■ Interagency Ecological Program for the San Francisco Estuary ■

IEP NEWSLETTER

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Of Interest to Managers

Fred Feyrer (USBR), ffeyrer@mp.usbr.gov

As part of our goal of providing timely news to managers, this issue includes new information from Ted Sommer and colleagues on possible alternative life history strategies for delta smelt. They provide data to suggest that a portion of the delta smelt population may not migrate but likely remains in upstream spawning locations through adulthood because of favorable environmental conditions. They conclude that different management actions may be necessary to support these contingents.

This issue also includes Quarterly Highlights on water project operations, the Fish Conservation and Culture Lab, delta juvenile fish monitoring, *Microcystis* blooms, the Chipps Island trawl net mouth geometry evaluation, the smelt larva Survey, and the new OCAP delta smelt Biological Opinion.

Kate Le and Andy Chu summarize water project operations for the final three months of 2008. They show that water project operations were coordinated between the SWP and CVP to ensure compliance with Bay Delta Standard under the very dry conditions.

Theresa Rettinghouse reports that UCD's Fish Conservation and Culture Lab collected an additional 70 delta smelt for the development of the refugial population. They also collected and successfully spawned longfin smelt.

Kenneth Behen and Jonathan Thompson summarize the results of the USFWS' Delta Juvenile Fishes Monitoring Program for the second half of 2008. The catch in Sacramento River trawls conducted near Sherwood Harbor was dominated by American shad and threadfin shad with few Chinook salmon captured. Mossdale Trawls catches were dominate by threadfin shad and an unidentified centrarchid, while Chipps Island trawls were dominated by American shad and striped bass. The catches in beach seine sampling were similarly dominated by non-native species, especially inland silverside. Threadfin shad was also a dominate species in the south delta, as was red shiner in the San Joaquin River.

Peggy Lehman reports that the *Microcystis* bloom in 2008 peaked late, reaching high levels in August and September instead of June and July in years past. She reports that low light levels due to smoke from forest fires may have caused the delay, and that nutrient levels were high during the bloom.

Jennifer Messineo reports that the field work has been completed for the net mouth evaluations of the Chipps Island Trawl. Data were collected for the two vessels used to tow the trawl, and data processing and analysis is underway.

Randy Baxter reports that a Smelt Larva Survey has been implemented to support the information needs of DFG under the listing of the longfin smelt. The every-other-week survey will provide near real-time information on larva distribution to be used by agency managers assessing entrainment vulnerability.

Cay Goude and Ryan Olah provide an overview of the new OCAP delta smelt Biological Opinion. On December 15, 2008, USFWS issued a jeopardy BO with a Reasonable and Prudent Alternative. Reclamation provisionally accepted the RPA with concerns about two of the five components of the RPA. Federal and State water contractors filed complaints challenging the BO on March 3, 2009, and March 4, 2009, respectively.

IEP NEWSLETTER is Going Electronic

Beginning this year, IEP Newsletter, will be available in electronic version. The IEP team is looking for ways to reduce paper, improve timeliness of information, and direct funds to other exciting opportunities. If you are interested in receiving the electronic version, please take a few minutes to provide Karen Gehrts, Managing Editor, *Kagehrts@water.ca.gov*, with the following information:

Name
Agency
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IEP QUARTERLY HIGHLIGHTS

DELTA WATER PROJECT OPERATIONS

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Hydrological conditions in the Delta region were very dry during the months of October through December 2008. In Figure 1, San Joaquin River (SJR) average daily flow ranged between 18 and 38 cubic meters per second (636 cfs and 1,342 cfs). Sacramento River daily average flow ranged between 185 and 393 cubic meters per second (6,532 cfs to 13,877 cfs). Daily Net Delta Outflow Index (NDOI) ranged between 42 and 483 cubic meters per second (1,483 cfs and 17,056 cfs). San Joaquin River flow was stable throughout the period, whereas Sacramento River and Outflow patterns were more responsive to precipitation (Figure 1).

Project operations in the Delta during the October through December 2008 period were scheduled primarily to meet the Bay-Delta Standards (Figure 2). The minimum monthly outflow for October was 113 cubic meters per second (4,000 cfs) and for November and December 127 cubic meters per second (4,500 cfs). The 7-day average outflow must be within 28 cubic meters per second (1,000 cfs) of the monthly standards. Other flow and water quality standards for the Delta are also listed in Figure 2.

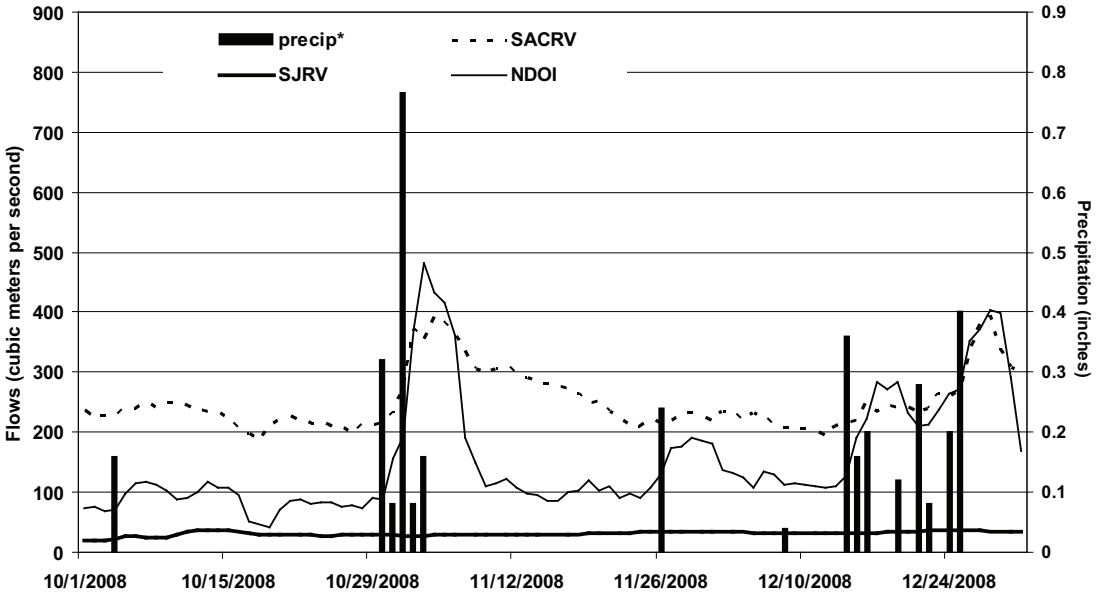

Figure 1 October through December 2008 Sacramento River, San Joaquin River, Net Delta Outflow Index, and Stockton Fire Station Precipitation

DRAFT

Bay-Delta Standards

Contained in D-1641

DRAFT

CRITERIA	Oct 08	Nov 08	Dec 08
FLOW/OPERATIONAL			
• Fish and Wildlife			
SWP/CVP Export Limits			
Export/Inflow Ratio	65%		
Minimum Outflow - mon.	3000 cfs	3500 cfs	3500 cfs
- 7 day avg.	2000 cfs	2500 cfs	2500 cfs
Striped Bass Survival			
Suisun Marsh			
Habitat Protection Outflow, X2			
River Flows:			
@ Rio Vista - min. mon. avg.	3000 cfs	3500 cfs	3500 cfs
- 7 day average	2000 cfs	2500 cfs	2500 cfs
@ Vernalis: Base -min. mon. avg.			
- 7 day average			
Pulse	*1000 cfs		
Delta Cross Channel Gates	* Up to an additional 28 TAF	Conditional: For Nov-Jan period, DCC gates may be closed for up to a total of 45 days	
WATER QUALITY STANDARDS			
• Municipal and Industrial			
All Export Locations	<= 250 mg/l Cl		
Contra Costa Canal	<= 150 mg/L Cl for 238 days (All days have been met)		
• Agriculture			
Southern Delta	30-day running average EC <= 1.0 mS		
• Fish and Wildlife			
San Joaquin River Salinity			
Suisun Marsh Salinity	19 mS/cm	15.5 mS/cm - Eastern / 16.5 - Western Marsh st	15.5 mS/cm

Water Year Classification: Critical (Based on 05/01/2008 forecast)
SVI (40-30-30 @ 50%) = 5.4 (CRITICAL) Apr 8RI: 1.892 MAF
SJV (60-20-20 @75%) = 2.1(CRITICAL)

Figure 2 October through December 2008 Bay-Delta Standards of D-1641

Export patterns shown in Figure 3 were coordinated between the projects to first ensure the compliances with Bay Delta Standards. No significant plant maintenance activities or power outages occurred during these months. Exports were low during this period as a result of dry hydrologic conditions and storages in conservation mode.

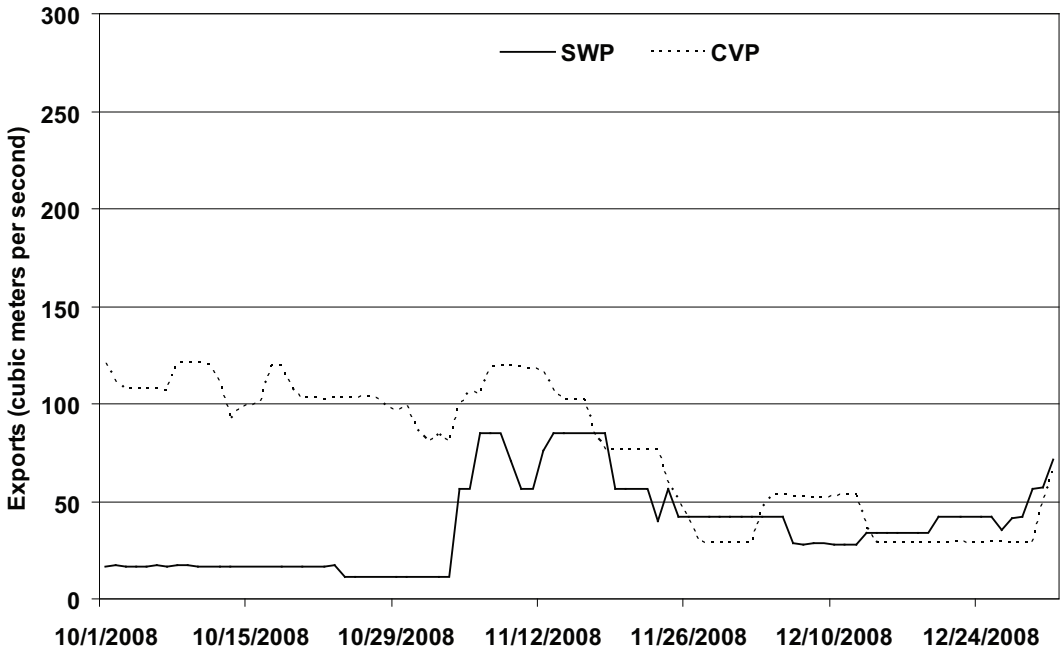

Figure 3 October through December 2008 State Water Project and Central Valley Project Pumping

Fish Conservation and Culture Lab (FCCL), Winter 2009

Theresa Rettinghouse (UCD),
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In 2008, we were once again granted permits to collect a small number of delta smelt (*Hypomesus transpacificus*) to supplement refugial population development at our site. On December 1, 2008, we caught 70 fish using a lampara net. This collection, on the western Sacramento River bank across from Sherman Lake, included the assistance of the US Bureau of Reclamation. The fish were collected between 7-10 a.m. during heavy fog in an average water temperature of 13.1° C with 90% in 1.5 ppt salinity and the remaining 10% at 3.2 ppt. There was only 1 fatality in the first 48 hours and the long term survival has been holding at 94% (Table 1).

Our lab was also recently approved to collect and spawn longfin smelt (*Spirinchus thaleichthys*). We currently have 8 adults remaining from a group of 18, collected by the US Fish and Wildlife Service on December 17, 2008. There were 4 collection related mortalities and several more delayed mortalities (Table 2). We had successful fertilization and embryo development following manual expression of ova from 2 females in December and have now stocked larvae to rearing tanks.

Table 1 2008 Wild delta smelt collection and survival

2008 Wild delta smelt collection and survival						
Total collected 12-01-08	Number live at 48hr	Survival at 48 hours	Total fish currently (1-20-09)	Survival currently (1-20-09)	Average fork length (mm; n=4)	Average weight (g; n=4)
70	69	98.6%	66	94%	65	2.48

Table 2 2008 Longfin smelt survival

2008 Longfin smelt survival						
Total received from USFWS 12-17-08	Number live at 48hr	Survival at 48 hours	Total fish currently (1-20-09)	Survival currently (1-20-09)	Average fork length (mm; n=10)	Average weight (g; n=10)
18	14	78%	8	44%	93	7.97

Delta Juvenile Fish Monitoring Program

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The goal of the Delta Juvenile Fish Monitoring Program (DJFMP) at the Stockton Fish and Wildlife Office is to monitor populations of juvenile fishes throughout the year in the Sacramento and San Joaquin Rivers and Delta. The program was established in the late 1970's to monitor juvenile Chinook salmon *Oncorhynchus tshawytscha*, but the program quickly expanded in response to water-management actions and endangered species listings (Brandes and McLain, 2001). The objective of this report is to summarize results from trawling and beach seines from June 2008 through January 3, 2009.

Trawling

For the reporting period, ten 20-minute Kodiak trawls were conducted 3 days a week at Mossdale Landing (San Joaquin River, river mile [RM] 54). Midwater trawls were conducted at Sherwood Harbor (Sacramento River RM 55) from June through September, twice weekly for the month of June and 3 times a week for the remainder of the sampling season. A Kodiak trawl was implemented at Sherwood Harbor in October to accommodate increases in our expected catch. Midwater trawls were conducted 2 days a week at Chipps Island (Suisun Bay RM 18) throughout the reported period. The greatest number of unmarked Chinook salmon (n = 76 fish) was captured at Chipps Island. Unmarked Chinook salmon captured at Chipps were: 73 fall-run sized and 3 late fall-run sized. Sampling at Mossdale resulted in the capture of 17 fall-run sized unmarked Chinook salmon. Using midwater trawling at Sherwood Harbor from June through Septem-

ber 2008, we captured 10 fall-run sized unmarked Chinook salmon. Kodiak trawling at Sherwood Harbor from October 2008 through January 3, 2009 resulted in catch of 3 unmarked Chinook salmon, 2 late-fall run, and 1 winter run. A total of 21 adipose fin-clipped Chinook salmon was recovered during the sampling period: 17 were recovered at Chipps Island, 2 were recovered at Sherwood Harbor via midwater trawling, and 2 were recovered at Sherwood Harbor via Kodiak trawling. The total average of weekly catch-per-unit effort, expressed as fish/10,000 m^3, was calculated for each sampling location for all fish species and salmon races.

For the reporting period, we captured 21,397 fishes (excluding marked salmon): 57 fishes representing 12 species at Sherwood Harbor via midwater trawling, 85 fishes of 12 species at Sherwood Harbor via Kodiak trawling, 7,160 fishes representing 23 species at Chipps Island, and 14,095 fishes representing 26 species at Mossdale Landing. American shad *Alosa sapidissima* and threadfin shad *Dorosoma petenense* comprised almost 60% of the catch at Sherwood Harbor via midwater trawl. After an increase in effort at Sherwood Harbor, inland silverside *Menidia beryllina* were most prevalent representing close to 50% of the catch. Mossdale surveys during June 2008 were conducted by the California Department of Fish and Game (Region 4). During the month of June, large quantities of an unidentified species were recovered. The unidentified species represented close to 45% of the catch. American shad represented the majority of the species recovered at Chipps Island, with 53% of the total catch (Table 1).

Table 1 The average and confidence interval of weekly catch per unit effort (fish /10,000 m^3) of eight species of interest caught via trawl for all sampling regions between June and December, 2008

Region Sampled	Threadfin shad	Stripped Bass	Delta Smelt	Fall-run sized Chinook salmon	Late fall-run sized Chinook salmon	Winter-run sized Chinook salmon	Sacramento Pickeminnow	Sacramento Sucker	Wakasagi	Topsmelt
Sacramento	0.03 (0.04)	0	0	< 0.01	< 0.01	0	0.01 (0.01)	0.13 (0.07)	0.01 (0.01)	0
Lower Sacramento	0.41 (0.24)	0	0	0	0	0.02 (< 0.01)	1.14 (0.40)	1.64 (.075)	0.03 (0.03)	0
Northern Delta	0.01 (0.01)	0.01 (0.01)	< 0.01	< 0.01	0	0	.04 (.03)	.016 (0.22)	< 0.01	0
Central Delta	0.10 (0.07)	0.07 (0.03)	0.01 (0.01)	0	0	0	0.02 (0.01)	0.01 (0.01)	0.1 (0.03)	0
Southern Delta	1.62 (1.54)	0.04 (0.02)	0	0	0	0	0.02 (< 0.01)	0.10 (0.04)	0	0
San Joaquin	0.35 (0.39)	0.07 (0.06)	0	0	0	0	< 0.01	0.03 (0.03)	0	0
SP and SF Bays	0	< 0.01 ()	0	0	0	0	0	0	*0*	0.62(0.30)

Beach Seining

For the reporting period, the DJFMP conducted 1,332 beach seine surveys at 52 sites. We conducted 213 surveys in the central Delta (9 sites) and 210 surveys in the southern Delta (9 sites). From June through September 2008, sampling intensity on the Sacramento River was reduced to accommodate expected reductions in catch. Sampling intensity was then increased in October to improve detection of less common races and life stages of Chinook salmon entering the Delta (Stockton, 2007). Sampling intensity was also increased with an additional seine run (Sacramento region) for the months of October through January. We conducted 98 surveys on the lower Sacramento River (7 sites) and 159 surveys in the northern Delta (10 sites) from June through September 2008. After increasing intensity, we conducted 44 surveys on the lower Sacramento River (5 sites), 93 surveys in the northern Delta (7 sites), and 327 surveys in the Sacramento region (8 sites). We conducted 74 surveys on the San Joaquin River (9 sites). A list of alternate sampling sites was added to the protocol on July 17, 2008 as a result of sampling difficulty (i.e., navigating by boat) under low-flow conditions. The sites added were the San Luis Refuge (San Joaquin River, RM 79), Route 132 (RM 76), Durham Ferry (RM 70), and Critchett Road (RM 65), whereas Sturgeon Bend (RM 74), Weatherbee (RM 58), Mossdale Landing (RM 55) and Dos Reis Park (RM 51) remained unchanged. Additionally, we conducted 114 surveys in San Pablo and San Francisco Bays (A total of 9 sites, collectively referred to as Bay seines). The Sacramento and San Joaquin Rivers and Delta sites were typically sampled once per week, and Bay sites were sampled every other week.

No unmarked Chinook salmon were captured in the central or southern Delta and only 1 fall-run sized unmarked Chinook salmon was captured in the northern Delta. We captured 2 winter-run sized, unmarked Chinook salmon in the lower Sacramento River. In the Sacramento region, we sampled 2 fall-run sized, unmarked Chinook salmon and 2 late fall-run sized, unmarked Chinook salmon. No Chinook salmon were captured in the San Joaquin River or in the Bay seines. In addition, no marked salmon were recovered in the beach seines during the reporting period.

A total of 139,165 fishes representing 57 species was captured using beach seines during the reporting period: 13,789 fishes from the lower Sacramento River, 4,175 fishes from the Sacramento region, 33,341 fishes from the central Delta, 12,139 fishes from the northern Delta, 37,916 from the southern Delta, 34,529 fishes from the San Joaquin River, and 3,276 fishes from the Bay. Samples from the lower Sacramento River contained mostly Sacramento sucker *Catostomus occidentalis* and Sacramento pikeminnow *Ptychocheilus grandis*, representing nearly 70% of catch. In the Sacramento region, northern Delta, central Delta and southern Delta, the inland silverside comprised over 85% of catch, whereas native species were represented in less than 5% of catch. In the San Joaquin River, red shiner *Cyprinella lutrensis* and inland silverside accounted for approximately 96% of the catch. Top smelt *Antherinops affinis* was the predominant species sampled in the Bay representing 91% of the total catch (Table 2).

Table 2 The average and confidence interval of weekly catch per unit effort (fish /10,000 m^3) of ten species of interest caught via beach seine for all sampling regions between June and December, 2008

Region Sampled	American Shad	Threadfin shad	Delta Smelt	Longfin Smelt	Fall-run sized Chinook salmon	Late fall-run sized Chinook salmon	Winter-run sized Chinook salmon	Stripped Bass
Sherwood Harbor M	1.24 (0.60)	0.9 (0.55)	0	0	0.69 (0.55)	0	0	0.13 (0.26)
Sherwood Harbor K	0	1.7 (0.93)	0	0	0	0.29 (0.39)	0.17 (0.32)	0
Chipps Island	4.22 (0.98)	1.83 (0.89)	0.26 (0.14)	0.63 (0.57)	0.22 (0.12)	0.05 (0.06)	0	1.75 (0.59)
Mossdale	0.53 (0.61)	11.73 (4.48)	0	0	0.15 (0.17)	0	0	4.16 (3.60)

Microcystis Bloom 2008

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The *Microcystis* bloom in 2008 reached comparatively high levels in August and September compared with previous years (Figure 1). The bloom arrived late, during August instead of June or July. This may partially explain the somewhat lower chlorophyll *a* values in August 2008 than August 2007. Forest fires in June and July may have delayed the development of the *Microcystis* bloom early in the season through reduction in light availability. Data from LICOR indicated the light available within the first 6 inches of the water column was less than 1000 µm quanta; LICOR values usually exceed 1000 µm quanta at this depth during the bloom. Water temperature, another threshold variable was above the required 20°C temperature threshold starting in June, so it was not responsible for the delayed growth.

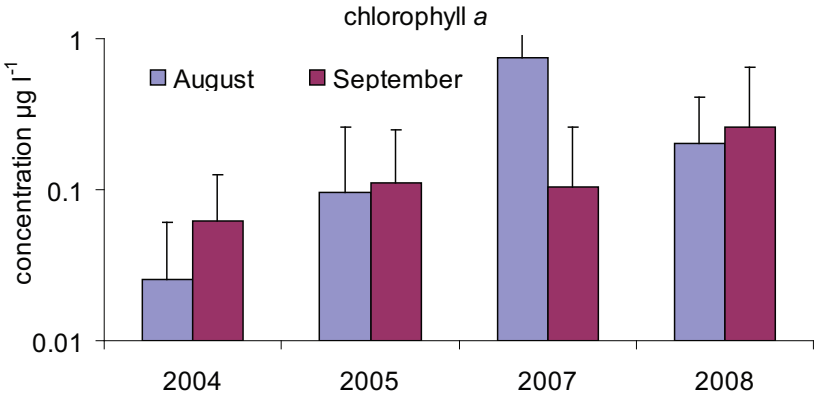

Figure 1 Average chlorophyll *a* concentration for net tows at stations sampled in surveys from 2004 to 2008; Chipps Island (508), Collinsville (704), Middle Ground (504), Old River (915) and San Joaquin River (910).

Nutrient concentrations during the bloom were high as usual with average dissolved nitrate at 0.42 mg/L (range 0.23 - 0.66 mg/L), soluble reactive phosphorus at 0.072 (range 0.04 – 0.09 mg/L) and silica at 149 mg/L (range 10.1 – 17.9mg/L). Average nitrogen (nitrate plus ammonium) to phosphorus (soluble) ratios (molar) were slightly below the Redfield ratio at 14 (range 9 - 23) and decreased toward the end of the summer. Dissolved ammonia concentration was between 0.02 and 0.03 mg/L (1.43 and 2.1 µM/L) during August and September 2008 and within the range of values measured between 2004 and 2007 of 0.01 and 0.05 mg/L (0.7 and 3.6 µM/L) for the same months (Lehman et al. 2005; 2008). Ammonia values over 4 µM/L may reduce diatom growth rate by inhibiting the use of nitrate as a nitrogen source, but may enhance *Microcystis* growth (Wilkerson et al. 2006).

Citations

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F.P. Wilkerson, R.C. Dugdale, V.E. Hogue and A. Marchi. 2006. Phytoplankton blooms and nitrogen productivity in San Francisco Bay. Estuaries and Coasts 29:401-416.

Update on the Net Mouth Geometry Evaluation: Chipps Island Midwater Trawl

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The Net Mouth Geometry Evaluation Project recently completed tows on 2 US Fish and Wildlife Service (USFWS) vessels used for the Chipps Island Midwater Trawl Survey. The goals were: 1) to measure the net mouth area and variability during trawling for each vessel; and 2) to subsequently compare net mouth behavior between the 2 vessels as a partial means to substantiate comparability as the USFWS retires its current vessel, RV Whitesel, and begins using its new replacement vessel. Field work was conducted during 2 days in February 2009. Sixteen valid tows were completed on the R/V Whitesel and 17 valid tows were completed on the new vessel, R/V Confluence. Data processing is underway and results will be reported in the future.

We completed data processing and a substantial portion of the data analysis for field work was completed fall 2008 with DFG's Fall Midwater Trawl and San Francisco Bay Study Midwater Trawl surveys. We will report the results in an upcoming newsletter.

The project ran into technical difficulties when system components used to measure net-mouth-area malfunctioned during initial field work with the USFWS. However, with continued onsite support from Desert Star Systems (electronics vendor), repairs were made and the entire Net Track system is properly functioning.

Smelt Larva Survey Initiated January 2009

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The Smelt Larva Survey started field work January 5, 2009 in support of the Department of Fish and Game's information needs during candidacy period of longfin smelt, which was petitioned for listing under the California Endangered Species Act (CESA). This every-other-week survey provided near real-time larvae distribution information used by agency managers assessing entrainment vulnerability and providing advice on means to reduce potential entrainment at the south Delta water export facilities. The Survey successfully and safely completed field operations on March 4, 2009. Laboratory processing and data posting steps went smoothly and efficiently throughout the season, and both steps were completed in a timely manner. Larva identification for the March Survey is still in progress and should be completed before the end of March. This survey will commence again next January to provide information to help manage longfin smelt, if it is listed as threatened under the CESA. Survey results for longfin smelt and other species can be viewed on the web at: (http://www.delta.dfg.ca.gov/data/projects/?ProjectID=SLS).

OCAP Biological Opinion

Cay Goude(USFWS), Ryan Olah (USFWS)

The Coordinated Operation of the Bureau of Reclamation's (Reclamation's) Central Valley Project (CVP) and the California Department of Water Resources' (DWR's) State Water Project (SWP), commonly referred to as OCAP, requires a Biological Opinion (BO) for effects upon delta smelt. The BO includes both the operations of the CVP and SWP reservoirs as well as the Delta export facilities. The 2004 OCAP BO was invalidated in May 25, 2007 and the Federal Court ordered interim restrictions for the 2008 water year on the CVP and SWP pending completion of a new BO. On December 15, 2008 the Fish and Wildlife Service (Service) issued a jeopardy BO with a Reasonable and Prudent Alternative (RPA). Reclamation provisionally accepted the RPA with concerns about two of the five components of the RPA (Component 3 and 4). Federal and state water contractors filed complaints challenging the BO on March 3, 2009, and March 4, 2009, respectively.

The development of the BO included the use of various sources of data and information. The Service relied heavily on IEP survey information and the various research that has been funded or developed by member agencies. In development of the BO the Service used a team approach to synthesize and evaluate the information to be analyzed. The teams included an Internal Peer Review Team made up of Service employees with expertise in endangered species and fish biology. The Service also formed an interagency team of delta smelt experts that provided additional review and information. In addition, the Service contracted to have an Independent Review Team review both our effects analysis and our Actions which ultimately became the RPA. This Independent Review Team included individuals with expertise in the Delta, delta smelt, and ecological factors impacting the Delta.

The five components of the RPA are: Component 1) protection of the adult delta smelt life stage; Component 2) protection of larval and juvenile delta smelt; Component 3) improve habitat for delta smelt growth and rearing; Component 4) habitat restoration; and Component 5) monitoring and reporting. Component 1 includes a restriction of Old and Middle River Flows (OMR) to protect prespawning adults from December through March. The protective measures under this Component include a 14-day export curtailment resulting in OMR flows being no more negative than -2000 cfs that is initiated based on various biological and hydrologic factors. After this 14-day action, the Component calls for the protection of delta smelt after migration and prior to spawning by managing OMR flows between -1250 and -5000 cfs as determined using an adaptive process until spawning is detected or spawning criteria are reached. The goal of Component 2 is to manage habitat to allow larval and juvenile delta smelt to rear in the Delta and migrate downstream. Again, OMR under this Component OMR would range between -1250 to -5000 cfs as determined by an adaptive process until June 30th or when Delta water temperatures reach 25 degrees C. The goal of Component 3 is to improve habitat for delta smelt growth and rearing. This will increase fall habitat quality and quantity and is only required during above normal and wet water years. This component includes an additional increment of Delta outflow in Sep-

tember and October. Component 3 has a vigorous and formal adaptive management process with focused scientific studies. This Component was provisionally accepted by Reclamation conditioned upon additional review and refinement. Component 4 requires the applicant (DWR) to implement a program to create or restore 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh. Again this component was provisionally accepted by Reclamation. Component 5 requires monitoring necessary to implement the RPA and evaluate the effectiveness of the RPA. It also requires Reclamation and DWR to continue the relevant long-term monitoring elements of the IEP.

The Reclamation, DWR, and Service are currently implementing the RPA during this critically dry year. Based on unusual hydrologic conditions and no adult delta smelt salvage in much of January and February there were no actions called for during these months within the context of the RPA. On March 3, 2009 the Service began the implementation of the adaptive process of Component 2 for the protection of larval and juvenile delta smelt.

The Service has formed a Habitat Study Group to implement the formal adaptive management process required for Component 3. IEP, as one of the major science based programs, will be an integral part of this process. IEP can provide guidance and the needed research to implement or refine this component based on the regulatory needs. In addition, the long-term monitoring that IEP performs is essential to the adaptive process that the Service will use to determine the necessary protective actions under the RPA. In addition, without past and ongoing IEP studies and monitoring programs the sound science that was used to evaluate the status of delta smelt in the BO would not have been available.

Contributed Papers

Delta Smelt Life-History Contingents: A Possible Upstream Rearing Strategy?

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Although species are often considered to have relatively standard life cycles, migratory fishes commonly have alternative life histories (Clark 1968; Secor 1999). The "contingent hypothesis" proposes that these fishes have divergent migration pathways that help the species survive in variable and heterogeneous environments. Moreover, these strategies may be influenced by habitat use at early life stages. As a specific example, Clark (1968) and Secor (1999) describe how favorable upstream habitat conditions likely promote striped bass residency near spawning areas. Complex life histories are also evident in Central Valley steelhead trout, which show strategies ranging from year-round upstream residence to anadromy (McEwan 2001).

Given the extreme variability in the habitat of delta smelt, we propose that the contingent hypothesis may also apply to a portion of the delta smelt population. The typical life history strategy for this fish is for adults to migrate upstream during early winter flow pulses, followed by spawning events in late winter and early spring (Moyle et al. 1992; Bennett 2005). Most of the offspring subsequently move downstream in spring and summer to slightly brackish rearing habitat. However, we propose that a portion of young delta smelt remain in upstream spawning areas through adulthood because of favorable habitat conditions. If so, these fish may not undergo true migration since they never leave the spawning grounds.

To help illustrate this point, Table 1 shows the presence of delta smelt in stations located in three regions of the Delta (Figure 1) during two periods: recent years (2002-2008) and historical years (1967-1973). For recent years, the data show that delta smelt were present in all months in the west Delta, which is the pre-spawning center of distribution for the species (Sommer et al. In review). The result is similar for the Cache Slough station, a known upstream spawning area where fish were collected in all recent months when samples were collected (Table 1). It is unlikely that delta smelt moved downstream in recent years during August, the only month for which Cache Slough station data are missing. In addition, Nobriga et al. (2005) found delta smelt throughout the summer (including August) during 2001 and 2003 in Liberty Island, a flooded island in the Cache Slough region. Beach seine sampling in Liberty Island during 2002-2004 showed a similar pattern with summer collections of delta smelt at many sites (U.S. Fish and Wildlife Service, unpublished data). We hypothesize that the fish remaining in the Cache Slough region through summer represent a life-history contingent. Moreover, we propose that these fish may be a fairly substantial portion of the population as about 42% of the Spring Kodiak Trawl delta smelt catch during March-May since 2005 was in the Cache Slough complex (http://www.delta.dfg.ca.gov/data/projects/?ProjectID=SKT). High turbidities (Nobriga et al. 2005) and prey densities (Sommer et al. 2004; DWR, unpublished data) in the region may encourage young smelt to remain upstream through maturity.

Catch of delta smelt in the west Delta and Cache Slough is markedly different from recent results for the south Delta (Table 1), where fish were clearly absent during the summer. The historical data for the south Delta region cover only half of the year, but indicate that delta smelt remained in upstream areas of the south Delta during warm summer months. This suggests that the south Delta may have historically supported contingents. As discussed by Nobriga et al. (2008), the absence of delta smelt in the south Delta during recent years is likely a result of deteriorating habitat conditions, particularly decreasing turbidity caused by reduced sediment inputs and the "filtering" effect of expanding beds of aquatic weeds (Egeria).

The catch data raise the possibility that some delta smelt may show the opposite pattern to fish in the Cache Slough complex, where we propose that some contingents do not move downstream towards brackish zones. Delta smelt continue to be collected year-round in fairly large numbers in the west Delta (Table 1). This could indicate that there are contingents that are spawned in the west Delta but never migrate upstream.

We acknowledge that some of the catch data presented may be affected by difficulties in the identification of delta smelt. However, our brief analysis includes data from multiple years, survey types, and investigators, making it unlikely that the year-round presence of delta smelt near spawning areas in the Cache Slough complex is a sampling artifact. Moreover, the fact that contingent behavior seems to be common in migratory fish (Secor 1999; McEwan 2001), including its congener *Hypomesus nipponensis* in its native habitats in Japan (Katayama et al. 2000; Arai et al. 2006), indicates that it would be reasonable to find multiple life history strategies in delta smelt.

The idea that there are delta smelt contingents is supported by preliminary analyses by Dr. James A. Hobbs (UC Davis Center for ICP-MS), who found evidence of substantial diversity in delta smelt life history, with extended freshwater residence in some individuals. Similarly, recent studies demonstrate that there are typically multiple delta smelt spawning events over the course of the year, each of which has highly variable success depending on environmental conditions (Dr. Bill Bennett, UC Bodega Marine Laboratory, unpublished data).

Management Implications

If we are correct that delta smelt have alternative life history strategies, different management actions may be necessary to support contingents. Actions to protect fish that remain in spawning areas such as the Cache Slough Complex may be completely different than actions to protect contingents that undergo regular upstream and downstream movements. Indeed, much of the current management emphasis for delta smelt is on the protection of adults and juveniles during their migrations. One possible implication of contingency is that habitat restoration in regions that presently support delta smelt (e.g. north and west Delta), or could do so in the future (e.g. south Delta) may have more benefits to the species than previously understood.

Table 1 Presence of delta smelt for sampling in 3 regions of the estuary during 2 time periods: 2002-2008 and 1967-1973

	Recent Years 2002-2008			Historical Years 1967-1973			
Month	West Delta	Cache Slough	South Delta	West Delta	Cache Slough	South Delta	Survey
1	X	X	X	n/a	n/a	n/a	SKT
2	X	X	X	n/a	n/a	n/a	SKT
3	X	X	X	n/a	n/a	n/a	SKT
4	X	X	X	n/a	n/a	n/a	SKT, 20 mm
5	X	X	X	n/a	n/a	n/a	SKT, 20 mm
6	X	X	X	X	n/a	X	20 mm, Townet
7	X	X	X	X	n/a	X	20 mm, Townet
8	X	n/a	0	X	n/a	X	Townet
9	X	X	0	X	n/a	X	FMWT
10	X	X	0	X	n/a	X	FMWT
11	X	X	0	X	n/a	X	FMWT
12	X	X	0	X	n/a	X	

X" indicates the presence of delta smelt for one or more stations or survey methods,
"O" represents no detected delta smelt, and
"n/a" indicates that there was no sampling during that month or period.

The surveys were as follows:
Townet (see Nobriga et al. 2008); SKT, spring Kodiak trawl (www.dfg.ca.gov); 20 mm (see Dege and Brown 2004); and FMWT (see Feyrer et al. 2007).
Note that there was no 20 mm or SKT sampling during the historical period.

The general locations of West Delta ("Stations 704 and 706"); Cache Slough ("Station 716") and South Delta ("Stations 812 and 815") sampling are shown

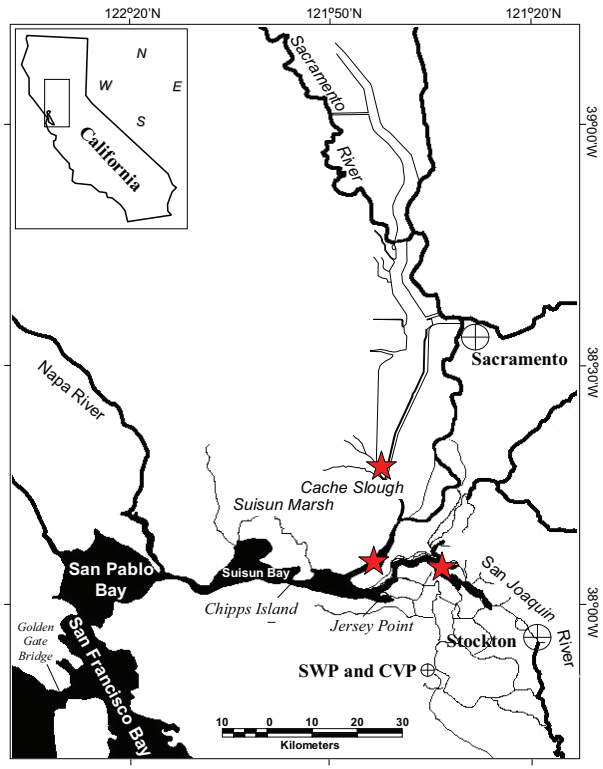

Figure 1 The San Francisco Bay Estuary. The general locations of the three sampling regions described in Table 1 are identified with red stars

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2009 IEP

In lieu of the annual Asilomar workshop, the IEP will hold a series of smaller, local and focused workshops, primarily aimed at scientists but open to all. Participants will be asked to consider several overarching questions in their presentations and discussions to facilitate the overall goal of improving IEP and associated monitoring and research in the San Francisco Estuary. The series will culminate in a final workshop about long-term and emerging monitoring questions, needs, tools and initiatives relevant to environmental assessment and management of the Bay-Delta system.

Physical Modeling and Fish Management with Expert Review Panel

May 26, 1- 5 PM & May 27, 9 AM -5 PM

650 Capitol Mall, 5th Floor, Bay Room

Contact: Lenny Grimaldo (USBR)

lgrimaldo@mp.usbr.gov

-This workshop will provide a comprehensive overview of hydrodynamic and coupled physical-biological modeling in the San Francisco estuary and include a review of IEP modeling activities by an independent panel of experts, the IEP Science Advisory Group (SAG).

Food Webs and Invasive Species

June 25, 9 AM to 5 PM

3500 Industrial Blvd. West Sacramento

Contact: Kathy Hieb (DFG)

khieb@dfg.ca.gov

-Updates on IEP phytoplankton, zooplankton, benthic, and fish monitoring.

-Updates on POD special studies such as benthic biomass and *Microcystis*.

Workshop Series

Ammonia Summit

August (date and location TBA)

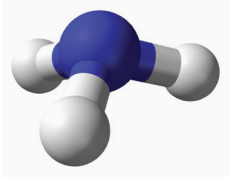
Contact: Stephanie Fong, CVRWQCB

swfong@waterboards.ca.gov

-Presentations of new local results

-Discussion of results and future studies

-Discussion of Research Framework (http://www.science.calwater.ca.gov/events/workshops/workshop_ammonia.html)



Modeling the Pelagic Organism Decline:

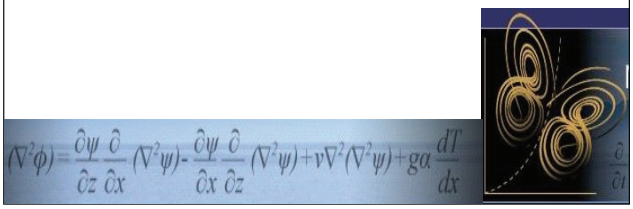
Results from IEP POD-NCEAS Systems Ecology Group

September 8 – 9, UC Davis

Contact: Fred Feyrer (USBR)

ffeyrer@mp.usbr.gov

-This two-day workshop will present and discuss results of various modeling approaches such as ECOPATH, changepoint analysis, and multivariate autoregressive models.



Bay-Delta Monitoring Questions and Tools for the 21st Century

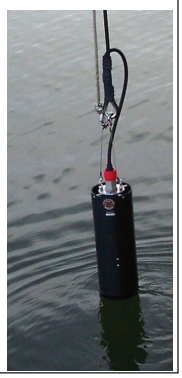
October (date and location TBA)

Contact: Bruce Herbold (EPA)

Herbold.Bruce@epa.gov

-Presentations about new monitoring tools tested in the Bay-Delta.

-Workshop series synthesis: synthesize questions and information related to Bay-Delta monitoring and assessment from the previous four workshops.



- Please note: registration is not required for any of the 2009 IEP workshop series.
- Additional information can be obtained from:

  Kelly Souza, CDFG

  ksouza@dfg.ca.gov

  Anke Mueller-Solger, CALFED

  Anke.mueller-solger@calwater.ca.gov

  or

  http://iep.water.ca.gov/

  or

  http://www.water.ca.gov/calendar/

■ Interagency Ecological Program for the San Francisco Estuary ■

IEP NEWSLETTER

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For information about the Interagency Ecological Program, log on to our website at http://www.iep.water.ca.gov. Readers are encouraged to submit brief articles or ideas for articles. Correspondence—including submissions for publication, requests for copies, and mailing list changes—should be addressed to Patricia Cornelius, California Department of Water Resources, P.O. Box 942836, Sacramento, CA, 94236-0001. Questions and submissions can also be sent by e-mail to:pcorn@water.ca.gov.

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