Comment Letter SLDMWA

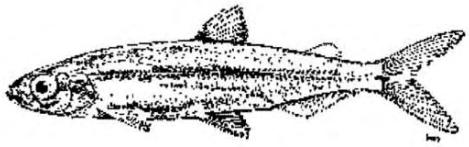
02-07-2006 05:14PM FROM-SLDMWA +2098278040 T-897 P.007/016 F-303

ATTACHMENT 1

FEB 07 2006

The State of the Delta:
What is Killing the Delta Smelt?

By Dr. B.J. Miller



January 2006

02-07-2006 05:14PM FROM-SLDMWA +2098278040 T-897 P.008/016 F-303

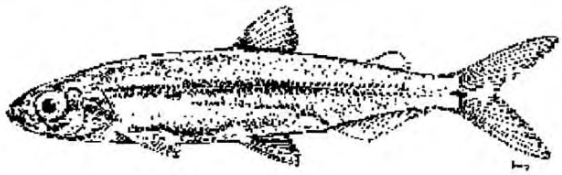
The State of the Delta: What is Killing the Delta Smelt?

Introduction

FEB 07 2006

Recent declines in delta smelt, a pelagic (open water) fish of the San Francisco Bay Delta ecosystem, have generated significant interest in the scientific community. Delta smelt are designated as a threatened species under both the state and federal Endangered Species Acts. Some of these small fish enter state and federal pumping facilities in the southeastern Delta from which water is exported to farms and cities throughout California. Exports are curtailed when too many delta smelt enter the pumping plants, making this small fish among the most important in California.

The focus on the delta smelt has highlighted the fact that, despite decades of data collection by state and federal fish agencies and hundreds of millions of dollars spent on habitat restoration, we know little about the major determinants of the abundance of fish residing in the Delta. Only now, with the delta smelt abundance index[1] at its lowest point in 40 years, are we beginning to understand the interactions between flows, fish, food and water quality in the vast and complex Delta ecosystem.



What we now know, based on research described in this paper, is that the delta smelt's declining abundance appears to be closely linked to localized declines of an alien (non-native) zooplankton called Pseudodiaptomus that has been the delta smelt's primary food source in the summer. When Pseudodiaptomus are scarce in the areas of the Delta where smelt congregate during the critical late summer and early fall period, the subsequent fall abundance index is low. What causes these localized declines in Pseudodiaptomus remains unclear, although there are indications that the decline is linked to alien species, including consumption by the Amur River clam, contamination by toxins produced by an alien blue-green algae, Microcystis, or competition with another alien zooplankton, Limnoithona. Contamination by a new class of pesticides, less harmful to humans but more harmful to fish, is another possibility.

This new research further demonstrates that despite years of exhaustive research, scientists have yet to identify any link or correlation between water exports – the water sent by aqueduct to farms in the San Joaquin Valley and cities throughout California – and abundance of delta smelt.

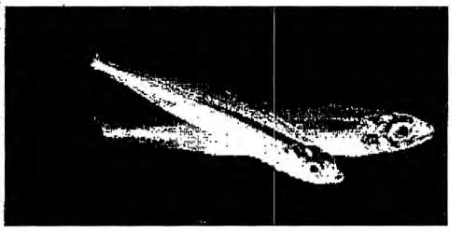
1. State and federal fishery managers do not use population estimates in connection with delta smelt. Instead, they use an "abundance index" to estimate whether there are more or less of the fish in the Delta than in previous surveys. The "official" index of abundance for delta smelt is the Fall Midwater Trawl index of sub-adult abundance, obtained from surveys made in September through December.

02-07-2006 05:14PM FROM-SLDMWA +2098278040 T-897 P.009/016 F-303

Delta smelt background

FEB 07 2006

The delta smelt is a fragile fish that typically grows to only two to three inches as adults, although some have been recorded with lengths up to five inches. Delta smelt have a bluish hue and appear almost translucent. They are found only in the Sacramento-San Joaquin Delta and have been found as far upstream as the mouth of the American River on the Sacramento River and Mossdale on the San Joaquin River. They extend downstream into San Pablo Bay. Delta smelt live primarily in brackish water with salinity around two parts per thousand.



Delta smelt California Department of Fish& Game

During the late winter to early summer, delta smelt spawn throughout much of their range. Females produce approximately 1,000 to 2,600 eggs that sink to the bottom and attach to plants and other material. Larvae hatch 10 to 14 days after the eggs have been released. Delta smelt are fast growing with the majority of growth in the first seven to nine months of life. Most smelt die after spawning in the early spring although five percent or so survive to a second year.

Fish abundance and recent declines

Since 1967, California Department of Fish and Game biologists have conducted surveys of fish species at numerous locations throughout the Delta. These surveys provide a nearly 40-year record of abundance trends for delta smelt and several other species. These surveys show wide swings in abundance from year to year, with some species showing recent declines while others appear to be doing well. Indeed, recent swings in the abundance index for delta smelt (Exhibit A), recorded in surveys between 1998 and 2003 are less dramatic than changes to the abundance index recorded in the early 1980s and early 1990s. However, because the most recent swing brought the abundance index to a historically low point, scientists have focused on determining what caused this change.

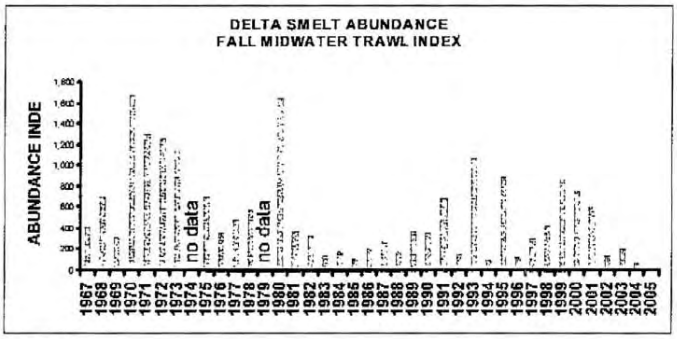


Exhibit A California Department of Fish & Game

The complex nature of the Delta ecosystem is further highlighted by the recovery that appears to be underway by anadromous salmon, also surveyed extensively by the Department of Fish and Game since 1952 (Exhibits B and C). From these data it is clear that whatever factors caused the decline in delta smelt did not have a similar effect on salmon.

FEB 07 2006

The State of the Delta: What is Killing the Delta Smelt?

Salmon abundance 1952– 2004
San Joaquin River and Sacramento River

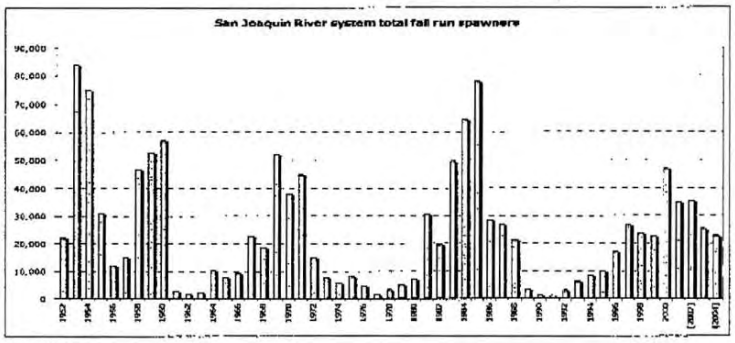


Exhibit B

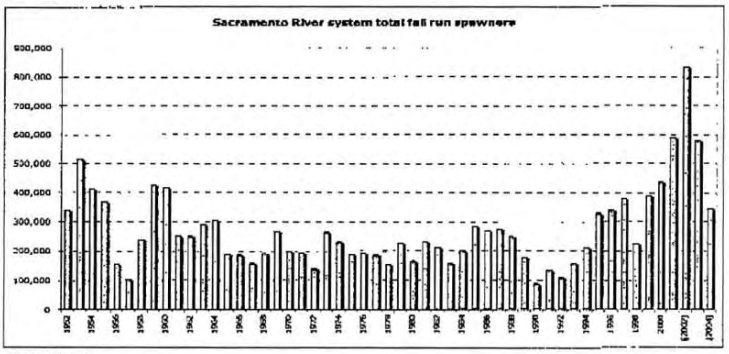


Exhibit C

Factors that influence delta smelt mortality

Export Operations

As the scientific community looked at the delta smelt's life cycle, the focus immediately turned to water export operations. For decades, water exports have been suspected as a major cause of fish mortality in the Delta, especially with regard to delta smelt. Consequently, state and federal fishery managers have regularly curtailed exports in the belief and hope that doing so would help the species recover.[2]

2. The focus on exports as a fishery management strategy has been an evolving issue within the scientific community. Once believed to have significant effects on salmon populations, exhaustive research and data analysis have led to a growing consensus among scientists that exports have very limited to no effect on salmon. Consequently, export curtailments are no longer viewed as an effective means of managing salmon populations on the Delta.

3

The State of the Delta: What is Killing the Delta Smelt?

To better understand the relationship between exports and delta smelt, I and other scientists began looking for correlations to help us determine how exports affect the fish species.[3] Fortunately, there was a robust body of data to aid in this research. Since the late 1960s, the Department of Fish and Game has conducted an annual Fall Midwater Trawl survey of several pelagic fish species that make the Delta and Suisun Bay their home. Additionally, the California Department of Water Resources and the United States Bureau of Reclamation have extensive records of the amount of water exported daily from the Delta.

FEB 07 2006

We first looked for a correlation between export volumes from the Central Valley Project (CVP) and the State Water Project (SWP) and the numbers of sub-adult smelt counted during annual surveys conducted each fall by the Department of Fish and Game. Surprisingly, we were unable to find any correlation between export volumes and the delta smelt abundance index (Exhibit D). In other words, in some years when exports were high, the delta smelt abundance index also was high. In other years, a low volume of exports was followed by a low fish abundance index.

Export volumes compared to delta smelt abundance index
No correlation

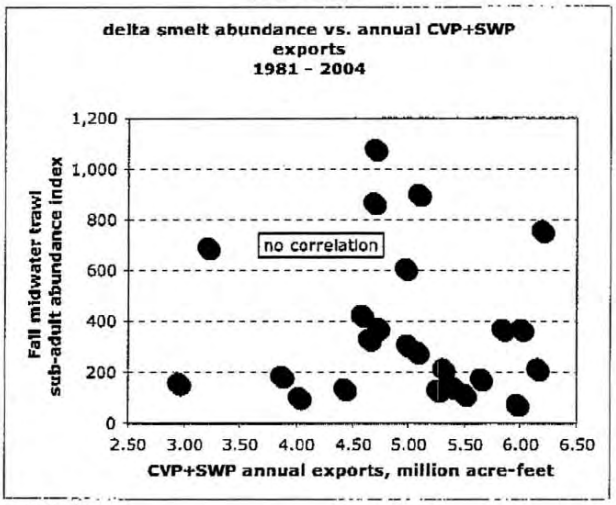


Exhibit D

We then conducted more exhaustive analysis. Rather than look only at export volumes, we looked for correlations between the numbers of adult delta smelt salvaged (or counted) at export pumping facilities and the subsequent Fall Midwater Trawl. We also looked at the numbers of larval and juvenile delta smelt entrained (or killed) at export facilities during pumping operations and the subsequent abundance index found in the Fall Midwater Trawl. This investigation followed a logical assumption that significant numbers of delta smelt, especially larval and juvenile fish, killed or trapped at export pumps during the spring when export volumes are at their highest, would result in low adult abundance indices during the following Fall Midwater Trawls.

In both adult and juvenile studies, we were unable to find any correlation (Exhibits E and F). In years when very few adult and/or juvenile delta smelt were counted or killed at export pumping facilities, there was an equally good chance that the subsequent Fall Midwater Trawl would record high abundance indices as low abundance indices.

3. While correlations do not tell the entire story, they are an important and useful indicator of the major determinants of causation. When we find correlations between actions and effects, we can and should conduct additional research to better understand how those relations should be reoriented. However, the absence of correlations or clear relationships suggests that research resource may be better focused elsewhere.

)06 05:15PM FROM-SLDMWA

FEB 07 2006

The State of the Delta: What is Killing the Delta Smelt?

Correlation analysis of delta smelt juvenile and adult salvage at export facilities 1994—2005

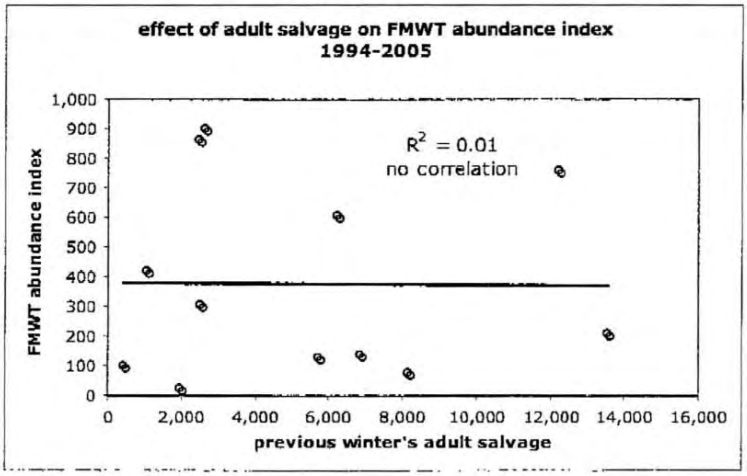


Exhibit E

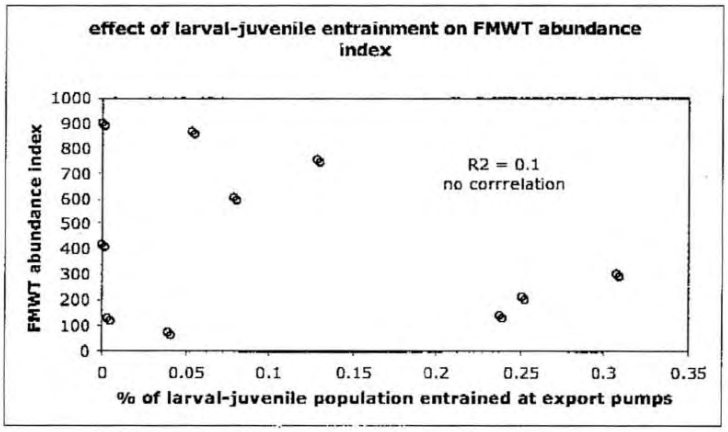


Exhibit F

Finally, we estimated the percentage of the total population of delta smelt in the Delta counted at export facilities during numerous years to determine if high percentages of fish counted at these facilities was followed by a low abundance index during the subsequent Fall Midwater Trawl. Again, we were unable to find any correlation, suggesting again that exports do not have a significant effect on delta smelt abundance (Exhibit G).

FROM-SLDMWA

FEB

The State of the Delta: What is Killing the Delta Smelt?

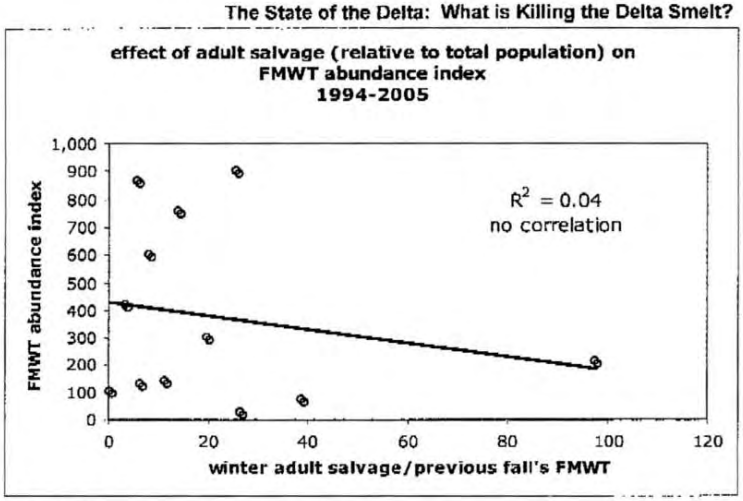


Exhibit G

od Abundance

Having ruled out exports as a major factor in the smelt's mortality, we then turned our attention to food sources. One of the earliest indications that od deprivation is important for delta smelt occurred in 1999. Dr. Bill Bennett f the University of California at Davis, Bodega Marine Laboratory, analyzed a arge number of delta smelt caught in the Delta in an effort to determine the cause of high rates of mortality between the fish's juvenile and adult stages. Dr. Bennett found large numbers of the fish with significant signs of malnourishment in the late summer and early fall. Put simply, the fish were starving to death.

With the focus shifting to food deprivation, it became important to understand what delta smelt eat. All indications are that delta smelt historically have relied primarily on two zooplankton for their food, both of them non-native or alien species.

During most of the 20th Century, the delta smelt's primary food source appears to have been *Eurytemora affinis*, a zooplankton (small floating animal). Although the origins of Eurytemora are not known, some researchers believe it was introduced into the Delta in the latter part of the 19th Century along with striped bass.

In 1986, the voracious Amur River clam (*Corbula amurensis)* was introduced into the Delta from the bilge water of ocean going vessels. Within two years, the Amur River clam took over large portions of Suisun Bay and the western Delta, and with the ability to filter nutrients from enormous volumes of water, the Amur River clam essentially eliminated Eurytemora during parts of the year.[4]

4. In the deeper water regions of the Delta, the Asian clam can filter the entire water column over the channels more than once per day and over the shallows almost 13 times per day.

6

FEB 07 2006

Fortunately for the delta smelt, another alien zooplankton, *Pseudodiaptomus forbesi*, made its appearance in the Delta from China about the same time as the Amur River clam. As the population of Eurytemora plunged, the population of Pseudodiaptomus increased dramatically, and it rapidly became the delta smelt's primary food source (Exhibit H).

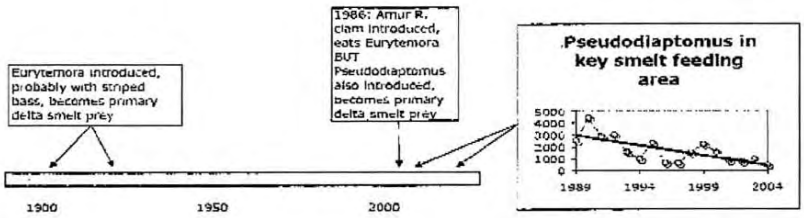


Exhibit H

For many years, biologists from the Department of Fish and Game have sampled the Delta in numerous locations and recorded the presence of zooplankton and other fish food sources in the water. Again, this survey data going back many years provides a rich resource to help us determine when and where the delta smelt's main food supply is found in the Delta.

It became clear to us that the abundance of delta smelt in the fall (as measured by the Fall Midwater Trawl abundance index) did not depend simply on their abundance in the summer. Nor did it depend simply on the summer abundance of prey (primarily Pseudodiaptomus). It seemed that abundance in the fall depended on the right combination of delta smelt and prey in the summer. In other words, it did no good to have lots of smelt where there was little prey or lots of prey where there were no smelt. Delta smelt juveniles and their prey had to co-occur in the summer to produce high abundance of delta smelt sub-adults in the fall.

Following this line of reasoning, we found an excellent correlation between the co-occurrence of smelt juveniles and their prey in July and the subsequent abundance of sub-adults in the fall (Exhibit I). As of now, this is the only correlation that anyone has found between the Fall Midwater Trawl index and any other factor using data from the last quarter of a century.

We also found that the three areas where delta smelt and prey typically co-occurred in July were the lower Sacramento River, from just upstream of Threemile Slough to the confluence with the San Joaquin River, the area around and just downstream of the confluence of the two rivers, and farther downstream in Suisun Bay. The lower Sacramento River area was by far the most important.

02-07-2006 05:15PM FROM-SLDMWA +2098278040 T-897 P.015/016 F-303

FEB 07 2006

The State of the Delta: What is Killing the Delta Smelt?

What has been going on with delta smelt prey in those areas? What factors control prey abundance there? We have an answer to the first question: Prey abundance has been declining and is trending down toward zero. As for the second question, we have not been able to identify the cause of the decline in prey abundance.

We found no correlations between prey abundance and either river flow, salinity, water clarity, or water temperature. We and others continue to search for the cause of the prey decline in the key areas of co-occurrence in the summer.

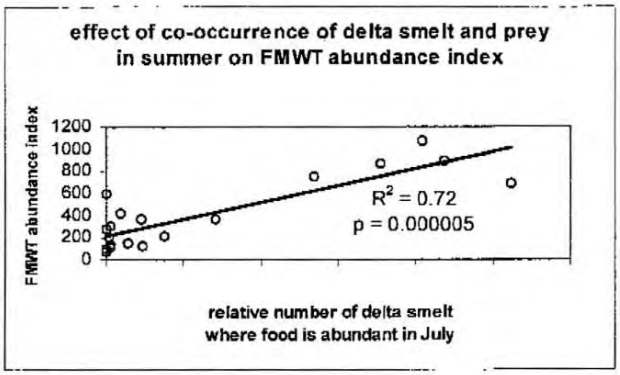


Exhibit I

Export operations and food supply

A logical question that arises from these findings is, to what extent do export operations effect Pseudodiaptomus in the Delta. While this may be an area worthy of additional research, the co-occurrence analysis suggests it

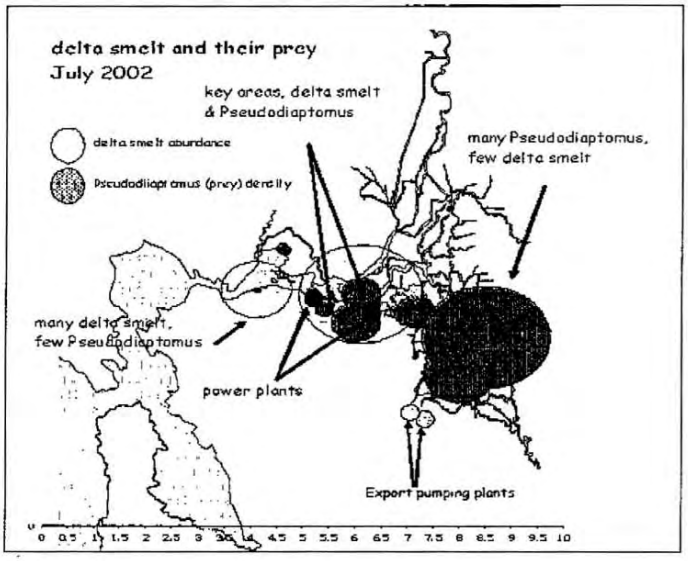


Exhibit J

8

02-07-2006 05:13PM FROM-SLDMWA +2098278040 T-897 P.001 F-303

February 7, 2006

Mr. Paul A. Marshall
Department of Water Resources
South Delta Branch
1416 9th Street, 2nd Floor
Sacramento, CA 95814

FEB 07 2006

FAX: (916) 653-6077

Ms. Sharon McHale
U.S. Bureau of Reclamation
Mid-Pacific Region
2800 Cottage Way
Sacramento, CA 95825

FAX: (916) 978-5094

RE: South Delta Improvement Program, Draft Environmental Impact Statement/Environmental Impact Report Comments

842 SIXTH STREET

SUITE 7

P.O. BOX 2157

LOS BANOS

CALIFORNIA

93635

(209) 826-9696
OFFICE

(209) 826-9698
FAX