Salinity Variability and Improving Conditions for Desirable Organisms in the Delta and Suisun Marsh

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"You could not step twice into the same river; for other waters are ever flowing on to you."
Heraclitus (540 BC - 480 BC)

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The PPIC-UC Davis report, *Envisioning Futures for the Sacramento-San Joaquin Delta* (Lund et al., 2007), suggests that increasing variability is a key tool for improving conditions in the San Francisco Estuary (SFE) for desirable organisms, especially for fish such as the delta smelt and striped bass. More specifically, the report suggests the value of creating regions in which salinity fluctuates sufficiently to discourage alien pest species and provide productive open-water habitat for desirable species. A perceived problem with this suggestion is that the salinity fluctuations required may exceed fluctuations the system experienced historically. Here we suggest that this 'problem' is in fact an opportunity, given that the future Delta (and indeed the entire future SFE) will almost certainly be very different from the Delta we see today.

The Delta of today has little in common with the pre-European Delta. During the late 1800s and early 1900s, the Delta was converted from extensive tidal marsh to leveed islands – now subsided, with deep channels running between them. Upstream water diversions and pumping from the Delta have changed the timing and magnitude of freshwater inflows. These landscape and hydrologic changes have greatly altered the seasonal patterns of salinity, flow, and water quality and dramatically reduced the quantity and quality of aquatic habitats suitable for native species. Changes to the physical environment also improved conditions for alien plant and animal species, further changing the environment.

Restoration of the Delta to conditions approaching those in the pre-Gold Rush era is not possible. Complete restoration would require refilling Delta islands with more than a billion cubic yards of material, removing over 1,000 miles of levees, eliminating upstream and in-Delta water diversions on a large scale (diversions that irrigate millions of acres in the Sacramento, San Joaquin, and Tulare Basins and water cities for tens of millions of people from Redding to San Diego), and eradicating dozens of invasive species of alien plants, invertebrates, and fish.

In lieu of restoration, it should be possible to create a Delta that has a structure and function that support human uses of the Delta while better serving native species. A key step toward this alternative – a reconciled Delta – is allowing salinity, and physical habitat in general, to vary in ways that favor desirable fishes, such as the delta smelt and striped bass, but discourage aggressive invaders such as the overbite clam and Brazilian waterweed.

Currently, there is some reasonable disagreement over where and how much salinity variability existed in the past. The advocacy nature of the presentation of much of the early data accentuates these disagreements. But there is little disagreement that greater seasonal and inter-annual salinity variability once existed in the SFE, including the Delta (Young, 1929; Matthews, 1931; DWR, 1993, 2001; TBI, 1998; Atwater et al., 1979; Antioch case records, 1920s). An objective analysis of where and how much salinity varied, synthesizing early salinity and botanical records, and hydrodynamic modeling results, could provide insight into the environment in which native organisms evolved and how we arrived at our present state, both ecologically and historically. However, given our inability to restore the Delta to its original condition, better knowledge of historical salinity variability has

limited future management significance, aside from legal and political deliberations to determine which parties bear responsibility for altering Delta conditions.

A major point of the PPIC-UC Davis report is that variability – in salinity, flows, turbidity, residence time, and other water and land characteristics – is likely to be important for the successful environmental management of the Delta and Suisun Marsh. In short, managing the SFE for heterogeneity, rather than homogeneity (as is presently done), is needed. Levee failures and continued sea level rise are destined to increase salinity intrusion in the future. Thus, for the modern, highly-altered Delta, desirable areas of variability today may not be located where they were in pre-European times. Fluctuations also may have to be greater than they were historically to reduce the harmful effects of both freshwater and saltwater invasive species. Nevertheless, salinity variability is important as part of a broader, detailed environmental rehabilitation plan.

The current debate over historical salinity fluctuations also misses a larger point of the PPIC-UC Davis report: Regardless of salinity variability, the Delta remains unsustainable because of continuing land subsidence, decreasing levee reliability, changing inflows, and persistent declines of desirable fishes. Clearly, we need to disentangle environmental and water supply management in the Delta. The major suggestions in the report embrace increased environmental heterogeneity in the Delta for environmental and economic purposes – salinity variation is just one part of this idea.

In short, salinity and other aspects of Delta flow and water quality likely varied more in the distant past than they have in the last 60 years and they almost certainly will vary much more in the future (whether we manage for this or not). The return to more variable conditions can either be a disaster or an opportunity, depending on actions taken in the near future. Today's opportunity is a window of time to design comprehensive environmental solutions for the Delta. Some environmental solutions for the Delta can begin now. But the development of other effective solutions will require a longer timeline and considerable experimentation. Less time will be required if experimentation is planned and coordinated. The current reliance on a minimally-varying freshwater Delta for water supplies precludes much of the experimentation required for success. This suggests the need for significant change in the institutional and regulatory framework for managing the Delta and SFE.

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