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CALFED DIVERSION EFFECTS ON FISH TEAM
Subcommittee on Harvest Management

Draft dated October 5, 1998

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 the recovery of Central Valley salmon stocks.
- 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 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

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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.

The Harvest Management Issues

The first organized commercial fishery in the Sacramento-San Joaquin River system was developed between 1848 and 1850. Chinook salmon were taken in gill nets and seines in the rivers, Delta, and the Bay. The ocean salmon fishery developed in the 1890s and early 1900s largely replaced the river fishery ~~and may have further contributed to the depletion of Central Valley chinook salmon stocks.~~ Although harvest has certainly contributed to the depletion of California salmon populations, ~~the~~ other causes ~~primary reason~~ for their decline has been the degradation and loss of freshwater spawning, rearing and migration habitats.

One of the issues is that t~~T~~he resiliency of the salmon population to respond to more favorable freshwater and estuarine habitat under CalFed, ~~however,~~ will depend in part, upon ocean harvest rates. Ocean harvest ~~Management of the ocean fishery~~ has resulted in a shift in the age composition of most Central Valley salmon runs from a predominance of four and five-year old spawners to three-year old fish. The change in age structure has decreased the reproductive potential of the stock because egg production increases with age. ~~Consequently, the ability of salmon populations to meet the CalFed restoration goals is highly dependent upon the level of ocean harvest.~~

The main issue for the California commercial fleet is how to maintain fishing opportunity to access abundant Central Valley hatchery stocks in the face of ESA listings and competition. Commercial landings currently account for about 70% of the catch off California. Increasing restrictions on the ocean fishery, coupled with price competition from farmed salmon, have resulted in a decline in the number of active salmon trollers. The number of troll vessels that accounted for 90% of the landings has decreased from 2,024 vessels in 1978 to 375 in 1997. Average annual harvests off California, which in the 1960s and 70s were 1,025,000 salmon, dropped during the 1980s to 856,000 and have declined further during the 1990s to 586,000. Commercial effort off California averaged 59,000 fishing days annually during the 1980s. Commercial effort in 1997 was a record low 18,700 fishing days, although 487,500 chinook salmon were still landed. This data indicates that while the number of vessels had declined, the fleet still has the potential for large harvests and high harvest rates. ~~The main issue for the California commercial fleet is how to maintain fishing opportunity to access abundant Central Valley hatchery stocks in the face of ESA listings.~~

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 (PFMC) and the Magnuson-Stevens Fishery Conservation and Management Act. In California state waters, 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 salmon harvest in federal waters (3-200nm) and is responsible for implementing the Magnuson Act consistent with other applicable law, including the federal Endangered Species Act (ESA). The PFMC is made up of representatives from the resource agencies and the commercial and recreational fishing interests. The ESA provides an umbrella management authority over the other regulatory processes.

Under its salmon Fisheries Management Plan (FMP), the PFMC develops annual management measure recommendations for the ocean fishery off the coasts of California, Oregon and Washington. In developing the management recommendations, the PFMC analyzes proposed federal and state management options in the ocean, estuary, and freshwater areas. The PFMC makes recommendations to the Secretary of Commerce on a management regime for the ocean salmon fishery. If the Secretary approves the recommendations, he implements the management measures in federal waters as regulations issued by the U.S. Department of Commerce. The states of California, Oregon, and Washington manage their waters consistent with the management scheme approved by the Secretary of Commerce.

Central Valley Harvest Index

The Central Valley Index (CVI) is a relative measure of stock strength for Central Valley chinook stocks. The CVI is the sum of ocean chinook harvests in areas south of Point Arena and the Central Valley spawning escapement of hatchery and naturally spawning adult chinook salmon of all races into the Sacramento and San Joaquin river systems in the same year. The CVI is not a true measure of stock abundance since some fraction of Central Valley stocks are caught north of Point Area and some fraction of the South of Arena catch are salmon that do not originate from the Central Valley. The CVI is predicted by regressing the CVI on the in-river age-2 chinook of the previous year. Once the CVI is estimated, a harvest rate on CVI (CVI harvest index) is computed as the landings south of Point Arena divided by the CVI of the same year. The CVI harvest index is an indicator of the relative impact of the ocean fishery harvest on salmon stocks in any given year. Any specific numerical value for the CVI, or for the CVI harvest index, should recognize variability in the fisheries. Between 1970 and 1990, for instance, the exploitation index varied between 0.50 and 0.79 with essentially the same fisheries operating on the population. The uncertainty in CVI abundance projections and the absence of actual exploitation rates on Central Valley chinook will continue as long as no program to measure actual stock strength and exploitation rates is instituted.

In order to determine the actual ocean harvest impact rates, it is necessary to estimate both the number of coded-wire-tagged (CWT) salmon that are harvested by ocean fisheries and the number which were available to ocean fisheries, which is usually estimated through cohort reconstructions based on spawning escapement estimates.
There have been several attempts to compute true harvest rates. Robert Kope in his Ph.D. thesis computed harvest rates for Central Valley fall chinook salmon. NMFS has computed separate harvest rates on winter 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 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 would 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 desirable 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

Fish population dynamics models can be developed to evaluate the CalFed restoration actions. Options ~~These methods~~ include a review of population trend data, cohort replacement rates, and extinction modeling. The work group discussed the adequacy of using a cohort replacement rate (CRR) > or equal to1.0 in meeting other goals such as the winter-run recovery goal or the CVPIA fish doubling goal. A CRR is simply the ratio of a spawning population to its parent spawning population. Populations with CRRs greater than 1 are growing. 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 the PFMC's recommendations for meeting the ESA jeopardy standards , the National Marine Fisheries Service (NMFS) completed section 7 consultations and issued biological opinions in 1991, 1996, and 1997 for winter-run chinook salmon. Beginning in 1996, NMFS required that ocean harvest be reduced sufficiently to provide an adult winter chinook CRR of 1.7. NMFS estimated that a CRR of 1.7 would provide an 80% probability that the CRR would be at least 1.0 in any given year.
The use of average CRRs by CalFed should take into consideration the large natural variation in salmon populations; CRRs are best used as indicators of long term trends.

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:

1. A more comprehensive inland CWT recovery program.
2. Ocean catch distribution of weak stocks.
3. More complete carcass surveys to determine natural spawning escapement.
4. More accurate counts of hatchery fish escapement.

5. Estimates of harvest rates of stocks of management concern.
6. 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.
7. Expanded DNA microsatellite marker research.
8. More accurate stock composition projections.

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

1. Review the practice of outplanting hatchery fish .
2. Don't allow surplus hatchery fish to spawn naturally or be returned to the river.
3. Expand CWT constant fractional marking programs.

Summary of Existing Regulations

During the period from 1971 to 1978, 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 1993 in response to the requirement to meet tribal harvest allocations on the Klamath River. Significant changes in ocean harvest regulations for sport harvest occurred in 1996 to provide for the recovery of the endangered Sacramento River winter chinook salmon. Season lengths have been reduced, minimum size limits increased and gear restrictions imposed. A copy of the summary of the fishing regulations is attached.

The FMP escapement goal for Central Valley stocks is between 122,000 to 180,000 adult Sacramento River salmon, hatchery and natural spawners combined. The harvests are set on the basis of several models which predict the abundance and effects of harvest on numerous west coast salmon stocks. In recent years, the abundance of Central Valley fall chinook has not been a limiting factor in constraining the ocean fisheries off California. Harvest restrictions necessary to protect ESA listed stocks and reduce harvests of Klamath River chinook salmon limit ocean harvest off California to levels below that necessary to achieve Central Valley fall chinook escapement goals. The CVI harvest index was 0.64 and 0.66 in 1996 and 1997 respectively, compared to an average index of 0.74 during the 10 year period between 1986 and 1995.

Actions that Might Benefit the Recovery of Weak Stocks

The work group discussed two types of ocean management which may have the potential to reduce impacts on weak stocks while still providing harvest opportunity: selective harvest of hatchery stocks and structuring ocean harvest seasons and areas to selectively avoid weak stocks.

Selective Harvest of Hatchery Stocks

The mass marking of hatchery-produced salmon has been discussed extensively as a tool for evaluating and improving hatchery practices and as a means to selectively harvest hatchery stocks in the mixed stock ocean fisheries. Selective fisheries, in which marked hatchery fish are landed and unmarked naturally produced salmon are released and allowed to spawn, have been proposed as a solution to the low harvest rates currently required to protect the weakest of the natural stocks. The potential problems associated with a selective harvest of mass marked hatchery salmon include the following: 1) the mortality related to the marking itself; 2) the magnitude of the hook and release mortality of naturally produced salmon in a fishery sorting for hatchery fish; 3) the impact on the current management system which depends on CWT data; 4) the cost of mass marking and monitoring; 5) difficulty in enforcement; and 6) a lack of demonstrated benefits to the fisheries from this untested action. While the states of Washington and Oregon are initiating selective coho fisheries, at this time selective fisheries need further investigation.

Selective Avoidance of Weak Stocks

Fishing seasons are currently structured to avoid impacts on weak stocks. Off California the stocks of concern are winter, spring, and late fall-run chinook, and Klamath fall-run chinook. Winter-run chinook and coho are both listed under the ESA, and the spring-run is listed under the California ESA. ~~Klamath fall chinook.~~ Since 1993, California commercial harvests have been constrained to allow 50% of the available harvest of Klamath fall chinook to be taken by in-river Tribal fisheries. The ability to craft seasons which avoid weak stocks is dependent on knowledge of the ocean distribution of weak and strong runs. The use of genetic identification to provide better information on distribution and stock contribution offers the potential of implementing localized "bubble fisheries" which have little or no impact on stocks of concern. For example, genetic sampling is currently being used to determine the contribution of Klamath fall chinook to the catch in a near-shore commercial test fishery conducted this year in the Bodega Bay area. ~~and~~ Genetic sampling has been used to analyze to contribution of winter chinook and Klamath fall chinook to April commercial fisheries south of Point Sur.

~~The work group~~ Members of the work group noted that ocean protections for spring and winter-run chinook salmon are possible because of run timing differences with fall-run, but San Joaquin fall-run could not be protected on a similar basis. Some of the protection measures for winter-run were based upon establishing minimum size limits which would protect comparatively smaller winter-run chinook salmon. In the case of protecting individual fall-run chinook salmon stocks, there would be too much overlap in size and run timing characteristics that would make stock separation unfeasible.

Anticipated Regulatory Changes over the Next 7 – 10 Years

While potential new regulatory actions were hard to define, members of 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. ~~The~~ Members of the work group also noted that most of the regulatory actions available to fisheries managers are likely to result in additional concessions by ocean fishing interests and would be inconsistent with the CALFED solution principle of "no significant redirected impacts".

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 t~~ The group did not have time to evaluate the cost of this or other options ~~consider economies~~ 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 evaluate and compare the relative contributions to recovery of actions taken to improve fresh water habitat with reductions in harvest mortality, a life-cycle model is needed. Life cycle models generally require detailed information on survival between key life-history stages. They incorporate many complexities, including separation of natural and hatchery production, a juvenile migration, the fate of adults surviving natural mortality (as harvested in several sectors, spawning in natural areas, or returning to the hatchery). As one would expect, life-cycle models require extraordinary levels of detailed information. Habitat-based models attempt to project future population abundance resulting from improved habitat conditions. This requires modeling the relationship between habitat and egg production, instream mortality rates, and smolt production. They incorporate density-dependent first-year survival, and demographic stochasticity in the spawner sex ratio. The approach requires knowledge of streambed morphology, its relation to potential fish density, and data on survival and fecundity rates. There is currently strong interest in developing such models, particularly as applied to Oregon coastal coho; detailed measures of habitat quality have the potential to allow modeling of individual stream reaches.

Current efforts to develop a life cycle model include the CPOP life cycle model, Pete Lawson's habitat based model for coho salmon, and the IEP Salmon Work Team's salmon 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 Central Valley 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) (Score, Certainty level)	8,000 Wild Spawners 500 Mill Creek 500 Deer Creek[2] (Score, Certainty level)	20,000 Median Escapement for Stanislaus, Tuolumne, and Merced[1] (Score, Certainty level)
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**

Scoring Criteria:

- 1 - 2 = Regulations are inadequate to contribute to recover 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

[1] It is important to note that the new regulation actions may not be consistent with the CALFED solution principle of "no significant redirected impacts".

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[2] The score for genetic analysis for San Joaquin chinook is based upon the analyses to date that suggests we can't detect genetic differences between Sacramento and San Joaquin fall-run. The low certainty score applies to our ability to develop this genetic tool. However, if this genetic tool was available, we would have a higher level of certainty that it could work.

[3] From San Francisco Bay Native Fishes Recovery Plan.

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