Name of study: 20-mm Survey

Program element: 033

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**Purpose/Objective:** Monitor and provide information on young-of-the-year delta smelt abundance and distribution in the upper San Francisco Estuary.

Conduct larval fish surveys to determine the timing, distribution, and abundance of delta smelt larvae and their food supply. Help estimate larval delta smelt fish losses and determine the magnitude of entrainment of both larval and juvenile delta smelt at CVP and SWP intakes.

**Data collected:** temperature, specific conductance, water transparency, turbidity, water volume, tidal stage, fish, and zooplankton.

Geographic range of field work: upper San Francisco Estuary.

**Number of sites:** 47 core stations. Between 41 and 55 stations have been sampled since 1995. See 20mm Station Table in the 20-mm Microsoft Access database for Station information.

Period of record (start year): 1995.

Database: All data is currently housed on the Tier 3 SQL server in one application.

**Sample frequency per time unit (second, week, month):** starting in early spring (March/April) sampling is conducted every other week and continues through mid-summer (July/August) when catch efficiency decreases or delta smelt are not in danger of being entrained at the CVP and SWP. Standard sampling weeks are identified by Survey numbers less than 10. Additional, or Supplemental sampling weeks are identified by Survey numbers greater than 9.

**Field sampling:** The 20-mm net is a conical plankton net 5.5 m in length with a mouth opening of 1.51  $m^2$ , that is mounted on a weighted tow frame with skids. The net features a 1,600  $\mu$ m (1/16 in.) knotless nylon Delta mesh (35 lb. test). Durable canvas encases the mouth and cod-end to prevent premature wear from contact with the substrate. Fish are collected in a removable 2.2 L screened (474  $\mu$ m stainless steel wire bolting cloth) cod-end jar. Zooplankton are collected with a Clarke-Bumpus (CB) net attached to the top of the 20-mm net frame. The CB net consists of 160  $\mu$ m knotless nylon mesh and measures 78 cm long with a open mouth area of 0.010101 m<sup>2</sup>. A General Oceananics flowmeter is mounted in the mouth of the 20-mm and CB nets to estimate the volume (m<sup>3</sup>) of water sampled. To sample the entire water column efficiently, three 10-minute stepped oblique tows (1.2 m per step) are completed at each station (the CB net is only fished during the first tow). After each tow, the entire sample is transferred to a labeled holding jar containing 10% formalin neutralized with sodium borate. Rose Bengal dye is added to each jar to aid in separating animals from detritus.

**Laboratory analysis:** Sample jars are taken to the laboratory at the California Department of Fish and Wildlife's Bay Delta, Stockton. For fish samples, the complete contents are sorted and any larval fish

present are identified and counted. All fish are identified to species or lowest possible taxon. The first 300 fish (1995-98), or 100 fish (1999-00), or 50 fish (2001-) from each tow are randomly selected and measured (FL, or TL if no fork) to the nearest millimeter. All delta smelt are measured regardless of catch size. Individual zooplankton samples are diluted in a beaker to a concentration that will give approximately 200 organisms per ml. The sample is thoroughly mixed and a one millimeter aliquot is extracted and placed on a Sedgewick-Rafter slide cell. Between 1995 and 2003 processing consisted of identifying and counting the first 200 organisms (not including rotifers). If 200 organisms were not attained on the first cell, additional cell(s) (up to 10) would be counted until at least 200 organisms were recorded. Beginning in 2004, zooplankton sub-sampling consisted of diluting a sample as described before and processing 6% of the sample. Starting in 2006, a minimum value of 5 cells and a maximum of 20 cells were added to the 6% processing protocol. This new processing method provides a better estimate of the organisms in a sample and increases the sensitivity of detection for the relatively less abundant organisms. All zooplankton are counted and identified down to family and most are identified to genus.

## Relative density analysis:

The mean number of fish per volume water sampled (standardized to 10,000 m<sup>3</sup>) is calculated using the following equations:

## $V_t = A * K * D$

Where: V = volume of water (m<sup>3</sup>) filtered through the net per tow (t)

A = mouth opening of the net  $(m^2)$ 

K = calibration factor for the flow meter

D = difference in flow meter counts from start to finish of tow

### $n_t = F_t / V_t * 10,000 m^3$

Where:  $n = number of fish per 10,000 m^3 per tow (t)$ 

F = fish sampled per tow

V = volume of water filtered through the net  $(m^3)$  per tow

#### $N = \Sigma n_t / 3$

Where:  $N = mean number of fish per 10,000 m^3 per station.$ 

The number of each zooplankton taxon per cubic meter taken in the Clarke-Bumpus net is calculated using the following equations:

# V = A \* K \* D

Where:  $V = volume of water (m^3)$  filtered through the net

A = mouth opening of the net  $(m^2)$ 

K = calibration factor for the flow meter

D = difference in flow meter counts from start to finish of tow

$$Z = \Sigma(C_c X / V) / N$$

Where:

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- Z = the number of zooplankton per m<sup>3</sup>
- C = the number of zooplankton taxon counted per cell (c)
- X = the sample volume (sample dilution)
- V = the volume of water filtered by the net  $m^3$
- N = number of cells completed.

### 20mm Survey Delta Smelt Index:

The calculation of a delta smelt index from the 20-mm survey began in the early to mid-2000s, after which an index was produced for all previous years. Prior the mid-2000s, no index had been calculated or distributed. At this time, there has been no formula established to calculate indices for any species other than delta smelt from 20-mm survey data.

The index is calculated each year once the 20-mm data have been though the quality assurance and quality control (QA/QC) process. The calculation of the delta smelt index from 20-mm data has been facilitated by a series of queries in the 20-mm database housed at the Bay-Delta, East office. The following is a summary of the methods used by the queries to calculate the index.

For consistency among years, surveys 1 through 9 are considered for the purpose of index calculation. The index is calculated using the data from only 4 of these surveys: the two before and the two after the point where the average length of delta smelt (less than 60mm in length) equals 20mm. From this subset of surveys, the delta smelt catch-per-unit-effort (CPUE) is calculated for each "core" station, which includes 41 stations that have been consistently sampled throughout the history of the survey. To each station's CPUE, 1 is added, and then a log10 transformation is performed. For example:

CPUE	3.45
CPUE+1	4.45
Log10Trans = log(4.45)/(log10)	0.65

The average is taken of all the resulting "Log10Trans" values within a survey in order to obtain one value. The geometric mean is calculated on this average value, like so:

# 10^(Avg([Log10 Trans]))-1

The final 20-mm delta smelt index is the summation of the 4 geometric means.

## Changes over time:

1995 – N/A

1996 – Napa River Stations (341, 342, 343, 344, 345, 346, & 347) added to sampling program.

1997 – Napa River stations (341 & 347) and Big Break station (802) discontinued from sampling program.

1998 – Zooplankton taxa stages (*Eurytermora* copepodid & *Pseudodiaptomus* copepodid) added to database.

1999 – Number of fish measured reduced from 300 to 100 (all delta smelt are measured regardless of catch size).

2000 – N/A

2001 – Number of fish measured reduced from 100 to 50 (all delta smelt are measured regardless of catch size).

2002 – Napa River stations 347, 348, & 349 added to sampling program when higher outflow conditions persist in Napa River.

2003 – Zooplankton taxon *Pseudodiaptomus* spp. speciated to include *Pseudodiaptomus* euryhalinus, *Pseudodiaptomus* forbesi, and *Pseudodiaptomus* marinus.

2004 – Zooplankton processing changed from identifying the first 200 organisms to 6% of the subsample.

2005 – Zooplankton processing continued to process 6% of the sub-sample, but would not exceed 20 slides from a sample.

2006 – Zooplankton processing will continue to process 6% of the sub-sample, but will process a minimum of 5 cells and a maximum of 20 cells from a sample. Zooplankton taxa stages (*Acartia* copepodid, *Acartiella* copepodid, and *Tortanus* copepodid) added to database. Cumaceans and Chironomid larvae were dropped from the list of organisms to be identified.

2007 – N/A

2008- Cache Slough complex stations (718, 720, 726, 724, 723, 719) added to regular sampling program.

2009- Supplemental sampling in Sacramento Deepwater Channel stations (794, 795, 796, 797, 798, 799) occurred over surveys 7 and 8.

2010 - Implementation of the use of a Hach Model # 2100P Turbidimeter as Standard Operating Procedure to record turbidity in NTU's. Recorded Latitude and Longitude on datasheets, but not entered into database.

2011 – Latitude and Longitude recorded in field and entered into database.

2012 – N/A

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2013 – N/A

2014 – N/A

2015 – Review of project documents indicated a discrepancy between documented 20-mm net dimensions and actual 20-mm net dimensions. In 1995 staff worked with Lodi Tent and Awning to accommodate for shrinkage of the canvas-collar mouth of the nets. The problem was resolved by increasing the circumference of the mouth from 455 cm to 493 cm. It appears that all subsequent 20-mm net purchases incorporated this change; however, these changes were not incorporated into documentation of net dimensions. The updated net dimensions are now available in the protocol.

Database was revised by Tuongvan Nguyen at ITB as part of the Bay Delta Application Hosting. Data is now entered into 20-mm\_Local.mdb, housed in 20-mm\_Query.mdb (local server), and appended to the tier 3 server before uploading to the webpage.

A total of 6 additional tows were performed during surveys 6-9 at stations 706, 707 and 719 as part of a pilot study on Delta Smelt genetics at UC Davis. Samples were preserved in 95% EtOH and sent to Mandi Finger, with Bernie May's lab. Stations sampled each survey was based on the likelihood of Delta Smelt occurrence, as indicated by results of prior surveys.

The vendor that historically supplied the net mesh to construct 20-mm nets went out of business. A new vendor was found, Christensen Net Works. New nets were constructed and used in 2015.

2016 – Like 2015, no flowmeter calibration occurred in 2016. The factory value was used for all meters, and 9 meters were sent for refurbishing prior to the survey season.

2017 – Flowmeter calibration occurred in 2017 but a calculated k factor for each flowmeter was not used due to potential malfunctioning of UC Davis Hydraulics lab equipment. The factory value was used for all meters, and 11 meters were sent for refurbishing prior to the survey season.

2018 – No flowmeter calibration occurred in 2018, the factory value was used for all meters.

2019 – No flowmeter calibrations were conducted at the UC Davis hydraulics lab, but each flowmeter was tested using a General Oceanics "checker" prior to use for each survey. We experimented with using sodium phosphate buffers instead of a borate buffer to buffer the formalin used to collect fish samples. The intent was to better preserve fish for histopathology work. Solution made with phosphate buffers crystallized onto the fish if samples were collected in salty water, making ID more difficult. Following that observation, we ceased use of phosphate buffers.

### Data handling:

07/02/2014: Updated FTP database to include zooplankton data through 2012 for public use. Deleted and re-appended environmental and fish data through 2013 to incorporate changes made to the data over time. Archive version located at: U:\NativeFish\FTP Site Delta Smelt Folder\ARCHIVE\2014\20mm.mdb. Updated version available at: U:\NativeFish\FTP Site Delta Smelt Folder\20-mm.mdb. Done by L.Damon.

2015: Conducted a thorough review of coordinates for all years of the study by plotting locations, fixing data entry errors, and converting erroneous coordinates from each station. Changes were tracked in the 20-mm Tracking Log.xslx.

2017: The database structure was modified in 2017 to align with EMP zooplankton data. Previously, fish data was entered locally and then updated to the Tier 3 server (see 2015), but in this year fish data was

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directly entered to the Tier 3 server using the managed access login application. Zooplankton data is still entered locally due to a delay. Additional documentation of the database structure changes are available on the FTP site as a readme.txt and an updated data file format.