INTERAGENCY ECOLOGICAL PROGRAM
2013 ANNUAL WORKSHOP

APRIL 24 – 26, 2013
LAKE NATOMA INN
FOLSOM, CA

WORKSHOP AT A GLANCE

All oral presentations will be in the Sierra Ballroom and the poster reception will be held in the Pavilion.

WEDNESDAY, APRIL 24

8:00 – 10:15	IEP Registration and Poster Set-up
10:15 – 10:20	Joint IEP and CWEMF Introduction
10:20 – 11:40	Session I - Models of Ecosystem Dynamics
11:40 – 1:10	Lunch
1:10 – 3:00	Session I (continued) - Models of Ecosystem Dynamics
3:00 – 3:20	Break
3:20 – 4:10	Session II - IEP and MAST Update
4:10 – 6:00	IEP Poster Set-up and Viewing

THURSDAY, APRIL 25

8:30 – 9:50	Session III - First Flush at Second Blush
9:50 – 10:10	Break
10:10 – 10:30	Haiku/Poetry Slam Poster Introduction Blitz
10:30 – 12:10	Session IV – From the Rivers to the Bay I: New Tools and Technologies for Understanding and Managing Rivers and Estuaries
12:10 – 1:30	Lunch
1:30 – 3:10	Session V - Making the Most of IEP Monitoring Data: Opportunities and Challenges
3:10 – 3:30	Break
3:30 – 5:00	Session VI - Everybody Talks About it, What are we Doing About it? Collaborative Science Panel Discussion
5:00 – 7:00	Poster Reception

FRIDAY, APRIL 26

8:10 – 10:10	Session VII - Water Quality and Lower Trophic Dynamics
10:10 – 10:30	Break
10:30 – 12:10	Session VIII - Examining Health and Diet Thresholds of Delta Smelt
12:10 – 1:30	Lunch
1:30 – 2:50	Session IX – Tidal Habitat Restoration in the San Francisco Bay: Examples on How to Monitor and Detect Ecosystem Change
2:50 - 3:10	Break
3:10 – 4:30	Session X – From the Rivers to the Bay II: Examining Biological Production, Fish Movement and Trends

GENERAL INFORMATION

Overview: The Interagency Ecological Program (IEP) for the San Francisco Estuary / Sacramento-San Joaquin Delta consists of nine member agencies, three State (Department of Water Resources, Department of Fish and Wildlife, and State Water Resources Control Board) and six Federal (Fish and Wildlife Service, Bureau of Reclamation, Geological Survey, Army Corps of Engineers, NOAA Fisheries, and Environmental Protection Agency). The IEP also partners with the San Francisco Estuary Institute, the Delta Science Program, and many academic and private scientists. The mission of the IEP is, in collaboration with others, to provide ecological information and scientific leadership for use in management of the San Francisco Estuary. More information about the IEP can be found at http://www.water.ca.gov/iep/ .

The annual IEP Workshop serves as a focal point for IEP activities. The program for this year's Workshop is diverse, with many oral and poster presentations and some new activities. This year's Workshop once again features a full three-day program and coordination with the California Water and Environmental Modeling Forum (CWEMF, http://cwemf.org/). The CWEMF annual meeting is taking place April 22-24 at the Lake Natoma Inn, and a joint CWEMF-IEP session about ecosystem restoration modeling will be held on April 24. There will also be a panel discussion about collaborative science featuring IEP agency Directors, scientists and stakeholders of the IEP on April 25. Also on April 25, the IEP will host a luncheon for early career scientists to meet with established IEP professionals and academia.

2013 IEP Workshop Program Committee: Lenny Grimaldo (USBR, Chair), Josh Israel (USBR), Lori Smith (USFWS), Fred Feyrer (USBR), Steve Culberson (USFWS), Louise Conrad (CDWR), Elaine Bartolomew (CVRWQCB), Kari Daniska (CVRWQCB), B.J. Miller (San Luis and Delta Mendota Water Agency), Deanna Serrano (CCWD), Matt Moses (CCWD), Anke Mueller-Solger (DSC), and Kelly Souza (CDFW).

WEDNESDAY, APRIL 24

JOINT CWEMF AND IEP INTRODUCTION AND RESTORATION MODELING SESSION

Moderator: Lenny Grimaldo (USBR)
Location: Sierra Ballroom
10:15 – 10:20

SESSION I – MODELS OF ECOSYSTEM DYNAMICS

Moderator: Chris Enright (DSC)
Location: Sierra Ballroom

10:20-10:40	We Need to do the Modeling: Imagining How Models and Modelers Advance Understanding of the San Francisco Estuary	Chris Enright, DSC
10:40-11:00	Physical Processes Influencing Habitat at a Breached Delta Island: Implications for Restoration Management and Planning	Matt Brennan, ESA
11:00-11:20	Bay-Delta EDT: A Tool for Restoration Planning	Chip McConnaha, ICF
11:20-11:40	Are Shallower, Slower Habitats Necessarily "Greener"? How Clams Upend Conceptual Models Guiding Ecosystem Management in the Delta	Lisa Lucas, USGS

11:40 – 1:10 Lunch Location: Area restaurants

SESSION I (CONTINUED) – MODELS OF ECOSYSTEM DYNAMICS

Moderator: Marianne Guerin (RMA)
Location: Sierra Ballroom

1:10-1:30	Yolo Bypass Ecosystem Reconciliation – Insights from Many Models and Lots of Field Work	Robyn Suddeth, UCD
1:30-1:50	Mathematical Models in Support of Restoration: Examples from the Klamath Basin and Beyond	Mike Deas, Watercourse Eng.
1:50-2:10	San Joaquin River Restoration Program Use of Modeling Tools to Guide Floodplain Restoration	Katrina Harrison, USBR
2:10-2:30	Applying Modeling Results to Tidal Restoration Project Alternatives Development and Selection: Prospect Island	Stuart Siegel, WWR
2:30-3:00	Habitat Restoration in the Delta: The Delta Independent Science Board Review	John Wiens, Delta ISB

3:00 – 3:20 Break

SESSION II – IEP INTRODUCTION AND MAST UPDATE

MODERATOR: DAVID VAN RIJN (USBR)

LOCATION: SIERRA ROOM

3:20-3:50	IEP Introduction, Science Highlights, and Program Update	Anke Mueller-Solger, DSC and Gregg Erickson, CDFW
3:50-4:10	MAST Synthesis Report: A Four Year Comparison of Delta Smelt Drivers	Larry Brown, USGS

THURSDAY, APRIL 25

SESSION III – FIRST FLUSH AT SECOND BLUSH

Moderator: Mike Hoover (USFWS)

Location: Sierra Ballroom

8:30-8:50	Delta Sediment Transport and Turbidity During the December 2012 'First Flush' Runoff Event	Scott Wright, USGS
8:50-9:10	The Hydrodynamics of Position Maintenance and Upmigration of Delta Smelt	Jon Burau, USGS
9:10-9:30	Riders on the Storm: Tides, Turbidity, and Transitory Traveling Delta Smelt	Bill Bennett, UCD
9:30-9:50	Feeding Ecology of Adult Delta Smelt During a Seasonal Pulse of Turbidity	Aaron Johnson, SFSU-RTC

9:50 – 10:10 Break

10:10-10:30 Haiku/Poetry Slam Poster Introduction Blitz

Moderator: Steve Culberson (USFWS)

SESSION IV – FROM THE RIVERS TO THE BAY I: NEW TOOLS AND TECHNOLOGIES FOR UNDERSTANDING AND MANAGING RIVERS AND ESTUARIES

Moderator: Tanis Toland (USACE)

Location: Sierra Ballroom

10:30-10:50	Facilitating Science Communication and Community: California Estuary Monitoring Workgroup Tool	Val Connor, SFCWA
10:50-11:10	The Pulse of the Estuary: Continuous Monitoring Reveals How Conditions in the Lower Sacramento River are Connected to Processes in Liberty Island	Bryan Downing, USGS
11:10-11:30	DNA Barcoding of Zooplankton from Delta Smelt Gut Contents	Tomo Kurobe, UCD

11:30-11:50	Application of Telemetry and Hydrodynamic Data for Levee Design on the Sacramento River	Dave Smith, USACE
11:50-12:10	SmeltCam: Underwater Video Codend for Trawled Nets: An Application to the Distribution of Delta Smelt	Fred Feyrer, USBR

12:10 – 1:30 Lunch
Location: Area restaurants

12:10-1:30 Early Career Scientist Mentor Social
Folsom Room

SESSION V – MAKING THE MOST OF IEP MONITORING DATA: OPPORTUNITIES AND CHALLENGES AHEAD
Moderator: Joe Kirsch (USFWS)
Location: Sierra Ballroom

1:30-1:50	Collapse of South and East Delta Fishes in the Summer Townet Survey	Katherine Osborne, CDFW
1:50-2:10	Estimating the Reproductive Potential of Delta Smelt	Lauren Damon and Julio Adib-Samii, CDFW
2:10-2:30	Through a Glass Darkly: Issues With Inferring Distribution and Abundance from Survey Data	David Fullerton, MWD
2:30-2:50	Catch Me if You Can: Quantifying Relative Species and Size Selectivity of IEP Fish Trawls	Matt Dekar, USFWS
2:50 – 3:10	Implementation of Central Valley Steelhead Monitoring	Ryan Fortier, CDFW

3:10 – 3:30 Break

SESSION VI – EVERYBODY TALKS ABOUT IT, WHAT ARE WE DOING ABOUT IT?
COLLABORATIVE SCIENCE PANEL DISCUSSION
3:30-5:00
MODERATOR: BOB LOHN (RETIRED, NMFS REGIONAL ADMINISTRATOR)
PARTICIPANTS: JEFF KEAY (USGS), REN LOHOEFENER (USFWS), TIM VENDLINKSI (USEPA), BYRON BUCK (STATE AND FEDERAL CWA), CHRISTINA SWANSON (NRDC), PETER GOODWIN (DSC)
Location: Sierra Ballroom

5:00 – 7:00 IEP Poster Reception
Location: Pavilion

FRIDAY, APRIL 26

SESSION VII – WATER QUALITY AND LOWER TROPHIC DYNAMICS

Moderator: Erin Gleason (USFWS)
Location: Sierra Ballroom

8:10-8:30	Sediment Concentration Declines in the San Francisco Bay and Delta: A Summary	Tara Morgan-King, USGS
8:30-8:50	Influence of Particle Properties on Habitat Quality in the San Francisco Estuary	Mike Sauer, USGS
8:50-9:10	Distribution of the Copepod *Pseudodiaptomus forbesi* in Salinity-space	Karen Kayfetz, SFSU-RTC
9:10-9:30	Stable Isotope Analysis of Historical Zooplankton Samples Documents Food Web and Biogeochemical Changes in the San Francisco Estuary	Julien Moderan, SFSU-RTC
9:30-9:50	Limnology of the Sacramento River Deepwater Ship Channel, 2012	Erwin Van Nieuwenhuyse, USBR
9:50-10:10	Effects of the Cyanobacteria *Microcystis aeruginosa* on a Copepod in the San Francisco Estuary	Rita Dumais, SFSU-RTC

10:10 – 10:30 Break

SESSION VIII – EXAMINING HEALTH AND DIET THRESHOLDS OF DELTA SMELT

Moderator: Erin Foresman (EPA)
Location: Sierra Ballroom

10:30-10:50	The Effect of Winter Food Limitation on Delta Smelt Growth and Reproduction – A Pilot Study	Meredith Nagel, UCD
10:50-11:10	Evaluation of Delta Smelt Diet and Nutritional Status During Juvenile Rearing and Adult Spawning Stages	Shawn Acuna, UCD and Steve Slater, CDFW
11:10-11:30	Temperature-dependent Food Consumption of Different Delta Smelt Life Stages	Kai Eder, UCD
11:30-11:50	Does Turbidity Matter for the Health and Reproductive Condition of Delta Smelt	Dolores Baxa, UCD
11:50-12:10	Turbidity, Salinity and Temperature Effects on Physiological and Molecular Stress Responses and Feeding in Juvenile Delta Smelt (*Hypomesus transpacificus*)	Matthias Hasenbein, UCD

12:10 – 1:30 Lunch
Location: Area restaurants

SESSION IX – TIDAL HABITAT RESTORATION IN THE SAN FRANCISCO BAY: EXAMPLES OF HOW TO MONITOR AND DETECT ECOSYSTEM CHANGE

Moderator: Rachel Johnson (USBR)
Location: Sierra Ballroom

1:30-1:50	Fish Monitoring in the South Bay Salt Pond Restoration Program	Jim Hobbs, UCD
1:50-2:10	Experimental Flooding of Agricultural Land as Rearing Habitat for Juvenile Salmon at Knaggs Ranch in the Yolo Bypass	Louise Conrad, CDWR
2:10-2:30	Ecological Modeling of the Liberty Island Marsh Ecosystem	Enrique Reyes, ECU
2:30-2:50	Restoration at the Landscape Scale in the San Francisco Bay Delta	Michelle Orr, ESA

2:50- 3:10 BREAK

SESSION X – FROM THE RIVERS TO THE BAY II: EXAMINING BIOLOGICAL PRODUCTION, FISH MOVEMENTS AND TRENDS

Moderator: Pat Brandes (USFWS)
Location: Sierra Ballroom

3:10-3:30	Does Elevated Ammonia Negatively Impact Phytoplankton Biomass and Community Composition?	Bhupinder Dhaliwal, CCCSD-Consultant
3:30-3:50	Does the Past Predict the Future? Trends and Cycles in San Francisco Estuary Fish Populations from 30+ Years of IEP Sampling	Kathy Hieb, CDFW
3:50-4:10	Late-fall Run Chinook Salmon (*Oncorhynchus tshawytscha*) Smolts and the San Francisco Estuary: Friend or Foe?	Bruce MacFarlane, NFMS
4:10-4:30	Seasonal Movement and Residence Patterns of Sub-adult Striped Bass in the San Francisco Estuary Watershed	Cynthia LeDoux-Bloom, CDWR

2013 IEP Workshop Posters

Evaluation Process for Restoration Design Alternatives Using DRERIP Conceptual Models
Atkins C. [1], A. Ballard [1], B. Herbold[2], S. Siegel [3], and C. Enright[4]
[1] California Department of Fish and Wildlife, Sacramento, CA
[2] Retired, Environmental Protection Agency
[3] Wetlands and Water Resources, San Rafael, CA
[4] Delta Science Program, Delta Stewardship Council, Sacramento, CA

Comparison of Adult Delta Smelt Prey use Between Wet (2011) and Dry (2012) Winters
Bippus T., A. Cardoza, T. Lee, P. Poirier, and S. Slater
California Department of Fish and Wildlife, Stockton, CA

Is There a Credible Alternative to Monitoring Delta Smelt Abundance?
Blankenship S[1] and G. Schumer[1,2]
[1]Cramer Fish Sciences, West Sacramento, CA
[2] Department of Agricultural and Environmental Sciences, University of California, Davis

Delta Science Plan – One Delta, One Science
Brand M., L. Correa, C. Enright, P. Goodwin, S. Harader, L. Hastings, R. Hoenicke, M. Holland, G. Isaac, M. Koller, K. Morrice, E. Mortazavi, and J. Vinton
Delta Science Program, Delta Stewardship Council, Sacramento, CA

Quantifying Incidence of Predation Using Genetic Barcodes and its Potential as a Near Real-Time Ecological Monitoring Tool
Brandl S. [1], G. Schumer[2], B. Schreier[3], J. Louise Conrad[3], B. May[1], and M. Baerwald[1]
[1]Genomic Variation Lab, University of California, Davis.
[2]Cramer Fish Sciences/Genidaqs, West Sacramento, CA
[3]Aquatic Ecology Section, Department of Water Resources, West Sacramento

Otolith Strontium Isotope Life History Reconstructions of Delta Smelt, *Hypomesus transpacificus*
Bush, E.[1] J. Cook[1], N. Ikemiyagi[2], G. Ramos [1], and J. Hobbs[1]
[1] Department of Wildlife, Fish & Conservation Biology, University of California, Davis
[2] California Department of Water Resources, West Sacramento, CA

Modeling The Response Of Delta Smelt *Hypomesus transpacificus* to Fall Outflow and Community Composition in the Low Salinity Habitat
Castillo G.
US Fish & Wildlife Service, Lodi, CA

Visualizing Juvenile Salmonid Behavior, Mortality and Salvage in the Delta: Practical Application of an Individual Based Model
Cavallo B. [1] and T. Hinkelman[2]
[1]Cramer Fish Sciences, Auburn, CA
[2]Datavore Consulting, Lincoln, NE

Compilation of Historical DFW Survey Data of the Arc Project Study Regions: The North Delta Region, Sherman Island, and the Eastern Suisun Marsh Region
Chandos A., J.Durand, P. Moyle, M.Young, K.Perales, and J. Montgumery
Department of Wildlife, Fish & Conservation Biology, University of California, Davis

An Evaluation of the Sensitivity of Lab-Reared and Field-Collected *Hyalella azteca* to the Pyrethroid Insecticide Bifenthrin
Clark S. [1], R. Ogle[1], A. Gantner[1], and G. Mitchell[2]
[1]Pacific EcoRisk, Fairfield, CA.
[2]FMC Agricultural Products, Ewing, NJ.

FLaSH: Growth Dynamics of Delta Smelt, *Hypomesus transpacificus*
Cook J.[1], Bush, E.[1], N. Ikemiyagi[2], G. Ramos [1], and J. Hobbs[1]
[1] Department of Wildlife, Fish & Conservation Biology, University of California, Davis
[2] California Department of Water Resources, West Sacramento, CA

Site Specific Growth of Largemouth Bass, *Micropterus salmoides*, in the SF Bay-Delta
Cook J.[1], J. Hobbs[1], F. Feyrer[2], A. Chandos[1], C. Balagot[1], S. Hanson[1]
[1] Department of Wildlife, Fish & Conservation Biology, University of California, Davis
[2] United States Bureau of Reclamation

Experience the Estuary Workgroup (CEMW) Decision Support Toolset and Projects
Cowin K. [1], S. Fong [1], B. Templin [2], and A. Weber-Stover[3]
[1] State and Federal Contractors Water Agency, Sacramento, CA
[2]California Department of Water Resources, West Sacramento, CA
[3]The Bay Institute, San Francisco, CA

Patterns of Movement and Residency of Sacramento Splittail in a Remnant Tidal Marsh
De Carion D. [1], J.Durand[1], T. O'Rear[1], A.Sih[2], and P.Moyle[1]
[1] Department of Wildlife, Fish & Conservation Biology, University of California, Davis.
[2] Department of Environmental Science & Policy, University of California, Davis.

Continuous Nitrogen and Phosphorus Monitors in Liberty Island, Cache Slough at Ryer Island and Sacramento River at Decker Island
Bryan D., B. Bergamaschi, J. Saraceno, B. Pellerin, M. Sauer and R. Fujii
US Geological Survey, Sacramento, CA

The Past, Present and Future of the Passage Assessment Database; a Tool for Stream Habitat Connectivity Restoration via the Publicly Available Calfish Website
Elston A.[1], and L. Ryley[2]
[1]Pacific States Marine Fisheries Commission, Sacramento, CA
[2]Pacific States Marine Fisheries Commission, Monterey, CA

Enzymatic and Histopathologic Biomarkers of Delta Smelt, *Hypomesus transpacificus*
Gandhi, S and S. Teh
School of Veterinary Medicine, Department of Anatomy, Physiology and Cell Biology, University of California, Davis

EcoAtlas: An Online Management Support Tool for the Delta and San Francisco Bay Ecosystem
Grosso C., K. Cayce, P. Frontiera, and M. Williams
San Francisco Estuary Institute - Aquatic Science Center, Richmond, CA

Ecosystem Restoration Program Overview
Grover J. [1], J. Garcia[1], J. Roeh[1], M. Dunne[2], and T. Porter[2]
[1]California Department of Fish and Wildlife, Sacramento, CA
[2]California Department of Fish and Wildlife, Rancho Cordova, CA

The Comparative Toxicity of Five Pesticides in *Hyalella azteca* and *Chironomus dilutus*
Hasenbein S. [1], K. Callinan[1], J.P. Geist[2], I. Werner[3], A.K. Miles[4], R.E. Connon[1], S. Teh[1], and S.P. Lawler[5]
[1]School of Veterinary Medicine, Department of Anatomy, Physiology and Cell
Biology, University of California, Davis
[2]Chair of Aquatic Systems Biology, Technische Universitaet Muenchen, Germany
[3]Swiss Centre for Applied Ecotoxicology, Eawag/EPFL, Duebendorf, Switzerland
[4]US Geological Survey, Western Ecological Research Center, University of California, Davis
[5]Department of Entomology, University of California, Davis

Collaborative Data Management with the CERES Library
Harris D.
CERES, California Natural Resources Agency, Sacramento, CA

Do Increased Temperature and Salinity Influence the Success of Cyanobacteria in the San Francisco Bay Delta?
Johnson A., A. Parker, and F. Wilkerson
Romberg Tiburon Center, San Francisco State University, Tiburon, CA

The Effects of Salinity on Longfin Smelt Larvae in Rearing Trials
Kammerer B., G. Tigan, and J. Lindberg
School of Veterinary Medicine, Fish Conservation and Culture Lab, University of California, Davis

Ecosystem Restoration Program Delta Project Highlights
Lasko G., and D. Burmester
California Department of Fish and Wildlife, Water Branch, Sacramento, CA

Ammonium vs. Nitrate Uptake by the Cyanohab, *Microcystis aeruginosa*, in the San Francisco Estuary Delta
Lee J., A. Parker, and F. Wilkerson
Romberg Tiburon Center-San Francisco State University, Tiburon, CA

The Importance of Vegetated Versus Open Water Ponds to Material Flux in the Freshwater Tidal Wetland Liberty Island, California
Lehman P. [1], S. Mayer[2], B. Larsen[2], and M. Dempsey[1]
[1]Division of Environmental Services, California Department of Water Resources, West Sacramento, CA
[2]North Central Region Office, California Department of Water Resources, West Sacramento, CA

Characterization of the *Microcystis* Bloom and its Nitrogen Supply in San Francisco Estuary Using Stable Isotopes

Lehman P.[1], C. Kendall[2], M. Guerin[3], M. Young[2] , S. Silva[2], G. Boyer[4] and S. Teh[5].
[1]Division of Environmental Services, California Department of Water Resources, West Sacramento, CA
[2]United States Geological Survey, Menlo Park
[3]Research Management Associates, Fairfield, CA,
[4]College of Environmental Science and Forestry, State University of New York, Syracuse, New York,
[5]School of Veterinary Medicine, Department of Anatomy, Physiology and Cell
Biology, University of California, Davis

A New Exotic Shrimp within the San Francisco Estuary: Coming to a River Near You

Miklos P. and D. Barnard
US Fish & Wildlife Service, Lodi, CA

Energetics of the Invasive Clam, *Potamocorbula amurensis*: The Interactive Role of Temperature, Salinity, and Food Availability

Miller N.[1], X. Chen[1], and J. Stillman[1, 2]
[1]Romberg Tiburon Center, San Francisco State University, Tiburon, CA
[2]Department of Integrative Biology, University of California, Berkeley

Effects of Fin Ray Removal on the Swimming Performance of Sub-adult White Sturgeon

Nguyen P. [1], D. Peterson[1], and Z. Jackson[2]
[1]Warnell School of Forestry and Natural Resources, University of Georgia, Athens
[2]U.S. Fish and Wildlife Service, Lodi, CA

Building and Implementing New Ecological Indicators for California's Streams and Rivers

Ode P. and A. Rehn
Aquatic Bioassessment Laboratory, California Department of Fish and Wildlife, Rancho Cordova, CA

The Summer Townet Delta Smelt Index: A Comparison of Methods

Osborn K. and M. Avila
California Department of Fish and Wildlife, Stockton, CA

Developing Technology Solutions to Support Co-Equal Goals and the Larger Delta Community

Osti A [1], Osti D. [1]
[1]34 North Inc, Truckee, CA

Exploring Water Quality Trends, with an Emphasis on Chlorophyll *A*, Using Georeferenced Water Quality Data within the Tidal Freshwater Cache Slough Complex

Perales K., M. Young, J. Durand, T. O'Rear, J. Montgomery, A. Chandos, J. Hobbs, and P. Moyle.
Center for Watershed Sciences, University of California, Davis

A Morphometric-based Index of Fish Somatic Condition of Delta Smelt, *Hypomesus transpacificus*

Ramos G.[1], S. Acuña[2], J. Hobbs[1], and S. Teh[2]
[1] Department of Wildlife, Fish & Conservation Biology, University of California, Davis
[2] School of Veterinary Medicine, Aquatic Health Program, University of California, Davis

CalFish and the California Fish Passage Assessment Database
Ryley L.
Pacific States Marine Fisheries Commission, Monterey, CA

Reproduction and Mortality of Key Copepods Low-Salinity and Freshwater Habitats of the San Francisco Estuary
Slaughter A. and W. Kimmerer
Romberg Tiburon Center, San Francisco State University, Tiburon, CA

Adaptive Management of Tidal Marsh Habitat Restoration in the Delta: Addressing Uncertainties in Aquatic Food Web Responses
Spautz H. [1,], J. Rosenfield [2], J. Downs [1], N. Clipperton [1], A. Ballard [1], C. Wilcox [1], K. Fritsch [1], and D. Zezulak [1]
[1]California Department of Fish and Wildlife, Water Branch, Sacramento, CA
[2]The Bay Institute, San Francisco, CA

Unprecedented Bloom of Toxin-producing Cyanobacteria in the Southern Bay-Delta Estuary Has Negative Impact on the Aquatic Food Web
Spier C. [1], W.Stringfellow[1,3], J. Hanlon[1,3], M.Brunell[1,2], M. Estiandan[1,2], T. Koski[4], J. Kääriä[4]
[1]Ecological Engineering Research Program, School of Engineering & Computer Science, University of the Pacific, Stockton, CA
[2]Department of Biological Sciences, University of the Pacific, Stockton, CA
[3]Lawrence Berkeley National Laboratory Earth Sciences Division, Berkeley, CA
[4]Turku University of Applied Sciences, Turku, Finland

When to Bolt: Fry or Smolt? Estimating Survivorship of Juvenile Salmon Migratory Life Histories Using Otolith Strontium Isotopes
Sturrock A.[1], T. Heyne[2], J. Wikert[3], C. Mesick [3], P. Weber[4], G. Whitman[1], J. Glessner[5], and R. Johnson[1,6]
[1] Institute of Marine Sciences, University of California, Santa Cruz
[2] California Department of Fish and Wildlife, Tuolumne River Restoration Center, La Grange, CA
[3] US Fish and Wildlife Service, Anadromous Fish Restoration Program, Lodi, CA
[4]Livermore National Laboratory, Chemical Sciences Division, Livermore, CA
[5] Interdisciplinary Center for Plasma Mass Spectrometry, Department of Geology, University of California, Davis
[6] US Bureau of Reclamation Bay-Delta Office , Applied Sciences Branch, Sacramento, CA

Evaluating Fish Behavior Using Acoustic Telemetry
Sullivan C., K. Kumagai, S. Johnston, and B. Rowdon
HTI Hydroacoustic Technology Inc., Seattle, Washington

Development of New Genetic Resources for Management of Central Valley Chinook Salmon
Tomalty K., M. Meek, M. Baerwald, M. Stephens, A. Goodbla, B. May
Department of Animal Science, University of California, Davis

Zebra/Quagga Mussel Monitoring and Research in the State Water Project
Veldhuizen T. and B. Sakata
California Department of Water Resources, Sacramento, CA

How Does Nitrogen Redox State and N:P Stoichiometry Influence Phytoplankton?
Wilkerson F., P. Glibert, A. Parker, R. Dugdale, A. Pimenta, and S. Blaser
Romberg Tiburon Center, San Francisco State University, Tiburon, CA

Preliminary Findings on Fish Communities along the North Delta "Arc"
Young M., J. Durand, T. Orear, M. Perales, A. Chandos, J. Montgomery, J. Hobbs, and P. Moyle
Center for Watershed Sciences, University of California, Davis

ABSTRACTS

2013 IEP PRESENTATIONS

Acuña, Shawn[1] and Steven B. Slater[2], Randall Baxter[2], Swee Teh[1] [1]Aquatic Health Program, UC Davis, 1 Shields Ave, Davis, CA 95616; scacuna@ucdavis.edu, (530) 752-1967, [2]California Department of Fish and Wildlife, 4001 North Wilson Way, Stockton, CA 95205-2486, Steve.Slater@wildlife.ca.gov (209) 948-7800

Evaluation of delta smelt diet and nutritional status during juvenile rearing and adult spawning stages

Abstract: In 2011, the IEP Fall Low Salinity Habitat (FLaSH) studies examined the effects of habitat quality on condition of delta smelt, *Hypomesus transpacificus*, in the San Francisco Estuary (SFE). Our FLaSH study, collaboration with California Department of Fish and Wildlife (CDFW) and the Aquatic Health Program at UC Davis, examined the response of condition and nutritional status with dietary indices in delta smelt. Delta smelt were collected during routine CDFW fish surveys between August 2011 and May 2012. Individual delta smelt were analyzed for dietary indices (feeding incidence, stomach fullness, and prey item composition), condition (condition factor, gonadosomatic, indices, and hepatosomatic indices), and nutritional indices (RNA/DNA and triglyceride concentration). Results were grouped by regions of salinity defined as >6, 1-6, and <1 ppt and also from the Cache Slough-Sacramento River Deep Water Ship Channel (CS-SRDWSC) region. Preliminary results indicate that multiple condition and nutritional indices are highly correlated with dietary indices.

Statement of Relevance: Information presented in this study examines the concepts outlined by the FLaSH to determine the effect of habitat quality on the health of delta smelt and potentially other species of management concern in the upper San Francisco Estuary.

Baxa D.V., Javidmehr A, Kurobe T, Acuña SC, Teh SJ, Aquatic Health Program, School of Veterinary Medicine Department of Anatomy, Physiology, and Cell Biology, University of California Davis dvbaxa@ucdavis.edu, ajavidmehr@ucdavis.edu, tkurobe@ucdavis.edu, scacuna@ucdavis.edu, sjteh@ucdavis.edu

Does turbidity matter on the health and reproductive condition of delta smelt?

Abstract: Delta smelt cohorts were collected in 2010 and along similar habitats in 2011 during the Fall X2 Fish Health survey in the Sacramento–San Joaquin Delta that were mainly affected by "first flush". The goal is to determine the potential role of turbidity and other physicochemical factors on the general health and reproductive potential of delta smelt during low (dry) and high (wet) flow years. Significant differences in water quality were observed between the two years across the sampling sites. Comparative health analyses based on time of collection at "first flush" indicate that indicators of general condition including condition factor, hepato and gonadosomatic indices of female delta smelt in 2010 are significantly higher with mature oocyte stages than

2011 female delta smelt. An assay based on E2, the hormone responsible for sex differentiation and maturation in female fish, was developed for predicting gonad maturity and reproductive potential of wild delta smelt. Cohorts in both years generally harbored *Mycobacterium* (DNA) and other bacteria commonly found in contaminant polluted environments with decreased proportion of Delta smelt harboring bacterial organisms in 2010 (29.74%) compared to 2011 (50.68%) cohorts.

Statement of Relevance: Comprehensive fish health assessments provide the knowledge for predicting the potential effects of environmental conditions associated with first flush on the general health and reproductive potential of delta smelt and other threatened species.

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Suspended Sediment Transport and Geomorphic Processes at a Breached Delta Island: Implications for Restoration Management and Planning

Abstract: Long-term planning for the Delta has identified habitat restoration as a key element for reconciling human impacts with ecosystem function in the Delta. However, the linkages between physical processes and the resulting habitat evolution are not well understood. As part of the BREACH III project team, we have developed hydrodynamic, wind-wave, and sediment transport models for Liberty Island, a former diked area now breached to restore flow, to understand these linkages. We have represented the northwest portion of the Delta, encompassing Liberty Island and surrounding channels, with a two-dimensional hydrodynamic model (Delft3D) coupled with a wind-wave model (SWAN). These two models are used to predict the re-suspension, transport, and deposition of suspended sediment. The models are forced with a range of inputs, including tides, wind, and river discharge, including the Yolo Bypass. By analyzing the predicted response to different forcing conditions and ambient sediment conditions, we assess the implications for restoration management and planning. Applications include: circulation, residence time & export; waves and levee erosion; sediment budget and pathways; the proposed Yolo Bypass conservation measure; and vegetation expansion and habitat evolution.

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Facilitating Science Communication and Community: California Estuary Monitoring Workgroup Tool

Abstract: Getting to "One Delta One Science" in Sacramento San Joaquin estuary will require an integration of science with policy and management action not only at the local level, but at regional and state levels as well. Estuary biology and ecology, along with social, political and economic considerations, can influence policy design and implementation. Decision-support tools can integrate these sciences and facilitate discussion by organizing and simplifying often complex processes into a format that the public, policy makers and managers can understand, use and amend. The California Estuary Monitoring Workgroup (CEMW) is beginning to answer stakeholder questions with a collaborative toolset that brings together peer-reviewed datasets with useful tools to help practitioners tell their stories. This presentation will describe the workgroup's collaborative approach as a workgroup of the CA Water Quality Monitoring Council. The presentation will also demonstrate the current toolset and ongoing efforts.

Statement of Relevance: Decision-support tools can integrate sciences and facilitate discussion by organizing and simplifying often complex processes into a format that the public, policy makers and managers can understand, use and amend.

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Experimental flooding of agricultural land as rearing habitat for juvenile salmon at Knaggs Ranch in the Yolo Bypass

Abstract: Floodplain habitat restoration is an essential aspect of large-scale plans for the Sacramento-San Joaquin Delta, including the Bay Delta Conservation Plan and the National Marine Fisheries Service's Biological Opinion for Chinook salmon. These plans specifically target the Yolo Bypass, a major floodway for the Sacramento area and an agricultural center for the northern Delta. While the benefits of flooded habitat in the Yolo Bypass for juvenile salmon growth and survival have been shown previously, critical uncertainties remain regarding the potential benefits of seasonal, managed inundation of agricultural land for salmon habitat. The 2013 Knaggs Ranch Experimental Floodplain project is investigating juvenile salmon growth and survival, water quality, food web structure, and habitat preference across three basic agricultural land treatments: fallow, disked, and rice stubble. Hatchery origin juvenile salmon were stocked on the experimental floodplain, paired with releases in the Tule Canal of the Yolo Bypass and the Sacramento River for comparison. Across all treatments, juvenile salmon growth was markedly high relative to the Tule Canal comparison release group and historical data for the Yolo Bypass and Sacramento River. Habitat preference assessed by tracking fish movement through an array of passive integrated transponder (PIT) antennas encompassing all three land treatments revealed a higher frequency of detection in the disked habitat. Future work will investigate other challenges to managed inundation strategies, such as comparison of hatchery and natural-origin fish habitat use, understanding the potential impact of bird predation, and determining optimal timing and duration of managed inundation.

Deas, Mike Watercourse Engineering

Mathematical Models in Support of Restoration: Examples from the Klamath Basin and Beyond

Abstract: Mathematical models used to support restoration planning and implementation has been occurring for decades. However, the role of models in restoration has different meanings in different settings and to different people/groups. Examples from the Klamath River basin and other locations are used to identify successes and challenges at a range of scales from local reach restoration to watershed scale efforts. These examples focus on flow or water quality to support restoration of aquatic ecosystem functions (e.g., salmon recovery efforts).

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Catch me if you can: quantifying relative species and size selectivity of IEP fish trawls

Abstract: Gear selectivity evaluations are needed to integrate catch data from multiple trawl surveys to estimate abundance and ultimately to model population dynamics for delta smelt and other species of management concern. We quantified gear selectivity from simultaneous and adjacent deployment of IEP trawls in the lower Sacramento River on 27 September and 25 October, 2012. The experimental design was developed to sample seasonally, targeting different life stages, as delta smelt are captured by various gears. Relative gear selectivity among trawls was analyzed by species, including delta smelt and other species of management concern, and size (fork length). Using a simplifying assumption that the Spring Kodiak Trawl (SKT) was 100% efficient at capturing and retaining delta smelt, we applied the density of fish captured by the SKT to the volume sampled by the other gears to quantify gear selectivity relative to the SKT. Preliminary efforts, targeting juvenile to sub-adult delta

smelt, indicated considerable among-gear variation in selectivity. Standardized to catch-per-unit-effort (CPUE = fish / 10 000 m^3), the SKT captured significantly more delta smelt (n = 435; CPUE = 100.8) in September relative to the other gears, including the Chipps Island Midwater Trawl (CMWT, n = 12; CPUE = 1.3), the Fall Midwater Trawl (FMWT, n = 7; CPUE = 1.0), and the Summer Townet (STN, n = 19; CPUE = 8.2). Similarly, the SKT captured more delta smelt (n = 207; CPUE = 45.1) in October relative to the CMWT (n = 7; CPUE = 0.5), the FMWT (n = 26; CPUE = 4.1) and the STN (n = 8; CPUE = 5.2). In general, the SKT captured the broadest size distribution of delta smelt during both sampling occasions. Relative to the SKT, the CMWT and the FMWT demonstrated low capture efficiency and retention across the size distribution of delta smelt in September. In contrast, the STN was effective at capturing delta smelt in the 45–50 mm range but capture efficiency was low for larger individuals. With additional sampling occasions proposed for 2013, we anticipate developing species-specific models and selectivity curves for each gear type to reduce the uncertainty associated with IEP trawl data.

Statement of Relevance: Gear selectivity evaluations are needed to integrate catch data from multiple trawl surveys to estimate abundance for species of management concern.

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Temperature-dependent Food Consumption of Different Delta Smelt Life Stages

Abstract: Delta and longfin smelt abundance in the San Francisco Estuary has declined dramatically since the 1980s. Individual-based population life-cycle models (IBMs) were developed for both species to explore the population response to various environmental and management scenarios. However, key data gaps exist for the bioenergetics (growth) components of both IBMs, necessitating laboratory studies to determine the quantity of food consumed by delta and longfin smelt. To develop parameters of the consumption component of the bioenergetics model, daily food consumption was determined at three different temperatures. Daily food consumption of juvenile and adult delta smelt was estimated by determining the gastric evacuation rate and quantifying the stomach content during continuous feeding. Procedures to estimate the gastric evacuation rate included starving fish for 24 hours to ensure empty digestive tracts, hand-feeding to satiation with a dry diet, holding in food-free enclosures, and sampling periodically for up to 36 hours post-feeding. To quantify stomach contents during continuous feeding, fish were fed *ad libitum* for five consecutive days and sampled periodically. Similar studies were conducted with larval delta smelt; however, larval fish gut contents were quantified by counting prey extracted from the entire gut. The rate of gastric evacuation of adult delta smelt was highest for fish held at 18.1 ˚C (R = 0.265), while the lowest rate was determined for fish maintained at 10.2 ˚C (R = 0.138). Fish held at 14.1 ˚C had a gastric evacuation rate R of 0.175. In correspondence with these findings, fish maintained at 18.1 ˚C and 14.1 ˚C took less time to evacuate their stomachs (between 15 and 18 hours), while fish at 10.2 ˚C used up to 21 hours to empty their stomachs. Results from continuous feeding experiments indicated that the daily stomach content weight of adult delta smelt held at 10.2 ºC was approximately 50% of the stomach content weight extracted from fish held at 18.1 ºC and 14.1 ºC. In contrast, stomach content weights from fish maintained at 14.1 ºC and 18.1 ºC did not differ. Daily consumption estimates indicated that food uptake of adult fish increased with water temperature increase. While daily food consumption of adult delta smelt was approximately 0.9% of the fish wet weight at 18.1 ºC, significantly less was consumed at lower temperatures. In addition, results from this study suggested that food uptake was low in the morning and increased throughout the day. This trend was observed in all treatment groups, independent of water temperature. Preliminary data suggests similar trends for juvenile and larval delta smelt food consumption.

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Does Elevated Ammonia Negatively Impact Phytoplankton Biomass and Community Composition?

Abstract: Elevated NH_4 has been linked to low phytoplankton biomass. It has been hypothesized that NH_4 (>1-4 µ mol) blocks the phytoplankton uptake of NO_3. Consequently, phytoplankton biomass is relatively lower when NH_4 is present in elevated concentrations even though adequate NO_3 levels exist to support higher levels of phytoplankton. Additionally, elevated NH_4 has been linked to suppression of NH_4 uptake by phytoplankton as well. Further, it has been hypothesized that increased NH_4:NO_3 and N:P ratios cause a shift in phytoplankton composition, from diatoms to flagellates dominance. This shift in phytoplankton composition, in turn, results in relatively less nutritious food for phytoplankton consumers. The reduction of food quality and quantity disrupts the food web and has been considered as one of the causes of pelagic organism decline in the San Francisco Estuary. We present here data from a field study in which NH_4 was deliberately increased and its effects on phytoplankton biomass and composition assessed. The field data shows that a) elevated NH_4 does not negatively impact phytoplankton biomass and b) increased NH_4:NO_3 and N:P ratios do not negatively impact diatom abundance.

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SmeltCam: Underwater video codend for trawled nets with an application to the distribution of delta smelt

Abstract: Studying rare and sensitive species is a challenge in conservation biology. The problem is exemplified by the case of the imperiled delta smelt, a small delicate fish species endemic to the San Francisco Estuary, California. Persistent record-low levels of abundance and relatively high sensitivity to handling stress pose considerable challenges to studying delta smelt in the wild. To attempt to overcome these and other challenges we have developed the SmeltCam, an underwater video camera codend for trawled nets. The SmeltCam functions as an open-ended codend that automatically collects information on the number and species of fishes that pass freely through a trawled net without handling. We applied the SmeltCam to study the fine-scale distribution of juvenile delta smelt in the water column in the upper San Francisco Estuary. We learned that during flood tides delta smelt were relatively abundant throughout the water column and that during ebb tides delta smelt were significantly less abundant and occurred only in the lower half and sides of the water column. The results suggest that delta smelt manipulate their position in the water column to facilitate retention in favorable habitats. With the application of the SmeltCam we increased the survival of individual delta smelt by 72% compared to using a traditional codend, where all of the fish would have likely died due to handling stress. The SmeltCam improves upon similar previously-developed silhouette photography or video recording devices and demonstrates how new technology can be developed to address important questions in conservation biology as well as lessen the negative effects associated with traditional sampling methods on imperiled species.

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Drivers of Estuarine Fish Abundance: Insights from 30 years of Monitoring San Francisco Estuary

Abstract: We provide new insights on drivers of fish abundance in estuaries based upon an examination of over thirty years of monthly data collected in San Francisco Estuary. This monitoring program, started in 1980 by the Interagency Ecological Program, samples both Demersal and pelagic fishes and has resulted in over 30,000 samples containing over 8 million fishes. It is perhaps the most comprehensive estuarine fish data set in the world.

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Implementation of Central Valley Steelhead Monitoring

Abstract: The monitoring implementation plan is a refinement of the "Comprehensive Monitoring Plan for Steelhead in the California Central Valley" (Eilers et al. 2010) that details the specific monitoring equipment and scientific procedures for the mainstem Sacramento River mark-recapture, Sacramento River tributary mark-recapture, and upper Sacramento River tributary escapement monitoring programs to measure Central Valley steelhead life cycle parameters and provide statistically-valid data to guide resource management. Equipment and monitoring procedure selection was based on best available science practices and the least impact to organism behavior and survival. Central Valley steelhead use a variety of stream habitats during various life history stages, therefore, monitoring equipment and monitoring methods were adapted to specific site conditions. Based on historical success in obtaining large quantities of upstream migrating adults for marking and subsequent upstream recapture, construction, and operation of seven fyke traps will be implemented in the mainstem Sacramento River downstream of the American River Confluence. The use of internal half-duplex passive integrated transponder tags and coordinated data management is critical to identification and tracking of individuals throughout the watershed over the course of their life. There will be an enhancement of California Fish and Wildlife angler harvest monitoring and broodstock trapping at Coleman National Fish Hatchery, Feather River State Hatchery, and Nimbus State Hatchery to identify recaptured individuals and quantify angler and hatchery-origin steelhead impacts to the natural population.

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Through a Glass Darkly

Abstract: Catch data from the Fall Midwater Trawl, the Summer Townet, the Spring Kodiak Trawl, the 20 Millimeter Trawl, and the Bay Study surveys are the foundations upon which fish distribution and abundance estimates are commonly made. However, the transformation of computed CPUE values into species distributions and abundance estimates is not straightforward if biases exist in the catch data. The problem is particularly serious if average bias levels differ between years or geographic locations. If bias exists, distributions and abundance estimates will, to some degree, represent the degree of bias rather than actual distributions and abundances. Additional analysis and field work may be needed in order to correct the survey data so that less biased distributions and abundance estimates can be made. Survey bias may be linked to such variables as tidal phase, the time of day the survey is taken, the depth of the water in which the survey is taken, and the turbidity of the water. In turn, average turbidity may be linked to other drivers such as reduced sediment loading and average wind speeds. Evidence will be presented supporting the hypothesis that significant levels of survey bias exist for delta smelt, longfin smelt, striped bass, yellowfin goby and other species. Field and analytical work that might confirm/refute the existence of bias and help to correct for any bias identified will also be presented.

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San Joaquin River Restoration Program Use of Modeling Tools to Guide Floodplain Restoration

The San Joaquin River Settlement Agreement, signed in 2006, requires channel and structural improvements in several reaches of the San Joaquin River to contribute towards the restoration goal of restoring and maintaining fish populations in good condition, with emphasis on Chinook salmon. Floodplain rearing habitat is an important habitat need for juvenile Chinook salmon, and implementation of channel improvements in two reaches will be focusing on increasing floodplain rearing habitat. However, there is uncertainty on: 1) defining floodplain rearing habitat suitable for juvenile Chinook salmon rearing, 2) how much rearing habitat is currently available, and 3) how much floodplain rearing habitat is needed to achieve the Restoration Goal. The SJRRP has developed a number of modeling and analytical tools to inform floodplain management decisions, both at specific channel improvement sites, as well as river-wide. This presentation will provide an overview of those modeling and analytical tools, with focus on how these tools were used to develop minimum rearing habitat area requirements.

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Abstract: The delta smelt (*Hypomesus transpacificus*) is an endangered pelagic fish, endemic to the Sacramento-San Joaquin Estuary and abiotic parameters like turbidity and salinity are known to be of critical importance to the completion of its life cycle. We evaluated the effects of turbidity and salinity on feeding performance and physiological stress response of delta smelt using food intake, transcriptomic assessments as endpoints. Juvenile delta smelt were exposed to a matrix of turbidities and salinities ranging from 5 to 250 NTU and 0.2 to 15 ppt, respectively, for 2 h. Salinity did not significantly impact feeding performance; however, increasing turbidities resulted in reduced feeding rates, especially at 250 NTU. Sodium potassium ATPase - (*Na/K-ATPase*) – an indicator of osmoregulatory stress, and hypothalamic proopiomelanocortin (*POMC*) – a precursor protein to Adrenocorticotropic hormone (*ACTH*; expressed in response to biological stress) were significantly affected by salinity, with greater induction at salinities > 12 ppt, and at < 2 ppt. Glutathione-S-transferase (GST), a phase II detoxification enzyme that protects cells against reactive oxygen species (ROS), was significantly affected by both salinity and turbidity. Overall these data suggest that turbidity is an important determinant of feeding, whereas salinity is an important factor influencing the cellular stress response. Our data support habitat association studies that have shown greater delta smelt abundances in the low salinity zone (0.5-6.0 ppt) of San Francisco Bay, a zone that is also understood to have optimal turbidities. By determining physiological and molecular responses of delta smelt to key abiotic factors such as turbidity and salinity we aim to define the fundamental niche.

Statement of Relevance: Delta smelt are in the center of political and public attention regarding entrainment and water intake policies. Turbidity, salinity and temperature are considered main drivers determining its abundance. This research will aid resource managers in making informed decisions in support of delta smelt conservation approaches in the Sacramento-San Joaquin Estuary.

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Feeding ecology of adult delta smelt during a seasonal pulse of turbidity

Abstract: The delta smelt (*Hypomesus transpacificus*) is a small, pelagic fish endemic to the San Francisco Estuary. Recent declines in the abundance of this species have necessitated its protection under state and federal endangered species acts. We examined the feeding ecology of adult delta smelt before and during the first seasonal pulse of turbidity of the water year that came through the estuary during a heavy rainstorm. We chose this timeframe for sampling because we hypothesized that this first pulse of turbidity would act as a trigger for the delta smelt spawning migration. Our sampling was focused in the Sacramento River, just upstream of the confluence with the San Joaquin River in order to catch migrating fish leaving Suisun Bay on their way upstream. Zooplankton were sampled concurrently with hourly delta smelt sampling over full tidal cycles every other day from December 21, 2010 to January 1, 2011. Gut samples from a selection of fish were analyzed along with concurrent zooplankton samples to compare prey ingested to prey availability. We did not get a clear signal of the migration from our fish sampling, so we were unable to evaluate the role of food availability in migratory behavior. However, the study did reveal some unexpected feeding behavior in delta smelt when compared to previous delta smelt diet studies in the literature. Previous studies of delta smelt feeding at earlier life stages have emphasized calanoid copepods as their main food source, whereas the most frequent prey organisms ingested by delta smelt sampled in this study were cladocerans and epibenthic amphipods. This implies a very different foraging strategy and foraging habitat for adult delta smelt than for earlier life stages. Other studies have found mysid shrimp to be an important prey species for delta smelt during the adult life stage, and mysid shrimp were absent from the guts we analyzed. This may be an indication of a long term feeding shift in adult delta smelt associated with declines in mysid populations in Suisun Bay and the Sacramento-San Joaquin Delta. Comparison of zooplankton samples to gut samples suggests delta smelt selected strongly for amphipods. This may be because the sampling method was intended to sample zooplankton and may not have been adequate for characterizing amphipod abundances. Subsequent sampling protocols have been changed to include methods that will give better estimates of amphipod abundance. Information from this study will increase understanding of foraging behavior and help identify foraging habitats of adult delta smelt during seasonal pulses of turbidity. It will increase understanding of the effects of recent food web changes on delta smelt at the adult life stage. It may also help devise and evaluate management strategies to reduce mortality and restore habitat for this endangered species.

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Distribution of the copepod *Pseudodiaptomus forbesi* in salinity-space

Abstract: Distributions of estuarine organisms are dictated in part by physiological tolerances to salinity, but salinity is not the only factor that determines where species are found. This study examines how biological interactions may influence the distribution of the copepod *Pseudodiaptomus forbesi* in the upper San Francisco Estuary (SFE). Two lines of evidence suggest that biotic interactions, not physiology, limit the range of *P. forbesi* in the SFE. First, historical records show that *P. forbesi* was abundant across a broader range of salinity before than after 1993, when two copepods (*Limnoithona tetraspina* and *Acartiella sinensis*) were introduced to the estuary that may compete with or prey upon *P. forbesi*. Second, laboratory experiments on the salinity tolerance of this species show that it is physiologically capable of tolerating a wider range of salinity than it currently inhabits in the SFE. Feeding experiments show that while *P. forbesi* exploits some food sources that are not used by *L. tetraspina* there is also some overlap, indicating potential for competition. Predation on *P. forbesi* by *A. sinensis* was examined in laboratory experiments and has a small effect on its population. *P. forbesi* is an important food source for many fish species in the SFE including the endangered delta smelt. Understanding the ecology and distribution of this species provides insight into the productivity of the system and the resources available to higher trophic levels.

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DNA barcoding of zooplankton from delta smelt gut contents

Abstract: Zooplankton composition and abundance in the San Francisco Estuary has been intensively monitored by the California Department of Fish and Wildlife over the past 37 years. The standard method used for the identification of zooplankton is based on morphological identification and counting by light microscopy. However, the standard methodology for identification of zooplankton becomes challenging when animals are ingested and morphologically altered, or when specimens are in early life stages (e.g., nauplii). To address these limitations, we adopted a DNA barcoding approach for specific identification of micro and meso zooplankton species present in the gut contents of delta smelt that rely on zooplankton for food. DNA barcoding is a new method of identifying organisms based on species-specific DNA regions. Our study will demonstrate the genetic relationships of various zooplankton species found in delta smelt gut contents and discuss possible future applications of DNA barcodes obtained through the project.

Statement of Relevance: The DNA barcoding system established for zooplankton in this study will support ongoing zooplankton monitoring by providing genetic information on key zooplankton species. In the future, specific identification of zooplankton at early life stages and partly digested in fish gut contents may provide important information on the identity and abundance of ingested zooplankton and their relevance to fish nutrition.

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Seasonal Movement and Residence Patterns of Sub-adult Striped Bass in the San Francisco Estuary Watershed

Abstract: Striped bass *Morone saxatilis* is an introduced, recreationally valuable fish in the San Francisco Estuary Watershed (SFEW). Striped bass young-of-the-year and juvenile stages are well described in the SFEW, however, sub-adults (age 2 in males; age 4-6 in females) remain poorly understood. In this study, we investigated the movement and residence patterns of 99 sub-adult striped bass that were surgically implanted with individually coded acoustic transmitters which were detected by a large (over 300 receivers), cooperative, fixed receiver array over 17 months. Of the 49 fish that were detected for two or more seasons, 43 were included in the statistical and visualization analyses. Movement and residence differed showing three distinct patterns segregated by salinity. Riverine Residents remained within freshwater habitat across all seasons. Low Salinity Zone (LSZ) Residents exhibited movement primarily within mesohaline habitats, seldom visiting the freshwater or marine habitats. The Bay Residents moved within polyhaline and euhaline habitats across all seasons. In late spring 2011, an upstream migration occurred which may indicate that some male fish matured and engaged in their first spawning run. Additionally, 6 fish moved from the LSZ to the South Bay and into Coyote Creek, possibly to spawn. In fall, an upstream foray was undertaken with fish returning to their residence location. Our findings on the movement and residence patterns of sub-adult striped bass concur with historic and recent otolith microchemistry studies in the SFEW, and work on the U.S. Atlantic Coast.

Statement of Relevance: Movement and residence have important consequences to the management of the economically important recreational fishery, Endangered Species Act-listed species recovery plans, and future restoration planning.

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Delta EDT: A tool for restoration planning

Abstract: The Bay-Delta has been greatly altered by development including the loss of much of the tidal marshes and other habitats that supported delta fish species. Restoration of these habitats is likely to be a high priority in the recovery of delta smelt and other species. To be effective, restoration needs a strategic approach based on prioritization of restoration needs, both biologically and spatially, as well as recognition of legal, social and logistical constraints on the feasibility of restoration actions. Restoration of tidal environments in the delta at this scale has not been attempted and considerable learning about restoration is expected through experimentation and adaptive management. A habitat based model, Delta-EDT is being developed that could provide a framework for organizing available information to develop strategies and priorities for restoration of habitat. Delta-EDT provides a comprehensive structure for assembling information from other models, scientific studies and expert knowledge to create an overall working hypothesis that is scalable from the delta to individual projects. The model is based on the Ecosystem Diagnosis & Treatment (EDT) system that has been successfully applied to stream environments and salmonid fishes throughout Washington, Oregon and California. It is being adapted to the complex hydrologic network and unique environment of the delta and to the needs of delta smelt. Delta-EDT evaluates the environment along multiple spatial-temporal pathways defined by the delta smelt life history and plotted across the DSM2 hydrologic network. The quantity and quality of habitat along these pathways is evaluated in terms of the carrying capacity, productivity (density-independent survival) and equilibrium abundance of delta smelt; integration across the multiple pathways provides an estimate of the potential population performance of delta smelt in the modeled environment. The model is scalable spatially (delta-geographic subregions-DSM2 reaches), biologically, by life stage, and environmentally by attribute. Delta-EDT can provide insights into limiting factors and spatial patterns of habitat quality. A particularly powerful feature of EDT is the ability to evaluate life history strategies that define the exposure of fish to conditions in the delta. Conditions can be compared between scenarios (alternative strategies or points in time) to identify restoration priorities (locations and attributes) or to evaluate restoration actions. Delta-EDT is being developed as a tool to analyze habitat needs for delta smelt and to prioritize restoration actions leading to an informed strategy for restoration actions. Development of Delta-EDT to date has provided a modeling structure that has been parameterized to provide a proof-of-concept. The greatest value of Delta-EDT will be realized if it becomes the collective product of scientific and management community to reflect the currently best available science and relevant management questions. The model is now at a point where the scientific and management community can enter the development process by providing knowledge and review leading to a useful framework for restoration strategies.

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Late-fall run Chinook salmon (*Oncorhynchus tshawytscha*) smolts and the San Francisco Estuary: Friend or Foe?

Abstract: Juvenile (smolt) emigration from riverine origins to the ocean is thought to be the most vulnerable life stage in populations of Chinook salmon (*Oncorhynchus tshawytscha*) in California's Central Valley, a recruitment bottleneck of sorts. Consequently, several studies have investigated survival and migration patterns during this life stage in Central Valley watersheds, but there is a severe shortage of information regarding the estuary portion of this emigration, in part due to a difficulty in sampling. Recent advances in the miniaturization of acoustic telemetry transmitters have allowed tagging and tracking of Chinook salmon smolts through this 'black box'. Every winter from 2007 to 2011, 200 to 300 hatchery-origin yearling late-fall run Chinook salmon smolts were tagged and released into the Sacramento River. Acoustic receivers were deployed throughout the watershed, including

five geographically strategic locations to delineate the estuary, starting at Chipps Island and ending at the Golden Gate. Using the Cormack-Jolly-Seber model for live recaptures, reach-specific and total survival estimates for the estuary were calculated. Mean annual survival through the estuary for the five years was 32 % (± 3 % SE); lower than for other large West Coast rivers. Survival models found low support for inter-annual variability in survival rates, but strong support for reach-specific variability. Specifically, estuary survival rates were somewhat similar (~90 % per 10km) among the three reaches farthest from the ocean, but dropped to 68 % per 10km in the final reach from Richmond Bridge to the Golden Gate. It should be noted that the lowest reach-specific survival rate recorded in the river and delta portions of the watershed was 92 %, indicating that the estuary may be the most perilous portion of the late-fall run's outmigration. The overall average travel time through the estuary was 4.4 days (± 0.2 SE), varying significantly by year. Comparing years, there seems to be a correlation between faster travel times and higher total survival, suggesting that survival may be a function of both distance traveled and residence time. Given the relatively fast transit times and low survival in the estuary portion of the outmigration, the function of the estuary *vis-a-vis* yearling Chinook smolts may be no more than a migration corridor.

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Stable Isotope Analysis of Historical Zooplankton Samples Documents Food Web and Biogeochemical Changes in the San Francisco Estuary-Delta

Abstract: We examined trends in carbon and nitrogen stable isotope ratios of zooplankton collected in the IEP long-term monitoring program in the San Francisco Estuary. Stable isotope (SI) analysis is a powerful tool to study nutrient fluxes and food webs in aquatic ecosystems. It has also been successfully applied to retrospective analysis, but often using inert tissues (scales, bones...). Analysis of preserved soft tissues is currently receiving more attention and opens up exciting opportunities to characterize foodweb and biogeochemical changes over time scales of decades using a broader range of organisms. The San Francisco Estuary experiences strong anthropogenic influence, which has resulted in many changes in the structure and dynamic of its food webs and in a strong decline of the pelagic organism biomass. We hypothesize that zooplankton SI composition could reflect trends in the contributions of autochthonous versus terrestrially-derived organic matter (δ13C), or the degree of carnivory, bacterial activity, or nutrient cycling (δ15N). These results could be valuable in improving our understanding of the upper San Francisco Estuary and the possible mechanisms contributing to the Pelagic Organism Decline. To assess our ability to interpret trends in historical samples, we measured the impact of preservation method and storage duration on the SI composition of 8 common estuarine zooplankton species. We reported limited and predictable changes in carbon and nitrogen ratios, validating the use of formalin-preserved zooplankton samples to study how estuarine pelagic foodwebs respond to anthropogenic perturbations. First results from a freshwater station in the San Joaquin River showed no marked trend in SI composition of individual species during summer from 1976 through 2010, but several highly 15N-enriched samples suggest inputs of anthropogenic N to the system and subsequent incorporation in the foodweb. These variations in zooplankton nitrogen isotope composition often appear to be directly related to variations in salinity and nutrients concentration.

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The effect of winter food-limitation on Delta Smelt growth and reproduction – a pilot study

Abstract: The San Francisco Bay Delta Estuary (Bay-Delta) is a dynamic environment that serves as habitat for 750 species of plants and wildlife. Bay-Delta seasonal variation coupled with anthropogenic changes, species introductions, and modified outflows may have contributed to the endangered status of the endemic delta smelt (*Hypomesus transpacificus*). Variation in food availability is common throughout the entire delta smelt life-span, and has been indicated as a potential cause of poor fish health and condition, predation mortality, and reduced abundances in the Bay-Delta. A winter food-limited period, occurring just prior to gametogenesis and the spring spawning season, may have the greatest impact on growth and reproduction in fish. A pilot study was initiated to investigate the effects of winter food-limitation on the growth and fecundity of the delta smelt. The food-limitation period occurred for eight weeks prior to the spring spawning season (December-February). The control group was fed 1.5% of the body weight per day during the winter cold-water period versus the food-limited group which was fed the same ration but only 4 times per week (0.57% of their body weight per day). Following the food-limitation period, females were monitored regularly through the spawning season for mature eggs, number and size of eggs per clutch, and frequency of spawns. Fish were also sub-sampled (every 4-weeks) throughout the experiment for enzymatic and histologic biomarker analysis. Preliminary results indicate delayed initial gonad maturation in both females and males of the food-limited group as compared to the control group.

Statement of Relevance: These laboratory data provide strong evidence of effects of food-limitation on delta smelt reproduction which will help interpret the health and condition of wild-caught fish. The importance of winter food-limitation to reproductive fitness and possible population impacts on delta smelt will be evaluated following completion of the pilot study and larger experiment planned for 2013-2014.

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Restoration at the Landscape Scale in the San Francisco Estuary

Abstract: Regional-scale restoration presents opportunities to restore significant ecosystem benefits. It also introduces complexities that don't typically come into play for smaller restorations. Because of this, successful restoration of larger areas requires more than extrapolating from the experience of smaller sites. This presentation draws primarily on wetland restoration examples from the San Francisco Bay-Delta, with select comparisons to other regional restoration efforts. Projects planned for the Bay-Delta total tens of thousands of acres and would approximately double the extent of tidal habitats. By virtue of their scale, larger restorations have the potential to affect regional processes such as estuarine sedimentation, tidal hydrodynamics, and salinity regime. Successful planning requires that these regional changes are considered in terms of how they affect offsite land uses and the restored areas themselves. Within the restored areas, these changes can affect the evolution of habitats and achievement of restoration goals. This presentation will discuss adaptive management as a means of managing uncertainty in large-scale restoration implementation.

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The South & East Delta Fish Collapse in the Summer Townet Survey

Abstract: The California Department of Fish and Wildlife established The Summer Townet (STN) Survey in 1959 in response to the Central Valley Water Project's development of pumping plants to export water from the Sacramento-San Joaquin Delta. The original purpose of the STN survey was to measure relative abundance of age-0 striped bass (*Morone saxatilis*) and their distribution relative to the location of diversions. Since then, the study focus has broadened, and now all fishes encountered are identified, measured and enumerated. We

examined regional abundance patterns across years for juvenile fishes caught by the STN. We looked at catch per tow as in index of abundance for: A) all fishes, B) two pairs of contrasting fish assemblages, pelagic versus demersal and native versus introduced species, and C) selected species of interest, including striped bass and delta smelt (*Hypomesus transpacificus*). The 31 stations sampled during each STN bi-weekly July survey were grouped into three regions: the High Salinity Region, the lower Sacramento and San Joaquin Rivers, and the South and East Delta. For each region, we examined trends in temperature, specific conductance, and secchi values. Relative abundance dropped in all regions over the 50-plus year course of the study, but the drop was especially pronounced in the South and East Delta region, coincident with an accelerating increase in water clarity. Demersal and native fishes have all but disappeared from catch, while pelagic and introduced fish catch dropped from the thousands to the tens. Although additional gear avoidance would be expected with improved water clarity, improved clarity cannot explain such a precipitous decline across groups.

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Ecological Modeling of the Liberty Island Marsh Ecosystem

Abstract: A landscape vegetation model was developed to provide a predictive level of understanding about abiotic and biotic controls on vegetation colonization and expansion on Liberty Island, with the goal of investigating how to restore wetlands integrating historical and concurrent environmental data, and assess the evolving wetland features at the landscape scale. The initial conceptual model developed from the BREACH studies was used as base for an evolutionary path from subtidal open water, through emergent mudflats to vegetation colonization and ultimately mature marshes. This conceptual model identified different stages in wetland development and articulated the interactions among these factors for intertidal pioneer and mature tule (*Schoenoplectus acutus*) conditions. We implemented this conceptual model unto a large-scale dynamic model to understand how hydrologic and geomorphic changes and ecological responses at different scales from local to the entire restoration site, and relationships to the adjoining landscape. The result was a multiple-scale biophysical model for the Liberty Island marshes capable of simulating long-term regional habitat change. This mechanistic process-based ecological landscape model assessed "restoration thresholds" of emerging wetlands. This type of spatial model incorporates location- specific algorithms to allow feedback between the local processes and landscape dynamics. Thus, the biophysical model for Liberty Island compiles physical and biological information at different scales in three modules: hydrodynamic, soil, and macrophyte productivity dynamically coupled via a *unit ecosystem model.* Calibration results show that plant colonization is highly correlated to water depth and wave exposure. Model results could be used to assess how restoration goals can be met using water transport and routing influence changes in habitat composition within the basin.

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Applying Modeling Results to Tidal Restoration Project Alternatives Development and Selection: Prospect Island

Abstract: Prospect Island is proposed for tidal restoration by the Department of Water Resources as partial fulfillment of the 8,000 acres of tidal restoration required in the 2008 USFWS delta smelt biological opinion and referenced in the 2009 NMFS salmonid biological opinion on the long-term operations of the State Water Project and Central Valley Project. The restoration purposes are, among others, to enhance primary and secondary aquatic food web productivity within Prospect Island and to transport that productivity into surrounding Delta waterways. The 1,600-acre Prospect Island is located at the confluence of Cache Slough, Miner Slough, and the Sacramento Deep Water Ship Channel. We applied hydrodynamic modeling as a key tool for developing restoration alternatives and identifying which alternatives to carry forward into detailed restoration planning, and modeling will continue to be used to refine alternatives and support effects assessment. Prospect Island has the

potential for tidal connections to be located on Miner Slough and/or the DWSC, with the specific breach configuration expected to exert a major influence over aquatic productivity within the site and the transport of that productivity off site. Breach configuration could also influence whether and to what extent a variety of other project effects may occur, both beneficial and adverse. Thirty conceptual alternatives were identified initially and grouped into 15 alternatives for screening-level modeling analysis. This initial modeling examined internal residence time as a proxy for phytoplankton production and particle tracking as a proxy for productivity transport. It also examined flood stage effects, tide stage effects, velocities in Miner Slough and the DWSC, and DOC transport to the Barker Slough Pump Plant. Restoration planners then convened an expert panel two-day workshop that drew extensively upon the modeling results to recommend five alternatives to advance and to recommend modeling approaches for the next phase of analysis. That modeling will soon be initiated. *Note: Collaborative Effort of the Fish Restoration Program Agreement at the Department of Water Resources and California Department of Fish and Wildlife, Wetlands and Water Resources, Stillwater Sciences, cbec eco engineering, and Resource Management Associates with guidance from the Delta Science Program*

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Yolo Bypass Ecosystem Reconciliation – Insights from Many Models and Lots of Field Work

Abstract: The Yolo Bypass is often cited as one of the more promising locations for habitat restoration in the Bay Delta system due to its large size and the benefits it already provides for many fish and waterfowl species. The Yolo Bypass also serves economic and social functions in Yolo County for farmers, duck hunters, and visitors to the state wildlife area. Finally, the Yolo Bypass is important for Sacramento Valley's flood control, able to carry many times the flow of the Sacramento River during floods. This talk presents an overview of past and present efforts to understand the many ecologic, hydraulic, and economic components of Yolo Bypass functioning, and suggests ways to translate this knowledge into promising management alternatives for future reconciliation efforts on the floodplain. A relatively formal method is used to explore promising environmental reconciliation solutions for Yolo Bypass

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Understanding fall phytoplankton blooms in the lower Sacramento River

Abstract: Phytoplankton production in the lower Sacramento River, as in the rest of the Delta, has declined substantially over the last four decades. Low food supply is partly responsible for the low relative abundance of delta smelt and other pelagic fish populations. Increasing the Delta's phytoplankton production may thus help increase pelagic fish production and further the recovery of delta smelt and other listed fish populations. One proposed strategy for accomplishing this objective is to increase the amount of tidal slough and side channel acreage in areas that drain into the Delta. Whether or not such a strategy would succeed is uncertain. This talk will present empirical evidence indicating that a large and sustained phytoplankton bloom in the lower Sacramento River during the fall of 2012 was made possible by the export of phytoplankton from tidal sloughs in the Cache Slough Complex. To better understand the role of tidal sloughs in the formation of blooms in the Delta, we propose two experiments, one near-term focused on stimulating fall blooms in the North Delta, and a second larger experiment focused on restoring fall blooms to the central and south Delta.

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Habitat restoration in the Delta: the Delta Independent Science Board review

Abstract: The 2009 Sacramento-San Joaquin Delta Reform Act created the Delta Independent Science Board (DISB) to provide oversight of science in the Delta in order to achieve the co-equal goals of providing a reliable water supply and restoring and enhancing the Delta ecosystem. The DISB is charged with reviewing scientific research, monitoring, and assessment programs in the Delta that support adaptive management. The reviews focus on broad thematic areas of science applications in the Delta. The first review dealt with habitat restoration, emphasizing how restorations will be managed adaptively in the face of climate change. Between summer 2012 and February 2013, the DISB drew on a variety of sources of information, including interviews with representatives of 25 federal and state agencies, water districts, consultants, non-profit organizations, and universities. The major findings from this review are: (1) There is a high level of dedication and knowledge among those directly involved with habitat restoration in the Delta; (2) Individual restoration projects are generally well-planned and have a strong science foundation; (3) Despite this, there is little coordination and integration among existing or planned restoration projects. Project goals are not interrelated, potential effects of one project or management activity on other projects are not considered, and there is little evidence of planning for long-term changes in the Delta ecosystem. Based on these findings, the DISB recommends:

(1) Establish a mechanism to coordinate planning and implementation of habitat-restoration projects to capitalize on potential synergies and complementarities.

(2) Incorporate uncertainty and potential climate-change effects in the design and implementation of habitat-restoration projects, using modeling tools where appropriate.

(3) Prioritize restoration projects in strategically designed networks to make the best use of limited funds.

(4) Strengthen and integrate scientific information and expertise to support monitoring and adaptive management.

2013 IEP Workshop Poster Presentation Abstracts

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Evaluation Process for Restoration Design Alternatives Using DRERIP Conceptual Models

Abstract: In October 2012, the Ecosystem Restoration Program (ERP) and Fish Restoration Program Agreement (FRPA) staffs assembled a team of experts (hereafter Evaluation Team) to evaluate 15 design alternatives for the Prospect Island tidal wetland restoration project. Substantial habitat restoration for salmon and delta smelt, of which Prospect Island is a lead candidate, is required by the NMFS and USFWS biological opinions for State Water Project and Central Valley Project operations. The Evaluation Team used the Delta Regional Ecosystem

Restoration Implementation Plan (DRERIP) conceptual models and scientific evaluation process to narrow the 15 restoration options to 5 that would be further evaluated through additional modeling and environmental documentation. The design elements considered by the Evaluation Team included varying the number, length, and location of levee breaches; channel morphology; Miner Slough salmonid access; and connectivity between properties, as well as other factors that constrain restoration actions. Hydrodynamic modeling was conducted prior to, and during, the evaluation. The Evaluation Team considered the likely effects on mercury methylation, aquatic vegetation recruitment and establishment, primary productivity, harmful algal blooms, salmonid and delta smelt habitat, predation, and changes in regional hydrodynamics. This process provided a transparent review of the current science and discussion of the potential outcomes of different restoration activities as they relate to the FRPA goals and objectives. This process will be used for future FRPA restoration actions and other related efforts (e.g., BDCP).

Statement of Relevance: This style of evaluation provides transparent, critical review of restoration proposals so that managers may weigh the likely positive and negative outcomes, geographic and temporal scale, reversibility, and overall opportunity for learning associated with different restoration actions.

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Comparison of Adult Delta Smelt Prey Use between Wet (2011) and Dry (2012) winters

Abstract: Delta smelt (*Hypomesus transpacificus*) is one of several pelagic fishes in the estuary that have suffered a steep decline in abundance in recent years, yet increased in number during the wet year of 2011. There is little information on adult delta smelt feeding habits during winter months, the time this species matures gonads for its energetically demanding spring spawning period. This poster will present delta smelt's regional use of prey that occurred during the wet and dry winters of 2011 and 2012, respectively. Adult delta smelt were examined for stomach contents and fullness during the winter months (November-April) of 2011 and 2012. Fish were collected from Suisun Bay upstream through Cache-Slough (CS) and Sacramento River Deep Water Ship Channel (SRDWSC) by California Department of Fish and Wildlife (CDFW) surveys Fall Midwater Trawl and Spring Kodiak Trawl. In winter months, delta smelt consumed a diverse variety of prey types, the majority being calanoid and cyclopoid copepods, cladocerans, amphipods, and mysids. Fish larvae were also found in stomachs of delta smelt collected in Suisun Bay. Delta smelt collected in CS-SRDWSC consumed similar types of prey both winters, primarily copepods and cladocerans, yet the copepod:cladoceran ratio varied between years; the calanoid copepod *Pseudodiaptomus forbesi* was consumed at a high percent by number in winter of 2011 and low percent in 2012 and the opposite annual pattern occurred for percent by number of cladocerans consumed. This study is ongoing and additional results are pending.

Statement of Relevance: This study was conducted as part of the Interagency Ecological Program's (IEP) Fall Low Salinity Habitat (FLaSH) studies to provide information in the management of this fish and its habitat.

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Is there a credible alternative to monitoring Delta smelt abundance?

Abstract: The Independent Review Panel review of Delta smelt Reasonable and Prudent Alternatives stated the lack of N_e information was a critical information gap. Recently, Delta smelt N_e has approached the threshold where long-term population persistence could be impacted. As N_e decreases faster than it increases,

deliberations about ways to improve current methods of tracking abundance (N) may delay recognition of population viability problems. N_e can be estimated with known precision from ongoing surveys using genetic methods that measure indices affected by N_e. In fishes, the most common methods are variance effective size calculations in form, which measure the random loss of alleles. For example, the temporal method compares standardized variances of gene frequencies from two time points, and the linkage disequilibrium method estimates N_e using the magnitude of chance associations of genes between loci. Knowing N_e would both credibly demonstrate whether the Delta smelt population remains above the threshold triggering long-term extinction risk concerns and provide an early warning capability. The next steps are to educate about and foster consensus regarding monitoring N_e.

Statement of Relevance: There is controversy surrounding activities implemented to monitor Delta smelt abundance. While technical groups deliberate, the long term health of the Delta smelt remains uncertain. A scientifically defensible population metric can be quantified from existing activities that directly relates to recovery planning and population viability, the effective population size (N_e).

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Delta Science Plan – One Delta, One Science

Abstract: There are many science efforts in the Sacramento-San Joaquin Delta (Delta), but many are too narrowly focused and uncoordinated to allow synthesis for the broadly integrated knowledge base needed to support adaptive management of the complex Delta ecosystem and water management system. In addition, there is no generally accepted and adequately supported organizational structure and process for developing high-caliber system-wide scientific synthesis and its communication to inform Delta policy and management decision making. The Delta Science Plan is being developed to address these problems. It builds a shared vision and framework for coordination, integration, synthesis, efficient development, and communication of scientific knowledge. The Delta Science Plan aims to achieve the vision of '*One Delta, One Science'* – a framework for an open Delta science community that works together to build a shared state of knowledge with the capacity to adapt and inform future water and environmental decisions. The Delta Science Plan establishes and strengthens science synthesis and communication among policy, science and management communities. It also builds the infrastructure for growing the knowledge base through research, shared modeling, integrated monitoring, improved data management and accessibility, synthesis to accelerate knowledge discovery, independent scientific peer review and advice, and communication. The Delta Science Program is working with others, including the IEP and CWEMF, to develop the Delta Science Plan in response to the Delta Stewardship Council's recommendation in its Delta Plan to develop a Delta Science Plan by December 31, 2013.

Statement of Relevance: The Delta Science Plan builds a shared vision and framework for coordinating, integrating and communicating efficient development of scientific knowledge and synthesis to support Delta water and environmental policy and management decisions.

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Quantifying incidence of predation using genetic barcodes and its potential as a near real-time ecological monitoring tool.

Abstract: Predation on larval fish may be an important factor in the decline of delta smelt and other species in the San Francisco Estuary-Watershed. Visual gut content analysis only shows us part of the picture with a bias toward identification of bony or undigested specimens. Genetic gut content analysis avoids these biases by identifying species' genetic barcodes extracted from predator gut contents. The sensitivity of the method allows us to identify prey composed of soft tissue and prey long after they have been ingested. We are currently investigating the frequency of predation by non-native bass and the native Sacramento pikeminnow on larval and sub-adult threatened and endangered species using quantitative PCR. The data on incidence of predation will be used to identify locations and environmental parameters associated with unwanted predation on at-risk species. With this data, habitat restoration efforts can be fine-tuned to minimize danger to at-risk species. New technology is making near real-time ecological monitoring an attainable goal. Our current project incorporates genetic detection of nine prey species in four predator species using the new high-throughput platform. Increased sample sizes, simultaneous detection of a dozen or more species and fast turnover time makes using qPCR as an ecological monitoring tool feasible. How the new platform works, what is possible and its limitations will be addressed.

Statement of Relevance: We are quantifying incidence of predation on all life stages of delta smelt and other delta species using genetic barcodes. Incidences of predation are used to identify locations where bass prey heavily on at-risk species. With this data, habitat restoration efforts can be fine-tuned to minimize danger to at-risk species.

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Otolith Strontium Isotope Life History Reconstructions of Delta Smelt, Hypomesus transpacificus

Abstract: The USFWS Biological Opinion identified increased fall freshwater outflow as one of the Reasonable and Prudent Alternatives to protect delta smelt from extinction. In the fall of 2011 freshwater outflow in the fall serendipitously meet this criteria and multiple investigators from State, Federal Agencies and the University of California Davis set out to study the impacts of increased fall outflow on the Low-Salinity Habitat of the upper estuary. In collaboration with Interagency Ecological Program (IEP) long-term fish monitoring surveys, this study examined the strontium isotope ratios to assess the life history variability and adult salinity habitats for fish collected in 2005,2006,2010 and 2011. Otolith strontium isotope ratios from birth to death identified several different migratory life history types, including year-round freshwater resident fish, early and late migrating fish and fish that reared in brackish water for their entire life. Patterns appeared to vary between the study years, but due to small sample sizes in 2005-06 and 2010 patterns were obscure. In 2011 we sampled 297 individuals and observed distinct patterns in migration timing, with a two modes of migration out of the lower Sacramento River; one around 30 days old and another between 60-90 days old irrespective of birthday, suggesting behavior control of their migration out of freshwater. The transition to salinities greater than 2ppt however exhibit a more uni-modal distribution suggesting early migrating fish resided in very low salinity waters until a size or age was reached at which higher salinities could be tolerated. Adult salinity history varied considerably among the study years, with 2011 exhibiting the lowest overall adult salinity history, while 2006 had the highest salinity history, although making broad conclusions about previous years may be obscured by the small sample sizes.

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Modeling the Response of Delta Smelt (*Hypomesus transpacificus*) to Fall Outflow and Community Composition in the Low Salinity Habitat

Abstract: The importance of low salinity habitat (LSH) to the delta smelt population is being actively investigated. The objectives of this study were to: 1) construct community models for the delta smelt subsystem under the 3 outflow scenarios, and 2) evaluate the response of the delta smelt population based on model predictions and field data. Signed-digraph qualitative community models were used to evaluate ecological interactions and predicted delta smelt responses under low, intermediate and high outflow scenarios during the fall. The 3 outflow scenarios corresponded to those examined by the Fall Low Salinity Habitat (FLaSH) team based on the near-bottom 2 psu salinity position in the estuary (X2), where X2 of 85, 81 and 74 km correspond respectively to low, intermediate and high daily net outflows of c.a. 5,000, 8,000 and 11,400 cfs. Community composition for each outflow scenario was determined relative to the geographical distribution of the LSH (1-6 psu). The high outflow scenario included 6 variables (phytoplankton, zooplankton, delta smelt, predators of delta smelt, the overbite clam *Potamocorbula amurensis* and outflow). The intermediate outflow scenario included two additional variables (the Asian clam *Corbicula fluminea* and the cyanobacteria *Microcystis aeruginosa*). The low outflow scenario included the same variables as in the intermediate flow scenario except that the overbite clam was excluded and the Brazilian waterweed, *Egeria densa* was added. In response to enhanced outflow, the predicted response of the delta smelt population in the models would be: 1) predominantly positive under the high outflow community scenario, 2) ambiguous under the intermediate outflow community scenario and 3) very ambiguous under the low outflow community scenario. These model predictions are supported by field results and provide additional evidence for the hypothesis that a shift in the LSH towards X2 = 74 km is a necessary condition for the fall outflow action to exert a positive influence on the delta smelt population.

Statement of Relevance: Understanding the mechanisms leading to delta smelt population responses under different outflows conditions is an area of significant interest, both in terms of policy and adaptive management.

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Visualizing juvenile salmonid behavior, mortality and salvage in the Delta: practical application of an individual based model

Abstract: Managers and biologists are expected to manage water project operations and take other actions which can contribute to recovery, or minimally, to provide protection for sensitive fish species. In addition, Delta researchers need a means to quantitatively assess the possible fates of tagged fish between points of detection or recovery. We have developed an individual (or agent-based) model (the IB-DPM) which provides a "sand box" wherein biologists and managers can explore how different assumptions about juvenile salmonid behavior, predation and their respective interactions with hydrodynamic conditions may influence the proportion of fish surviving to Chipps Island or arriving at export facilities. The IB-DPM represents a simplified network of Delta channel which includes primary migratory routes for juvenile salmonids entering from both the Sacramento and San Joaquin Rivers. The routes represented in the IB-DPM include 192 DSM2 channels and 14 channel junctions including two physical barriers (DCC and HORB). Fish migrating through this virtual Delta are influenced by location specific hydrodynamic conditions, predation intensity and gate operations. Hydrodynamic conditions represented in the model are provided by DSM2 HYDRO scenarios representing more than 30 combinations of boundary conditions (exports, inflows, and gate positions). The IB-DPM is written for the Netlogo modeling environment- a cross-platform application that is freely available for download. The IB-DPM provides an example of a powerful, yet relatively simple individual-based modeling approach which can be more broadly applied to enhance understanding and effective management of complex ecological issues in the Delta.

Statement of Relevance: Managers require simple, intuitive models which can effectively integrate biological and physical data to help guide effective management. Our poster will allow conference attendees to interact with such a model, exploring how assumptions about fish behavior, project operations and predation influence the fate of Delta juvenile salmonids.

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Historical Data from the FWS North Bay Aqueduct Study Sites in the North Delta Region of the Arc Project

Abstract: Examining historical data is a useful compliment to current study data. Historical data from relevant sites of the North Bay Aqueduct study in Barker, Lindsey, and Cache sloughs was used to investigate previous trends in fish abundances in the North San Joaquin Delta region. Historical data from the North Bay Aqueduct data set is especially interesting to the "Arc" project being undertaken by UCD biologists due to: the long duration of sampling, from 1993 through 2004 at most sites; because it incorporates data from both high and low water years; and because it includes data from before and after the sudden decline of the species of the POD (pelagic organism decline) that was observed in the Sacramento Delta. The "Arc" Project is currently being conducted by Peter Moyle, John Durand, and collaborators, and is a comprehensive study of water quality, zooplankton, benthic invertebrates, and fish assemblages within three regions of the San Francisco Bay Estuary (Cache Slough complex, Sherman Island, and Suisun Marsh). Sampling consists of continuous water quality monitoring within these regions, otter trawling, minnow trapping, benthic grabs, and zooplankton tows.

Statement of Relevance: The current regions being studied by the UC Davis "Arc" team has yielded detailed information concerning the current fish fauna, invertebrates, zooplankton, and water quality within these regions. Historical DFG data can complement this information, and provide perspective on our current study.

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An evaluation of the sensitivity of lab-reared and field-collected *Hyalella azteca* to the pyrethroid insecticide bifenthrin

Abstract: *Hyalella azteca* are epibenthic macroinvertebrates commonly used for sediment toxicity studies. *H. azteca* has recently seen considerable use in toxicity tests of water samples, as the organisms are reported to be more sensitive to pyrethroid insecticides than other routine invertebrate toxicity test species. Resident *H. azteca* are known to occur, at times in abundance, in some sediment containing pyrethroid pesticides concentrations that are toxic to lab-reared *H. azteca.* This suggests potential significant differences in the sensitivity of lab-reared and resident field populations of *H. azteca* to pyrethroids. The goal of this study was to determine the sensitivity of various *H. azteca* populations, including field populations, to the pyrethroid bifenthrin. *H. azteca* were collected from Pleasant Grove Creek, a site with a historical record of robust populations of *H. azteca*. Lab-reared *H. azteca* were obtained from a widely-used commercial vendor, and were 7-14 days old (and within 2 days of age) when initiating testing. Since the field organisms could not be aged, they were sieved to obtain a size close to that of the lab-reared organisms. The *H. azteca* were exposed to bifenthrin in water for 96-hours. The resulting LC_{50} was 10.6 ng/L and >72 ng/L for the lab and field *H. azteca*, respectively. Based on these results, a follow-up exposure was performed with higher concentrations of bifenthrin. The resulting LC_{50} was 2.7 ng/L and >388 ng/L for the lab and field *H. azteca*, respectively, a difference of greater than two orders of magnitude. Resident *H.* azteca collected from a variety of other sites influenced by both urban and agricultural runoff routinely were less sensitive to bifenthrin than lab-reared organisms, whereas the sensitivity of organisms collected from remote sites that are

not expected to receive urban and/or agricultural runoff were similar in sensitivity to lab-reared organisms.

Statement of Relevance: Laboratory toxicity tests are commonly used to identify the potential for toxicity to occur in ambient waters and sediments since the tests correlate with conditions in the field. However, this study has identified circumstances when these tests don't correlate with toxicity in the field, which can affect an assessment of the status of aquatic ecological conditions.

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FLaSH: Growth Dynamics of Delta Smelt, Hypomesus transpacificus.

Problem Statement: The USFWS Biological Opinion identified increased fall freshwater outflow as one of the Reasonable and Prudent Alternatives to protect delta smelt from extinction. In the fall of 2011 freshwater outflow in the fall serendipitously meet this criteria and multiple investigators from State, Federal Agencies and the University of California Davis set out to study the impacts of increased fall outflow on the Low-Salinity Habitat of the upper estuary. In collaboration with Interagency Ecological Program (IEP) long-term fish monitoring surveys this study utilized the growth rate information in fish ear bones to assess the benefit of increased fall outflow in 2011 on fall specific growth rates for the 2011 cohort and compared growth to 2010 the preceding dry year and the 2006-2005; wet-dry year cycle for additional comparisons of dry to wet years. Our preliminary assessment of fall specific growth suggests the 2011 year-class experienced good growth rates in the fall, however this was primarily due to an ontogenetic difference in the size and birthdates of fish in 2011 due to the cool spring-summer water temperatures and later spawning events. In addition to the analysis regarding the fall of 2011, we also developed a novel approach to compare otolith based growth rates by fitting traditional Gompertz growth models to back-calculated size-at-age data for individuals, creating a parameterized model that could describe growth curves at different life stages and directly compare otolith growth increments size-at-age as a benchmark proxy for delta smelt otolith growth rates and make comparisons among the 2011-2010, 2006-2005 study years.

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Site Specific Growth of Largemouth Bass, *Micropterus salmoides*, in the SF Bay-Delta.

Abstract: The goal of the project was to assess the effects of different environmental conditions on the growth of young of the year (YOY) and adult largemouth bass (LMB) in the SF Bay Delta. Over the course of two years, 2010 and 2011, LMB were collected from 4 sites in the Delta during the months of July and August by DC electrofishing. The sites include Sherman Island, Big Break, Franks Tract and Mildred Island (west to east). They were chosen to include a wide range of water quality metrics such as salinity, temperature and dissolved oxygen. In past studies, salinity and temperature were found to have a significant effect on the growth and maximum size of LMB (DeVries et al., 2013). Overall, we aged 676 otoliths from individual fish by mounting, sanding and polishing them to expose daily annuli. We then used Image J to count the annuli and measure their respective distance from the core in microns. To quantify growth rate we used the direct-proportion method to estimate the size of the fish using increment widths and calculate the change in body length over time (Schramm et al., 1992). Preliminary data suggests that Big Break and Franks Tract had higher growth rates than those of Sherman Island and Mildred Island in 2010.

Statement of Relevance: This project is relevant to water policy and management because it addresses the ways in which Largemouth bass growth is affected by water quality differences in a dry year 2010 and a wet year 2011.

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California Estuary Monitoring Workgroup – Using Web Portals to Improve Scientific Understanding

Abstract: The California Estuary Monitoring Workgroup (CEMW) is continuing efforts to develop the public portal, improve web-based collaboration tools, enhance access to environmental monitoring data, and identify performance measures (ecosystem health indicators with target goals). Learn why you should, and how you can, be part of this collaborative effort, involving multiple government agencies and non-government organizations, working toward improved estuarine science, restoration and protection of beneficial uses.

Statement of Relevance: This portal uses IEP data and other data sources to inform management decisions with unified science.

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Patterns of movement and residency of Sacramento splittail in a remnant tidal marsh

Abstract: Diking has extensively disconnected marsh plains and slough networks in Suisun Marsh, with poorly understood consequences for native fishes. Data collected by the University of California, Davis Suisun Marsh Fish Study suggest that the First and Second Mallard Slough tidal marsh network, which contains the largest remaining undiked habitat in Suisun Marsh, provides refuge for at-risk native fish species. In particular, First Mallard Slough is consistently inhabited by Sacramento splittail (*Pogonichthys macrolepidotus*) and yields higher than average catches of young-of-year compared to other areas in Suisun Marsh. While this remnant tidal marsh network offers a range of natural physical and ecological functions to which native fish species are adapted, no factor is likely as important to native fish distribution and abundance as the presence of intertidal marsh channels. Intertidal marsh channels are shallow, sinuous waterways that flood and drain with the tides and that provide nursery grounds for juvenile fishes. My study examines how native fishes use these distinctive geomorphic features by quantifying individual variation in patterns of movement and residency of Sacramento splittail using Passive Integrated Transponder (PIT) tag technology. A clear understanding of their behavior in remnant tidal marshes is needed for defining habitat-specific goals for tidal marsh restoration in the lower San Francisco Estuary.

Statement of Relevance: Currently, there is little consensus among resource managers in the SFE regarding the benefit of tidal marsh restoration for native fishes. This is especially true of Sacramento splittail, arguably the native fish most dependent on tidal marsh for growth and survival.

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The Past, Present and Future of the Passage Assessment Database, a Tool for Stream Habitat Connectivity Restoration via the Publicly Available CalFish Website

Abstract: In recognition of the importance of restoring California's once-abundant salmon and steelhead

populations, an inter-agency cooperative project was initiated to inventory barriers to fish passage throughout the coastal watersheds of California. The Passage Assessment Database (PAD) is an ongoing map-based inventory of known and potential barriers to fish in California. The PAD compiles currently available fish passage information from several sources, including federal, state and local government agencies and from non-governmental sources throughout California. The PAD is publicly available via the CalFish website (www.calfish.org). CalFish, a California Cooperative Anadromous Fish and Habitat Data Program, is a multi-agency website presenting anadromous fish, stream habitat and migration barrier data in California which includes standards and tools used for the collection, management and analysis of these data. The poster will include an overview of the PAD, a description of PAD's past and future, newly implemented standards and improvements including a new field for capturing species benefited from barrier removal, use CalFish as a tool to access and review PAD data, and a discussion of how future contributions can be made to the dataset. The presentation will also include a description of other datasets available on CalFish; CalFish tools for analyzing data and answering commonly asked questions; and new barrier remediation reports.

Statement of Relevance: The PAD enables the analysis of the cumulative impacts of barriers on fish migration. It is an important management tool for determining the outcomes of fish passage improvement projects. Data on CalFish are applicable to policy, planning, management and recovery of anadromous fish and related aquatic resources in California.

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Enzymatic and Histopathologic biomarkers of delta smelt, *Hypomesus transpacificus*

Abstract: The Fall Low Salinity Habitat (FLaSH) study examined the potential effect habitat quality has on the health, nutrition, and reproductive status of the delta smelt (*Hypomesus transpacificus*) within the San Francisco Estuary (SFE). In collaboration with California Department of Fish and Wildlife (CDFGW) long-term fish monitoring surveys, the Summer Tow Net, Fall Midwater Trawl and the Spring Kodiak Trawl, the FLaSH has been investigating delta smelt health occupying the SFE. This study examined the effects of xenobiotics on delta smelt, *Hypomesus transpacificus* in the SFE using biochemical and histopathologic biomarkers. Acetyl cholinesterase (AChE), Sodium Potassium Adenosine Triphosphate (Na^+K^+ ATPase) and Ethoxyresorufin O-deethylase (EROD) can be used as biomarker of exposure to metal, organophosphate (OP), carbamate pesticides, PAH and PCB contaminants in aquatic biota. These enzymes when combined with histopathology have the potential to serve as a biomarker of toxic stress and to serve as sensitive parameters for testing exposure of organisms to toxicants. Results of our study indicated fish collected at certain sites from August 2011 to May 2012 had low AChE, Na^+K^+ ATPase and EROD activity which suggesting contaminant etiology. Comparison of enzymatic and histopathologic biomarkers on fish collected during December 2011 and December 2012 will be performed and presented. These results will serve as baseline information to study the health status of delta smelt between wet (December 2011) and dry (December 2012) years.

Statement of Relevance: This data will provide significant understanding of the relative importance of different toxic contaminants that affect the fish health in the SFE. The comparative study will provide a baseline to study the health status of delta smelt between wet and dry years.

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EcoAtlas: An Online Management Support Tool for the Delta and San Francisco Bay Ecosystem

Abstract: Effective management of the Bay-Delta ecosystem requires synthesis of multiple data types related to

wetland extent and condition. Consideration of objectives for water supply, water quality, habitat, recreation, flood protection, agriculture, and industry requires timely access to environmental data and information that is specifically formatted to support management decisions at site-specific and landscape scales. EcoAtlas is an online tool developed through the Wetland Monitoring Workgroup of the Water Quality Monitoring Council to enable integration of a wide range of data in order to meet federal and state reporting requirements about wetland extent and condition, restoration activity, and water quality conditions in the system. It complements the Monitoring Council's more publicly targeted Wetlands Portal. We will present how this online tool can be used to aggregate and synthesize the data needed to support specific planning, reporting and management actions: compensatory mitigation planning at the landscape scale, climate change planning, and 305(b) reporting. Its interactive maps and project tracking tools enable users to easily access, analyze, synthesize, and visualize different data sets in a spatial context. EcoAtlas serves both spatial and tabular point data. Spatial layers include historical wetlands maps, permitted project information, and maps of current wetlands extent via the California Aquatic Resources Inventory. Additionally, data from surveys of wetland condition using the California Rapid Assessment Method (CRAM) and CEDEN can be displayed spatially in the map. A Landscape Profile tool is embedded in EcoAtlas so that users can explore a particular area of interest. The Landscape Profile is a report compiling information relevant to management of natural resources – especially streams, wetlands, and open water features. The summary includes aquatic resource extent, CRAM wetland condition results, restoration activity; potential threatened or endangered species, and land use and census information. Data are provided from multiple publicly available sources using web services.

Statement of Relevance: EcoAtlas functionality addresses multiple agency concerns: (1) planning and coordinating restoration and compensatory mitigation; (2) incorporating wetlands and riparian areas into Integrated Reporting (CWA Sections 305(b)/303(d)); and (3) coordinating mitigation planning and Endangered Species Act decisions. The tool supports the emerging State Water Board's Wetland and Riparian Area Protection Policy.

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Ecosystem Restoration Program Overview

Abstract: The CALFED Bay-Delta Program (CALFED Program) was created in December 1994 with the signing of the Bay-Delta Accord, as an unprecedented effort to better manage California's water. The CALFED Program's mission was to establish a long-term comprehensive plan that would restore ecosystem health, and improve water management for beneficial uses of the Bay-Delta system by addressing ecosystem quality, water quality, water supply reliability, and levee system vulnerability. As one of the original CALFED Program Elements, the Ecosystem Restoration Program (ERP) continues to support a vision to increase the extent of aquatic and terrestrial habitats, and improve ecological functions to support sustainable populations of native plant and animal species in the Bay-Delta and its watershed. To accomplish this vision, the ERP administers a grant program that has provided funding opportunities for over 500 restoration projects ranging from research to full-scale implementation. Administration of the ERP is carried out by the California Department of Fish and Wildlife, in coordination with the United States Fish and Wildlife Service and the National Oceanic and Atmospheric Administration Fisheries Service. The ERP priorities for the Bay-Delta, Sacramento Valley, and San Joaquin Valley Regions focus on improving and restoring the integrity of estuary and watershed ecosystems to sustain native fish, wildlife, and plant communities.

Statement of Relevance: The CALFED Program was created to develop solutions for water and environmental management problems of the Bay-Delta System. The ERP Program continues to support research, planning, and

restoration implementation projects that increase our scientific understanding of Bay-Delta ecosystems, environmental water quality, and ecological trade-offs with water management alternatives.

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Collaborative Data Management with the CERES Library

Abstract: In order to promote open access to research data, many agencies require that data be made publicly available. Researchers can comply with these requirements by depositing data into a repository which provides built-in support for good data management practices. The CERES Library, formerly known as CEIC, is an online directory for sharing and discovering valuable environmental information resources for California, and includes about 7,000 entries in electronic format. It is a partnership of numerous organizations including cities, counties, utilities, state and federal agencies, private businesses and academic institutions. The updated CERES site includes a more powerful search interface, and a data contribution interface that is secure, simple, fast, and easy to use. It contains both geospatial and non-geospatial data and links, and allows users to enter, edit, visualize, and download. By building connections within the community, the CERES Library facilitates discovery of information that contributes to effective natural resource management. The site can support a variety of data management initiatives including projects by individuals, programs, departments, and multi-organizational teams. The data contribution interface organizes data products into "workgroups" for easier collaboration. Files may be archived, not merely cataloged, to ensure preservation of valuable data. The library enhances participant capacity to synthesize, analyze, and assimilate data, assisting policymakers in making more informed decisions. To maximize exposure of data products, the CERES Library exports to popular web search engines. The CERES Library is integrated into a federated network of data access sites such as the California State Geoportal, preventing the need to re-key and avoiding duplication of effort. The CERES Library reduces costs by decreasing the time it takes to find data to hours instead of months. It reduces data collection timeframes for GIS projects and reduces development and maintenance of inconsistent data.

Statement of Relevance: The CERES Library facilitates data management for California Natural Resources Agency entities and partners through enhanced search, contribution, and mapping interfaces. Good data management supports science that promotes effective environmental management and policy. The library includes contributions from over 250 California conservation science, management and policy organizations.

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The comparative toxicity of five pesticides in *Hyalella azteca* and *Chironomus dilutus*

Abstract: The substantial use of chemicals around the Sacramento-San Joaquin River Delta has resulted in pesticides detected in water, sediment, and biota at levels that can be toxic to non-target organisms, such as fish and aquatic invertebrates. Organophosphate and pyrethroid insecticides are of particular importance due to their broad-spectrum aquatic toxicities. The purpose of this study was to compare the toxic effects of five insecticides of concern (permethrin, bifenthrin, cyfluthrin, lambda-cyhalothrin and chlorpyrifos) on two widely used standard freshwater test species, *Hyalella azteca* and *Chironomus dilutus.* Both are resident species within the Delta and

have been shown to be highly sensitive to pyrethroids and organophosphates. Log-logistic, Weibull or hormetic dose-response models were performed, based on a best-fit analysis using Akaike's Information Criteria, for the evaluation of survival, swimming performance and growth across both species. Ten-day tests with *H. azteca* resulted in lower lethal concentration values than *C. dilutus* across all chemicals tested. Sublethal effects, however, were more pronounced in *C. dilutus,* and occurred at a fraction of lethal effect concentrations. Lambda-cyhalothrin caused the greatest effect on mean swimming velocity (38% of control), followed by permethrin (47%), cyfluthrin (50%), chlorpyrifos (55%), and bifenthrin (82%). End dry weight was measured as low as 24% of the control for bifenthrin and lambda-cyhalothrin, 33% for cyfluthrin, 37% for permethrin, and 69% for chlorpyrifos. On the other hand, lethal and sublethal responses coincided with *H. azteca*, most often exhibiting sublethal effects only at concentrations that also caused mortality. Sublethal responses were still measureable, however, showing a 30-66% mean decrease in swimming performance and an 18-65% decrease in growth. Results indicate that patterns in sublethal responses vary across species, and that mortality alone does not encompass all ecologically important effects, even for low trophic-level, aquatic invertebrates like *H. azteca* and *C. dilutus.*

Statement of Relevance: This study highlights the importance of using multiple endpoints to adequately assess the effects of contaminants on aquatic species. While lethal and sublethal effects may fall within a short range of concentrations for some species (such as *H. azteca*), other species experience substantial and ecologically relevant effects at concentrations far below lethal levels.

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Do increased temperature and salinity influence the success of cyanobacteria in the San Francisco Bay Delta?

Abstract: Models of climate change indicate that estuaries will likely contend with both increasing water temperature and increasing salinity (a result of sea level rise). These drivers are hypothesized to promote the occurrence of cyanobacteria blooms globally and shift estuaries towards cyanobacteria dominance. The San Francisco Estuary Delta (Delta) may already be experiencing just such a shift. Blooms of toxic cyanobacteria in the Delta have been increasing since 1999 and affect water quality, the estuarine food web and potentially human health. Of the cyanobacteria occurring in the Delta, the cyanoHAB *Microcystis aeruginosa* tends to dominate the community during summer. With the goal of understanding how temperature and salinity influence cyanobacteria success in the Delta, a series of 20-L enclosures and small bottle experiments were conducted using field collected phytoplankton including cyanobacteria-dominant assemblages. Chlorophyll-a and cyanobacterial biomass responded favorably to warmer water temperature. Cyanobacteria grew at substantially higher salinities compared to where they currently occur in the Delta, suggesting the potential for habitat expansion. These data linking cyanobacteria to conditions associated with predicted climate change provides insight into the future microbial community structure and function in the Delta.

Statement of Relevance: The persistence of summer cyanoHAB blooms in the Sacramento – San Joaquin Delta represent an ecosystem level change in the environment. CyanoHABs have the potential to affect water resources, via production of cyanotoxins harmful to human health, alter foodweb structure, and alter aesthetics.

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The effects of salinity on longfin smelt larvae in rearing trials

Abstract: Longfin smelt (LFS) are an imperiled, euryhaline osmerid of the San Francisco Estuary (SFE), thought to spawn and rear in low-salinity waters (0-10ppt). Understanding the tolerances of larvae to salinity where they rear at early life stages, may inform estuary and fishery management efforts. Rearing trials were conducted with two early life stages: early larvae (0-42 days post hatch (dph)) and late-larvae (50-92 dph), to assess the effects of gradually increasing salinity on activity level, feeding, size, and survival. Larvae were stocked in black tanks (n=3) in re-circulating, bio-filtered systems at 11±1°C and fed rotifers and artemia for early larvae or artemia only for late-larvae in algal-turbidities of 10±2 NTU. Two saline conditions were tested with early larvae: Instant Ocean (IO) or salt (NaCl), increased at 1 ppt/ week, as compared to fresh water (FW) ; late larvae were tested with the IO and FW only, increased at 2 ppt/week. Larval activity was assessed visually 15 minutes after feeding (3 times/wk for 15 seconds). Gut content evaluation and total lengths measurements were taken 3 times/wk (10 fish/tank). Survival was determined by monitoring mortalities and counting fish at the end of trials. Early larvae lengths increased while gut fullness and larval activity decreased, and mortalities decreased in NaCl ≥3 ppt (>29 dph). Survival was significantly lower in NaCl (18%), though it remained similar in IO and FW (72-75%). In late larvae, activity after feeding was higher in IO than FW. Gut fullness, length of larvae, and mortalities also increased with salinity. Results indicate longfin larvae are sensitive to the type of salt water they are reared in, being far more tolerant of IO than NaCl. Data suggest that larvae actively or passively transported to low salinity water after hatch, will feed, grow, and survive well.

Statement of Relevance: This data provides evidence that could influence the management of Delta water outflow as larval tolerances may underlie their relationship to it. Understanding the conditions which benefit longfin smelt larvae could affect how Delta pumping, with respect to salinity zones, is managed in the interests of this species.

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Ecosystem Restoration Program Delta Project Highlights

Abstract: Since its inception in 1995, the Ecosystem Restoration Program (ERP) has been at the forefront of restoration efforts in the Delta and its watersheds, awarding over $700 million in grants to more than 500 projects. ERP has acquired or restored over 82,000 acres of habitat program wide and is currently managing over 75 projects. ERP has funded and will continue to fund projects that have an important impact on restoration and management practices in the Bay-Delta ecosystem. ERP has funded a diverse set of projects providing multiple benefits that address ERP Strategic Goals and Objectives. These projects have made significant progress toward understanding species requirements, habitat restoration strategies, ecological process rehabilitation, and stressor reduction in the Bay-Delta ecosystem. ERP continues to fund projects that restore habitat, reduce entrainment, improve fish passage, improve ecosystem water and sediment quality, assess at-risk species, and research hydrodynamic sediment transport and flow regimes. Scientific and management implications of ERP funded projects are numerous and range from providing technical assistance for development of the Delta Plan and the Bay-Delta Conservation Plan, to bridging data gaps, and prioritizing Bay-Delta ecosystem restoration needs. Sharing findings and documenting achievements are important to tracking and improving the health of the Bay-Delta ecosystem. ERP is committed to knowledge transfer and communication of project success for future application.

Statement of Relevance: The Ecosystem Restoration Program (ERP) has played a significant role in advancing the understanding of processes, functions, and the species that make up the Bay-Delta ecosystem. ERP will continue

to fund relevant projects that incorporate the latest knowledge and address existing and emerging challenges faced by the ecosystem with the goal of restoring a healthy Bay-Delta ecosystem.

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Ammonium vs. Nitrate Uptake by the cyanoHAB *Microcystis aeruginosa* in the San Francisco Estuary Delta

Abstract: In the last decade there has been an apparent increase in frequency and intensity of the harmful cyanobacterial blooms of *Microcystis aeruginosa* in the San Francisco Estuary Delta (Delta), the heart of California's water infrastructure. It has been hypothesized that nutrients, especially nitrogen, may promote these blooms but little is known about which chemical forms of nitrogen are used by *M. aeruginosa* in the Delta. Nitrogen uptake kinetic experiments were conducted using four ^{15}N-labeled substrates (nitrate, ammonium, urea and glutamic acid). Uptake by field-collected *M. aeruginosa* was assessed at ambient Delta water temperatures after 1 hour. Maximum specific uptake rates were highest for ammonium and lowest for glutamic acid. *M. aeruginosa* showed preference for nitrogen in the following order: ammonium, urea, nitrate, glutamic acid. Kinetics parameters (Ks and Vmax) obtained from field-collected *M. aeruginosa* were compared to published values for other phytoplankton taxa and with ambient nitrogen concentrations to infer whether the nitrogenous nutrition capability of *M. aeruginosa* offers a competitive advantage over other algae and help to explain its success in the Delta.

Statement of Relevance: Understanding the role of nutrients in *M. aeruginosa* blooms may aid in informing management about reducing specific nitrogen inputs to decrease bloom occurrence. The potential hepatotoxicity of *M. aeruginosa* blooms and its aesthetic effects can have detrimental consequences on drinking water, recreational activities and the food web in the Delta.

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Characterization of the *Microcystis* bloom and its nitrogen supply in San Francisco Estuary using stable isotopes

Abstract: The factors that have initiated and sustained *Microcystis* blooms in San Francisco Estuary since they first appeared in 1999 are not fully understood. It was hypothesized that (1) most of the *Microcystis* colonies and inorganic or organic nutrients that support the bloom originated in the San Joaquin River where the bloom biomass is elevated and (2) that *Microcystis* has an impact on the quantity and quality of dissolved organic carbon production in the estuary. In order to test these hypotheses, particulate and dissolved inorganic and organic matter in water and tissue samples were collected biweekly during *Microcystis* blooms in the summers of 2007 and 2008. At each station, *Microcystis* abundance, carbon to nitrogen ratio, dissolved organic carbon, chlorophyll *a* and toxic total microcystins were measured along with the stable isotopic composition of particulate and dissolved organic matter with POM-δ^{13}C, POM-δ^{15}N and DOC-δ^{13}C and dissolved inorganic matter with NO3-δ^{15}N and NO_3-δ^{18}O of nitrate, and H_2O-δ^{18}O and H_2O-δ^{2}H of water. These data were supplemented by a suite of physical and chemical water quality measurements including water temperature, specific conductance, pH, dissolved oxygen, total suspended solids and concentrations of the nutrients nitrate, ammonium and soluble reactive phosphorous. Hydrodynamic one dimensional modeling was used to characterize the percentage of

streamflow from different riverine sources. *Microcystis* primarily entered the estuary from the San Joaquin and Old Rivers and was associated with a shift in the quality of the dissolved organic carbon. Nitrate, particulate organic matter and water isotopic compositions differed for the Sacramento and San Joaquin River samples and varied along the salinity gradient. The San Joaquin River was a source of nitrate to the sampling stations but ammonium from the Sacramento River was the primary source of nitrogen that supported the *Microcystis* bloom due to the selective uptake of ammonium rather than nitrate. As a result, the bloom biomass increased with the percent ammonium of the total dissolved nitrogen pool for each river.

Statement of Relevance: Understanding the association between water quality, particularly ammonium concentration, and the increased abundance of the toxic cyanobacterium *Microcystis aeruginosa* is an important management issue which will affect operation of the SWP, development of BDCP and future nutrient TMDLs for the Delta.

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The importance of vegetated versus open water ponds to material flux in the freshwater tidal wetland Liberty Island, California

Abstract: Liberty Island is a freshwater tidal wetland composed of vegetated and open water ponds that is thought to provide habitat and food resources for the endangered delta smelt in San Francisco Estuary. However, little is known about the mechanisms that control environmental conditions and material production within the wetland and their contribution to the adjacent riverine channel. This study was designed to address the question: Do the small vegetated ponds contribute significantly to the material flux and fishery habitat within freshwater tidal wetlands and the adjacent river channels? To address this question, a suite of physical, chemical and biological variables were measured at four locations in open and vegetated ponds within Liberty Island between 2010 and 2011. Both discrete and continuous measurements were used to quantify water temperature, pH, specific conductance, dissolved oxygen, turbidity and chlorophyll *a* fluorescence and nutrient concentration. Chlorophyll *a* concentration, water temperature, specific conductance and turbidity were greater in the vegetated ponds. Vegetated ponds also had greater nitrate, ammonium, soluble reactive phosphorus and silica concentrations. Vegetated ponds exported suspended solids, salt and chlorophyll *a* to ponds within the wetland and adjacent river channels. In contrast, the open water pond stored these materials. Material flux was primarily driven by flow for the vegetated ponds and tide for the open water pond. This study suggests that material flux and water quality conditions within the wetland are highly variable and highly dependent on different processes in open water and vegetated ponds.

Statement of Relevance: Wetland restoration will be a major aspect of BDCP work in the Delta and yet we know little of how these wetlands operate especially freshwater tidal wetlands. This work funded by DFG Restoration Program is a part of the Breech III program that tries to characterize wetland processes.

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Delta EDT: A tool for restoration planning

Abstract: The Bay-Delta has been greatly altered by development including the loss of much of the tidal marshes and other habitats that supported delta fish species. Restoration of these habitats is likely to be a high priority in the recovery of delta smelt and other species. To be effective, restoration needs a strategic approach based on

prioritization of restoration needs, both biologically and spatially, as well as recognition of legal, social and logistical constraints on the feasibility of restoration actions. Restoration of tidal environments in the delta at this scale has not been attempted and considerable learning about restoration is expected through experimentation and adaptive management. A habitat based model, Delta-EDT is being developed that could provide a framework for organizing available information to develop strategies and priorities for restoration of habitat. Delta-EDT provides a comprehensive structure for assembling information from other models, scientific studies and expert knowledge to create an overall working hypothesis that is scalable from the delta to individual projects. The model is based on the Ecosystem Diagnosis & Treatment (EDT) system that has been successfully applied to stream environments and salmonid fishes throughout Washington, Oregon and California. It is being adapted to the complex hydrologic network and unique environment of the delta and to the needs of delta smelt. Delta-EDT evaluates the environment along multiple spatial-temporal pathways defined by the delta smelt life history and plotted across the DSM2 hydrologic network. The quantity and quality of habitat along these pathways is evaluated in terms of the carrying capacity, productivity (density-independent survival) and equilibrium abundance of delta smelt; integration across the multiple pathways provides an estimate of the potential population performance of delta smelt in the modeled environment. The model is scalable spatially (delta-geographic subregions-DSM2 reaches), biologically, by life stage, and environmentally by attribute. Delta-EDT can provide insights into limiting factors and spatial patterns of habitat quality. A particularly powerful feature of EDT is the ability to evaluate life history strategies that define the exposure of fish to conditions in the delta. Conditions can be compared between scenarios (alternative strategies or points in time) to identify restoration priorities (locations and attributes) or to evaluate restoration actions. Delta-EDT is being developed as a tool to analyze habitat needs for delta smelt and to prioritize restoration actions leading to an informed strategy for restoration actions. Development of Delta-EDT to date has provided a modeling structure that has been parameterized to provide a proof-of-concept. The greatest value of Delta-EDT will be realized if it becomes the collective product of scientific and management community to reflect the currently best available science and relevant management questions. The model is now at a point where the scientific and management community can enter the development process by providing knowledge and review leading to a useful framework for restoration strategies.

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A new exotic shrimp within the San Francisco Estuary: coming to a river near you

Abstract: Exotic species have been implicated as a major threat to native freshwater ecosystems and the cause of major economic loss throughout the world. Unfortunately, the San Francisco Estuary has been recognized as the most invaded estuary in the world where over 230 exotic species have become established. Recently, the US Fish and Wildlife Service's Delta Juvenile Fish Monitoring Program (DJFMP) has detected the expansion of a new exotic shrimp species known as the ghost or glass shrimp (*Palaemontes kadiakensis)* within the San Francisco Estuary. *P. kadiakensis* is a common aquarium species that is native to the Mississippi drainage system and northeastern Mexico. The exotic shrimp was first detected within California by researchers from University of California at Davis in the lower Cosumnes River during 2005. Subsequently, the DJFMP has detected individuals in the north Delta and lower Mokelumne and San Joaquin Rivers using beach seines. Although there is evidence of expansion into and throughout the upper portions of the San Francisco Estuary, the current distribution, relative abundance, and expansion rate of *P. kadiakensis* is not fully understood based on limitations of current monitoring programs and possible misidentification. As a result, the impact of *P. kadiakensis* on the aquatic community structure within the Estuary remains unknown. Therefore the objectives of this poster were to 1) invoke awareness of *P. kadiakensis* and its occurrence within the San Francisco Estuary and 2) highlight morphological characteristics that can be used to accurately distinguish *P. kadiakensis* from other exotic shrimp species within the Estuary.

Statement of Relevance: *Paleomontes kadiakenis,* a new exotic shrimp species, is becoming established within the San Francisco Estuary. The distribution expansion of this species could have a major impact on the food web

dynamics of the Delta. Further research is needed to better understand their impact so resources managers can address this issue, and begin to develop potential mitigation efforts to control this threat.

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Energetics of the invasive clam, *Potamocorbula amurensis*: The interactive role of temperature, salinity, and food availability

Abstract: The role an organism plays within an ecosystem often depends upon the rate at which they utilize energy, which in turn is influenced by environmental variables such as temperature, salinity, or food availability. Understanding how energy use varies with environment provides the opportunity to predict how a new species might impact an ecosystem, or how an existing species might respond to environmental change. Here we describe our work clarifying how environmental variables influence the energetics of the invasive clam, *Potamocorbula amurensis*. Our previous work has shown that clam metabolic rates in the field are relatively insensitive to changes in temperature, salinity, or chlorophyll *a* concentration. Here we sought to determine 1) if a more detailed, biochemical examination of clam energetics might identify patterns previously undetected, 2) if controlled, laboratory conditions might identify energetic responses to temperature, salinity, or food that were undetected in the field, and 3) if different energetic pathways (aerobic vs. anaerobic) might be used in response to particular environmental variables. We determined that clam energetics is quite insensitive to environmental change, even when examined from a biochemical point of view. We also determined that strong patterns in energy use were not elicited in our laboratory experimental manipulations, though it does appear that clams collected at different times exhibit different patterns of energy use. Finally, we identified from our field data several dates with low salinity and relatively high temperatures when clams predominantly utilized anaerobic metabolic pathways. During these periods the clams may have had relatively high energetic demands, but because of the low salinity remained closed for prolonged periods and utilized anaerobic metabolism. This remains to be explored, but raises the possibility that while clams may not alter their final energetic response to environmental change, they may alter their path there.

Statement of Relevance: Building upon previous field data, we show that even under controlled conditions the energetics of *P. amurensis* is insensitive to difference in temperature, salinity, and chlorophyll *a*. Consequently, changes in water management in the SFE are unlikely to alter, from an energetic standpoint, this clam's role in the system.

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Building and Implementing New Ecological Indicators for California's Streams and Rivers

Abstract: Over the last two decades, there has been a national and global shift toward the emphasis of ecological assessment tools in aquatic resource management. Assessment of biological assemblages that live in freshwater environments, such as fish, algae or aquatic insects, has the potential to transform water quality management strategies by providing direct measures of ecological integrity. In partnership with the Department of Fish and Wildlife's Aquatic Bioassessment Laboratory (ABL), the State Water Board's Surface Water Ambient Monitoring Program (SWAMP) has spent the last decade developing technical tools and infrastructure needed to assess the ecological condition of wadeable streams throughout California. The centerpiece of this effort is a new quantitative tool for standardizing the assessment of stream health based on benthic invertebrates. The State

Water Board is now developing policy that will guide the implementation of this tool in the State's regulatory and non-regulatory monitoring programs. Much of the technical work to support this implementation is now complete. We present an overview of the technical basis for the new scoring tool and describe its supporting infrastructure, including standard field and laboratory methods, quality assurance and data management. We also illustrate a number of examples of current and potential applications of the tool for the assessment of stream health.

Statement of Relevance: Biological assessment is quickly becoming one of the most important tools available for assessing the health of freshwater resources. The work presented here is the culmination of a decade-long effort to standardize the assessment of biological integrity in wadeable perennial streams throughout California.

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The Summer Townet Delta Smelt Index: A Comparison of Methods

Abstract: The delta smelt, *Hypomesus transpacificus*, is a small osmerid endemic to the upper San Francisco Estuary. Following a dramatic population decline in the 1980's, the species was listed as threatened in 1993 under the Federal and State endangered species acts. In response to this decline, the Summer Townet (STN) Survey developed an annual index of relative abundance for delta smelt based on the first two bi-weekly surveys. Alternate calculations of this index have been visited twice in past. Here, we revisit calculation of the delta smelt index again, to determine whether the current version is the best indicator of relative abundance. We compared the current delta smelt index to three alternate indices: a time-standardized index set in July, an index set by the timing of the size-standardized 38.1 mm striped bass index, and a size-standardized index (35 mm). For the SB-based index and the 35 mm index, we revisited work done by previous STN biologists. We also examined survivorship, by looking at correlation with the Fall Midwater Trawl index. Our results indicated that calculating the index according to any of the alternate methods would increase correlation to the FMWT index, although the 35mm index showed the least improvement, and the July index had the greatest improvement.

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Developing Technology Solutions to Support Co-Equal Goals and the Larger Delta Community

Abstract: www.baydeltalive.com web and iPhone applications bring Delta science and operations together with local community activities including businesses, recreational activities, fishing, boating and Points of Interest. BDL aggregates daily Delta Water Operations, Real-Time Water Quality and Hydrologic Conditions, Tides and Weather, Restoration Activity, Science Projects, News and more into a simple interface that makes it easy to stay informed and involved. Business and local activity contributors can manage their own Business/Project Pages and data so that all information is up-to-date ready to share and interact with the rest of the community. Come join the effort and download the app. This project is in its early stages and welcomes feedback and content ideas from the larger community.

Statement of Relevance: BDL aggregates daily Delta Water Operations, Real-Time Water Quality and Hydrologic Conditions, Tides and Weather, Restoration Activity, Science Projects, News and more into a simple interface that makes it easy to stay informed and involved.

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Exploring water quality trends, with an emphasis on chlorophyll *a*, using georeferenced water quality data within the tidal freshwater Cache Slough complex.

Abstract: Cache Slough complex is located in the northern portion of the San Joaquin-Sacramento delta and seems to support higher numbers and diversity of native fishes relative to the rest of the delta. An essential component to understanding the spatial distribution of native fishes in this tidal freshwater system is to have a firm understanding of seasonal water quality patterns and distributions. This poster sets out to summarize and present the first 6 months of georeferenced water quality data, with an emphasis on chlorophyll *a* distribution. Areas exhibiting increased concentrations of chlorophyll *a* may have a disproportionate influence on secondary production. This being the case makes it important to identify the distribution, concentration mechanisms and rate of export of chlorophyll *a*. Monthly horizontal water quality transects were done throughout the Cache Slough Complex using the following methods: data was collected using a Hydrolab DS5 Multiparameter Sonde in a flow through configuration and a Trimble Yuma/Pro 6T receiver. Data is georeferenced and displayed using ArcMap. Preliminary results, subject to change, will be presented.

Statement of Relevance: This poster presents data from a larger study under the alias of the Arc Project. The Arc project seeks to inform future and current restoration efforts in the delta by elucidating native fish-habitat relationships.

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Effects of Fin Ray Removal on the Swimming Performance of Subadult White Sturgeon

Abstract: Several populations of white sturgeon (*Acipenser transmontanus*) on the Pacific Coast of North America currently support important recreational fisheries; however, quantifiable age and growth data are needed to ensure effective management. Although pectoral fin spines from harvested fish can provide some of these data, current fishery regulations prohibit harvest of fish outside of the current slot limit of 102-152 cm FL (40-60 in). Methods for non-lethal sampling of pectoral fin spines have been used to obtain similar data from other sturgeon species; however, effects on the swimming performance of white sturgeon have not been assessed. The objective of this study was to assess the effects of two different fin-spine sampling methods on the swimming performance and behavior of captive white sturgeon. In the first method (T1), only a small section (~2 cm) of the marginal pectoral spine was removed at the body integument using a small hacksaw and knife. In the second method (T2), the entire marginal pectoral spine was removed. Using a modified Brett-type swim chamber, we determined critical station-holding speed (CSHS) and swimming orientation to quantify significant differences in the swimming performance of sturgeon subjected to each fin spine sampling method. Our results showed that mean CSHS (± standard error) of controls, T1, T2 were 239 cm/s (± 29), 241 cm/s (± 28), and 234 cm/s (± 21) respectively, indicating that fin-spine sampling had no significant effect on CSHS. The results of this study suggest that non-lethal sampling of pectoral fin spines in white sturgeon is a minimally invasive procedure. Additional experiments are being conducted to evaluate long-term effects of fin spine sampling on survival and growth of white sturgeon.

Statement of Relevance: Age and growth data are needed to identify problems, inform management decisions, and provide feedback on the effectiveness of management practices. Fin rays are popular structures for age estimation because they have been shown to provide reasonably accurate age estimates in many fish species and do not require sacrificing fish.

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A Morphometric-Based Index of Fish Somatic Condition of Delta Smelt (*Hypomesus transpacificus*)

Abstract: The Fall Low Salinity Habitat (FLaSH) study examined different aspects of health and condition of delta smelt, *Hypomesus transpacificus*, in relation to habitat quality. This morphometric study evaluated delta smelt collected by UC Davis and California Department of Fish and Wildlife during the Fall Midwater Trawl survey of 2011. The fish were digitally photographed; two-dimensional body length and depth, at several standardized locations, were measured (mm) with Image J (NIH) software. Using principal component analysis, we combined the different morphometric measurements to derive a single parameter describing the condition of the fish. Correlation analyses of the morphometric conditions were analyzed against the weight and condition factor of each fish. Positive correlations were found between the morphometric condition index and weight and condition factor. Thus, morphometric analysis of digital images could be used in conjunction with other condition metrics to describe health of delta smelt. This method could be applied to the field for a simple indication of health.

Statement of Relevance: Morphometric measurements from digital images may provide another measure of fish health and condition that could be both efficient and non-lethal.

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CalFish and the California Fish Passage Assessment Database

Abstract: CalFish (www.calfish.org), a California Cooperative Anadromous Fish and Habitat Data Program, is a multi-agency website presenting anadromous fish, stream habitat and migration barrier data in California which includes standards and tools used for the collection, management and analysis of these data. This poster presentation will be paired with a second poster titled "The Past, Present and Future of the Passage Assessment Database, a Tool for Stream Habitat Connectivity Restoration via the Publicly Available CalFish Website" authored by Anne Elston. The Passage Assessment Database (PAD) is an ongoing map-based inventory of known and potential barriers to fish in California. The PAD is publicly available through CalFish. The CalFish poster will include an overview of the CalFish site, a description of other datasets available on CalFish, CalFish tools for analyzing data and answering commonly asked questions, and new fish passage barrier remediation reports.

Relevance of work to water and environmental policy and management:

Data on CalFish are applicable to policy, planning, management and recovery of anadromous fish and related aquatic resources in California.

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Reproduction and Mortality of Key Copepods Low-Salinity and Freshwater Habitats of the San Francisco Estuary

Abstract: Declines in abundance and evidence of food limitation of several pelagic fish in the low salinity and freshwater habitats of San Francisco Estuary have prompted further investigation into foodweb interactions within these habitats. We analyzed zooplankton samples from 1991 to 2011 to estimate copepod reproductive and mortality rates. Copepod egg production rates were persistently low (a suggestion of food limitation) for historically dominant and ecologically important *Pseudodiaptomus forbesi*. Mortality of copepodite and adult *P. forbesi* was consistently higher in freshwater and lower in low salinity, while mortality of nauplii had the opposite

trend. These patterns are consistent with higher planktivory by fish on larger copepods in freshwater, consumption of nauplii and competition for food by bivalves in low-salinity, and transport of copepods from freshwater to low-salinity habitats. These findings suggest that food limitation plays a significant role in the productivity of zooplankton in the low-salinity foodweb and that abundance of copepod prey for fish at early life stages is maintained by transport from freshwater habitats.

Statement of Relevance: The POD has prompted an intense effort to understand the causes of long-term change in the estuarine ecosystem. Evidence for food limitation of planktivorous species suggests a need to examine the abundance and population dynamics of their food.

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Adaptive Management of Tidal Marsh Habitat Restoration in the Delta: Addressing Uncertainties in Aquatic Food Web Responses

Abstract: Restoring freshwater and brackish tidal marsh habitat in the Sacramento-San Joaquin Delta and Suisun Bay is likely to produce a multitude of ecosystem benefits, including creation of habitat for native terrestrial and aquatic species, many of which are federally and State-listed threatened or endangered. However, conceptual models for the system (including those developed for the Delta Regional Ecosystem Restoration Implementation Plan [DRERIP]) indicate significant uncertainties associated with many of the key proposed benefits of restoring tidal marsh in the Delta. These uncertainties include the value of mature tidal marsh, as well transitional stages during restoration, to native fish for spawning, foraging, and rearing, and the timing and magnitude of the contribution of tidal marsh primary production exports to the pelagic food web. There is critical need for an adaptive management strategy to guide planning for large-scale restoration targeted to benefit native fish species, including development of an experimental phased approach to implementation, to resolve uncertainties, and to use new knowledge to adjust our expectations and guide future actions. We present existing conceptual models and a proposed new composite conceptual model for tidal marsh restoration elucidating key uncertainties related to tidal marsh contributions to the pelagic food web in support of delta smelt. We propose an adaptive management approach to implementing landscape-scale tidal marsh restoration focused on resolving these uncertainties.

Statement of Relevance: Approximately 60,000 acres of tidal marsh restoration are proposed for the Delta and Suisun Marsh under the BDCP and other programs. A well-defined adaptive management strategy is needed to help resolve key uncertainties early in implementation, to increase the likelihood of achieving the desired outcomes and inform future management decisions.

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Unprecedented Bloom of Toxin-Producing Cyanobacteria in the Southern Bay-Delta Estuary has Negative Impact on the Aquatic Food-Web

Abstract: Recently, there has been a collapse in the pelagic fish community in the San Francisco Estuary, known as the pelagic organism decline (POD). Blooms of the *Microcystis*, which often produce the cyanotoxin microcystin,

were first documented in the Sacramento-San Joaquin Delta in 1999. Cyanotoxins have been suspected as one contributing factor to POD. It has been proposed that microcystin could be contributing to POD directly though poisoning of fish or indirectly by affecting zooplankton and other food sources.
In this study, we documented the spatial and temporal extent of cyanobacteria blooms in the Southern Bay-Delta Estuary (south Delta), an area further east and upstream in the San Francisco Estuary than previously studied. Copepod, rotifer and total zooplankton abundance was examined in comparison to the spatial distribution of microcystin. The environmental factors associated with cyanobacteria blooms in the south Delta were investigated. A large, persistent *Microcystis* bloom was observed in the summer of 2012, but not in 2009 or 2011. There was a strong relationship between microcystin and cyanobacteria biomass (r^2=0.74). Samples that had quantifiable concentrations of microcystin (> 5 ng L^{-1}) had lower mass of total zooplankton (alpha = 0.10). Waters with microcystin concentrations > 15 ng L^{-1} harbored significantly lower densities and masses of all categories of zooplankton, except rotifer density, than waters with microcystin concentrations < 15 ng L^{-1} (alpha = 0.05). In July and August of 2012, microcystin concentrations were measured above California EPA recreational advisory limits (0.8 µg/L) and World Health Organization drinking water limits (1.0 µg/L), with a maximum observed concentration of 2.8 µg/L. We compared water quality, flow and climate conditions of 2012, when the persistent bloom occurred, to 2009 and 2011. Significantly higher phosphorus concentrations and temperatures appeared to correspond to higher cyanotoxins concentrations, but cause and effect cannot yet be determined.

Statement of Relevance: The *Microcystis* bloom observed in this study was associated with lower density and mass of zooplankton. Continued study of *Microcystis*, microcystin, and zooplankton in the southern Delta is needed to determine the causes of cyanobacteria blooms and to further understand the effect of these blooms on the aquatic food-web.

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When to Bolt?: Fry or Smolt? Estimating Survivorship of Juvenile Salmon Migratory Life Histories Using Otolith Strontium Isotopes

Abstract: The maintenance of life history diversity is critical for the persistence of salmonid populations and central to many recovery efforts. Juvenile Chinook salmon leave their natal rivers at different sizes, ages and times of the year, and it is thought that this life history variation contributes to their population sustainability. Preserving and restoring diversity of life history traits depends in part upon the environmental factors affecting their expression. Rotary-screw traps (RST) at Caswell have indicated that when winter flows are high, large numbers of fry-sized Chinook salmon emigrate from the Stanislaus River, presumably rearing downstream in the San Joaquin, delta and/or estuary. Here, we used otolith ("earstone") Sr isotopes ($^{87}Sr/^{86}Sr$) in adult Chinook salmon returning to the Stanislaus River to bridge the information gap between the influence of river conditions on juvenile outmigration patterns and the survivorship of different life history strategies. A total of 200 paired otolith and scale samples were used to reconstruct size-specific outmigration patterns of successful juvenile salmon in an 'Above Normal' (2000) and a 'Below Normal' (2003) water year type. For each returning adult, the size that it had emigrated from the Stanislaus River was reconstructed by coupling otolith $^{87}Sr/^{86}Sr$ and otolith radius measurements. Juveniles were classified by size, and the proportions of fry (≤55mm), parr (>55 to ≤75mm) and smolt (>75mm) captured at the Caswell RST were compared with those reconstructed in the adults from the

same cohort in order to estimate survivorship of different juvenile life history types across contrasting hydrologic regimes. The results indicate that in both years, over 50% of the returning adults had left their natal river as fry or parr outmigrants.

Statement of Relevance: This work is relevant to water and environmental management actions, given the economic and cultural importance of the Central Valley Chinook salmon, and the significant questions that remain regarding the mechanistic relationships between hydrologic regime and juvenile salmon behavior and survival.

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Evaluating Fish Behavior using Acoustic Telemetry

Abstract: Acoustic tagging studies routinely provide information about fish presence and absence. This detection information is combined into a chronology of time-stamped tag detections to measure fish survival and fish passage estimates, among others. Beyond this simple tag detection data, if tag detections are uniformly spaced to a high level of precision then the detection time series can be used to assess fish behavior. Behavior of fish ranges from the simple to complex and some of these behaviors can be interpreted from acoustic tag detections. From single receivers, simple movement toward or away can determine directionality, observed cessation of tag movement interpreted as holding behavior or, observed for extended periods as mortality or tag defecation. From two dimensional and three dimensional receiver arrays for example, patterns of detections that indicate focused movements of active migrations can be distinguished from more wandering movements indicative of resident species or predators. As more and larger fish populations are studied, more acoustically tagged fish will interact, increasing the complexity of interpreting these observed behaviors. These behaviors include predator avoidance, schooling/shoaling, predation, and tag defecation. Behavior can be further interpreted when tag detection histories are observed and analyzed in relation to each other and not as isolated tag detections. In this presentation, we document the behaviors of acoustically tagged fish and discuss the implications for interpreting various fish behaviors.

Statement of Relevance: Resolution of fine-scale animal movement and interactions is important for studies of the ecology of aquatic populations, including issues of physical impacts of structures, species-specific interactions, and invasive species.

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Development of new genetic resources for management of Central Valley Chinook salmon

Abstract: Central Valley Chinook salmon (*Oncorhynchus tshawytscha)* have experienced dramatic declines in recent years. Increased scientific understanding of population dynamics and factors contributing to survival and fitness is needed to aid in restoration and recovery efforts. We are developing new genetic resources for Chinook salmon and applying them to a number of studies focused on understanding the biology and ecology of Chinook in the Bay-Delta system. We are identifying thousands of new single nucleotide polymorphism (SNP) markers using next generation RAD-sequencing technology and positioning these SNPs onto a Chinook genetic map. These markers will be used to identify the different runs of Chinook salmon in the Central Valley and their natal origin. These markers will also be used to conduct association studies related to phenotypic traits of conservation importance. As temperature is predicted to be an increasing stressor for Chinook in the Central Valley, we are also

examining the gene expression profiles of fall run Chinook at increasing temperatures and evaluating thermal tolerances via RNA-sequencing. These new tools will be applied to studies that address pressing research needs for Chinook salmon management in the Bay-Delta system, including identifying unknown Chinook salmon to run and potentially natal stream, determining habitat use by juvenile Chinook, and thermal stress of adult Chinook salmon in the mainstem Sacramento River and Yolo bypass.

Statement of Relevance: This work is highly relevant to the management of Central Valley Chinook salmon. The SNP marker development will allow more accurate identification of juvenile Chinook salmon. We are also developing markers that will be useful in evaluating thermal stress in Chinook, which will be increasingly important with climate change.

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Zebra/Quagga Mussel Monitoring and Research in the State Water Project

Abstract: Quagga and zebra mussels could have a significant impact on the State Water Project (SWP). The greatest anticipated impacts are associated with biofouling of structures, internal piping and filters. In response, DWR formed the Aquatic Nuisance Species Program within the Division of Operations & Maintenance. Under this program, DWR routinely monitors the California Aqueduct, SWP reservoirs and the Sacramento-San Joaquin Delta for the presence of mussels. DWR uses three different methods to monitor for mussels: zooplankton tows (with DNA analysis) for veligers and settlement plates and bioboxes for adults (attached/settled stage). Since the inception of the program in 2007, over 800 veliger samples have been analyzed. Currently, no mussel populations are established in the SWP, the Delta or other SWP source waters. DWR's consultant, RNT Consulting, conducted an evaluation of the habitat suitability of the entire SWP based on water quality conditions. The key factors in the analysis were calcium and pH levels. Based on the results, we divided the SWP into 3 management zones. Zone 1 has calcium and pH levels too low to support mussels. This zone includes the Upper Feather River reservoirs, Lake Oroville, lower Feather River, and Sacramento River upstream of Hood. Zone 2 has calcium and pH levels that are usually adequate to support mussels, but do fall below the minimum levels during some months. This zone is potentially able to support mussels and encompasses the Delta, San Luis Reservoir, and California Aqueduct north of the Tehachapi Mountains. Zone 3 has year-round adequate levels of calcium and suitable pH. Mussels are expected to thrive here. This zone includes Pyramid, Castaic, Silverwood, and Perris reservoirs. Zones 2 & 3 require early detection monitoring, boat inspection programs, and facility vulnerability assessments and management plans.

Statement of Relevance: Zebra and quagga mussels pose a serious threat to water delivery systems and ecosystems in California. The DWR aquatic nuisance species program monitoring and studies in the SWP provide a better understanding of overall implications to future management and control of dreissenid mussels in the SWP.

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How does nitrogen redox state and N:P stoichiometry influence phytoplankton?

Abstract: Eutrophication is a major estuarine problem. With rapid human population increases, nutrient pollution

is changing N:P ratios and nitrogen supply for phytoplankton. In many regions, including the San Francisco Bay Delta, N loads are increasingly in the form of reduced (ammonium, urea) rather than oxidized nitrogen forms (nitrate). This has consequences for the amount of primary productivity and the phytoplankton community composition. Chemically reduced forms of nitrogen, e.g. ammonium may inhibit, rather than stimulate algal production if concentrations are sufficiently high (oligotrophication) and this can lead to shifts in the functional groups of phytoplankton away from diatoms to groups that are more ammonium-tolerant. We tested the relevance of nitrogen redox state and N:P stoichiometry by conducting experimental enrichments with combinations of nitrogen and phosphorus. The inhibition of nitrate uptake was consistently observed with ammonium enrichment, but the degree of inhibition varied with season (temperature), the community composition at the time of the enrichment and its overall nutritional state. These findings aid our understanding of how different types of nutrient loading will influence not only overall eutrophication effects, but also how food webs may also be affected with changes in nutrient forms and ratios.

Statement of Relevance: This research funded by Bay Delta Science and SFWCA helps explain published detrimental relationships between ammonium loading and the pelagic food web with management implications due to the higher loadings with increasing population.. It will inform the Nutrient Science and Management Strategy for SFB and Suisun Bay Modeling by SFEI.

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Preliminary Findings on Fish Communities along the North Delta "Arc"

Abstract: Along the Sacramento River corridor in the Sacramento-San Joaquin Delta there are several regions which have been identified as areas of interest. The Cache Slough Complex, the Confluence of the Sacramento and San Joaquin rivers, and the eastern half of Suisun Marsh are all connected via the Sacramento River and distributaries and are heavily used by native fishes and of interest for two primary reasons: first, these regions have yet unspecified current conditions which support relatively robust native fish populations; second, these areas are important for both informing and supporting future restoration efforts. Ongoing surveys of these habitats have revealed strong differences in fish communities both within region and between regions. A combination of trawls, beach seines, minnow traps, and boat electrofishing has provided a complete picture of fish communities present in these regions. In addition, fine-scale sampling and mapping of discrete habitats has allowed for distinction between habitat types and evaluation of how fish use these different habitats. These are the preliminary findings of sampling along the Sacramento "Arc".