

NERRS Science Collaborative Progress Report for the Period 11/15/11 through 02/29/12

Project Title: Managing for resilience in the face of climate change: a scientific approach to targeted oyster restoration in San Francisco Bay and Elkhorn Slough, California

Principal Investigator(s): Matt Ferner

Project start date: 11/15/2011

Report compiled by: Matt Ferner, Kerstin Wasson

Contributing team members and their role in the project:

Collaboration Lead: Marilyn Latta, Project Manager
California State Coastal Conservancy
Oakland, CA
Role on project: Marilyn will oversee integration of the applied science with the needs of core local and regional end-users.

Co-Principal Investigators: Andy Chang, Research Scientist
San Francisco Bay National Estuarine Research Reserve
Tiburon, CA
Role on project: Andy will co-lead laboratory experiments, environmental monitoring, oyster surveys and population connectivity studies with a focus on San Francisco Bay sites.

Ted Grosholz, Professor of Environmental Science and Policy
University of California, Davis / Bodega Marine Laboratory
Davis, CA
Role on project: Ted will advise the science team, participate in environmental monitoring and oyster surveys in San Francisco Bay, and facilitate interactions with end-users of project results.

Kerstin Wasson, Research Coordinator
Elkhorn Slough National Estuarine Research Reserve
Watsonville, CA
Role on project: Kerstin will coordinate and lead development of end-user products resulting from the project. She will also assist with project management and field monitoring.

Chela Zabin, Research Scientist
University of California, Davis
Davis, CA
Role on project: Chela will co-lead environmental monitoring and oyster surveys with a focus on Elkhorn Slough sites. She also will work closely with the Collaboration Lead and regional end-users.

Graduate Investigators: Jill Bible, Graduate Student
University of California, Davis / Bodega Marine Laboratory
Bodega Bay, CA
Role on project: Jill will co-lead laboratory tests of potential

stressors on oysters collected from study sites that span a range of environmental conditions in San Francisco Bay.

Brian Cheng, Graduate Student
University of California, Davis / Bodega Marine Laboratory
Bodega Bay, CA

Role on project: Brian will co-lead laboratory tests of potential stressors on oysters collected from study sites that span a range of environmental conditions in San Francisco Bay.

Anna Deck, Research Technician
San Francisco Bay National Estuarine Research Reserve
Tiburon, CA

Role on project: Anna will co-lead environmental monitoring, oyster surveys and population connectivity studies with a focus on San Francisco Bay sites.

A. Progress overview

Project Goal: The overall goal of this project is **to increase the resilience of oyster restoration projects in the face of climate change**. We will do this by developing restoration planning tools for end users that characterize and prioritize restoration sites and source material for restoration project at two central California estuaries. We will also achieve this goal by synthesizing broader lessons learned about best approaches for enhancing resilience by shellfish in the face of climate change. These end-products will be based on science tailored to address critical information gaps identified by local and regional end-users. We will quantify stressor levels across sites within and between the two estuaries, determine which climate-related and other anthropogenic stressors have the greatest potential to impact native oysters, investigate how these stressors interact, and characterize oyster population connectivity among the San Francisco Bay sites.

Accomplishments: We launched both the applied science and collaborative components of our project during this initial reporting period. We established subcontracts for the participating institutions to enable work by our large PI team to begin. For the applied science component, we drafted plans for the laboratory experiments and field monitoring. San Francisco State University hired researchers Andy Chang and Anna Deck to work on this project through the San Francisco Bay National Estuarine Research Reserve. For the collaborative component, our project team sought early feedback from end-users to shape the focus areas of the new science to be generated and the design of the tools to be created as final products. The project team identified critical end-users engaged in work related to Olympia oyster restoration (in the realms of policy, on the ground restoration, science, funding, and strategic planning) and developed a survey to obtain early feedback from these end-users on project design and implementation. The 48 surveys that were returned provided valuable guidance on project focus, site and stressor selection, and ultimate products that would be most useful for guiding Olympia oyster restoration. We are now incorporating this feedback as we move forward with beginning the scientific examination of stressors and characterization of restoration sites. Through conference calls and in-person meetings the project team also refined plans for field site selection, stressor selection, oyster surveys, and laboratory tests of stressor interactions.

B. Working with Intended Users

Our major goal for this reporting period was to obtain early feedback on project scope, objectives, and desired outcomes from the intended end-users: community members participating in on-the-ground oyster restoration, and professionals engaged in oyster restoration planning, permitting, or policy. We accomplished this by presenting and discussing our findings at a meeting with end-users, and moreover by presenting our project overview and soliciting feedback using SurveyMonkey for a larger group of end-users. We synthesized the findings and met as a project team to incorporate the results into our next steps. More detail on each of these elements is presented below.

San Francisco Bay Native Oyster Working Group

On 11/15/2011, we presented our project scope and goals to members of the SFBNOWG. Our presentation was followed by a lively discussion, in which we received recommendations for site selection, further end-users to include, and potential partnerships for citizen monitoring.

Regional Olympia Oyster End-Users

We developed a database of regional end-users to engage in our project, building on existing databases used for the San Francisco Habitat Goals project, the West Coast Olympia Oyster Restoration Workshop participants, and the Elkhorn Slough Tidal Wetland Project. The refined database included 170 San Francisco Bay area end-users, 35 Elkhorn Slough area end-users, and 30 broader West Coast end-users. Although our targeted list of critical participants is smaller, we wanted to keep a larger group in the loop about our work, and give them the opportunity to provide feedback.

We designed a SurveyMonkey to obtain feedback from these end-users. The survey was edited heavily by project scientists to ensure all critical elements of the project were captured. The survey was also edited by our collaboration specialists with the goal of using phrasing and structure that would be most accessible to the end-users. We made use of NOAA Coastal Services Center and SurveyMonkey tutorials to design a survey that could be completed rapidly with straightforward scoring questions, but also allowed for open-ended feedback on all issues.

The survey was sent to end-users on 12/13/2011 along with the project overview flyer prepared in preparation with NSC staff, and closed on 1/17/2012. We received 48 responses to the survey. About half the respondents work in the San Francisco Bay region, which is appropriate since this is the nexus of Olympia oyster restoration in the state. Another 35% work either in Elkhorn Slough or in a broader region of California. The remainder works elsewhere in the Pacific range of the Olympia oyster. About half of respondents work directly on some aspect of Olympia oyster restoration. The majority of these are engaged in strategic planning for restoration and oyster science.

We summarized survey responses in a 15-page document which we will eventually make public. The major take-home messages are reprised here:

- Focus of new science: All the proposed focus questions for new scientific inquiry scored as being moderately to very important for designing sustainable restoration strategies. The top-scoring focus areas were understanding how climate-related stressors affect oyster growth and survival, and identifying which sites have the lowest stressor levels and thus are most likely to support successful restoration projects.

- Stressors: The top stressors for these end-users were acidification and sedimentation. Low salinity and high temperature were the next highest ranked stressors. Low oxygen and invasive species also scored fairly high. For testing effects of multiple stressors, combinations involving temperature and other stressors were mostly commonly identified as important.
- Information products and restoration planning tools: Respondents ranked scientific publications as by far the most important product for capturing lessons learned from this project. In terms of restoration planning tools, interactive maps and decision-support tools for site selection ranked highest.
- Additional end-users to engage: Respondents provided numerous suggestions as to additional organizations and types of end-users to engage in this project. Some of these are traditional coastal resource management agencies which had not been included, such as California Department of Fish and Game's marine region or NOAA's Coastal Services Center. Other suggestions included less traditional stakeholders, such as farmers (who influence oysters through eutrophication) and marine designers and engineers, who would be engaged in climate-related shoreline protection.

Incorporation of end-user feedback into project planning and implementation

On 2/1/2012, our PI team met for four hours to refine plans for the laboratory experiments and field sampling based on the end-user feedback received. Significant adjustments were made to our original plans. For instance, we will focus more on sedimentation as a critical stressor identified by end-users. We will add sites of interest to groups engaged in restoration, and engage them in citizen science to help with the monitoring. We also will increase our database of end-users to contact for formative feedback and to invite to the midpoint and final workshops, based on the suggestions received.

We are currently editing the summary of survey results to indicate how these results have shaped our project. We will post this summary document on a project website that we will launch within the next six months. We will then send the link to the website with a brief email update to all the end-users in our database.

C. Progress on project objectives for this reporting period

The most critical objective for this reporting period was to engage end-users and obtain feedback from them. Accomplishments in this area are described in the previous section. Here, we elucidate other progress on the applied science objectives for this period.

Selection of study sites and stressors

As noted above, feedback on stressors and sites for oyster surveys were provided by the end-users and incorporated into project planning. Additional criteria for site selection included issues related to site access, permit requirements, tidal height of known oyster populations, and locations of existing water quality data collection. We recently identified "supplemental" sites where collaborating organizations will expand the coverage of our monitoring efforts with the help of citizen scientists who will receive appropriate training and follow our established methods of data collection. In addition to intertidal surveys that will be conducted at all sites, a subset of sites in each estuary will be surveyed for subtidal oysters and environmental conditions to inform future subtidal restoration efforts. Table 1 shows the current list of sites.

Table 1. Current list of study sites for environmental monitoring and oyster surveys.

Estuarine regions	Elkhorn Slough sites	San Francisco Bay sites
High Oceanic Influence	Hudson Landing	Brickyard Cove
High Oceanic Influence	Azevedo North	Sausalito
High Oceanic Influence	Kirby Park	Berkeley
High Oceanic Influence	-----	<i>Supplemental: Audubon/Arambaru</i>
Medium Oceanic Influence	North Marsh	Oyster Point
Medium Oceanic Influence	Whistlestop	Coyote Point
Medium Oceanic Influence	South Marsh Footbridge	<i>Supplemental: Eden Landing</i>
Low Oceanic Influence	Vierras	China Camp
Low Oceanic Influence	Bennett Slough West	Point Orient
Low Oceanic Influence	ML Road North	Loch Lomond
Low Oceanic Influence	-----	<i>Supplemental: Point Pinole</i>

Multiple environmental variables will be measured in the field and compared among study sites, but due to constraints on time and personnel only a key subset of these variables will be tested in the lab for interactive stressor effects on oysters. Following end-user feedback and project team discussions as noted above, the four environmental stressors that we will evaluate in the lab are high temperature, low salinity, low dissolved oxygen, and sedimentation. Our original intent was to incorporate acidification as one potential stressor of concern and many end-users perceived acidification to be an important emerging stressor for oysters in the region. However, recent evidence from ongoing research indicates that although acidification can significantly reduce oyster growth rates, the other environmental stressors we are investigating present more immediate and lethal threats to oyster survival. Additionally, diurnal variation in estuarine pH is substantial and the long-term trend within the estuary (at least in Elkhorn Slough) appears to be increasing pH rather than the reverse. Following much deliberation on these points, we revised our plans to no longer include acidification as a controlled factor in our lab experiments.

Planning for field monitoring and laboratory studies of stressor effects

During this reporting period we began developing detailed plans for deployment of data loggers, surveys of existing oysters and future recruits, and studies of oyster population connectivity in San Francisco Bay. Dates have been selected for initiation of field efforts and final purchasing and logistical planning is underway.

The project team has already successfully collected oysters, spawned them, collected settling larvae in the lab, and raised the oysters through post-settlement stages. Detailed plans for lab experiments are currently being developed and will be the subject of upcoming meetings.

Over the next six months we will initiate environmental monitoring, field surveys, connectivity assessments and laboratory experiments following revisions to our project plans as noted above. We also will hold monthly meetings of the project team and implement effort-tracking methods in order to document progress on the various complementary aspects of this project.

D. Benefit to NERRS and NOAA

The results of our survey, revealing the climate change questions and stressors of most interest to end-users working on aspects of shellfish restoration, will be of some relevance to the NERRS and the NOAA Restoration Center. We will post the report of survey results on a public website where it can be shared with these groups.

Another aspect of our project of relevance to the NERRS is our use of Basecamp to organize all written documents and correspondence about the project's development. We have encountered some challenges with using Basecamp, and have addressed most of these. We would be glad to share our lessons learned with others interested in using this tool. For instance, our project team felt overwhelmed to receive constant emails from Basecamp, whenever anyone added a message to a thread. We have dealt with this by "unsubscribing" everyone from our message threads. This way, participants can log in and catch up with a message thread at the time of their choosing, rather than receiving emails daily. Another problem was version control of group edited documents. We have addressed this by posting all documents on the Message, rather than File tab of Basecamp, and putting in "Version control alert" messages indicating that someone is editing the master version and that others should wait until the next version is uploaded. We also found it useful to create an "AAA-Start Here" message category, where all participants start each time they use Basecamp. We place an update as the top message in this category, with directions as to where active areas of discussion or editing are. With these modifications, we have found Basecamp to be a very useful tool and would encourage other NERRS users to try it.

E. Additional updates

The CTP Coordinator for the San Francisco Bay National Estuarine Research Reserve resigned during this initial grant period. By conducting literature searches to inform our efforts, we were able to carry out an effective SurveyMonkey without support from this position. When the new CTP Coordinator is hired, we will engage them in the project so that they can support the final coastal training workshop as originally anticipated.