Interagency Ecological Program San Francisco Estuary Smelt Larva Survey (SLS) Metadata

Contents

Study Management

IEP Study Name: Smelt Larva Survey (SLS)

Program element: 096

Agency: Department of Fish and Wildlife, Bay Delta Region (R3)

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Study Overview

Purpose/Objective: Monitor and provide information on larval Longfin Smelt (*Spirinchus thaleichthys*) abundance, timing, and distribution in the upper San Francisco Estuary. Help estimate larval Longfin Smelt fish losses and determine the magnitude of entrainment of larval Longfin Smelt at the CVP (Central Valley Project) and SWP (State Water Project) intakes.

Data Collected: Surface water temperature (°C), surface and bottom electro-conductivity (EC, μS/cm, normalized at 25 °C), Secchi depth (cm), surface water turbidity (NTU, FNU), water volume (m^3), tidal stage, start and end tow coordinates (DMS). Fish are identified to the lowest possible taxonomic level, enumerated, and measured (mm) to fork length when possible or total length when the fork in the caudal fin is not present.

Geographic Range of Work: Lower Napa River to the city of Napa, San Pablo Bay upstream throughout Suisun Bay; San Joaquin River to Stockton, Old and Middle Rivers in the south Delta to West Canal; Sacramento River to Rio Vista; Cache Slough from Rio Vista to Shag Slough; 1 station at the mouth of the Sacramento Deep-water Ship Channel.

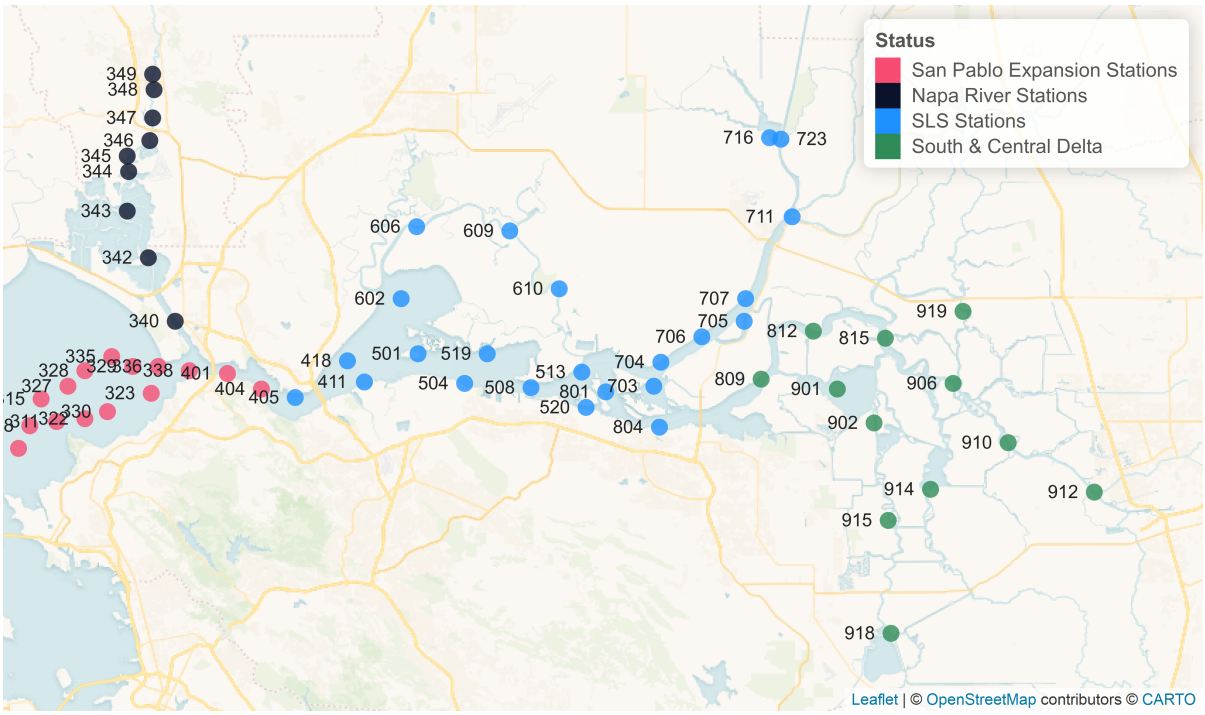

Figure 1: Map displaying the geographic range of work. Each point represents the location of a sampling station.

Number of Stations: 59 stations. See the metadata section for additional details of each station.

Data Range: 2009-01-05 to 2026-03-11 (YYYY-mm-dd)

Sampling Frequency: Sampling begins in December and is conducted *every other week*. Sampling ends:

1. in March,
2. or when catch efficiency decreases,
3. or when high densities of Longfin Smelt are no longer found in the southern and central Delta and in danger of being entrained at the CVP and SWP intakes.

Field Sampling Methods

Net: The SLS samples using a cone shaped net with a length of 3.35 meters (m), a mouth area of 0.37 m^2, and a 505 μm NitexR mesh. The mesh size was altered prior to the 2014 season to 500 μm NitexR, when the original mesh size was no longer available and new nets were purchased (see 2014 changes below). These new nets were incorporated as old nets became unusable. The net is mounted on a fixed D-frame with skis and is connected to the frame by a canvas mouth. At the end of each tow, net contents are washed into a cod-end jar attached to the end of the net. A General Oceanics flowmeter is mounted across the net's mouth to estimate the water volume filtered during each tow. Prior to 2015, all flowmeters were calibrated at UC Davis before the start of the season to determine its calibration factor required for water volume calculations. After 2015, the calibration flume at UC Davis became inoperable, and the meters were sent to General Oceanics for refurbishing before each field season and the factory calibration factor used. Since 2019, meters are inspected at the end of every field season and are replaced with new units if refurbishing is required to support the continued use of the factory calibration factor. In 2026, Zooplankton samples were collected at the Napa and San Pablo expansions stations. The zooplankton Clarke-Bumpus (CB) net is sampled concurrently with the fish net using CB housing attached to the top of the SLS sled. The CB net is 78 cm in length, has a mouth area of 0.010101 m^2, and features a 160 μm knotless nylon mesh.

Tow: A single 10-minute stepped oblique tow with the boat moving at 1 m/s is conducted at each of the sampling stations. The amount of cable released is dependent on the water depth at the station. A gradual oblique tow is achieved following the tow schedule specific to the amount of cable released and the duration of the tow. Although most tows are 10 minutes in length, tow times can be reduced to 5 or 2.5-minutes. An alternate tow schedule is then followed, and the duration is recorded. Periods of heavy samples may result due to algal blooms, jellyfish blooms, or heavy debris events. If material is still overflowing from the cod-end jar in a 2.5-minute tow, the entire station is dropped. Re-tows can occur if a sample is compromised, or the flowmeter reading is less than 10,000 or greater than 30,000 in a 10-minute tow. All abnormal events are to be recorded in the "comments" section of the datasheet.

Environmental and Water Quality Data: Immediately prior to each tow, surface and benthic water quality data are independently collected and recorded using a calibrated and rinsed YSI ProDSS including surface water temperature (°C), surface turbidity (FNU) (NTU prior to 2023), and surface and bottom electro-conductivity (μS/cm, normalized at 25 °C). Secchi depth (cm) is measured using Secchi discs mounted to rigid meter sticks to a maximum depth of two meters; values are measured in the shade without sunglasses on, off the side of the boat by the same person for the day for consistency. Water bottom depth (ft) is recorded using a depth sounder on the boat. Tide data is recorded as the visually observed tidal stage by the crew during the tow as high slack, ebb, low slack, or flood.

Table 1: The SLS collects various environmental data per station.

Variable	Equipment	Unit
Water temperature (surface)	YSI ProDSS	°C
Water EC (surface)	YSI ProDSS	µS/cm
Water EC (bottom)	YSI ProDSS	µS/cm
Water turbidity (surface)	YSI ProDSS	FNU
Water turbidity (surface)	HACH 2100p	NTU
Secchi depth	Two-meter sticks	cm
Flowmeter	General Oceanics 2030R	
Depth	Onboard meter	Feet
Tide	Visual	

Catch Data: At the end of every tow, the net is washed down so that all visible vegetation, fish, sand, and debris are washed into the cod-end jar. Large debris and identifiable fish ($\geq$ 50 mm) can be removed if positively identified. When salmonids are caught, fork lengths are measured, presence or absence of the adipose fin is noted, and the fish are immediately released gently and alive. All other larval and juvenile fish are kept in distinctively labeled sampling jars and preserved in 10% buffered and dyed formalin for later processing in the laboratory.

Lab Analysis, Fish ID and QC

In the laboratory, fish are identified and enumerated from each sample under a microscope. First, fish are separated from debris and other organisms during a process referred to as "sorting". Then, the entire sample undergoes a quality control (QC) check to ensure that no fish were missed during the sorting step. Finally, fish undergo a first round of identification (ID) and count by an identifier, followed by a QC from a larval fish ID specialist to confirm all species identifications and counts. This QC process is dependent on the experience of the first identifier doing the first ID. Fish identifiers will begin with all their identifications QC'ed and transition to having fewer samples QC'ed with experience, until the identifier is considered a larval fish ID specialist. Once the larval fish ID specialist level is acquired, samples are randomly selected to undergo the QC process. Across all samples (QC required or not), all CESA and ESA fishes and any questionable fish IDs must undergo a second ID. All fish are identified to species or the lowest possible taxon. Only the first 50 randomly selected individuals of each species from each tow are measured for lengths to the nearest millimeter, and the rest of the sample is simply enumerated. However, all Delta Smelt (*Hypomesus*

transpacificus) are measured for lengths regardless of catch size. Up to 100 Longfin Smelt are measured from each tow and any additional individuals are enumerated.

Relative Density Analysis

The total number of fish per volume water sampled (standardized to 1000 m^3) is calculated using the following two equations:

$V_t = A * K * D_t$

Where:

V_t = volume of water (m^3) filtered through the net per tow t

A = mouth opening of the net (0.37 m^2)

K = calibration factor of the flowmeter, 0.026873027 since 2015

D_t = difference in flowmeter counts from start to finish of tow t

$n_t = F_t/V_t * 1000m^3$

Where:

n_t = number of fish per 1000 m^3 per tow t

F_t = fish caught per tow t

V_t = volume of water filtered through the net m^3 per tow t

Data Management

All data is entered into a digital Microsoft Access database once the fish identification process has been finalized. Immediately after data entry, data undergoes two rounds of 'line-by-line' checks, wherein all data fields are checked against the original datasheets for fidelity. At the end of the SLS field season, after all the fish samples have been processed in the laboratory and data entry is complete, all data is 'finalized' to be as accurate as possible for public use. The first step in this process is to conduct two additional final line-by-lines checks. Next, a project lead will run a series of coded queries to analyze the underlying data distributions and detect potential outliers in the environmental data. Not all data is changed if it is flagged as an outlier (generally beyond 2 standard deviations of the mean). In most cases, outliers are real data. These queries simply alert the project lead of potential erroneous data, and care is taken to edit only data that truly needs to be edited, e.g., data that was entered incorrectly or caused by equipment failures. All resulting data edits are documented in a separate log file.

Project History

The table below is a timeline of critical changes to the survey methods since its inception. The years listed below are separated by water years, which begin three months before the new calendar year on October 1.

Table 2: History of substantial changes to the SLS since its inception.

Water Year	Note
2009	Project start. Five biweekly Delta-wide (35 stations) surveys conducted from early January to early March.
2010	Temporal extension of sampling temporarily for this season; six biweekly (35 stations) surveys conducted from early January to late March (this addition lasted only this season).
2010	Implementation of using a Hach Model 2100P Turbidimeter as Standard Operating Procedure to record turbidity in NTU.
2010	Recorded sampling latitude and longitude on datasheets, but this data was not entered into the database.
2011	Latitude and longitude of tows recorded into database.
2011	Yolk sac and oil globule presence noted in the database.
2012	Sixth survey permanently added.
2013	N/A
2014	Spatial extension of sampling into the Napa River as part of an agreement with the State Water Contractors (stations 340, 342, 343, 344, 345, 346, 347, 348, and 349).
2014	Database was revised by Tuongvan Nguyen at ITB as part of the Bay Delta Application Hosting to move public facing data onto a secured Tier 3 server. Data is now entered into 'SLS_Local.accdb' (local server) and appended to the Tier 3 server before uploading it to the public webpage.
2014	New nets were incorporated (manufactured on 5/10/2013 by Lodi Tent and Awning) with a different Nitex Mesh purchased from Sefar (500-micron, 47% open space, part #06-500/47).
2015	Factory k value (0.026873027) used in the 'MeterCorrections' table. Flowmeters were not calibrated at UC Davis due to machinery malfunction. The facility is awaiting repairs.
2016	Continued using factory k value for 'MeterCorrections'. Flowmeters were sent to General Oceanics for refurbishing prior to field season.
2017	Continued using factory k value for 'MeterCorrections'. Flowmeters were sent to General Oceanics for refurbishing prior to field season.
2018	Continued using factory k value for 'MeterCorrections'. Flowmeters were sent to General Oceanics for refurbishing prior to field season.
2019	Continued using factory k value for 'MeterCorrections' now and going forward. Flowmeters were sent to General Oceanics for refurbishing prior to field season or replaced with new meters if readings are inaccurate (assessed at the end of a season).
2019	Spatial reduction of sampling. Ceased sampling stations within the Napa River (stations 340, 342, 343, 344, 345, 346, 347, 348, and 349).
2019	On 2019-09-10, two tables were removed from the local copy of the database: 'Zooplankton' and 'Zoo Catch'. These tables were appended to the database from the 20–mm database back in 2013. The SLS does not survey for zooplankton.
2020	Surveys 2 and 3 only sampled the high priority stations in the south and central Delta due to concerns related to the COVID-19 pandemic.
2021	Two additional surveys were added in December 2020 but were limited in geographic range to the south/central Delta to inform risk of entrainment for larval Longfin Smelt.
2022	The two additional surveys in December were expanded to encompass all stations. Napa River stations (340, 342, 343, 344, 345, 346, 347, 348, and 349) have been added back to the surveys, including the supplemental December surveys.

2022	End latitude and longitude of tows recorded on datasheets starting in survey 1, but this data was not entered into the database.
2022	End latitude and longitude of tows recorded into database starting in December.
2023	Reduced Longfin Smelt measurements from all catch to 100 individuals per tow.
2023	Switched water quality instrument from YSI model 30 to YSI ProDSS which can measure turbidity (FNU). Ceased the use of a Van Dorn to retrieve benthic water samples. After this year, turbidity (NTU) will no longer be collected using the HACH 2100p turbidimeter.
2023	Ethanol jugs brought into the field to preserve any identifiable juvenile or adult Osmerids now and going forward.
2023	Added 15 Fall Midwater Trawl stations in the San Pablo Bay region to improve spatial balance in accordance with the Monitoring Design Committee.
2024	Corrected error in tow schedule for water depth of 25 ft. It was originally 110 ft cable length, but the correct cable length is 105 ft.
2024	Corrected “Rockfish (Unid)” and “Bluefin Killifish” fish code to match 20-mm Survey database.
2024	Added “Hypomesus spp.” and “Lepomis spp.” to ‘FishCodes‘.
2025	Added “Pacific Sanddab” and “Showy Snailfish” to ‘FishCodes‘.
2025	Sampled a supplemental survey (14) which only consisted of two stations.
2025	Updated and revised station descriptions and coordinates.
2026	Converted "Lepomis spp." back into "Centrarchids (unid) " for consistancy in ’FishCodes’.
2026	Added "Whitebait Smelt", "Cabezon", and "Walleye Surfperch" to ’FishCodes’
2026	"Herring unid" converted to "Clupeid (unid)" for clarity in ’FishCodes’.
2026	Collected CB zooplankton samples at Napa and San Pablo expansion stations only.

Station Metadata

Station theoretical latitudes and longitudes and start and end dates are provided in Table 2. A visualization of the number of surveys per water year (which encapsulates a field season) is also provided in Figure 2.

Table 3: List of stations sampled by SLS since its inception. "StartDate" indicates the date when sampling first began for a station; "EndDate" indicates the date when sampling last ended at a station, and "Ongoing" represents stations that are still actively sampled by the survey.

Station	Latitude	Longitude	StartDate	EndDate
306	38.00042	-122.4149	2022-12-06	Ongoing
308	38.01744	-122.4044	2022-12-06	Ongoing
311	38.02086	-122.3774	2022-12-06	Ongoing
315	38.03814	-122.3936	2022-12-06	Ongoing
322	38.02364	-122.3508	2022-12-06	Ongoing
323	38.04289	-122.2863	2022-12-06	Ongoing
327	38.04772	-122.3667	2022-12-06	Ongoing
328	38.06028	-122.3500	2022-12-06	Ongoing
329	38.06361	-122.3040	2022-12-06	Ongoing
330	38.02853	-122.3282	2022-12-06	Ongoing
335	38.07111	-122.3240	2022-12-06	Ongoing
336	38.06308	-122.2789	2022-12-06	Ongoing
338	38.06003	-122.2489	2022-12-05	Ongoing
340	38.09750	-122.2622	2014-01-07	Ongoing
342	38.14625	-122.2887	2014-01-07	Ongoing
343	38.18192	-122.3095	2014-01-07	Ongoing
344	38.21269	-122.3087	2014-01-07	Ongoing
345	38.22383	-122.3090	2014-01-07	Ongoing
346	38.23639	-122.2872	2014-01-07	Ongoing
347	38.25361	-122.2847	2014-01-07	Ongoing
348	38.27436	-122.2835	2014-01-07	Ongoing
349	38.28633	-122.2844	2014-01-07	Ongoing
401	38.05758	-122.2124	2022-12-07	Ongoing
404	38.04644	-122.1789	2022-12-07	Ongoing
405	38.03936	-122.1464	2009-01-08	Ongoing
411	38.05117	-122.0782	2009-01-08	Ongoing
418	38.06750	-122.0956	2009-01-08	Ongoing
501	38.07333	-122.0263	2009-01-07	Ongoing
504	38.05000	-121.9818	2009-01-08	Ongoing
508	38.04717	-121.9172	2009-01-07	Ongoing
513	38.05886	-121.8678	2009-01-07	Ongoing
519	38.07253	-121.9592	2009-01-07	Ongoing
520	38.03217	-121.8631	2009-01-08	Ongoing
602	38.11556	-122.0424	2009-01-08	Ongoing
606	38.17058	-122.0279	2009-01-08	Ongoing
609	38.16742	-121.9378	2009-01-08	Ongoing
610	38.12219	-121.8891	2009-01-08	Ongoing
703	38.04861	-121.7974	2009-01-06	Ongoing
704	38.06658	-121.7903	2009-01-06	Ongoing

705	38.09761	-121.7087	2009-01-06	Ongoing
706	38.08608	-121.7504	2009-01-06	Ongoing
707	38.11469	-121.7079	2009-01-06	Ongoing
711	38.17742	-121.6623	2009-01-06	Ongoing
716	38.23856	-121.6839	2009-01-06	Ongoing
723	38.23725	-121.6731	2009-01-06	Ongoing
801	38.04369	-121.8440	2009-01-07	Ongoing
804	38.01644	-121.7913	2009-01-07	Ongoing
809	38.05378	-121.6930	2009-01-20	Ongoing
812	38.09053	-121.6418	2009-01-06	Ongoing
815	38.08494	-121.5720	2009-01-06	Ongoing
901	38.04625	-121.6185	2009-01-20	Ongoing
902	38.02039	-121.5827	2009-01-05	Ongoing
906	38.05003	-121.5065	2009-01-05	Ongoing
910	38.00500	-121.4530	2009-01-05	Ongoing
912	37.96642	-121.3686	2009-01-05	Ongoing
914	37.96892	-121.5282	2009-01-05	Ongoing
915	37.94561	-121.5690	2009-01-05	Ongoing
918	37.85900	-121.5671	2009-01-05	Ongoing
919	38.10581	-121.4966	2009-01-05	Ongoing