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

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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

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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