



CALFED Progress Report
California Sea Grant College Program

ConfirmationNumber
20100416151039

Printed: 4/16/2010 3:12:18 PM ProjectYear_2A 1st ProjectNo_2C R/SF-29
TypeQuestionnaire_2B Interim Questionnaire

Preparer Information

PrepName_1A Heidi Weiskel
PrepEmail_1B hwweiskel@ucdavis.edu
PrepPhone_1C (530) 902-0878

Project Information

ProjectNo_2C R/SF-29 StartDate_3a 10/01/2007 EndDate_3b 06/30/2010
ProjectTitle_4 Nutrients & Benthic Invasion Dynamics in San Francisco Bay

CALFed Fellow contact information

FelTitle_5A Ms. FelLast_5B Weiskel FelFirst_5C Heidi FelInit_5D W
FelInstitution_5E University of California, Davis
FelDepartment_5F Enviromental Science & Policy
FelStreetAddr_5G 979 North Vernal Avenue
FelCity_5H Mill Valley FelState_5I CA FelZip_5J 94941
FelPhone_5K (530) 902-0878 FelFax_5L (530)752-3350
FelEmail_5M hwweiskel@ucdavis.edu
FelPositionTitle_5N Graduate Student (PhD Candidate)

Research Mentor (for additional please see #8)

RMTTitle_6A Dr. RMLastName_6B Grosholz RMFirstName_6C Edwin RMInit_6D D
RMInstitution_6E University of California, Davis
RMDepartment_6F Environmental Science and Policy
RMStreetAddr_6G One Shields Avenue
RMCity_6H Davis RMState_6I CA RMZip_6J 95616
RMPhone_6K (530) 752-9151 RMFax_6L (530) 752-3350
RMEmail_6M tedgrosholz@ucdavis.edu
RMPositionTitle_6N

Community Mentor (for additional please see #9)

CMTTitle_7A Dr. CMLastName_7B Talley CMFirstName_7C Drew CMInit_7D M
CMInstitution_7E University of San Diego
CMDepartment_7F Marine Science & Environmental Studies
CMStreetAddr_7G 5998 Alcalá Park
CMCity_7H San Diego CMState_7I CA CMZip_7J 92110
CMPPhone_7K (619) 260-6810 CMFax_7L (619) 260-6874
CMEmail_7M dtalley@sandiego.edu
CMPositionTitle_7N Assistant Professor

Additional Research Mentors and Community Mentors

Additional Research Mentors_8

Form with 6 horizontal lines for entering additional research mentors.

Additional Community Mentors_9

Form with 6 horizontal lines for entering additional community mentors.

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

ProjectObjectives_10

The two primary objectives for this study were to determine:

1) whether and how nutrients affect competitive interactions between native and invasive invertebrate species in benthic marine habitats; and 2) what effects invasive species have on benthic communities at the onset of their invasion and after they become established.

The impetus for the project was to consider more broadly both how a basal resource (in this instance, nutrients) could affect higher trophic levels, and to assess how one pollution source (excessive nutrients) might interact with another (invasive species as biological pollution). The focal species were two invasive snail species-one that has been in San Francisco Bay for many decades (*Ilyanassa obsoleta*), and one that has arrived within the last decade (*Batillaria attramentaria*)-and one endemic, the only native mud snail in San Francisco Bay (*Cerithidea californica*).

The main hypotheses for the project-based on previous studies-were that:

1) enhanced nutrient input would alter the composition of benthic microalgae, which would in turn affect competitive dynamics

Summary of progress in meeting each of these goals and objectives

ProgressSummary_11

I am on track with regard to my yearly outcomes for this project. I have completed all of my fieldwork and am planning to graduate in the Fall of 2010, when I will also start a postdoctoral position. I am currently writing the manuscripts that will be submitted for my dissertation and for publication on this project.

We conducted Experiments 1 and 2 in the Robert's Landing salt marsh in San Leandro, CA in 2007 and repeated and expanded it in 2008. It involved 168 cages and 14 species-density-nutrient addition treatment combinations in a fully crossed factorial design in two separate habitats. We are still analyzing the results but the suggestions are clear that nutrients do affect dynamics between native and invasive ecologically equivalent grazing species (in this study, snails), and that this effect is stronger in some habitats than others. We measured microalgal community composition and abundance, growth and mortality rates of the snails, and multiple sediment characteristics (carbon:nitrogen ratios, organic matter, chlorophyll a). We also collected ^{13}C and ^{15}N stable isotope samples from the snails in different treatments.

The work for Experiment 3 has been on-going. We have collected critical data on the parameters of the invasion and population demographics, including abundance, density, distribution, areal extent, parasite infection rate, size class frequency, movement rates, and genetics. We have also collected sediment data, including carbon:nitrogen ratios, organic matter, and chlorophyll a. We have compared the invaded areas to both non-invaded sites in the same area (controls) and we have compared the new invasion to established populations in Tomales Bay. We are in the midst of analyzing these results as well but among our findings we see that the San Francisco *Batillaria* population is growing at a surprising rate, as shown by both a dramatic shift to a smaller mean size class and an increase in population from fewer than 500,000 to more than 4 million individuals. We also have some evidence for a positive feedback loop that may facilitate the invasion. At high densities of snails, we see higher sediment chlorophyll a levels, suggesting that the snails at current densities may be experiencing a type of inverse density-dependent control on population size.

I have regularly presented both projects at multiple conferences and in other settings (lab seminars, undergraduate courses) since

receiving the CALFED Science Fellowship in 2007.

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

Modifications_12

We combined Experiments 1 and 2 in a single, two-year, large-scale field manipulation in the East Bay. This made scientific and logistical sense, as we were already incorporating single-species treatments in our major multi-factorial study.

We expanded our *Batillaria* work (Experiments 3 and 4) to include a more comprehensive survey of established populations in Tomales Bay over time, and to compare the San Francisco Bay population to yet another introduced population of the snail in Bodega Harbor. We incorporated more eradication efforts and continued to apply for more resources to specifically address the eradication aspect of the project (see Awards section). Unfortunately, the funding freeze prevented us from being able to conduct the nutrient enrichment studies.

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

There are two important applied results that have come out of our research to date. First, nutrients do appear to affect both grazer growth and mortality, and the effect is enhanced in certain habitats. Interestingly, the 2003 Management Cues document, to which we have been referred for considering the applied aspects of our research, does not mention nutrients in San Francisco Bay. Traditionally, SF Bay has been considered to be light-, not nutrient-limited (Cloern 2001). However, our results-which are focused on the benthic intertidal mudflats and salt marshes-suggest that in fact thresholds have not been achieved, and therefore Bay species may be susceptible to nutrient enrichment. Thus, reducing nutrient enrichment is an important management objective that should be considered along with other forms of pollution in the Bay.

The second major result with management implications is that the new invasive species, *Batillaria attramentaria*, may facilitate its own invasion by rapidly achieving extremely high densities and altering the habitat to increase the standing biomass of benthic microalgae. While our study was not designed to explicitly test this hypothesis or to determine the mechanism, the pattern is there in our results, and should be noted. If this species achieves a certain density threshold in the North Bay (the only place where it currently exists), it could trigger a positive feedback loop that would make it even more difficult to control or eradicate.

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

Conference Presentations

- 1) Demographics and eradication of a new invasive population of *Batillaria attramentaria*. Weiskel, H. W., and C. M. Bowles. 2010. Mathias Symposium of the University of California Natural Reserve System. Bodega Bay, CA. 26-28 February 2010.
- 2) Nutrient loading & benthic native-invasive species dynamics. Weiskel, H. W., C. N. Janousek, and E. D. Grosholz. Sixth International Conference on Marine Bioinvasions. Portland, OR. 24-27 August 2009.
- 3) Nutrient loading & benthic native-invasive species dynamics. (Poster). Weiskel, H. W., Janousek, C. N., and E. D. Grosholz. Fifth Biennial CALFED Science Conference. Sacramento, CA. 22-24 October 2008.
- 4) Nutrient loading & benthic native-invasive species dynamics. Weiskel, H. W. and E. D. Grosholz. Ninety-third Annual Ecological Society of America Meeting. Milwaukee, WI. 3-8 August 2008.
- 5) Nutrient loading & benthic native-invasive species dynamics. Weiskel, H. W. and E. D. Grosholz. Thirty-Seventh Annual Benthic Ecology Meeting. Providence, RI. 10-12 April 2008.

Invited Lectures & Campus Talks

- 1) P. E. O. (Philanthropic Educational Organization) Chapter Meeting Guest Speaker. 24 February 2010: How far can one snail take you? Or how the PEO Scholarship has supported my career.
- 2) University of California, Davis Bodega Noon Research Seminar Series. 22 June 2009: Nutrient loading & benthic native-invasive species dynamics.
- 3) University of California, Davis upper division course in Rapid Environmental Change. 16 May 2009: Novel introductions of an invasive snail: What founder populations reveal about invasion dynamics on northern CA mudflats.
- 4) San Francisco State University Romberg Tiburon Center for Environmental Studies Seminar Series. 5 November 2008: Nutrient loading & benthic native-invasive species dynamics.
- 5) Point Reyes National Park Research Seminar Series. 15 May 2008: Novel introductions of an invasive snail: What founder populations reveal about invasion dynamics on northern CA mudflats.
- 6) University of San Francisco upper division course in Ecology and Management of Invasive Species. 19 April 2008: Nutrients and benthic invasion dynamics in San Francisco Bay.
- 7) Estuary Ecology Day with the San Francisco Bay National Estuarine Research Reserve, Romberg Tiburon Center for Environmental Studies (SFSU). 15 March 2008: Nutrients influence animals?: Investigating the effects of nutrient loading on native-invasive species dynamics.

