Interagency Ecological Program 2024
Quantitative Analysis of Stomach Contents and Body Weight for Pelagic Fishes
"Fish Diet and Condition Study"

Project Manager and Affiliation

James Hobbs, CDFW

Principal Investigator and Affiliation

Steve Slater, CDFW

Annual Cost (thousands) and Funding Sources

$104 DWR; $104 USBR

Identification and enumeration of fish stomach contents, with examples of some common prey organisms.

Description

The Diet and Condition study has provided information on the foraging habits of pelagic fishes in the estuary since 2005. We focus on the temporal and spatial differences in

diet composition and feeding success of Delta Smelt, Striped Bass, Threadfin Shad, Longfin Smelt, Mississippi Silversides, and American Shad.

Project Need

Data from this project has been used to inform Fall Low Salinity (FLaSH), Directed Outflow Program (DOP), and Delta Smelt Management Analysis and Synthesis (MAST) synthesis efforts and reports, as well as life history models used for the conservation of fish and their habitats. Understanding what prey are utilized for food in the context of available prey, with the associated body-condition of fish, helps clarify the existence and timing of food limitation for young pelagic fish in the estuary. This work began as part of the POD investigations and continued as a contributor to FLaSH investigations during which we collaborated with the Fish Health Monitoring Project funded by ERP.

Finally, we will process Delta Smelt diets from investigations prompted by the Delta Smelt Resilience Strategy to inform management actions which use augmented flow to enhance habitat conditions, monitoring and evaluating the operation of the Suisun Marsh Salinity Control Gates, North Delta Food Web, and as part of the Directed Outflow Project (see elements 062, 326, and 335).

Project Objectives

- What are the diets of pelagic fishes (especially Delta Smelt and Longfin Smelt) in the estuary and do they vary regionally or temporally?
- Is there evidence of reduced feeding success spatially or temporally in the estuary?
- Is feeding success associated with changes in relative weight or condition of fish?
- Is there seasonal and regional overlap of diets between species?
- How do flow actions affect food resource availability and feeding success of fishes in the estuary?

Schedule of Milestones

- Winter to Spring 2024: Complete processing Delta Smelt and Longfin Smelt collected in 2023.
- Summer 2024: Quality check and transfer Delta Smelt diet data to UC Davis collaborators. Work with UC Davis collaborators focusing on age-0 longfin smelt diet and condition. Archive Longfin Smelt caught in 2024.
- Fall 2024: Update published data on EDI with Delta Smelt diet data. Archive Longfin Smelt caught in 2024.

Project Products and Publications

Written Products:

IEP. 2005. Interagency Ecological Program Synthesis of 2005 work to evaluate the Pelagic Organism Decline (POD) in the Upper San Francisco Estuary. Interagency Ecological Program for the San Francisco Estuary. POD Synthesis Report. 55 pp.

Gartz, R. G. 2005. Fish condition and health indices. Department of Fish and Game IEP POD report. 19 pp. Microsoft Word - Fish condition and health 2005.doc (baydeltalive.com)

Baxter, R., R. Breuer, L. Brown, M. Chotkowski, F. Feyrer, M. Gingras, B. Herbold, A. Mueller-Solger, M. Nobriga, T. Sommer, and K. Souza. 2008. Pelagic Organism Decline Progress Report: 2007 Synthesis of Results. Interagency Ecological Program for the San Francisco Estuary. 86 pp.

Baxter, R., R. Breuer, L. Brown, L. Conrad, F. Feyrer, S. Fong, K. Gehrts, L. Grimaldo, B. Herbold, P. Hrodey, A. Mueller-Solger, T. Sommer, and K. Souza. 2010. Interagency Ecological Program 2010 Pelagic Organisms Decline work plan and synthesis of results. Interagency Ecological Program for the San Francisco Estuary, Technical Report.

S. B. Slater. 2012. Delta Smelt Regional Feeding Patterns in Fall 2011. Interagency Ecological Program for the San Francisco Estuary Newsletter 25(2):36-43.

Brown, L.R., Baxter, R., Castillo, G., Conrad, L., Culberson, S., Erickson, G., Feyrer, F., Fong, S., Gehrts, K., Grimaldo, L., Herbold, B., Kirsch, J., Mueller-Solger, A., Slater, S., Souza, K., and Van Nieuwenhuyse, E., 2014, Synthesis of studies in the fall low-salinity zone of the San Francisco Estuary, September–December 2011: U.S. Geological Survey Scientific Investigations Report 2014–5041, 136 p., http://dx.doi.org/10.3133/sir20145041

Slater, S., and R. Baxter. 2014. Diet, Prey Selection, and Body Condition of Age-0 Delta Smelt, Hypomesus transpacificus, in the Upper San Francisco Estuary. San Francisco Estuary and Watershed Science 12.

Hammock, B. G., J. A. Hobbs, S. B. Slater, S. Acuna, and S. J. Teh. 2015. Contaminant and food limitation stress in an endangered estuarine fish. Sci Total Environ **532**:316-326.

IEP-MAST (Interagency Ecological Program–Management Analysis and Synthesis Team). 2015. An updated conceptual model of Delta Smelt biology: our evolving understanding of an estuarine fish. Interagency Ecological Program, Sacramento, CA.

Hammock, B. G., S. B. Slater, R. D. Baxter, N. A. Fangue, D. Cocherell, A. Hennessy, T. Kurobe, C. Y. Tai, and S. J. Teh. 2017. Foraging and metabolic consequences of semi-anadromy for an endangered estuarine fish. PLoS One **12**: e0173497.

Hammock, B. G., R. Hartman, S. B. Slater, A. Hennessy, and S. J. Teh. 2019. Tidal Wetlands Associated with Foraging Success of Delta Smelt. Estuaries and Coasts **42**:857-867.

Slater, S. B., A. Schultz, B. G. Hammock, A. Hennessy, and C. Burdi. 2019. Patterns of Zooplankton Consumption by Juvenile and Adult Delta Smelt (*Hypomesus transpacificus*). Pages 11-72 in A. A. Schultz, editor. Directed Outflow Project Technical Report 1. U. S. Bureau of Reclamation, Bay-Delta Office, Mid-Pacific Region, Sacramento, CA. Technical Report – Final Draft. 402 pp.

FLOAT-MAST (Flow Alteration - Management, Analysis, and Synthesis Team). 2020. Synthesis of data and studies relating to Delta Smelt biology in the San Francisco Estuary, emphasizing water year 2017. IEP Technical Report 95. Interagency Ecological Program, Sacramento, CA.

Burdi, C. E., S. B. Slater, T. L. Bippus, and J. A. Jimenez. 2021. Mysid and Amphipod Length-Weight Relationships in the San Francisco Estuary. IEP Newsletter 40(1).

FLOAT-MAST (Flow Alteration - Management Analysis and Synthesis Team). 2022. White papers providing a synthesis of knowledge relating to Delta Smelt biology in the San Francisco Estuary, emphasizing effects of flow. Interagency Ecological Program, Sacramento, CA. IEP Technical Report #98. 191 pp.

Lojkovic Burris, Z. P., R. D. Baxter, and C. E. Burdi. 2022. Larval and juvenile Longfin Smelt diets as a function of fish size and prey density in the San Francisco Estuary. California Fish and Wildlife Journal 108: e11

Bashevkin, S. M., Burdi, C. E, Hartman, R., & Barros, A. (2023). Long-term trends in seasonality and abundance of three key zooplankters in the upper San Francisco Estuary. *San Francisco Estuary and Watershed Science*, 21(3). http://dx.doi.org/10.15447/sfews.2023v21iss3art1

Presentations:

Slater, S. B. 2006. Diet composition of pelagic fishes in the San Francisco Estuary (2005). Presented at the Interagency Ecological Program 2006 Annual Workshop, March 1-3, 2006. Asilomar Conference Grounds, Pacific Grove, California.

Vu, S. H. and S. B. Slater. 2006. Do I Look Fat to You? Determining the Condition of Pelagic Fishes in the Upper San Francisco Estuary. Presented at the 4th Biennial CALFED Science Conference 2006, October 23-25, 2006. Sacramento Convention Center, Sacramento, California.

Slater, S. B. 2006. Regional Food Habits of Pelagic Fishes of the San Francisco Estuary (2005). Presented at the 4th Biennial CALFED Science Conference 2006, October 23-25, 2006. Sacramento Convention Center, Sacramento, California.

Baxter, R., K. Hieb, K. Fleming, and S. Slater. 2006. Grow or Die: Trends in Growth of Pelagic Fishes of the Upper San Francisco Estuary. Presented at the 4th Biennial CALFED Science Conference 2006, October 23-25, 2006. Sacramento Convention Center, Sacramento, California.

Slater, S. B. 2007. Regional Food Habits of Pelagic Fishes of the San Francisco Estuary (2005). Presented the Interagency Ecological Program 2007 Annual Workshop, February 28-March 2, 2007. Asilomar Conference Grounds, Pacific Grove, California.

Slater, S. B. 2008. Feeding Habits of Longfin Smelt in the Upper San Francisco Estuary. Presented at the 5th Biennial CALFED Science Conference 2008. October 22-24, 2008, Sacramento Convention Center, Sacramento, California.

Steven B. Slater. 2010. Effects of Formalin Preservation and Delayed Measurements on Length, Weight, and Condition Estimates of Longfin Smelt, Striped Bass, and Threadfin Shad. Presented the Interagency Ecological Program 2010 Annual Workshop, May 25-26, 2010. California State University, Sacramento, Sacramento, California.

Steven B. Slater. 2011. Allometric Growth in Delta Smelt and Implications for Determination of Condition. Presented the 2011 Interagency Ecological Program Annual Workshop, March 30, 2011. Lake Natoma Inn, Folsom, California.

Bippus, T., M. H. Nicolini, P. Poirier and S. B. Slater. 2011. Feeding Habits Of Adult Delta Smelt in Winter and Spring. Presented at the 10th Biennial State of the San Francisco Estuary Conference, September 20th - 21st, 2011. Oakland Marriott at City Center, Oakland, California.

Bippus, T., A. Cardoza, T. Lee, P. Poirier, and S. Slater. 2013. Comparison Of Adult Delta Smelt Prey Use Between Wet (2011) And Dry (2012) Winters. Presented at the 2013 Interagency Ecological Program Annual Workshop, April 25, 2013. Lake Natoma Inn, Folsom, California.

Furler, A., D. Jordan, T. Bippus, and S. Slater. 2014. Length-Weight Relationships of the Amphipods Americorophium spinicorne and A. stimpsoni in the San Francisco Estuary. Presented at the 2014 Interagency Ecological Program Annual Workshop, February 27, 2014. Lake Natoma Inn, Folsom, California.

Furler, A., T. Bippus, R. Paiste, and S. Slater. 2014. Young stripers with an appetite: age-0 Striped Bass regional diets in fall 2011. Presented at the 8th Biennial Bay-Delta Science Conference. October 28-30, 2014, Sacramento Convention Center, Sacramento, California.

Bippus, T., D. Jordan, A. Furler, S. Slater, G. Schumer, B. Schreier, L. Conrad, and M. Baerwald. 2014. Into the belly of the beast: traditional and genetic prey detection in Liberty Island's Mississippi Silversides. Presented at the 8th Biennial Bay-Delta Science Conference. October 28-30, 2014, Sacramento Convention Center, Sacramento, California.

Furler, A., T. Lee, T. Bippus, and S. Slater. 2015. Examination of stomach development in larval Delta Smelt and implications for diet studies. Presented at the 2015 Interagency Ecological Program Annual Workshop, March 18-20, 2015. Lake Natoma Inn, Folsom, California.

Slater, S., A. Schultz, B. Hammock, A. Hennessy, and C. Burdi. 2019. Patterns of zooplankton consumption by the endangered Delta Smelt (Hypomesus Transpacificus). Presented at the American Fisheries Society and The Wildlife Society 2019 Joint Conference, September 29 – October 3, 2019. Reno-Sparks Convention Center, Reno, Nevada.

Burdi, C. E. 2019. Bugs and Guts: Zooplankton Community Response and Delta Smelt Diets to the Suisun Marsh Salinity Control Gate Project. Oral Presentation to the Estuarine Ecology Project Work Team.

Burdi, C. E. 2019. Bugs and Guts: Zooplankton Community Response and Delta Smelt Diets to the Suisun Marsh Salinity Control Gate Project. American Fisheries Society Annual Meeting.

Jimenez, J.A. and T.L. Bippus. 2020. Cyclopoids. ZoopFest: Zooplankton Identification Workshop.

Jimenez, J.A., T.L. Bippus, and C. E. Burdi. 2020. Fish Guts: Open for a View of Cyclopoids in the San Francisco Estuary. Interagency Ecological Program Virtual Annual Workshop.

Avila, M., T. L. Bippus, and J. A. Jimenez. 2020. Microscopic Tasks of Monumental Importance: Zooplankton and Other Invertebrate Processing by the Bay-Delta Region Labs. CDFW Science Symposium.

Burdi, C. E. 2022. Hunger Games: Dietary overlap in larval Longfin Smelt, Prickly Sculpin, and Pacific Herring in the San Francisco Estuary. IEP Annual Workshop.

Johnson, M.W., T.L. Bippus, and C.E. Burdi. 2022. Acanthocyclops spp. Ecology and Identification. ZoopFest 2022: Zooplankton Workshop on Cyclopoids.

Data Publications:

Slater, S.B., C.E. Burdi, J.W. Gaeta, and M.A. Frick. 2020. Delta Smelt Formalin Fixation and Preservation Effects on Fish Weight and Length ver 1. Environmental Data Initiative. https://doi.org/10.6073/pasta/d4c7a43ba17b2ed1885d42cf0380c1dd