Name of study: 20-mm Survey

Program element: 033

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Purpose/Objective: Monitor and provide information on 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, electro-conductivity, water transparency, 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 20mm Microsoft Access database for Station information.

Period of record (start year): 1995.

Size for complete data base for program element in KB (MB): 44+ megabytes.

Number of individual files: one file or database contains all data.

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 endanger 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 5.1 m in length with a mouth opening of 1.5 m^2, and is mounted on a weighted tow frame with skids. The net features a 1,600 μm (1/16 in.) knotless nylon Delta mesh (35 lb. test) or 1,600 μm (1/16 in.) Nitex monofilament. Durable canvas mouth and cod-end sections are attached to the net to prevent premature wear from contact with the substrate. Fish are collected in a removable 2.2 L screened (474 μm 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 μm knotless nylon mesh and measures 78 cm long with a 12 cm mouth diameter. A General Oceananics flowmeter is mounted in the mouth of the 20-mm and CB nets to estimate the volume (m^3) 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 Game's Bay Delta Branch, 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) 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. 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^3) is calculated using the following equations:

$$V_t = A * K * D$$

Where: V = volume of water (m^3) 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

Zooplankton processing:

$$Z = CX / S / V$$

Where (1995-2003):

Z = the number of zooplankton per m^3

C = the number of zooplankton taxon counted per cell

X = the sample volume (sample dilution)

S = the number of Sedgewick-Rafter cells counted

V = the volume of water filtered by the net m^3.

$$Z = \Sigma(C_cX / V) / N$$

Where (for 2004 and subsequent years):

Z = the number of zooplankton per m^3

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 20mm 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. Unlike other long term monitoring project surveys operated out of the CDFG Bay-Delta, East office, the 20mm index does not use a weighted value that takes spatial area into account. Instead, the 20mm index is calculated by summing the geometric means of delta smelt catch over a specific period of time for each year. At this time, there has been no formula established to calculate indices for any species other than delta smelt from 20mm survey data.

The index is calculated each year once the 20mm data have been though the quality assurance and quality control (QA/QC) process. The calculation of the delta smelt index from 20mm data has been facilitated by a series of queries in the 20mm 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 though 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 station (for consistency among years, a subset of the 41 "core" stations is used). To each station's CPUE, 1 is added, and then a log10 transformation is preformed. For example:

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

These calculations are made for each station within a given survey. 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 20mm 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 sub-sample.

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, 724, 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.

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