



REVISED PLAN OF WORK

Project Title:

Baseline Characterization of Rocky Intertidal Ecosystems for MPAs along the North Coast of California

Principal Investigator: Sean Craig (HSU)

Co-Principal Investigators: Joe Tyburczy (CA Sea Grant), Andrew Kinziger (HSU), Pete Raimondi (UCSC), Rosa Laucci (Smith River Rancheria), Ivano Aiello (MLML).

We submit this document in response to input from reviewers and panels, including modifications to our proposed work as well as providing clarification where requested.

Summary of Work

Our project is designed to achieve the following goals: (1) produce a quantitative baseline characterization of the structure of rocky intertidal ecosystems in four of the newly established Marine Protected Areas (MPAs) in the North Coast Study Region (NCSR), (2) provide a quantitative comparison between rocky intertidal ecosystems in these MPAs and associated reference areas in the NCSR, (3) analytically explore baseline characterizations for potential indicators of the state of rocky intertidal ecosystems using newly collected data along with existing PISCO datasets (from Co-PI Raimondi) of the region (sites where PISCO monitoring is ongoing), (4) integrate these assessments with other components of the baseline survey [e.g., Rocky Reefs and Kelp-Forests (Craig-PI), Reef Check (Friewald-PI), Sandy Beach (Nielsen-PI), collaborative fishing (Mulligan-PI) to inform the role and design of those programs for future monitoring and evaluation, (5) generate a fish biodiversity baseline within rocky intertidal habitats, and (6) monitor and characterize rockfish recruitment into tidepool habitats.

We plan to conduct sampling at four pairs of MPAs and reference sites (eight sites), plus two additional reference sites known to experience intertidal settlement of juvenile black rockfish. Pending renewed funding of PISCO, biodiversity work will also be conducted at three additional sites. Study sites and sampling methods are summarized in Table 1. The primary sampling methods will be:

- Invertebrate and algal diversity surveys, led by Dr. Raimondi (UCSC).
- Invertebrate and algal focal species surveys, led by Dr. Craig (HSU), Ms. Laucci (Smith River Rancheria), and Dr. Tyburczy (CA Sea Grant).
- Fish diversity and rockfish settlement surveys, led by Dr. Kinziger (HSU) and Dr. Tyburczy (CA Sea Grant).
- High-resolution topographic surveys, led by Dr. Aiello (MLML) and Dr. Raimondi (UCSC).

Table 1. Sites, north to south, and sampling methods for intertidal baseline monitoring.

Study Sites	Site type (pairing)	PISCO	Invert. & Algal Diversity	High Res. Topography	Invert & Algal Focal Species	Fish Diversity	Rockfish Settlement	Proposed Subtidal Study Sites
Pyramid Point	SMCA (1)		X	X	X	X		†‡
Pt. St. George	reference (1)		X	X	X	X	X	
Ender's Beach	PISCO-dependent	X	X					
Damnation Creek	PISCO-dependent	X	X					
False Klamath Cove	reference	X	X	X	X	X	X	
Palmer's Point	reference		X	X	X	X	X	†*
Cape Mendocino, Petrolia	PISCO-dependent	X	X					
Shelter Cove	reference (2)	X	X	X	X	X		
Double Cone	SMCA (2)		X	X	X	X		†
Kibesillah Hill	reference (3)	X	X	X	X	X		
Ten Mile	SMR (3)		X	X	X	X		†‡
Mackerricher	SMCA (4)		X	X	X	X		†‡
Mackerricher	reference (4)		X	X	X	X		

†Sites that will be sampled by HSU SCUBA survey

*Palmer's Point is close to Trinidad where HSU will conduct SCUBA surveys

‡Sites that will be sampled by Reef Check survey

Note that the ROV, HSU SCUBA, and Reef Check survey sites may change.

Invertebrate and algal diversity surveys (Raimondi)

Comprehensive surveys of invertebrate and algal biodiversity will be conducted at 10 sites (plus an additional 3 contingent on the funding status of the PISCO consortium) according to the well-established and rigorous protocols of the Coastal Biodiversity Survey (<http://www.eeb.ucsc.edu/pacificrockyintertidal/index.html>) that has been used in all the other MPA study regions. Over the course of Years 1 and 2, a biodiversity survey will be conducted once at each site. A 30m sampling grid marked with permanent hex bolts and spanning from high to low intertidal will be established at each site. A combination of point contact surveys will be used to collect data on relative abundance and spatial distributions, while belt transects and randomly spaced quadrats, stratified by intertidal zone (low, mid, and high) will better capture the abundance and distribution of mobile invertebrates including sea stars and abalone.

Invertebrate and algal focal species surveys (Craig, Laucci, Tyburczy)

We will conduct surveys of target species at 10 sites, twice per year (winter and spring) in Years 1 and 2 according to MARINE protocols – via a variety of methods found to be effective for the various taxa including fixed photoquadrats, point-contact transects, circular plots, belt transects, and surveys of irregular plots. Target species include:

- mussels (*Mytilus californianus*)
- barnacles (*Chthamalus* spp., *Balanus glandula* and *Pollicipes polymerus*)
- anemones (*Anthopleura elegantissima*)
- macroalgae (*Endocladia muricata*, *Hesperophycus harveyanus*, *Fucus gardneri*, *Pelvetiopsis limitata*, *Silvetia compressa*, *Mazzaella* spp., *Mastocarpus papillatus*)
- surfgrass (*Phyllospadix scouleri/torreyi*)
- owl limpets (*Lottia gigantea*)
- abalone (*Haliotis cracherodii*, *H. rufescens*)
- sea stars (*Pisaster ochraceus*)

Fish diversity and rockfish settlement surveys (Kinziger, Tyburczy)

Surveys of fish diversity will be conducted at ten sites twice annually in Years 1 and 2, in conjunction with the invertebrate and algal focal species surveys. Rockfish settlement, as well as fish biodiversity, will be sampled twice monthly from May-August during both years at three sites. During these surveys, a set of 5 tidepools at each site will be rapidly drained via portable gas-powered pump while all fish are captured via dipnets. Tidepools will be immediately refilled while captured fish, temporarily held in a tank will be measured, identified to species, and returned to the tidepool. A small fin clip will be taken from the second dorsal fin of all rockfish in order to mark all individuals allowing accurate estimation of total seasonal settlement, as well as affording the option of future genetic work.

The three sites selected for the settlement work are subject to change – and final choices will be made on the basis of finding appropriate tidepools, proximity to HSU to minimize travel expenses, and especially collocating sites with the two SCUBA projects that can provide independent estimates of rockfish recruitment (via counts of young-of-the-year fish). By collaborating with the HSU and Reef Check SCUBA projects, this pilot project will allow us to evaluate the potential of intertidal monitoring as an inexpensive alternative to offshore and diving-based methods for estimating rockfish recruitment in this region. Since fish diversity data will also be collected during rockfish settlement surveys, these three sites will receive much greater sampling effort (temporally) allowing the creation of a species accumulation curve.

Conducting this project simultaneously with the focal species surveys means it requires minimal additional funding while contributing a baseline and characterization of this important species assemblage that has not been addressed in other MPA regions. This project will also provide a valuable training experience and ample data for a Masters student.

High-resolution topographic surveys (Aiello, Raimondi)

This component of the project will establish permanent benchmarks, and employ differential GPS and Terrestrial Laser Scanning to create a high-resolution, 3-dimensional map of each site with ~5cm resolution. Each of ten sites will be surveyed once over the course of Years 1 and 2.

The high-resolution topography project is now only a small portion of the budget of the project and heavily leveraged with match by Dr. Aiello. This work holds promise to help shed light on the importance of the extent to which small scale topographic features shape rocky intertidal communities – an idea that has long been considered, but before now could not be rigorously evaluated. This work will provide high-resolution topographic models of these intertidal sites – a potentially very important aspect of the physical environment of intertidal ecosystems, including their response to future sea level rise, that is only possible now via this new technology.

Outcomes and Deliverables

- Final report (Jan 2017) detailing our baseline characterization of rocky intertidal habitats in the NCSR including both MPAs and reference sites. In addition to sharing project data via Oceanspaces.org as required, we will make our data available through the California Coastal Geoportal. Data and analysis in this final report will also include:

- Examination of patterns of species abundance and diversity including comparisons among algal, invertebrate, and fish species.
- Analysis of the influence of fine-scale topography on species distributions and community composition.
- Annual reports (Jan 2015, Jan 2016) will provide results, budget, and progress to date on all deliverables and objectives.
- Printed and online outreach materials for PISCO and Sea Grant will be developed as part of each annual and final report (Jan 2015, Jan 2016, Jan 2017).
- All data and metadata from the project will be provided to Department of Fish and Wildlife, Ocean Protection Council, Sea Grant, and Ocean Science Trust upon completion of the project. These datasets will include:
 - A database with all photoquadrat images from focal species surveys.
 - Processed and raw data from the topographic surveys of all sites. Data will be available in ESRI geodatabase file format and will include benchmark locations, topographic points, contour maps, and hillshade models.
 - Spreadsheets that includes data and metadata for all biodiversity and focal species surveys.

MILESTONES CHART

TASKS AND MILESTONES	2014												2015												2016																							
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D												
Initial Project Planning and Organization	X	X																																														
Invert. & Algal Diversity Surveys				X	X	X	X		X	X	X	X				X	X	X	X		X	X	X	X																								
Invert. & Algal Focal Species				X	X	X	X		X	X	X	X				X	X	X	X		X	X	X	X																								
Fish Diversity Surveys				X	X	X	X		X	X	X	X				X	X	X	X		X	X	X	X																								
Rockfish Settlement Surveys				X	X	X	X									X	X	X	X																													
High-Res Topography				X	X	X	X									X	X	X	X																													
Review of previous year's protocols and results ¹											X	X																																				
Review of project protocols and results ²																										X	X	X	X																			
Project Data management								X	X						X	X					X	X					X	X	X																			
Analyses																							X	X	X	X	X	X																				
Syntheses / Ecological Indicators																											X	X	X	X																		
Monitoring recommendations																																					X	X	X	X	X							