MPA Baseline Program

Annual Progress Report

Principal Investigators - please use this form to submit your MPA Baseline Program project annual report, including an update on activities completed over the past year and those planned for the upcoming year. This information will be used by the MPA Baseline Program Management Team to track the progress of individual projects, and will be provided to all MPA Baseline Program PIs and co-PIs prior to the Annual PIs workshop to facilitate discussion of project integration. Please submit this form to California Sea Grant when complete (sgreport@ucsd.edu, Subject [Award Number, project number, PI, "Annual Report"].)

Project Information

Project Year	2015	**MLPA Region**	North Coast
Project Title & Number	R/MPA-33A North Coast MPA Baseline Program: Rocky Intertidal		

PI name	Sean Craig	**Co-PI name**	Joe Tyburczy

PI Contact Info **Co- PI Contact Info**

(please list additional PIs and contact info in the "Project Personnel" section if necessary)

Address	Humboldt State University Department of Biological Sciences 1 Harpst St. Arcata, CA 95521	**Address**	California Sea Grant Extension 2 Commercial St., Suite 4 Eureka, CA 95501
Email	sfc4@humboldt.edu	**Email**	jtyburczy@ucsd.edu
Phone	707-826-3656	**Phone**	707-443-8369

Project Goals & Objectives

The goal of this project has been to coordinate and lead field sampling of intertidal fish biodiversity and focal algal and invertebrate species at 10 intertidal sites for the North Coast MPA region. Dr. Tyburczy has also overseen data entry and quality control and will contribute to data analysis and preparation of the final report with Dr. Craig this coming summer.

We have collected the following data on these focal taxa:

Invertebrates

- Percent cover, mobile invertebrates, and individual sizes of mussels within mussel beds (*Mytilus californianus*)
- Abundance, size, and disease class of sea stars (especially the ochre star *Pisaster ochraceus*)
- Abundance and size of red abalone (*Haliotis rufescens*) focused at Fort Bragg

Algae/plants

- Transects for surf grass, *Phyllospadix* spp.
- Transects for the sea palm, *Postelsia palmaeformis*

Intertidal fish

- Intertidal settlement of juvenile rockfish (focused on 2 sites = Palmer's Point and False Klamath Cove)
- Diversity of intertidal fish in 3 pools at each site

The final report will summarize this data to provide a baseline of abundance for these focal taxa and how this varies seasonally and across the 2-year period of this baseline study.

Summary of Project Activities Completed to Date

Overview of Project Year _2_ Activities, including progress towards meeting goals & objectives

Dr. Sean Craig was responsible for high-level oversight of the project including budgeting and dealing with HSU payroll for students supported under this project.

Dr. Joe Tyburczy led the Humboldt State University intertidal research team of graduate students and undergraduate students in completing summer 2015 and winter 2015/2016 field sampling.

Dr. Tyburczy oversaw work by technician Kellan Korcheck and graduate student Jason Lopiccolo on data entry, quality control, and entry into the UC Santa Cruz/MARINe database. All data for summer and winter 2014 and summer 2015 has been entered, and we are now in the process of entering data from winter 2015, the final field season for the project. Dr. Joe Tyburczy and Dr. Andrew Kinziger assisted graduate student Kevin Hinterman with intertidal fish biodiversity surveys which were conducted at all sites except Pyramid Point, Shelter Cove, and Kibesillah Hill. Dr. Tyburczy presented preliminary analysis of data from the first three field seasons at the 2015 Western Society of Naturalists conference (November 5-8, 2015 in Sacramento). Drs. Craig and Tyburczy contributed to a talk by Dr. Brian Tissot and assisted in the preparation of three posters for this conference on different aspects of this project presented by: 1) Jason Lopiccolo (graduate student of Dr. Craig's in biology at HSU), 2) Kevin Hinterman (graduate student of Dr. Kinziger's in fisheries at HSU) and 3) a team of undergraduate students (see attached program with highlighted abstracts).

Dr. Tyburczy handled all permitting, including coordination with CDFW, State Parks, and the National Park Service as well as arranging site access with landowners and the City of Fort Bragg. He have also been the primary point of contact to coordinate activities with collaborating research teams from the Tolowa Dee-Ni' Nation (formerly Smith River Rancheria), UC Santa Cruz and San Jose State University.

Our work for the remainder of the project will focus on entry of the final field season of data (winter 2016), preparation of this data and metadata for uploading to public database(s), and preparation of the final report with project results.

MPA Baseline Program Annual Report

Highlights from project progress so far, such as successes achieved, new collaborations or partnerships, or interesting stories from the past year that may be suitable for a blog post or other media venue

Preliminary analysis of data from the first three field seasons indicates that abundance of large sea stars at the two northernmost sites dropped rapidly after the first summer – and suggests that abundances at sites further south in the region had already been impacted by sea star wasting syndrome (SSWS). These two northern sites exhibited significant recruitment of juvenile stars in summer 2015 and the prevalence of SSWS had decreased at all sites. Though data entry and analysis are not yet complete for winter 2015/2016, anecdotally there may have been an increase in SSWS prevalence.

Another significant finding was the marked decline in the abundance of red abalone at Noyo Headlands, a site that was formerly privately held as part of the Georgia Pacific mill. The City of Fort Bragg, with funding from the California Coastal Conservancy, purchased and rehabilitated most of this parcel as public open space. When we began monitoring the site in summer 2014 there was an extremely high abundance of abalone including legal-sized individuals in the intertidal. By summer 2015, their abundance (especially the large ones) in the more accessible parts of the site, had decreased markedly – likely as a result of trespassers harvesting abalone since the site wasn't yet open to the public.

Description of any unforeseen events and substantial challenges, and resulting effects on project activities and progress. Please indicate any issues that may affect other PI's or require coordination with other Baseline partners (e.g., ME, DFG, Sea Grant).

Sampling over winter 2015/2016 was challenging and a combination of storms (which made sampling unsafe) and holidays (which hindered sampling by limiting the availability of student field assistants) coincided with some of the best tides. As a result, we missed sampling one or two replicates of some taxa at a few sites. This limitation is not so great that it should impact interpretation or analysis however.

As with last year, logistics prevented us from sampling at Shelter Cove, Kibasillah Hill, or False Klamath Cove during the summer or winter – and so we will have to rely on sampling by Dr. Pete Raimondi's crew at those sites during the summer only.

Dr. Craig had to deal with significant family health issues which limited his ability to be more involved in fieldwork: his daughter was diagnosed with Ehlers-Danlos syndrome, a serious (incurable) connective-tissue disorder. She has been hospitalized twice in this past year, and maintaining her health, visiting doctors and specialists, assisting her through her high school coursework, etc. has taken a great deal of Dr. Craig's time.

Data status (i.e., paper/raw format or digitized; if digitized, what format?)

Most data for summer and winter 2014 and summer 2015 has been entered into Excel according to the MARINe format. We have also entered data for mussel photoquadrats and surfgrass transects into Excel, but are still working to enter these into the MARINe Access database. We are also in the process of entering data from winter 2015-16, the final field season of the project.

Activities Planned for following Project Year __ (if applicable) – *Please describe remaining work and approximate timelines for completing that work, including any anticipated budget variances necessary to complete the project.*

Data entry and quality control should be completed in early summer 2016, at which point final analysis and report preparation can begin. We anticipate completion of the final report no later than March 1, 2017 as required.

Project Personnel – *Please indicate additional project personnel involved in your MPA baseline project, including students and volunteers, or additional PI contact information if necessary, as well as the nature of their assistance in the project project.*

	Students Supported	*Student Volunteers*	*Nature of Assistance*
K-12			
Undergraduate	*12*		*field work*
Masters	*3*		*field work, data entry*
PhD			

Number of other Volunteers not counted above and the nature of their assistance in the project:

None

Additional PI contact info not listed on first page:

Dr. Andrew Kinziger

Humboldt State University
Department of Fisheries Biological Sciences
1 Harpst St.
Arcata, CA 95521

Email: andrew.kinziger@humboldt.edu
Phone: 707-826-3944

Cooperating Organizations and Individuals - *Please list organizations or individuals (e.g., federal or state agencies, fishermen, etc.) that provided financial, technical or other assistance to your project since its inception, including a description of the nature of their assistance.*

Name of Organization or Individual	*Sector (City, County, Fed, private, etc.)*	*Nature of cooperation (If financial, provide dollar amount.)*
Sherwood Valley Band of Pomo Indians	*Tribe*	*Collaboration in continuing abalone monitoring at Fort Bragg*
California Department of Fish and Game	*State*	*Permitting*
California State Parks	*State*	*Permitting and collaboration in fieldwork at Patrick's Point State Park*
National Park Service	*Federal*	*Permitting and collaboration in fieldwork at False Klamath Cove*
City of Fort Bragg	*City*	*Site access (Noyo Headlands)*
Erin Sullivan	*Private landowner*	*Site access (Abalobadiah/10-Mile SMR)*
Dr. Ben & Nancy Housel	*Private landowners*	*Site access (MacKerricher SMCA)*

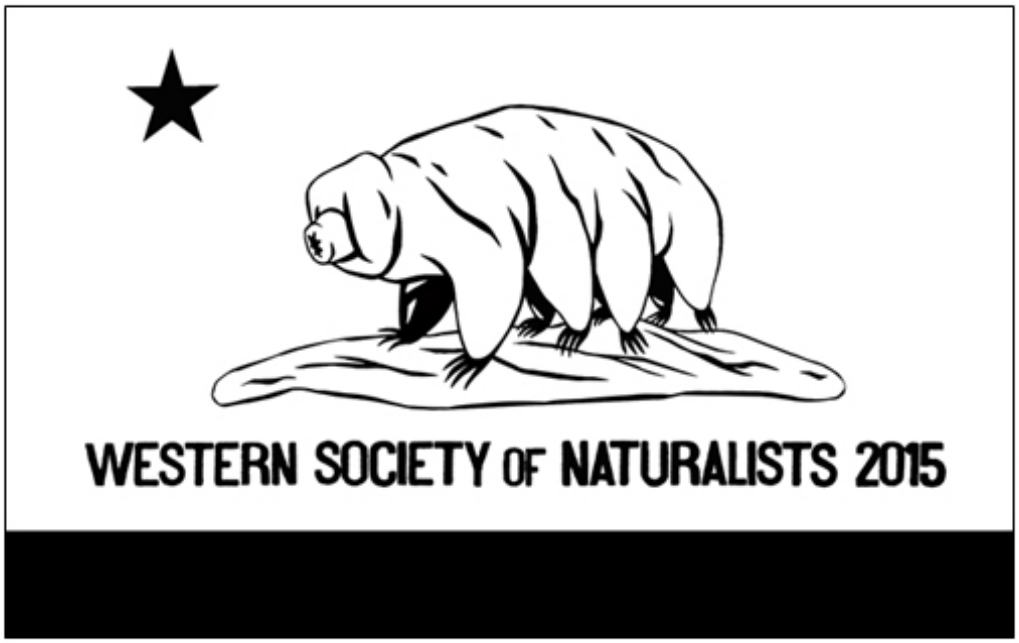
Project Outputs and Materials: *Please provide any other project-relevant information, such as descriptions of attached materials, media coverage your project has received, presentations, publications, images etc.*

Attached is a .pdf with highlighted abstracts for talks and posters that presented results or incorporated data from this project at this past fall's Western Society of Naturalists (WSN) meeting.

Dr. Tyburczy delivered additional presentations at the following events that incorporated results from this project:
-MPA Enforcement Training Event, 14 Oct 2015, Eureka, CA & 15 Oct 2015, Crescent City, CA
-North Coast MPA Collaborative Meeting, 17 Nov 2015, Fortuna, CA
-HSU Natural History Museum Lecture Series, 15 Dec 2015, Arcata, CA

Western Society of Naturalists

Meeting Program



Sacramento, CA

November 5–8, 2015

zone of the California Current Ecosystem until the fall of 2014. However, after upwelling subsided in the fall, warming led to significant ecological impacts such as seabird and marine mammal mortality events, suggesting severe food shortages. We discuss the nexus of climate variability (The Blob) and climate change (upwelling intensification) that may serve to mask or accentuate ecosystem change in the California Current.

Tissot, B.N. [1*], Craig, S.F. [1], Tyburczy, J.A. [2], Raimondi, P.T. [3], Korchek, K. [1], Schneider, J.H. [1], Litt, J. [1], Lopiccolo, J. [4]

SEA STAR WASTING DISEASE IN NORTHERN CALIFORNIA MPAS

1 - Humboldt State University, 2 - California Sea Grant Extension, 3 - UC Santa Cruz

Sea star wasting disease has been observed along the northern California coast since the spring of 2013 and has been associated with significant declines in abundance that could have profound long-term effects on rocky intertidal community structure. We report results of surveys conducted between 2014-15 at 11 northern California sites as a component of baseline surveys of newly established MPAs in the region. At seven sites we used variably-sized sea star plots to estimate species composition, abundance, size, and the incidence of lesions associated with wasting diseases. At an additional four sites near the marine lab in Trinidad, we examined the same variables along band transects in relation to temperature and habitat complexity. Changes in abundance varied among sites with *Pisaster ochraceus* showing declines at some sites but increases at others associated with recruitment of juveniles. Similar patterns were observed in *Lepasterias* spp. The incidence of lesions indicative of wasting diseases declined at all sites suggesting that the effects of the disease are declining.

Todgham, A.E. [1*], Davis, B.E. [1], Kinsey, M.J. [1], Pasparakis, C. [2]

HIGH AND DRY: MOVING BEYOND SIMPLE HEAT SHOCKS TO UNDERSTAND THE THERMAL PHYSIOLOGY OF AN INTERTIDAL LIMPET

1 - University of California Davis, 2 - University of Miami

Intertidal zone organisms may be among the most vulnerable groups of organisms to global climate change (GCC) since it is hypothesized that these organisms have already maximized their capacity to tolerate environmental change. Much of our understanding of the thermal physiology of intertidal organisms comes from single acute heat shock studies of organisms submerged in water despite the fact that these organisms more typically experience consecutive sublethal heat stresses that vary in magnitude while the organisms are aerially emersed. Using the fingered limpet, *Lottia digitalis*, we demonstrate that these complexities in the thermal environment matter and specifically that aerial exposure, inducible stress tolerance and stochastic vs. predictable changes in temperature affect the thermal physiology of *L. digitalis*. Our results suggest that previous studies have overlooked important mechanisms underlying thermal tolerance of intertidal animals and that research that incorporates the biophysical characterization of the stochasticity of the thermal environment is critical if we are to forecast the impacts of GCC on intertidal communities.

Tyburczy, J.A. [1*], Craig, S.F. [2], Tissot, B. [2], Raimondi, P.T. [3], Korchek, K. [2], Litt, J. [2], Lopiccolo, J. [2], Schneider, J. [2]

CHANGES IN MUSSEL BED METRICS AND ABUNDANCE AND WASTING SYNDROME PREVALENCE IN PISASTER IN CALIFORNIA'S NORTH COAST MPA REGION

1 - California Sea Grant, 2 - Humboldt State University, 3 - University of California, Santa Cruz

Baseline monitoring of rocky intertidal habitats in the North Coast Region of California's marine protected area (MPA) network began in summer 2014 - roughly one year after sea star wasting was first observed here. We present preliminary results from the first three seasons (summer and winter 2014 and summer 2015) of sampling at three MPAs and four nearby control sites. We used MARINe protocols to sample abundance, size, and presence/severity of wasting syndrome lesions in the keystone predator Pisaster ochraceus within marked irregular plots; and the percent cover, size distribution of individuals, and bed depth of the mussel Mytilus californianus within marked 50 x 75 cm quadrats. Disease prevalence has decreased as has abundance of large P. ochraceus at nearly all sites, though some exhibited significant recruitment of juveniles. Mussel bed depth and percent cover have increased overall, but the average size of individual mussels has not changed significantly.

†Tydlaska, M.M.*

VISITOR AWARENESS OF MPAS, VISITOR ACTIVITIES AND IMPACTS ON THE SPECIES COMPOSITION OF ROCKY INTERTIDAL SITES

Coastal and Marine Institute, San Diego State University

Species' population sizes and geographic ranges are declining worldwide due tohuman stressors that impact rocky intertidal ecosystems including increasing urbanization, recreational activities, and harvesting of species. San Diego's temperate coastal climate attracts large numbers of visitors to the rocky intertidal coastline. This study investigates (1) visitor knowledge about Marine Protected Areas (MPAs) in San Diego County, (2) visitor activities and (3) visitor impacts on the species composition of three select MPA intertidal locations and three nearby non-

along the Pacific coast of North America. This crab serves as an intermediate host for a variety of parasites, including the acanthocephalan worm *Profilicollis altmani* and the trematode *Microphallus nicolli*. When definitive hosts such as marine birds and mammals consume infected crabs, these parasites complete their life cycle. In this study we examined several epidemiology-related parameters of this host-parasite relationship; they included parasite distribution and volume within the host, degree of coinfection and their relationship with host size and host gender. Crabs were collected from Monterey Bay, California, measured (total length), dissected, and examined for parasites. Acanthocephalan cystacanths and trematode metacercarial cysts were counted, measured, and their volume calculated. Females harbored both parasites in significantly higher numbers than male crabs. Although there was no evidence of intraspecific or interspecific competition among these helminth species, there was a positive correlation between host size and mixed infections; i.e., larger crabs hosted both parasites. Our results demonstrate that host size and gender are the primary factors governing prevalence and intensity of infection of these two helminth species in this sand crab population.

†Hinterman, K.D. [1*], Tyburczy, J.A. [2], Craig, S.F. [1], Kinziger, A.P. [1]
ESTABLISHING A BIODIVERSITY BASELINE FOR ROCKY INTERTIDAL FISH COMMUNITIES IN NORTHERN CALIFORNIA
1 - Humboldt State University, 2 - Humboldt State University, California Sea Grant Extension
In December, 2012, a network of new marine protected areas (MPAs) was implemented in northern California, covering 137 square miles of coastline with the goal of maintaining commercially important species and to preserve biodiversity. The purpose of this study was to create a biodiversity baseline of rocky intertidal fish communities within MPAs and in unprotected reference sites near each protected area. Diversity, total abundance, and size structure were compared among seven sites from Fort Bragg to Crescent City during the summers and winters of 2014 and 2015. Fish were collected from three tide pools at each site, one in the high, mid, and low intertidal zones. A total of 32 species were collected throughout sampling with the highest diversity and abundance coming from unprotected sites. Many young-of-year recruits of recreationally and commercially important species were collected, indicating the rocky intertidal zone may be an important nursery area for some species. Contrary to previous studies, high numbers of rockfish, (*Sebastes*) recruits were not detected in intertidal areas. In addition to geographical location, intertidal location and temporal data were examined to test hypotheses about the influence of these variables on the fish assemblages found in a particular pool.

†Hirsh, H.K.*, Torres, W.I., Shea, M.M., Mucciarone, D.A., Dunbar, R.B.
COUPLED BIOGEOCHEMICAL AND HYDRODYNAMIC MEASUREMENTS OVER A PALAUAN SEAGRASS BED: CAN SEAGRASSES MITIGATE ACIDIFICATION STRESS?
Stanford University
Interest in seagrass beds as a tool to locally mitigate ocean acidification is growing rapidly. Much of the interest in seagrasses is motivated by their root structure, which is able to sequester carbon over interannual and longer timescales. Far less is known about their biogeochemistry on shorter diel timescales, yet we know that diel cycle variation in CO_2 chemistry on coral reefs can be quite substantial. Understanding short-term seagrass biogeochemistry is critical to evaluating if, and how, seagrasses may eventually be utilized to mitigate OA on coral reefs. We present the results of a high-resolution, 24-hour control volume experiment conducted in the Republic of Palau covering a 50m x 100m seagrass bed. Our interdisciplinary dataset includes diel cycles of hydrodynamic (current profiles and turbulence), biogeochemical (pH, pCO2, TA, DIC, and O_2, and environmental (temperature and salinity) parameters. We use these coupled hydrodynamic-biogeochemical measurements to estimate ecosystem metabolism and better quantify the capacity of seagrass to mitigate local acidification through the photosynthetic uptake of CO_2. Combining our field observations with box model predictions allows us to gain better insight into the mechanisms that control seagrass metabolism and their ability to buffer CO_2 for downstream corals.

Hofmann, G.E.*, Hoshijima, U., Bachhuber, S.
THE VALUE OF LONG TERM OCEANOGRAPHIC DATA SETS FOR GLOBAL CHANGE ECOLOGY
University of California, Santa Barbara
Multi-year, long-term oceanographic data sets from the Santa Barbara Channel indicate that organisms Multi-year, long-term oceanographic data sets from the Santa Barbara Channel indicate that organisms within the kelp forest ecosystem experience wide fluctuations in oceanographic conditions associated with seasonal upwelling and other biological drivers such as photosynthesis by beds of macrophytes. Understanding the potential impacts of shifting oceanographic conditions on the biology of calcifying organisms, especially during vulnerable larval life history stages, provides valuable insight into how ocean acidification and global climate change will impact economically and ecologically valuable organisms within the California Current Large Marine Ecosystem. Current research in the Hofmann laboratory is focused on examining the impacts of ocean acidification, temperature shifts, and changes in oxygen content on calcifying organisms in fish and marine invertebrates of the kelp forest ecosystem. In this poster, we highlight our pH sensor network and the relationship between hypoxia and pH. We also present data on studies

us to document the distribution of another dozen species of foliose Bangiales in the region, including *Boreophyllum aestivale*, *Fuscifolium tasa*, *Pyropia fallax*, *Py. fucicola*, *Py. gardneri*, *Py. kurogii*, *Py. nereocystis*, *Py. pseudolanceolata*, *Py. torta*, *Wildemania amplissima*, *W. norrisii*, and *W. variegata*.

Lopiccolo, J.A. [1]*, Tyburczy, J.A [2], Raimondi, P.T [3], Craig, S.F. [1]
EFFECTS OF INCREASED ACCESS ON ABALONE WITHIN A PRIVATELY HELD, DE FACTO MARINE RESERVE
1 - Humboldt State University, 2 - California Sea Grant Extension Humboldt State University, 3 - University of California Santa Cruz
Intense fishing pressure has removed nearly all large red abalone (*Haliotis rufescens*) from publicly accessible intertidal sites. During baseline sampling of marine protected areas (MPAs) along Mendocino County in the summer of 2014, we discovered an intertidal site with abundant *H. rufescens* that had functioned as a *de facto* marine reserve due to its long history of private ownership. Using three 2 x 10 m belt transects (60 m^2) and count data from three irregular plots we found a density of 2.1 abalone m^{-2}, including 0.5 individuals m^{-2} above legal harvest size (178 mm). This site has recently experienced a marked increase in accessibility as the surrounding beaches have been opened to the public. Resampling in 2015 found minimal abalone recruitment and mortality rates ranging from 18-100% for larger size classes and a 24% decline in overall abundance. The greatest reductions in densities were found in the most accessible transects, with those requiring more effort to reach remaining largely unperturbed. We discuss the unique benefits of protecting unexploited intertidal sites including: monitoring the health of abalone populations; evaluating recovery within MPAs; and investigating the functional role of abalone in intertidal ecosystems.

†Lord, D, W.*, Smee, D.L., Diskin, M.S.
THE EFFECTS OF BLACK MANGROVE RANGE EXPANSION ON SOUTH TEXAS SALT MARSH FAUNA
Texas A&M University-Corpus Christi
In recent years, black mangroves (*Avicennia germinans*) have expanded their range northward as winters have not been cold enough to control their growth. This northward expansion has resulted in the Black Mangrove displacing *Spartina alterniflora* in coastal habitats along the Southern Texas coast. This change in marsh habitat was studied by comparing marsh areas that had black mangroves present to marsh areas that had only *S. alterniflora* present in the summer and fall of 2014. All locations are in South Texas, north of Corpus Christi. Nekton samples were collected using a suction sampler, and benthic samples were collected with a benthic corer. Eight samples were collected from marsh habitat that was only *S. alterniflora* while 16 samples were collected from marsh habitat that also had black mangroves present. Organisms from each sample were identified to the lowest taxonomic unit possible, measured, and counted. Initial finding show a seasonal pattern with total organismal abundance and shrimp abundance higher in *S. alterniflora* only marsh in the summer and both shrimp and fish abundance higher in S. alterniflora in the fall. However, fish abundance was significantly higher in black mangrove marshes during the summer. Overall, when black mangroves were not present or nearby, secondary production was found to be higher in *S. alterniflora* marshes. These results may suggest that the encroachment of black mangroves northward may have effects on the overall structure of marsh ecosystems. Further study is needed to document changes in wetland fauna as the range of black mangrove

Mangelli, M.M. [1]*, Sato, K.N. [2], Levin, L.A. [2]
PREDICTING FOOD AVAILABILITY IN THE DEEP SEA FROM SEA URCHIN JAW AND TEST MORPHOLOGY
1 - University of California, San Diego, 2 - Integrative Oceanography Division, Scripps Institution of Oceanography
Previous studies have shown *Strongylocentrotus franciscanus*, a shallow water urchin, displays phenotypic plasticity in its feeding apparatus that responds to changes in food availability. When food abundance is low, the mouth structure, known as the Aristotle's Lantern (AL), increases in size relative to test diameter, when food becomes abundant, the lantern shrinks. We applied this proxy to a deep-dwelling species of urchin to test the widely accepted hypothesis that food availability is reduced with increasing water depth in the deep sea. We compared ratios of AL jaw length: test diameter of *S. fragilis* urchins collected across a depth gradient of 90 - 1,100 meters. Ratios were compared across the following depth bins: Upper Slope (90-300m), Mid Slope (300-500m), and Outer Slope (500-1100m). We found that the AL jaw length: test diameter ratio decreases with increasing water depth, trend which is opposite to our initial hypothesis. Explanations may be a) food does not decline with water depth for this species or b) low pH conditions at 500-1100 m suppress the expected AL enlargement. Further analyses that incorporate age structure, environmental variables, ecological interactions, and food availability are needed to groundtruth the AL jaw length: test diameter proxy in the deep sea.

MPA Baseline Program

Annual Progress Report

Principal Investigators - please use this form to submit your MPA Baseline Program project annual report, including an update on activities completed over the past year and those planned for the upcoming year. This information will be used by the MPA Baseline Program Management Team to track the progress of individual projects, and will be provided to all MPA Baseline Program PIs and co-PIs prior to the Annual PIs workshop to facilitate discussion of project integration. Please submit this form to California Sea Grant when complete (sgreport@ucsd.edu, Subject [Award Number, project number, PI, "Annual Report"].)

Project Information

Project Year	2	**MLPA Region**	North Coast
Project Title & Number	Baseline Characterization of Rocky Intertidal Ecosystems for MPAs along the North Coast of California, R/MPA-33: Invertebrate and Algal Diversity Surveys.		
PI name	Pete Raimondi	**Co-PI name**	

PI Contact Info

(please list additional PIs and contact info in the "Project Personnel" section if necessary)

Address	Long Marine Lab, UC Santa Cruz 100 Shaffer Rd. Santa Cruz, CA 95060	**Address**	
Email	raimondi@ucsc.edu	**Email**	
Phone	831-459-5674	**Phone**	

Co- PI Contact Info

Project Goals & Objectives

The objectives of this project are to:

1) Produce a baseline characterization 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) Explore baseline characterizations for potential indicators of the state of rocky intertidal ecosystems using newly collected data along with existing PISCO datasets of the region. 4) Integrate these assessments with other components of the baseline survey (kelp forests, sandy beaches, collaborative fisheries, etc.). 5) Generate a fish biodiversity baseline within rocky intertidal habitats. 6) Monitor and characterize rockfish recruitment in tidepool habitats.

These objectives will be met using a combination of survey methods including invertebrate and algal diversity surveys (Raimondi), invertebrate and algal focal species surveys (Craig/Tyburczy/Laucci), fish diversity and settlement surveys (Kinziger/Tyburczy), and high-resolution topographic surveys (Aiello).

Invertebrate and algal diversity surveys will be conducted at each of 12 sites over the course of Years 1 and 2. A combination of point-contact surveys, quadrat counts, and swaths along vertical transects will be used to quantify the abundance and distribution of invertebrate and algal species at both the MPA and reference sites. These surveys follow a set of established Biodiversity Survey protocols that have been used for baseline characterization of the South Coast, Central Coast, and North Central Coast study regions.

Summary of Project Activities Completed to Date

Overview of Project Year _2_ Activities, including progress towards meeting goals & objectives

We conducted Biodiversity Surveys at six rocky intertidal sites within the NCSR:

Site	Sample Date	MPA Status	Latitude	Longitude
Damnation Creek	May 2015	reference	41.6530	-124.1301
Palmers Point	May 2015	reference	41.1312	-124.1633
Cape Mendocino	June 2015	reference	40.3412	-124.3630
Abalobadiah Creek	June 2015	SMR	39.5691	-123.7718
MacKerricher	June 2015	SMCA	39.4826	-123.8036
Fort Bragg	June 2015	reference	39.4392	-123.8184

We also conducted ongoing long-term monitoring surveys (MARINe/PISCO), including focal species sampling, at the following sites:

Site	Sample Date	MPA Status	Latitude	Longitude
Enderts Beach	May 2015	reference	41.6957	-124.1436
Damnation Creek	May 2015	reference	41.6530	-124.1301
False Klamath Cove	May 2015	reference	41.5943	-124.1053
Cape Mendocino	June 2015	reference	40.3412	-124.3630
Shelter Cove	June 2015	reference	40.0227	-124.0739
Kibesillah Hill	June 2015	reference	39.6041	-123.7888

MPA Baseline Program Annual Report

Highlights from project progress so far, such as successes achieved, new collaborations or partnerships, or interesting stories from the past year that may be suitable for a blog post or other media venue

The Year 2 field season was very successful. We established four new Biodiversity sites and resampled two existing Biodiversity sites within the NCSR as part of this project. Collaboration between the UCSC, HSU, and MLML field teams has been successful with coordinated and cooperative field sampling. We continued to maintain strong partnerships with the National Park Service and California State Parks for access and support sampling several of these sites.

Description of any unforeseen events and substantial challenges, and resulting effects on project activities and progress. Please indicate any issues that may affect other PI's or require coordination with other Baseline partners (e.g., ME, DFG, Sea Grant).

We were unable to conduct long-term monitoring surveys (MARINe/PISCO) at Enderts Beach, Damnation Creek, and False Klamath Cove in December 2015 due to unfavorable weather and swell. This work was rescheduled for January 2016.

Data status (i.e., paper/raw format or digitized; if digitized, what format?)

We have entered all data from Year 2 and data are currently in raw format (.xls spreadsheets). We are in the process of QA/QC for this dataset.

Activities Planned for following Project Year __ (if applicable) – *Please describe remaining work and approximate timelines for completing that work, including any anticipated budget variances necessary to complete the project.*

We will continue data processing and will begin data analysis and report writing.

We will conduct ongoing long-term monitoring surveys (MARINe/PISCO), including focal species sampling, at the following sites:

Site	Sample Date	MPA Status	Latitude	Longitude
Enderts	Jan 2016/ May 2016/ Dec 2016	reference	41.6957	-124.1436
Damnation Creek	Jan 2016/ May 2016/ Dec 2016	reference	41.6530	-124.1301
False Klamath Cove	Jan 2016/ May 2016/ Dec 2016	reference	41.5943	-124.1053
Kibesillah Hill	June 2016	reference	39.6041	-123.7888
Shelter Cove	June 2016	reference	40.0227	-124.0739
Cape Mendocino	June 2016	reference	40.3412	-124.3630

Project Personnel – *Please indicate additional project personnel involved in your MPA baseline project, including students and volunteers, or additional PI contact information if necessary, as well as the nature of their assistance in the project project.*

	Students Supported	*Student Volunteers*	*Nature of Assistance*
K-12			
Undergraduate			
Masters			
PhD			

Number of other Volunteers not counted above and the nature of their assistance in the project:

Additional PI contact info not listed on first page:

Sean Craig (HSU), sean.craig@humbolt.edu

Joe Tyburczy (CA Sea Grant), jtyburczy@ucsd.edu

Andrew Kinziger (HSU), andrew.kinziger@humbolt.edu

Rosa Laucci (Smith River Rancheria), Rosa.Laucci@tolowa.com

Ivano Aiello (MLML), ivano.aiello@sjsu.edu

Cooperating Organizations and Individuals - *Please list organizations or individuals (e.g., federal or state agencies, fishermen, etc.) that provided financial, technical or other assistance to your project since its inception, including a description of the nature of their assistance.*

Name of Organization or Individual	*Sector (City, County, Fed, private, etc.)*	*Nature of cooperation (If financial, provide dollar amount.)*
National Park Service	*Federal*	*Site access and field assistance*
California State Parks	*State*	*Site access and field assistance*

Project Outputs and Materials: *Please provide any other project-relevant information, such as descriptions of attached materials, media coverage your project has received, presentations, publications, images etc.*

MPA Baseline Program

Annual Progress Report

Principal Investigators - please use this form to submit your MPA Baseline Program project annual report, including an update on activities completed over the past year and those planned for the upcoming year. This information will be used by the MPA Baseline Program Management Team to track the progress of individual projects, and will be provided to all MPA Baseline Program PIs and co-PIs prior to the Annual PIs workshop to facilitate discussion of project integration. Please submit this form to California Sea Grant when complete (sgreport@ucsd.edu, Subject [Award Number, project number, PI, "Annual Report"].)

Project Information

Project Year	2015	**MLPA Region**	North Coast
Project Title & Number	Baseline Characterization of Rocky Intertidal Ecosystems for MPA's along the North Coast of California		

PI name	Ivano W. Aiello	**Co-PI name**	

PI Contact Info **Co- PI Contact Info**

(please list additional PIs and contact info in the "Project Personnel" section if necessary)

Address	Moss Landing Marine Laboratories 8272 Moss Landing Rd., Moss Landing 95039 CA	**Address**	
Email	iaiello@mlml.calstate.edu	**Email**	
Phone	831-7714480	**Phone**	

Project Goals & Objectives

The overarching goal of this project was to produce high-resolution, digital elevation models (DEMs) of rock surfaces at scales between cm to tens-of-meters of 9, selected rocky intertidal areas within the North California MPA: Point S. George, Kibesillah Hill, Shelter Cove, False Klamath Cove, Pyramid Point site, Abalobadiah Creek, Fort Bragg, MacKerricher State Park, and Patricks Point State Park.

Geospatial surveys data allow quantitative methods to assess the relationships/controls between geology of the rocky substratum and biodiversity of intertidal species. Linked, geospatial/biodiversity maps and datasets allow broader understanding of the ecology of different species, and serve as a basis for assessment of change resulting from (as examples) sea level rise, temperature variation and change in wave climate due to both climate change and potential wave energy arrays.

The main objective was to create high-resolution maps using state-of-the-art Terrestrial Laser Scanning (TLS), a relatively new mapping technology that allows multi-scale geospatial surveys over spatial scales ranging between cm to hundreds of meters, high resolution (0.01 m), accuracy (<0.005m), and repeated survey feasibility, and the ability to collect thousands of high-resolution topographic data points. The proposed strategy was to combine the TLS surveys with more traditional field reconnaissance methods to identify structural and lithologic discontinuities that might affect rock's geomorphology. The DEMs obtained with the TLS surveys provide 3D topographic data were to be georeferenced so they could be combined with other geospatial dataset sand used with GIS applications that work with standard digital data formats (e.g. DXF).

The project goals also included the creation of standard procedures to parameterize the surface geomorphology, and quantify ecologically-significant rock characteristics such as rugosity at various spatial scales (between cm to tens of meters).

Summary of Project Activities Completed to Date

Overview of Project Year __ Activities, including progress towards meeting goals & objectives

During the period under consideration, one of the main goal has been to complete the TLS surveys of 4 of the total 9 sites that are the object of this investigation: Abalobadiah Creek, Fort Bragg, MacKerricher State Park, and Patricks Point State Park.
The field procedure for the 4 surveys followed the one that we established during the first 5 surveys: creation of benchmarks using a differential GPS, establishment one or two fore-sights from which the surveys were conducted plus one or two back-sights to orient the instrument, establishment of 4 or more ground controls.
Each site survey required approximately 2 days of field work.
Field reconnaissance was also done to establish the main lithologies and structural features present in the survey area as well as to collect hand samples for lab analyses.
The survey data collected with the Trimble VX were then post-processed using Trimble's RealWorks, a proprietary 3D software that allows cleaning and registration of the topographic data points and, ultimately, the creation of high-resolution (cm) DEMs of each of the survey sites.

The DEMs were further analyzed to ascertain three main geomorphological parameters that have been selected to model the surface characteristics of the rocky intertidal outcrops: 1) "Surface roughness" or root mean squared error (RMSE) of points from an interpolated surface defined by a linear polynomial function; 2) "Relief" or Surface to Planar ratio (S:P); 3) “Relief” based on the ration between Surface to PCA area.

The parameterization of rock surfaces was done testing two different approaches:

1) Using ArcGIS.

RMSE and S:P were measured for virtual quadrates created at 5 scales ($0.1m^2$, $0.5m^2$, $1m^{\wedge 2}$, $5m^{\wedge 2}$, $10m^{\wedge 2}$).
The ArcGIS procedure included: 1) random point generation to locate the center of virtual quadrats and dissect the DEMs in smaller plots; 2) selection only of the virtual quadrats that passed quality standards (e.g. enough points in the quadrats, homogenous distribution of points and lack of clustering); 2) calculation of the surface parameters RMSE and S:P for the quadrats that passed the quality control.

2) Using Matlab

We developed a Matlab script that carries out a Delaunay triangulation to produce a Triangular Irregular Network (TIN) of the original survey data. Then, the script calculates the area of each triangle (TRI) and the areas of the triangle projected on the XY plane. A window of selected size-range (usually between 5cm and 10m) is centered at each surveyed datapoint, and the Delauney triangles fully included in it identified. These triangles are used to calculate the ratio between surface and projected area (S:P).
However, this ratio is strongly affected by the slope, so using this parameter ‘flat’ surfaces on slope can result highly rugose. In order to de-trend for the slope the script also calculates the area of an interpolated triangle to each Delauney triangle included in the moving window using Principal Component Analysis (TRI-PCA). This “PCA Area” is finally used to calculate rugosity expressed as the TRI/TRI-PCA ratio.
Using this Matlab it has been possible, for the first time, to calculate changes in rugosity through a continuum spectrum of spatial scales.

MPA Baseline Program Annual Report

Highlights from project progress so far, such as successes achieved, new collaborations or partnerships, or interesting stories from the past year that may be suitable for a blog post or other media venue

I posted a blog about this project presenting the excitement, challenges and new results in the OceanSpaces website (blog on February 23rd 2015).
I am about to submit a second post discussing the main outcomes of the projects on the same website.

Description of any unforeseen events and substantial challenges, and resulting effects on project activities and progress. Please indicate any issues that may affect other PI's or require coordination with other Baseline partners (e.g., ME, DFG, Sea Grant).

Nothing to report

Data status (i.e., paper/raw format or digitized; if digitized, what format?)

Activities Planned for following Project Year __ (if applicable) – *Please describe remaining work and approximate timelines for completing that work, including any anticipated budget variances necessary to complete the project.*

NA

Project Personnel – *Please indicate additional project personnel involved in your MPA baseline project, including students and volunteers, or additional PI contact information if necessary, as well as the nature of their assistance in the project project.*

	Students Supported	*Student Volunteers*	*Nature of Assistance*
K-12			
Undergraduate			
Masters	*Ashley Wheeler, Sara Worden*		*Field surveys and data post-processing*
PhD			

Number of other Volunteers not counted above and the nature of their assistance in the project:

Additional PI contact info not listed on first page:

Cooperating Organizations and Individuals - *Please list organizations or individuals (e.g., federal or state agencies, fishermen, etc.) that provided financial, technical or other assistance to your project since its inception, including a description of the nature of their assistance.*

Name of Organization or Individual	*Sector (City, County, Fed, private, etc.)*	*Nature of cooperation (If financial, provide dollar amount.)*

Project Outputs and Materials: *Please provide any other project-relevant information, such as descriptions of attached materials, media coverage your project has received, presentations, publications, images etc.*

Together with Dr. Peter Raimondi (UCSC), I am the convener of a special session on cross-disciplinary, geobiological studies in marine environments: Session ME24C- Exploring Biological-Geological Interactions in Coastal and Nearshore Habitats at the 2016 Ocean Science Meeting of the America Geophysical Union in New Orleans.
At this session, I will present a paper on the geobiology of rocky intertidal outcrops in Northern California Marine Protected Areas.
The paper (in preparation for PlosOne), “Exploring multi-scale relationships between geology and ecology in Northern and Central California’s intertidal habitats”, is based on this study and describes, for the first time, the use of spatial imaging to create geomorphologic baselines and parameterization of rock surfaces in intertidal habitats which can be used by ecologists to understand and predict biodiversity and plan for management of these important ecosystems.