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SWRCB Proceeding on Delta Flow Criteria

<u>The Nature Conservancy Exhibit 1</u> – Summary of Findings and Recommendations from TNC Exhibits 2 and 3

Submitted by Leo Winternitz, The Nature Conservancy

State Board's Key Issue: What volume, quality, and timing of Delta outflows are necessary for the Delta ecosystem under different hydrologic conditions to protect public trust resources?

Our experience and review of some of the existing literature indicate that freshwater flows to estuaries are a critical component of the health of estuarine systems and the biota that live in those systems. However, before the State Board determines the volume, quality and timing of Delta outflows necessary for the protection of public trust resources, the State Board should consider the magnitude of change in Delta outflows over the historical period and the insights gained in other places where freshwater flows to estuaries have been evaluated.

TNC Exhibit 2 (Historical Context of Delta Freshwater Flow in Relation to Other Uses that Deplete Water from the Delta Watershed) provides a graphical representation of Delta outflow, upstream depletions, state and federal exports and in-Delta uses for the 76-year period between 1930 and 2005. These data indicate a long-term trend in the decline in the overall quantity of outflows, and a corresponding decline in the ratio of Delta outflow to upstream depletions and exports, in all water year types.

The data in Figure 6 show that average Delta outflow during the decade of the 1930s comprised 80 percent of the natural flow and reservoir releases entering the Sacramento-San Joaquin Valley System. In contrast, in the period from 2000 to 2005, Delta outflow represents only about 45 percent of water entering the system. While natural hydrological variability may account for some of this difference, the reduction is due in large part to water development within the Bay-Delta watershed -- resulting in increased upstream water depletions -- and water exports from the state and federal pumping facilities in the Delta.

Figures 3 through 5 display the same water available/outflow data grouped into water year types -- wet and above normal, above normal and below normal and dry and critical, allowing examination for outflow trends in relation to depletions and exports. The data from these relationships show a trend of declining outflow for all water year types.

Figure 7 provides the most graphic representation of decreased outflows. It depicts outflow trends during dry and critically dry periods. In the 1930s during these year types, outflow

represented about 70 percent of available water. In the 1980s – 2000s period, outflow represents only about 33 percent of available water.

It is interesting to note the limited variance in depletions and exports across all water year types from the period 1980 – 2005 (Figure 5); this indicates that regardless of water year type (wet or dry) depletions and exports remained relatively constant during this period. The limited variance in depletions and exports has resulted in the substantial decline of Delta outflows, particularly during the drier periods.

TNC Exhibit 3 is a synopsis of various studies conducted worldwide that assess the importance of freshwater flows to the health and integrity of estuarine systems. The overarching conclusion from these studies is that despite the complexities of the systems studied and the number of biotic and abiotic variables acting upon the systems, causal and significant statistical relationships exist that tie freshwater flows to productivity, species integrity, and general ecosystem health of estuarine systems.

Particularly noteworthy among the studies cited is the report by Longley (1994), which presents a list of impacts attributable to reduced freshwater inflows to Texas bays and estuaries. The most significant impacts identified were:

- increased salinities and vertical stratification of the water column
- penetration of the salt-wedge farther upstream allowing intrusion of predators and parasites of estuarine species, and increased intrusion into groundwater and surface water resources
- increased frequency of benthic anaerobic conditions and decreased inputs of nutrient and organic matter used by estuarine species
- loss of characteristic species and economically important seafood harvests
- increases in erosion of delta areas resulting from the reduction of sediment flux

These impacts identified for Texas bays and estuaries resulting from decreased freshwater inflow are similar to the most significant issues we face today in the Sacramento-San Joaquin Delta estuary.

Conclusions and Recommendations

Our experience and review of existing literature and data suggest two primary conclusions relevant to the Key Issue identified by the Board. Following these conclusions are our recommendations for addressing questions 1, 2, 4 and 5 raised in the Boards Notice of Proceeding.

<u>Conclusion 1</u>:

There have been substantial reductions in Delta outflow over the 76-year period from 1930 to 2005. Reductions in outflow are most evident during drier year periods, but the data indicate decreased outflow trends over the course of the entire period, regardless of water year type. In the 1930s, dry year outflows represented about 70 percent of total water available in the watershed, whereas in the 1990s to 2000s, dry year outflows represent only about 33 percent of available water. The primary causes for reductions in outflow are upstream depletions resulting from development of the watershed and water exported from the Delta by the state and federal facilities.

Conclusion 2:

Estuaries are highly productive, complex systems that depend on freshwater flows that provide for many important biological and physical processes. A number of studies and published works describe the causal and significant statistical relationships that tie inflows to productivity, species integrity, and general ecosystem health of estuarine systems. However, because of the complexity of estuarine systems, precise quantitative answers cannot be provided regarding flow parameters necessary to protect and restore the ecosystem. Therefore, it is essential to establish criteria using the best information available and employ an adaptive management approach in the management of estuarine systems. In summary:

- Adequate freshwater flows are critically important to the health of estuarine ecosystems.
- We must accept that our understanding of the causal mechanisms relating flows to ecologic health is not often adequate to allow precise a priori prescription of adequate flows.
- Initial estimates of adequate flow must be made with the best available knowledge.
- An effective adaptive management approach must be employed to adjust flow prescriptions as new knowledge of ecosystem processes and response is obtained.

Recommendation 1:

This first recommendation addresses the Board's question on the type of methodology to use to develop flow criteria for the Delta. Taking into consideration the complexity of the system and the information available to address this question, we recommend a suite of methodologies associated in part with those described in Fleenor et al, 2010 – *On Developing Prescriptions for Freshwater Flows to Sustain Desirable Fishes in the Sacramento-San Joaquin Delta.*

In priority order, the suite of methodologies consists of using:

1. Causal mechanisms over simple correlations

2. Lacking mechanistic explanations, the use of statistical relationships that are backed with conceivable conceptual models
3. Flows in a historical period, representing 'good' conditions
4. Timing, magnitude duration and frequency of unimpaired flows to guide establishing flow criteria

Elements of this approach have been largely used by the Bay Institute and others to develop more specific initial flow criteria for protection of public trust uses. Consequently, we also recommend the Board accept the flow criteria The Bay Institute et al have developed for consideration and use in developing initial flow objectives for protection of beneficial uses.

We also recommend employing an adaptive management approach that presents flow prescriptions as hypotheses coupled with appropriate monitoring and research to ensure we are able to learn from and adjust our water management actions to protect public trust resources.

Recommendation 2:

The information provided by TNC Exhibit 2 suggests that reduction in freshwater flows to the Delta is most significant during the drier periods when water supply demands represent a greater proportion of the available flow. At the same time, drier years induce stress upon aquatic systems as a result of decreased freshwater flows. Water supply extraction during these periods adds to that stress. Implementation of conjunctive use practices (the integrated use of groundwater and surface water) on a regional or statewide basis could help to maintain water supply while leaving surface flows in river systems to provide for additional Delta flows when they are most needed.

For example, the Sacramento River watershed is the source of about 80 percent of the Delta's inflow. During drier years, senior water right holders with access to groundwater could pump additional groundwater, leaving surface water that would have otherwise been diverted to provide for Delta inflow and outflow needs. During the wetter periods, their water supplies would come primarily from surface sources, allowing the groundwater basin to recharge, or managed recharge programs could be implemented to supplement natural groundwater recharge.

This system would work only to the extent that appropriate compensation or assurances were provided to those practicing conjunctive use management, and if groundwater pumping during dry years was conducted in a way that does not unduly impact surface flows for ecosystems. Also, appropriate monitoring and controls would be needed to ensure these flows were not diverted for other uses prior to serving their public trust functions.