



# ***IEP NEWSLETTER***

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# IEP QUARTERLY HIGHLIGHTS

## DELTA WATER PROJECT OPERATIONS

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During July through September 2009, San Joaquin River flow was stable, whereas Net Delta Outflow Index and Sacramento flows were more variable due to additional transfer water made available from upstream. Sacramento flows ranged between 223 cms and 557 cms, and San Joaquin flows ranged between 15 cms and 34 cms. Net Delta Outflow Index flows ranged between 34 cms and 216 cms. No precipitation activity during this period, which is normal since it was summer time.

Pumping during the July through September 2009 period was stable at the Central Valley Project (CVP), but fluctuated at the State Water Project (SWP) as shown in Figure 2. Pumping at the CVP ranged between 83 cms and 123 cms, whereas SWP pumping ranged between 27 cms and 203 cms. The brief pumping decline in early July at the CVP was in response to south Delta water level concerns due to both projects pumping at full capacity during the beginning of July. Thereafter, CVP pumping remained stable for the remainder of the period. Unlike last year, SWP pumping varied during this period to accommodate various water transfers.

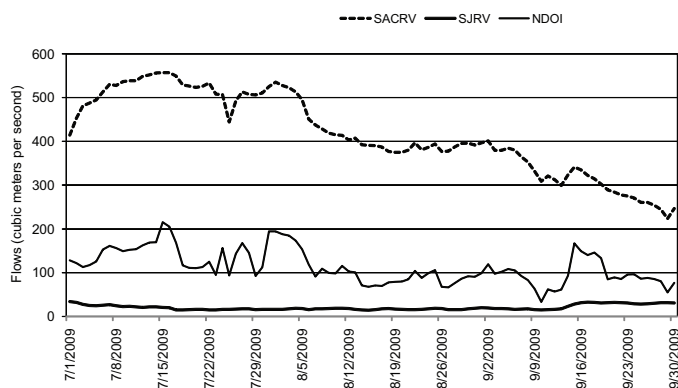


Figure 1 July through September 2009 Sacramento River, San Joaquin River, Net Delta Outflow Index.

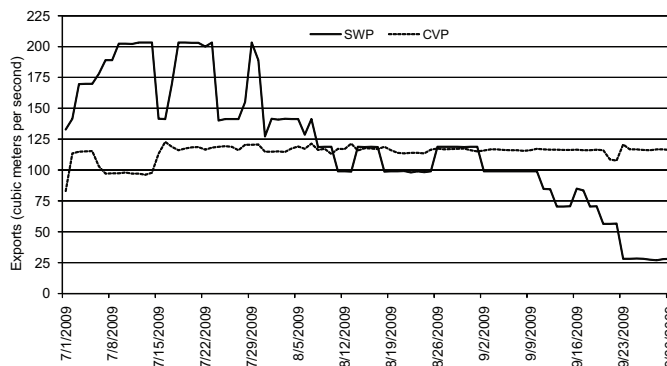


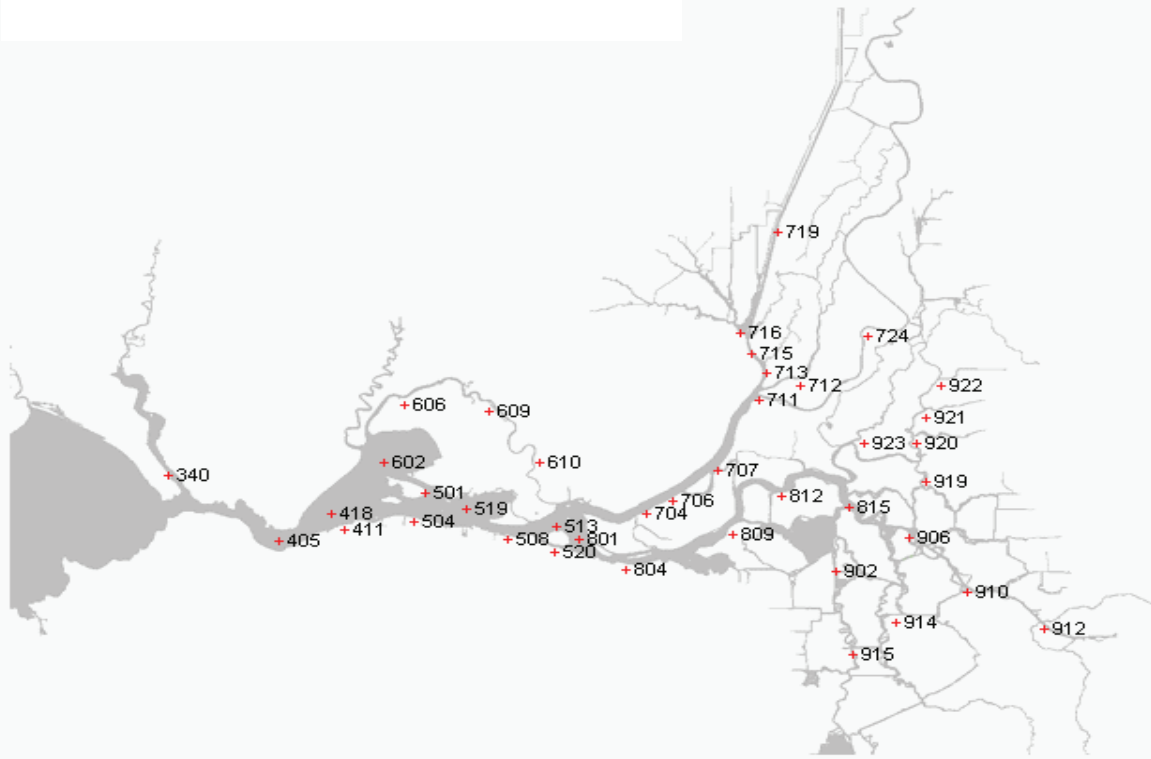
Figure 2 July through September 2009 State Water Project (SWP) and Central Valley Project (CVP) Pumping.

## 2009 Spring Kodiak Trawl Survey for the San Francisco Estuary

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The 2009 Spring Kodiak Trawl (SKT) survey, conducted by the California Department of Fish and Game (DFG), ran from January to May 14, 2009. The objective of the SKT is to determine the distribution of delta smelt (*Hypomesus transpacificus*) and provide water managers and fisheries regulators with information on areas of probable spawning. This information is of particular interest when the distribution of delta smelt favors the eastern or southern Delta, which can lead to increased salvage of adults and subsequent juveniles. In addition to detecting distribution of adult delta smelt, the SKT survey also monitors the gonadal maturation of male and female delta smelt to determine the proportion of catch which is unripe, ripe, and spent.

From its onset in 2002, the SKT initially employed 2 alternating sampling regimes. Delta-wide surveys (numbered 1 – 5), were designed to monitor the distribution of delta smelt and sampled 40 stations from the Napa River to Ryde on the Sacramento River and to the city of Stockton on the San Joaquin River (Figure 1). Supplemental surveys (numbered 11 – 15, when conducted), were designed to monitor the reproductive maturity of delta smelt, and were conducted in areas of greatest delta smelt density indicated by the catch data from preceding Delta-wide portion of the SKT survey. Beginning in 2008 and to reduce the take of delta smelt, only monthly Delta-wide surveys were conducted.



**Figure 1** Current station locations sampled for the DFG Spring Kodiak Trawl Delta-wide Survey.

Gear and gear deployment methods are previously described by Souza (2002). All fish caught were speciated, enumerated, and measured to the nearest millimeter for fork length (FL). Sex and reproductive stage were recorded for all adult delta smelt. Sub-samples of delta smelt were preserved in ethanol (heads) and 10% buffered formalin (bodies), for later age, fecundity, and histopathology evaluations.

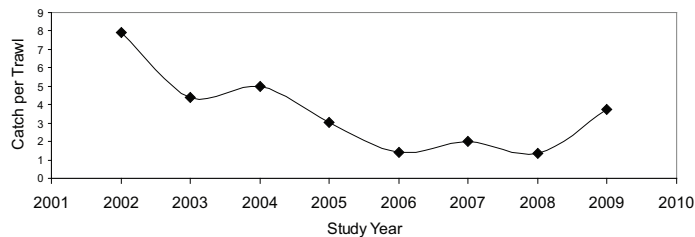
The 2009 survey recorded the greatest single-tow catch (375) of delta smelt for the period of record (2002 through 2009). The catch occurred during Survey 1 in the Sacramento Deep Water Shipping Channel (SDWC) and is 1.5 times greater than the second largest single-trawl catch for any Delta-wide survey, which occurred in 2004 (Table 1). This single catch effectively boosted annual delta smelt catch per trawl to pre-POD levels (Figure 2). Total catch per survey was (as is typical) higher early in the year then declined (Figure 3).

Originally described as semelparous, delta smelt were believed die after 1 spawning event. Field observations from 2008 and 2009 reveal that female delta smelt collected in the SKT show evidence of multiple spawning events within the reproductive season. Individual females

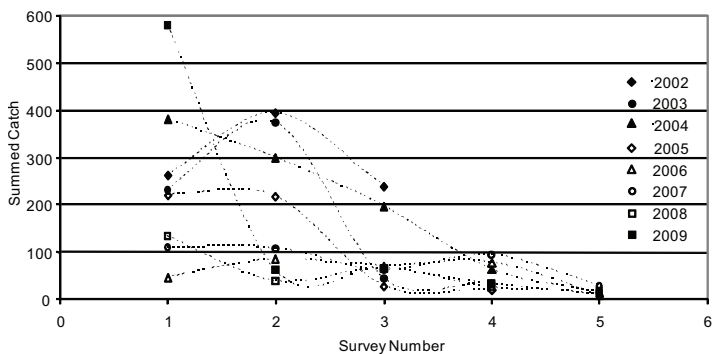
exhibited multiple stages of ova development at the same time. Specifically, these females were staged in the field as being in pre-spawn condition, but contained at least one egg that was often enlarged, hydrated, and translucent indicating over-ripeness and believed to represent eggs retained from a previous clutch.

**Table 1** Ten highest single-trawl catches of delta smelt from the DFG's Spring Kodiak Trawl for the period of record: 2002 - 2009.

<i>Catch Rank</i>	<i>Year</i>	<i>Survey</i>	<i>Date</i>	<i>Station</i>	<i>Catch</i>
1	2009	1	14-Jan-09	719	375
2	2004	1	15-Jan-04	609	248
3	2002	2	05-Feb-02	606	184
4	2004	2	17-Feb-04	609	105
5	2002	3	05-Mar-02	609	103
6	2004	3	09-Mar-04	606	93
7	2002	1	08-Jan-02	609	89
8	2009	1	13-Jan-09	706	87
9	2005	2	24-Feb-05	606	85
10	2005	1	27-Jan-05	609	81



**Figure 2** Summed annual delta smelt catch divided by the summed annual number of trawls from the DFG Spring Kodiak Trawl for the period of record: 2002 - 2009.

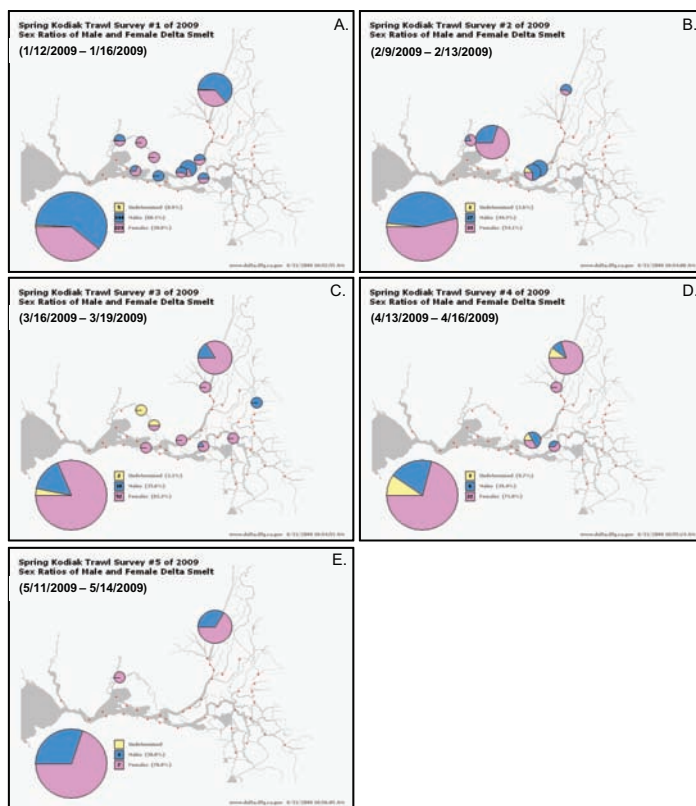


**Figure 3** Summed catch of delta smelt by survey number of the DFG Spring Kodiak Trawl for the period of record: 2002 - 2009.

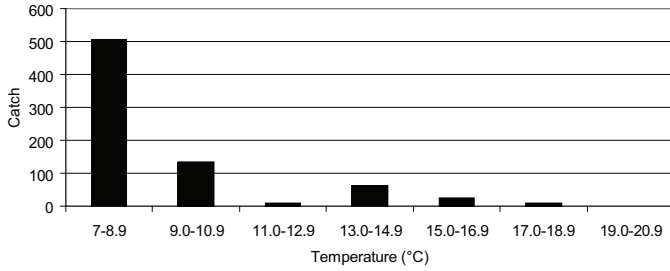
Delta smelt distribution throughout the upper estuary during Survey 1 was broad; ranging from western Montezuma Slough to the lower San Joaquin and Sacramento rivers, and north to the SDWC (Figure 4A). The SDWC had the highest concentrations of delta smelt for 4 out of the 5 surveys conducted in 2009. Only Survey 2 recorded higher densities of delta smelt outside of the SDWC. Survey 2's largest catch occurred in eastern Montezuma Slough, and higher densities of delta smelt were also detected at 2 lower Sacramento River stations than in the SDWC (Figure 4B). Survey 3 proved to be broad in delta smelt distribution as well, with a slight shift east from Survey 1. Fish were detected from Montezuma Slough and eastern Suisun Bay to the San Joaquin and Mokelumne rivers, and again north to the SDWC (Figure 4C). With the season progressing and catch dropping off, Survey 4's delta smelt distribution was limited to 2 areas; the lowest reaches of the San Joaquin and Sacramento rivers, and the Cache Slough and SDWC complex (Figure 4D). During Survey 5, detection of only 1 delta smelt occurred outside of the SDWC. This was located in western Montezuma Slough, while the rest of the delta smelt detected in Sur-

vey 5 (9 fish) were located in the SDWC (Figure 4E). Since the addition of the SDWC station (Stn. 719) to the SKT in 2005, the project consistently observes relatively higher delta smelt densities in the SDWC suggesting that this is a preferred spawning location. However, there is little information on what specific factors contributed to this preference or occurrence.

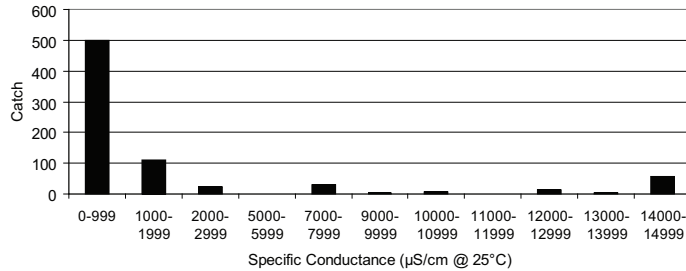
Delta smelt catch data from all 2009 Delta-wide surveys were combined to account for the frequency of occurrence in particular temperature and specific conductance ranges. Driven mainly by the single record-high haul from Survey 1, we see that approximately 67% of all delta smelt collected in 2009 occur in the <9°C and <1000 µS/cm ranges for water temperature and specific conductance respectively (Figures 5 & 6).



**Figure 4** Geographical distribution of delta smelt by catch and by male-female ratio for each 2009 Delta-wide survey, from the DFG Spring Kodiak Trawl web-page (<http://www.delta.dfg.ca.gov/data/projects/?ProjectID=SKT>).



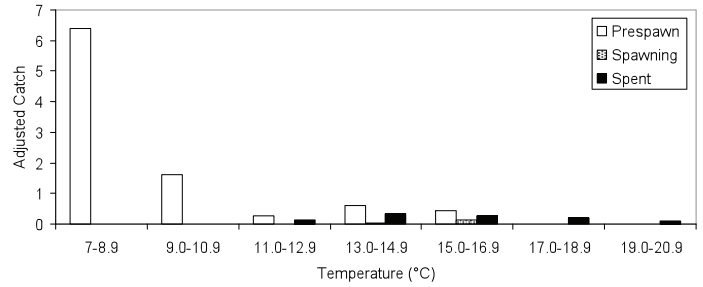
**Figure 5** Temperature ranges in which delta smelt were collected during the DFG Spring Kodiak Trawl 2009 field season.



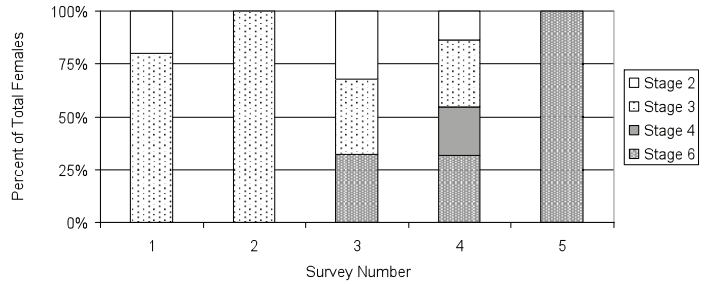
**Figure 6** Specific conductance ranges in which delta smelt were collected during the DFG Spring Kodiak Trawl 2009 field season.

To examine the relationship of water temperature and the reproductive status of female delta smelt, female catch data from all 2009 Delta-wide surveys were combined and then adjusted to account for the frequency of temperature readings, so that more frequent readings are not overrepresented. Delta smelt catch in each temperature group was divided by the number of times the respective group was observed in the field. Greater than 68% of all pre-spawn females were collected at water temperatures <9°C, while 100% of spent females were collected at temperatures >12°C (Figure 7).

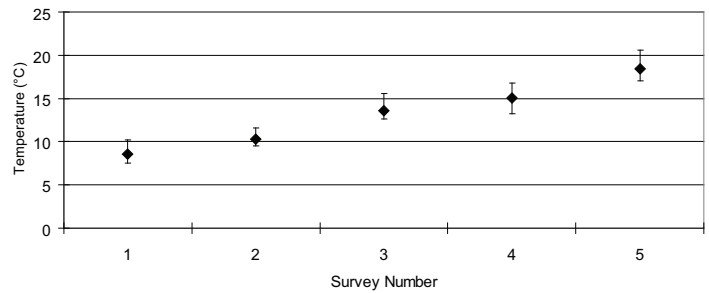
Figure 8 shows the female gonadal stage distribution for the 2009 sampling year and (as is typical) the fraction of both ripe and spent fish increases with the seasonal increase in water temperature. Spawning (i.e. ripe or spent females) was detected during Survey 3, coincident to a 3.1°C rise in average survey temperature from Survey 2 to Survey 3 which pushed the average survey water temperature (Figure 9) above a purported 12°C trigger/threshold to initiate spawning (Lindberg et al., 1997). Water temperatures reported by the California Data Exchange Center (CDEC, <http://cdec.water.ca.gov/>) for three delta locations revealed that a warming trend to >12°C in the Cache Slough region occurred up to three weeks before the start of Survey 3 (Figure 10), which indicates spawning may have initiated just days after Survey 2 was completed.



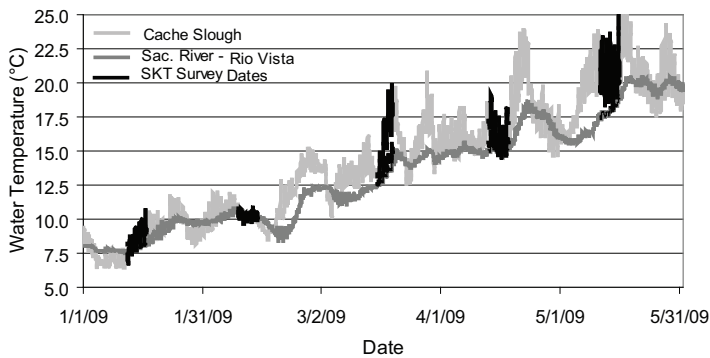
**Figure 7** Temperature ranges in which female delta smelt were collected during the DFG Spring Kodiak Trawl 2009 field season. Female gonadal stages are broken down into pre-spawn, ripe, and spent groups.



**Figure 8** Gonadal-stage percent distribution of female delta smelt during each 2009 Delta-wide survey of the DFG Spring Kodiak Trawl. Stages 2 & 3 are pre-spawn, Stage 4 is ripe, and Stage 6 is spent.



**Figure 9** Temperature readings taken from every sample in each 2009 Delta-wide survey of the DFG's Spring Kodiak Trawl; survey average temperatures are noted.



**Figure 10 Hourly water temperatures recorded in the Sacramento River at Rio Vista, Cache Slough, and Montezuma Slough as reported by CDEC (<http://cdec.water.ca.gov/>). Black lines highlight and represent corresponding DFG's Spring Kodiak Trawl survey dates.**

The 2010 Spring Kodiak Trawl field season is scheduled to begin in January 2010 and run through May 2010 using monthly surveys. Currently, there are no plans to alter 2010 field sampling in any way from the previous year. However, the addition of a precisely-timed supplemental survey might provide valuable data regarding the timing and environmental factors of certain spawning events. A supplemental survey may also provide additional presence/absence information in areas of high interest (e.g., the south Delta). Minor laboratory processing changes will be implemented in 2010 to facilitate later genetic analysis. These data, along with the geographic distributions of delta smelt, are available for viewing on our web page at <http://www.delta.dfg.ca.gov/data/projects/?ProjectID=SKT>.

## References

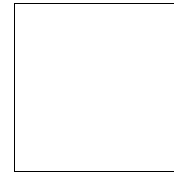
- Lindberg J, Mager R, Bridges B, Dorshov S. 1997. Status of delta smelt culture. IEP Newsletter 10(Summer):21-22.
- Souza K. 2002. Revision of California Department of Fish and Game's Spring Midwater Trawl and Results of the 2002 Spring Kodiak Trawl. IEP Newsletter 15(3):44-47.

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■ Interagency Ecological Program for the San Francisco Estuary ■

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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](mailto:pcorn@water.ca.gov).

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