Name of study: Spring Kodiak Trawl Survey

Program element: 088

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Purpose/Objective: Monitor and provide information on pre-spawning and spawning Delta Smelt distribution in the upper San Francisco Estuary.

Conduct fish surveys to determine the timing, distribution, and abundance of spawning Delta Smelt and to provide maturity/egg-stage data for adult Delta Smelt. Help estimate Delta Smelt fish losses and determine the magnitude of entrainment of both larval and adult Delta Smelt at CVP and SWP intakes. Improved detection of Delta Smelt will better inform water-export facility operators of the potential to entrain adult Delta Smelt in subsequent weeks and their offspring later in the year.

Data collected: surface water temperature, surface water electro-conductivity, water transparency, water turbidity, water volume sampled, tidal stage, water depth, and fish information.

Geographic range of field work: upper San Francisco Estuary.

Number of sites: 39 sites from 2002 to 2004. 40 sites from 2005 to present.

Period of record (start year): 2002.

Size for complete data base for program element in KB (MB): 8+ megabytes.

Number of individual files: Two local applications house data, one application for front-end forms and second applications houses data tables and queries. Data must be uploaded in batches to tier 3 server prior to being displayed on the webpage.

Sample frequency per time unit (week, month): starting in early January, sampling is conducted monthly and continues until late spring, or until detectable spawning of Delta Smelt has ended. The

Delta-wide distributional survey (4-5 days) takes place at the beginning of the month and the Supplemental survey (if conducted) occurs two weeks after.

Field sampling: The SKT survey employs a standard Kodiak trawl with a total length of 65' (19.8-m), and a fully expanded mouth opening of 25' by 6' (7.62-m by 1.83-m). A weighted foot-rope and head-rope with floats allows the trawl to fish the top 1.8-m of the water column. The trawl is constructed of green or black variable mesh ranging in dimension from 2" knotted stretched mesh at the mouth and decreasing by ½" through a series of 5 panels to ¼" knotless stretched mesh at the cod-end. The cod-end is tied off with a slipknot. A 10-lb. cannon-ball weight is attached to each wing-tip, and a 15-lb cannon-ball weight is attached on each side of the net approximately 10-ft forward of the mouth. Secchi depth, surface water temperature, surface water turbidity, and surface water EC are taken prior to each tow at each station and are recorded on the field data sheet. The net is deployed and towed for nine minutes and thirty seconds. Flow meter readings are taken upon completion of each tow and the contents of the net are identified, enumerated, measured, and recorded on the field data sheet.

Laboratory analysis: All unidentifiable fish are returned to the Stockton laboratory for positive identification. Further or secondary gonadal staging of Delta Smelt may occur at this time.

Relative density analysis: The mean number of fish per volume water sampled (standardized to 10,000 m^3) is calculated using the following equations:

$$\mathbf{V = A * K * D}$$

Where: V = volume of water (m^3) filtered through the net per tow (one tow per station)

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

$$\mathbf{N = F / V * 10{,}000\ m^3}$$

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

F = fish sampled per station

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

Changes over time: Please consult the SKT S.O.P. and Protocol for complete sampling procedures.

2002 – Survey's inception. Sampling protocol is developed. Delta Smelt are returned to the lab where they are measured and maturity/egg stages are determined. As such, Delta Smelt lengths are formalin fixed for this year.

2003 – All Delta Smelt are measured and enumerated in the field for the purpose of obtaining fresh fork lengths, not formalin preserved fork lengths. Maturity/egg stages for all Delta Smelt are determined in the field. Sub-samples (15-25 Delta Smelt per station) are retained for researchers at UC Davis. Each retained Delta Smelt is identified in the database by a unique numeric identifier. Egg samples from each female Delta Smelt are retained and preserved in 6:3:1 clearing solution with the unique numeric identifier associated with the sub-sampled fish. Heads from all Delta Smelt are severed and preserved in 70% ethanol with the unique numeric identifier associated with the sub-sampled fish. The remaining body of the sub-sampled fish is preserved in 10% buffered formalin with the unique numeric identifier. Sampling takes place from February to May; a January survey is not conducted.

2004 – Due to limited funding during 2004, it was decided to retain only samples from stage 4 females, collecting no more than 30 stage 4 individuals per station. Half way through survey 3 the cod-end of the net got caught in the propeller; the replacement cod-end had 1/8" mesh (instead of 1/4"). The rest of the survey year was completed using 1/8" cod-end mesh.

2005 – Station 719 (Sacramento Deep Water Channel) is added to the core list of sampling sites and incorporated into the delta wide survey. For Delta Smelt sub-sample processing up to 20 fish per station during the Delta-wide surveys and up to 30 fish per station from the Supplemental surveys are retained for UC Davis researchers. Head, body, egg, and caudal fin samples are collected. Only egg samples from stage 3 and 4 females are retained. 1/8" cod end mesh is used because it retains both adults and the current year class of Delta Smelt.

2006 – No egg or caudal fin samples are collected or retained.

2007 – Cod end mesh of the Kodiak net is changed from 1/8' stretched mesh back to ¼' stretched mesh prior to start of survey in an effort to reduce take of current year class of fish.

2008 – IEP Management Team eliminates Supplemental Surveys to reduce take. Sampling only includes the delta wide survey once a month.

2009 – To avoid excess take associated with large Delta Smelt catches, staff biologists implement additional protocol when sampling stations with historically high Delta Smelt density. This protocol has identified specific stations where two 5 minute tows are conducted instead of one 10 minute

tow. If < 50 Delta Smelt are collected in the first 5 minute tow, conduct a second 5 minute tow. If ≥ 50 Delta Smelt are collected in the first 5 minute tow, no additional 5 minute tow is necessary.

2010 – Implementation of the use of a Hach Model # 2100P Turbidimeter as Standard Operating Procedure to record turbidity in NTU's. Survey 11 is Smelt Turbidity Study, a special survey conducted by USBR in January 2010.

2011 – N/A

2012 – Delta Smelt are field staged and preserved whole in liquid nitrogen to be given to UC Davis in conjunction with FLaSH studies.

2013 - Delta Smelt are field staged and preserved whole in liquid nitrogen to be given to UC Davis in conjunction with FLaSH studies; late stage 3 and stage 4 females are divided equally between UCD and CDFW (preserved in EtOH or 10% formalin for CDFW Fecundity Study).

2014- Continued preserving most Delta Smelt in liquid nitrogen for UC Davis in conjuction with FLaSH studies; fecundity fish preserved as heads/bodies in ethanol/formalin for otoliths and fecundity. Used new black net (made to standard specifications) purchased on 03/25/2014 from Research Nets, Inc. for the entire season. Cod-end from previous year (1/4" mesh) used while waiting for new cod-ends. Database revised and implemented prior to 2014 season by Tuongvan Ngyuen at ITB as part of the Bay Delta Application Hosting. Data is now entered into SKT_Local.mdb, housed on local server in SKT_Queries.mdb, and uploaded to tier 3 server before displaying on the webpage.

2015- Continued providing Delta Smelt in liquid nitrogen to UC Davis, and also continued subsampling for fecundity/otolith work. See supplemental work below. A new net was used that was purchased from Research Nets, it matches existing specifications. Conducted a thorough review of coordinates from 2008-2015. Added database edit log to FTP site. Index was reviewed and changes were made. See 2015 Delta Smelt abundance index memo.

2016: Continued providing Delta Smelt in liquid nitrogen to UC Davis. Clipped salmonids are reported to ESA webpage for first time per new NMFS permit. FieldRace and FinalRace fields were added to tblFishInfo in SKT_query.mdb for Chinook salmon for tracking and compliance with ESA reporting.

2017: Continued providing Delta Smelt in liquid nitrogen to UC Davis. Continued to report clipped salmonids to ESA webpage, and utilized "FinalRace" field. CWT results, hatchery release notifications, and catch data were used in combination to inform ESA take above and beyond length-at-date race keys.

2018: Continued providing Delta Smelt in liquid nitrogen to UC Davis. Continued to report clipped salmonids to ESA webpage. Used a new vessel, the "New Munson" for two days in February, but discontinued use due to very slow winch speed.

2019: Continued providing Delta Smelt in liquid nitrogen to UC Davis. Incorporated reporting clipped salmonids to ESA webpage indefinitely.

Supplemental Surveys

2010**:** Survey 11 – Smelt Turbidity Study Pilot

2014: Survey 22 – FMWT Shadow Trawling: a subset of stations during the standard FMWT survey were shadowed with SKT gear as part of Gear Efficiency Studies
Survey 12 – Complete SKT survey completed in December as part of Drought Monitoring Studies

2015: Surveys 12, 13, 14, 15 – Replicate tows done at stations 711, 508, and 902 during standard surveys requested by Ken Newman in order to address 'false zeros' for Delta Smelt Life History Model
Survey 22 – Drought monitoring tows at 3 sites in Old River as part of an early warning indicator for entrainment, initiated by Carl Wilcox
Survey 20 – Complete SKT survey completed in December as part of entrainment take calculation verification (Ken Newman), Drought Monitoring, and early warning indicator.

2016: Survey 12 – Complete SKT survey completed in December as part of Drought Monitoring Studies

2017: Survey 11 – Exploratory sampling was conducted in January (Survey 1) at eight "high outflow" stations in San Pablo Bay and the Napa River. These station locations correspond to 20-mm stations 342, 343, 323, 328, 329, 334, 335, and 336. The request came from management at CDFW and USFWS to assist distribution data collected by USFWS Enhanced Delta Smelt Monitoring Program. Survey 12 – Complete SKT survey completed in December as an increase in temporal effort in response to low abundance.

2018: Survey 12 – Complete SKT survey completed in December as an increase in temporal effort in response to low abundance.