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IEP NEWSLETTER

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Revision of California Department of Fish and Game's Spring Midwater Trawl and Results of the 2002 Spring Kodiak Trawl

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The Department of Fish and Game (DFG) has conducted the Spring Midwater Trawl Survey (SMWT) annually since 1991, as an extension of the Fall Midwater Trawl Survey (FMWT), to monitor the winter and spring distribution and abundance of delta smelt (*Hypomesus transpacificus*). The information collected was intended to provide an indication of adult spawning distribution favoring the eastern or southern Delta, which could lead to increased adult salvage at the south Delta water export facilities and potentially result in high juvenile salvage later in the year. The SMWT employed the same protocols and gear as the FMWT survey (Souza 2002), but did not sample all of the San Pablo Bay stations.

In September 1994, a special survey designed to investigate the efficiency of various nets at capturing delta smelt, developed evidence strongly suggesting the current midwater trawl gear and protocol was not as effective as the U.S. Fish and Wildlife (USFWS) Chipps Island trawl or a Kodiak trawl. Replicate side-by-side surface tows were conducted with all three trawls and the density of delta smelt from each trawl was compared. Density data from these comparisons strongly suggested the Kodiak trawl was much more efficient at capturing delta smelt than either the Chipps Island trawl or the conventional midwater trawl. Therefore, beginning with the 2002 sampling season, the midwater trawl gear was replaced with a Kodiak trawl to take advantage of its greater catch efficiency and improve the detection rate of pre-spawning delta smelt. Potentially, this will enable us to better inform water export facility operators of the potential to entrain adult delta smelt and their offspring.

The 2002 SKT sampled four days during the first week of each month from January through March. To offset the additional costs of an added boat operator, and an additional boat, the number of stations were reduced, to

decrease the duration of the survey. This also addressed another concern, which was exceeding allotted take limits of delta smelt. The 100 SMWT stations were reduced to 41 stations extending from Napa River east, to Walnut Grove on the Sacramento River, and Stockton on the San Joaquin River (Figure 1). The majority of the stations were existing sample sites from DFG's Townet Survey. They were chosen because the stations are evenly distributed throughout the Sacramento-San Joaquin Delta and already known to our boat operators. Additionally, eight FWMT stations located in the North and South Mokelumne rivers and Cache Slough were added to increase the spatial distribution into areas of potential spawning.

A standard Kodiak trawl (mouth opening of 7.1-m by 1.7-m and 64-mm cod-end mesh) was surface-towed for 10 minutes. All fish, except delta smelt, were measured to the nearest millimeter and released. All delta smelt were preserved in formalin and brought back to DFG Stockton, to obtain sex and maturity status (stage of gonadal development).

To examine the maturity stage of delta smelt specimens, three incisions were made to the left side of the body. The first incision was vertically from the vent to the lateral line. The second incision was horizontally across the lateral line to the pectoral fin. A vertical incision from the pectoral fin to the ventral-most part of the abdomen completed the opening. The "flap" created by these incisions was then pulled away from the body, and "macro-characteristics" were observed and recorded (Table 1).

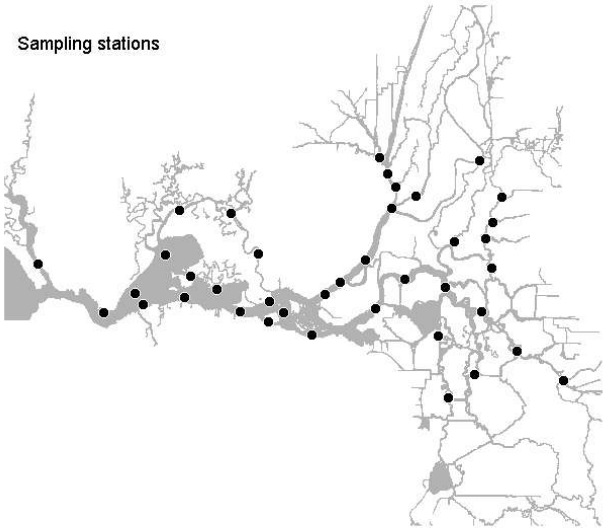

Figure 1 Locations of sampling stations for California Department of Fish and Game's Spring Kodiak Trawl Survey, Sacramento-San Joaquin Delta

Table 1 Macro-characteristics of male and female delta smelt (*Hypomesus transpacificus*) gonads used for obtaining maturity status of preserved specimens (Source: adapted from R. Mager, personal communication, see "Notes").

Stage	*Male*	*Female*
I	Left testis is barely visible and the right testis is impossible to find. Gonads < 0.1% of body weight.	Left ovary translucent and grainy in texture. Right ovary difficult to impossible to find.
II	Testis visible as thin strands ventrolateral to the swim bladder. Gonads are less than 0.5% of body weight.	Not differentiated from stage 1 for this study.
III	Right testis is visible as a small pale white or grey cord. Left testis has developed in the central portion of the gonadal cord.	Individual oocytes slightly orange, 0.25 to 0.50 mm in diameter, and visible to the naked eye.
IV	Both testes are clearly visible, smooth, and pale white.	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.
V	Testes are bright white and very smooth. Testes account for 2% to 4% of body weight. Milt can be released by gentle pressure.	Oocytes are lager than 1 mm in diameter, and hydrated. Clear fluid surrounds the orange oocytes that become increasingly cloudy and degenerate.
VI	Testes and milt not as bright white as during stage V. During summer months, indicated by a decrease in size of testes.	Gonad is translucent and textured with a few leftover oocytes embedded in tissue. Loose abdomen easily detected.

Results

Distribution

The 2002 SKT caught 15,094 fish representing 17 species and 10 families. The most common fishes encountered were threadfin shad (*Dorosoma petenense*) (91%), followed by delta smelt (*Hypomesus transpacificus*) (7%). Other families collected (listed from most common to least common) were atherinidae, cyprinidae, salmonidae, gasterosteidae, percichthyidae, ictaluridae, petromyzontidae, and centrarchidae.

Distribution of delta smelt constricted as the survey progressed, with the largest concentration always occurring in Montezuma Slough. Densities at stations inside Montezuma Slough were very high and ranged from 8 to 32 smelt per 1000 m^3 and averaged 13.5 smelt per 1000 m^3. In January, distribution spanned from Carquinez Straits, through the confluence area, into the South Delta, and as far north as Cache Slough (Figure 2). The February distribution was more confined, with fewer delta smelt collected in the South Delta and Cache Slough. Distribution was centered in the Suisun Bay to lower Sacramento area (Figure 3). In March, a larger proportion of the catch (27%) came from the Sacramento River than in any other month however, the majority of delta smelt were still located in Montezuma Slough (Figure 4).

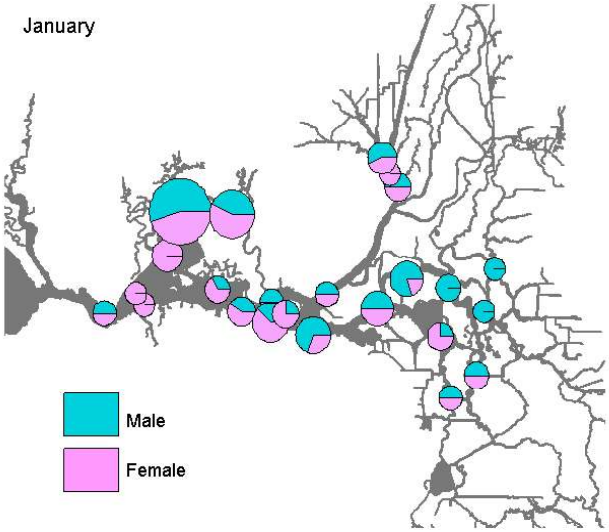

Figure 2 Distribution of male and female delta smelt (*Hypomesus transpacificus*) collected during January of the 2002 Spring Kodiak Trawl, Sacramento-San Joaquin Delta

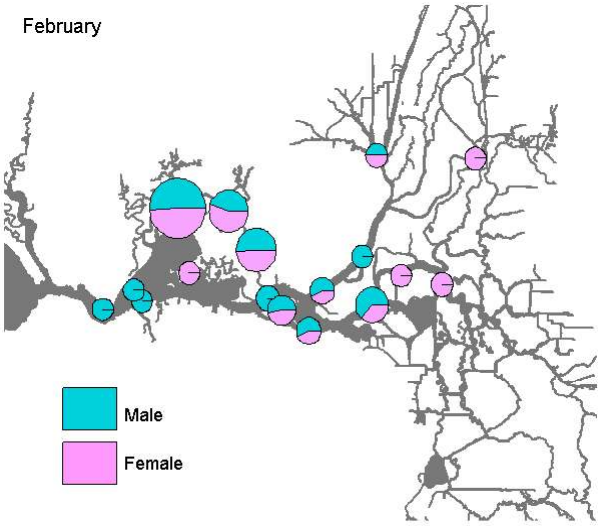

Figure 3 Distribution of male and female delta smelt (*Hypomesus transpacificus*) collected during February of the 2002 Spring Kodiak Trawl, Sacramento-San Joaquin Delta

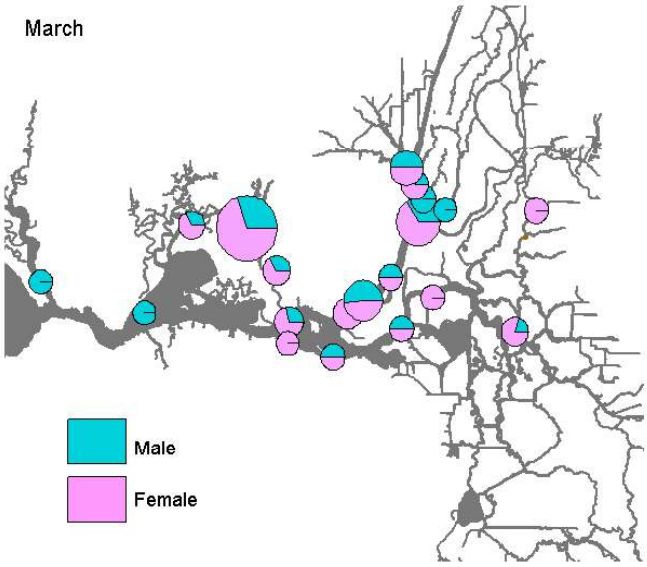

Figure 4 Distribution of male and female delta smelt (*Hypomesus transpacificus*) collected during March of the 2002 Spring Kodiak Trawl, Sacramento-San Joaquin Delta

Gonadal Staging

Examination of the gonadal stages of delta smelt revealed that sex ratios of delta smelt captured changed as the spawning season progressed. In January and February, the ratio of females to males was 1:1. This ratio increased to 2:1 in March. Possible explanations are (1) females persist

longer into the spawning season; (2) females become more vulnerable to the gear; or (3) males arrived sooner and left sooner. Gonadal staging results also indicate that males and females appear to be functionally mature at the same time and place. This was especially evident in March, when a large proportion of mature male and female delta smelt were collected in the Sacramento River. Previous to March, only 10 delta smelt were collected in the lower Sacramento, and none of them were functionally mature.

Females collected in January and February were predominately found to be Stage III (see Table 1), a long-lasting stage in which the oocytes are developing and enlarging with yolk (R. Mager, personal communication, see "Notes"). Males collected in January and February were found to be in middle and late recrudescence, the two stages prior to functional maturity (see Table 1). It was not until March that functionally mature males and females, and successfully spawned females were collected in the Sacramento River. Temperatures at which spent females were collected ranged from 12.2 °C to 12.8 °C. At this same time, no spent males were collected in the Sacramento River, but a large proportion of the males present were mature (Stage V), potentially ready to spawn at any time. The March survey also collected more delta smelt in Montezuma Slough than in the Sacramento River, however there was no evidence of spent individuals of either sex from Montezuma Slough. In March, 89% of the individuals caught were still unspawned, including Stage III females (oocytes still developing) and Stage IV males (late recrudescence). This indicates that the majority of spawning had not taken place by the end of the SKT survey.

The SKT was more successful than the SMWT for describing the distribution of delta smelt. A total of 895 delta smelt was collected, five times more than the average number of delta smelt collected during previous SMWT surveys (1991 to 2001). Sampling will continue next year, with a few modifications. To improve our temporal coverage of delta smelt, the duration of the survey will commence in the later half of February and extend into April (and possibly May). Sampling effort may also double to twice per month. To increase our spatial coverage of delta smelt, we are considering adding stations within Lindsay, Prospect, and Cache sloughs. (Detailed graphs and descriptions of gonadal maturity stages of delta smelt collected during all months of the SKT can be found at www.delta.dfg.ca.gov).

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Notes

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Ocean Influences on Central Valley Salmon: The Rest of the Story

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Abstract

There is increasing awareness of the strong influence of changing ocean conditions on variability in abundance of Pacific salmon throughout the northeast Pacific. Improved understanding of ocean variability can reduce the uncertainty in management of the associated freshwater resources by reducing the unexplained variance in observations. Ocean effects on Pacific salmon have been dominated by a regime shift in ocean conditions in the mid-1970s, leading to an increase in abundance of Alaska salmon and a decline in coho salmon in the California Current. On interannual time scales, ocean conditions related to El Niños appear to drive variability in coho and chinook salmon in the California Current. However, knowledge of these general regional effects is not sufficient to determine specific ocean effects on local, Central Valley populations. Sampling programs in the local coastal ocean will be necessary. Monitoring of local biological productivity and physical oceanographic conditions associated with variable upwelling winds, along with sampling of local juvenile salmon can be used to reduce the unexplained variability that hinders management of Central Valley salmon populations.