

Project Objectives: Please type your responses, and answer the questions in a style appropriate for laymen.

ProjectObjectives_10

Climate change and water diversions have greatly modified freshwater outflow into the San Francisco Estuary, changing the Estuary's salinity regime. These climate- and water diversion-driven changes in salinities may have a wide range of impacts on important components of the San Francisco Estuary including the distribution of threatened/endangered species, the success of habitat restoration and the management of invasive species. I proposed to examine two important, closely-linked questions with direct implications for restoration efforts of the native oyster *Ostrea lurida* and the management of invasive species in the Estuary, including the mussel *Mytilus galloprovincialis*: (1) How are local populations of these species connected to each other in the San Francisco Estuary? (2) How does low salinity exposure from climate change-driven winter storms affect the fitness and reproductive output of these species?

I proposed to first establish long-term survey sites to track the abundance of these focal species in the Bay, then use trace elemental fingerprinting methods to determine the natal origin and fate of larvae of these taxa, and also conduct salinity stress tests to determine low salinity tolerances and examine effects of low salinity stress on reproductive output.

Summary of progress in meeting each of these goals and objectives

ProgressSummary_11

In Year 2 of the project, we continued our progress toward achieving objective 1. We completed trace element microchemistry analyses of larval and juvenile oyster shells collected in 2010 throughout the San Francisco Estuary. While initial statistical analyses showed some promise in detecting differences among regions, and thus in being able to use this method to accurately determine the natal origins of newly settled juveniles, we determined that we needed larger sample sizes for more precise answers.

The wet winter and spring in 2011 created a unique opportunity to collect data on how oyster fecundity, recruitment, and connectivity patterns change in response to high freshwater flow entering San Francisco Bay (objective 2). Additional time was essential to completing data collection, preparing samples for trace element microchemistry analyses to determine the natal origins of newly settled oysters, and to analyze the data and prepare manuscripts and the final report. Since we were unable to collect data for most of the recruitment season in 2009 for reasons related to the availability of funds (which arrived in mid-September 2009), our additional data for summer 2011 ensured that we had at least two solid years of data (2010 and 2011). These data are essential to informing a broader understanding of *O. lurida* population dynamics and connectivity patterns as related to freshwater flow. We are preparing shell samples for trace element microchemistry analyses and will be performing the analyses in summer 2012.

PROJECT MODIFICATIONS: Please explain any substantial modifications in research plans, including new directions pursued. Describe major problems encountered, especially problems with experimental protocols and how they were resolved. Describe any ancillary research topics developed.

Modifications_12

While data on population density, recruitment, survival, and connectivity were collected for both *Ostrea* and *Mytilus*, we have chosen to focus our remaining funds on *Ostrea*, as this species was the original focus and main priority of the grant. We will seek additional funding to complete analyses of *Mytilus* populations.

BENEFITS AND APPLICATIONS: Suggest the relevance of these new findings to management. Describe any accomplishment, that is significant effects your project has had on resource management or user group behavior. CALFED is looking for "management cue" (see <http://science.calwater.ca.gov/pdf/soemgmtcues.pdf>).

BenefitsApplic_13

Preliminary results suggest that trace elemental fingerprinting is a viable technique to use for assessing the population connectivity of bivalve larvae in the San Francisco Estuary, but sample size is a critical issue. Determining whether populations in south San Francisco Bay and northern San Francisco Bay (and locations within these regions) are isolated from each other is important to targeting restoration efforts in these areas and predicting the possible spread pattern of non-native species introduced to a given area. Assessments of the density, growth, recruitment, and survival of *Ostrea* aid our understanding of how these populations are maintained in the Estuary. For example, overwinter survival of existing populations in the North Bay was much lower than in the South Bay in 2011 due to lowered salinity from freshwater runoff in winter and spring. Although the highest recorded *Ostrea* densities are in the North Bay, the South Bay populations may be critical to long-term survival of *Ostrea* in the Bay because they are less frequently exposed to low salinity conditions due to their geographic location. Consequently, South Bay populations may be more consistently present and a more reliable source of larvae for the next generation of *Ostrea*.

PUBLICATIONS: List any publications, presentations, or posters that have resulted from this funded research. Give as many

details as possible, including status of paper (e.g., in review; in press), journal name, conference location and date of presentation. Please note (as outlined in the conditions of the award) that each fellow is required to submit an abstract for an oral or poster presentation at each State of the Estuary conference and CALFED Science Conference during the duration of the fellowship.

Publications 14

ORAL PRESENTATIONS

Chang AL (2010). Storms and droughts: why and how history matters to communities. Invited seminar, San Francisco State University.

Chang AL, Malm P, Attoe S, Fisher JL, Morgan SG (2010). Going with the flow or staying close to home?. Population connectivity, freshwater flow, and native oyster restoration in San Francisco Bay. CALFED Bay-Delta Science Conference, Oakland, CA. 29 Sept 2010.

Chang AL, Malm PD, Deck AK, Willits K, Attoe S, Fisher JL, Morgan SG (2010). Going with the flow or staying close to home? Population dynamics and connectivity of bivalves in San Francisco Bay. Western Society of Naturalists Annual Meeting, San Diego, CA. 14 Nov 2010.

Chang AL, Deck A, Malm PD, Willits K, Attoe S, Fisher JL, Morgan SG (2010). Going with the flow or staying close to home? Linking habitat quality and population dynamics of Olympia oysters in San Francisco Bay. Ecological Society of America Annual Meeting, Austin, TX. 12 Aug 2011.

Chang AL, Deck AK, Malm PD, Willits K, Attoe S, Fisher JL, Morgan SG (2011). Great place to live, but I don't want to raise my kids there: Linking habitat quality and population dynamics of Olympia oysters. Western Society of Naturalists Annual Meeting, Vancouver, WA. 12 Nov 2011.

POSTERS

Chang AL, Deck AK, Malm PD, Willits K, Attoe S, Fisher JL, Morgan SG (2011). Great place to live, but I wouldn't want to raise my kids there: Linking habitat quality and population dynamics of Olympia oysters in San Francisco Bay. State of the San Francisco Estuary Meeting, Oakland, CA. 20 Sept 2011.

other assistance to your project since inception. Describe the nature of their collaboration.

CoopOrganiz_15

Smithsonian Environmental Research Center (Marine Invasions Research Lab): Logistical, financial and technical support to postdoctoral fellow.....

NOAA Fisheries: Technical support.....

UC Davis.: Bodega Marine Laboratory: Logistical and technical support.....

San Francisco State University./ Romberg Tiburon Center: Logistical and technical support.....

AWARDS: List any special awards or honors that you, or mentor or members of the research team, have received during the duration of this project.

Awards_16

N/A.....

KEYWORDS: List keywords that will be useful in indexing your project.

Keywords_17

freshwater flow, population connectivity, Ostrea lurida, Olympia oyster, Mytilus galloprovincialis, restoration, San Francisco Bay, estuary, salinity.....

PATENTS: List any patents associated with your project.

Patents_18

N/A.....

Additions: Additional information can be added here. Please begin the text with the number of the question you are adding to.

Additions_19

Lined writing area for the questionnaire response.