**Dataset Title**

Interagency Ecological Program San Francisco Estuary Smelt Larva Survey

**Short name or nickname you use to refer to this dataset:**

IEP-SLS

**Abstract**

The Interagency Ecological Program San Francisco Estuary Smelt Larva Survey was initiated by the California Department of Fish and Wildlife (CDFW) in 2009 to monitor the distribution and abundance of newly-hatched Longfin Smelt (*Spirinchus thaleichthys*) in the San Francisco Estuary. Surveys are conducted bi-weekly and sampling begins in December, and continues through March. The surveys sample at fixed locations, stations, from Carquinez Strait through Suisun Bay and into the Sacramento-San Joaquin River Delta. Napa River stations were added in 2014.Each survey consists of 44 stations. At each station, one 10 minute stepped-oblique (bottom to top) tow is made following a prescribed tow schedule. The net is a conical 505 µm mesh lashed to a D shaped frame mounted on skis. Larval fish samples are preserved in the field in 10% Formalin and brought back to the CDFW Stockton Lab for identification to species and enumeration under a microscope. Several types of data are collected at each station in addition to the larval fish sample, including the volume of water sampled by the net, surface water temperature, surface and bottom specific conductance (EC normalized at 25˚C), Secchi disk depth, tow duration, tidal condition, and surface water turbidity.

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**Keywords**

Interagency Ecological Program for the San Francisco Bay Delta Estuary, estuaries, long term monitoring, endangered species, fishes, Longfin Smelt, Delta Smelt, population dynamics, larvae, CDFW Stockton Labs, turbidity, water temperature, tides, SLS, IEP

**Timeframe**

• Begin date: 01/05/2009

• End date: N/A

• Data collection ongoing/completed: ongoing

**Geographic location**

• Verbal Description: Lower Napa River to the city of Napa, eastern Carquinez Strait 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.

• North bounding coordinates: 38.286333°N 122.284361°W

• South bounding coordinates: 37.859°N 121.567139°W

• East bounding coordinates: 37.966417°N 121.368556°W

• West bounding coordinates: 38.182361°N 122.309278°W

**Taxonomic species or groups**

Delta Smelt (*Hypomesus transpacificus*), Longfin Smelt (*Spirinchus thaleichthys*)

**Methods**

1.) Data Collection methods:

A single 10 minutes stepped-oblique tow of the net is conducted at each of 44 sampling stations. Environmental conditions data, including tide, surface turbidity, surface and bottom conductivity, surface water temperature, and Secchi depth are collected at each station at the time of sampling. A General Oceanics (GO) flowmeter is mounted across the net’s mouth to estimate the water volume filtered. At the end of each tow, net contents are washed into a cod-end jar attached at the end of the net. Large debris and adult fish (≥ 50 mm) are removed if positively identified. If salmonids are caught, lengths and presence of adipose fin are immediately recorded, and the fish are released gently and alive. The remaining contents in the jar are preserved in 10% formalin for identification in the lab. The distinctively labeled sample jars are taken to the laboratory at the California Department of Fish and Wildlife’s Bay Delta Region, Stockton. 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 50 fish of each species from each tow are randomly selected and measured (FL) to the nearest millimeter and the rest enumerated. All Longfin Smelt and Delta Smelt are measured regardless of catch size. Only non-zero catch of species caught are recorded. Since the inception of the survey, there has not been identification shifts, i.e., identifying a species to an even lower taxonomic group, or nomenclature shifts in the collection method.

2.) Link to blank datasheet:

Available upon request (see data contact information)

3.) Instrument and Equipment Specifications, including QAQC methods and frequency:

The IEP-SLS uses a cone shaped net 3.35 meters in length with a mouth area of 0.37 m2. The net itself is composed of 505 µm NitexR and is mounted on a fixed metal tube frame with skis. The mesh was altered prior to the 2014 season to 500 µm NitexR, when new nets were purchased, and the original mesh was no longer available (see 2014 changes below). These new nets were incorporated as old nets became unusable. The net is connected to the frame by a canvas mouth. Nets are checked for tears after each tow. The YSI Model 30 is used to measure water temperature (°C) and electrical conductivity (µS/cm, normalized to 25 °C). The probe is rinsed between samples by storing it in a bottle of distilled water that is discarded at the end of the day. YSI units are calibrated using commercially available conductivity standards annually before the beginning of each survey season (SLS, SKT, and 20 mm). Hach 2100P turbidity meters are used to measure turbidity in nephelometric turbidity units (NTUs). Turbidity meters are calibrated annually with commercially available standards designed specifically for the model before each field season. Secchi discs are black and white discs that measure water clarity by measuring the depth of disappearance from the water’s surface, or the distance light can penetrate. Secchi discs are mounted onto rigid meter sticks, with a maximum depth of 200 cm. Measurements are taken in the shade, with no sunglasses on, and are done by the same person the entire day for consistency. All General Oceanics flowmeters are checked at the end of the season to determine if readings are correct or not. Prior to 2015, all flow meters were calibrated at UC Davis before the start of the season; after 2015, all flow meters were sent back to GO for refurbishing (2015-2019) or replaced with new units once readings become inaccurate (2019-current).

4.) Analysis Methods and SOPs:

Water volume sampled in each tow is calculated using data collected by a flowmeter mounted to the net. First, the difference in flowmeter counts (distance traveled) is calculated by subtracting the flowmeter reading when the net is put into the water from the flowmeter reading when the net is taken out of the water. This value is then multiplied by a factory calibration factor to convert the reading into a number of meters of flow. This is finally multiplied by the area of the net to estimate the volume of water sampled in each tow (m3):

**Vt = A \* K \* Dt**

Where: Vt = volume of water (m3) filtered through the net per tow (t)

A = mouth opening of the net (0.37 m2)

K = calibration factor for the flow meter (0.026873027 since 2015)

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

Total number of fish caught per volume water sampled (CPUE) standardized to 1000 m3 is calculated for the SLS using the following equation:

**nt = Ft / Vt \* 1,000m3**

Where:nt = number of fish per 1,000 m3 per tow (t)

Ft = fish sampled per tow

Vt = volume of water filtered through the net (m3) per tow

5.) Project History:

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’s

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 data

2012 - Sixth survey permanently added

2013 - NA

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 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. 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 survey does not survey for zooplankton. More information and a copy of the tables can be found on the local server: U:/NativeFish/SmeltData/Zooplankton/SLS\_Erroneous\_ZooTables.xlsx

2020 - NA

2021 - Spatially constrained, temporal extension of sampling: two additional surveys were added in December and 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 are 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.

6.) QA/QC

Field methods: After each tow, the field lead verifies that the flowmeter count is within the appropriate range, and if not, a re-tow is required. If there is an obvious reason that the flow meter was out of range, (e.g., weeds caught in the net or on the flowmeter), it is recorded as the reason for a re-tow in the “comments” section of the datasheet. The net can clog during algal blooms, jellyfish blooms, or heavy debris loads. If material is overfilling the cod end jar, the tow time is reduced to 5 minutes or 2.5 minutes and the appropriate tow schedule is followed. The acceptable flowmeter check range is reduced accordingly. If a 2.5-minute tow is performed and material like algae, jellyfish, or peat is still overfilling the cod end, that tow at that entire station is dropped. For consistency, all larval and juvenile fish other than salmonids are preserved and processed in the laboratory.

Fish ID: In the lab, fish are separated from debris and other organisms present in a sample in a process referred to as sorting. The entire sample undergo a quality control check after sorting to ensure that fish were not missed. Next, fish identification involves a first ID person and a QC by a larval fish ID specialist to confirm all species. Following a QC frequency protocol based on the experience of the identifier, fish identifiers will begin with all their identifications QC'ed when first starting to then having fewer and fewer samples QC’ed until they are considered a fish ID specialist. Samples for identification QC are randomly selected. The larval fish ID specialist will confirm identification and counts for all fish in the sample. For all samples (QC required or not), all CESA and ESA fish and any questionable fish must undergo a second ID.

Data: All field data is entered into a digital Access database. Immediately after entry, entered data undergo two rounds of ‘line by line’ checks, wherein all data fields are checked against the original datasheets for fidelity. At the end of the survey field season, once all of the fish samples have been processed in the laboratory and data entry is complete, the environmental and fish data is ‘finalized’ such that it is clean for analysis and available for public consumption. The first step in this process is to conduct final line-by-lines. Each survey gets two complete line-by-lines (in addition to the two line-by-lines conducted upon entry). Once the end of season line-by-lines are complete, a project lead will run a series of coded queries to analyze the underlying data distributions to detect potential outliers in the environmental data. Not all data is changed if it is flagged as an outlier (outside of 2 standard deviations is the criteria for most queries). In most cases, outliers are real data. These queries are to 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 were entered incorrectly or caused by equipment failures. All edits are documented in a separate log file.

7.) Source of the available data tables:

The “Catch.csv”, “FishCodes.csv”, “Length.csv”, “MeterCorrections.csv”, “Station\_Lookup.csv”, “TowInfo.csv”, and “WaterInfo.csv” are available “base tables” from the SLS Access database. These tables are exported directly from Access and the only manipulation was to remove irrelevant columns while all data rows remained untouched. Users interested in using these base tables should be aware of the units of these recorded values. Users should also be aware that zero catches of each species per tow are not recorded in the base “Catch.csv” table, but the environmental data associated with that tow is recorded in the base “TowInfo.csv” table. This export step per table is coded in R and the relevant codes are housed at. The “SLS.csv” file is the integrated dataset that combines the 6 base tables (the “FishCodes.csv” table” is not included). Users of the integrated dataset should be aware that the “count” data provided is the adjusted length frequency of each recorded length per species per tow:

Where: Fa,l = adjusted frequency of each recorded length

Tc = total catch

Fm,l = measured frequency of each recorded length

Tm = total number of fish measured

The integration process leverages existing code from the LTMRdata package and is provided with the dataset as “SLS.R” and housed at [this GitHub location.](https://github.com/sbashevkin/LTMRdata) Users should familiarize themselves with the code before attempting to use the integrated dataset.

8.) Contractor Information: N/A

9.) External Review Process: N/A

10.) Methods References:

Samuel M Bashevkin. (2020). LTMRdata: Data for the IEP long term monitoring survey review (v1.0.0). Zenodo. https://doi.org/10.5281/zenodo.3934724

**Data Table**

Catch.csv: Fish catch data from the Smelt Larval Survey

|  |  |  |  |
| --- | --- | --- | --- |
| Column Name | Description | Unit or Code Explanation or Date Format | Empty Value Code |
| Date | Date when sampling occurred | YYYY/MM/DD | NA |
| Station | Project station number | 3-digit station identifier | NA |
| Tow | Tow number, 1 for all SLS stations | Cardinal integer 1 | NA |
| FishCode | Numeric code assigned to each fish taxon | Number from 1-99 | NA |
| Catch | Number of fish taxon sampled per tow | Number of fish | NA |
| X1.4Subsampled | A ¼ sample of the total sample, rarely used | Number of fish | NA |
| X1.2.Subsampled | A ½ sample of the total sample, rarely used | Number of fish | NA |
| CatchID | Auto number | Numeric | NA |

FishCodes.csv: Common names and corresponding fish codes

|  |  |  |  |
| --- | --- | --- | --- |
| Column Name | Description | Unit or Code Explanation or Date Format | Empty Value Code |
| Common.Name | Common name of the fish taxon sampled | String | NA |
| Fish.Code | Numerical code assigned to each fish taxon | Numeric | NA |

Length.csv: Data related to fish size, including fork length, yolk sac, and adipose fin of measured individuals

|  |  |  |  |
| --- | --- | --- | --- |
| Column Name | Description | Unit or Code Explanation or Date Format | Empty Value Code |
| Date | Date when sampling occurred | YYYY/MM/DD | NA |
| Station | Project station number | 3-digit station identifier | NA |
| Tow | Tow number, 1 for all SLS stations | Cardinal integer 1 | NA |
| FishCode | Numeric code assigned to each fish taxon | Number from 1-99 | NA |
| Length | Fork length of each fish taxon sampled | Millimeter | NA |
| EntryOrder | Auto number | Numeric | NA |
| YolkSacOrOilPresent | Yes/No field for presence of oil or yolk sac | Logical | NA |

MeterCorrections.csv: Instrument information for flow meters used throughout the seasons

|  |  |  |  |
| --- | --- | --- | --- |
| Column Name | Description | Unit or Code Explanation or Date Format | Empty Value Code |
| StudyYear | Year of the study | YYYY | NA |
| MeterSerial | Serial number of the net flow meter | Numeric | NA |
| CalibrationDate | Date flow meter was calibrated | YYYY/MM/DD | NA |
| kFactor | Meter calibration constant: factory value used after 2014 | Numeric | NA |
| Notes | Comments | String | NA |

Station\_Lookup.csv: theoretical GPS coordinates of all SLS stations

|  |  |  |  |
| --- | --- | --- | --- |
| Column Name | Description | Unit or Code Explanation or Date Format | Empty Value Code |
| ID | Auto number | Numeric | NA |
| Station | Project station number | 3-digit station identifier | NA |
| Description | Location description of each station | String | NA |
| Lat | Station latitude in WGS 1984 Coordinate | dd° mm’ ss.s” | NA |
| Long | Station Longitude WGS 1984 Coordinate | dd° mm’ ss.s” | NA |

TowInfo.csv: metrics relating directly to the tow

|  |  |  |  |
| --- | --- | --- | --- |
| Column Name | Description | Unit or Code Explanation or Date Format | Empty Value Code |
| Date | Date when sampling occurred | YYYY/MM/DD | NA |
| Station | Project station number | 3-digit station identifier | NA |
| Tow | Tow number, 1 for all SLS stations | Cardinal integer 1 | NA |
| Time | Time of day when sampling started | 1899-12-30 HH:MM:SS | NA |
| Tide | Tide stage (1:high, 2:ebb, 3:low, or 4:flood) | 1:high, 2:ebb, 3:low, 4:flood | NA |
| BottomDepth | Water depth of station | Feet | NA |
| CableOut | Amount of line out on tow | Feet | NA |
| Duration | Time of an individual tow | Minutes | NA |
| NetMeterSerial | Serial number of the net flow meter | Meter | NA |
| NetMeterStart | Net meter reading at beginning of tow | Meter | NA |
| NetMeterEnd | Net meter reading at end of tow | Meter | NA |
| NetMeterCheck | Difference between end and start net readings | Meter | NA |
| Comments | Comments pertaining to the tow | String | NA |

WaterInfo.csv: metrics relating directly to water measured during the tow

|  |  |  |  |
| --- | --- | --- | --- |
| Column Name | Description | Unit or Code Explanation or Date Format | Empty Value Code |
| Survey | A sequential number indicating the completion of all  or most stations in the study area on a bi-weekly basis | Cardinal integers | NA |
| Date | Date when sampling occurred | YYYY/MM/DD | NA |
| Station | Project station number | 3-digit station identifier | NA |
| Temp | Surface water temperature of a station | Degrees Celsius | NA |
| TopEC | Surface electro-conductivity | Microsiemens per centimeter | NA |
| BottomEC | Bottom electro-conductivity | Microsiemens per centimeter | NA |
| Secchi | Water transparency | Centimeters | NA |
| Turbidity | Surface water turbidity | Nephelometric turbidity units | NA |
| Lat | Station latitude in WGS 1984 Coordinate | dd°-mm’-ss.s” | NA |
| Long | Station longitude WGS 1984 Coordinate | dd°-mm-’ss.s” | NA |
| Comments | Comments pertaining to the station | String |  |

SLS.csv: joined long formatted data frame of the base tables. This table is produced from the LTMRdata package

|  |  |  |  |
| --- | --- | --- | --- |
| Column Name | Description | Unit or Code Explanation or Date Format | Empty Value Code |
| Source | Data source, name of the survey | String | NA |
| Station | Project station number | 3-digit station identifier | NA |
| Latitude | Station latitude in WGS 1984 Coordinate | Degrees | NA |
| Longitude | Station longitude in WGS 1984 Coordinate | Degrees | NA |
| Date | Date when sampling occurred | YYYY/MM/DD | NA |
| Datetime | Date and time when sampling occurred | YYYY/MM/DD HH:MM:SS | NA |
| Survey | A sequential number indicating the completion of all or most stations in the study area on a bi-weekly basis | Cardinal integers | NA |
| Depth | Water depth of station | Meter | NA |
| SampleID | Unique identifier string composed of the Source, Date, Station, and Tow # | String | NA |
| Method | Type of tow method employed | String | NA |
| Tide | Tide stage | “High Slack”; “Ebb”; “Low Slack”; “Flood” | NA |
| Sal\_surf | Salinity converted from conductivity measured at the water surface, standardized to 25°C | Practical salinity unit | NA |
| Sal\_bot | Salinity converted from conductivity measured at the water bottom, standardized to 25°C | Practical salinity unit | NA |
| Temp\_surf | Temperature measured at the water surface | Celsius | NA |
| Secchi | Water transparency | Meter | NA |
| Turbidity | Turbidity measured at the water surface | Nephelometric Turbidity Unit | NA |
| Tow\_volume | Volume of water sampled | Meter cubed | NA |
| Cable\_length | Amount of line out on tow | Feet | NA |
| Tow\_duration | Time of an individual tow | Minutes | NA |
| Taxa | Scientific name, generally at the genus and species level | String | NA |
| Length | Fork length of each fish taxon sampled | Millimeter | NA |
| Count | Number of individuals caught, unique to each data entry, expanded if a subsample occurred | Numeric | NA |
| Length\_NA\_flag | Designates if no fish were caught during a tow | String | NA |
| Notes\_tow | Comments pertaining to the tow | String | NA |
| Notes\_flowmeter | Comments pertaining to the flow meter | String | NA |