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ON BEHALF OF
THE SAN LUIS & DELTA-MENDOTA WATER AUTHORITY

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John Kirlin
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Delta Vision Blue Ribbon Task Force
650 Capitol Mall, 5th Floor
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RE: Dr. Herbold's letter of October 11

Dear Mr. Kirlin,

We are writing to respond to Dr. Herbold's letter of October 11, 2007, to the Delta Vision Blue Ribbon Task Force. At the outset, we observe that the science surrounding the Bay-Delta is a long history of discredited ideas. This is evident from the attached appendix to the UC Davis/PPIC report "Envisioning Futures for the Sacramento-San Joaquin Delta**,"** largely written by Professor Peter Moyle of UC Davis. However, there are two undeniable facts at the basis of Bay/Delta science:

1. The Bay/Delta is the most invaded estuary in the world
2. Wave after wave of invasions by alien species have helped make the Bay/Delta one of the least biologically productive estuaries in the world.

Dr. Herbold correctly notes the importance of the Amur River clam invasion. This clam, *Corbula amurensis*, (native to the Amur River in northeastern Asia) was introduced in 1986 (Cohen 2005). It subsequently revolutionized the western Delta and downstream ecosystem by devastating the phytoplankton base of the food web for open water fish (Kimmerer 1994). Dr. Herbold says and we agree that consideration of purported population level effects of Bay/Delta flows on fish populations must focus on years after this invasion of the alien clam. Out-dated conclusions from the early 1990s, cited by Dr. Herbold, must be revised in the light of this invasion.

About 70 species of fish have been found in the Bay-Delta system in recent years (BDAT 2007). Only two of these show any relationship between abundance and Delta outflow. These two relationships, along with those for one species of shrimp, juvenile striped bass survival, and total organic carbon are the basis for the X2 water quality standard. The standard requires minimum levels of Delta outflow, and compliance can require releases of large amounts of water from upstream reservoirs.

Longfin smelt are "Exhibit A" for claims of a strong relationship between adult fish abundance and Delta outflow. However, close examination of the data shows the relationship is really between longfin smelt abundance and whether or not it is a Wet year on the Sacramento River. In this instance, a Wet year is a year when California Department of Water Resources Water Year Type for the Sacramento Valley is "Wet." (DWR 2007) Longfin abundance is higher in Wet years as compared to all other types of years, i.e., non-Wet years. It appears from the data that longfin smelt benefit from environmental conditions resulting in large, uncontrolled runoff into the Bay-Delta. In Wet years, more upstream flooding occurs, and it is not hard to imagine more nutrients and other life-supporting substances washing downstream. Those conditions are not replicated by controlled reservoir releases, designed to manipulate the location of X2 and push it westward.

The same is true of *Crangon* shrimp and starry flounder, the only other species with X2 relationships between adult abundance and Delta outflow. In addition, there is no relationship between Delta outflow and longfin smelt or starry flounder abundance in non-Wet years, when Delta outflow can be controlled.

Crangon shrimp are one species of Caridean shrimp (DFG 2007). The distribution of the Caridean shrimp species varies with spring Delta outflow. In non-Wet years, there is a relationship between abundance of Caridean shrimp and spring Delta outflow. This relationship indicates that a 10% increase in March-May Delta outflow will produce a 3% increase in total Caridean shrimp [including *Crangon*] in the Bay. Average March-May Delta outflow for all non-wet years in the last 20 years is about 3.7 million acre-feet. So, on average, a 10% increase would require about 370,000 acre-feet of water (worth about $74,000,000). According to the abundance-outflow relationship, that would produce only a 3% increase in Caridean shrimp abundance.

Dr. Herbold mentions irrelevant X2 relationships with "striped bass survival," *Neomysis* shrimp and "even total organic carbon." The X2 relationship is with *juvenile* striped bass *survival* in the Bay/Delta. There is no relationship between X2 and juvenile or adult striped bass *abundance*. Moreover, there is no relationship between juvenile survival and adult abundance. *Neomysis* populations were devastated by the *Corbula* invasion. At their present very low levels *Neomysis* show little response to Delta outflow or any other environmental variable. Finally, total organic carbon depends on Delta inflow. Delta inflow is very highly correlated with Delta outflow, so the relationship between total organic carbon and Delta outflow is not surprising.

The much-heralded X2 relationships supposedly show continuous relationships between increasing Delta outflow and increased abundance of a few organisms in the Bay/Delta. In contrast, the data actually show discontinuous relationships between abundance and spring outflow (except for Caridean shrimp). If it is a Wet year, abundance is higher. Otherwise, abundance is not higher.

No amount of human-induced change in Delta outflow can modify the weather to convert a non-Wet year to a Wet year. This highlights the futility of attempting to affect Bay/Delta biology with flow modifications.

Dr. Herbold alludes to food effects on fish populations when mentioning the invasive copepod *Limnoithona*. We are surprised that he did not mention strong evidence that food availability controls abundance of the key "POD" species, including delta smelt and longfin smelt (Manly 2006, Miller 2007). He has been present many times when those relationships were publicly presented. Those relationships are well reported, including recently at the recent State of the Estuary conference where Feyrer and Sommers of the Department of Water Resources presented evidence of food effects on threadfin shad (Feyrer 2007).

As regards the 2006 increase in longfin smelt abundance, the increase was more in line with the increase expected from the Wet year index relationship than the increase predicted by the Delta outflow (X2) relationship.

Dr. Herbold's focus on outflow ignores the dominant role of food-fish co-occurrence in the highly modified Bay/Delta habitat as a determinant of fish abundance.

Finally, fish habitat in the Bay/Delta has been radically altered by many invasive species (Light 2005), not just the Brazilian water weed, *Egeria*, mentioned by Dr. Herbold.

As indicated by Prof. Moyle's appendix (attached), past versions of Bay/Delta science, widely accepted by many and used as the basis for important water management decisions, have not been correct. Given that poor record, the Delta Vision Blue Ribbon Panel would be well advised to undertake a searching and critical review of the mistaken scientific orthodoxy claiming Delta outflow has substantial population level effects on Bay/Delta fish.

Tom Mongan and BJ Miller

References

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(DFG 2007) Department of Fish and Game, http://www.delta.dfg.ca.gov/baydelta/monitoring/cfran.asp

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(Feyrer 2007) Feyrer, F., Sommer, T., Recruitment of Threadfin Shad is Affected by Manageable Environmental Conditions that Control Prey Density, Poster presented at State of the San Francisco Estuary Conference, October, 2007

(Kimmerer 1994) Kimmerer, W.J., E. Gartside and J.J. Orsi. 1994. Predation by an introduced clam as the likely cause of substantial declines in zooplankton of San Francisco Bay. Marine Ecology Progress Series 113: 81-93.

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(Manly 2006) Manly, Bryan F.J., Review of Analyses Presented at the Environmental Water Account Meeting of December 7-8, 2005, July 2006, available from CalFed Bay Delta Science Program

(Miller 2007) Miller, W.J., Mongan, T.R., Spring Co-occurrence of delta smelt and Eurytemora, presented at June 12, 2007 meeting of Estuarine Ecology Team

(Nichols 1990) Nichols, F. H., J.K. Thompson and L.E. Schemel. 1990. Remarkable invasion of San Francisco Bay (California, USA) by the Asian clam Potamocorbula amurensis. II. Displacement of a former community. Marine Ecology Progress Series 66: 95-101.Clam devastates

Appendix

UC Davis/PPIC report "Envisioning Futures for the Sacramento-San Joaquin Delta" Appendix A: Paradigm Shifts in Our Understanding of the San Francisco Estuary as an Ecosystem

(Dr. Peter Moyle is largely responsible for the material in this appendix)

"In all affairs it's a healthy thing now and then to hang a question mark on the things you have long taken for granted."
Bertrand Russell

The San Francisco Estuary has a long history of being important to Euro-American endeavors in California. In the 19th century, it supported commercial fisheries and was a major transportation corridor, while the Delta and Suisun Marsh gradually became developed as farmland (and then as freshwater marsh managed for waterfowl). These functions continued well into the 20th century, while urban areas expanded, filling in marshlands and dumping large amounts of raw sewage into the water. The basic attitude of this era was that the natural environments would take care of themselves and their health was subservient to human needs.

When the State Water Project was built in the 1960s, some restrictions were included to protect Suisun Marsh and the Delta, recognizing that freshwater outflows were needed to protect duck hunting, agriculture, and western Delta cities as well as to feed water to the pumps in the southern Delta. The passage of the Clean Water Act in 1972 resulted in the rapid cleanup of sewage treatment plants around the estuary. This and other state and federal laws passed in the 1970s reflected a changing public attitude toward the need for a healthy environment, especially to protect human health. These changes in attitude and ways of managing the San Francisco Estuary reflect paradigm shifts in our understanding of how ecosystems work, including the human role in them.

[A paradigm is a "set of interrelated assumptions on the functioning of a system that form a conceptual framework" (Craine, 2006, p. 449). When the assumptions change as the result of new information, a shift to a new paradigm or understanding can occur.]

The first major paradigm shift was from the concept that ecosystems were infinitely resilient and existed for humans to use as they pleased, with no harmful consequences resulting from such use. The shift was toward the view that ecosystems could be greatly harmed by human activity, often to our own detriment, but that changes were reversible. This led to the concept that ecosystems could be restored to their former states. Ecological theory, developing rapidly in the latter half of the 20th century, originally supported the restoration concept. The paradigm was stated succinctly as the "balance of nature": An ecosystem knocked off center would return to its ideal, desirable state if allowed to do so.

By the 1990s, however, this paradigm had shifted to the paradigm that "the only constant is change," that ecosystems are constantly changing in response to multiple factors, especially rapid and long-term shifts in climate and geology. Human activity by and large accelerates natural change and forces it in directions that are often undesirable from the perspective of native organisms and, increasingly, humans themselves. These changes are often irreversible. In a situation such as the Delta, “restoration” means choosing the attributes and organisms regarded as desirable and then finding ways to manage the system for desired conditions. Rosenzweig (2004) prefers to call such actions “reconciliation” rather than restoration because the managed system is going to remain human-dominated no matter what.

Not surprisingly, shifts in societal perceptions of the environment and in ecological understanding are reflected in actions taken to manage the Delta’s estuarine ecosystem, although the target of management has usually been aquatic organisms, especially fish. The motivation for management has been declines in important fish species, initially those that supported fisheries (e.g., striped bass, Chinook salmon, sturgeon) but more recently native species perceived as being at risk of extinction (e.g., delta smelt, splittail, winter-run Chinook salmon). These declines have been under way for a long time. Arguably, the rate and extent of declines could have been reduced if the biologists advising managers had had a better understanding of the Delta ecosystem. Indeed, many of the basic concepts of how the system worked—which formed the basis for decisions regulating outflow by the State Water Resources Control Board—were wrong or inadequate.

The misconceptions start with calling the upper estuary the Delta, implying that it was created primarily by deposits of river sediment, as are other deltas. Instead, it was created as a unique marsh/peat system where slowly rising sea level in a low-lying area created the anoxic conditions suitable for the deposition of organic material from marsh plants, supplemented by deposits of river sediments. This initial misconception helped to fix the idea of the Delta as the upper portion of a more or less linear, river-driven estuary, such as those found in the eastern United States Thanks to research conducted over the last 20 years, our understanding of how the Delta and estuary work has improved greatly, resulting in the paradigm shifts discussed here.

Listed below are major paradigm shifts that have taken place or are starting to take place regarding the San Francisco Estuary, especially the Delta, along with shifts in some key underlying assumptions that support the paradigms. We have tried to state succinctly the new paradigm or assumption and then the one (old) that it has replaced. [During the period of Delta formation, the accumulation of organic matter made it a net sink for carbon; carbon dioxide is a major greenhouse gas contributing to global warming. Since the advent of agriculture, the carbon historically locked up in Delta peat has been released into the atmosphere. Stopping or reversing this process could contribute to slowing climate warming.]

Uniqueness of the San Francisco Estuary

- New paradigm: The San Francisco Estuary is unique in many attributes, especially its complex tidal hydrodynamics and hydrology.
- Old paradigm: The San Francisco Estuary works on the simple predictable model of East Coast estuaries with linear gradients of temperature and salinity controlled by outflow with edging marshes, both salt and fresh water, supporting biotic productivity and diversity.

- New assumption: Daily tidal excursions have more hydrodynamic influence on the ecology of the estuary than outflows do, especially in the western and central Delta, except during high outflow events.
- Old assumption: The most important hydrodynamic force in the ecology of estuary is freshwater outflows, especially within the Delta.

- New assumption: Striped bass are only one part of the estuary ecosystem and conditions that benefit them do not necessarily benefit native organisms.
- Old assumption: If the estuary is managed for striped bass (an East Coast species), all other organisms, but especially other fish, will benefit.

- New assumption: Creating more shallow freshwater habitat benefits mainly alien species in the Delta. Development of dendritic channel patterns with residence time diversity might be a key to restoration.
- Old assumption: Creating more shallow freshwater habitat is the key to making the Delta more friendly to native species.

Invasive Species

- New paradigm: Alien species are a major and growing problem that significantly inhibits our ability to manage for desirable species.
- Old paradigm: Alien (nonnative) species are a minor problem or provide more benefits than problems.

  - New assumption: Some alien species have major effects on ecosystem structure and function, with negative effects on highly valued species.
  - Old assumption: Alien species mainly increase biotic diversity and harm mainly low-value native species.

Interdependence

- New paradigm: Changes in the management of one part of the entire estuary system affect other parts.
- Old paradigm: The major parts of San Francisco Estuary can be managed independently.

  - New assumption: All areas are part of the estuary and can change states in response to outflow and climatic conditions.
  - Old assumption: The Delta is a freshwater system, Suisun Bay and Marsh are brackish water systems, and San Francisco Bay is a marine system.

  - New assumption: Floodplains are of major ecological importance for many organisms, including salmon and other native fish as well as migratory birds, and they affect estuarine function.
  - Old assumption: Floodplains such as the Yolo Bypass have little ecological importance and are independent of the estuary.

- New assumption: Suisun Marsh is an integral part of the estuary ecosystem and its future is closely tied to that of the Delta.
- Old assumption: Suisun Marsh is independent of the rest of the estuary.

Stability

- New paradigm: Delta landscapes will undergo dramatic changes as the result of natural and human-caused forces such as sea level rise, flooding, climate, and subsidence.
- Old paradigm: The Delta is a stable geographic entity in its present configuration.

  - New assumption: The Delta will most likely change dramatically in the next 50 years.
  - Old assumption: The Delta can be maintained pretty much in its present configuration indefinitely.

  - New assumption: There will still be an ecosystem if the configuration of the Delta changes; some changes may actually be an improvement (from a fish perspective) over the existing ecosystem.
  - Old assumption: A change in Delta configuration will destroy the present ecosystem.

  - New assumption: Management of the Delta requires a flexible, adaptive approach, where objectives change in response to improved knowledge of the system.
  - Old assumption: Management of the Delta requires fixed, achievable objectives.

  - New assumption: All Delta levees will or can fail; building bigger levees just reduces the frequency of failure.
  - Old assumption: Levees can be built in the Delta that will not fail.

  - New assumption: Agriculture is an unsustainable use of land and water in many parts of the Delta, which may instead be best suited for recreation or natural habitats.
  - Old assumption: The best and most desirable use of land and water in the Delta is agriculture.

Delta Pumping

- New paradigm: The big pumps in the southern Delta are one of several causes of fish declines and their effect depends on species, export volume, and timing of water diversions.
- Old paradigm: The big SWP and CVP pumps in the southern Delta are the biggest cause of fish declines in the estuary.

  - New assumption: Entrainment of fish at the power plants at Pittsburg and Antioch is potentially a major source of mortality, especially of larval fish, that could significantly contribute to the pelagic organism decline.
  - Old assumption: Entrainment of fish in the power plants at Pittsburg and Antioch is a minor source of fish mortality and can be ignored.

- New assumption: Changes in ocean conditions have major effects on the Delta by affecting rainfall and other aspects of climate, as well as the survival rates of anadromous fish such as Chinook salmon.
- Old assumption: Changes in ocean conditions (e.g., El Niño events, Pacific Decadal Oscillation) have no effect on the Delta.

- New assumption: Hatcheries are an important contributor to the decline of wild salmon and steelhead populations and confuse salmonid restoration work in the Delta because of our inability to determine the effects on hatchery versus wild fish.
- Old assumption: Hatcheries have no effect on wild populations of salmon and steelhead.

- New assumption: Although chronic toxicants continue to be a problem, episodic toxic events (e.g., from storm drains and agricultural applications) are also a major problem (e.g., they can alter food webs).
- Old assumption: Chronic toxicants (e.g., heavy metals, persistent pesticides) are the major problems with toxic compounds in the estuary.