BASELINE MONITORING AND CHARACTERIZATION OF NEARSHORE ROCKY REEFS AND KELP FORESTS OF MARINE PROTECTED AREAS ALONG THE NORTH COAST OF CALIFORNIA

REVISED PLAN OF WORK- 12/16/13

One of the most prominent and well know ecosystem features of the nearshore Marine Protected Areas (MPAs) along the California coast are the subtidal rocky reefs and macroalgal kelp forests associated with them. Rocky reefs and kelp forests are integral parts of the diversity and structure of nearshore ecological communities and provide structure, food, shelter, and nursery habitat for a vast array of marine species. They support commercial and recreational fisheries that target a diversity of fishes and invertebrates while also providing a diversity of non-consumptive services. North Coast rocky reefs and the marine species relying upon them are particularly important components of the economy and image of the small coastal communities in this region. The overall goal of this project is to provide a summary description, assessment, and understanding of ecological conditions within nearshore rocky reef and kelp forest habitats both inside and outside of marine protected areas (MPAs) throughout the North Coast Study Region (NCSR).

We plan to meet the overall goals of the Project by:
(1) Producing a quantitative baseline characterization and comparison of the structure of nearshore rocky reef and kelp forest ecosystems in MPAs and comparable reference areas of the NCSR. To achieve this goal SCUBA surveys at 4 MPA and 4 reference sites will collect data on fishes, invertebrates, and macroalgae as well as characterize substrate and reef rugosity.
(2) Document initial ecological changes to rocky reefs and kelp forests within and outside of MPAs. This will be accomplished by comparing any notable trajectories of species densities, sizes and community composition between MPA and reference sites during the two year study period, and comparing data collected during this study to historical subtidal data from the area that has been collected by CDFW and HSU.
(3) Provide a thorough baseline characterization of socioeconomically and ecologically important species found along North Coast rocky reefs, specifically describing current densities and sizes of two high priority species, red abalone (*Haliotis rufescens*) and red sea urchin (*Strongylocentrotus franciscanus*), that are likely to be part of metrics for assessing ecosystem health and change.

The Project team is comprised of experienced and published rocky reef and kelp forest scientists from multiple institutions and agencies, and all data will be collected by utilizing a scientifically rigorous sampling approach carried out by trained, experienced AAUS research divers with years of North Coast diving experience. Logistical support will be provided through HSU's Diving and Boat Safety Program. We also will collaborate with the California Sea Urchin Commission and North Coast commercial

urchin divers, who posses some of the most detailed knowledge of rocky reefs in the NCSR and will assist with targeted survey efforts for red sea urchins and red abalone.

Plan of Work
Our approach to create a baseline characterization of rocky reef and kelp forest ecosystems in the NCSR will continue to involve surveys of targeted elements of nearshore subtidal rocky reef ecosystems using SCUBA: fishes, invertebrates, algae and habitat features, with particular emphasis on red sea urchins and red abalone. We propose to conduct surveys inside and outside of MPAs to characterize 1) the density of macroinvertebrates, macroalgae, and benthic fishes, 2) the size structure and density of red abalone and red sea urchin populations, 3) the percent cover of sessile and colonial invertebrates and algae, and 4) the substrate type and reef structure at all sites. For the purposes of a baseline characterization of an area as large as the NCSR attempting to increase spatial coverage is most important in describing the distribution of key attributes of the ecosystem and, despite the necessity of reducing site coverage, remains the primary focus of this Proposal. Each location will be sampled once in each of two years with surveys conducted over the course of a six to seven month sampling period and therefore incorporating some degree of temporal variability. Individual MPAs and nearby reference sites will be sampled as closely as possible in time in order to avoid confounding direct comparisons with temporal effects. The project's major tasks and timeline are depicted in Figure 1.

We propose to sample 4 MPAs and 4 references sites spread throughout the NCSR (Table 1). At the less visited and remote MPAs (Pyramid Point SMCA and Double Cone Rock SMCA) and the reference site at Abalone Point, we will use a series of exploratory dives to asses benthic topography and estimate core rocky reef sampling area available. These early exploratory dives are expected to take place in the Spring and early Summer of 2014. We expect to begin baseline monitoring surveys at these sites during mid to late Summer of 2014. At the southern end of the NCSR, we propose to sample MPA sites at Ten Mile SMR and Point Cabrillo SMR with comparable rocky reef and kelp forest ecosystems.

Reference sites will be located at (from north to south), Trinidad, Abalone Point, Caspar (2), and Elk Headlands. Reference sites were selected based upon (1) habitat characteristics at these sites are as comparable as possible to sites sampled within MPAs, including reef rugosity and exposure to oceanic conditions, (2) a spatial distribution that allows sampling of nearshore rocky reefs outside of MPAs throughout the NCSR, and (3) project staff having experience diving and working in the immediate area of these sites.

Some of the sites we were forced to drop from our original proposal will be sampled by volunteer divers through funding allocated by the NCSR ME to ReefCheck. These untrained divers will sample shore-accessed sites primarily in the easily accessible Mendocino-Fort Bragg area at the southern end of the NCSR. We will overlap on 2-3 of our sites which will provide comparisons of survey methods and diver reliability between the groups.

Collaboration with the commercial divers will help with survey timing and safety considerations while focusing on red sea urchin and red abalone densities and population size structure as part of the special focus on ecologically and economically important indicator species. Commercial urchin diver assisted surveys will occur at relatively remote sites (i.e., Double Cone SMCA and Abalone Point) at which the commercial divers have more practical experience working as well as at the two Caspar sites and Point Cabrillo SMR, sites that are of specific interest to the commercial urchin fleet because of previous sea urchin research at these locations and continued work planned for the future.

We propose to maintain the same overall stratified random permanent sampling design, in which randomly located transects are sampled within fixed sites ("cells"). We will use the extensive experience of the project leaders and associated staff as well as exploratory dives (see above) to identify the distribution of rocky reefs within each of the MPAs and corresponding reference areas that we propose to sample. We propose to maintain the same PISCO-style sampling protocol but with increased sample effort directed towards abalone and sea urchins (Appendix 1).

Project Deliverables

Data deliverables will include annual reports, all databases generated as part of collection and analysis for this project, spreadsheets of analyzed data, and a final technical report. An attempt will be made to capture still and video images of this important NCSR habitat. However, due to budget cuts, safety concerns, generally poor subsurface visibility along the North Coast, and time limitations when in the field we do not anticipate allocating extra time for this endeavor and thus can not guarantee these images as deliverables.

All data will be collected, checked for quality control, and entered by post-doc Ryan Jenkinson. Annual progress reports will be prepared both years following completion of the field season, likely during the winter months. Progress reports will contain a summary of all dive activities for the year, a summary of data collected, and preliminary analysis of collected data. Reports, species and dive-specific data, and metadata will be made available to CDFW, OPC, SeaGrant, and OST on an annual basis.

The third and final year of the project will not include field work and will focus on analyses and the generation of a final technical report and outreach material. Databases and the results of analyses for baseline characterization and indicators will be incorporated into the final report. The final report, along with all associated data, will be delivered to CDFW, OPC, SeaGrant, and OST. In addition, the rocky reef data will be disseminated among closely associated monitoring programs at HSU. Groups that have species or community overlap with the subtidal rocky reef habitat (e.g., rocky intertidal and shallow water fishes) have coordinated overlapping site selection and will coordinate data analysis approaches. By integrating analytical approaches for assessing population and community characteristics of key fish and invertebrate taxa across ecosystems we will be able to provide a more holistic characterization of species and community

structure, identify commonalities and differences among monitoring programs and make recommendations for integrated long-term monitoring of MPAs across multiple ecosystem features.

Consistent with our stated objectives, this monitoring program will deliver a comprehensive analysis of all collected data by the core Proposal team and collaborators, specifically:

1) A quantitative baseline characterization and comparison of the structure of nearshore rocky reef and kelp forest ecosystems in MPAs (SMRs and SMCAs) and comparable reference areas of the NCSR. Data will be obtained from HSU surveys at all proposed sites, each of which will be sampled once per year.

2) An analysis of initial ecological changes to rocky reefs and kelp forests within and outside of MPAs. This will be accomplished by comparing any notable trajectories of species densities, sizes and community composition between MPA and reference sites during the two year study period, and comparing data collected during this study to historical subtidal data from the area that has been collected by scientifically robust programs through HSU.

3) Provide a thorough baseline characterization of red abalone and red sea urchins on North Coast rocky reefs both inside and out of MPAs. Survey data will be collected by HSU and local commercial urchin divers and be used to analyze both species densities and population structure at various management protection levels and spatial scales.

The final report will be produced in 2016 in coordination with all collaborators. This report will definitively describe and characterize the status of rocky reef and kelp forest habitats throughout the NCSR during the initial implementation of the MLPA reserve network along the North Coast, use historical and current data to describe initial ecological changes, and make recommendations towards future monitoring of NCSR MPAs.

Table 1. Sites to be surveyed and entities conducting each survey.

Site	Type	HSU	Urchin Divers
Pyramid Point	SMCA	Survey	-
Trinidad	Reference	Survey	-
Double Cone	SMCA	Survey	Survey
Abalone Point	Reference	Survey	Survey
Ten Mile	SMR	Survey	-
Caspar North	Reference	Survey	Survey
Caspar Closure Area	Reference	Survey	Survey
Point Cabrillo	SMR	Survey	-
Elk Headlands	Reference	Survey	-

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
Training and Preparation			X	X											X																					
Exploratory Dives				X	X	X																														
Field Surveys					X	X	X	X	X	X	X					X	X	X	X	X	X	X														
Data Management											X	X											X	X												
Analysis																									X	X	X	X	X							
Monitoring Recommendations																													X	X	X	X				
Report Writing												X												X						X	X	X	X	X	X	X

Figure 1. Major tasks and timeline.