Fall Midwater Trawl Survey Results

Lee Miller

The 1997 fall midwater trawl abundance index for young striped bass is 565. The abundance index is the sum of monthly indices for September-December. The 1997 index is higher than indices from the last two years, but is the fifth lowest of record. The December index is 64, the second lowest of record. Young striped bass were found mainly in the lower San Joaquin and Sacramento Rivers in September, with distribution expanding into Suisun Bay in October and into San Pablo Bay by December.

The 1997 fall midwater trawl abundance index for American shad is 2,302. The 1997 index is almost half the 1996 index and almost one-third of the record high index of 6,859 recorded in 1995.

The fall index for longfin smelt is 689, about half of last years index of 1388 and more than an order of magnitude lower than the 1995 index of 8,633.

More information about fall midwater trawl results can be viewed on the Internet. The URL is www.Delta.dfg.ca.gov/data/mwt97/.

Bay Fish and Shrimp Monitoring

Kathy Hieb

The San Francisco Bay Study fisheries monitoring survey collected 3 "new" species in November 1997. One species is a recently introduced goby from Asia (*Tridentiger barbatus*) and its introduction is discussed by Kevin Fleming in the next article in this newsletter. We also collected a blue crab (*Callinectes sapidus*) in Carquinez Strait and a juvenile white seabass (*Cynoscion nobilis*) in South Bay. Although several blue crabs have been collected by bay shrimp trawlers in recent years, we do not know if a reproducing population is established in the estuary. These collections may have been recaptures from one or several deliberate introductions. The white seabass collection was not unexpected, as the white seabass population has increased north of Point Conception during the present El Niño event.

Pacific sardine catches increased to record numbers in the estuary in late 1997. In November and December 1997, Pacific sardines were more common than northern anchovy, which is a first for the survey. Not only have Pacific sardine numbers increased, but northern anchovy numbers have decreased along the

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Exotic Goby Takes Up Residence in Estuary

Kevin Fleming, DFG

One more exotic species of goby appears to have taken up residence in the estuary. Four sh^kihaze gobies, *Tridentiger barbatus* (Gunther), have been collected in otter trawls during routine sampling of the estuary by the San Francisco Bay/Delta Outflow Study. The first, a 32mm TL juvenile, was collected on November 3, 1997, in the San Joaquin River near West Island at a depth of 12.9 meters. The bottom temperature was 17.6°C and the bottom salinity was 1.8. The next three were collected on December 3, 1997, in a single tow in San Pablo Bay near Point San Pedro at a depth of 6 meters. The bottom temperature was 13.9°C and the bottom salinity was 12.8.

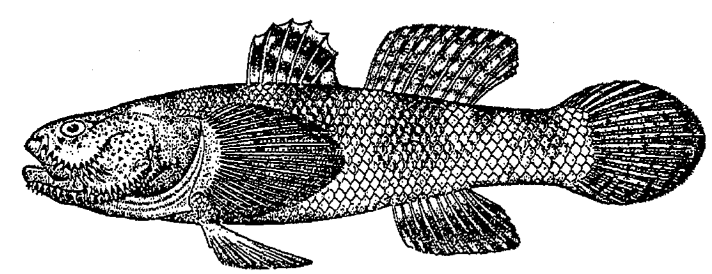
Our information on the sh^kihaze goby is limited to descriptions of morphology and range; a literature review is underway. The sh^kihaze goby can be distinguished from other gobies by the presence of barbels on the edges of the suborbital and lower jaw. No other goby in the estuary exhibits this characteristic. The sh^kihaze is native to Asian marine and brackish waters, from China to Japan and Korea (Jordan and Synder 1902, Masuda *et al* 1984, Tomiyama 1936).

Reference

Jordan D.S., J.O. Synder. 1902. A Review of the Gobioid Fishes of Japan, with Descriptions of Twenty-One New Species. Proceedings of the United States National Museum 24(1244):33-132.

Masuda H., K. Amaoka, C. Araga, T. Uyeno, T. Yoshino, editors. 1984. The Fishes of the Japanese Archipelago. 2 ed. Tokyo: Tokai University Press. 437 p.

Tomiyama I. 1936. Gobiidae of Japan. Japanese Journal of Zoology 7(1):37-112.



Source: Jordan and Snyder 1902.

Figure 1
The sh^kihaze goby has recently been found in the estuary.

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central California coast during the present El Niño.

Preliminary 1997 abundance indices for selected estuarine species, including the shrimp *Crangon franciscorum*, Dungeness crab, longfin smelt, and starry flounder indices have been calculated and will be reported in the next issue of the IEP Newsletter.

Phytoplankton Biomass and Community Composition

A gradual decrease in chlorophyll a concentration characterized stations in the upper estuary between October and December. The highest chlorophyll a concentrations occurred in October in the southern Delta (stations P8 and C10), where concentrations were 6-22 ug/l due to an increase in diatoms and greens; *Skeletonema potamos* was the most abundant diatom. At the rest of the stations, chlorophyll a concentrations were 3 ug/l or less. By November, chlorophyll a concentrations decreased by a factor of two in the southern Delta (3-12 ug/l) with the decline of *Skeletonema potamos*. A small increase in chlorophyll a concentrations to 5 ug/l in the lower Sacramento River at Point Sacramento (D4) was associated with the flagellate, *Cryptomonas ovata*, but concentrations at the rest of the stations remained at <2 ug/l. Chlorophyll a concentrations continued to decrease and the maximum concentration in December was only 5 ug/l at Vernalis (C10).

Indirect Measurement of Delta Outflow Using Ultrasonic Velocity Meters and Comparison with Mass-Balance Calculated Outflow

Richard N. Oltmann, USGS

A measurement of the quantity of water flowing from the Sacramento-San Joaquin Delta into Suisun Bay (Delta outflow) has been desired by those studying and managing the San Francisco Bay/Delta estuary since the 1920s. Historically, Delta outflow has been estimated using a mass-balance calculation that uses measured Delta inflows and exports, and imprecise estimates of consumptive use for the approximately 2,000 small agricultural diversions within the Delta. The DWR has estimated Delta outflow for 1929 to present using the computer program DAYFLOW. The USBR also estimates Delta outflow using the mass-balance method; their estimates are in close agreement with the DWR estimates. Although the mass-balance method has worked reasonably well over the years, it has several shortcomings. The method does not account for the filling and draining of the Delta during the spring-neap tidal cycle, and neglects any effects from variations in atmospheric pressure and wind (wind effects will not be discussed in this article). Also, any error in the estimation of Delta consumptive use is passed directly to the estimate of Delta outflow.

As part of the IEP, the USGS can now provide indirect measurements of Delta outflow by combining flow measurements from 4 of the 10 continuous flow monitoring stations currently operated by the USGS in the Delta. Ultrasonic velocity meters (UVM) are being used to provide 15-minute interval time-series of tidal flow data at the ten flow monitoring stations.

For an explanation of the operation of a UVM, please refer to the autumn 1995 Newsletter article "Continuous Flow Measurements Using Ultrasonic Velocity Meters: An Update". Indirect measurements of Delta outflow are obtained by combining the measured flow data from the UVM stations for the San Joaquin River at Jersey Point, Sacramento River at Rio Vista, Threemile Slough, and Dutch Slough at Jersey Island (Figure 1).

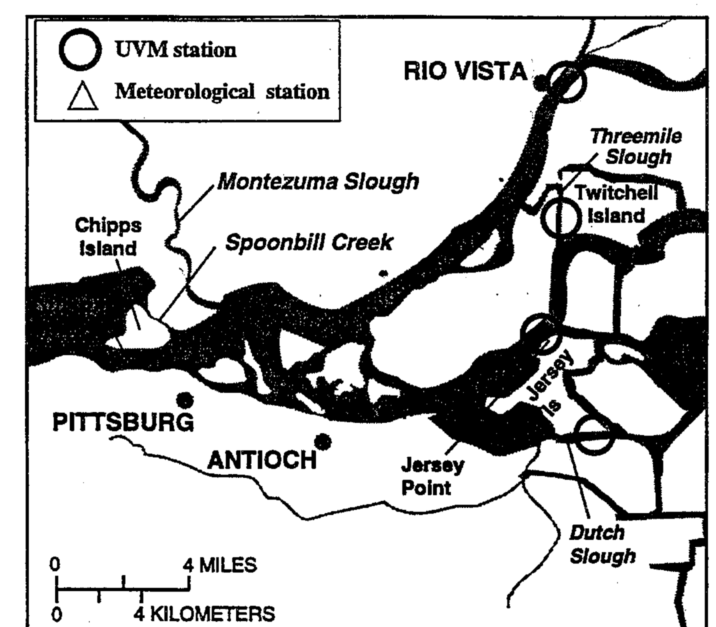

Figure 1
Continuous flow monitoring UVM stations used to provide indirect measurement of delta outfflow.

The first attempt by the USGS to

measure Delta outflow occurred in 1980 with the installation of a UVM at Chipps Island (Figure 1). Operation of the UVM failed because the 3,800-ft acoustic path length was too long for the salinity and water temperature conditions encountered, which resulted in fatal ray-bending problems of the acoustic signals that were transmitted back and forth across the channel. As a result, flow measuring stations were selected to the east of Chipps Island where water density and path length problems are more manageable.

The Delta outflow measured by the four UVM stations

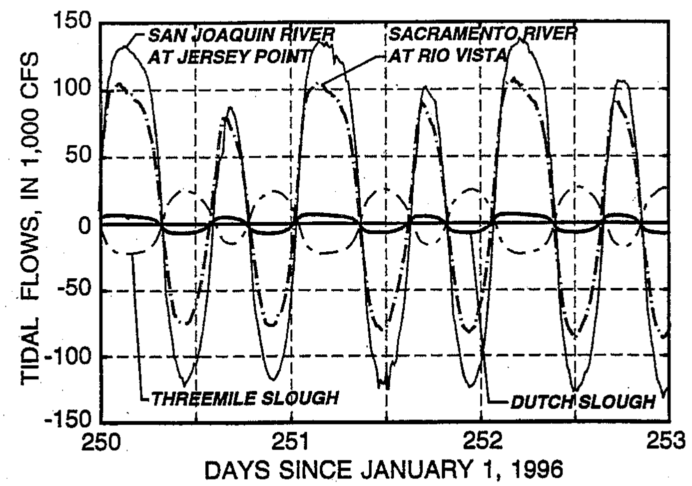

Figure 2
Tidal flows at delta outflow UVM stations for September 6-8, 1996.

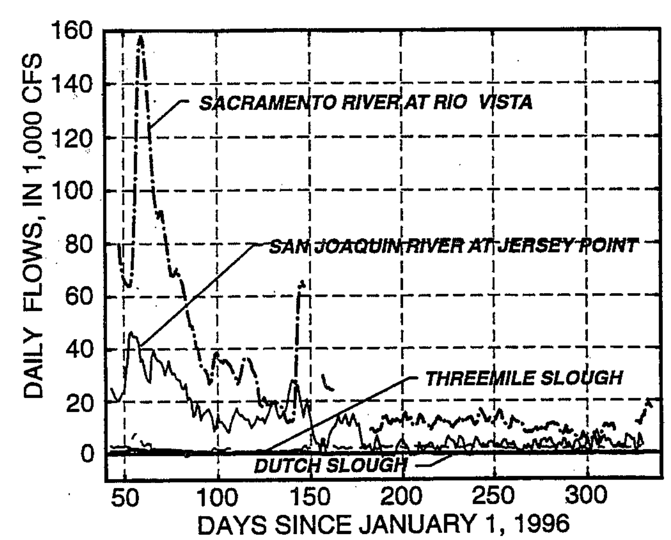

Figure 3
Daily flows at delta outflow UVM stations for February to November 1996.

represents the flow leaving the Delta at the longitude of Antioch (Figure 1). The UVM-measured Delta outflow is referred to as an indirect measurement because Delta outflow is not directly measured at one location. The UVM-measured Delta outflow is not equivalent to the flow at Chipps Island; to calculate the flow for Chipps Island, flows for Montezuma Slough and the channel east of Chipps Island (Spoonbill Creek) would have to be included in the calculation.

The installation of the Dutch Slough UVM station was completed on February 12, 1996, and was the last of the required four UVM stations to be operational. With the completion of the fourth station, measurement of Delta outflow using UVMs began; daily Delta outflow data are available for all periods when all four UVM stations have been operational.

Figure 2 shows tidal flow data for the four Delta outflow UVM stations for a 3-day period during September 1996 (days 250-252). The data show the dynamic nature of the tidal flows and the relative differences between the tidal flow magnitudes at the four UVM stations. Positive indicates seaward flows except for Threemile Slough where positive flow indicates flow from the Sacramento River to the San Joaquin River. Maximum tidal flows range from about 8,000 cfs for Dutch Slough to about 130,000 cfs for the San Joaquin River, or about 16 times larger than Dutch Slough flows. There are two noteworthy items with regard to the Threemile Slough flows: (1) when the Sacramento and San Joaquin River tidal flows are flooding, the flow in Threemile Slough is from the Sacramento River to the San Joaquin River, and in the opposite direction during ebb flows, and (2) the water flowing either out of or into Threemile Slough from the San Joaquin River is flowing to or from the upstream (northern) reach of the San Joaquin River, or in other words, the water is flowing back and forth around the southwest tip of Twitchell Island (Figure 1).

To compute daily flows for each UVM station, the time-series of measured tidal flows were tidally averaged using a digital filter that removes the tidal frequencies from the data. Figure 3 shows daily flow hydrographs for the four UVM stations for the period February to November 1996 (days 45-330). An expanded plot of Figure 3 for the low-flow period of July to November 1996 (days 180-330) is shown in Figure 4 to show the relative magnitude of the daily flow at each of the four UVM stations. Figure 4 shows that for this particular period, which is a typical flow condition, the Sacramento River provides the largest flows to Delta outflow relative to the other three UVM stations. Dutch Slough generally provides the smallest portion of flow, and for this particular period, the flow is actually a negative quantity indicating that the net direction of flow is to the east into the central Delta. A noteworthy observation is that the net flow for Threemile Slough for the period is about 2,500 cfs from the Sacramento River to the San Joaquin River and is roughly equal to the seaward flow of the San Joaquin River. This leads to a net flow to the west from the central Delta (QWEST) of approximately zero (QWEST flows can be calculated using three of the four Delta outflow UVM stations).

A measurement of Delta outflow is obtained by mathematically combining the daily flows for each of the four UVM stations; flow for Threemile Slough is subtracted from flow for the Sacramento River at Rio Vista, and the resultant is summed with flows for the San Joaquin River at Jersey Point and Dutch Slough. Figure 5 shows a Delta outflow hydrograph as measured at the four UVM stations for the period February to November 1996. During this period, estimated Delta outflow ranges from about 200,000 to 2,000 cfs. An expanded plot of Figure 5 for the low-flow period of July to November 1996 along with tidally averaged water-surface elevation (stage) for Threemile Slough is shown in Figure 6. These plots show how Delta outflow varies with the spring-neap tidal cycle, and the corresponding filling and draining of the Delta. During the period indicated by the first two vertical lines shown on Figure 6 (around day 240), the net stage increased which is indicative of transistion from a neap to a spring tide. During this period, the Delta filled resulting in a decrease in Delta outflow relative to the period when the net stage decreases and the Delta drains as shown by Figure 6 for the period between the second and third vertical lines.

Figure 7 shows two hydrographs of Delta outflow for the period February to November 1996 as computed using the mass-balance method and as measured by the UVMs . The two hydrographs match fairly well for the high-flow periods, but not as well for the low-flow periods. An expanded plot of Figure 7 for the July to November low-flow period is shown in Figure 8 and shows a lot of variation between the two hydrographs. Some of the variation is due to the spring-neap tidal cycle. Some of the variation is due to changes in atmospheric pressure and probably to the imprecise estimate of consumptive use used in the mass-balance calculation. To show the effects of atmospheric pressure, Figure 9 shows tidally averaged stage for Threemile Slough and atmospheric pressure recorded at the USGS meteorological station in Suisun Bay. During the period from about day 280 to the end of the record, the average stage for Threemile Slough is lower relative to the period prior to day 280, and this lowering in stage corresponds to an increase in atmospheric pressure. The largest difference between the two flow hydrographs occurs around day 280 (Figure 8). The hydrograph of UVM-measured flow shows much higher flows

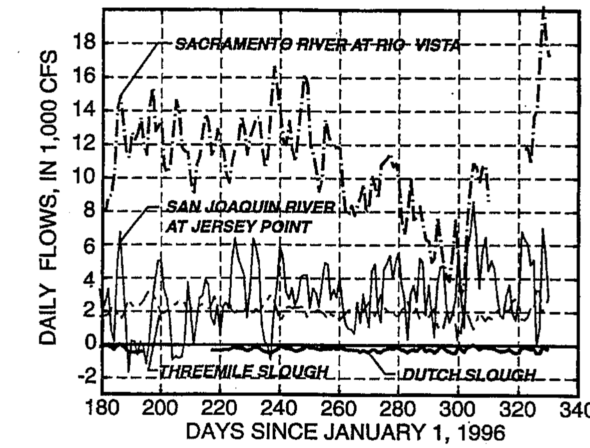

Figure 4
Daily flows at delta outflow UVM stations for July to November 1996.

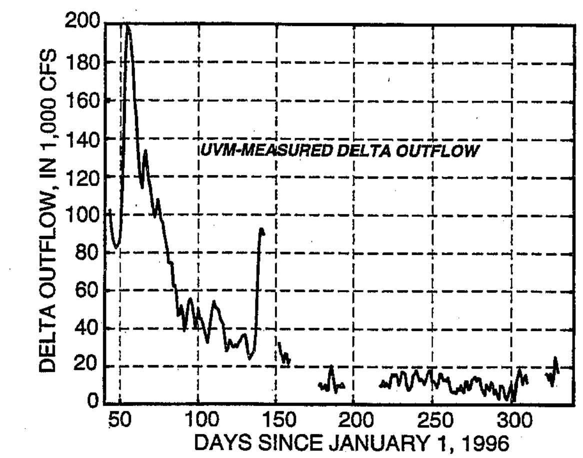

Figure 5
Delta outflow as measured by UVMs for February to November 1996.

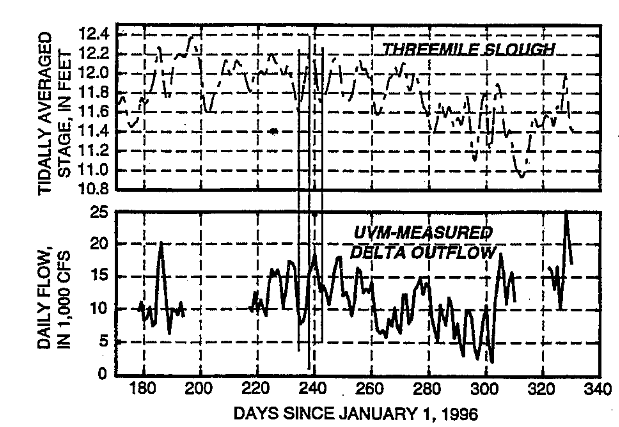

Figure 6
Spring-neap tidal effects of delta outflow; tidally-averaged stage for Threemile Slough and UVM delta outflow for July to November 1996.

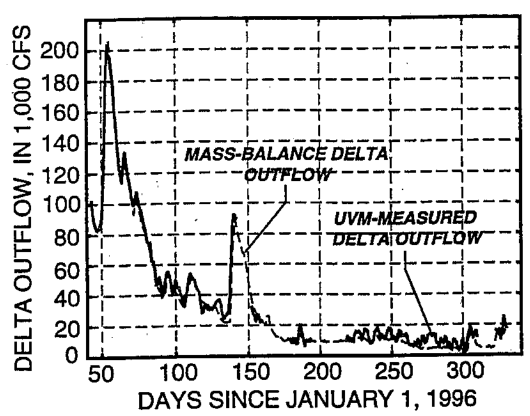

Figure 7
Flow hydrographs of UVM delta outflow and mass-balance computed delta outflow for February to November 1996.

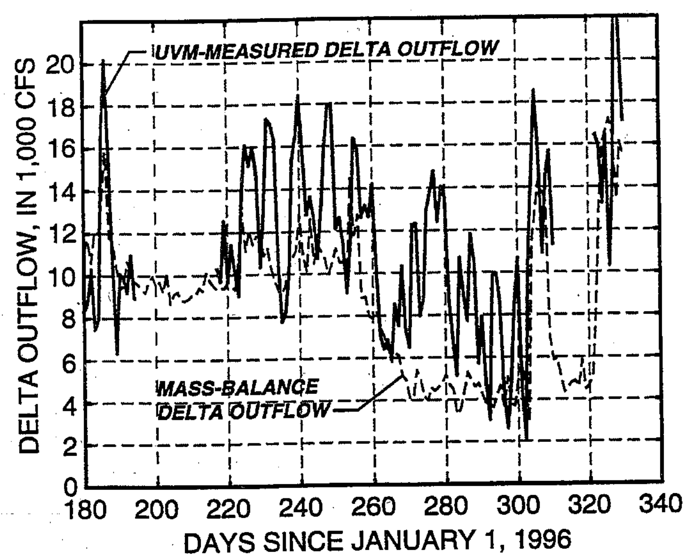

Figure 8
Flow hydrographs of UVM delta outflow and mass-balance computed delta outflow for July to November 1996.

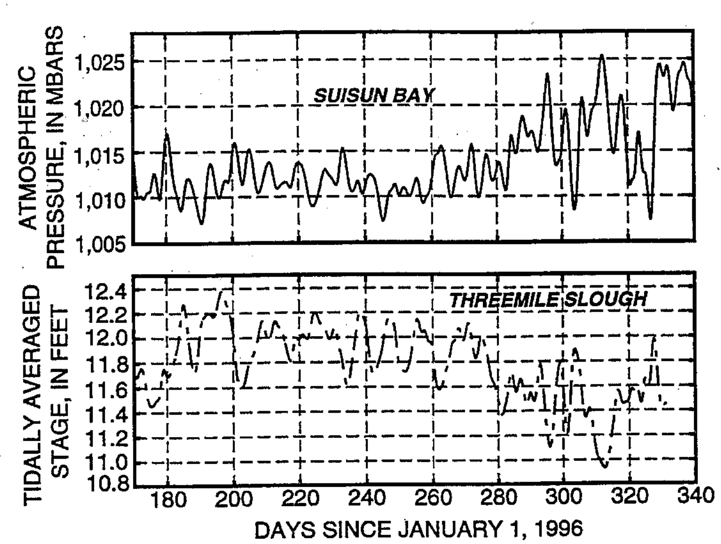

Figure 9
Atmospheric pressure effects on delta outlfow; atmospheric pressure recorded at Suisun Bay and tidally-averaged stage for Threemile Slough for July to November 1996.

relative to the mass-balance flows during this period which could be attributed to the draining of the Delta caused by the increase in atmospheric pressure.

Continuous monitoring of flow in four western Delta channels using UVMs and then combining the flow data collected at those stations to provide a measurement of Delta outflow appears to be feasible. A significant disadvantage of using four stations to measure Delta outflow is that if one station fails, a measurement of Delta outflow is not obtainable. During 1997, one of the four UVM stations was not operational for about 60 percent of the year due to damage sustained during the January 1997 floods or transducer piles being destroyed by passing vessels. In an attempt to reduce station down time, new heavy-duty transducer cable was installed to replace damaged cables, and the transducer pile at the San Joaquin River station was relocated hopefully out of harms way. Periodic data of measured Delta outflow are available for 1997, but not shown here. Advantages of using four stations include being able to measure QWEST indirectly, learning more about the hydrodynamics of the Delta than possible with only one flow record, and having more flow data available to calibrate numerical models. The data presented here show that the use of the mass-balance method to obtain an estimate of Delta outflow is probably adequate for most applications for medium- to high-flow periods. However, for low-flow periods, the effects of the spring-neap tidal cycle, atmospheric pressure changes, and the imprecision of estimates of Delta consumptive use may cause significant errors in the estimation of Delta outflow.

Acknowledgments

The USGS greatly appreciates the funding provided by the DWR, USBR, State Water Resources Control Board, Contra Costa Water District, and the Department of the Interior Ecosystem Initiative Program to install and operate the four UVM flow monitoring stations needed to indirectly measure Delta outflow. The author acknowledges Mike Simpson, Rick Adorador, Jim DeRose, and Scott Posey (no longer with the USGS) of the USGS for their dedicated effort in the installation, troubleshooting, and operation of the UVM stations.

Fishes Collected in Submersed Aquatic Vegetation, *Egeria densa*, in the Delta

Mike McGowan and Al Marchi, Romberg Tiburon Center for Environmental Studies, San Francisco State University

This study is to provide information to assess the potential effects on fishes of proposed Department of Boating and Waterway's (DBW) projects to control the nonnative invasive submersed aquatic plant *Egeria densa* in the Delta. DBW is performing a comprehensive evaluation of control methods and their potential effects, of which the fish study is one part. Key questions are (1) to what extent, if at all, do delta smelt, splittail, or migratory salmonids use *Egeria* beds as habitat, (2) what other fish species occupy the *Egeria*, and (3) how would reducing or eliminating the *Egeria* affect the fish community?

Following a literature survey and communication with specialists in California and in other states, pop-nets were selected as the best sampling device for fish in dense beds of aquatic plants. Four nets were constructed of plastic pipe, galvanized pipe, and 1.6 mm mesh nylon netting. The nets were 1 m^2 area by 3 m high between a floating top frame and a weighted bottom frame. A 1 m skirt with purse rings extended below the bottom frame. The frames, net, and skirt were deployed collapsed on the bottom surrounding 1 m^2 of *Egeria* bed.

After a 2-hour soak time, the top frame was released to float to the surface to enclose a column of water. The skirt was pursed underneath the bottom frame and then lifted to the surface, uprooting and collecting the *Egeria* that was within the net frame. A few attempts were made to collect samples with a minnow seine and with a beach seine. We also searched for fishes by hand in truckloads of *Egeria* and other aquatic plants harvested from experimental plots.

The mean catch rate in 24 deployments of these pop-nets in three locations was 0.375 fish per m^2 (includes before and after mechanical harvesting). Proportion of samples positive for fish was 0.25, that is, one of four samples contained at least 1 fish. At this low catch rate, statistical comparisons could be misleading. Catch rates should be higher in spring and summer for improved statistical power. However, this size pop-net will be biased towards small fish associated with the *Egeria* canopy. Other gear will be needed to sample for large, less abundant fish, midchannel demersal fish (catfish), and schooling fish (shad, smelt).

The following trends in the data were noted but not tested statistically because of small sample sizes in this preliminary study. More fish were caught before harvesting *Egeria* than after harvesting at all three slough sites (Seven Mile, Sand Mound, White). Fish concentration with *Egeria* was similar, but total abundance increased from Seven Mile to Sand Mound to White sloughs because mean *Egeria* concentration per m^2 as sampled by pop-net increased from Seven Mile to Sand Mound to White sloughs (Table 1.) Mean *Egeria* concentration per m^2 decreased after harvest at all three sites.

Pop-nets caught three species of fish: bluegill, redear sunfish, and largemouth bass. Additional fish were sorted from truckloads of plant material removed from the test sites by the harvester. The mechanical harvester caught the same three species as the pop-nets plus seven other species: warmouth, black crappie, goldfish, mosquito fish, golden shiner, threadfin shad, and inland silverside. No native species were collected. A beach seine caught the same three species as the pop-net, but bluegill and redear sunfish were larger than in the pop-net catches.

Concentration of fish captured by beach seine at Sand Mound Slough was $0.22/m^2$ to $1.1/m^2$ (entire area seined vs. area covered by *Egeria*). Using beach seine and minnow seine was impractical at most locations where dense beds of *Egeria* were found because of the soft, muddy slough bottom, tree snags, tules, riprap near shore, and general scarcity of beaches.

Mechanical harvesting incidentally captured a range of species and sizes of fish.. The most abundant species (Figure 1) were the same ones collected by the pop-nets. However, the mechanical harvester collected some water hyacinth with the *Egeria* and operated at times in patches of open

Table 1. Fish Abundance Estimates by Area and Weight of *Egeria densa*

	Seven Mile Slough	Sand Mound Slough	White Slough
Egeria (g/m^2) by pop-net	859 ± 249 S.E.	947 ± 211 S.E.	2342 ± 632 S.E.
Fish (no./m^2) by pop-net	0.125	0.375	0.625
Fish (no./mt *Egeria*) from harvested material	152 ± 150 S.E.	596 ± 391 S.E.	387 ± 210 S.E.