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2014 20-mm Survey Fish Catch Summary

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California Department of Fish and Wildlife (CDFW) conducts the 20-mm Survey annually to monitor the distribution and relative abundance of larval and juvenile Delta Smelt (*Hypomesus transpacificus*) in the upper San Francisco Bay Estuary. The survey began in 1995 and supplies near real-time catch data to water and fisheries managers as part of an adaptive management strategy to limit the risk of Delta Smelt entrainment during water exports.

From March 17 to July 10, 2014, nine bi-weekly surveys were completed. The 20-mm Survey conducts multiple tows at 47 stations (Figure 1) to measure larval fish and zooplankton densities. Six stations in the Napa River and one station in San Pablo Bay were omitted from survey 1 due to logistical issues, but the Napa River was sampled in the same week by the CDFW Smelt Larva Survey (for more information, see the Smelt Larva Survey article in this issue). The 20-mm survey used a conical net with 1600-micron mesh for collecting young of the year (YOY) fish. The net was 5.1 meters long with a mouth area of 1.51 square meters, and was attached to a rigid steel D-ring frame mounted on skis. At each station, the entire water column was sampled using three stepped-oblique tows and a single zooplankton tow. All samples were preserved in 10% buffered formalin dyed with Rose Bengal for later identification and enumeration in the laboratory. Fish were measured to the nearest millimeter fork length, if the tail was forked, or nearest total length if the tail was not forked. Zooplankton data is available on our webpage (see link below), but is not reported on in this article.

The 20-mm Survey in 2014 caught a total of 47,270 fish representing 45 taxonomic groups (Table 1). Tridentiger spp. (gobies) was by far the most abundant group, making up about 57% of the total catch. Pacific Herring (*Clupea pallasii*), Threadfin Shad (*Dorosoma petenense*), and Northern Anchovy (*Engraulis mordax*) were the next three most-abundant species, making up about 25% of the total catch. Delta Smelt was the 10th-most abundant species, making up less than 0.01% of the total catch. The 257 Delta Smelt caught represent the second-lowest total catch in the history of this survey (1995 – 2014). Larval and juvenile Delta Smelt catches were extremely low in March and early April (survey 1 and 2; n = 3 and n = 1, respectively). Catch increased through April and peaked in mid-May (survey 5) with 112 Delta Smelt caught (20.9-mm mean length). Delta Smelt catch decreased through June, and only three fish were caught in the final survey in July (survey 9). Overall, this is a normal seasonal catch pattern because the 20-mm net's limited efficiency at retaining small larvae and large juveniles (Figure 2).

The first Delta Smelt larvae were caught in the first survey (3/17 – 3/21) and ranged in size from 6 – 12 mm, the larger sizes indicating that spawning began in February when water temperatures reached 12 °C. The last newly-hatched larvae (ca. 6 mm) were caught in late April, indicating the final hatch of the spawning season occurred earlier that month. Delta Smelt grew an average of 4.4 mm between each survey, and reached a mean length of 48 mm by the last survey in July (survey 9). This was the largest mean length reached by Delta Smelt at the end of season for the history of this survey (Figure 3).

Young of the year Delta Smelt were concentrated in the Sacramento Deep Water Ship Channel (SDWC) and

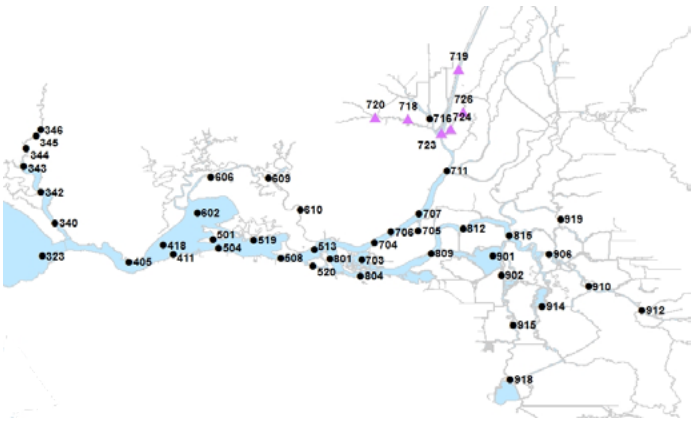

Figure 1 The CDFW 20-mm Survey stations, showing current sampling locations in the upper Sacramento-San Joaquin Estuary. Stations marked with a black dot are core stations used in index calculations. Stations marked with a purple triangle are non-core stations used for distribution information, but not index calculation.

North Sacramento-San Joaquin River Delta (Delta) for most of the season, with some catches near the confluence of the Sacramento and San Joaquin rivers (Confluence) and in the lower Sacramento and San Joaquin rivers (Figure 4). Catch during the 20-mm Survey season was sporadic and patchy. Delta Smelt larvae were only present in the South and Central Delta in March and April, when they were caught in Little Potato Slough near Terminous (station 919). They were also caught in Montezuma Slough in three non-consecutive surveys. Only one fish was detected in Honker Bay in late June, indicating a minimal larval presence downstream of the Confluence. This is likely a function of low Delta outflow resulting from minimal precipitation and reservoir releases causing high salinities throughout Suisun Bay and reaching into the Delta. The X2 was located upstream of the Confluence in every survey during the 20-mm season (United States Fish and Wildlife Service Smelt Working Group 2014). Delta Smelt were caught in conductivities ranging from 224 µS/cm to 14,240 µS/cm. The upper end of this conductivity range was relatively high compared to the mean conductivity (about 1,600 µS/cm) of stations where Delta Smelt were caught for all years (1995-2014).

The low abundance and limited distribution of YOY Delta Smelt in 2014 was likely attributable to the drought conditions experienced that year. The Water Year Type for 2014 was critically dry for both the Sacramento and San

Table 1 Species composition from the 2014 CDFW 20-mm Survey.

Common name	*n*	*% Catch*
Tridentiger spp.	27,119	57.37%
Pacific Herring	4,287	9.07%
Threadfin Shad	4,223	8.93%
Northern Anchovy	3,236	6.85%
Striped Bass	2,665	5.64%
Longfin Smelt	1,938	4.10%
Yellowfin Goby	1,716	3.63%
Prickly Sculpin	395	<0.01%
Jacksmelt	326	<0.01%
Delta Smelt	257	<0.01%
Three Spine Stickleback	212	<0.01%
Arrow Goby	206	<0.01%
American Shad	169	<0.01%
Bay Goby	116	<0.01%
Centrarchids	91	<0.01%
Bay Pipefish	78	<0.01%
Bigscale Logperch	35	<0.01%
Inland Silverside	29	<0.01%
Chinook Salmon	25	<0.01%
Topsmelt	25	<0.01%
Cheekspot Goby	22	<0.01%
Cyprinidae	13	<0.01%
Rainwater Killifish	12	<0.01%
Shimofuri Goby	11	<0.01%
White Catfish	10	<0.01%
Longjaw Mudsucker	9	<0.01%
Pacific Staghorn Sculpin	7	<0.01%
Splittail	6	<0.01%
Sacramento Sucker	5	<0.01%
Carp	5	<0.01%
Mosquitofish	3	<0.01%
Atherinopsidae	3	<0.01%
Shokihaze Goby	2	<0.01%
Channel Catfish	2	<0.01%
Starry Flounder	2	<0.01%
Speckled Sanddab	1	<0.01%
White Sturgeon	1	<0.01%
Plainfin Midshipman	1	<0.01%
California Tonguefish	1	<0.01%
Bluegill Sunfish	1	<0.01%
Black Crappie	1	<0.01%
Largemouth Bass	1	<0.01%
Tule Perch	1	<0.01%
Wakasagi	1	<0.01%
English Sole	1	<0.01%

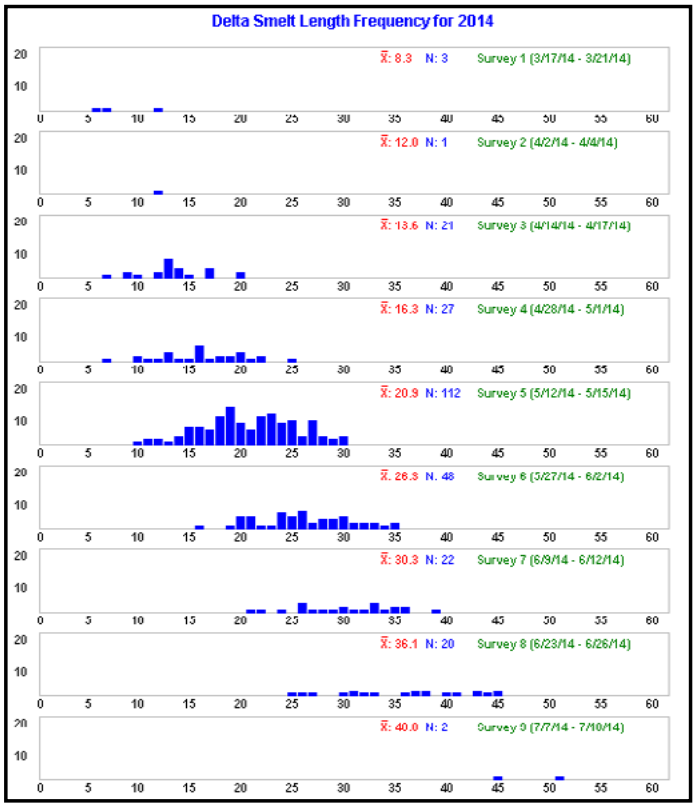

Figure 2 Delta Smelt length frequency distributions by survey from CDFW 2014 20-mm Survey (http://dfg.ca.gov/delta/data/20mm/Length_frequency.asp). Length in millimeters is on the X-axis and number of individuals is on the Y-axis.

Joaquin valleys (California Data Exchange Center 2016). As noted above, conductivity in parts of Delta Smelt rearing habitat were high, as were water temperatures in other locations. Delta Smelt tend to spawn and rear upstream in drier water years (Wang 2007), but water temperatures upstream surpassed 23 °C in early June and exceeded 24 °C by July, making those habitats unsuitable for Delta Smelt (Gleason et al. 2007; Nobriga et al. 2008; Sommer and Mejia 2013).

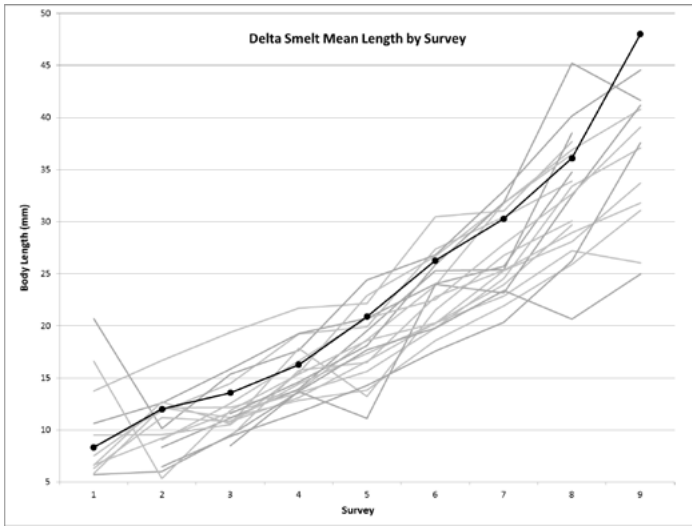

Figure 3 Mean lengths by survey and year of Delta Smelt caught by CDFW 20-mm Survey (1995–2014). 2014 is the black line with black-filled circles, all other years are grey.

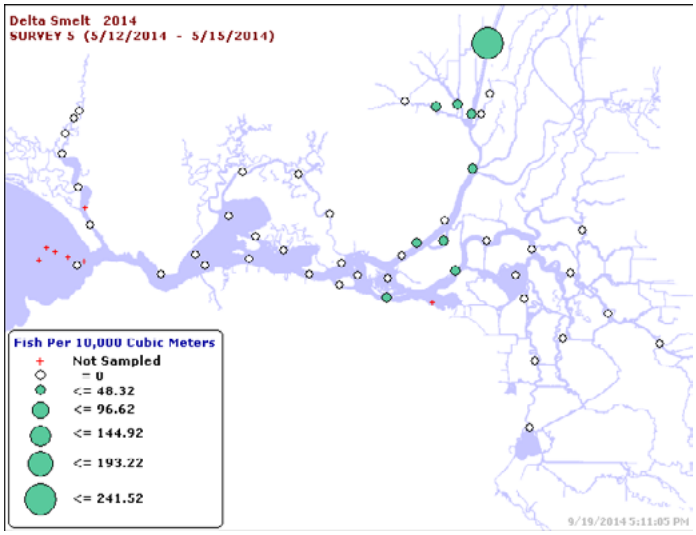

Figure 4 Delta Smelt distribution from CDFW 20-mm Survey 5 (taken from http://dfg.ca.gov/delta/projects.asp?ProjectID=20mm). Green bubbles represent the relative abundance of YOY Delta Smelt at each site. White bubbles are sampled stations with no YOY Delta Smelt caught. Red crosses indicate the station was not sampled.

An index of Delta Smelt abundance for the 20-mm Survey was calculated by CDFW using data from the four surveys around which the mean length of the YOY Delta Smelt was 20 mm. The index was calculated using only the 41 stations ("core" stations, Figure 1) which have been sampled consistently since the survey's inception in 1995. The 2014 index was 1.1 (Figure 5) and was calculated using Surveys 3 (April) through 6 (May). The 2014 index represented a large decrease from 2013, and the second lowest index on record after the 2007 index of one.).

Current and past data graphically depicted are available on the 20-mm Survey webpage http://dfg.ca.gov/delta/projects.asp?ProjectID=20mm. Data, metadata, and protocols are available through our FTP site ftp://ftp.dfg.ca.gov/Delta%20Smelt/.

Year	Index
1995	4.4
1996	33.9
1997	19.2
1998	7.7
1999	39.4
2000	23.7
2001	10.9
2002	7.7
2003	13.0
2004	8.2
2005	15.4
2006	9.8
2007	1.0
2008	2.9
2009	2.3
2010	3.8
2011	8.0
2012	11.1
2013	7.8
2014	1.1

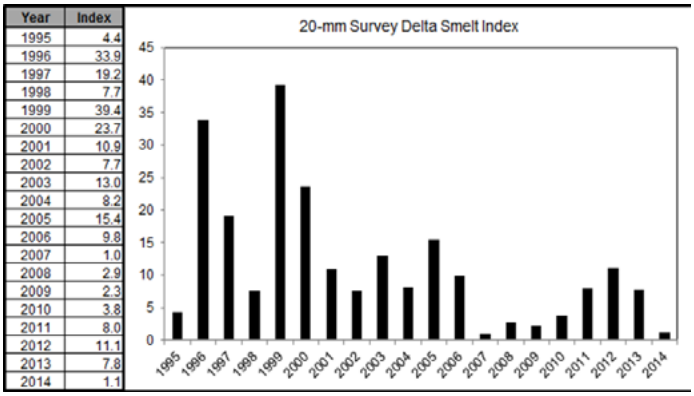

Figure 5 CDFW 20-mm Delta Smelt Index of Relative Abundance (1995-2014) by year.

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Zooplankton biomass and chlorophyll-*a* trends in the North Delta Arc: two consecutive drought years

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Introduction

Lower trophic level ecosystem dynamics are poorly understood in the upper San Francisco Estuary (SFE) (Durand 2015; Kratina & Winder 2015). Monitoring programs targeting pelagic habitats along the main channels of the San Francisco Bay and Sacramento-San Joaquin River Delta (Delta) have consistently found low abundance of phytoplankton and zooplankton (California Department of Fish and Wildlife 2015, California Department of Water Resources 2015). After 1987 and again after 2000, planktonic organisms displayed steep declines in abundance (Bennett 2006; Sommer et al. 2007; Mac Nally et al. 2009), probably due to the colonization of alien species (such as the grazing clam *Potamocorbula amurensis*) (Carlton et al. 1990; Kimmerer et al. 1994) and changes in water outflow and quality (Glibert et al. 2011; Dugdale et al. 2012). Pelagic plankton-feeding fishes, such as Delta Smelt (*Hypomesus transpacificus*), Longfin Smelt (*Spirinchus thaleichthys*), and Northern Anchovy (*Engraulis mordax*) were affected by low food availability, resulting in near extinction for the Delta Smelt (Matern et al. 2002; Sommer et al. 2007; Moyle et al. 2016). Other species have declined in the upper SFE as well, in part because of low food availability for juvenile fish recruits (Bennett & Hinton 1995; Feyrer et al. 2003; Hammock et al. 2015; Merz et al. 2016), habitat alterations (Nichols et al. 1986; Grimaldo, Stewart, et al. 2009; Whipple et al. 2012), and disruption of Delta hydrodynamics (Jassby & Powell 1994; Feyrer & Healey 2003; Grimaldo, Sommer, et al. 2009).

The North Delta Arc is a series of longitudinally connected habitats that may provide the best remaining opportunities for restoration in the Delta region (Moyle et al. 2012; Hanak et al. 2013), partly because of the greater number and proportion of native fishes observed in the region (Williamson et al. and Young et al., this issue). The North Delta Arc ranges from Suisun Marsh upstream along the Sacramento River to the Yolo Bypass, including the confluence of the Sacramento and San Joaquin rivers, the Cache Slough Complex, Liberty Island, Little Holland Tract, the Toe Drain, and the Deepwater Shipping Channel (DSC).

The UC Davis North Delta Arc Project (Arc) monitors major and minor sloughs and shallow peripheral aquatic habitats in eastern Suisun Marsh (Nurse-Denverton Slough Complex) and the Cache Slough Complex. The goal of the Arc Project is to document the fish assemblages and habitat quality in these areas as a conservation tool, including assessing baseline conditions, occurrences of listed and uncommon native fishes, and post-restoration project succession. Both theory (Kneib 1997; Lucas et al. 1999; Lopez et al. 2006) and empirical evidence (Jassby & Cloern 2000; Durand 2010) suggest that plankton abundance, under some conditions, can be higher in shallow water embayments or terminal sloughs,

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