Institute for Applied Marine Ecology

Annual Report 2015-2016

Institute for Applied Marine Ecology (IfAME)
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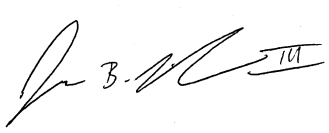
Letter from the Director

The Institute for Applied Marine Ecology (IfAME) at CSU Monterey Bay was founded in 2007 to address the significant disconnect between academic science and the needs of federal and state resource managers and policy makers. Since 2014 the IfAME has expanded to encompass the activities of seven tenured/tenure track faculty and their respective laboratories (Section 2). The benefits of the IfAME for CSUMB, the Division of Science and Environmental Policy, and the community at-large are considerable and multifaceted, including direct support of mangers and policy-makers at local, state, federal and international levels (see the list of Community Partners in Section 7 below).

The 2015/2016 academic year was an active one. IfAME projects spanned the globe (Section 3), ranging from the US to the Arctic to the eastern Mediterranean and the Red Seas; from the intertidal to shallow kelp forests and coral reefs to the deep continental shelf and the open ocean; from invertebrates to coastal fishes to large predators. These projects were funded by nearly $9 million in collaborative grants and contracts, including $3.3 million in new support to CSUMB (Section 5). These grants and contracts supported direct engagement of students in the research process, including 15 graduate students and 43 undergraduates.

Further, the IfAME is ever expanding to encompass additional partners, including the CSU Council on Ocean Affairs, Science and Technology (COAST) which now has two full-time program staff occupying offices at the IfAME and Camp Sea Lab, which is using IfAME facilities for several of its student research activities.

Sincerely,



James Lindholm, Ph.D.
Director, Institute for Applied Marine Ecology

1. Mission, Need, and Program Vision

"Conducting relevant science to inform sound marine policy"

Mission - The mission of the IfAME is to develop clear linkages between ecological phenomena and potential and realized management regimes along the California coast, across the US, and throughout the world. Using cutting-edge technology, the goal of the IfAME is to provide insight, to reorganize thinking, and to improve paradigms for understanding the interaction of marine ecological systems and human activities.

The Need – The need for the IfAME is predicated on two persistent challenges within the marine science and management community:

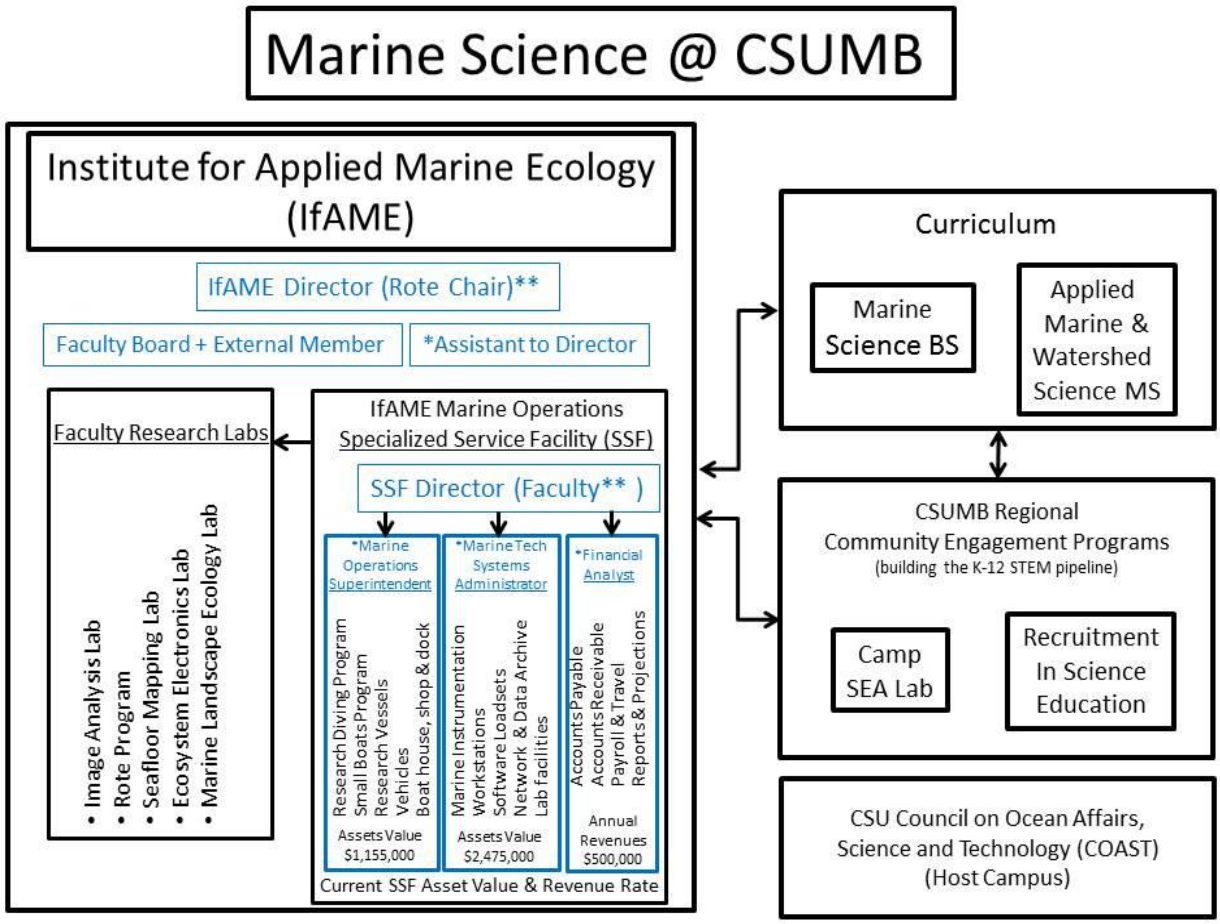
- A significant *disconnect* between much of the science conducted by academia and the actual needs of those responsible for management and policy development. The explanations for this disconnect are numerous and can be attributed to both academia and to government agencies. Well-intentioned academic efforts often fall short in addressing specific government needs due to a fundamental lack of understanding as to how the government functions and what its precise needs are. Government agencies, in turn, responding to the exigencies of management, are often compelled to act without communicating with academic scientists to determine precisely what data are available or needed.

- Insufficient *financial support* from either State or Federal agencies directed towards conducting the critical science necessary to underlie major policy initiatives. These unfunded mandates undermine the success of the initiatives and ultimately the marine environment loses.

The Vision - The IfAME addresses the above disconnect through the conduct of strategically-planned, user-driven scientific research in support of specific manager and decision-maker needs. Specifically, agency employees are frequently engaged directly in the planning, execution, and/or analysis of field research projects. In this way, the transition from completed science to realized management and/or decision-making is streamlined.

The IfAME addresses this challenge of limited financial support by engaging a continuous stream of undergraduate and graduate research assistants in the conduct of all IfAME projects. In this way, the students are direct participants in the execution of applied research projects, while the government agencies effectively expand the footprint of what they are able to take on by collaborating with the IfAME.

2. Organizational Structure



This extraordinary trajectory of growth and success of the new Center of Excellence in Marine Science at CSUMB has outgrown the original organizational and support models envisioned for the program. In response the faculty of marine science developed a restructured organizational design that sustainably couples the strong extramural research programs, growing academic curriculum, and established community engagement programs. The capabilities of CSUMB are significantly amplified through this structural reorganization and integration of existing assets under the single umbrella of the IfAME. The IfAME presents a unified public face and serves as the primary vehicle for linking the Marine Science Curriculum, regional community engagement programs, and external partnerships.

Director: Dr. James Lindholm, the James W. Rote Distinguished Professor of Marine Science and Policy within the Division of Environmental Policy, is the Director of the IfAME.

SSF Director: Dr. Rikk Kvitek, Professor, is the Director of the Specialized Service Facility that encompasses Marine Operations.

Faculty: Dr. Corey Garza, Associate Professor, Marine Landscape Ecology Lab
Dr. Alison Haupt, Assistant Professor
Dr. Cheryl Logan, Assistant Professor
Dr. Steve Moore, Professor, Ecosystem Electronics Lab
Dr. Kerry Nickols, Assistant Professor

Labs: Ecosystem Electronics Lab (https://csumb.edu/eel) (EEL)
Haupt Lab (csumb.edu/directory/people/alison-haupt) (HL)
Logan Lab (loganlabcsumb.weebly.com/) (LL)
Image Analysis Lab (http://sep.csumb.edu/ifame/) (IAL)
Marine Landscape Ecology (http://sep.csumb.edu/mlel/) (MLEL)
Nickols Lab (kerrynickols.weebly.com) (NL)
Seafloor Mapping Lab (http://seafloor.otterlabs.org/) (SFML)

Staff: Megan Bassett - REU Outreach Coordinator
Dr. Jody Beers – Adjunct Research Faculty
Alexandria Blackwell, Polar-ICE Social Media Specialist
Carrie Bretz – IfAME & Rote Program Specialist
Dr. Bridgette Clarkston - REU Program Coordinator and MLEL research associate
Pam Consulo – Data Processing Staff Manager
Frank Degnan – Dive Safety Officer
Kristen Hart, REU Graduate Student Assistant
Pat Iampietro – Marine Geospatial Systems Analyst
Flower Moye – Assistant Dive Safety Officer
Dr. Michael Navarro - NSF Postdoctoral Fellow
Daniel Orr - MLEL GIS Technician
William Williamson – Marine Operations Superintendent

Advisory Committee: The IfAME is supported by an Advisory Committee made up of scientists and managers from around the country. The current Advisory Committee includes:

Dr. Peter Auster – University of Connecticut
Dr. Andrew DeVogelaere – Monterey Bay National Marine Sanctuary
Dr. William Head – California State University Monterey Bay
Dr. Richard Starr – Moss Landing Marine Labs, UC Sea Grant Extension

Research Assistants: Research assistants include both undergraduate and graduate students at CSUMB and elsewhere who each work on subsets of many projects that are on-going at the IfAME, supported either through IfAME funds or through the Undergraduate Research Opportunities Center (UROC):

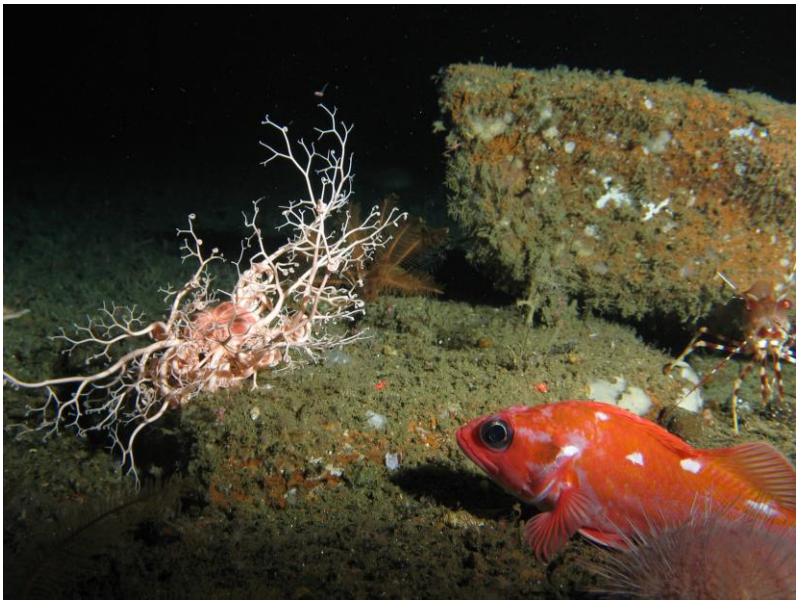
Graduate Students	
Bethany Fitch (SFML)	Emily Aiken (IAL)
Jorge Chagoya (SFML)	Nicole Alvarado (IAL)
Stephanie Marcos (SFML)	Carrie Boyle (IAL)
David Norman (SFML)	Larissa Lemon (IAL)
Andrew Cline (LL)	Jordan Maeding (IAL, MLEL)
Kirsten Boyer (LL)	Flower Moye (IAL)
April Makukhov (LL)	Michael Esgro (IAL)
	Amanda Wasserman (IAL)

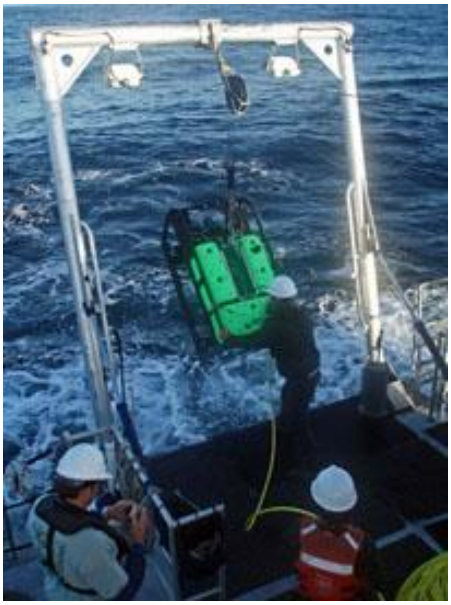
Undergraduate Students	
Gavin Leavitt (SFML)	Karson Hayden (IAL)
Evan Dailey (SFML)	Cristian Hernandez (IAL)
Alison Aceves (IAL)	Tyler Jerome (IAL)
Jose Madrid (UROC, HL)	Katherine Johnson (IAL)
Leilani Chantry (UROC, HL)	Trevin Li (IAL)
Katie Brown (UROC Scholar, HL)	Samantha Mendez (IAL)
Kyle Mooers (UROC Scholar, HL)	Alicia Miller (IAL)
Kristen Burroughs (IAL)	Zach Nyquist (IAL)
Alexandra Daly (IAL)	Sandra Powell (IAL)
Marina Del Valle (IAL)	Jackie Resnik (IAL)
Emily Doyle (IAL)	Tyler Ruttan (IAL)
Taylor Eddy (IAL)	Nicholas Ta (IAL)

Ali Fremont (IAL)	John Tench (IAL)
Nicole Barbour (MLEL)	Jacob Green (UROC, LL)
Kirby Bartlett (MLEL)	Jesirae Collins (MLEL)
Madison Heard (MLEL)	Chelsea Burgess (MLEL)
Avery Thurson (UROC Scholar, NL)	Alex Cabral (International, NL)
Katherine Neylan (UROC Scholar, NL)	Beatriz Neves (International, NL)
Libbie Duskin (UROC, NL)	Tiffany Thisner (NL)
Ahalya Nalamothu (UROC, NL)	Rosie Connors (NL)
Nicole Taylor (UROC, NL)	Corinne Ross (NL)
Sarah Farnsworth (UROC, NL)	

3. Recent Accomplishments

Deepwater Site Characterization in the Monterey Bay National Marine Sanctuary (MBNMS)





IfAME Principal Investigator: James Lindholm

***Collaborators*:** Dr. Andrew DeVogelaere (MBNMS)

***Financial Support*:** Sanctuary Integrated Monitoring Network (SIMoN); CSUMB Undergraduate Research Opportunities Center; private donations.

***Field Support*:** NOAA Vessel *Fulmar;* FV *Donna Kathleen*

***Summary*:** The primary goal of this collaborative project, which is in its 9th year, is the characterization of the continental shelf (50-200 m water depth) and slope (200-400 m) in the Sanctuary. Video transects are being conducted at previously unexplored locations and areas of interest using a remotely operated vehicle (ROV) and a towed camera sled. Data on the distribution of fishes, invertebrates, and seafloor habitats are collected in

real-time for inclusion on the Shelf Characterization and Image Display website (http://sep.csumb.edu/ifame/scid). Post-processing and further analysis are completed in the IfAME Image Analysis Lab.

***Student Involvement*:** Since its inception in 2007, this project has provided a total of 61 student positions for students from CSUMB and neighboring institutions, including 50+ undergraduate positions and 26 graduate student positions, encompassing field research activities, data post-processing, and analysis. A total of nine Honors Capstone theses have been completed using project data to-date. This year the project also expanded to include high school research assistants from the Santa Catalina School in Monterey.

***Broader Significance*:** This project is directly informing the on-going efforts to conserve and manage the marine environment within NOAA's Monterey Bay National Marine Sanctuary, the largest of the 14 Sanctuaries in US waters.

A photo taken by the ROV off Pt. Sur during this project graced the cover of the January 2011 edition of Sea Technology.

Development of Low-cost Instrumentation to Support Student marine Ecology Projects

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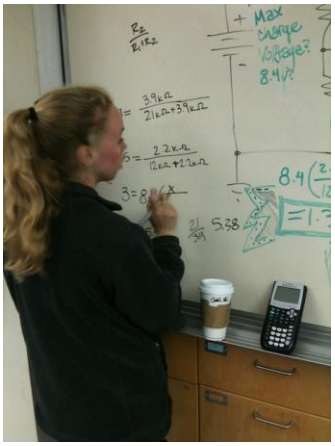

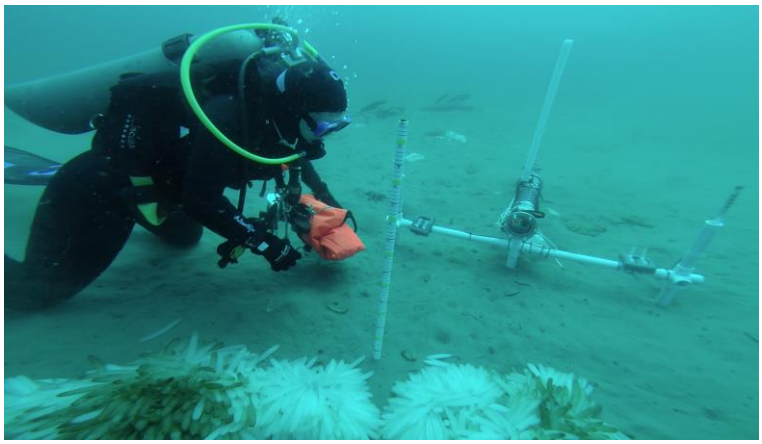

IfAME Principal Investigator: Steve Moore

Collaborators: N/A

Financial Support: CSU Faculty Support Grant

Field Support: N/A

Summary: Senior undergraduate students enrolled in MSCI 437 (Ocean Instrumentation Projects) design, build, and test innovative, low-cost, seafloor instrumentation, which they and their peers can use to collect data for marine research projects. For two consecutive years, a CSU Faculty Support Grant has provided funds to purchase parts and materials for these student inventions. The Spring 2016 class improved upon the previous year's design of "SquidPod," a time-lapse underwater camera system that can be left on the seafloor for weeks at a time to record factors affecting the survival of Market Squid egg clusters. Any surface marker buoy attached to SquidPod would invite theft, so the students also invented "RoboBuoy." When it's time to retrieve SquidPod, the students toss RoboBuoy in the water. It uses GPS navigation to swim to a point directly above SquidPod, then maintains position against winds and currents. By serving as a stationary visual landmark on the ocean surface, RoboBuoy makes it easier for students to keep a small boat positioned directly over

the seafloor instrumentation while they use divers (shallow water) or a ROV (deep water) to retrieve SquidPod.

***Student Involvement*:** This year, 12 undergraduates were enrolled in the Ocean Instrumentation Class and participated directly in the design, construction, testing, and/or deployment of RoboBuoy and the improved SquidPod. Ten of those students extended that work to investigate changes in sand dollar beds over time and presented that research for their Senior Capstone project. AMWS student Michael Hang used SquidPod and RoboBuoy to collect data for his master's thesis project. In addition, several students certified as AAUS scientific divers improved their research diving skills by helping the class deploy and retrieve SquidPod.

Broader Significance: A large fraction of California's commercial and recreational fishing is concentrated on or over the continental shelf at "twilight zone" depths between about 20 m and 200 m (65 to 650 feet). This depth range is characterized by significant variations in temperature, light intensity, water motion, dissolved oxygen, and pH, so it is fertile ground for marine ecology research projects – both basic and applied – aimed at understanding how these factors influence the biodiversity and productivity of California's coastal waters. These depths are inaccessible to most scuba divers, so other methods must be used to observe and study them. Although oceanographic research vessels have the equipment necessary to collect these data, ship time on these vessels is generally beyond the budget available for routine undergraduate research. SquidPod and RoboBuoy represent the latest additions to IfAME's growing suite of low-cost, but capable, student-designed tools – including small ROVs, towed cameras, and datalogging flow sensors – that are specifically designed to be deployed by students working from small boats (e.g., Zodiac inflatables or even sea kayaks) in areas where twilight zone depths are accessible near shore. Thus, they enable a much larger number of undergraduate students to contribute to meaningful marine ecology research. In addition to gaining experience with marine research, students who participate in creation of these instruments develop valuable skills in electronics, computer programming, and robotics.

Evaluating Relative "Protectedness" Across Individual White Sharks in the North Eastern Pacific

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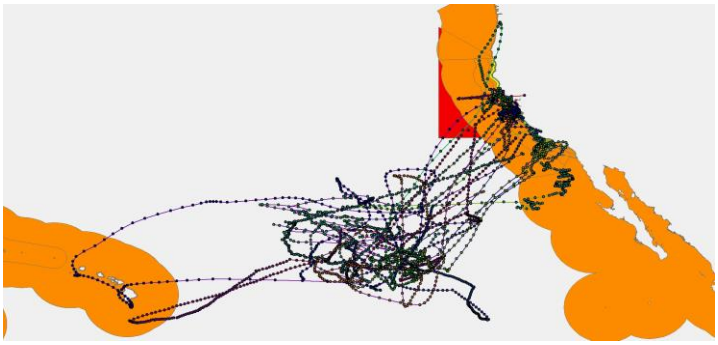

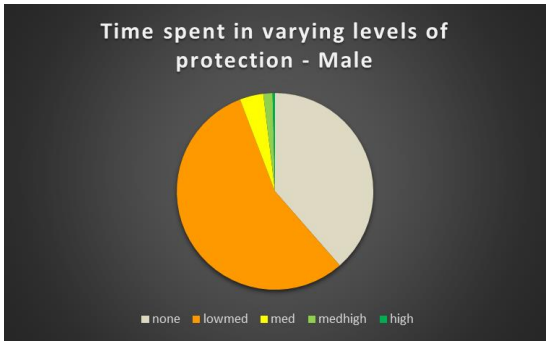

IfAME Principal Investigator: James Lindholm

Collaborators: Barbara Block (Stanford/Hopkins)
Sal Jorgensen (Monterey Bay Aquarium)
Michael Domeier (Marine Conservation Science)

Financial Support: Private donations to the James W. Rote Distinguished Professorship in Marine Science and Policy at CSU Monterey Bay.

Field Support: N/A

Summary: The project is focused on evaluating the extent to which individual white sharks are more or less protected depending on where in the marine environment they are swimming. A preliminary map of the regulatory environment has been developed for California waters, US federal waters, Mexican waters, and international waters. Individual tracks from white sharks tagged with satellite transmitters by our research collaborators are being mapped onto that regulatory environment.

***Student Involvement*:** This project, thus far, has engaged a total of 10 graduate students from CSUMB, including a course-based group project as well as an independent study.

Broader Significance: White sharks are focal animals with respect to many different issues, including their role as top predators in the marine environment and charismatic megafauna that attract extraordinary public attention. However no comprehensive analysis of the extent to which they are protected in the various locations in which they occur has been conducted to-date.

Extreme Event Beach Change

IfAME Principal Investigator: Rikk Kvitek

Financial Support: FEMA, California State Coastal Conservancy

Field Support: R/V *KelpFly*, SFML unmanned aircraft

Summary: The CSUMB Seafloor Mapping Lab was originally responsible for monitoring beach profile change and high water mark positions pre- and post-storm events during the 2014/2015 winter season along 17 km of the southern Monterey Bay shoreline (Monterey to the Salinas River mouth). When the predicted El Niño winter did not materialize, the project period was extended by the sponsor at the request of CSUMB to include the 2015/2016 storm season which was predicted to be a more severe El Niño episode. CSUMB students and staff used SFML's existing mobile terrestrial LIDAR system and GPS to create continuous high resolution digital elevation models (DEMs) of the entire beach and dune face of the southern Monterey Bay shoreline. This technique has been perfected and used by the SFML to quantify shoreline change for the Monterey Bay during previous pre-/post- El Niño winters (Quan et al. 2012). The time series

results from those prior studies were employed along with other existing airborne LIDAR data as baseline for the 2014/2015 and 2015/2016 surveys. This laser-based approach was to be augmented using CSUMB's newly acquired unmanned eBee aerial mapping vehicle equipped with high resolution photogrammetry system capable of achieving 3cm DEMs. However, subsequent drone-related policy actions, taken by both the FAA and CSU Chancellor's Office, has kept all CSUMB drones grounded until further notice. As a result, all data collection apart from the proof of concept drone work pictured above was completed using GPS and LIDAR.

Student Involvement: In addition to the PSM graduate student working on this project for their required internship, the undergraduate students in the fall 2014 and spring 2015 ENVS332 GIS/GPS classes, and grad students in the spring 2016 ENVS532 Advanced GIS class have also participated in the shoreline mapping and analysis for this project. Three of these students were also invited by the sponsor and larger community to participate in two regional sea level rise planning and information meetings as described under Broader Significance below.

Broader Significance: This project is linked with similar efforts being conducted by the USGS aimed at modeling and predicting the spatial distribution and rates of coastal erosion patterns under the expected climate change and sea level rise scenarios for California. The PSM Graduate Internship student (Evan Dailey) who took the lead on this project was asked by the sponsor to present his results to federal, state and local agencies at the 2016 Annual Adapt Monterey Bay Sea Level Rise Summit in April. Evan has now been ask by the conveners of that summit to present the work at the larger regional public forum on sea level rise planning being organized for summer 2016. In addition, one of the grad students in the ENVS532 class who worked on the project and participated in the annual summit has been asked by the sponsors to help organize the upcoming summer forum.

From the Intertidal to the Deep Ocean: Monterey Bay Regional Ocean Science Research Experiences for Undergraduates

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IfAME Principal Investigator: Corey Garza

Collaborators: Elkhorn Slough National Estuarine Research Reserve, Hopkins Marine Station of Stanford University, Monterey Bay Aquarium Research Institute, Moss Landing Marine Labs, Naval Postgraduate School

Financial Support: National Science Foundation

Field Support: Research fleets and field equipment from each of the partner institutions.

Summary: California State University, Monterey Bay serves as the hub of this dynamic REU program. In addition to working with faculty at CSUMB, we place students at five host institutions: Hopkins Marine Station of Stanford University, the Naval Postgraduate School, Moss Landing Marine Laboratories, Monterey Bay Aquarium Research Institute, and Elkhorn Slough National Estuarine Research Reserve. The 10-week summer REU program leverages the scientific and educational assets of the Monterey Bay region to increase the number and diversity of students pursuing careers in Ocean Science. The program engages students in innovative

research in Oceanography, Marine Biology and Ecology, Ocean Engineering, and Marine Geology; provides rigorous research and professional development support for students during and after the REU to maintain interest and involvement in the Ocean Sciences and, provide students with high-caliber faculty mentoring across all phases of the REU experience.

Student Involvement: To date the project has supported 33 undergraduate students from across the United States in Ocean Science research in the Monterey Bay. Four CSUMB MSCI majors, Taylor Eddy, Madison Heard, Aileen San and Catrin Wendt and one CSUMB CSIT major, Jay Lowe have participated in the program.

Broader Significance: The Monterey Bay REU forms an undergraduate research alliance among a Hispanic Serving Institution (CSUMB), Tier One Research Institutions (Hopkins, MBARI, and NPS), a California State University consortium marine lab (MLML), and a federal research reserve (ESNERR). The REU program aims to 1) recruit 11 REU participants with an emphasis on students from underrepresented groups and those with limited access to Science, Technology, Engineering, and Mathematics (STEM) research; 2) prepare students in advance of the 10 week REU for the rigors of undertaking an original research project; 3) engage students in innovative research in Oceanography, Marine Biology and Ecology, Ocean Engineering, and Marine Geology; 4) provide rigorous research and professional development support for students during and after the REU to maintain interest and involvement in the Ocean Sciences; and 5) provide students with high-caliber faculty mentoring across all phases of the REU experience. The social context of the program is the demographics of the U.S, whose composition is rapidly changing, with little reflection of this change seen in the ranks of Ocean Science institutions of the U.S. To meet this need, a vigorous recruitment and outreach effort leverages campus based resources, connections with diversity-focused programs of professional societies, and the experience of the PI in engaging with students from underrepresented student populations. Our outreach model allows us to recruit, engage and retain diverse student populations who can provide the unique perspectives required to engage in 21st century Ocean Science research.

Improved Polar Data Access and Communication

IfAME Principal Investigator: Dr. Corey Garza

Collaborators: Dr. Oscar Schofield (Rutgers), Dr. Josh Kohut (Rutgers), Dr. Janice McDonnell (Rutgers), Dr. George Matsumoto (MBARI)

Financial Support: National Science Foundation

Field Support: Rutgers Teledyne glider fleet, U.S. Antarctic Research Vessel Laurence M. Gould, U.S. Antarctic Program Palmer Research Station.

Summary: In collaboration with Rutgers University and MBARI, we are enhancing the capacity of polar scientists for communicating and engaging with diverse audiences. This project will create scalable, in-person and virtual research opportunities for educators and students to engage with polar scientists and their research through data visualizations, data activities, educator workshops, webinars, and student research symposia. The use of a polar based underwater glider fleet and ocean observing systems provides remote access to a rich array of data for research and education from the Polar regions. The desired product is a set of data rich research and instructional materials, and customized professional development trainings that virtually expand access and opportunity to engage more educators and their classrooms in polar science.

Student Involvement: One graduate student, Ms. Jesirae Collins, will be brought onto the project this Fall to work on a thesis project associated with the grant.

Broader Significance: This effort will improve the communication capacity of the polar science community. It will help bring real-world datasets, models, and simulations into the classroom and make scientific data from the poles and information about polar research widely available and useful to various audiences. The project will engage under-represented and underserved students in polar scientific research and many of the materials created and connections between scientists and educators are likely to be sustainable.

Kelp Forest Hydrodynamics in Restored Kelp Forests in Palos Verdes

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IfAME Principal Investigator: Kerry J Nickols

Collaborators: Dr. Tom Ford (The Bay Foundation)
Dr. Brian Gaylord (UC Davis)
Kristen Elsmore (UC Davis)

Financial Support: California Coastal Conservancy

Summary: The Bay Foundation in Southern California has an ongoing project restoring kelp forests in Southern California from urchin barrens. In conjunction with restoration efforts, we are measuring how the hydrodynamics of nearshore habitats change as kelp begins to grow back. We are also studying the role of kelp forest habitats in wave attenuation in nearshore habitats in erosion-prone areas.

Student Involvement: I am advising a graduate student, Kristen Elsmore from UC Davis, during this project. We are in the early phase of data collection and we plan on involving a CSUMB masters student and undergraduate students in subsequent field efforts in 2017.

Broader Significance: This project not only informs us how nearshore landscapes change as a foundation species is being restored, but also quantifies the ecosystem services of giant kelp via wave attenuation and storm protection in Southern California. The results of this study may lead to the development of climate change mitigation strategies.

Landscape ecology of nearshore biological communities along the California coast: from video-based diver transects to spatial modeling

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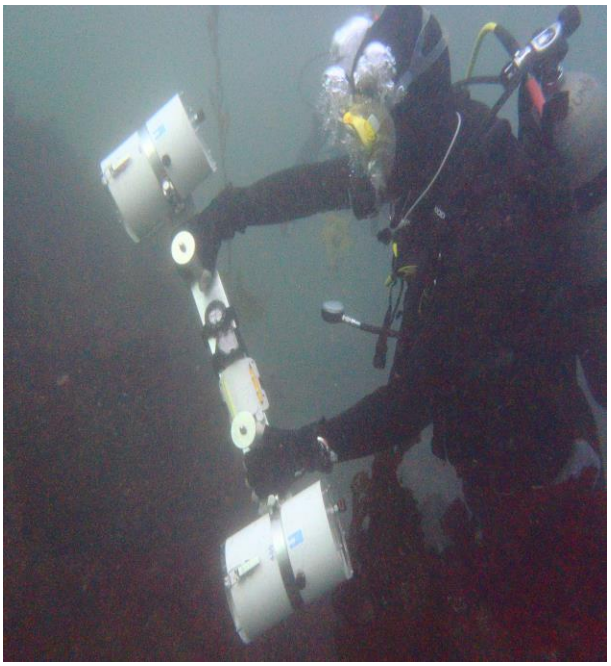

IfAME Principal Investigator: James Lindholm

***Collaborators*:** PISCO; Reef Check California; California State Parks

***Financial Support*:** SEP.org, US Department of Education; Private Donations to the IfAME

***Field Support*:** CSUMB Research Diving Program

***Summary*:** The three-fold goals of this project are a) to study patterns in the distribution of nearshore marine communities across the state, b) to collect data inside and out of State marine protected areas, and c) to establish a video archive of imagery for use in future analyses. The project replicates in the nearshore (< 20 m water depth) of California a similar study design to our existing ROV sampling across the state ranging from

Point Arena to La Jolla in waters ranging from 20 – 500 m water depth (http://sep.csumb.edu/ifame/). We collect both structural and biological community data in the shallow, rocky subtidal at locations including northern CA, north-central CA (north of Pt. Conception), south-central CA (south of Point Conception), and southern CA. Specific sampling locations include (from north to south) Gerstle Cove within the Salt Point State Park, the Big Creek Ecological Reserve, Refugio State Park, Leo Carillo State Beach, and La Jolla Cove. Each location was selected for the general biogeographic regime that it represents, the presence of existing monitoring data (e.g., California Reef Check), and for the presence of state marine reserves or conservation areas (at most sites).

In Summer 2016 three additional sites will be added around the Monterey Peninsula, including Carmel River State Beach, Carmel Beach, and McAbee Beach in Monterey.

Student Involvement: All SCUBA dives are conducted by trained research divers from CSU Monterey Bay's Research Diving Program. Additional sampling sites and time periods are planned as the number of project partners is expanded in the coming years. At total of 20 undergraduates and two graduate students have participated directly in the project to-date. Two graduate internships (through CSUMB's Professional Science Masters Program) will be focused on the project over the summer of 2016.

Broader Impacts: Analyses of project data will include changes in abundance, diversity, and species composition with latitude as well as inter-annual changes related to recent El Nino events. Other on-going efforts include fine-scale analyses of patterns in fish-habitat interactions within and among sites as well as inside and out of State Marine Protected Areas, and spatial modeling resulting from the combination of observational data and the high-resolution topographic maps produced by the California State Mapping Project.

Long-Term Monitoring of Subtidal Marine Ecosystems on the Israeli Continental Shelf

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IfAME Principal Investigator: James Lindholm

Collaborators: Aviad Scheinin (Hamaraag/University of Haifa)

***Financial Support*:** Private donations to the James W. Rote Distinguished Professorship in Marine Science and Policy; US Department of Education.

***Field Support*:** University of Haifa Dive Program

Summary: This project was initiated in 2014 to support the development of subtidal monitoring along the Mediterranean coastline of Israel. To-date discussions have focused on approaches to deep (ROV sampling) and shallow (SCUBA sampling) subtidal habitats, while field work has been entirely SCUBA based.

***Student Involvement*:** The project has yet to include CSUMB students. However the long-term plans for collaboration with the University of Haifa will hopefully include a student exchange between the two campuses.

Broader Significance: This project demonstrates the international scope of the IfAME approach to conducting science in support of management.

Mapping Coral Thermal "Toughness" Across American Samoa – Building SCLERA: the "Samoan Coral Local Environmental Resistance Atlas"

IfAME Principal Investigator: Dr**.** Cheryl Logan

Collaborators*:* Dr. Tom Oliver, University of Hawaii and NOAA; Dr. Ruth Gates, University of Hawaii

Financial Support: NOAA Coral Reef Conservation Program

Summary: Reefs sites in American Samoa, like the rest of the globe, face compounding threats from local pollution and overfishing, as well as the global threat of rising temperatures. To both investigate the linkages between these threats and inform the public about them, we will work with local communities and stakeholders across multiple sites in American Samoa, to (a) spatially map coral critical thermal thresholds, (b) correlate them with environmental history, algal symbiont distributions, land based pollution levels and site-specific management efforts. We will couple our experiments in each site with outreach activities and citizen-scientist trainings. Finally, using estimates of the heritability of these thresholds and regionally oceanographic connectivity, we will parameterize 1st-generation models of regional thermal threshold evolution.

Student Involvement: This project provided direct research experience for

two CSUMB undergraduates (one who travelled to American Samoa for one month of field work), and two local American Samoa high school students.

Broader Significance: Outcomes of the project include (a) a growing atlas of coral thermal “toughness” across reef sites in American Samoa, (b) a better understanding of the effect of management actions on coral thermal resistance, (c) a 1st generation regional model of the evolution of these critical thermal thresholds, and (d) communities that are more engaged and informed on these issues. Performance will be evaluated by our production of scientific publications, relevant management reports, and outreach materials, as well as by the engagement of local communities and the support for budding citizen scientists.

Multiple stressor effects of ocean acidification and hypoxia on behavior, physiology, and gene expression of temperate reef fishes

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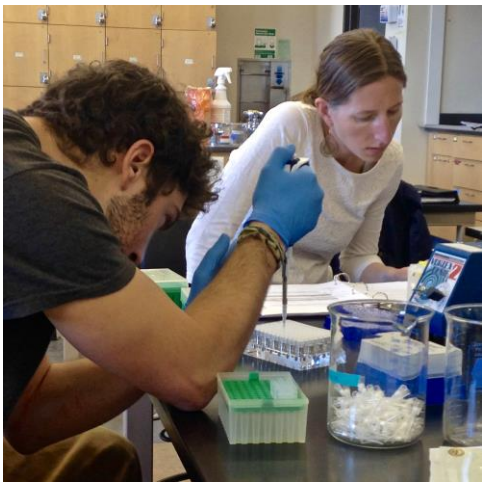

IfAME Principal Investigator: Dr. Cheryl Logan

Collaborators: Dr. Scott Hamilton, SJSU-MLML
Dr. Susan Sograd, NOAA-SWFSC;
Dr. Brian Tissot, Humboldt State University;
Dr. Eric Bjorkstedt, NOAA-SWFSC /Humboldt State University

Financial Support: National Science Foundation (Ocean Acidification program)

Summary: The objectives of this study are to examine the effects of each stressor alone and in combination on behavior, physiological capacity, and gene expression in temperate reef fishes. Because mortality in early life stages has important carryover effects on recruitment processes, understanding the synergistic effects of these stressors is critical for predicting future climate change impacts on global fish populations. Rockfishes (*Sebastes* spp.) comprise a vital economic and ecological component of west coast demersal ecosystems. Recruiting juveniles settle in nearshore habitats where they will be highly susceptible to ocean acidification and hypoxia events. Our research will compare the

sensitivities of early juvenile stages of different species with contrasting life histories and the potential for adaptation to the variable and dynamic pH and DO conditions of the California Current. Response variables will include: (1) behavioral metrics such as olfactory sensitivity and tests of brain function; (2) metabolic metrics such as critical swimming speed and aerobic scope; and (3) the underlying cellular mechanisms to these responses, using next generation transcriptome sequencing to look at changes in gene expression and enzymatic assays to examine acid-base regulation.

***Student Involvement**:* This project is providing educational opportunities and direct research experience for graduate and undergraduate students at the 4 partner institutions. Students are actively engaged in all components of the lab experiments, field sampling, and genomic analyses. P.I.'s Logan, Sogard and Hamilton and their graduate students are mentoring several UROC students. Students gain valuable research experience in fish physiology, genomics, and nearshore oceanography, preparing them for entry into competitive graduate programs. This funding has also supported a group capstone undergraduate laboratory course taught in Spring 2015 and 2016 at CSUMB. The course teaches students how next generation sequencing techniques can be used to solve environmental problems. Students in this course (~14 undergraduates) have learned how to prepare samples for RNAseq and go through the pipeline for how to construct a *de novo* transcriptome and analyze gene expression data. Students present their findings at the capstone festival each Spring.

***Broader Significance**:* In addition to student involvement described above, this project will also expand the experimental capabilities of HSU's marine laboratory for educational and interdisciplinary collaborative research efforts, with P.I.s Bjorkstedt, Abell, and Mulligan. Two of the P.I.s (Hamilton and Logan) are new faculty members developing new research programs, and this project will provide valuable support in those efforts. The results of the field studies and lab experiments will be rapidly disseminated to fisheries management agencies, oceanographic observing programs, and the science community to provide information on climate change impacts for economically valuable groundfish.

Ocean Opportunities

IfAME Principal Investigator: Corey Garza

Collaborators: Dr. James Yoder (Woods Hole Oceanographic Institution)

Financial Support: Deerbrook Charitable Trust

Summary: Ocean Opportunities is a partnership to develop a new, coordinated strategy by the ocean sciences community to increase the number of underrepresented minorities in ocean science and ocean engineering graduate programs. This strategy was discussed and endorsed at the fall 2010 Ocean Science Educators Retreat (OSER), hosted by the Consortium for Ocean Leadership in Washington, D.C. Ocean Opportunities seeks to acquaint underrepresented minority undergraduate students with these opportunities, encouraging students to pursue a graduate degree in ocean science and engineering programs.

Student Involvement: To date the project has supported 90 undergraduate students from across the United States in Ocean Science outreach experiences across the United States. In particular students have been provided with graduate school immersion experiences at the University of South Florida, Scripps Institution of Oceanography and Woods Hole Oceanographic Institutions. Twelve students from CSUMB have participated in these trips.

Broader Significance: The partnership aims to promulgate the career and educational possibilities of these programs by supporting institutional-neutral booths at scientific meetings that attract undergraduate students, distributing brochures and other promotional information, supporting a webpage informing potential students of programs and careers in ocean science and ocean engineering fields, and coordinating campus visits by representatives from institutions offering graduate studies in ocean science and engineering to minority-serving colleges and universities.

Quantification of Seafloor Habitat Impacts from Bottom Trawling under Selected Trawl Modifications

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IfAME Principal Investigator: James Lindholm

Collaborators: David Crabbe (Pacific Fishery Management Council); Huff McGonigal and Shems Judd (Environmental Defense Fund); Giovanni Pennisi (Pioneer Fishing); Dr. Andrew DeVogelaere (NOAA-MBNMS)

***Financial Support*:** NOAA Saltonstall-Kennedy; Environmental Defense Fund; Private donations to the IfAME

***Field Support*:** F/V *Donna Kathleen; MARE;* F/V *Pioneer*

Summary: The goal of this project is to quantify the relative impacts of traditional bottom trawl gear and modified trawl gear on the structural attributes of seafloor habitat that form an important component of Essential Fish Habitat (EFH) for many groundfish species. Structural attributes in this context include topographic complexity in the substrate as well as any emergent biogenic structure, such as soft corals, sponges, and anemones. The traditional gear will use bottom-contact trawl doors, a small footrope, and un-elevated. Specific modifications to the new gear include pelagic trawl doors, door sensors, bottom contact and catch sensors, four seam

nets, elevated sweeps, and spaced discs that have been shown to be effective in the Bering Sea and Europe at reducing benthic impacts.

***Student Involvement*:** The project to-date has supported two graduate student research assistants and more than 20 undergraduate students through group-based capstone projects.

Broader Significance: In addition to potentially reducing benthic impacts relative to traditional gear, this modified gear has potential to significantly reduce fuel costs due to lower drag while at the same time producing a higher quality product due to greater door spread and shorter tow times.

Repower of R/V Harold Heath

IfAME Principal Investigator: Rikk Kvitek

Financial Support: Carl Moyer Program for Marine Vessel Repower, Monterey Bay Unified Air Pollution Control District

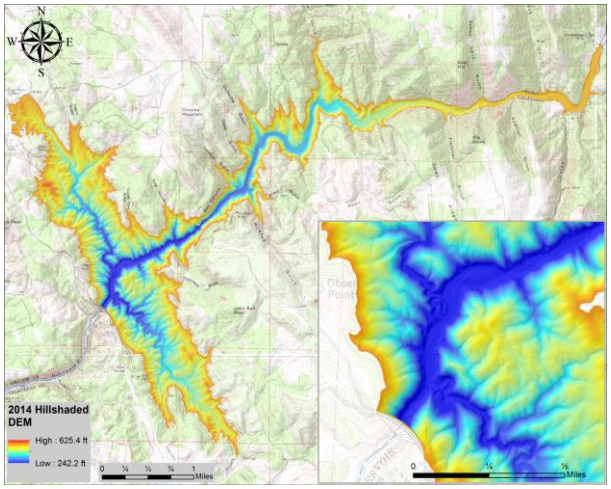
Field Support: CSUMB R/V *Harold Heath*

Summary: In October of 2015 the Carl Moyer federal program for marine vessel repower awarded a grant to the Seafloor Mapping Lab at California State University Monterey to pay for the replacement of the aging diesel engines aboard the R/V Harold Heath, a 46' Hatteras and largest of CSUMB's research vessel fleet. New twin Volvo marine diesel engines have now been installed as well as a new diesel generator. These changes have increased fuel efficiency by 30% and have eliminated the sooty exhaust that plagued the original Cummins diesels. This change has also significantly reduced the overall weight of the vessel allowing greater passenger and instrumentation payloads, and increased the cruising speed to over 20kt.

Student Involvement: An enthusiastic group of 6 undergraduate student volunteer interns have been critical to the success of the repower project. These students participated in the haul out, cleaning and stripping of the hull, flying bridge, cabin and decks in preparation for the install, as well as re-installation and/or new fabrication of all components removed. The interns will now become deck hands for weekly maintenance runs in the Bay required to keep the vessel in top trim, and on research cruises.

Broader Significance: The Carl Moyer Program's purpose is to reduce regional contributions to air pollution by outdated diesel engines that federal policy requires be taken out of service. CSUMB's main research vessel, which qualified for this grant program due to the large number of sea days and heavy fuel consumption over the past several years, is now a highly efficient and clean running research and education vessel, consistent with CSUMB's emphasis on environmental sustainability.

Reservoir Capacity Studies



IfAME Principal Investigator: Rikk Kvitek

Financial Support: East Bay Municipal Utilities District.

Field Support: CSUMB R/V *VenTresca*, R/V *KelpFly*, R/V *MacGinitie*

Summary: In August of 2014 EBMUD awarded a contract to the Seafloor Mapping Lab at California State University Monterey to conduct a combined hydrographic and topographic survey of Pardee Reservoir. The success of that reservoir capacity study lead to an augmentation of the original budget and scope of work to include two additional EBMUB reservoirs in this project; Upper San Leandro and Briones that were completed in spring 2016. The survey data yielded 2 foot resolution digital elevation models (DEM) of reservoir bathymetry and topography which were used to calculate reservoir volume losses since construction in the 1920's.

Student Involvement: This project originated through the interest of AMWS PSM student John Urness, who took on an internship with EBMUD and convinced them to engage the SFML to determine the capacity of their reservoirs. John has taken the lead in data processing, product creation and report preparation for this project.

Broader Significance: The importance of this project and related SFML efforts is underscored by the unprecedented drought California is undergoing along with the predicted loss of the state's Sierra snowpack by mid-century.

Roles of acclimatization & adaptation in responding to climate change

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IfAME Principal Investigator: Dr. Cheryl Logan

Collaborators: Dr. Jody Beers, Hopkins Marine Station of Stanford University
Dr. George Somero, Hopkins Marine Station of Stanford University
Dr. Stephen Palumbi, Hopkins Marine Station of Stanford University

Financial Support*:* CSUPERB

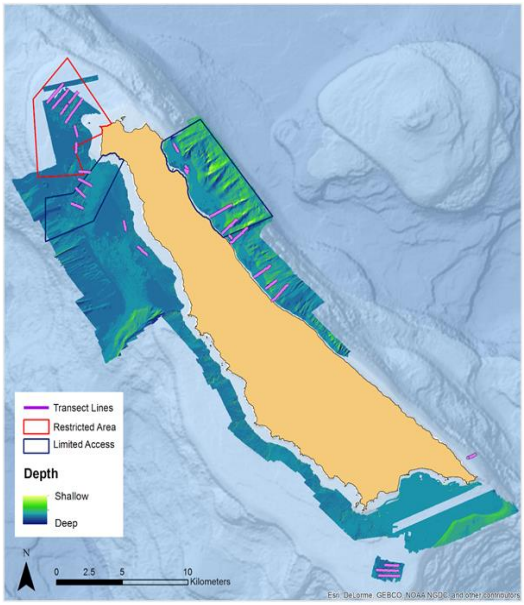
Summary: To predict the winners and losers of climate change, we must understand the capacity of animals to adjust their physiology to tolerate warmer temperature. This is particularly true for organisms that cannot move away to cooler climates, like plants or animals that have no ability to move. Organisms have a variety of mechanisms that can use to increase temperature tolerance over different timescales. For example, animals can increase their temperature tolerance over the course of their lifetimes in a process called acclimatization, or over multiple generations via genetic adaptation. Our proposal is to test the strength and limits of acclimatization and adaptation in response to temperature variation across small and large spatial scales in an ecologically important, rocky intertidal species, the California sea mussel. We will characterize the capacity for physiological acclimatization and genetic adaptation of a key species in an important U.S. coastal ecosystem. Results from our research can be integrated into mechanistic predictive models to better understand how this species' distribution is likely to shift with climate change.

Student Involvement: Two CSUMB undergraduate students will be trained to conduct physiological assays and gain a basic understanding of transcriptomics using next generation sequencing. The CSUMB Undergraduate Research Opportunities Center (UROC), a program for high achieving undergraduates wishing to pursue graduate school, will support

the undergraduate. An M.S. student will also be trained and lead the sample preparation and bioinformatics. I will play a significant role in advising students on technique, preparation, and analysis for all experiments. Students will present their research findings via poster presentations at the Western Society of Naturalists (WSN) conference in Fall 2016.

Broader Significance*:* This system will be among the first non-model marine species to incorporate physiological and genomic measures of acclimatization and adaptation in a natural setting in the context of increased climate stress. Results from our research can be integrated into mechanistic predictive models to better understand how this species' distribution is likely to shift with climate change. This CSUPERB proposal will provide funding to collect additional preliminary data to support a full NSF proposal submission to the Integrative and Organismal Systems directorate in 2017.

San Clemente Island Baseline Characterization and Monitoring Project



IfAME Principal Investigator: James Lindholm

Collaborators: Rikk Kvitek; Pete Raimondi (UCSC)

Financial Support: US Department of Defense; CSUMB Undergraduate Research Opportunities Center; James W. Rote Distinguished Professorship in Marine Science and Policy at CSU Monterey Bay, Private donations.

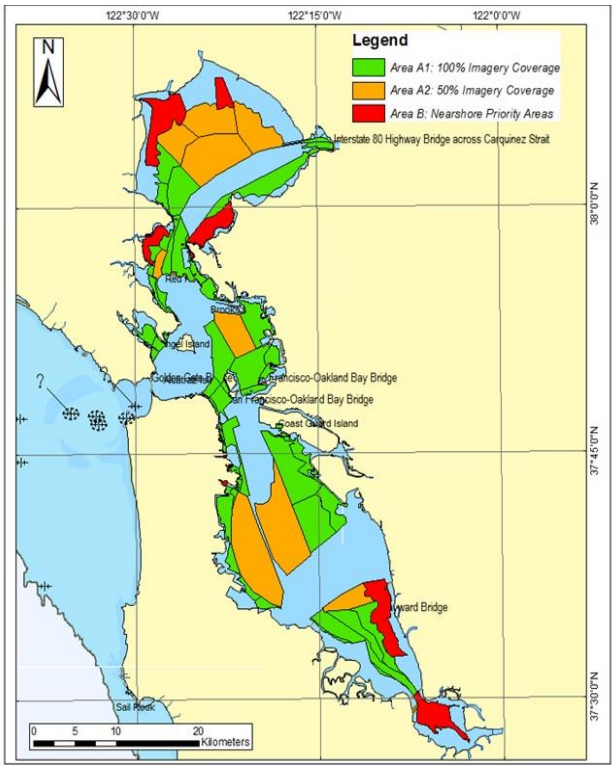
Field Support: F/V *Donna Kathleen;* RV *Harold Heath*

Summary: The primary goal of this project is to characterize the distribution, abundance, and community composition of fishes, invertebrates, and seafloor microhabitats using an approach that is comparable to the South Coast MPA Baseline project described below. Imagery is collected using an ROV. Post-processing of project data is on-going in the IfAME Image Analysis Lab. Additional high-resolution topographic mapping of the seafloor was conducted by the Seafloor Mapping Lab.

***Student Involvement*:** This project, thus far, has engaged a total of 32 students from CSUMB, including 28 undergraduates and 4 graduate students, in field research activities, data post-processing, and analysis. Currently, while decisions on the timing of long-term monitoring across the state are being considered, the emphasis is on the analysis of data extracted from existing video.

Broader Significance: On January 1, 2012, the California Fish and Game Commission designated 52 marine protected areas (356 square miles) in the South Coast Study Region (extending from Point Conception in the north to the US-Mexico border in the south) under California's Marine Life Protection Act. San Clemente Island, which is owned by the US Navy, was not included in the wider southern California region initially. However, after the baseline characterization began, the Navy requested that similar projects be conducted at the island. Additional funding for long-term monitoring is currently under consideration.

San Francisco Bay Shallow Water Mapping



IfAME Principal Investigator: Rikk Kvitek

Collaborators: Fugro Pelagos Inc. (FPI), NOAA

Financial Support: California Ocean Protection Council

Field Support: SFML vessels: R/V MacGinitie, R/V KelpFly, new SeaRobotics USV being built for this project.

Summary: In spring 2016, SFML staff and students completed the mapping of the extreme shallow water habitat areas of SF Bay identified as high priority sites by a broad community of regional stakeholders (red polygons in map above). These habitats had never been mapped due to the limitations of conventional hydrographic mapping vessels and technology. This project therefore was also designed to serve as a proof-of-compete for the use of unmanned surface vessels (USV) for ultra-shallow water mapping. SFML in conjunction with SeaRobotics developed and

tested a specially designed USV for operation within the extremely shallow subtidal areas of SF Bay. This USV is now the property of the University Corporation and part of the SFML research vessel fleet.

Student Involvement: CSUMB students were involved in the acquisition and processing of the bathymetry and habitat data.

Broader Significance: These data are the first of their kind collected for these high priority habitats in SF Bay, and if successful, the new USV will be a valuable tool for mapping the other bays and estuaries along the California coast. These data are a crucial piece of the modeling effort being undertaken by the State as it plans for sea level rise in urban coastal communities.

Sentinels of Change: Phenology of Zooplankton Communities and their Potential as Ecosystem Indicators in the Central California Current

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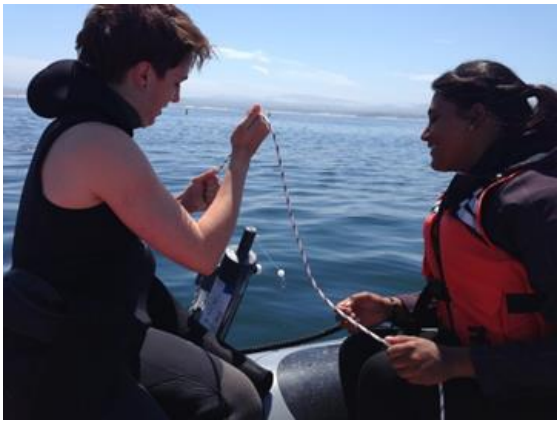
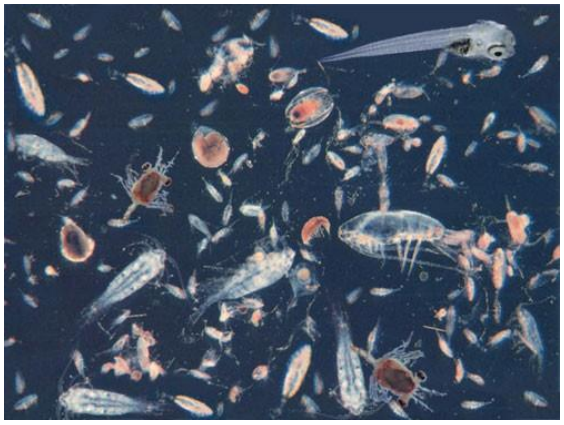




IfAME Principal Investigator: Kerry J Nickols

Collaborators: Eric Bjorkstedt (NOAA National Marine Fisheries Service and Humboldt State University)
Jennifer Fisher (NOAA NMFS)

Financial Support: CSU Monterey Bay Faculty Incentive Grant

Field Support: CSUMB RV *VenTresca,* RV *Kelpfly,* RV *MacGinitie*

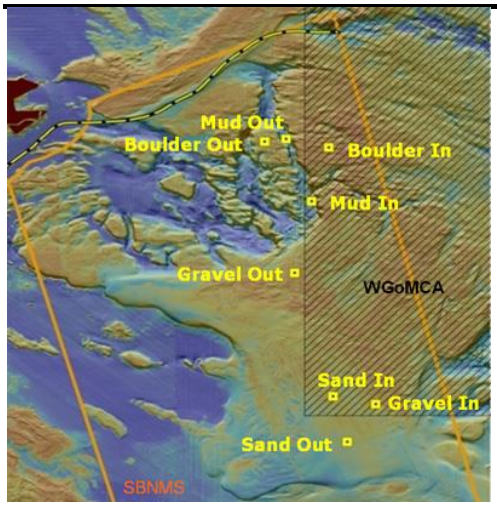
Summary: Upwelling systems, such as the California Current, are among the most productive ecosystems in the world, covering less than 2% of ocean surface area yet accounting for 20% of global fish catch. The productivity of the California Current region is tied to physical processes driven by climate. Changes in the climate system affect the abundance of organisms at the base of the food web, and can lead to dramatic impacts on higher trophic level organisms such as whales, seabirds, and fish. Zooplankton - microscopic animals that are abundant in the California Current - are critical links between the physical processes in the ocean and higher trophic level animals, making them sentinels of change within the California Current. In order to understand the impacts a changing ocean will have on fisheries species, we need to study the responses of lower

trophic level organisms. Such efforts are underway in the Northern California Current and have contributed substantially to knowledge about fisheries productivity and management, yet are a critical research gap in Central California. PI Nickols has established a new time series of lower trophic organisms (zooplankton) and environmental conditions off the coast of the Monterey Peninsula in the Central California Current.

***Student Involvement*:** To date, four undergraduate students and one AMWS graduate student have contributed to data collection. During Fall 2016, one undergraduate and one graduate student will develop protocols fro data analysis and PI Nickols will integrate this project into MSCI 270 Intro to Oceans, a lower division course required of all MSCI majors.

Broader Significance: We are missing potential signals of ecosystem change in the central California Current ecosystem. The sampling frequency by other groups in this region does not allow for appropriate resolution to link physical processes to fisheries. High frequency (2-4 weeks) sampling in this region done through this project fulfills a critical research gap and also informs ecosystem health. Zooplankton are key moderators of energy transfer to higher trophic levels and this research project will allow us to predict ecosystem impacts of a changing ocean on higher trophic levels.

Seafloor Habitat Recovery Monitoring Program



IfAME Principal Investigator: James Lindholm

***Collaborators*:** Dr. Peter Auster (University of Connecticut)
Dr. Page Valentine (US Geological Survey)
Dr. Les Watling (University of Hawaii)

***Financial Support*:** Stellwagen Bank National Marine Sanctuary; National Undersea Research Center for the Northeast Atlantic and Great Lakes; NOAA Fisheries

***Field Support*:** R/V *Connecticut*; NOAA *Ship Ferrel*; NOAA Ship *Nancy Foster;* F/V *Christopher Andrew*

***Summary*:** The primary goal of this project, which entering in its 18th year, is the quantification of recovery rates for fish, invertebrates and seafloor habitats in the western Gulf of Maine. Data on the distribution of fishes, invertebrates, and seafloor microhabitats were extracted from still photographic and videographic imagery collected using an ROV and a camera sled. Sediment samples and infaunal invertebrates were collected using a benthic grab sampler. Post-processing and further analysis are completed in the IfAME Image Analysis Lab at the University of Connecticut, and at the University of Maine.

Student Involvement: Since its inception in 1998, this project has provided more than 22 student positions for students from institutions around the country, encompassing field research activities, data post-processing, and analysis, and produced 3 masters theses.

Broader Significance: This project is directly informing the New England Fishery Management Council's on-going efforts to manage fishing effort and impacts to Essential Fish Habitat (EFH) under the Sustainable Fisheries Act of 1996. Further, the project is contributing to the conservation of the marine communities in NOAA's Stellwagen Bank National Marine Sanctuary, one of only 14 National Marine Sanctuaries in US waters, and the only Sanctuary in the northwest Atlantic.

South Coast Marine Protected Area Baseline Characterization and Monitoring Project

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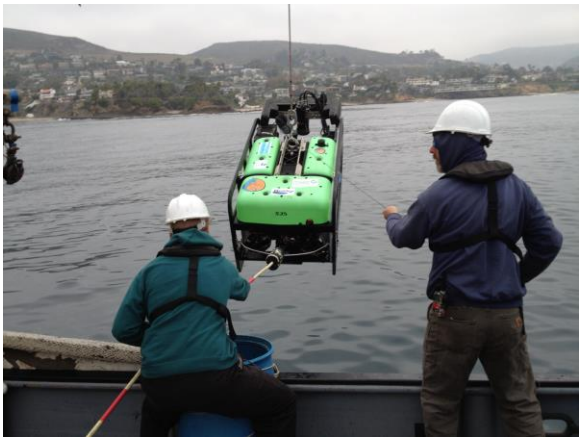

IfAME Principal Investigator: James Lindholm

Collaborators: Dirk Rosen (MARE)
Jennifer Caselle (UCSB)

Financial Support: California SeaGrant; CSUMB Undergraduate Research Opportunities Center; James W. Rote Distinguished Professorship in Marine Science and Policy at CSU Monterey Bay, Private donations.

Field Support: F/V Donna Kathleen

Summary: The primary goal of this project is to characterize the distribution, abundance, and community composition of fishes, invertebrates, and seafloor microhabitats in ten of the newly-designated MPAs in the CA Marine Life Protection Act's South Coast Study region. Photograph and video imagery was collected (2011-2013) collected using an ROV. Post-processing of project data is on-going in the IfAME Image Analysis Lab.

Currently the primary emphases on this project are a) synthesizing data with other baseline characterization projects, and b) planning for long-term monitoring.

***Student Involvement*:** This project, thus far, has engaged a total of 10 students from CSUMB, including 5 undergraduates and 5 graduate students, in field research activities, data post-processing, and analysis.

Broader Significance: On January 1, 2012, the California Fish and Game Commission designated 52 marine protected areas (356 square miles) in the South Coast Study Region (extending from Point Conception in the north to the US-Mexico border in the south) under California's Marine Life Protection Act. This project is part of the South Coast MPA Baseline Data Collection Project, which will directly inform the management of these MPAs.

Spatial Realism in the Mussel Bed Disturbance Paradigm

IfAME Principal Investigator: Corey Garza

Collaborators: Dr. Carlos Robles (CSULA), Dr. Patricia Halpin (UCLA)

Financial Support: National Science Foundation

Field Support: Shared CSULA/CSUMB Research Boats (1, 16 ft Achilles inflatable and 1, 16 ft Cope aluminum) each with 30 HP outboard engine. MV Barkley Star 35 ft workboat owned by Bamfield Marine Sciences Center.

Summary: As part of a collaboration with California State University, Los Angeles and the University of California at Los Angeles our lab group is participating in a project to enhance our understanding of how disturbance structures natural communities. Our understanding of how physical disturbance shapes the structure of populations and communities owes much to field studies of wave-generated gap formation in mussel beds. Prior studies depict mussel beds as a non-equilibrium system, in which disturbance is spatially unpredictable, generating a random patchwork of mussel cover and gaps. The study tests assumptions and predictions of an alternative view, that disturbance shows predictable landscape patterns that depend not merely on spatial distribution of external forcing (wave

stress) but also on biological processes determining the structure of the aggregation. Specifically, spatially varying mussel productivity (recruitment and growth), physiological stress, and predation interact to produce landscape patterns in the structure of the mussel cover. Field work emphasizes construction of a detailed GIS database using geospatial sampling methods applied to mussel bed sites in Barkley Sound, British Columbia. GIS data layers for each site include wave force, topography (tidal height, slope, and aspect), mussel size structure, mussel bed thickness, differentiation of layering, and size-specific attachment strengths stratified by layer. GIS interpolations and regression analyses are used to first examine assumptions of the hypothetical landscape process and then test specific predictions regarding spatial patterns in the occurrence of disturbance and recovery.

Student Involvement: Two graduate students, Daniel Orr, Mary Young have participated in this project. Mr. Orr and Ms. Young have both completed their graduate degrees. Four CSUMB undergraduates have been supported by the project; Amber Reichert, Patrick Sabordo, Veronica Larwood and Franco Sanchez. Ms Reichert is now a graduate student at Moss Landing Marine Labs, Mr. Sabordo works for CDFW while Ms. Larwood has been hired as a full time research position within this project. Mr Sanchez begin worke within the project this summer.

Broader Significance: The proposed work would test assumptions and predictions of an alternative view that disturbance shows predictable landscape patterns that depend not merely on spatial distribution of external forcing (wave stress) but also on biological processes determining the structure of the aggregation. Therefore, spatial patterns of gap formation and recovery in nature may in fact emerge from a unified landscape process.

System-Wide Science Support for NOAA's Office of National Marine Sanctuary

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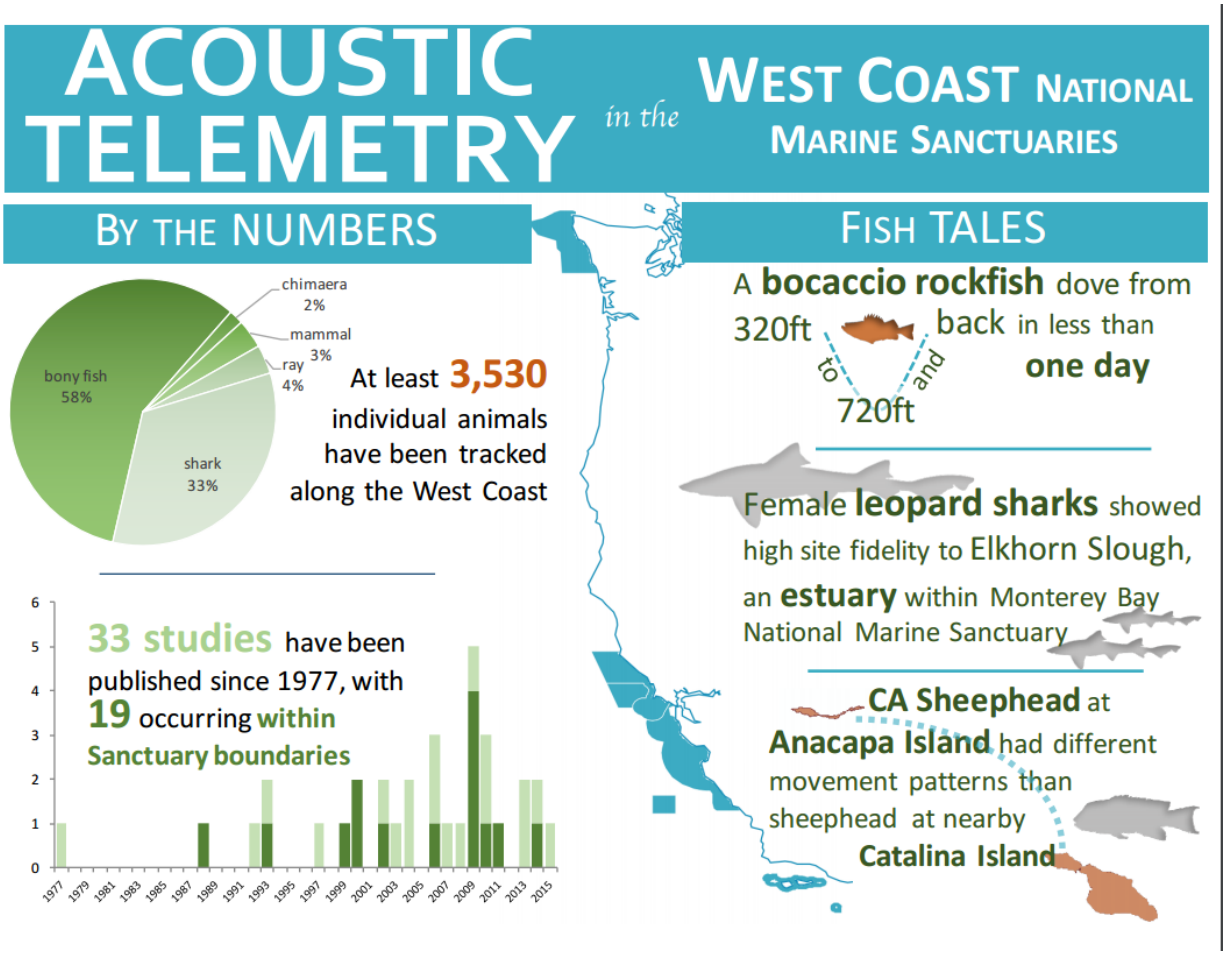

IfAME Principal Investigator: James Lindholm

Collaborators: Mitchell Tartt (NOAA/ONMS)

Financial Support: National Marine Sanctuary Foundation; Private donations to the James W. Rote Distinguished Professorship in Marine Science and Policy at CSU Monterey Bay.

Field Support: N/A

Summary: The primary goal of this project is to support the Conservation and Science Division of the National Marine Sanctuary Program with its various science needs. Currently that effort has been focused on a system-wide assessment of acoustic telemetry research on fish movements throughout the Sanctuaries, including a published literature review, a review of existing and planned projects, as well as the development of informational graphics to showcase use of telemetry to answer specific science questions.

Student Involvement**:** This project, thus far, a single CSUMB graduate student.

Broader Significance: This project occurs as part of a broader, nation-wide 'University Partnership' with the Office of National Marine Sanctuaries. CSUMB is leading the way in defining best practices for how the nation's universities can support the federal government's science needs while simultaneously providing students with opportunities to participate as part of their educations. To that end this initial project is laying a foundation for a great deal of future work.

The Seasonal Dynamics of Sandy Habitat Geomorphology and Epifaunal Associations on the Continental Shelf of Monterey Bay, California

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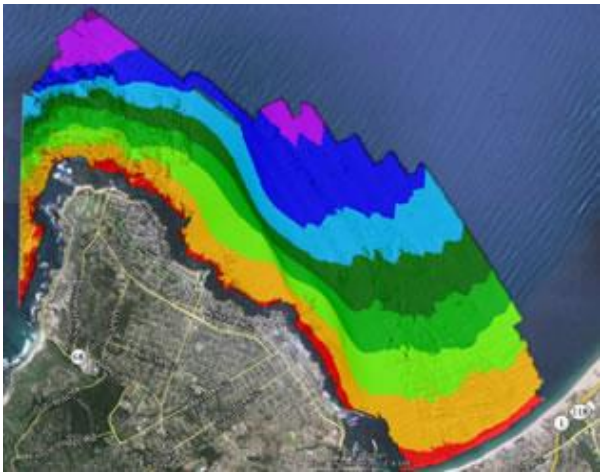

IfAME Principal Investigator: Corey Garza

Collaborators: Dr. Michael Navarro (CSUMB), Dr. Rikk Kvitek (CSUMB) and Dr. Steve Moore (CSUMB)

Financial Support: National Science Foundation

Field Support: CSUMB Boats (1 16 ft inflatable) with 25 HP motor and RV VanTresca. Side scan sonar and ROV.

Summary: In many areas geomorphology drives species distribution and abundance. On the continental shelf, the sandy plains habitat comprises one of the largest habitats of the north-eastern Pacific and is of great importance to California's largest commercial fisheries, Dungeness crab and market squid. Yet, large knowledge gaps remain and impede a clear understanding of the dynamics of the sandy substrate geomorphology as well as for understanding of what drives organismal distributions. This research will investigate how structural changes of the seafloor of the continental shelf (15-160 m depth) impact the biological habitat. Seasonal use of, acoustical methods (mulitbeam and side scan sonar) will be used to quantify geomorphological dynamics of the seafloor and video methods

gathered via remotely operated vehicle will be used to quantify associated epifaunal species densities. The results of this research will not only fill needed knowledge gaps for the scientific community but, it will also provide timely information to coastal marine resource managers and policy makers.

Student Involvement: To date the project has supported the participation of 4 undergraduates. Three CSUMB students Nicole Barbour, Madison Heard and Jesirae Collins are active participants in the projects. Chelsea Burgess of Haskell Indian Nations University in Kansas participated in the project as student researcher through the CSUMB Ocean Science REU program this past summer.

Broader Significance: The project provides new insights into how geological variation on the continental shelf drives populations dynamics in this commercially important fishery species in California.

The Value of Habitat Diversity in Marine Reserves: Spiny Lobster use of the Intertidal Zone at the Santa Catalina MPA

IfAME Principal Investigator: Corey Garza

Collaborators: Dr. Steve Litvin (Hopkins Marine Station of Stanford University)

Financial Support: University of Southern California Sea Grant, California Ocean Science Trust

Field Support: CSUMB Boats (1 14 ft inflatable) with 20 HP motor. USC Wrigley Marine Station Dive Facility. RV Miss Christie, 50 ft USC work boat.

Summary: A guiding principle in the design of marine protected areas is that a diversity of habitats must be included to provide the complete range of ecosystem services for exploited species. This is especially true of species that use different habitats at different times in their reproductive cycles. In this study we propose to use a long term data set on intertidal habitat composition and demography of spiny lobster in the Santa Catalina Island MPA. This set of data is unique in that it contains information on intertidal habit composition and demographic information for spiny lobsters in the years preceding the establishment of the MPA, the year the MPA

was established and in the years following the establishment of the MPA. As part of this project we will collect two additional years of survey data which will then be analyzed in a Before After Control Impact Paired Series (BACIPS) analysis. Our project can provide researchers and managers with strong quantitative information on the impact of the Catalina MPA on key demographic features of in populations of spiny lobster. This project will also provide insight into the importance of incorporating intertidal habitat into the design of MPAs that target this species in Southern California.

Student Involvement: The project has supported the participation of 2 graduate students, Mary McCormick and Sean Windell. Ms. McCormick and Mr. Windell completed their graduate degrees this past July. Ms. McCormick teaches introductory Ocean Science courses here at CSUMB while Mr. Windell holds a position as Sea Grant State Fellow in Sacramento. Three undergraduate have been supported by the project, Mr. Mitchell Takata, Ms. Katie Sowul and Ms. Oliviya Wyse. All three have graduated from CSUMB Ms. Sowul and Ms. Wyse currently work as scientific aides for CDFW

Broader Significance: The project provides new insights on how scaling mismatches between reserve design and the scale at which target species utilize habitat can impact the performance of an MPA. Our integrated GIS and stable isotope approach is providing new insight into how manager can improve future MPA designs in order to minimize these types of scaling mismatches.

4. Facilities

Currently, the IfAME is distributed across multiple buildings on the main CSUMB campus. The Image Analysis Lab, the Marine Landscape Ecology Lab, the Ecosystem Electronics Lab, and the Logan lab are located in the Chapman Science Academic Center (Building 53). The Marine Operations/Seafloor Mapping Lab and the Haupt and Nickols labs are located in the Science Annex (Building 13) adjacent to Chapman. The majority of the vessels and small boats are located in the on-campus boat house, while the R/V *Harold Heath* is maintained at a floating dock adjacent to the Coast Guard Pier in Monterey Harbor. The Research Diving Program offices are located in Chapman and the dive locker is located adjacent to the pool.

5. Financial Report for FY2015/2016

Extramural Funding: Support for the IfAME comes almost entirely from extramural funding obtained by the faculty through grants and contracts facilitated by the University Corporation at Monterey Bay. Table 1 depicts the multiple sources of support that were active during FY2015/2016. As this funding rarely conforms to the state fiscal year schedule, column four in Table 1 shows the amount per project that was available during that time period. Additionally, a donation account was established through the Office of University Advancement in 2008 to receive any private donations to the IfAME.

Table 1. List of extramural grants, contracts, and gifts that were active during FY2015/2016, including the amount available for FY2015/2016, the total amount for each project received by CSUMB to-date, and the total budget for each project (including partner institutions).

Project Name	Source	Funding Type	CSUMB FY2015/2016	CSUMB To-Date	Total Budget To-Date **
Deepwater Site Characterization in the Monterey Bay National Marine Sanctuary	NOAA via the Monterey Bay Sanctuary Foundation	Contract	$67,428	$550,312	$550,312
Extreme Event Beach Change	FEMA/SCC	Contract	$25,000	$25,000	$25,000
From the Intertidal to the Deep Ocean: Monterey Bay Regional Ocean Science REU	National Science Foundation	Grant	$505,000	$505,000	$505,000
Improved Polar Data Access and Communication	National Science Foundation	Grant	$83,801	$83,801	$1,100,000
Kelp Forest Hydrodynamics in Restored Kelp Forests in Palos Verdes	CA Coastal Conservancy	Grant	$15,000	$15,000	$15,000
Mapping Coral Thermal “Toughness” Across American Samoa	NOAA Coral Reef Conservation Program	Grant	$11,034	$11,034	$11,034
Multiple Stressor Effects on Ocean Acidification and hypoxia on Behavior, Physiology, and Gene Expression of Temperate Reef Fishes	NSF Ocean Acidification Program	Grant	$294,731	$294,731	$1,000,000
Ocean Opportunities	Deerbrook Charitable Trust	Gift	$10,000	$170,000	$185,000
Quantification of Trawl Impacts from multiple gear types	NOAA Saltonstall-Kennedy; Environmental Defense Fund	Grant	$255,555	$255,555	$427,735

Repower of R/V Harold Heath	Carl Moyer Program for Marine Vessel Power, Monterey Bay Unified Air Pollution Control District	Grant	$210,563	$210,563	$210,563
Reservoir Capacity Studies	EBMUD	Contract	$113,851	$113,851	$113,851
Roles of Acclimatization & Adaptation in Responding to Climate Change	CSUPERB	Contract	$5,000	$5,000	$15,000
San Clemente Island Baseline Characterization	US Navy	Contract	No-cost Extension	$707,338	$707,338
San Francisco Bay Shallow Water Mapping	CA Ocean Protection Council	Contract	$834,132	$834,132	$834,132
Seafloor Habitat Recovery Monitoring Program	NOAA via Skidaway Institute for Oceanography	Contract	No-cost Extension	$185,797	$2,400,000
Sentinels of Change: Phenology of Zooplankton Communities and their Potential as Ecosystem Indicators in the Central California Current	CSU Monterey Bay	Grant	$9,971	$9,971	$9,971
South Coast Marine Protected Area Baseline Characterization and Monitoring	CA Sea Grant	Grant	No-cost Extension	$345,122	$780,000
Spatial Realism in the Mussel Bed Disturbance Paradigm	National Science Foundation	Grant	$25,000	$720,000	$780,000
System-Wide Science Support for the Office of National Marine Sanctuaries	National Marine Sanctuary Foundation	Grant	$35,196	$35,196	$35,196
The Seasonal Dynamics of Sandy Habitat Geomorphology and Epifaunal Associations on the Continental Shelf of Monterey	National Science Foundation	Grant	$85,000	$85,000	$170,000

The Value of Habitat Diversity in Marine Reserves: Spiny Lobster Use of the Intertidal Zone at The Catalina MPA	USC Sea Grant; CA OST	Grant	$2,000	$79,000	$80,000
		Total	$2,588,262	$5,241,403	$9,955,132

** Due to the collaborative nature of IfAME projects, a portion of a project's budget is frequently directed to one or more collaborating institutions to support ROV operations and research vessel charter without coming through CSUMB. These numbers are included to show the full value of the projects in the IfAME is engaged.

Expenditures: Salary and benefits comprised the majority of the funding that came to CSUMB (see Table 1 above). The majority of salary was dedicated to supporting student research assistants and/or student stipends at CSUMB. Research assistants are hired to work on particular grants for specific time periods. When those grants/contracts are closed students are either moved to other grants/contracts or removed from the payroll until another source of funding arises.

6. Proposed Budget for FY2016/2017

Extramural Funding: The majority of the twenty (20) funded projects listed in Table 1 as operating in FY2015/2016 will continue in FY2016/2017. In addition to those projects we have the following proposals pending for next year:

Project	**Expected Budget**
Characterization of Bottom Trawl Interactions with Fishes and Seafloor Habitats from a Net-Mounted Camera	$80,000
Long-Term Monitoring of California's MPA Network	$800,000
Long-Term Monitoring of Military Closures at San Clemente Island	$500,000
Center for Ocean Food Security	$20,000,000
Polar Interdisciplinary Coordinated Education	$1,100,000
RUI: Collaborative Research: Kelp forest ecosystem interactions with seawater CO_2 and oxygen levels in situ – the role of foundation species in a changing climate	$759,913
Total	$23,239,913

Leveraged Support: Each of the proposed projects will leverage considerable support from many of the partner institutions list below.

Expenditures: Expenditures will continue to track extramural funds for FY2016/2017.

7. Community Partners

The organizing principle of the IfAME places it in direct contact with a wide variety of state and federal agencies, non-governmental organizations, universities, primary and secondary schools, high schools and other community groups. Below is representative list of the IfAME's many community partners:

State Agencies

California Coastal Conservancy
California Department of Fish and Game
California Governor's Office
California Ocean Protection Council
California Ocean Science Trust
California State Assembly
California State Senate
MPA Monitoring Enterprise

Federal Agencies

National Centers for Coastal Ocean Science
National Estuarine Research Reserves
National Park Service
NOAA Fisheries
Office of National Marine Sanctuaries
Office of Ocean Exploration and Research
US Geological Survey

International Agencies

Hamaarag – Israel's National Nature Assessment Program
South African Environmental Observation Network (SAEON)

Universities

Boston University
California State University (all 23 campuses via the CSU Council on Ocean Affairs, Science and Technology (COAST))

Hatfield marine Science Center of Oregon State University
Kelp Ecosystem Ecology Network (www.kelpecosystems.org)
Monterey Institute for International Studies
Monterey Peninsula College
Moss Landing Marine Labs
Naval Postgraduate School
Oregon State University
Rutgers University
Scripps Institute of Oceanography
University of California Davis
University of California Los Angeles
University of California San Diego
University of California Santa Barbara
University of California Santa Cruz
University of Cape Town (South Africa)
University of Connecticut
University of Haifa
University of Hawaii
University of Miami
University of Michigan
University of New Hampshire
University of North Carolina
University of Rhode Island
University of Southern California
University of South Florida
University of Tel Aviv
University of Victoria, Wellington
University of Washington
Washington State University
Woods Hole Oceanographic Institution

Non-Governmental Organizations

American Academy of Underwater Sciences
American Samoa Coral Reef Advisory Group
Center for Ocean Solutions
Communication Partnership for Science and the Sea (Nationwide)
Consortium for Ocean Science Education Excellence (COSEE)
Environmental Defense (Nationwide)
Institute for Broadening Participation

Marine Conservation Biology Institute (Redmond, WA)
Marine Conservation Science Institute (Fallbrook, CA)
Monterey Bay Aquarium (Monterey, CA)
Monterey Bay Aquarium Research Institute (Moss Landing, CA)
Monterey Bay Sanctuary Foundation (Monterey, CA)
MPA Collaborative Implementation Project
National Association of Black SCUBA Divers
National Marine Sanctuary Foundation (Silver Spring, MD)
Pfleger Institute for Environmental Research (Oceanside, CA)
Rotary International
Society for Advancement of Hispanics/Chicanos and Native Americans in Science
Skidaway Institute of Oceanography (Savannah, GA)
The Ocean Conservancy (Monterey offices and Worldwide)
The Ocean Futures Society (Nationwide)
The Nature Conservancy (Monterey offices and Worldwide)
Zooniverse

Primary, Secondary and High Schools

Carmel High School
Carmel Middle School
Carmel River School
Los Osos Junior High School
Monterey Peninsula High School
Morro Bay High School
San Luis Obispo High School
Santa Catalina High School

8. Publications

CSUMB Honors & Group Capstone Theses

Analysis of Current Public Knowledge of Marine Protected Areas in Monterey Bay and Suggestions for Education
Tiffany Barber, Amber Carvalho, Leoni Dickerhoff, Rachel Edwards, Elyssa Farmer, Amanda Fay, Belinda Gomez, Esther Haile, Kelly McNee, Hailee Miller, Ahalya Nalamothu, Katherine Neylan, Andrea Amor Perez, Justin Rader, Keila Terry, Sean Williams, and Matthew Wold ~Advisor: Dr. Kerry J Nickols

Designating the Chumash Heritage National Marine Sanctuary
A. Aceves, M. Alvarez, M. Berkowitz, M. Campos, E. Doyle, H. Dunn, D. Hensley, K. Johnson, L. Juarez, A. Leal, K. O'Husky, I. Thomas, N. Tran ~Advisor: Dr. James Lindholm

Do recent trends in geomorphic change in the Monterey submarine canyon head pose a threat to the coastal community?
Benitez, M, Howard B, Marcos, S, ~ Advisor: Rikk Kvitek

Effects of hypoxia on the copper rockfish (*Sebastes caurinus*) transcriptome
Paul Castro, Joe Casarez, Shannon Cornick, Emily Doyle, Emily King, Sara Bear Magallanes, Hope Martin, Diana Moreno, Judith Rutherford ~Advisor: Dr. Cheryl Logan

Habitat-Mediated Behaviors and Associations of Flatfish in Unconsolidated Sediment on the Continental Shelf off Central California
Burroughs KK, Daly AM, Eddy TA, Johnson KML, Mendez SA, Miller AM, Powell SK, Resnik JJ, Ruttan TM ~ Advisor: James Lindholm

Landscape ecology of near-shore biological communities along the California coast: results of SCUBA-based visual census surveys
Nicole Alvarado, Marc Berkowitz, Tyler Gerome, Robert Holbrook, Nicholas Knauss, Yerlany Mendez, Katherine Neylan, Zachary Nyquist, Nicholas Ta, and John Tench ~ Advisor: Dr. James Lindholm

Making Sense out of Dollars: Seeing Change over Time on the Sea Floor
Hunter Burnham, Jorge Chagoya, Carolyn Erickson, John Freutel, Madeleine Harris, Trevin Li, Jesse Ng, Lauren Powell, Jessamyn Weld, and Charnelle Wickliff ~Advisor: Dr. Steve Moore

Marine debris on sandy beaches of Monterey Bay, CA: A comparative study in time and space
Joshua Canepa, Joane Contawe, Jordan Duffner, Shannon Mone, Connor Rudd, and Bailey Warren ~Advisor: Dr. Kerry J. Nickols

The Sandy Bottom Project
Jesirae Collins -Advisor: Dr. Corey Garza

CSUMB Masters Theses

Lingcod (*Ophiodon elongatus*) habitat associations: Implications for Conservation and Management. Megan Bassett. ~ Advisor: Dr. James Lindholm

Large-Scale Patterns in Marine Fish Habitat Use as Determined from a Meta-Analysis of Acoustic Telemetry Studies. Allison Cramer. ~Advisor: Dr. James Lindholm

*Peer-Reviewed Publications (**Bold** indicates Student Authors)*

Smith, J. and J. Lindholm. *In Press*. Vertical stratification in the distribution of demersal fishes along the walls of the La Jolla and Scripps submarine canyons, California, USA. Continental Shelf Research.

Hammed, S., J.W. White, S.H. Miller, K.J. Nickols, and S.G. Morgan. *In press*. Inverse approach to estimating larval dispersal reveals limited population connectivity along 700 km of wave-swept open coast. Proceedings of the Royal Society B.

Druehl, L. and Clarkston, B.E. 2016. Pacific Seaweeds: A Guide to Common Seaweeds of the West Coast. Harbour Publishing. 320 pp.

Clarkson, B.E. 2015. A Field Guide to Seaweeds of the Pacific Northwest. Harbour Publishing.

Garza, C. 2016. Landscape complexity effects on fisheries: Insights from marine landscape ecology. Current Landscape Ecology Reports. Special Issue: Interaction of landscape structure and natural resource management. DOI: 10.1007/s40823-016-0003-z.

Garza, C. 2015. Reaching out to underserved communities. Marine Technology Society Journal. Special Issue, Blue Futures: Educating the Next Generation, 49 (4): 8-12.

Takesita, Y, Frieder CA, Martz TR, Ballard JR, Feely RA, Kram S, Nam S, **Navarro MO**, Price NN, Smith JE. 2015. Including high frequency variability in coastal ocean acidification projections. Biogeosciences, 12:5853-5870

Port, J.A., J.L. O'Donnell, O.C. Romero-Maraccini, P.R. Leary, S.Y. Litvin, K.J. Nickols, K.M. Yamahara, and R.P. Kelly. 2016. Assessing vertebrate biodiversity in a kelp forect ecosystem using environmental DNA. Molecular Ecology 25: 527-541.

9. Future Activities

The unified IfAME is offering CSUMB students unparalleled research opportunities linked directly to their Marine Science degree program, including research assistantships and internships working at the cutting edge of the science-policy interface. The IfAME also serves to anchor the Marine Science Curriculum through rigorous course-based research activities that engages all marine science students directly in research and outreach efforts with the many state and federal partners in the larger Monterey Bay region. Importantly, this engagement occurs through a linked curriculum offering Freshmen through Seniors training in sophisticated research and policy analyses that are “scaffolded” at every step by courses they have already taken at CSUMB. In addition to the continuation of the projects described above, in the 2016/2017 academic year the faculty, staff and students of the IfAME will be actively developing new projects in the region, across the state and the nation, and around the world. Stay tuned!