of recovery. Alternative 2 seems likely to negatively affect probability of recovery. Alternative 3 seems likely to improve the probability of recovery. All of these assessments are subject to the uncertainties already identified above.

4. SUMMARY MATRIX

The reader is strongly urged to read the detailed species reports in the Appendices for the details of the evaluations. In these reports each species teams developed rational and matrixes that scored the effects of the impact parameters on the life stages of each species by month for each alternative. In that process each team used an evaluation scoring scale referenced to a baseline that allowed that team to make relative evaluations between the alternatives for that species. Some set baseline at existing conditions with a score of "0" while others set baseline to pre-water project conditions. These scales were used by the teams to assist in addressing the primary and other issues. The teams did not try to achieve complete comparability in the baselines and scoring of the various species. For this summary report the team's adjusted the scores so that "0" , the baseline, in all cases is existing conditions and +7 is approaching full restoration. A minus score indicates that the alternative is worse than the existing conditions for the particular species. In general, the scores may be further subdivided as follows:

-3 to -1 = decreases in abundance likely (opposite effect of program goals)
0 = abundance is likely to be similar to existing conditions
+1 to +2 = small increases in abundance at best (unlikely to achieve program goals)
+3 to +5 = increase in abundance likely (may achieve program goals)
+6 to +7 = high likelihood that goals of restoration and recovery may be achieved.

Two types of general uncertainty were associated with the evaluation: 1)uncertainty associated with the existing conditions and causes of impacts on the species, and 2)uncertainty associated with the predicted benefits and impacts of the alternatives. Both types were integrated in the uncertainty scores in the tables below. For existing conditions the salmon team felt the causes of impacts on salmon species are well known and the uncertainty scores do not apply. The salmon team also recognized that considerable exists as to causes, but chose to reflect only uncertainty in predicted benefits and impacts in assigning uncertainty scores.

The integrated levels of uncertainty associated with the scores were assigned:

1 = Low uncertainty
2 = Moderate uncertainty
3 = High uncertainty

The following summary matrices show the score for improvement of the species, the uncertainty associated with the score, and a highlight of the benefit or impact for each alternative.

Salmon

Alternatives	**Sacramento River Salmon**	**San Joaquin River Salmon**
Existing Conditions	Score: 0 Uncertainty: NA - Interior-Delta survival is low. - Entrainment losses, suboptimal flow below Hood, and losses to Delta agricultural diversions.	Score: 0 Uncertainty: NA --Detriments associated with low interior-Delta survival, insufficient Vernalis flows, and high entrainment losses.
No Action	Score: 0 Uncertainty: 1 - Minor additional detriments did not warrant a change in summary score.	Score: 0 Uncertainty: 1 -Minor additional detriments did not warrant a change in summary score.
Common Programs	Score: +2 Uncertainty: 2 - Improvement would be driven by both increased shallow water habitat (shelter and reduced predation), and improved food supply. - Improved flows and reduction in agricultural-diversion losses also would contribute to improvement.	Score: +1 Uncertainty: 2 - Improvement would be driven by both increased shallow water habitat (shelter and reduced predation), and improved food supply. - Improved flows and reduction in agricultural-diversion losses also would contribute to improvement.
Alternative 1	Score: +2 Uncertainty: 2 - Benefits derived from Common Programs. - Insufficient change from Common Programs to warrant a change in summary score. - Small reduction in entrainment losses.	Score: +2 Uncertainty: 2 - Improved screens in the south Delta would provide a substantial benefit.
With new storage	Score: +1 Uncertainty: 2 - Reduced flow associated with storage considered sufficient to diminish Interior-Delta survival and increased entrainment losses reduce summary score for this option.	Score: +1 Uncertainty: 2 - Increased exports would contribute to increased entrainment and reduced interior-Delta survival. - Improved screens in the south Delta would provide a substantial benefit.
Alternative 2	Score: -1 Uncertainty: 3 - Interior-Delta survival would be improved. - Improvement would be outweighed by reduced flows below Hood, juvenile entrainment losses at the Hood screen, and the barrier to adult upstream migration (increased straying and delayed migration).	Score: +3 Uncertainty: 3 - Improved flow distribution in the interior Delta would increase survival. - Improved screens in the south Delta would provide a substantial benefit.
With new storage	Score: -2 Uncertainty: 3	Score: +2 Uncertainty: 3

Alternatives	**Sacramento River Salmon**	**San Joaquin River Salmon**
	- Reduced flow associated with storage considered sufficient to diminish Interior-Delta Survival and increased entrainment losses reduce summary score for this option.	- Similar adverse effects as in Alternative 1. - Improved screens in the south Delta would provide a substantial benefit.
Alternative 3	Score: +2 Uncertainty: 3 - Interior-Delta survival would be improved. - Improvement would be outweighed by reduced flows below Hood and juvenile entrainment losses at the Hood screen. - Tradeoff between beneficial and adverse effects yields the same summary score as for Common Programs.	Score: +4 Uncertainty: 2 - Anticipated ~80% reduction in south-Delta exports would reduce entrainment losses and further improve interior-Delta survival. - Improved screens in the south Delta would provide a substantial benefit.
With new storage	Score: +2 Uncertainty: 3 - Minor additional detriments did not warrant a change in summary score.	Score: +4 Uncertainty: 2 - Minor additional detriments did not warrant a change in summary score. - Improved screens in the south Delta would provide a substantial benefit.

Striped Bass

Alternatives	**Striped Bass**
Existing Conditions	Score: 0 Uncertainty: NA • Major entrainment of young life stages
No Action	Score: -1 Uncertainty: 3 • Major entrainment of young life stages
Common Programs	Score: +1 Uncertainty: 3 • Uncertain benefits of habitat improvements • Uncertain benefits/detriments of water quality improvements • In-Delta screening benefits juveniles
Alternative 1	Score: +1 Uncertainty: 3 • Increased entrainment of young life stages over existing conditions • Decreased mortality of entrained juveniles • QWEST not improved
Alternative 2	Score: 0 Uncertainty: 3 • Potential increased entrainment of eggs & larvae (north and south Delta) • Transport flows for eggs and larvae possibly decreased and mortality

Alternatives	**Striped Bass**
	increased • Decreased mortality of entrained juveniles • Improved QWEST • Adult passage problems and detrimental change in spawning location
Alternative 3	Score: +3 Uncertainty: 3 • Potential increased entrainment of eggs & larvae at Hood • Reduced entrainment of eggs, larvae and juveniles from the Delta • Transport flows for eggs and larvae possibly decreased and mortality increased unless strategic curtailments implemented. • Improved QWEST and Delta nursery habitat.

Delta Smelt

	Delta Smelt -Water Year Type	
Alternative	Wet	Dry
Existing Conditions [1]	Score: 0 Uncertainty: 2 - Baseline condition	Score: 0 Uncertainty: 2 - Baseline condition
No Action	Score: -1[2] Uncertainty: 3 - Negative effect because of increased diversion to meet increasing demand.	Score: -1 Uncertainty: 3 - Negative effect because of increased diversion to meet increasing demand.
Common Programs	Score: +2 Uncertainty: 3 - Positive benefit is hypothesized for increased shallow-water habitat. - Positive benefit is hypothesized for consolidation and screening of agricultural diversions.	Score: +2 Uncertainty: 3 - Positive benefit is hypothesized for increased shallow-water habitat. - Positive benefit is hypothesized for consolidation and screening of agricultural diversions.
Alternative 1	Score: +1 Uncertainty: 3 - The Common Programs provide the only positive benefit.	Score: +2 Uncertainty: 3 - The Common Programs provide the only positive benefit.
Alternative 2	Score: +1 Uncertainty: 3 - The Common Programs provide the only positive benefit. - The changes in conveyance and resulting hydrodynamics will negatively effect all life stages.	Score: +1 Uncertainty: 3 - The Common Programs provide the only positive benefit. - The changes in conveyance and resulting hydrodynamics will negatively effect all life stages.
Alternative 3	Score: +4 Uncertainty: 3 - Positive benefits of Common Programs. - Reduced entrainment. - Improved hydrodynamics.	Score: +5 Uncertainty: 3 - Positive benefits of Common Programs. - Reduced entrainment. - Improved hydrodynamics.

[1] Existing conditions for wet and dry conditions are not the same. Existing conditions for dry years are worse than

for wet conditions. Do not compare across the columns.

[2] The negative effect for both year types is actually less than a full unit. The -1 simply implies a slight negative effect, in this case only.

DIVERSION EFFECTS ON FISH

APPENDIX A

CALFED ALTERNATIVE EVALUATION FOR CENTRAL VALLEY SALMON SURVIVAL WITHIN THE DELTA

DIVERSION EFFECTS ON FISH

CALFED ALTERNATIVE EVALUATION FOR CENTRAL VALLEY SALMON SURVIVAL WITHIN THE DELTA NARRATIVE

Draft - June 23, 1998

In this report, we describe an analysis of diversion effects on Central Valley chinook salmon within the Delta. Our assignment was to evaluate variations in the survival of chinook salmon within the Delta for each of several scenarios being considered in the CALFED Program. The scenarios are No Action, Common Programs and Alternatives 1, 2, and 3, and are evaluated in relation to Existing Conditions. Our evaluation is based on one operation study for each scenario. Because variations in operations could result in considerable differences in effects on chinook salmon within the Delta, our analysis provides only a first approximation of potential differences among scenarios.

We evaluated the effects of CALFED water storage and conveyance alternatives on chinook lifestages in the Delta; we did not evaluate overall effects on chinook population dynamics. An analysis of survival throughout the entire Sacramento and San Joaquin basins, in the Delta and Bay, and in the ocean would be necessary to assess the effects of the CALFED program on overall chinook population dynamics. Evaluation of effects on survival upstream from the Delta would be particularly important for the CALFED Ecosystem Restoration and Water Quality Programs. Evaluation of effects of ocean conditions and commercial and recreational harvests would be important to provide an appropriate perspective on impacts in the ocean. Although our within-Delta analysis is not sufficient to evaluate the effects of the entire CALFED program, it is sufficient to describe the full effects of the alternative ways of transferring water across the Delta being considered in the CALFED Programmatic Environmental Impact Statement.

We prepared separate analyses for chinook salmon from the Sacramento and San Joaquin systems, because of their different uses of the estuary. From the San Joaquin system, only one race, fall run, is involved. From the Sacramento system, four races are involved, each juvenile lifestage using the estuary to a different extent and during a distinctive time period, collectively using the estuary in every month except July. (In August, estuary use is limited to adults immigrating upstream, and the subcommittee identified no adverse effects.)

Two of the races, the Sacramento winter and spring runs, are receiving protection under endangered species laws and thus require special consideration in making management decisions. At this stage, the subcommittee's analysis integrates effects over all runs, without separately identifying effects on the listed runs.

We first analyzed the effects (by month) of parameters expected to influence salmon survival in the Delta. We used the results of this analysis to answer a series of questions posed by CALFED. This report includes both a description of our analysis and answers to CALFED's questions.

The subcommittee is co-chaired by Patricia Brandes, U. S. Fish and Wildlife Service and Sheila Greene, Department of Water Resources. Other biologists participating fully throughout the analysis were Serge Birk, Central Valley Project Water Association, Pete Chadwick, Department of Fish and Game, Karl Halupka, U. S. National Marine Fisheries Service, Jim Starr, Department of Fish and Game, and Jim White, Department of Fish and Game.

METHODS

We developed a matrix for each CALFED scenario. All matrices consist of rows for each parameter expected to affect salmon survival in the Delta, and columns for each month and the sum of all months (Appendix A, pages A15-A20). We assign an integer value to each matrix cell reflecting the relative magnitude of adverse or beneficial effects of each parameter on the population of juvenile chinook in the Delta in each month. We scored Existing Conditions first, and then sequentially No Action, Common Programs, and Alternatives 1, 2, and 3. We completed two analyses for Alternatives 1, 2, and 3; for the alternatives with no additional storage and for the alternative with the maximum amount of storage being considered by CALFED. Initially, under Existing Conditions, integer values ranged from -3 to +3, but for matrices that were scored subsequent to Existing Conditions, values ranged outside -3 to +3 to maintain a consistent assessment of magnitude of effect relative to Existing Conditions.

The primary goal of scoring the Existing Conditions matrix is to obtain a set of consensus values that accurately describe present conditions. These values subsequently serve as a baseline for comparison with other scenarios. We assign Existing Conditions values that we consider reasonable in relation to limiting factors, without making any attempt to relate values to some specific set of historical conditions. We do not attempt to define “recovery,” “restoration,” or any other potential CALFED goals.

We consider both the magnitude of effect of each parameter and the proportion of the population present in the Delta in determining the value for each cell in the matrix. For example, a parameter causing a small change on a large proportion of the population could have the same population effect as a parameter causing a large change on a small proportion of the population, and thus could receive the same value.

We used best professional judgement to determine the degree to which each parameter affects salmon survival. We considered empirical relationships between parameters and survival, when relationships were available. Our evaluations were based on qualitative assessments of the degree to which water operations, water management facilities, and biological factors affect chinook salmon in the Delta.

For the Sacramento system, we consider each of the four races of chinook and their occurrence in the Delta as fry, smolts and yearlings. We integrate effects over all life stages of all races, including returning adults immigrating through the Delta, to determine values for each matrix cell.

To clarify and summarize the results in the matrix analysis, we created composite parameters (Tables 2 and 3; Appendix A, pages A15-A20). One composite parameter is Entrainment Losses. It is an estimate of losses occurring immediately in the vicinity of export diversions, either at the SWP and CVP south Delta diversions or at a new Hood facility. The overall estimate of Entrainment Losses is based primarily on the Percent Exposed parameter. If the sum of the other three entrainment related parameters (Screen efficiency/Predation, Trucking/

Handling and Clifton Court Forebay Loss) exceeds 3, we adjust the Percent Exposed parameter by -1 to reflect increase severity of Entrainment Losses.

Another composite parameter is Interior-Delta Survival. It is the survival of juvenile salmon diverted from the mainstem Sacramento River into the Mokelumne and San Joaquin portions of the Delta, and juvenile salmon emigrating through the San Joaquin portions of the Delta, exclusive of Entrainment Losses. Interior-Delta Survival is the sum of Flow Distribution, Delta Cross Channel, Predation, Temperature, and Salinity. Flow Distribution is based on flows in Old and Middle Rivers and San Joaquin River downstream of the Mokelumne River in the DSMII operation studies. Old and Middle Rivers connect the lower San Joaquin River to the south Delta export facilities.

We make separate estimates for the five component parameters under Interior-Delta Survival to reflect some knowledge of the independent effects of individual parameters, but are more certain of the overall estimate of Interior-Delta Survival than the values of the individual parameters. Our increased certainty is based on extensive smolt release and recapture experiments using hatchery smolts. Paired experiments result in an estimate of differential survival of smolts released simultaneously in the mainstem Sacramento River and in the Interior Delta, and subsequently recaptured downstream of the Delta. We recognize the survival of hatchery smolts probably does not reflect the survival of wild smolts precisely. Although the experiments were not designed to identify the sources of decreased survival, we assumed the sources to be the five parameters under Interior-Delta Survival. The results of the paired experiments were that survival of smolts diverted into the interior Delta was one third or less of the survival of smolts remaining in the mainstem Sacramento River (Table 1). The small proportion of chinook salvaged at the CVP and SWP south Delta exports indicates most of the decrease in survival is due to Interior-Delta Survival rather than Entrainment Losses.

Among the component parameters under Interior-Delta Survival, a majority of the subcommittee considers the Flow Distribution parameter to be a surrogate for effects associated with flow and olfactory cues, which are believed to be related to survival indirectly through mechanisms such as influencing the duration of emigration. Members of the committee all agree that the Flow Distribution effects are greatest near the south Delta export facilities when pumping rates are greatest. There is not consensus as to how widespread the effects are, and in particular whether they extend to the San Joaquin River in the central Delta where tidal flows far exceed net freshwater flows. Also, a minority of the subcommittee recommended it would be more appropriate to distribute some of the magnitude of effects represented in the Flow Distribution parameter among the other component parameters, such as, predation, temperature and salinity.

We based our evaluations on a single operation study for each scenario. The specific CALFED operation studies used for each scenario are: Existing Conditions - 558, No Action - 516, Alternative 1 without storage - 518, Alternative 1 with storage - 609, Alternative 2 without storage - 528, Alternative 2 with storage - 532a, Alternative 3 without storage - 595, and Alternative 3 with storage - 567. Flow changes associated with the Common Programs were evaluated by comparing flows below Hood and at Rio Vista in study 518 to flows in studies 516 and 518, and from tables in Appendix E of the 19 May 1998, draft modeling studies. The operation studies consist of flows at selected locations in the Delta, computed on a monthly timestep, then averaged over all years from 1922 to 1994, dry and critical years, and other subsets. We recognized the pitfalls associated with using average values, but we did not have time to explore fully, or to consider scoring, the full range of annual variability.

One of the parameters included in the matrices is Toxics. Acute and chronic toxic effects have been identified in the Delta, but results of standard toxicity bioassays have not been related directly to salmon in ways that the subcommittee felt competent to judge. Such effects would be expected to change due to the CALFED Water Quality Program, but that program is not yet described with sufficient specificity to judge how it might affect salmon. Water quality differences may also occur among alternatives due to differences in dilution in different areas of the Delta, or due to changes in the toxic constituents delivered to the Delta associated with changes in proportional flow from the Sacramento and San Joaquin rivers. The subcommittee did not feel competent to offer judgements on any of these aspects of toxicity.

In the matrices, the sum of all months is the overall annual effect of each parameter. Upon examining annual estimates for some parameters, or groups of parameters, in the Sacramento matrices, the subcommittee concluded that some parameters were not weighted properly in relation to other parameters. In such cases, the subcommittee divided or multiplied the annual estimate by a constant to provide the proper relationship among parameters or groups of parameters. Only the annual estimates were weighted in that fashion, so the reader needs to use caution in reaching conclusions based on comparing monthly values. For the San Joaquin system, weighting among parameters was incorporated directly as cells were assigned monthly values.

Two weighting factors were applied to the results of Sacramento River evaluations. When we compared the annual estimates for Entrainment Losses (-20) to the annual estimate for Interior-Delta Survival (-30), we concluded that this reflects an over weighting of Entrainment Losses (Table 2). Dividing Entrainment Losses by 4 brought them roughly into balance with empirical evidence on the relative effects on survival of these two parameters. Entrainment Losses in all Sacramento matrices were weighted in this fashion.

We identified another weighting disparity between relative magnitudes of Interior-Delta Survival and Flow below Hood in the Sacramento River. We concluded that Flow Below Hood should be multiplied by 2 to make the annual estimates for that parameter similar in range to the annual estimates for Interior-Delta Survival. Our justification for weighting survival in the Sacramento River and in the interior Delta nearly the same is that about four times as many salmon remain in the Sacramento River with the Delta Cross Channel gates closed as are diverted into the Delta, but the survival rate of juvenile salmon diverted into the interior Delta is reduced to one third or less of the rate for smolts that remain in the Sacramento River (Table 1).

RESULTS

Chinook Salmon From The Sacramento System

Existing Conditions

In summary, we determined that Existing Conditions have negative impacts primarily due to decreased Interior-Delta Survival and Entrainment Losses, both being substantial in all months except July and August.

No Action

We concluded that the only substantial difference in comparison to Existing Conditions was due to increases in exports of about 10% annually. The result of increased exports were shown as small increases in Entrainment Losses in January and February and small decreases in Interior-Delta Survival in December and January (Table 2).

Common Programs

The Common Programs that we judged would have some effect on survival of Sacramento salmon were the flow augmentations, wetland and riparian restoration (which translated into decreased predation, more extensive shallow water habitat, and enhanced food supply in the analysis), and agricultural diversion screening components of the Ecosystem Restoration Program (Table 2). We believe the effect of a flow augmentation of about 5% in March and May would be marginal in the Delta in relation to the other parameters' effects, therefore we increased the value of Flow Below Hood only during May in the matrix.

The relative effects of wetland and riparian restoration programs were difficult to judge. Where these habitats are available, they are used by juvenile salmon as rearing habitat, and provide both terrestrial and aquatic foods for both rearing and emigrating juvenile salmon. These habitats also would be likely to increase the abundance of predators, but most biologists agree that some net benefits would occur for salmon. We are not aware of experimental evidence that estimates the magnitude of such benefits. In the Ecosystem Restoration Program, CALFED proposes moderate increases in existing habitat in the Delta. It is not clear, however, how restored habitat will be distributed. Benefits would likely be greater than those we estimated if the habitat were concentrated in migration corridors for salmon. We concluded that restored habitat would provide modest rearing benefits, primarily from December through March, food supply benefits from December through May, and reduced in-Delta predation from March through May.

We estimated that screens on Delta agricultural diversions would reduce existing impacts in April, May, and June.

Alternative 1

We concluded that the primary changes in relation to Existing Conditions, beyond those attributable to the Common Programs, would be small decreases in Entrainment Losses (Table 2). The new fish screens at the intake to Clifton Court Forebay for both the CVP and SWP would improve screen efficiencies and eliminate predation losses now occurring in Clifton Court Forebay. Under Alternative 1 with storage, this improvement would be offset, to some degree, by exposure of a greater number of salmon to the screens from December through March, and decreased Interior-Delta Survival from October through March, due to increased exports.

Alternative 2

Several substantial changes would occur under Alternative 2 (Table 2). First, Entrainment Losses would increase. This would result from the combination of exposure to a new diversion at Hood and continued exposure to diversions in the south Delta. The fraction exposed to a diversion at Hood would be substantially greater than the fraction exposed now to the diversions in the south delta. The fraction exposed in the south Delta would not change much, as a result of a fairly complicated set of interactions. A larger fraction of the salmon would be diverted into the interior Delta, due to the lower flows below Hood intake increasing both the density of salmon in the Sacramento River and the proportion of flow diverted through Georgiana Slough into the interior Delta. The increase would be more or less offset by more favorable flows in the interior Delta causing a smaller fraction of the salmon to go to the south Delta diversion and a larger fraction to migrate west towards the ocean.

A second adverse effect would be the Flow below Hood in the Sacramento River. The subcommittee expects this would decrease survival from September through June, with the greatest reductions occurring when the greatest fraction of flow is being diverted at Hood and when the flows are the lowest.

A third adverse effect would be the need to pass adult salmon migrating upstream through the San Joaquin-Mokelumne route to the Sacramento River. These fish would have to pass the Hood fish screen and pumping plant. While a bypass facility would be built, we determined it would probably impose new impacts on the adult population.

A beneficial effect under Alternative 2 would be improved Interior-Delta Survival for salmon smolts diverted through Georgiana Slough, due to more favorable flow distribution in the San Joaquin River and the avoidance of any need to open the Delta Cross Channel gates.

Alternative 3

This Alternative would not have the adult salmon passage problems at the Hood fish screens and pumping plant as would occur with Alternative 2. Otherwise the changes would parallel those for Alternative 2.

Entrainment Losses would increase (Table 2) for the same reasons described for Alternative 2, but the increases would be less than in Alternative 2, because exports from the south Delta would be reduced by about 80% and water diverted into Georgiana Slough would be distributed more favorably.

Survival in the Sacramento River below Hood would be reduced by essentially the same amount as for Alternative 2.

Interior-Delta survival would be even better than for Alternative 2, due to better flow distribution in the San Joaquin River.

Chinook Salmon from the San Joaquin System

Existing Conditions

Salmon from the San Joaquin system use the Delta over a smaller portion of the year than salmon from the Sacramento system (Appendix 2). Adults migrate upstream in the fall, some fry move downstream in January and February to rear in the Delta, and most of the juveniles emigrate downstream as smolts from March through June.

Entrainment Losses in the south Delta are controlled by the same parameters as those that control Entrainment Losses for salmon from the Sacramento, but the proportion of the population exposed to the screens is much greater because the screens are directly on their migratory pathway.

Interior-Delta Survival is also controlled by similar parameters, except that opening the Delta Cross Channel gates does not have a direct impact, but a barrier at the head of Old River reduces impacts.

Flows at Vernalis replace flows below Hood as a parameter. Flows at Vernalis have been shown to be correlated to escapement two and a half years later (Kjelson, Brandes, 1989). In addition, the survival of CWT smolts released in the south Delta is positively correlated to flow at Stockton and Vernalis (IEP Newsletter, Winter 1998).

Flows during the fall are inadequate for adult attraction and upstream passage. Entrainment Losses, Flows at Vernalis and Interior-Delta Survival are all of concern from January through June. Measures prescribed in the VAMP agreement and the head of Old River barrier partially mitigate adverse conditions in April and May.

No Action

Conditions are similar to Existing Conditions, except for slightly greater Entrainment Losses and poorer Flow Distribution in January and February (Table 3).

Common Programs

As for the Sacramento system, screening Agricultural Diversions and creating wetland and riparian habitat as part of the Ecosystem Restoration Program provide benefits of the same magnitude, and subject to the same caveats as those described for the Sacramento system (Table 3). In addition, flow augmentation provided as part of the Ecosystem Restoration Program are expected to improve conditions in May.

Alternative 1

New screens at the intake to Clifton Court Forebay would substantially reduce Entrainment Losses particularly for Alternative 1 without storage (Table 3). For this alternative with storage, Flow Distribution would become somewhat worse in January through March.

Alternative 2

In comparison to Alternative 1, Interior-Delta Survival would improve due to improved Flow Distribution downstream from the mouth of the Mokelumne River (Table 3). Otherwise conditions would be similar to those for Alternative 1.

Alternative 3

Reductions in diversions from the south Delta by about 80% would substantially reduce Entrainment Losses and improve Interior-Delta Survival due to Flow Distribution throughout the San Joaquin Delta being even more favorable than in Alternative 2 (Table 3). These changes would improve conditions both for adults migrating downstream and for young rearing in the Delta and migrating downstream.

QUESTIONS

5. Which population or life stages are most sensitive to diversion effects under no action and Alternatives 1, 2, and 3? When and where are they most affected?

Under the No Action Alternative, the San Joaquin basin chinook would be more vulnerable to effects of diversions from the south Delta than Sacramento chinook. All San Joaquin chinook migrate through the south Delta, where they are highly susceptible to direct entrainment, predation in Clifton Court Forebay, and reduced survival associated with unfavorable flow distribution in the southern and a much smaller proportion of the population of Sacramento chinook are affected by diversions from the south Delta.

Under Alternative 1, San Joaquin and Sacramento chinook Entrainment Losses would be reduced by elimination of Clifton Court Forebay predation, although the altered flow distribution still would affect San Joaquin and Sacramento chinook through prolonged exposure to a variety of mortality sources in the Delta.

Under Alternative 2, the entire population of Sacramento chinook would emigrate past Hood and thus would be exposed to a screened diversion at Hood and to reductions in flow in the Sacramento River downstream from Hood. The San Joaquin and Sacramento chinook that would emigrate through the interior Delta would still be affected by changes in interior-Delta hydrodynamics, although to a lesser degree than in Alternative 1, because of the increased frequency of net downstream flows below the mouth of the Mokelumne River. An effect unique to Alternative 2 would be that adult salmon returning to the Sacramento basin that have been attracted to the Mokelumne River portion of the Delta would be affected adversely due to delays in migration and other impacts at whatever fish passage facility would be constructed at Hood to return these salmon to the Sacramento River.

Under Alternative 3, San Joaquin chinook would benefit from restored flow distribution patterns in the south and central Delta, reduced pumping, and improved screens in the south Delta. Sacramento chinook would still be adversely affected by reduced flows in the Sacramento River. The effect of altered flow distribution on the survival of salmon that enter the interior Delta would be better than for Alternatives 1 or 2.

Juvenile chinook are considered to be at greatest risk to diversion effects due to their need to find their way through the Delta to the ocean. Yearlings and smolts are considered more subject to diversion effects than rearing fry, because they are actively migrating. Fry rearing in the Delta are important to salmon production, especially in wet years, and their survival depends on conditions over a several month period prior to their migrating to the ocean as smolts. During their emigration, they are presumably just as subject to diversion effects as smolts entering the Delta after rearing in upstream areas.

2. Can diversion effects in the South Delta be offset by habitat improvements and other common program actions?

Modest benefits for juvenile chinook were estimated due to enhanced food supply and physiological condition, reduced toxicity, reduced entrainment in small diversions, and more extensive rearing and escape habitat associated with the ERP element of the Common Programs. Considerable uncertainty surrounds how the ERP will be implemented and thus the magnitude of associated benefits. The presumed benefit for salmon from improvement or type conversion of existing habitat is proportionally modest. If the ERP emphasized improving habitat along migration corridors for salmon, benefits would be greater than estimated in this analysis. Increased flows in March and May in the Sacramento River and in May in the San Joaquin River provided by the ERP would provide a minor improvement in chinook survival in the Delta, in addition to the benefits that would be expected upstream of the Delta. Overall, we concluded that the common programs would not provide enough benefits in the Delta to offset fully diversion effects.

The subcommittee did not attempt to estimate benefits to salmon from the Water Quality Program.

3. To what extent can Alternatives 1, 2 and 3 offset diversion effects as presently configured?

   Our answer to question 1 answers this question as well.

4. To what extent can diversion effects be offset by modifications to the Alternatives or by operational changes?

   The subcommittee has not addressed this question.

5. What is the risk and chances of success of species recovery for each alternative?

The probability for recovery depends on conditions throughout the life history of salmon. Because the subcommittee considered only needs of young and adults in the Delta, the following answers only partially address the question of recovery.

No Action- The No Action scenario continues to rely on closure of the Delta Cross Channel gates from November through June to improve the survival of salmon migrating down the Sacramento River. This has a high risk of conflict with water supply operations during low flow periods.

The ongoing efforts of the Ops Group to improve salmon survival under Existing Conditions in the face of limited operational flexibility indicates that very little “recovery” potential would exist under the No Action scenario.

Common Programs- See the answer to Question 2.

Alternative 1- As with the No Action scenario, reliance on closure of the Delta Cross Channel gates would continue.

Experience with fish screen operations in the south Delta indicate a high probability that the benefits expected from improved fish screens would be achieved. Such benefits are limited by the need for continued handling and trucking, but experimental evidence indicates this is less of a risk for salmon than for many other species.

Alternative 1 includes measures such as the Water Use Efficiency and Water Transfer programs, which would somewhat increase flexibility in water supply operations. Thus Alternative 1 offers some potential for shifting diversions to times less detrimental to salmon, but such shifts would be likely to increase impacts on other species, would sometimes interfere with water supply benefits, and probably would not be sufficient to cause major improvements in salmon production.

Overall, Alternative 1 is not likely to result in significant increases in survival for salmon from the Sacramento system.

For the San Joaquin, Alternative 1 would increase salmon survival somewhat, due to the improved structure and location of the fish screens.

Alternative 2- Risks for new screens in the south Delta are the same as described for Alternative 1. Several new risks for salmon from the Sacramento system are inherent in Alternative 2 associated with the diversion at Hood. One is the fish screens themselves. Advances in fish screen design provide good evidence that a successful screen can be built, but all large fish screens have inherent risks. Even the best screen would increase the risk for salmon from the Sacramento system, due to the greater exposure of the population to the screen. Also, the screen and the pumping plant that would accompany it would pose a new risk for adults migrating upstream. Finally, the diversion would reduce flows in the Sacramento River below Hood. The subcommittee recognized considerable uncertainty in the consequences of that reduction, based both on questions about evidence of the effects on survival and about the magnitude of flow reductions that would occur over the range of operating conditions. The subcommittee, however, believes that Alternative 2 would pose risks for salmon from the Sacramento system greater than any other alternative. For salmon from the San Joaquin, Alternative 2 would be intermediate between Alternatives 1 and 3.

Alternative 3- San Joaquin basin chinook have the greatest potential to benefit from Alternative 3, but the improvement may not ensure "recovery". Flows at Vernalis are strongly correlated to population levels of San Joaquin salmon, and although the Alternatives would improve San Joaquin flows as a result of ERP flows and VAMP, the improvements in survival are expected to be small.

The benefits that are most certain are the reduction in entrainment losses associated with the large reduction in diversions from the south Delta. Those benefits would be greatest for San Joaquin stocks and for those smolts diverted into the central Delta from the Sacramento River via Georgiana Slough.

Alternative 3 would not have the risk for upstream migrants that Alternative 2 would have because there are no attraction flows for adults in the central Delta. Other risks of the Hood diversion would be essentially the same as those described for Alternative 2.

6. What increment of protection or improvement for fish species will be provided by other programs such as the CVPIA, biological opinions?

The increment of improvement for the various programs is difficult to quantify, but if most of the actions contained within the Anadromous Fish Restoration Plan are implemented, substantial improvement should be achieved. The CALFED program, as it is proposed, would include restoration elements not included in CVPIA and the Winter Run and Delta Smelt

Biological Opinions.

7. What degree of benefit and impact will the common programs provide?

We estimated that improvement would occur with the common programs. Much of the benefit predicted is due to the creation of additional shallow water habitat of several different types. The effect on salmon is uncertain, largely due to the scarcity of evidence regarding the ecological tradeoffs associated with increasing restored habitat area in an aquatic ecosystem dominated by introduced species. Salmon, particularly presmolts, are likely to use restored habitat. Although the habitat will also be favorable for predators, the increased cover and food supply will increase salmon survival in the opinion of most salmon biologists. Screening Delta diversions and improved Delta water quality are also expected to be beneficial.

8. What are the direct and indirect effects on chinook populations resulting from each Alternative and what is the expected response of the populations to these effects?

The Results section and summary tables included in this report address this question. However, the subcommittee is concerned that some readers may focus on the summarized information without appreciating the imprecision and uncertainties involved. The numbers in the summary tables should be interpreted carefully and are most appropriately used to support broad generalizations such as those offered after the summaries. Imprecision and uncertainty are involved throughout, and the subcommittee is particularly concerned with Flow Below Hood and Interior-Delta Survival. We did not have adequate time to explore and cite the available evidence to the degree that we would have liked, and even if we had, considerable uncertainty would remain as to both the magnitude of effects and the controlling mechanisms.

The annual sums are useful for gross comparisons among scenarios, but the monthly evaluations are essential for more fully understanding the scenarios and formulating alternative operations.

A summary for the Sacramento system (Table 1) is that compared to Existing Conditions the Common Programs would provide a substantial benefit, but some negative consequences would persist. With Alternatives 1 and 3, approximately the same net magnitude of consequences would persist as with the Common Programs, but for quite different reasons. For Alternative 1 there would be little change from the Common Programs for any category of parameters, and for Alternative 3, our estimate of improvements in Interior-Delta Survival would be offset by detriments from flow reductions below Hood. For both Alternatives 2 and 3, the consequences of flow reductions below Hood would vary considerably depending on the magnitude of flow. In high flow periods, effects might be inconsequential, but in low flow periods, survival would probably be less than the approximation of the overall average included in the summary.

A summary for the San Joaquin system (Table 2) is that compared to Existing Conditions the Common Programs would provide benefits similar to those provided for the Sacramento system. As in the Sacramento system, Alternative 1 would provide little change from the Common Programs. For Alternatives 2 and 3 the consequences would be quite different than for the Sacramento system. Alternative 3 would clearly be superior, and Alternative 2 would provide intermediate benefits.

Table 1

Survival indices to Chipps Island for coded wire tagged fall run smolts and late-fall run yearlings released at Ryde and in Georgiana Slough between 1992 and 1996.

Fall run

Date	Ryde	Georgiana Slough	Ratio (GS/R)
4/6/92	1.36	0.42	0.30
4/14/92	2.14	0.73	0.34
4/27/92	1.67	0.20	0.12
4/14/93	0.41	0.13	0.31
5/10/93	0.86	0.29	0.33
4/12/94	0.20	0.06	0.30
4/25/94	0.18	0.11	0.61
		Mean =	0.33

Late fall

Date	Ryde	Georgiana Slough	Ratio (GS/R)
12/2/93	1.91	0.28	0.14
12/5/94	0.57	0.16	0.28
1/4/95	0.33	0.12	0.36
1/10/96	0.66	0.17	0.25
1/13/98*	0.90	0.24	0.27
12/4/97*	0.70	0.03	0.04
		Mean =	0.22

* Preliminary data

Table 2

Summary of matrices evaluating the effects in the Delta on chinook salmon from the Sacramento River basin. Alternatives 1, 2, and 3 were evaluated without any new storage and with maximum new storage contemplated by CALFED (results are presented: without/with).

Effects	Existing	No Action	Common	Alt. 1	Alt. 2	Alt. 3
Entrainment Losses	-5	-6	-6	-4 / -5	-7 / -8	-6 / -7
Flow below Hood	-6	-6	-4	-4	-28	-28
Interior-Delta Survival	-30	-32	-25	-25 / -31	-7 / -12	0
Shallow water habitat, food supply & ag diversion screens	-3	-3	+10	+10	+10	+10
Upstream migration of adult salmon	0	0	0	0	-19	0
Total	-44	-47	-25	-23 / -30	-51 / -57	-24 / -25
Change from existing conditions		-3	+19	+21 /+14	-7 / -13	+20 /+19
Change from Common Programs				+2 / -5	-26 / -32	+1 / 0

Table 3
Summary of matrices evaluating the effects in the Delta on chinook salmon from the San Joaquin River basin. Alternatives 1, 2, and 3 were evaluated without any new storage and with maximum new storage contemplated by CALFED (results are presented: without/with).

Effects	Existing	No Action	Common	Alt. 1	Alt. 2	Alt. 3
Entrainment Losses	-12	-13	-13	-7 / -10	-7 / -10	-2 / -2
Vernalis flow	-18	-18	-17	-17	-17	-17
Interior-Delta Survival	-23	-25	-19	-19 / -22	-2 / -5	+14 /+14
Shallow water habitat, food supply & ag diversion screens	-3	-3	+8	+8	+8	+8
Total	-56	-59	-41	-35 / -41	-18 / -24	+3 / +3
Change from existing conditions		-3	+15	+21 /+15	+38 /+32	+59 /+59
Change from Common Programs				+6 / 0	+23 /+17	+44 /+44

DIVERSION EFFECTS ON FISH

APPENDIX B

CALFED ALTERNATIVE EVALUATION FOR STRIPED BASS

CALFED ALTERNATIVE EVALUATION FOR STRIPED BASS NARRATIVE

Draft - June 23, 1998

Introduction-Evaluation Team and Process:

The CALFED task of evaluating diversion effects on fish was divided into species subcommittees. The striped bass subgroup met twice and evaluated the diversion impacts of the alternatives based on information provided in the CALFED Phase II report and recent operation studies.

The striped bass evaluation is based on a review by biologists with knowledge of the striped bass population and historic relationships of egg and larva distribution and abundance, young-of-the-year abundance, and adults in relation to estuarine conditions and historic changes. Participants on the work team are Stephani Spaar (Department of Water Resources), David Kohlhorst, Lee Miller, Kevan Urquhart, and Don Stevens (Department of Fish and Game). Elise Holland (Bay Institute) was a member of our team but was unable to attend the meetings when the matrices of diversion effects were developed. This report is the result of the interactions of this group.

Methods:

We completed matrices (pages B10-B17) for: existing conditions, no action conditions (projection of increased demand on existing facilities), common programs, diversion alternatives 1, 2, and 3 and full restoration. The matrices were used as a guide and checklist to assure our consideration of the relevant diversion issues. We adopted a scale of -5 to +5 to express the relative impact of effects identified in the matrix as major components that would affect striped bass in relation to water diversions. Evaluations were based on qualitative assessments of the degree to which operations affect the population. We used two CALFED operations draft studies to evaluate future operations (CALFED 1998). Entrainment impacts included predation in Clifton Court, losses related to screen inefficiencies, handling and release site mortality. However, these were not separately scored but were included in our evaluation. After the matrix scoring was completed, we assigned relative weight factors to each component of the matrix. We also limited the fall-winter periods to combinations of months which became self-weighting in the process since striped bass during these periods generally tend to be less vulnerable to diversions.

Existing conditions are the diversions as operated currently with the 1995 Water Quality Control Plan Delta Standards in effect. An evaluation of full restoration conditions relative to the existing conditions and alternative choices was made to assess the extent to which the striped bass population would be restored with the proposed alternatives. All matrices were completed using the CALFED operations studies provided. This was a judgmental process with no striped bass modeling, data analysis, or quantitative assessments because time constraints did not permit more rigor. In many cases we cannot be certain how the population might respond to the new conditions being proposed.

Results

The following questions were evaluated.

1. Which life stages are most sensitive to diversion effects under no action and alternatives 1, 2, and 3? When and where are they most affected?

Existing Conditions

Diversions in the Delta have had a major impact on the striped bass population whose nursery area historically has been the Delta and Suisun Bay. (Chadwick et al. 1977, Stevens, et al. 1985, IESP 1987, Department of Fish and Game 1992). The decline in both the young of the year (YOY) measure of abundance (38 mm index) and adults have been linked to the effects of entrainment losses in the Delta. Diversion effects on striped bass and other fish were empirically demonstrated in 1977, a severe drought year, when flows were so low that export pumping was minimal or ceased for much of the year because of water quality problems related to low freshwater inflow. As a result there was an accumulation of striped bass in the Delta made evident by the large number of striped bass salvaged when export pumping did resume when Delta inflow increased in December. Such accumulations of fish in the Delta were not evident in either 1976 or 1978, years when export pumping was not curtailed in the summer (Table 1).

Table 1. Export pumping rates and delta smelt and striped bass salvage by the State Water Project (SWP) in 1976, 1977 and 1978. Data prepared for CALFED by H. K.Chadwick 1998.

	1976-1977			1977-1978			1978-1979		
	SWP Pumping- 00's cfs	Delta smelt 000's	striped Bass 000's	SWP Pumping 00's cfs	Delta Smelt 000's	Striped Bass 000's	SWP Pumping -00's cfs	Delta Smelt 000's	Striped Bass 000's
May	6	102	16	11	3	0	9	4	1
June	3	277	717	3	3	53	33	36	633
July	3	371	639	3	43	367	34	1	1,115
Aug	21	68	156	2	6	12	40	2	307
Sept	35	1	13	2	18	1	35	0	18
Oct	14	0	2	1	3	0	20	0	173
Nov	16	0	32	9	0	22	22	0	171
Dec	10	0	20	22	55	63	27	1	172
Jan	33	7	58	60	134	590	13	0	34
Feb	19	2	10	61	54	306	16	1	8

More recent analyses also support these findings. Recently Kimmerer, et al. manuscript, suggests that density-dependent survival may moderate the effects of flows and diversions on year class strength. While relative year class strength often changes between YOY and recruitment at age 3, density-dependent survival does not fully compensate for lower numbers of

YOY striped bass. The adult population was 1.8 million in early 1970's and has declined to about 0.5 to 0.7 million in the 1990's. This decline in adults is consistent with the general declines in egg abundance and the 38-mm index of young abundance. Compensation is insufficient to offset the decline in egg production which has ranged from 319 billion in 1969, to 31 billion, in 1996. Hence, there has been an order of magnitude decline in egg production versus only a 2/3 decline in the number of adults. Kimmerer, et al., manuscript, states "the median losses to pumping were estimated at 33 percent, a substantial fraction of the total mortality and losses were often much higher."

The Oakridge National Laboratory Individual Based Model results (draft report is in preparation by Kenny Rose) indicate that diversions and food supply variables together account for the decline in striped bass. However, if only diversions were set at pre-bass decline levels in the model, the population would recover to a stable population of about 1.5 million adults which, though not the historic measured high of 1.8 million, is evidence of the importance of diversions in driving the striped bass population decline. Food by itself in the model caused only a decline to 1.5 million adults but when both food and diversions are included the population declined to 0.5 million. These model runs were made with density-dependence accounted for in the model.

Apparent adult mortality has also increased in recent years and increased ocean migrations which result in straying to other estuaries and possibly intermittent returning to this estuary to spawn has been suggested as an explanation by Bennett, ms. The decline in egg production appears to be a combination of fewer adults due to less recruitment and a greater decline in older fish due to higher mortality, although the cause of the increase in mortality is unknown.

No Action.

Striped bass eggs and larva and juveniles are the life stages directly impacted by water diversions in the Delta during the first year of life from April through the fall and sometimes during winter. The impact on eggs, larvae and young juveniles occurs from April to July with further impacts on juveniles through the summer and fall. These impacts would continue under the No Action Alternative. Total exports under the No Action Alternative during the spawning and nursery season are roughly the same as average existing conditions (CALFED 1998, Appendices A, E). Although average annual exports for this alternative are 6.5 % higher than existing exports, most of this increase occurs from August to March. The added impact on striped bass during this period tends to be relatively small in wet years and greater in dry and critical years because of longer fish residence time in the Delta when flows are low.

It is unclear whether increased exports over current levels would further deplete the population of young striped bass in the Delta, since they may already be nearly depleted there under current export levels in dry and critical years. Under current conditions the population is likely to continue to decline in the absence of a hatchery stocking program (Department of Fish and Game 1998). In recent years, young striped bass abundance has remained low despite higher than average delta outflows and low export rates, both of which are conducive to strong year classes. The most apparent cause is the continuing decline in egg production caused by average lower recruitment since the 1970's due to entrainment losses and relatively fewer, older, more fecund adults as a result of lower recruitment and an increase in adult mortality rates.

Alternative 1.

Under Alternative 1, entrainment of eggs, larvae, and juveniles in the south Delta would continue, but additional juveniles would be salvaged because of improvements in fish facilities and elimination of Clifton Court pre-screen losses. The closure of the cross channel gates through the spawning season from April to June for winter-run chinook salmon protection, would reduce the diversion of Sacramento River striped bass eggs and larvae in comparison to

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periods when the cross channel gates were open in years before the winter-run criteria went into effect. However, closing these gates may lead to greater negative flows in the San Joaquin River. As in the past, eggs and larvae would move across the Delta from the Sacramento River through Georgiana and Three-mile sloughs and some would be entrained at the export facilities.

Alternative 2.

Under Alternative 2, increased numbers of eggs and larvae would be diverted and entrained from the Sacramento River because fish screens at the Hood diversion would be inadequate to screen these stages. At the Clifton Court diversion, eggs, larvae, and juveniles would continue to be entrained; additional juveniles would be salvaged because of improvements in fish facilities and elimination of Clifton Court pre-screen losses.

However, adults would be adversely affected because they would be attracted by the high proportion of Sacramento water in the Mokelumne River and hence blocked from completing their migration by the fish screen at Hood. This problem requires a feasible means of fish passage. Apparently, it is possible to trap and pass striped bass over such structures but whether it is feasible, advisable and cost effective to move several hundred thousand striped bass around a structure in a short time, remains to be explored. If trapped adults spawn in the Mokelumne River in response to rising temperatures before they are passed around the fish screen, most of their progeny would be highly vulnerable to Delta diversions, although tidal dispersion at the junction of the San Joaquin River and Mokelumne River might enable some to escape initial entrainment. Estimates of the percentage reduction in the population of striped bass eggs and larvae in the Delta are substantial under existing conditions. Estimates of reduction in low flow years range from 73.5 to 99.6 percent (DFG 1992). Population reduction would likely increase if Sacramento River bound fish spawn in the Mokelumne River and that water goes directly to the export pumps.

It is unknown what proportion of the population might use this channel to attempt to access the Sacramento River. If flows diverted at Hood are a large proportion of the Sacramento flow, as might occur in dry years, more fish might be attracted to the Mokelumne River as a corridor to the spawning grounds. Some striped bass tagged and released in the San Joaquin River are commonly recaptured within a few weeks from the Sacramento River above Sacramento, but it is unknown which pathways from the San Joaquin River to the Sacramento River are most important.

Alternative 3.

Increased numbers of eggs and larvae could be diverted and entrained from the Sacramento River because fish screens at the Hood diversion would be inadequate to screen these stages. However, a higher proportion of the juveniles entrained would be salvaged because of improvements in fish facilities and elimination of Clifton Court pre-screen losses. The magnitude of the diversion of eggs and larvae from both the Sacramento and San Joaquin rivers, as well as eggs, larvae and juveniles from the San Joaquin, depends on operation of the facilities. For example, a temporary reduction in diversion at Hood during the striped bass spawning season would reduce diversion of eggs and larva from the Sacramento River and provide transport flow to move young bass to the nursery areas downstream. If diversions are not curtailed entrainment of egg and larva will be high and transport flows will likely be inadequate. Adult migrations would not be affected as for Alternative 2 because the facility is isolated. When diversion occurs in the south Delta, some entrainment would continue for eggs, larvae, and juveniles from the San Joaquin River and through other Delta channels. However, because QWEST flows would be improved over existing conditions and less water would be diverted from the south Delta, we expect less entrainment of striped bass and improvement of nursery habitat in the Delta.

2. Can diversion effects in the South Delta be offset by habitat improvements and other common program actions?

Striped bass can use various habitats to rear, including shallow water. Any improvements in habitat such as an increase in tidal marshes in Suisun Bay, San Pablo Bay or in other areas secure from entrainment effects could help striped bass; however, there is no way to determine, a priori, if such habitat change would offset entrainment losses and indirect mortality from transport flow reductions on the Sacramento River. As stated above, south Delta diversions have a major impact on the population so habitat improvements would need to have a large impact to offset existing conditions.

Reduction in toxicants may improve striped bass survival, but toxicants have not been identified as a major controlling factor for the striped bass population. Hence, population increases resulting from this program would likely be small.

Some common programs may adversely affect striped bass and other fish populations if nutrients and turbidity are reduced. For example, if nutrients, carbon input, and primary production are decreased this would reduce the food supply for fish. Turbidity reduction could result in increased predation on young striped bass and other fish. While these common programs are difficult to evaluate, some would likely be an improvement over existing conditions.

3. To what extent can alternatives 1, 2, and 3 offset diversions effects as presently configured?

All three alternatives screen the intake to Clifton Court Forebay which reduces predation and other losses now occurring in Clifton Court. The No Action choice would continue these losses. Screening of agriculture diversions would reduce losses of some young striped bass which are beyond the egg and larva stage.

Alternative 1.

Alternative 1 offers marginally improved conditions for striped bass compared to existing conditions by elimination of predation on young striped bass in Clifton Court Forebay. However, striped bass in the Delta would still be exposed to large potential entrainment losses due to screen inefficiencies, handling mortality, and indirect losses. This alternative maintains flows in the Sacramento River below Hood as occurs under present conditions, providing for faster transport of striped bass out of the river and into the lower river and Suisun Bay than either Alternatives 2 or 3. Striped bass survival between egg and larva stages increases with increased river flow (IESP 1994).

Alternative 2.

Because the Hood diversion would reduce transport flows for larvae, potentially result in significant numbers of adults spawning in the Mokelumne River, and entrain large numbers of eggs and larvae from the Sacramento River, this alternative would provide worse conditions for striped bass than existing diversion conditions. The extent of these impacts is uncertain given the unknowns associated with the above. How these facilities are operated to minimize impacts during the spawning season is important.

If only a few adults were blocked from migrating to the Sacramento River at Hood, Alternative 2 would likely decrease the entrainment of striped bass in the South Delta by creating more positive net flows in the San Joaquin River. Operation studies indicate that net San Joaquin

River flows at Antioch would be positive for all months of the year and in April-July would be about double the No Action conditions or conditions under Alternative 1. However, these flows are still small relative to the tidal volume. On average, reverse flows would no longer occur on the San Joaquin River (based on operations studies: QWEST, 1921-1994; Flow at Antioch, 1975-1991).

Alternative 3.

The use of Alternative 3 in lieu of existing conditions for times of the year other than the striped bass spawning period would greatly reduce the entrainment losses now occurring in the south Delta. Additionally, because it is an isolated facility, it would not attract adult fish and this obviates the need to deal with the problem of passing fish past a fish screen at Hood as in Alternative 2. The diversion of eggs and larvae during the spawning season and reduced transport flows in the Sacramento River below Hood would decrease the survival of eggs and larvae in that river reach. If the facility were operated to minimize such diversions when striped bass spawn and south Delta diversions were also minimized during the spawning and nursery period, this would provide greatly improved conditions for striped bass. Positive flows in the San Joaquin River would be good for striped bass spawning in the San Joaquin River; it would move them west to better nursery conditions and away from entrainment and improve the Delta as nursery habitat for striped bass. This alternative scored highest in the matrix exercise.

5. What is the risk and chances of success of species recovery for each alternative?

The striped bass population has been declining. The adult population is affected by reduced recruitment as a result of early life stage losses without sufficient density-dependent survival (compensation) to maintain the numbers of adults that were historically present. Although some compensation is apparently occurring between the summer abundance in the first year of life and recruitment at age 3, the population of adults, which numbered 1.8 million in the early 1970's, has declined to about 700,000 presently. Recovery cannot occur under the No Action Alternative. Alternatives 1 and 2 appear to exacerbate present striped bass population stresses related to using the Delta as a water export conduit. Alternative 3 still falls short of full restoration to historic population levels (see Appendix matrix, page 8), largely because water demands exclude achievement of full restoration conditions. Alternative 3, if operated in a manner which minimized entrainment of young striped bass, provides the best opportunity for some restoration of the population.

6. What increment of protection or improvement for fish species will be provided by other programs such as the Central Valley Project Improvement Act(CVPIA), biological opinions, etc.?

This is difficult to evaluate since no water has been firmly committed to any striped bass restoration scenario. It is unlikely that the 800,000 acre feet of water allocated under the CVPIA doubling of anadromous fish will cause a doubling of striped bass given the existing export conditions and diversion impacts.

7. What degree of benefit and impact will the common programs provide?

The common programs will likely provide some benefits for young striped bass, but these are difficult to evaluate. Screening of small Agricultural diversions would reduce mortality of young striped bass. Planned increases in the amount of tidal marsh habitat for nursery areas adjacent to Suisun Bay and San Pablo Bay could increase survival of young striped bass. Reducing point and non-point sources of toxic chemicals and metals could improve conditions for all life stages to some degree, however, present population effects of toxicants have not been demonstrated. Reduction of organic input and decreasing turbidity may adversely affect striped bass production.

8. What are the direct and indirect effects on fish populations resulting from each alternative and what is the expected response of the populations to these effects?
Covered in answers to questions 1-6.

9. What Sacramento River flow is required below a Hood diversion to protect salmon, striped bass and delta smelt?
Transport flows to move striped bass into the estuary are important. When large numbers of striped bass eggs and larvae are moving down the Sacramento River, diversion should stop or be minimized to reduce the impact of entrainment and to assure sufficient transport flow to promote the survival of larvae. We recommend that flows be maintained at a high enough level to transport eggs to Collinsville to Rio Vista reach of the river within 4 days after passing Hood. Reduction of flows below Hood to less than what now occurs when I street flows are 13,000 cfs or greater would be detrimental to young striped bass.

10. What survival rate can be expected for striped bass eggs and larvae and delta smelt passing through Sacramento River screens and pumps in Alternative 2?
We would expect that most striped bass eggs and larvae would be entrained with water diverted at Hood and channeled to the pumping plants; therefore, survival would be very low. Some would likely be caught in the tidal volume and move back and forth in the San Joaquin River and of these some might avoid entrainment by moving beyond the influence of the pumps, depending on San Joaquin River net flows and dispersion in the lower San Joaquin River. However, as previously indicated, net flows are low relative to the tidal volume which suggests that residence time within the influence of the pumps will be long. Modeling of the hydrodynamics might be helpful to estimating the proportion of striped bass larvae and juveniles lost to pumping.

11. Should there be a screen on the Sacramento River intake of Alternative 2?
A screen for striped bass eggs and larvae, if feasible, would likely be very expensive and difficult to maintain in a debris free state. A screen for salmon juveniles or young striped bass would also be a negative factor if it traps striped bass adults migrating through the Mokelumne River to the Sacramento River spawning grounds.

12. What are the logical stages for a preferred alternative?
Alternative 3 is the preferred alternative for striped bass. It is not clear how this could be built in stages based on biological considerations.

Uncertainties

There are many uncertainties in this evaluation, both large and small. Even with further data exploration, there is much that would remain speculative in our assessment of potential benefits and detriments. First, there is the uncertainty regarding how much striped bass entrainment losses will be reduced and access to nursery areas enhanced with positive downstream flows rather than reverse flows in the lower San Joaquin River. Similarly, when Sacramento River flows necessary for larva transport are greatly reduced below Hood, how much will this affect the survival of striped bass left in the river? At this location, transport flows obviously become more important in years of low inflow. The proportion of the adults that would use the Mokelumne River as a migration corridor to the Sacramento River spawning ground is unknown. If that proportion is small, it will have a minor effect, but if it is large, it will have a major negative impact.

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DIVERSION EFFECTS ON FISH

APPENDIX C

CALFED ALTERNATIVE EVALUATION FOR DELTA SMELT

DIVERSION EFFECTS ON FISH

CALFED ALTERNATIVE EVALUATION FOR DELTA SMELT
NARRATIVE

Draft - June 12, 1998

The delta smelt team consists of Michael Thabault, U.S. Fish and Wildlife Service, Larry Brown, U.S. Bureau of Reclamation, Dale Sweetnam, Department of Fish and Game, and Chuck Hanson, State Water Contractors. Those who participated in the creation of the first draft of the matrices include Michael Thabault, Larry Brown, and Dale Sweetnam.

The scale of each matrix box (pages C24-C29) ranges from +3 to -3 which expresses the relative impact of the effects identified that would affect delta smelt in relation to water diversions. Entries were based on a qualitative discussion of the degree to which operations or proposed operations impact the delta smelt population. The values in each box represent the combination of two estimates on the part of the Team: 1) the potential effect on the delta smelt population if exposure occurs, and 2) the probability that the population will be exposed. Therefore, caution should be used in interpretation of the matrix values. For example, exposure to toxicants includes the likelihood that fish will be exposed in addition to a judgement on the possible effects to the individuals that experience the exposure.

The delta smelt matrices were divided into "wet years" and "dry years" because distribution is strongly tied to hydrologic conditions and the effects (positive or negative) of potential actions in the delta potentially would be dampened in "wet years". The differences between the magnitude of the effects in wet and dry years is discussed in the narrative.

Definitions and Assumptions

Entrainment: Entrainment is defined as the direct effects of entrainment of delta smelt at the Cenral Valley Project and State Water Project pumping plants. Agricultural diversions are treated separately below. Consideration of other large diversions was not included in the charge to the group. Also, such consideration would require documentation and model runs for any changes in operation considered as part of CALFED or possible interactions of present operations with changes in Delta conditions that would result from the CALFED alternatives. The direct effects considered are: 1) entrainment and loss through export; 2) predation in Clifton Court Forebay and any other predation related to screens; and 3) losses due to handling of fish at fish salvage facilities. The entrainment score represents an overall effect of the three factors. The matrix includes rows for the three factors but the three rows may not necessarily add up to the total effect score assigned to entrainment. The extra scores are meant to indicate the relative importance of the various factors included in entrainment**.**

Hydrodynamics: Hydrodynamics is defined to include the indirect effects of holding delta smelt in the interior Delta longer than would occur under more natural flow conditions. We assumed that the mortality rate in the interior Delta is higher than that in Suisun Bay, where most juvenile rearing occurs. Thus, the effect does not imply changes in mortality rates but differing durations of exposure to different mortality rates. The higher mortality rate was presumed to occur through longer exposure of delta smelt to undefined mortalities that occur in the central Delta. These sources of mortality could include predation by species common in the Delta such as largemouth bass and silversides, differences in water quality, or differences in food production and availability in different areas. The Team recognizes that this assumption is based on sparse data but the view is consistent with the existing view of delta smelt ecology (Moyle et al. 1992, U.S. Fish and Wildlife Service 1995a,b). The environmental cues delta smelt use to migrate to Suisun Bay (assuming active rather than passive transport) are unknown but the simplest assumption is that they can detect or use the net direction of water movement in combination with tidal flux to choose a migration path. If this process is correct, delta smelt could be transported, either actively or passively, in the direction of the net flows described in the modeling runs that form the basis of the assessment. The effects of hydrodynamics were assessed by explicitly considering the following geographic locations identified in modeling runs: 1) cross Delta flow; 2) Qwest; 3) Old River @ Bacon Island; 4) Sacramento River at Rio Vista; 5) San Joaquin River at Antioch.

Predation: Predation includes all predation other than that occuring in Clifton Court Forebay and in front of screens.

Handling: Handling losses are included in entrainment. Handling is associated with a very high level of mortality given the delicate nature of delta smelt.

Food supply: Recent studies of delta smelt feeding indicate that the availability of appropriate food types may be very important at certain points in the delta smelt life cycle and for overall survival (Nobriga 1998, Lott and Nobriga, in prep.). Food supply summarizes the best guess of the team as to the effects certain actions will have on availability of food to the population.

Shallow-water habitat: Assessments of shallow-water habitat are based on possible effects on spawning habitat and food supply. The Team assumes that the majority of shallow-water habitat rehabilitation will involve perennial tidal marsh located in the interior Delta. Nothing definitive is known about the need of delta smelt for perennial tidal marsh habitat. This type of habitat is known to be used for spawning but it is unclear if spawning habitat is limited under present conditions. There is no compelling evidence that this habitat is used as rearing habitat. Past assessments of delta smelt ecology suggest that shoal habitat is important in Suisun Bay (Moyle et al. 1992, U.S. Fish and Wildlife Service 1995a,b) indicating that rehabilitation of shoal habitat in the western Delta might provide some benefit. However, ongoing studies of delta smelt habitat use suggest that larval and juvenile delta smelt are not selecting the shallow (<3m) edges of the channels compared to the deeper mid-channel areas (Sweetnam, unpublished data). Given the uncertainty in location and types of habitats to be rehabilitated and the benefit of shallow-water habitat as rearing habitat, shallow-water rearing habitat was not considered in the assessment.

Water quality (temperature): The Team believed that none of the alternatives would have a major effect on in-Delta water temperatures. This row was scored 0 through all matrices; therefore it was omitted from the matrices.

Salinity/X2 (originally called Water quality (salinity)): For delta smelt, the original "Water quality (salinity)" row was changed to Salinity/X2. We believe this better defines the variable of interest for delta smelt.

Agricultural diversions: The Team assumed an aggressive program of screening and consolidation of in-Delta agricultural diversions. Screen design was assumed to have some benefit for various life stages of delta smelt

Sources of uncertainty

The Team identified many sources of uncertainty. New data addressing. The major areas are identified below. Additional text is provided in the narrative for each of the alternatives.

We do not know the absolute size of the delta smelt population. All effects are based on sampling data from the various existing monitoring programs, including: 1) mid-channel vs. shallows larval sampling; 2) the 20-mm estuary-wide juvenile survey (includes flooded tracts); 3) Real-time Monitoring Program; 4) midwater trawling; 5) kodiak trawling; and 6) fish salvage at the state and federal pumping plants. The Team considered all of these relevant programs to minimize any bias that might result from considering data from any single sampling method or sampling design.

Screening criteria for both large project screens and smaller agricultural screens are unknown. Benefits for delta smelt are assumed; however, recent behavioral studies suggest that it may be very difficult to design screens that actually benefit delta smelt to a significant degree (Swanson et al 1998). It was also assumed there was some benefit to all life stages, which may not be the case depending on final screen design.

The benefits of shallow-water habitat rehabilitation to delta smelt are unknown. Such habitat is used for spawning and may contribute to overall productivity of the system. It is not known if spawning habitat is a limiting factor for the population. Shallow-water habitat is not believed to be an important rearing habitat for delta smelt. The Team assumes that the majority of shallow-water habitat rehabilitation will involve perennial tidal marsh located in the interior Delta. Nothing definitive is known about the need of delta smelt for perennial tidal marsh habitat. There is no compelling evidence that this habitat is used as rearing habitat. Past assessments of delta smelt ecology suggest that shoal habitat is important in Suisun Bay (Moyle et al. 1992, U.S. Fish and Wildlife Service 1995a,b) indicating that rehabilitation of shoal habitat in the western Delta might provide some benefit. However, ongoing studies of delta smelt habitat use suggest that larval and juvenile delta smelt are not selecting the shallow (<3m) edges of the channels compared to the deeper mid-channel areas (Sweetnam, unpublished data). Given the uncertainty in location and types of habitats to be rehabilitated and the benefit of shallow-water habitat as rearing habitat, shallow-water rearing habitat was not considered in the assessment.

We have little understanding of in-Delta predation dynamics on delta smelt.

As indicated at several points above, we have relatively little understanding of limiting factors for the delta smelt population. Recent studies suggest that availability of specific food types at specific times may be very important (Nobriga 1998, Lott and Nobriga, in prep.).

Existing Conditions

Entrainment: Entrainment values are based on historical salvage of delta smelt at the water project diversions in the South Delta. The strongest negative effects occur in the late spring/early summer when young-of-the-year delta smelt become large enough to be counted as salvage at the facilites in May, June and July. Entrainment of larval and early juvenile delta smelt < 21 mm are not counted as take at these facilities, therefore salvage data does not represent larval losses to entrainment and the peak effect might be prior to the salvage peaks observed in May or June. Screening efficiencies and pre-screening losses (e.g., predation) for delta smelt are not known so actual losses of delta smelt cannot be calculated. We assume that significant predation occurs on delta smelt entrained into Clifton Court Forebay, however it may be comparable to other species of the same size and shape (and swimming ability). The Team acknowledges that there are differences among life stages in the probability of survival to reproduction, with earlier life stages having lower probabilities but without carefully designed and implemented studies of life-stage specific mortality rates, the magnitude and importance of the differences is uncertain. The Team did qualitatively consider the relative importance of larval, juvenile, and adult effects.

Delta smelt usually do not survive the handling process, therefore the larger the potential for handling smelt, the larger the potential negative effect. Handling of delta smelt was also assumed to be proportional to entrainment effects. More delta smelt are entrained in dry years therefore the potential for handling mortality increases. Survival may also be influenced by water temperature, which would be higher in dry years.

Secondary effects of moving delta smelt out of optimal delta smelt rearing areas is covered under hydrodynamics.

The negative effects of entrainment are strongest in dry years when a larger proportion of the population is located in the delta for a longer period of time. In wet years, the population is more widely dispersed and distributed from the Delta to Suisun Bay. A second period of entrainment occurs in the late winter and early spring when pre-spawning adults move to freshwater to spawn.

Hydrodynamics: The effects of project related hydrodynamics on delta smelt occur mainly in the spring and summer months when pre-spawning adults move upstream to spawn and young-of-the-year delta smelt are present in freshwater before migrating to brackish water in the summer. The rest of the year, delta smelt are usually associated with the low salinity areas of the estuary west of the Delta, primarily Suisun and Grizzly bays. The negative effects of hydrodynamics in dry years are stronger and longer in duration than in wet years (DWR 1994, Biological assessment of ...).

Cross-Delta Flow: There may actually be some Cross-Delta flow in wet years but little effect is expected because of general high outflow conditions in wet years. In dry years, Cross-Delta flow will be [positive] larger and tend to move delta smelt spawned above the Delta Cross-Channel toward the central and southern Delta channels. The modeling studies used in this assessment use the variable Cross Delta Flow which combines flows in Georgiana Slough, the Delta Cross Channel, and Snodgrass Slough/Alternative 2 discharge. The modeling runs provided assume that the Delta Cross Channel Gates are open from 1 July to 1 November. Particle tracking results verify that Cross-Delta flow occurs through Georgiana Slough when the Cross Channel Gates are closed.

Qwest: Qwest is generally positive over the period of record so it was assumed that Qwest would be positive in wet years and there would be little effect on delta smelt. In dry years, Qwest is negative in most months and only slightly positive in the remaining months. As described earlier, the retention of delta smelt in the Delta was felt to be a significant negative effect on the population, particularly for larvae and juveniles in the spring months.

Old River @ Bacon Island: Based on the 1975-1991 period of record analyzed, flow in Old River was negative during all months. Spawning in wet years is diffuse and significant spawning can occur in the central and southern Delta. A slight negative effect was assigned in the winter because adults could be induced to spawn farther south than they would otherwise and larvae and juveniles spawned in the area would be held in the area of the pumps longer. During dry years negative flow in the area is assumed to be high. This negative flow is assumed to retain larvae and juveniles in the southern Delta and this is presumed to have a negative impact on survival. Particle-tracking model results indicate that 62% of the particles injected into Old River are exported from the pumping facilities within 20 days. This suggests that weakly swimming larvae are likely moved toward the pumps for some period of time, even if they are not directly entrained.

Sac River @ Rio Vista: Sacramento River flow is strongly positive during wet years with no effect expected on delta smelt. Sacramento River flow will be lower in dry years but this is not felt to be a major effect on the delta smelt population. Most of the negative effects are already implicitly included in the Qwest effect indicated above. In dry years, delta smelt accumulate in the Sacramento River and will be subject to the Qwest effect. The delta smelt remaining in the more upstream portion of the Sacramento River were also felt to be negatively affected, but not to the degree of the rest of the population. Current regulatory requirements in the 1995 Water Quality Control Plan limits the movement of X2 into the Sacramento River channel. The Team believed a relatively small proportion of the population used the portion of the Sacramento River above Hood for spawning in dry years.

San Joaquin River @ Antioch: San Joaquin River flows likely stay positive during all months during wet years with little effect expected on delta smelt. In dry years, flow in the San Joaquin River is dramatically reduced. Significant reverse flows occur in some months. Moyle et al. (1992) hypothesized that this is a negative effect on the delta smelt population. The negative values for this parameter indicate longer residence time in an area where survival was believed to be relatively poor. Fish in this area might also be vulnerable to moving into areas subject to the other effects described above (e.g. Old River flows).

Predation: There were two main types of predation that were considered for delta smelt: larval predation by inland silversides, and predation at structures other than screens by striped bass, largemouth bass, etc. Predation effects are diminished in wet years when the smelt population was widespread with a larger proportion out of the Delta. The potential for inland silverside predation appears to be greatest in drier years when the majority of the population spawns above the Confluence. Predation on adults was considered to be relatively low with the effect increasing in months when larvae and juveniles are present.

Food Supply: Recent studies suggest that *Eurytemora affinis* is a preferred food item of delta smelt Nobriga 1998, Lott and Nobriga in prep.). Redutions in *Eurytemora* abundance through the introduction of exotic species such as clams (*Potamocorbula*) and copepods (*Psuedodiaptomus*, *Sinocalanus*, etc.) has led to the potential for food limitation for delta smelt. Wet years provide higher levels of food production in the estuary and decrease the effects of the clam on the ecosystem.

The negative effect of exporting a proportion of the food production with withdrawal of water from the estuary was also considered. This effect was not considered important in wet years. In dry years a negative effect was assigned. The negative effect appears earlier than direct effects of entrainment because the Team felt that earlier export of primary production, nutrients, and zooplankton might have some effect on productivity later in the season, even though fish were not present.

Shallow/Nearshore Habitat: Shallow or nearshore habitat is important to delta smelt as spawning habitat. It is not believed to be as important to delta smelt as rearing habitat. It was difficult to assign a value to this for two reasons. First, while it is clear that such habitat has declined it is unkown whether spawning habitat is a limiting factor on the population. Effects were assigned during the spawning season from December through May**;** however, uncertainty with the existence and magnitude of any effect is very high. Even thought the location and amount of available spawning habitat varies between wet and dry years the team did not feel that the magnitude of the effect varied enough to warrant a change in effect especially given the level of uncertainty involved. Second, the Team also believes that shallow-water habitat may have some value as a source of nutrients and production to the channels.

Water Quality (Temperature): Delta water temperatures are not controlled by water project operations. As water temperatures increase in the delta, delta smelt are thought to move to cooler portions of the estuary, therefore the delta smelt team decided that there was “no effect” of temperature on delta smelt for either water year type.

Water Quality (Salinity/ X2 Position): The delta smelt team decided that the effects of salinity on delta smelt are best described by the relationship between delta smelt abundance and X2 position. Delta smelt are most abundant when X2 is located in Suisun Bay in the spring. Although the relationship is somewhat weak, it does explain a statistically significant proportion of the variance (about 20%). However, much of the variability in the delta smelt population is unaccounted for by X2 alone. Maintenance of X2 position is mainly dependent on freshwater inflow to the estuary. In wet years, the salinity gradient has little effect on delta smelt except in the summer months when outflow declines and the gradient moves upstream into the Delta. In dry years, the effects of salinity may be much longer and last from February through November. The months of February through April were given positive effects in order to reflect export limitations and X2 flow requirements under the 1995 Water Quality Control Plan.

Agricultural Diversions: There are over 1800 agricultural diversions in the delta, which at times in the summer may export a similar magnitude of water as the export facilities in the south delta. Additional agricultural diversions in Suisun Marsh have the ability to entrain delta smelt when the population is located farther downstream in Suisun Bay. Not only do these exports have the potential to entrain larval and juvenile fishes, plankton and nutrients are also diverted. There may be agricultural diversion effects on delta smelt year round in different areas of the estuary, however the majority of impact would be at high levels of diversion in the spring and summer.

No Action Conditions

Entrainment: Based on modeling runs the majority of the increased diversions resulting from the 2020 level of demand would occur in December-March and July-August. The largest increases in exports (resulting in higher levels of entrainment) occur in February and March in wet years, and December-March in dry years. During this period, pre-spawning adults might be entrained at higher rates. The July increase in wet years was given a greater effect because young-of-year delta smelt are more likely to be in the area at that time compared to August.

Hydrodynamics: Changes in hydrology based on the increased level of demand are similar to existing conditions with increases in negative effects observed throughout the winter and spring. The magnitude of the effect might be greater in wet years since additional water would be available to be exported in the spring. Negative effects were lessened in April of both year types for export constraints already in place. The reduction did not carry through May because protections are curtailed while large numbers of young smelt are still present. San Joaquin River at Antioch appeared slightly worse in December and January, which may have an effect on adult delta smelt staging to move into the Delta.

Predation: No change from existing conditions for wet years with no additional effect. In dry years there is the potential for increased effects in the winter when additional water is exported; however, no changes in scores were made.

Handling: No change from existing conditions for wet years with no additional effect. In dry years there is the potential for increased effects in the winter when additional water is exported; however, no changes in scores were made.

Food Supply: With increased exports in the winter, higher levels of primary production and zooplankton are also exported. The team decided that this additional effect would be observed in December and January.

Shallow/Nearshore Habitat: The increased level of demand in the No Action Alternative would not change the amount or effect of shallow/nearshore habitat.

Water Quality (Temperature): No change from existing conditions.

Salinity/ X2 Position: According to the modeling runs available, there is little discernible difference in X2 position between the existing and no action conditions. The numbers in the matrix reflect these numbers. (For the consideration of the group our original comments were: With increased exports in the winter and early spring, there might be additional effects on habitat conditions in the spring. In wet years, these effects may be observed in January and February if rainfall occurs later in the spring. In dry years the effect may be observed from December through March. Our original comments were based on extrapolations from total Delta outflow.)

Agricultural Diversions: Unless there is same change in demand, no change in existing conditions is anticipated.

Common Programs

Entrainment: The Common programs do not address this issue.

Hydrodynamics: The Common programs do not address this issue.

Predation: The Common programs do not address this issue.

Handling: The Common programs do not address this issue.

Food Supply: Restoration programs and increases in Shallow/nearshore habitat may lead to increases in primary production, which may be a benefit year round.

Shallow/Nearshore Habitat: Additional shallow/nearshore habitat may benefit delta smelt in terms of spawning habitat. Shallow water areas as nursery habitat do not appear to be that important to delta smelt. This benefit is uncertain because there is no evidence that shallow/nearshore habitat is a limiting factor on the population.

Water Quality (Temperature): Common programs may affect the temperature of water coming into the Delta but no in-Delta change is anticipated.

Salinity/ X2 Position: The Common programs do not address this issue.

Agricultural Diversions: There is a net benefit of screening for delta smelt, which may be observed throughout the entire year. The largest magnitude of a positive benefit of screening would be observed in months when delta smelt are in close proximity to agricultural diversions and demand is high. This assumes that screening criteria and diversion consolidation can be designed to minimize effects on all life stages of delta smelt. Benefits will have to be adjusted if only certain life stages are benefited. This benefit includes screening and consolidation in Suisun Marsh.

Alternative 1

Alternative 1 was assumed to be the result of the benefits of the common programs above the existing conditions added to the No Action Alternative (expressed as Alt 1 = (Common Programs - Existing Conditions) + NA). See the text for the No Action alternative for explanations of factors.

Entrainment:

Hydrodynamics:

Predation:

Handling:

Food Supply:

Shallow/Nearshore Habitat:

Water Quality (Temperature):

Water Quality (Salinity/ X2 Position):

Agricultural Diversions:

Alternative 2

Entrainment: Increased exports from the southern Delta in December through March in all years were assigned a large negative effect because of the size of the increase (about 3,000 cfs). A similar large increase occurred in July and August.

Less effect was assigned to direct entrainment at the times of the year when delta smelt would be large enough for effective screening, if screens with the correct criteria can be designed. Additional negative effects were assigned to handling because screened fish will have to pass through a bypass system. Clifton Court Forebay predation effects are now defined as taking place in front of the screens rather than in the Forebay proper. The greater effect in dry years results from a larger proportion of the population experiencing the effects.

Hydrodynamics: In wet years, modeling results indicate improvements in Qwest; however, Cross-Delta flows and Flows at Old River @ Bacon Island get worse. These negative effects outweigh the improvement in Qwest. In dry years, the negative effects are magnified, especially for Cross-Delta flow and Old River at Bacon Island. Reductions in flow of the Sacramento River were also assigned a negative value. Qwest remained favorable, except for June, July and August, when slight negative effects were assigned. Conditions in the San Joaquin River at Antioch remained favorable all year. The large negative effect of Alternative 2 is linked not only to hydrodynamic changes but to interactions with the physical changes as well. The Team believes that with this alternative any net production of delta smelt to the east of the "new" canal would be completely lost. It also seemed possible that young-of-year produced to the west of the new canal could be at risk if tidal action periodically moves young-of year in and out of the areas influenced by the new canal. It seems likely that hydrodynamic effects of east-west (more or less) tides on the water moving north-south (more or less) in the canal will be complex and difficult or impossible to model with existing tools.

Predation: No change from Alternative 1.

Food Supply: No change from Alternative 1.

Shallow/Nearshore Habitat: The possible benefits of shallow/nearshore habitat were reduced because strong Cross-Delta flows would reduce the value of such habitat within the influence of the diverted water.

Salinity/ X2 Position: No change from Alternative 1.

Agricultural Diversions: No change from Alternative 1.

Alternative 3

Entrainment: The isolated facility reduces entrainment effects substantially and a large positive benefit (compared to existing conditions) is assigned. Reduction in predation is assigned a similar benefit. There is still some pumping from the South Delta and some negative effect is still assigned to the fish that would go through the bypass facility.

Hydrodynamics: Alternative three improves Cross-Delta and Old River flows substantially resulting in substantial improvement for delta smelt. Positive benefits are assigned to increased San Joaquin River flows in this alternative because there is no longer any complicating interactions with Cross-Delta and Old River flows, which stay positive in all months.

In dry years positive benefit was assigned to Old River at Bacon Island because negative flows were reduced and in February-June were near zero.

Predation: Predation in the Delta declines because hydrodynamics are now favorable and fish are no longer held in the Delta for an extended period of time.

Food Supply: No major change from Alternative 1.

Shallow/Nearshore Habitat: No change from Alternative 1.

Salinity/ X2 Position:

Modeling results indicate a decrease in X2 position of roughly 2 kilometers in July and 6 kilometers in August (also 4 kilometers in September). This was given a positive benefit though it seems inconceivable to the Team that this is not a mistake. Why would Alternative 3 be operated in this way?

Agricultural Diversions: No change from Alternative 1.

Primary Issues

9. **Which species, populations, and life stages are most sensitive to diversion effects under no action and alternatives 1, 2, and 3? When and where are they most affected?**

   No Action: Larvae and young juveniles are the most sensitive life stages. These life stages are present in the spring and early summer. The major effects occur in the central and south Delta where altered hydrodynamics and entrainment are important. As delta smelt become adults, they migrate downstream to brackish water areas in the fall and winter and are considered less vulnerable to diversion effects. Pre-spawning adults migrating back into freshwater to spawn in the late winter and early spring become vulnerable to entrainment effects once again.

   Alternative 1: The same as No Action.

   Alternative 2: Larvae and young juveniles are still the most sensitive stages and are still vulnerable at the same times. The major changes in hydrodynamics anticipated with Alternative 2 are believed to be a negative factor for all life stages of delta smelt, but especially these sensitive stages. These negative effects are expected to be most severe in the eastern Delta.

   Alternative 3: Alternative 3 was given high benefit because of its positive effects on returning Delta hydrodynamics to a more "natural" condition, meaning the rivers and most channels maintain positive outflows at most times and places. Positive benefits for delta smelt may be high compared to other species because it is the only species to complete its entire life cycle in the estuary.

2. **Can diversion effects in the South Delta be offset by habitat improvements and other common program actions?**

   No, common program actions have very uncertain effects for delta smelt but it seems unlikely that the positive benefits will outweigh the entrainment and hydrodynamic effects.

3. **To what extent can alternatives 1, 2, and 3 offset diversions effects as presently configured?**

   Alternative 1: Little effect.

   Alternative 2: Makes things much worse.

   Alternative 3: Makes things better.

4. **To what extent can diversion effects be offset by modifications to the alternatives or by operational changes?**

   (Not to be answered yet)

5. What is the risk and chances of success of species recovery for each alternative?

For the delta smelt team recovery is defined in “The Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes” (Attachment 1). Alternative 1 is not a major change and probably has little influence on probability of recovery. Alternative 2 seems likely to negatively affect probability of recovery. Alternative 3 seems likely to improve the probability of recovery. All of these assessments are subject to the uncertainties already identified above.

6. What increment of protection or improvement for delta smelt will be provided by other programs such as the CVPIA, biological opinions?

The protections set forth for delta smelt under the Biological Opinion (USFWS 1995a) on the operation of the State and Federal water project diversions are similar to conditions set forth in the 1994 Water Accord and therefore are considered part of the baseline conditions known as “existing conditions” in the model runs provided.

7. What degree of benefit and impact will the common programs provide?

We estimated that improvement would occur with the common programs. Much of the benefit predicted is due to the creation of additional shallow water habitat of several different types. The effect on delta smelt is uncertain. Much of this uncertainty stems from the scarcity of evidence of the effects of increasing such habitat. Delta smelt use such habitat for spawning but it seems to be of no special importance as rearing habitat. There is no evidence that spawning habitat is a limiting factor for the delta smelt population. While the habitat will also be favorable for predators, the increased spawning habitat and possible increases in Delta primary productivity and food supply were believed to be possible benefits and were assigned benefits even though this is an area of high uncertainty. Screening Delta diversions and improved Delta water quality are also expected to be beneficial.

8. What are the direct and indirect effects on delta smelt populations resulting from each Alternative and what is the expected response of the populations to these effects?

The improvement in conditions for Alternatives 1 and 2 are purely a result of the benefits assigned to the common programs. Neither of these alternatives improves in-Delta hydrodynamics to a significant degree, and the team believes that Alternative 2 will result in hydrodynamic conditions that are significantly worse than any other alternative. Alternative 3 performs best for delta smelt because the hydrodynamic changes associated with this alternative appear likely to have positive effects on the delta smelt population in addition to the positive effects of the common programs.

A summary of our assessments suggest that Alternatives 1 and 2 will aid the delta smelt population somewhat, through improvements related to the common programs, and that Alternative 3 represents a significant improvement. However, it is unclear if the population will actually benefit to the degree anticipated in this document. Recent studies suggest that the success of the delta smelt population might be linked to timing and abundance of particular food organisms. Further, the ecology of these food organisms may be linked more to the effects of introduced predators and competitors than to the issues addressed in the alternatives. If this is actually the case, then the anticipated beneficial effects of the alternatives for delta smelt might not actually be achieved.

9. What Sacramento River flow is required below a Hood diversion to protect delta smelt?

10. What survival rate can be expected for delta smelt passing through Sacramento River screen and pumps in Alternative 2?

11. Should there be a screen on the Sacramento River intake of Alternative 2?

    Yes.

12. What are the logical stages for a preferred alternative?

13. What is the range of biological criteria that should be considered in the operations of the three alternatives?

References
(including Attachment 1)

Moyle, P.B., B. Herbold, D.E. Stevens, and L.W. Miller. 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. Transactions of the American Fisheries Society.121:67-77.

Swanson, C. P.S. Young and J.J. Cech. 1998. Swimming performance of delta smelt: maximum performance, and behavioral and kinematic limitations on swimming at submaximal velocities. Journal of Experimental Biology: 201, 333-345.

Sweetnam, D.S. and D.E. Stevens. 1993. Report to the Fish and Game Commission: a status review of the delta smelt, (*Hypomesus transpacificus*) in California. California Department of Fish and Game. Candidate Status Report 93-DS.

U.S. Fish and Wildlife Service. 1995a. Formal consultation and conference on effects of long-term operation of the Central Valley Project and the State Water Project on the threatened delta smelt, delta smelt critical habitat, and proposed threatened Sacramento splittail, March 6, 1995. U.S. Fish and Wildlife Service, Portland Oregon. 52pp.

U.S. Fish and Wildlife Service. 1995b. Sacramento-San Joaquin Delta Native Fishes Recovery Plan. U.S. Fish and Wildlife service, Portland, Oregon. 195pp.

Attachment 1

The following is the Recovery section of the Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes for delta smelt (USFWS 1995b), pages 29-34 and 37-38:

RECOVERY

Recovery Objective

The objective of this part of the Delta Native Fishes Recovery Plan is to remove delta smelt from the Federal list of threatened species through restoration of its abundance and distribution. Recovery of delta smelt should not be at the expense of other native fishes. The basic strategy for recovery is to manage the estuary in such a way that it is a better habitat for native fish in general and delta smelt in particular. Improved habitat will allow delta smelt to be widely distributed throughout the Delta and Suisun Bay, recognizing that areas of abundance change with season. Recovery of delta smelt will consist of two phases, restoration and delisting. Separate restoration and delisting periods were identified because it is possible that restoration criteria can be met fairly quickly in the absence of consecutive extreme outflow years (I. e., extremely wet or dry years). However, without the population being tested by extreme outflows there is no assurance of long-term survival for the species. Thus, restoration is defined as a return of the population to pre-decline levels, but delisting is not recommended until the population has been tested by extreme outflows. Delta smelt will be considered restored when its population dynamics and distribution pattern within the estuary are similar to those that existed in the 1967-1981 period. This period was chosen because it includes the earliest continuous data on delta smelt abundances and was a period in which populations stayed reasonably high in most years (see below for a more detailed justification). The species will be considered recovered and qualify for delisting when it goes through a five-year period that includes two sequential years of extreme outflows, one of which must be dry or critically dry. Delta smelt will be considered for delisting when the species meets recovery criteria under stressor conditions comparable to those that led to listing and mechanisms are in place that insure the species' continued existence.

Recovery Criteria

Restoration of delta smelt should be assessed when the species satisfies distributional and abundance criteria. Distributional criteria include: (1) catches of delta smelt in all zones 2 of 5 consecutive years, (2) in at least two zones in 1 of the remaining 3 years, and, (3) in at least one zone for the remaining 2 years. Abundance criteria are: delta smelt numbers or total catch must equal or exceed 239 for 2 out of 5 years and not fall below 84 for more than two years in a row. Distributional and abundance criteria can be met in different years. If abundance and distributional criteria are met for a five-year period the species will be considered restored. Delta smelt will meet the remaining recovery criteria and be considered for delisting when abundance and distributional criteria are met for a five-year period that includes two successive extreme outflow years, with one year dry or critical. Delisting is contingent on the placement of legal mechanisms and interagency agreements to manage the CVP, SWP, and other water users to meet these criteria. Both criteria depend on data collected by DFG during the FMWT, during September and October.

Justification for using FMWT numbers: The FMWT covers the entire range of delta smelt distribution and provides one of the two best measures of delta smelt abundance (Sweetnam and Stevens 1993). The summer tow-net survey samples juveniles of this annual species and provides another good measure of abundance. The FMWT provides a better measure of abundance because it samples pre-spawning adult delta smelt. An index based on pre-spawning adults, rather than on juveniles, which are vulnerable to high mortality, provides a better estimate of delta smelt stock and recruitment. The FMWT may not be as efficient at sampling delta smelt compared with the Kodiak trawl, which is pulled by two boats and tends to sample the upper water column, but it has been continuously done for almost 30 years (since 1967) and so has a solid base of historical data with known sampling error.

September and October numbers of adults were chosen, because these are the months that were sampled most consistently in all years. In addition, when delta smelt begin moving upstream to spawn in November and December, they occur less frequently in the FMWT. Weather conditions are also more stable in September and October. The more frequent storms of November and December produce conditions that result in more variability in fish-capture numbers. There is a high correlation between September and October numbers and total numbers (r= 0.93).

Number of delta smelt rather than abundance index was used for recovery criteria. The abundance index was initially developed for striped bass. Numbers were chosen because delta smelt occupy the upper water column. Multiplying delta smelt captured by volume of water in the portion of the estuary sampled probably doesn't give a good representation of the number of fish present. Using numbers for delta smelt simplifies the assumptions of the criteria and there is a close correspondence between numbers and the abundance index for delta smelt (r=0.89).

Justification for using 1967-1981 for the standard: Graphs from different surveys were used to establish pre-decline and post-decline periods for delta smelt (Moyle *et al.* 1992). The surveys included were: (1) FMWT, (2) summer tow-net, (3) Suisun Marsh fish survey, and, (4) the bay survey (Appendix A). Each of the surveys showed slightly different patterns of decline. The most noticeable trend is that delta smelt decline began earlier in the south and east Delta than in the rest of the estuary (Sweetnam and Stevens 1993). The pre-decline period identified by Moyle *et al.* (1992) is 1967 through and including 1981; the post-decline period is 1982-92. Using 1982 as the beginning of the decline period is justified because 1982 and 1983 were very wet years and declines in delta smelt abundance correspond to extremes in outflow: very wet and very dry years result in low numbers (Moyle *et al.* 1992). The mechanisms for this are that delta smelt larvae are washed downstream of favorable nursery grounds in wet years; dry years decrease spawning habitat and move adults and juveniles upstream into less productive deep river channels where they are more at risk to entrainment in water projects.

Other alternatives were proposed for the decline period. One possibility was to use 1981 as the beginning of the decline period because it was a dry year followed by the wet year 1982. The occurrence of a dry year followed by a wet year produces a double stress on delta smelt and this may have been the true beginning of the decline.

An argument can also be made for using 1983 as the beginning of the decline: this is the year that delta smelt declined in the FMWT and so is consistent with other recovery criteria (which is based on the FMWT). There is a noticeable change in geographic distribution of delta smelt in 1982 and 1983, which corresponds to the periods used in the Biological Opinion and the decline in FMWT numbers, respectively. The decline in delta smelt numbers actually occurred over a multi-year period from 1981-1983; the midpoint of this period, 1982, was used as the beginning of the decline.

Justification for including distributional recovery criteria: Geographical distribution and numbers of fish were used to measure recovery because recovery of delta smelt should include a restoration of the species to portions of their former range. Before 1982, delta smelt were captured at an average of 19 FMWT stations; after 1981 they were captured at an average of 10 stations. From 1986-1992, the delta smelt population was concentrated in the lower Sacramento River between Collinsville and Rio Vista (Sweetnam and Stevens 1993). Historically, when delta smelt were more abundant, the population was spread from Suisun Bay and Montezuma Slough through the Delta. The shallow, productive waters of Suisun Bay and Suisun Marsh are important habitat for delta smelt. Large percentages of delta smelt catches are in Suisun Bay when outflows are sufficient to maintain the mixing zone and salinities of 2-3 parts per thousand in that area. When concentrated in deep river channels due to intrusion of high salinities in Suisun Bay, delta smelt are more vulnerable to entrainment in water project facilities, predation and other risks.

FMWT stations chosen to measure recovery: Stations chosen for recovery criteria were sampled in every year (that the FMWT was conducted) and had a record of delta smelt catches. Occasionally, this was modified to include stations sampled in all years but one (stations 509, 511, 602). The total number of stations is 35 and there is a strong correlation between delta smelt at **these stations and** total numbers of delta smelt (r = 0.94).

Zone A (North Central Delta)
11 stations
802 804 806 808 810 812 814 903 904 906 908

Zone B1 (Sacramento River)
5 stations
701 703 705 707 709

Zone B2 (Montezuma Slough)
4 stations
602 604 606 608

Zone C (Suisun Bay)
15 stations
410 412 414 416 418 501 503 505 507 509 511 513 515 517 519

Distributional criteria: Distributional criteria were developed on the basis of number of stations in each zone where delta smelt were captured during the predecline period (Tables 2.2, 2.3, Figures 2.7 and 2.8). Each zone has the following criteria: (1) in Zone A, delta smelt must be captured in 2 of 11 sites; (2) in Zone B (includes B1 and B2), delta smelt must be captured in 5 of 9 sites; and (3) in Zone C, delta smelt must be captured in 6 of 15 sites. Criteria for all zones need to be met in all years. Criteria for recovery are as follows: (1) site criteria must be met in all zones 2 of 5 consecutive years, (2) in at least two zones in 1 of the remaining 3 years, and, (3) in at least one zone for the remaining 2 years. A failure in all zones in any year will result in the start of a new 5-year evaluation period for the distributional criteria. Failure to meet these criteria in consecutive years should be avoided because such conditions will place the species in danger of extinction. These distributional criteria will be met in concert with the abundance criteria.

Abundance criteria: Abundance of delta smelt constituting recovery is based on pre-decline delta smelt numbers from the FMWT (Table 2.3). Two numbers were identified that had to be met during the five-year recovery period: (1) a low number below which abundance can not fall for more than two years in a row and, (2) a high number to be reached or exceeded in two out of five years. A low number was chosen to protect delta smelt from the risk of extinction during prolonged droughts or extremes of outflow. The lowest two-year running average of abundance in the pre-decline years was used for the low number. A running average was used because of the great degree of variability in delta smelt abundance. The high number is the median of delta smelt abundance in pre-decline years, in other words, abundance of delta smelt half of the time in the pre-decline period. To meet recovery criteria, delta smelt abundance must meet or exceed 239 in two out of five years and the two-year running average must never fall below 84. If any of these conditions are not met, the five-year recovery period will start again.

Length of restoration and recovery period: Delta smelt generation time and frequency of occurrence of very dry and very wet years were used to determine appropriate length of the restoration period. Because delta smelt live only a year, a five-year recovery period would include five generations of delta smelt; five generations is comparable to the period used in recovery plans for other fishes. A five-year restoration period has a reasonable probability of including years with extreme outflow. The 40:30:30 (Footnote: Year-type categories adopted by the SWRCB in the 1991 Salinity Control Plan.) Sacramento River Indices (SRI) from 1906-1992 was used for this analysis. The goal was to identify a period that had a high probability of including two extreme outflow years, preferably back-to-back. This method was chosen because when two extreme years occur together, delta smelt are at risk of extinction. Because extremes in outflow led to the listing of the delta smelt, the period identified for recovery differs from restoration and includes a stressor period. Delta smelt will be considered for delisting when abundance and distributional criteria have been met over a five-year period that includes two sequential years of extreme outflows. However, delisting may not take place until there is reasonable assurance that long term solutions to delta problems are in place. One of the extreme years must be dry or critically dry (SRI $\leq$ 6.0); the other can be wet SRI $\geq$ 11.2). Other indices can be used to identify dry, critically dry, and wet years, if appropriate. Dry conditions are included because delta smelt losses increase in dry and critical years due to high proportions of outflow diverted, which results in habitat loss and increased entrainment in water projects. Analysis of the historical hydrograph indicated that there is about a 24 percent chance that two extreme years (one being dry or critical) will occur in a five-year period. There is a 48 percent chance (based on the historical hydrograph) that the period of time required to delist delta smelt could be 10 years. According to existing records, the longest amount of time required to delist delta smelt is 38 years.

Table 2.2 Number of sites with delta smelt from FMWT September and October numbers for 35 stations. Numbers in brackets refer to station numbers. The FMWT did not sample in 1974 and 1979. See Figure 2.8 for how minimum number of sites was determined.

	Sites		
Year	Zone C Suisun Bay (410-519)	Zone B Montezuma Slough Sacramento River (602-709)	Zone A North Central Delta (802-908)
		Pre-decline	
1967	6	8	2
1968	9	6	8
1969	11	7	0
1970	12	8	7
1971	13	8	8
1972	12	8	9
1973	9	9	4
1975	12	5	5
1976	1	5	2
1977	0	5	5
1978	11	6	0
1980	10	8	3
1981	8	6	0
Minimum number of sites	6 of 15	5 of 9	2 of 11
Number of years minimum number of sites occurred	11 out of 13	13 of 13	10 of 13
		Post-decline	
1982	6	6	1
1983	5	4	0
1984	9	3	0
1985	2	3	0
1986	10	5	1
1987	2	4	1
1988	3	3	0
1989	6	5	3
1990	4	6	0
1991	4	6	3
1992	0	5	1
1993	12	6	4
1994*	**1**	**5**	**1**
1995*	**14**	**7**	**1**
1996*	**8**	**4**	**2**
1997*	**3**	**4**	**1**
Number of years minimum number of sites occurred	7 out of 16	9 of 16	4 of 16

Table 2.3 Numbers used for delta smelt abundance criteria. Numbers are from the September and
October FMWT for 35 stations. The FMWT did not sample 1974 and 1979.

Year	Number	Two-year running average .
	Pre-decline	
1967	139	
1968	251	195
1969	128	190
1970	589	359
1971	352	471
1972	551	452
1973	305	428
1975	**239**	272
1976	22	131
1977	146	**84**
1978	108	127
1980	312	210
1981	78	195
	Post-decline	
1982	37	58
1983	17	27
1984	51	34
1985	29	40
1986	70	50
1987	72	71
1988	43	58
1989	76	60
1990	81	79
1991	171	126
1992	26	98
1993	400	213
1994*	**19**	**210**
1995*	**255**	**137**
1996*	**28**	**146**
1997*	**62**	**44****

*** - Criteria updated to 1997**
**** - Two-Year Running Average below 84 criteria**

Diversion Effects on Fish

Evaluation of a Revised Through-Delta Scenario

Prepared by the

CALFED Diversion Effects on Fish Team

September 28, 1998

EXECUTIVE OVERVIEW

An interagency/stakeholder Diversion Effects on Fish Team (DEFT) was formed to address the technical issues related to diversion impacts on fisheries for CALFED. DEFT initial task was the review and evaluation of the Phase II alternatives. The results of that review were presented in a June 25, 1998 draft report prepared by DEFT.

Upon review of that report the CALFED Policy Group asked DEFT to consider various options to improve the "through-Delta" alternatives and recommend an improved alternative that would significantly increase the likelihood for recovery of threatened and endangered Delta fish species. With that direction, the DEFT team looked at structural and operational actions that would benefit fish and potentially lead to recovery of threatened and endangered fish.

The DEFT team developed a preliminary array of actions that would improve the performance of a through-Delta alternative using criteria developed for the June 25 report. These actions plus a small array of actions developed by the CALFED Operations Group's NoName Team were combined into a new scenario and analyzed by the DEFT team. A description of the scenario and the results of the analysis are presented in this report.

As with the June report, this report and its recommendations should be interpreted cautiously, recognizing the scenario evaluated is only a starting point from which further refinements in structures and operations is possible. The scenario developed and evaluated represents an initial attempt at improving a "through-Delta" alternative and does not necessarily meet all CALFED Program objectives and principles at this time, nor does it have the full support of either the DEFT or No-Name Group or the teams' members. Also the evaluation of the scenario only involved effects on three species of fish: chinook salmon, delta smelt, and striped bass, and thus may not reflect impacts to other species.

The scenario developed includes structural and operational changes in Stage 1 that would improve chances of recovery of key Delta species.

Structural Changes:

- A new Tracy Demonstration/Testing Fish Screen and Handling Facility capable of screening 2,500 cfs at 0.2 fps through-screen velocity and 5,000 cfs at 0.4 fps through-screen velocity.

- A new Clifton Court Screen and Handling Facility at the northeast entrance to Clifton Court Forebay capable of screening 6,000 cfs at 0.2 fps through-screen velocity and 12,000 cfs at 0.4 fps through-screen.

- A new Hood Diversion Demonstration/Testing Facility on the Sacramento River capable of diverting up to 2,000 cfs from the Sacramento River to the Mokelumne River.

- A Head-of-Old-River Barrier (Gates) on the San Joaquin River at the head of Old River as described in the Interim South Delta Program (ISDP) and CALFED alternatives.

Operational Changes:

- Lower export to inflow ratios from late fall through spring and higher summer ratios than prescribed in the 1995 Water Quality Control Plan.
- VAMP program expanded from 30 to 61 days of export limitation including all of April and May.
- February to June X2 location per 1962 level of development rather than as prescribed in the 1995 Water Quality Control Plan.
- Flexible operations allowing changes in inflow, conveyance pathways, and export levels from present standards, in combination with an Environment Water Account that would allow banking of water saved.

In addition to the above actions for fish recovery, the following water supply actions being evaluated by the No-Name Group were included in the model runs evaluated by the DEFT team. These features were included in original evaluations for other alternatives and were included here to provide a consistent basis for comparisons for alternatives. The DEFT team has not evaluated or recommended these actions other then their combined effects with the above evaluated actions.

NoName Actions included in Scenario:

- Intertie between Tracy and Clifton Court.
- South Delta salinity control structures.
- Expanded Banks pumping capacity (to 10,300 cfs).
- Enlargements or dredging of Old River (South Delta) and Mokelumne (North Delta) channels.
- CVP and SWP intertie south of the Delta.
- Madera Ranch Ground Water Storage Project.

The following are the preliminary assessments of the new scenario developed by DEFT species teams.

The **salmon** team evaluated the potential for recovery of Sacramento River, San Joaquin River, and East Side streams and concluded that the new scenario provided a greater potential for recovery of these salmon populations than either Alternatives 1 or 2, or existing conditions. They also concluded that although they could not state recovery is likely, chances for recovery for all races and runs would be relatively high. Remaining concerns include hindrance of upstream migrating adult salmon in the Hood diversion, screen impacts at the Hood facility, and continued exports from the south Delta.

The **striped bass** team concluded that actions in the new scenario would likely provide greater potential for recovery than Alternatives 1 and 2, or existing conditions, and help to restore the adult population to historic levels. However, concerns remain for continuing south Delta exports, higher summer export/inflow ratios, blockage of adult striped bass within the Hood facility, greater net flows in the south Delta toward the pumping plants, and continued exports from the south Delta.

The **delta smelt** team concluded that the new scenario would improve chances of recovery over that of Alternatives 1 and 2, or existing conditions, however uncertainty associated with this evaluation is extremely high. Whereas Alternatives 1 and 2 provided moderate improvements compared to existing conditions through benefits derived from the Common Programs, the new scenario provides additional benefits in dry years beyond the Common Programs that would help the population toward recovery. Concerns remain for the potential negative effects of greater net flows in the south Delta toward the pumping plants and continued exports from the south Delta. The new screen systems in the south Delta would offer little benefit to delta smelt, unlike striped bass and salmon. Likewise the south Delta barriers of the ISDP potentially would adversely affect delta smelt by drawing more smelt from the central Delta into the south Delta. The degree of potential benefit from the new scenario would be highly variable depending on the timing and degree to which the Common Programs are implemented.

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1. INTRODUCTION

An interagency/stakeholder Diversion Effects on Fish Team (DEFT) was formed to address the technical issues related to diversion impacts on fisheries for CALFED. DEFT's initial task was the review and evaluation of the Phase II alternatives. The results of that review were presented in a June 25, 1998 draft report prepared by DEFT.

Upon review of that report the CALFED Policy Group asked DEFT to consider various options to improve the "through-Delta" alternatives and recommend an improved alternative that would significantly increase the likelihood for recovery of threatened and endangered Delta fish species. With that direction, the DEFT team looked at structural and operational actions that would benefit fish and potentially lead to recovery of threatened and endangered fish.

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As with the June report, this report and its recommendations should be interpreted cautiously, recognizing the scenario evaluated is only a starting point from which further refinements in structures and operations is possible. The scenario developed and evaluated represents an initial attempt at improving a "through-Delta" alternative and does not necessarily meet all CALFED Program objectives and principles at this time, nor does it have the full support of either the DEFT or No-Name Group or the teams' members. Also the evaluation of the scenario has only involved effects on three species of fish: chinook salmon, delta smelt, and striped bass, and thus may not reflect impacts to other species. Other important species that may be affected by changes in delta conditions, but whose responses may differ from the species analyzed here, include: green sturgeon, white sturgeon, longfin smelt, Sacramento splittail, and American shad. CALFED may need to develop a future analysis to address these species.

This report presents progress toward developing an improved through-Delta alternative and should not be considered anything other than an initial attempt at an improved alternative. Efforts continue at evaluating and revising actions. This report summarizes the DEFT organization, the evaluation process, and the tentative conclusions reached by the species teams and the full DEFT.

Team Organization

Members of the DEFT are listed below under the species team on which they primarily served. Some participated in several teams. Several people contributed to the species teams that are not on the DEFT. They are identified with an (*).

Salmon team

Patricia Brandes (co-chair), U.S. Fish and Wildlife Service
Shelia Greene (co-chair), Department of Water Resources
Serge Birk, Central Valley Project Water Association
Pete Chadwick, Department of Fish and Game
Karl Halupka, U.S. National Marine Fisheries Service
Jim White, Department of Fish and Game
Joe Miyamoto, East Bay Municiple Utilities District
*Jim Starr, Department of Fish and Game
Striped Bass Team
Lee Miller (chair), Department of Fish and Game
*Stephani Spaar, Department of Water Resources
*David Kohlhorst, Department of Fish and Game
Kevan Urquhart, Department of Fish and Game
*Don Stevens, Department of Fish and Game
Delta Smelt Team
Dale Sweetnam (co-chair), Department of Fish and Game
Larry Brown (co-chair), U.S. Bureau of Reclamation
Michael Thabault, U.S. Fish and Wildlife Service
*Chuck Hanson, State Water Contractors
Harvest Management Team
Joe Miyamoto (Acting Chair), East Bay Municipal Utility District
Dan Viele, National Marine Fisheries Service
Gary Stern, National Marine Fisheries Service
LB Boydstun, California Department of Fish and Game
Alan Baracco, California Department of Fish and Game
Zeke Grader, Pacific Coast Federation of Fishermen’s Association
Bill Kier, Consultant for Pacific Coast Federation of Fishermen’s Association
Peggy Beckett, Golden Gate Fishing Association
Roger Thomas, Charter Boat Fishing Association
Rick Sitts, Metropolitan Water District of Southern California
Jim Buell, Consultant for Metropolitan Water District of Southern California
Terry Mills, CalFed staff
Serge Birk, Central Valley Project Water Association
DEFT members not on a specific species team
Bruce Herbold, U.S. Environmental Protection Agency
Pete Rhoads, Metropolitan Water District Southern California
Michael Fris, U.S. Fish and Wildlife Service
Jim Buell, Metropolitan Water District Southern California
Elise Holland, Bay Institute
Ron Ott, CALFED

Goal and Objectives

The original review of the program alternatives found various problems (impacts) associated with the “through-Delta” alternatives (see DEFT June 25, 1998). The goal of this latest endeavor was to eliminate or reduce the problems identified via an array of new or revised actions with less risk to and a higher potential for recovery for key species.

To meet this goal the team developed the following objectives based on hypotheses on what controls fish survival in the Delta.

1. Improve Delta Hydrodynamics

   a. Improve net flows west from the Central Delta (QWEST). (Hypothesis: Net positive flows from the Delta would help reduce risk of fish moving toward and into the south Delta where they are subject to export.)

   b. Improve Delta outflow as measured by average X2 location in the Bay and Delta. (Hypothesis: X2 is a potential surrogate for many factors related to fish survival and productivity in the Bay-Delta.)

   c. Reduce negative flows in the south Delta toward the pumping plants at key times of the year. (Hypothesis: Negative flows in the Old and Middle River channels in the south Delta are believed to affect the zone of influence of the pumping plants.)

   d. Improve flows in the lower San Joaquin River in April and May. (Hypothesis: San Joaquin River salmon would benefit from higher transport flows in April and May, their key outmigration period. The existing VAMP period of 30 days of increased flows and lower exports does not adequately protect outmigrating salmon from San Joaquin tributaries.)

2. Improve Migration Pathways for Fish

   a. Reduce the potential for movement of outmigrating juvenile San Joaquin salmon into the south Delta via the Head of Old River. (Hypothesis: Survival of outmigrating San Joaquin salmon is much lower even in wetter years if they pass into the Delta via the Head of Old River.)

   b. Reduce the movement of juvenile Sacramento River salmon into the interior Delta via the DCC and/or Georgianna Slough. (Hypothesis: Survival of juvenile salmon released in these areas is much reduced over those released in the lower Sacramento River below the DCC).

3. Reduce Exports

   a. Reduce exports at key times of the year. (Hypothesis: High export rates in winter and spring appear to reduce survival of important fish.)

   b. Reduce the export to inflow ratio in fall and winter. (Hypothesis: Higher export/inflow ratios in fall and winter in recent decades are associated with declining populations of winter run and late-fall run chinook salmon and delta smelt.)

4. Reduce Entrainment Losses

   a. Reduce losses of juvenile fish at Tracy and Clifton Court Forebay fish facilities. (Hypothesis: Existing fish facilities are inefficient and cause significant loss to predation in the forebay and to mortality of salvaged fish in handling and trucking.)

   b. Reduce losses of fish at other Delta diversions (Hypothesis: Eggs, larvae, and juvenile fish are lost in large numbers to Delta diversions.)

5. Improve Delta Habitat

   a. Make habitat in central and south Delta more fish friendly. (Hypothesis: A through-Delta alternative should require improved habitat in the central and south Delta to not only slow fish movement toward pumping plants, but to increase food supply and fish growth and survival, which are adversely affected by south Delta exports.)

   b. Create more shallow water, riparian, and wetland habitat in the Delta. (Hypothesis: Survival of key fish species would be enhanced with more spawning and rearing habitat in the Delta.)

6. Improve Water Quality

   a. Reduce the amount of contaminants in water and sediment. (Hypothesis: High concentrations of contaminants in water and sediment reduce survival of fish in the Delta.)

   b. Reduce the amount of toxins in fish tissues. (Hypothesis: high concentrations of toxins in fish are a potential human health hazard.)

   c. Improve water temperatures. (Hypothesis: high water temperatures at certain times of the year may limit survival of some fish in the Delta.)

7. Improve Fish Harvest Management

   a. Review ocean harvest management. (Hypothesis: ocean harvest management may not be adequate to protect key salmon populations.)

   b. Review possible fishing regulatory actions that could contribute to recovery. (Hypothesis: the effectiveness of actions varies considerably.)

Approach

To address the goal and objectives the DEFT team developed specific actions that reduced or eliminated some or all of the environmental problems identified by DEFT for Alternatives 1 and 2. The DEFT team consulted with the Ecosystem Restoration Program team to determine what actions were slated for short-term implementation (Stage 1). The DEFT team developed various concepts for review and analysis in hydrologic and operations models developed by the Bureau of Reclamation and the California Department of Water Resources (DWR). DWR staff ran the operations models to determine effects of various options considered. Model output was provided for a set of key discriminating factors that relate directly to the objectives. Finally, DEFT species teams evaluated various potential actions and evaluated effects of these actions. These teams included a salmon team, a delta smelt team, and a striped bass team. A harvest team was added to evaluate upstream and ocean effects on salmon. The following discussions summarize some of the aspects of the approach including what impact parameters and discriminating factors were used by the teams and how the teams conducted impact assessments.

Impact Parameters
To guide the species teams and to provide a framework for addressing issues, the DEFT team developed a list of impact parameters that have direct and indirect effects on the key fish species. Each species team considered on or more of the impact parameters listed below in their assessments.

- Entrainment of juvenile fish into water diversions
- Delta hydrodynamics (flow magnitudes and direction)
- Predation on juvenile fish
- Handling of juvenile fish at fish facilities
- Fish food supply
- Fish spawning, rearing, and migrating habitat
- Water quality - contaminants, water temperature, and salinity
- Agriculture diversions (location, amount, and timing)
- Adult fish straying from primary migration routes

Flow Parameters
To gain insight into the various impact parameters and how they varied by alternative, the assessment team relied on model predictions of the following key flow parameters:

- Cross-Delta Flow - refers to the combined net flow from the lower Sacramento River into the Central Delta via the DCC and Georgianna Slough. (Changes in cross-Delta flow may reflect vulnerability of Sacramento River fish being drawn into the interior Delta, as well as the amount high quality, low salt content of Sacramento River water entering the Delta.)

- **Sacramento River Flow below Hood** - increases and decreases in cross-Delta flow would correspond to decreases and increases, respectively, in the flow in the Sacramento River below the channels conducting cross-Delta flow. (Lower Sacramento River flow may be positively related to fish transport and survival.)

- **QWEST** - the net flow from the Central Delta to the Western Delta via the lower San Joaquin and nearby channels. (Changes in QWEST may reflect ability of juvenile fish to move to western Delta and Bay rather than toward the south Delta export pumps. QWEST may also be related to foodweb productivity.)

- **Lower San Joaquin River Flow at Antioch** - net flow in the San Joaquin channel; this factor is similar to QWEST.

- **Flow in Old River near Bacon Island** - extremes and net flows in the lower Old River channel near Bacon Island. (Changes in flows at this location may reflect changes in the vulnerability of fish in the south Delta to being lost to south Delta export.)

- **Monthly average location of X2** - average monthly location of the 2 ppt salinity position in the estuary salinity gradient expressed in miles above the Golden Gate. (Changes in X2 may represent changes in foodweb productivity, low salinity habitat, and hydrological transport mechanisms that may affect fish distribution and survival.)

- **Electrical Conductivity at various Delta locations** - EC is a measure of the extent of salinity intrusion and lack of dilution of high conductivity agricultural return water in the Delta. (Higher EC represents effects on water quality, water supply, and environmental values.)

- **South Delta Exports and Export/Inflow Ratios** - a key discriminating factor among the alternatives was the magnitude and seasonal distribution of exports and the export/inflow ratio. (Exports and the export ratios have been shown to be directly related to fish abundance, distribution, and losses at the south Delta pumping plants.)

- **Delta Outflow** - the magnitude and seasonal distribution of freshwater flow or net flow exiting the Delta to Suisun Bay. (Delta outflow has been shown to be directly related to abundance of key fish and fish prey.)

Species Team Assessments

These impact parameters and flow parameters were used by the respective teams to evaluate the effects of specific actions and various scenarios evaluated. The species teams developed matrices on the effects of the impact parameters on the life stages of each species by month for arrays of actions. These were used by the teams to address the objectives. The detailed matrices and interpretations are described in individual species reports in appendices.

Harvest Management Team Assessments

The harvest management team evaluated additional opportunities to enhance salmon and striped bass populations through harvest controls in Stage 1. They evaluated actions proposed as part of the CVPIA program and CALFED's ERP.

Habitat Team Assessments

The habitat team evaluated ERP actions that DEFT may consider to enhance striped bass, salmon, and delta smelt populations in Stage 1.

2. SCENARIO DESCRIPTION

The DEFT team developed and evaluated a specific array of actions, termed a scenario, that could be used to meet the above defined objectives and goal of an improved through-Delta alternative. The scenario developed should be considered preliminary and results of the impact associated should be interpreted cautiously, recognizing the many informational and procedural limitations inherent in these work products. The short time frame provided for this work compelled the team to rely primarily on professional judgement to evaluate the degree to which each relevant factor affects each of the key species. Assumptions had to made that in some cases limited the team's ability to answer some issues. The actions or the full scenario may not meet all CALFED principles or objectives.

DEFT Actions for Stage 1 Evaluation

The proposed scenario includes actions described below by category.

Structural Changes:

8. A new Hood Diversion Demonstration/Testing Facility on the Sacramento River capable of diverting up to 2,000 cfs from the Sacramento River to the Mokelumne River. The facility would have an alignment as defined for Alternatives 2 and 3, so that those options would not be precluded in the future. Screen operation would be under criteria established by NMFS, FWS, and DFG. The facility would be operated for the following purposes:

    i. Test screening efficiency, cleaning and bypass mechanisms .
    ii. Test upstream passage mechanisms.
    iii. Enable closing the Delta Cross Channel without compromising interior Delta water quality.
    iv. Improve Delta water quality.
    v. Improve cues for migrating fish.

    This action also has some potential negative effects:
    - Exposes young salmon to a new screen system
    - May impair cues of migrating fish
    - May block or impair upstream passage of migrating fish

9. A Barrier at the Head-of-Old-River. The facility will be used for the following purposes:

    i. Improve San Joaquin salmon survival.
    ii. Improve water quality in lower San Joaquin River below the Barrier.

    This action also has some potential negative effects:
    - May impair upstream migration of San Joaquin salmon in the fall

- May increase entrainment of organisms living in the central and southern Delta

10. A new Tracy Demonstration/Testing Fish Screen and Handling Facility capable of screening 2,500 cfs at 0.2 fps through-screen velocity and 5,000 cfs at 0.4 fps through-screen velocity. Screen operation would be under criteria established by NMFS, FWS, and DFG. The facility would be operated for the following purposes:

    i. Will improve survival of salvaged fish at the Tracy pumping plant.
    ii. Will reduce entrainment at the Tracy pumping.
    iii. Will provide valuable information for design of future fish facilities.

    This action also has some potential negative effects:

    - There may be some stranded costs if the point of diversion is moved sometime in the future.

11. A new Clifton Court Screen and Handling Facility at the northeast entrance to Clifton Court Forebay capable of screening 6,000 cfs at 0.2 fps through-screen velocity and 12,000 cfs at 0.4 fps through-screen. Screen operation would be under criteria established by NMFS, FWS, and DFG. There two primary options to consider:

    - Design the screens and low head pumping facilities to screen 6,000 cfs at 0.2 cfs approach velocity. For pumping above 6,000 cfs use a combination of the screens and the existing intake gates. Operate both the salvage facilities at the new screens and at Skinner.

    - Design the screens with the capability to operate at 0.2 to 0.4 fps approach velocity and the low head pump station at 10,300 cfs. To achieve the 10,300 cfs capacity through the new screens at particular times, the approach velocity would be increased to accommodate the total flow (approach velocity around .33 cfs).

    DEFT recommends that the facility be designed not to preclude either option and to continue with the research at UC Davis Treadmill and the Research work at Tracy to help guide the use of flexible criteria. The facility would be operated for the following purposes:

    i. Improve survival of fish in the south Delta near the State export pumping plant.
    ii. Reduce predation of fish in Clifton Court Forebay.
    iii. Provide constant export rates (less gulping) to reduce disruption of fish migrations and reduce exposure of fish residing in or migrating through the central and south Delta to entrainment.

    This action also has some potential negative effects:

    - There may be conflicts with higher pumping rates (e.g., over pumping screens or exporting water that is not first screened).

Operational Changes

12. Allow higher or lower export rates and changes to export-to-inflow ratios other than those prescribed by Water Quality Control Plan. Shift pumping rates seasonally and on a real-time bases such as reducing pumping when inflow is low or fish are present in large numbers, or increasing pumping when outflow is high or few fish are present in the south Delta. Greater flexibility, both seasonally and in real-time appears to be possible and has good potential to provide greater environmental protection. An environmental water account might function to keep track of pumped and stored water that could become credits against pumping at critical environmental periods. The export rates could be altered for the following purposes:

    i. Reduce entrainment.
    ii. Improve foodweb productivity.
    iii Protect fish migrating through the Delta.

    This action also has some potential negative effects:

    - Impacts may shift to other species or life stages.
    - May locally impact water quality.

    The export rates would be managed in the following ways:

    Seasonally:
    - More restrictive at times, providing greater environmental protection.
    - Less restrictive at times, providing water for environmental benefit at later more critical periods.
    - Shift high pumping to seasons of high flows, especially high San Joaquin flows
    - Shift high pumping to seasons of low fish sensitivity
      Current requirements in the WQCP and Biological Opinions require seasonal adjustments in operations, modified by hydrological patterns. Further protection to allow recovery may need to expand on these tools. Seasonal shifts in operation may be most appropriate for conditions that occur predictably or where the times of sensitivity overlap for several species. Examples of such seasonal responses that the DEFT team has considered include: increasing the period of the Vernalis Adaptive Management Program from 31 to 60 days and relaxation of the Export/Inflow ratio to 75% in August and September.

    Real-Time Flexibility-Monitoring Response:
    - More restrictive at times, providing greater environmental protection.
    - Less restrictive at times, providing water for environmental benefit at later more critical periods.
    - Shift high pumping to periods of high flows, especially high San Joaquin flows

- Shift high pumping to periods of low fish sensitivity

13. Modify flow volumes, distributions, frequency, and pathways. Flows may be changed by altering inflows, exports, barriers (e.g., DCC, Head of Old River barrier, Montezuma Slough salinity barrier, etc.). Flow would be altered for the following purposes:

    i. Reduce entrainment.
    ii. Improve foodweb productivity.
    iv. Improve fish migrating cues.
    iii. Protect fish migrating through the Delta.
    iv. Improve fish habitat - (e.g., alter salinity, water temperature, inundate floodplain).
    v. Improve water quality - (e.g. reduce concentrations of toxins, areas of low dissolved oxygen).

    This action also has some potential negative effects:

    - Impacts (such as water temperature) may shift to other species or life stages either in-Delta or upstream.
    - May locally impact water quality.

Habitat Actions

The following are specific Stage 1 habitat restoration actions.

14. Restore tidal freshwater, riparian and seasonal and permanent wetland habitat in the area of the proposed Yolo Bypass National Wildlife Refuge including Prospect, Liberty, and Little Holland island-tracts, and tidal portions of the Yolo Bypass.

15. Create large areas of shallow tidal wetland habitat in the vicinity of Suisun Bay, Sherman Lake, and Big Break.

16. Restore and rehabilitate riparian and SRA habitat along all practicable reaches of major fish migration corridors including the Sacramento River, the San Joaquin River, Georgiana Slough, and Steamboat Slough.

17. Restore and rehabilitate riparian, SRA, tidal freshwater, and seasonal and permanent wetland habitats along the North and South Forks of the Mokelumne (including dead-end sloughs of the Eastern Delta) to bolster migration and rearing of salmon from the Mokelumne and Consumes rivers.

18. Restore the habitat corridor of the lower Consumes and Mokelumne rivers within and above the Delta including floodplain, riparian, SRA, and wetland habitats to bolster salmon populations in these rivers.

19. Restore a large area of tidal freshwater, riparian, and marsh habitat in the South Delta as

a pilot project to test concept of “interceptor habitat”.

20. Restore tidal freshwater, riparian, and marsh habitats along the lower San Joaquin River between Stockton and Mossdale as a pilot project to test tidal river floodplain restoration.

21. Restore freshwater, riparian, SRA, and marsh habitats in the floodplain of the Sacramento River below Sacramento as a pilot project.

22. Restore Frank’s Tract’s fish habitat values including creation of a broad expanse of shallow water and wetland habitats within the tract.

23. Evaluate habitat restoration options in the non-tidal portion of the Yolo Bypass that are consistent with its present flood control and agricultural uses.

Harvest Actions

The following are specific Stage 1 harvest management actions.

24. Explore “bubble fisheries” to protect weak stocks. Requires unique genetic markers to identify weaker wild stocks.

25. Evaluate the feasibility of restricting harvests of weaker stocks by expanding existing restrictions in fishing times and locations for winter run salmon to other weaker stocks including spring-run and San Joaquin fall-run. Requires expanded tagging and recovery program, cwt tag recovery data analysis, and DNA microsatellite marker analysis.

26. Evaluate the feasibility of selective fisheries to protect weaker stocks by evaluating marking hatchery fish, restrictions on fishing methods that have high hooking mortality rates, and focusing harvest on hatchery fish at times and locations in coastal and inland fisheries. Requires expanded tagging and recovery program, cwt tag recovery data analysis, and DNA microsatellite marker analysis.

DEFT Future Evaluations

DEFT is proceeding with evaluation of benefits, costs and institutional measures of suggested flexible operations. The DEFT and No Name teams are working together to develop a recommended through-Delta alternative that meets all of the CALFED objectives and principles. Of greatest concern is continuing exports from the south Delta and the associated entrainment and salvage of important fish species. To address this concern, both teams agree that the key component of a through-Delta alternative should be flexible operations with an environmental water account. Flexible operations offers opportunities to provide the water necessary for actions evaluated by the DEFT team that are essential to minimize entrainment impact of a through-Delta alternative. We recognize that there will be risks to both water supply and the environment with this approach, but that the approach is consistent with the adaptive management framework adopted for CALFED particularly during Stage 1 (see Draft Strategic

Plan).

The following describes further the concept of flexible operations and what steps the teams plan to take to further develop the concept.

> Examination of patterns of fish salvage at the CVP and SWP fish facilities demonstrate the sometimes episodic nature of entrainment losses. The intermittent occurrence of high losses suggest it may be possible to reduce entrainment impacts through relatively brief but substantial reductions in export pumping. Conversely, there appear to be periods in which increases in export pumping would not increase entrainment. Unlike habitat or water quality actions, the impacts of entrainment are often quite species-specific.
>
> Fish salvage and other fish distribution data from the Interagency Ecological Program's Real Time Monitoring may be used more extensively than in the past to reduce entrainment problems by reducing exports on a daily or weekly basis in relation to monthly standards when the selected species are perceived to be at short-term risk, and increasing exports when entrainment risks are low Such operations will require reliable short-term monitoring data (such as has been provided by IEP in the last three years), a rapid response mechanism for adjusting the CVP/SWP export operations, and agreement on a reasonable limitation on the size, frequency and duration of export alterations. This process could occur without change to the 1995 Water Quality Control Plan by taking advantage of the little-used option to change daily export rates above and below the required longer-term targets.
>
> Salvage data have been used to explore the potential for this approach. Other real-time data would be appropriate to use in conjunction with salvage data to anticipate peak salvage events and detect when risk is likely to decrease.
>
> Modeling this approach to operations will be difficult in part because the frequency of loss events that would instigate a rapid short-term operations adjustment is predicted based on historic salvage information. Particle tracking and DSM outputs will allow some estimation of the protective value to fish of short-term export restrictions but cannot account for fish behavior. Water supply effects of such changes in operations cannot be addressed by most of the current modeling tools. Daily models such as Delta SOS Model may be useful to estimate water supply impacts but are not comparable to DWRSIM runs of total system operations. Developing ways to make all relevant types of models more realistic and comparable with each other will require substantial effort.

3. SCENARIO SUMMARY

The following table provides a summary of the main structural and operational features of the new scenario as compared to Alternatives 1 and 2, and existing conditions.

	Existing Conditions	Alternative 1	Alternative 2	New Scenario	Reason for Change
Structures					
Hood Diversion	none	none	10,000 cfs	2,000 cfs	A Hood diversion of 2,000 cfs allows closure of DCC and provides for improved water quality and higher QWEST.
Barrier Head of Old River	temporary structure	barreir	barrier	barrier	Barrier allows opening and closing as needed to protect water quality and fish.
Tracy Fish Screen Facility	existing Tracy Fish Facility	new screen	new screen	2,500 cfs test screen and fish facility	Test screen facility would test systems to improve fish salvage survival and reduce entrainment at Tracy Pumping Plant.
CCF Fish Screen Facility	existing CCF fish facility	New screen and fish facility at entrance to CCF	New screen and fish facility at entrance to CCF	New screen and fish facility at entrance to CCF	New screen facility would test to improve fish salvage survival and reduce entrainment at SWP Pumping Plant.
Water Project Operations					
E/I Ratio	.35 Feb-June .65 July-Jan	.35 Feb-June .65 July-Jan	.35 Feb-June .65 July-Jan	.25 Feb-June .55 Nov .45 Dec-Jan .75 Aug-Sep	Reduce export rates when fish are vulnerable; allow increase when not.
VAMP	31 days	31 days + additional 10 days of pulse flow	31 days + additional 10 days of pulse flow	61 days	Extending period would protect downstream migrating San Joaquin salmon and increase protection for delta smelt and striped bass.
X2 location (Delta outflow)	1995 WQCP -	1995 WQCP -	1995 WQCP -	1962 level of development	Increase survival and production of salmon, delta smelt, and striped bass through improved transport, habitat, food supply, and reduced vulnerability to exports.
Fish Habitat					

In Delta Habitat	Existing conditions	Restore shallow water, riparian, and wetland habitats.	Restore shallow water, riparian, and wetland habitats.	Restore shallow water, riparian, and wetland habitats.	Increasing habitat would enhance fish survival and production.
Rivers and Tributaries	Existing conditions	Restore shallow water, riparian, and wetland habitats.	Restore shallow water, riparian, and wetland habitats.	Restore shallow water, riparian, and wetland habitats.	Increasing habitat would enhance fish survival and production.
Fish Harvest					
restrictions on fisheries	Existing conditions	Evaluate measures to restrict fisheries to protect weak stocks	Evaluate measures to restrict fisheries to protect weak stocks	Evaluate measures to restrict fisheries to protect weak stocks	Restrictions on times and locations may increase escapement (run size) of selected populations.
harvest restrictions	Existing conditions	Evaluate harvest restrictions	Evaluate harvest restrictions	Evaluate harvest restrictions	Restricting harvest rates may increase escapement of selected populations.
restrictions on fishing methods	Existing conditions	Evaluate selective fisheries	Evaluate selective fisheries	Evaluate selective fisheries	Restricting fishing methods may increase escapement of selected populations.

4. NEW SCENARIO PERFORMANCE

The DEFT team evaluated the performance of the scenario developed by the DEFT-NoName subcommittee by comparing model output on flow parameters and impact parameters for the new scenario, Alternatives 1 and 2, and existing conditions.

Flow Parameters

The DEFT team reviewed the effects of the scenario on the key flow parameters including Delta hydrology and export rates. Changes in hydrology and export rates were obtained from simulations using the DWRSIM model for the Delta. DWR modelers provided summary output for model runs and graphical and tabular comparisons among model runs of the various alternatives. The following is summary of the results for the new scenario and comparisons with Alternatives 1 and 2, as well as existing conditions.

Old River Flow at Bacon Island

The concern for Old River flow at Bacon Island is the net -3,000 to -5,000 cfs in the channel in most years except critical and very wet years. Alternative 2 increased the net negative flows over existing conditions. While Alternative 1, existing conditions, and the new scenario have similar characteristics for this parameter, the new scenario reduces the negative flows slightly (generally 10-20%) in the December to July period in dry and critical years and in the April to June period of above normal and wet years. In contrast the negative flows are increased sharply in August and September in response to the need to make up earlier export deficits in winter and spring. In dry and critical years net flows would change from the existing approximately -2,500 cfs to -4,000 cfs.

Cross Delta Flow

Under existing conditions Cross Delta flow averages 2,000 to 6,000 cfs with lower levels from November to June and higher levels in the July through October period. This pattern generally follows that for south Delta exports. Alternative 2 increased this flow on average 1,000-4,000 cfs in the November to June period. Alternative 1 was very similar to existing conditions, except for slightly higher flows from July through October. The scenario evaluated has similar flows as Alternative 1 and existing conditions, except for higher flows (1,000-2,000 cfs higher) in August and September, and lower flows (less about 2,000-3,000 cfs) in October. The facility allows more water to move across the Delta when the DCC is open (August and September) and allows closure of the DCC in October.

Lower Sacramento River Flow below Hood

Lower Sacramento River flow changes essentially the opposite of Cross Delta flow. If inflows are unchanged as assumed in the model runs, lower Sacramento River flows would decline as more of inflow is diverted through the central Delta. Because a 2,000 cfs Hood facility would allow more of the lower Sacramento River flow to pass into the central Delta via the Mokelumne channels than either existing conditions or Alternative 1, lower Sacramento River flows may be reduced compared to existing conditions or Alternative 1.

Qwest/Lower San Joaquin River Flow at Antioch

Qwest and lower San Joaquin flows follow closely the pattern of Cross Delta flow with some modification by changing exports. The higher the Cross Delta flow the higher the Qwest flow. Alternative 2 provides the highest Qwest because of higher Cross Delta flow than either existing conditions or Alternative 1. The new scenario provides Qwest and lower San Joaquin flows similar to Alternative 1 and existing conditions, except for higher April-May Qwest from reduced exports from the extented VAMP. Qwest flows are also slightly higher in drier years from December through March and in June. The scenario also has slightly lower Qwest flows from August through October.

Delta Water Quality (EC)

Water quality as measured by electrical conductivity (EC), a measure of the amount of salinity in the water, varies opposite to the amount of Sacramento River water entering the central Delta via Cross Delta flow. Based on the Cross Delta flow changes, the new scenario would provide similar interior Delta EC patterns as existing conditions and Alternative 1, with a peak in winter and minimum in spring. However, The new scenario would increase interior Delta EC in October and reduce it in August and September.

Delta Exports
Delta exports are similar for Alternatives 1 and 2 and existing conditions. The scenario has reduced exports from October through June due to the extended VAMP and lower export/inflow ratios. Exports are increased in summer to make up the deficit created from lower October through June exports. In reality, flexible operations would make such operational changes far less definitive.

Delta Outflow
Delta outflow under the scenario would increase slightly from December through May of drier years and April through May of wetter years. Outflow would be lower in October.

Key Species Assessments

The DEFT team compared impact parameters among existing conditions, Alternatives 1 and 2, and the new scenario for the three key species: chinook salmon, striped bass, and delta smelt. These three species also represent three differing life history scenarios and vulnerabilities to Delta exports.

Evaluations were based on the team's best professional judgement to the degree of which each relevant parameter affects each key species. The judgements considered empirical relationships between parameters and survival, where such relationships were available. Evaluations were based on operations modeling studies and qualitative assessments of the degree to which water operations, water management facilities, and biological parameters affect the populations of each species. More rigorous quantitative analysis was not possible within the time constraints imposed on this process.

The evaluations recognized the many sources of uncertainty that derive from the limitations of our scientific knowledge about the species and Bay-Delta ecosystem. From an analytical perspective, monthly averaged hydrology was the primary hydrologic parameter used in the analysis. A more rigorous daily simulation of hydrological effects may reduce some of the uncertainty of the assessment and provide more perspective on how operational flexibility will work in the future.

Sources of uncertainty on biological processes takes a variety of forms and makes any predictions of actual results at the population level extremely problematic. For example, the benefits of shallow water habitat to Delta smelt are not yet well understood. With regard to striped bass, the continuation of historic relationships into the future is unclear due to the many changes in the system. For salmon, the sources of mortality in the Delta are poorly understood. The various sources of uncertainty were acknowledged, identified, and considered to the extent possible in the evaluation

The evaluation focused on assessing the potential for recovery under the new scenario relative to existing conditions and Alternatives 1 and 2. The recovery potential included the potential benefits of the Common Program. The evaluation of the effects of the Common Programs posed particular challenges for this evaluation due to lack of specificity of Common Program elements. There was a broad consensus among the team that the common programs will provide benefits to each of the evaluated species. Quantifying these benefits has however proved difficult. Increasing the amount of habitat will almost certainly increase the potential for survival of each of the evaluated species, but the magnitude of the increase is uncertain.

Salmon Team Evaluation

The salmon team concluded that the new scenario offered significant improvements over Alternatives 1 and 2. The San Joaquin chinook salmon populations would gain significantly from the extended VAMP, improved QWEST, Head-of-Old-River barrier, new south Delta fish facilities, lower exports, and improved Delta outflows. The Sacramento salmon populations would benefit from these same features, but would also be subjected to lower Sacramento flows, exposure to the new screen system, and the potential for delays in adult upstream migration from straying up behind the screen. Despite these potential effects the team concluded that the scenario with the Common Program would likely contribute significantly to the recovery of the Sacramento salmon populations. Despite significant improvements to the San Joaquin populations chances for recovery, the team was less optimistic for chances of recovery that for the San Joaquin populations, because of continuing exports from the south Delta and uncertainty of habitat conditions in the San Joaquin River and its tributaries.

Striped Bass Team Evaluation

The striped bass team determined that the new scenario would substantially improve chances for recovery of the population over Alternatives 1 and 2. Reduced winter and spring exports, and higher winter and spring QWEST and X2 flows would benefit striped bass. Improved fish facilities at the south Delta pumping plants would be a substantial improvement over existing conditions, but similar to Alternatives 1 and 2. The potential degree of recovery however would be tempered by potential delays or stranding of adult striped bass below the Hood screen system, increases in summer exports from the south Delta, and continuing exports from the south Delta in all months of the year.

Delta Smelt Team Evaluation

The delta smelt team determined that the new scenario improved chances for recovery over Alternatives 1 and 2, particularly in dry years, but DEFT actions were not sufficient to ensure recovery because of the uncertainties of a through-Delta alternative. Reduced exports in winter and spring would improve survival, as would higher winter and spring QWEST and X2 flows. In summer, higher exports, more negative QWEST, and more negative Old River flows at Bacon Island would reduce survival of delta smelt. Compared to existing conditions, the new scenario would improve the recovery potential for delta smelt in dry years, but not in wet years.

5. SUMMARY OF POTENTIAL FOR RECOVERY OF KEY SPECIES

The reader is strongly urged to read the detailed species reports in the Appendices for the details of the evaluations. In these reports each species teams developed rational and matrixes that scored the effects of the impact parameters on the life stages of each species by month for each alternative.

The following is a summary of the species team evaluations under the criteria listed below:

0 - existing conditions
1 or 2 - some benefit but would not contribute significantly to recovery
3 to 5 - will likely contribute to recovery
6 or 7 - likely to achieve recovery

	Alternative 1	Alternative 2	New Scenario
Delta smelt	1/2*	1/1	2/3
Striped Bass	1	1	2
Sacramento fall-run salmon	5	4	5
San Joaquin fall-run salmon	4	4	4
Winter run salmon	5	4	5
Spring run salmon	5	4	5
Eastside fall-run salmon	4	to be added	5
Late fall-run salmon	5	4	5

*wet year/dry year

DIVERSION EFFECTS ON FISH

APPENDIX A

DEFT EVALUATION FOR
CENTRAL VALLEY SALMON SURVIVAL
WITHIN THE DELTA

UPDATE OF CALFED ALTERNATIVE EVALUATION FOR
CENTRAL VALLEY SALMON SURVIVAL

Introduction

On June 25, 1998 the Diversion Effects on Fish Team (DEFT) completed a draft report entitled "Diversion Effects on Fish: *Issues and Impacts*". That report included an appendix describing in some detail the results of analyses of effects on salmon prepared by a subteam of DEFT. DEFT was instructed by management to pursue additional work on possible alternatives for consideration by management. The purpose of this draft is to summarize the additional work done by the salmon subteam.

The principal elements of the additional salmon-related work have been:

- Considering whether various technical criticisms of the earlier analyses warrant changes in the original analyses.

- Identifying potential additional alternatives for through-Delta conveyance which would provide better benefits for fish than Alternatives 1 and 2 described in CALFED's Phase II report and evaluated in the June 25, 1998 draft. Then evaluating the effects of any such alternative on salmon.

- Provide an assessment of the overall benefits of the CALFED program on salmon. The June 25, 1998 report considered only effects within the Delta and Suisun Bay of the CALFED alternatives for actions within the Delta. For salmon, the additional task involves integrating the effects of CALFED actions upstream from the Delta, with effects of Delta actions, and actions on harvest regulations.

- Analyze the consequences of the CALFED actions on salmon runs in the Eastside tributaries of the Delta. The team's original analyses included only salmon from the Sacramento and San Joaquin watersheds. While the runs in the Eastside tributaries are small, they are both locally important and reflect needs in the Delta different from other runs.

In response to the second point, DEFT developed a new scenario. Within the Delta, this scenario involves:

- A more detailed description of habitat restoration measures to be undertaken during Stage 1 (the first 7 years after approval of CALFED's preferred alternative).

- Harvest management actions proposed by a Harvest Management Subgroup.

- The following structural actions: a 2,500 cfs fish screen for the CVP intake, a 6,000 cfs fish screen at the intake to Clifton Court Forebay, an operable barrier at the head of Old River, and a 2,000 cfs screened channel from Hood to the Mokelumne River.

- The following operational actions: more stringent E/I ratios from November through June and maintaining X2 at the 1962 level of development from February through June.

Terry Mills of the CALFED staff and Joe Miyamoto of East Bay Municipal Utilities District were added to the Salmon Team to add expertise on upstream CALFED actions and East-side tributaries. This was essential to completing the broader assignment.

Technical Concerns About Original Analysis

The Salmon Team is aware of three primary technical concerns. Those and the responses to them are as follows:

1. Salmon are guided by salinity in the salinity gradient during their migration to the ocean. We agree that this is well substantiated in the literature. One manifestation of it probably is the rapid migration of salmon smolts from Suisun Bay to the Golden Gate demonstrated in studies done during the early 1980s.

Use of salinity as a cue does not necessarily indicate any relationship between survival and the location of the salinity gradient. Salmon presumably make a transition from cuing primarily on flow to cuing on salinity as they migrate downstream to the ocean, and the location of where that transition takes place may not be related to survival. Analyses of the survival of marked salmon smolts, however, indicate that survival may be related to the location of the salinity gradient.

Regardless, the major consideration in our evaluation is that the salinity gradient is in approximately the same location in each alternative, so salinity cues are not a probable cause of differences among alternatives. (One qualification on this conclusion is we understand that the operations studies for the CALFED alternatives did not take into account the degree to which salinity intrusion associated with reverse flows may differentially affect exports. That might mean that in real operations some differences in the salinity gradient would exist, but we doubt that they would be enough to negate our conclusion.)

2. The relationship between flow and survival in the lower Sacramento River is not valid. We agree that the original analysis we made was based on an invalid interpretation of information. We have analyzed other information in an attempt to determine whether a relationship between flow and survival exists. There are indications that such a relationship exists, but the information is far from definitive. We have not had sufficient resources and time to examine the information exhaustively. The ongoing evaluation of the information should be completed and the topic reconsidered based on the full evaluation.

Meanwhile, at the very least, our initial evaluation is more uncertain than we indicated in the June 25 report. The salmon team considered responses ranging from concluding that flows are not a significant consideration to leaving the impact assessment unchanged. The majority of the team decided, given the time constraints, to let the analysis stand as in the original report, while a minority believe the original report should be changed to indicate significantly less impact for flow below Hood.

3. Net flows are not as significant as we estimated. The point has been made that net flows diminish in relation to tidal flows as one proceeds down the estuary and are only a small fraction of tidal flows in much of the estuary. Particle tracking model results indicate travel times of several weeks under some conditions from locations downstream of the Old-Middle River complex to the pumping plants. We acknowledged in the original report that net flows are often small in relation to tidal flows, as our critics contend, but we believe significant effects are associated with net flows.

As common sense and particle tracking studies indicate, the higher the export rate the larger the area within the influence of the pumps becomes. The area of influence also depends on the magnitude of freshwater flow. Particle tracking studies are available for exports ranging up to 8,000 cfs, and indicate that at high exports and low flows, the San Joaquin River downstream of the Mokelumne is within the area of short term influence of the pumps.

The operations studies for the CALFED alternatives indicate that average monthly exports will exceed 8,000 cfs in 8 of the 12 months. Hence about half of the time in those months export rates will exceed the largest exports examined in particle tracking model studies. Hence we have not evaluated the full range of potential impacts. As we were aware of during the original analysis, the months when average exports are less than 8,000 cfs are those when downstream migrant salmon are most abundant.

After reviewing this information, we believe that the third paragraph on page A-3 of the June 25, 1998 DEFT Report accurately describes our perception of the significance of net flows and is valid. Hence we stand by our original analysis.

Analysis of Effects on Salmon in the Sacramento River and Tributaries

TO BE ADDED

Analysis of Effects on Salmon in the San Joaquin River Tributaries

TO BE ADDED

Analysis of Effects on Salmon in the Eastside Tributaries

Evaluation scores were developed for baseline conditions, CalFed alternative 1, and the New scenario. The criteria in the June 25, 1998 draft DEFT report was used as the basis to score the alternatives.

In general, the scores for the Eastside tributaries were derived from either the scores from the Sacramento or San Joaquin River with adjustments made to account for higher levels of entrainment (than Sacramento River fish). The modifier for Sacramento entrainment impacts was changed from a four to a two for the Eastside tributaries to give this score a higher weighting. This adjustment was made on the basis of the differences in cwt recoveries of Sacramento (1 %) and Mokelumne origin (3 - 5 %) salmon smolts at the export pumps.

In scoring entrainment and interior Delta related impacts, the following life stages were assumed to be present: fall-run chinook salmon fry (December to March), fall-run chinook salmon smolts (April to June) and fall-run chinook salmon yearlings **(**October to December).

For all alternatives and existing conditions, a negative score was assigned for the installation of a barrier at the head of Old River. The barrier would have the effect of diverting more Eastside tributary salmon towards the export pumps than if the barrier was not in place. The barrier at the head of Old River was assumed to be removed after the month of May.

Impacts from Ag diversions were not scored until April when the irrigation season was assumed to first begin.

While temperature related impacts were identified in the delta, no differences were assumed between the baseline or any of the alternatives.

No score was assigned for Delta Cross channel operations for the Eastside tributaries since this category was used as a surrogate to represent the percentage of Sacamento origin salmon that enter the interior Delta. Any changes to the survival of Eastside tributary salmon from the Delta Cross Channel operations would be reflected in the interior Delta survival scores.

Existing Conditions

Existing conditions have negative impacts on salmon fry, smolts, and yearlings primarily from entrainment, interior delta flow distribution, and predation related losses. The score for the month of June was adjusted to reflect the Mokelumne River trap and truck program during dry and critically dry water year types.

Alternative 1

The new fish screens at the Clifton Court forebay intake would reduce entrainment and predation losses of Eastside tributary salmon. Increased exports from October through December would entrain a greater number of yearling salmon and may offset some of the benefits to smolts from the new fish screens at Clifton Court Forebay.

The score for this alternative was also improved by the cumulative benefits from the common programs. The CalFed Ecosystem Restoration Program proposes moderate increases in existing shallow water habitat by creating areas where inundation of vegetation occurs more frequently. Predatory fish would also be attracted to the shallow water habitat during the months of March through June. Overall, the creation of shallow water habitat would probably result in a net benefit to juvenile salmonids, especially to salmon fry and presmolts since it would provide food and escape cover. These benefits are expected to accrue from January through March for shallow water habitat and from January through June for increased food supply.

Screens on Delta agricultural diversions from the common program would also reduce entrainment losses of salmon smolts during April through June. Salmon fry would not be at risk because the irrigation season does not begin until Apirl.

Evaluation of New Scenario

The Team evaluated in-Delta consequences of the new scenario based on the habitat, structural and operational assumptions described above and model runs describing the consequences of the operational measures on Delta hydrology. (The model runs for Scenario A used the 1995 level of demand for water, which is the same level of demand used for Existing Conditions in the original analysis. The estimated 2020 level of demand was used in evaluations of other alternatives in the original analysis. As a result of using the 1995 level of demand, the Scenarios A evaluation is biased somewhat towards overestimating environmental benefits in relation to the other CALFED alternatives.)

The month-by-month analyses for the Sacramento, Eastside tributaries, and San Joaquin runs are presented in Tables 1 and 2.

For the Sacramento runs, the primary positive features were reduced entrainment losses in the south Delta associated with reduced exports from December through June and improved interior Delta survival associated with improved flows in the same months. Those benefits were partially offset by exposure of downstream and upstream migrants to the Hood diversion, as described for Alternative 2, but to a substantially lesser degree. The overall result was a total score of -20, which is slightly better than the score for any other alternative (see Table 2 of June 25 report). The difference, however, is not sufficient to warrant a summary score higher than the +2 given for Alternatives 1 and 3 in the June 25 report.

For the San Joaquin runs, decreased exports and improved flow conditions lessened entrainment losses and improved interior Delta survival also resulted in a total score of -20. That is similar to Alternative 2 and substantially less than for Alternative 3 (see Table 3 of June 25 report). The resulting summary score is +3, the same as that for Alternative 2.

For the Eastside Tributaries, the scores for entrainment showed an improvement over alternative

1 to reflect more restrictive E/I ratios under the Scenario A alternative. Scores for interior delta flow distribution showed an improvement similarly to the San Joaquin River scores. The resulting summary shows a one unit improvement for Delta related actions between Alternative 1 and Scenario A.

The San Joaquin River score used an adjustment factor of positive three (*1/5th of the improved overall score in proportion to the pilot and full scale diversion, 2,000 vs 10,300 cfs*) to account for more positive flow in the Central Delta with the 2,000 screened diversion at Hood. No similar adjustment factor was used for the Eastside tributaries because the operation of this facility is not viewed as a positive measure for these fish since these flows would divert more fish into the Mokelumne South Fork where they would be more vulnerable to entrainment losses at the export pumps.

The team considered whether the significant benefits attributed to habitat restoration in the original report should be changed. A majority of the team concluded that they should not. The primary issue continues to be uncertainty over the degree to which shaded riverine aquatic habitat will be rehabilitated along the Sacramento system portion of the Delta. While DEFT's habitat report states that such habitat "should" be restored to the extent "practicable", the salmon team is concerned about the uncertainty denoted in the description, which seems warranted by historical practices and estimated costs of restoration in that area.

Table 1 summarizes our analysis of new scenario in the same format used in the summary table for salmon on page 14 of the June 25, 1998 DEFT report.

Table 1. Summary of evaluation of new scenario.

Alternative	Sacramento River Salmon	San Joaquin River Salmon	Eastside Tributary Salmon
Scenario Without Storage	Score +2 -Interior Delta survival improved in relation to Alternative 1 by better flows and reduced exports -improvement partially offset by reduced flows below Hood, juvenile	Score +3 -Lower exports improve survival at south Delta screens -Improved flow conditions in interior Delta improve survival	Score +3 -Lower exports improve survival at south Delta screens -Improved flow conditions in interior Delta improve survival -Improvement partially offset by the flow patterns from the 2,000 cfs

	entrainment losses at Hood screen, and the barrier to adult migration.		diversion into Snodgrass Slough that would divert more fish into the Mokelumne South Fork where entrainment losses would be expected to be higher.

Integration of Upstream, Harvest and Delta Actions

CALFED staff provided the team a list of upstream actions expected to take place during Stage I of the implementation of the CALFED program and a list of actions expected during the remainder of the CALFED program. Both sets were evaluated to estimate the value they would have for salmon at maturity of the habitat. The evaluations are described in detail in Appendix 2 and summarized here.

Benefits were estimated separately for many runs in various parts of the Central Valley system and then summarized by races of salmon for major portions of the system (Table 2). Scores were assigned using the following criteria:

- +1 or +2 Upstream improvements in stream habitat quality and function likely **will not** increase chinook salmon production within the stream sufficiently for CALFED through its system-wide program, to achieve its salmon recovery goal.

- +3 through +5 Upstream improvements in stream habitat quality and function **may** increase chinook salmon production within the stream sufficiently for CALFED , through its system-wide program, to achieve its salmon recovery goal.

- +6 and +7 Upstream improvements in stream habitat quality and function **likely will** increase chinook salmon production within the stream sufficiently for CALFED , through its system-wide program, to achieve its salmon recovery goal.

Caveat: T*he Delta portion of the results from the different river systems should not be compared with each other since different categories of environmental and operational variables were used to score each river system (Sacramento, San Joaquin, or Eastside Tributaries). For each river system, the scores should be used to compare only the alternatives within a given river system (ie San Joaquin scores should not be compared against the Eastside tributaries or the Sacramento).*

Table 2. Comparison of benefits of upstream actions proposed to be implemented during Stage 1 with the upstream benefits to be implemented throughout the CALFED Program for various runs

of Chinook salmon.

Salmon Run	Stage 1 Upstream Actions	Long-term Upstream Actions
Sacramento Fall Run	+3	+6
San Joaquin Fall Run	+3	+4
Spring Run	+4	+6
Late Fall Run	+5	+6
Winter Run	+5	+6
Eastside Tributaries	+4	+6

The analysis indicates that in most cases substantially greater benefits can be expected from the long term actions than from the Stage 1 actions, and that long term actions fall in the highest category of recovery probability, except for San Joaquin fall run.

The next step in the analysis was to estimate benefits for harvest actions. The September 9 1998 minutes of the Harvest Management Team indicates that they concluded that over the next seven years new regulations will warrant a +6 score for salmon, indicating the regulations are likely to be sufficient to achieve recovery goals. We used that value in our analysis.

An important issue in integrating benefits over the three types of actions is the relative weight to be given to each type of action. After testing for sensitivity within the range of weighting factors the team considered reasonable, the team adopted the weighting factors indicated in Table 3. These factors reflect the team's judgement that Delta conditions are more important for salmon from the San Joaquin system than for those from the Sacramento system, reflecting their more direct exposure to the export system under today's conditions.

Table 3. Weighting factors for various types of actions for use in computing overall benefits of CALFED actions on salmon populations.

Type of Action	Sacramento System Salmon	San Joaquin System Salmon	Eastside Tributary Salmon
Upstream Action	0.5	0.4	0.4
Delta Actions	0.3	0.4	0.4
Harvest Actions	0.2	0.2	0.2

Tables 4 and 5 illustrate the approach used in integrating salmon benefits over all CALFED actions using the Delta actions for new scenario.

Table 4. Details of Integration of Benefits over All CALFED Actions for new scenario - Upstream Actions include all actions over the life of the CALFED Program.

Salmon Run	Long-term Upstream Actions	Delta Actions	Harvest Actions	Weighted Average
Sacramento Fall Run	+6	+2	+6	+5
San Joaquin Fall Run	+4	+3	+6	+4
Spring Run	+6	+2	+6	+5
Late Fall Run	+6	+2	+6	+5
Winter Run	+6	+2	+6	+5
East-Side Runs	+6	+3	+6	+5

Table 5. Details of Integration of Benefits over All CALFED Actions for the new scenario and Stage 1 Upstream Actions

Salmon Run	Stage 1 Upstream Actions	Delta Actions	Harvest Actions	Weighted Average
Sacramento Fall Run	+3	+2	+6	+3
San Joaquin Fall Run	+3	+3	+6	+4
Spring Run	+4	+2	+6	+4
Late Fall Run	+5	+2	+6	+4
Winter Run	+5	+2	+6	+4
East-Side Runs	+4	+3	+6	+4

The same approach was used in evaluating the integrated benefits for each of the other CALFED alternatives, using the summary scores from the summary table for salmon on page 14 of the

June 25, 1998 DEFT report. The weighted averages are shown in Tables 6 and 7. They indicate that the overall benefits of CALFED actions as currently envisioned will ultimately be greater for salmon from the Sacramento System and Eastside tributaries than for those from the San Joaquin, and that much of the difference will be due to actions upstream from the Delta implemented after Stage 1.

Table 6. Comparison of Benefits Integrated over CALFED Actions Upstream of the Delta, in the Delta, and Harvest Regulations for Salmon from the Sacramento System. Table contrasts differences between Stage 1 actions upstream of the Delta and All proposed actions upstream of the Delta.

Alternative	Stage 1 Upstream Actions, plus Delta and Harvest Actions	All Upstream Actions, plus Delta and Harvest Actions
Alternative 1 Without Storage	+3	+5
Alternative 2 Without Storage	+2	+4
Alternative 3 Without Storage	+3	+5
New Scenario Without Storage	+3	+5

Table 7. Comparison of Benefits Integrated over Actions Upstream of the Delta, in the Delta and Harvest Actions for Salmon from the San Joaquin System. Table contrasts results with upstream Stage 1 actions and all upstream actions.

Alternative	Stage 1 upstream, plus Delta actions + Harvest actions	All upstream actions plus Delta Actions plus Harvest actions
Alternative 1 Without storage	+3	+4
Alternative 2 Without Storage	+4	+4
Alternative 3 Without Storage	+4	+4

New Scenario Without Storage	+4	+4

Table 8. Comparison of Benefits Integrated over Actions Upstream of the Delta, in the Delta, and Harvest Actions for Salmon from the Eastside Tributaries. Table contrasts results with upstream Stage 1 actions and all upstream actions.

Alternative	Stage 1 upstream, plus Delta actions + Harvest actions	All upstream actions plus Delta Actions plus Harvest actions
Alternative 1 Without Storage	+4	+4
Alternative 2 Without Storage	To be Added	To be Added
Alternative 3 Without Storage	To be Added	To be Added
New Scenario Without Storage	+4	+5

Table. Logic behind the derivation of scores for new scenario.

	Alternative 1 Matrix Score	Assigned Score	New Scenario Matrix Score	Assigned Score
Sacramento River System	-23	2	-20	2
San Joaquin River System	-35	2	-20	3
Eastside Tributaries	-28	2	-14	3

File: salrept3.wpd

DIVERSION EFFECTS ON FISH

APPENDIX B

EVALUATION FOR STRIPED BASS

Introduction-Evaluation Team and Process:

The DEFT evaluation team for striped bass met twice to evaluate the DEFT-NONAME operations study and the potential population impact on striped bass. The first meeting (9/10/98) raised questions about the process and the charge. The second meeting (9/11/98) was more productive because we had a clearer picture of the charge and a new set of operations studies depicting changes from existing conditions. We used the diversion impacts of the alternatives based on information provided in the Preliminary Analysis of Delta Hydrodynamic Studies CALFED/DEFT Alternatives (dated 9-10-98) and Preliminary Analysis of Delta Operation Studies CALFED/DEFT Alternatives (dated 9-10-98) to evaluate the changes relative to existing conditions that would affect striped bass. We scored these in a matrix as was done in the previous evaluation for existing conditions (baseline).

The striped bass evaluation is based on a review by biologists with knowledge of the striped bass population and historic relationships of egg and larva distribution and abundance, young-of-the-year abundance, and adult abundance in relation to estuarine conditions and historic changes. Since this effort was done with little advance notice and only a few hours were allotted to completion of the effort, the only participants were David Kohlhorst, Lee Miller, and Donald Stevens (Department of Fish and Game).

Overall we concluded that this modified version of the Through-Delta Alternative is a substantial improvement over existing conditions (see scores for existing conditions unweighted and weighted in Appendix 1 and the DEFT-NONAME conditions in Appendix 2). The weighted score of -88 was an improvement of about two-thirds over the existing condition score of -248. Note that these are both negative scores, indicating that this version of the Through-Delta Alternative has negative impacts and does not "restore" the striped bass population in the estuary.
The main points leading to our conclusions are:

- Greater positive (downstream) QWEST in April- June would reduce entrainment by transporting striped bass downstream away from the influence of the export pumps and agricultural diversions in the Delta.

- Exports and entrainment losses in April-June are reduced compared to existing conditions.

- Higher exports and entrainment losses in August and September, particularly in dry and critical years when the proportion of bass is higher in the Delta, was discounted to some extent because the actual magnitude of losses then and the time value of these fish is poorly understood and needs more evaluation than was possible in the short time available.

We scored this alternative in relation to existing conditions on the DEFT scale of -3 to +7 as described in the DEFT Report, *Diversion Effects on Fishery Populations Issues and Impacts* prepared by the DEFT in June, 1998. The table of scores is included here for comparison, although the underlying conditions, level of development specified and assumptions of model runs may make these comparisons defective. Scoring of uncertainty levels were changed on some of the previous scores to reflect the consensus of the team.

Striped Bass

Alternatives	**Striped Bass**
Existing Conditions	Score: 0 Uncertainty: NA • Major entrainment of young life stages
Through Delta DEFT-NONAME	Score: 2 Uncertainty: 2 • higher QWEST flow for April- June results in less entrainment • Exports and entrainment losses for April-June are reduced compared to existing conditions. • Higher exports and higher entrainment losses in August and September.
No Action	Score: -1 Uncertainty: 2 • Major entrainment of young life stages
Common Programs	Score: +1 Uncertainty: 2 • Uncertain benefits of habitat improvements • Uncertain benefits/detriments of water quality improvements • In-Delta screening benefits juveniles
Alternative 1	Score: +1 Uncertainty: 2 • Increased entrainment of young life stages over existing conditions • Decreased mortality of entrained juveniles • QWEST not improved
Alternative 2	Score: 0 Uncertainty: 3 • Potential increased entrainment of eggs & larvae (north and south Delta) • Transport flows for eggs and larvae possibly decreased and mortality increased • Decreased mortality of entrained juveniles • Improved QWEST • Adult passage problems and detrimental change in spawning location
Alternative 3	Score: +3 Uncertainty: 3 • Potential increased entrainment of eggs & larvae at Hood • Reduced entrainment of eggs, larvae and juveniles from the Delta • Transport flows for eggs and larvae possibly decreased and mortality increased unless strategic curtailments implemented. • Improved QWEST and Delta nursery habitat.

DIVERSION EFFECTS ON FISH

APPENDIX C

EVALUATION FOR
DELTA SMELT

INTRODUCTION

The delta smelt team consists of Michael Thabault, U.S. Fish and Wildlife Service, Larry Brown, U.S. Bureau of Reclamation, Dale Sweetnam, Department of Fish and Game, and Chuck Hanson, State Water Contractors. Those who participated in the creation of the first draft of the matrices include Michael Thabault, Larry Brown, Bruce Herbold, and Dale Sweetnam.

The team asked to evaluate a series of model runs named NoName+DEFT (1995 LOD) in relation to existing conditions (1995 LOD) and a series of model runs representing conditions under NoAction (2020 LOD), Alt 1C (2020 LOD), Alt 2B (2020 LOD) and Alt 3X (2020 LOD). Results of the previous analyses are reported in "Diversion Effects on Fish: Issues and Impacts" dated June 26, 1998.

The NoName+DEFT (1995 LOD) model runs were evaluated by scoring potential impacts of each diversion effect on delta smelt in relation to the previous analyses of the other alternatives. The scale of each matrix box ranges from +3 to -3 which expresses the relative impact of the effects identified that would affect delta smelt in relation to water diversions. Entries were based on a qualitative discussion of the degree to which operations or proposed operations impact the delta smelt population. The values in each box represent the combination of two estimates on the part of the Team: 1) the potential effect on the delta smelt population if exposure occurs, and 2) the probability that the population will be exposed. The delta smelt matrices were once again divided into ?wet years? and ?dry years? because distribution is strongly tied to hydrologic conditions and the effects (positive or negative) of potential actions in the delta potentially would be dampened in ?wet years?.

LIMITATIONS AND QUALIFICATIONS

Extreme care must be taken when interpreting these results since the Level of Demand (LOD) between the NoName+DEFT Scenario model runs and the previously evaluated Alternative model runs is different. This difference has the potential to either mask or exaggerate differences between model runs.

This evaluation was based on the series of model runs dated 9/4/98. These model runs included regression equation estimates of some parameters. Due to the lack of adequate time for review, the actual DWRSIM model runs dated 9/10/98 have not been completely evaluated and may dramatically change some scores in the matrix.

Structural changes to be implemented under Stage 1 have not been adequately evaluated. Proposed structural changes such as a new Hood diversion or new fish screening facilities the CVP and SWP were not evaluated, however, scores for predation at Clifton Court Forebay were increased since the majority of water is proposed to circumvent the Forebay. No analysis of the effects of the barriers in the southern delta (either the Head of Old River Barrier or the agricultural barriers) was done.

The "Common Programs" were not reevaluated as to what proportion of the projects proposed would be accomplished in the first 1-7 years, therefore a much more extensive evaluation of the positive and/or negative benefits must be completed. The NoName+DEFT matrices are presented both with and without the common programs so that the effect of the scenario itself may be judged.

In addition, the entire Delta Smelt Team has not had enough time to adequately review some of the results and conclusions presented in this evaluation. Therefore, a revision of the analyses and conclusions presented here may be submitted at a later date.

SUMMARY MATRIX

	Delta Smelt -Water Year Type	
Alternative	Wet	Dry
Existing Conditions [1]	Score: 0 Uncertainty: 2 - Baseline condition	Score: 0 Uncertainty: 2 - Baseline condition
No Action	Score: -1[2] Uncertainty: 3 - Negative effect because of increased diversion to meet increasing demand.	Score: -1 Uncertainty: 3 - Negative effect because of increased diversion to meet increasing demand.
Common Programs	Score: +2 Uncertainty: 3 - Positive benefit is hypothesized for increased shallow-water habitat. - Positive benefit is hypothesized for consolidation and screening of agricultural diversions.	Score: +2 Uncertainty: 3 - Positive benefit is hypothesized for increased shallow-water habitat. - Positive benefit is hypothesized for consolidation and screening of agricultural diversions.
Alternative 1	Score: +1 Uncertainty: 3 - The Common Programs provide the only positive benefit.	Score: +2 Uncertainty: 3 - The Common Programs provide the only positive benefit.
Alternative 2	Score: +1 Uncertainty: 3 - The Common Programs provide the only positive benefit. - The changes in conveyance and resulting hydrodynamics will negatively effect all life stages.	Score: +1 Uncertainty: 3 - The Common Programs provide the only positive benefit. - The changes in conveyance and resulting hydrodynamics will negatively effect all life stages.
Alternative 3	Score: +4 Uncertainty: 3 - Positive benefits of Common Programs. - Reduced entrainment. - Improved hydrodynamics.	Score: +5 Uncertainty: 3 - Positive benefits of Common Programs. - Reduced entrainment. - Improved hydrodynamics.
NoName+ DEFT (1995 LOD)	Score: +2 Uncertainty: 3 - Reduced entrainment. Improved hydrodynamics - Positive benefits of Common Programs (see Limitations).	Score: +3 Uncertainty: 3 Reduced entrainment. Improved hydrodynamics in South Delta. Improved X2 position. Positive benefits of Common Programs (see Limitations).

[1] Existing conditions for wet and dry conditions are not the same. Existing conditions for dry years are worse than for wet conditions. Do not compare across the columns.

[2] The negative effect for both year types is actually less than a full unit. The -1 simply implies a slight negative effect, in this case only.

NONAME+DEFT (1995 LOD) SCENARIO

Entrainment: Reductions in the negative effects of entrainment observed in the previous analyses of Alternative 2 were observed from January through June. The mechanisms for these reductions are due to the reduction of the E/I ratio and expanded Vernalis Adaptive Management Plan (VAMP) for 61 days.

The predation of delta smelt in Clifton Court Forebay was changed to ?no effect? since all of the water was assumed to go through a new screened diversion before entering the Forebay. Handling losses were not changed since delta smelt usually do not to survive the handling process. It was unclear whether changes in screen efficiencies might increase the amount of delta smelt that would be handled.

Hydrodynamics: : The delta smelt team decided that entrainment and hydrodynamics were highly correlated. For example, under existing conditions, the amount and timing of moving water across the delta (or around it) had a direct effect on the amount of entrainment and predation that a delta smelt would encounter.delta smelt team decided that entrainment and hydrodynamics were highly correlated. For example, under existing conditions, the amount and timing of moving water across the delta (or around it) had a direct effect on the amount of entrainment and predation that a delta smelt would encounter.

The effects of project related hydrodynamics on delta smelt occur mainly in the spring and summer months when pre-spawning adults move upstream to spawn and young-of-the-year delta smelt are present in freshwater before migrating to brackish water in the summer. The rest of the year, delta smelt are usually associated with the low salinity areas of the estuary west of the Delta, primarily Suisun and Grizzly bays. The negative effects of hydrodynamics in dry years are stronger and longer in duration than in wet years.

Cross-Delta Flow: In both wet and dry years cross delta flow patterns were similar to existing conditions and therefore score the same. Differences in October would not affect delta smelt since the majority of the population would be downstream of the delta at this time.

Qwest: In wet years, Qwest conditions were similar to existing conditions. In dry years, positive or nearly positive flows were scored higher in April, May and June. Higher negative flows in August were scored lower.

Old River @ Bacon Island: In wet years, flows in Old River were comparable to existing conditions during the winter and approximately 1,000 cfs greater than modeled for Alternative 2. Flows in March through June were positive and higher than existing conditions. Reverse flows in July, August, and September were greater than existing conditions.

Reductions in negative flows in dry years by up to 2,000 cfs in the winter and early spring result in better habitat conditions for delta smelt in the southern delta. Reverse flows in the months of December, February, and April were less than existing conditions.

Sac River @Rio Vista: Sacramento River flow is strongly positive during wet years with no effect expected on delta smelt. Sacramento River flow will be dramatically lower in dry years. Flows in June and July may be reduced by as much as 50% which may have a strong negative effect on the population, which is often situated, in the lower Sacramento River in dry years.

San Joaquin River @ Antioch: In dry years, positive flows in the lower San Joaquin create better habitat conditions than existing conditions.

Predation: Same score as Alternative 2. There was NO change in the scoring of the ?Common Programs? which were given on the basis of 30 years of the proposed restoration projects completed.

Food Supply: Same score as Alternative 2. There was NO change in the scoring of the ?Common Programs? which were given on the basis of 30 years of the proposed restoration projects completed.

Shallow/Nearshore Habitat: Same score as Alternative 2. There was NO change in the scoring of the ?Common Programs? which were given on the basis of 30 years of the proposed restoration projects completed.

Water Quality (Salinity/ X2 Position): In wet years, the salinity gradient has little effect on delta smelt except in the summer months when outflow declines and the gradient moves upstream into the delta. Export to inflow ratios and export restrictions in April and May appears to slow the movement of X2 into the delta by up to 1-2 km in the months of April, May and June. In dry years, the effects of changes in the E/I ratio and export restrictions (VAMP) on salinity may be much longer and last from December through May. Improvements in X2 position of up to 5 km move the average X2 position below the confluence in dry and critical years.

Agricultural Diversions: Same score as Alternative 2. There was NO change in the scoring of the ?Common Programs? which were given on the basis of 30 years of the proposed restoration projects completed which includes screening.

DIVERSION EFFECTS ON FISH

APPENDIX D

EVALUATION FOR
HARVEST MANAGEMENT

Introduction

An interagency and stakeholder committee was formed to address the technical issues related to harvest management and species recovery under the CalFed Bay Delta program. The general objectives of the work group included:

- Review ocean harvest management and possible actions that could assist with species recovery.
- Determine what percentage ocean harvest could contribute to recovery.

The DEFT also provided more specific objectives for the work group to complete:

- Determine the relationship between the Central Valley Harvest Rate Index and actual harvest rates.
- Summarize existing fishing regulations.
- Identify potential additional harvest management actions over the next seven years.
- Evaluate cohort replacement rates as a tool to gage species recovery.
- Provide an assessment of how fishing regulatory actions would contribute towards species recovery.

To develop the information requested by the Diversion Effects on Fish Team (DEFT) a work group was formed that consisted of the following agency/stakeholder representatives:

Joe Miyamoto (Acting Chair), East Bay Municipal Utility District
Dan Viele, National Marine Fisheries Service
Gary Stern, National Marine Fisheries Service
LB Boydstun, California Department of Fish and Game
Alan Baracco, California Department of Fish and Game
Zeke Grader, Pacific Coast Federation of Fishermen's Association
Bill Kier, Consultant for Pacific Coast Federation of Fishermen's Association
Peggy Beckett, Golden Gate Fishing Association
Roger Thomas, Charter Boat Fishing Association
Rick Sitts, Metropolitan Water District of Southern California
Jim Buell, Consultant for Metropolitan Water District of Southern California
Terry Mills, CalFed staff
Serge Birk, Central Valley Project Water Association

The work group held two meetings on August 27, 1998 and September 4, 1998 at the Resources Building in Sacramento.

Harvest Management Issues

The work group was referred to the Bay-Delta Oversight Council briefing paper on harvest management for a summary of the major issues. The primary issues identified in the BDOC paper include the following:

- The identification of the origin and race of any individual ocean caught salmon is problematic and there are no distinguishing characteristics to do so.

- The age structure has changed from spawning runs dominated by four- and five-year old fish to the present dominance of three-year old fish. This change in age structure has diminished the reproductive potential of the stock because egg production increases with age. Older fish are substantially more vulnerable to the fishery and have a higher harvest rate.

- The annual harvest rate index used by the Pacific Fishery Management Council (PFMC) has fluctuated between 0.40 and 0.80 over the past 40 years.

- A PFMC science team in reviewing harvest data, concluded that an increasing trend of harvest may bring the harvest to a level that could not be sustained.

- There is disagreement among fishery experts over the cause of salmon abundance fluctuations in the San Joaquin system. Some experts argue that San Joaquin runs have declined because of overharvest while others point out that population spikes have occurred independent of dramatic decreases in harvest and are responsive to more suitable habitat and hydrologic conditions. Other experts feel this is not the case without some key consistency in relationships using total production rather than just spawning escapement.

- Winter-run chinook salmon have declined despite harvest rates of only one-third the rate of fall-run chinook salmon causing some fishery experts to believe the declines are related to habitat changes.
- Major variations in survival can also be tied to ocean conditions.

- The commercial and sport harvest of salmon is large enough to have a substantial effect on spawning escapement.

- Trends of increased harvest rates, decreased average age of spawners, and failure to meet spawning escapement goals raise “serious questions and concern” if the salmon stocks are being overharvested. The BDOC report states: “At a minimum, the evidence would seem to dictate a need for more effective regulation of harvest to meet spawning escapement goals.”

Current Management Authority and Process

The existing harvest management regulatory process is under several state and Federal authorities including the State Legislature, Fish and Game Commission, Pacific Fishery Management Council, and Endangered Species Act. In California, the Fish and Game Commission regulates the sport harvest while the legislature regulates the commercial harvest through the Director of the Department of Fish and Game. The US Department of Commerce regulates the ocean harvest to protect species within the Federal fishery management and conservation zone. The PFMC is made up of representatives from the resource agencies and the commercial and recreational fishing interests. The Endangered Species Act (ESA) provides an umbrella management authority over the other regulatory processes.

The CVI has not constrained the ocean fisheries. The ocean troll fishery has been restricted by regulations to protect weak Oregon coho stocks and to allocate catch for tribal harvests of Klamath River chinook salmon. The sport fishery has been constrained by size limits and time and area closures to protect two-year-old winter run chinook salmon. These restrictions have protected other Central Valley stocks that need focused attention such as San Joaquin fall-run and spring-run chinook salmon.

The Fisheries Management Plan provides for a Central Valley wide spawning escapement goal of between 122,000 to 180,000 adult salmon. The harvests are set on the basis of a CVI model which predicts the adult return from the previous years jack counts.

Because of increasing restrictions on the ocean fishery, the number of active salmon trollers has greatly decreased. Those troll vessels that accounted for 90% of the landings has decreased from 2,000 vessels in 1978 to less than 400 in 1997. The ratio of commercial to sport landings is three to one. The recreational harvest targets two-year old fish while the commercial catch targets three-year olds salmon.

Central Valley Harvest Rate Index

The work group discussed the relationship between the Central Valley Index and actual harvest rates. Catches which are a part of the index include only those catches south of Point Arena, although historically, over one-half of the harvest may have occurred in this area. In addition, ocean conditions such as El Nino may distribute the Central Valley stocks so they are more vulnerable to Oregon fisheries. Given these factors, the catch used in the CVI Harvest Rate may be low compared to the actual harvest.

The spawning escapements used in the index include both hatchery and wild or natural salmon stocks. However, not all escapements from Central Valley streams are incorporated in the index.

There have been several attempts to compute true harvest rates. Robert Cope in his PhD thesis computed harvest rates for Central Valley fall-run chinook salmon. NMFS has computed separate harvest rates on winter run chinook salmon on the basis of coded wire tag recoveries. CDFG evaluated coded wire tag recovery information from the Coleman National Fish Hatchery to determine an exploitation rate. Based upon this cursory analysis, the actual exploitation rates were consistently lower than the CVI harvest rate index by 10 to 20%. The methodology used by CDFG is based primarily on three-year-old fish which are fully vulnerable to the fishery.

One member of the work group questioned why there was so much of an emphasis on harvest rates. He noted there are other important factors such as sustainability of the population and a complete assessment would evaluate all sources of mortality including man induced and natural mortality.

Based upon information from a coded wire tagging recovery group, the following data might be included in an assessment of salmon exploitation rates:

- Estimate of actual harvest.
- Estimate of non-catch mortality.
- Inland harvest and associated non-catch mortality.
- Illegally taken salmon.
- Estimate of natural mortality.
- Spawning escapement (including straying)
- Man induced mortality different than harvest.

While the CVI provides information on trends of harvest and abundance, additional harvest management tools are needed to address the reproductive capacities of the different stocks. The work group agreed that it would be useful to develop a new management tool separate from the CVI for managing the ocean fishery. Some of the new tools might utilize exploitation rates, genetic analysis, and ocean stock distribution.

Cohort Replacement Rates and Recovery Goals

CalFed is using fish population dynamics models to evaluate the CalFed restoration actions. These methods include a review of fishery population trend data, cohort replacement rates, and extinction modeling. The work group discussed the adequacy of using a cohort replacement rate > or equal to1.0 in meeting other goals such as the winter-run recovery goal or the CVPIA fish doubling goal. The CVPIA doubling goal was legislatively mandated and the State' goal is to double the fish population over the 1980 levels of abundance. The CalFed goal is to exceed the recovery goals and also to provide a sustainable harvest. Both of these goals need to be reviewed in terms of habitat carrying capacity.

For the purposes of evaluating the adequacy of other goals for meeting the ESA recovery goals, NMFS will review the adequacy of the existing regulatory requirements. Using escapement data from 1989 to 1993, NMFS computed the cohort replacement rate (CRR) for winter run chinook salmon and determined that a CRR 1.7 would provide an 80% probability that the CRR would be at least 1.0 in any given year. This targeted goal assumes recovery will occur by the year 2015.

The use of average cohort replacement rates by CalFed may be of limited value because a high CRR does not mean the population is in good shape. CRRs should be limited as indicators of how well we are managing the fishery and habitat and to examine trends in species abundance.

Additional Data Requirements

The work group discussed a number of areas where data could be improved for managing the ocean harvest. These data needs include the following:

- A more comprehensive inland cwt recovery program.
- Ocean catch distribution of weak stocks.
- More complete carcass surveys to determine natural spawning escapement.
- More accurate counts of hatchery fish escapement.
- Estimates of harvest rates of stocks of management concern.
- Studies to determine the size range and length frequency of jack salmon based upon scale samples from naturally spawning fish of different stocks or races.
- Expanded DNA microsatellite marker research.
- More accurate stock composition projections.

In addition to these data requirements, the following actions were thought to be beneficial.

- Review the practice of trucking fish to the western Delta.
- Don't allow surplus hatchery fish to spawn naturally or be returned to the river.
- Expand cwt constant fractional marking programs.

Actions that Might Benefit the Recovery of Weak Stocks

The work group discussed the limitations of a selective fishery that would protect weak salmon stocks. For this program to work, the majority of the fish available for harvest would have to be hatchery fish. If there is not an abundance of hatchery fish, then too many fish would have to be handled in order to sustain a fishery. The estimated hooking mortality rate for sport caught released fish is 37% based on the use of barbless circle hooks in a mooching fishery. This hooking mortality rate could be further reduced by prohibiting mooching in recreational fisheries.

A "bubble fishery" could be explored as a method to protect weak stocks, however, other genetic markers are needed for the other salmon stocks before this method could be applied on a more wide spread scale. In 1997 a bubble fishery was conducted near San Luis Obispo and the fishery was shut down after only two days of fishing based upon the results from DNA microsatellite analysis which indicated fishermen were taking a substantial number of winter-run chinook salmon. The DNA microsatellite marker analysis provided a powerful tool to protect a weak salmon stock. One major limitation, however, with using just stock composition data for in-season management is that it still does not provide the relative strengths of the runs because the in-season data cannot be expanded to stock size.

The work group noted that ocean protections for spring and winter-run chinook salmon are possible because of life history time differences with fall-run, but San Joaquin fall-run could not be protected on a similar basis.

Summary of Existing Regulations

During the period from 1971 to 78, there were few changes to the ocean fishing regulations. The first major changes did not occur until 1979 in response to changes in Federal law. The next set of major changes in ocean harvest regulations occurred in

1983 in response to the need to meet tribal harvest allocations on the Klamath River. A copy of the summary of the fishing regulations is attached.

Anticipated Regulatory Changes over the Next 7 – 10 Years

While potential new regulatory actions were hard to define, the work group thought there would be greater specificity in the management of the ocean fishery. There may be more micro-management and new tools available to manage the fishery. Future regulations may be more flexible in time based upon ocean conditions. There may be increases in efficiency of fishing methods that will reduce the amount of bycatch (non-target species or races). The work group concluded that any evaluation of future fishing regulatory actions is really an evaluation of the regulatory process.

Contributions of Harvest Management Actions Towards Species Recovery

The work group assigned scores to the list of existing and potential fishing regulatory actions. (see attached table). The work group used the following scoring criteria:

1 –2 = Regulations are inadequate to contribute to recovery goals.
3 – 5 = Regulations may be sufficient to contribute to recovery goals.
6 –7 = Regulations will likely contribute to recovery goals.

The winter run goal in the scoring matrix is a de-listing goal. The recovery goals for spring-run and San Joaquin fall-run are from the Native Fishes Recovery Plan. In addition to these goals there are also CVPIA mandated doubling goals that go well beyond the ESA recovery goals.

The following assumptions were made in scoring the matrix:

- Genetic analysis can be used as a management tool on a post season basis only.
- Because of the lack of stock separation by time and area, selective fisheries offer few opportunities toward recovery of spring and fall-run chinook salmon
- Protection of winter, spring, and SJ fall-run chinook in a selective fishery relying on a 100% hatchery fish mark is based upon a target fishery on marked fall-run chinook salmon (few winter and spring-run chinook are tagged). There is a high assumed hook and release mortality with this option. This option would be expensive to implement but the group did not consider economics in their assessment.

In scoring new regulatory actions, there is a high comfort level that the existing regulatory process will protect weak stocks.

The work group had diverse opinions over the adequacy of existing fishing regulations to protect San Joaquin fall-run chinook salmon. At least some members of the group felt that a much lower score was warranted based upon a dramatic decrease in abundance of San Joaquin River stocks between 1988 and 1991. Other members of the work group felt that this decline was due to drought conditions. This drought was statewide and may have equally affected all Central Valley chinook salmon runs.

Better Management Tools

To improve ocean harvest management, the workgroup discussed the following tools and data needs:

- Development of stock specific exploitation rates.
- More complete spawner carcass surveys. The discrepancy between the RBDD counts and carcass survey based estimates for winter-run chinook is one example to justify this action.
- Genetic based mixed stock fishery analysis.

While the development of stock specific exploitation rates may be a resource agency responsibility, CalFed should consider funding this task with existing Category III funds.

Life Cycle Models

In order to gain a better understanding of the interrelationship between harvest, habitat, and water management requirements, a life cycle model is needed. Current efforts to develop a life cycle model include the USFWS efforts to revise the CPOP life cycle model, Pete Lawson is developing a habitat based model for coho salmon, and the IEP Salmon Work Team is developing a salmon conceptual model. More focused models on a given life stage include the USFWS salmon smolt survival model and the Newman Rice version of the same model. The CPOP model was developed to simulate changes in salmon population abundance in response to changes in habitat, toxics, and harvest. The model was never used and users were cautioned that they should not rely on the model output and the usefulness of the model is for comparison purposes only. An updated version of the model for all races of Sacramento River chinook salmon is currently under review by the USFWS (Wim Kimmerer, personal communication).

CONTRIBUTIONS OF HARVEST MANAGEMENT ACTIONS TOWARDS SPECIES RECOVERY

ACTION	WINTER RUN CHINOOK	SPRING RUN CHINOOK	SAN JOAQUIN FALL-RUN CHINOOK
Recovery/Restoration Goal	20,000 (10,000 females) (Delisting Goal)	8,000 Wild Spawners 500 Mill Creek 500 Deer Creek[1]	20,000 Median Escapement for Stanislaus, Tuolumne, and Merced[1]
Existing Fishing Regulations	**6,2**	**4,1**	**4,2**
New Regulations Over the Next Seven Years	**6,2**	**6,2**	**6,2**
Genetic Analysis	**7,3**	**6,2**	**6,1**
Selective Fishery (Time/Area)	**6,2**	**4,2**	**2,2**
Selective Fishery (100% Hatchery Fish Mark)	**5,2**	**5,2**	**6,2**
Improved Gear or Method & Use	**4,2**	**4,2**	**4,2**
Better Management Tools	**6,2**	**6,2**	**6,2**

[1] From San Francisco Bay Native Fishes Recovery Plan

Scoring Criteria:
- 1 – 2 = Regulations are inadequate to contribute to recovery goals
- 3 – 5 = Regulations may be sufficient to contribute to recovery goals
- 6 – 7 = Regulations will likely contribute to recovery goals

Levels of certainty are:
- 1 = low certainty
- 2 = moderate certainty
- 3 = high certainty

DIVERSION EFFECTS ON FISH

APPENDIX E

EVALUATION FOR HABITAT