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Summary

Monitoring in the Stockton Ship Channel showed that DO levels consistently fell below the 5.0 mg/L and 6.0 mg/L objectives set by the State. Although the location of the low DO areas varied, eight of the nine monitoring runs conducted between July 23 and December 18, showed DO levels in the Channel below the 6.0 mg/L objective. In addition, average DO levels in the East and East-Central Channel regions were below the 6.0 mg/L objective in seven of the nine sampling runs. Both instances in which average DO levels in the East and East-Central Channel regions exceed 6.0 mg/L occurred during the period in which the Barrier was in place.

In previous years, DO levels throughout the Channel typically remained at greater than 6.0 mg/L within the Channel in late fall due to cooler water temperatures and improved inflows. In 2002, however, DO levels dropped below 6.0 mg/L in the Eastern Channel on November 21, and to less than 4.0 mg/L on December 3. The removal of the Barrier on November 15, during a period of high Delta exports or upstream diversions, markedly reduced net flows past Stockton and apparently contributed to these low late-fall DO values within the Eastern Channel.

DO conditions improved slightly on December 18 with surface DO levels greater than 6.0 mg/L in much of the Eastern Channel, and bottom DO values in the Eastern Channel greater than 5.0 mg/L. Significantly cooler water temperatures, along with a moderate increase in net daily San Joaquin River flows past Stockton in December, appear to have ultimately contributed to sustained improvement of DO conditions in the Channel.

2003 Spring Kodiak Trawl

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During spring 2003, the California Department of Fish and Game (DFG) completed 4 Delta-wide and 3 supplemental Kodiak trawl surveys designed to identify delta smelt (Hypomesus transpacificus) distribution and pro-
vide water managers and fisheries regulators with information on potential spawning distributions. This information is of particular interest when the distribution of Delta smelt favors the eastern or southern Delta, which usually precedes increased salvage (take) of adults and subsequent juveniles. The Delta-wide surveys (numbered consecutively beginning with 1) took 4 days to complete and sampled 39 stations extending from the Napa River to Walnut Grove on the Sacramento River, and to the city of Stockton on the San Joaquin River (Figure 1). Supplemental surveys (numbered consecutively beginning with 11) were intended to provide information about the progression of delta smelt maturity. They took 2 days to complete and were conducted in areas of greatest delta smelt density, as indicated by the catch data of the previous Delta-wide portion of the survey. Both the Delta-wide and supplemental surveys occurred once per month, beginning with a Delta-wide survey on 18 Feb 03, then alternating between sampling regimes every other week through early May.

Spring Kodiak trawl gear and gear deployment methods are described in Souza (2002). All fish caught were speciated, enumerated, and measured to the nearest millimeter fork length (FL) or total length (TL). Additional information collected for delta smelt included total volume of each fish (nearest mL), sex, and reproductive stage (Table 1). During supplemental surveys, heads were preserved in ethanol, small samples of eggs from stage 4 females were preserved in a 6:3:1 (formalin, ethanol, acetic acid) clearing agent, and the remaining body was preserved in 10% buffered formalin. These specimens are currently being archived; however, future research will include evaluations of hepatosomatic indices, fecundity, maturation, otoliths, gonad histology, and gonad histopathology.

Figure 1 Locations of sampling stations for DFG’s Delta-wide Spring Kodiak Trawl survey, Sacramento-San Joaquin Delta.
During the Delta-wide portion of the 2003 SKT, a total of 3,202 fishes representing 27 species and 14 families were collected. Three families comprised 89% of the total catch: Salmonidae (51%), Osmeridae (24%), and Clupeidae (14%). The most common fishes encountered were Chinook salmon (*Oncorhynchus tshawytscha*), followed by delta smelt, and threadfin shad (*Dorosoma petenense*). Large juvenile Chinook catches were likely due to hatchery releases that coincided with our sampling efforts.

Delta smelt were more widely distributed during survey 1 (18 Feb 03) and survey 2 (17 Mar 03) than during subsequent surveys. During this time, they were collected from the western-most area of Suisun Bay, within Montezuma Slough, through the confluence area, and inside of Cache Slough. During survey 1, smelt were also collected in the San Joaquin River, and during survey 2, smelt were collected as far north as Walnut Grove in the Sacramento River. With the exception of survey 3, stations in Cache Slough accounted for the majority of delta smelt catch (survey 1=56%, survey 2=49%, and survey 4=67%). This is different from distribution during 2002 when Montezuma Slough consistently had the largest concentration of delta smelt catch in all surveys (Souza 2002). This difference could be a result of the survey timing (which was deliberately delayed 6 weeks in 2003), rather than a function of environmental conditions. As the spawning season progressed, functionally mature delta smelt (stage 4 females and stage 5 males) distribution shifted from Suisun Bay and the confluence area upstream to Cache Slough (Figure 2). Surveys 3 and 4 suggest that males appear to arrive later than females to spawning areas (Figure 2).

Distribution of spent fish (fish that have spawned) was limited during survey 1. Subsequent surveys had a larger range of spent smelt, including areas as far north as Walnut Grove on the Sacramento River (surveys 2 and 3), and in the North and South Mokelumne (survey 3) (Figure 3). The SKT has yet to detect spent fish in the Napa River (2002 or 2003), and very rarely are spent fish collected in Montezuma Slough (survey 2, Figure 3).

Environmental conditions at the time and location of capture for the majority of delta smelt collected consisted of water temperatures between 11 and 14 °C (94%) (Figure 4) and specific conductivities (corrected for 25 °C) ranging between 131 and 3,200 mS/cm (97%) (Figure 5). Delta smelt catch from the Delta-wide surveys were adjusted to account for the frequency of temperature and specific conductance readings so that more frequent readings were not overrepresented.

### Table 1 Macro-characteristics of male and female delta smelt (*Hypomesus transpacificus*) gonads used for determining reproductive maturity status of preserved specimens.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Left testis is barely visible and the right testis is impossible to find. Gonads &lt; 0.1% of body weight.</td>
<td>Left ovary translucent and grainy in texture. Right ovary difficult to impossible to find.</td>
</tr>
<tr>
<td>II</td>
<td>Testis visible as thin strands ventrolateral to the swim bladder. Gonads are less than 0.5% of body weight.</td>
<td>Looks the same as stage 1 when observed without a microscope.</td>
</tr>
<tr>
<td>III</td>
<td>Right testis is visible as a small pale white or grey cord. Left testis has developed in the central portion of the gonadal cord.</td>
<td>Individual oocytes slightly orange, 0.25-0.50 mm in diameter, and visible to the naked eye.</td>
</tr>
<tr>
<td>IV</td>
<td>Both testes are clearly visible, smooth, and pale white.</td>
<td>Abdomen is enlarged with egg mass and observable without dissection. Oocytes are bright orange and about 1 mm in diameter. Eggs can be stripped with gentle pressure.</td>
</tr>
<tr>
<td>V</td>
<td>Testes are bright white and very smooth. Testes account for 2-4% of body weight. Milt can be released by gentle pressure.</td>
<td>Oocytes are larger than 1 mm in diameter, and hydrated. Clear fluid surrounds the orange oocytes that become increasingly cloudy and degenerate.</td>
</tr>
<tr>
<td>VI</td>
<td>Testes and milt not as bright white as during stage V. During summer months, indicated by a decrease in size of testes.</td>
<td>Gonad is translucent and textured with a few leftover oocytes embedded in tissue. Loose abdomen easily detected.</td>
</tr>
</tbody>
</table>

Source: Adapted from personal communication (Mager 2001).
Figure 2 Distribution of stage 5 males and stage 4 females (spawning) delta smelt (Hypomesus transpacificus) collected during the 2003 Spring Kodiak Trawl, Delta-wide surveys.
Figure 3 Distribution of stage 6 male and female (spent) delta smelt (*Hypomesus transpacificus*) collected during the 2003 Spring Kodiak Trawl, Delta-wide surveys.
Supplemental Surveys

Most of the supplemental surveys were conducted within the Sacramento Deep Water Channel (SDWC). Attempts were made to sample Honker Bay, Montezuma Slough, Nurse Slough, and the lower Sacramento River near Brannan Island, but sufficient numbers of fish were not collected in those areas to warrant additional sampling. Consistently low catches of delta smelt indicated that fish were further upstream so subsequent sampling was concentrated in the SDWC, where numerous delta smelt were consistently collected. Tows were made between lights 53 and 54 (approximately 1.7 miles above the confluence of Cache and Miner sloughs), throughout the SDWC adjacent to the Yolo Bypass Wildlife Area, and all the way to the Sacramento Turning Basin, past Lake Washington.

More delta smelt were collected in the SDWC during supplemental surveys (n=678) than during all 4 Delta-wide surveys (n=669). Males and females collected in this area were found to be predominately in stage 5 and 4, respectively (functionally mature), and stage 6 (spent).

The male to female sex ratio was constant (1:4) in all supplemental surveys, and, in Delta-wide surveys, the sex ratio was as great as 1:15 (Table 2). This is the same pattern that was observed in the 2002 SKT survey, during which the number of females collected gradually increased with the progression of the spawning season. It is not clear why this pattern exists, but possibilities include: (1) females may be more vulnerable to the sampling gear at this time, or (2) females persist longer after spawning.

More detailed maps of delta smelt reproductive maturity can be found at http://www.delta.dfg.ca.gov/data/skt/.

<table>
<thead>
<tr>
<th>Date</th>
<th>Survey</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
<th>M:F Sex ratio</th>
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<td>Delta-wide surveys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2/18-2/21</td>
<td>1</td>
<td>82</td>
<td>145</td>
<td>227</td>
<td>1.2</td>
</tr>
<tr>
<td>3/17-3/20</td>
<td>2</td>
<td>113</td>
<td>258</td>
<td>371</td>
<td>1.2</td>
</tr>
<tr>
<td>4/14-4/17</td>
<td>3</td>
<td>8</td>
<td>35</td>
<td>43</td>
<td>1.4</td>
</tr>
<tr>
<td>5/13-5/16</td>
<td>4</td>
<td>2</td>
<td>29</td>
<td>31</td>
<td>1.15</td>
</tr>
<tr>
<td>Supplemental surveys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/3-3/4</td>
<td>11</td>
<td>55</td>
<td>195</td>
<td>250</td>
<td>1.4</td>
</tr>
<tr>
<td>4/2-4/4</td>
<td>12</td>
<td>34</td>
<td>124</td>
<td>158</td>
<td>1.4</td>
</tr>
<tr>
<td>4/26-5/2</td>
<td>13</td>
<td>72</td>
<td>269</td>
<td>341</td>
<td>1.4</td>
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<tr>
<td>Total</td>
<td>366</td>
<td>1,055</td>
<td>1,421</td>
<td></td>
<td>1.3</td>
</tr>
</tbody>
</table>

References


Notes

Mager RC. (Department of Water Resources). 14 June 2002. E-mail communication.