# Metadata: Environmental and biological data associated with captive-reared Delta Smelt Study, Sacramento-San Joaquin Delta, CA, January-April 2019

Version: 2.0

## Dataset Title

Environmental and biological data associated with captive-reared Delta Smelt Study, Sacramento-San Joaquin Delta, CA, January-April 2019

## Abstract

The endangered Delta Smelt *Hypomesus transpacificus* is an osmerid fish endemic to the upper San Francisco Estuary. A captive breeding program for the species led by the Fish Culture and Conservation Laboratory (FCCL), University of California, Davis, began in 1996 to create a refuge population. In order to better understand how captive Delta Smelt would fare in conditions outside of the hatchery, we placed captive-reared fish in enclosures in the Sacramento San-Joaquin Delta, and evaluated their ability to survive, feed, and maintain condition.

Fish were acclimated in the hatchery at FCCL, tagged, swabbed, weighed, measured, and transferred to enclosures in the field. There were three types of enclosures (n=2 for each type), varying in mesh size and wrap condition. In January 2019, 384 adult Delta Smelt (243 days post hatch) were transferred to enclosures in Rio Vista. In February 2019, 360 adult Delta Smelt (278 days post hatch) were transferred to enclosures in the Deepwater Shipping Channel. For each deployment, fish remained in enclosures for approximately one month, then were retrieved from enclosures, euthanized, identified, weighed and measured. A subset were also analyzed for diet contents. During the one-month long deployments, cages were checked for biofouling, damage, and dead fish, and water quality measurements and zooplankton samples were collected.

## Investigators

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## Keywords

Delta Smelt, zooplankton, enclosure, hatchery, Sacramento-San Joaquin Delta, Rio Vista, Deepwater Shipping Channel

## Permitting of this work:

| PI First Name | PI Middle Initial | PI Last Name | Permitting Agency and Permit Type | Permit Number | Brief Description |
| --- | --- | --- | --- | --- | --- |
| Tien-Chieh |  | Hung | UC Davis IACUC | 19841 | Animal care and use permit |
| Tien-Chieh |  | Hung | USFWS | TE-027742 | 10(a)(1)(A) Recovery Permit |

## Timeframe

* Begin date: 1/23/2019
* End date: 3/27/2019
* Data collection ongoing or completed: Completed

## Geographic location



* Verbal description: Rio Vista and Deepwater Shipping Channel, Sacramento-San Joaquin Delta
* North bounding coordinate (decimal degree): 38.32583
* South bounding coordinate (decimal degree): 38.14627
* East bounding coordinate (decimal degree): -121.65
* West bounding coordinate (decimal degree):-121.692

## Taxonomic species or groups

Delta smelt, zooplankton, aquatic macroinvertebrates

## Methods

### Deployment and Retrieval

1. In January 2019, 384 adult Delta Smelt (243 days post hatch) were transferred to six enclosures in Rio Vista (64 fish per cage) using black 19L buckets with screw top lids.
2. Fish were retrieved after approximately one month.
3. In February 2019, 360 adult Delta Smelt (278 days post hatch) were transferred to six enclosures in the Deepwater Shipping Channel (60 fish per cage) using black 19L buckets with screw top lids.
4. Fish were retrieved after approximately one month.
5. There were three different types of enclosures (n=2 for each type). See table below for details.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Enclosure design type | Side/bottom material | Hole Size (mm) | Center to Center Distance (mm) | Openness (%) | Mesh Size of wrap (mm) |
| A = small | perforated steel sheet | 3.18 | 4.76 | 41 | N/A |
| B = large | perforated steel sheet | 3.97 | 4.76 | 63 | N/A |
| C = wrap | perforated steel sheet with outer wrap of stainless steel mesh on lower 50% | 3.97 | 4.76 | 63 + mesh | 4 x 4 |

### Field Data Collection

#### Water Quality

1. During site visits, a YSI Pro DSS was used to collect measurements of water temperature (°C), dissolved oxygen (mg/L), specific conductivity (µSiemens/cm), electric conductivity (µSiemens/cm), pH, and turbidity (FNU) approximately 1m below the surface
2. A secchi disc was used to collect secchi depth (m)
3. Velocity measurements were taken using a portable handheld velocity meter (m3/s, Hach, model #FH950) which was angled to face the direction of highest velocity
   1. Since velocity was highly variable, three 10-second average replicate velocity readings were collected

#### Zooplankton

1. Zooplankton were collected during each site visit using a 53 μm mesh conical 0.5 m x 2 m plankton net (SEA-GEAR) with a General Oceanics flowmeter (Model 2030R) suspended from the center of the net mouth
2. Tows were collected just below the surface for 2 minutes
3. All samples were stored in 1 L wide-mouth Nalgene bottles and preserved with 5% formalin dyed with Rose Bengal

### Lab Sample Processing and Tracking

#### Fish Measurements

1. Fish were obtained from the University of California – Davis Fish Conservation and Culture Laboratory (FCCL).
2. Prior to deployment of fish in the field, fish were anesthetized with MS-222 (Tricaine Methanesulfonate) and weighed (g), measured (fork length; mm) and tagged with Visible Implant Alphanumeric (VIA) tags (Northwest Marine Technology Inc, Olympia, WA).
3. After fish were collected from the field at the end of the study period, fish were euthanized with MS-222 (400 mg/L). Each fish was weighed (g), measured (fork Length; mm), identified (VIA tag) and preserved in formalin.

#### Zooplankton

1. Samples were enumerated and identified by BSA Environmental Services, Inc. (Beachwood, OH USA)
2. Individuals were identified to genus for cladocerans, order for harpacticoids, and species and life stage for calanoid and cyclopoid copepods

#### Diet

1. After fish were collected from the field at the end of the study period, 10 fish per enclosure (60 fish per site) were assessed for diet
2. 2-3 fish were randomly selected from discrete size bins
3. The fish were dissected and the stomachs (no intestines) were removed, cleaned of any other tissue, and preserved in 10% formalin
4. Stomachs were removed and sent to the University of Washington’s Wetland Ecosystem Team laboratory (WET lab; Seattle, WA USA) for analysis
5. The total contents of each stomach were weighed and enumerated
6. When possible (not too digested), individuals were identified to genus for cladocerans, order for harpacticoids, and species and life stage for calanoid and cyclopoid copepods

### Quality Assurance and Control

#### Data quality control

1. Field data are checked before leaving the site by a different crew member than the recorder
2. Datasheets are reviewed when entered into Excel and a separate staff member then compares the field datasheets to the entered data
3. During analysis, data are reviewed for outliers and suspect data is flagged or removed

#### Instrument quality control

1. The YSI Pro DSS used to collect discrete water quality is calibrated, following standard manufacturer protocols, monthly for all sensors and each morning prior to sampling for dissolved oxygen
2. The Hach FH950 flowmeter is calibrated following manufacturer guidelines prior to the start of the sampling season

Notes on Data Quality:

* For Delta Smelt measurements, tags were occasionally shed, mis-read, or fish died in enclosures, leading to pre-deployment measurements that didn’t have a post-deployment match, and vice versa.

### Calculations and Analysis

* Biomass estimates for zooplankton were obtained from the San Francisco State University Kimmerer lab’s unpublished synthesized biomass dataset. For less common zooplankton species that did not have a unique estimated biomass, an average of the biomass across other species within the order was applied as a proxy.
* Fulton’s Condition factor (K) was calculated for fish as a measure of fish condition:
* Delta\_x = Post\_x - Pre\_x, where x = CF, FL\_cm or Weight\_g
* PropChangex = Delta\_x/Pre\_x, where x = CF, FL\_cm or Weight\_g

## Data Table

**Table name:** Delta Smelt Diet

**Table description:** Delta Smelt Diet Composition

| **Column name** | **Description** | **Unit or**  **code explanation or date format** | **Missing value code** |
| --- | --- | --- | --- |
| Location | Location of cage deployment | DWSC = Deepwater Shipping Channel, RV = Rio Vista | NA |
| Date | Date | mm/dd/yyyy | NA |
| Cage | Cage ID |  | NA |
| Tag | Fish tag ID |  | NA |
| ContentsWeight | Weight of stomach contents | Gram | NA |
| Fullness | Stomach fullness |  | NA |
| Digestion | Degree of digestion | 0 = nothing identifiable or empty; 3 = 25% or less identifiable; 4 = 25-50% identifiable; 5 = 50-75% identifiable; 6 = no digestion; all prey identifiable | NA |
| PreyTaxa | Prey taxa | 1 = no prey; empty stomach, 2 = trace of prey, 3 = 25% or less full, 4 = 25-50% full, 5 = 50-75% full, 6 = full stomach | NA |
| LHStage | Life stage | Adult, copepodid, egg, eggs, juvenile, larva, nauplius, numph, pupae, resting egg, undetermined | NA |
| Count | Count | number | NA |
| TaxonomicGrouping | Higher taxonomic grouping |  | NA |
| Comments | Comments |  | NA |

**Table name:** Delta Smelt Growth and Condition Factor

**Table description:** Delta Smelt Growth and Condition Factor

| **Column name** | **Description** | **Unit or**  **code explanation or date format** | **Missing value code** |
| --- | --- | --- | --- |
| Location | Location of cage deployment | DWSC = Deepwater Shipping Channel, RV = Rio Vista |  |
| Cage | Cage ID |  |  |
| Enclosure | Enclosure ID. Same as Mesh but ID matches manuscript notation | A = small mesh, B = large mesh, C = wrap mesh |  |
| Mesh | Mesh type |  |  |
| Pre\_FL\_cm | Fork length before deployment | centimeter | NA |
| Post\_FL\_cm | Fork length after deployment | centimeter | NA |
| PropChange\_FL | Proportional fork length change after deployment | dimensionless | NA |
| Pre\_Weight\_g | Weight before deployment | gram | NA |
| Post\_Weight\_g | Weight after deployment | gram | NA |
| PropChange\_Weight | Proportional weight change after deployment | number | NA |
| Pre\_CF | Fulton's condition factor before deployment | gramsPerCubicCentimeter | NA |
| Post\_CF | Fulton's condition factor after deployment | gramsPerCubicCentimeter | NA |
| Delta\_CF | Change in Fulton's condition factor | gramsPerCubicCentimeter | NA |

**Table name:** Delta Smelt Survival

**Table description:** Delta Smelt Survival

| **Column name** | **Description** | **Unit or**  **code explanation or date format** | **Missing value code** |
| --- | --- | --- | --- |
| Location | Location of cage deployment | DWSC = Deepwater Shipping Channel, RV = Rio Vista |  |
| Mesh | Mesh category | Large, small, mesh |  |
| Cage | Cage ID |  |  |
| Survived | Number of fish that survived | number |  |
| n | Number of fish in cage | number |  |
| rate | Rate of survival | percent |  |

**Table name:** Zooplankton Data

**Table description:** Zooplankton data associated with Delta Smelt enclosures

| **Column name** | **Description** | **Unit or**  **code explanation or date format** | **Missing value code** |
| --- | --- | --- | --- |
| Location | Location of cage deployment | DWSC = Deepwater Shipping Channel, RV = Rio Vista |  |
| Date | Date date | mm/dd/yyyy |  |
| SetTime | Zooplankton set time in minutess | minutes |  |
| FlowMeterStart | Zooplankton flowmeter start number | number |  |
| FlowMeterEnd | Zooplankton flowmeter end number | number |  |
| Rotations | Number of flowmeter rotations | number |  |
| MeshSize | Mesh size of net | micrometer |  |
| RingSize | Ring size of net | centimeter |  |
| TotalVolume | Total volume sampled | milliliter |  |
| SubsampledVolume | Volume subsampled | milliliter |  |
| Taxon | Taxonomic ID |  |  |
| Count | Count | number |  |
| nSubsamples | number of subsamples | number |  |
| TaxonomicGrouping | Taxonomic grouping |  |  |
| BiomassIndex | Biomass index | microgramCarbonPerIndividual |  |
| TotalBiomass | Total biomass | gram |  |

**Table name:** Cage Velocity Data

**Table description:** Cage Velocity Data

| **Column name** | **Description** | **Unit or**  **code explanation or date format** | **Missing value code** |
| --- | --- | --- | --- |
| Location | Location of cage deployment | DWSC = Deepwater Shipping Channel, RV = Rio Vista |  |
| Date | Date | mm/dd/yyyy |  |
| Weather | Weather code | CLR = clear; RAN = rainy |  |
| Tide | Tide stage | EBB = ebb tide; FLD = flood tide | NA |
| Cage | Cage ID |  | NA |
| Vel1 | Velocity 1 | footPerSecond | NA |
| Vel2 | Velocity 2 | footPerSecond | NA |
| Vel3 | Velocity 3 | footPerSecond | NA |
| AvgVel | Average Velocity | footPerSecond |  |
| Time | Time | hh:mm, clock time |  |
| WaterTemp | Water temperature | celsius |  |
| DO | Dissolved Oxygen | milligramPerLiter |  |
| SpCond | Specific Conductance | microSeimensPerCentimeter |  |
| EC | Electrical Conductivity | microSeimensPerCentimeter |  |
| pH | pH | dimensionless |  |
| Turb1 | Turbidity 1 | nephelometricTurbidityUnit |  |
| Turb2 | Turbidity 2 | nephelometricTurbidityUnit |  |
| Turb3 | Turbidity 3 | nephelometricTurbidityUnit |  |
| AvgTurb | Average Turbidity | nephelometricTurbidityUnit |  |
| ZooplanktonCollected | Whether or not zooplankton was collected |  |  |
| PlatesDeployed | Whether or not plates were deployed |  |  |
| Notes | Notes |  |  |

**Table name:** Deployment and Retrieval Information

**Table description:** Information associated with deployment and retrieval of fish

| **Column name** | **Description** | **Unit or**  **code explanation or date format** | **Missing value code** |
| --- | --- | --- | --- |
| Location | Location of cage deployment | DWSC = Deepwater Shipping Channel, RV = Rio Vista |  |
| Action | Deployment or retrieval |  |  |
| Date | Date | mm/dd/yyyy |  |
| Cage | Cage ID |  |  |
| MeshType | Cage mesh type |  |  |
| nFish | Number of fish in cage | number | NA |
| Time | Time | hh:mm; clock time (DST starting March 3) |  |
| B1\_WaterTemp | Temperature in bucket 1 | celsius | NA |
| B1\_DO | DO in bucket 1 | milligramPerLiter | NA |
| B2\_WaterTemp | Temperature in bucket 2 | celsius | NA |
| B2\_DO | DO in bucket 2 | milligramPerLiter | NA |
| Cage\_WaterTemp | Temperature in cage | celsius | NA |
| Cage\_DO | DO in cage | milligramPerLiter | NA |
| Notes | Notes |  |  |

**Table name:** Field Data

**Table description:** Field data associated with daily checks

| **Column name** | **Description** | **Unit or**  **code explanation or date format** | **Missing value code** |
| --- | --- | --- | --- |
| Location | Location of cage deployment | DWSC = Deepwater Shipping Channel, RV = Rio Vista |  |
| Date | Date | mm/dd/yyyy |  |
| Time | Time | hh:mm; clock time (DST starting March 3) | NA |
| Weather | Weather Code | CLD = cloudy; CLR = clear; FOG = foggy; RAN = rainy; WND = windy |  |
| Secchi | Secchi depth | meter | NA |
| WaterTemp | Temperature | celsius |  |
| DO | Dissolved Oxygen | milligramPerLiter |  |
| SpCond | Specific Conductance | microSeimensPerCentimeter |  |
| EC | Electrical Conductivity | microSeimensPerCentimeter |  |
| pH | pH | number |  |
| Tide | Tide stage | EBB = ebb tide; FLD = flood tide; LOW = low tide | NA |
| MicrocystisRank | Microcystis rank | 1 = no Microcystis |  |
| Turb1 | Turbidity 1 | nephelometricTurbidityUnit |  |
| Turb2 | Turbidity 2 | nephelometricTurbidityUnit |  |
| Turb3 | Turbidity 3 | nephelometricTurbidityUnit |  |
| AvgTurb | Average Turbidity | nephelometricTurbidityUnit |  |
| Vel1 | Velocity 1 | footPerSecond | NA |
| Vel2 | Velocity 2 | footPerSecond | NA |
| Vel3 | Velocity 3 | footPerSecond | NA |
| AvgVel | Average Velocity | footPerSecond | NA |
| ZooplanktonCollected | Whether or not zooplankton was collected | N = no; Y = yes |  |
| FlowmeterSpeed | Flowmeter speed | REG = regular speed | NA |
| SetTime | Set time | minutes | NA |
| FlowMeterStart | Flowmeter start number | number | NA |
| FlowMeterEnd | Flowmeter end number | number | NA |
| Rotations | Number of flowmeter rotations | number | NA |
| ZoopNotes | Zooplankton Notes |  | NA |
| Damage\_A | Whether cage A was damaged | N = no; Y = yes | NA |
| Damage\_B | Whether cage B was damaged | N = no; Y = yes | NA |
| Damage\_C | Whether cage C was damaged | N = no; Y = yes | NA |
| Damage\_D | Whether cage D was damaged | N = no; Y = yes | NA |
| Damage\_E | Whether cage E was damaged | N = no; Y = yes | NA |
| Damage\_F | Whether cage F was damaged | N = no; Y = yes | NA |
| DamageNotes | Notes on cage damage |  | NA |
| Biofoul\_A | Rank of biofouling on cage A | 1 = clean; 2 = partial blockage; 3 = significant blockage | NA |
| Biofoul\_B | Rank of biofouling on cage B | 1 = clean; 2 = partial blockage; 3 = significant blockage | NA |
| Biofoul\_C | Rank of biofouling on cage C | 1 = clean; 2 = partial blockage; 3 = significant blockage | NA |
| Biofoul\_D | Rank of biofouling on cage D | 1 = clean; 2 = partial blockage; 3 = significant blockage | NA |
| Biofoul\_E | Rank of biofouling on cage E | 1 = clean; 2 = partial blockage; 3 = significant blockage | NA |
| Biofoul\_F | Rank of biofouling on cage F | 1 = clean; 2 = partial blockage; 3 = significant blockage | NA |
| Biofoul\_Notes | Biofouling notes |  | NA |
| PlatesCollected | Whether or not plates were collected | Y = Yes; N = No | NA |
| Mortality\_A | Number of mortalities in cage A | number | NA |
| Mortality\_B | Number of mortalities in cage B | number | NA |
| Mortality\_C | Number of mortalities in cage C | number | NA |
| Mortality\_D | Number of mortalities in cage D | number | NA |
| Mortality\_E | Number of mortalities in cage E | number | NA |
| Mortality\_F | Number of mortalities in cage F | number | NA |
| FishNotes | Notes on fish |  | NA |
| MiscNotes | Miscellaneous notes |  | NA |

**Table name:** Stations

**Table description:** Station locations

| **Column name** | **Description** | **Unit or**  **code explanation or date format** | **Missing value code** |
| --- | --- | --- | --- |
| StationCode | Code for station | DWSC = Deepwater Shipping Channel, RV = Rio Vista |  |
| StationName | Longer station name |  |  |
| Longitude | Longitude of sample location | numericDegree |  |
| Latitude | Latitude of sample location | numericDegree |  |

## Scripts/code (software)

Processing scripts are located on GitHub at [Smelt-cages/smelt\_2019\_winterspring at main · EMRR-DISE/Smelt-cages (github.com)](https://github.com/EMRR-DISE/Smelt-cages/tree/main/smelt_2019_winterspring). See v1.0.0.

## Notes and Comments

### Versioning History

| **Version number** | **Date created** | **Description of changes** | **Justification for change** | **Version editor(s)** | **Contact info** |
| --- | --- | --- | --- | --- | --- |
| V1.0 | 11/1/2022 | First version |  | Catarina Pien, Nicole Kwan | [cpien@usbr.gov](mailto:cpien@usbr.gov); [Nicole.kwan@water.ca.gov](mailto:Nicole.kwan@water.ca.gov) |
| V2.0 | 3/23/2023 | Altered zooplankton methods to remove throw method description. Altered metadata table to remove Method and Tow Distance columns, as well as some NA codes. Altered map. | We removed throw (dockside) data from manuscript due to results being different from other zooplankton samples. We altered the map to match the map in our manuscript. | Catarina Pien | [cpien@usbr.gov](mailto:cpien@usbr.gov) |

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