Feeding Habits Of Adult Delta Smelt in Winter and Spring

Tricia Bippus, Mary Helen Nicolini, Phillip Poirier and Steven B. Slater (sslater@dfg.ca.gov)
California Department of Fish and Game, Long-Term Monitoring Unit, Stockton, California

Introduction

In recent years, abundance of several pelagic fishes in the San Francisco Estuary has suffered a steep decline. The decline has been severe enough to result in upgrading delta smelt (*Hypomesus transpacificus*) to endangered status. This decrease in abundance has coincided with the changes in community composition and long term decline of zooplankton, including calanoid copepods and mysids, some of which are important food for the entire life of delta smelt. There is little current information regarding adult delta smelt use of available zooplankton prey in the estuary. This study was conducted to investigate the temporal use of food items by adult delta smelt as part of the Interagency Ecological Program's (IEP) Pelagic Organism Decline (POD) special studies.

Methods

Adult delta smelt were collected from Suisun Bay upstream through the Sacramento Deep Water Ship Channel (SDWSC) in winter and spring months between 2005 and 2011 by several California Department of Fish and Game (CDFG) surveys. Fish were preserved in 10% buffered formalin and brought to the laboratory (Stockton, CA) for examination. Length measurements and observations for parasites were recorded before dissection of the esophagus and stomach for gut content identification. Zooplankton were identified to the lowest taxonomic level. All photos, with the exception of the harpacticoid copepod, were taken from prey items removed from delta smelt stomachs during this study. Photos of prey items are not to scale. Zooplankton mean catch-per-unit-effort (CPUE) data (number-per-cubic-meter) from CDFG Zooplankton Study Sacramento River stations.

Results

- A total of 173 delta smelt were processed, only 2 had empty stomachs (Table 1).

Table 1. Monthly summary of stomach content presence and mean fork lengths (mm) of delta smelt collected 2005 through 2011. Months grouped to capture seasonal comparisons in figures were highlighted with various colors in this table.

	2005	2006	2007				2008		2010			2011			Total
	12	4	2	3	4	12	1	3	10	11	12	1	2	4	
Contents present	20	10	20	8	10	10	17	10	7	8	19	12	10	10	171
Contents absent											2				2
Mean FL (mm)	57.1	65.7	60.1	62.8	65.6	60.5	64.2	66.9	N/A	62.7	65.3	60.5	64.3	63.4	62.8

- Observations of external features revealed all fish appeared healthy.

- Internal observations found cysts in body tissues of 2 fish from December 2010 and 1 fish from February 2007; nematodes were also found in 4 fish from February 2007.

- Adult delta smelt consumed a variety of prey types, with major food items calanoid (*Sinocalanus* sp., *Pseudodiaptomus forbesi*, and unidentified), cyclopoid and harpacticoid copepods, cladocerans, and amphipods (*Gammarus* spp. and *Corophium* spp.) consumed with consistency among years (Figures 1-3).

- Less frequent food items found in stomachs included other calanoid copepods (*Eurytemora affinis* and *Acartiella sinensis*), flying insects (flies, gnats, leaf hoppers), thrips, mites, aquatic larval insects, and larval fish (goby and sculpin) (Figures 1-3). Other zooplankton (mysids, ostracods, and rotifers) contributed trace amounts to the diet.

- The December 2005 predominant food items observed in stomachs of delta smelt from Suisun Bay and the Sacramento River were cyclopoid copepods (other 52.3% and *Limnoithona* spp. 4.9%) and cladocerans (34.2%) (no figure).

- Stomach contents of delta smelt collected from the SDWSC in April 2006 was dominated by calanoid copepods (*Sinocalanus* sp. 78.5% and unid. calanoids 18.8%) (no figure).

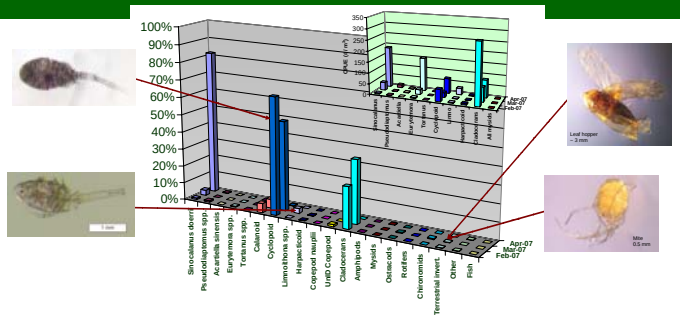

Figure 1. Diet composition by percent number of prey categories of delta smelt collected in the Sacramento Deep Water Ship Channel February through April 2007. Inset figure of CDFG Zooplankton CPUE data.

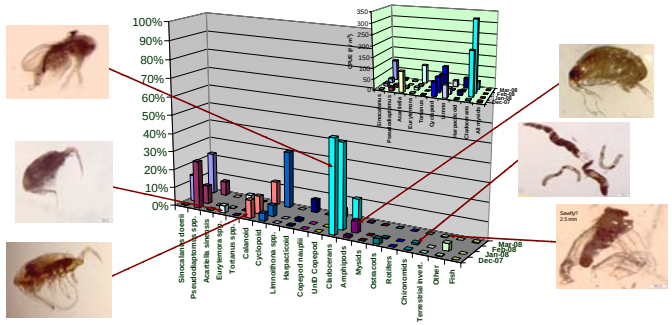

Figure 2. Diet composition by percent number of prey categories of delta smelt collected in the lower Sacramento River and Sacramento Deep Water Ship Channel December 2007 through March 2008. No samples were available in February 2008. Inset figure of CDFG Zooplankton CPUE data.

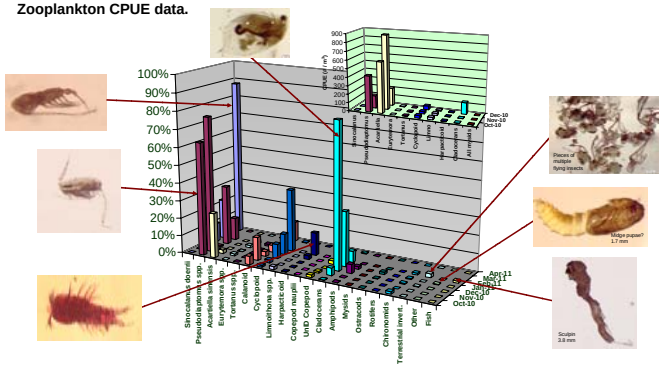

Figure 3. Diet composition by percent number of prey categories of delta smelt collected from the lower Sacramento River upstream through the Sacramento Deep Water Ship Channel October 2010 through April 2011. No samples were available in March 2011. Inset figure of CDFG Zooplankton Study data.

Results cont.

- The December 2010 delta smelt were collected over a 12 hour period during the Smelt Turbidity Study (STS) hourly sampling in the lower Sacramento River; no delta smelt were caught between 12:00 and 16:00 hours on December 30th, 2010 (Figure 4).

- Cladocerans composed the majority of food items in delta smelt collected during STS from 07:00 hours through 11:00 hours and again at 17:00 hours. At 17:00 hours there was a very high incidence of cladoceran consumption; excess of 100 cladocerans per fish gut examined resulting in the fullest stomachs by weight.

- Amphipods also were consumed at high numbers with a maximum of 20 amphipods identified (16 *Gammarus* spp., 4 *Corophium* spp.) in one fish.

- Lesser numerically consumed items during STS included calanoid copepods (*Eurytemora* and *Pseudodiaptomus* species) and the "Other" items consumed consisted of a few occurrences of chironomids, cyclopoid copepods, ostracods, rotifers, and terrestrial invertebrates (gnats).

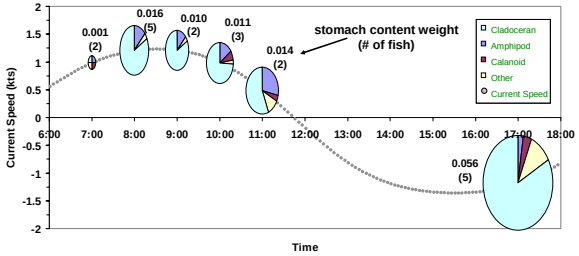

Figure 4. Delta smelt mean stomach content weight (grams) by pie size, pie slices represent prey category by percent number, and number of fish with food present in guts (#) over a 12 hour period and tidal cycle; positive current speed was the flood tide and negative was ebb tide. Fish were collected during the Smelt Turbidity Study on December 30, 2010.

Conclusions

- Delta smelt collected in the late-fall (October) through spring (April) had a high frequency of feeding incidence, with only 2 fish found with empty stomachs. Fish with empty stomachs came from collections made early in the morning (07:00 hr of STS).

- Among several years, calanoid copepods were numerically dominant in stomachs of fish in the late-fall and spring months with cladocerans and amphipods being numerically dominant in stomachs during most winter months.

- Numbers of organisms found in stomachs of fish mostly corresponded with abundance of available zooplankton.

- This summary of diet by percent number could underestimate the importance of prey mass due to numerically low and infrequent prey of large size (amphipods); diet by percent weight is currently being examined for these samples.

Acknowledgements

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