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SWRCB EXECUTIVE

ISSUES FOR SWRCB INTERIM BAY-DELTA HEARINGS

EVALUATE HOW MUCH WATER THE BAY-DELTA NEEDS FOR ECOSYSTEM HEALTH

Abundance indices calculated by the Interagency Ecological Program (IEP) through 2007 suggest recent marked declines in four pelagic fishes in the upper San Francisco Estuary (the Delta and Suisun Bay). These fishes include delta smelt which is listed under State and federal Endangered Species acts and the longfin smelt, which has been proposed for protection under those acts. Although several species show evidence of long-term declines, the recent low levels were unexpected given the relatively moderate winter-spring flows of the past several years.

The construction and operation of two large water projects, the federal Central Valley Project (CVP), and the State Water Project (SWP) have been especially important to these declines. The potential negative effects of these projects on important fisheries were recognized and extensive efforts were made to mitigate the expected effects. Salmon hatcheries were established below some dams and extensive fish screening facilities were established at the pumping facilities in the Delta (Brown et al. 1996). Despite these efforts, populations of important fish species continued to decline in the San Francisco Estuary and its watershed, culminating in listings of a number of species in the 1990s, including winter-run and spring-run Chinook salmon *Oncorhynchus tshawytscha*, Central Valley steelhead *O. mykiss*, delta smelt *Hypomesus transpacificus*, and Sacramento splittail *Pogonichthys macrolepidotus*.

Coincident with changed water project operations in 2000, state and federal agency scientists became concerned when Fall Midwater Trawl abundance indices for these four pelagic fishes began to decline and deteriorated over the next several years. Abundance indices for 2002-2005 included record lows for delta smelt and age-0 striped bass, and near-record lows for longfin smelt and threadfin shad. By 2004, these declines became widely recognized and discussed as a serious issue, and collectively became known as the Pelagic Organism Decline (POD). Longfin smelt and age-0 striped bass showed some recovery in 2006 but delta smelt and threadfin shad remained at low levels. The abundance of delta smelt is of particular concern because it is listed as a threatened species under both federal and state endangered species legislation.

The IEP scientists have since developed a simple basic conceptual model to describe possible mechanisms by which a combination of long-term and recent changes in the ecosystem could produce the observed pelagic fish declines. This conceptual model is rooted in classical food web and fisheries ecology and contains four major components: (1) prior fish abundance, which posits that continued low abundance of adults leads to reduced juvenile production (i.e., stock-recruit effects); (2) habitat, which posits that estuarine water quality variables, disease, and toxic algal blooms in the estuary affect survival and reproduction; (3) top-down effects, which posits that predation and water project entrainment affect mortality rates; and (4) bottom-up effects, which posit that food web interactions affect survival and reproduction. The California Water Impact

Network [C-WIN] and California Sportfishing Protection Alliance [CSPA] believe that Bay/Delta export pumping controls each of these components and therefore has caused most of the ecological degradation reflected by the POD.

Estuaries are commonly characterized as highly-productive nursery areas for a suite of organisms. Nixon (1988) noted that there actually is a broad continuum of primary productivity levels in different estuaries, which in turn affects fish yield. Compared to other estuaries, pelagic primary productivity in the upper San Francisco estuary is poor and a low fish yield is expected. Moreover, there has been a significant long-term decline in phytoplankton biomass (chlorophyll *a*) and primary productivity to very low levels in the Suisun Bay region and the lower Delta (Jassby et al 2002). Hence, low and declining primary productivity in the estuary is likely a principal cause for the long-term pattern of relatively low and declining biomass of pelagic fishes.

PROBLEM: WHAT CAN THE SWRCB DO ABOUT THIS EMERGENCY SITUATION?

ANSWER: USE THE SWRCB's WATER RIGHTS AND WATER QUALITY AUTHORITY TO RE-REGULATE THE STATE AND FEDERAL EXPORT PUMPS TO CREATE BETTER BAY-DELTA ECOSYSTEM CONDITIONS BY TAKING THE FOLLOWING STEPS:

1. DETERMINE WHETHER THERE WILL BE FISH PASSAGE AT CENTRAL VALLEY WATERSHED RIM DAMS.

WHY: There was very little spawning and rearing habitat for salmonids that existed below the locations of the lowest elevation water user dams on the edge of the Central Valley. Most estimates by government studies indicate that as much as 95% of the natural spawning and rearing habitat for the listed winter and spring run salmon and the Central Valley steelhead has been blocked by dams. There is presently no system of access for these fish to return to their native streams and to the upper elevation deep cold water that would allow the fish to survive on their own as they did before the dams. If access to this important habitat remains blocked, it will be necessary for the SWRCB to dedicate ever increasing amounts of stored, cold water to fish and wildlife needs.

2. DEDICATE RESERVOIR STORAGE FOR ENDANGERED FISH HABITAT.

WHY: Reservoirs are the only source for the cold water that salmon and steelhead depend on for habitat to survive below dams that restrict fish access to historical habitat above them. If fish are to have any chance to survive expected future temperature increases resulting from climate change, reservoir storage must be dedicated to fish habitat or access for fish must be restored to higher elevation habitat with colder water. A program must be designed and executed to protect fish during this drought. The present state of cold water reservoir reserve is insufficient and may result in salmonid extinction unless more of **this winter's water run-off** is dedicated to fish and wildlife in the Central Valley rivers leading into the Bay-Delta estuary.

3. CHANGE HOURLY RESERVOIR FLOW RELEASES.

WHY: Water flow is not only water supply for agriculture and urban California. Water flow is habitat for fish and other aquatic species. Because water users have eliminated much of the natural habitat for salmonids by building dams on Central Valley streams and rivers, salmon and steelhead are trapped in very small areas for spawning and rearing. This year's drought and the high volume water export since 2000 have nearly exhausted reservoir water available to provide habitat for fish and other aquatic species. The SWRCB should use it's authorities under the Clean Water Act, and the Water Code to prevent additional depletion of reservoir storage that risks extinction for salmon and steelhead.

4. CHANGE TEMPERATURE OF RESERVOIR FLOW RELEASES.

WHY: To the extent possible, water storage facilities should be managed to provide cold water for fish during the summer and early fall months. Since the salmon and steelhead are trapped below project dams, they are exposed to unnaturally high water temperatures that can have both lethal and chronic effects. For these fish, cold water is habitat. Without it, they die. The SWRCB must modify rim dam water rights permits to preserve cold water for water year 2009.

5. ESTABLISH ADDITIONAL COLD WATER RESERVOIR STORAGE FOR BAY-DELTA ECOSYSTEM PURPOSES.

WHY? There are several reasons to expect that climate change will have negative long-term influences on pelagic habitat suitability for the POD fishes. First, there has been a trend toward more Sierra Nevada precipitation falling as rain earlier in the year (Roos 1987, 1991; Knowles and Cayan 2002, 2004). This increases the likelihood of winter floods and may have other effects on the hydrographs of Central Valley rivers and Delta salinity. Altered hydrographs interfere with pelagic fish reproduction, which is usually tied to historical runoff patterns (Moyle 2002). Second, sea level is rising (IPPC 2001). Sea level rise will increase salinity intrusion unless sufficient freshwater resources are available to repel the seawater. This will shift fish distributions upstream and possibly further reduce habitat area for some species. Third, climate change models project warmer temperatures in central California (Dettinger 2005). As stated above, water temperatures do not currently have a strong influence on POD fish distributions. However, summer water temperatures throughout the upper estuary are fairly high for delta smelt. Mean July water temperatures in the upper estuary are typically 21-24°C (Nobriga et al. in press) and the lethal temperature limit for delta smelt is about 25°C (Swanson et al. 2000). Thus, if climate change resulted in summer temperatures in the upper estuary exceeding 25°C, delta smelt would have little chance of maintaining viable populations.

Water storage in Shasta and Oroville are approaching historic lows and are at or below 1977 levels now. The principle cause of this shortfall is the cannibalization of north-of-Delta storage over the last several years to supply south-of-Delta storage in Semi-Tropic and Kern water banks and Diamond Valley Reservoir. Unless the approaching water year proves to be extremely wet, next year's instream flows on the Feather, Sacramento and Yuba rivers are likely to approach record lows. These low flows will likely cause and contribute to reductions in spawning and rearing habitat, lethal temperatures and increases in pollutant concentration. Given the dramatic crash of pelagic species and the recent acceleration in the long-term decline in salmonid escapement, these expected low flows could trigger a catastrophic disaster to fisheries already hovering on the edge of extinction.

6. EVALUATE WATER QUALITY IN RIVERS LEADING INTO BAY-DELTA:

WHY: Concern over contaminants in the Delta is not new. There are long standing concerns related to mercury and selenium in the watershed, Delta, and Bay (Linville et al. 2002; Davis et al. 2003). Phytoplankton growth rate may occasionally be inhibited by high concentrations of herbicides (Edmunds et al. 1999). New evidence indicates that phytoplankton growth rate may at times be inhibited by ammonium concentrations in and upstream of Suisun Bay (Wilkerson et al. 2006, Dugdale et al. 2007, Dugdale et al unpublished). Toxicity to invertebrates has been noted in water and sediments from the Delta and associated watersheds (e.g., Kuivila and Foe 1995; Giddings 2000; Werner et al. 2000; Weston et al. 2004). Undiluted drainwater from agricultural drains in the San Joaquin River watershed can be acutely toxic (quickly lethal) to fish and have chronic effects on growth (Saiki et al. 1992). Evidence for mortality of young striped bass due to discharge of agricultural drainage water containing rice herbicides into the Sacramento River (Bailey et al. 1994) led to new regulations for discharge of these waters. Bioassays using caged fish have revealed DNA strand breakage associated with runoff events in the watershed and Delta (Whitehead et al. 2004). Kuivila and Moon (2004) found that peak densities of larval and juvenile delta smelt sometimes coincided in time and space with elevated concentrations of dissolved pesticides in the spring. These periods of co-occurrence lasted for up to 2-3 weeks, but concentrations of individual pesticides were low and much less than would be expected to cause acute mortality. However, the effects of exposure to the complex mixtures of pesticides actually present are unknown.

7. EVALUATE BIOLOGICAL EFFECTS OF SALT INPUT INTO THE BAY-DELTA.

WHY: High levels of salt, as measured at Vernalis, has major potential to damage Bay-Delta agriculture and to cost water users substantial treatment costs at the place of use. The State Board assigned DWR and the Bureau the responsibility for meeting salinity objectives in the 1979 Delta Plan, D-1485 and the 1995 Delta Plan and D-1641. Salinity standards continue to be routinely violated. The San Joaquin River Salinity and Boron TMDL assigns responsibility for controlling salt delivered to the San Joaquin Valley from the Delta to the Bureau. The Bureau's salt load reductions are to be addressed through a joint Management Agency Agreement with the Central Valley Board. Unfortunately, the Bureau is claiming sovereign immunity and, while promising some level of cooperation, refuses to accept specific enforceable load limits that will actually lead to reductions in salt loading to the San Joaquin River.

8. ESTABLISH ORIGIN OF SALT INPUT INTO THE BAY-DELTA.

WHY: The SJR Salt TMDL is a poster child for the failures of the TMDL program to secure improvements in water quality. Salinity problems on the river have been recognized for over a century. The long-delayed salt TMDL is the first 100-foot TMDL in the nation's history, only protecting a short stretch of river below the San Joaquin's confluence with the Stanislaus River. Water quality violations continue to occur upstream of the confluence and downstream below Vernalis: this despite the fact that EPA regulations and the Central Valley Board's Basin Plan require that standards must apply throughout a waterbody, not simply at a single compliance point. While TMDL implementation plans must ensure attainment of water quality standards, the salt TMDL contemplates a 19% exceedance of standards in critical years and a 7% exceedance in dry years. The TMDL fails to reserve any assimilative capacity, thus depriving downstream farmers of the ability to irrigate and discharge return flows. Although the State Board has expressly directed the Central Valley Board to control salt loading from municipal and industrial dischargers, the Board is routinely allowing massive increases in salt loading in recently adopted NPDES permits. An example of the Central Valley Board's inability to meaningfully address salt is the City of Modesto's NPDES wastewater permit renewal issued in April 2008. The permit doesn't require compliance with final salt limits until July 2022 or July 2026. The SJR TMDL assigns load allocations to coalitions operating under the irrigated lands waiver but fails to incorporate the control elements of the Nonpoint Source Control Program, thus ensuring failure. The largest responsibility for reducing salt loads is assigned to the Bureau but these reductions are to be addressed through a joint Management Agency Agreement. Unfortunately, the Bureau is claiming sovereign immunity and promises vague cooperation but refuses and specific enforceable limits that that will actually reduce salt loads. Delta salinity standards continue to be violated with impunity. Both the 1995 Water Quality Control Plan for the Delta and D-1641 (2000) directed the Central Valley Board to move the salt compliance point upstream of Vernalis. Thirteen years latter, the Central Valley Board has still not released the proposed upstream salinity objectives.

9. ESTABLISH INTERIM X2-BAY-DELTA FALL OUTFLOW REQUIREMENT FOR ALL YEAR CONDITIONS.

WHY: Pelagic habitat quality in the San Francisco Estuary can be characterized by changes in X2 (Distance from the Golden Gate of the 2 psu isohaline). The abundance of numerous species increases in years when flows into the estuary are high and the 2 psu isohaline is pushed seaward (Jassby et al. 1995), implying that the quantity or suitability of estuarine habitat increases when outflows are high. The importance of salinity in this study was not surprising, given the relationships of population abundance indices with X2 for many species. Fall salinity has been relatively high during the POD years, with X2 positioned further upstream, despite moderate to high outflow conditions during the previous winter and spring of most years. Recent increases in fall salinity could be due to a variety of anthropogenic factors although the relative importance of different changes have not yet been fully assessed. *Initial results from 2007 POD studies have identified increased duration in the closure of the Delta Cross Channel, operations of salinity gates in Suisun Marsh, and changes in export/inflow ratios (i.e. Delta exports/reservoir releases) as contributing factors.*

Fall represents the time period when the delta smelt year class matures to adulthood. Hence, fall stressors have a direct effect on the delta smelt spawning population. The evidence to date indicates that habitat is a significant issue for delta smelt in fall (Feyrer et al. 2007). Delta smelt is strongly associated with low salinities and high turbidities, which can be used to index the "environmental quality" of habitat for the species. Feyrer et al. (2007) report that fall environmental quality has shown a long-term decline. There is statistical evidence that these changes have population-level effects (Feyrer et al. 2007). A multiple linear regression of fall environmental quality in combination with adult abundance provided statistically significant predictions of juvenile production the following year. Hence, both habitat and stock-recruit factors are important issues during fall.

10. DETERMINE BIOLOGICAL EFFECTS OF PROJECT PUMPING.

WHY: It is important to keep in mind that river flows influence estuarine salinity gradients and water residence times. The residence time of water affects both habitat suitability for benthos and the transport of pelagic plankton. High tributary flow leads to lower residence time of water in the Delta (days), which generally results in lower plankton biomass (Kimmerer 2004), but also lower cumulative entrainment effects in the Delta (Kimmerer and Nobriga in press). In contrast, higher residence times (a month or more), which result from low tributary flows, may result in higher plankton biomass. This can increase food availability for planktivorous fishes; however, much of this production may be lost to water diversions under low flow conditions. Under extreme low flow conditions, long water residence times may also promote high biological oxygen demand when abundant phytoplankton die and decompose. (Lehman et al. 2004; Jassby and Van Nieuwenhuyse 2006). Recent particle tracking modeling results for the Delta show that residence times in the southern Delta are highly variable depending on Delta inflow, exports, and particle release location (Kimmerer and Nobriga, in press). Very high inflow leads to short residence time. The longest residence times occur in the San Joaquin River near Stockton under conditions of low inflow and low export flow.

These observations led to a hypothesis that the hydrodynamic change could be indexed using net flows through Old and Middle rivers, which integrate changes in inflow, exports, and barrier operations (Arthur et al. 1996; Monsen et al. 2007). Net or residual flow refers to the calculated flow when the effects of the tide are mathematically removed. An initial analysis revealed that there was a significant inverse relationship between net Old and Middle rivers flow and winter salvage of delta smelt at the SWP and CVP (P. Smith, unpublished). These analyses were subsequently updated and extended to other pelagic fishes (Figure 18, L. Grimaldo, in preparation). The general pattern is that POD species salvage is low when Old and Middle rivers flow are positive.

Statistical analyses of the long-term delta smelt trends (Manly and Chotkowski 2006) confirm that there has been a rapid decline of delta smelt since 2000. We propose that changes in water project operations and adult abundance are contributing causes of this recent decline. Increased water project exports during winter resulted in higher losses of adult smelt, particularly early spawning fish (and their offspring) that may be proportionally more important to the population. By contrast, reduced exports during spring may have increased survival of later-spawned larvae. Reduced spring exports from the Delta have been the result of the Vernalis Adaptive Management Plan (VAMP), a program designed to benefit outmigrating juvenile Chinook salmon. VAMP has been operating since 2000. Finally, we propose that the population is now at such low levels that recovery is unlikely in a single year but will require several years of successful reproduction and recruitment. spawning fish (and their offspring) that may be proportionally more important to the population.

11. ESTABLISH EFFECTIVE FISH SCREENS AT PROJECT PUMPING FACILITIES IN THE BAY-DELTA.

WHY: Because large volumes of water are drawn from the estuary, water exports and inadvertent fishentrainment at the SWP and CVP export facilities are among the best-studied top-down effects in the San Francisco Estuary (Sommer et al. 2007). The export facilities are known to entrain most species of fish in the upper Estuary (Brown et al. 1996), and are of particular concern in dry years, when the distributions of young striped bass, delta smelt, and longfin smelt shift closer to the diversions (Stevens et al. 1985; Sommer et al. 1997). As an indication of the magnitude of the effects, approximately 110 million fish were salvaged at the SWP screens and returned to the Delta over a 15-year period (Brown et al. 1996). However, this number greatly underestimates the actual number of fish entrained. It does not include losses at the CVP. Even for the SWP alone, it does not account for mortality of fish in Clifton Court Forebay and the waterways leading to the diversion facilities, larvae < 20 mm FL are not collected by fish screens, and losses of fish > 20 mm FL are inefficiently removed by the louver system. Larval entrainment is unknown because larvae are not sampled effectively at the fish screening facilities. To address this shortcoming, Kimmerer and Nobriga (in press) coupled a particle tracking modeling with survey results to estimate larval entrainment. Kimmerer (in press) used data from several IEP monitoring programs to estimate entrainment of delta smelt. These approaches suggest that **larval delta smelt entrainment losses could exceed 50% of the population under low flow and high export**

One piece of evidence that export diversions played a role in the POD is the substantial increases in winter CVP and SWP salvage that occurred contemporaneously with recent declines in each of the four primary fishes. Increased winter entrainment of delta smelt, longfin smelt and threadfin shad represents a loss of pre-spawning adults and all their potential progeny. Similar increases in the salvage of littoral species including centrarchids and inland silverside were observed during the same period.

12. DETERMINE WHETHER THE HORB IS IN OR OUT IN THE FUTURE:

WHY: In trying to evaluate the mechanism(s) for increased winter-time salvage, POD studies by USGS made three key observations (IEP 2005). First, there was an increase in exports during winter as compared to previous years (Figure 16). Second, the proportion of tributary inflows shifted. Specifically, San Joaquin River inflow decreased as a fraction of total inflow around 2000, while Sacramento River increased (Figure 17). Finally, there was an increase in the duration of the operation of barriers placed into south Delta channels during some months. These changes may have contributed to a shift in Delta hydrodynamics that increased fish entrainment.

13. ESTABLISH INFLOW-OUTFLOW WEEKLY RATIO FOR ALL WEEKS OF THE YEAR.

WHY: Habitat for pelagic fishes is open water, largely away from shorelines and vegetated inshore areas except perhaps during spawning. This includes large embayments such as Suisun Bay and the deeper areas of many of the larger channels in the Delta. More specifically, pelagic fish habitat is water with suitable values for a variety of physical-chemical properties, including salinity, turbidity, and temperature, suitably low levels of contaminants, and suitably high levels of prey production to support growth. Thus, pelagic fish habitat suitability in the estuary can be strongly influenced by variation in freshwater flow (Jassby et al. 1995; Bennett and Moyle 1996; Kimmerer 2004).

14. EVALUATE CROSS CHANNEL GATE AND SUISUN GATE OPERATION.

WHY: Fall salinity has been relatively high during the POD years, with X2 positioned further upstream, despite moderate to high outflow conditions during the previous winter and spring of most years. Recent increases in fall salinity could be due to a variety of anthropogenic factors although the relative importance of these different changes have not yet been fully assessed. *Initial results from 2007 POD studies have identified increased duration in the closure of the Delta Cross Channel, operations of salinity gates in Suisun Marsh, and changes in export/inflow ratios (i.e. Delta exports/reservoir releases) as contributing factors.*

15. PREVENT BAY-DELTA OPERATIONAL EFFECT ON THE TRINITY AND OTHER RIVERS.

WHY: As an example of redirected impacts from water supply actions, the Trinity River Record of Decision (ROD) is predicated on an increase in minimum instream flows from 340,000AF/year to a weighted annual average of 594,500 AF/year, in order to restore the Trinity River fishery, a public trust asset and a tribal trust asset of the Hoopa Valley and Yurok tribes. The Trinity River ROD assumes a 5% **DECREASE** in Trinity River exports to the Central Valley commensurate with the **INCREASED INSTREAM FLOW RELEASES,** since the Trinity Reservoir cannot maintain historic exports and increased fishery flows.

However, the minimum SWRCB permitted instream flow is still the 1959 amount of 120,500 AF. The CALFED ROD promised a 15-20% increase in CVP south of Delta water deliveries instead of the decrease that the Trinity ROD promised. Therefore, there is an over-allocation of the Trinity River's water that ranges from 240,000 AF to 475,000

AF. According to the Area of Origin section of the D-1641 Court Decision, it is deliveries of water to the Central Valley/Bay Delta and CVP South of Delta contractors that should be reduced by that amount.

The massive increase in Delta exports over the past 3 years has caused a redirected impact on the cold water storage of Trinity, Shasta, Oroville and Folsom reservoirs which is severely limiting fish habitat this year. Trinity temperatures are good this year but will have problems if another year of drought continues. For the American River, temperatures are 70 degrees, and lethal to the gametes and eggs of salmon. The Sacramento River temperature standard of 56 degrees F is only a few miles below Keswick Dam instead of Red Bluff as required in the Basin Plan or Ball's Ferry, a typical compliance point. Therefore, habitat for listed species such as winter run chinook, spring chinook and steelhead has been severely limited by the increased water deliveries the past 3 years.

A standard of 56 Degrees average daily temperature was established based on studies by the Department of Fish and Game (Healey? – it's in WR 90-05) as an acceptable standard to protect Chinook salmon in Water Right Order 90-05. The standard was applied to both the Sacramento and Trinity Rivers. However, the standard was not applied to any other rivers draining in the Bay-Delta.

The Trinity River also has a Basin Plan Temperature Objective that goes beyond that contained in Water Right Order 90-05. A daily average of 60 degrees F was adopted as part of the Water Quality Control Plan for the North Coast Region to protect gametes developing within holding Trinity River spring run chinook. The Hoopa Valley Tribe also has its own Water Quality Control Plan with time and site specific water quality objectives that must be considered. The USEPA has given the Hoopa Valley Tribe the same water quality authority as a State.

Interim Solution: Adopt a WR Order to implement all Trinity River Basin Plan temperature objectives and limitation of exports to the Central Valley according to the Trinity River Record of Decision. Concurrently reduce the amount of water exported out of the delta commensurate with the reduction in Trinity River deliveries to the CVP.

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