

2012 Spring Kodiak Trawl Survey

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The 2012 Spring Kodiak Trawl (SKT) survey, conducted by the California Department of Fish and Wildlife (CDFW), ran from January 17 to May 3, 2012. 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 entrainment loss of adults and 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. Macro-characteristics used for gonadal staging are described by R.C. Mager (personal communication, June 14, 2002) and are shown in Table 1.

The SKT has employed Delta-wide surveys (numbered 1 – 5; Figure 1) each year and has often conducted supplemental surveys (numbered 11 – 15). Supplemental surveys are designed only to monitor the reproductive maturity of delta smelt and are conducted in areas of greatest delta smelt density as indicated by catch from preceding Delta-wide surveys. Beginning in 2008 and to reduce the take of delta smelt, only monthly Delta-wide surveys have been conducted.

Delta-wide Surveys consist of at least 8 boat days and 160 man hours; 4 field staff use 2 boats to sample (trawl) once at 40 stations over ~ 4 days. Gear and gear-deployment methods are previously described by Souza (2002). Following field sampling, laboratory staff examine a sub-set of all delta smelt samples collected to ensure accuracy of the gonadal staging process.

All fish caught were speciated and measured to the nearest millimeter fork length (FL) or total length (TL). Sex and reproductive stage were recorded for all

adult delta smelt; each fish was given a unique serial number, wrapped in foil, and placed in liquid nitrogen for later histopathology work. Sub-samples of female delta smelt were preserved in 10% buffered formalin or 70% ethanol for later assessment of fecundity.

The 2012 SKT collected the highest total delta smelt catch ($n = 1167$) during its 5 Delta-wide surveys, and collected the 2nd highest average delta smelt catch per trawl for the period of record (2002 – 2012, Figure 2). Total catch per survey was (as is typical) higher early in the year (Figure 3), which is expected from the annual life-cycle of delta smelt.

Throughout the entire sampling period (Surveys 1 – 5), delta smelt distribution ranged broadly (Figures 4A – 4E), with the highest densities of delta smelt occurring at the Confluence, in Montezuma Slough, and in the Sacramento Deep Water Ship Channel (SDWC). From these distributions, it is difficult to discern an upstream migration for the purposes of spawning, likely due to the higher than average catch numbers throughout the upper estuary.

The female gonadal-stage distribution year was typical, as the fraction of spent fish increased with water temperature (Figure 5). Ripe and spent females (Stages 4 & 6) were first detected during Survey 2, when water temperatures (Figure 6) were just below the purported 12°C trigger/threshold needed to initiate spawning (Lindberg et al, 1997).

We found ~90% of all delta smelt were collected at temperatures <16°C (Figure 7) and that greater than 70% were collected at conductance values of <3000 $\mu\text{S}/\text{cm}$ (Figure 8). By adjusting catch to account for the frequency of temperature readings (so that more frequent readings per temperature group are not overrepresented), we found that roughly 70% of all pre-spawn females were collected at water temperatures <12°C, pre-spawn females were collected throughout the entire season's temperature range (6.7°C – 21.1°C; Figure 9), and greater than 95% of all ripe and spent females were collected at temperatures $\geq 12^\circ\text{C}$.

The 2013 Spring Kodiak Trawl field season is scheduled to begin in January 2013 and run through May 2013 using monthly surveys. SKT data and

the geographic distribution of delta smelt are available for viewing on our web page at <http://www.dfg.ca.gov/delta/projects.asp?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.

Spring Kodiak Trawl Sampling Stations

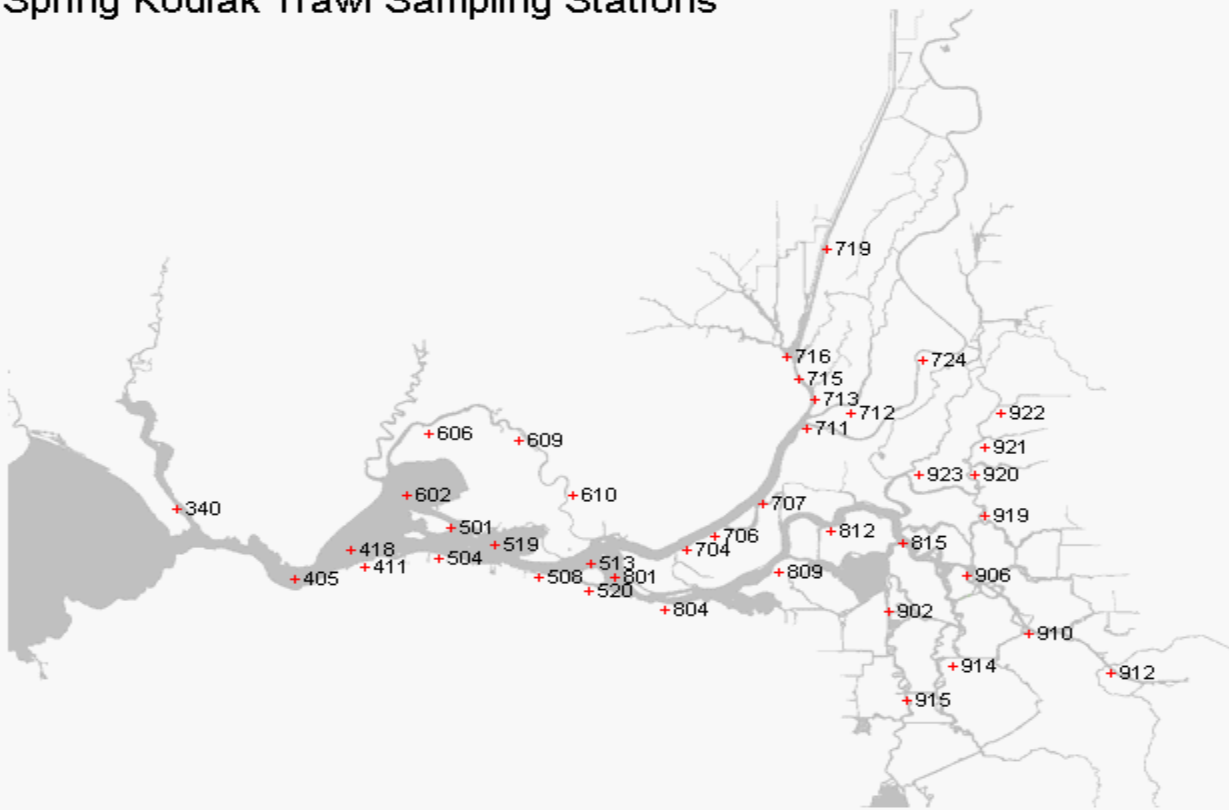


Figure 1. Current station locations sampled for the CDFW Spring Kodiak Trawl Delta-wide Survey.

Average Delta Smelt Catch per Trawl for Delta-wide Surveys

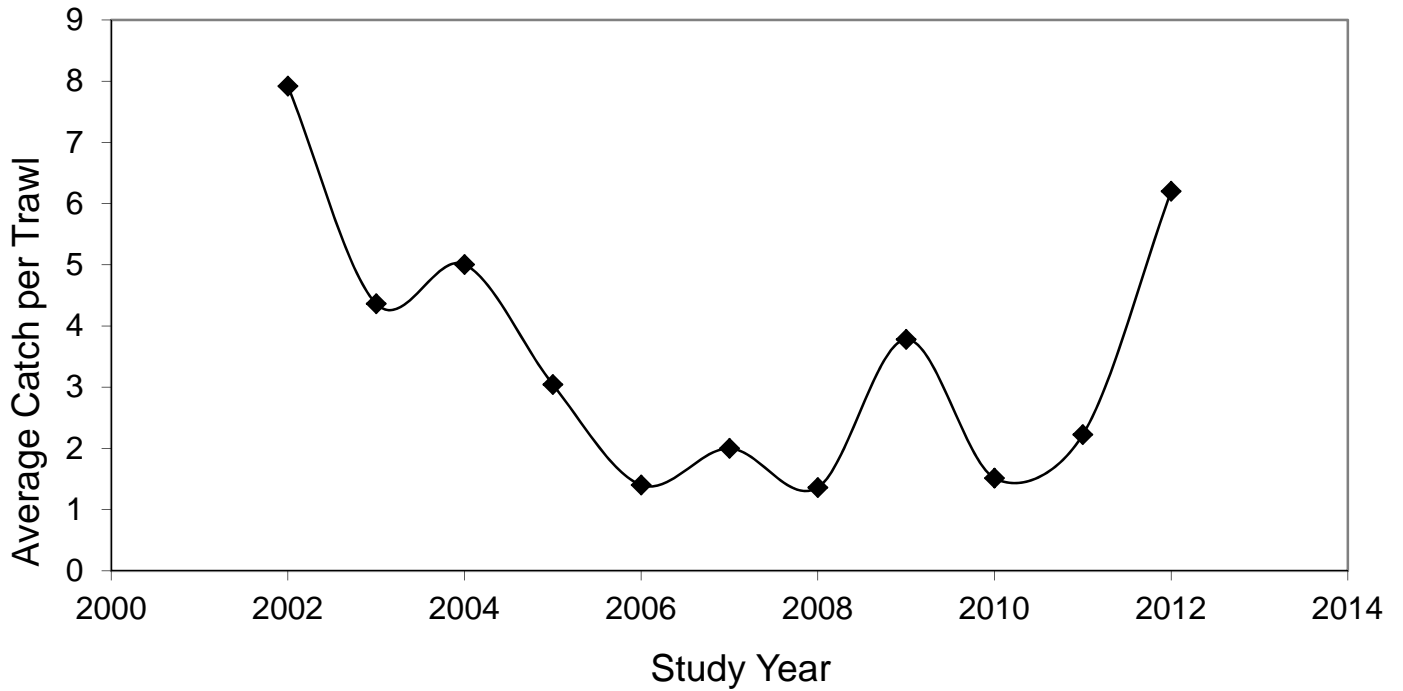


Figure 2. Summed annual delta smelt catch divided by the summed annual number of trawls from the CDFW Spring Kodiak Trawl for the period of record: 2002 – 2012.

Summed Delta Smelt Catch by Survey

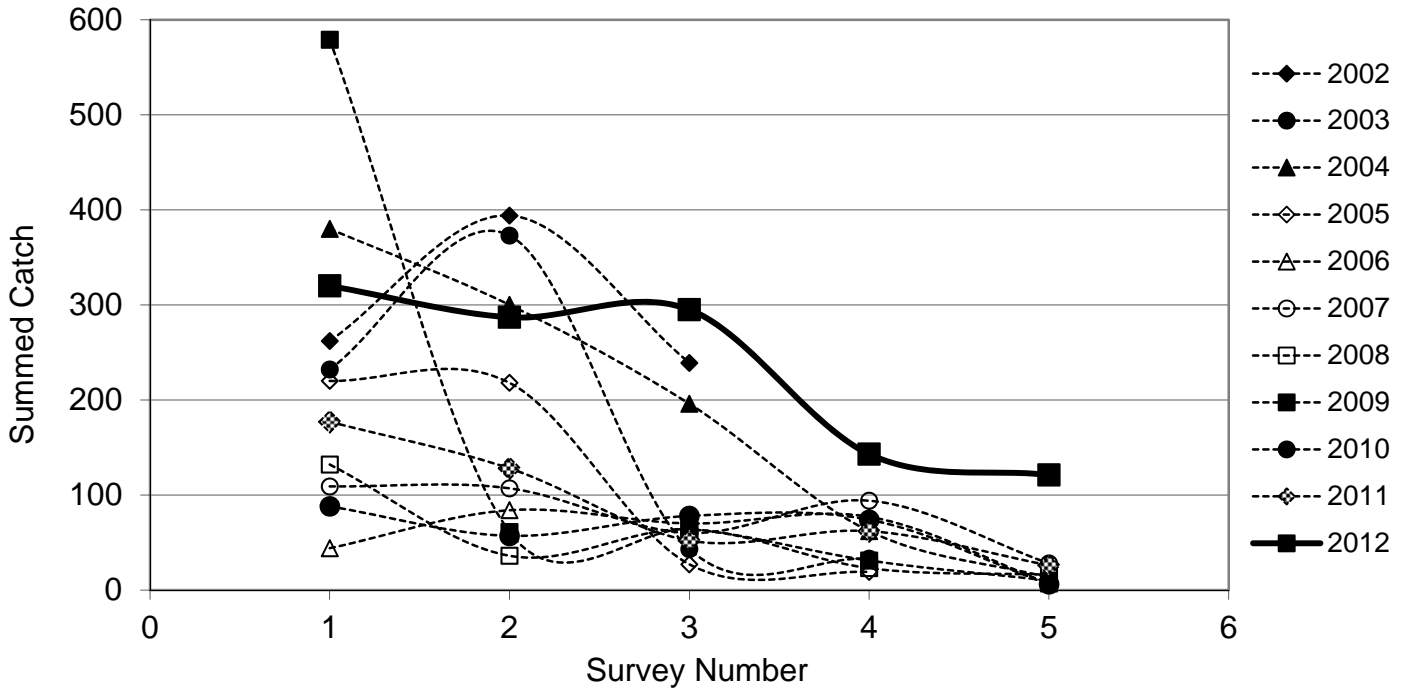


Figure 3. Summed catch of delta smelt by survey number of the CDFW Spring Kodiak Trawl for the period of record: 2002 – 2012.

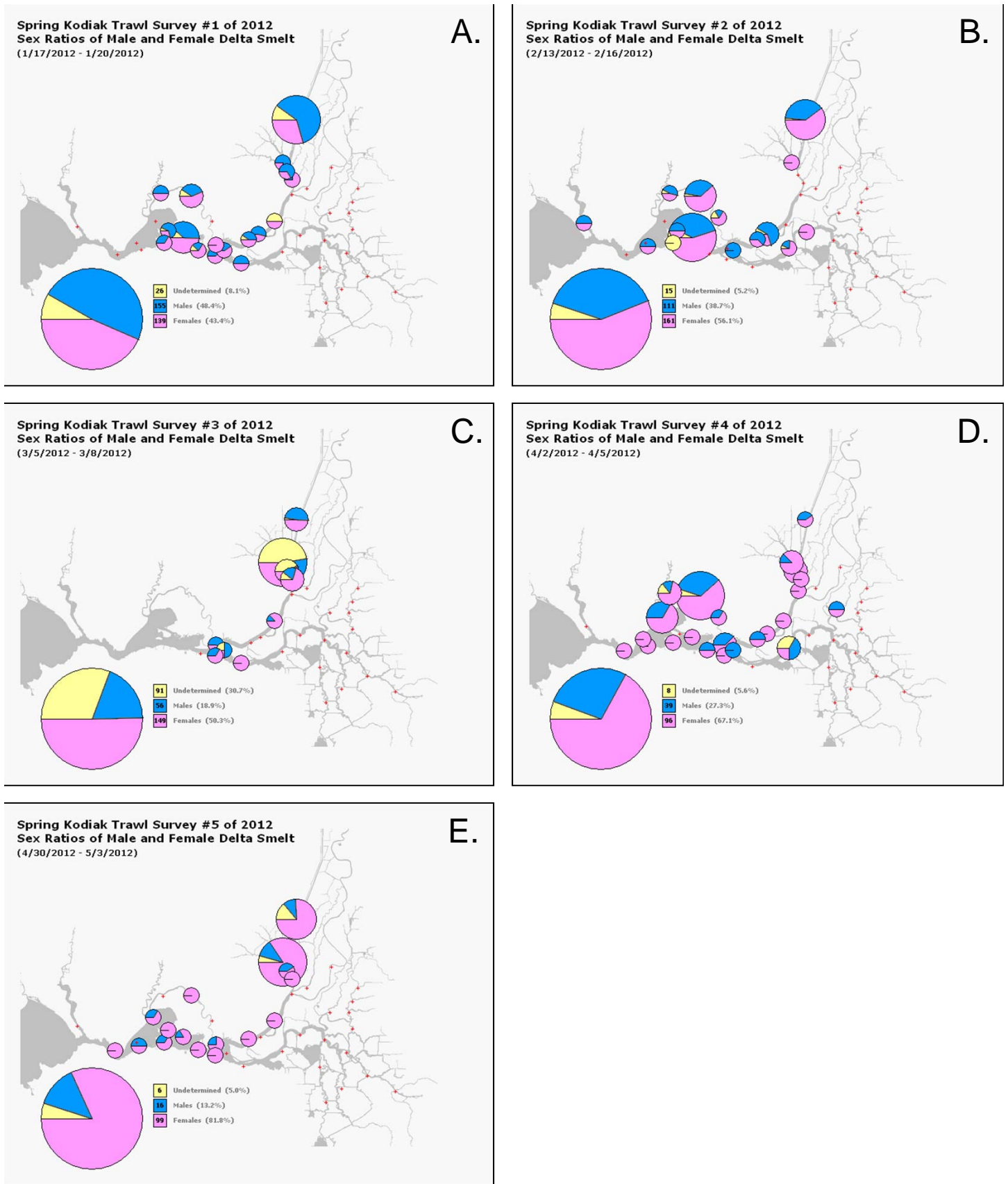


Figure 4. Geographical distribution of delta smelt by catch and by sex ratio for each 2012 Delta-wide survey, from the CDFW Spring Kodiak Trawl web-page (<http://www.delta.dfg.ca.gov/data/projects/?ProjectID=SKT>).

Female Gonadal Staging by Survey

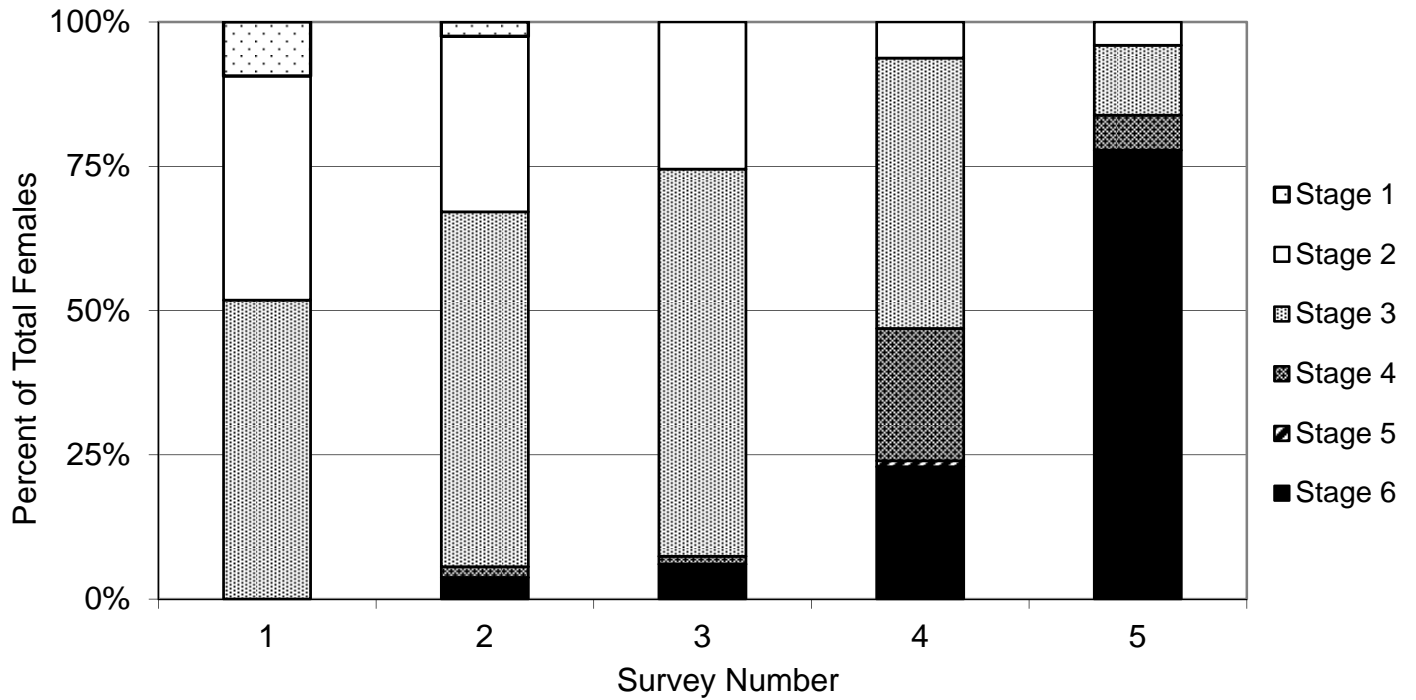


Figure 5. Gonadal-stage percent distribution of female delta smelt during each 2012 Delta-wide survey of the CDFW Spring Kodiak Trawl. Stages 2 & 3 are pre-spawn, Stage 4 is ripe, and Stage 6 is spent.

Average Water Temperature by Survey

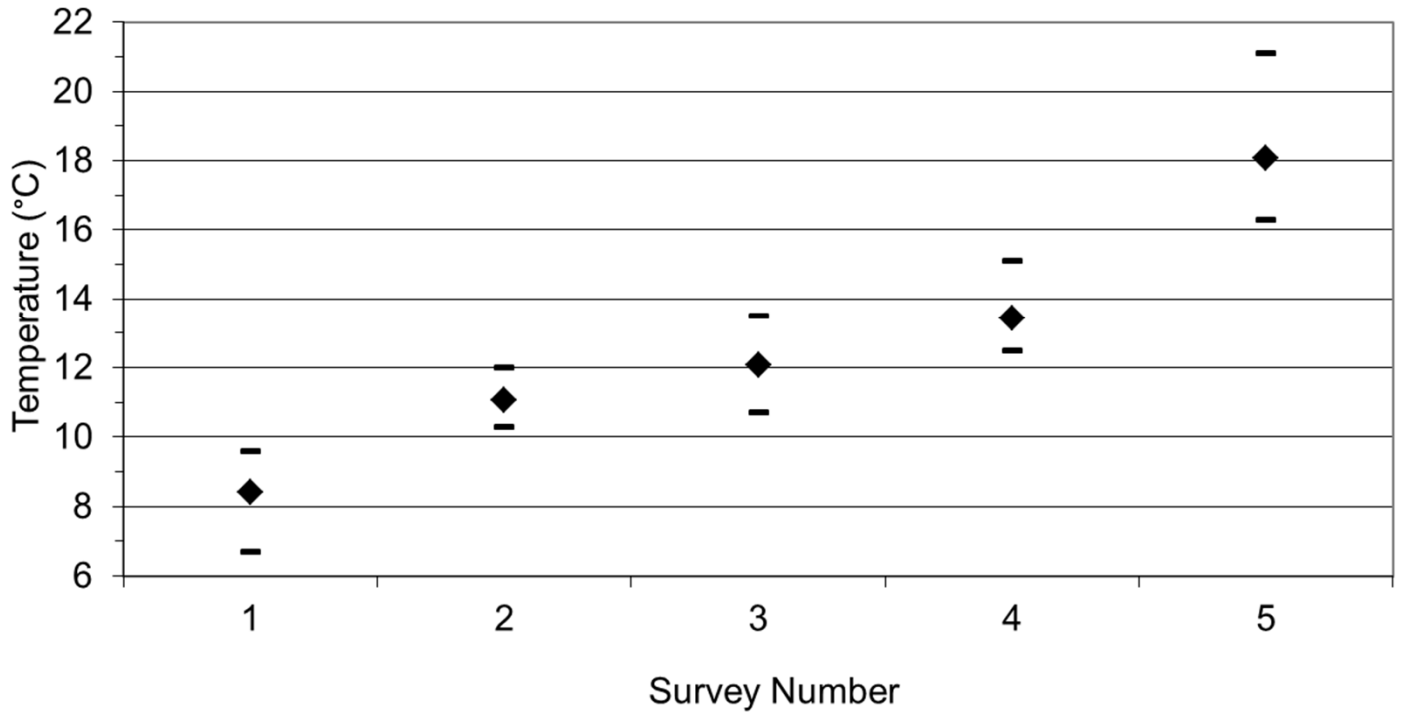


Figure 6. High, low, and average temperatures for each 2012 Delta-wide survey of the CDFW's Spring Kodiak Trawl.

Distribution of Delta Smelt Catch by Water Temperature

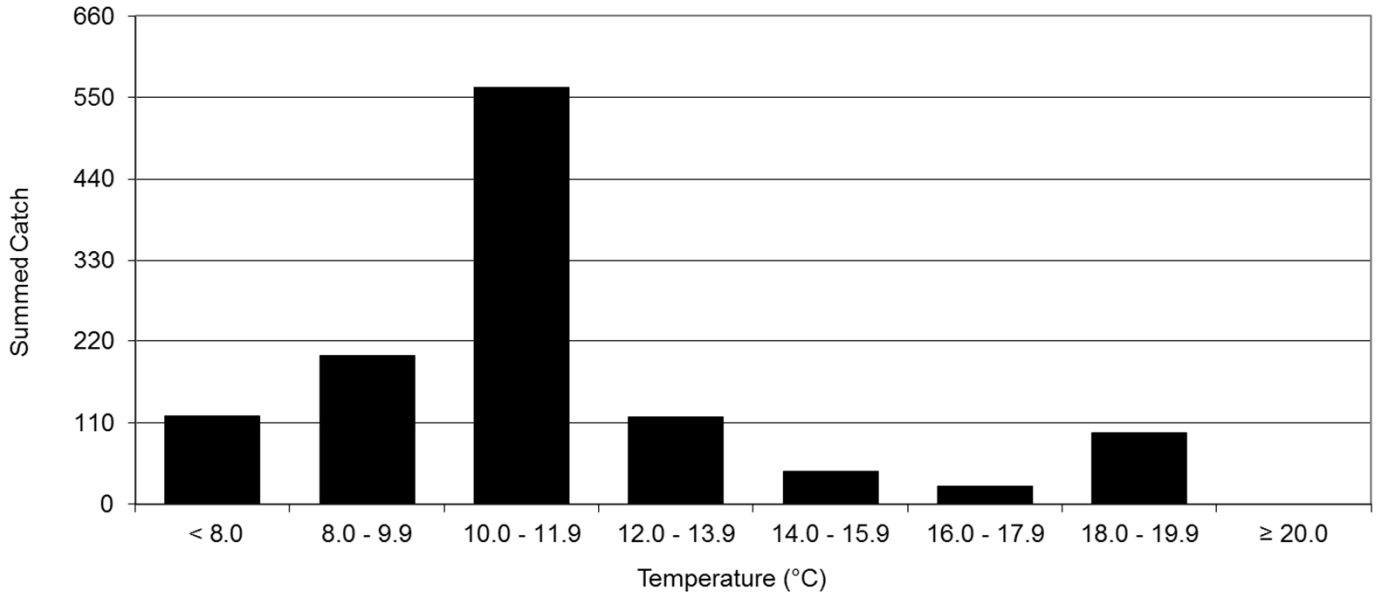


Figure 7. Temperature ranges in which delta smelt were collected during the CDFW Spring Kodiak Trawl 2012 field season.

Distribution of Delta Smelt Catch by Surface Conductivity

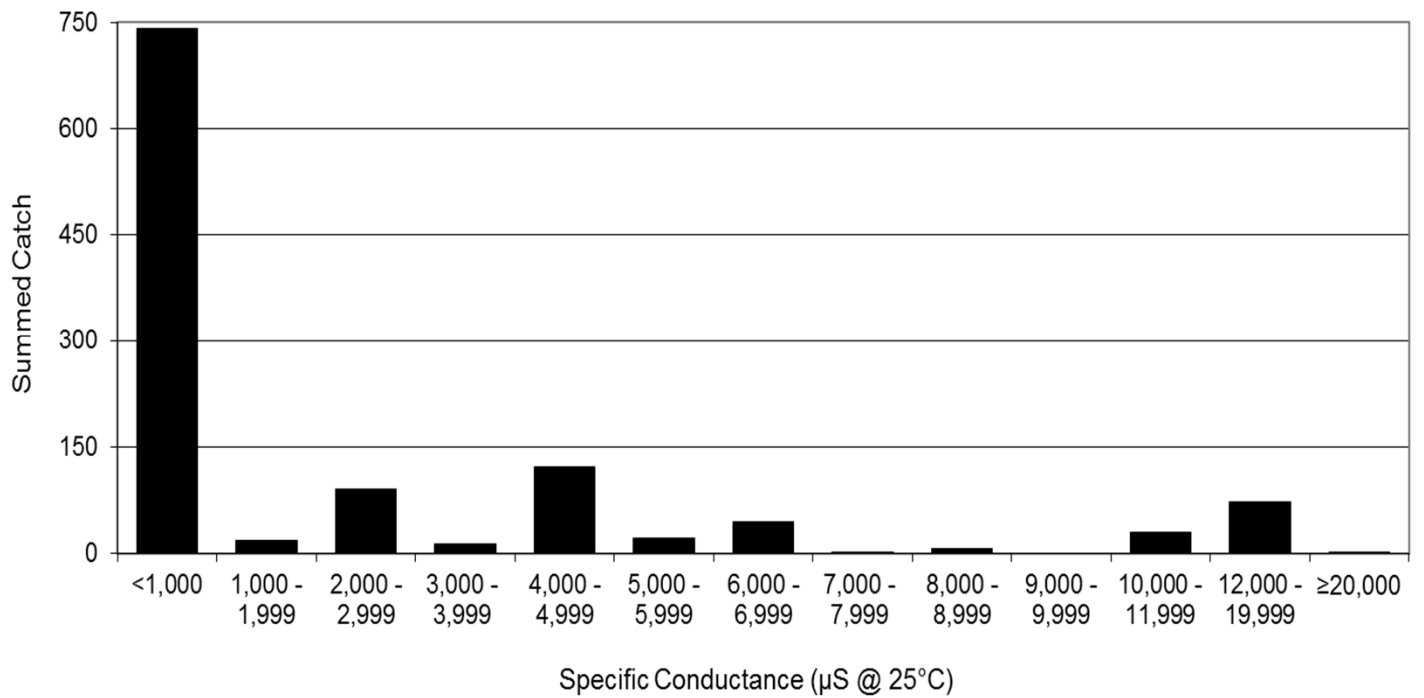


Figure 8. Specific conductance ranges in which delta smelt were collected during the CDFW Spring Kodiak Trawl 2012 field season.

Female Delta Smelt Gonadal Stage by Water Temperature

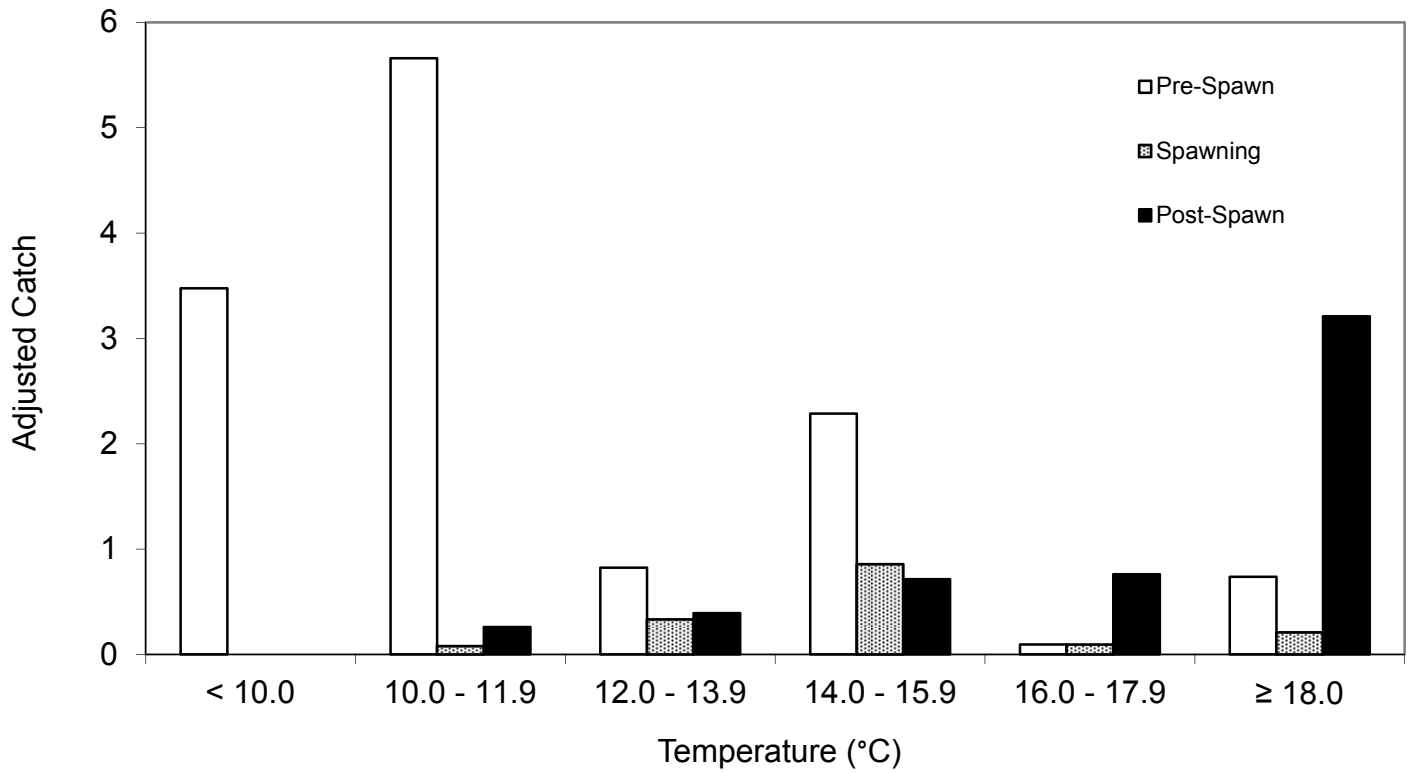


Figure 9. Temperature ranges in which female delta smelt were collected during the CDFW Spring Kodiak Trawl 2012 field season. Female gonadal stages are broken down into pre-spawn, ripe, and spent groups.

Table 1. Macro-characteristics of male and female delta smelt gonads for the purpose of identifying maturity stage; adapted from R. C. Mager (personal communication, June 14, 2002).

Stage	Male	Female
I	Left testis barely visible and right testis impossible to find.	Left ovary translucent and grainy in texture. Right ovary difficult to impossible to find.
II	Testis visible as thin strands ventrolateral to swim bladder.	Not differentiated from stage 1 for this study.
III	Left testis has developed in the central portion of the gonadal cord. Right testis visible as a thin pale white or gray cord.	Individual oocytes slightly orange, 0.25 – 0.50 mm in diameter, and visible to the naked eye.
IV	Both testis clearly visible, smooth, and pale white in color.	Abdomen is enlarged with egg mass and observable without dissection. Oocytes are bright orange and about 1 mm in diameter.
V	Testes are bright white and very smooth. Milt can be released with gentle pressure.	Oocytes are larger than 1 mm in diameter and hydrated. Clear fluid surrounds oocytes which become increasingly cloudy and degenerate.
VI	Testes and milt not as bright white as during stage V. Can be indicated by a decrease in size of testes.	Gonad is translucent and textured with a few leftover oocytes embedded in tissue. Loose abdomen is easily detected.