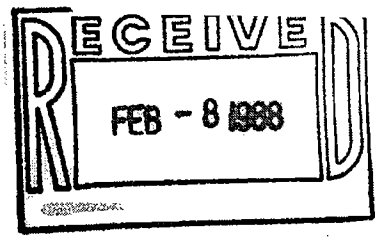

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

IN THE MATTER OF

PHASE I OF THE BAY-DELTA
ESTUARY HEARINGS

(CLOSING BRIEF OF
(
(THE ROMBERG TIBURON CENTER
(FOR ENVIRONMENTAL STUDIES
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The Romberg Tiburon Center for Environmental Studies submits as its closing brief the following proposed findings of fact derived from the exhibits and testimony which it has sponsored.

THE PAUL F. ROMBERG
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CLOSING BRIEF:
FINDINGS OF FACT & RECOMMENDATIONS FOR THE BAY-DELTA HEARINGS

Michael A. Rozengurt, Michael J. Herz & Feld, S.A.

For the past three years the Romberg Tiburon Center (TCES) has conducted a program of research designed to:

(1) Describe and evaluate freshwater inflow to the Delta and San Francisco Bay and the manner in which flow has been modified since the early part of the century (especially since the construction of the Central Valley and State Water Projects);

(2) Examine the relationship between modifications in flow and associated changes in the fishery resources of the system;

(3) Develop data-based recommendations regarding the quantity of freshwater required to maintain the health of this important estuary.

Because there existed no other detailed evaluation of water supply to the Delta and San Francisco Bay or any investigation of the relationship between flow and fisheries resources, this information was developed for presentation to the State Water Resources Control Board as part of the Bay-Delta Hearings, as well as for use by other government agencies concerned with decision making for this estuary, and by other interested parties.

The results of this research have been presented in reports submitted as hearing exhibits:

Rozengurt, M., Herz, M.J., & Feld, S. 1987. Analysis of the Influence of Water Withdrawal on Runoff to the Delta-San Francisco Bay Ecosystem (1921-1983), Romberg Tiburon Center for Environmental Studies Technical Report No. 87-7. (TCES Exhibit # 1)

Rozengurt, M.J., Herz, M.J., & Feld, S.A. 1987 The Impact of Freshwater Diversions on the Ecosystem of the Delta & San Francisco Bay: An Inventory of Questions on the Status of Knowledge. (TCES Exhibit # 2)

Rozengurt, M., Herz, M.J., & Feld, S. 1987. The Role of Water Diversions in the Decline of Fisheries of the Delta-San Francisco Bay & Other Estuaries, Romberg Tiburon Center for Environmental Studies Technical Report Number 87-8. (TCES Exhibit # 20)

Leopold, L.B. 1987. Sacramento Delta Water Supply and Review of the Tiburon Center Report. Unpublished. (TCES Exhibit # 22.

Rozengurt, M.A., Herz, M.J., & Josselyn, M. 1987. The impact of water diversions on the river-delta-estuary-sea ecosystems of San Francisco Bay and the Sea of Azov. In D.M. Goodrich (Ed.), San Franccisco Bay: Issues, Resources, Status, and Management. Washington, D.C.: NOAA Estuarine Programs Office, NOAA Estuary-of-the-Month Seminar Series No. 6, 35-62. (TCES Exhibit # 23)

Rozengurt, M.A., & Herz, M.J. 1987. The effects of freshwater diversion on the fisheries, flushing and health of San Francisco Bay and the Sea of Azov. In Managing Inflows to California's Bays and Estuaries. Sausalito, CA, The Bay Institute. (TCES Exhibit # 24)

Much of the data contained in these reports, as well as additional information, was presented before the State Board as testimony (or elaborated upon in cross examination; Hydrology, July 14, 1987, Hearing Volume 5A; Impacts of Freshwater Inflow on San Francisco Bay, December 9, 1987, Hearing Volume 56).

The most relevant findings from this research program are:

Modifications in Freshwater Flow to the Delta & San Francisco Bay

(1) Since 1967, annual diversions have reduced natural Delta outflow to San Francisco Bay (1921-1978 mean = 27.2. MAF) by as much as 60%. These maximum annual withdrawals (14-21 MAF) are 3-5 times higher than before completion of major components of the CVP and SWP. (TCES Exhibit # 1, pages II.7, IV.2)

(2) For the spring -- the most critical period for providing optimal physical, biological and biochemical conditions for maintaining fisheries resources in the estuary and water quality in the Delta-Bay ecosystem -- up to 85% of the freshwater inflow has been diverted in some spring months for use outside the basin. (TCES Exhibit # 1, page IV.3)

(3) As a rule, since the construction of the major water projects, the largest percentages of freshwater flow are diverted in years of subnormal and critical wetness. Although the absolute quantities of water withdrawn in these dry years are much less than diversions in normal years, the impacts are greater. (TCES Exhibit # 1, page II.11)

(4) Overall, spring water supply (for 5-year periods), which normally fluctuates within +/- 25% of its long-term average in this and most other estuaries, is currently one third the levels prior to CVP/SWP construction. Would-be-normal flow conditions are currently characterized by negative deviations of -40 to -85%. (TCES Exhibit # 1, page III.29)

(5) Between 1967 and 1984, residual spring outflows to San Francisco Bay were equivalent to unimpaired flows in years of subnormal, dry or critical years (1.5-2.5 MAF/mo). (TCES Exhibit # 1, page IV.6)

(6) As a result of excessive water diversions since the beginning of project operations (1944-1983), the cumulative quantity of water not reaching San Francisco Bay is 366 MAF (60 times the volume of the Bay). (TCES Exhibit # 2, page 60)

(7) In the post project period, diversions which previously occurred only in the spring are made throughout the year. (TCES Exhibit # 1, page IV.7)

(8) Annual and spring low flow events which happened only rarely under unregulated conditions have now become the predominant events for the system, occurring on an almost annual **basis, except in very wet years. (TCES Exhibit # 20, page 56)**

(9) Since the beginning of CVP/SWP operation, the number of years in which inflow is considered wet has decreased from natural conditions from 30% of all years to 15% of years while the number of critically dry years has increased from 14% of all years to 39%. Thus diversions and depletion under present conditions have doubled the number of years considered critically dry. (TCES Exhibit # 22, page 5)

(10) The amount of water permitted to be diverted each year depends upon the water year-type (e.g., wet, dry, critical). Current decisions regarding water distribution in California are based upon the Four River Index system, a year-type classification system which excludes 25% of the Sacramento-San Joaquin watershed, which represents only 61% of the normal river inflow to the Delta. This system has resulted in overestimates of water availability and has therefore permitted excessive diversions. (TCES Exhibit # I, page I.46-50; TCES Exhibit # 20, **page 41 & Figure 3-1; December 9, 1987 Hearing Record, Volume 56,** pages 83-86)

Relationship Between Flow Modification & Fisheries Decline

(1) For the 1916-1931 period (when the Delta and Bay were still relatively healthy and could support significant commercial fisheries), salmon catch was highly correlated with both annual and spring regulated outflows to the Delta 3-5 years earlier ($r = 0.80-0.97$, $p<.01$). Successful catches occurred with annual flows of 19-23 MAF and mean spring monthly runoff (April + May + June/3) of 2.5-4.0 MAF. (TCES Exhibit # 20, pages 81 and 87).

(2) In the post-project period, the number of fall-run salmon returning to spawn at the Red Bluff Dam was highly correlated with annual and spring regulated Delta outflow 3-5 years earlier. Successful migration appears to require mean annual flows of 17-19 MAF and mean spring monthly flows of 2.3-2.8 MAF for several successive years. (TCES Exhibit # 20, pages 93, 95, 96)

(3) For the 1916-1935 period, high correlations were found between commercial catches of striped bass and both annual and spring Delta outflows 3-5 years earlier. (TCES Exhibit # 20, pages 110, 111)

(4) Similar relationships were found for party boat catches of striped bass and flows lagged by 3 years for the 1944-1985 period. For both the early commercial period and the later party boat era, optimal catches were observed with annual flows of 17-22 MAF and spring monthly flows of 2.0-3.4 MAF. (TCES Exhibit # 20,pages 116, 119, 121)

(5) High correlations were also observed between commercial catches of American shad (1916-1931) and annual (20-25 MAF) and mean spring monthly (2.5-3.5 MAF) flow 3-5 years earlier. (TCES # 20, pages 128-130)

(6) Correlations alone do not "prove" that highly correlated events are causally related, i.e., that the amount of available water determines the magnitude of catch or level of productivity. **However, when a variety of measures such as** commercial and party boat catch in three different fish species, data from both pre- and post-water project construction, and other measures of fish production (striped bass index, salmon spawning migration) all correlate significantly with Delta outflow 3-5 years earlier, the likelihood of there being a causal relationship between these factors is greatly enhanced. Such associations have been obtained in many other estuaries and are widely accepted as evidence that freshwater inflow is the principal factor in estuarine health and fish production. (TCES Exhibit # 20, page 20-28, Figures 2-1 & 2-7, Hearing Record, December 9, 1987, Volume 56, pages 66-67, 118

Conclusions

(1) In general, for the pre-project period, optimal commercial salmon, striped bass and shad catches were obtained when total spring regulated Delta outflow was 6.9-10.5 MAF and annual regulated Delta outflow was 19-22 MAF. (These conditions represent 64-97% of the normal, unimpaired spring and 70-81% of annual Delta outflow (normal = 10.8 and 27.2 MAF, respectively, for the 1921-1978 period.) (TCES Exhibit # 20, page 143)

(2) For the post-project period, the high correlations between production indices (salmon fall run, Striped Bass Index, striped bass party boat catch) and average spring and annual regulated Delta outflow for several consecutive years of the post-project period (1944-1985) suggest that the health and productivity of the Delta and Bay can best be maintained with mean monthly spring flows of 2.3-2.5 MAF (38,655-42,014 cfs) and annual Delta outflows of 17-19 MAF for periods of 3 to 5 years (64-70% and 62-70% of spring and annual unregulated flows - 1921-1978 averages = 3.6 and 27.2 MAF, respectively). (TCES Exhibit # 20, page 144)

(3) Deterioration of the San Francisco Bay estuarine system and its living resources (decreases in fish catches and population levels) started in the late 1960s and became obvious in the late 1970s, when flows were reduced to mean spring monthly levels of 1.0-1.5 MAF and mean annual flows of 11-15 MAF (27-42% and 40-55% of their respective unregulated 1921-1978 averages). (TCES Exhibit # 20 ,pages 26, 27, 144)

Recommended Flows for Preservation & Maintenance of the River-Delta-Bay Ecosystem & Its Living Resources

Based on this evaluation of modifications in regulated flows and their impacts on salmon, striped bass and shad populations and catches in the Delta and San Francisco Bay, we propose the following criteria for mean spring and annual regulated Delta outflows which must be maintained for periods of at least 2-3 consecutive years to ensure adequate water quality, seasonal displacement of the entrapment zone and optimal conditions for fish migration and spawning, larvae, egg and juvenile survival, and catch success in the Delta and San Francisco Bay (sport and recreational) and the coastal zone of the Gulf of the Farallones (sport, recreational and commercial):

Total Spring Regulated Delta Outflow (RDO)	**6.9-7.5 MAF**	**63.9-69.4% of 1921-1978 normal=10.8 MAF**
Mean Spring RDO	2.3-2.5 MAF (38,653-42,014 cfs)	64.1-69.6% of 1921-1978 normal=3.6 MAF
Total Annual RDO	17-19 MAF	62.5-69.8% of 1921-1978 normal=27.2 MAF
Total Winter RDO	8.5-9.5 MAF	61.5-68.7% of 1921-1978 normal=13.8 MAF
Total summer-autumn RDO	1.6-2.0 MAF	62.0-77.5% of 1921-1978 normal=2.6 MAF

(The monthly distribution of regulated outflows may differ from seasonal averages, especially for winter and spring, **provided that volumes are sufficient to maintain optimal balanced** water quality conditions for different waater users regardless of year-type.)

Methods for Achieving Recommended Flows

(1) Rescheduling and reducing seasonal water diversions. For the spring, especially May and June, provide for the release to the Delta and Bay of volumes equal to at least 75% probability of exceedance for at least 2-3 years.

(2) Accumulation during the winter of sufficient water to provide flows adequate for maintaining or improving conditions for Delta and Bay water quality and living resources, especially when regulated river inflow and Delta outflow both correspond to lower than subnormal seasonal wetness.

(3) Seasonal redistribution of runoff more closely resembling natural patterns which are now distorted by reduction of spring flows and artificial increases in late summer and fall vflows.

(4) Re-examine plan to increase Delta pumping capacity since it is likely that export levels during the past decade have been 3-5 times greater than the volume of the Delta. Current exports already exceed the volume of the San Joaquin River outflow and may be responsible for serious reverse flows in the Delta, resulting in salt intrusion and decline in Delta water quality.

(5) Evaluate the potential value of water conservation, recycling, and increased efficiency of use (industrial, agricultural and municipal), marketing and trading for reducing demand before increasing entitlements or devloping new facilities.

(6) Utilize dry creek beds as retarding basins or increase storage capacity of existing reservoirs to accumulate part of wet year surplus winter and spring flows for discharge to the Delta and Bay in dry years. Such flows would be reserved to maintain adequate conditions for repelling salt intrusion, flushing, fish migration and spawning, and improving water quality. Such a program should be undertaken only after statutory or legislative controls are in place guaranteeing that the reserved flows are not for export.

The scientific and technical information submitted to the State Water Resources Control Board as exhibits for the Bay-Delta Hearings represents a wide range of data, evaluations and recommendations. Because of the lack of agreement among the many exhibits, it is recommended that the State Board request that this body of information be subjected to an exhaustive, independent evaluation by a neutral body of experts such as the National Research Council of the National Academy of Sciences. (Hearing Record, 12/9/87, pages 50-54)

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February 1, 1988