Delta Flow Criteria Informational Proceeding

Before the

State Water Resources Control Board

March 22-24, 2010

Exhibit CCWD-9
Closing Statement

Submitted on behalf of

Contra Costa Water District
P.O. Box H2O
Concord, CA 94524

Contact:
Gregory Gartrell
Assistant General Manager
Contra Costa Water District

Contents

Recommendation for Old and Middle River Flow Criteria 1
Background 1
Operational Flexibility through use of Multiple Methods 2
Limiting Entrainment at the Export Facilities....................2
Recommendation 3

Recommendation for the Suppression of *Egeria densa*....................4
Variability Hypothesis: CALFED Science Program Workshop examined the variability hypothesis and identified uncertainty....................4
Suppression of *Egeria densa* with Elevated Salinity 5
Ecosystem Response to Artificial Salinity Regime 6
Recommendation 7

References....................8

Figures

Figure 1 – Prediction of net flow in Old and Middle Rivers for Operational Planning.........9
Figure 2 – Prediction of delta smelt salvage from total exports and San Joaquin River inflow....................10
Figure 3 – Prediction of delta smelt salvage from measured Old and Middle River flow ..11
Figure 4 – Areal Coverage of *Egeria densa*, 2000 12

Delta Flow Criteria Informational Proceeding

Exhibit CCWD-9
Closing Statement

Gregory Gartrell, Ph.D., P.E.
Contra Costa Water District

Recommendation for Old and Middle River Flow Criteria

During the Proceeding on March 24, 2010, Chair Hoppin asked that Contra Costa Water District (CCWD) include information in its closing comments regarding criteria for Old and Middle River that would both protect the public trust resources and allow efficient operations. With these two objectives in mind, CCWD recommends an approach incorporating the existing method (5-day and 14-day average of measured stream flows) and an additional index method that provides the same level of fishery protection but allows efficient operations of the State Water Project and Central Valley Project.

Background

To minimize entrainment and salvage of fish at the State Water Project (SWP) and federal Central Valley Project (CVP) export facilities in the South Delta, the recent biological opinions for operation of the SWP and CVP include water-management alternatives to limit net flow in Old and Middle River. Old and Middle River (OMR) flows are determined by tides, exports, San Joaquin River inflows, wind and barometric pressure (as they affect tides), physical barriers within channels, and hundreds of small diversions. The largest factors are always the tides (including wind and barometric pressure), export pumping and San Joaquin River inflows. Other factors are an order of magnitude or more smaller, except in the months of April through June, when barriers may be important and diversions in the South Delta may become important (the latter being on the order of 1000 cfs at most). Because tides do not follow a 5-day or 14-day cycle, the measured flow averaged over 5 and 14 days can show significant variation on the same order of magnitude as San Joaquin River inflow even without variations due to wind and barometric pressure. As a result, the operations require a significant "buffer" or margin of safety to ensure compliance at all times. This results in inefficient operations and was confirmed in the responses to questions before the Board.

Using the best methods to estimate the unknowns, Paul Hutton (Metropolitan Water District of Southern California) developed a model to predict net OMR flow from exports, San Joaquin River flows and the best estimates of other diversions and unknown (or ungauged) channel flows. However, as shown in Figure 1, the prediction of OMR net flow (y-axis) has considerable noise when plotted with field measurements of OMR (x-axis); the uncertainty in the range of interest (OMR < 0 cfs) is on the order of +/- 1,500 cfs or more. The inability to accurately predict net OMR flow often leads to a more conservative, inefficient operational scheme, costing significant water supply without providing additional fishery benefits.

Operational Flexibility through use of Multiple Methods

The inefficiency in the current practice results from basing the flow requirements on analysis of long-term average (multiple months) Old and Middle River net flow, correlated to salvage at the export facilities over the same long-term period, and then applying the requirements to short-term (daily or weekly) operations. Over multiple months, variations in tides are averaged out, but over a shorter term the tidal variability due to the spring-neap cycle and to weather conditions means that, for example, measured OMR for one 5 day period can be very different from the measured OMR for the following 5 day period even if there are no changes in Delta inflows, diversions, or exports. This short-term variability causes inefficiencies in operations to meet the flow requirements, as Project operators must compensate for natural variation.

This same situation was encountered in developing the X2 objective[1]. In that case, the average location of X2 over 5 months (February to June) was correlated with fish indices. That relationship was then applied to shorter term objectives (a number of days in a month) and required a flexible method to meet the objective. The method adopted allows compliance if any of the following conditions is met: a long-term average (14-day) salinity; or a short-term average (daily) salinity; or a 3-day outflow index.

In the current case for OMR, compliance methods for the long- and short-term averages (in this case 14-day and 5-day) are already in place. It suffices to add an index based on flows.

Limiting Entrainment at the Export Facilities

By examining field data, CCWD determined the key independent variables for predicting salvage of delta smelt are San Joaquin River flow into the Delta and export pumping at the State Water Project and federal Central Valley Project facilities in the south Delta (the location of salvage). That these are the largest variables can be confirmed by doing an "order of magnitude" analysis on all the important factors listed above. CCWD found that these two variables correlate as well or better with salvage than net Old and Middle River flows for the same years upon which the current regulations are based.

As shown in Figure 2, this Flow Index [total exports at the Jones and Tracy Pumping Plants (in cfs) minus one-half the San Joaquin River flow at Vernalis (in cfs)] predicts delta smelt salvage at those facilities with an R-squared value of 0.67. This correlation is similar to, but slightly better than, the correlation between measured Old and Middle River net flow and salvage (Figure 3). Therefore, use of the Flow Index that equals the total exports minus one-half San Joaquin River flow would allow management of entrainment at the export facilities to the same level of confidence as the use of measured OMR net flow. The Flow Index has the same advantage as the net outflow index used for X2: it is measurable on a daily basis and does not vary with the vagaries of the tides or uncontrollable factors.

---

[1] X2 is the distance in kilometers from the Golden Gate Bridge to the location of the 2 parts per thousand (ppt) <u>bottom</u> salinity. The Water Quality Control Plan objective uses an equivalent <u>surface</u> salinity or equivalent Delta outflow.

The Flow Index method has definite benefits over the current method of adjusting exports to manipulate measured flow in Old and Middle rivers, including: (1) ease of calculation, (2) operational certainty and (3) natural variability. First, the Flow Index is easy to calculate. Exports must simply be less than one-half the San Joaquin River inflow plus the absolute value of the OMR flow limit (for example, if OMR is to be no more negative than -5,000 cfs, exports must be less than one-half the San Joaquin River inflow plus 5,000 cfs). Second, the method provides better operational certainty because state and federal operators have direct control of the level of exports and fairly good prediction capabilities for the San Joaquin River flow at Vernalis.

Finally, the Flow Index method allows natural variability to remain in the system. Under natural conditions, net OMR flow would exhibit natural spring-neap tidal variability and fluctuations due to atmospheric conditions. With exports at a constant level, this natural variability still exists in the system. However, if exports are managed on a daily basis to meet a net OMR flow all the time, exports may be increased and decreased to remove the natural variability; this manipulation in export pumping has been evident during periods with restrictions on OMR flow.

Recommendation

For implementation of Old and Middle River flow restrictions, compliance should be allowed if either of the following is met:

1) 14-day average of tidally filtered flows measured in Old and Middle River are greater than –X, where X is the flow level in cfs, and 5-day average of tidally filtered flows measured in Old and Middle River are greater than –1.25*X, where X is the flow level in cfs (the same as current practice); or

2) 3-day average of exports is less than one-half the 3-day average of San Joaquin River inflow measured at Vernalis plus A*X, where X is the flow level in cfs and A is a constant multiplier.

Recommendation for the Suppression of *Egeria densa*

The State Water Board should not set flow requirements for the suppression of *Egeria densa* because the action would not protect the public trust resources for the following reasons:

(1) the use of flow and salinity to suppress *Egeria densa* is based on a hypothesis that has not been tested;

(2) the level of salinity necessary to suppress *Egeria densa* is much greater than natural salinity levels in the Delta, even during droughts; and

(3) the unnatural salinity conditions necessary to suppress *Egeria densa* would be likely to adversely impact native aquatic species.

Details on each of these issues are presented below with references to testimony before the State Water Resources Control Board as well as a workshop hosted by the CALFED Science program that included many expert witnesses from the State Water Board's Delta Flows Proceeding. Further information will be provided to the State Water Board upon request.

Variability Hypothesis: CALFED Science Program Workshop examined the variability hypothesis and identified uncertainty

The CALFED Science Program hosted a workshop titled "Defining a Variable Delta to Promote Estuarine Fish Habitat"[2] on June 11, 2007 (hereafter, "Workshop"). Many of the scientists on the expert panels for the State Water Board's Delta Flows Informational Proceeding participated in the Workshop. The final report was drafted by Matt Nobriga with input from Jon Burau (U.S. Geological Survey), Dr. Greg Gartrell (Contra Costa Water District), Dr. Lauren Hastings (CALFED Science Program), Dr. Mike Healey (CALFED Lead Scientist), Dr. Wim Kimmerer (San Francisco State University), Dr. Peter Moyle (UC Davis), Tara Smith (Department of Water Resources), and Dr. Jan Thompson (U.S. Geological Survey).

Workshop presenters agreed that habitat variability must include a broad range of attributes and that focusing on salinity variability alone as a comprehensive surrogate for habitat quality is too narrow and inappropriate. The Workshop presentations and final report address a number of uncertainties concerning ecosystem response and identify areas of vital research and analysis that are necessary <u>before</u> any large-scale system manipulation experiments should be considered.

Findings from this Workshop are discussed in the following sections, supplemented with additional information from testimony from the State Water Board's Delta Flows Proceeding.

---

[2] The presentations and final report for the Workshop are available on the CALFED Science website at http://www.science.calwater.ca.gov/events/workshops/workshop_variable.html

Suppression of Egeria densa with Elevated Salinity

Background on *Egeria densa*

Native to Brazil, *Egeria densa* (also known as Brazilian waterweed) is a popular aquarium plant in California, which is probably how it entered the Delta about 40 years ago. The Delta is a predominantly freshwater system, with rising temperatures in the spring and summer conducive to growth of *Egeria densa*. Now infesting approximately 6,000 acres, or 12 percent of the Delta[3], *Egeria densa* grows in dense patches in regions far removed from the San Francisco Bay (see Figure 4).

Experimental studies on the effects of salinity on *Egeria densa* revealed that both root formation and growth decline with increasing salinity (Obrebski and Booth, 2003); however, even at 6 parts per thousand (ppt) salinity, the plant shoots continued to grow, with an average growth of 10% to 40% over 18 days, depending on temperature. Hauenstein and Ramirez (1986) found no growth of roots or stems at salinity greater than 10 ppt. Therefore, suppression of *Egeria densa* will require salinity levels near 10 ppt.

Natural flow and salinity in the Delta[4]

The level of salinity necessary to suppress growth of *Egeria densa* (i.e. 10 ppt salinity) is unnatural for most locations within the Delta. As discussed in CCWD Exhibit 6, the furthest salinity intrusion into the Delta occurred during the drought in the 1920's and 1930's, with the maximum occurring in 1931. If *Egeria densa* had been present in 1931, salinity may have caused necrosis in some of the plants near Franks Tract. However, the dense growth of *Egeria densa* inland of the Franks Tract region (e.g. White Slough near Empire Tract and Old River near Coney Island, see Figure 4) would not be likely to be impacted by increased salinity intrusion[5]. Given the widespread growth of *Egeria densa* within the Delta, *Egeria densa* is likely to reinvade any areas potentially affected by elevated salinity[6].

During the drought in the 1920's and 1930's, salinity intrusion was exacerbated by anthropogenic changes, including reclamation of Delta islands, straightening and deepening of the Sacramento River near Decker Island, and diversion of water upstream of the Delta to irrigate over 4 million acres of crops. Since salinity intrudes into the Delta much further under current (i.e. post-European settlement) conditions than evident in the previous 2,500 years (see Figure 2-5 in CCWD Exhibit 6), any additional increase in salinity must be carefully evaluated for adverse effects on native aquatic species. Some potential adverse impacts were identified in the

---

[3] Acreage estimate from the California Department of Waterways website (accessed on April 9, 2010): http://www.dbw.ca.gov/Environmental/Aquatic.aspx

[4] Further information on natural salinity variability is provided in CCWD Exhibit 6.

[5] For instance, in 1931, salinity peaked near 4.5 ppt on White Slough near Empire Tract and 3.0 ppt on Old River near Coney Island (DPW, 1931). As indicated in the salinity experiments cited above, this level of salinity is unlikely to suppress growth of *Egeria densa*.

[6] For instance, following herbicide treatments to control *Egeria densa*, some stems that became chlorotic (i.e. changed color from green to yellow) or exhibited defoliation, later exhibited regrowth (Ruch et al., 2006).

Workshop and are summarized in the "Ecosystem Response to Artificial Salinity Regime" section below.

<u>Necessary flows to achieve elevated salinity to suppress *Egeria densa*</u>

During 1931, net Delta outflow was negative (on average, water from San Francisco Bay was flowing into the Delta) from early June through the first week in September[7], such that the average outflow for June through September was -1,000 cfs (eastward)[8]. During this period, unimpaired outflow averaged +3,900 cfs (seaward)[9], which indicates that salinity intrusion was exacerbated by the nearly 5,000 cfs reduction in outflow due to upstream and within Delta diversions.

With the existing Delta configuration (channel and island geometry), initial studies indicate that without reversing flow at Carquinez, it would take four to five months of very low net Delta outflow (250 cubic feet per second) to reach a daily average salinity of 10ppt at Jersey Point (approximately 5 river miles west of Franks Tract). During this low flow period, residence times in channels would be very high, and they would accumulate any discharges from adjacent lands or upstream agricultural and municipal developments.

If this reduction of net Delta outflow is achieved by limiting releases from upstream reservoirs, ecosystem impacts that would result from the flow reduction or temperature increase in the upper watershed could be substantial. If a peripheral canal is built to achieve salinity intrusion, it may need to be far upstream (above Sacramento) to be located where the water is still fresh.

Ecosystem Response to Artificial Salinity Regime

There is no scientific consensus that major modifications to habitat in the Delta by increasing salinity intrusion would be beneficial on net. In fact, there is an abundance of data that link improved fish populations with fresher, not saltier, conditions.[10,11,12] A saltier regime could have significant redirected impacts to many species and would likely promote the overbite clam population.

The proposed range of salinity is currently observed in some areas of Suisun Bay that are part of the permanent habitat of the overbite clam[13]. It is unknown whether sustaining the low salinity

---

7 with the exception of a few days in mid-June
8 Historical outflow was obtained from the IEP's DAYFLOW program (http://www.iep.ca.gov/dayflow/index.html).
9 Unimpaired outflow was obtained from Ejeta (2009), which is an updated version of DWR (1987).
10 Feyrer F, Nobriga ML, Sommer TR. 2007. Multi-decadal trends for three fish declining fish species: habitat patterns and mechanisms in the San Francisco Estuary. Canadian Journal of Fisheries and Aquatic Sciences. (32, 6).
11 Guerin M, Denton RD, Gartrell G. 2006. Linkages Between Fall Salinity, Delta Outflow and Delta Smelt Population Decline. CALFED Science Conference. Sacramento CA.
12 The Bay Institute presented evidence to the State Water Board that their composite flow index, termed the 'Delta Flow Index', exhibits a strong correlation with the relative abundance of six Delta pelagic fish species. The presentation is available online at:
http://www.waterrights.ca.gov/baydelta/docs/pelagicorganism/tbi_swanson_ppt_061907.pdf
13 Workshop report. Pages 10 and 11.

for a longer period of time will kill the overbite clam and/or allow the Asiatic freshwater clam to establish in the region. Currently, the two clam populations, the overbite clam and the Asiatic freshwater clam, inhabit primarily different areas of the Bay-Delta, with a small region of overlap near the confluence of the Sacramento and San Joaquin rivers at Collinsville[14]; the overbite clam lives to the west of the confluence while the Asiatic freshwater clam lives to the east. At this time, we do not know how the clam populations will respond to a change in the salinity regime. The primary habitat may simply shift[15], with the possible consequence of increasing the area of overlap between the two species.

Shifting the habitat may increase the biomass of one clam species at the expense of the other. Recent research indicates that the overbite clam is likely more detrimental to the ecosystem than the Asiatic freshwater clam – the overbite clam filters water (including "fish food") faster and accumulates selenium faster[16]. At this point, we cannot predict how the ecosystem will respond to a new salinity regime. The Workshop report cautions: "dynamics of clam-phytoplankton interactions under different salinity regimes are not currently predictable. Therefore, the food web responses of fishes feeding on clams or competing with them for food are likewise not currently predictable."

In addition to the clam-related food-web issues, there is a great deal of uncertainty in the role of Brazilian waterweed in the food-limited ecosystem of the Delta. It is currently unknown whether the Brazilian waterweed, the algae that covers its leaves, or the invertebrates common within the beds are important in the food-web. If the change in salinity regime is successful in killing large quantities of Brazilian waterweed, it may adversely impact the food-web.

Furthermore, sediment geochemistry may be altered by a change in salinity, potentially affecting inorganic mercury-methylation. Additionally, if the Brazilian waterweed dies quickly, the bottom of the water column may become anoxic, with the potential to release toxic metals from sediments and plants. The response of the waterweed to increased salinity, including the rate of dieback and fate of dead vegetation is currently unknown.

Finally, impacts to nearby aquatic regions, including Suisun Bay and Marsh, San Pablo Bay, central San Francisco Bay, and South Bay and potential impacts on terrestrial species in adjacent areas are not known.

Recommendation

No flow objectives for the control of *Egeria densa* should be set. The use of flow and salinity to suppress *Egeria densa* is based on a hypothesis that has not been tested and the flows required would raise Delta salinity to unprecedented levels for long periods of time, creating conditions that would be likely to adversely affect native species.

[14] Workshop presentation. Thompson, slide 12
[15] Workshop presentation. Thompson, slide 12
[16] Workshop presentation. Thompson, slide 13

References

[DPW] Department of Public Works. 1931. Variation and Control of Salinity in Sacramento-San Joaquin Delta and Upper San Francisco Bay. Bulletin No. 27. State of California, Department of Public Works, Division of Engineering and Irrigation. See http://www.archive.org/details/variationcontrol27calirich

[DWR] Department of Water Resources. 1987. California Central Valley Unimpaired Flow Data. State of California. The Resources Agency. Division of Planning.

Ejeta, M. 2009. Unimpaired NDO data provided as an update to the February 1987 DWR publication "California Central Valley Unimpaired Flow Data". June 8, 2009.

Hauenstein, E., and C Ramirez. 1986. The influence of salinity on the distribution of Egeria densa in the Valdivia river basin, Chile. Arch. Hydrobiol. 107:511-519.

Nobriga, M. 2007. Report on the CALFED Science Program Workshop "Defining a Variable Delta to Promote Estuarine Fish Habitat" Available at http://www.science.calwater.ca.gov/events/workshops/workshop_variable.html

Obrebski, S., and R. Booth. 2003. Experimental Studies of the Effects of Temperature, Salinity and Light Intensity on Growth of *Egeria densa*. Report to the California Department of Boating and Waterways, December 2003.

Ruch, S. A. and California Department of Boating and Waterways, Aquatic Weed Unit. 2006. Utilizing Differential Quantitative Mapping Technologies and Traditional Botanical Knowledge to Assist Brazilian waterweed Management in the Sacramento-San Joaquin Delta: An Example from Franks Tract. Presented at California Invasive Plan Council Symposium.
Available at http://www.cal-ipc.org/symposia/archive/2006_presentations.php

Thompson, J. "Clams – where, how, and can we limit the damage." Presented at CALFED Science Program Variable Delta Workshop. June 2007. Available at http://www.science.calwater.ca.gov/events/workshops/workshop_variable.html

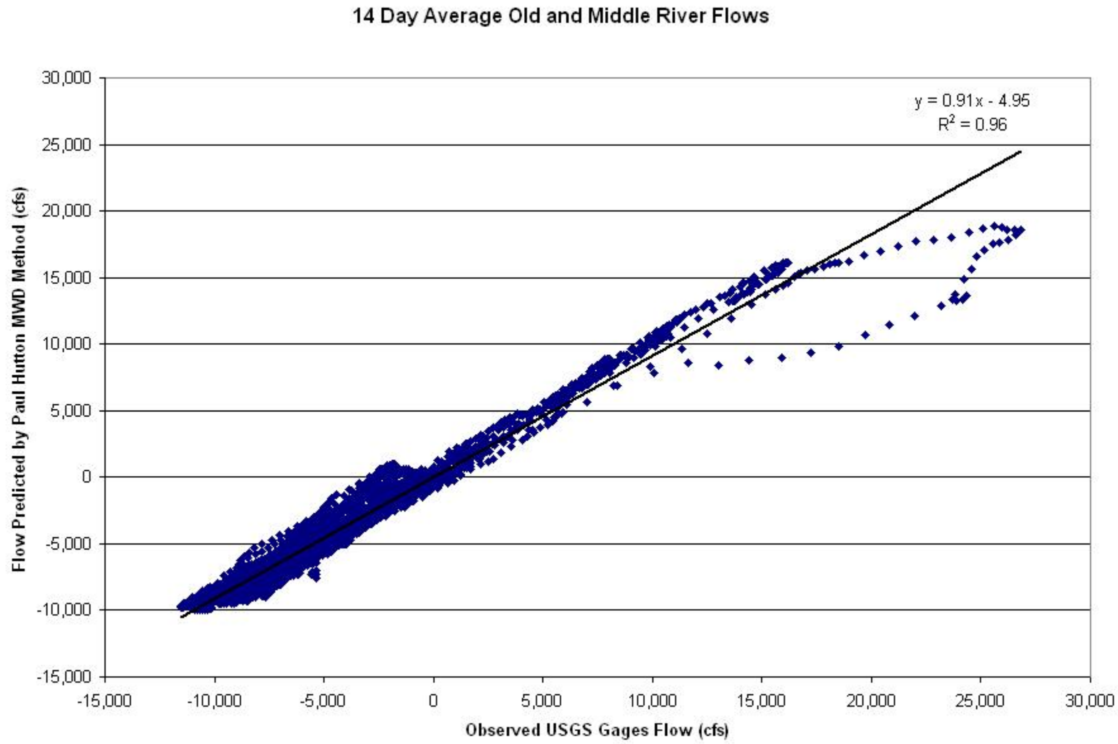

Figure 1 – Prediction of net flow in Old and Middle Rivers for Operational Planning
Demonstration of uncertainty in field measurements and estimates of 14-day average flow from 1993 to 2009. Predicted values (y-axis) incorporate estimates of diversions affecting OMR net flow, yet considerable uncertainty remains, particularly in the range of interest (negative levels).

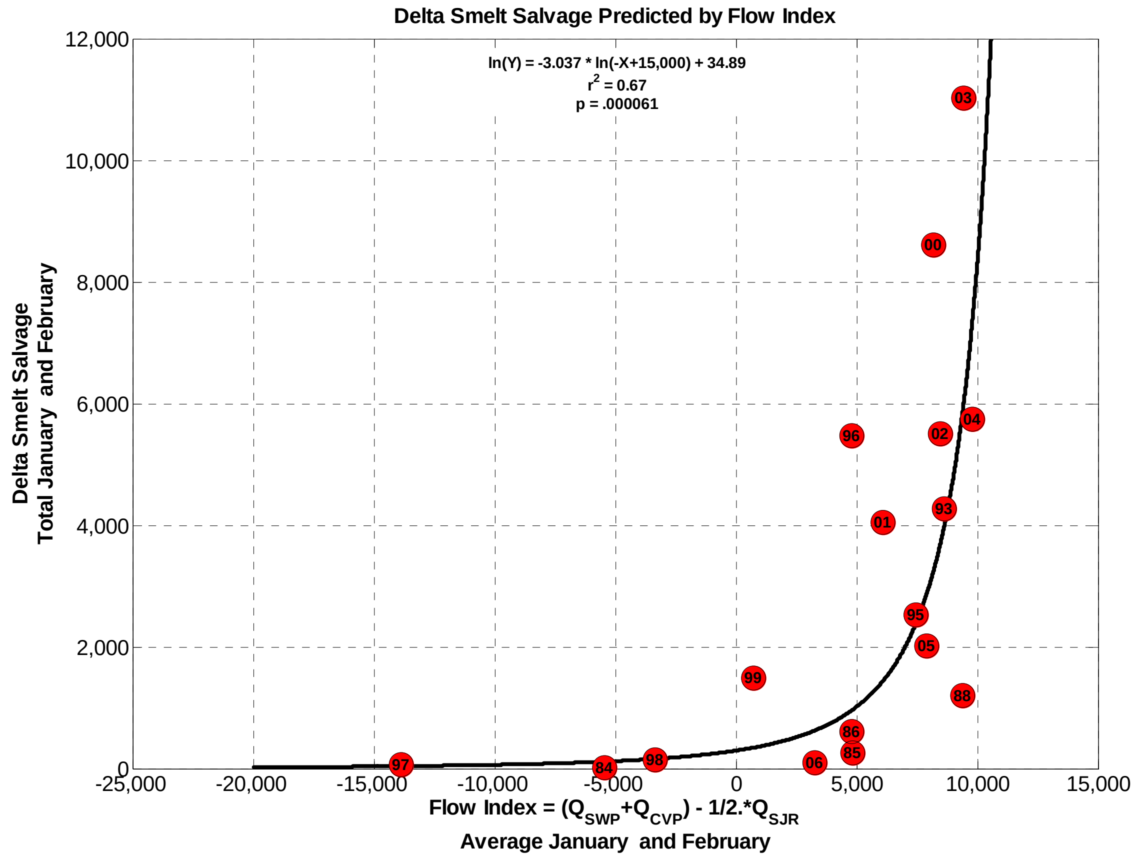

Figure 2 – Prediction of delta smelt salvage from total exports and San Joaquin River inflow

Data are from the period 1984-2007, excluding years with low turbidity (1987, 1989-1992, and 2007), as specified in the 2008 U.S. Fish and Wildlife Biological Opinion (see Figure B-13).

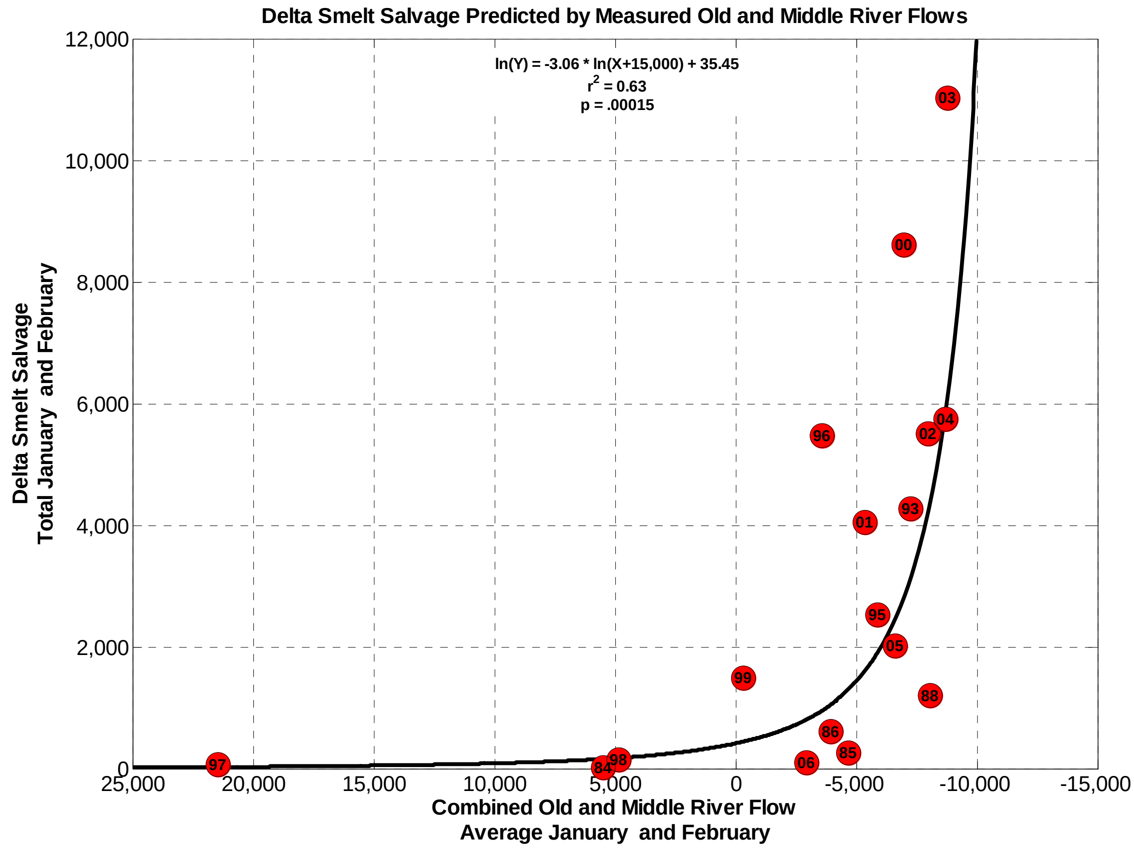

Figure 3 – Prediction of delta smelt salvage from measured Old and Middle River flow

Data are from the period 1984-2007, excluding years with low turbidity (1987, 1989-1992, and 2007), as specified in the 2008 U.S. Fish and Wildlife Biological Opinion (see Figure B-13).

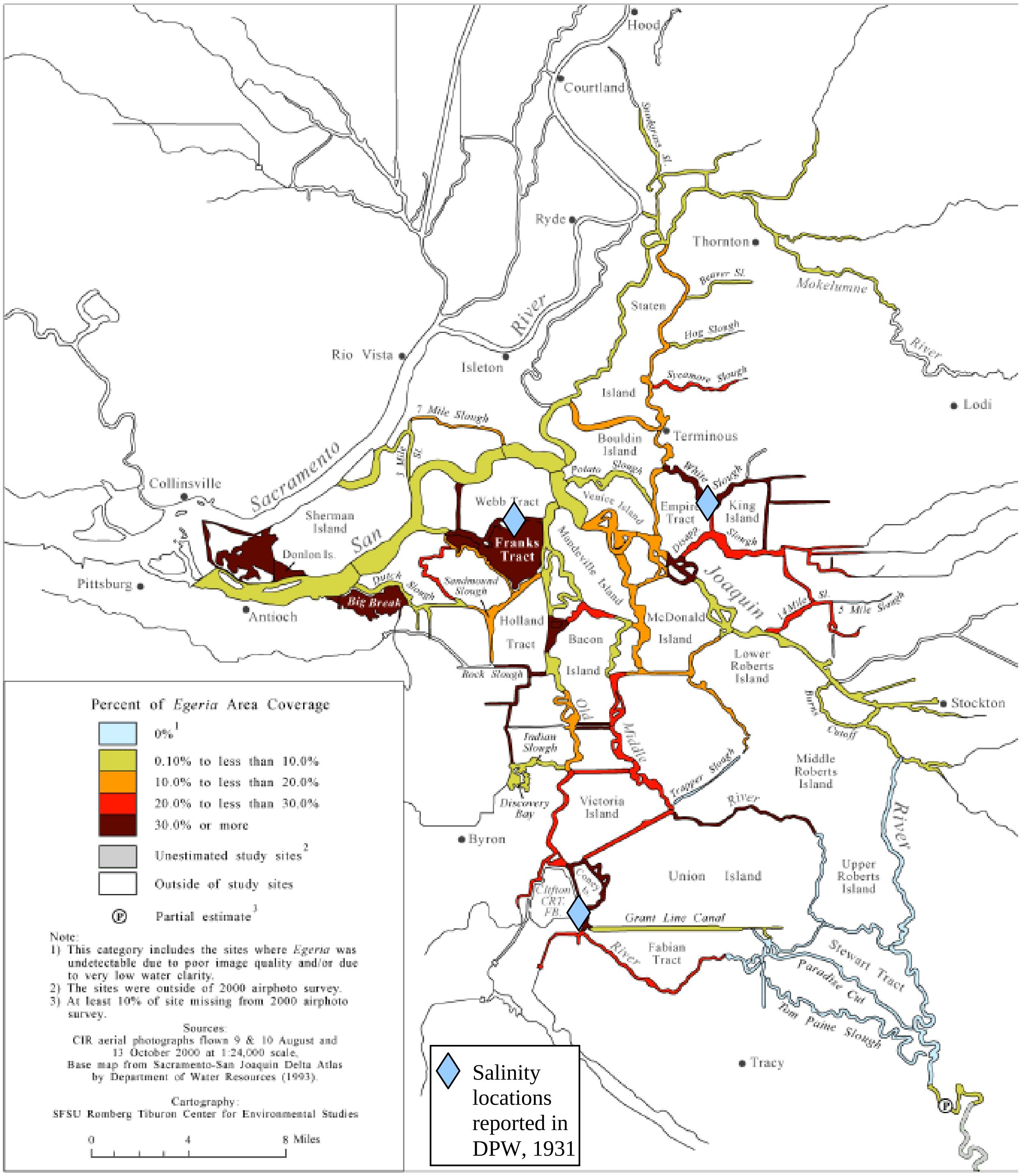

Figure 4 – Areal Coverage of *Egeria densa*, 2000

Created by P.G. Foschi et al., SFSU Romberg Tiburon Center, cartographer: M. Odaya. Locations of salinity measurements reported from DPW (1931) are indicated with blue diamonds.