Western Society of Naturalists
Meeting Program

Western Society of Naturalists
Tacoma, WA
2014

Tacoma, WA
Nov. 13-16, 2014
95TH ANNUAL MEETING
NOVEMBER 13-16, 2014
IN TACOMA, WASHINGTON

Registration and Information
Welcome! The registration desk will be open Thurs 1600-2000, Fri-Sat 0730-1800, and Sun 0800-1000. Registration packets will be available at the registration table for those members who have pre-registered. Those who have not pre-registered but wish to attend the meeting can pay for membership and registration (with a $20 late fee) at the registration table.

Unfortunately, banquet tickets cannot be sold at the meeting because the hotel requires final counts of attendees well in advance. The Attitude Adjustment Hour (AAH) is included in the registration price, so you will only need to show your badge for admittance. WSN t-shirts and other merchandise can be purchased or picked up at the WSN Student Committee table.

A partial list of restaurants near the Murano Hotel can be found at the end of the program.

Continuing This Year!
In addition to all the traditional WSN special events (see the schedule!), the dance immediately following the auction on Saturday night (so probably starting ~11 pm) is back by popular demand! The Student Committee will provide music. A cash bar will be available from 10 PM – 12 AM, and the dance floor will be open until midnight.

Thanks to Student Travel Fund Donors
We’d like to thank all of you who made donations to the Student Travel Fund when you registered; those funds are greatly appreciated by our many student members. Thanks to all!
SCHEDULE OF EVENTS

THURSDAY, NOVEMBER 13, 2014
2030  BENEATH THE WAVES FILM FESTIVAL and MIXER (Pavilion AGD)
     Open to all WSN Members

FRIDAY, NOVEMBER 14, 2014
0820-1200  STUDENT SYMPOSIUM (Pavilion AGD)
             CONSERVATION IN THE ANTRHOPOCENE: BALANCING NATURE AND
             HUMAN NEEDS
1200-1300  LUNCH
1300-1800  CONTRIBUTED PAPERS (Pavilion A, B, C, D, E, F)
1830-2200  WSN POSTER SESSION (Venice Ballroom)
1900-2200  ATTITUDE ADJUSTMENT HOUR (AAH) (Venice Ballroom)

SATURDAY, NOVEMBER 15, 2014
0820-1115  PRESIDENTIAL SYMPOSIUM (Pavilion AGD)
             CHALLENGES BOUNDING TRADITIONAL MARINE ECOLOGY
1115      AWARDING OF LIFETIME ACHIEVEMENT AWARD (by Corey Garza)
1130      AWARDING OF NATURALIST OF THE YEAR AWARD (by Mark Carr)
1135      WSN NATURALIST OF THE YEAR (Steve Lonhart)
1200-1300  LUNCH
1300-1800  CONTRIBUTED PAPERS (Pavilion A, B, C, D, E, F)
1830-1930  ANNUAL BUSINESS MEETING (Pavilion C)
2000-2200  PRESIDENTIAL BANQUET (Pavilion AGD)
2200-2300  WSN AUCTION (Pavilion AGD)

SUNDAY, NOVEMBER 16, 2014
0930-1130  CONTRIBUTED PAPERS (Pavilion A, B, C, D, E, F)
1200-1250  PLENARY SPEAKER (Pavilion AGD)
             Dr. Daniel Pauly
1250-1300  BEST STUDENT PAPER/POSTER AWARDS ANNOUNCEMENT
1300-1400  COWBOY BBQ LUNCH (Rotunda, Pavilion CF)
THURSDAY, NOVEMBER 13, 2014

BENEATH THE WAVES FILM FESTIVAL and MIXER (2030-2230)  PAVILION AGD

The Beneath the Waves Film Festival aims to encourage, inspire, and educate scientists, advocates, and the general public to produce and promote open-access, engaging marine-issue documentaries. Our goal is to facilitate widespread science communication by bringing together marine films from around the world for open discussion, while also providing hands-on educational opportunities for researchers interested in film and media outreach.

www.beneaththewavesfilmfest.org

2030 FIRST SESSION

Shadow Reef (5 min., Elke Specker)
Stress Physiology of Sharks in Fishing (4 min., Christine Shepard)
Sponges of the Caribbean: What ecological factors affect them most (3 min., Joseph Pawlik)
Ecosystem Science: Facing Tradeoffs in Ocean Management (4 min., Phil Levin)
Oceans: A Silent World (8 min., Marta Bolgan)
Postcard from the Oregon Coast (6 min., Trip Jennings)
A Tale of Two Urchins (3 min., Sofia Castello y Tickell & colleagues)
Harbor Heroes: Little Oysters in the Big Apple (10 min., Jaclyn Yeary)

2115 Intermission (15 min)

2130 SECOND SESSION

The Immigrant (3 min., Omar Malik & colleagues)
Plate Tectonics (8 min., Dorota Szuta & Christine Mann)
Pinto Abalone Restoration (2 min., Paul Hillman)
The Reef (10 min., Jessica Hamel)
Harbor Seal Monitoring in Puget Sound (4 min., Paul Hillman & Tata Smithee)
Two Fish (8 min., Sarah Curry)
Michael and the Peppermints (8 min., Michael Crandall & Chelsey Crandall)
FRIDAY, NOVEMBER 14, 2014

STUDENT SYMPOSIUM (0820-1200)  PAVILION AGD

CONSERVATION IN THE ANTHROPOCENE: BALANCING NATURE AND HUMAN NEEDS

0820  INTRODUCTION AND ANNOUNCEMENTS (Jenn Burt)

0830  Michael Soulé, University of California, Santa Cruz
THE ANTHROPOCENE: ARE KEYSTONE SPECIES DOOMED?

0900  Patrick Christie, University of Washington
TOWARD A NEW PARADIGM OF OCEAN SUSTAINABILITY SCIENCE: EVOLUTION (AND RESISTANCE)

0930  Katie Arkema, The Natural Capital Project, Stanford University
SCIENCE IN THE SERVICE OF PEOPLE AND NATURE

1000  BREAK

1030  Peter Kareiva, The Nature Conservancy
NATURAL HISTORY AND CONSERVATION IN THE 21ST CENTURY

1100-1200  PANEL DISCUSSION

1200-1300  LUNCH
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<td>† Anderson, KM FUTURE LEVELS OF CO2 AND TEMP IMPACT AN ALGAL-HERBIVORE INTERACTION VIA CHANGES IN HERBIVORE POPULATION SIZE</td>
<td>† Howard, B LARVAL DISTRIBUTION OF INVASIVE EUROPEAN GREEN CRAB IN BARKLEY SOUND, BRITISH COLUMBIA</td>
<td>Johnsen, AM SEA STAR WASTING ALONG THE OREGON COAST: TIME COURSE OF THE EPIDEMIC</td>
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<td>† Larson, WA SIGNALS OF HETEROGENOUS SELECTION AT AN MHC LOCUS IN GEOGRAPHICALLY PROXIMATE ECOTYPES OF Sockeye SALMON</td>
<td>† Tanner, RL CORRELATING SECONDARY PRODUCTIVITY AND HABITAT COMPOSITION OF EELGRASS BEDS IN A SOUTHERN CALIFORNIA MPA</td>
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<td>† Brown, NE ECOLOGICAL RESPONSES TO ASCIDIAN INVASION AND OCEAN ACIDIFICATION BY MARINE FOLLUING COMMUNITIES</td>
<td>† McQuinn, LL MUSSEL RECRUITMENT AND THERMOTOLERANCE ACROSS AN UPWELLING CYCLE</td>
<td>† Sullivan, JM A CLOSER LOOK AT SEA STAR WASTING SYNDROME: OBSERVATIONS AT SMALL SIZE CLASSES AND POTENTIAL FOR RECOVERY</td>
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<td>† Hargarten, HL ECOLOGICAL DIVERGENCE BETWEEN PHENOTYPIC MORPHS OF GIANT KELP</td>
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<td>† Carvalho, PG EFFECTIVENESS OF PERIODICALLY HARVESTED CLOSURES IN MEETING FISHERIES AND CULTURAL OBJECTIVES</td>
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USING STABLE ISOTOPES OF SPERM WHALES TO INVESTIGATE EFFECTS OF THE EL NIÑO SOUTHERN OSCILLATION ON A MESOPELAGIC FOOD WEB IN PERU
SATURDAY, NOVEMBER 15, 2014

PRESIDENTIAL SYMPOSIUM (0820-1115) PAVILION AGD

CHALLENGES BOUNDING TRADITIONAL MARINE ECOLOGY

0820  INTRODUCTION (Steven Morgan)

0830  Andrew Whitehead, University of California, Davis
GENOME FUNCTION AND EVOLUTION RESPONSE TO NATURAL AND ANTHROPOGENIC STRESS

0905  Claire Paris, University of Miami
THE ODYSSEY OF MARINE LARVAE: NEW INSIGHTS ON THE BEHAVIORAL CONTROL ON LARVAL RECRUITMENT

0940  Dustin Marshall, Monash University
MARINE LIFE HISTORIES: TODAY AND TOMORROW

1015  BREAK

1040  Amy Freestone, Temple University
GLOBAL BIODIVERSITY AND BIOINVASIONS: INSIGHTS FROM EXPERIMENTAL MACROECOLOGY

1115  AWARDING OF WSN LIFETIME ACHIEVEMENT AWARD (by Corey Garza)

1130  AWARDING OF NATURALIST OF THE YEAR AWARD (by Mark Carr)

1135  WSN NATURALIST OF THE YEAR (Steve Lonhart)

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<td>† Casey, JM FACILITATORS OF CORAL DISEASE: THE IMPACT OF TERRITORIAL DAMSELFISHES ON BENTHIC MICROBIAL COMMUNITIES</td>
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| 1315  | Miner, BG INFECTIOUSNESS OF SEA STAR WASTING DISEASE |
| 1330  | † Abbott, JM ARE FUNCTIONAL TRAIT DIFFERENCES CORRELATED WITH RELATEDNESS IN EELGRASS GENOTYPES? |
| 1345  | † Jeffries, SV BIOMASS AFFECTS SEXUAL REPRODUCTION OF TWO RECENTLY SYNONYMOIZED MORPHOLOGIES OF M. PYRIFERA IN CA |
| 1400  | Berumen, ML DEMOGRAPHIC AND EVOLUTIONARY CONNECTIVITY PATTERNS IN RED SEA CORAL REEF FAUNA |
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|       | Shelton, AO HISTORICAL TRENDS AND DRIVERS OF NEARSHORE VEGETATED HABITATS: 40 YEARS OF EELGRASS AND KELP IN THE SALISH SEA (1972-2012) |
|       | Tapia, FJ GENE EXPRESSION PATTERNS ACROSS AN OCEANOGRAPHIC DISCONTINUITY IN CENTRAL-NORTHERN CHILE |
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SUNDAY, NOVEMBER 16, 2014

PLENARY SPEAKER (1200-1300) Pavilion AGD

**IMPACTS OF FISHERIES AND GLOBAL WARMING ON MARINE ECOSYSTEMS**

1200  **Daniel Pauly** (University of British Columbia)

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ABSTRACTS
Student Symposium

Soulé, M.*
THE ANTHROPOCENE: ARE KEYSTONE SPECIES DOOMED?
*University of California, Santa Cruz
The “anthropocene” is a hypothetical episode during which the worth of biological diversity is measured mostly by economists, not poets, artists and naturalists. This trend represents a negation of humanity’s ethical compass. It symbolizes our failure to feel the beauty of wild, the worth of undominated things. I know that many of you still have the capacity to feel and act compassionately toward the controversial, inconvenient, and weaker ones including the keystone species that keep ecological systems from dis-integrating. These keystone species, like prairie dogs, beavers, coyotes, cougars and wolves, still hang on by their teeth and claws. It isn’t inevitable that civilization will usurp all of the remaining wild, productive habitats. It isn’t inevitable that all the nooks and crannies where wildness and wild creatures persist will be crushed by ATVs or other gas toys. Enough wildness and beauty remain to reanimate the world, if we love it enough. It is still possible.

Christie, P.*
TOWARD A NEW PARADIGM OF OCEAN SUSTAINABILITY SCIENCE: EVOLUTION (AND RESISTANCE)
*School of Marine and Environmental Affairs and Jackson School of International Studies, University of Washington
Society does not have a sustainable relationship with the ocean. This has serious consequences for ecosystems and vulnerable human populations. While misanthropy, disillusionment, and draconian ‘solutions’ are common, there are many positive examples of successful, equitable science-activism-policy partnerships. An emergent generation of researchers, activists, and policy makers has identified, with experimentation and approximately one decade of empirical social-ecological science in dozens of countries, many of the elements that result in effective marine resource management and sustainability programs. In the global South, the majority of sustainability programs—that are driven by the global North, ecological (and not social) scientific knowledge, and external/temporary funding—do not exhibit many of the factors associated with long-term success. In the North, reliance mainly on command and control management has clear limitations. In short, there is a need for a new, complementary paradigm for ocean environmental management and science. Innovation is leading to exciting demand-driven sustainability programs based on interdisciplinary social-ecological research and program monitoring, capacity development through learning networks, social movements, participatory planning, and environmental justice. The external, scientific expert has a role to play as student, facilitator and mentor, but should be reluctant to determine priorities and create dependencies. Vested interests resist change.

Arkema, K.*
SCIENCE IN THE SERVICE OF PEOPLE AND NATURE
*The Natural Capital Project, Stanford University
Popular press and recent surveys suggest the environmental movement is dead. Yet, governments, multi-lateral investment banks, and corporations in the U.S. and around the world want information about human-environment interactions to guide their resource management, conservation and development decisions. This is an opportunity for scientists to articulate new and challenging research questions that require a diversity of disciplines and approaches. For example, recent advancements in our understanding of relationships between ecology, economics and human well-being are increasing our ability to quantify not only our impacts on the environment, but also how changes in ecosystems influence the benefits nature provides to people. While this concept of ecosystem services has been around for some time, its utility for informing “on-the-ground” decisions has rarely been tested, especially in marine environments. I will talk about several projects that tackle these issues, including marine spatial planning in Mozambique and Belize and natural defenses from coastal hazards in the United States. I will highlight opportunities for advancing the knowledge and uptake of human-environment relationships into decision-making.

Kareiva, P.*
NATURAL HISTORY AND CONSERVATION IN THE 21ST CENTURY
*The Nature Conservancy
Conservation science formed as an academic discipline in the mid-1980s with a focus on species biology, demography and population genetics. From these roots in population biology, the field has developed into a truly interdisciplinary enterprise that seeks to quantify the values nature offers to humanity and develop tools that can support decision making under complexity and uncertainty. Despite the now more interdisciplinary nature of conservation science, we have failed to address obvious and fundamental environmental problems that one might call “too big to handle” (such as climate change and antibiotic resistance). With what many feel is a global failure of governments around the world, the keys to saving nature may well be public and corporate behavior. While it may
not seem obvious—natural history can play a profound role in the next century of conservation—but it will not be
the abstract natural history of biodiversity mapping, but rather the in-depth natural history of plant and animal
interactions and struggles in the face of climate change and rampant human intrusions, and it will be the natural
history of the wild interacting with humans as never before. Now is the most exciting time ever to be a conservation
scientist because so much is possible given the data and technology and awareness available, and yet so much is
on the cusp of being lost—both spiritually and materially depending on the choices.
Whitehead, A.*
GENOME FUNCTION AND EVOLUTION IN A CHANGING ENVIRONMENT
University of California, Davis
Marine organisms increasingly face the challenge of rapid environmental change in many dimensions including temperature, pH, dissolved oxygen, and salinity variability. Persistence in future environments will require a combination of strategies including migration, acclimation, and evolutionary adaptation. Phenotypic flexibility can quickly enable individual resilience to changing environments, whereas evolutionary adaptation may enable rescue of populations over longer time periods. This acclimation and adaptation potential is encoded within the genomes of individuals (flexibility-enabling mechanisms) and of populations (adaptive mutations). Genomics technologies thereby offer insight into the mechanisms that enable phenotypic flexibility, and into the genetic variants that may be adaptive for future environments. Genomics technologies are becoming increasingly accessible to a broader research community, thereby facilitating study of genome function and evolution in diverse species, including those of greatest ecological and economic importance. Examples will be discussed from a diversity of marine organisms, with particular emphasis on killifish, about how comparative transcriptomics and population genomics are offering insights into the complex ways in which genomes function and evolve to enable persistence in changing environments.

Paris, C.B.*
The Odyssey of Marine Larvae: new insights on the behavioral control on larval recruitment
Rosenstiel School of Marine and Atmospheric Science, University of Miami
Within just the past two decades, studies focusing on the early-life history stages of marine organisms have led to new paradigms in population dynamics. Marine larvae have a tremendous capacity to actively influence their dispersal. This is continuously revealed as we develop new techniques to observe larvae in their natural environment. Motor and sensory capabilities are present in post-hatch larvae and continue to develop throughout the pelagic period. Unlike plant seeds that are transported at the pure mercy of winds, marine larvae process ambient ocean signals. Understanding their ability to detect and use such information holds the key to their journey back home, or to new suitable settlement habitat. Here I will discuss how directed swimming, guided by a series of diverse cues found in the pelagic environment, affects larval recruitment and ultimately population connectivity. I will present innovative in situ and theoretical approaches developed to better describe dispersal kernels and to understand the underlying mechanisms of larval dispersal. These methodologies are already the base of exciting findings and are promising tools for documenting the behavior of other small pelagic organisms into the future.

Marshall, D.*
MARINE LIFE HISTORIES: TODAY AND TOMORROW
Monash University
Marine life histories are complex and complicated. We’ve been studying them for over 100 years, and our understanding of them has increased but fundamental challenges remain. Here, I will explore what we know about marine life histories, what we think we know and what we really don’t know. I will provide my own view on what are the most important obstacles to a better understanding of marine life histories and where fruitful paths of research may lie.

Freestone, A.L.*
GLOBAL BIODIVERSITY AND BIOINVASIONS: INSIGHTS FROM EXPERIMENTAL MACROECOLOGY
Temple University
One of the clearest patterns in ecology is the latitudinal diversity gradient whereby species richness increases toward the equator in most taxonomic groups. While the origin of the latitudinal diversity gradient is likely evolutionary in nature, ecological studies can elucidate the processes that maintain global patterns of biodiversity in contemporary time. Large gaps remain in our understanding of these processes, however. For example, the striking and predictable difference in species richness across latitude raises the question of whether the relative influences of ecological processes are independent of latitude or if processes—like the patterns of species richness they maintain—change predictably across the globe. Through the emerging field of experimental macroecology, with studies that employ standardized experiments across large spatial scales, we are now well positioned to address these questions. I will draw from terrestrial and marine examples and my own research on coastal marine invertebrate assemblages of North and Central America to demonstrate that community processes can differ between tropical and temperate regions, and these differences have important consequences for patterns of biodiversity. I will then build on these insights to develop a framework for improved understanding of global patterns of biological invasions, a primary driver of global change.
Invited Plenary Speaker

Pauly, D.*
IMPACTS OF FISHERIES AND GLOBAL WARMING IN MARINE ECOSYSTEMS
The period following the Second World War saw a massive increase in fishing effort, particularly in the 1960s. However, crashes due to this overfishing began to be reflected in global catch trends in the 1970s, and intensified in the 1980s and 1990s. In response, the industrialized countries of the Northern Hemisphere (where overfishing-induced catch declines appeared first) moved their effort toward deeper waters, and toward the south, i.e., to the coasts off developing countries, and beyond into the southern hemisphere, all the way to Antarctica. Now, in the second decade of the 21st century, the global expansion of fisheries is completed, and global catch, which peaked in the late 1980s, continues to decline. In parallel, the collateral damage to marine ecosystems and biodiversity continues to increase. Several factors act to prevent the public in developed countries from realizing the depth of the crisis fisheries are in, notably the increased imports by developed countries, of seafood from developing countries. Also, the misleading perception that aquaculture can substitute for declining catches is widespread. In some countries, notably the US, stocks are being rebuild, but elsewhere, the failure to respond creatively to these clear trends bode ill for the next decades will become more pronounced. Indeed, the effects of global warming (productivity declines in the tropics, widespread disruptions at high latitudes), which have been increasingly felt in the last decades, will strongly impact fisheries and global seafood supply.
**Contributed Talks**  
* indicates presenting author  
† indicates eligibility for Best Student Paper/Poster Award

**Aalto, E.A.*, De Leo, G.A.**  
VARIABLE SEX RATIO CAN ALLOW LOCAL ADAPTATION IN A PANMICTIC SPECIES  
*Hopkins Marine Station of Stanford University*  
The European eel *Anguilla anguilla* has a semelparous panmictic lifecycle with multiple juvenile populations in lagoons across Europe and Northern Africa but a single annual breeding migration to the Sargasso Sea. Although nursery habitat conditions can vary dramatically, local adaptation is hindered by the high gene flow from panmictic breeding. However, returning juveniles are undifferentiated sexually with final determination based on the lagoon environment. Choice of sex can thus potentially act as a form of local adaptation given sex-dependent juvenile survival rates that differ between lagoons. To explore this dynamic, we developed a discrete 2-patch population model with variable degrees of panmixia and sex ratio plasticity. We found that with primarily local breeding, the optimal sex ratio was biased towards the sex with lowest survival to maintain the optimal 1:1 ratio. However, as the degree of panmixia increased the bias shifted to favor the sex with highest survival because the symmetrically skewed local populations combined into a single balanced global breeding population. These results suggest that when juvenile survival is sex-dependent and varies spatially, sex determination based on local factors can act as an alternate form of local adaptation when global breeding precludes local genetic adaptation.

† **Abbott, J.M.*, DuBois, K., Williams, S.L., Stachowicz, J.J.**  
ARE FUNCTIONAL TRAIT DIFFERENCES CORRELATED WITH RELATEDNESS IN EELGRASS GENOTYPES?  
*Bodega Marine Laboratory, University of California, Davis*  
Biodiversity and ecosystem function are often linked because species richness is correlated with the functional trait diversity of the community, which in turn affects the productivity and stability of the community through niche partitioning and complementarity. However, species richness is a crude metric of functional diversity, and recently there has been an increased interest in using phylogenetic distance as a proxy for ecological trait distance. While the same principles should apply at the population level with interacting individuals of the same species, few studies have explored using genetic relatedness as a proxy for trait differentiation within species. Here we explicitly test the relationship between genetic relatedness and trait distance using 40 eelgrass (*Zostera marina*) genotypes. We measured traits related to nutrient uptake, morphology, biomass and growth, photosynthesis, and chemical defences for all genotypes. We used these trait measurements to calculate a multivariate pairwise trait distance for all possible genotype combinations. We then examined the relationship between trait distance and pairwise relatedness estimated from 11 microsatellite markers. We found significant trait variation among genotypes for nearly every measured trait. Surprisingly, we found no evidence of a significant correlation between genetic relatedness and multivariate trait distance. This pattern was true for individual traits as well. Our work suggests that while relatedness may be a poor proxy for trait differentiation between genotypes, it may still influence intraspecific interactions.

**Allen, B.J.*, Bourdeau, P.E.*, Miller, L.P.*, Denny, M.W.**  
PREDICTING ECOLOGICAL CONSEQUENCES OF INCREASING TEMPERATURE VARIABILITY: MATCHING DATA WITH THEORY  
1 - California State University, Long Beach, 2 - Hopkins Marine Station of Stanford University  
Increasing temperature variability is likely to be an important biological disturbance over the next few decades, as it increases the risk that species’ tolerance limits will be exceeded. In response to thermal stress, many organisms exhibit characteristic physiological changes that increase tolerance to subsequent high temperatures. The activation of this so-called “heat shock response” requires, however, a significant energetic investment. In addition to positive effects on survival, heat shock responses may involve large sublethal effects that include reduced growth or reproduction due to energetic trade-offs between competing life history traits. Although there is growing recognition that stress may have important implications for population persistence and species interactions in the face of global climate change, we still lack a general framework for understanding how increasing temperature variation will influence the relative size of sublethal versus lethal thermal effects in natural ecosystems. That said, theoretical approaches that have worked in other ecological contexts (e.g., optimal behavioral and morphological prey responses to predator risk) might be successfully modified to provide predictions about thermal stress as well. We present several such models, highlighting their potential to guide the development of rigorous hypotheses and associated predictions for how organisms might respond to increasing environmental temperatures.

A CHEATER AND CHEMICAL DEFENSE THIEF IN A MUTUALISM BETWEEN ANTARCTIC MACROALGAE AND AMPHIPODS: PARTIAL DRIVER OF CHEMODIVERSITY?

† Anderson, E.S.¹*, Waltz, G.T.¹, Nakamura, R.¹, Ruttenberg, B.I.¹, Starr, R.M.², Wendt, D.E.¹

THE EFFECT OF MARINE PROTECTED AREAS ON THE TROPHIC INTERACTIONS OF NEARSHORE GROUND FISH

1 - Cal Poly Center for Coastal Marine Sciences; 2 - California Sea Grant Extension Program, Moss Landing Marine Laboratories

Marine Protected Areas (MPAs) are a management tool employed throughout coastal California to protect fish stocks and buffer against fishing pressure. Nearshore groundfish populations in MPAs and adjacent reference sites have been continuously monitored since the MPA network installation in 2007. Catch-per-unit-effort (CPUE) of Lingcod (Ophiodon elongatus), has increased inside the Point Buchon State Marine Reserve (SMR) from 2007 through 2013. However, the CPUE of Lingcod in the Point Buchon reference site has not shown a significant increase over this time period. Prey species of Lingcod, such as the Gopher Rockfish (Sebastes carnatus), have shown significant decreases in CPUE during this time period in both the Point Buchon SMR and reference site. This may suggest that Lingcod predation limits the benefits of MPAs for lower trophic level species, such as Rockfish. Stomach contents obtained from Lingcod in 2013 and 2014 suggest that Lingcod consume more Rockfish and less octopus in the Point Buchon SMR compared to the reference site. In addition to the lack of fishing pressure, Lingcod in the Point Buchon SMR may benefit from a more nutritious diet, composed of more Rockfish compared to Lingcod in the reference site, which are eating mostly octopus.

† Anderson, K.M.¹*, Heldt, K.A.¹, Harley, C.D.G.¹, Munguia, P.², Russell, B.D.², Connell, S.D.²

FUTURE LEVELS OF CO2 AND TEMPERATURE IMPACT AN ALGAL-HERBIVORE INTERACTION VIA CHANGES IN HERBIVORE POPULATION SIZE

1 - University of British Columbia, 2 - University of Adelaide

Herbivores have the potential to maintain biodiversity and regulate primary productivity. These interactions may be greatly affected by changes in individual feeding rates and overall herbivore population size. Similarly, changes in primary producer palatability may mediate the top-down pressure exerted by herbivore populations. There is reason to expect both of these processes may be influenced by increases in ocean temperature and/or carbon dioxide associated with climate change. Using a mesocosm experiment spanning several generations of amphipod populations, we established that a strong combined effect of elevated CO2 and temperature drove a near doubling in overall herbivory on palatable turf algae. This increase in herbivory resulted from an increase in population size and biomass. While temperature had a negative impact on per capita herbivore feeding rates and CO2 a negative impact on algal palatability, when both algal and herbivores were simultaneously exposed to projected future levels of both variables, there was no overall effect of either temperature, CO2, or their combination on individual feeding rates. In this plant-herbivore system, the impacts of climate change on population size overshadow minimal changes in per capita level interaction strength.

Anderson, S.S.¹,²*, Steele, C.L.², Rodriguez, D.², O’Hirok, L.², Lambrinos, J.³, Anderson, S.S.², Anderson, G.D.⁴

THE NATURAL HISTORY AND MANAGEMENT OF SANDY BEACHES

1 - Pacific Institute for Restoration Ecology, 2 - California State University, Channel Islands, 3 - Oregon State University, 4 - Oaks Christian Middle School

We explored 40 sandy beaches across California and the Pacific in 2014 to finalize our Sandy Beach Rapid Assessment Synoptic Survey (SBRASS) protocol. SBRASS assesses ecological (e.g. parasites, infauna, avifauna, flora, fecal indicator bacteria), geomorphological (e.g. beach profile, grain size, groins), landscape (e.g.
fragmentation, land use, watershed size), and anthropogenic (density of people, dogs, parking spaces, corvids & gulls) variables and appears to be a useful rapid assessment tool (equivalent to an EPA Tier II protocol). Human density, shorebird abundance, sand crab abundance, Acanthocephala prevalence, slope, and fecal indicator bacteria are most strongly correlated, suggesting short field sampling events (1-2 hours) may be sufficient to characterize the condition of a given beach. Our longitudinal survey (2005-2014) of opinions and behaviors surrounding sandy beaches is supplementing this field work by helping us better understand how the public value these ecosystems. Beaches are the single most visited natural area among coastal residents (visited 6x more than the next most popular location), with clear preferences for the type of beach most valued. Crowding, ease of parking and access drive a four-fold preference between beaches. Degraded beaches have lower value, with grooming and depauperate wildlife significantly reducing desirability (60, 30% less popular, respectively).

ESA-LISTED ROCKFISH IN PUGET SOUND, WA: COOPERATIVE RESEARCH TO HELP MANAGE THESE POPULATIONS
1 - NOAA’s Northwest Fisheries Science Center, 2 - NOAA’s Western Regional Office
Yelloweye rockfish Sebastes ruberrimus, canary rockfish Sebastes pinniger, and bocaccio Sebastes paucispinis populations in Puget Sound, WA were listed on the endangered species list in 2010. These listings were based on two primary reasons. First, population estimates suggested large decreases in these species’ abundance over the last 50+ years, and genetic evidence suggested that rockfish populations in Puget Sound are likely isolated from coastal populations and thus constitute a distinct population segment. However, much of the data used to list these species came from other rockfish species with similar life histories. In order to collect new information on these species, we are collaborating with local recreational charter boat captains and experienced anglers to collect biological, genetic and contaminant information from these species. The primary objectives are to determine whether ESA-listed Puget Sound rockfish populations are genetically similar to or distinct from their respective coastal populations and to create working relationships with the recreational fishing community in order to develop sustainable management practices. Data collection is still ongoing, but we will present biological data collected to date and experiences with the recreational fishing community.

† Artim, J.M., Sikkel, P.C.
A COMPARISON OF TRAP DESIGNS FOR ESTIMATING ABUNDANCE OF FISH-PARASITIC GNATHIID ISOPODS
Arkansas State University
Small mobile invertebrates are an important component of marine ecosystems. "Demersal zooplankton" are the mobile invertebrates found in and around benthic substrates. Diel activity patterns and abundance of these organisms have been quantified using a variety of trap designs including emergence, baited, and light traps. Estimates obtained from traps likely reflect unknown biases introduced by the trap design when combined with the organism’s sensory biology and behavior. Gnathiid isopods, a common component of demersal plankton community, are temporary blood parasites of coral reef fish. Studies of gnathiid abundance have relied on the same trap designs used to study other demersal zooplankton. In this study we compared the effectiveness of several trap designs. Our results indicate that gnathiids are strongly attracted to light sources at night regardless of lifecycle stage, but are attracted to host-fish baited traps only when searching for a blood meal. By comparing counts from various trap types, we estimated nightly emergence rate and gnathiid population density for one site and one substrate type. We discuss extensions of this work needed to refine these estimates in both space and time. Ultimately, we will use these results to calibrate traps for quantitative assessment of gnathiid parasite community interactions.

† Barnes, C.L., Starr, R.M., Harvey, J.T., Hamilton, S.L., Reilly, P.N.
REPRODUCTIVE BIOLOGY OF CALIFORNIA HALIBUT (PARALICHTHYX CALIFORNICUS): RESULTS FROM THE CENTRAL COAST
1 - Moss Landing Marine Laboratories, 2 - California Department of Fish and Wildlife
A clear understanding of the reproductive biology of harvested species is critical for effective management. However, financial and logistical limitations often prevent extensive data collection. In 2011, the California Department of Fish and Wildlife conducted its first stock assessment for California Halibut (Paralichthys californicus). However, limited life history data were available for incorporation into stock assessment models. In an effort to reduce data deficiencies surrounding the reproductive biology of California Halibut, 704 fish (261 male, 443 female) were collected from recreational anglers, commercial fishermen, and seafood processors throughout central California. Specimens from each of the five harbors sampled were measured, weighed, sexed, and placed on ice until further processing. Where possible, maturity stages were assigned macroscopically and validated via histology. Gonads and livers were weighed to calculate gonadosomatic and hepatosomatic indices (i.e., GSI and HSI), respectively. GSI, HSI, and the biweekly spawning fraction (used as a proxy for spawning frequency) were
evaluated throughout the sampling period. Batch fecundity was determined by combining oocyte size frequency distributions, the gravimetric method, and autodiamic techniques. Rates of atresia were calculated from histological slides and combined with spawning frequency, the duration of the summer spawning season, and batch fecundity to provide an estimate of realized annual fecundity for this heterochronal species. Because 2012 and 2013 resulted in different spawning patterns, intra-annual growth was measured from thin-sectioned otoliths and analyzed along with corresponding environmental data (e.g., temperature, photoperiod) to gain insight into how California Halibut life history parameters respond to exogenous factors. Synthesized data from this work not only enhances our understanding of California Halibut life history, but also provides essential information for use in future stock assessments.

† Barnett, L.A.K.*, Baskett, M.L.
MARINE RESERVES CAN ENHANCE ECOLOGICAL RESILIENCE
University of California, Davis

One goal of ecosystem-based management (EBM) is to protect ecological resilience, the magnitude of a perturbation that a community can withstand and remain in a given state. Although marine reserves have been proposed as a component of EBM that may enhance resilience and thereby reduce the likelihood of undesirable regime shifts, this has yet to be quantitatively tested. Here we test whether reserves can increase ecological resilience compared to conventional fishery management using a dynamic model of a simplified rockfish community with structured predation and competition that can generate alternative stable states. Relative to conventional fishery management, reserves increased the range of initial predator densities that result in reaching the desired (predator-dominated) equilibrium state, thus enhancing resilience. Systems degraded to the undesirable (competitor-dominated) state may be most effectively restored to the preferred state by a combination of reserves and culling of competitors or stock enhancement of adult predators.

† Barry, S.N.*, Crow, K.D.
HOX GENE EXPRESSION IN THE DEVELOPING PELVIC FINS AND CLASPERS OF THE LITTLE SKATE, LEUCORAJA ERINACEA
San Francisco State University

Hox genes are considered master regulatory genes that specify organs and appendages during animal development. In early development, expression of Hox genes set up an address system specifying the anteroposterior axis. In vertebrates, limbs develop at later stages and are patterned by the HoxA and HoxD genes during forelimb and hind-limb budding and growth, as well as the specification of digits. In fishes, these same genes are expressed during fin development, yet relatively little is known about development of pelvic fins and differences in Hox expression that may be associated with novel fin modifications. In cartilaginous fishes, the pelvic fins of males are modified to form claspers, intermittent organs used for internal fertilization. By means of quantitative PCR and in situ hybridization we have found a significant difference in Hox gene expression between males and females during pelvic fin morphogenesis. Further, we have found strong expression of HoxA13, HoxD12 and HoxD13 in the claspers at different developmental stages. These results suggest that Hox genes are a contributing factor in clasper development and growth, and that Hox genes play a role in the sexual dimorphism of cartilaginous fishes.

Bayliss, S.L.*, terHorst, C.P.*, Lau, J.A.*
INTERACTIVE EFFECTS OF DISTURBANCE AND HERBIVORY ON BIOTIC RESISTANCE TO PLANT INVASION
1 - California State University, Northridge, 2 - Michigan State University

Understanding the factors that control invasion success is crucial in addressing economic and ecological impacts of biological invasions. In addition to studying which traits of the invader make it successful, it is also important to determine which properties make certain communities susceptible to invasion. Biotic resistance occurs when interactions among native species work to prevent the establishment or spread of an invader. We used a manipulative study to estimate the independent and interactive effects of two proposed biotic resistance components, herbivory by insects and disturbed environments, on plant performance and traits of Medicago polymorpha. We set up a four-treatment, fully-crossed factorial design in which we manipulated the presence and absence of disturbance and of insect herbivores. As estimates of invasion success, we measured leaf damage, plant size (height) and fecundity (flower number). Disturbance had positive effects on size, and negative effects on leaf damage, but only in the presence of insects. Fecundity was positively affected by the removal of insects and by disturbance. The results suggest that disturbance and herbivory may be important interdependent factors in regulating invaders. Our work highlights the importance of considering complex interactions between biotic and abiotic factors when determining which communities are susceptible to invasion.

WHAT EARLY LIFE HISTORY TELLS US ABOUT RESTORATION SUCCESS IN OLYMPIA OYSTERS
Native Olympia oysters have been the subject of widespread restoration efforts across the west coast, including in Puget Sound. Ultimately, the goal of restoration is to establish populations that are self-sustaining or exporting new offspring. Predicting larval behaviors and settlement preferences can allow practitioners to design habitats, choose sites, and distribute restoration networks more effectively. The purpose of this study was to map the spatial and temporal distribution of oyster larvae and settlers in a bay in Puget Sound that has been the subject of restoration work over the past decade. From April through July 2013, we monitored the reproductive state of adults and the relative abundance and distribution of larvae and spatfall. Analyses are ongoing, although adult data indicate low reproductive synchrony and settler data reveal that juvenile oysters settled preferentially near adult oysters rather than across depths and locations. We will compare larval distribution data to determine if larvae are distributed throughout the area and are preferentially settling in optimal habitat, or if they remain in specific areas throughout the dispersal period. These results will be used to improve restoration efforts and to inform our upcoming studies of larval dispersal of this important ecosystem engineer throughout Puget Sound.

† Bell, T.W.*, Siegel, D.A.
TEMPORAL AND SPATIAL VARIABILITY IN THE PHOTOSYNTHETIC CONDITION OF GIANT KELP
University of California, Santa Barbara
Throughout the dominant range of giant kelp in California, nutrient and light conditions exhibit high spatial and temporal variability due to upwelling patterns and oceanographic climate. The photosynthetic condition (photosynthetic pigment concentrations, ratios, and nitrogen status) of giant kelp responds quickly to changes in these environmental conditions, with low light, high nutrient conditions increasing pigment to carbon ratios. Data on pigment and nutrient concentrations of giant kelp would allow researchers to better estimate the productivity of giant kelp, link the performance of kelp to environmental conditions, and explore a large number of other ecological questions. Giant kelp canopy extent and biomass have been quantified using remotely sensed data, however remote assessments of the photosynthetic condition of giant kelp have yet been made over broad scales. Here, we examine how pigment to carbon ratios change across a broad geographic range (San Diego to Santa Cruz, CA) and how the reflectance spectra of giant kelp blades show light on photosynthetic condition and productivity and their applicability to remote observations.

† Benkwitt, C.E.¹, Hixon, M.A.¹,²
EATING THE LION’S SHARE IN MULTIPLE HABITATS: WIDESPREAD ECOLOGICAL EFFECTS OF INVASIVE LIONFISH
1 - Oregon State University, 2 - University of Hawai‘i
Understanding the ecological effects of invasive species among different habitats is crucial to understand and effectively manage invasions. The lionfish is an invasive predator in the tropical western Atlantic that causes drastic reductions in the abundance and species richness of small native fish on coral reefs. However, the effects of lionfish in other habitats are largely unknown. We observed lionfish leaving patch reefs during twilight hours, suggesting that they may be foraging in the surrounding seagrass beds. To determine whether lionfish affect native fishes in the areas around coral patch reefs we conducted a manipulative field experiment, maintaining 8 reefs with low lionfish densities and 8 reefs with high lionfish densities. We then monitored native fish communities at varying distances from the reefs over the course of 8 weeks. As previously shown, there were significantly fewer native fish (density and richness) on high-lionfish reefs than low-lionfish reefs. There were also significantly fewer native fish on small natural and standardized habitat patches up to 35 m away from high-lionfish reefs than low-lionfish reefs. These results suggest that lionfish feed substantially in the habitats surrounding patch reefs and thus are having broader negative effects on native fish communities than previously documented.

† Benseman, S.A.*, Allen, L.G.
DISTRIBUTION AND GROWTH ESTIMATES OF YOUNG-OF-THE-YEAR GIANT SEA BASS, STEREOLEPIS GIGAS, OFF SOUTHERN CALIFORNIA
California State University, Northridge
Life history information on an ecologically, and once economically, important species such as the giant sea bass (Stereolepis gigas) is critical for the continued management of its fishery. Little is known about the life history of S. gigas due to the over exploitation of their fishery in the early 1900’s, and depressed populations have prevented any detailed research. The goal of this study is to fill in gaps in the early life history of the juvenile giant sea bass by 1) determining distribution and general ecology for the young-of-the-year of S. gigas in the wild, and 2) estimating their growth rates based on site aggregations and collections for otoliths analysis. Spawning aggregations during the summer months yield a larval duration of approximately 30-60 days, after which settlement should start to occur. SCUBA transects with video and laser measurements will be used to estimate cohort populations and sizes in the field. Collecting individuals for otolith analysis, to determine growth rates and planktonic larval duration, yields
for more accurate estimates of future populations for fisheries management policies. The early development is crucial for completing the life history of this endangered species and this study is a key component of their life history.

† Berchtold, A.E., Colborne, S.F., Longstaffe, F.J., Neff, B.D.
ECOMORPHOLOGICAL PATTERNS LINKING MORPHOLOGY AND DIET IN PUMPKINSEED SUNFISH
1 - Simon Fraser University, 2 - University of Western Ontario
Relationships between morphological traits and their ecological function frequently result in general patterns that are consistently observed within taxa. Across fishes, the field of ecomorphology has identified a number of morphological traits linked to foraging tactic. Here we examined the links between morphology and diet in pumpkinseed sunfish (Lepomis gibbosus) from three temperate freshwater lakes. We focused on morphological variation in pharyngeal jaw and gill raker structures, both involved with the processing of prey after capture, in relation to diet. Using stomach contents and stable isotope analysis we established resource use estimates on average for both populations and individual fish. Among our lakes as well as among individuals within lakes we observed that pharyngeal jaw size and gill raker spacing increased with the consumption of littoral prey (e.g. hard-shelled snails) relative to pelagic prey (e.g. zooplankton), but the morphological changes were greater for the pharyngeal jaws. Overall, the relationships we observed between morphology and foraging tactic were consistent with patterns observed for other fish species. Individual-level diet variation associated with morphology may result in phenotypic diversity within populations that has multiple ecological and evolutionary implications for these populations.

† Bernhardt, J.R.*, O’Connor, M.I.
FUNCTIONAL BASIS OF NUTRITIONAL DIVERSITY IN AQUATIC ECOSYSTEMS
University of British Columbia
Humans rely on food from aquatic ecosystems for protein and essential micronutrients such as vitamins and minerals. Indeed, consumption of seafood may combat ‘hidden hunger’, i.e., micronutrient deficiency, in many coastal communities. A primary challenge is to understand links between the functional composition of aquatic food webs and their ability to provide a diversity of nutrients essential to the human diet. In this study we test whether functional traits can predict species’ nutritional value to people. We analyzed published food composition data for several micronutrients, including iron, calcium, zinc and essential fatty acids for more than 400 edible aquatic species. We defined a species’ nutritional profile as its micronutrient content per 100 g of edible tissue. We found that key ecological traits such as body size and trophic position explain patterns in the nutritional profile of commonly consumed aquatic species. Further, species’ nutritional profiles vary along latitudinal gradients, indicating that local species assemblages may differ geographically in their ability to meet human nutritional demands. We conclude that the range and quantity of micronutrients in aquatic food webs can be considered an ecosystem function, predicted in part by species’ functional traits.

DEMOGRAPHIC AND EVOLUTIONARY CONNECTIVITY PATTERNS IN RED SEA CORAL REEF FAUNA
1 - King Abdullah University of Science and Technology, 2 - California Academy of Sciences, 3 - James Cook University, 4 - University of Florida, 5 - University of Hawai’i, 6 - Universidad Austral de Chile, 7 - University of Milano-Bicocca
Red Sea coral reefs were the destination of choice for many early natural historians, who quickly recognized the region as a biodiversity hotspot with high levels of endemism. Recent decades have seen an unfortunate decline in accessibility to many parts of the Red Sea, hindering efforts to study connectivity mechanisms that create and maintain distributions of Red Sea reef fauna. Here we present data from connectivity studies at both ecological (demographic) and evolutionary (phylogeographic) scales from the Arabian region. At demographic scales, genetic parentage analysis reveals unexpectedly low levels of self-recruitment that are potentially explained by a biophysical oceanographic model. Population genetic analyses provide some insight to the evolutionary history of some Red Sea reef fauna and the potential ecological barriers to larval dispersal in the region. A combination of molecular and morphological taxonomy has identified dozens of new species, including fishes and corals, indicating that endemism in the region may be underestimated. These studies collectively provide insight to connectivity at several scales within the Red Sea, with implications ranging from designing MPA networks to understanding mechanisms maintaining biodiversity patterns.

Bignami, S.*, Enochs, I.C., Manzello, D.P., Sponaugle, S.*, Cowen, R.K.*
OCEAN ACIDIFICATION ALTERS THE OTOLITHS OF A PAN-TROPICAL FISH SPECIES WITH IMPLICATIONS FOR SENSORY FUNCTION
Ocean acidification affects a variety of marine organisms and is of particular concern for vulnerable larval stages critical to population replenishment and connectivity. The study of larval fishes has produced diverse results, with few consistencies other than acidification impacts on fish behavior and otolith (ear stone) size. We utilized new three-dimensional micro-computed tomography to conduct in situ analysis of the impact of ocean acidification on otolith size and density of larval cobia (Rachycentron canadum). We show that 2100 µatm pCO2 ocean acidification significantly increases not only otolith size (up to 50% greater volume and 58% greater mass) but also otolith density (6% higher), with 800 µatm pCO2 producing significantly greater mass (14%) and a similar but non-significant trend for otolith size. By using a modeling approach, we demonstrate that these changes could affect auditory sensitivity including a ~50% increase in hearing range at 2100 µatm pCO2, which may alter the perception of auditory information by larval cobia in a high-CO2 ocean. Our results indicate that ocean acidification has a graded effect on otoliths, with the potential to substantially influence auditory sensory function critical to the dispersal, survival, and recruitment of fishes.

† Bittick, S.J.†, Scoma, S.†,†, Clausing, R.J.†, Fong, C.R.†, Fong, P.†
A FOUNDATIONAL MARINE MACROALGA SUPPORTS EPiphyTES THAT FACILITATE FORAGING BY HERBIVOROUS FISH ON A FRINGING REEF IN THE SOUTH PACIFIC
1 - University of California, Los Angeles, 2 - California State University, Northridge, 3 - University of California, Santa Barbara

An abundant and expanding brown macroalgal species in the South Pacific, Turbinaria ornata, may be an important foundation species on the fringing reefs, supporting communities of associated macroalgae and juvenile fish. The goal of this study was to determine the impact increasing T. ornata densities have on important coral reef species such as herbivorous fish shown to serve a key role in maintaining coral dominance in these systems. Epiphyte load and foraging behavior were measured for plots with manipulated T. ornata densities (eight treatments between 0-30 thalli/50cm²) over 18-days to determine any effect increasing T. ornata density may have on primary producers and their consumers. There was an increase of ~15% in percent cover by epiphytes on T. ornata thalli as a function of density until 15 thalli/50cm² at which point the relationship saturated. Foraging behavior, measured as the number of bites taken by the dominant family of herbivorous fish in 10 minutes, increased ~4-fold or more until saturation at 25-30 thalli/50cm². This work suggests that T. ornata communities are complex and may play an important role in facilitating juvenile fish. It is important to continue to understand the impact these relationships may have on overall reef resilience.

† Bogeberg, M.A.†, Kane, C.N.†, Tissot, B.N.†
HABITAT ASSOCIATIONS OF YELLOW TANG (ZEbrASOMA FLAVESCENS) FROM SHALLOW TO UPPER MESOPHOTIC CORAL REEFS (3-40 M) IN WEST HAWAII
1 - Washington State University, 2 - Humboldt State University

Understanding habitat utilization of coral reef fish at each life stage is critical for determining their vulnerability to changing ocean conditions and for successful reef fish management. The yellow tang (Zebrasoma flavescens) is a herbivorous surgeonfish and is heavily collected in the Hawaiian marine aquarium trade. Previous work suggests that recruits and juveniles utilize branching coral at mid depths (~12 m) and make an ontogenetic shift to shallow (~3 m) depths as adults. These studies, however, have not explored yellow tang abundances beyond ~18 m. Here, we analyze the distribution of yellow tang to deeper depths. Fish and benthic surveys were conducted on the west coast of the island of Hawaii (West Hawaii) along a depth gradient from shallow to the upper mesophotic zone (3-40 m). The results confirmed previous research, however, adults were also found in low but consistent abundances from 21-40 m and juveniles were found to 30 m when branching coral habitat was present. Thus, the upper mesophotic zone may be serving as additional nursery, foraging, breeding, or refuge grounds for yellow tang in Hawaii.

† Bolton, D.K.†, Clark, G.C.†, Johnston, E.L.†,†
THE BIGGEST LOSER: DOES BODY SIZE MEDIATE THE EFFECT OF PREdATION?
1 - Subtidal Ecology and Ecotoxicology Lab, UNSW, 2 - Sydney Harbour Research Program

Predation is a major driver of marine community structure, but studies of fish predation upon sessile invertebrates have produced conflicting results over its importance. Predation pressure may interact with certain stages of recruitment, affecting the size/age structure of a community rather than the entire assemblage. A community dominated by larger individuals would indicate selective targeting of younger (more vulnerable) recruits, where a few individuals make it through the ‘predation gauntlet’. A factorial caging experiment using 4, 8 and 12 week old sessile assemblages was used to assess the vulnerability of sessile invertebrates to fish predation. Furthermore, we aimed to identify an age/size that sessile invertebrates may become resistant to predation. Using a mounted GoPro® camera we observed fish predation on invertebrate communities and identified a size refuge for ascidians...
and sponges. There was evidence for vegetative growth in colonial ascidians and large recruitment events overcoming predation effects over this relatively short time period. Filming the fish preying on the experimental sessile assemblages is a novel way to confirm fish predation and identify the fish species involved. This is one of the first studies to record actual predation pressure and relate it to the structure of sessile invertebrate assemblages.

Bracken, M.E.S.¹*, Douglass, J.G.², Perini, V.³, Trussell, G.C.³
FUNCTIONAL CONSEQUENCES OF BIODIVERSITY LOSS DEPEND ON TIME AND LOCATION ALONG A LATITUDINAL GRADIENT
1 - University of California, Irvine, 2 - Florida Gulf Coast University, 3 - Northeastern University
Most studies evaluating the consequences of biodiversity loss have been conducted at a single location, limiting the inferences that can be drawn about the generality of biodiversity effects. Here, we evaluate how changes in producer diversity affect producer biomass along a latitudinal and thermal gradient to quantify how environmental context mediates the functional consequences of biodiversity loss. Initial observations at our nine sites—three sites in each of three regions spanning 500 km of the Gulf of Maine coastline—suggested that seaweed cover increased with seaweed diversity. We experimentally evaluated whether diversity was actually influencing seaweed cover by removing seaweed species from plots to create five experimental treatments: monocultures of each of the three most abundant seaweed species, polycultures containing all of those species, and controls. Diversity effects were idiosyncratic for the first year of the experiment, with overyielding—higher seaweed cover in diverse polyculture assemblages than predicted by single-species treatments—evident at some times and locations but not at others. Consistent overyielding in all three regions did not occur until two years after the experiment was initiated. These results demonstrate that the effects of biodiversity on ecosystem functioning depend on location and may take considerable time to emerge.

† Brandl, S.J.*, Bellwood, D.R.
SMALL SCALE, BIG DIFFERENCE? MICRO-HABITAT NICHE PARTITIONING AMONG HERBIVOROUS CORAL REEF FISHES
ARC Centre of Excellence for Coral Reef Studies and College of Marine and Environmental Studies, James Cook University
By feeding on algae, herbivorous fishes perform an important functional role on coral reefs. Yet, while the last decade has seen the intensive use of categorical functional classification schemes, many aspects of niche partitioning among herbivorous reef fishes have remained unexplored. In a series of interrelated studies, we reveal that micro-topographical complexity represents an important ecological axis driving functional complementarity in reef herbivores. First, using an ecromorphological assessment, we present a suite of morphological features related to the use of concealed microhabitats and associate these features to the social behavior of reef fishes. Then, using a novel analysis of niche overlap designed for individual-based data, we demonstrate that micro-habitat utilization during foraging decreases functional redundancy among herbivorous reef fishes. In addition, using an assessment of early life-stage corals and macroalgae, we highlight the potential ecological significance of concealed micro-habitats for competitive interactions among corals and macroalgae and the role of herbivores in mediating the former. Finally, we describe a novel behavioral system, which permits the safe exploitation of algal resources in small crevices on coral reefs. Overall, micro-habitat niche partitioning among herbivorous fishes is driven by morphological and behavioral adaptations and may be an important factor for reef-scale benthic processes.

† Briggs, A.A.*, Carpenter, R.C.
THE INFLUENCE OF LIGHT AND PHOTOSYNTHESIS ON THE RESPONSE OF A TROPICAL CRUSTOSE CORALLINE ALGA TO OCEAN ACIDIFICATION
California State University, Northridge
Ocean acidification (OA), caused by increased carbon dioxide emissions by humans, is leading to shifts in the carbonate chemistry of the oceans. These changes mean that under OA, calcification may become more difficult, while at the same time photosynthesis may become easier for certain species. Since photosynthesis and calcification are physiologically linked, photosynthesis could therefore play a role in the resistance of marine calcifiers to the negative impacts of OA. We hypothesized that light, through its influence on photosynthetic rates, can mediate the response of calcification to OA, so that calcifying autotrophs growing in higher light will show less sensitivity in their calcification rates to OA. To test this, we conducted a four-week experiment in 2014, in Moorea, French Polynesia. We compared net calcification, photosynthesis and respiration rates, as well as dark-adapted quantum yield, a proxy for photochemical efficiency of Photosystem II, of Porolithon onkodes, a common crustose coralline alga in coral reefs, kept in ambient (400 µatm) or elevated (850 µatm) pCO₂ treatment tanks, under high, medium, or low irradiance levels (411, 65, and 24 µmol photons m⁻² s⁻¹). We will report the results of that experiment, and their implications for coral reef communities in the future under OA.
Recent restoration efforts for the native Olympia oyster, *Ostrea lurida*, are commonly motivated by potential return of ecosystem services, including increased water filtration. The impact of these services on another species of restoration concern, eelgrass *Zostera marina*, is unclear, but is hypothesized to be positive if oyster filter feeding behavior increases light penetration to eelgrass. For two years after installation of a constructed oyster bed we monitored eelgrass response in an adjacent eelgrass bed compared to two nearby reference eelgrass beds through changes in water column light intensity, shoot density and biomass. Two years after construction, no clear positive impacts of the oyster restoration on eelgrass shoot density or light intensity were seen; however no strong negative impacts were seen either. Both eelgrass shoot density and light intensity varied seasonally without a discernible impact of oyster restoration presence. Eelgrass below-ground biomass was potentially negatively impacted after one year by the oyster bed; however two years after construction, below-ground biomass did not differ significantly from pre-construction levels. These findings support the potential coexistence of a restored Olympia oyster bed shoreward of an existing eelgrass bed, which is relevant to the design of future restoration efforts for both species.

**Global Economic Impacts of Shoreline Degredation: A Socioeconomic Analysis**

Shoreline Degradation is an economically important issue, which damages coastal tourism economies, and causes shifts in flows of tourist capital. Shifts in flows of tourist capital have the potential to cause shifts in economic power relationships between nations. Governments and planning agencies should acknowledge the inherent dependence of coastal tourism economies on shoreline health and water quality, and conceptions framing the two issues as dichotomous are destructive—causing urban decisions to be made as if environmental and economic interests are mutually exclusive. It is important that such perceptions shift in order to maintain healthy coastal economies. Additionally, the socio-economic impacts of poorly planned and managed tourism industries need to be recognized, in the knowledge that broader economic health of a state or nation is not a definitive indicator of quality of life of residents of the immediate host population in the tourism community.

**Ecological Responses to Ascidian Invasion and Ocean Acidification by Marine Fouling Communities**

Interspecific variability in tolerance to stressors can drive complex community level responses to change. We conducted a study in field-deployed flow-through mesocosms to test the simultaneous effects of ocean acidification and invasion on marine fouling community structure and diversity. We suspended bare recruitment plates in mesocosms subjected to ambient or elevated CO$_2$. Invasive ascidians (*Botryllus schlosseri*) were weeded from one of two plates in each mesocosm. After sixteen weeks, we found that acidification and ascidian invasion significantly altered the relative abundances of recruiting native species. Invasive botryllids were strong competitors, taking up 50% more space than native communities. Communities with botryllids were 15% less diverse. The effects of acidification were more subtle and variable when compared to a similar experiment in the previous year. Importantly, there was no effect of acidification on abundance of *B. schlosseri*. Furthermore, in at least one case, the effect of the invasive increased with ocean acidification; serpulid abundance was only reduced under combined high CO$_2$ and invasive presence. We demonstrate that acidification can have negative impacts on native communities, while invasive species may be resistant to acidification. As a consequence, the relative dominance of invasive species may increase in an acidified ocean.

**Using Biomass Models to Identify Sites for Restoration of Eelgrass (Zostera marina) in Puget Sound**

The Puget Sound Partnership has identified a goal of increasing the area of eelgrass (*Zostera marina*) in Puget Sound by 20% by 2020. We are developing a biomass model that predicts eelgrass growth to aid in identifying restoration sites. We used experimental data on the effects of light, temperature, and salinity on photosynthesis and respiration to determine the functional forms and parameters for these relationships. To predict the potential for eelgrass growth throughout Puget Sound, we used a 3D hydrodynamic model to provide water elevation, temperature, and salinity. Data on light availability are scarce; we used marine water quality monitoring data as
available. We found that model predictions were improved by using region-specific metabolic functions and parameters. When used as an index of habitat suitability, the model predicts eelgrass cover reasonably in some areas of Puget Sound (e.g. river deltas, Northern Puget Sound) and less well in others (South Sound, parts of Central Puget Sound). The model would benefit from additional data, including physiological data over a broader range of environmental conditions, subpopulations, and seasons. In addition, improved information on light attenuation is necessary for spatially and temporally comprehensive predictions in areas as complex and variable as Puget Sound.

† Burt, J.M.*, Salomon, A.K.
FIELD GRAZING TRIALS ELUCIDATE MECHANISMS RESPONSIBLE FOR DEFORESTATION OF KELPS BY URCHINS
Simon Fraser University and Hakai Institute
Sea urchins are recognized as the most important temperate reef herbivore, capable of driving kelp forests between alternative states. While the occurrence of destructive sea urchin grazing has been documented globally, there is little empirical evidence that addresses the mechanisms governing the rate of kelp consumption, giving us little predictive power to forecast when and where community transitions may occur. We conducted subtidal grazing experiments at eight rocky reef sites on the central coast of British Columbia, Canada to quantify how the abundance, size and behaviour of red urchins (*Mesocentrotus franciscanus*), as well as drift abundance, wave exposure, and the presence of other algal species influence the rate of kelp loss. We found that grazing rates were highly variable among sites, and also among urchin patches within sites. Total grazing rates varied as a function of ambient urchin density such that kelp loss initially increased at low ambient sea urchin abundance, but then saturated at high urchin densities. The ability to quantify how ecological processes vary due to local conditions, urchin abundance, and per capita effects will help us predict the magnitude of deforestation that drive kelp forest ecosystem dynamics.

† Butler, G.B.†, Williams, G.J.†, Eynaud, Y.†, Gleason, A.C.R.†, Edwards, C.B.†, Sandin, S.A.†, Smith, J.E.†
HUMAN ACTIVITY ALTERS CORAL COMMUNITY COMPOSITION AND SPATIAL STRUCTURE
1 - Scripps Institution of Oceanography, University of California, San Diego, 2 - Rosenstiel School of Marine and Atmospheric Science, University of Miami
Terrestrial ecologists commonly use life-history strategies and spatial patterning to describe community composition and predict change over time, but similar work is mostly absent in coral reef literature. This study tested whether coral reefs impacted by human activity are more spatially fragmented and dominated by weedy or “stress-tolerant” coral species, and whether reefs on uninhabited islands are less fragmented and dominated by “competitive” (late successional stage) species. Here, we used a combination of quantitative classification of life-history strategies and spatially explicit data collected using photo-mosaics to examine the distribution of corals at the landscape scale. Photo-mosaics were taken from fore-reefs on Fanning Island (impacted) and Palmyra Atoll (uninhabited) in the Central Pacific and were digitized to extract the degree of fragmentation and percent cover for each life-history strategy classification. While both islands have high cover of weedy species (reflecting the dynamic fore-reef environment), Fanning Island is dominated by “stress-tolerant” species and is spatially fragmented, whereas Palmyra Atoll is dominated by “competitive” species and is less fragmented. This study suggests that communities may shift towards species that are more tolerant to stressful conditions on impacted reefs, but the spatial fragmentation associated with those reefs has negative implications for resilience and recovery.

† Carr, L.A.*, Gittman, R.K., Bruno, J.F.
OCEAN TEMPERATURE INFLUENCES HERBIVORY IN THE GALÁPAGOS ISLANDS, ECUADOR
University of North Carolina at Chapel Hill
Temperature can influence trophic interactions via predictable variation in individual metabolic function. Metabolic theory and experiments indicate warmer temperatures can increase the top-down strength of grazers on plant biomass in several different systems, resulting in decreased standing plant biomass. However, the influence of temperature on herbivore-plant interactions across natural, in situ, environmental gradients is less known. We utilized a comparative-experimental design across a natural regional-scale gradient in temperature (via oceanographic currents and upwelling intensity) to examine its influence on the grazing rate of sea urchins on green algae in the Galápagos Islands. Our experimental design included three treatments: urchin exclusion, urchin-only cages (i.e., controlling grazer identity and density), and open plots where all local herbivores had unrestricted access to algae. We repeated this experiment at four sites in two seasons, across which temperature varied naturally. We used the open plot treatments to test the generality of findings from the urchin-only treatments. Our results indicate that warmer temperatures increased herbivore consumption rates, resulting in less algal biomass. Ultimately, our findings provide evidence for a mechanistic link between environmental temperature and herbivore consumption rates across a natural regional-scale temperature gradient.
Carson, H.S.*, Ulrich, M.
THE SUSTAINABILITY OF THE SEA CUCUMBER AND RED SEA URCHIN DIVE FISHERIES IN THE SAN JUAN ISLANDS, USA
Washington Department of Fish and Wildlife
The San Juan Archipelago is the most intensely fished region of Washington State for echinoderms, and populations of California sea cucumbers (Parastichopus californicus) and red sea urchins (Mesocentrotus franciscanus) experienced overharvest from 1987 - 1994. We evaluate the current management of these fisheries using a biomass estimate from ROV surveys, a time series of relative abundance from SCUBA index stations, and harvester log book data. The fully-utilized quota for Parastichopus represents an 11.4% annual harvest rate on the harvestable biomass estimate, density in shallow water is conspicuously low, relative abundance has remained depressed, and catch-per-unit-effort (CPUE) continues to decline. Abundant animals below harvestable depths may not be of sufficient density to act as an efficient reservoir to replenish the shallows with recruits. The partially-utilized quota for Mesocentrotus represents a 3.9% annual harvest rate on the biomass estimate, relative abundance has increased from a recent low, and there is no trend in CPUE. Despite the challenges of co-managing the fisheries among several regions and stakeholder groups, tentative agreement has been reached to ensure the long term viability of the Parastichopus fishery using reduced harvest quotas and a closure during peak spawning months, and to continue to closely monitor the Mesocentrotus fishery.

† Carvalho, P.G.*, Januchowski-Hartley, F.A.†, Jupiter, S.D.†, White, C.†
EFFECTIVENESS OF PERIODICALLY HARVESTED CLOSURES IN MEETING FISHERIES AND CULTURAL OBJECTIVES
1 - California Polytechnic State University, San Luis Obispo, 2 - University of Exeter, 3 - Wildlife Conservation Society, Fiji Country Program
Periodically harvested closures (PHCs) are traditional management practices implemented within customary marine tenure areas throughout Melanesia. PHCs are often within Locally Managed Marine Areas (LMMAs), which have broad objectives of fishery sustainability and conservation. PHCs are designed more specifically to increase harvest efficiency and opportune occasional exploitation of protected stocks to support local events. Despite their prevalence, effectiveness of LMMAs with PHCs for simultaneously achieving these objectives remains uncertain. To assess these systems, we developed a bioeconomic fisheries model and quantified how PHC open-closed schedule effects LUMMA harvest efficiency (catch-per-unit-effort), biomass conservation and sustainable fishery yield. We also compared effects with those by non-spatial or no-take marine reserve harvest regulations – forms of conventional management often heralded as optimal in well-managed and over-fished systems, respectively. Optimal PHC design was sensitive to fishing pressure, but regardless PHCs were more effective at achieving the multiple objectives than either conventional method. Key to the results is the fishers' ability to reduce fish wariness and increase catchability in PHCs with strategic harvest schedules. These findings challenge the dogma that PHCs are simply a cultural legacy to be accommodated by contemporary fisheries science, and instead place PHCs center stage as a potentially optimal fisheries management strategy.

Caselle, J.E.*, Cochrane, G.†, Young, M.†, Davis, K.†, Ruttenberg, B.†, Schroeder, D.†
MODELING FISH HABITAT RELATIONSHIPS IN THE SANTA BARBARA CHANNEL, CALIFORNIA USA
1 - University of California, Santa Barbara, 2 - University of California, Santa Cruz, 3 - United States Geological Survey, 4 - California Polytechnic State University, San Luis Obispo, 5 - Bureau of Ocean Energy and Management Pacific Region
Effective marine management requires understanding of how local impacts to fish populations affect the regional population. Advances in habitat mapping and suitability modeling enables the prediction of the spatial distribution of species and the factors driving those distributions. While much of this progress has occurred in shallow coral reef habitats, these approaches have been less used in cold temperate, nearshore systems. Here we present results of a study that coupled the distribution of habitats and species habitat affinities using GIS technology to measure species habitat utilization patterns at scales that are commensurate with both ecosystem processes and fisheries management. We used a stratified random sampling design for fish surveys using SCUBA. Habitat maps were compiled from all available sources from the shoreline out to the 20 meter isobath. Data types include multibeam sonar, sidescan sonar, and air photos. The habitat classes were reduced to hard or soft bottom. A 100 by 100 meter mesh was used to partition the study area. Because soft bottom predominates in the area, cells were then selected in a stratified random scheme to insure that a significant number of hard bottom sites were included. Using generalized additive models, we found that the abundance and distribution of several important fish species correlated with seafloor substrate, kelp biomass, and depth. For example, the biomass of kelp rockfish (Sebastes atrovirens) increases with increases in hard substrate and kelp biomass and decreases with increases in depth. These relationships can be used to extrapolate biomass estimates across the study area, including regions where biomass was not sampled.
Casorani, M.C.N.\textsuperscript{1,5}, Baskett, M.L.\textsuperscript{2}  
DISTURBANCE FREQUENCY, EXTENT, AND SEVERITY MEDIATE COMPETITIVE COEXISTENCE  
1 - Marine Science Institute, University of California, Santa Barbara, 2 - Dept. of Environmental Science & Policy, University of California, Davis  
Disturbance can influence population dynamics directly by changing rates of mortality and fecundity or indirectly by altering rates of migration among disturbed and undisturbed patches (e.g., by shifting resource availability). Variation in disturbance frequency, spatial extent, and severity may mediate coexistence among competing species. However, little is known about how variation in disturbance regimes or interactions among disturbance factors influences demographic mechanisms of species coexistence. Benthic marine ecosystems are excellent for testing the effects of disturbance frequency, extent, and severity on coexistence mechanisms because they are characterized by highly variable disturbance regimes and many species competing for space. In North Pacific estuaries, eelgrass (Zostera marina) outcompete burrowing ghost shrimp (Neotrypaea californiensis) for benthic space, but ghost shrimp can coexist at the landscape scale by rapidly colonizing eelgrass disturbances. However, the relative influences of eelgrass mortality and ghost shrimp migration on coexistence remain obscure. Furthermore, it is unclear how variation in disturbance regimes might mediate competitive coexistence. Conducting large or frequent disturbances in manipulative field experiments is impractical and unethical, and ‘natural experiments’ often confound disturbance factors. Therefore, to resolve our research questions we simulated eelgrass and ghost shrimp population dynamics using a spatially-explicit mathematical model with stochastic disturbance. Our analysis revealed that disturbance regimes have strong and nonlinear effects on population dynamics and species coexistence. Long-term coexistence appears to be possible across a range of intermediate disturbance regimes, but there may be interactions among disturbance factors.

Catton, C.A.\textsuperscript{14}, Lessard, J.\textsuperscript{2}, Rogers-Bennett, L.\textsuperscript{1,3}  
CHARACTERIZING NORTHERN ABALONE POPULATIONS ACROSS A BROAD GEOGRAPHIC RANGE: PERSPECTIVES ON ENDANGERED LISTING CONSIDERATION  
1 - California Department of Fish and Wildlife, 2 - Fisheries and Oceans Canada, 3 - Bodega Marine Laboratory, University of California, Davis  
Northern abalone (Haliotis kamtschatkana) is being considered for listing on the Endangered Species List, based on severe population declines from Alaska to California since the 1970s. The declines may be due to a combination of stressors, including overfishing and limited reproduction in low-density areas. The particular impacts, and the potential for future population growth, differ across the geographic range. We investigated these differences by characterizing populations in British Columbia, the San Juan Islands (Washington), and California (northern and southern). We compare population densities, aggregation characteristics, and size-frequency distributions to determine the relative health of the populations across this broad geographic range. We found populations in northern California to be the healthiest, with increasing densities since 2006, and a broad spectrum size range. The southern California population also showed a broad size distribution despite an overall lower estimated density. Southern British Columbia populations showed evidence of high adult mortality, possibly due to poaching, whereas the population in the San Juan Islands showed evidence of reproductive failure. These results reveal that density declines have occurred only in the northern extent of the species range, but that recovery may be possible with actions limiting poaching in British Columbia and enhancing reproduction in Washington.
TEMPERATURE ALTERS AVAILABILITY AND EDIBILITY OF PLANT RESOURCES IN A FRESHWATER SYSTEM
University of British Columbia
In plant herbivore-systems, theory predicts that increased temperature directly increases grazing pressure and indirectly affects the rates and outcomes of species interactions by altering the edibility of plant resources and the feeding behavior of consumers. We hypothesized that temperature-induced increases in consumer pressure are mediated by both temperature- and consumer-driven changes in primary producer assemblages to determine steady-state community-level responses to warming. We tested this hypothesis in freshwater algal-grazer communities maintained at nine temperatures over 11 weeks. We found evidence for direct, positive effects of temperature on whole-system oxygen fluxes (NPP, ecosystem respiration), and direct negative effects on phytoplankton cell size. We observed shifts in species composition among algae from plankton dominated to periphyton dominated assemblages with warming, consistent with indirect effects on competitive interactions. Taken together, shifts in cell size and functional type with warming indicate a shift toward less palatable algal species, which may alter food web structure and function, especially under increased grazing pressure. We conclude that palatability shifts are predictable with warming, and that temperature-dependent community theory can be expanded to include these indirect effects of temperature on species interactions.

CAN SUB-DOMINANT PREDATORS COMPENSATE FOR THE LOSS OF PISASTER OCHRACEUS AFTER SEA STAR WASTING SYNDROME?
Oregon State University
Sea star wasting syndrome first appeared on the Oregon coast in spring 2014 and resulted in rapid mortality and population declines in many sea star species, including Pisaster ochraceus. Loss of this keystone predator has the potential to significantly alter community structure in the rocky intertidal low zone. We tested the capability of three sub-dominant predators, whelks Nucella canaliculata and Nucella ostrina and the smaller sea star Leptasterias hexactis, to compensate for Pisaster loss and delay movement of mussels into the low zone. We conducted experimental removals of these sub-dominant predators at two sites with significant Pisaster declines and monitored sessile prey abundance. Preliminary results indicate that adult abundance of the mussel Mytilus trossulus was reduced over time in all treatments, with the strongest effect in plots with whelks present. Other sessile prey recruited heavily to all plots and persisted. Primarily due to low abundance, Leptasterias had little effect on prey. In late summer, whelk densities dropped in all treatments, indicating that their effects may vary seasonally. Results suggest that whelks may be able to compensate for reduced Pisaster densities, particularly if whelk populations increase. However, other factors, including recovery of juvenile Pisaster, may have stronger impacts than sub-dominant predators.

IMPACTS OF CONSTRUCTED OYSTER BED ON INFAUNAL INVERTEBRATE COMMUNITIES IN JACK DUNSTER MARINE RESERVE
1 - California State University, Long Beach, 2 - California State University, Fullerton
A recent oyster restoration effort in Alamitos Bay CA provides us with an opportunity to analyze the composition of infaunal assemblages under and near constructed oyster beds. Oysters are very important to the health and resilience of estuarine ecosystems because of the many functions they provide to these ecosystems. However, restoration techniques that include bed construction can impact sediment organic matter and benthic invertebrates that also provide trophic support for species of commercial importance. The objective of this study is to assess the impacts of a constructed bed on oyster bed-associated sediment and infaunal communities. Results show there is more organic matter both near and under the oyster bed site as compared to the control site. Overall abundance of invertebrates is reduced only under the oyster bed. There is an altered community structure only under the oyster bed (driven by a reduction in Tubificidae). These results are possibly explained by the shell’s action as a barrier to the mud-water interface. While significant, the impacts of oyster bed construction are spatially restricted to just under the bed. Longer term studies should be conducted to address the effects of the oysters themselves once they settle in greater abundance.

THE RELATIVE ROLES OF HISTORY AND ENVIRONMENT IN DRIVING THE STRUCTURE OF MARINE BENTHIC COMMUNITIES
School of Biological Sciences, Monash University
What factors drive the variation in community structure? It is now recognised that neither niche nor neutral theory could alone explain community structure. Instead, there have been repeated calls to quantify the relative strength of niche and neutral processes yet tests are difficult in most systems. Marine benthic communities are structured by
larval settlement history as well as the environment in which these settlers grow. At small scales, larval recruitment is largely stochastic and thus a neutral process. Environmental effects such as climatic tolerance, limiting resources, and competition are largely deterministic and thus niche processes. The relative roles of these niche and neutral processes in marine systems remains unclear. In the field, we transplanted early stage natural marine benthic communities immediately after larval recruitment, and again after a longer period of community assembly. We then quantified the variation in community structure before and after the translocation. Here, we report the relative contribution of history and environment to the observed variation in community structure.

Chittaro, P.M.¹, Hegg, J.², Kennedy, B.², Weitkamp, L.¹, Bucher, C.¹, Johnson, L.¹, Connor, W.³, Zabel, R.W.¹
RECONSTRUCTING THE EARLY LIFE HISTORY STAGE FROM ADULTS OF THREATENED FALL CHINOOK SALMON.
1 - Northwest Fisheries Science Center, 2 - University of Idaho, 3 - U.S. Fish and Wildlife Service
For a threatened population of fall Chinook salmon in Snake River of Idaho, planning restoration efforts would benefit from knowing which freshwater locations contribute individuals to the adult population and how fish from these locations vary in out-migration strategy (sub-yearling vs yearling) and size and age as they enter the ocean. To do this we reconstructed the early life history of returning wild adult Chinook using the location-, size-, and age-recording properties of their otoliths. Lower Snake River was an important location because 72-84% of our analyzed adults originated, reared, and overwintered here. 74% of our sampled adults exhibited a yearling strategy and despite overwintering in freshwater, 40% overlapped with sub-yearlings in fork length and post-emergence age at estuary entry. Thus, for some individuals exhibiting the yearling strategy, overwintering may not necessarily result in a size-related benefit relative to sub-yearlings, and that most of this overwintering period may occur prior to emergence. Lastly, an individual’s estuarine somatic growth and residence time was comparable between strategies, indicating that both strategies use the estuary in similar ways. The results of this study provide management agencies quantitative estimates of how out-migration strategies, size, and age vary relative to natal and rearing locations.

† Chu, J.W.F.*, Tunnicliffe, V.
IN SITU OXYGEN LIMITS AND THE COLLAPSE OF EPIBENTHIC COMMUNITY STRUCTURE FROM SHOALING HYPOXIA
University of Victoria
We repeated a 2 km benthic transect (annually for 8 years) across a shifting oxycline (<0.05 to > 3 ml/l) to determine the epibenthic response to shoaling hypoxia. ROVs with HD-cameras and CTD+O₂ transected depths from 180 to about 50m in Saanich Inlet, a highly productive and seasonally-hypoxic fjord on the west coast of Canada. Species-specific hypoxia determined their spatial distribution which shifted with the changing oxygen profile. Multivariate analyses determined oxygen variability, not mean, best predicts community structure. Slender sole (Lyopsetta exilis) and Squat lobster (Munida quadrispina) dominate the community living on bacterial mats in severe hypoxia (O₂ < 0.5 ml/l). In particular, L. exilis is the most numerically abundant animal found in the severe hypoxia zone, can tolerate waters near anoxia (O₂ < 0.05 ml/l), and actively buries itself in the H₂S bacterial mats. As oxygen levels increase (O₂ > 0.75 ml/l), more animals appear including commercial species. The high resolution time-series from the nearby VENUS observatory (96 m depth) shows a trend of oxygen loss in the past 8 years. As hypoxic waters encroach into the shallows, the habitat area of commercial species will be compressed and interactions among species increased.

Clark, G.F.¹*, Stark, J.S.², Johnston, E.L.¹, Runcie, J.W.²,³, Goldsworthy, P.M.², Raymond, B.²,⁴, Riddle, M.J.²
LIGHT-DRIVEN TIPPING POINTS IN POLAR ECOSYSTEMS
1 - Evolution and Ecology Research Centre, University of New South Wales, 2 - Australian Antarctic Division, Department of Sustainability, Environment, Water, Population and Communities, 3 - School of Biological Sciences, University of Sydney, 4 - Antarctic Climate and Ecosystems Cooperative Research Centre, University of Tasmania
Some ecosystems can undergo abrupt transformation in response to relatively small environmental change. Identifying imminent “tipping points” is critical for biodiversity conservation, particularly in the face of climate change. Here we identify a nonlinear relationship between the timing of ice melt and the amount of light that some ecosystems receive annually, and describe how this may induce widespread regime shifts in polar ecosystems. We demonstrate the principle on Antarctic shallow seabed ecosystems, which data suggest are sensitive to small changes in the timing of sea-ice melt. Algae respond to light thresholds that are easily exceeded by a slight reduction in sea-ice duration. Earlier sea-ice loss is likely to cause extensive regime-shifts in which endemic shallow-water invertebrate communities are replaced by algae, reducing coastal biodiversity and fundamentally changing ecosystem functioning. Modeling shows that recent changes in ice and snow cover have already transformed annual light budgets in large areas of the Arctic and Antarctic, and both aquatic and terrestrial ecosystems are likely to experience further significant change in light. This mechanism renders polar ecosystems
acutely vulnerable to abrupt ecosystem change, as light-driven tipping points are breached by relatively slight shifts in the timing of snow and ice melt.

† Clements, S.M.1, Kelly, E.L.A.2, Smith, J.E.2
FORAGING ECOLOGY AND FUNCTIONAL DIVERSITY OF SURGEONFISHES IN MAUI, HAWAII
1 - University of California, San Diego, 2 - Scripps Institution of Oceanography
Herbivores on coral reefs are instrumental in mitigating the competitive interactions between reef-building corals and fleshy algae; however, not all herbivores provide the same ecological function. Surgeonfishes (family Acanthuridae), for example, consume turf algae (and associated organic matter) that are the primary spatial competitors to corals in the Main Hawaiian Islands. This study highlights functional diversity among surgeonfishes through observations of foraging behavior, analysis of stomach contents, and analysis of stable isotopic signatures of muscle tissue ($\delta^{13}C$ and $\delta^{15}N$) for three common species (Acanthurus nigrofuscus, Acanthurus olivaceus, and Ctenochaetus strigosus) on the leeward side of Maui. Similar foraging behavior was observed in A. nigrofuscus and in C. strigosus, while similar diet composition based on stomach contents was found in C. strigosus and A. olivaceus. Measured $\delta^{15}N$ values were similar in the three species; however, muscle tissue in C. strigosus was significantly enriched in $\delta^{13}C$, suggesting that it consumes a different primary food source than A. nigrofuscus and A. olivaceus. Collectively, these data suggest that surgeonfish grazers exhibit significant within-guild functional diversity; however, the differences and degree of divergence revealed depend on the methods used.

Collin, S.B.1, Edwards, P.2, Leung, B.2, Johnson, L.E.1*
EARLY RECRUITMENT PATTERNS IN AN INVASIVE ASCIDIAN: "HOTSPOTS" AND "NOT-SPOTS" AND THE IMPLICATION FOR EARLY DETECTION
1 - Université Laval, 2 - McGill University
Knowledge of dispersal during the early stages of invasion is essential for allocating monitoring effort, detecting nascent populations and predicting spread. The scarcity of these data, however, provides little guidance for monitoring programs. Early recruitment patterns relative to the distribution of adults were documented for a nascent population of the invasive ascidian Ciona intestinalis in Prince Edward Island, Canada. A grid of 80 settling plates was sampled eight times over two years following initial detection. The initial dispersal kernel became undetectable in later surveys as the distribution of recruits become more homogeneous as the population expanded. Surprisingly, despite an order of magnitude increase in recruitment in the following year, the pattern of recruitment became heterogeneous again for all periods. Although consistently heterogeneous, the pattern of recruitment was nevertheless spatially stable with distinct clustering of sites of high and low recruitment ("hotspots" and "not-spots"). We attribute early heterogeneity to the small and restricted nature of the founding population and the latter heterogeneity and stability to a greater influence of abiotic factors on recruitment. Such information can provide valuable guidance for managers in their efforts of the early detection of aquatic invaders.

Comeau, S.*, Edmunds, P.J., Lantz C.A., Carpenter, R.C.
COMPARATIVE RESPONSE OF CORAL REEF COMMUNITIES FROM FRENCH POLYNESIA AND HAWAII TO OCEAN ACIDIFICATION
California State University, Northridge
Ocean acidification (OA) poses a severe threat to tropical coral reefs, yet much of what is known about these effects comes from studies of individual organisms, whereas little is known about the response of tropical reef communities. We have constructed coral reef communities (including sediment) matching natural back reef communities in large outdoor flumes in Moorea (French Polynesia) and Hawaii to investigate the effects of OA. Constructed reef communities were maintained under controlled conditions of flow and light at ambient (~400 µatm) and high pCO$_2$ (~1300 µatm) for 8 weeks in Moorea, and 2 replicates of 3 weeks in Hawaii to measure the response of calcification to OA. In Moorea, community calcification was depressed 59% under high pCO$_2$, with sediment dissolution explaining ~ 50% of this decrease. In Hawaii calcification was depressed 30% under high pCO$_2$, and sediment dissolution explained ~70% of this decrease. These results show that despite the capacity of corals and calcifying algae to maintain calcification at high pCO$_2$, sediment dissolution will lead to a severe reduction in net calcification of back reef communities by the end of this century in both Moorea and Hawaii.

† Corey, K.R.1*, Kirk, N.L.1, Meyer, E.1, Coffroth, M.A.2, Weis, V.M.1
HOST SPECIFICITY AMONG CLOSELY RELATED DINOFLAGELLATES: USING AUTO-FLUORESCENCE TO ENUMERATE SYMBIOTONS IN AIPTASIA SEA ANEMONES
1 - Oregon State University, 2 - State University of New York at Buffalo
Symbiotic relationships between cnidarians and dinoflagellates within the genus Symbiodinium are critically important for the success of coral reefs. These symbionts provide their hosts with photosynthetically-fixed carbon in exchange for nutrients and shelter. Symbiodinium is a phylogenetically diverse genus that is often typed by sequencing the ribosomal internal transcribed spacer (ITS) region. However, this approach may miss fine-scale
genetic differences among the types, which may have large functional importance. Here we examined differences in host specificity by inoculating aposymbiotic individuals of the sea anemone Aiptasia sp. with six different cultured strains of type “B1” Symbiodinium isolated from different cnidarian hosts. Infection was tracked over time using image analysis of Symbiodinium autofluorescence as a rapid and non-destructive proxy for cell counting. There were significant differences in infection rates among the different Symbiodinium strains compared to a B1 strain initially isolated from Aiptasia. Specifically, a strain cultured from the Caribbean octocoral Antillogorgia elisabethae had significantly lower infectivity compared to the native strain. This corresponded to larger genetic distance between these two cultures as diagnosed by restriction site associated DNA (RAD) sequencing of SNPs compared to other B1 cultures that infected at similar rates. This indicates high specificity between Aiptasia and Symbiodinium.

Côté, I.M.*, Favaro, C.
THE SCIENTIFIC VALUE OF SCIENTIFIC WHALING
Simon Fraser University
Since the global moratorium on the commercial exploitation of whales in 1986, most legal whaling has been conducted for scientific purposes under permits by the International Whaling Commission. Our goal was to measure the scientific output of such whaling programs. We specifically asked whether scientific whaling countries have produced more publications relevant to the conservation goals stated on IWC permits than socio-economically similar countries conducting non-lethal whale research. We searched the Aquatic Sciences and Fisheries Abstracts database to find all relevant articles published between 1986 and 2013. Over three decades, whaling and non-whaling countries have published a similar number of articles on whales, but only one-third of publications by whaling countries were peer-reviewed, compared to two-thirds for non-whaling countries. Publications on whales by non-whaling countries were cited five times more often than those of whaling countries. The number of whales taken per publication ranged from <1 (for Sei whale Balaenoptera borealis) to 332 (for minke whale B. acutorostrata). Few hunts are as controversial as whaling, and the decision to exploit whales is as much an ethical matter as a conservation concern. This first quantitative evaluation of the science produced by scientific whaling informs both aspects of this issue.

† Cramer, A.N.†, Lindholm, J.†, Starr, R.†
WHAT DOES IT MEAN TO BE A HOMEBODY? LARGE SCALE PATTERNS IN MARINE FISH SITE FIDELITY
1 - Institute for Applied Marine Ecology, California State University, Monterey Bay, 2 - Moss Landing Marine Laboratories
The concept of ‘site fidelity’ is common throughout the ecological literature, with modifiers such as ‘strong’ and ‘high’ frequently added for effect. However, precisely what site fidelity means—strong, high, or otherwise—varies significantly across studies. The term is frequently applied to marine fishes, where fidelity can refer to the percentage of time spent at a certain habitat feature. We conducted a meta-analysis of studies that use acoustic telemetry to study the site fidelity and movements of marine fishes and the environmental factors that drive movement patterns. Using meta-level modeling and Akaike’s information criterion (AIC) we asked: Are there universal patterns in marine fish site fidelity? Across species, are there factors that influence site fidelity in a predictable way? Results of an analysis of 26 studies indicated that while 40% of tagged fishes exhibited high site fidelity (residents≥ 90% of time), residency of the other 60% varied significantly (p-value < 0.05), contrary to expectations for resident fishes. AIC results indicated that genus and species were not good predictors of site fidelity – length, temperature, and feeding behavior metrics are better predictors. These results improve our understanding of residency in marine fishes and provide direction for future investigations of site fidelity.

Crandall, E.D.††, Treml, E.A.†, Liggins, L.†, Gleeson, L.†, Yasuda, N.†, Barber, P.H.†, Wörheide, G.†, Riginos, C.†
RETURN OF THE GHOSTS OF DISPERAL PAST: HISTORICAL SPREAD AND CONTEMPORARY GENE FLOW IN THE BLUE SEA STAR LINCIKA LAEVIGATA
1 - University of California, Santa Cruz, 2 - University of Melbourne, 3 - University of Queensland, 4 - University of Miyazaki, 5 - University of California, Los Angeles, 6 - Ludwig-Maximilians - Universität München
Marine animals inhabiting the Indian and Pacific oceans have some of the most extensive species ranges in the world, sometimes spanning over half the globe. These Indo-Pacific species present a challenge for study with both geographic scope and sampling density as limiting factors. Here, we augment and aggregate phylogeographic sampling of the iconic blue sea star, Linckia laevigata, and present one of the most geographically comprehensive genetic studies of any Indo-Pacific species to date, sequencing mitochondrial COI from 791 individuals from 38 locations spanning over 14,000 km. We first use a multiple-regression approach to simultaneously evaluate the relative influence of historical and contemporary gene flow together with putative barriers to dispersal. We then use a discrete diffusion model of phylogeography to infer the historical migration and colonization routes most likely used by L. laevigata across the Indo-Pacific. Importantly, both methods indicate that gene flow and colonization
have generally proceeded in a step-wise manner across the Indian and Pacific oceans. However the diffusion model was equivocal about the location of the mitochondrial most recent common ancestor. These results underscore the importance of comprehensive range-wide sampling in marine phylogeography.

**Dafforn, K.A.**<sup>1,*</sup>, **Glasby, T.M.**<sup>2</sup>, **Airoldi, L.**<sup>3,4</sup>, **Rivero, N.K.**<sup>1</sup>, **Mayer Pinto, M.**<sup>1</sup>, **Johnston, E.L.**<sup>1</sup>

**MARINE URBANISATION: AN ECOLOGICAL FRAMEWORK FOR DESIGNING MULTIFUNCTIONAL ARTIFICIAL STRUCTURES**

1 - University of New South Wales, 2 - New South Wales Department of Primary Industries, 3 - University of Bologna, 4 - Hopkins Marine Station of Stanford University

Underwater cities have long been the subject of science fiction novels, but the ‘urban sprawl’ of artificial structures from terrestrial to marine environments is occurring with widespread ecological consequences. The practice of combining ecological principles with the planning, design and operation of marine artificial structures is gaining in popularity, and examples of successful engineering applications are increasing. Here we use case studies to explore marine ecological engineering in practice, and introduce a conceptual framework for designing artificial structures with multiple functions. The rate of marine urbanization will almost certainly escalate and “aquatourism” is driving the development of underwater accommodations. We show that current and future marine developments could be designed to reduce ecological impacts while maximising ecosystem services.

**† de Nesnera, K.L.*

**MUSSEL RECRUIT SUBSTRATE ASSOCIATIONS WITHIN CENTRAL CALIFORNIA ROCKY SHORES**

University of California, Santa Cruz

Along the rocky shores of the west coast of North America, recruiting mussels (*Mytilus californianus*) are considered poor settlers of bare rock and are thought to require associations with habitat-forming species to facilitate growth and survival. Despite the ecological importance of this species, few studies have identified or explored the importance of these associations. To identify substrate associations and evaluate their importance across a tidal stress gradient, I conducted field surveys of mussel recruits and available substrate in the upper and lower tidal range of the mussel zone at four central California sites. At all sites, mussel recruits had strong positive and negative associations with available substrate in the upper portion of the mussel zone (p<0.002) while no positive or negative associations were identified in the lower portion of the mussel zone (p>0.150). This result may reflect the role of desiccation and heat stress in driving the importance of associations between mussel recruits and settlement substrate. Based on previous work, I hypothesized that mussel recruits would positively associate with byssal-like substrates. Instead, mussel recruits in the upper mussel zone had the strongest positive associations with robust overlying algal canopies (e.g. Fucoid algae, articulated coralline algae, and *Mastocarpus spp.*).

**† Denney, C.T.**<sup>1,*</sup>, **Starr, R.**<sup>1,2</sup>, **Fremont, A.**<sup>3</sup>

**HOW TIMING OF SETTLEMENT INFLUENCES COMPETITION IN JUVENILE BLUE ROCKFISH (SEBASTES MYSTINUS)**

1 - Moss Landing Marine Laboratories, 2 - California Sea Grant Extension Program, 3 - California State University, Monterey Bay

For those rockfishes that survive the larval life stage, the highest mortality rates occur during the post-settlement juvenile stage. In this project, we examined how competition between different cohorts within a single year class influenced survival and growth in newly settled Blue Rockfish (*Sebastes mystinus*). We hypothesized that older juveniles that settle to kelp forests earlier in the season have a competitive advantage (as evidenced by increased growth) over those fish that settle later. In order to test this hypothesis, we separated juvenile Blue Rockfish caught with nets using SCUBA into older and younger age groups. The two age groups were weighed, measured, marked with subcutaneous elastomer dye, divided into two control treatments and a mixed treatment group, and then were placed in cages in the kelp forest for a month. After a month fish were again measured and weighed, and then dissected to obtain the liver weight, gut contents and otoliths. Initial results of this experiment will be presented in this talk.

**Dethier, M.N.**<sup>1,*</sup>, **McBride, A.**<sup>2</sup>

**THE IMPACTS OF ARMORING ON SALISH SEA SHORELINES**

1 - Friday Harbor Labs of University of Washington, 2 - Skagit River System Cooperative

Shoreline armoring is widespread in the Salish Sea, but few data have documented actual impacts on physical or biological features of local nearshore ecosystems. Some impacts, such as ‘starving’ the beach of sediments, may take decades to become visible, while others such as ‘placement loss’ are immediate. We quantified a range of geophysical and biological parameters at 65 pairs of adjacent armored and unarmored beaches throughout the Salish Sea. Demonstrating differences attributable to armoring is challenging given the high natural variability among beaches. However, armoring consistently results in reductions in beach width, riparian vegetation, numbers of stranded logs, and amounts and types of beach wrack and the invertebrates that occupy it. For some
parameters, such as accumulated logs, there is a distinct threshold in elevation of armoring that causes increased impacts. This large dataset for the first time allows us to identify cumulative impacts that appear when large proportions of drift cells are armored; at large spatial and temporal scales, armoring much of a drift cell results in reduction of the finer grain size fractions on beaches, including those used by spawning forage fish.

† Doane, M.1*, Friedlander, A.M.2, Sala, E.3,4, Rohwer, F.5, Kelly, L.W.1, Dinsdale, E.A.1
SHARK SKIN MICROBIOTA: ADDING TO THE CURIOUS NATURE OF SHARKS
1 - San Diego State University, 2 - University of Hawai‘i, 3 - National Geographic Society, 4 - Centre d'Estudis Avançats de Blanes, Consejo Superior de Investigaciones Científicas
Sharks are key members of marine habitats and despite popular belief are susceptible to changing conditions. Our understanding of how sharks interact with their environment is poorly known. Microbial life is a key component of marine habitats shaping present day oceanic chemical components and further the health of this system. As dominant member of marine systems, sharks are influence by oceanic microbial life. The aim of our study is to provide an understanding of the microbial activity associated with skin surface (the first line of defense) of a shark species. We characterized the skin microbiota of 8 Blacktip reef sharks (Carcharhinus melanopterus) from 4 coral atolls in the southern Line Islands using metagenomic approaches. The microbes were “supersuckered” from the underside of the sharks, after which the sharks were released, unharmed. DNA from the microbes was extracted and sequenced on Roche 454 technology with titanium chemistry. The MG-RAST platform was used to annotate the resulting genomic data. Metagenomic data included high quality sequences with an average length of 303 base-pairs and library sizes ranged between 22,576 sequences to 210,698 sequences. The proportion of sequences matching known microbiota ranged from 9% to 45%, suggesting vast unknown microbial taxa. Bray-Curtis measures indicate low similarity between microbial profiles between individual sharks. Permutational ANOVA (PERMANOVA) showed a difference between shark skin and water column microbiota (p<0.05). Further, there was little evidence for spatial patterns in the skin microbiota as illustrated using multi-dimensional scaling techniques. The skin surface of sharks is textured, reducing fluid friction and sharks do not produce mucus like bony fishes. We hypothesize that the texture of shark skin is producing a random mixture of microbes on the skin. To further evaluate the impact of the skin topology on structuring the microbial communities, different shark species will be assessed and an experiment will be conducted to verify the effects of skin texture.

CUSTOMARY HUMAN IMPACTS ON CORAL REEF FISHES ACROSS CUSTOMARY FISHERIES MANAGEMENT BOUNDARIES IN HAWAI’I
1 - University of Hawai‘i at Mānoa, Fisheries Ecology Research Lab, 2 - NOAA Pacific Island Fisheries Science Center, 3 - US National Park Service, 4 - The Nature Conservancy of Hawai‘i, 5 - University of Hawai‘i at Mānoa, Hawai‘i Institute of Marine Biology, 6 - State of Hawai‘i, Division of Aquatic Resources
Large declines in coral reef fisheries resources in Hawaii has raised concerns over sustainability, yet a clear picture of the resources at a scale commensurate with management is needed. In order to help address this issue, for the first time, we have synthesized data on fish assemblages throughout Hawaii, allowing us to ask spatially explicit questions about the structure and function of nearshore ecosystems. With this robust data set, we have developed a biogeographic framework to examine anthropogenic factors that influence patterns of reef fish assemblages in the context of oceanographic forcing and habitat variability. The traditional Hawaiian district or moku was used as a unit of spatial stratification for comparisons within the MHI, providing a context for examining spatial patterns at a scale useful for management. Biomass of resource species was negatively correlated with human population pressure among moku, with extremely low biomass in areas with high human population, and a number of remote areas with low human population and a high standing stock of resource fishes. Additional locations were found to have lower than expected biomass based on physical factors alone, highlighting the importance of considering natural variability in the context of human induced variation. Collectively, these results show the strong gradients of natural forcing and human impacts that occur across the MHI.

Drell, P.B.1*, Chow, B.1, Desmet, D.1, Chapman, M.D.2, Cohen, C.S.1
INTERACTIONS BETWEEN DIDEMNUM VEXILLUM AND PACIFIC HERRING (CLUPEA PALLASII) IN NATURAL AND ARTIFICIAL ROE DEPOSITION EXPERIMENTS
1 - San Francisco State University, 2 - University of Alaska Southeast, Sitka
Pacific herring (Clupea pallasii) sustain important commercial and subsistence fisheries. Pacific herring deposit eggs on various substrates including shallow rocky bottoms. Didemnum vexillum, a globally-invasive colonial ascidian, has been found to rapidly overgrow competitors on shallow rocky bottoms. Nonindigenous D. vexillum populations occur at multiple locations within the natural range of Pacific herring. The 2010 discovery of D. vexillum in Sitka, Alaska raised concerns about interactions between these species. In this study, natural and artificial egg deposition experiments were carried out in San Francisco Bay examining D. vexillum as spawning substrate. In
artificial deposition, eggs were transferred to *D. vexillum* tunics. In natural deposition, tunicates cultured on PVC plates were placed in areas of herring spawn. Some natural deposition occurred on *D. vexillum*, with relatively lower egg abundance on smoother tunicate surfaces in comparison to more rugose tunicate topography. In experiments in the lab and in situ, *D. vexillum* overgrew some eggs prior to hatching. In Sitka, Alaska in 2013, herring spawn occurred in a *D. vexillum* infested area. Preliminary field observations suggested similar interactions. If successful egg deposition is reduced by *D. vexillum*, or if egg overgrowth occurs significantly in the wild, this invasive species could impact herring reproduction.

† Eckdahl, K.A.*, Zacherl, D.C.
COME SHELL OR TIDEWATER...THE BLACK ABALONE (*HALIOTIS CRACHERODII*) ‘RETURNS’ TO THE SOUTHERN CALIFORNIA MAINLAND
California State University, Fullerton

The black abalone (*Haliotis cracherodii*) is an endangered species that was once abundant in the rocky intertidal zone of southern California until overfishing and Withering Disease drastically reduced populations on the mainland and the Channel Islands. The black abalone was listed as endangered in 2009. Its current geographic range is from Point Arena, California, USA to Bahia Tortugas, Mexico; however, since the mid 1990s, black abalone have been rare south of Point Conception on the California mainland coast. In recent years populations on the Channel Islands have experienced recruitment, but the current status of black abalone on the southern CA mainland remained unknown. I conducted rocky intertidal surveys for black abalone from Point Conception to San Diego to determine if recruitment is occurring on the mainland and to measure population density. I also conducted habitat assessments to document black abalone habitat availability. Black abalone are present but rare along the southern CA coast; the presence of smaller individuals indicates recruitment has occurred within the last few years. Densities are much lower than the published minimum density required for successful spawning to occur. Good black abalone habitat remains, but in some areas sessile organisms occupy potential recruitment space.

Eckert, G.L.*, Z. Hoyt¹, Gill, V.²
SEA OTTER FORAGING ON COMMERCIALLY IMPORTANT SHELLFISH IN SOUTHEAST ALASKA
1 - University of Alaska Fairbanks, 2 - Bureau of Ocean and Energy Management

The recolonization of sea otters in Southeast Alaska has resulted in direct competition with humans for shellfish. Sea otters were exterminated in Southeast Alaska during the 18th-19th century fur trade, and their shellfish prey flourished for 100-200 years in their absence. To quantify the direct impact of sea otters on commercially important invertebrate species, we investigated sea otter foraging in Southeast Alaska. Commercially important invertebrate prey species observed in sea otter diets include red sea urchins, Dungeness crab, sea cucumbers, pinto abalone, geoduck clams, red king crab, Tanner crab and several species of shrimp. Diet diversity increased logarithmically as a function of the duration of sea otter occupation, and the fraction of commercially important invertebrates in the diet decreased with sea otter density and time of occupation. Several areas in the region showed evidence of sea otters reaching or exceeding carrying capacity as preferred prey species were reduced; however, in most regions, sea otter density increased without limitation. We expect that the sea otter population in Southeast Alaska will continue to expand until preferred resources are reduced across the region, with increasing conflict for commercial and subsistence shellfish fisheries.

Edmunds, P.J.*, Burgess, S.C.²
SIZE-DEPENDENCY IN THE RESPONSE OF THE BRANCHING CORAL *POCILLOPORA VERRUCOSA* TO ELEVATED TEMPERATURE AND HIGH PCO₂
1 - California State University, Northridge, 2 - Florida State University

We tested the hypothesis that colony size (2-13 cm diameter) of the coral *Pocillopora verrucosa* affects the response to temperature (26.6°C and 29.8°C) and PCO₂ (405 μatm and 1007 μatm) as measured by growth, dark respiration, and gross photosynthesis (at 8 cm s⁻¹). After 25 d, growth was affected by the interaction of PCO₂ × temperature, respiration by the interaction of temperature × size, and photosynthesis by the interactions of temperature × size and PCO₂ × temperature. Growth was depressed by high PCO₂ at low temperature (but not high temperature), and gross photosynthesis was accentuated by high PCO₂ at high temperature (but not low temperature); the respiration of small- (1–3 cm) and medium- (4–6 cm) sized colonies was accelerated by high temperature, whereas large colonies (9–14 cm) escaped the effects of high temperature; for gross photosynthesis, small colonies were adversely affected by high temperature, medium colonies benefited from high temperature, and large colonies escaped the effects of high temperature. In addition to demonstrating how the response of a coral to high PCO₂ can be modulated by temperature, these results underscore the important of colony size for branching corals in determining the response to GCC (but not OA).

Edwards, M.S.*, Konar, B.K.², Efird, T.²
LOCAL VERSUS REGIONAL HABITAT INFLUENCES ON FISH ASSEMBLAGES IN THE DIMINISHING KELP FORESTS ACROSS THE ALEUTIAN ARCHIPELAGO

1 - San Diego State University, 2 - University of Alaska Fairbanks

Fish distributions are influenced by changes in both their local habitat features and regional oceanographic conditions. Currently, the coastal waters of the Aleutian Archipelago are dominated by two discrete habitats types, kelp forests and urchin barrens, both of which occur on opposing sides of known biogeographic breaks. Overall, urchin barrens are far more abundant and cover a greater spatial area, but small remnant kelp forests remain on most of the islands. This study assessed how local habitat characteristics and regional oceanographic patterns influence nearshore fish assemblages throughout the Aleutian Archipelago. To explore this, 28 kelp forests and 28 urchin barrens were surveyed for fish assemblages and habitat characters. Multivariate analysis indicated that while local factors, namely the abundance of stipitate kelps, understory fleshy algae and encrusting coralline algae, and the percent cover of gravel and bedrock, best accounted for the variation in fish assemblages, these did not significantly impact them. In addition, it appears that the biogeographic break at Samalga Pass is significant for nearshore fish assemblages, particularly for gadids and greenlings. If water mass properties and patterns change around Samalga Pass in the future, then impacts may be seen in the fish assemblages in these areas.

Eernisse, D.J.*, Draeger, A.²
A LIKELY NEW CHITON SPECIES OF FERREIRAELLA FOUND ON SUNKEN WOOD DEPLOYED OFF BIG SUR, CALIFORNIA

1 - California State University, Fullerton, 2 - Kensington, California

Three chiton genera are found on sunken wood in the deep ocean, but a hypothesized wood diet has recently been rejected for wood-associated members of two of the three genera based on stable isotope evidence. Most members of the third genus, Ferreiraella, are wood associated, and most are restricted to the Western Pacific. Two other species of Ferreiraella are known from the Caribbean and one, F. scrippsiana, is the only known species in the Eastern Pacific, specifically from south of Cabo San Lucas, Mexico. We recently examined three small chitons found living on one of 36 Acacia logs that were deployed in 2006 at 3203m off Big Sur, CA, by Drs. Craig McClain and James Barry. Morphological examination reveals these belong to a species of Ferreiraella that substantially differs from the other Eastern Pacific member of the genus, F. scrippsiana, and more subtly differs from other Ferreiraella species in the arrangement of its aesthete pores. DNA sequencing is underway to test our assignment of this species to Ferreiraella and, if supported, estimate its phylogeographic affinities with other sequenced species of Ferreiraella. We have harvested the intestines from the intended paratype specimen to investigate whether there is evidence for wood digestion.

Elahi, R.¹*, O'Connor, M.I.², Byrnes, J.E.³
HUMAN-DRIVEN GAINS AND LOSSES OF LOCAL SPECIES DIVERSITY IN MODERN MARINE COASTAL SYSTEMS

1 - Hopkins Marine Station of Stanford University, 2 - University of British Columbia, 3 - University of Massachusetts

The modern biodiversity crisis reflects global extinctions and local introductions, and their real consequences for ecological integrity and ecosystems services. Surprisingly, temporal trends in the number of species in fine-scale sampling areas have not reflected predictions of loss given pervasive human impacts, raising questions about the severity of the biodiversity crisis and the resilience of biological communities to human impacts. We analyzed 452 time series and found that net loss of species in marine coastal systems was associated with localized Effects of detrimental human activities, but that local net gain of species was the prevailing signal in the absence of documented human stressors. Most assemblages in our dataset gained species in recent decades: communities with relatively low richness experienced the greatest gains, assemblages low in the food chain exhibited greater increases than consumers and predators, and site-scale richness increased faster than plot-scale richness. These patterns are consistent with a dominating influence of human activities on biodiversity, in which local species loss in areas with direct, heavy human impacts is complemented by invasions and range expansions in lower impact areas.

Eliott, J.K.*, Dewey, C., Lee, J., Lim, A.Y., Lochner, R.H., Clark, C., Barton, K.E., Martin, M.O.
SAWMILLS, SULFIDES, AND SYMBIOSIS: NOVEL RELATIONSHIPS BETWEEN BACTERIA AND MARINE ORGANISMS AT SULFIDE SEEPS IN PUGET SOUND

University of Puget Sound

Visible mats of filamentous bacteria have been observed on the surface of sediments and other substrates (e.g., rocks and crabs) in nearshore areas of Commencement Bay, WA. These areas have been found to have high amounts of wood debris (from former sawmills) buried in the sediments, and decomposition by sulfate-reducing bacteria has created a very high sulfide environment (> 1 mM) in sediment porewater and where streams of water are seeping from intertidal sediments at low tide. The objective of this study was to use microscopy (SEM, FISH)
and genetic methods (cloning and sequencing, next generation sequencing) to compare the diversity, distribution, and abundance of bacteria on these different substrates. There were significant differences in the types of microbes and their relative abundances between sand (with and without eelgrass), rocks and crabs. Sulfide-oxidizing bacteria were the most common members of the microbial communities, and they were closely related to those found on deep sea hydrothermal vents. These microbial communities are amenable to detailed experimental study, which will provide insight into ecological relationships of microbes in high sulfide environments and symbioses with marine organisms.

† Ellis, A.E.*, Edmunds, P.J.
THE EFFECTS OF TEMPERATURE AND SUBSTRATUM TYPE ON THE SETTLEMENT PREFERENCE AND POST-SETTLEMENT SUCCESS OF A REEF CORAL
California State University, Northridge
Chemical cues from crustose coralline algae (CCA) may be pivotal for the settlement and recruitment of marine invertebrates including coral, with certain CCA facilitating larval settlement and post-settlement growth. While coral settlement onto CCA declines under elevated temperatures, it is unknown how high temperatures affect post-settlement success (survivorship and growth) for corals on CCA vs. other surfaces. This study tested the effects of temperature (26.5°C and 30°C) on settlement and post-settlement success of Pocillopora damicornis when settled on CCA and bare rock. After 48 h exposure to settlement surfaces, most larvae chose CCA (>55%) vs. bare rock (<2%), and settlement was unaffected by temperature. Over 4 weeks, post-settlement survivorship on bare rock at 30°C was lower than in any other treatment combination, but growth (basal tissue area and skeleton diameter) was greater on bare rock versus CCA. Together, these results suggest that the factors determining the success of coral recruits is more complex than originally suggested, with high survivorship on CCA uncoupled from rapid growth, at least over 30 d following settlement.

† Elsberry, L.A.*, Bracken, M.E.S.
SPECIES CO-OCCURRENCE PATTERNS AND ENVIRONMENTAL FILTERING ARE DRIVERS OF INTERTIDAL COMMUNITY COMPOSITION
University of California, Irvine
Ecologists have debated whether communities are formed stochastically or if environmental filters determine which species are present at a given location. We examined species co-occurrence to determine if environmental filtering is occurring across four rocky intertidal communities on the US west coast. At each site, we surveyed organisms in quadrats located at 0.5-meter vertical intervals along three randomly located transects. We compared our observed communities to random, simulated communities as a null expectation of stochastic community development. We found that patterns of co-occurrence for all species were non-random at the largest spatial scale. However, when species were divided into sessile vs. mobile organisms, this pattern held true only for mobile species. At a regional scale, random co-occurrence patterns were associated with including the northernmost site in Oregon. Co-occurrence was also random when transects within sites were compared. We found that there were similar numbers of positive and negative interactions based on pair-wise correlation of abundances of species. However, the only significant associations were negative, for both mobile and sessile species. By understanding these general patterns of community composition, we can formulate more specific hypotheses about the roles of biotic and abiotic filters and species interactions in structuring intertidal communities.

† Evensen, N.R.*, Edmunds P.J.
THE EFFECTS OF OCEAN ACIDIFICATION ON COMPETITIVE INTERACTIONS AMONG CORALS IN A SIMULATED CORAL COMMUNITY
California State University, Northridge
The dispersion of competitors within a habitat can affect the outcomes of competitive interactions, and these effects are likely to be mediated by the physical environment. pCO₂ is one aspect of the physical environment that may be important in this regard, and this creates a means by which ocean acidification (OA) could modulate coral community structure. In this study, we tested the hypothesis that OA affects how neighboring corals interact with a focal coral through competitive interactions. Single colonies of Pocillopora verrucosa were placed in competitive arrangements surrounded by 0, 1, or 3 colonies of P. verrucosa or Acropora hyacinthus, and incubated at 400 µatm or 1000 µatm pCO₂ for 4 weeks at 7 cm/s flow speed; calcification, planar area, and apical growth were measured for the focal coral. Calcification and planar area were both affected by pCO₂ and competitive arrangements, decreasing 29% and 50% (respectively) under elevated pCO₂, but the effect of pCO₂ on calcification was mediated by neighboring conspecific corals. Apical growth was affected by competitive arrangements, but not pCO₂, with growth lower in interspecific pairings compared to intraspecific pairings. These results show that OA can alter how corals interact, with measures of growth differently affected by pH.

† Feehan, C.J.*, Scheibling, R.E.
EFFECTS OF SEA URCHIN DISEASE ON COASTAL MARINE ECOSYSTEMS

Dalhousie University

Outbreaks of disease in herbivorous sea urchins have led to ecosystem phase shifts from urchin barrens to kelp beds (forests) on temperate rocky reefs, and from coral to macroalgal-dominated reefs in the tropics. We analyzed temporal patterns in epizootics that cause mass mortality of sea urchins, and consequent phase shifts, based on published records over a 42-year period (1970–2012). We found no evidence for a general increase in disease outbreaks among seven species of ecologically important and intensively studied sea urchins. Periodic waves of recurrent amoebic disease of *Strongylocentrotus droebachiensis* in Nova Scotia coincide with periods when the system was in a barrens state and appear to have increased in frequency. In contrast, following a major epizootic that decimated *Diadema antillarum* throughout the Caribbean in 1983, subsequent outbreaks of disease were highly localized and none have been reported since 1991. Epizootics of *Strongylocentrotus* in the NW Atlantic and NE Pacific, and *Paracentrotus* and *Diadema* in the eastern Atlantic, have been linked to climate change and overfishing of sea urchin predators. The spatial extent of recurrent disease outbreaks in these species, and the frequency of phase shifts associated with these epizootics, has decreased over time due to the expansion of the macroalgal state and its stabilization through positive feedback mechanisms.

† Fennie, H.W.†, Hamilton, S.L.†, Sogard, S.M.‖, Barry, J.P.‖

EARLY LIFE HISTORY DETERMINES THE EFFECTS OF OCEAN ACIDIFICATION ON THE BEHAVIOR AND PHYSIOLOGY OF JUVENILE ROCKFISHES

1 - Moss Landing Marine Laboratories, 2 - NOAA Southwest Fisheries Science Center, 3 - Monterey Bay Aquarium Research Institute

The rapid increase of anthropogenic carbon dioxide (CO₂) emissions to the atmosphere is altering seawater chemistry at an alarming rate. Many studies have shown that elevated dissolved seawater CO₂ (i.e. pCO₂) concentrations and associated decreases in seawater pH will have negative impacts on marine organisms that secrete calcium carbonate structures. Recent research has shown that decreased pH affects the behavior and physiology of several tropical and temperate fishes, but some species appear to be resilient to near future pH levels. We investigated how two early life history strategies of Central California nearshore rockfishes determine susceptibility to pH mediated behavioral and physiological impairments. We reared three canopy recruiting rockfish species and three benthic recruiting rockfish species in 4 pH treatments (8.0, 7.8, 7.5, and 7.2) for 3 months. During that time, we examined the effect of decreased pH on behavioral lateralization, critical swimming speed, and aerobic scope. We found that benthic recruiting species appear resistant to pH-mediated impairments while canopy recruiting species suffer behavioral and physiological impairments at low pH. These findings indicate that ocean acidification may differentially affect the fitness of Central California nearshore rockfishes, which could alter the species composition of California’s kelp forests in the future.

† Flenbee-Dexter, K.*, Feehan, C.J., Scheibling, R.E.

PHASE SHIFTS FROM KELP BEDS TO TURF OR INVASIVE ALGAL-DOMINATED ASSEMBLAGES OVER DECADAL TIME SCALES IN NOVA SCOTIA

Dalhousie University

Changing environmental conditions, such as ocean warming, increased storm activity and invasive species can dramatically alter ecosystem structure. We show that the algal community has significantly changed in the last 46 years in rocky subtidal ecosystems in Nova Scotia, with a reduction in the abundance of habitat-forming kelp species and a shift towards a turf or invasive-algal dominated state. We tracked changes in kelp biomass from 1968 to 2014 and measured algal community composition along 120 km of coastline in 2000, 2007 and 2014. Kelp loss, and the associated increase in turf-forming algae, was most pronounced in protected bays where blade fragmentation due to warming temperatures and encrustation by an invasive bryozoan is prominent. The invasive rockweed *Fucus serratus* was abundant in the westernmost sites, where it is expanding its range. The invasive green alga *Codium fragile fragile* was present in most sites, but at lower abundance than in previous years. Sediment accumulation was higher in sites with high turf biomass, and may prevent kelp re-establishment. While colder, more exposed kelp beds demonstrate some resilience to the multiple perturbations that have occurred over the last 4 decades, the sheltered coastline has experienced a substantial loss of habitat structure and productivity.

† Fitzgerald, M.*, Funk, J.L.‖, Whitcraft, C.‖, Allen, B.J.‖

THE RELATIONSHIP BETWEEN PLANT BIODIVERSITY AND ECOSYSTEM FUNCTION IN A COASTAL WETLAND

1 - California State University, Long Beach, 2 - Chapman University

The loss of as much as 90% of coastal wetlands in California over the past century has motivated research aimed at understanding the effects of such habitat decline. Although many of the most significant impacts of habitat loss are assumed to be related to reductions in species diversity, investigations into the relationship between biodiversity and ecosystem function (BEF) have historically focused on terrestrial communities. Our research
explores the BEF relationship in Colorado Lagoon, a recently restored salt marsh in Long Beach, CA. We hypothesize that: (1) experimentally increasing plant diversity will result in higher primary productivity and increased recruitment of native salt marsh plants; (2) observed variation in plot-level responses will be correlated with species-specific variation in individual demographic parameters; and (3) variation in demographic parameters and resulting ecosystem processes among treatments at a given diversity level will be correlated with species-specific functional traits. Preliminary data suggest that elevation and plant species identity contribute to patterns of plant survival and percent cover, and that patterns of recruitment support an active restoration strategy. We are currently evaluating the degree to which plant life history traits correlate with observed functional differences to help managers assemble the most successful planting palettes for restoration.

Francis, T.B. 1*, Shelton, A.O. 2, Williams, G.S. 2, Levin, P.S. 2
PREDATION IS A MAJOR SOURCE OF HERRING EGG MORTALITY IN PUGET SOUND, WA
1 - Puget Sound Institute, University of Washington, Tacoma, 2 - Conservation Biology Division, Northwest Fisheries Science Center
Predation can drive fish populations into lower-abundance stable states by reducing stock productivity. Therefore, understanding predator effects can be critical in devising recovery strategies for depressed or declining fish stocks. Specifically, predation on Pacific herring eggs can decouple spawning stock biomass (SSB), a metric of egg production used to track herring population trends, from larval production, a measure of egg hatch rates. Egg loss rates in Puget Sound herring vary across subpopulations, as do trends in SSB. However, the sources of egg loss – including wave action, contamination, predation – have not previously been identified. We investigated the role of predation in herring egg mortality by measuring egg loss rates of 5 subpopulations of herring across Puget Sound. We estimated in situ egg loss rates in the presence and absence of large predators (e.g., birds and large fish) over a 14-day incubation period, and found much greater egg loss outside of predator exclusion devices across all sites. Intense egg predation by diving ducks was observed on all new herring spawn. We explore some of the population-level consequences of predator-driven egg mortality for Puget Sound herring. Our findings highlight the importance of food web interactions in the management of marine ecosystems.

† Fuentes, C.M. 1*, Whitcraft, C. 2, Zacherl, D. 1
OLYMPIA (OSTREA LURIDA) AND JAPANESE (CRASSOSTREA GIGAS) OYSTER RECRUITMENT ONTO A CONSTRUCTED OYSTER BED IN ALAMITOS BAY, CA
1 - California State University, Fullerton, 2 - California State University, Long Beach
Oyster restoration projects seek to increase oyster density via augmentation of mudflat with hard substrata to increase recruitment. We examined the effects of a constructed oyster bed on the settlement and recruitment rates, and adult densities of native Ostrea lurida and non-native Crassostrea gigas at Jack Dunster Marine Reserve in Alamitos Bay, CA. Dead C. gigas shell was used to construct a 2X30m bed. Throughout the next two years we periodically monitored shell loss via point-contact sampling, settlement via deployment of replicate (n=4) ceramic tiles, and recruitment and adult oyster density via excavation of replicate (n=7) 25cm X 25cm plots randomly placed within the bed and at an un-augmented control bed. After heavy shell loss of ~72% after one year, the bed was augmented on the seaward side with more shell. There were higher densities of O. lurida recruits and adults on the constructed bed relative to the control, with densities on the initial bed 5X, and on the new section of bed 62X, those of reference populations throughout Alamitos Bay. C. gigas also recruited in densities 3X greater than reference populations. Adding more shell at the seaward side achieved a higher shell % cover and increased O. lurida densities.

† Gatins, R.1*, Saenz-Agudelo, P. 2, Scott, A. 3, Berumen, M.L. 1
FINE-SCALE POPULATION STRUCTURE OF TWO HOST SEA ANEMONES IN KIMBE BAY, PAPUA NEW GUINEA
1 - Red Sea Research Center, King Abdullah University of Science and Technology, 2 - Universidad Austral de Chile, 3 - National Marine Science Centre, Southern Cross University
Anemonefish are one of the main groups that have been used over the last decade to empirically measure larval dispersal and connectivity in coral reef populations. A few species of sea anemones are integral to the life history of these fish, yet the biology and population structure of these anemones remains poorly understood. In this study, our aim was to measure the genetic structure of these anemones within and between two reefs, separated by approximately 25 km, to assess their reproductive mode and dispersal potential. We sampled two species (Stichodactyla gigantea and Heteractis magnifica) almost exhaustively at Tuare and Kimbe Island in Kimbe Bay. Panels of microsatellite markers were developed for each species using next generation sequencing tools. Analyses confirmed six pairs of clones for S. gigantea (n=350) and none for H. magnifica (n=128), indicating presence/absence of asexual reproduction in this region. Results show the first genetic evidence of their reproductive characteristics, with high levels of connectivity and kinship being found within and between islands.
Host anemones are heavily targeted for the aquarium trade and are also susceptible to bleaching, so understanding their biology is crucial for developing better management strategies.

Gerstenmaier, C.E., Krueger-Hadfield, S.A., Sotka, E.E.*
GENETIC DIVERSITY AFFECTS COMMUNITY PROCESSES WITHIN A NON-NATIVE POPULATION OF THE SEAWEED GRACILARIA VERMICULOPHYLLA
Grice Marine Laboratory, College of Charleston
Species diversity affects community and ecosystem processes such as productivity, nutrient cycling, and resistance to stressors. Recent evidence indicates that genetic diversity within populations of keystone and numerically-dominant species may play analogous and equally-important roles. We tested whether intraspecific diversity within a numerically-dominant population of non-native seaweed alters community-level processes. The Asian red seaweed Gracilaria vermiculophylla occurs in virtually every temperate estuary of the Northern Hemisphere. In South Carolina and Georgia, estuarine mudflats are historically-devoid of native seaweeds, and currently Gracilaria represents 90-100% of the standing biomass. Two field surveys indicated that genotypic diversity (as determined by 7 microsatellite markers) at small (0.04 m²) spatial scales did not correlate with epibiotic abundance nor diversity nor bacterial abundance. However, when we outplanted monocultures and polycultures (8 genotypes) of Gracilaria, we found that polycultures tended to have higher growth rates, and lower bacterial loads and epifaunal abundances. These results suggest that the effect of even modest levels of genetic diversity can influence community processes within non-native populations of seaweeds.

† Gil, M.A.*, Heim, A.M.†
FISHBOOK: DO PREY SOCIAL NETWORKS INFLUENCE PREDATOR EFFECTS ON REEF FISHES?
1 - University of Florida, 2 - Princeton University
Perceived risk of predation can impose significant costs on prey (i.e., non-consumptive predator effects, NCPEs), including reduced energy intake and increased emigration. While NCPEs can be driven by direct predatory cues, sensory information delivered by other prey can also drive NCPEs. This ‘social information’ can spread rapidly over tremendous spatial scales, linking the behavior of many individuals, including conspecifics and heterospecifics. Using remote video camera arrays in a field experiment, we quantified the effect of a non-consumptive predator (spear fisherman) on mixed-species assemblages of reef fishes and whether this effect depended on the prey social network. Our results indicated that reef fishes unanimously abandoned high-resource patches when they were visited by the non-consumptive predator. Our results further showed that prey flight from resource patches depended on the density of prey, with flight occurring sooner (i.e., at greater predator distances) with higher reef fish densities. Our findings suggest that social information reinforces NCPEs on reef fishes, whose local function may consequently be reduced. Moreover, the primary reef fishes in our study were herbivores that consume benthic algae that harm corals, suggesting that NCPEs and social information could influence the resilience of coral reefs, in which fishing practices are increasing worldwide.

Good, T.P.*, Ward, E.J., Antonelis, K.
DEADLIEST BYCATCH: ESTIMATING THE IMPACTS OF DERELICT FISHING GEAR ON MARINE TAXA
1 - Northwest Fisheries Science Center/NOAA Fisheries, 2 - Natural Resources Consultants, Inc.
Millions of tons of fishing gear is lost or abandoned into the world’s oceans annually, where it persists and threatens marine organisms. In Puget Sound and the Northwest Straits, thousands of fishing nets have been lost over the last 50 years, posing a risk to marine wildlife. Since 2002, almost 5000 derelict fishing nets have been located and removed from Puget Sound waters. We used data collected from 4000+ recovered derelict gillnets to: document mortality of marine animals (ghost fishing); pinpoint characteristics of gillnets associated with observed mortality; and use those characteristics to estimate mortality impacts of derelict gillnets over time. Almost 200,000 individuals of more than 200 marine vertebrate and invertebrate species were recorded dead in recovered gillnets. Net characteristics (e.g., location, habitat, size, net suspension) influenced biological impacts (presence/counts of animals; animals/m² of net) for all major taxon groups. Estimated mortality impacts of derelict nets during their ghost fishing time, using varying catchability over time, dwarfed numbers recorded during gear recovery. Bathymetry and net characteristics of derelict nets recovered from the southern Salish Sea (Puget Sound) are being used to predict hotspots in the northern Salish Sea to guide and prioritize removal of derelict gear in British Columbia.

† Goodell, W.*, Stamoulis, K.A., Friedlander, A.M.
JUVENILE FISH HABITATS: INTEGRATING SCIENCE, GIS, AND LOCAL KNOWLEDGE TO INFORM COMMUNITY-BASED MANAGEMENT IN HĀ’ENA, KAUA‘I
Fisheries Ecology Research Lab, University of Hawai‘i at Mānoa
Nearshore fish populations are in decline in the Main Hawaiian Islands, and in recent years there has been greater emphasis on the value of ecosystem-based local management. This project integrates multiple knowledge sources
to provide a basis for effective community-based resource management in a rural Hawaiian community. Set in the context of existing local knowledge of nearshore resources, nursery habitats for juvenile reef fishes - areas of particular ecological value for sustaining fisheries resources – are identified. This is achieved with a spatially-explicit approach based on detailed habitat maps to better understand the patterns and processes that regulate ecosystem function. This study tests the hypothesis that juvenile reef fish are significantly influenced by seascape variables, such as composition of surrounding habitat types. By placing the nursery-role hypothesis in a clearly defined and testable framework, nursery habitats of coral reef fishes in the nearshore reefs of Hā‘ena, Kaua‘i are investigated in a quantitative manner, supplementing the local knowledge that exists within the community. An ecosystem-based management approach, informed by multiple knowledge sources, will help to ensure the sustainability of fisheries and maintain the societal benefits provided by the ecosystem.

† Gould, A.L.1*, Harii, S.2, Dunlap, P.V.1
HOMING, SITE FIDELITY, AND OLFACTORY PREFERENCES OF A SYMBIOTICALLY BOLUMINESCENT CARDINALFISH
1 - University of Michigan, 2 - Sesoko Station, University of the Ryukyus
Cardinalfishes (Apogonidae) generally express fidelity to daytime resting sites and are known for their ability to home from relatively large distances, affecting both nutrient cycling and the community assemblage at a reef. Here we determine the preference of the symbiotically bioluminescent cardinalfish, *Siphamia tubifer*, for a host urchin species as its daytime refuge, and define the fish’s fidelity to a particular urchin, ability to return home after displacement, and preference for relevant olfactory cues. Using field transects and mark-recapture methods in Okinawa, Japan, we observed a distinct preference for *S. tubifer* to associate with *Diadema setosum* as its host (*P*<0.001), daily fidelity to an urchin (26-37% of tagged *S. tubifer* were recovered at the same urchin over one week), and significant homing ability (23-43% of tagged fish returned within two days to their original reef from two kilometers away). In a two-channel choice flume, juvenile and adult *S. tubifer* preferred the chemical cues of their home site water and luminous bacterial symbiont, but not of their host urchins, and only juveniles preferred the olfactory cues of conspecifics. Our results indicate that *S. tubifer* may use site-specific chemical cues, including that of their symbiont, to home, potentially influencing symbiont acquisition by recruiting larvae.

† Grason, E.W.*
FEAR OF THE UNKNOWN: EVIDENCE FOR GENERALIZED RISK ASSESSMENT IN NON-NATIVE MARINE SNAILS
University of Washington
Strong anti-predator defenses in response to general risk cues (cues originating from injured or disturbed conspecifics) are thought to be maladaptive, because they could cause prey to overestimate risk, and incur unnecessary opportunity costs. However, when prey lack a co-history with the predator, as is typically the case in species invasions, prey could be constrained to rely on general cues because they might be naïve to more specific information from novel predators. In mesocosm experiments, I explored the relative importance of general versus specific predation risk information in seven marine snail species (3 native, 4 non-native) in response to a single native crab. All non-native snails assayed demonstrated generalized risk assessment, based on: 1) avoidance behavior was greater in response to the general (injured conspecifics) than specific cue (predator); and 2) the presence of the full predation cue (conspecific prey consumed by predator) did not further increase avoidance behavior. Conversely, native snails avoided maximally only when presented with the full predation cue, thus requiring maximum information content to demonstrate the strongest avoidance behavior. Information generalism is prevalent among invasive snails in Washington, but it remains unclear whether it is a driver of, or a response to, species invasions.

† Gravem, S.A.*, Morgan, S.G.
OLLY OLLY OXEN FREE! VERTICAL AND MICROHABITAT SHIFTS OF AN INTERTIDAL SNAIL FOLLOWING MASS MORTALITY OF A SEASTAR PREDATOR
Bodega Marine Laboratory, University of California, Davis
Behavioral and population size responses by the herbivorous intertidal snail Chlorostoma funebralis after the mortality of their small seastar predator Leptasterias sp. reveal the dynamic nature of zonation patterns for prey organisms in the intertidal zone. Nearly 100% of *Leptasterias* died in a local mortality event in early December 2010 on Bodega Head, Bodega Bay CA and the population has not recovered. Before the mortality event in spring 2010, small individuals (< 15 mm diameter) were more common in the high intertidal zone and tended to be outside tidepools containing *Leptasterias* at low tide. Large snails, which are less vulnerable to *Leptasterias* predation, showed no pattern with shore level or seastar presence. After predator mortality, during which no other predators were strongly affected, small snails were 144% more abundant, shifted nearly 1m lower on the shore, and 15% more shifted into tidepools. Little change was detected for large snails. We show that even small predators can have drastic effects on prey populations, and anti-predator behavior strongly dictates the vertical distribution and
habitats. This project deployed the Catlin Seaview Survey SVII imaging system (known for collecting tropical imagery for Google Earth and the Global Reef Record) around Sydney Harbour, Australia. This is the first study to provide detailed maps of shallow sub-tidal rocky reef habitat in the area, from which to investigate heterogeneity, fragmentation and the effects of a range of stressors on species distribution. The field program produced 11,000 1 x 1 m photo quadrats from 9 reef sites, which were classified using SCRIPPS CoralNET machine learning tool. Initial investigation of heterogeneity has reinforced our knowledge of the importance of urchins in determining the persistence of dominant kelp Ecklonia radiata. Furthermore, species distribution models built from this high resolution spatial data set will allow investigation into effects of a range of threats and stressors across multiple spatial scales.

This project is a collaboration between the Sydney Institute of Marine Science (SIMS), the Global Change Institute at the University of Queensland, Australia, and the Catlin Seaview Survey/Underwater Earth.

Grunbaum, D.†, Emlet, R.‡
THE FUNCTIONAL MORPHOLOGY OF MINIMALIST MORPHOLOGIES: SWIMMING PERFORMANCE OF BLASTULAE, GASTRULAE, AND OTHER SPHEROIDAL ORGANISM ARCHITECTURES
1 - University of Washington, 2 - Oregon Institute of Marine Biology
Late stage marine larvae and many other plankton develop complex morphologies with features such as arms or other extensions, skeletons, and cilia or muscles that play important roles in orientation, speed and other elements of swimming performance. Equally interesting, and perhaps more basal in evolutionary history, are blastulae, gastrulae and other organisms with minimalist, spheroidal morphologies that swim, are subject to performance requirements, but lack elaborations traditionally associated with swimming. How do these “simple” organisms swim, and how are their morphologies constrained by the need to do so? Cell divisions that produce blastulae or gastrulae with uneven distributions of tissue have preferred orientations that are stable in still water and provide righting moments in turbulence. Theory predicts that if these stages have locomotory structures that are radially distributed around the axis determined by the offset centers of mass and buoyancy, they will swim in a direction parallel to this axis until the intensity of water motion overcomes their shape-dependent orientation abilities. We explored this prediction and inference by surveying the initial swimming stages of marine invertebrate taxa and with computational simulations which model shape, centers of mass and buoyancy and various arrangements of locomotory cilia.

†Hargarten, H.L.†, Johansson, M.L.†, Coelho, N.C.†, Jeffries, S.‡, Graham, M.H.‡, Alberto, F.†
ECOLOGICAL DIVERGENCE BETWEEN PHENOTYPIC MORPHS OF GIANT KELP
1 - University of Wisconsin, Milwaukee, 2 - Moss Landing Marine Laboratories
Organisms living along environmental gradients often utilize phenotypic plasticity to maximize their survival across a range of conditions. Wherever gradients occur, there is potential for divergence through isolation-by-adaptation (IBA) to build-up between genotypes experiencing different selective pressures. Giant kelp, Macrocystis spp., shows striking plasticity in holdfast morphology and reproductive strategy when colonizing intertidal (M. integrifolia morph) versus subtidal (M. pyrifera morph) areas along temperate rocky coastlines of the eastern Pacific Ocean. In the intertidal, high levels of irradiance limit development of spores, recruitment of microscopic gametophytes, and survival of embryonic sporophytes of M. pyrifera. Few studies have examined the effects of irradiance stress on M. integrifolia's developmental stages, thus we focus on understanding the role IBA and plasticity have in maintaining Macrocystis morphs along the California coastline. Genetic results from the field show higher differentiation between adjacent subtidal and intertidal patches than between subtidal patches, suggesting IBA. Several potential mechanisms could explain this result: non-random mating, longer generation times via asexual growth, and differential mortality due to early adaptive divergence. To explore the hypothesis of differential survival due to adaptive divergence, we experimentally tested assortative matting at different development stages using controlled crosses of the two morphs under irradiance stress.

Hart, A.*
EFFECTS OF MULTIPLE STRESSORS ON THE GROWTH OF AN INTERTIDAL ROCKWEED
University of Washington
The rockweed Fucus distichus experiences gradients of tidal immersion, competition, and herbivory across its vertical range in the rocky intertidal. I designed two experiments to separate the effects of these stressors and examine potential non-additivity. In a test of F. distichus growth under simulated intertidal and subtidal conditions, growth was slower when always immersed, herbivorous snails had a stronger effect than immersion in reducing growth, and the combined effects were additive. Herbivory had a greater effect in reducing epiphyte load than immersion. In a test of growth across immersion time in the absence of herbivory, F. distichus had the lowest growth when always immersed and manual removal of epiphytes increased growth additively.

† Hart, C.E.*, Lema, S.C., Hardy, K.M.
IMPACT OF 4-NONYLPHENOL ON THE GENE-LEVEL IMMUNE RESPONSE OF THE PACIFIC OYSTER, CRASSOSTREA GIGAS, FOLLOWING BACTERIAL INFECTION
California Polytechnic State University, San Luis Obispo
Endocrine disrupting compounds (EDC’s) are chemicals that can interfere with hormone signaling pathways and are now recognized as pervasive in estuarine and marine waters. One emerging EDC in California’s coastal waters is the xenoestrogen 4-nonylphenol (4-NP), which has been shown to impair reproduction, development and in some cases immune function of marine invertebrates. To further investigate effects of 4-NP on marine invertebrate immune function, we conducted molecular-level characterizations of gene transcript changes in the Pacific oyster (C. gigas) following bacterial exposure. To quantify these effects we exposed oysters to dissolved phase 4-NP at high (100 mg/L) or low (2 mg/L) concentrations for 7 days, and then experimentally infected (via injection into the adductor muscle) the oysters with the marine bacterium Vibrio campbellii. After 24 hours, tissues (gill, mantle and hemocyte) were dissected and flash frozen in liquid nitrogen. Quantitative real-time RT-PCR was used to measure relative transcript abundances for genes known to respond to bacterial challenge (Bigdef1-3, BPI, DefH1-2, galectin, lectin2, lysozyme, transglutaminase, and TIMP). Thus far we have determined that exposure to 4-NP has a significant effect (p<0.06) on relative mRNA levels of BPI and galectin in the gill tissue with the most substantial differences occurring in the low dose for both bacterially-infected and -naïve oysters. Furthermore, bacterial infection alone has effects (p<0.06) on relative mRNA levels of TIMP, transglutaminase, and lysozyme across all 4-NP concentrations evaluated. These results suggest that exposure to 4-NP can alter the transcriptional responses of immune-related genes to bacterial infection in C. gigas.

† Hata, T.*, Denny, M.W.
HIGH FLOWS IN LOW PLACES: MEASURING SUB-MILLIMETER SCALE WATER VELOCITIES IN THE ROCKY INTERTIDAL ZONE
Hopkins Marine Station of Stanford University
Hydrodynamic forces generated by breaking waves are one of the greatest environmental stressors experienced by organisms residing in the rocky intertidal zone. Although past studies have developed methods to measure water velocity in this environment on the scale of centimeters—a scale relevant to relatively large organisms such as barnacles and limpets—measuring at finer scale has not been possible. Flow at sub-millimeter scales is important to characterize as it affects the distribution of small benthic organisms as well as larvae and spores seeking to settle. We have designed a pressure block able to continuously measure flow 250 microns above the substrate. We are also able to manipulate the topography immediately surrounding the pressure block to determine the effectiveness of apparent hydrodynamic shelters (e.g., within the interstices of a mussel bed). Data show that the flow environment across a flat plate at this height can exhibit extremely high velocities (> 5 m/s) with great
frequency (several occurrences per minute). Although local topography can reduce water velocities by up to 50%, these water velocities remain substantial. These measurements suggest that organisms of this size range cannot hide from hydrodynamic forces by residing in the boundary layer.

Haupt, A.J., Mach, M.
ARE CUMULATIVE IMPACT INDICES AN APPROPRIATE METRIC FOR CALIFORNIA CURRENT ECOSYSTEMS?
1 - University of Massachusetts, 2 - California State University, Monterey Bay, 3 - Center for Ocean Solutions, Stanford University

Marine ecosystems continue to be degraded due to increasing pressures from a variety of human activities and to assess these impacts a cumulative impact model was developed for the California Current. This cumulative impact score quantifies where impacts are the greatest along the coast, and is potentially useful to managers and policy makers because it narrows a complex interaction of factors into a single number that can directly contribute to environmental management decisions. However, it remains unclear whether impact scores accurately reflect the ecological status of marine systems. We compared cumulative impact scores and physical factors that play a role in structuring coastal ecosystems to biological data from rocky intertidal and kelp forest communities. Through a linear-mixed model approach we found evidence that suggests that in general, physical parameters, such as wind, wave and kelp abundance, perform as well or better than the cumulative impact models. We find that these cumulative impact scores may be useful indicators of ecological status at large regional scales, but do not perform as well at the local level. This study emphasizes the need for caution when using metrics like the cumulative impact models at local scales for policy and management of marine resources.

† Hayford, H.A.*, Carrington, E.C.
CATCHING WAVES: RADIO TRACKED SNAILS USE TIDAL CYCLES TO THERMOREGULATE
Friday Harbor Labs, University of Washington Biology

Intertidal organisms survive both marine and terrestrial stresses on a daily basis. If they are careful, mobile animals can take advantage of both habitats to avoid environmental extremes. The whelk, Nucella ostrina, finds its barnacle prey in greater abundance in the high intertidal. These regions are aerially exposed for long durations and temperature extremes occur far more frequently than in the thermally stable ocean. We hypothesized that migration and foraging behavior of free-range snails would lead to reduced exposure to extreme temperatures. We were interested in when during a tidal cycle snails moved into exposed high shore areas and whether these decisions shifted the distribution of temperatures the snails experienced. We tracked snails in exposed high-shore regions with radio frequency identification (RFID) tags and antennas affixed to the rocky intertidal. Snail presence in an antenna’s range was correlated to body temperature for a thermal snail mimic at that location. Snails chose a narrower range of temperatures than those available in the environment, disproportionately selecting intermediate temperatures and avoiding the highest environmental temperatures.

† Hayman, N.T.*, Hentschel B.T., Renick, V.C., Anderson, T.W.
EFFECTS OF FLOW SPEED AND SUB-LETHAL PESTICIDE EXPOSURE ON PREDATOR-PREY INTERACTIONS BETWEEN AN ESTUARINE FISH AND A POLYCHAETE
Coastal and Marine Institute, San Diego State University

We conducted a laboratory flume experiment to quantify how predator-prey interactions between California killifish (Fundulus parvipinnis) and a spionid polychaete (Polydora cornuta) vary with flow speed and sub-lethal exposure to the pesticide chlordane. Each organism was exposed to one of three chlordane concentrations (0, 1, 3 ppb) prior to being placed in the flume. The flume included a 300-cm² area of defaunated sediment in which we positioned 24 P. cornuta in a central patch (98.4 cm²). We videotaped groups of three killifish for 50 min at one of four flows (6, 9, 12, or 15 cm/s) and recorded their bite rate and the proportion of bites that were directed at the central prey patch. Worms also were videotaped to quantify their deposit- and suspension-feeding activities. At 6 cm/s 70% of the bites by killifish that were not exposed to chlordane were directed at the prey patch, and their patch selection decreased linearly as flow increased. Killifish exposed to chlordane did not selectively bite at the prey patch in any of the flows tested. Fish feeding was not altered by contaminating the prey with chlordane. The effects of flow speed and chlordane exposure on worm feeding behaviors were much more variable.

† Heare, J.E.*, Davis, J.P., Vadopalas, B., Roberts, S.
IDENTIFYING LOCAL OLYMPIA OYSTER STOCKS USEFUL FOR RESTORATION
University of Washington

Olympia oysters, Ostrea lurida, in Puget Sound, Washington are known to initiate reproduction at a specific temperature threshold. Bays along a latitudinal gradient within the Sound exhibit temporal variation in attaining this temperature. This gradient of habitat types has been shown in recent studies (Savolainen, 2007) to induce the phenomena of local adaptation within semi sessile and sessile native organisms. Since O. lurida is native to the
west coast, it is hypothesized that populations along a latitudinal gradient have become locally adapted to their environment. This adaptation would have important ramifications for conservation and restoration projects within the Puget Sound. To test these differences we set up a reciprocal transplant experiment among three populations from Fidalgo (Northern), Dabob (Central), and Oyster (Southern) bays along a latitudinal axis as well as a fourth bay (Manchester NOAA facility) as a control repository. We monitored growth, survival, and fecundity from August 2013 to August 2014. We observed only minor growth and survival differences among populations. Throughout the spawning season, Southern oyster population produced significantly more brooding oysters at two of the three sites compared to the other two populations. Oyster populations native to these diverse bays may have genetically diverged their spawn timing to conform to environmental conditions within each bay, or the Southern population may simply have greater fitness. Through our ongoing research, we intend to determine whether Olympia oyster populations exhibit local adaptation within Puget Sound.

† Heery, E.C.*, Sebens, K.P.
MATERIAL FLUXES FROM SUBTIDAL MAN-MADE STRUCTURES TO ADJACENT SOFT SEDIMENT HABITATS IN THE URBAN SUBTIDAL
University of Washington
Over the next ten years, the percentage of people living in coastal areas is projected to rise from 50 to 75%, increasing coastal populations by an estimated 2.5 billion people globally. Most of this growth will take place in coastal cities, where rapid urbanization is likely to cause substantial changes to the marine landscape. One of the main ways in which marine environments are altered by urbanization is through the addition of man-made structures. In the complex patchwork of soft sediment and man-made hard structures that results from the urbanization process, material fluxes and cross-habitat interactions may be frequent. In preliminary surveys in the Seattle area, we found that red macroalgae and shell material were becoming dislodged from man-made structures and incorporated into surrounding soft sediment habitats. To test the effect of material fluxes of red macroalgae and shell hash on soft sediment communities, we conducted a series of enrichment plot experiments on subtidal sand flats in Seattle. Shredded red macroalgae (Chondracanthus exasperatus, Polynemura latissima, and Sarcodiotheca gaudichaudii) and shell hash (>1 mm) were added to experimental plots in 7 treatment combinations. Sediment core samples collected after 1 week, 8 weeks, and 16 weeks were evaluated for macrofauna composition and phaeopigment concentrations (to ensure that algal enrichment was effective). We present results from this experiment and discuss the potential impacts of spatial subsidies and biogenic material from man-made structures on neighboring soft sediment communities in urban landscapes.

† Heldt, K.A.*, Connell, S.D., Munguia, P.
AMPHIPOD POPULATION-LEVEL RESPONSES TO CLIMATE CHANGE VARY AMONG ALGAL HABITATS
Southern Seas Ecology Lab, University of Adelaide
Under future climate, it is predicted that ecosystems will experience drastic shifts in the composition of foundation species resulting in altered habitats (e.g., kelp beds to turf barrens). Species closely associated with plant hosts, such as amphipods residing in macroalgae, may have difficulty adapting to sudden changes in habitat composition. Of particular concern are the population-level consequences of habitat shifts due to rapid changes in climatic conditions. Amphipod populations (Cymadusa pemptos) were established in mesocosms containing two algal habitats, kelp (Ecklonia radiata) and turf (mixed assemblages), and subjected to future climate conditions. After three months, we found that future climate increased male sexually selected traits (claw size and body size) in kelp populations but not in turf populations. Both populations showed a greater proportion of fecund females under future climate relative to current climate. In addition, turf population females exhibited greater fecundity than kelp population females under future climate. Yet population size only significantly increased in kelp habitats under future climate. These results suggest that population-level responses and the selection of traits under future climate will depend greatly on habitat composition.

Helix, M.E.*
CITIZEN SCIENCE: FINDING A MATCH FOR THE MULTI-AGENCY ROCKY INTERTIDAL NETWORK (MARINe)
Department of the Interior, Bureau of Ocean Energy Management
Citizen science groups, due to a confluence of increased public interest in coastal areas and declining public funding for research, have gained popularity in recent years as a mutually beneficial arm of coastal research programs. The Multi-Agency Rocky Intertidal Network (MARINe) program is interested in the applicability of citizen science for this long-term monitoring effort along the Pacific coast. A widespread outbreak of seastar wasting disease was noted in the summer of 2013, and MARINe enlisted citizen science groups to collect data to quickly supplement our knowledge of the extent of the disease. Ultimately, MARINe envisions that citizen science groups using a simplified MARINe surveying protocol can collect data to supplement data collected by MARINe scientists. MARINe is planning to evaluate concurrent data collection by different types of citizen scientists (high school students, retired scientists, and rocky intertidal reserve docents) and by MARINe scientists to better understand.

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which group characteristics and factors are the most important in ensuring the appropriate data collection for MARIne. MARIne hopes to use citizen scientists long-term at a few locations where funding has lapsed and groups are well-positioned to carry out a monitoring effort.

Hessing-Lewis, M.L.*, Vaughan, M.*
SEAGRASS COMMUNITIES IN BC’S CENTRAL COAST: AN OTTER CASCADE?
1 - Hakai Beach Institute, 2 - University of British Columbia

Top-down effects of sea otters have structured a quintessential trophic cascade in ecology (otters-urchins-kelp). Recently, the otter predation has also been found to cause cascades in seagrass systems (otters-crabs-mesograzers-epiphytes). Here, epiphytic overgrowth of seagrass, symptomatic of eutrophication, is alleviated. To test the context specificity of this seagrass cascade, we surveyed seagrass communities across four otter-occupied sites on B.C.’s Central Coast. Here, we found considerable variation in seagrass biomass and density and no correlations with crab abundance. While crabs do not appear to regulate mesograzers, fish may play a role given their high abundance. Mesograzers abundance and biomass, interestingly, were positively correlated with epiphyte biomass at some sites. These observational surveys demonstrate that seagrass community structure controls the presence, pathway and strength of otter cascades. We hypothesize that the availability and connectivity of both protected bays and exposed kelp forest habitats may dissipate the strength of top-down otter effects in these seagrass systems. Additionally, nutrient conditions and physical processes may mitigate bottom-up pressures in these systems. Coupled with studies of sea otter foraging and movement, kelp forest ecology, and habitat mapping, the Hakai Beach Institute’s “Otter Shores” research program aims to identify the drivers of change across this complex coastal landscape.

Hill, M.S.*, Hill, A.L.
SIGNIFICANCE OF SPONGE-SYMBIODINIUM SYMBIOSES: GENETIC INTERACTION, POPULATION REGULATION, AND PHYSIOLOGICAL INTEGRATION.
University of Richmond

Symbiodinium symbioses are arguably the most important ecological interaction on coral reefs because zooxanthellae energetically subsidize the entire community. Despite this, we have a limited understanding of the symbiont's niche (e.g., why is Symbiodinium distribution so restricted among potential sponge hosts?). We will present recent theoretical and empirical work designed to elucidate the evolutionary, ecological and physiological forces that shape associations between heterotrophic and autotrophic symbiotic partners. Through transcriptomic analysis of reinfection dynamics in Cliona varians, we have begun to identify genes that appear strongly regulated during uptake of the homologous Clade G Symbiodinium. We will present work demonstrating how artificial establishment of Symbiodinium symbioses in sponges that do not normally harbor these microbes may expose factors that lead to specialization between a particular symbiont and its host (and vice versa). Our work highlights the unique capacity of sponges to elucidate key components of the Symbiodinium niche. Finally, we will present preliminary results from modeling approaches that promise to facilitate understanding of the dynamics of Symbiodinium associations, and the conditions that permit long-term interactions between the host and the symbiont.

† Ho, M.*, Carpenter, R.C.
DIFFERENTIAL GROWTH RESPONSES TO WATER FLOW AND LOWERED PH IN MARINE MACROALGAE
California State University, Northridge

Water motion is an essential contributing factor in transferring nutrients and dissolved gases to marine organisms. As ocean acidification (OA), the shift in carbonate chemistry leading to a reduction in seawater pH, continues to rise, the potential impacts on coral reefs are likely to be important in determining the relative abundances of benthic organisms. This study examined the effects of OA on several dominant macroalgal species under different flow regimes. Commonly found in the back reef of Moorea, French Polynesia, two brown algae, Dictyota bartayresiana and Lobophora variegata, and a rhodophyte, Amansia rhodantha, were placed in four outdoor flumes subjected to 400 μatm or 1,000 μatm pCO2 conditions. Three seven-day treatments were conducted at three different flow speeds (0 cm/s, 5 cm/s, and 8 cm/s) and specific growth rates of macroalgae were measured. Between pCO2 treatments, only L. variegata and A. rhodantha growth rates were different. However, across all flow speeds the growth rates were significantly affected, with the greatest decrease in growth in A. rhodantha (21.7%) at zero flow under elevated pCO2. These varying responses to OA and flow could be due to different carbon-use strategies and may provide advantages to certain macroalgal species.

† Hofmeister, J.K.*, Voss, K.M.*
MOVEMENT PATTERNS OF OCTOPUS BIMACULATUS USING ACOUSTIC TELEMETRY
1 - University of California, Berkeley, 2 - Alaska Pacific University
Octopuses have significant ecological roles and predatory impacts on prey populations, yet their movement and activity patterns are very rarely included in studies of habitat selection and usage. During August 2014 on Catalina Island, CA, nine Octopus bimaculatus were caught and tagged with VEMCO V9-2L continuous transmitters. Of the nine tags, six stayed on for the duration of the tags’ battery lives; two tags fell off immediately, and one fell off after five days. Six of the octopuses were actively tracked for a 24 h period, and daily GPS locations were recorded for all individuals. Octopuses were primarily active at night and exhibited no central tendency during the duration of the study. Movement data will be analyzed in conjunction with sea floor habitat data from CSU Monterey Bay. This study is the first of its kind in California, and one of the first successful octopus acoustic telemetry studies. Understanding octopus movement will provide insight to habitat choice and the intersection of octopuses and anthropogenic activity.

† Holdridge, E.M.*, terHorst, C.P.
RELATIVE EFFECT OF EXPLOITATIVE AND INTERFERENCE COMPETITION VARIES WITH POPULATION DENSITY
California State University, Northridge
Intraspecific competition is a major factor influencing population dynamics. Competition can occur via an exploitative mechanism, where individuals compete indirectly through depletion of a shared limiting resource, or an interference mechanism, in which individuals directly inhibit one another’s ability to access resources either aggressively or passively. Although exploitative competition is inherently dependent upon resource levels, interference competition can potentially decrease population growth rates independent of resource availability. Interference competition is common in most systems, but it is still unclear whether interference increases in intensity with population density. Using experimental microcosms and maximum likelihood models, we tested the hypothesis that the strength of intraspecific interference competition increases as a function of population density. Interestingly, we found that at low densities, resource availability drove differences in population growth rates between low and high resource experimental groups, while at high densities we found no effect of resource level. To test whether this pattern was due to a shift from exploitation to interference competition, we used maximum likelihood to estimate the intensity of interference within the system. We found that as density increases, populations shifted from a more exploitation-based system to a more interference-based system. Our results show that interference competition increases with density, driving interesting patterns in population dynamics and density-dependence.

† Honka, L.D.*, Salomon, A.K.
A GRADIENT IN OCCUPATION TIME REVEALS PROFOUND SHIFTS IN FORAGING DYNAMICS OF SEA OTTERS
School of Resource and Environmental Management, Simon Fraser University and Hakai Beach Institute
As preferred prey become scarce, theory suggests that predator consumption rates of targeted prey decline while their diet diversifies. As keystone predators, sea otters (Enhydra lutris) have been shown to have substantial differences in their foraging behaviour and prey depletion at recent versus long-established sites. However, to date we have had little ability to predict the magnitude and timing of these effects. We quantified sea otter foraging rates and diet diversity along a gradient in sea otter occupation time (1-33 years) on British Columbia, Canada’s Central Coast. A total of 598 foraging dives made by 72 sea otters were recorded across 5 sites varying in occupation time. Sea otters were successful on 86% of foraging dives capturing at least 19 different prey items. Otters initially targeted sea urchins, but diversified their diet to include abalone, clams and crabs after 2 years of site occupation. We found strong evidence that occupation time was an important predictor of per-capita consumption rates on urchins. In addition, there was greater strength of evidence for prey-dependent rather than predator-dependent models of sea otter consumption of urchins. Based on the most parsimonious model, a one year increase in occupation time yielded, on average, a 90% decline in per-capita consumption rates on urchins.

† Houle, K.C.*, Craig, S.F.
SESSILE INVERTEBRATE RESPONSE TO SEDIMENT SUSPENSION AND ACCRETION IN THE FOULING COMMUNITY
Humboldt State University
Sediment suspension and accretion in coastal marine environments can occur through natural processes (i.e. tidal exchange, wave action, bioturbation, storm surges) and anthropogenic disturbances (i.e. dredging, coastal development, boating activity). Humboldt Bay receives a large amount of sediment from its surrounding watersheds during winter rainfall events, in addition to annual dredging and coastal development projects. These events range from a few days to several weeks, in which turbidity levels are elevated beyond normal background levels. We know very little about how the biological communities of Humboldt Bay respond during and after these disturbances. My study exposed naturally settled communities of sessile marine invertebrates to 14 days of suspended or accreted sediment at levels mirroring a high suspension event in a controlled laboratory setting.
Preliminary results from two, 14-day trials, indicate that communities in sediment accretion treatments experienced higher mortality rates than those communities exposed only to sediment in suspension, which incurred little to no mortality across all turbidity treatments. Species within sediment accretion treatments were differentially affected. Encrusting species (*Botryllus* spp., *Botrylloides* spp., *Celleporella* *hyalina*, *Watersipora* *subtorquata*) experienced higher mortality than erect species (*Ciona* *intestinalis*, *Bugula* spp.) that were in part, above the accreted sediment.

**† House, P.H.*, Allen, L.G.**
THE RETURN OF THE KING: GIANT SEA BASS, STERELEPIS GIGAS, POPULATION AND BIOMASS DENSITIES OFF SANTA CATALINA ISLAND, CA

California State University, Northridge

Giant Sea Bass, *Stereolepis gigas*, is the largest reef associated bony fish off Southern California. During the early 20th century they were heavily fished and their population crashed in 1935. In 1981, they were listed as critically endangered and protected both recreationally and commercially. Although Giant Sea Bass have been protected for 33 years, very little is known about their recent population dynamics. This study aims at establishing minimum Giant Sea Bass population and biomass densities for Santa Catalina Island, CA. During the summer of 2014, 8 sites were surveyed every 2-weeks around the island. At each site 5, 3-minute 100 x 10m transects were conducted using dive propulsion vehicles (DPVs). For length determination, DPV’s were outfitted with 10.16 cm calibrated lasers and HD video. Along each 1000m² transect individuals were counted and measured. Biomass (kg/m²) was determined by converting length to weight using a published growth curve. Our results show that the majority of individuals and biomass occurred at 3 of the 8 sites during mid-late July, and through photo-identification ~50 individuals were observed during the summer. This information is important in determining how many Giant Sea Bass there are and a possible recovery in Southern California.

**† Howard, B.†*, Calbick, S.†, Therriault, T.W.*, Côté, I.†**
LARVAL DISTRIBUTION OF INVASIVE EUROPEAN GREEN CRAB IN BARKLEY SOUND, BRITISH COLUMBIA

Adult population densities of the invasive green crab (*Carcinus maenas*) in Barkley Sound, British Columbia are some of the highest known throughout their global range. However, densities are not uniform across the Sound, ranging from 0.74 ind/m² (northwest side) to 0.01 ind/m² (southeast side). One hypothesis for this regional variation is insufficient propagule pressure on the southeast side of the Sound. To test this hypothesis, I conducted monthly plankton tows between May and August, 2014, at 22 locations throughout Barkley Sound and quantified the number of green crab larvae at each site. Green crab larvae were found at all sites and were most abundant in June. Larval densities were highest on the northwest side of the Sound, at 5.8 ± 3.6 larvae/m³. Green crab were found at up to 1.1 ± 0.6 larvae/m³ on the southeast side of Barkley Sound. These results suggest that insufficient larval transport may not explain why green crab have not established throughout the Sound. This study represents the first investigation of green crab larval abundance in Barkley Sound and will help to refine future research on the role of propagule pressure in the spread of an established marine invasive species on the West Coast.

Hultgren, K.M†*, Jeffery, N.†, Rubenstein, D.R.†, Chak, T.S.‡, Duffy, J.E.§
GENOME SIZE VARIATION AND SOCIAL BEHAVIOR IN SPONGE-DWELLING SNAPPING SHRIMP

1 - Seattle University, 2 - University of Guelph, 3 - Columbia University, 4 - Virginia Institute of Marine Sciences, 5 - Smithsonian Institution

Although animal genome sizes vary from 0.02 -130 Gb, most animal groups have small and relatively invariable genomes (<10 Gb). In many arthropod groups, however, comparative studies have demonstrated correlations between genome size and traits such as body size, developmental rate, and parasitism. Here we document extensive genome size variation in a clade of sponge dwelling snapping shrimp (genus *Synalpheus*) that also vary widely in social behavior, from monogamous pair-living to eusociality. Genome size in this closely related group, measured across 43 species, ranged from 5-22 Gb. Intriguingly, genome size also shows some correlations with social behavior and with reproductive characteristics such as hermaphroditism, suggesting variation in genome size may have phenotypic consequences for this group.

Idjadi, J.A.†*, Salois, S.L.‡
HERBIVOROUS FISH BEHAVIOR MAY SLOW CORAL RECOVERY VIA A POSITIVE FEEDBACK LOOP: WHY DO THEY IGNORE ALGAE WHERE IT IS MOST ABUNDANT?

1 - Eastern Connecticut State University, 2 - Northeastern University Marine Science Center

On Caribbean reefs, disease, bleaching, and storm damage have killed corals and provided space for macroalgae. “Healthy” reef communities can remain virtually macroalgae free after coral die-offs if intact herbivore communities remove algae as it grows. In an unfortunate result, investigators working on the GBR found that herbivorous fish eat less algae where algae is dense. They hypothesized that predators hiding in the structure of algal beds may deter
herbivores. We tested an alternative hypothesis; that perhaps due to their evolutionary history of foraging on coral dominated reefs; fish forage poorly when algae occurs against a homogenous background of other algae. To test this hypothesis in the Bahamas, we presented fish with palatable algae against both contrasting (beige) and algae-mimicking backgrounds. We found that fish ignore algae when it appears to occur in a dense patch. In addition, fish ignore algae that come from dense patches even if it is presented outside of these patches. Future work will investigate the role of epiphytes and/or allelochemicals in explaining this effect.

Iles, A.C.*, Novak, M.
NETWORK COMPLEXITY IMPROVES THE PREDICTABILITY OF COMMUNITY RESPONSES TO PERTURBATIONS
Oregon State University, Department of Integrative Biology
The complexity of ecological networks has long plagued attempts to predict species responses to perturbations. The more speciose and connected the network, the lower the confidence in predictions, unless accurate estimates of species interaction strengths are known. Previous investigations of network predictability have assumed independent, random interaction strengths. We investigated how knowledge of the non-random structure of interaction strengths may influence predictive certainty. We did so by simulating allometric trophic network (ATN) models with topologies varying in species richness and connectance. Predictive sensitivity with respect to the “true” net responses of each simulated community was assessed by systematically varying the uncertainty of interaction strengths. ATN models exhibited considerably improved predictability over previous research and, counter-intuitively, revealed an increase in predictability with increasing connectivity in large networks. We show that this occurred due to changes in the frequency distributions of interaction strengths in the networks, which are directly influenced by network complexity. As a consequence, having accurate estimates of only the strongest species interactions dramatically improves predictability, especially for complex networks. Efforts to predict the response of multispecies communities to perturbations will therefore profit by embracing network complexity and focusing on the identification and estimation of the strongest interactions.

† Ingeman, K.I.*, Hixon, M.A.1,2, Novak, M.1
INTRODUCED MARINE PREDATOR ALTERS DENSITY-DEPENDENT PATTERNS OF MORTALITY IN PREY
1 - Oregon State University, 2 - University of Hawai‘i at Mānoa
Species introductions can alter population, community, and ecosystem-level properties of invaded systems. It is therefore essential to determine whether novel predators alter predation-mediated regulatory mechanisms, potentially destabilizing prey dynamics. The invasive Indo-Pacific lionfish (Pterois volitans) is a new mesopredator that voraciously consumes native coral-reef fishes of the tropical Western Atlantic and Caribbean. The fairy basslet (Gramma loreto) is a common prey of lionfish, which experiences regulating density-dependent mortality due to predation by native piscivores. We previously compared G. loreto mortality rates before vs. after the lionfish invasion and demonstrated that mortality has undergone a density-independent increase. We followed-up this work with a second field experiment, manipulating both basslet settlement density and lionfish presence in a cross-factored design. Using information-theoretic model comparison and maximum-likelihood parameter estimation, we fit dynamic models as explicit tests of our hypotheses regarding the effects of lionfish on the density-mortality relationship in prey. Over four weeks, G. loreto populations experienced higher loss rates on reefs with introduced P. volitans, compared to reefs with native piscivores alone. However, in contrast to previous analyses, the best-performing dynamic models included lionfish-specific terms for both density-independent and density-dependent loss, suggesting that lionfish may alter both the magnitude and intensity of prey density dependence.

Janousek, C.N.1,2*, Edgarian, T.K.2, Guntenspergen, G.R.2, Takekawa, J.Y.2, Thorne, K.M.2
SPECIES-SPECIFIC FLOODING EFFECTS ON PLANT GROWTH AND DECOMPOSITION IN A SAN FRANCISCO BAY SALT MARSH
1 - Oregon State University, 2 - US Geological Survey
Tides influence the vertical distribution of plants in coastal marshes via gradients in flooding and salinity, but inundation effects on key processes such as productivity and organic matter decomposition are poorly known for most species. Understanding species-specific functional responses to these gradients is critical for assessing climate change effects on salt marsh structure and function. We manipulated flooding duration (<1 to 80%) over one growing season in mesocosms deployed along a tidal channel near Petaluma, California. Plant growth responses to flooding were species-specific. Bolboschoenus maritimus and Spartina foliosa had unimodal responses, with maximum above-ground biomass occurring at about 25 and 40% flooding respectively. Sarcocornia pacifica biomass, however, declined markedly when inundation exceed 10-20%. We generally found close correspondence between the elevation of maximum growth for each species in the experiment and the elevation range of maximum cover in a separate field survey conducted at the site. Organic matter decomposition rates also varied by species, with greater loss in Spartina than in Bolboschoenus or Sarcocornia. However, except
for reduced rates in the least flooded treatment (<1%), inundation had little effect on organic matter loss. Our results suggest how plant composition and function may change in future marshes with relative sea-level rise.

† Jeffrey, K.M.*, Côté, I.M., Reynolds, J.D.
FISHING OUT TRAIT CHANGES FROM A SEA OF DATA: A META-ANALYSIS ON CHANGES IN BODY SIZE OF PACIFIC SALMON
Simon Fraser University
Exploited fish populations frequently demonstrate changes in phenotypic traits that may be a result of the strong, directional pressure exerted by fisheries on certain size-classes. Pacific salmon have been intensely exploited for over a century, thus it is possible that fishing has induced marked changes in these species. Using meta-analytical techniques, we quantified the rate of change in body size of Pacific salmon from 1950 to 2012 using commercial catch statistics. Over this period, the average weight of Pacific salmon declined at a rate of 0.6% per annum. Fish caught by seines and gillnets experienced similar declines in average weight. However, the average weight of fish caught by trolling declined significantly faster than fish caught by other gears in all species but Chum salmon and even-year Pink salmon. Among species, average weight of Coho and Pink salmon declined significantly faster than that of Chinook, Chum, and Sockeye salmon. Regardless of whether these changes have an evolutionary basis, the potential ecological and socio-economic consequences of reduced body size are of great concern. Managers should be wary of such changes as they occur quickly, may threaten the sustainability of fish stocks, and may be hard to reverse.

† Jeffries, S.V.*
BIOMASS AFFECTS SEXUAL REPRODUCTION OF TWO RECENTLY SYNONYMNIZED MORPHOLOGIES OF MACROCYSTIS PYRIFERA IN CENTRAL CALIFORNIA
Moss Landing Marine Laboratories
Two of the recently synonymized species of Macrocystis co-occur in central California and vary in their reproductive mode. The deep-water pyrifera morphology produces sori on sporophyll blades for sexual reproduction. The shallow-water integrifolia morphology primarily grows vegetatively via a rhizome as it has little success recruiting sexually. In September 2014, Macrocystis biomass collections were conducted in Stillwater Cove, California in order to assess the contributions of biomass to reproduction. pyrifera individuals were collected in their entirety, and integrifolia individuals were collected using a 25x25cm quadrat to account for the difficulty in discerning true “individuals” of this morphology. Samples were measured for individual biomass, soral biomass and area and reproductive (zoospore) output. A significant effect of depth on total biomass was found, with the deeper pyrifera morphology having higher biomass. Soral area and biomass were strongly positively correlated with total biomass, with pyrifera individuals having significantly larger and heavier sori. Finally, there was higher reproductive (zoospore) output for the pyrifera individuals than the integrifolia, but this difference was non-significant. These results indicate that depth strongly affects individual biomass, and biomass affects reproductive investment. There have been very few studies which compare the morphologies of Macrocystis. Integrative studies like these are needed to understand the relationship between these morphologies and their impacts on the nearshore environment.

Jellison, B.M.*, Gaylord, B.P.
ACIDIFIED SEAWATER IMPAIRS ANTI-PREDATOR RESPONSES OF AN INTERTIDAL SNAIL
Bodega Marine Laboratory, University of California, Davis
Rising levels of atmospheric carbon dioxide have led to a global drop in average oceanic pH and pose a major threat to marine biota. Previous research has highlighted the physiological consequences of lowered pH on individual species. However, emerging evidence suggests that marine acidification can alter behavior through mechanisms that are not yet well understood. One such mechanism may involve the disruption of an organism’s ability to perceive or integrate chemical cues from their environment, which has the potential to change species interactions and lead to unforeseen ecosystem level consequences. We investigated effects of ocean acidification on chemoreception and the “crawl out” behavior of the intertidal turban snail, Chlorostoma funebralis (formerly Tegula funebralis) as induced by chemical cues from the predatory sea star, Pisaster ochraceus. Results indicated that CO2 did not affect cue detection but did affect decision-making in C. funebralis, reducing the avoidance response to predator cue at elevated CO2. The percent time snails spent out of water in the presence of cue decreased with increasing pCO2. Values of pH examined in our study are already in rock pools inhabited by turban snails; however, the low pH conditions that alter snail decision-making occur exclusively during low tides and periods of upwelling. In coming decades, as lower-pH conditions comprise an increasingly large fraction of a typical day, snails may exhibit a substantial reduction in their ability to avoid predation, with potential consequences not only for themselves but for the trophic web in which they are embedded.

Johnson, A.M.*, Sullivan, J.M., Cerny-Chipman, E.B., Menge, B.A.

66
SEA STAR WASTING ALONG THE OREGON COAST: TIME COURSE OF THE EPIDEMIC
Oregon State University
The current Sea Star Wasting Syndrome outbreak has recently caused mortality and population declines in a number of sea star species along the U.S. west coast. The rocky intertidal team of the Partnership for Interdisciplinary Studies of Coastal Ocean at Oregon State University has been monitoring for Sea Star Wasting Syndrome at 11 field sites along the Oregon coast. We quantified the abundance of *Pisaster ochraceus* and classified habitat, size, color and disease level for every individual found using surveys. In addition, long-term transects at our 6 main field sites have allowed us to generate a more defined individual population estimate. While sea star wasting syndrome began appearing from southern California to Alaska in summer and fall of 2013, it did not hit Oregon’s coastline until late April of 2014. High frequency of sampling from the outbreak onset in Oregon has enabled us to examine correlations in sea star dynamics and temperature, showing a spike in both air and water temperature just before the SSWS outbreak on Oregon’s coast. This could be a potential outbreak trigger, but further examination is needed to better understand the delay in wasting presence in Oregon’s rocky intertidal zone.

Johnson, D.W.¹*, Bernardi, G.², Freiwald, J.³
DIVERSITY DRIVES DYNAMICS: VARIABLE REGULATION OF BLACK SURFPERCH POPULATIONS
1 - California State University, Long Beach, 2 - University of California, Santa Cruz, 3 - Reef Check
The dynamics of a population will depend on how that population grows when small and declines when big. This phenomenon, known as demographic density dependence, is responsible for regulating populations in the wild, yet the strength of density dependence often varies for reasons that are not always clear. Here, we examine the dynamics of Black surfperch (*Embiotoca jacksoni*) throughout much of their geographic range. Black surfperch exhibit strong, overall evidence of density dependence in population growth rates. However, local populations differ widely in the degree to which they are regulated: some populations fluctuate wildly, yet others are remarkably stable. We tested whether genetic diversity affects the strength of density dependence. If populations that are more genetically diverse exhibit greater niche differentiation, then these populations should compete less intensely and exhibit weaker density dependence. Consistent with this hypothesis, our results suggest that populations that are more genetically diverse experience weaker regulation. Additional analyses suggest that one mechanistic link between diversity and strength of regulation is greater spatial dispersion and more even use of microhabitats in high diversity populations.

Juanes, F.*, Tupper, M.
FORAGING IN LIMITED BUT RISKY AREAS: TESTING FORAGING ARENA THEORY
University of Victoria
Foraging arena theory was developed 20 years ago to evaluate trade-offs related to the impacts of harvesting and protection of aquatic ecosystems and became the basis of dynamic ecosystem models such as Ecosim. The underlying ecological theory created spatial refuges from predation for juvenile fishes that foraged in limited but risky areas near these refuges. Models of food density dynamics within such limited foraging areas predict that food availability and feeding rates per time spent feeding should depend strongly on juvenile density and habitat. Selection should act on the time that juveniles spend foraging, so as to strike a balance between growth and predation risk. However, foraging arena theory has rarely been explicitly tested experimentally. We test these concepts by focusing on the early life history of cunner (*Tautogolabrus adspersus*). Our results show that contrary to expectation foraging time and energy increased as habitat complexity or conspecific density decreased. Instead, time and energy spent in refuge defence increased with increasing predation risk (as mediated by habitat complexity) or conspecific density. Future recruitment studies should include examination of spatial habitat use by juveniles, and the behavioral and physiological mechanisms for adjusting behavior to varying food density and predation risk.

† Jurgens, L.J.*, Wynkoop, L.M., Gaylord, B.
SURVIVING DESICCATION STRESS ON ROCKY SHORES: NEW INSIGHTS INTO AN OLD PROBLEM
Bodega Marine Laboratory, University of California, Davis
Desiccation has long been established as a key stressor for small invertebrates on rocky shores, and a large portion of intertidal biodiversity is found chiefly inside biological habitats formed by beds of mussels, surfgrass or algae at low tide. We explored the hypothesis that physical effects of such foundation species buffer inhabitants from desiccation stress using beds of the common, widespread California mussel (*Mytilus californianus*) at Bodega Marine Reserve (CA, USA). We compared relative humidity, temperature and desiccation inside mussel beds and on exposed rock surfaces using small sensors, an established biological proxy (agar cubes), and field exposures of two species: porcelain crabs (*Petrolisthes cinctipes*) and predatory isopods (*Cirolana harfordi*). We found substantially higher humidity and lower temperatures inside mussel beds than on rock clearings. Microhabitat strongly influenced desiccation of crabs and isopods, which lost 30-35% of their tissue water mass outside the bed
animal species from researchers in countries around the world. Our present collaboration among researchers at

science because it offers the opportunity for high

eDNA promises to be an important tool for the future of marine ecology and environmental

It is now feasible to collect and sequence residual DNA left behind by sp

community composition with depth are likely a result of habitat structure and availability instead of depth itself.

Peaks in coral cover correspond with peaks in reef fish ric

indicate coral cover peaks between 12

but are largely unknown in deeper extensions of the

HAWAII

† Kane, C.N.

† Jury, C.P.

＊ , Plowman, C.P.

＊ , Tissot, B.N.

UNDER-ROCK INVERTEBRATES AT EUROPE’S FIRST MARINE RESERVE

At Lough Hyne Marine Reserve in SW Ireland, the shallow subtidal, under-rock community was investigated in late summer 2014. Twenty sites, each 10-m wide, were surveyed at low tide. Half of the sites had been surveyed annually for two decades; the other half had been previously surveyed in 1955 and 1990/91. Each rock was lifted, the underside photographed, the solitary organisms (mobile and sessile) counted, and then the rock was replaced in its original position. Biodiversity indices were calculated for each site to evaluate how diversity varied with location (north vs. south basin of lough), frequency of disturbance (annual vs. multi-decadal rock-turning), degree of hypoxia/anoxia (hydrogen sulfide smell and black discoloration), number of rocks turned, and other factors. The richness of solitary invertebrates averaged 21 taxa per site with significantly more in the south basin (near the lough’s connection to the Atlantic Ocean) than the north basin. The Shannon-Weiner Index (mean = 3.3) did not vary significantly with variables investigated. Evenness, however, varied significantly with disturbance: the communities were more even at sites where rocks were turned annually. Photographic data on encrusting sponges, ascidians, and bryozoans are still being analyzed as are temporal patterns of change.

† Kane, C.N.

＊ , Bogeborg, M.

＊ , Tissot, B.N.

SHIFTS IN CORAL REEF FISH COMMUNITY STRUCTURE ALONG A 40M DEPTH GRADIENT IN WEST HAWAII

At 68
Hybrid vigor is an important aspect of breeding programs aiming to enhance production in many species including the Pacific oyster *Crassostrea gigas*. Despite the economic and evolutionary importance of this phenomenon, its functional basis remains poorly understood. To identify mechanisms underlying hybrid vigor, we conducted genome-wide SNP genotyping and gene expression profiling in hybrid and inbred families produced by crossing inbred lines. Measurement of shell lengths revealed that growth rates varied both between hybrid and inbred families, and among hybrid families. To investigate whether hybrid growth advantages depend on genetic distances between parents, thousands of parental SNPs were genotyped. We then tested for associations between growth rate and heterozygosity in an effort to identify genomic regions associated with hybrid vigor. To explore mechanisms underlying this variation, we profiled gene expression using RNA-Seq. We compared expression profiles in each hybrid relative to its parental lines to identify genes associated with hybrid vigor. Mapping these expression profiles back to the genome allowed us to test for relationships between heterozygosity, gene expression, and growth rates. Our study tests previously proposed explanations for hybrid vigor, and identifies genomic regions associated with this phenomenon in a commercially important and widely studied species.
Knight, N.S.*, Prentice, C., Tseng, M., O’Connor, M.I.  
A COMPARISON OF EPIFAUNAL INVERTEBRATE COMMUNITIES IN NATIVE SEAGRASS ZOSTERA MARINA AND NON-NATIVE ZOSTERA JAPONICA  
University of British Columbia  
The introduction of non-native species can modify and shape local communities and ecosystems. Although introduced species may negatively affect local communities, positive effects are also possible. In particular, habitat-building species may facilitate local species when introduced. Zostera japonica is a non-native eelgrass introduced to the Northeast Pacific coast. It is a foundational species that appears to expand total eelgrass habitat, potentially facilitating local eelgrass-dwelling species. In this study, we tested whether local invertebrate communities that inhabit beds of Z. japonica differed from those that live in beds of its native congener, Z. marina. We sampled and quantified invertebrate assemblages from monospecific stands of both eelgrass species, and quantified morphological characteristics of eelgrass, such as shoot density and surface area, which could influence the quality of eelgrass as habitat for epifaunal invertebrates. Our results show that Z. japonica and Z. marina support the same invertebrate species; however, Z. japonica supports a greater abundance of invertebrates, and the relative abundance of different invertebrate species varies between the two types of eelgrass. This result is consistent with interspecific differences in the density of vegetative and reproductive shoots, and blade surface area. The introduction of Z. japonica appears to increase available habitat for local epifaunal invertebrates.  

Kosaki, R.1*, Kane, C.2, Pyle, R.3, Wagner, D.1  
CHARACTERIZATION OF MESOPHOTIC CORAL ECOSYSTEMS OF THE NORTHERN HAWAIIAN ISLANDS  
1 - NOAA Papahānaumokuākea Marine National Monument, 2 - Washington State University, 3 - Bernice P. Bishop Museum  
Mesophotic coral ecosystems, also known as the coral-reef “twilight zone”, are receiving increased attention from coral-reef ecologists and managers because of their potential contributions to tropical biodiversity, and because of their potential to serve as refugia for fishes that are depleted due to anthropogenic activities on shallow reefs. However, the composition and trophic structure of these fish communities are poorly characterized. We present the results of the first quantitative mesophotic coral reef fish assemblage characterizations from the Northwestern Hawaiian Islands (NWHI). Each fish species recorded during transects was assigned to one of seven feeding guilds (corallivore, herbivore, mobile invertebrate feeder, omnivore, piscivore, sessile invertebrate feeder, planktivore), and one of two biogeographic groups (Hawaiian endemic, widespread). When compared to shallow reefs (<30 m) of the NWHI, the mesophotic reefs exhibited a virtual absence of herbivores, and an abundance of planktivores. These deep reef fish assemblages (50-80 m) were also found to have the highest recorded levels of endemism known from any marine ecosystem, with endemic species comprising >90% of the total assemblage at Midway and Kure Atolls. High endemism was driven by the numerical dominance of small-bodied, endemic planktivorous fishes of the families Chaetodontidae, Serranidae (subfamily Anthiinae), and Pomacentridae.  

Krug, P.J.*, Ellingson, R.A., Vendetti, J.E.  
CHALLENGING A PARADIGM OF LARVAL BIOLOGY: EVIDENCE THAT SPECIES SELECTION FAVORS PLANKTOTROPY, NOT LECITHOTROPY  
California State University, Los Angeles  
Species selection results when a trait increases diversification (speciation minus extinction) for a lineage. A textbook example is that marine snails with short-lived lecithotrophic larvae have reduced dispersal and gene flow, and supposedly out-diversify related lineages with highly dispersive planktotrophic larvae. For 40 years, paleontological studies have argued that species selection favors lecithotrophs, which speciate more often and accumulate over time in some neogastropod families. However, lecithotrophs also have elevated extinction rates, and molecular phylogenies of diverse groups instead suggest lecithotrophs accumulate without diversifying due to frequent life-history shifts from planktotrophic ancestors. We performed the first explicit test of these alternative hypotheses using a four-gene phylogeny of 202 species in Sacoglossa, a group of photosynthetic sea slugs. Evolutionary quantitative-genetic models and stochastic character mapping support 27 origins of lecithotrophy, indicating frequent losses of highly dispersive offspring. Maximum likelihood methods supported models in which larval type influenced diversification; however, contrary to long-standing assertions, species selection strongly favored planktotrophs. Most lecithotrophic lineages originated through character change, and did not subsequently diversify. Thus, life-history evolution frequently results in shifts to short-lived larvae, and ultimately in short-lived lineages. These findings challenge long-standing assumptions about the evolutionary consequences of larval type.  

Krumhansl, K.A.*, Salomon, A.K.  
TEMPERATURE-MEDIATED RECOVERY DYNAMICS OF MACROCYSTIS INTEGRIFOLIA FOLLOWING CANOPY HARVEST IN HIGH LATITUDE KELP FORESTS  
Simon Fraser University and Hakai Beach Institute
There is currently a pressing need to understand how global climate change can amplify or dissipate the effects of local disturbances, such as resource exploitation. In marine ecosystems however, where the commercial harvest of primary producers such as kelp is burgeoning, there is little information on how changing ocean conditions may alter harvest and recovery rates. We quantified the recovery of *Macrocystis integrifolia* following an experimental canopy removal at five sites on a north-south gradient in British Columbia, Canada. At each site, we measured differences in environmental variables (e.g. temperature, wave exposure) and kelp bed characteristics (e.g. density, biomass, productivity) in experimental and un-harvested plots to link bed-scale dynamics to a harvest response. We found significant differences in growth (m d⁻¹) and recovered canopy biomass (kg) among sites such that sites with higher average water temperatures had significantly slower regrowth. These results suggest that oceanographic context mediates the resilience of kelp beds to harvest disturbances therefore, local management should take into account both human-induced climate change and natural ocean climate cycles (e.g. el Nino, PDO) when designing harvest strategies.

† Kwan, C.K.1,2*, Sanford, E.2, Long, J.D.1

CONTEXT-DEPENDENCY OF PREDATOR NON-CONSUMPTIVE EFFECTS IN AN ESTUARINE FOOD CHAIN: IMPACT OF COPPER POLLUTANTS AND ABIOTIC FACTORS

1 - Coastal and Marine Institute, San Diego State University, 2 - Bodega Marine Laboratory, University of California, Davis

Although predator non-consumptive effects are common in communities, their strength is often context-dependent. Despite this recognition, we are only beginning to understand the impact of human-caused stressors such as chemical pollutants on these species interactions. Additionally, prey responses to predation risk and pollutants can weaken over time as prey acclimate to these stressors. Previously, we found copper pollutants reduced predator non-consumptive and consumptive effects on prey in short-term exposures. To examine these interactions over longer durations, we conducted a longer laboratory experiment studying the impact of copper on a food chain of predatory crabs, whelks, and barnacles. In the absence of copper, crab cues induced lower whelk consumption rates of barnacles. Copper decreased the influence of crabs on whelks initially, but this effect attenuated over time. We also conducted a field experiment in San Francisco Bay to investigate whether differences in pollutant levels and abiotic factors among three sites would influence species interactions. The strength of predator non-consumptive effects varied among sites. Namely, crab non-consumptive effects may have been weakened at the site with warmer waters. Our results support the notion that predator-prey interactions are often context-dependent, and may especially be influenced by human-caused stressors such as chemical pollutants.

Lafrenz, M.D., Eppley S.M., de Rivera, C.E.*

SALT MARSH RESPONSE TO DIKE REMOVAL: IMPLICATIONS FOR FUTURE SEA LEVEL RISE

Portland State University

The ecosystem functions and services of saltmarshes may be altered by sea level rise. To assess the rate of habitat shifts from increased inundation, we sampled saltmarsh soil, fauna, and vegetation one, two, and 35 years after dike removal and increased inundation. Conditions in the low marsh approximated the reference after two years. However, in the high marsh, organic content, representing sequestered carbon, was lower than in the reference 35 years following dike removal. Plants and animals had lower species richness and diversity in the dike-removal than the reference marsh, especially in the high marsh. The marshes differed in community composition as well. Percent above ground cover and percent root cover, both of which affect accretion rates, also are lower in the dike-removal sites than references. Hence, the high marsh is responding slowly because of the low flood frequency while the daily inundation of the low marsh hastens a return to near reference conditions for many variables. We expect a net loss of high marsh function with sea level rise, leading to a loss of coastal storm protection and carbon storage potential.

† Lagos, M.E.1,2*, White, C.R.1, Marshall, D.J.2

AVOIDING LOW OXYGEN ENVIRONMENTS: OXYTAXIS AS A MECHANISM OF HABITAT SELECTION IN A MARINE INVERTEBRATE

1 - University of Queensland, 2 - Monash University

The availability of oxygen is highly limited in some marine environments, particularly manmade coastal habitats. On the benthos and a small scales, where processes such as larvae settlement occur, skimming flow can generate boundary layers that are almost entirely devoid of oxygen. Recent studies suggest that oxygen levels in low flow environments may fall below the physiological tolerance of organisms. However, it remains unclear as to whether settling larvae avoid settling in low oxygen conditions. Here we examined the response of marine invertebrate larvae to different oxygen levels, using the bryozoan *Bugula neritina* as a model organism. We found that larvae avoid low oxygen through a variety of mechanisms. Our results suggest that marine larvae are a rare example of oxytaxis.
Lange, R.*, Monro, K., Marshall, D.J.
SETTLEMENT DEPTH IS AN AGENT OF SELECTION IN A SUBTIDAL SPECIES
Monash University
Spatial environmental variation can drive local adaptation in marine species and cause non-intuitive patterns of larval dispersal, such that isolation-by-distance does not occur. Local adaptation due to spatial variation is usually measured along a longitudinal axis, but rarely along a vertical axis. Marine environments, however, vary immensely with increasing depth. We here present recent findings showing that settlement depth can cause strong variation in adult phenotype and is an agent of selection that could potentially generate local adaptation in the colonial bryozoan *Watersipora subtorquata*.

Lantz, C.A.*, Carpenter, R.C., Comeau, S., Edmunds, P.J.
TOTAL ALKALINITY AND DISSOLVED INORGANIC CARBON OF AN EXPERIMENTAL CORAL REEF COMMUNITY: METHODS TO LINK ORGANISM AND COMMUNITY METABOLISM
California State University, Northridge
Current research on nearshore calcifying marine ecosystems seeks to link the responses to ocean acidification (OA) at differing functional levels of biological organization. While multiple studies have identified organism-level responses to OA, isolating and connecting these effects to the community level has proven difficult given the large number of parameters that affect organism metabolism, such as light, temperature, flow, and nutrient uptake. To accommodate these difficulties, Deffeyes diagrams can be used to examine total alkalinity (TA) vs. dissolved inorganic carbon (DIC) slopes, which represent the community balance in organic and inorganic metabolism. To explore the utility of this technique as a means to link functional scales in their response to OA, TA/DIC slopes were calculated for coral reef communities incubated in 600 L outdoor flumes, and for constituent organisms incubated in separate 2 L chambers under the same conditions. Results show that the sum of the constituent organism-level TA/DIC slopes was equal to the mean community-level TA/DIC slope, suggesting that the measured community TA/DIC slope is a reflection of benthic community composition and may be used to link changes at the community and organism level.

Larson, S.E.*
SEATTLE AQUARIUM’S COLLABORATIVE CONSERVATION RESEARCH PROGRAMS: ESTIMATES OF SEA OTTERS, ROCKFISH, AND SIXGILLS IN WASHINGTON
Seattle Aquarium
The Seattle Aquarium’s formal research program, the Seattle Aquarium Research Center for Conservation and Husbandry (SEARCC), was launched in 2002 and includes over 14 concurrent research projects ranging from marine mammals to sharks. The aquarium has been conducting collaborative research projects on fish and marine mammal abundance in Washington waters for over a decade. The projects highlighted here include sea otter (*Enhydra lutris kenyoni*), rockfish (*Sebastes* spp.), and sixgill shark (*Hexanchus griseus*) abundance estimates. The aquarium has been participating in annual sea otter surveys off the Washington coast since 2001. Partners include USFWS, WDFW, NOAA, the Point Defiance Zoo and Aquarium. The aquarium began conducting rockfish surveys in the Strait of Juan de Fuca in 2005. In 2010 we expanded this work by adding more sites to include south and central Puget Sound. In 2003 the aquarium began a study to estimate sixgill shark abundance in Elliott Bay. Partners in this project include NOAA, WDFW and Point Defiance Zoo and Aquarium. Each of the projects partners, methods and results will be discussed to highlight the benefit of long term collaborative research.

† Larson, W.A.*, Seeb, J.E., Dann, T.H., Schindler, D.E., Seeb, L.W.
SIGNALS OF HETEROGENEOUS SELECTION AT AN MHC LOCUS IN GEOGRAPHICALLY PROXIMATE ECOTYPES OF SOCKEYE SALMON
University of Washington
Parasites and pathogens exert considerable selective pressure on wild populations, creating a constant arms race. The genes of the major histocompatibility complex (MHC) are an important component of this arms race and have been found to be under strong natural selection in many vertebrates. Here, we sequenced a 350 base pair region of the MHC class II peptide binding region to quantify MHC diversity in 27 populations of sockeye salmon spawning in the Wood River system in southwest Alaska. We found that MHC variation is partitioned by spawning ecotype with fish that spawn in streams, rivers and beaches displaying markedly different MHC genotypes. Additionally, tests for selection indicated that beach populations are generally undergoing directional selection whereas stream populations show signatures of balancing selection. These data suggest that fine-scale variation in parasite communities has resulted in strong genetic differentiation at the MHC in populations that are separated by < 1 km.

† LaScala-Gruenewald, D.E.†*, Miller, L.P. †, Allen, B.J. ‡, Denny, M.W. †
USING MICROALGAL MORPHOTYPES TO CHARACTERIZE INTERSPECIFIC COMPETITION IN UPPER INTERTIDAL LIMPETS
Exclusion experiments have suggested that the upper intertidal limpets Lottia scabra and Lottia austrodigitalis are in direct competition for epilithic microalgae. However, microalgae are part of a diverse assemblage, containing diatoms and cyanobacteria in addition to macroalgal spores and invertebrate larvae. Here, we examine the competition between L. scabra and L. austrodigitalis at the scale of microalgal morphotypes. Settlement plates were deployed across six sites in the rocky intertidal zone adjacent to Hopkins Marine Station in Pacific Grove, California. At each site, there were four treatments: a fenced, ungrazed plate, an unfenced plate, a fenced plate containing four L. scabra, and a fenced plate containing four L. austrodigitalis. Samples of mature biofilm were collected from each plate and were haphazardly sampled using a Scanning Electron Microscope. Percent cover of morphotypes was characterized in over seven hundred SEM images; morphotypes were identified using size and shape criteria. The ungrazed plates were found to have significantly more filamentous cyanobacteria and diatoms than all other treatments, suggesting that L. scabra and L. austrodigitalis are indeed in direct competition at the morphotype level. However, near-significant differences between the grazing patterns of the two species suggest the possibility of some partitioning of food resources.

† Launer, A.L.1*, Starr, R.M.1,2, Harvey, J.T.1, Hamilton, S.L.1, Ebert, D.A.1,3
SEX-SPECIFIC DISTRIBUTIONS OF LEOPARD SHARKS (TRIAKIS SEMIFASCIATA) IN AN ESTUARINE ENVIRONMENT
1 - Moss Landing Marine Laboratories, 2 - California Sea Grant Extension Program, 3 - Pacific Shark Research Center
Estuaries are used seasonally by many elasmobranchs for reproduction and as nurseries. The character, location, and availability of elasmobranch habitats in estuaries are often altered by anthropogenic activities and environmental changes. These habitat changes may have different effects on groups within a shark population because sex-specific segregations are common for many elasmobranchs. Leopard Sharks (Triakis semifasciata) are important estuarine predators in California and are known to exhibit sexual segregations. Movements of 13 Leopard Sharks (male n=6, female n=7) tagged with coded acoustic transmitters were recorded from March 14, 2013 to March 9, 2014 using moored receivers in Elkhorn Slough, CA. Movement patterns were compared by region within the slough and related to environmental variables. Tagged individuals of both sexes were found to spend the majority of time in the middle section of Elkhorn Slough, though females were more frequently present early in the day and uncommonly recorded after noon; males were consistently abundant throughout the day. The monthly amount of hours Leopard Sharks were detected in the study site was positively correlated with mean monthly temperature. Differences in frequency of detection at temperatures ranging from 13°-16° C were dependent on sex and region of the slough.

† Leary, P.R.*
"INTERNAL TIDEPOOLS" AND PATCHY KELP FOREST DISSOLVED OXYGEN
Hopkins Marine Station of Stanford University
In coastal upwelling systems, severe hypoxic pulses occur often on the inner shelf, though their hydrodynamics here and their effects on rocky reef communities are largely unknown. The primary driver of coastal hypoxic events in Monterey Bay is horizontal transport by internal waves. Most research on internal waves has been conducted over smooth bottoms, and interaction with complex topographies such as kelp forests/rocky reef systems has been largely unstudied. Previously, we have shown that spatial dissolved oxygen variability at 10m scales is strongly influenced by phasing with local internal wave activity, and hypothesized that the observed variability is a consequence of flow-reef interactions. Here we present preliminary evidence for an "internal tide pool" phenomenon, where the relaxation of internal waves leaves pools of dense hypoxic water retained in depressions within the subtidal reef. We show that the recovery of these depressions, following an internal wave event, can lag surrounding areas by several hours. Further, we predict that the resulting patchy dissolved oxygen /temperature fields drive avoidance-like shifts in distributions of mobile communities within the kelp forest system.

† Lee, L.C.*, Salomon, A.K.
PREY BEHAVIOR AND BIOPHYSICAL FACTORS ENHANCE OUR ABILITY TO PREDICT EFFECTS OF SEA OTTER PREDATION ON NORTHERN ABALONE
Coastal Marine Ecology and Conservation Lab, School of Resource and Environmental Management, Simon Fraser University and Hakai Institute
Understanding the mechanisms that drive species interactions is a cornerstone of ecology. Increasingly, empirical evidence is demonstrating the importance of understanding how prey behaviour and environmental conditions can modulate predator-prey dynamics. With the goal of identifying the primary factors that drive northern abalone populations, we conducted subtidal reef surveys in 3 geographic regions of British Columbia, Canada, to quantify how sea otter predation and other biophysical factors affect abalone abundance. We found that increasing otter occupation time resulted in an overall decrease in abalone density, however this effect differed between behaviour
classes: exposed abalone decreased by a factor of 1.5, whereas covered and cryptic abalone increased by a factor of 0.5 and 0.1, respectively. Abalone density differed by region, decreased with increasing depth, wave exposure, and sunflower star biomass, and increased with increasing sea urchin biomass, kelp stipe density and substrate suitability. For exposed abalone, the magnitude of otter occupation time was more than 3 times greater than that of other factors. Experimental results suggested that sunflower stars more successfully captured exposed abalone in high, compared with low, rugosity habitats. With this mechanistic understanding of predator-prey interactions, we can predict sea otter effects on abalone and define key abalone habitats.

† Leung, E.*
THE INFLUENCE OF ENVIRONMENTAL VARIATION ON YEAR-CLASS STRENGTH IN WHITE SEABASS, ATRACTOSCIION NOBILIS, OF SOUTHERN CALIFORNIA
California State University, Northridge
During warm climate events, growth rates can increase in fish, suggesting that they benefit from the increase in sea surface temperature. Climate events such as El Niño Southern Oscillation and Pacific Decadal Oscillation can greatly influence the growth of a species. Studies have shown that species of fish can either thrive or dramatically decline during these shifts between warm and cool phases. White seabass (Atractoscion nobilis) is a prominent commercial and recreational fishery species in Southern California. Largely attributed to overfishing, by 1982 the population had dramatically declined and both fisheries collapsed. Recent studies have shown signs that the native population is in recovery and may benefit from El Niño events through increased growth rates. I addressed the question, “do environmental conditions effect variation in year-class strength among cohorts in white seabass?” This study established the population structure of white seabass over a 12-year period (1997 - 2008) and revealed year-class strength was the greatest in 1996 and 1997. Ultimately, year-class strength was not significantly correlated with sea surface temperature or any of the climate indices. Information provided here can better inform fisheries and update management to ensure the persistence of white seabass as the marine environment continues to change.

ECOSYSTEM CONNECTIVITY AND TROPHIC SUBSIDIES OF BEACHES
1 - California Ocean Science Trust, 2 - University of California, Santa Cruz, 3 - San Francisco State University, 4 - University of California, Santa Barbara, 5 - University of California, Davis
Sandy beach ecosystems support high production of intertidal macroinvertebrates, which are prey for abundant shorebirds and terrestrial fauna. Beaches are classic examples of recipient ecosystems, which depend on subsidies from primary productivity in donor ecosystems. Deposited on beaches as wrack, drift macrophytes from kelp forests, rocky reefs and bays represent a major subsidy that supports beach food webs and ~ 50% of macroinvertebrate biodiversity. To explore connectivity among nearshore and beach ecosystems, we characterized wrack and wrack-associated invertebrate abundance and composition at10 beaches sampled monthly for a year. We characterized coverages of three adjacent ecosystems, examining shoreline attributes and multispectral aerial imagery, for 1) kelp beds, predominantly composed of Nereocystis luetkeana, 2) rocky intertidal zones, and 3) bay and estuarine regions, using Postelsia palmaeformis and Zostera marina as proxies for 2) and 3), respectively, as they are common and abundant elements of wrack on beaches from these ecosystems. We found geographic relationships between the abundance of wrack of all three macrophyte species and their local abundance within their source ecosystems. Thus, subsidies to beaches rely on the proximity and productivity of adjacent donor ecosystems, and should be considered when managing sandy beach and adjacent coastal ecosystems.

Lindstrom, S.C.*
DETERMINANTS OF SEAWEED BIOGEOGRAPHY ALONG THE NORTH PACIFIC RIM
University of British Colombia
A number of authors have proposed various schemes depicting biogeographic provinces along the west coast of North America. Since the boundaries of these provinces vary, depending on the author, it is hardly surprising that molecular sequencing of present-day collections provides support for only some of the boundaries as well as suggesting new ones. Molecular data from seaweeds collected along the Pacific rim from California to Japan indicate that biogeographic breaks occur near Cape Mendocino, California, the eastern end of the Strait of Juan de Fuca, British Columbia, the northwestern Gulf of Alaska, and in the Aleutian Islands. Moreover, unique genotypes are found along the Monterey Peninsula, and some of these appear to represent distinct species. Examples from species of Acrosiphonia, Halosaccion, Laminaria, Mastocarpus, Mazzaella, Palmaira, and Pyropia among others will be used to illustrate these biogeographic patterns. Oceanographic and other conditions, including glacial and post-glacial history, that may be responsible for these distribution patterns will be discussed.

Long, J.D.*, Muir, C., Cooper, R.
DEFENSE CONSEQUENCE: PREVIOUSLY GRAZED SEAWEEDS SUPPRESS SNAIL GROWTH AND GAMETE PRODUCTION
Coastal and Marine Institute, San Diego State University
Although inducible responses to grazing occur in both vascular plants and seaweeds, their impacts on grazers differ markedly. In vascular plants, inducible responses commonly suppress grazer performance and fitness. In contrast, seaweed inducible responses typically reduce palatability but have unknown consequences on grazer performance. This bias in experimental endpoint prevents a thorough understanding of how seaweed inducible responses influence grazer population dynamics, and how this effect compares to the effect of vascular plant induction on grazers. To address this gap, we compared the performance of intermediate-sized Tegula funebralis reared on one of three diets in tidal mesocosms: previously-grazed Silvetia compressa, non-grazed Silvetia, and a starvation control. During our 60 d experiment, snails fed previously-grazed Silvetia grew less and produced gametes less frequently than snails fed non-grazed Silvetia. Diet did not influence snail survivorship. A follow-up experiment suggested that the negative impacts of Silvetia inducible responses were not mediated by changes in feeding. Together with two previous studies, our study suggests that seaweed inducible responses can reduce grazer performance, though the affected trait was study-specific. Given that stressors can prevent grazers from distinguishing between previously-grazed and non-grazed tissues, these data suggest that seaweed inducible responses may increasingly suppress grazer populations.

Long, W.C.*, Van Sant, S.B.‡, Haaga, J.A.†
REDS VS. BLUES: WHEN JUVENILE KING CRABS OF DIFFERENT SPECIES INTERACT, WHO WINS?
1 - Kodiak Laboratory, Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 2 - Southeast Fisheries Science Center, NOAA NMFS
Red king crab (Paralithodes camtschaticus) and blue king crab (P. platypus) have a generally non-overlapping distribution except in the Pribilof Islands. In the 1970s and '80s blue king crab dominated in the Pribilof area of Bering Sea, but since the 1990s red king crab have been dominant and competition between juveniles may be important. We performed habitat choice experiments with and without predators, determined the effect of temperature and habitat on predation on year-0 blue king crabs, and performed a 12 week competition experiment holding red and blue king crabs both separately and together. Red king crabs preferred complex habitats over simple especially in the presence of predators. Blue king crabs preferred simple habitat with an increased preference for complex habitat in the presence of predators. Predation on year-0 blue king crabs was lower at 1.5 than at 5 or 8 °C and was lower in complex habitats. Red king crab survived better when blue king crabs were present. Blue king crabs had much lower survival in the presence of red king crabs. We conclude that year-0 red king crabs have a competitive advantage over blue king crabs, and that this may affect blue king crab productivity in the Pribilofs.

Lowell, N.C.*, Kelly, R.P.
COMPARING THE USE OF “BEST AVAILABLE SCIENCE” BY REGULATORY AGENCIES UNDER THE ENDANGERED SPECIES ACT
University of Washington
In order to mitigate biodiversity loss in the United States, Congress passed the Endangered Species Act in 1973 to protect and recover species at risk of extinction and delegated implementation to the Fish and Wildlife Service and National Marine Fisheries Service. When agencies share regulatory space, a variety of consequences may follow. In order to maximize positive consequences and minimize negative consequences of shared regulatory space, one must analyze differences between the agencies and have a way of measuring effectiveness of implementation. I will compare the agencies’ use of credible scientific data as a proxy for effectiveness of implementation, in part because the statute requires the agencies to use the "best available science" in implementing the Act. To do this, I will review litigation history and use regulatory documents to analyze the ways in which the agencies incorporate emerging technology, the age and credibility of references, and authorship diversity. Then, I will highlight major differences between the agencies that may explain differences in effectiveness of implementation. Lastly, I will apply a framework for shared regulatory space to propose management recommendations for the improved conservation of biodiversity. Here, I present preliminary findings.

† Lucas, B.J.*, Smith, J.R.
AN EVALUATION OF MANAGEMENT STRATEGIES TO PROTECT ROCKY INTERTIDAL SPECIES FROM THE IMPACTS OF HUMAN ACTIVITIES
California State Polytechnic University, Pomona
In urbanized southern California, marine rocky intertidal habitats are frequented by large numbers of human visitors. Visitor activities, such as collecting, can harm rocky shore flora and fauna, including reducing their abundances, diversity, and shifting the size/age structure of populations. Research characterizing human use of these ecosystems in 1995/96 at 8 sites in Orange County, California, suggested that levels of visitation and
collecting were high at some sites, despite being within Marine Protected Areas, and that these behaviors have adversely impacted some organisms. Over the following decade, the Orange County Marine Protected Area Council (OCMPAC), a local conservation collaborative, increased efforts in education, outreach, and enforcement to reduce the harmful activities of visitors. To evaluate the effectiveness of OCMPAC management, we compared human use patterns between 1995/96 and 2013/14. While comparisons reveal an increase in visitation at most sites, the frequency of collecting and fishing, have decreased. Additionally, we compared the size structures of *Lottia gigantea*, an exploited limpet herbivore, over the last two decades. Although variable among sites, patterns of increases in limpet size were detected. Results suggest that OCMPAC management has been effective in reducing the detrimental activities of visitors and, potentially, the recovery of an impacted species.

† Lujan, S.L.1°, Newsome, S.D.1, Coletti, H.2, vonBiela, V.3, Monson, D.H.3, Ballachey, B.3, Bodkin, J.L.3

**IMPORTANCE OF MICRO-VERSUS MACROALGAE TO INTERTIDAL INVERTEBRATE COMMUNITIES IN SOUTH CENTRAL ALASKA**

1 - University of New Mexico, 2 - National Park Service, 3 - United States Geological Survey

North Pacific intertidal ecosystems are highly diverse and dynamic ecosystems fueled by a combination of macroalgae and phytoplankton (microalgae). Despite a detailed knowledge of how intertidal communities are structured, little is known about the relative importance of these two sources of primary production and how this varies over time and space. In this study, we quantified the importance of macro versus microalgae to the invertebrate community via carbon (δ13C) and nitrogen (δ15N) stable isotope analysis of particulate organic matter, macroalgae (~8 species), and invertebrates (~9 species) from 15 sites distributed across three regions along the south central Alaskan coast. Our results show that while isotope values can significantly vary across small spatial scales, similar patterns in mean macroalgae δ13C were observed at the site level: Rhodophyta < Chlorophyta < Ochrophyta. Mixing model results suggest that source(s) of carbon utilized by invertebrate consumers varied with functionality. Consumers at higher trophic levels (e.g. *Pycnopodia*) are more dependent on Ochrophyta, whereas those that occupy lower trophic levels—filter feeders (e.g. *Mytilus*) and grazers (e.g. *Strogylocentrotus*)—are more dependent on Chlorophyta and Rhodophyta. In addition, we will also present results on the effects of lipid-extraction on invertebrate δ13C and δ15N values.

† Lyles, J.M.1°, Best, P.N.1, Graziano, K.1, Luna, M.1, Stevenson, T.1, Pollnac, R.B.2, Warren, B.3,4, Christie, P.1

**A SOCIAL AND ECOLOGICAL EXAMINATION OF PUGET SOUND MARINE PROTECTED AREAS: DO THEY WORK?**

1 - University of Washington, 2 - University of Rhode Island, 3 - Sustainable Fisheries Partnership, 4 - National Fisheries Conservation Center

Marine protected areas (MPAs) are spatial management tools used to enhance fisheries and protect biodiversity and critically important habitats. To date, there have been over 120 MPAs established in Washington state, yet there is little known about their management efficacy and social dimensions. With the continual erosion of ecosystems in Puget Sound, there has been increased interest by state and federal management agencies and non-governmental organizations in the potential of MPAs to meet social and ecological recovery goals. We explored perceptions held by marine resource users and biological data to understand the implications MPAs have on these dimensions in Puget Sound. We used face-to-face structured surveys in 13 MPAs and 3 reference sites meeting specified criteria, and obtained biological data from REEF to examine general trends in relative fish abundance at selected MPAs sites. The results of our study may help inform decisions about the human dimensions of MPAs in response to recent declines in rockfish populations and other changes to the Puget Sound ecosystem.

† Maguire, A.K.1,2°, Nielsen, K.3, Rogers-Bennett, L.1,4

**THE BLOOD SUCKING ECTOPARASITIC SNAIL (EVALEA TENUISCULPTA) AND ITS RED ABALONE HOST (HALIOTIS RUFESCENS): A CRYPTIC INFESTATION OF CONCERN ON WILD AND AQUACULTURED ABALONE IN CALIFORNIA**

1 - California Department of Fish and Wildlife, 2 - Sonoma State University, 3 - Romberg Tiburon Center, San Francisco State University 4 - University of California, Davis

Blood sucking parasitic gastropods in the family pyramidellidae can have significant effects on mollusk fisheries impacting shell formation, growth, mortality, and transmission of disease. Ocean warming may exacerbate the frequency and intensity of parasite infestations by allowing parasitic to complete their life-cycles faster. We found >40% of red abalone, *Haliotis rufescens*, from ten sites (n=1460) in central and northern California were infected with the pyramidellid snail, *Evalea tenuisculpta*. These ectoparasites were also found in four of six red abalone aquaculture facilities sampled in California. Red abalone are the basis of economically important sport and aquaculture fisheries in California and may be important herbivores in subtidal communities. Infected red abalone had an average of 9 snails (range 0-279), averaging 4.8 mm in length (range 1.0 to 9.8 mm). These are some of the largest pyramidellids ever documented. In the laboratory, 85% of these snails laid one egg mass every three
days with average of 360 eggs each. Larvae also developed faster in higher seawater temperatures. The high infection rates, parasite loads, and reproductive potential of this snail, merits additional investigation of the ecology of this common, yet under studied host-parasite relationship.

†Malpica-Cruz, L. 1*, Green, S.J. 2, Côté, I.M. 1
THE CHANGING TROPHIC IMPACTS OF A MARINE INVADER
1 - Simon Fraser University, 2 - Oregon State University
Indo-Pacific lionfish (Pterois volitans and P. miles) are invasive predatory fishes currently established throughout the Western North-Atlantic and Caribbean. They have caused significant decreases in native reef fish recruitment, biomass and diversity. Anecdotal evidence now suggests that lionfish diet might be shifting away from a predominance of fish prey in Atlantic areas first colonized by lionfish. The trophic web interactions created and disrupted by lionfish may therefore also be changing. We tested the dietary shift hypothesis by comparing the stomach contents and stable isotope signatures of lionfish from natural reefs kept at high or low lionfish density through experimental culling. We predicted that high lionfish densities should lead to faster prey depletion and/or increased intra/interspecific competition, with concomitant dietary consequences. Our prediction was confirmed, although we cannot yet identify the driving mechanism. This study provides further evidence of the negative effects of these invasive predators and a glimpse into potential impacts on reef ecosystem function. Our results support the notion that long-term management efforts can reduce the negative impacts of this invasion.

Marraffini, M.L. 1*, Harris, L.H. 2, Chang, A.L. 1, Ruiz, G. 1
EFFECTS OF SESSILE COMMUNITY PHYSICAL STRUCTURE AND COMPOSITION ON ASSOCIATED POLYCHAETE DIVERSITY
1 - Smithsonian Environmental Research Center, 2 - Museum of Natural History, Los Angeles County
Fouling communities are home to a large diversity of sessile and mobile marine invertebrates, often including dominant non-native species that may have a variety of shapes, creating physical structures for the associated mobile communities. Few studies have looked at the associations between polychaetes and sessile fouling species. San Francisco Bay, one of the world's most invaded estuaries, we assessed the fouling community by deploying settlement plates for three months below floating docks, then characterized the physical structure of the sessile community and identified all organisms morphologically. During a recent one-year period (2012-2013) we found significant interannual variation in the physical structure created by the sessile community. Both the abundance and identity of sessile species in the community changed in ways that appeared linked to environmental conditions. The abundance and identity of polychaetes present was correlated with both the physical structure and species composition of the sessile community. Communities with greater three-dimensional structure created by sessile species had higher polychaete species richness. Our results highlight the importance of these factors in species distribution studies.

THE EFFECTS OF FISHING LOW TROPHIC LEVEL SPECIES ON ECOSYSTEM STABILITY
Northwest Fisheries Science Center, NMFS
Understanding how fisheries affect ecosystems remains an important challenge. Here, we use time-series approaches and output from an ecosystem model of the California Current to estimate how fishing changes ecosystem stability. The Atlantis Ecosystem Model of the California Current is a spatially explicit, multi-sector model that includes oceanographic forcing, a food web model, and fishing. We modeled fishing on low trophic-level species to understand how removing biomass from the prey base of the food web changed community stability. We fit multivariate autoregressive state-space models to 25-year time-series of Atlantis output. We estimated the interaction matrix between functional groups, and used that matrix to estimate properties of stability such as return time and reactivity. We found that stability changed with fishing pressure, but not in ways explained by total biomass removed, trophic level, or body size of the target species. Fishing productive groups led to increased reactivity of the ecosystem initially, but reactivity declined as fishing mortalities exceeded maximum sustained yield. This work demonstrates that even low levels of fishing on certain low trophic level groups can reduce ecosystem stability. This method is a novel approach for detecting the effects of perturbations to ecosystems on the stability of communities.

Mayer-Pinto, M. 1*, Dafforn, K.A. 1, Cole, V.J. 2, Johnston, E.L. 1
THE IMPLICATIONS OF FORESHORE ARMOURING FOR THE STRUCTURE AND FUNCTIONING OF COASTAL SYSTEMS
1 - Evolution & Ecology Research Centre, School of Biological, University of New South Wales, 2 - University of Western Sydney
The loss and modification of coastal habitats is a global issue and it is estimated that armouring shorelines will cost US$770 billion. In Sydney Harbour, Australia, more than 50 % of the shoreline has been replaced by artificial
structures such as seawalls and pilings. These structures support novel ecosystems unlike any that exist naturally, but there is little understanding of how they alter ecosystem function or contribute to important ecosystem services, such as primary productivity or water filtration. Investigating the functioning of these novel systems is essential to understand and, consequently, improve their contributions to ecosystem services. This study evaluated the differences in structure and functioning of ecosystems in three different types of intertidal and subtidal habitats: pilings, seawalls and natural rocky reefs. Three locations of each habitat were surveyed. The abundance and composition of epifauna were measured intertidally and subtidally via photoquadrats and scrapings. Functional endpoints were also measured in each location to assess differences, if any, in the functioning of these artificial and natural systems. The growth-rates and photosynthetic efficiency of the kelp *Ecklonia radiata* were measured using the traditional punch-hole method and a diving PAM, respectively. Also, clearance rates of oysters were measured *in situ* using enclosure chambers. Results of these surveys will have implications in the design and management of multifunctional structures in marine systems.

† McCollum, B.A.*, Edwards, M.S.
THE EFFECT OF RECRUITMENT DENSITY ON THE SURVIVAL OF JUVENILE GIANT KELP (*MACROCYSTIS PYRIFERA*)
Coastal and Marine Institute, San Diego State University
Most sessile organisms are faced with the unique situation of being unable to change their habitat if the location in which they settle is unsuitable. Suitability of a particular habitat depends on the alignment of several factors including the availability of resources such as light, nutrients, and substrate space, and an acceptably low level of competition for these resources. Giant kelp (*Macrocystis pyriforma*) utilizes many strategies for maximizing recruitment potential including producing billions of zoospores that can carpet any available space, the ability for gametophytes to delay reproduction during poor environmental conditions, and the ability to grow rapidly under good conditions. However an inherent problem exists within *M. pyriforma*’s recruitment strategy. Producing enough zoospores to carpet an area may result in a high level of density-dependent mortality that could be avoided by settling at a lower density. This study examines how density affects the survival of juvenile *M. pyriforma* at three life history stages under natural and experimental conditions in the Point Loma kelp forest off San Diego, CA. Different size classes of juvenile *M. pyriforma* appear to be differentially susceptible to density-dependent mortality, and the initial density at which the juveniles recruit may directly influence their survival to adulthood.

ECOLOGICAL EFFECTS OF CLAM (*PANOPEA GENEROSA*) AQUACULTURE ON RESIDENT AND TRANSIENT MACROFAUNA IN AN URBAN ESTUARY
1 - University of Washington Program on the Environment, 2 - Washington State University, 3 - University of Washington School of Aquatic and Fishery Sciences
Advances in aquaculture present opportunities to enhance food security and local economies but concomitant social and environmental impacts must be addressed. Culture of geoduck clams (*Panopea generosa*) initially involves large-scale out-planting to intertidal habitats and installation of PVC tubes and netting to exclude predators and increase early survival. Once clams have reached market size, they are extracted by hand in a process facilitated by injecting water into surrounding sediments. Each part of this culture cycle is characterized by relatively novel disturbances of the local habitat. The aim of the present work was to investigate effects on community diversity and taxa abundance as part of Before-After-Control-Impact design. We used multivariate statistics and generalized linear mixed models (GLMMs) to examine the factors contributing to patterns within plots. Results suggest that resident and transient macrofauna respond differently to pulse and press perturbation associated with aquaculture, which may reflect adaptation to natural disturbance regimes. We observed short-lived, localized effects mostly because structure additions change habitat characteristics. Harvest effects were negligible for most taxa. This study provides the first look at the effects of multiple phases of geoduck farming and has important implications for management of a rapidly expanding sector of the aquaculture industry.

† McQuinn L.L.*, Sorte C.J.B., Maurel S.A., Davis, K.A.
MUSSEL RECRUITMENT AND THERMOTOLERANCE ACROSS AN UPWELLING CYCLE
University of California, Irvine
Species unable to tolerate or adapt to climate change *in situ* will be forced to shift their ranges to more climatically suitable locations. Poleward range shifts may be relatively challenging for sessile species, such as the mussel *Mytilus californianus*, in areas like the U.S. west coast where dominant currents flow toward the equator. We collected mussel larvae daily over a ten day upwelling cycle in late August to assess how wind direction affected total recruitment and how recruit thermotolerance varied over time, potentially indicating differential larval origins and local adaptation. During a period of upwelling-favorable winds, we collected fewer recruits with higher thermotolerances. In contrast, after a transition to downwelling-favorable winds, more numerous and less thermotolerant recruits were collected. We compared our findings with the results of a particle tracking study using
an oceanographic circulation model (Regional Ocean Modeling System, ROMS) to explore larval sources and recruitment magnitude. We will ultimately compare thermotolerances across potential source populations indicated by the particle tracking study to more clearly understand the connections between dispersal patterns and potential responses to climate change.

† Meyers-Cherry, N.L.*, Nakamura, R., Ruttenberg, B.I., Wendt, D.E.
SPATIAL AND TEMPORAL COMPARISONS OF GOPHER ROCKFISH (SEBASTES CARNATUS) LIFE HISTORY TRAITS IN SOUTH CENTRAL CALIFORNIA
California Polytechnic State University, San Luis Obispo
Life history traits including growth parameter values are critical to determine appropriate fisheries management efforts; they can be used as indicators to predict species and population-level vulnerability, and to determine harvest restrictions for economically valuable species. Moreover, it is well understood that natural and anthropogenic factors affect the physiological condition of individuals and hence the populations they compose. Understanding regional variation in life history characteristics due to multifarious environmental influences among geographically distinct locations can improve current management strategies. Gopher rockfish, Sebastes carnatus, comprise 50% of the estimated shallow nearshore recreational rockfish catch in California, yet insufficient local data exist regarding life history traits of this species. Our study locally defines growth parameters (maximum size and age) for gopher rockfish in south central California. Growth parameter values calculated for our study are similar to previously published research for gopher rockfish collected from central California (primarily Monterey) in the 1980s. Furthermore, we examined spatial and temporal differences of life history information, within and outside of two south central California Marine Protected Areas (MPAs) established in 2007, between two time periods. Our data show that the size and longevity of individuals has increased after the establishment of MPAs.

Miller, L.P.*†, Allen, B.J.2, Denny, M.W.1
WARMER WEATHER WHILE WAITING FOR WAVES LETS LIMPETS LIVE LARGE
1 - Hopkins Marine Station of Stanford University, 2 - California State University, Long Beach
Rocky intertidal grazers must typically restrict their foraging to times when the rocks are submerged or splashed by high tides, which will result in a stable body temperature near ocean temperature while actively moving and feeding. At low tide, when grazers such as limpets are forced to sit in place and wait for the return of the next high tide, body temperatures may range widely, from very low at night to very high on sunny days. What are the potential impacts of this low-tide temperature variation on limpet metabolism and growth? Using temperature and growth rate measurements from a field experiment in central California, we observed a positive effect of warmer low tide temperatures on limpet growth rates for two high-shore species when sufficient food resources were available, and minimal effects for two low-shore species. These results suggest that warmer microhabitats may bolster growth rates even when limpets are inactive and not feeding, provided temperature conditions remain non-stressful.

† Miller, S.D.*†, Mattiasen, E.G., Collins, C.A., Fulton-Bennett, H., Hamilton, S.L.
QUANTIFYING HERBIVORY BY MARINE FISHES IN THE SOUTHERN GULF OF CALIFORNIA
Moss Landing Marine Laboratories
Herbivory has been extensively studied in tropical marine ecosystems due to the ability of top-down processes to strongly influence the structure and function of benthic communities, yet it has not been well-studied in the subtropical Gulf of California. No studies have quantified the grazing behavior of parrotfishes in this area despite their functional importance on coral reefs, and few studies have examined herbivory in other fish taxa. This study quantified rates of herbivory on different macroalgal taxa using a grazing assay experiment and estimated daily parrotfish grazing impacts through behavioral observations of species- and substrate-specific bite rates. We conducted this study at two islands that differed in the degree of parrotfish fishing. We found that the protected island had higher rates of macroalgal biomass loss and greater daily parrotfish grazing impacts on the benthos. Additionally, the islands differed in benthic community structure, with the protected island having higher percent cover of filamentous turf algae and the fished island having higher cover of coralline algae. Our study is the first to quantify parrotfish grazing behavior in the Gulf of California and provides evidence that grazing by herbivorous fishes may be driving changes in the benthic communities of these islands.

Miller, S.H.*†, Breitburg, D.L.1, Burrell, R.B.1, Keppel, A.G.1,2
EVIDENCE OF LOCAL ACCLIMRATION TO HYPOXIA IN HIGHLY MOBILE ESTUARINE FISH
1 - Smithsonian Environmental Research Center, 2 - Marine, Estuarine, and Environmental Sciences, University of Maryland, College Park
Hypoxia is an important marine stressor, particularly in shallow waters where cycles of respiration, photosynthesis, and tides result in daily fluctuations of dissolved oxygen (DO). Some aquatic organisms exhibit behaviors to cope with hypoxia, including aquatic surface respiration (ASR) in fish. During ASR, fish sip from the thin layer of water in
contact with the atmosphere because it is slightly more oxygenated. The frequency of ASR and the level of DO that triggers the behavior vary among species, and could vary with exposure history. In this study, we investigated the behavioral response to hypoxia in two important estuarine forage fishes, the silversides *Menidia menidia* and *M. beryllina*. Fish were collected from sites with differences in DO and observed in the lab for ASR and mortality as we reduced DO. In both species, fish from well oxygenated sites performed ASR and died at higher DO concentrations than fish from sites with frequent hypoxia. These results were corroborated by a laboratory study in which we raised fish under controlled conditions. Our findings indicate that these species have the capacity to acclimate to hypoxia, which has important implications for future climate change scenarios in which the frequency and duration of hypoxic events increase.

**Miner, B.G.*, Beck, R., Kohl, W.**

**INFECTIOUSNESS OF SEA STAR WASTING DISEASE**

*Western Washington University and Shannon Point Marine Center*

Sea star wasting disease has ravaged many populations of sea stars along the west coast of North America, and is now one of the largest disease-related mortality events that has been observed in the oceans. Currently, little is known about this disease, and we were interested in testing whether individuals with objective symptoms of the disease could infect conspecifics. We performed several laboratory experiments with two species, *Pycnopodia helianthoides* and *Pisaster ochraceus*, to answer this question. In addition, we also tested whether reducing water temperature would slow or eliminate the progression of objective symptoms in individuals that appeared to have the disease. We will discuss the results of these experiments and how they related to the observed mortality patterns in the field.

**Miner, C.M.*, Multi-Agency Rocky Intertidal Network**

**DOCUMENTING THE IMPACTS OF SEA STAR WASTING SYNDROME THROUGH LONG TERM SURVEYS AND CITIZEN SCIENCE MONITORING**

1 - *University of California, Santa Cruz, 2 - see www.marine.gov for complete list of researchers*

An ongoing disease epidemic of unprecedented magnitude has devastated sea star populations along much of the west coast of North America. Sea star wasting syndrome (SSWS) was first documented on the Olympic Coast of Washington in June 2013, and has since resulted in massive sea star die-offs ranging from Sitka, AK to southern California. The Multi-Agency Rocky Intertidal Network (MARINe) collects population data for the ochre star, *Pisaster ochraceus*, at over 100 west coast sites as part of a long-term monitoring program, and communication among MARINe members was critical to the early detection of SSWS and a coordinated, coast-wide sampling effort. This effort was further expanded by enlisting the help of both citizen science groups to collect data from under-represented areas and the general public to submit observations to better document the extent of SSWS. Some unexpected patterns have emerged from these data in relation to how SSWS has impacted *P. ochraceus* populations regionally. These patterns could influence the outlook for recovery of the ochre star, and help us to better understand the expected community response resulting from the decline of this keystone predator.

**Mittelstaedt, H.*, Hultgren, K.**

**VARIATION IN COLOR CHANGE ABILITIES IN A GUILD OF MARINE ISOPODS (IDOTEA)**

*Seattle University*

Marine isopods are small herbivorous crustaceans that live and feed on a variety of intertidal algal habitats, including red algae, green algae, kelp, and sea grass. Isopods often match the color of their algal habitats, suggesting these animals may use color camouflage to escape predators. However, little work has been done on the adaptive benefits of color camouflage or the color change abilities of different isopod species from the Puget Sound region. This study investigates the ecology of color change in three species of isopod found in Puget Sound: *Idotea wosnesenskii*, *I. schmitti*, and *I. resecata*. Field surveys indicate that *I. wosnesenskii* and *I. schmitti* vary significantly in color between different-colored habitats. Field tethering experiments demonstrate that *I. wosnesenskii* similar in color to their algal habitat are preyed on less frequently, suggesting color is adaptive as camouflage in this species. Color change assays with isopods from different habitats, and fed different algal diets, suggest color change ability varies between species. *I. schmitti* and *I. wosnesenskii* appear to change color using both pigment sequestration and chromatophores, while *I. resecata* shows a lower magnitude of color change, based primarily on pigment sequestration.

**Molina, M.E.*, Robles, C.D.**

**PLASTIC GROWTH AND ENERGY STORAGE IN THE KEYSTONE PREDATOR PISASTER OCHRACEUS WITH IMPLICATIONS FOR PREY POPULATION REGULATION**

*California State University, Los Angeles*

The predatory sea star *Pisaster ochraceus* maintains the lower boundary of mussel beds on the rocky intertidal despite year to year variation in the recruitment of juvenile mussels. This archetypal example of the stable
regulation of prey populations depends, in part, on the predators’ numerical response to changing mussel zonation. We examined whether changes in body size might provide an additional response. Our results show that natural or experimentally induced up-shore shifts of the lower boundary of the mussel beds reduced growth rates and energy storage; down-shore shifts caused rapid growth to larger sizes and elevated energy storage. Remarkably, shifting the lower boundary of the mussel zone from extreme down-shore to extreme up-shore positions caused the sea stars to shrink but the sea stars were still able to stow energy in the storage organ. Energy stored at the end of the season converts to reproductive output. Thus, it appears that individual fitness constraints support the idea that predator responses are essential in regulating prey populations. Without such predator responses, boom and bust years of prey recruitment would cause marked multi-year shifts in prey zonation.

Monro, K.*, Grosberg, R.K.2, Marshall, D.J.1 CO-EVOLUTION OF GAMETES ACROSS FERTILISATION AND DEVELOPMENTAL MODES 1 - Monash University, 2 - University of California, Davis
Within the marine invertebrates, internal fertilisation has arisen repeatedly and developmental mode shows tremendous diversity. How might such differing life-histories have influenced the evolution and co-evolution of gamete phenotypes in this group? To explore this question, we used phylogenetic analyses to compare sperm and egg traits across ~600 marine taxa, and present evidence for the correlated evolution of these traits within and across sexes that further interacts with life-history mode.

† Mor, C.*, Carpenter, R.C. LIGHT INTENSITY INFLUENCES THE RESPONSE OF HALIMEDA MACROLOBA TO OCEAN ACIDIFICATION California State University, Northridge
Decrease in pH and aragonite saturation state as a result of increased carbon dioxide emissions affect the physiology of many calcifying organisms. Environmental conditions, such as light intensity, can influence the outcome of the effects of ocean acidification on the physiology of calcifying autotrophs. Halimeda macroloba is a green calcified alga that is a major contributor to sediment production and coral reef accretion. H. macroloba grows in reef crevices and open areas, therefore some are exposed to higher light intensities than others. The role that light plays in the coupling between photosynthesis and calcification in H. macroloba was investigated experimentally through a combination of two pCO2 levels (360 and 1200 uatm) and three irradiances (80, 150, and 595 µmol quanta m-2 s-1) treatments for 32 days. Elevated pCO2 caused a decrease in calcification at low light intensities, but not at medium or high light intensities. Photosynthetic rates were unaffected by elevated pCO2 across all light intensities, however photosynthetic rates were affected by light. These unaffected photosynthetic rates, when accompanied by a decrease in calcification at low light intensity and elevated pCO2, suggest that the coupling between photosynthesis and calcification in H. macroloba growing in reef crevices may be disturbed by ocean acidification conditions.

† Moritsch, M.M.*, Raimondi, P.T.*, Maynard, J.A.*2, Harvell, C.D.2, Gaddam, R.1 COAST-SCALE ENVIRONMENTAL AND ANTHROPOGENIC FACTORS ASSOCIATED WITH SEA STAR WASTING SYNDROME 1 - University of California, Santa Cruz, 2 - Cornell University
From summer 2013 to 2014, an epidemic of sea star wasting syndrome (SSWS) has been causing mass mortalities of sea stars on the North American Pacific coast, severely reducing asteroid populations. For infectious diseases to spread, they require a susceptible host and appropriate conditions. It is not yet known if a pathogenic agent is responsible or what factors are driving this epidemic to unprecedented spatial extent. To identify potential environmental and anthropogenic factors associated with wasting syndrome occurrence, we combined data from PISCO’s sea star surveys and citizen scientist observations of wasting sea stars from 2013 and 2014. Using GIS to perform geospatial analysis, we searched for correlations between SSWS presence and several factors including: anomalous temperatures, sea star population density, distance from human population centers, distance from coastal wastewater outfalls, and pollutants. The probability of SSWS presence was associated with monthly temperature anomalies. While these factors do not necessarily cause SSWS, they may influence host susceptibility through physiological stress or provide conditions conducive to pathogen spread. Understanding the driving factors behind SSWS will allow us to predict where this epidemic and its ecological consequences are most likely to occur.

† Moye, J.*, Lindholm, J.B. GENDER-SPECIFIC HABITAT UTILIZATION OF KELP GREENLINGS (HEXAGRAMMOS DECAGRAMMUS) ALONG THE CENTRAL COAST OF CALIFORNIA California State University, Monterey Bay
The boundaries of most demersal marine fish assemblages are broadly correlated with water temperature and depth. At smaller scales demersal fishes associate with specific substrates such as rocky reef or unconsolidated sediments. However, at the finest scale, the scale at which individual fish interact with the seafloor, our
understanding continues to be limited. This information is increasingly necessary for marine spatial planning efforts, including the designation of marine protected areas (MPAs). In this study, data on the distribution of Kelp Greenlings (*Hexagrammos decagrammus*) were extracted from video and photographic imagery collected by a remotely operated vehicle along 89 transects ranging from Point Arena to Pillar Point off central California. Micro-habitat associations of 815 fish were quantified and the geo-referenced positions were plotted over high-resolution (2 m) bathymetric maps. Results suggest males have a stronger association than females with low-relief, hard substrate across study sites. Females formed the majority of fish observed over unconsolidated sediments, though still adjacent to rock. These observations combined with predictive modeling techniques in ArcGIS allowed us to map suitable habitat and potential areas of occurrence beyond the relatively limited areas sampled. Ultimately, this study advances our understanding of an exploited species in support of spatial management.

**Munguia, P.*
**
**STRUCTURAL HETEROGENEITY IN SOURCE-SINK COMMUNITIES**

_The University of Adelaide_

Community ecology focuses on understanding the mechanisms that drive patterns of diversity, with emphasis on conservation efforts that maintain species abundance and distribution. As habitats become fragmented or destroyed, the spatial distribution and physical characteristics of habitats will play an important role in community dynamics. Source-sink relationships are controlled by mechanisms that change based on the dispersal strategies of the individual species. A habitat may become a source or sink population based on the combination of abiotic factors and coexisting species. However, a community does not necessarily behave as a source or a sink for all the species present. The occurrence of multiple dispersal strategies and life histories within a community creates the opportunity for heterogeneity to drive species’ abundance patterns and alter species distribution. In the northern Gulf of Mexico, we explored the effects of structural heterogeneity on the diversity of shallow-water benthic species. PVC tiles were used to form 10x10 cm² communities, and we used community age as a surrogate for the establishment of sources and sinks. Tiles were paired in close proximity at different levels of heterogeneity. In the northern Gulf of Mexico, we explored the effects of structural heterogeneity on the diversity of shallow-water benthic species. PVC tiles were used to form 10x10 cm² communities, and we used community age as a surrogate for the establishment of sources and sinks. Tiles were paired in close proximity at different levels of heterogeneity. Here, we report the response of populations’ sources and sinks to heterogeneity, and its effect on overall tile diversity.

**Neeb Wade, P., Toledo, D.*
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**ENGAGING MINORITY STUDENTS IN SCIENCE AND CONSERVATION**

_Monterey Bay Aquarium_

Over the last decade there has been an augmented effort to increase female participation in the sciences, specifically amongst minority students. The Young Women in Science (YWS) program at the Monterey Bay Aquarium engages culturally and linguistically diverse middle school girls in authentic marine science, allowing the students to recognize its importance to their own lives and their surrounding environment. This strategy provokes conservation awareness and action, in hopes that participants will continue to be involved and also become future stewards of the ocean. The program is uniquely designed to combine science education, language, and leadership skills. It targets middle school students entering 7th or 8th grade living in the tri-county area of Monterey, Santa Cruz, and San Benito California. The program’s bilingual facilitation provides opportunities of engagement to the student body that is composed of predominantly Latino girls. Program evaluations have shown an increase in the girls’ connection to, comfort in and care of the ocean. After completing the program the majority of participants indicated they were more aware of their own impacts on the environment and believed they have the power to help the ocean.

**Novak, M.*, Coblentz, K.E., Shepard, I.D.**

PREDATOR-INTERFERENCE, PREY-SWITCHING, AND THE DENSITY DEPENDENT NATURE OF SPECIES INTERACTION STRENGTHS

_Oregon State University_

Understanding the empirical nature of predator-prey functional responses is central to food web theory. A longstanding and vigorous debate in predator-prey ecology concerns whether functional responses are prey-dependent (responding only to prey abundances) versus predator-dependent (responding to prey and predator abundances). Theory suggests that predator-dependence can explain many of nature’s paradoxes left unexplained by simple prey-dependent models. However, the occurrence of predator-dependence has rarely been assessed and only so in specialist predators which are rare in nature. Similarly, prey-switching (adaptive foraging) by generalist predators is considered an important stabilizing mechanism in food webs but has rarely been quantified. Here we develop an observational framework for estimating both prey attack rates and predator interference rates in the functional responses of generalist predators interacting with an arbitrary number of predator species. We apply the approach in an observational study and a manipulative experiment involving the intertidal whelks *Nucella ostrina* and *N. canaliculata*. We show that (i) neither intra- nor interspecific predator-dependence is detectable despite considerable statistical power, and that (ii) per capita attack rates are inversely dependent on prey densities. The latter insights stands in contrast to expectations derived for optimally foraging predators.
Obaza, A.K.\textsuperscript{1*}, Williams, J.P.\textsuperscript{2}, Chesney, W.B.\textsuperscript{1}

THE FOULING COMMUNITY ASSEMBLAGE OF OVERWATER STRUCTURES WITHIN THE SOUTHERN CALIFORNIA BIGHT

1 - NOAA Fisheries, West Coast Regional Office, 2 - Occidental College, Vantuna Research Group

Overwater structures within coastal estuaries are novel habitats that may facilitate the introduction and spread of non-native fouling organisms by creating substrate that native species are not adept at exploiting. These non-indigenous species (NIS) may threaten already stressed ecosystems, damage aquaculture operations and cause other economic harm. In order to explore this unappreciated habitat impact, data on fouling communities were collected via photoquadrat at eleven bays and harbors throughout Southern California to quantify percent coverage of NIS and fouling community relationships among systems. Results show a greater percent coverage of NIS compared with native species both underneath and along the sides of structures in high and low flow areas of embayments. Non-native ascidians were the most abundant taxonomic group, followed by non-native bryozoans and native brown algae. In addition, the site with lowest surrounding development also had the lowest coverage of NIS. Future work will incorporate succession and temporal changes in fouling community assemblages and further explore the influence of surrounding development. This work highlights the importance of evaluating a full suite of impacts from coastal development projects.

O’Connor, M.I.*

EFFECTS OF WARMING ON FOOD WEB STRUCTURE AND FUNCTION MEDIATED BY TROPHIC STRUCTURE AND SHIFTS IN GRAZER BODY SIZE

University of British Colombia

Temperature affects the demographic rates and energy fluxes central to food web structure and function. Theory predicts that at the community and ecosystem level, constraints of temperature on flux interact with community shifts in composition and size to shift food web structure with warming. We empirically tested the effects of temperature and food chain length on energy fluxes, biomass distribution, body size and species composition in experimental pond food webs. We found that primary productivity and respiration, estimated by oxygen fluxes, increased with warming as predicted by metabolic theory. This effect of temperature on system-level fluxes depended on food chain length, indicating that trophic structure interacts with energetic constraints at the system level. We also found that shifts toward smaller grazer body sizes occurred in the absence of predators, but not when predators were present, indicating that trophic can constrain community responses to warming.

O’Donnell, J.L.\textsuperscript{1*}, Lowell, N.C.\textsuperscript{1}, Shelton, A.O.\textsuperscript{2}, Samhouri, J.F.\textsuperscript{2}, Williams, G.D.\textsuperscript{2}, Hennessey, S.M.\textsuperscript{2*}, Port, J.A.\textsuperscript{3}, Kelly, R.P.\textsuperscript{1}

ENVIRONMENTAL DNA AS A COMMUNITY SURVEY TOOL IN A DYNAMIC MARINE ECOSYSTEM

1 - University of Washington School of Marine and Environmental Affairs, 2 - Conservation Biology Division, Northwest Fisheries Science Center, NOAA, 3 - Center for Ocean Solutions, Stanford University

Organisms release tissue and cells into the environment, from which DNA can be extracted and sequenced. This environmental DNA (eDNA) can detect the presence of individually targeted organisms such as invasive, threatened, and commercially important species. As the cost and time investment of DNA sequencing continues to drop, the sampling of eDNA has the potential to become a powerful cost- and time-effective supplement or replacement for traditional community survey methods. However, important questions remain about eDNA’s accuracy and effectiveness as a non-invasive community survey technique. We used traditional methods to survey the invertebrate communities of eelgrass beds along an urban gradient in Puget Sound in order to assess the efficacy of eDNA sampling in this context. We designed primers that exclusively target a small fragment of the mitochondrial 16S gene in metazoans, and sequenced the resulting product on the Illumina MiSeq platform. Here, we compare the eDNA results to those of the traditional sampling method, and discuss aspects of spatial and temporal variability of each.

O’Farrell, S.\textsuperscript{1,2,3*}, Salguero-Gómez, R.\textsuperscript{3,4,5}, vanRooij, J.M.\textsuperscript{6}, Mumby, P.J.\textsuperscript{3,1}

DISENTANGLING ANTAGONISTIC MORTALITY IN SPECIES WITH DECOUPLED SIZE AND AGE

1 - College of Life and Environmental Sciences, University of Exeter, 2 - Smithsonian Marine Station, 3 - School of Biological Sciences, University of Queensland, 4 - Evolutionary Demography Laboratory, Max Planck Institute for Demographic Research, 5 - School of Natural Sciences & Trinity Centre for Biodiversity Research, University of Dublin, 6 - Department of Marine Biology, University of Groningen

Size and age are fundamental organismal traits, and both can be important predictors of mortality. For many organisms, however, size and age predict mortality in ontogenetically opposing directions (antagonistic mortality). Mortality due to predation is often intensified on smaller individuals whereas mortality due to aging impacts, by definition, on older individuals. This presents a problem when modeling population dynamics or fitness components in organisms for which size and age are decoupled - including many plants, invertebrates, fishes, reptiles and
amphibians - because size-structured models may perform poorly at capturing age-based mortality and vice versa. Using demographic data from a coral reef fish, we demonstrate how an agent-based model (ABM) can be implemented to investigate population dynamics when size and age are decoupled. Our ABM decomposes mortality into independent functions comprising size and/or age components. By validating outputs against empirical data, we show that excellent fits to complex demographic data can be achieved when mortality is influenced independently yet simultaneously by size and age. Our approach may provide novel insights in fields where growth and lifespan are uncoupled yet associated, including evolutionary ecology (e.g., trade-offs between growth and lifespan) and conservation biology (e.g., impacts of invasive predators on native size structure but not lifespan).

† Perry, D.C.1*, Jeppesen R.K.F.2, Wasson, K.2
MACROALGAL BLOOMS OVER TIME AND THE EFFECTS OF WRACK ON SALT MARSH IN ELKHORN SLOUGH ESTUARY
1 - University of New Haven, 2 - Elkhorn Slough National Estuarine Research Reserve
Estuaries are particularly susceptible to the impacts of increased nutrient input due to estuarine habitats acting as a buffer between coastal and terrestrial ecosystems. This study examined the effects that the nutrient driven growth of Ulva spp. had on Sarcocornia pacifica, the dominant salt marsh plant in Elkhorn Slough Estuary. We examined historical aerial photos of Elkhorn Slough to estimate Ulva abundance from 1930s to 2010; these values were compared to nutrient concentrations. Ulva abundance increased over time, but was not significantly related to nutrient concentrations. We conducted a field experiment that tested the effects of Ulva coverage on S. pacifica using two treatments; S. pacifica free of algae and S. pacifica covered by algae. S. pacifica consistently covered had significantly lower percent cover, percent flowering, and canopy height than plots clear of Ulva. We monitored wrack abundance of 15 areas along the salt marsh edges of the estuary over a 3-month period. Wrack density in these areas varied over time, and the overall wrack density along the main channel of the estuary was not consistent over time. Excessive macroalgal cover is a characteristic of eutrophication which may be attributing to marsh erosion and dieback within Elkhorn Slough Estuary.

† Pettersen, A.K.1*, White, C.R.2, Marshall, D.J.1
DOES METABOLISM SCALE WITH OFFSPRING SIZE?
1 - Monash University, 2 - The University of Queensland
Body size is one of the most important traits of the life history. Size defines many physiological and ecological parameters, such as longevity, fecundity, development and survival. The effects of offspring size variation are ubiquitous across taxa and can persist throughout the life-history. Many models have sought to define an offspring size-fitness relationship, where there is a single optimal level of investment per offspring that will maximise parental reproductive success. However, defining the ‘optimal’ offspring size involves a fundamental trade-off with fecundity, where selection acts to maximise maternal fitness within the constraints of resource availability. One of the most widely studied relationships in biology is that of metabolic rate and body mass. However there are profound divergences between size optimality models, which assume energy use (metabolism) to be directly proportional to the total mass of an organism, and metabolic theory, which predicts a scaling exponent of less than 1. Determining the value of the metabolic scaling component is therefore important, and could potentially alter offspring size theory. We measured the relationship between offspring size and metabolism rate in two marine invertebrates, Bugula neritina and Watersipora subtorquata. Here, we report how metabolic rate varies with offspring size and developmental stage.

Plowman, C.Q.1, Trowbridge, C.D.1*, McAllen, R.2, Davenport, J.2
STRESSED FROM ABOVE, STRESSED FROM BELOW: THE STORY OF OXYGEN FLUCTUATIONS IN LOUGH HYNE
1 - Oregon Institute of Marine Biology, 2 - University College Cork
Dissolved oxygen (DO) concentrations of Lough Hyne Marine Reserve, in SW Ireland, were sampled in 2014 to investigate the consequences of recent seasonal proliferations of ulvoid and ectocarpoid algae. DO was measured above, in, and below the thermocline, above and below rocks in each of 20 established benthic monitoring sites, and in the Tidal Rapids (lough’s connection to Atlantic Ocean). Also, HOBO data loggers, which sampled DO and temperature every 15 minutes, were deployed from March to August in shallow subtidal habitats. At the thermocline (29 m in mid-August), DO dropped to 0.6 mg/L thus constraining all marine organisms to shallower water. Oxygen above subtidal rocks was normoxic to hyperoxic in the daytime (100% to 226.3% air saturation), while DO below rocks was hypoxic to anoxic (2 to 0.24 mg/L). The south basin water exhibited less hypoxia than the north basin, presumably due to the higher water flow of the former. DO levels in the rapids were normoxic, regardless of tidal state (ebbing/flowing/slack), type (spring/neap), or time of day. Data continue to be analyzed: (1) to determine if there may be a correlation between DO and weather or algal cover, and (2) to evaluate the physiological consequences of DO fluctuations.
Poe, M.R.¹²*, Levin, P.S.², Tolimieri, N.², Norman, K.C.²
SUBSISTENCE FISHING IN A 21ST CENTURY CAPITALIST SOCIETY? EXAMINING COMMUNITY ECONOMIES IN U.S. WEST COAST PORTS
1 - University of Washington, Sea Grant Program, 2 - NOAA Northwest Fisheries Science Center
Over 37.5 million pounds of fish and shellfish were kept for “personal use” by commercial fishing operators in Washington and California between 1990-2010. Although a nominal figure in the overall catch, retention of seafood for personal use/subsistence among 21st century market-based commercial fishing operators reveals a more diverse array of economic systems than previously imagined. In this talk, we examine the extent, range, and diversity of noncommercial wild ocean seafood subsistence harvests and test the relationship between market drivers and subsistence behavior. We analyze a prevailing rational economic model for its potential to explain patterns of personal use by two participant groups: tribal (indigenous) commercial operators and nontribal operators. Out of the species tested, only one fit the market relationship with statistical significance and the model failed to predict personal use patterns for any of the other species. We conclude that the market is not a driver for subsistence and fails to explain why fishing operators keep seafood for personal and community use. We suggest that alternative logics are at play in the informal economies of fishing communities; these logics include cultural food practices and social support networks for which nonmarket seafood sharing may play important roles in community wellbeing and food security.

† Powell, K.K.*, Konar, B.H.
THE METABOLIC PROCESSES OF TWO ECHINODERMS: LEPTASTERIAS HEXACTIS AND OPHIURA SARSII DUE TO TEMPERATURE AND PHYSICAL MODIFICATION
University of Alaska, Fairbanks
Ocean temperatures are currently rising, and we are just now realizing the indirect effects. One possible concern for most marine organisms is that increasing ocean temperature will result in increased metabolic rates. This study investigated whether an increase in water temperature and stress, would increase the metabolic rate of two common echinoderms, Leptasterias hexactis and Ophiura sarsi. Leptasterias hexactis is a small but very abundant predatory asteroid living in the rocky intertidal and O. sarsi is a deposit feeding ophiuroid inhabiting deeper water where it is thought to be prey for various fish species. Both organisms display autotomy, or limb loss, when they are stressed by processes such as wave action or sublethal predation. To examine how increasing temperatures and stress influences metabolic rates in these two echinoderms, un-manipulated and manipulated (one arm removed) individuals were incubated in water tight jars at three temperatures. Oxygen consumption was calculated as a proxy for metabolic rate. Both species metabolized more oxygen at higher temperatures; however, L. hexactis metabolized more oxygen then O. sarsi, and responded negatively to simulated autotomy. This suggests that if ocean temperature increases, changes in metabolic rate and responses to stress could have negative impacts on echinoderms.

† Price, H.L.*, Gohad, N.V.², Mount, A.S.², Wendt, D.E.¹
INVESTIGATION OF LARVAL SENSORY MECHANISMS IN THE MARINE BRYOZOAN, BUGULA NERITINA
1 - Cal Poly Center for Coastal Marine Sciences, 2 - Clemson University
Bugula neritina is a marine bryozoan found in temperate and tropical waters worldwide. While much is known about B. neritina larval behavior and anatomy, the underlying sensory pathways controlling settlement and metamorphosis are not well understood. We are investigating B. neritina larval sensory mechanisms by using a combination of larval settlement assays and fluorescence microscopy. We confirmed previous work showing that light inhibits larval attachment, and simultaneously exposed larvae to an adrenergic receptor blocker and light. We found significantly higher attachment in treated compared to control larvae; a result which suggests that B. neritina larvae possess adrenergic-like receptors that are involved in the photosensory pathway. We also found that an adrenergic agonist inhibited larval attachment, whereas an adrenergic antagonist did not. Larvae stained with a fluorescently labeled adrenergic antagonist also revealed the presence of adrenergic-like receptors, which are concentrated in the larval locomotory organ. Based on our results, we put forth a putative settlement pathway that explains the influence of both light and adrenergic compounds on larval attachment. Understanding the larval sensory systems of fouling organisms like B. neritina is essential for developing new technologies to control ship hull fouling and mitigate the spread of non-native species in coastal ecosystems.

Pritchard, E., Granek, E.F.*
CONCENTRATIONS AND EFFECTS OF EMERGING CONTAMINANTS IN MARINE INVERTEBRATES
Portland State University
Pharmaceuticals and personal care products (PPCPs) have gained attention in recent years as emerging contaminants that are increasing in use and have demonstrated negative effects on aquatic organisms. There is a growing body of literature on the effects of PPCPs on freshwater and vertebrate marine organisms, but little
research has been conducted on the effects of PPCPs in marine and estuarine invertebrates. We present a review of the current published research on the biological effects on marine and estuarine invertebrates exposed to PPCPs. We also present empirical data on contaminant types and concentrations in Olympia oysters (Ostrea lurida). Field sampling identified variability in contaminant types across sites and between seasons from samples collected in Oregon during 2013-14.

**Rasher, D.B.**, Hay, M.E.

**ESCALATION IN CHEMICAL WARFARE: COMPETITION WITH CORAL INDUCES INCREASED ALLELOPATHY IN A TROPICAL SEAWEED**

1 - Darling Marine Center, University of Maine, 2 - Georgia Institute of Technology

Many seaweeds induce chemical defenses in response to herbivory, but whether they induce chemical resistance against competitors (allelopathy) remains unknown. We evaluated whether two tropical seaweeds induce increased allelopathy in response to competition with a reef-building coral. We also assessed the effects of competition on seaweed growth, palatability, and chemical defense against herbivores. In response to 8 days of competition with the coral *Porites cylindrica*, the chemically rich seaweed *Galaxaura filamentosa* induced increased allelopathy and as a result became nearly twice as damaging to the coral. However it also experienced reduced growth and increased palatability to herbivores (due to reduced chemical defenses). By contrast the seaweed *Sargassum polycystum* did not induce allelopathy, nor did it experience a change in growth or palatability, as a result of competition. This is the first demonstration of induced allelopathy in a seaweed, or of a competitor reducing seaweed chemical defenses against herbivores. Our results suggest that, if common among chemically rich seaweeds, such phenomena could play an important role in shaping the recovery potential of degraded coral reef ecosystems.

**† Rasmuson, L.K.**, Shanks, A.L.

**INDIVIDUALLY BASED MODELS OF DUNGENESS CRAB MEGALOPAE VERTICAL MIGRATION: IMPLICATIONS OF BEHAVIOR AND CIRCULATION**

*Oregon Institute of Marine Biology*

In coastal upwelling regions vertical migratory behaviors prevent population from being advected seaward. Dungeness crab megalopaes are found off the continental shelf and subsequent recruitment in the nearshore is strongly correlated with upwelling in the spring/summer. We used individual-based-biophysical models to study the advection of megalopae onto the shelf. We generated three types of circulation models (idealized upwelling, idealized spring transition and “realistic” models) using the Regional Ocean Modeling. Three “behaviors” were modeled using LTRANS: passive particles (five depths: 0-300m) and both standard and twilight vertical migrations (TVM) (5 depths: 50m-bottom). Validation with light trap data suggests megalopae exhibit TVM. TVM resulted in the most particles being advected onto the shelf and advection occurred equally during both upwelling and relaxation. TVM particles were advected onto the shelf from an average 1.5km. We propose the following conceptual hypothesis. Off the shelf megalopae exhibit TVM; occupying the neuston during twilight, below the Ekman layer at night and near the bottom during the day. Megalopae are advected onto the shelf at which point they occupy the neuston resulting in advection off the shelf. The coupling of these behaviors results in the circulation and retention of megalopae near the shelf break.

**Rechsteiner, E.U.**

**MALE SEA OTTER FORAGING BEHAVIOUR AT A NEWLY OCCUPIED SITE, AND ASSOCIATIONS WITH HARLEQUIN DUCKS**

*Hakai Beach Institute*

Sea otters exert top-down effects on invertebrate communities that trigger changes in prey availability and in turn influence their foraging behaviour. Sea otters can also have indirect effects on other foragers, producing subsidies via their feeding activities. We documented foraging in male sea otters (*Enhydra lutris*) as they expanded into an area unoccupied by sea otters since the 19th century. Observations were made from January - October 2014. Initially, sea otters foraged over rocky habitats where their diet consisted mostly of large (8-12 cm TD) red sea urchins (*Mesocentrotus franciscanus*) with Harlequin ducks (*Histrionicus histrionicus*) scavenging opportunistically on pieces of sea urchin created by the foraging otters. After 5 months, the size of urchins eaten by sea otters declined, sea urchin diet diversified, and otters began to forage in soft sediment and seagrass habitats. By 10 months, the size of all prey species taken by otters had declined and sea otters were rare. Our observations indicate that sea otters foraging on red urchins may provide a temporally explicit but valuable subsidy to Harlequin ducks, which rarely feed on echinoderms. Our findings also suggest that once male sea otters have depleted easily exploited, large prey items they move on to new areas.

**Reidenbach, L.B.**, Milbrandt, E., Martignette, A.J.

**SURGE UPTAKE OF NITROGEN BY SOLIERIA FILIFORMIS (KÜTZING) IN THE GULF OF MEXICO, FL**
1 - California State University, Northridge, 2 - Sanibel-Captiva Conservation Foundation Marine Lab
Polluted freshwater is released from Lake Okeechobee into the Caloosahatchee River to prevent flooding south of the lake in the Everglades Agricultural Area. Consequently, this causes eutrophic conditions in the nitrogen limited Gulf of Mexico, near the mouth of the Caloosahatchee River and nuisance macroalgae blooms. We performed a growth experiment in high and low nitrate concentrations using Solieria filiformis, Agardhiella subulata, Gracilaria tikvahiae, and Eucheuma isiforme. We found that S. filiformis fragments had growth rates that were an average of three times faster than the other species in both treatments. To elucidate the mechanisms of nutrient uptake in this abundant, fast growing species, a three hour time-course depletion experiment was performed on S. filiformis fragments in a range of nutrient additions (NaNO₃ and NH₄Cl in equal concentrations). We then compared the uptake rates to substrate concentrations using the Michaelis-Menten formula for enzyme kinetics after 20, 90, and 180 minutes. We found that S. filiformis can take advantage of high nutrient environments by utilizing surge uptake when internal nutrient pools are empty. This strategy can be advantageous in an environment that experiences pulses of nutrient additions such as Lake Okeechobee water releases into the Caloosahatchee River.

† Reimer, J.N.*, Hacker, S.D., Menge, B.A.
MARINE WRACK DISTRIBUTION PATTERNS SHOW EVIDENCE OF OUTWELLING ALONG THE PACIFIC NORTHWEST COAST
Oregon State University
Marine wrack, or dislodged macroalgae and seagrasses, frequently washes onto sandy beaches and is a potentially important ecological subsidy for coastal interface habitats. To better understand wrack prevalence in the Pacific Northwest, we surveyed wrack deposition and species composition at 12 coastal sites located from southern Washington to northern California. We used linear mixed-effect models to test how location, season, and environmental variables (distance from rocky reefs and estuaries, upwelling, and beach shoreline change rate) affect the amount and composition of wrack onshore. Northern sites (n=5) had high wrack patch density but lower biomass comprised of mostly eelgrass (72.6%); southern sites (n=3) had lower patch densities but higher biomass comprised of mostly kelp (69.4%); and central sites (n=4) had the lowest patch density and biomass comprised of both eelgrass (21.8%) and kelp (59.0%). Importantly, wrack at all sites contained eelgrass, providing the first evidence of outwelling, or movement of debris between estuaries and the open coast, along the Pacific Northwest. Upwelling, proximity to source habitat, and beach geomorphology also helped explain onshore wrack distribution. Further research on wrack subsidies in sandy ecosystems would substantiate wrack as an important coastal link, which could have potential implications for dune restoration and conservation.

† Rhoades, O.K.*, Lonhart, S.I., Stachowicz, J.J.†
IMPACTS OF FISHING AND SCUBA DIVING ON FISH FLIGHT RESPONSES IN MARINE RESERVES
1 - Bodega Marine Laboratory, University of California, Davis, 2 - Monterey Bay National Marine Sanctuary, National Oceanic and Atmospheric Administration
Intensive fishing can reduce the abundance of fished populations, with indirect effects on marine community structure. In addition, fishing disproportionately harvests bold individuals, and spearfishing increases flight responses in surviving fishes. SCUBA diving can also increase fish flight. Together, these activities cause fish to reduce foraging and shift habitat use, potentially modifying their ecological role. Marine reserves may reverse these effects; however, since certain human activities are permitted within reserves, ecological functioning could be slow to recover. No studies have yet examined the combined impacts of fishing and SCUBA diving on fish flight, or how marine reserves mitigate these impacts. To investigate this, SCUBA surveys of commonly harvested fishes were conducted at Central California marine reserves varying in age, fishing pressure, and SCUBA diving traffic. Divers haphazardly encountered and pursued individual fish to initiate flight. The distance between diver and fish when the fish fled was lower in old, no-take reserves relative to new no-take and limited-take reserves, due to a long-term reduction in commercial and recreational fishing. Species with strong site fidelity rapidly returned to the location from which they had fled. Extreme boldness (complete unresponsiveness to divers) occurred at sites that experience heavy diver traffic, irrespective of fishing pressure. These behaviors may differently influence local population dynamics and the ecological role of these predatory fishes.

Rice, J.A.*, Baker, J.E.
BUILDING THE ENCYCLOPEDIA OF PUGET SOUND
Puget Sound Institute, University of Washington
Digital media is changing the way natural history is shared and understood. Thanks to crowd sourcing and other collaborations, the Web is now full of open access descriptions, photographs, sounds and videos for even obscure species. The Encyclopedia of Puget Sound (www.eopugetsound.org) is an online resource published by the University of Washington focusing on the science of ecosystem recovery in the Puget Sound region. Through a topic editor system inspired by the Encyclopedia of Earth and the Encyclopedia of Life, an editorial board of scientists recruits and reviews content concerning interdisciplinary topics related to Puget Sound protection and
restoration. The site also includes regional species lists, localized species accounts, maps and other resources. The Encyclopedia was formally launched in October 2012 by the University of Washington Puget Sound Institute and receives major support from the Environmental Protection Agency. This presentation will describe the Encyclopedia’s editorial structure and some of the ways that natural history and species inventories are being applied to local conservation efforts.

† Rinehart, S.A.*, Long, J.D.
PREDATORS GOING GREEN: FLOWERS REDUCE THE CONSUMPTIVE EFFECTS OF OMNIVOROUS BEETLES RESPONSIBLE FOR A TROPHIC CASCADE
Coastal and Marine Institute, San Diego State University
Trophi cascades should weaken with increasing omnivory as consumer effects will spread out across multiple trophic levels. Despite growing support for this prediction, we often lack an understanding of the mechanisms by which omnivory weakens cascades. For example, changing plant traits may induce omnivores to change their predation rates. To test this hypothesis, we assessed the consumptive effect of beetles on scale insects in the presence of alternative plant stages – vegetative or reproductive. Flowers reduced beetle predation on scales, presumably because beetles switched from scales to pollen. To test if this diet-switch was related to performance, we reared beetles on several separate diets. Beetle survival was greatest on a mixed diet of flowers and scales suggesting that flowering increases beetle omnivory because these plants contribute to a more nutritious diet. To examine the potential for beetles to induce a trophic cascade, we conducted a 16 week long mesocosm experiment that measured the impacts of lethal and nonlethal beetles on plant growth. In the absence of flowers, beetles indirectly benefited below-ground plant growth by consuming herbivorous scales. We hypothesize that the shift from vegetative to reproductive plants could weaken this cascade by increasing omnivory in predatory beetles.

† Ritson-Williams, R.*, Putnam, H.M., Gates, R.D.
CORAL RECRUITMENT IN A HIGH CO2 ENVIRONMENT: A TRANS-GENERATIONAL PERSPECTIVE
University of Hawai'i
As atmospheric CO2 increases, it is unknown how ocean acidification (OA) will impact coral recruitment (i.e., larval supply, settlement, and post-settlement survival), processes critical to reef persistence and recovery. Furthermore, no coral studies have tested the potential for trans-generational acclimatization. We manipulated CO2 using a pH-stat system (daily pH fluctuations of 7.8-8.2 [ambient] and 7.5-7.8 [high]) and exposed adult Pocillopora damicornis colonies to OA conditions during brooding, followed by a reciprocal treatment of their larvae. After 6, 10 and 14 weeks of exposure, fecundity was consistently reduced in the corals exposed to high OA. Larval survival was greater when adult corals were preconditioned to OA for 10 weeks. Conversely, larvae exposed to OA for 4 days had lower survival than control exposure, regardless of brooding conditions. After one month of growth, recruits from adults preconditioned to OA had higher growth rates, but there was no effect of OA on survival. Corals exposed to OA conditions as adults had fewer larvae, but those larvae were more fit, suggesting that larval phenotype is plastic. This work highlights the importance of examining trans-generational studies to further our understanding of the potential impacts of OA on demographic processes that drive reef dynamics.

Rivera Vázquez, Y.*, Bingham, B.L.
THE EFFECTS OF CHEMICALS RELEASED FROM ULVARIA OBScura ON THE DEVELOPMENT OF SAND DOLLAR AND OYSTER LARVAE
Shannon Point Marine Center, Western Washington University
Green tides are vast accumulations of green macroalgae that, in the last decade, have become a common nuisance worldwide. Compounds in the algae release may negatively affect other organisms, particularly under high-density bloom conditions. Ulvaria obscura, a dominant contributor to green tides along the Pacific coast of the United States, produces, among other compounds, dopamine, a catecholamine and neurotransmitter known to affect settlement and metamorphosis of marine invertebrates. We tested the effects of U. obscura exudates and commercially purchased dopamine on fertilization, early development, and larval survival and morphology of the sand dollar Dendraster excentricus and Pacific oyster Crassostrea gigas. The exudate and dopamine treatments did not strongly affect fertilization success of either species, but they did affect their early development and larval morphology. We found significant differences in archenteron length of D. excentricus gastrulae and shell morphology of C. gigas veligers exposed to the exudates or dopamine. Morphology of D. excentricus plutei also varied significantly among the exudate treatments with larval arm lengths being affected. Our data indicate that compounds released by U. obscura can impact development and, presumably, survival of embryos and larvae, but that the effects differ between species.

† Roberts, M.B.*, Berumen, M.L.*, Thorrold, S.R.
BIOGEOGRAPHICAL PATTERNS IN REEF FISH COMMUNITIES OF THE SAUDI ARABIAN RED SEA
1 - King Abdullah University of Science and Technology, 2 - Woods Hole Oceanographic Institute
As a region renowned for high biodiversity, endemism and extreme temperature and salinity levels, the Red Sea is of high ecological interest. Despite this, there is relatively little literature on basic broad scale characteristics of the biodiversity or general reef fish communities and how they change across latitude. We conducted visual transects recording the abundance of over 200 species of fish from 45 reefs spanning over 1000 km of Saudi Arabian coastline and used hierarchical cluster analysis to find that for combined depths from 0m-10m across this geographical range, the reef fish communities are relatively similar. However we find some interesting patterns both at the community level across depth and latitude as well as in individual species ranges. This type of baseline data on reef fish distribution and possible factors that may influence their ranges in the Red Sea are critical for future scientific studies as well as effective monitoring and management in the face of the persistent anthropogenic influences such as overfishing and climate change.

Robinson, J.W.*, Menge, B.A.
CONTEXT-DEPENDENT FACILITATION OF MUSSEL COLONIZATION BY BARNACLES ON THE OREGON COAST
Oregon State University
Mussel and barnacles, key intertidal ecosystem engineers, are classic examples of species competing for the same space while facing pressure from predation. However, the complex interactions, including potential positive effects between these two species, are not well characterized. Therefore, we sought to examine how predation, competition and facilitation influence the colonization of mussel and barnacles. To study these interactions, we conducted a species removal experiment in the mid-intertidal zone at six sites within three capes along the Oregon Coast. Plots were cleared in the spring and subjected to five treatments during recolonization throughout the following year: control, procedural control, predator removal, predator and barnacle removal, and predator and mussel removal. Plots were photographed once per month throughout the year and percent cover of species in each plot was analyzed. We found relatively low mussel recruitment (Cape Foulweather and Cape Blanco sites), mussel colonization was greatly reduced when barnacles were removed, while with high mussel recruitment (Cape Perpetua sites), mussels colonized even when barnacles were removed. We conclude that barnacle facilitation of mussel colonization is context-dependent and important when mussel recruitment is relatively low but with dense settlement of mussels, less desirable rock surface texture will serve as settlement sites.

† Rosen, H.E.1,2*, Gilly, W.1, Bell, L.1, Abernathy, K.2, Marshall, G.2
CHROMOGENIC BEHAVIORS OF HUMBOLDT SQUID, DOSIDICUS GIGAS (D’ORBIGNY, 1835), STUDIED IN SITU WITH AN ANIMAL BORNE VIDEO PACKAGE
1 - Hopkins Marine Station of Stanford University, 2 - National Geographic Society
Dosidicus gigas (Humboldt or jumbo flying squid) is an economically and ecologically influential species, yet little is known about its natural behaviors due to difficulties in studying this active predator in its oceanic environment. By using an animal-borne video package, National Geographic’s Crittercam, we were able to observe natural color-patterning behaviors in free-swimming D. gigas in the Gulf of California. We documented eight static patterns and two dynamic displays. One dynamic pattern, termed “flashing” is characterized by a global oscillation (2-4 Hz) of body color between white and red, with many of the wave properties apparently under the squids’ control. Flashing was almost always observed when other squid were visible in the video frame, and this behavior presumably represents intraspecific signaling. Another dynamic display termed “flickering” was observed whenever flashing was not occurring. This behavior is characterized by irregular wave-like activity in neighboring patches of chromatophores, creating patterns mimicking reflections of down-welled light in the water column, suggesting that this behavior may provide a dynamic type of camouflage. Rapid and global pauses in flickering indicate that flickering is under inhibitory neural control. Although flashing and flickering have not been described in other squid, functional similarities are evident with other species.

† Salas, E.1,2*, Bernardi, G.2, Berumen, M.3, Gaither, M.4, Rocha, L.A.1
TELL ME A RAD STORY: THE POPULATION CONNECTIVITY OF A DAMSELFISH IN THE INDOPACIFIC
1 - California Academy of Sciences, 2 - University of California, Santa Cruz, 3 - Red Sea Research Center, King Abdullah University of Science and Technology, 4 - Durham University
We studied the population genetics of Dascyllus trimaculatus, a common and widespread damselfish, found in the Pacific and Indian Ocean. Mitochondrial data and microsatellites suggest there are various genetic clades, including one from the Indian Ocean and others in the Pacific. The present study is concerned with the genetic structure of the Indian Ocean clade and the populations that live in the boundaries of the Indian and Pacific oceans. We used double digest Rad sequencing to survey the genome and analyze 1000’s of loci, so we can better understand the patterns of genetic variation among populations, and look into the roles of selection and gene flow.

Samhouri, J.F.1,2*, Stier, A.C.1, Hennessy, S.1, Novak, M.2, Halpern, B.S.3, Levin, P.S.1
ORDERED RE-ASSEMBLY IN MARINE ECOSYSTEMS
Human activities have dramatically altered ecological communities. These changes have included incidental, and sometimes undesired, changes in ecosystem functions and services. A prime example comes from marine ecosystems, where enormous attention has been devoted to studying how communities have been dis-assembled from the top-down (via fishing down the food web), reducing fisheries and economic yields. Much less consideration has been given to the reverse process of community re-assembly. In this paper we begin to bridge the gap between marine conservation on the one hand and community assembly, succession, and restoration theory on the other. We used a fisheries database to identify three major strategies of re-assembly in the ocean: prey first, predator first, and all-trophic-levels-simultaneously. Of these, predator first re-assembly was not commonly implemented, but both prey first and simultaneous strategies were observed frequently. Analysis of a theoretical community model showed that simultaneous recovery of predators and their prey sped up community recovery, whereas predator first re-assembly slowed it down. Prey first re-assembly produced rates of community recovery qualitatively similar to simultaneous re-assembly, but caused noisy transient dynamics in the prey populations. Together, these findings suggest that community-level harvest moratoria can facilitate ecosystem recoveries on meaningful management timeframes.

Sanchez, A.*, Hovel, K.A.
EFFECTS OF COPPER FROM BOAT HULL PAINT ON SEAGRASS COMMUNITY STRUCTURE
San Diego State University
Heavy metals are toxic to almost all marine organisms; however the concentrations of heavy metals used in laboratory experiments are usually much higher than what is observed in nature and are above the lethal level. Instead of direct mortality, sublethal concentrations of heavy metals will affect organismal behavior such as colonization, predator avoidance, or food choice. The accumulation of these sublethal affects can then result in a change in community structure and diversity. Unfortunately, it is unclear how heavy metals affect coastal assemblages. To try and answer this question, we took advantage of the fact that seagrass absorbs copper to relatively high concentrations. Real seagrass units (SGUs) made from Zostera marina were soaked in Harbor Island West Marina for 3 weeks and then transferred to Shelter Island (a fairly unpolluted area). SGUs were allowed to colonize for 3 weeks. The communities on exposed SGUs were compared with clean SGUs. After initial loss, exposed Z. marina plots sustained a concentration of ~50 µg Cu/g DW throughout the experiment. Diversity did not differ; however community composition differed between treatments.

† Satterthwaite, E.V.*, Morgan, S.G.
SURFZONE CHARACTERISTICS APPEAR TO DRIVE A DIRECT RELATIONSHIP BETWEEN REPRODUCTION AND RECRUITMENT IN A COMMON INTERTIDAL CRAB
Bodega Marine Laboratory, University of California, Davis
The degree of coupling between reproductive output and recruitment is a central unanswered question for most marine populations. A direct relationship between reproductive output and recruitment is often difficult to detect for many species, and the underlying factors affecting the relationship are often poorly explored. In this study, we investigated whether reproductive output and subsequent recruitment were correlated in a model intertidal crustacean species, the flat porcelain crab (Petrolisthes cinctipes), and which factors may affect this relationship. We measured reproductive output, recruitment and relevant biological and physical factors at five sites spanning 300 km of the Northern California coastline. Total reproductive output and total recruitment were positively correlated: sites with greater reproductive output had greater recruitment. Larger sites had more suitable habitat per area and steeper habitats had lower ovigerous female and recruit densities. These relationships may be related to surfzone characteristics affecting the adult habitat and subsidies of food and larvae. Thus, surfzone hydrodynamics appeared to be an important driver of the direct relationship between reproductive output and recruitment in P. cinctipes populations.

† Schemmel, E.*, Friedlander, A.
INTEGRATING LOCAL MONITORING AND ECOLOGICAL KNOWLEDGE WITH SCIENTIFIC TOOLS FOR LOCAL STEWARDSHIP AND FISHERIES MANAGEMENT
University of Hawai‘i at Mānoa
We are working with local communities to combine traditional ecological knowledge and community monitoring with scientific assessment to better understand and protect valuable marine resources in Hawai‘i. Through this process we developed monitoring programs to identify fish spawning seasonality to help inform community-based management. These monitoring programs have been successful in evaluating seasonal, monthly, and daily ecological cycles of harvested fish species, and are being used to develop sustainable harvest practices at the community level. To assist in determining fish spawning periodicity we have developed endocrine steroid assays that are used along with histology techniques, and community observations. This information is being used to
determine temporal and spatial variation in reproductive characteristics and timing of spawning for resource species among three bays spread across a broad geographic area within the Main Hawaiian Islands (Hanalei Bay, Kauai, Maunalua Bay, Oahu, and Kiholo Bay, Hawaii). This approach is providing reproduction information needed for local resource management for several nearshore species of fishes with the ultimate goal of enhancing community stewardship of Hawai'i's precious marine resources.

† Schultz, J.A. 1,2*, Côté, I.M. 1, Marliave, J.B. 2
ECOLOGICAL IMPACTS OF SEA STAR WASTING SYNDROME IN HOWE SOUND, BRITISH COLUMBIA

The northeast Pacific recently experienced a mass mortality of sea stars. In Howe Sound, British Columbia, the sunflower star Pycnopodia helianthoides – a previously abundant predator of bottom-dwelling invertebrates – began to show signs of a wasting syndrome in early September 2013, and dense aggregations disappeared from many sites in a matter of weeks. Extreme reductions in the abundance of this generalist predator may have far-reaching impacts on the rocky reef and kelp ecosystems they inhabit. Here, we assess changes in subtidal community composition by comparing the abundance of fish, invertebrates and macro-algae at 10 sites in Howe Sound before and after the 2013 sea star wasting event. We observed changes in the abundance of several species, most notably a six-fold increase in the number of green sea urchins, Strongylocentrotus droebachiensis. Behavioural experiments indicated a strong avoidance response of green urchins to sunflower stars, suggesting that community shifts are the result of release from predation. Understanding the ecological implications of this sudden and extreme decline in sunflower star populations may further elucidate the role of sea stars in temperate seas, and provide insight into the resilience of marine ecosystems to biological disturbances.

† Selden, R.L.*, Warner, R.R., Gaines, S.D.
HARVEST-INDUCED CHANGES IN PREDATOR SIZE: WHEN DOES IT MATTER FOR MARINE FOOD WEBS

University of California, Santa Barbara

Fishing-induced changes in predator size structure are ubiquitous, and occur even when fisheries are managed sustainably. Because body size determines an individual’s role in aquatic food webs, changes in predator body size has the potential to dramatically alter food web dynamics. To minimize these impacts, scientists have proposed that a balanced harvest approach be used to maintain the unfished size composition of marine communities. Because this approach will require significant changes to fishing practices, and markets, it will be critical to identify the conditions under which maintaining predator size structure will be the most important to prevent adverse ecosystem outcomes. We evaluate the degree to which diets must differ with size in order to cause unintended ecosystem consequences relative to a balanced harvest approach. We find that maintaining predator size structure only matters when abrupt diet shifts in species composition occur at or above the minimum size limit in the fishery. Changes in size composition do not cause the same adverse effects if adequate biomass of small predators can maintain mortality rates on small prey size classes. Our classification scheme could be used to prioritize the predator species for which it will be most critical to maintain predator size distributions.

RELATIONSHIPS BETWEEN TERRESTRIAL INPUTS AND GORGONIA VENTALINA ASPERGILLOSIS
University of the Virgin Islands, St. Thomas

The sea fan Gorgonia ventalina is distributed throughout the Caribbean, and is a conspicuous member of coral reef communities in nearshore waters around St. Thomas, United States Virgin Islands. Despite this, little is known about local G. ventalina populations and the drivers of the fungal disease aspergillosis within these populations. In order to determine how coastal effluent is linked with G. ventalina aspergillosis, we performed ten in situ SCUBA surveys on permanently marked G. ventalina sub-populations in four separate bays on the north side of St. Thomas USVI over the span of one year. Watersheds connected to each bay differed in size and land use. Results suggest that aspergillosis prevalence differs by location, and that seasonal terrestrial inputs, in addition to marine temperature, may contribute to disease development. The results of this study may help identify land-based runoff as an aspergillosis pathogen source, and is therefore relevant Caribbean-wide.

Shanks, A.L. 1, Morgan, S.G. 2
LATITUDINAL VARIATION IN BARNACLE POPULATIONS DEPENDS ON SURFZONE CHARACTERISTICS RATHER THAN UPWELLING

1 - Oregon Institute of Marine Biology, 2 - Bodega Marine Laboratory, University of California, Davis

We related latitudinal variation in the structure of barnacle populations to characteristics of surf zones and latitudinal variation in the strength of upwelling. We sampled 42 populations from San Diego to the Olympic Peninsula. At several sites we measured daily settlement and weekly recruitment and related these data to surfzone characteristics. While upwelling and population density varied with latitude, there was not a relationship between upwelling and barnacle populations. Population density, new recruit density, daily settlement and weekly
recruitment all varied significantly with surfzone width, which explains 50 to >80% of the variability in barnacle populations. Population densities, settlement and recruitment were up to three orders of magnitude higher at wider (> 50 m), more dissipative surf zones, than at sites with narrow (< 50 m) more reflective surf zones. Rip currents were only present at wider surf zones and at these sites recruit density was correlated with population density. At sites without rip currents population density did not vary with recruit density and, at a fourth of these sites, recruit and population densities were very low, < 0.01 and <0.3 individuals cm\(^{-2}\), respectively. Alongshore variation in barnacle populations is determined by alongshore variation in surfzone hydrodynamics rather than upwelling.

† Shantz, A.A.*, Lemoine, N.P., Burkepile, D.E.
GLOBAL NUTRIENT LOADING JEOPARDIZES THE PERFORMANCE OF KEY NUTRIENT-SHARING MUTUALISMS
Florida International University
Nutrient-sharing mutualisms between phototrophs and heterotrophs, such as Symbiodinium and coral, underpin the functioning of many ecosystems. Mutualisms are critical for structuring communities, promoting biodiversity, and maintaining food security. Global nutrient loading may threaten these relationships by altering the costs and benefits of the interactions for each partner. We used meta-analyses to show an overall decline in mutualism performance across terrestrial and marine environments in which phototrophs benefited under nutrient enrichment at the expense of their heterotrophic partners. Heterotroph identity and the type of nutrients provided (e.g. nitrogen vs. phosphorus) mediated the responses of different mutualisms to enrichment. The impairment of nutrient-sharing mutualisms from alterations of the world’s nitrogen and phosphorus cycles represents a potentially severe, yet unrecognized threat of global change.

Shelton, A.O.*, Francis, T., Feist, B.F., Williams, G.
HISTORICAL TRENDS AND DRIVERS OF NEARSHORE VEGETATED HABITATS: 40 YEARS OF EELGRASS AND KELP IN THE SALISH SEA (1972-2012)
1 - Conservation Biology Division, Northwest Fisheries Science Center, 2 - Puget Sound Institute, University of Washington, Tacoma
Habitat-forming species such as eelgrass and kelps (e.g. Laminaria spp., Nereocystis luetkeana) play a vital role in the life-history of a wide range of marine species – e.g. providing shelter for juvenile salmon, forage for migrating birds, and spawning habitat for herring. Despite the ecological importance of such foundation species, a lack of long-term data has limited our understanding of how the occurrence and abundance of these species has changed both spatial and temporally. We use a massive data set of spatially referenced surveys of nearshore vegetation collected by the Washington Department of Fish and Game to provide the first description of spatial and temporal patterns occurrence of nearshore vegetation types in Puget Sound, Washington (1972-2012). We present results for eelgrass, the non-native Sargassum muticum, and Laminaria spp. from two locations (Port Orchard and Birch Bay, WA). Our analysis suggests that there is no overall trend in eelgrass occurrence at either site; both are relatively stable. However, there is strong evidence for localized declines in eelgrass occurrence within each site. In contrast, both Laminaria and Sargassum show a generalized increase in occurrence over the past 40 years. We discuss environmental and land use variables that affect each species.

† Shen, C.*, Menge, B.A.
RESPONSE OF EPIFAUNAL COMMUNITIES TO STRUCTURAL CHANGES IN CORALLINE TURF HABITAT
Oregon State University
Articulated coralline algae are common habitat-formers in rocky intertidal environments, growing in short, mat-like turfs. Coralline turfs are made up of tightly packed, finely branched fronds and provide a structurally complex habitat. Generally, habitat complexity has a positive effect on the abundance and diversity of inhabitants. Therefore, we hypothesized that the structural complexity of coralline turf contributes positively to epifaunal diversity. In our experiment, we manipulated habitat complexity in corallines by thinning and trimming turf to reduce turf density and height, respectively. Manipulations were initiated in June 2013 at four field sites along the Oregon-northern California coast, and the epifaunal community in the turfs was evaluated two months later. Contrary to expectations, reductions in turf complexity had no significant effect on the abundance, diversity, or community composition of associated epifauna. Instead, site was the primary determinant of epifaunal community structure, highlighting the extensive influence of regional scale environmental factors at even the smallest community scales.

† Shukla, P.*, Edwards, M.S.
ELEVATED CO\(_2\) CONCENTRATIONS FACILITATE RAPID GROWTH IN MICROSCOPIC LIFE STAGES OF MACROCYSTIS PYRIFERA
Coastal and Marine Institute, San Diego State University
Elevated atmospheric CO\(_2\) concentrations and temperatures are leading to warmer, more acidic coastal environments. Calcareous organisms have been shown to struggle physiologically under these conditions, yet little
is understood about how habitat-forming fleshy algae will respond. In this study, we cultured gametophytes of the giant kelp (*Macrocystis pyrifera*) for 15 weeks under present-day conditions (12°C, 400 ppm CO₂), elevated CO₂ alone (12°C, 1500 ppm CO₂), elevated temperature alone (15°C, 400 ppm CO₂), and future conditions (15°C, 1500 ppm CO₂). After 10 weeks, an upwelling event was simulated by adding nitrate to each treatment for the remaining five weeks. In the first 10 weeks, gametophyte survivorship was significantly higher in the elevated CO₂ treatment than in other treatments. Likewise, after the simulated upwelling event, embryonic sporophytes developed more rapidly in the elevated CO₂ treatment. This may be due to the low energetic cost associated with passive uptake of CO₂ as opposed to the active absorption of HCO₃⁻ and conversion into CO₂ via carbon-concentrating mechanisms. Therefore, elevated CO₂ concentrations may benefit these vulnerable life stages by expediting their growth to adulthood.

† Siegle, M.R.*, O’Connor, M.I.
TEMPERATURE AND POPULATION GROWTH IN THE SPLASH POOL COPEPOD, *TIGRIOPUS CALIFORNICUS*

Department of Zoology and Biodiversity Research Centre, University of British Columbia

Temperature is predicted to increase population growth rates in ectotherms by accelerating development and shortening generation time. However, temperature may not affect all life stages equally, potentially leading to complex life-history responses to changing climate conditions. We used a life table response experiment to investigate the effect of temperature on population vital rates and population growth-in two populations of the splash pool copepod, *Tigriopus californicus*. We established two laboratory populations originating from the cooler and warmer ends of a thermal gradient in British Columbia, Canada, at three temperatures (18, 22 and 26), and sampled stage-specific abundances every five days for one month. Preliminary results show a positive effect of temperature on population growth (*r*) for the cool-region population; population growth was greatest at the highest temperature treatment. In contrast, the greatest population growth for the warm-region population was observed at the medium temperature treatment. This suggests that while cooler-adapted populations may benefit from warming temperatures, warmer-adapted populations may show declines in growth rate with warming.

† Silbiger, N.J.*, Guadayol, O.², Thomas, F.I.M.¹, Donahue, M.J.¹
THE CORAL REEF BALANCING ACT: ACCRETION AND EROSION ALONG A NATURAL ENVIRONMENTAL GRADIENT

1 - University of Hawai‘i at Mānoa, 2 - University of Hull

Management efforts to sustain coral reefs often focus on coral health and growth, but reef resilience also depends on bioerosion rates and their response to local and global human impacts. Calcifying organisms build reefs through the accretion of CaCO₃ skeletons and bioeroders break them down by grazing on or boring into the substrate. A persistent challenge for coral reef scientists is to distinguish the effects of climate change from other forms of environmental variation. In this context, we tested how gross accretion and erosion rates respond to natural environmental variability within a lagoon reef in Kāne‘ohe Bay, Hawai‘i. Using µCT, we calculate highly accurate erosion and secondary calcification rates from micrometer-scale 3D images of CaCO₃ blocks deployed on the reef. We then correlated these rates with a suite of high resolution environmental sensors and water samples that measure microhabitat variation in the environment. We found that pH was the strongest driver of reef erosion while depth was the strongest driver of secondary calcification. These data suggest that coral reef erosion rates may be an important indicator of reef response to ocean acidification and thus the ability of coral reef ecosystems to maintain their delicate accretion-erosion balance.

† Sloan, L.M.*, Hardy, S.M.
ZOMBIE CRABS: WILL THERE BE MORE AS THE CLIMATE CHANGES?

University of Alaska Fairbanks

The parasitic barnacle *Briarosaccus callosus* can infect all commercially-harvested Alaskan king crab species. After infection, the parasite does not kill its crab host, but reduces it to a body that is controlled by the parasite, in other words a “zombie crab.” Infected crabs cannot reproduce; instead they raise and care for the parasite eggs and larvae. Salinity and temperature are important factors that likely influence the survival of *B. callosus* larvae; in Alaskan waters these environmental factors are rapidly changing, which could influence the prevalence of *B. callosus* in commercially important king crab populations. We examined the effects of temperature and salinity on *B. callosus* larval survival by raising larvae at a range of temperatures (0 – 16 °C) and salinities (19 – 40). Larval survival was highest at temperatures between 4 and 8 °C and at salinities between 28 and 34; survival declined rapidly outside these temperature and salinity ranges. This study indicates that future changes in temperature and salinity are unlikely to increase the prevalence of *B. callosus*, since current values already produce the highest larval survival. Future temperature increases and salinity decreases may decrease *B. callosus* larval survival, but this will depend on larval behavior and depth distribution.
† Smith, D.M.*1, Paxton, A.B.2
MIRROR, MIRROR ON THE REEF: A STUDY OF VISUAL CUES IN FISH COMMUNITIES ON AN ARTIFICIAL REEF IN ALBANIA
1 - Friday Harbor Laboratories, University of Washington, 2 - University of North Carolina, Chapel Hill
Intense anthropogenic impacts, ranging from point-source events on local reefs to climate change on a global scale, have highlighted the increasing importance of mitigation efforts in the form of artificial reefs and repurposed submerged structures. Consequently, scientific studies surrounding the design and efficacy of artificial reefs have been on the rise in primary literature with the two major questions of ‘production versus attraction’ and optimal configurations being addressed in both tropical and temperate ecosystems. For this study, we used a purpose-sunk, Cold War-era torpedo boat from the Albanian Navy as a natural laboratory to investigate schooling, predator avoidance, spawning and other behaviors in fish communities associated with the wreck site. Over nine consecutive days in 2013 and six consecutive days in 2014 off the southern Albanian coast, we deployed 360° arrays of GoPro cameras, a 2 m x 1.5 m mirror, and a 2 m x 1.5 m piece of clear Plexiglas on the artificial reef to determine how fish communities respond to visual changes in the structures on the wreck and in their perceived habitats. This initial study has the capability to lend insights into fish community behaviors and predictive artificial reef design.

† Smith, J.S.*1, Lindholm, J., Knight, A.
VERTICAL DISTRIBUTION AND COMPOSITION OF DEMERSAL FISH COMMUNITIES ALONG THE WALLS OF THE LA JOLLA-SCRIPPS CANYONS
Institute for Applied Marine Ecology, California State University, Monterey Bay
Ecologists have long recognized the importance of characterizing fish-habitat associations, especially for the design and implementation of marine protected areas. Despite this importance, little is known about fish distribution and habitat suitability in submarine canyons which have proven difficult to sample adequately. The active continental margin of the California coast is cut by eight submarine canyons, many of which extend from the shore to the deep abyssal plain. We sampled the demersal fish communities in two of those canyons, the La Jolla Canyon in the San-Diego-Scripps Coastal Marine Conservation Area (SMCA), and the Scripps Canyon the Matlahuayl State Marine Reserve (SMR), in depths ranging from 20-300m using a remotely operated vehicle (ROV). Species composition, abundance, and habitat (slope and complexity) were quantified and mapped using ArcGIS. Thirty-seven species of demersal fishes representing 17 families were obtained from 21 vertical transects along the canyon walls. Species composition was assessed in 15 depth-stratified bins (20m per bin) along, and to either side, of the canyon walls. Although sampling effort decreased with depth, species composition (richness/m) increased along this gradient. Ongoing analyses of canyon dynamics will provide more detailed insight to factors that facilitate demersal fish communities.

† Smith, N.S.*, Côté, I.M.
THE DIVERSITY-INVASIBILITY RELATIONSHIP: DOES SPATIAL SCALE REALLY EXPLAIN THE INVASION PARADOX?
Simon Fraser University
Classic ecological theory suggests that species-rich environments should be less easily invaded than species-poor environments, but empirical evidence does not consistently support this prediction. While fine-scale experiments tend to yield the predicted negative association between diversity and invasibility, broad-scale observational surveys generally report a positive association. This so-called ‘invasion paradox’ is thought to arise due to differences in spatial scale between experimental and observational studies. We asked whether the invasion paradox disappears when the potentially confounding issue of scale is removed. To do so, we conducted a meta-analysis to quantify the strength and direction of published diversity-invasibility relationships, limiting our review to studies conducted at fine spatial scales (i.e., < 10 m² or < 500 ml). Contrary to expectation, we still found heterogeneity in diversity-invasibility relationships. Small-scale experiments showed a moderate, negative association between diversity and invasibility, whereas small-scale observational studies showed the opposite effect. Discrepancies in spatial scale therefore do not underpin the invasion paradox. Instead, we propose that differences in temporal scale of experiments versus observational studies might be a key determinant of diversity-invasibility patterns. We are currently investigating this hypothesis.

† Smolenski, J.R.*, Edmunds, P.J.
THE EFFECT OF TEMPERATURE ON THE CALCIFICATION OF PORITES RUS DOES NOT EXPLAIN THE DISTRIBUTIONS OF ITS COLOR MORPHOTYPES
California State University, Northridge
Phenotypic plasticity is used by corals to expand realized niches with morphotypes that are matched to dissimilar environmental conditions. In Moorea, French Polynesia, the coral Porites rus occurs as two color morphotypes, which appear to be unequally distributed throughout the lagoon. We exploited this pattern to test two hypotheses:
1) color morphotypes are differentially abundant in fringing versus back reef habitats, and 2) the distribution of color morphotypes reflects tolerance of thermal environments that differ between back (cooler) and fringing (warmer) habitats. The relative abundance of brown and blue colonies differed significantly between habitats, with 23% brown and 14% blue on fringing reefs (where seawater temperature exceeds 30°C on summer afternoons) and 16% brown and 23% blue in the back reef (where seawater temperature rarely exceeds 30°C). To test whether the non-random distribution of color morphotypes reflects contrasting thermal tolerances, corals were grown in mesocosms at 26.0°C and 29.5°C. Both brown and blue morphotypes exhibited similar calcification rates at 26°C (1.2 and 1.1 mg/cm²/d) and at 29.5°C (1.5 and 1.4 mg/cm²/d), respectively. As back and fringing reef habitats also differ in sedimentation rates, we are exploring the possibility that color morphotypes differ in sediment shedding abilities.

**Sorte, C.J.B.*, Bracken, M.E.S.**

**INTERACTIONS BETWEEN MULTIPLE ASPECTS OF CLIMATE CHANGE: A FIELD MANIPULATION OF CO₂ AND TEMPERATURE IN TIDE POOL COMMUNITIES**

*University of California, Irvine*

The climate is changing and biological systems are responding, yet we are still far from being able to predict the outcomes of future changes. Our study addressed key gaps in the understanding of climate change impacts, including how multiple aspects of climate change manifest in natural communities and consequences for ecosystem functioning. We conducted a short-term *in situ* factorial field manipulation of CO₂ and temperature in tide pools at a site in southeastern Alaska. Over a 16-day period, there were few changes in community diversity. However, there was an interactive effect of warming and CO₂ on net primary productivity (NPP), which we assessed by measuring O₂ fluxes in pools in the dark and in the light. NPP declined in warmed pools that had ambient CO₂ levels but not in pools with added CO₂. These changes in productivity may reflect changes in seaweed physiology in response to our experimental manipulations. For example, C:N in tissue samples of the most abundant seaweed, *Odonthalia floccosa*, also responded to warming at ambient CO₂ levels but not at elevated CO₂ levels. These results indicate that ecosystem functioning can respond rapidly to changing environmental conditions, even in the absence of diversity changes.

† **Stamoulis, K.A.,** Friedlander, A.M., Meyer, C.G., Fernandez-Silva, T., Toonen, R.J.

**EVALUATING THE EFFICACY OF MARINE PROTECTED AREAS IN CONTROLLING INVASIVE ALGAE**

1 - Curtin University, 2 - Fisheries Ecology Research Lab, University of Hawai‘i at Mānoa, 3 - National Geographic Society, 4 - Hawai‘i Institute of Marine Biology, University of Hawai‘i, Mānoa, 5 - California Academy of Sciences

Bloom of nonindigenous marine algae have become common in the Hawaiian Islands over the last several decades, greatly altering the health and stability of near shore ecosystems. On reefs subjected to anthropogenic disturbances, high algal growth rates may result in overgrowth of corals and other benthic invertebrates. Herbivorous fishes have been severely overfished in Hawai‘i which has been thought to contribute to the increase in macroalgae. We used a three pronged approach to test the hypothesis that Marine Protected Areas (MPAs) will be more resistant to alien algal invasion owing to a higher biomass of herbivorous fishes. We conducted ecological surveys of fish and benthos at the Hawai‘i Marine Laboratory Refuge in Kāne‘ohe Bay and on adjacent patch reefs open to fishing over a two year time period. Simultaneously, we used acoustic telemetry to examine movements of herbivorous fishes captured in the reserve and applied next-generation sequencing to analyze their fecal samples. Results from the ecological surveys indicated significantly higher herbivore biomass in the MPA compared with outside, while invasive algal cover was significantly lower. Herbivorous fish movements were confined to the MPA and fecal analysis indicated presence of invasive algae, suggestive of MPA resistance to invasive algae invasion.

**Steele, M.A.*, Adreani, M.S.**

**REPRODUCTIVE ECOLOGY OF THREE KELP FOREST FISHES**

*California State University, Northridge*

Many aspects of the reproductive ecology of even the most abundant and ecologically important fish species in kelp forests is still poorly known. We studied the reproductive ecology of three key species in kelp forests in southern California: kelp bass (*Paralabrax clathratus*), California sheephead (*Semicossyphus pulcher*), and señorita (*Oxyjulis californica*). Spawning season duration, spawning frequency, batch fecundity, and total seasonal reproductive output were estimated at 3 sites over 5 years. We evaluated how these reproductive parameters differed among sites and among years; and we tested the hypotheses that (1) the onset of reproduction occurred earlier in years when the ocean temperature warmed earlier, and (2) extended longer and resulted in greater reproductive output in years with consistently warm temperatures. These two hypotheses were supported in one species (*Paralabrax clathratus*) but not in the other two species. These results indicate that our study species use different cues to trigger reproduction, and that variation in ocean climate affects their reproductive output in different ways.

† **Stein, L.S.*, Nakamura, R., Ruttenberg, B., Wendt, D.**
RATE OF ROCKFISH (SEBASTES SPP.) EXPERIENCING BAROTRAUMA & ANALYSIS OF RESPONSES TO CONTROLLED RECOMPRESSION FOLLOWING CAPTURE
California Polytechnic State University, San Luis Obispo
Each year, approximately 60% of all fish caught recreationally are released or discarded. Rockfish (Scorpaenidae: Sebastes spp.) are an important coastal marine fish assemblage consisting primarily of demersal species. Fish usually undergo barotrauma when rapidly brought to the surface. The swim bladder expands due to drastic changes in hydrostatic pressure. This causes fish to become excessively buoyant, making it difficult to swim to depth. In turn, they are more susceptible to predation, starvation, and periods of acute stress. In this study, the rate of seven species of rockfish experiencing barotrauma was assessed. Additionally, species-specific physiological and behavioral responses caused by rapid ascent from hook-and-line fishing were analyzed. A simple, inexpensive, and practical recompressing device was used to descend fish back to their capture depth. Immediate morphological responses following release were evaluated through video analysis. Our results indicate that not only was the descending device effective, but both vulnerability and initial recovery of barotrauma differs among species. 56% of Canary, 41% of Gopher, 36% of Vermillion, and 35% of Northern Blue rockfish experienced barotrauma. 39% of Canary, 53% of Gopher, of 24% Vermillion, and 47% of Northern Blue rockfish were successfully released and barotrauma symptoms appeared to be reversed after recompression.

† Stephens, T.A.*, Hepburn, C.D.
MASS TRANSFER GRADIENTS ACROSS KELP BEDS INFLUENCE MACROCYSTIS PYRIFERA GROWTH OVER SMALL SPATIAL SCALES
University of Otago, New Zealand
Nitrogen is essential for algal productivity but often reaches limiting concentrations in temperate ecosystems. Increased water motion enhances nitrogen uptake by decreasing the thickness of the diffusion boundary layer surrounding algal surface tissue, allowing for increased nitrogen mass-transfer across this boundary. Macrocystis pyrifera forms large beds that span the water column and can alter the surrounding physical environment by creating bed-wide boundaries that may reduce current and wave propagation to the bed interior; reduced water motion may decrease mass-transfer rates and therefore alter nitrogen uptake. We investigated whether a water mass-transfer gradient across Macrocystis beds exists by identifying three bed types likely to experience different water motion intensities (open, shoreline exterior and shoreline interior) and whether this gradient influenced heterogeneity in Macrocystis growth and tissue status during summer and winter (low and high ambient nitrogen, respectively). Gypsum dissolution suggested that mass-transfer significantly increased across beds; open bed dissolution rates were approximately 6% higher than the shoreline exterior, which exhibited mean dissolution rates 17% higher than the shoreline interior. Summer kelp growth, pigmentation, tissue %N and C:N paralleled mass-transfer. The same trends did not exist during the winter, suggesting that mass-transfer is an important mechanism for nitrogen acquisition during limitation events.

† Stevens, J.M.*, Gentry, R.R.², Maue, C.C.², Bell, T.W.², Kappel, C.V.², Lester, S.E.², Wendt, D.E.¹, White, C.¹
MARINE SPATIAL PLANNING MAKES ROOM FOR OFFSHORE AQUACULTURE IN A CROWDED COASTAL ZONE
1 - California Polytechnic State University, San Luis Obispo, 2 - University of California, Santa Barbara
Offshore aquaculture is an emerging industry predicted to contribute significantly to global seafood production and food security. However, aquaculture farms displace existing ocean sectors (user groups) and generate environmental impacts. Further, there are multiple farm types with different seafood species, productivity levels and impacts. Thus, it is important to strategically and simultaneously plan farm type and location in order to most effectively maximize aquaculture value, minimize inter-sectoral conflicts and avoid environmental impacts across the seascape. We address this problem and demonstrate the value of multi-sector planning with a case study that integrates bioeconomic modeling with ecosystem service tradeoff analysis to inform the marine spatial planning (MSP) of mussel, kelp and finfish aquaculture farms in the already-crowded Southern California Bight (SCB). Results indicate that significant inter-sectoral conflicts and environmental impacts, expected under conventional planning, can be reduced substantially by strategic planning. For example, 28% of mussel farm sites overlap with wild-capture halibut fishery grounds, yet MSP can enable mussel aquaculture to generate up to a third of its total potential industry value without impacting halibut fishery yield at all. This study informs aquaculture farm design in the SCB, and demonstrates the value of multi-sectoral planning as a key component in MSP.

† Stevenson, C.F.¹*, Demes, K.W.¹², Salomon, A.K.¹²
WHEN SIZE MATTERS: ACCOUNTING FOR SIZE-SPECIFIC PREDATION AND GRAZING RATES IMPROVES OUR ABILITY TO PREDICT TROPHIC CASCADES
1 - School of Resource and Environmental Management, Simon Fraser University, 2 - Hakai Network for Coastal People, Simon Fraser University

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Predation can influence the magnitude of herbivory that grazers exert on primary producers by altering both grazer abundance and their per capita consumption rates. However, models based solely on changes in abundance may miss a key component of grazing pressure. We quantified shifts in grazing pressure associated with changes in the abundance and per capita consumption rates of sea urchins triggered by size-selective predation by sea otters (*Enhydra lutris*). Field surveys suggest that sea otters dramatically decreased the abundance and median size of sea urchins. Furthermore, lab experiments revealed that kelp consumption by sea urchins varied nonlinearly as a function of urchin size such that consumption increased to the 0.56 and 0.66 power of biomass for red and green urchins respectively, suggesting that shifts in urchin size structure due to size-selective predation by sea otters alter sea urchin per capita grazing rates. Comparison of two quantitative models estimating total consumptive capacity revealed that a model incorporating shifts in urchin abundance while neglecting urchin size structure overestimated grazing pressure compared to a model that incorporated size ($p = 0.003$). Consequently, incorporating shifts in total consumptive capacity resulting from shifts in urchin size structure better predicted field estimates of kelp abundance compared to equivalent models based only on urchin abundance. We conclude that size-specific grazing parameters can easily increase our ability to describe and predict trophic interactions.

**Stier, A.C.1†, Samhouri, J.F.2, Levin, P.S.2, Gray, S.3, Martone, R.4, Mach, M.4, Scarborough, C.1, Kappel, C.1, Hunsicker, M.1, Halpern, B.1**

**DIFFERENCES IN PERCEPTION NOT (NECESSARILY) VALUES PRODUCE CONSERVATION CONFLICT**

1 - National Center for Ecological Analysis and Synthesis, 2 - Northwest Fisheries Science Center, NOAA, 3 - University of Massachusetts, 4 - Center for Ocean Solutions, Stanford University

Conflict among agencies, NGOs, and industry can impede successful implementation of conservation and management objectives. Environmental conflict typically emerges from stakeholders groups that (1) differ in values, (2) vary in levels of trust of one another or in management agencies, and/or (3) have different perceptions of how changes in management strategy will affect ecosystem services. Here we describe how variation in perceived ecosystem structure among scientific experts from different backgrounds provides insight into conflict surrounding the pacific herring fishery in British Columbia. Instead of a typical approach that assumes conflict originates from individuals who come from different backgrounds, we offer an alternative strategy that first evaluates how each individual perceives the ecosystem and then clusters individuals based on how their system responds to simulated management strategies. Our approach demonstrates that background characteristics poorly predict variable perceptions. Instead individuality drives variation in perceived ecosystem structure and function. Some management scenarios exhibit limited evidence for polarized opinions, but divergent groups emerge when it comes to herring. Our findings demonstrate that individuality instead of background characteristics underlies variation in perceived food web structure, and that alignment of experts based on shared experiences poorly predicts how experts perceive herring-centric food webs recovery following collapse.

†**Sullivan, J.M.†, Cerny-Chipman, E.B., Johnson, A.M., Menge, B.A.**

**A CLOSER LOOK AT SEA STAR WASTING SYNDROME: OBSERVATIONS AT SMALL SIZE CLASSES AND POTENTIAL FOR RECOVERY**

Oregon State University

Many sea star species along the West coast of the United States have been recently impacted by a "sea star wasting" syndrome (SSWS) at epidemic proportions, virtually eliminating entire populations from intertidal and subtidal habitats ranging from California to Canada. Without quick recovery, SSWS is likely to result in important changes to community structure and functioning. The potential for population recovery is uncertain and will likely depend in large part on larval recruitment and juvenile survival. We conducted surveys at four sites along the Oregon coast that include abundance, distribution and wasting observations of the keystone predator *Pisaster ochraceus* juveniles and of *Leptasterias hexactis*, a smaller sea star with which *P. ochraceus* likely competes at early life history stages. Preliminary survey results indicate a relatively lower (but present) incidence of wasting relative to adults and relatively high abundance of both sea star species, with *L. hexactis* being patchy in distribution. These data indicate potential for recovery of *P. ochraceus* populations at these sites in Oregon, provided sea stars at small size classes remain relatively resistant to wasting and that competition with *L. hexactis* does not create a "bottleneck" against successful *P. ochraceus* recruitment.


**SPECIES TRAITS AND CLIMATE VELOCITY EXPLAIN MARINE RANGE SHIFTS IN A CLIMATE WARMING HOTSPOT**

1 - University of British Columbia, 2 - University of Tasmania, 3 - CSIRO Marine and Atmospheric Research, 4 - The University of Western Australia, 5 - Australian Institute of Marine Science, 6 – Plymouth Marine Laboratory, 7 - University of Southampton
Species are shifting globally in response to climate warming, with substantial variability among taxa. Relationships between range dynamics and intrinsic species traits may be particularly tractable in the ocean, where temperature more directly shapes species distributions. Here we test the role of species traits and climate velocity on the rate of range extensions in a large, rapidly warming ocean region. Species traits more than doubled our ability to explain variation in range shifts. Swimming ability, omnivory, and latitudinal range size each had positive effects on range extension rates, supporting hypotheses of dispersal and ecological generalism in promoting range extensions. We find independent support for one hypothesis explaining the latitudinal range effect: narrow marine latitudinal ranges are out of equilibrium with climate. These findings suggest small-ranging species are in double jeopardy, with a poorer ability to escape warming and greater intrinsic vulnerability to stochastic threats.

† Sur, C.1, Grosholz, E.D.1,2
EPIFAUNAL RESPONSES TO CLIMATE STRESSORS INFLUENCE COMMUNITY STRUCTURE IN EELGRASS BEDS
1 - Bodega Marine Laboratory, University of California, Davis 2 - Environmental Science and Policy, University of California, Davis
Mobile crustacean grazers play a critical role in maintaining seagrass ecosystem function by controlling the growth of epiphytic microalgae on seagrass blades. Our experiment aimed to address the potential impacts of climate change on these diverse communities and the resulting consequences for eelgrass Zostera marina. We focused on two projected climate change stressors: increased sea surface temperature and decreased salinity due to extreme precipitation events. We tested these impacts on three dominant grazer species found in eelgrass beds in Bodega Harbor, CA and conducted mesocosm experiments at the Bodega Marine Lab to compare survival and grazing responses of each species to independent treatments of temperature increases and salinity decreases. Temperature treatments resulted in the lowest epiphyte biomass, suggesting that increased temperatures stimulated metabolic rate and subsequently increased grazing. Salinity stress negatively affected grazer survival and showed higher remaining epiphyte biomass, though the response varied across species. Our study indicates that while dominant epiphyte grazers can generally withstand these stressors and even overcompensate under increased temperature conditions, specific species tolerances will be important drivers of eelgrass community structure under future conditions.

† Tamburello, N.*, Côté, I.M.
METAPOPULATION MODELLING FOR THE MANAGEMENT OF MARINE INVASIONS: A CASE STUDY WITH INVASIVE INDO-PACIFIC LIONFISH (PTEROIS VOLITANS)
Department of Biological Sciences, Simon Fraser University
Metapopulation modelling can pinpoint patches critical for population persistence in fragmented landscapes. Although developed for conservation, this approach also lends itself to planning invasive species management in naturally patchy habitats. We show how this approach can be used to optimize the spatiotemporal distribution of limited management resources among populations of invasive Indo-Pacific lionfish (Pterois volitans) in the Western Atlantic. We collected field data on lionfish occupancy and movement in a Bahamian patch reef network and use these data to parameterize an incidence function model (IFM) and examine the effects of patch area, connectivity, and landscape features on the long-term probability of patch occupancy. Through simulation, we show that removals at individual patches also reduce the probability of occupancy of surrounding patches and that this effect increases by 0.4% per m² increase in target patch area and decays with distance at a rate of 7% per m. However, the beneficial effect of removals are tempered by habitat features that facilitate recolonization such as nearby continuous reefs, which act as source populations, and inter-patch debris, which function as stepping stones. By explicitly considering seascape structure when allocating management efforts, managers can improve the success of marine invasive species management.

† Tanner, R.L.1,2, Obaza, A.K.2, Ginsburg, D.W.1
CORRELATING SECONDARY PRODUCTIVITY AND HABITAT COMPOSITION OF EELGRASS BEDS IN A SOUTHERN CALIFORNIA MARINE PROTECTED AREA
1 - University of Southern California Environmental Studies Program, 2 - National Marine Fisheries Service
Seagrass meadows are an important component of essential fish habitat (EFH), which under the Pacific Coast Groundfish Fishery Management Plan is used to emphasize conservation efforts. When describing EFH, fishery management councils are required to use the best available information on habitat value ranging from species presence to secondary productivity. In this study, we estimated the fishery productivity of eelgrass (Zostera marina) habitat in the Blue Cavern State Marine Conservation Area located off Santa Catalina Island for a recreationally important fish, Paralabrax clathratus. Surveys were conducted monthly to evaluate the abundance, density, and length of eelgrass, as well as the abundance and size of P. clathratus. These data were used to calculate seasonal habitat use and population structure of kelp bass to provide a quantitative estimate for a component of secondary productivity within eelgrass. Our findings indicate highest rates of secondary productivity amongst juvenile P.
By imposing high levels of mortality on particular size and age groups, intense fishing can cause rapid evolution. University

**GENOMIC SIGNATURES OF SELECTION IN A CLASSIC FISHERIES EXPERIMENT**

Therkildsen, N.O.

1 - Department of Oceanography, Universidad de Concepción, 2 - Programa COPAS Sur-Austral, Universidad de Concepción, 3 - Institute of Marine Sciences, University of California, Santa Cruz, 4 - Centro de Estudios Avanzados en Zonas Aridas

Historical observations along central-northern Chile show a shift in the regime of physical variability in coastal waters at 30°S. South/north of this latitude, near-shore temperatures respond strongly/weakly to wind forcing typical of this upwelling region. A shift in the structure of intertidal communities has been found along the same region. We combined environmental and genomic data to test whether physiological constraints imposed by oceanographic variability are the main driver of a latitudinal shift in community structure. Our model was the intertidal gastropod *Tegula atra*, sampled in winter and summer 2014 from four sites along 28-31°S. High-throughput transcriptome sequencing was performed via illumina technology. A bioinformatics approach was used to assess differential gene expression profiles across seasons and sites. The results revealed striking seasonal differences in the pattern of gene expression within sites, as well as among-site differences within seasons. Specimens from the southernmost and coldest site exhibited the strongest transcriptomic response to summer conditions, whereas the weakest response was observed at the northernmost site. Intertidal species along this region may employ a “frontloading” strategy, involving some chaperon genes such as heat shock proteins, to cope with environmental variability largely induced by oceanographic processes interacting with local habitat conditions.

**EFFECTS OF ADDITIVE SELECTION ON TRAITS**

† Tarjan, L.M.¹, Tinker, M.T.¹,², Bentall, G.², Golson, E.A.³

1 - University of California, Santa Cruz, 2 - US Geological Survey, 3 - Moss Landing Marine Laboratories

Patterns of animal movement vary across species from organisms that are sessile to those that are panmictic. Within a species, differences in resource requirements and interactions affect movement patterns of males and females. Over ten years of sea otter movement data in Monterey and Big Sur, CA reveal stark differences in space-use between sexes. Strikingly, parameters describing space-use (including sub-tidal area, coastline length, and number of centers of use) were normally distributed among females but were strongly bi-modal for males. The two distinct patterns of space-use by males appear to correspond to alternate reproductive tactics, territory defense and opportunistic mating. These alternate spatial strategies have implications for the risk of exposure to point source threats such as terrestrial inputs of pollutants or infectious disease. Future work using genetic microsatellite and paternity analyses will investigate the reproductive success of males using each tactic.

**DIRECT ECOLOGICAL EFFECTS DRIVE NON-ADDITIVE SELECTION ON TRAITS**

† TerHorst, C.P.¹, Lau, J.A.², Conner, J.K.²

1 - California State University, Northridge, 2 - Michigan State University

In natural communities, species interact with many others, resulting indirect ecological effects with important fitness consequences. Indirect effects can also cause non-additive natural selection. Given that indirect ecological effects are common in nature, non-additive selection may also be common, and thus critical for predicting evolution in natural multispecies communities. Here we develop a method for testing for non-additive selection and consider how it affects adaptation in multispecies communities. The simulation model we used to validate our null hypothesis indicates that fitness must be standardized across, rather than within, experimental treatments. We also quantified the strength of non-additive selection in two case studies. In one case, insect herbivores and an invasive plant imposed strong non-additive selection on herbivore resistance in a native plant. In a second case, three pollinators imposed strong non-additive selection on anther exertion in wild radish. Our results suggest that non-additive selection may be common in nature, and may be as important as pairwise selection in predicting evolution in natural communities. We call for further studies using this methodology to determine how common non-additive selection is and under what conditions it is most likely to occur.

**GENOMIC SIGNATURES OF SELECTION IN A CLASSIC FISHERIES EXPERIMENT**

Therkildsen, N.O.¹, Munch, S.B.², Conover, D.O.³, Palumbi, S.R.¹

1 - Hopkins Marine Station of Stanford University, 2 - NOAA Southwest Fisheries Science Center, 3 - Stony Brook University

By imposing high levels of mortality on particular size and age groups, intense fishing can cause rapid evolution. Overwhelming evidence suggests that fishing has driven widespread changes in life history traits such as growth rate and timing of maturation across the world’s fish populations. In many cases, the changes appear to be at least
partially genetic, making fishing one of the most pervasive, human-caused evolutionary impacts in the sea. Yet, so far almost nothing is known about the underlying genomic basis for these common changes in fish stocks: what types of genetic variation does fisheries-selection act on, how extensively does it impact the genome, and how reversible are the changes once fishing stops? To address these questions, we have returned to a seminal experiment that demonstrated substantial evolution in growth rates and a suite of correlated traits in response to size-selective fishing over just five generations in the Atlantic silverside (Menidia menidia). With a combination of RAD-tag and exome sequencing of archived samples from the original experiment, we have begun to characterize the genomic response underlying the observed phenotypic divergence between selected lines (e.g. a nearly two-fold difference in adult size) and will present our initial results.

Thom, R.M.*, Southard, S.L., Borde, A.B.
CLIMATE-LINKED MECHANISMS DRIVING EELGRASS GROWTH AND ABUNDANCE IN PACIFIC NORTHWEST ESTUARIES
Marine Sciences Laboratory, Pacific Northwest National Laboratory

Using laboratory experiments on temperature and leaf metabolism, and long-term field data sets we developed lines of evidence showing that variations in water temperature, mean sea level (MSL), and desiccation stress appear to drive spatial and temporal variations in eelgrass (Zostera marina). Variations in the Oceanic Niño Index (ONI) and MSL, especially during the strong 1997–2001 El Niño-La Niña event, corresponded with variations in leaf growth rate of an intertidal population. Field studies suggested that this variation was associated with both desiccation period and temperature. Subtidal eelgrass shoot density recorded annually over a 10-year period was lowest during the warm and cool extremes of sea surface temperatures, corresponding with the extremes in the ONI. Variations in density of a very low intertidal population in a turbid estuary were explained by both variations in temperature and light reaching the plants during periods of higher MSL. These results show complex interactions between water-level variation, temperature and light as mechanisms regulating variation in eelgrass, which complicates the ability to predict the effects of climate variation and change on this important resource. Seagrass species should be considered useful indicators of the effects of climate variation and change on marine and estuarine ecosystems.

Timpane-Padgham, B.1*, Klinger, T.1, Beechie, T.2
EXAMINING SOURCES OF ECOLOGICAL RESILIENCE TO CLIMATE CHANGE FOR RESTORATION PLANNING
1 - University of Washington, 2 - NOAA, Northwest Fisheries Science Center, Seattle

Restoration ecology is a burgeoning field and ecological restoration efforts are becoming ubiquitous. However, studies reveal that many restoration efforts fail to accomplish their objectives because they do not address the root cause of degradation or because there is a mismatch between the scale of the problem and scale of the restoration action. Currently, practitioners are faced with the dual challenge to restore system functioning while also preparing for unknown impacts from anthropogenic climate change. Restoring natural sources of resilience is believed to be an effective way to build adaptive capacity to climate change. There are however many questions surrounding the pragmatic application of resilience theories. One such barrier is identifying what factors within a system influences response to disturbance. Consequently, a critical first step is to identify the dynamic processes and associated attributes that influence resilience in natural systems. In this study, I examined published literature to identify a suite of ecological attributes that influence resilience, either through resisting change or recovering from disturbance. I then developed a Decision Support Tool (DST) to navigate the resilience attributes and to help integrate resilience planning and monitoring into restoration projects.

Tissot, B.1*, Craig, S.1, Tyburczy, J.1,2, Raimondi, P.3, Korcheck, K.1, Schneider, J.1, Hennessy, J.1, Lopiccolo, J.1
SEA STAR WASTING DISEASE IN NORTHERN CALIFORNIA
1 - Marine Laboratory & Biological Sciences, Humboldt State University, 2 - California Sea Grant Extension, Eureka, CA, 3 - Department of Ecology and Evolutionary Biology, University of California, Santa Cruz

Sea star wasting disease has been observed along the northern California coast since the summer of 2013 and has been associated with significant declines in abundance that could have profound long-term effects on rocky intertidal community structure. Here we report initial results of surveys at 11 northern California sites conducted along with 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, the same variables were examined along band transects in conjunction with data on several physical parameters. Initial surveys found six species common in the intertidal zone with Pisaster ochraceus or Leptasterias spp. the numerically dominant taxa at all sites. Four species were observed with lesions indicative of wasting diseases but they were most common in P. ochraceus and occurred in 17% of all individuals (range 7-36%) across study sites. Monitoring physical parameters among sites
Continuous respirometry showed routine metabolic rates of 1.75 µmol g⁻¹ hr⁻¹ at 10°C and 3.24 µmol g⁻¹ hr⁻¹ at 10°C and may be useful to identify environmental factors associated with disease and declines.

**Tolimieri, N.*, Shelton, A.O., Feist, B., Simon, V.**

**CAN WE INCREASE OUR CONFIDENCE ABOUT THE LOCATIONS OF BIODIVERSITY HOTSPOTS BY USING MULTIPLE DIVERSITY INDICES?**

*Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA*

Some have suggested that targeting conservation efforts on biodiversity hotspots—areas of exceptionally high diversity—is the most efficient way to use limited resources to protect species and maintain ecosystem function. However, there are many ways to define biodiversity and a plethora of diversity indices. Do these indices agree on where biodiversity hotspots are, and by extension, where conservation should take place? We use a habitat modeling approach to map spatial and temporal patterns in five community metrics of the demersal fish community in the California Current Large Marine Ecosystem: species density, species evenness, taxonomic distinctness, functional divergence and total biomass. Over 40% of the study area was classified as a biodiversity hotspot (cells where an index was in the top 10% of its range) by at least one metric. However, there was minimal spatial overlap among 10% hotspots for the five indices. No area was identified as a hotspot by all five metrics and only slightly more than 1% of the coast was identified as within a hotspot for three or more metrics. Since different indices represent various aspects of diversity, we must define our objectives and then choose the relevant metrics for the problem.

† Traiger, S.B.*, Konar, B.

**EFFECTS OF GLACIAL DISCHARGE ON RECRUITMENT AND SUCCESSION IN SUBTIDAL KELP BEDS**

*University of Alaska Fairbanks*

Melting of subarctic glaciers discharges sediment-laden freshwater that can structure benthic communities by restricting settlement and altering succession. The goal of this study was to determine the influence of glacial discharge on recruitment and succession in subtidal kelp communities. Recruitment and succession was monitored at six sites along a glacial discharge gradient by estimating algal and invertebrate cover on cleared rocks at 10 meter depth from March 2013 to September 2014. Cluster analysis on community structure that formed on the cleared rocks grouped the sites into three regions within the bay: two sites on the southern side of the outer bay upstream of glacial discharge, three inner bay estuarine sites, and one site on the outer northern side of the bay. Early recruits to the outer southern sites consisted of spirorbid worms, followed by encrusting algae and kelp. Bare space at inner bay sites was quickly filled by barnacles. Rocks at the outer northern site remained bare for several months, with encrusting brown and crustose coralline algae recruiting in mid to late summer. Early recruitment and succession were similar in 2013 and 2014. Next steps for the project include determining the relationships between community structure, glacial factors, and non-glacial factors.

† Tremblay-Boyer, L.¹*, Harley, S.J.², Pilling, G.M.², Harley, C.D.G.¹, Martell, S.J.D.³

**POSITIVE RELATIONSHIPS BETWEEN RANGE SIZE AND ABUNDANCE IN HIGHLY MOBILE LARGE PELAGICS**

¹ - University of British Columbia, 2 - Secretariat for the Pacific Communities, 3 - International Pacific Halibut Commission

Abundance-driven range contractions or expansions (intraspecific abundance-occupancy relationships, AORs) are highly relevant to managers and conservation practitioners, as management planning relies critically on knowledge about where species can be found. AORs are, however, challenging to document since they require long-term and spatially-explicit abundance time-series that span periods of changing population size. Data from harvested species can lead to informative insights about AORs as their population abundance are "manipulated", as in an uncontrolled experiment, providing the required contrast in abundance to assess the presence and strength of AORs. Here we modeled changes in spatial distribution for seven tropical and temperate tuna and billfish species over a period of changing stock biomass from 1960 to 2010. We found that all species exhibited positive AORs but that the detection threshold used to convert continuous abundance to binary presence-absence data affected the shape of the relationship. We argue that this methodological artifact is highly relevant to all studies of the geographic range, and discuss implications for the ecology, conservation and management of both terrestrial and marine species.

Trueblood, L.A.*

**SALPS METABOLISM: THE EFFECT OF TEMPERATURE AND OXYGEN PARTIAL PRESSURE**

*La Sierra University*

Salps are pelagic tunicates that play an important role in carbon cycling of the marine environment, forming dense fecal pellets that sink rapidly to the deep ocean, essentially fixing the carbon there. There is limited understanding of salp physiology, and how they are impacted by environmental changes. Here I present data from aggregate zooids of *Salpa fusiformis* that were collected during the UNOLS 2012 Chief Scientist Cruise. Endpoint and continuous respirometry showed routine metabolic rates of 1.75 µmol g⁻¹ hr⁻¹ and 3.24 µmol g⁻¹ hr⁻¹ at 10°C and
17°C, respectively (Q_{10} = 2.4). Individual zooids showed temperature independent hypoxia tolerance, with P_{crit} = 2 kPa, and all were able to completely consume the oxygen in the respirometry chambers. The observed decrease in metabolism with decreased temperature and hypoxia tolerance may assist S. fusiformis in diurnal migrations into oxygen minimum zones. Expansion of this work across a broader set of species will help elucidate both the role salps have in carbon cycling and the impact of climate change on them.

† Truitt, A.M.*, de Rivera, C.E.
TWO OPPOSING RISKS TO IMPERILED INVERTEBRATE POPULATIONS: INBREEDING DEPRESSION VERSUS WOLBACHIA INDUCED CYTOPLASMIC INCOMPATIBILITY
Portland State University
The proposed research will experimentally examine two opposing risks to small invertebrate populations: inbreeding depression and cytoplasmic incompatibility. We will compare whether loss of genetic variability and reduced fitness from inbreeding depression or the effects of reduced fecundity due to Wolbachia have higher potential to reduce populations faster rates. The world’s butterfly populations are declining in part because of exposure to novel pathogens, which can be spread through management aimed at maintaining genetic variability and resuscitating populations at risk of extinction. An example of this is the captive rearing and release program that is specified in Speyeria zerene hippolyta’s recovery plan. To reduce the risk of extirpating unstable populations and to promote genetic variability, this augmentation program captures female butterflies from larger populations and releases offspring into smaller populations. Augmentation programs that move propagules between populations could put a population at risk if novel pathogens, including novel strains of the reproductive parasite Wolbachia, from a source population go undetected. This study will evaluate the extinction risk caused by both inbreeding depression and Wolbachia induced cytoplasmic incompatibility.

Tsounis, G.*, Edmunds, P.J.
ENVIRONMENTAL FACTORS DRIVING LONG TERM COMMUNITY DYNAMICS IN SCLERACTINIAN AND OCTOCORAL COMMUNITIES IN ST JOHN, US VIRGIN ISLANDS
California State University, Northridge
Climate change has contributed to the decline in the cover of reef building scleractinian corals on many tropical reefs over the last few decades. Efforts to study the patterns and identify exact causes of the changes are usually focused on scleractinians, while the impacts on other taxa, such as non reef building octocorals (i.e. soft corals) in the Caribbean, are less well understood. We compared 27-year community trajectories of scleractinians with octocorals in St. John, US Virgin Islands, and tested association of change with the environmental factors maximum/minimum/average temperature; number of hot/cold days; rainfall and hurricanes. Spearman rank similarity testing shows that the combination of rainfall with maximum annual temperature was strongly associated with scleractinian community change at one site in Lameshur Bay, where scleractinians suffered a dramatic decline in cover in one site, from which they have not recovered. However, we found no association with environmental factors at another nearby site, where bleaching contributed to a decline in coral cover that was followed by recovery. Octocoral community dynamics were not associated with the 5 environmental factors tested, possibly due to higher resilience, sensitivity to other factors (e.g. diseases), faster growth rates and stronger recruitment.

† Turner, B.C.*, de Rivera, C.E.
EXAMINING INDUCIBLE DEFENSES TO NOVEL PREDATORS
Department of Environmental Science and Management, Portland State University
Invasive species that can identify and respond to novel, native predators in a manner that reduces predation risk, such as the expression of inducible defenses, will be more likely to establish and spread. Few studies have examined if native predators trigger inducible defenses in invasive species, and those that have used species that have coexisted for decades rather than prey naïve to predator cues. Naïve specimens, particularly from their native range, would best represent how a species responded to predator presence and activity during the earliest stages of the invasion process. Specimens of the purple varnish clam (Nuttallia obscurata), a species native to Asia and introduced to the Pacific Northwest (PNW), were collected at Whalen Island, Oregon. Tethered N. obscurata increased their burrowing depth in the presence of risk cues (PNW crab predators with crushed N. obscurata), with burrowing depth varying with predator identity. When exposed to individual risk cues, clams burrowed deepest in response to the physical presence of Dungeness crabs (Metacarcinus magister). Our upcoming work will compare responses of clams from Japan to specimens from the PNW when exposed to M. magister. We hypothesize that only specimens from PNW will respond to predator cues with increased burrowing depths.

† Tuttle, L.J.*, Hixon, M.A.2
GOBIES AS THE SPICE OF LIFE: AN INVASIVE PREDATOR LEARNS TO AVOID A TOXIC PREY FISH
1 - Oregon State University, 2 - University of Hawai‘i at Mānoa
Invasive red lionfish (*Pterois volitans*) are voracious, generalist predators of Atlantic coral-reef fishes. There is concern that lionfish may consume cleaner gobies (*Elacatinus* spp.): ubiquitous, conspicuous, and ecologically important species that clean parasites off of other reef fishes. We conducted two laboratory experiments to test whether or not (1) juvenile lionfish and native groupers eat *E. genie*, and (2) lionfish learn not to eat *E. genie*, which have a putative skin toxin. Nearly half of invasive lionfish (n=31) and native graysby grouper (n=21) ate *E. genie*, all of which hyperventilated for several minutes post-consumption. During the second experiment, most lionfish (n=18 of 24) either successfully ate the goby, or ate it and spit it out immediately, hyperventilating in either case. During subsequent exposures of the same lionfish to *E. genie* over the course of two weeks, lionfish would often approach the goby closely, then turn away without striking. These data are supported by field observations indicating that the presence of lionfish does not alter *Elacatinus* spp. abundance. Due to their distastefulness, *E. genie* may be one of the few fishes on Atlantic coral reefs that escape the jaws of invasive lionfish.

† Tydlska, M.M.*, Edwards, M.S.
VISITOR AWARENESS OF MPAS, VISITOR ACTIVITIES AND IMPACTS ON THE BIODIVERSITY OF ROCKY INTERTIDAL SITES
Coastal and Marine Institute, San Diego State University
Species’ population sizes and geographic ranges are declining worldwide due to human 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 biodiversity of three select MPA intertidal locations and three nearby non-MPA intertidal locations. Pilot data suggest that visitor’s knowledge about MPAs is limited at most sites except for the Cabrillo National Monument MPA site. Visitors were observed collecting sea stars, mussels, limpets, crabs, and snails at the three non-MPA sites. Visitors were also seen poaching abalone, crabs and snails at the three MPA sites. The main problems facing rocky intertidal sites are (1) lack of effective enforcement, (2) inadequate signage and (3) lack of visitor knowledge about intertidal harvesting regulations. Improvements in management techniques are needed at all locations to reduce human impacts on rocky intertidal areas.

† Valley, J.R.*, Hiebert, L.S.
SUNLIGHT AND COLORATION IN THE PURPLE URCHIN STRONGYLOCENTROTUS PUPURATUS
Oregon Institute of Marine Biology, University of Oregon
Many marine invertebrates display intrapopulation variation in coloration. For example, the urchin *Strongylocentrotus purpuratus* is known for its purple color, but green juveniles are often found under rocks adjacent to exposed urchin beds where purple juveniles can be found. From this, we hypothesized that light exposure, and specifically ultraviolet radiation (UVR), may explain the disparity of habitat and color in juvenile urchins and that pigment production is a phenotypically-plastic response, presumably for photoprotection. While UVR and its damaging effects have been studied in echinoderms, most studies have focused on embryonic and larval stages. To test the role of sunlight in urchin coloration, field-collected green juvenile *S. purpuratus* were reared under ambient sunlight, UVR-filtered sunlight, or in darkness for over 100 days. Pigment production was monitored over time via photographic assessment of color and at the end of the study by spectrophotometric measurement of dermally-extracted pigment levels. Urchins reared under full or UVR-filtered radiation developed more pigment and sustained less damage from subsequent UVR exposure than those reared in darkness. The results of this study indicate that pigment production in *S. purpuratus* is a result of exposure to light and that this plasticity may be beneficial in protection against photodamage.

† van Hees, K.E.*, Ebert, D.A.
AN EVALUATION OF MERCURY OFFLOADING IN TWO COASTAL CALIFORNIA ELASMOBRANCHS
Moss Landing Marine Laboratories
Maternal offloading in elasmobranchs is one pathway through which juveniles may accumulate mercury, a harmful contaminant. Although elasmobranchs accumulate and may transfer high levels of mercury, this pathway has not been well investigated. This study examined maternal offloading of mercury in two common coastal elasmobranch species, Leopard sharks (*Triakis semifasciata*) and Thornback rays (*Platyrhoides triserata*). Elasmobranchs were collected in Elkhorn Slough, California, an important elasmobranch nursery area. Muscle tissue and liver samples were collected from adults and analyzed for total mercury concentration. Embryos and ova were collected from gravid females during early and late development. Female leopard sharks had significantly greater rates of mercury accumulation to their tissues with age than males. Leopard shark embryo mercury concentration increased with female mercury concentration, and females transferred an average of 0.05% of their mercury to ova. Female thornback ray mercury concentrations increased with total length. Embryo mercury concentration also increased with female mercury in this species, and females transferred an average of 1.7% of their mercury to offspring. The
degree of maternal offloading of mercury does not seem to be high in these two species, but more study is needed to determine the tolerance of developing elasmobranch embryos to mercury.

† Vaughan, M.L.H.*, Harley, C.D.G.
**PREDATOR-PREY INTERACTIONS IN A HIGH CO2 OCEAN**
*University of British Columbia*

Ocean acidification may improve or reduce the performance of marine species, and the relative impacts on interacting species will largely determine changes at the community level. The purpose of this study was to investigate the effects of acidification on predator-prey interactions between red sea urchins (*Strongylocentrotus franciscanus*) and sunflower stars (*Pycnopodia helianthoides*). We used laboratory mesocosm experiments to examine the impact of high CO2 (low pH) on the development of defensive traits (i.e., trait-mediated effects) in sea urchins exposed to sea star cues. Urchins were acclimated to control (~8.0) or low pH (~7.7) conditions, with or without a caged sea star, for 22 weeks. The results show that predator presence and low pH negatively and additively affected sea urchin growth rates, but did not affect alarm responses to predator cues. Urchin spine length was also significantly reduced under acidified conditions. Conversely, elevated CO2 had a positive effect on sea star growth, but no effect on the proportion of sea star calcified tissue. In addition, the consumption rate of turban snails (*Chlorostoma funebralis*) by sea stars was significantly higher in the low pH treatment. Differential effects of ocean acidification on this predator-prey pair could increase the strength of the trophic interaction and lead to stronger top-down control under near-future ocean pH conditions.

† Wall, C.B.1,2, Edmunds, P.J.1
**ELEVATED PCO2 ALTERS PROTEIN METABOLISM IN THE EARLY LIFE STAGES OF A TROPICAL REEF CORAL**
1 - California State University, Northridge, 2 - University of Hawai‘i at Mānoa

Early life stages of the coral *Seriatopora caliendrum* were used to test the hypothesis that high pCO2 perturbs protein metabolism and depresses dark respiration rates in coral recruits. First, the contribution of protein anabolism to respiratory costs under high pCO2 was evaluated by measuring the aerobic respiration of coral recruits with and without the protein synthesis inhibitor emetine following 1 to 4 days at 45 Pa versus 77 Pa pCO2. Second, protein catabolism at 47 Pa and 90 Pa pCO2 was evaluated by measuring the flux of ammonium (NH4+) from juvenile colonies in darkness. Two days post settlement, recruit respiration was affected by an interaction between emetine and pCO2 (reduced 63% and 26% at 45 Pa and 77 Pa pCO2), indicating protein anabolism is a significant metabolic cost in young coral recruits and is affected by high pCO2. Additionally, juvenile coral colonies (≤ 4cm diameter) showed net uptake of NH4+ at 45 Pa pCO2, but net release of NH4+ at 90 Pa pCO2, indicating protein catabolism and/or NH4+ recycling were affected by high pCO2. Together, these results support the hypothesis that high pCO2 affects corals in part through perturbed protein metabolism.

**THE CAL POLY SAN LUIS OBISPO CPFV OBSERVER PROJECT: AN 11 YEAR UPDATE**
1 - Center for Coastal Marine Sciences, California Polytechnic State University, San Luis Obispo

The commercial passenger fishing vessel (CPFV) industry in central California annually harvests approximately 250,000 nearshore groundfish with each vessel earning annually more than $100,000. Scientific fisheries observers aboard CPFV trips have provided state and federal resource managers a critical fisheries dependent dataset about this fishery. Cal Poly, San Luis Obispo has maintained a CPFV observer project where students and technicians count fishes and time spent fishing aboard CPFVs in San Luis Obispo County, since 2003. This dataset spans several regulatory changes and the establishment of the central coast Marine Protected Areas (MPAs). Cal Poly observers count a subset of the annual CPFV trips, and a subset of the anglers aboard the boat. Observers identify, measure, and record the fate of all fishes caught by the sampled anglers. Additionally, observers record the start and end time and GPS coordinates of each drop. Overall, catch per unit effort (CPUE) has declined from 2003 – 2013. The species composition of the CPFV catch has remained constant. However, there have been shifts in the abundance of individual species between 2003 -2013. These fisheries dependent data are critical to provide fine-scale information about nearshore groundfish stocks to assist management decisions about this previously data poor fishery.

Watson, J.*, Huntington, B.2, McIntosh, N.2, Matteson, K.2
**ASSESSING THE PERFORMANCE OF AN UNBAITED LANDER FOR ESTIMATING ABUNDANCE AND DIVERSITY OF NEARSHORE TEMPERATE FISH ASSEMBLAGES**
1 - Partnership for Interdisciplinary Studies of Coastal Oceans, 2 - Oregon Department of Fish & Wildlife

Video landers are increasingly used to monitor benthic marine communities. Here, we provide an assessment of an unbaited video lander in the nearshore waters of the Oregon coast for the study of temperate fish populations in shallow (10-30m) rocky habitats. We determined and will discuss the optimal deployment times to maximize
species richness and our evaluation of the attraction and repulsive behavior of various taxa to the lander using time of first arrival and time of MaxN per species. The video lander technique sampled a variety of nearshore species with 16 species belonging to 5 families observed. Six species of fish appeared regularly (>75% of all videos). As long-term monitoring programs are developing to evaluate the success of marine protected area systems along the west coast of the US (California and Oregon), monitoring standards like those established in this study will be useful criteria to develop effective monitoring plans of nearshore benthic communities.

† Wells, C.D.*
THE FAILED INTRODUCTION OF THE SEA ANEMONE SAGARTIA ELEGANS IN SALEM HARBOR, MASSACHUSETTS
University of Washington

Many studies have reported the arrival and subsequent range expansion of foreign species within the marine ecosystem, but few studies have documented species that arrive and fail to establish. In 2000, the sea anemone Sagartia elegans (Dalyell, 1848) was first found in Salem, MA on a rapid assessment survey and persisted seasonally until the winter of 2010-2011, after which it has not been found. In both laboratory- and field-based temperature growth studies, S. elegans began regressing in size at 11°C, stopped asexually reproducing at 9°C, and died by 4°C; these temperatures are far above the average winter sea surface temperature in the Gulf of Maine, therefore suggesting that S. elegans requires a warm-water refuge. It is still unknown as to what caused the population collapse, but it is likely a combination of both a lack of genetic diversity and an inability to tolerate the cold temperatures during winter.

† Wetmore, L.S.1,2, Rooker, J.R.1
NATURAL MARKERS INOTOSLTHS REVEAL DIFFERENTIAL NURSERY UTILIZATION AMONG CONGENERIC MANGROVE-ASSOCIATED SNAPPERS
1 - Texas A&M University, 2 - San Diego State University

Chemical tags in the otoliths of marine fishes are well established as natural markers of nursery origin on regional and basin-wide scales, but have rarely been evaluated for nursery habitats in close proximity (e.g. back-reef nurseries in the tropics). Here, we conducted otolith stable isotope (\(\delta^{13}C\) and \(\delta^{18}O\)) and trace element (Li, Mg, Mn, Co, Sr, Ba) analyses on juvenile snappers collected in 2009 from inner- and outer-shelf mangrove nurseries across two latitudinal regions in southern Belize. Otolith signatures from adult (age-4+) snappers collected in 2013 were then matched to the 2009 juvenile baseline. Preliminary stable isotope data had indicated that juvenile snappers could be sourced reliably to shelf position (74-92% classification success) but not study site; however, inclusion of otolith elemental concentrations greatly improved site-specific discrimination, with 75-90% of juveniles correctly identified to nursery of origin. Mixed stock analysis performed on adult snappers revealed distinct differences in nursery contribution among species, with Lutjanus apodus and L. griseus sourced primarily to outer-shelf nurseries (62-86%) and L. jocu sourced primarily to inner-shelf locations (>90%). These results suggest that juvenile nursery utilization can differ markedly even among congeners, which may have important implications for management efforts aimed at conserving essential nearshore habitats.

† Wheeler, S.G.*1, Anderson, T.W.2, Bell, T.W.3, Morgan, S.G.1, Hobbs, J.A.4
REGIONAL PRODUCTIVITY PREDICTS INDIVIDUAL GROWTH AND RECRUITMENT OF ROCKFISHES
1 - Bodega Marine Laboratory, University of California, Davis, 2 - San Diego State University, 3 - University of California, Santa Barbara, 4 - University of California, Davis

Recruitment of marine fishes is largely determined by biological and environmental factors acting on early-life stages. Overlap of larval production and favorable feeding conditions may drive recruitment for many temperate marine fishes, but challenges associated with studying marine larvae have made it difficult to assess how environmental processes act on individual larvae to affect their growth and survival. In a two-year field study, we assess the influence of regional productivity, temperature, and larval condition in explaining growth in rockfishes (Sebastes spp.). We employ a combination of otolith microstructure and satellite imagery to measure initial larval growth and estimate the productivity and temperature experienced by individuals to determine their relative importance in subsequent growth at metamorphosis. To gain insight into the predictive power of remotely sensed data, we compared model performance using indexed environmental conditions scaled over three different regions. Net primary productivity explained the most variation in pre-metamorphic growth relative to temperature and initial growth. This relationship was consistent across spatial regions, although model fit was highest scaled to the south shelf region. Recent settlement, juvenile recruitment, and individual growth were significantly higher in a year when productivity bloomed earlier and individual larvae experienced higher levels of productivity. These results support the hypothesis that large-scale oceanographic processes that stimulate upwelling and secondary production are primary drivers of larval growth and subsequent year-class strength in rockfishes.

† Windell, S.W.*, Garza, C.
Marine Protected Areas are a relatively new approach to managing exploited marine species. However, in order for MPAs to be effective, a diversity of habitats that incorporate all necessary ecosystem services for targeted species must be included in their design. The Southern California spiny lobster (*Panulirus interruptus*) is an exploited species for which MPAs have been designed. Previous work suggests this species forages within the intertidal zone during high tide; however the relative importance of this habitat in the early design of MPAs was not considered. As part of a study to test the efficacy of a longstanding MPA on Catalina Island, California, snorkel and scuba surveys recording abundance, size, and gender were conducted along transects within the MPA and outside at high tide. Intertidal habitat composition was also assessed at low tide using GIS to create photographic transects based off of spatial reference points which were then classified manually. We hypothesized that lobster demographics were higher in the MPA as well as higher in the intertidal zone relative to the subtidal. Results suggest current demographic parameters are higher outside of the reserve due to more suitable intertidal habitat containing the lobsters’ preferred prey item, *Mytilus californianus.*

† Worden, S.E.

AN EXPERIMENTAL TEST OF THE IMPORTANCE OF LIMPET GRAZING IN THE ROCKY INTERTIDAL: IS CENTRAL CALIFORNIA AN EXCEPTION TO THE RULE?

Moss Landing Marine Laboratories

The barnacle assemblage in the rocky intertidal zone has provided an excellent study system to examine species interaction webs. A current paradigm dictates that the negative impact of limpet grazing on macroalgal colonization in the high intertidal is mediated by the presence or absence of barnacles. Several studies, conducted across a broad range of locations have supported this paradigm. Consequently, this algal-grazer-barnacle interaction is assumed to occur in most intertidal communities, despite lack of further studies, including the central California coast. This study examines the interactions between the barnacle *Balanus glandula*, the seaweed *Pelvetiopsis limitata* and limpets at a site in central California. Experiments manipulating the presence and absence of *B. glandula* and limpets showed no significant effect of the presence or absence of limpets on *P. limitata* recruitment, contradicting the current paradigm. Results instead illustrate a significant, positive effect of *B. glandula* on macroalgal colonization, regardless of whether or not limpets are present. Algal recruits are almost exclusively attached to *B. glandula* tests, not to the rock. This suggests that barnacle tests provide a more optimal settlement substrate than the underlying rock, possibly due to increased surface heterogeneity and complexity that barnacle tests provide on a smooth rock surface.

Wynkoop, L.M.1,2*, Aquilino, K.M.3, Rogers-Bennett, L.2,3, Neuman, M.J.4, Cherr, G.N.1, Moore, J.D.2,3

ADVANCING TOWARD SUCCESSFUL WHITE ABALONE RECOVERY

1 - Bodega Marine Laboratory, University of California, Davis, 2 - California Department of Fish and Wildlife, 3 - Wildlife Health Center, School of Veterinary Medicine, University of California, Davis, 4 - NOAA, NMFS West Coast Region

White abalone (*Haliotis sorgenisen*) was the first marine invertebrate to become a federally listed endangered species in 2001. The decline of white abalone is attributed to massive fishing efforts, which depleted 99% of the population from 1970 to 1980. As white abalone populations continue to decline at a rate of 14% per year, captive breeding and subsequent outplanting have been identified as vital to the species’ recovery. The captive breeding program increased success over the past three spawning seasons, with an order of magnitude greater production each year. Key components of increased success were careful monitoring and maintenance of broodstock health. We routinely analyzed animal feces for DNA of the withering syndrome pathogen using PCR. An oxytetracycline bath treatment protocol we developed effectively eliminates withering syndrome in white abalone broodstock. A wax treatment applied to shells biannually minimizes shell degradation from epibionts. Additionally, we have increased the sophistication and capacity of larval settlement and juvenile grow-out facilities. These improvements have augmented production success and will allow for experimental testing of optimal conditions for culture and reproductive conditioning. We look forward to continuing to increase captive production, as we prepare for experimental outplanting efforts within the next few years.

† Zimmermann, S.A.*, Hillard, H., Edmunds, P.J.

ASSOCIATIONAL REFUGES BETWEEN MACROALGAE AND INVERTEBRATES ACROSS A FLOW GRADIENT ON THE NORTH SHORE OF MOOREA

California State University, Northridge

In areas of high physical stress, organisms can ameliorate the implications of stress for adjacent organisms, thereby creating an associational refuge. On the north shore of Moorea, French Polynesia, the reef crest (RC) is physically disturbed by waves, whereas the back reef (BR) is not. We investigated the association between
macroalgae (*Sargassum pacificum* and *Turbinaria ornata*), and invertebrates (a community dominated by copepods, amphipods, polychaetes) and explored its functional basis across the RC-BR gradient. We hypothesized that the algal/invertebrate association was driven by the avoidance of wave action near the RC, and therefore provided an example of an associational refuge. We censused the abundance of invertebrates on *Sargassum* and *Turbinaria* thalli at three distances (10, 50, 90 m) from the RC, and tested for effects of algae on invertebrate abundance by manipulating the density of algae in plots (¼ m²) as a function of proximity to the RC. The abundance of invertebrates increased with distance from the RC, but was unaffected by the removal of algae. These results suggest that the relationship between invertebrates and macroalgae in the back reef of Moorea cannot be explained by the classic benefits of an associational refuge.
MARINE AND BRACKISH-WATER PARASITES SUGGEST HABITAT USE IN THE COLUMBIA RIVER ESTUARY BY YEARLING CHINOOK SALMON
1 - California State University, Monterey Bay, 2 - University of Texas at Austin, 3 - Moorpark Community College

The spring-run Chinook salmon (Oncorhynchus tshawytscha) of the Mid/Upper Columbia River genetic group are listed as endangered under the Endangered Species Act. The Columbia River estuary serves as an important habitat for subyearling Chinook salmon foraging and refuge from predators. It is unclear if yearling salmonids, with a life history type that move rapidly through the estuary, use the estuarine habitats for foraging. This study evaluated the method of using trophically transmitted parasite communities in yearling Chinook salmon to determine estuarine foraging and contrast feeding patterns of hatchery and wild salmon. Results from 75 Mid/Upper Columbia River Chinook salmon collected in 2007 - 2011 in the Columbia River estuary show that these yearling salmon harbor a trophically transmitted parasite community that consists of freshwater and marine parasite taxa, including trematodes, nematodes and acanthocephalans. Marine taxa were recovered at 38.0% and freshwater taxa from 30.0% of the fish, demonstrating the use of trophically transmitted parasites as a biological marker to document yearling foraging. In addition, parasite assemblages differed between wild and hatchery salmon. This study contributes to a larger understanding of habitat restoration efforts in the Columbia River estuary potentially benefiting yearling Chinook salmon.

† Alger, E.I.*, Weng, X.2, Juenger, T.E.2
EXPLORING VARIATION IN PANICLE ARCHITECTURE ACROSS GEOGRAPHIC LOCATION FOR VARIOUS PANICUM HALI POPULATIONS
1 - California State University, Monterey Bay, 2 - University of Texas at Austin

Depletion of the world’s fossil fuel supply has led to the need for new sources of sustainable energy, such as biofuels. Panicum virgatum, or switchgrass, is an excellent biofuel crop candidate, but its yield and stress resistance must be improved. Panicle architecture is known to affect yield in rice and could possibly be used to increase switchgrass yield. Due to the polyploid nature of switchgrass this study was conducted on Panicum halli, a diploid relative. Two panicles from 69 different plants that each represented a specific population were collected from a common garden in Austin, Texas. Pictures of the panicles were taken and rachis length, average length of primary and secondary branches, and the number of primary and secondary branches were found using P-trap, a Panicle trait phenotyping tool. Using linear regression, all lengths were found to increase with decreasing longitude, while rachis and secondary branch length increased with latitude (p-value < 0.03). The number of primary and secondary branches was found to increase as latitude increased (p-value < 0.03). Our results suggest that panicle architecture varies in predictable patterns across geographic location. Future work must be conducted to determine if this variation can be used to significantly improve switchgrass yield.

Anderson, S.1, O’Hirok, L.1, Rodriguez, D.1, Schmitt, T.1*, Steele, C.1, Sunda, A.2, Tillman, C.3*
BIOTIC AND ABIOTIC IMPACTS ON SANDY BEACH ECOLOGY
1 - California State University, Channel Islands, 2 - Ventura Community College, 3 - Moorpark Community College

Sandy beaches are heavily impacted ecosystems with more than half of the world’s population located within 100 km of these coastal regions. These dynamic ecosystems are subject to constant change and are heavily affected by human development and a variety of natural processes (COSA Coastline 2002). The Southern California Bight is characterized by diverse infauna (organisms living in sediment) which primarily feed upon tidal oceanic plankton and detrital beach inputs from offshore kelp beds. During summer 2014, 27 Southern California beaches were surveyed between Santa Monica Beach and Rincon Beach. Abiotic and biotic aspects of the sandy beach ecosystems that affect infauna diversity were surveyed on (a) invertebrate and beach sediment in fauna, (b) geomorphology, and (c) offshore kelp bed and beach wrack presence. Our preliminary findings suggest that species diversity varies with the presence of offshore kelp beds and the slope of the beach face, while beach grooming does not have a significant impact on species diversity. This study is a continuation of a sandy beach research project conducted at CSU Channel Islands for the past nine years.

† Bachhuber, S.1*, Sullivan, J.2, Emlet, R.3, Grunbaum, D.4
IMPACTS OF SEA STAR WASTING SYNDROME ON LARVAL PISASTER OCHRACEUS: A PILOT STUDY ON PATHOGEN EXPOSURE

1 - University of California, Santa Barbara, 2 - Oregon State University, 3 - University of Oregon, 4 - University of Washington

A recent outbreak of sea star wasting syndrome (SSWS) along the U.S. West coast has decimated populations of many sea star species. If populations are unable to recover quickly, SSWS is likely to cause significant changes to intertidal and subtidal community structure and functioning in the Northeast Pacific ocean. Recovery will likely depend on the success of larval recruitment, but the impacts of SSWS on larvae are unknown. By varying seawater treatment filtration levels, we exposed embryos and early stage P. ochraceus larvae to different potential pathogens of SSWS. We assessed treatment impacts on larval survival, development, and size, and found that water treatment and filtration level had a significant effect on all three metrics. Preliminary results on the swimming behavior of late-stage brachiolaria larvae indicate that their response to shear and salinity gradients may serve as a more sensitive metric of larval health for future studies. While few definitive conclusions can be drawn from our results due to high larval mortality, additional work on the topics presented here will provide valuable insight into the future of sea star populations along the west coast.

† Badaoui, Z.1*, Osborn, K.2, Shaughnessy, F.1, Mulligan, T.2, Kullmann, S.3, Kalson, N.4, Largier, J.5

ESTUARINE MARINE PROTECTED AREAS IN CALIFORNIA: DISCOVERIES FROM THE FIRST SUMMER
1 - Department of Biological Sciences, 2 - Department of Fisheries Biology, 3 - Wiyot Tribe, 4 - H.T. Harvey & Associates, 5 - Bodega Marine Laboratory

Our Estuarine Marine Protected Area project describes baseline conditions in South Humboldt Bay and three riverine estuaries. We sampled two sites in each system. Several methods (e.g. coring, quadrats, traps, seining) were used to describe the biodiversity of infauna, mobile invertebrates, algae, plants and fish. All the sampling occurred during June 2014. We found that the 4 estuaries are very different from each other. South Humboldt Bay, an embayment receiving only small tributaries, showed low diversity but relatively high fish abundance. The Mad River Estuary (the only non-MPA site), with its minimally perched beach, had high fish diversity and relative abundance. The high beach at the Ten Mile Estuary creates a lagoon effect where fish may rely more on zooplankton than benthic invertebrates. The very marine Big River Estuary had thick, fringing eelgrass beds and a high density of ghost shrimp burrows. Our second outcome was the improvement of field methods so that sites were better protected from trampling (e.g. sampling from kayaks and boogie boards). Further changes will be made to trap small invertebrates that avoid or are eaten by larger predators. Sampling of all 4 sites will continue during winter and summer of 2015 and winter 2016.

Bandeli, M.W.1*, Sagarin, R.D.2

HOW DENSITY IMPACTS THE EFFECTIVENESS OF HERMIT CRABS AS BIOCONTROL WITHIN THE BIOSPHERE 2 OCEAN
1 - Rutgers University-Newark, 2 - Biosphere 2, University of Arizona

The Biosphere 2 Ocean biome is being transformed into a living model of the Gulf of California. However significant amounts of invasive algae must be removed first. In order to do so, 5,000 red-legged hermit crabs (Clibanarius digueti), native to the Sea of Cortez, were released into the ocean in the spring of 2014. After several months and little algal removal, we considered that the density of crabs was too low to significantly change algal presence within the 2.6 M liter ocean. To test the hypothesis that density has an effect on the hermit crabs’ ability to remove the algae, we conducted two experiments with different compositions of algae species within the shallow end of the B2 Ocean. In each experiment, three treatment densities were calculated based on similar, smaller scale lab projects. Treatments included a control plot without any crabs, a low density plot with 20 crabs, and a high density plot with 80 crabs. There is a correlation between hermit crab density and decrease in algae, with high density plots showing a larger decrease in algae coverage than low density plots. We estimate that 250,366 hermit crabs would be necessary to remove the algae in the B2 Ocean.

Beets, J.P.1,2*, Johnson, E.2,3, Dixon J.2,4, Wyllie-Echeverria, S.2, Lyons, R.3, Swarzenski P.5

EFFECTS OF INCREASED NITRATE CONCENTRATIONS ON ZOSTERA MARINA AND PREVALENCE OF LABYRINTHULA ZOSTERAE
1 - Friday Harbor Laboratories, University of Washington, 2 - University of Puget Sound, 3 - University of Redlands, 4 - Middlebury College, 5 - Center for Coastal & Watershed Studies, U.S. Geological Survey

Garrison Bay, in the San Juan Archipelago, was the site of a complete loss of eelgrass (Zostera marina) in 2003, and no recovery has occurred. Although the exact cause of the disappearance is unknown, one possible factor is nitrate loading caused by submarine groundwater discharge (SGD). This study was divided into two parts, first a field component focused on identifying SGD sites and determining the concentration of nitrate in the discharge. Second, in a mesocosm study Z. marina was exposed to ambient, 2X ambient, or 5X ambient concentrations of nitrate. Eelgrass grown in mesocosms was exposed to increased nitrate concentrations (2X and 5X) introduced into
the water column. Although shoot growth differences were not significant, there was a significant difference in the total number of lesions, associated with the marine pathogen *Labyrinthula zosterae*, found in each treatment. The fewest lesions were in the 5X ambient nitrate concentration and there were 180% more lesions in the 2X ambient nitrate concentration. This finding may indicate that while growth differences between treatments were not statistically significant, the 5X nitrate treatment may have decreased the spread of *Labyrinthula zosterae* along shoots.


**HERBIVORY AS A CONTROL FOR ALGAE IN TWO HAWAIIAN PARKS**

*University of Hawai‘i at Hilo*

Recent studies in Hawai‘i have shown that increased coastal nutrient inputs can encourage nuisance algal growth. However, where grazer density is large, herbivory can regulate algal overgrowth. Our study investigated the bottom-up effects of benthic nutrient inputs (through submarine groundwater discharge) and the top-down effects of fish and invertebrate grazing on algal growth rate within two Hawai‘i parks (Kaloko-Honokōhau and Kalaupapa National Historic Parks). Ten sampling stations were randomly selected at each park and sampled during summer months from 2011-2014. Herbivorous fish densities were greater at the more remote park, whereas, urchin density was significantly greater at the more urban park. Herbivory was experimentally evaluated using exclusion cages (all macrograzers, fish, and urchin exclusion treatments). Greater turf algal growth was observed in response to greater nutrient concentration. Herbivores significantly reduced turf algae compared to controls, with urchins contributing more biomass reduction than fishes. The results establish a baseline understanding of nutrient and herbivory interactions in these Hawaiian parks and will be useful for future management practices.

**† Bird, A.C.*, Zacherl, D.**

**DETERMINING POPULATION STRUCTURE, REPRODUCTIVE POTENTIAL AND HABITAT ASSOCIATIONS OF THREADED ABALONE IN SOUTHERN CALIFORNIA**

*California State University, Fullerton*

Seven species of abalone are found in subtidal kelp forests along the coast of California, five of which once supported viable commercial and recreational fisheries. However, stock collapse led to the closure of fisheries in central and southern California in 1997. The threaded abalone (*Haliotis kamtschatkana assimilis*), a subspecies of pinto abalone, once supported a modest commercial fishery in southern California. In July 2013 NMFS was petitioned to list the pinto abalone as threatened or endangered under the ESA. However, management strategies are not available for threaded abalone due to the lack of basic demographic knowledge and entire populations and their habitat may be inadvertently excluded from protection. Preliminary surveys in San Diego, CA, where one of the only currently known populations of threaded abalone are present, show threaded abalone density increases significantly with increasing depth and decreasing latitude. There is evidence of recent threaded abalone recruitment; individuals within the population represent a broad size range (30 – 160mm maximum shell length). Ongoing surveys will continue to examine population structure, habitat characteristics and reproductive potential for threaded abalone in San Diego. These data and procedures will inform recovery efforts for threaded abalone and other abalone.

**Blackhart, K.E.*, Greene, C.M., DeBruyckere, L.A.**

**ASSESSING THE STATUS OF PACIFIC COAST ESTUARIES AND THEIR ROLES FOR NOAA TRUST RESOURCES**

1 - NMFS Office of Science and Technology, 2 - NMFS Northwest Fisheries Science Center, 3 - Pacific Marine and Estuarine Fish Habitat Partnership

Estuaries are highly productive and critically important ecosystems that serve as habitat for a number of managed species along the Pacific Coast. To enhance understanding of the role of estuaries for these species and for ecosystem health of the California Current Ecosystem, the Pacific Marine and Estuarine Fish Habitat Partnership (PMEP) is coordinating three related efforts to assess West Coast fish habitats. Collectively, these assessments will provide information on the status and key threats to West Coast coastal habitats, the use of estuaries as nursery habitats, and habitat-related changes in the distribution and abundance of forage fish species. Although the focus and specific analytical methodologies of each assessment effort differs, each project shares several steps in common. These include an inventory and common classification scheme for nearshore and estuarine habitats; development of a spatial framework; collection of data on physical habitat, fish abundance and distribution, and anthropogenic threats; identification of high priority data gaps; and creation of shared tools and products. By combining efforts, PMEP and its assessment partners will be able to integrate data and share outcomes, leading to greater impact of overall assessment efforts and contributions to several other key regional needs.

**† Boyer, K.A.*, Traylor-Knowles, N.**
EVOLUTION OF THE AP-1 TRANSCRIPTION FACTOR AND ITS IDENTIFICATION IN ACROPORA DIGITIFERA
1 - California State University, Monterey Bay, 2 - Hopkins Marine Station of Stanford University
Rising sea surface temperatures have been linked to increased coral bleaching and mortality. The molecular processes that drive coral bleaching and heat stress responses are still largely unknown. In several coral species, the Jun and Fos protein families have been shown to be highly expressed in heat stressed corals. These two genes combine, in mammals, to form a transcription factor that activates genes responding to chemical and physical stress, cell differentiation, and apoptosis. However, their role in corals and their evolution in the animal tree of life is not understood. We use blast searches to identify potential AP-1 sequences in the genome of the coral Acropora digitifera and representatives from major phyla, then generate a phylogeny to visualize the early evolution of AP-1. We found three potential Jun orthologs and a single Fos ortholog in A. digitifera. However, motif analysis and phylogeny indicate that two of the A. digitifera Jun sequences are highly divergent and are likely non-functional. Future research will include assessing temporal expression of the AP-1 genes in heat stressed corals. Because Jun and Fos are considered early-response genes, transcription early in the heat stress response would provide further evidence that these genes code for functional AP-1 proteins.

† Braddock, A.M.1*, Fennie, H.W.2, Hamilton, S.L.2
THE EFFECT OF OCEAN ACIDIFICATION ON INVESTIGATORY BEHAVIOR OF TWO JUVENILE ROCKFISH SPECIES
1 - California State University, Monterey Bay, 2 - Moss Landing Marine Laboratories
The recent rise in atmospheric carbon dioxide (CO2) has led to increased absorption of CO2 into the oceans and a decrease in ocean pH. Many studies have shown that ocean acidification (OA) negatively affects shell-forming invertebrates, but more recent studies demonstrate that changes in pH can have sub lethal effects on fish (i.e. altered behavior). However, some fish species appear to be more resistant to future pH conditions than others. This study examines the effects of OA on the boldness and curiosity of juvenile fish from two closely related temperate species: Copper Rockfish (Sebastes caurinus) and Blue Rockfish (Sebastes mystinus). Individuals were acclimated to one of four different pH treatments (7.2, 7.5, 7.8, and 8.0) for 16 weeks. Each individual was exposed to a novel object and the time each fish investigated the object was measured over a 10 minute period. We found that there was a significant increase in investigation time for blue rockfish at pH 7.5. This altered behavior may affect fitness, which could lead to changes in the structure of rockfish communities in temperate reefs.

† Brett, M.N.*, Anderson, T.W.
CONSUMPTIVE VS. NON-CONSUMPTIVE EFFECTS OF FISH ON LIMPET GRAZING BEHAVIOR OF A SUBTIDAL KELP
San Diego State University
Predator-prey interactions can be defined through both consumptive and non-consumptive effects. To separate these effects, one must examine both density-mediated and trait-mediated interactions. These interactions are important in trophic cascades that affect primary producers. We our investigating a tri-trophic interaction in determining whether a temperate reef-associated fish, Oxyjulis californica, impacts a grazing limpet, Lottia insessa, by inducing a trait-mediated indirect interaction that benefits a common habitat-forming kelp, Egregia menziesii. In treatments allowing and restricting fish access to grazing limpets, the limpets modify their behavior in the presence of fish by decreasing grazing activity and movement. Changes in limpet feeding behavior directly benefit the kelp by increasing the breaking strength of fronds in the presence of fish, which should reduce the loss of kelp biomass. We plan to test the ecological realism of these interactions through caging experiments in the field.

† Brinkman, A.P.1*, Hall, T.A.1, Hanna, C.1, McEachearn, K.2, Power, P.3
SANTA ROSA ISLAND TORREY PINE DEMOGRAPHY
1 - California State University, Channel Islands, 2 - U.S. Geological Survey, 3 - National Park Service
The Torrey pine (Pinus torreyana) is the rarest pine species in North America, with populations limited to San Diego and Santa Rosa Island (SRI), CA. Over the past century, non-native ungulate grazing and erosion reduced recruitment and distribution of ssp. P. torreyana insularis. To aid this recovery, all non-native ungulates were removed from SRI in 2012. We began censusing this population in 2013 to determine: (a) population size and any recovery trajectory; (b) spatial variation in population structure; (c) spatial pattern of distinct age classes; (d) environmental factors correlating with seedling recruitment success; and (e) conservation gains associated with non-native ungulate removal. 24,192 individuals make up the SRI population, of which 3,068 are sexually mature. Using a point density calculation within ArcMap, we isolated six distinct groves on SRI. Younger individuals are frequently located on grove edges and older individuals tend to dominate grove centers. Groves were further characterized by collecting tree cores, soil and seeds to determine relative age, seedling survival, reproduction and viability between groves edges and cores. Additionally, permanent plots were established to monitor seedling and sapling survival. Data from this study is imperative for resource managers quantifying the ongoing recovery of the SRI Torrey pine.
† Burdi, C. E.*, Eernisse, D.J.
IS IT THE LIMPET KEY OR ME? A PCR BASED ASSAY CONFIRMS THAT LOTTIA SCABRA AND L. CONUS REALLY DO LOOK ALIKE
California State University, Fullerton
Lottia scabra and L. conus are two closely related species of intertidal limpets with similar morphologies, ecological habitats, and overlapping ranges in southern California with a transition zone centered around the Palos Verdes peninsula. There is a shifting ratio of abundance between these two species, which co-occur near San Pedro, with L. conus becoming more abundant than L. scabra towards San Diego. Initially, we were interested in documenting this transition; however, due to their similar appearance and dorsal shell plasticity, distinguishing them in the field and even in the lab proved to be difficult. Because each species has highly distinctive mitochondrial 16S rDNA gene sequences, we developed species-specific primers that were used in four primer combinations to identify individuals to species without costly sequencing. The low cost of our assay is allowing us to contrast the published shell characteristics and to test whether improved shell diagnoses are feasible for distinguishing L. scabra from L. conus. We plan to apply published techniques for extracting DNA from foot mucus to explore non-lethal methods for field identifications and help quantify the distributions of each species, so that we can study the potential ecological interactions between L. scabra and L. conus.

† Carilli, P.B.*, Beers, J.M.*, Litvin, S.Y.*, Somero, G.N.*
THE EFFECTS OF HYPOXIA ON THE PHYSIOLOGY OF JUVENILE BLUE ROCKFISH INHABITING COASTAL ECOSYSTEMS OF CENTRAL CALIFORNIA
1 - California State University, Monterey Bay, 2 - Hopkins Marine Station of Stanford University
Coastal kelp forests of Monterey Bay, California, experience periods of hypoxia due to seasonal upwelling events, thereby inducing abiotic stress on marine animals such as rockfishes. We studied the physiological effects of hypoxia on juvenile blue rockfish, Sebastes mystinus, an important fisheries species, that were exposed to both normoxic and hypoxic (<2 mg O2/L) conditions. Intermittent-flow respirometry was used to measure rockfish metabolism, while concurrently a video camera captured data for calculation of ventilation rates. As dissolved oxygen (DO) content declined, organismal standard metabolic rate (SMR) decreased, whereas ventilation rate increased. Significant changes in SMR and ventilation rate occurred below 5 mg O2/L. We measured hematocrit and hemoglobin content to assess blood biochemistry and found that the concentration of each parameter increased with hypoxic exposure, thus elevating blood oxygen-carrying capacity. Our data indicate that blue rockfish compensate for low DO by utilizing a suite of physiological mechanisms to supply adequate oxygen to their tissues and maintain cellular homoeostasis. Surprisingly, implementation of these mechanisms occurs at a DO level not notably below normoxic conditions. Results from our study suggest that juvenile blue rockfish incur physiological ‘costs’ at sub-lethal DO levels that may influence their growth, development and overall fitness.

FLOATING FORESTS: USING ONLINE CITIZEN SCIENCE TO ASSESS 30 YEARS OF SATELLITE DERIVED GIANT KELP ABUNDANCE AT A GLOBAL SCALE
1 - University of California, Los Angeles, 2 - University of Massachusetts, Boston, 3 - University of California, Santa Barbara, 4 - California State University, Monterey Bay, 5 - Estación Costera de Investigaciones Marina, Pontificia Universidad Católica de Chile, 6 - Centro de Ciencias del Mar, Universidade do Algarve, Portugal
Assessing changes in the abundances of marine species in nearshore ecosystems on global scales is challenging due to the logistical difficulties of large-scale sampling. While aerial and satellite methods provide one solution, the resulting images often defy easy classification by computers, and require detailed evaluation by humans. While this is suitable for examining areas at sub-regional scales over a handful of years, it does not scale to global datasets over longer time periods. Citizen science is fast becoming a way to acquire large amounts of data from these kinds of imagery datasets that confound automated computer processing. We demonstrate the use of citizen science to create a 30-year dataset of global giant kelp cover. Here we present Floating Forests (http://floatingforests.org): an international collaboration between kelp forest researchers and the citizen science organization Zooniverse. Floating Forests provides an interface that allows citizen scientists to identify canopy cover of giant kelp on Landsat images. This interface enables us to transform satellite imagery into kelp canopy data, and it serves as an outreach tool to engage and involve the public in coastal ecology. Floating Forests was launched on August 7, 2014; to date over 2,300 citizen scientists have classified over 810,000 images.

† Chow, B.*, Cohen, C.S.
JUVENILE PERFORMANCE VARIATION IN MARINE INVERTEBRATES: EFFECTS OF LOCAL ENVIRONMENT
Romberg Tiburon Center for Environmental Studies, San Francisco State University
Sessile marine invertebrates with restricted dispersal may have a greater potential for local adaptation or environmental matching. The environment that parents experience may carryover to influence offspring success.
Offspring size may affect growth rate and survival during the most vulnerable period of many marine invertebrate life histories. Early juveniles of colonial marine invertebrates are an excellent stage to evaluate the impact of local environments including varying temperature, salinity, water flow, and nutrient availability. To determine if ascidian and bryozoan species with limited natural dispersal show local adaptation or matching in the first generation, fine-scale growth rates of new settlers were measured on PVC plates at two sites in reciprocal transplant experiments, along with measurement of local variables. Photographs were taken for 5 weeks using an underwater camera and analyzed using ImageJ. A site in San Francisco Bay, California had water temperatures consistently higher than a site in Half Moon Bay, California (0.8 °C to 3.5°C) during this late summer experiment. Preliminary results for the bryozoan *Watersipora* sp. suggest that rather than environmental matching or local adaptation, colonies have higher growth rates in San Francisco Bay, independent of source location.

† Clark, B.L.F.*, Allen, L.G.  
COURTING AND SPAWNING BEHAVIOR OF GIANT SEA BASS, STEREOLEPIS GIGAS  
California State University, Northridge  
Giant sea bass, *Stereolepis gigas* (Polyprionidae), is a member of the northeastern Pacific nearshore fish fauna that has been historically overharvested resulting in its placement into the IUCN threat category, *Critically Endangered*. Understanding their reproductive behavior is necessary for effective management of critically endangered species, allowing for better predictions of the species’ recovery and vulnerability. This knowledge also benefits future stock assessments and serve as a baseline for spawning behaviors in other polyprionids. Based on these considerations, the goals of this study were to identify when, where, and how courting and spawning occurs in giant sea bass. I expected aggregations to be largest in the evening and spawning should occur in groups, which is common for large, reef-associated fishes. Observations were made June-August 2014 at Goat Harbor, Santa Catalina Island, CA on SCUBA and at Aquarium of the Pacific, Long Beach, CA. Behaviors observed at the aquarium were used as a baseline for those seen in the wild. Density surveys were conducted throughout the day and behaviors were captured using an HD video camera. Giant sea bass were most abundant at Goat Harbor during the mid-afternoon and courting behaviors were commonly seen in pairs in the field and aquarium.

Corrales-Ugalde, M.1,2,3, Quesada, A.J.1,4*, Naranjo, B.1,2, Sánchez-Jiménez, A.1, Rodríguez-Arrieta, A.1,5, Pérez, C.1,2, Blum, S.6, Cortés, J.1,2  
MEDUSAE, SIPHONOPHORES AND CTENOPHORES FROM EPI- AND MESOPELAGIC WATERS AT ISLA DEL COCO NATIONAL PARK, COSTA RICA (EASTERN TROPICAL PACIFIC)  
1 - Centro de Investigación en Ciencias del Mar y Limnología (CIMAR), Ciudad de la Investigación, Universidad de Costa Rica, 2 - Escuela de Biología, Universidad de Costa Rica, 3 - University of Oregon, 4 - Western Washington University, 5 - Centro de Investigación en Estructuras Microscópicas, Universidad de Costa Rica, 6 - DeepSee, UnderSea Hunter Group  
Gelatinous zooplankton arguably dominate the mesopelagic regions of the oceans. However, knowledge of species’ spatial distribution in this depth range, as well as their ecological role, is scarce. We present information on the spatial and temporal distribution of epi- and mesopelagic gelatinous zooplankton recorded by the DeepSee submersible on 811 dives made from 2006 to 2012 at Isla del Coco (Cocos Island), Costa Rica, an oceanic island in the Eastern Tropical Pacific. Two species of scyphomedusae, three species of hydromedusae, two genera of siphonophores and three species of ctenophores were observed at depths between 50 and 400 m. None of the species had been previously recorded in the waters around the island. Furthermore, except for the jellyfish *Pelagia noctiluca* and a siphonophore in the genus *Praya*, all are new records for Costa Rican waters. This study also includes the first record of the cnidarians *Modeeria rotunda*, *Solmissus* sp., *Halitrephes maasi* and *Apolemia* spp., and the ctenophores *Beroe forskali* and *Thalassocalyce inconstans* in the Eastern Tropical Pacific. We show that surveys of gelatinous zooplankton conducted with submersibles broaden our knowledge of their natural history and may result in new species records.

Coyle, O.L.*, Grünbaum, D.  
AFFORDABLE ENVIRONMENTAL SENSORS FOR CLASSROOM/CITIZEN SCIENCE COLLABORATIONS IN HARMFUL ALGAL BLOOM DETECTION  
University of Washington  
The recent availability of consumer desktop 3D printers and the continuing development of less costly and more powerful electronic microcontrollers is changing the paradigm of what is possible for environmental researchers and educators alike. It is now possible for people without extensive training in engineering or access to specialized machinery to design and build their own custom environmental sensors. Using these new technologies we have designed an environmental sensor for the detection of the harmful alga *Heterosigma akashiwo*, with the total cost of one sensor within the budget of an interested hobbyist or citizen scientist. We are using this device to build a first-of-its-kind *Heterosigma* early warning network for use by stakeholders in Puget Sound. This work also has an educational outreach component, with the placement in collaboration with the Chief Kitsap Academy, a grade 6-12
school operated by the Suquamish Tribe. Students will integrate data from the sensor with physical data logged by simple digital temperature, current, wave, and tide sensors the students build using electronic microcontrollers. We believe this hands-on approach to sensor design is widely applicable to the work of other environmental researchers and educators.

† Daly, A.*, Cramer, A.N., Knight, A., Lindholm, J.
GORGONIAN OR NO GORGONIAN? THAT IS THE QUESTION: FISH HABITAT ASSOCIATIONS IN SOUTHERN CALIFORNIA MARINE BENTHOS
Institute for Applied Marine Ecology, California State University, Monterey Bay
A current and widely used assumption in management is that fish associate with three dimensional structures, such as coral. To test this assumption we examined the relationship between the presence of gorgonians and the presence of fishes. In order to determine presence, a remote operated vehicle (ROV) was used to conduct transects in and around marine protected areas on the south coast of California. Data were collected across 89 video transects at Catalina Island, La Jolla Canyon, and Point Vicente on the presence of fish and gorgonians. The majority (85%) of fish observed were not found next to gorgonians. However, the percentage of fish that were associating with gorgonians was higher than expected, implying that there is a significant association of some sort (chi square \( p \)-value < 0.05). The strength of gorgonian associations differed between species, with \textit{Sebastes spp.} in particular meriting further analysis. Further study on possible associations with other three dimensional structures and species is needed in order to thoroughly examine the fish-gorgonian interaction.

HISTORICAL COMPARISONS INDICATE DECLINES IN MUSSEL ABUNDANCES IN THE GULF OF MAINE
1 - Whitman College, 2 - University of California, Irvine, 3 - Cornell University, 4 - University of Notre Dame, 5 - University of Massachusetts, Boston, 6 - NOAA National Marine Sanctuaries
Human activities, including climate change, have impacted intertidal communities and may have contributed to the northward range contraction of blue mussels on the east coast of the U.S. This contraction at the southern edge of the blue mussel's range suggests that changes might also be occurring at different locations within the species' current range. The Gulf of Maine (GOM) is historically home to the peak of blue mussel abundances, and changes to mussel populations in this area could lead to changes in populations of other species, as mussels are important foundation species. Historical data describing mussel abundances over the last forty years were compared to contemporary abundance data at four sites in the GOM. Across these sites, mussel abundances either declined or did not change significantly. Mussel abundance data were also collected at an additional sixteen sites spanning the GOM. Overall, these data indicate that mussels are more abundant at southern sites than northern sites, in May than in July, and at intermediate tide heights. Our results support the hypothesis that mussel abundance has declined over the last forty years in the GOM, and declines could continue with potential consequences for entire intertidal communities.

† Dedrick, A.G.*, Botsford, L.W., Baskett, M.L.
A SPATIAL FRAMEWORK FOR QUANTIFYING THE INTERACTIONS AMONG OCEAN ACIDIFICATION, TEMPERATURE CHANGE, AND FISHING
University of California Davis
Rising atmospheric concentrations of carbon dioxide will alter both ocean temperature and pH. Ocean acidification (OA) and changing temperatures could change the spatial distribution and persistence of marine invertebrate populations through their effects on the survival, growth, and development of invertebrate larvae, particularly those that calcify. Many of these species have economic as well as ecological value. For exploited populations, changes in population spatial structure will also alter the spatial pattern and intensity of fishing. Understanding the interactions among OA, temperature, and fishing in a spatial context is crucial to determining the overall population-level effects and the potential fishery impacts and response. This project develops a framework to explore and quantify these interactions.

† Dobkowski, K.A.*
KELP BED REGENERATION IN THE ANNUAL BULL KELP (\textit{NEREOCYSTIS LUETKEANAA})
Friday Harbor Laboratories, University of Washington
Bull kelp (\textit{Nereocystis luetkeana}) is an important primary producer and habitat-forming species in the Salish Sea, but kelp beds show temporal variability and declining trends in abundance. I tested herbivorous kelp crabs as possible agents of top-down impact on bull kelp in the San Juan Islands of Washington State. Juvenile \textit{N. luetkeana} were outplanted to four cage treatments providing different amounts of protection from large herbivores. The only treatment in which juvenile bull kelp survived and grew was the fully caged treatment. Further, the observed natural mortality of juvenile kelp was high, with <10% surviving more than two months. Based on laboratory feeding trials,
kelp crabs consume high amounts of *N. luetkeana* (1.4016 g/d fresh weight) and generally choose it over other possible diet items. Together, these results indicate that kelp crabs frequently elect to eat *N. luetkeana* over other macroalgae and may exert top-down control on bull kelp distribution and abundance when kelp sporophytes are small and therefore most vulnerable to catastrophic herbivory.

† Duncan, E.A., Miller, L.P., Denny, M.W., Allen, B.J.
PREDICTING EFFECTS OF INCREASING ENVIRONMENTAL VARIABILITY ON THERMAL RISK TO BLACK ABALONE: COMBINING ECOMECANICS WITH BEHAVIOR
1 - California State University, Long Beach, 2 - Hopkins Marine Station of Stanford University

Black abalone (*Haliotis cracherodii*) were once a common intertidal inhabitant on rocky shores in California, but have experienced dramatic population declines and local extinctions due to overharvesting and the emergence of withering syndrome (WS) disease. Susceptibility of black abalone to infection by WS is related to higher body temperature variability during aerial exposure at low tide, suggesting that temperature stress is a key risk factor determining their long-term viability. Our research is designed to quantify how body temperatures and associated risk of disease to black abalone might be altered in response to anthropogenic climate change. We created a heat-budget model for black abalone and coupled it with long-term meteorological records at Hopkins Marine Station (HMS) to generate information about environmental and topographic controls of body temperature at this site. We simultaneously collected real-time data across microhabitats at HMS on the distributions of body temperatures (*Tb*) of live abalone with a calibrated infrared camera and operative environmental temperatures (*Te*) with species-specific thermal mimics. These data will be combined to derive quantitative measures of the thermal quality of the habitat at HMS and the precision, accuracy, and effectiveness of thermoregulation by black abalone in the field.

† Dunn, R.P., Hovel, K.A.
RESPONSES OF PREDATORS TO URCHIN PREY ON ROCKY REEFS IN THE SOUTHERN CALIFORNIA BIGHT
1 - Coastal and Marine Institute, San Diego State University, 2 - University of California, Davis

Predation is an important driver of population dynamics in subtidal marine ecosystems, and predator responses to variable prey density have important implications for population regulation. The predator-urchin-kelp food chain is considered a classic example of a trophic cascade, but on rocky reefs in the Southern California Bight, where the archetypal urchin predator (the sea otter) is no longer present, community dynamics may be more complex. In mesocosm-based feeding assays, California spiny lobster (*Panulirus interruptus*) demonstrated a Type II functional response to urchin (*Strongylocentrotus purpuratus*) prey, whereby the proportion of prey consumed decreased with increasing prey density. On experimental rocky reefs constructed at two sites offshore of San Diego, CA, urchins suffered variable rates of mortality depending on the time since they were placed on reefs. Abundance and behavior of fish predators was analyzed with underwater videography, with aggregations of predators observed only on reefs with high prey density, as well as facilitative foraging behavior by sheephead (*Semicossyphus pulcher*). These results, while preliminary, fail to provide evidence of population regulation of urchins by predators. Future work will focus on interactions among urchin species and effects of intraguild predation between fish and lobsters on rocky reef community structure.

Eddy, T.A., Harvey, J.T.
DISTRIBUTIONAL CHANGES OF HUMPBACK WHALES (*MEGAPTERA NOVAEANGLIAE*) WITHIN FEEDING GROUNDS OFF CALIFORNIA
1 - California State University, Monterey Bay, 2 - Moss Landing Marine Laboratories

Ship strikes pose a threat to the recovery time of whale populations, making the understanding of their movements essential for conservation efforts. Examining humpback whale (*Megaptera novaeangliae*) distribution data, I assessed the variability of humpback whale distribution on two foraging grounds; the Gulf of the Farallones and Monterey Bay National Marine Sanctuaries. Data were collected by Applied California Current Ecosystem Studies (ACCESS) cruises in the Gulf of the Farallones (2004-2011) and by the Wind to Whales project in Monterey Bay (1997-2007). For data from Gulf of the Farallones, I used ArcGIS to create a hotspot map and used R to assess the annual variability in humpback whale foraging areas. For the Monterey Bay data, I conducted a Multi-Distance Spatial Cluster Analysis (Ripleys K function) to assess the distribution patterns of the humpback whales annually. In the Gulf of the Farallones there was no significant latitudinal variation, but based on visual analysis longitudinal variation of hotspots occurred around the shelf break that varied annually. In Monterey Bay, there was a slight annual variation latitudinally and in dispersal patterns. Because of these distributional variations, enforcing slower speeds, as opposed to changing the shipping lanes would be a more effective conservation method.

† Elsmore, K.E., McHugh, T.A., Leary, P.R., Raimondi, P.T.
THREE-DIMENSIONAL HABITAT MAPPING OF TWO MARINE RESERVES
1 - University of California, Santa Cruz, 2 - Stanford University
Temperate rocky reefs and kelp forests are some of the most productive and diverse ecosystems on earth, in part because they exhibit a great deal of spatial heterogeneity in habitat characteristics. To gain a better understanding of how habitat characteristics (e.g. relief, substrate type, and wave exposure) influence the composition of the associated marine community, we conducted detailed spatial surveys in two longstanding marine reserves on California’s central coast. In Fall 2013, a team of divers from UC Santa Cruz, Hopkins Marine Station, and the Monterey Bay Aquarium, sampled the permanent transects at each reserve collecting data on: depth, relative wave action, substrate type, mobile and sessile invertebrates, fish, and algae. These spatially explicit maps of the habitat surrounding the cables allow students and researchers to run preliminary statistics on habitat associations, species-specific associations, or physical and biological habitat associations. This map and data set provide further support for the marine reserve system and enhance training, education, and research opportunities provided through University of California, Santa Cruz and Hopkins Marine Station.

† Francis, F.T.-Y.*, Côté, I.M.
IMPACTS OF A MARINE INVADER ON CONSUMER MEDIATED NUTRIENT CYCLING
Simon Fraser University
Invasive Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) in the Western North Atlantic and Caribbean have had severe direct negative effects on native coral reef fish biomass. However, the indirect effects of these predatory invaders on functional processes such as nutrient cycling in reefs have not been assessed. Fish excretion is an important source of nutrients that can drive primary productivity in oligotrophic reefs and seagrass beds. We tested how the addition of lionfish to a reef system alters this fish-mediated nutrient pathway by modelling nutrient budgets on natural reefs with various lionfish densities manipulated through experimental culling. We measured inorganic nitrogen excretion rates from four major prey fish families accounting for ~70% of the biomass on the experimental reefs and developed linear excretion models for species within each family as well as for lionfish. Excretion rates increased with fish size and differed between prey fish species and lionfish. These rates were then combined with overall fish biomass for each reef to test whether reefs with higher lionfish densities have lower fish-mediated nutrient supply. These findings will help us better understand the long-term effects of invasive lionfish on ecosystem function.

† Fredle, M.T.*†, Launer, A.L.*
THE LEOPARD SHARKS AND THE THREE LOCATIONS: TEMPERATURE-MEDIATED MOVEMENTS OF *TRIAKIS SEMIFASCIATA* IN ELKHORN SLOUGH, CA
1 - California State University, Monterey Bay, 2 - Moss Landing Marine Laboratories
Leopard Sharks (*Triakis semifasciata*) are abundant in estuaries along the California coast during spring and summer months. Mature females are known to select habitat based on water temperature while residing in southern estuaries, but documentation of this in Central California is absent. Acoustic telemetry was used to determine the relationship between water temperature and the presence and abundance of Leopard Sharks within a Central Coast estuary from June 2013 to March 2014. Thirteen sharks (7 females, 6 males) were tagged with coded acoustic transmitters while five passive acoustic receivers were deployed in three locations throughout Elkhorn Slough, CA: the lower channel, the fork of the slough, and Parsons Slough. There was a significant relationship between water temperature and shark presence and abundance during summer and fall seasons. As temperatures increased, sharks were more likely to be present and more abundant; however, where the highest temperatures were recorded, abundance was low. This improves our understanding of what temperatures may be too hot or “just right” for Leopard Sharks’ habitat selection.

Friedlander, D.M.*
EXAMINING SURFACE CURRENTS AROUND VERY NEARSHORE FOAMLINES OFF CAPE ARAGO, OR
Oregon Institute of Marine Biology
Shore-parallel foam lines are common features of open rocky coastlines, and have long been associated with oceanographic fronts (Shanks et al., 2003; Weidberg et al., 2014; Wolanksi and Hamner, 1988). Although these fronts have been hypothesized to be convergence zones, little research has directly characterized the currents surrounding these features. This project used oranges as disposable surface drifters to describe the currents both shoreward and seaward of foam lines off an open coast site south of Shore Acres on Oregon’s Cape Arago. I used Google Earth images, an angle finder and a compass as basic surveying tools to track the drifters’ movements. In the presence of unbroken, well-defined foam lines, drifters generally converged and followed the lines north along the coast. On days when foam lines were absent or patchy, drifters tended to move towards the weak foam line and were carried southward. Future efforts should sample over multiple seasons to discern whether north/south winds influence the strength of the convergence of surface water. On the days with large wave events, drifters collided with the rocks almost immediately. From a larval transport standpoint, this wave energy could indicate a potential barrier for flux between the intertidal and shelf.

Francis, F.T.-Y.*, Côté, I.M.
IMPACTS OF A MARINE INVADER ON CONSUMER MEDIATED NUTRIENT CYCLING
Simon Fraser University
Invasive Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) in the Western North Atlantic and Caribbean have had severe direct negative effects on native coral reef fish biomass. However, the indirect effects of these predatory invaders on functional processes such as nutrient cycling in reefs have not been assessed. Fish excretion is an important source of nutrients that can drive primary productivity in oligotrophic reefs and seagrass beds. We tested how the addition of lionfish to a reef system alters this fish-mediated nutrient pathway by modelling nutrient budgets on natural reefs with various lionfish densities manipulated through experimental culling. We measured inorganic nitrogen excretion rates from four major prey fish families accounting for ~70% of the biomass on the experimental reefs and developed linear excretion models for species within each family as well as for lionfish. Excretion rates increased with fish size and differed between prey fish species and lionfish. These rates were then combined with overall fish biomass for each reef to test whether reefs with higher lionfish densities have lower fish-mediated nutrient supply. These findings will help us better understand the long-term effects of invasive lionfish on ecosystem function.
The meristem, or growth region, is of particular interest in plants and algae for both morphological and ecological studies as the meristem’s location, appearance, and chemical composition may determine much about a species. In kelps, the meristem is the site of growth for a blade, frond, or, in some cases, the entire individual. Many studies have examined the effect of meristem removal in kelps and have found the removal of the entire meristem to halt growth in the blade, frond, or entire individual, often causing the deterioration of the blade or individual. In Egregia menziesii (Turner) Areshoug, the intercalary meristem has long been thought to be at the transition between the rachis and terminal lamina, and if damaged, would halt the growth of the frond. This study found no significant difference in rachis growth between plants with their terminal lamina and transitional region removed and those with fronds left intact. The continued elongation after removal of what was thought to be the meristem suggests a more diffuse growth region than previously thought. This may be an important survival trait Egregia as it occupies the physically stressful rocky intertidal.

Many reef fish species depend on different coastal habitats in order to complete their life cycles. However, little information is available about the species connectivity between habitats in Baja California. This study evaluates the composition of fish species between mangrove and rocky reefs habitats in Playa Requeson, Baja California Sur. A total of 39 species were recorded, 19 in mangrove and rocky habitats, 15 exclusively in rocky habitats and 5 exclusively in mangroves. A high abundance of commercial species such as Lutjanus spp and Haemulon spp. was recorded in both habitats. These observations illustrate the importance of conserving coastline and environments encompassing a diverse variety of habitats as they are able to support highly diverse communities of fishes.

The fraction of inorganic carbon—in the form of CaCO$_3$ from back-filled shell hash—and sediment grain size in surface sediments are important characteristics controlling settlement processes and post-settlement survival. We found inorganic carbon content to be significantly greater in surface sediments of clam gardens, which could buffer pH at the sediment-water interface and substantially increase the likelihood of larval settlement. Trends also suggest that clam gardens have a greater fraction of sediment of grain size $> 1$mm in diameter, which could increase post-settlement survival. These preliminary findings yield insight into ancient management techniques and could have important implications for current aquaculture practices, especially in the context of ocean acidification if the addition of inorganic carbon could effectively buffer against its effects.

Sea star populations along the west coast of North America have dramatically declined due to an unknown wasting disease first reported in 2013 that rapidly spread from Alaska to northern Baja. This analysis quantifies the effects of this disease on populations of three sea star species monitored by Channel Islands National Park (CINP) kelp forest monitoring program. Asteroid wasting disease events have been documented on the west coast since the 1970’s and have historically been associated with warm water events. While the historical warm water disease symptoms are similar, this recent event has biologists searching for a different cause. The onset of this disease in CINP occurred between the 2013 and 2014 kelp forest monitoring sampling seasons. Population densities of Pisaster giganteus, Patiria miniata and Pycnopodia helianthoids have been evaluated from 1982-2014 to determine the incidence and degree of population decline likely to result from a disease event. Pisaster giganteus and P. helianthoids densities dramatically declined while P. miniata densities have changed little and seemed to be largely unaffected by this event. Despite the effects of this disease, the presence of juvenile stars in artificial recruitment modules (ARMs) suggests that the replenishment of star populations may already be underway.
† Guenther, R.1,2*, Carrington, E.2, Martone, P.T.1
THE EFFECT OF pH AND TEMPERATURE ON THE MATERIAL PROPERTIES OF ARTICULATED CORALLINE ALGAE
1 - University of British Columbia, 2 - Friday Harbor Laboratories, University of Washington
Algae living on wave-swept shores experience high hydrodynamic forces with every crashing wave. Unlike animals and invertebrates, algae are non-mobile and cannot re-locate to mitigate these forces. Therefore, they must form tissues that are strong enough to endure these hydrodynamic stresses. In articulated coralline algae, there are rigid calcified regions (intergenicula) intermixed with flexible uncalcified tissues (genicula). This structure provides a relatively rigid thallus that is also flexible. These genicula must be exceptionally strong to support the calcified tissue and not break. How the mechanical properties of algal tissues are affected by ocean acidification has yet to be thoroughly investigated. Changes in seawater pH and temperature may result in weaker tissues being produced in coralline thalli, leading to increased dislodgement and breakage. This study examined the effects of lowered pH and increased temperature on the growth and biomechanics of two species of coralline algae (*Calliarthron tuberculatum* and *Corallina vancouveriensis*). We found that a reduction in pH resulted in weaker but more flexible tissues. We also documented an increase in coralline growth with increased temperature and a reduction in growth with reduced pH. In both cases, however, these effects were more pronounced in *Corallina* tissue as compared to *Calliarthron* tissue.

† Gül, M.R.1*, Nielsen, K.J.2
INVASION SUCCESS OF BOTRYLLOIDES VIOLACEUS UNDER CONTRASING CONDITIONS OF TEMPERATURE, FOOD AVAILABILITY AND SPECIES RICHNESS
1 - Sonoma State University, 2 - Romberg Tiburon Center, San Francisco State University
Invasive species are considered a major threat to marine biodiversity, ecosystem function and coastal economies. However the factors that enhance or the ecological success of non-indigenous invasive species, including the potential role of climate change, remains uncertain. To improve our understanding of how species richness and environmental conditions may collectively influence the success of non-indigenous species, we compared the growth rate of *Botrylloides violaceus*, an invasive colonial tunicate, on PVC settlement plates under a range of naturally occurring conditions at two adjacent cites (Tomes Bay and Bodega Harbor). We compared growth, a measure of ecological success, at two different times within Bodega Harbor and at the same time between Bodega Harbor and Tomales Bay. Environmental conditions (water temperature and chl-a, a proxy for food availability) varies systematically between these two adjacent sites and as well as over time. The species pools are similar and overlapping, but not identical. We used photo surveys to measure the growth rate of *B. violaceus* on 120 plates at each site over six weeks. A general linear model was used to understand how species richness, temperature and food availability impact the growth rate and ecological success of *B. violaceus*.

Haggerty, J.M.*, Dinsdale, E.A.
REGIONAL SELECTION DISRUPTS CORRESPONDENCE BETWEEN TAXA AND FUNCTION OF MARINE MICROBES
San Diego State University
Microbial communities mediate ecological functions like primary production, nitrogen fixation and recycling of nutrients through the microbial loop. Due to the plasticity of microbial evolution with transposable genetic elements and genome streamlining, the metabolic and ecological functions of a microorganism cannot be assumed by taxonomic identification. While taxonomic identifiers may predict a core set of functional genes, regional adaptations and functional evolution produces a host of auxiliary genes that may be gained or lost within specific taxa. I used genetic data from 30 marine microbial communities from six distinct oceanographic regions to identify frequencies of taxonomic and functional gene matches. Cyanobacteria, oligotrophic and eutrophic bacterial dominate the marine oceans at different proportions. Taxa correspond to only a few core functional genes like photosynthesis and nitrogen metabolism when compared globally and regionally. Alternatively, many taxa show a global correlation with functions, but these patterns deteriorate at a regional scale. Functions include uptake and utilization of iron, sulfur and various carbon sources. My analysis identifies predictable patterns and presents testable hypothesis regarding resource use and adaptive strategies of marine microbes.

Haile E.A.*+, Eyster C.2
IN THE MUD: POST RESTORATION BENTHIC INVERTEBRATE COMMUNITY IN THE MOSS LANDING AREA SALT PONDS
1 - California State University, Monterey Bay, 2 - Point Blue Conservation Science
The Moss Landing Wildlife Area is a series of retired salt evaporation ponds that were restored in 2011 to create shallow water depressions for better foraging, roosting, and nesting habitat for shore birds. Water levels are managed throughout the year to benefit breeding and migratory birds. To assess post-restoration habitat quality,
we identified and quantified invertebrates living in the sediment of the restored salt ponds and sampled the salinity. Sediment samples from five ponds were collected, and invertebrates were sorted and identified to the lowest possible taxon. Within these ponds the most abundant invertebrate was *Monocorophium insidiosum*, found only within Pond 5. In Ponds 1 and 3, over seventy five percent of invertebrates in the samples were *Artemia franciscana*, brine shrimp. We found no definitive relationship between the salinity and the diversity found in each pond. However, salinity was a factor in what species were seen in each pond. Further sampling would help plan for the seasonal water management of the ponds.

Hansen, A.¹*, Shanks, A.¹, Emlet, R.¹, Sutherland, D.², Jarvis, M.¹, Rassmusen, L.¹, Valley, J.¹, Friedlander, D.¹, Robbins, K.¹, Spears, J.¹

**INVERTEBRATE SPAWNING IN WINTER STORMS**

1 - Oregon Institute of Marine Biology, 2 - University of Oregon

Researchers have observed a variety of invertebrates spawning during storms. In winter 2014 we investigated storm spawning with plankton samples collected for 73 consecutive days near Coos Bay, Oregon. Zooplankton were sorted into Operational Taxonomic Units (OTUs). 542 OTUs were observed, including 180 embryo types. A cluster analysis divided the 68 most common OTUs into five groupings. Group 1: Bivalves seen in the calm weather between storms. Group 2: A diverse group of embryos and planktotrophic larvae observed in calm weather throughout the time series. Group 3: A community of lecithotrophic chitons and embryos that appeared as spawning events during three periods of large waves, lower salinity and higher seawater temperature. Group 4: Embryos also present during the storms that characterized Group 3. Group 5: Calanoid copepods, barnacle nauplii, an embryo morphotype, and *littorina* egg cases did not fit into any of the four groups. In winter on the Oregon coast, large wave events, coupled with above average seawater temperature and below average salinity, are indicative of downwelling storm events. Invertebrates with lecithotrophic larvae and short planktonic durations may improve their chances of recruitment by releasing their larvae during these downwelling currents, thus avoiding larval wastage.

† Hartnett, R.H.¹*, Nielsen, K.J.¹, Wilkerson, F.P.¹, Jahncke, J.²

**CONNECTING THE DOTS IN THE GULF OF THE FARALLONES: FROM PHYSICAL OCEAN CONDITIONS TO OCEAN PRODUCTIVITY TO THE TOP OF THE FOOD WEB**

1 - Romberg Tiburon Center, San Francisco State University, 2 - Point Blue Conservation Science

The overall diversity and abundance of marine life in the Central California Current coastal ecosystem is supported by nutrients brought up into surface waters through the process of upwelling. Upwelling favorable winds drive cold, nutrient rich waters up the continental shelf slope to Bodega Canyon, in the Cordell Bank and the Gulf of the Farallones fueling phytoplankton blooms, the foundation of marine food webs. Changes in physical conditions that influence the process or timing of upwelling can result in reduced reproductive success in seabirds and other upper trophic level animals. Changes in nutrient availability are thought to drive these strong, apparently bottom-up effects. However, nutrient availability is often inferred from other physical proxies such as water temperature rather than directly measured. In this study we take advantage of a data-rich ten year time series of nutrient concentrations as well as physical oceanographic conditions, chlorophyll-a and zooplankton samples, and the abundance of marine mammals and seabirds to determine if nutrient availability data will improve our ability to model, understand and eventually predict changes in the response of the upper trophic levels of the pelagic ecosystem to climate change.

Hultgren, K.M., Callahan, H.*

**CRYPTIC SPECIES IDENTIFICATION OF SPONGE-DWELLING SNAPPING SHRIMP (SYNALPHEUS)**

Seattle University

Species-rich marine groups can be taxonomically challenging, as they often contain cryptic species that are difficult to identify using morphological criteria. Molecular data, in particular the COI barcoding gene, are increasingly being used to identify cryptic species. Here we use two phylogenetic criteria to identify potential cryptic species in the diverse snapping shrimp genus *Synalpheus*: reciprocal monophyly and genetic distance. Using COI sequence data, we calculated mean intraspecific divergence within several well-sampled species, and set an interspecific sequence threshold of ten times intraspecific divergence. We then sequenced several putative new species of *Synalpheus* from collections in Cuba, Jamaica, and Florida, and used the criteria to identify potential cryptic species. Out of eight groups of samples, four met the sequence divergence threshold, suggesting cryptic diversity is still high in this group despite decades of taxonomic work.

† Hunt, E.M.¹*, Chavez, J.B.¹, Miller, L.P.², Denny, M.W.², Allen, B.J.¹

**RECENT THERMAL HISTORY DETERMINES MICROALGAL RESPONSE TO ACUTE TEMPERATURE STRESS ON ROCKY SHORES**

1 - California State University, Long Beach, 2 - Hopkins Marine Station of Stanford University
In addition to higher average temperatures, global climate change is also resulting in higher temperature variability, increasing the risk that species’ tolerance limits will be exceeded. Our study was designed to determine how prior thermal history and the intensity of an acute high temperature challenge might affect post-stress photosynthetic performance of microalgae on rocky shores. We manipulated temperature variability on artificial substrata in the mid-intertidal zone, allowing microalgae to settle under low, natural, or high variation for at least one month. We then measured community-level net photosynthetic rate (NPR) for each experimental plate under benign conditions with a LICOR LX-1600, before and after exposure to one of five peak temperatures (18, 24, 28, 32, or 36 °C) during a 4.5-hour simulated low tide. The more extreme the acute temperature challenge, the more negative the effect on post-exposure NPR. More surprisingly, microalgae grown on low variation plates in the field were twice as vulnerable as microalgae on normal and high variability plates. Our current plan is to use scanning electron microscopy (SEM) and high-performance liquid chromatography (HPLC) to analyze changes in the identity and relative abundances of microalgal taxa for indications of variation in microalgal functional group composition and diversity.

Huntington, B.*1, McIntosh, N.1, Wagman, D.1, Watson, J.L.2, Matteson, K.1
COMPARING THE PERFORMANCE OF THREE SAMPLING TOOLS FOR ASSESSING FISH COMMUNITIES IN OREGON’S MARINE RESERVES
1 - Oregon Department of Fish & Wildlife, 2 - Partnership for Interdisciplinary Studies of Coastal Oceans
Comparing sampling tools allows selection of the best method to study a target fish community. We analyzed the structure of the nearshore fish community by comparing three tools: underwater visual census, video lander, and hook and line. Comparisons of these sampling techniques are rare in temperate nearshore systems. Yet, these tools are currently used to monitor the performance of the marine protected areas in California and Oregon. Hence, managers need to compare the strengths and limitations of these approaches to sample fish communities in nearshore environments. This pilot study aims to compare estimates of fish (1) abundance, (2) length, and (3) community composition between these three monitoring techniques by simultaneously sampling within 250000m² cells in shallow environments (10-20m). Species inventories and size ranges per tool will be compared. Likewise, frequency of occurrence for all observed taxa and the return of non-zero data will be compared. Further data analysis will emphasize how abundances of highly mobile, highly abundant, and cryptic species vary by sampling tool. As Oregon Department of Fish and Wildlife currently uses these tools to monitor Oregon’s marine reserves, these results will help select the most appropriate technique for generating precise and accurate data on specific fish populations.

† Jensvold, Z.D.*, Zimmerman, A.E.2, Worden, A.Z.2
PHYSIOLOGICAL RESPONSE OF OSTREOCOCCUS TO NUTRIENT DEPLETION
1 - University of Oregon, 2 - Monterey Bay Aquarium Research Institute
Phytoplankton are an important primary producer, which populate all of the oceans on Earth. One key limiting factor that controls population growth of phytoplankton is nutrient availability. Due to rising levels of atmospheric carbon dioxide and increasing density stratification due to warming oceans, the nutrients available to phytoplankton in the euphotic zone will likely change. To further understand the nutrient limitation of phytoplankton, I investigated how the growth rate and elemental quotas of the pico-phytoplankton Ostreococcus respond to the depletion of nitrogen and phosphorus. I addressed this question by monitoring the growth of Ostreococcus cultures in multiple nutrient conditions (nutrient replete and deplete) using flow cytometry. In addition, I collected samples for cellular elemental quotas from the different treatments and across different phases of growth. The results showed similar growth rates during the mid-exponential phase, but a decrease in carrying capacity when the cultures were subject to nutrient depletion. This suggests that Ostreococcus can grow well in low nutrient environments, but may not be abundant. Ultimately, the results of this study give us a deeper understanding of the role of phytoplankton in marine biogeochemical cycles and how their populations may be affected in the future.

† Johnson, G.M.*, Eckert, G.L.
MONITORING HARMFUL ALGAL BLOOMS IN SOUTHEAST ALASKA
University of Alaska Fairbanks
Consumption of shellfish from some Alaskan waters can pose risks of Paralytic Shellfish Poisoning (PSP). The toxins responsible for PSP are produced by dinoflagellates of the genus Alexandrium. During Alexandrium blooms, filter-feeding organisms, including shellfish, accumulate high concentrations of the toxins within their tissues. Environmental factors, such as temperature, wind speed, and precipitation, are known to influence phytoplankton growth and regulate algal blooms. This study aimed to determine the environmental factors involved in Alexandrium blooms in Southeast Alaska. Weekly sampling was conducted at Auke Bay Harbor, Juneau, AK. Water bottles and a phytoplankton net tow were used to obtain samples for cell counts, and a CTD was deployed for a water column profile. This data was combined with publicly available climate data. The time series was analyzed to detect trends in bloom onset and correlated environmental dynamics. Diatoms bloomed during early June and then
dinoflagellates, including Alexandrium, bloomed from mid to late June. None of the environmental parameters were significantly correlated with Alexandrium abundance. The CTD data collected from May-July 2014 indicated that increased stratification occurred immediately preceding the observed Alexandrium bloom. This finding suggests that future studies should investigate the role of stratification in the timing of Alexandrium blooms.

† Johnson, K.M.*, Lema, S.C.
ASSESSING THE ENDOCRINE-DISRUPTING IMPACTS OF THE XENOESTROGEN 4-NONYLPHENOL ON THE ESTUARINE ARROW GOBY (CLEVELANDIA IOS)
California Polytechnic State University
The chemical 4-nonylphenol (4-NP) has been identified an endocrine disrupting compound with estrogenic properties that can alter reproductive function in fish. Some of the highest tissue burdens of 4-NP recorded worldwide were found recently in the intertidal arrow goby (Clevelandia ios) in California’s estuaries, but it remains unknown whether these fish are impacted by the contamination. Here, we examined the effects of 4-NP exposure on established xenoestrogen biomarkers in the liver of adult male arrow gobies. Gobies were exposed in seawater (33 ppt) to either 4-NP at 5 µg/L or 4-NP at 50 µg/L, or to 17β-estradiol (E2) at 50 ng/L (positive control) or ethanol vehicle only (negative control), and then sampled at time points of 0 hrs, 24 hrs, 72 hrs, 12 days, and 20 days after commencing exposures. Exposure to E2 significantly elevated liver relative mRNAs encoding cgL and cgH within 24 hrs, vtgA within 72 hrs, and vtgC by 12 days. Data thus far suggest that exposing male gobies to the 50 µg/L dose of 4-NP also induced lesser elevations in abundance of these choriogenin and vitellogenin mRNAs in the liver, supporting the use of these transcripts as biomarkers for xenoestrogen exposure in this marine species.

LATITUDINAL VARIATION IN DIVERSITY AND ABUNDANCE OF INVERTEBRATES AND ALGAE IN NORTHERN CALIFORNIA MUSSEL BED
1 - Humboldt State University, 2 - Sea Grant Extension, 3 - University of California, Santa Cruz
Since 1999, California has been working to protect marine life through the Marine Life Protection Act. In May of 2014, Humboldt State University began collecting baseline data using MARINe’s MPA monitoring protocols to record the abundance of invertebrates and algae over time, both inside and outside of protected areas. One part of this work is to examine changes in mussel bed communities by establishing five permanent plots at each site. Sampling includes multiple measures of mussel bed depth and species diversity (using point-contact methods), as well as measurements of the size and number of mobile invertebrates within each mussel bed. Initial results show that northern sites harbor a greater abundance of barnacles, specifically Semibalanus cariosus and Pollicipes polymerus, while southern sites held a greater algal diversity, along with a higher abundance of mobile invertebrates (particularly limpets and littorine snails). These trends will be re-examined biannually in both summer and winter over the next two years to see whether seasonal changes occur, and whether these latitudinal patterns are stable through time. This will help us to assess the effects of MPA protection and changes caused by sea star wasting syndrome that has drastically reduced the abundance of these key mussel predators.

† Jones, E., Long, J.D.
GEOGRAPHIC VARIATION IN THE SENSITIVITY OF AN HERBIVORE-INDUCED SEAWEED DEFENSE
1 - Coastal and Marine Institute, San Diego State University, 2 - Bodega Marine Lab, University of California, Davis
Within-species variation in defense mechanisms has important implications for population and community regulation. However, despite a variety of studies testing for inducible defenses in seaweeds, we have limited knowledge of the factors that affect the strength of herbivore-induced responses within and among populations. In this study, we exposed two populations of the seaweed Silvetia compressa to several abundances of the snail Tegula funebralis to examine whether the strength of the seaweeds’ induced defenses varied with grazing pressure. We found that Southern California seaweeds require high levels of grazing to exhibit changes in palatability, while all levels of herbivory induce defenses in Northern California seaweeds. Constitutive defenses of the seaweeds did not explain these patterns, as Silvetia from southern sites was more palatable than Silvetia from northern sites. To better understand why seaweed responses differed at low levels of grazing, we conducted common garden experiments using seaweeds and herbivores from multiple sites. Herbivores did not alter southern seaweed palatability in any experiments, eliminating experimental conditions and herbivore source as driving differences in geographic sensitivity of induced defenses. Instead, it appears as though this variation in induction strength may be due to long-term abiotic and/or biotic differences in environmental history between populations.

† Kaplanis, N.J.*, Harris J.L., Smith J.E.
DISTRIBUTION PATTERNS OF THE INVASIVE SEAWEEDS SARGASSUM HORNERI AND UNDARIA PINNATIFIDA IN SAN DIEGO, BROADER CALIFORNIA AND BAJA
Scripps Institution of Oceanography, University of California, San Diego
Invasive marine algae are a growing issue due to rapid expansions in the number and frequency of introductions and associated impacts around the globe. These invasions have variable, but often negative impacts on native species and communities, yet few have been studied in detail. Here we report the occurrence of the two invasive algal species *Sargassum horneri* (Turner) C.Agardh and *Undaria pinnatifida* (Harvey) Suringar in San Diego County, and provide an updated distribution of these species on the California and Baja California Coasts, reporting both expansions in their ranges and novel locations where they have been documented. We also embed an analysis and discussion of establishment, spread and persistence patterns of these species on the San Diego Coast within the larger geographic context of California and Baja. Both species have exhibited all the characteristics of successful invaders, showing the ability to become established in new areas, spread locally, and persist through multiple generations in areas they invade. The rapid spread of these species so far, their inherent ability to invade novel locations, and the large number of potential recipient systems have broad implications for further spread in their ranges and increases in their impacts to native communities.

Kang, E.J., Kim, J.-H., Kim, K.Y.*  
PRIMARY AND SECONDARY PHOTOPROTECTION OF DRIFT GREEN ALGA *ULVA LINZA* IN THE YELLOW SEA  
Chonnam National University  
Floating green algal mats consistently expose to high light, and high light affects photoprotection mechanisms on drifting algae. Major specie of drift green alga in the Yellow Sea, *Ulva linza*, was cultured to four different light conditions (50, 175, 475 and 1170 µmol photons m⁻² s⁻¹) for 48 hours. Chlorophyll a fluorescence was measured to obtain photokinetic parameters, xanthophyll pigments and dimethylsulphide (DMS) that was analyzed after culture for 12 hours at each light condition. Xanthophyll pigment concentration was increased at the high light level, and energy quenching (qE) was increasing, while photoinhibitory quenching (qI) was decreasing with increasing light level. These results represent that drift green mat might have photoprotection mechanism to overcome photodamage under excess light condition. In addition, DMS production increased under higher light level, and this contributes reducing photooxidation stress. Our results proposed that floating algal mats have the photoacclimation strategies to tolerate high light stress, and this related to extent and maintenance of green algal mat.

Knight, A.¹, Sokolow, S.², De Leo, G.A.²  
SCHISTOSOMIASIS OUTBREAKS AND THEIR SPATIAL RELATIONSHIP WITH DAMS AND PRAWNS OF THE GENUS MACROBRACHIUM IN SUB-SAHRAN AFRICA  
1 - Medaille College, 2 - Hopkins Marine Station of Stanford University  
In some documented cases, schistosomiasis prevalence significantly increased after the construction of dams. In some regions dams cause ecological changes that promote population expansion of snails, the intermediate hosts of the parasite and also block the migration of native prawn species, voracious predators of snails. For example, the Diama Dam in Senegal reduced water flow and prevented saltwater intrusion and also blocked the migration of native prawn species, voracious predators of snails. We hypothesized that native prawn exclusion by dams may be a general mechanism by which schistosomiasis outbreaks have been promoted throughout Sub-Saharan Africa. To address this hypothesis, I evaluated the spatial relationship between historical outbreaks of schistosomiasis, the presence of dams and the native habitat ranges of river prawns across Sub-Saharan Africa. Using ArcGIS software I created a map of the dams, schistosomiasis endemic regions, and the natural habitat ranges of migratory freshwater prawns of the genus *Macrobrachium*. This map revealed that there are 20 countries in Sub-Saharan Africa where phenomena occurred. This information was suggestive that reestablishing native prawn populations where they have been excluded may complement drug treatment campaigns and help reduce schistosomiasis.

† Kramp, H.E.*, Hamilton, S.L.  
DENSITY AND BIOMASS AS A PROXY FOR FISH PRODUCTION: A COMPARISON FOR THREE KELP FOREST FISHES ALONG THE CALIFORNIA COAST  
Moss Landing Marine Laboratories  
Production is one of the most comprehensive measures for assessing ecosystem status because it incorporates a number of variables including density, size structure, growth, fecundity, and survivorship. However, the extensive data required to calculate production (i.e. life history characteristics) are often costly and challenging to attain. Previous studies have proposed using population density or biomass as a proxy for production, yet, production is a functional measure incorporating a number of variables (e.g. density, biomass, fecundity, survivorship, etc.) whereas density and biomass are structural response variables. Subtidal scuba monitoring surveys conducted by the Partnership for the Interdisciplinary Studies of Coastal Oceans (PISCO) along the coast of California over the last decade provide data on densities and size structures of three common kelp forest fishes. Published life history parameters allow for conversions of observed lengths to weights and ages, permitting estimation of the instantaneous rate of growth, or biomass production. Instantaneous production was calculated to provide a snapshot of production potential. Average density (no. m⁻²), biomass (g m⁻²), and production (g m⁻² yr⁻¹) were
compared for each species in the north, north central, south central, and south California coast.

† Krishnamraju, A.¹, Tewari, K.¹, Teixeira, J.B.², Pinheiro, H.T.¹,³*
PROSPECTS OF CONSERVATION IN A COASTAL MARINE PROTECTED AREA OF BRAZIL
1 - University of California, Santa Cruz, 2 - Programa de Pós-Graduação em de Ecologia e Conservação da Biodiversidade, Universidade Estadual de Santa Cruz, 3 - California Academy of Sciences
Marine Protected Areas (MPAs) serve a crucial role in marine conservation, ranging from sustainability to preservation. However, just a small amount of the marine realm has been protected and little information is available about the habitat representativeness of the existent MPAs. This study evaluates the efficiency of a MPA in protect local marine habitats along the coast of Brazil. Fishermen traditional ecological knowledge was used in order to look through the distribution of marine habitats and biologically significant areas (BSA), while fish landing databases contributed to identify specific species that need to be focused on for conservation. We found some habitats and BSA overrepresented in the MPA, and many fish species deserve attention regarding the sustainability of their catches. These findings demonstrate the need to study and improve the efficiency of MPAs around the world.

† Kroupa, T.F.¹*, Man, T.D.¹, Miller, L.P.², Denny, M.W.², Allen, B.J.¹
THERMAL DEFENSE STRATEGY DETERMINES LIMPET RESPONSE TO ACUTE TEMPERATURE STRESS ON ROCKY SHORES
1 - California State University, Long Beach, 2 - Hopkins Marine Station of Stanford University
Climate change models predict increases in the frequency and intensity of extreme weather events. The fitness consequences to many organisms will be determined by their capacity to adjust their thermal sensitivities and the associated energetic costs. Our study was designed to determine how thermal defense strategy (constitutive versus induced) and the intensity of an acute high temperature challenge might affect post-stress physiological performance of limpets on rocky shores. Found together in the high intertidal zone, Lottia scabra exhibits high constitutive levels of the stress protein Hsp70 but no additional induced synthesis at high temperatures, whereas L. australodigitalis exhibits low levels of constitutive Hsp70 and high inducibility. We measured respiration rate for field-collected and lab-acclimated individuals of each species under benign conditions in the lab with a fiber-optic fluorescence-based optode system, before and after exposure to one of five peak temperatures (14, 24, 28, 32, or 36 °C) during a 4.5-hour simulated low tide. Unlike L. scabra, L. australodigitalis exhibited a significant increase in oxygen consumption following aerial exposure to high temperature, consistent with activation of the heat shock response. We expect ongoing analyses to show a positive correlation between individual respiration rate and Hsp70 expression level in our experimental limpets.

Lafian, J.D.¹*, Chavez, F.P.²
BIOLOGICAL PROCESSES DRIVE DIEL PH SIGNALS NEAR SHORE
1 - Tompkins Cortland Community College, 2 - Monterey Bay Aquarium Research Institute
Nearshore marine ecosystems support an abundance of calcifying species; yet daily pH fluctuation in these areas has not been well-documented. We monitored nearshore pH by deploying small moorings with surface and bottom pH/temperature sensors in Monterey Bay, California. These sampled at 30 min intervals for two weeks in July 2014, from the intertidal to 20 m depth. Our data reveals a diel signal described by a maximum pH in the afternoon and a minimum pH in the early morning. We conclude that the signal is driven by photosynthesis and respiration, which prevail during afternoons and early mornings respectively. CO₂ consumption during photosynthesis raises pH; CO₂ emission when respiration dominates lowers pH. The signal's amplitude is largest in the intertidal and decreases relative to distance from shore. This research furthers our understanding of nearshore biogeochemical processes with relevance for scientists in the fields of biogeochemistry, marine ecology, physiology, and oceanography. These fields inform coastal conservation policy and help ensure that nearshore ecosystems continue to provide food, livelihood, and ecosystem services around the world.

† Lecky, J.H.¹*, Selkoe, K.A.², Oleson, K.L.L.¹
CUMULATIVE HUMAN IMPACT MAPPING FOR MARINE ECOSYSTEMS OF HAWAII'
1 - Department of Natural Resources and Environmental Management, University of Hawai'i at Mānoa, 2 - National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara
Understanding the spatial distribution, intensity, overlap, and cumulative influence of human activities, both on land and at sea, is essential for effective management of ocean resources. My research aims to provide such information to resource managers in Hawai'i by following and expanding upon an established methodology for mapping cumulative impacts on ocean ecosystems. The first step, currently underway, is to compile a database of all available spatial data related to human impacts on the marine environment in Hawai'i. Next, I will use expert opinion to determine the relative significance of each human activity to ecosystem function. A survey will be conducted that utilizes standardized methods for quantifying ecosystem vulnerability to various threats. Third,
Information from this survey will be used along with geospatial analysis techniques to produce continuous maps of the level of cumulative impact sustained across the marine environment of the populated Hawaiian Islands. Previous applications of similar analysis in other regions has helped marine managers identify priority areas for protection, surveillance, threat mitigation, ocean zoning, and monitoring for climate change effects. This project will begin to fill and essential gap needed for marine spatial planning and ecosystem based management to begin in Hawaii.

† Lenz, E.A. 1*, Edmunds, P.J. 2
PHYSIOLOGICAL TOLERANCE IN CONTRASTING MORPHOLOGIES OF THE STONY CORAL, PORITES RUS TO ELEVATED P\textsubscript{CO2} AND FLOW
1 - Hawai’i Institute of Marine Biology, 2 - California State University, Northridge
Tropical corals exhibit morphological diversity driven by physical gradients and biological processes. As ocean acidification (OA) intensifies, corals are anticipated to differ in their ability to acclimatize to emerging conditions, although the traits and environmental conditions assisting in this process remain unknown. In Moorea, French Polynesia, we investigated the responses of differing morphologies of Porites rus to OA under varying flow speeds. We tested the effects of P\textsubscript{CO2} (400 and 1000 \textmu atm) and flow (5 and 25 cm s\textsuperscript{-1}) on calcification, biomass, and dark respiration of branching and plating morphologies during a 21d experiment. We hypothesized high flow would increase mass transfer rates, alleviating the detrimental effects of increased P\textsubscript{CO2}. Our results show that plates were unaffected by high P\textsubscript{CO2}, with higher biomass, calcification, and respiration than branches. Branches had variable responses, with reduced respiration in elevated P\textsubscript{CO2} regardless of flow. In a complimentary 14d study testing the effects of P\textsubscript{CO2} (1000 \textmu atm) and flow on P. rus under natural light intensities, plates were unaffected, while branches had reduced calcification under low flow, high P\textsubscript{CO2}. Although, Porites rus appears to tolerate OA (1000 \textmu atm P\textsubscript{CO2}), branches may be more susceptible to high P\textsubscript{CO2}, particularly in high light environments.

† Lindsay, T.W. 1*, Hoover, C.A. 1, Goddard, J. 2, McPhillips, M. 1, Breslau, E. 1, Valdés, A. 1
SEEING DOUBLE: THE 'TWIN' DORIOPSILLA (MOLLUSCA, GASTROPODA, NUDIBRANCHIA) HAS MORE TWINS
1 - California State Polytechnic University, Pomona, 2 - University of California, Santa Barbara
Doriopsilla albopunctata and its ‘twin’ species Doriopsilla gemela are two common radula-less nudibranchs found along the coast of California down to the northern Sea of Cortez. Molecular analyses of samples of these two putative species collected from their entire geographic ranges, revealed an unexpected level of pseudocryptic speciation. Phylogenetic and species delimitation analyses recovered five distinct species (three under D. albopunctata and two under D. gemela). Re-examination of the three D. albopunctata species in light of the molecular results revealed consistent reproductive anatomy differences between them. This, along with the fact that the ranges of these species overlap partially or entirely suggest sympatric speciation may be involved. The two species in D. gemela do not overlap their ranges and differ in developmental mode, suggesting allopatric speciation.

† Linnenbrink, J.L. 1*, Walter, R.P., Zacherl, Eernisse, D.J.
GENETIC POPULATION STRUCTRE OF THE OLYMPIA OYSTER, OSTREA LURIDA, IN SOUTHERN CALIFORNIA
California State University, Fullerton
Restoration of the historically impacted Olympia oyster (Ostrea lurida) is ongoing all along the West Coast but in southern California, where restoration is underway, there is almost no information regarding its genetic structure. Project managers cannot yet effectively allocate time, money, and resources to best harness existing genetic variation. We aim to provide baseline genetic structure estimates for remnant Olympia oyster populations in eight southern California estuaries. Previous mitochondrial DNA sequence comparisons have not yet revealed enough variation to evaluate whether or not oyster populations are structured, so we have used more variable microsatellite markers. Our null hypothesis was that southern California populations have some genetic structure and that genetic similarity will reflect geographic proximity, as expected for isolation-by-distance (IBD) models. Results to date for Alamitos and Newport Bay have not found significant pairwise F\textsubscript{ST} values. STRUCTURE analysis supports K=1, suggesting that Alamitos and Newport Bay are members of a larger population. Despite this lack of overall population genetic structure so far, DAPC results indicate site-specific variation that could be due to private alleles in Alamitos and Newport samples. Population genetic characterization will enhance the opportunities for restoration managers to successfully restore this and possibly other native estuarine species.

Lopiccolo, J.A. 1*, Roche, J.S. 1, Polizzi, T.R. 1, Tyburczy, J.A. 1,2, Craig, S.F. 1
SHOOTING ABALONE IN A BARREL: AVOIDING AN INTERTIDAL TRAGEDY OF THE COMMONS WHEN PRIVATELY-HELD DE FACTO RESERVES ARE OPENED
1 - Humboldt State University, 2 - California Sea Grant Extension
Of the five California abalone species that supported popular sport and commercial fisheries, declines due to overharvest and disease have left only red abalone, Haliotis rufescens, sufficiently abundant to support a recreational fishery. However, intense fishing pressure has removed nearly all large abalone 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. Using three 2 x 10 m belt transects (60 m²) 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 functioned as a de facto marine reserve due to its long history of private ownership, but is scheduled to be opened to public access within a few years. We explore the relationship between de facto marine reserves and the public through the cautionary lens of drastic abalone population declines documented at Stornetta Public Lands after being opened to the public in 2005. We also discuss the unique benefits of protecting such unexploited intertidal sites including: monitoring the health of abalone populations; evaluating their recovery within MPAs; and investigating the role of abalone in intertidal ecosystems.

† Lowe, A.T.¹, Donoghue, C.², Horwith M.J.², Ruesink, J.L.¹, Trimble, A.¹
SPATIAL PATTERNS AND RELATIONSHIP OF PH TO WATER PROPERTIES IN SHALLOW BAYS IN WASHINGTON STATE
1 - University of Washington, 2 - Washington Department of Natural Resources
Shallow, tidally-influenced bays support ecologically and economically valuable species. Aquaculture in shallow bays is worth more than $100 million annually in Washington State, while eelgrass provides important habitat and ecosystem services. Local aquaculture and natural resource managers are concerned about the future of these habitats given natural and anthropogenic changes to ecosystem structure and environmental conditions. An understanding of the relative influences of environmental and biological processes on local water properties will be critical to future management decisions. We investigated these processes by mapping the distribution of pH, salinity, temperature, dissolved oxygen (DO) and chlorophyll in shallow bays in Washington State during summer 2014. We measured water properties along a salinity gradient from river to bay mouth using a Durafet pH meter and YSI 6600 installed in a flow-through system on a shallow-draft research vessel capable of accessing shallow eelgrass and oyster habitats. pH ranged from 7.3 in Totten Inlet to 8.5 in Samish Bay, with an average within-bay pH range of ~0.56. Across shallow tidal bays in Washington, pH was strongly, positively correlated to DO and salinity and negatively correlated to temperature. These data provide a first step to differentiating local- and regional-scale forcings on nearshore water properties.

† Machuca, B.J.¹*, van Hees, K.E.², Ebert, D.A.²
THEN AND NOW: A 40-YEAR TROPHIC ECOLOGY COMPARISON OF COASTAL SHARKS AND RAYS IN A CALIFORNIA ESTUARY
1 - California State University, Monterey Bay, 2 - Moss Landing Marine Laboratories
Sharks and rays are apex predators that inhabit Elkhorn Slough, a tidally influenced estuary in Moss Landing, California. These elasmobranchs use the Slough as a seasonal habitat and food source. Sharks and rays are upper trophic level predators that may be threatened by changes in their habitat, especially to their food source. Leopard sharks (Triakis semifasciata), bat rays (Myliobatis californicus), and thornback rays (Platyrhinoidis triseriata) were used to evaluate how trophic positions and food web relationships have changed over time, using a study by Barry et al. (1996) as a comparison. Stomach-gut Content Analysis (SCA) was used to visually analyze the stomach contents and ten replicates per species of liver and white muscle tissue were analyzed for trophic position using Stable Isotope Analysis (SIA). Additionally, whole frozen prey items underwent SIA for trophic position to provide a basis for the food web. Comparing the results from SIA and SCA identified whether the elasmobranchs were benthic or pelagic feeders and what percentage of their diet is dependent on prey items available within Elkhorn Slough. The results will determine if and how trophic relationships are changing in a key estuarine habitat, and assist with management decisions and conservation of elasmobranch species.

Manning, J.C.¹*, Steneck, R.S.²
PRELIMINARY STUDY ON THE EFFECTS OF OCEAN ACIDIFICATION ON THE COLDWATER CORALLINE ALGA CLATHROMORPHUM COMPACTUM
1 - California State University, Northridge, 2 - The University of Maine Darling Marine Center
Crustose coralline algae (CCA) are some of the most abundant organisms in the photic zone of coastal ecosystems. They are important ecosystem engineers and often induce the settlement of invertebrate larvae such as corals. However, as anthropogenic CO₂ is taken up by the ocean, resulting ocean acidification and the associated changes in seawater chemistry may negatively affect the soluble high-Mg calcite skeletons of CCA and put them at great risk. In this study I investigated the effects of three pH treatments (7.92, 7.50, 6.69) on the coralline alga Clathromorphum compactum. Reduced pH decreased the growth, calcification, and productivity of this alga. However, respiration did not differ between treatments. This species appears to compensate for decreased seawater pH by reducing the density of its calcium carbonate skeleton, as indicated by the reduced
density of the calcified cell walls of cells produced in the lowest pH treatment. This could have profound effects on the ability of corallines to resist grazing, compete for space on the benthos, and induce the settlement of invertebrates.

**Martin, B. †, Edmunds, P.J.**

**FREQUENT OVERGROWTH OF OCTOCORALS BY MILLEPORA IN ST. JOHN, US VIRGIN ISLANDS**

1 - University of Miami, 2 - California State University, Northridge

Octocorals and milleporine hydrocorals are common on the shallow (<14m depth) reefs of St. John, where they frequently encounter one another. Previous work (Wahle 1980) suggests such encounters allow Millepora spp. to seek, overgrow, and kill octocorals. In 2014, the presence of abundant Millepora-covered octocorals (i.e., “infected”) prompted us to ask whether such interactions were ecologically significant, and whether they arose through pursuit and contact by Millepora branches. Surveys revealed that a mean of 13±9% of octocorals were infected, although infection rates differed among genera: 5.7% of Gorgonia spp. (n=438), 7.8% of Antillogorgia spp. (n=600), and 12.9% of Eunicea spp. (n=410) were infected. Of infected colonies (n=131), 78% were fully encrusted with Millepora. The frequency of G. ventailina colonies infection with Millepora in St. John is higher that the mean infection rate of 2.5% recorded in 1981 for Gorgonia spp. on the shallow reefs of Puerto Rico. In St. John, most infected octocorals were 46±24 cm from the nearest Millepora branch, suggesting Millepora can initiate pursuit of octocorals from this distance. On the shallow reefs of St. John, octocoral-Millepora encounters may be sufficiently common to directly affect octocoral population dynamics.

† Martinez, E.*, Aguilar, A.

**POPULATION GENOMICS AND SIGNATURES OF SELECTION IN GRASS ROCKFISH**

California State University, Los Angeles

Traditionally, genetic studies in non-model organisms have used few loci to estimate demographic parameters and infer phylogenetic histories. New technologies allow for the use of thousands of loci that can also be used to identify candidate regions in the genome that may be under selection. In this study, we examine genetic variation and signatures of selection in grass rockfish (Sebastes rastrelliger). A total of 160 individuals collected from 8 localities throughout the geographic range were analyzed to estimate genetic diversity within and among sampling locations. Restriction-site associated DNA (RAD) sequencing was used to sample the genome via single nucleotide polymorphisms (SNPs). Thus far, over 12,000 SNPs at >30x coverage have been genotyped in 114 individuals from 6 locations. Preliminary analyses suggest high gene flow among sampling locations (mean FST ≈ 0). We expect a small proportion of these SNPs (outlier loci) to exhibit significantly increased levels of differentiation among sampling localities. Outlier loci may indicate the presence of adaptive variation, as grass rockfish occur in habitats that vary in environmental conditions (e.g. sea surface temperature). Furthermore, we plan to map outlier loci to the Sebastes genome to investigate whether outlier loci fall within or near genes.

McCandless, A.W.*, Lafrenz, M.D., de Rivera, C.E.

**DELINEATING SALTMARSH ECOSYSTEM SERVICES GIVEN SEA LEVEL RISE**

Portland State University

Sea level rise due to global climate change will widely impact saltmarshes by flooding existing marsh, thereby altering community composition to favor organisms more tolerant of increased inundation by salt water. Due to the non-linearity of elevation gain from current intertidal areas to high marsh, the proportions of intertidal habitats that are mudflat, eelgrass bed, low marsh, and high marsh will change following sea level rise. Because the proportion of the intertidal occupied by each zone will vary with sea level rise, so will relative species abundance between zones, even if future settlement patterns mirror current ones. Ecosystems are often evaluated based on measurements of ecosystem services. Given these impending changes, the extent of some ecosystem services provided by saltmarshes and seagrass beds will change as well. By distinguishing the ecosystem services particular to the various parts of the saltmarsh and surroundings, we are modeling how those services will change given the predicted spatial proportion of saltmarsh habitats in the Pacific Northwest. Impacted wetlands may not develop identical compositions to those we currently observe. Observing this dynamic development of coastal wetland ecosystem services provides the impetus for a more careful treatment of how sea level rise will impact those services.

† McCollough, R.M.*, Knight, A., Moye, J.F., Lindholm J.B.

**DO THEY LIKE IT STEEP AND/OR DEEP? HABITAT ASSOCIATIONS OF PRAWNS IN SOUTHERN CALIFORNIA**

Institute for Applied Marine Ecology, California State University, Monterey Bay

Spot Prawns (Pandalus platyceros) and Ridgeback Prawns (Sicyonia ingentis) support a valuable commercial fishing industry in Southern California. Despite their economic importance, our understanding of their distribution has largely come from trawl and trap studies where fine-scale habitat associations cannot be directly observed. In
2011 and 2012, we used a remotely operated vehicle (ROV) to sample demersal communities inside and adjacent to MPAs at three Southern California sites (Point Vicente, La Jolla, and Laguna Beach). We extracted 1168 Ridgeback and 406 Spot Prawn observations using geo-referenced ROV imagery. ArcGIS was used to map prawn distributions and characterize habitat attributes (depth and slope) based on multibeam bathymetry rasters. Across all sites, Ridgebacks were observed at shallow depths (140-200m) and flat slopes (10-20°), while Spot Prawns occurred at deeper depths (160-220m), and at steeper slopes (25-45°). Interestingly, at the La Jolla Study Site, both Ridgeback and Spot Prawns were found across the same slope range (0-80°), but Ridgebacks (n=238) were observed more shallow (max depth = 200) than Spot Prawns (n=390; 70-240m). Predictive maps were generated using Marine Geospatial Ecology Tools (MGET) to predict prawn species distributions for all three sites based on the habitat attributes of slope and depth.

McCune, K.S.*, Eernisse, D.J.
DO INTERIOR SHELL COLOR AND PROFILE DIFFERENCES COINCIDE WITH DNA EVIDENCE FOR A PAIR OF OVERLAPPING CRYPTIC LIMPET SPECIES?
California State University, Fullerton
In 1866, Carpenter proposed the name "cribraria" for a variety of what today is considered Lottia fenestrata (Reeve, 1855). More recent authors have used the variety name to correspond to the observation that more northern L. fenestrata have a darker coloration near the marginal edge on the shell interior, with the dark morphotype reported from as far south as Cayucos, California. This happens to approximately coincide with our discovery, based on combined maximum likelihood analysis of both mitochondrial and nuclear gene regions, that L. fenestrata is actually a north/south pair of distinct sister species with a transition zone we have narrowed down to the vicinity of Cayucos. To test whether the color or other differences could be reliably used to identify each species, we performed image color analysis, basic morphometric comparisons, and further sampling of limpets in the portion of California's central coast corresponding to the apparent transition zone between the species. Quantified color measurements were much more variable in the southern restricted L. fenestrata than in the more northern species, and we found that shell shape and profile consistently differed. Both of these traits have enough variation so that they are unlikely to allow confident discrimination by themselves.

Mccenery, W.*, Olejniczak, K., Quackenbush, A., Sadpour, N., Urness, J., Kvitek, R.
A 2014 ASSESSMENT OF GEOMORPHIC CHANGE IN THE MONTEREY CANYON USING HIGH-RESOLUTION MULTIBEAM ECHOSOUNDER
California State University, Monterey Bay
Located off the coast of Moss Landing, CA, the Monterey Canyon is one of the largest submarine canyons in North America. Previous research indicates the Monterey Canyon is undergoing active geomorphological change characterized by a state of dynamic equilibrium. We hypothesized that changes in sediment volume, canyon rim, and axial channel morphology will provide further evidence of this dynamic equilibrium. In order to quantify changes in sediment volume and canyon morphology, we took multibeam echosounder data acquired in the spring of 2014 using the R/V VenTresca to generate a digital elevation model. We then compared the spring 2014 data to previous surveys through raster subtraction and digitization. The change in sediment volume from 2013 to 2014 was 898,000 m³ ± 483,000 m³ which was two times the rate of change from the prior two year period and three times the rate of the overall 2008 to 2014 period. The results of this study supported our hypothesis that the geomorphology of the Monterey Canyon head is in dynamic equilibrium and that changes in sediment volume, canyon rim, and axial channel exhibit oscillations of increasing and decreasing areal extents over time.

Merolla, S.M.¹*, Chambers, R.C.²
EFFECTS OF ELEVATED CO₂ ON DEVELOPMENTAL PROGRESSION OF LARVAL SUMMER FLOUNDER
1 - California State University, Northridge, 2 - Howard Marine Sciences Laboratory
In response to the growing threat of ocean acidification, ample research has been conducted to investigate the effects of increased levels of dissolved CO₂ and reduced seawater pH on marine organisms. However, much of this effort has focused on invertebrates, thus resulting in a shortage of research involving commercially important vertebrates such as flatfish. In this study, larval summer flounder (Paralichthys dentatus) were reared in three pCO₂ level treatments: low (775 µatm), intermediate (1860 µatm), and high (4717 µatm), in order to observe the effects of increased CO₂ on larval development. Microscope photographs of larvae were taken weekly over 28 days, and then were analyzed to determine developmental stages of larvae based on morphology. Using the current methodology, there appeared to be no significant effect of CO₂ treatment on summer flounder larval development. However, results from a previous study examining larval summer flounder suggested that elevated CO₂ levels could affect development late in the larval period, thus indicating the need for a more accurate analysis of summer flounder developmental progression. Future studies may also benefit from a multi-stressor design that examines the combined effect of elevated CO₂ and temperature on larval development, as climate change is also a growing concern.
† Miller, J.T.*
IMPAIRMENT OF KILLFISH OSMOREGULATORY FUNCTION BY AQUATIC NANOCOPPER EXPOSURE
University of California, Davis
Coastal brackish and marine organisms may experience extreme variation in salinity that is influenced by tidal cycles and precipitation. To accommodate abrupt changes, killfish respond with compensatory physiological and morphological mechanisms of ion balance. A hypo-osmotic salinity challenge (32ppt transfer 0.1ppt) of killfish results in alterations to gill morphology and expression of pathways responsible for maintaining ionic homeostasis. Studies indicate that sub-lethal exposure to nano-particles in aqueous environments results in the disruption of the same genomic regulatory mechanisms that respond to a salinity challenge such as Na+/K+-ATPase and HIFs. Additionally, exposure results in gill pathophysiology and indicates concerning interactions of salinity on nano-particulate toxicity and stress. However, it remains unclear if exposure impairs the ability of fish to acclimate to an extreme salinity challenge. We will compare osmoregulatory capacity by measuring plasma osmolality and ion concentrations (Cl− and Na+) following a hypo-osmotic salinity challenge. To further understand the mechanism of impairment, we will compare transcription-profiles and histological responses of gills across time and concentrations of nano-copper. Osmoregulatory function is an extremely important trait for killfish to occupy salinity variable costal environments. If sub-lethal exposure reduces salinity tolerance ranges for killfish, nano-particulate contamination may have unforeseen consequences for coastal ecosystems.

† Momota, K.1*, Kitamura, T.2, Hamaoka, H.3, Isada, T.4, Nakaoka, M.1
SEASONAL CHANGE OF PLANT-ANIMAL INTERACTION IN EELGRASS BEDS OF AKKESHI, NORTHERN JAPAN
1 - Hokkaido University, 2 - City of Kushiro, 3 - Fisheries Research Agency
Biological community of eelgrass beds consists of plants and animals with many different functional traits which interact with each other in a complex manner. The abundance of each functional groups and their interacting pattern are not stable, but fluctuate seasonally with physical and chemical environmental factors of the ecosystems. In the present study, we investigated how the community structure, intensity of interaction between plants and grazers, and its relationship with environmental factors vary seasonally in eelgrass beds at highly-seasonal environment of Akkeshi (eastern Hokkaido, Japan). We conducted a three-time quantitative collections of animals and plants (June, August and and October), and examined most-likely causal relationships among different functional groups using structural equation modeling. Results showed that the impact of physical factors on communities was observed in all seasons, and its patterns varied among different seasons. The intensity of interaction among functional groups also differed seasonally, with more complex causal relationships observed in summer and autumn than in spring. The seasonal changes observed in the present study are attributed to seasonality of physicochemical environment and seasonal prevalence of community component species determined through their life history traits.

Mottet, G.J.*, McAvery, D.M.
EVOLUTIONARY DYNAMICS OF BROADCAST SPAWNERS
The Evergreen State College
In broadcast spawners, such as sea urchins and abalone, gametes freely interact in the water column. Successful fertilization depends on variables such as binding efficiency, sperm and egg concentration, blocking time and other physical characteristics of gametes. The binding proteins on the surface of gametes are known to evolve rapidly and show diversity of type within species. One theory to explain this diversity is selection pressure for reducing binding efficiency under high sperm concentration. We developed an agent based model to study the evolutionary dynamics of binding proteins under various environmental conditions. We show that above a critical value of the sperm concentration, rare mutant egg receptor proteins are selected for. Rare sperm ligand proteins are not selected for, unless accompanied by egg receptor mutations. The critical value of sperm concentration is a decreasing function of the blocking time.

Mulcahy, P.J.1*, Gravem, S.A.2, Morgan, S.G.2, Garza, C.1
USING GIS TO MODEL THE IMPACT OF CLIMATE CHANGE ON MYTILUS CALIFORNIANUS COVER
1 - California State University, Monterey Bay, 2 - Bodega Marine Laboratory, University of California, Davis
Abiotic processes play a key role in determining the distribution of intertidal species, including the California mussel (*Mytilus californianus*). Climate change could alter these processes, leading to potentially dramatic shifts in species distributions. Increased temperatures result in desiccation stress, limiting mussel fitness and survival. Increased wave force can increase mussel distribution by reducing desiccation stress and increasing larval recruitment, but can also result in disturbance events. Tidal height can help explain the relative influence of these environmental factors on mussel distribution. This study seeks to quantify the relationships between temperature, wave action, tidal height, and mussel bed cover. Utilizing abiotic and biotic data collected within an intertidal boulder field near
Bodega Marine Labs, CA, we interpolated values for the four considered factors across the entire boulder field using GIS. We then created a generalized linear model (GLM) designed to model the level of mussel cover based on the three abiotic variables. Wave action was a significant predictor, but the model was not an accurate predictor of mussel cover. Including additional variables will strengthen the model and allow us to predict how mussel beds will shift according to climate change projections.

† Mundy, K.F. 1*, Litvin, S.Y. 2, Carlisle, A.B. 2
EFFECTS OF LIPID AND CHITIN REMOVAL ON STABLE ISOTOPE RATIOS IN KRILL
1 - California State University, Monterey Bay, 2 - Hopkins Marine Station of Stanford University
Stable isotope analysis (SIA) is an ecological tool that has been used to address a variety of ecological questions, including those regarding trophic ecology and organism physiology. For SIA to be effectively used, it is important that tissue samples be processed in a manner that accounts for the biases associated with their chemical composition, as different components (e.g. lipids, chitin, etc.) fractionate isotopes very differently. This project aims to understand the effects of chemical extraction techniques on two species of krill that are important forage species in the California Current, *Thysanoessa spinifera* and *Euphausia pacifica*. To assess the influence of lipids and chitin on δ13C and δ15N values, lipids were extracted using 2:1 chloroform-methanol and chitin was removed through acidification by 1N HCl. As expected, there were no significant differences in δ15N values between the different treatments for each species (Kruskal-Wallis, p>0.05), but δ13C values changed significantly between treatments for both species (ANOVA, p<0.05). Removal of both lipids and chitin had significant effects on δ13C values, indicating that they need to be addressed in SIA. This research reveals that lipid and chitin extractions may interact, with the resulting δ13C values mediated by relative lipid and chitin compositions of the sample.

† Nelson, H.R. 1*, Altieri, A.H. 2, Kuempel, C.D. 2
EFFECTS OF CORAL MORTALITY ON REEF INVERTEBRATE COMMUNITIES
1 - California State University, Northridge, 2 - Smithsonian Tropical Research Institute
Numerous studies have projected substantial losses in reef biodiversity with declining live coral cover. However, most of these predictions are based on the responses of reef fishes, and not on the overall benthic community whose diversity is dominated by invertebrates. In this study, we examined the relationship between habitat and mobile invertebrate abundance and diversity in *Agaricia*-dominated fringing reefs on the Caribbean coast of Panama through a series of manipulative experiments and surveys. Our experiments tested the relationship between invertebrate colonization, reef habitat type (live coral, dead coral, sand), and habitat complexity (sand, rubble, whole coral colonies). We surveyed invertebrate communities across habitat types at three live coral- and three dead coral-dominated sites. Both the surveys and experiments indicated that dead coral habitats support invertebrate assemblages that are as diverse and abundant (or more so) than those associated with live coral habitats. Invertebrate colonization rates did not differ between rubble and whole pieces of dead coral, but were significantly lower in sand plots. We suggest dead reefs may temporarily sustain invertebrate assemblages by retaining structural complexity. However, this effect is likely to be short-term as reef architectural complexity declines due to mechanisms such as ocean acidification, storm damage, and bioerosion.

EFFECTS OF OCEAN ACIDIFICATION ON PODODESMUS MACROCHISMA AND BALANUS CRENATUS ON SETTLEMENT TILES IN MONTEREY BAY, CA
1 - San Diego State University, 2 - Moss Landing Marine Laboratories, 3 - Scripps Institution of Oceanography, 4 - Bigelow Laboratory for Ocean Sciences
Increasing anthropogenic carbon dioxide emissions are affecting the chemistry of the world’s oceans. The hydrolysis of CO2 as it dissolves in seawater results in a decrease in pH and carbonate ion concentration. This process has become commonly known as ocean acidification (OA). OA has been shown to decrease calcification rates in organisms which precipitate calcium carbonate skeletons. These skeletons are important for growth and protection in a number of ecologically and economically important marine invertebrates. Here we show the impact of increased carbon dioxide on two sessile marine invertebrate species; the bivalve *Pododesmus macrochisma* and the barnacle *Balanus crenatus*. The specimens used were collected on settlement tiles installed subtidally in Monterey Bay, CA for one year. After collection they were photographed and placed in ambient or elevated pCO2 seawater (400 uatm and 1000 uatm respectively). After 5 weeks of rearing in treatment conditions, the tiles were photographed once again and the images were used to calculate growth and mortality rates of individuals within each treatment. These data will help to further understanding on the impacts of OA on sessile marine invertebrates.

† Neylan, K.A. 1*, Miller, S.D. 2 Ponte, M.E. 2
NATURAL VARIATION IN CONDITION OF SURGEONFISHES FROM CENTRAL PACIFIC CORAL REEF ECOSYSTEMS
1 - California State University, Monterey Bay, 2 - Moss Landing Marine Laboratories

Coral reefs are threatened ecosystems, yet little is known about the role of natural variation in oceanographic conditions that structure these ecosystems. To isolate the effects of natural variation, this study was conducted in the Southern Line Islands, a chain of five remote, uninhabited atolls in the central Pacific. These islands span a strong productivity gradient, using chlorophyll a as a proxy. This gradient results in variation of bottom-up processes between the different islands, potentially indirectly affecting the fish communities through oceanographically driven changes in their prey base. In order to investigate fish condition, individuals of two species of surgeonfishes were collected from each island and dissected in order to measure the Hepatosomatic index (HSI), Fulton’s condition factor (K), and relative weight of fat. I expect to find that fish from islands located in more productive waters will have higher HSI, higher Fulton’s K values, and larger fat globules relative to fish size. This is expected due to a higher abundance of preferred prey in more productive areas. This study will help us understand natural variation of coral reef fish condition, and is important for acquiring baseline data that can be used in resource management assessments and strategies.

† Ng, Gî*, Parker, T.2

ASSESSING SPATIAL VARIATION IN PREDATOR COMMUNITY AND PREDATION RATE USING TETHERED MEGALOPAE AND UNDERWATER IMAGES

1 - University of California, Davis, 2 - California State University, Fullerton

Planktonic larval development, common in many benthic marine invertebrates, is associated with both costs and benefits relative to benthic larval development. One potential benefit includes a reduction in predation for planktonic larvae. Few studies have directly observed larval predation events or documented the specific predator and intervals between predator attacks in the field. In this study we investigated benthic and pelagic differences in predator assemblage and predation interval on megalopae of the Dungeness crab, *Metacarcinus magister*. To observe the predation events, we combined methods of tethering larvae with automated motion analysis of underwater camera images from daytime deployments off the dock at Friday Harbor Laboratories, Friday Harbor, WA. We measured and identified number of predation events, the interval in which those events occurred, and the predatory and non-predatory species that comprised the visible community. Predation was higher on the benthos than the surface, with more total strikes and a shorter interval to predation. Only one predator species was seen during the trials, *Artedius harringtoni*. These results are consistent with previous studies, and highlight the use of novel combination of methods to better inform predation interactions and their relative importance on each species.

Ohde, J.D.*, Carpenter, R.C., Ho, M.

EFFECTS OF OCEAN ACIDIFICATION AND FLOW ON THE MACROALGAE *TURBINARIA ORNATA* AND *SARGASSUM PACIFICUM* IN MOOREA

California State University, Northridge

Ocean acidification and flow have been known to be important factors for the growth of macroalgae. We tested the individual and combined effects of pCO2 and flow on two common macroalgae found in Moorea, *Turbinaria ornata* and *Sargassum pacificum*. Specific growth rates were calculated for *T. ornata* and *S. pacificum* over a 7 day span under ocean acidification conditions with flow speeds of: no flow (0cm/s), intermediate flow (~5cm/s), and high flow (~8cm/s). Results of a two way ANOVA indicate that pCO2 levels did not have an effect on either *T. ornata* or *S. pacificum* growth rates. However, flow did significantly affect the growth rates of both species. The highest growth rates for *T. ornata* and *S. pacificum* were in intermediate flow. This is most likely attributed to the rate at which nutrients are delivered to the algae and the flow creating a higher surface area to volume ratio of the algae. No flow and high flow are not ideal for *T. ornata* and *S. pacificum*. No flow due to the slow nutrient deliver rate, and in high flow because the algae thalli would bend over and collapse causing self-shade which could reduce growth.

Orr, D.W.*

ASSESSING MULTI-DECADAL CHANGE OF A REMOTE MANGROVE FOREST; A FOUNDATION SPECIES ON THE EDGE OF ITS NATURAL RANGE

Marine Landscape Ecology Lab, California State University, Monterey Bay

A major question surrounding global climate change is how foundation species will respond to future environmental changes. There is a gap in the long-term monitoring of these species along the edges of their geographic range. In some cases satellite imagery can address this. Mangrove forests are sensitive and important habitats in coastal ecosystems. The furthest latitudinal extent of their range can be found in deserts. Here distinguishing mangrove forest from the background environment in remotely sensed imagery is less difficult than in tropical settings. This is true along the eastern shores of Baja California. I used supervised classification of Landsat satellite imagery by a support vector machine to assess the prevalence of a rural mangrove dominated wetland located in Central Baja California, Mexico. Imagery spanning a 28 year period was assessed. Although this forest has been relatively free from impacts of local urbanization it has experienced an overall loss of area. Areas that are lost generally do not recover. The loss of this foundation species in the marine environment could have large impacts to local fisheries.
This study gives us insight into how habitat forming species on the edges of their geographic range may be impacted by global climate change.

Otis, C.¹*, Plowman, C.P.¹, Trowbridge, C.D.¹, McAllen, R.², Davenport, J.D.²
HYPOXIA AND LARVAL SURVIVORSHIP IN EUROPE’S FIRST MARINE RESERVE
1 - Oregon Institute of Marine Biology, 2 - University of College Cork
Lough Hyne, a marine reserve in SW Ireland, experiences rapid fluctuations in dissolved oxygen (DO). These fluctuations have a negative impact on adult and larval organisms in the lough, such as (1) the urchin Paracentrotus lividus, which experienced a major population crash in the early 2000s and (2) bryozoans, which have declined precipitously in the last 3 years. We investigated the effect of hypoxia on planktonic larvae with the hypothesis that most larvae are incapable of surviving bouts of hypoxia. Six 500-mL bottles of seawater were set to various DO concentrations, ranging from normoxic to anoxic, and ten larvae were added to each. After 12 hours, a vital stain was added and larval survivorship assessed. Due to a lack of access to urchin larvae, experiments were conducted using cyphonautes larvae for two trials, and gastropod veligers for the third. Percent mortality tended to increase as DO decreased. The percentage of dead cyphonautes increased exponentially with a decrease in DO concentration. Similarly, mortality increased logarithmically in respect to decreasing DO concentration for gastropod veligers. Based on these preliminary results, it is possible for urchins, bryozoans, and other invertebrates to die during periods of hypoxia, preventing the replenishment of damaged populations.

† Park, V.L.*, Forsgren, K.L.
REPRODUCTIVE PHYSIOLOGY OF PACIFIC SANDDAB COLLECTED NEAR A WASTEWATER OUTFALL SITE IN SOUTHERN CALIFORNIA
California State University, Fullerton
Wastewater effluent contains endocrine disrupting compounds that can potentially affect the physiology of organisms. We hypothesized that fishes collected near a wastewater outfall site would exhibit reproductive dysfunction. Pacific sanddab (Citharichthys sordidus) were collected from a wastewater outfall site (n=35) and a “clean” reference site (n=35) in southern California. Juvenile sanddab from the outfall site were significantly larger (p=0.027 length; p=0.020 weight) than juveniles at the reference site whereas adults were significantly smaller (p=0.011 length; p=0.001 weight) at the outfall. Gonadosomatic index (GSI) for juvenile fish did not differ significantly (p=0.292) between sites, but adults at the reference site had a significantly greater GSI (p=0.047). Skewed sex ratios were determined at both sites; the outfall was male skewed (27:8), the reference site was female skewed (3:4). Histological analysis revealed that ovaries from adult fish were dominated with late cortical alveolus (3:4). Preliminary data indicate that sanddab collected from the outfall site had altered size, sex ratio, and gonadal development. These data will provide information regarding how wastewater effluent may be affecting the reproductive health of benthic dwelling fishes in southern California.

† Parker, T.A.*, Torres, R., Burnaford, J.L., Zacherl, D.C.
RECRUITMENT, SURVIVAL, AND GROWTH OF OSTREA LURIDA AND CRASSOSTREA GIGAS AS A FUNCTION OF TIDAL HEIGHT
California State University, Fullerton
Surveys of seawalls in southern California bays have uncovered zonation of native (Ostrea lurida) and non-native (Crassostrea gigas) oysters, where non-natives reach their maximum density higher in the intertidal zone than natives. This zonation may be explained through differences in settlement, recruitment, and/or growth and survival across species. We explored the effects of varying tidal heights on recruitment, survival, and growth of native and non-native oysters in San Diego Bay, California. Twenty ceramic tiles were placed onto a fence at varying tidal heights and replaced every two weeks to assess recruitment levels. Ten ceramic tiles, each with ten recently settled native oysters and two to four non-native oysters, were transplanted to varying tidal heights from -0.25m MLLW to +1m MLLW and checked periodically for growth and survival. Increased tidal height significantly reduced recruitment of both species, with a more significant effect on native oysters. No native oysters survived above +0.6 m versus non-native oysters that survived at all experimental heights. Growth of native oysters was not significantly affected by tidal height, but non-natives achieved highest growth at intermediate heights. Results help to facilitate installment of restoration beds at tidal heights that maximize native performance and minimize non-native performance.

Pimentel, V.¹*, Ellingson, R.A.¹, Vendetti, J.E.², Krug, P.J.¹
SEQUENCING THE COMPLETE COI AND 18S GENES TO IMPROVE A PHYLOGENETIC HYPOTHESIS FOR SACOGLOSSA, A CLADE OF PHOTOSYNTHETIC SEA SLUGS
1 - California State University, Los Angeles, 2 - Natural History Museum of Los Angeles County
Sacoglossan sea slugs can survive periods without food due to photosynthesis by undigested chloroplasts from their algal prey (kleptoplasty). This groups is a model system for studies of early-stage endosymbiosis and ecological speciation by host shifting. Sacoglossans also have applied significance: some species contain bioactive substances in clinical trials as cancer treatments, while others have been proposed as biological control agents for invasive algae. However, evolutionary relationships among species and genera in Sacoglossa are currently unresolved. A preliminary phylogeny of 202 species based on four genes, including the barcoding front half of the mitochondrial cytochrome c oxidase I (COI) gene, failed to resolve evolutionary relationships within and among some genera and families. To improve the phylogeny of Sacoglossa, we sequenced the back half of COI plus the conserved nuclear 18S gene for 61 taxa. Five genera that were polyphyletic in a gene tree based on the barcoding fragment of COI were monophyletic using complete COI sequences, demonstrating improved phyllogenetic signal from full-length COI sequences. Analysis of a preliminary five-gene dataset fully resolved relationships for shelled taxa in superfamily Oxyaoacea. We will present expanded results for the five-gene dataset including superfamily Limapontioidea, improving resolution throughout the sacoglossan tree.

† Powell, J.A.*, Krug, P.J.
MULTIVARIATE SELECTION AND THE RANGE LIMIT OF ALDERIA WILLOWI: THE EFFECTS OF SALINITY AND INTERSPECIFIC COMPETITION ON FECUNDITY
California State University, Los Angeles
For estuarine animals, range limits may be set by complex interactions between abiotic factors, such as geographical gradients in salinity and temperature, and interspecific competition. Further, multivariate selection can inhibit adaptation to any one stressor. Thus, range limits may occur in different places than would be predicted by considering one environmental factor or trait in isolation. The northern range limit of the sea slug Alderia willowi may be set by low salinity following winter rains, and/or competition with its sister species A. modesta. We studied multivariate selection on A. willowi based on short-term fitness in laboratory experiments. Slugs were stressed by combinations of low salinity and presence of A. modesta, and egg production measured for 1-2 weeks. Analyses of multivariate selection considered the relationship of number of cerata (appendages that circulate body fluid), rate of ceratal beating, and body size on fitness. Preliminary results indicate that lower salinities significantly suppressed initial egg production, but slugs recovered to control levels after a one-week period of acclimation. There was no interaction between body size and fitness in preliminary experiments. Results of ongoing research will provide insight into the basis for northern range limits of estuarine animals along the U.S. west coast.

† Prince, C.D.*, Totten, A., Allen, B.J.
ENVIRONMENTAL VARIABILITY AND INVESTMENT IN THERMAL DEFENSES: THE IMPORTANCE OF RECENT HISTORY
California State University, Long Beach
Climate change models predict an increase in the frequency and intensity of extreme thermal events, suggesting that exposure to stressful high temperatures will likely become more common for many organisms. Because investment in thermal defenses is energetically expensive, a trade-off is expected to occur between thermal tolerance and growth or reproduction. In this study, we investigated how frequency of exposure to chronic heat stress influenced allocation of resources to competing demographic parameters in the California mussel, Mytilus californianus. We exposed mussels daily to 32 °C during a 6-h simulated low tide 0, 1, 4, or 7 days per week, for 8 weeks. We then challenged them with an acute exposure to more extreme temperatures (36, 39, or 42 °C). Our data provide support for the idea that acclimatory responses to temperature stress can drive trade-offs among traits, as predicted by theory. Chronic sublethal heat stress invoked a cost to individuals, expressed as a reduction in shell growth or size-specific tissue mass. However, increased frequency of prior thermal conditioning resulted in higher survival following acute exposure to potentially lethal temperatures. We are currently quantifying treatment-specific Hsp70 expression levels in our experimental mussels and expect to see a similar pattern.

† Pyne, K.*, Shultz H., Krauszer, M., Elliott, J.K.
THE EFFECT OF WASTING DISEASE ON POPULATIONS OF INTERTIDAL SEA STARS IN PUGET SOUND, WASHINGTON
University of Puget Sound
Sea star wasting disease has been reported to have a significant effect on sea star populations in the Pacific Northwest. We have surveyed Pisaster ochraceus and Evasterias troschelli populations at a variety of intertidal sites in Puget Sound since 2009. Resurveys of populations in the past year found that most sites had similar numbers and sizes of sea stars in June 2014, except those in enclosed bays where sea star populations had high mortality rates. Populations in the Tacoma area first showed evidence of wasting disease in late December 2013, with a major outbreak in July/August 2014. Mostly large individuals of both species were observed with wasting disease. The mean size of sea star populations decreased as a result of high mortality of large individuals and high recruitment of juveniles. Evasterias size and numbers decreased earlier in the year than Pisaster. These results
suggest that *Evasterias* populations were more affected by wasting disease than *Pisaster*, and that larger sea stars were more susceptible to the disease. Populations in enclosed bays were more affected by wasting disease. This may be a result of increased water temperatures or other associated environmental factors.

Quackenbush, A.M.*

**USING SOCIAL MEDIA TO ENGAGE THE PUBLIC IN SUSTAINABLE TOURISM AND RECREATION OPPORTUNITIES TO CHANGE ATTITUDES TOWARD OCEAN CONSERVATION**

*California State University, Monterey Bay*

Many people have an interest in protecting the oceans yet assert minimal personal engagement in ocean conservation issues. By using social media there is potential to engage the public, foster personal connections with marine protected areas, and change outlooks and behaviors toward ocean conservation. West Coast national marine sanctuaries launched the “Get Into Your Sanctuary Day” campaign in which national marine sanctuary representatives partook in a day of recreation and sustainable tourism activities and shared their experience on Facebook and Twitter. Additionally, the local community, tourism vendors, and travelers contributed to the event by posting their sanctuary “connections.” Following the campaign an evaluation report quantified public engagement on the social media outlets of national marine sanctuaries. On the “Get Into Your Sanctuary Day” there was a combined potential reach of 300,337 accounts on Facebook and Twitter and a total engagement of 763 interactions. This response was substantially higher (approximately 80%) than the average daily reach and engagement on these social media accounts. The methodology employed for this campaign and lessons learned, may be incorporated into the promotion of similar events to engage the public and change people’s attitudes toward ocean conservation.

Reshitnyk, L.Y.*, Holmes, K.R.

**REMOTE SENSING OF MARINE HABITATS IN COASTAL BRITISH COLUMBIA**

*Hakai Beach Institute and the Spatial Patterns and Analysis Research Lab, University of Victoria*

Habitat maps derived using remote sensing technologies are increasingly being used to assess the status of coastal marine habitats and are crucial to the conservation and monitoring of coastal habitats. Remote sensing technologies offer effective and efficient methods for mapping large remote tracts of coastal habitat compared to traditional field techniques. This year we collected two remote sensing datasets - very high resolution multispectral satellite imagery from the WorldView-2 sensor (8 band, 2 m) and aerial photographs (0.15 m) for the purpose of mapping nearshore marine habitats including canopy-forming kelps (*Macrocystis* sp. and *Nereocystis* sp.) and eelgrass beds (*Zostera marina*) with towed underwater video for ground-truth data. Situated on the central coast of British Columbia, the Hakai Beach Institute (HBI) seeks to conduct place-based research of long term ecological processes. We are exploring the methods, benefits and limitations of satellite imagery and aerial photography with regards to marine habitat mapping in temperate nearshore environments.

Robbins, K.M.*, Wolf, M.

**LIFE HISTORY AND LARVAL DEVELOPMENT OF A PARASITIC COPEPOD, *ISMAILA BELCIKI* ON A NORTHEAST PACIFIC NUDIBRANCH, *JANOLUS FUSCUS***

*Oregon Institute of Marine Biology*

Members of the genus *Ismaila*, like other Splanchnotrophid copepods, are endoparasites of heterobranch molluscs. The lifecycle of *Ismaila* species have been incompletely described and the stage at which the parasite becomes infective is yet unknown. Along the Oregon Coast, *Ismaila belciki* infects the nudibranch *Janolus fuscus*. The parasite is found within the body cavity and cerata of the host and infection with the parasite is determined by the presence of white-pink egg masses protruding from the mantle cavity. The larval stages of parasitic members of the Copepoda can vary from zero to six naupliar stages and one to five copepodid stages. Nauplii of *I. belciki* were collected from newly hatched egg masses and reared for 13 days in the laboratory. The internal infective stages include the copepodid, juvenile, and adult stages. These internal life stages were removed from the nudibranch host by dissection. Nauplius stages I through IV and copepodid II-V as well as the juvenile and adult stages were preserved for analysis. The morphology of the parasite at each of the stages was described using scanning electron microscopy and confocal imaging.

Schneider, J., Buderi, A.*, Peavy, A., Packer, M., Hennessy, J., Shauer, M., Brander, K., Tissot, B.

**ASSESSING RESPONSES OF INTERIDAL COMMUNITIES TO OCEAN ACIDIFICATION IN NORTHERN CALIFORNIA**

*Humboldt State University*

In the last decade, declining pH in ocean waters - ocean acidification - has been recognized as a growing threat to marine ecosystems. During bouts of strong upwelling nearshore areas in northern California can experience extended periods of hypoxic, corrosive waters due to a relatively narrow shelf and poleward shoaling of isotherms. As a result, coastal ecosystems in northern California are already experiencing end-of-the-century predictions of pH
for short durations. To assess the response of intertidal communities to these conditions we established and surveyed a series of intertidal sites in Humboldt County that vary in the extent of nearshore mixing and are likely to vary in exposure to hypoxia and low pH conditions. We report the results of initial surveys of our sites, including data on sea star wasting disease, and relationships to variation in temperature, salinity, pH and dissolved oxygen.

Schneider, J.H.*, Sinclaire, M.T., Craig, S.F.
THE EFFECTS OF ARTIFICIAL SUBSTRATES ON LARVAL SETTLEMENT AND COMMUNITY STRUCTURE IN HUMBOLDT BAY, CALIFORNIA
Humboldt State University
Different man-made substrates have been shown to have a strong effect on larval recruitment and subsequent community development in estuarine fouling communities. For example, floating docks and pier pilings have been shown to have an increased abundance of invasive species relative to natural substrates such as rock. To test the hypothesis that different man-made materials influence community structure, we deployed 50 settling plates made of the following materials: (1) concrete, (2) pressure treated wood, (3) untreated wood, (4) tire rubber and (5) ABS plastic (10 replicates each). These were mounted on PVC racks and suspended beneath a dock at the Woodley Island Marina in Eureka, California for a period of 4 months. The plates were removed and photographed on a monthly basis. Using point-intercept methods, the abundance of the 10 most abundant species was obtained and analyzed using a MANOVA test to compare communities across substrate. Results show that there were marked differences in initial barnacle settlement as well as final community structure (after 4 months) between treatments, revealing the importance of early settlement and substrate type on community composition.

† Snider, A.M., Knowlton, N., Al-Rshaïdat, M.M., Leray, M.
BARCODING AND METABARCoding THE CRYPTOFAUNA OF THE NORTHERN RED SEA
1 - National Museum of Natural History, Smithsonian Institution, 2 - Central Michigan University, 3 - University of Jordan Marine Science Station, Aqaba
Cryptofauna (small hidden organisms) are difficult to survey with traditional dive collection methods, but by using autonomous reef monitoring systems (ARMS), these invertebrates can be collected with relative ease. To better understand the biodiversity in the understudied Gulf of Aqaba (northern Red Sea), DNA barcoding and DNA metabarcoding were used to identify different sized organisms collected via ARMS. It was found that the biodiversity of organisms 500 µm - 2 mm in size is far greater than the biodiversity of organisms larger than 2 mm.

† Spence, E.A.*, Eernisse, D.J.
SNAIL TO SNAIL: COULD CREPIDULA ADUNCA AND CREPIDULA NORRISARIUM BE ONE IN THE SAME SPECIES?
California State University, Fullerton
Crepidula adunca (central California to Alaska) and C. norrisarium (southern California and northern Baja California) are West Coast marine gastropods known as slipper limpets (Calyptraeidae). Each of these is normally found on its own snail host species: Chlorostoma funebralis for C. adunca and Norrisia norrisii for C. norrisarium. There appears to be little range overlap with each species of slipper limpet found only north or south of Point Conception, a known biogeographic boundary in central California. The only mitochondrial COI sequences available in GenBank for each are identical to each other, which is surprising if they are separate species. Separate species usually have a minimum of about 2% pairwise sequence divergence. Alternatively, one of the sequences could be from the wrong species, or they could be the same species and their minor size, shell, and color differences instead reflect different growth patterns on different snail hosts at different latitudes. In order to test these possibilities, we are comparing mitochondrial COI from one population of C. norrisarium from off Santa Cruz Island in southern California with three localities (central California, Washington, and British Columbia) and C. adunca. Our results should contribute to better understanding of their genetic relatedness and morphological flexibility.

Sternberg, D.R.*, Peachey, R.
HAVE DIADEMA ANTILLARUM POPULATIONS IN BONAIRE RECOVERED 27 YEARS AFTER A MASS-MORTALITY EVENT?
California State University, Northridge
Marine community structure is impacted by large-scale catastrophic events, such as hurricanes and disease. In 1983, the sea urchin Diadema antillarum suffered mass-mortality resulting in a 95-99% decline in population size due to an unknown pathogen. Shortly afterwards, there was a phase shift from coral to macroalgal dominance on many Caribbean reefs. Increased local D. antillarum population density is linked to increased coral recruitment and reduced macroalgal cover, and therefore this die-off is considered to be a main contributor to the decline of Caribbean reef ecosystems. To test for population recovery of this once abundant herbivore, a study was undertaken in Lac Bay, Bonaire, to evaluate the population size and recruitment of D. antillarum in shallow water.
Recruitment (≤3mm test diameter) was evaluated using PVC panels anchored throughout Lac Bay. In 2010, *D. antillarum* population densities were recorded at 0.012±0.01 ind/m², less than 1% of the densities reported at this location in 1983 before the die-off. Population densities of juveniles were low in 1984 (<1 ind/m²), but were two orders of magnitude higher in 2010 (20.83 ind/m²). While recruitment rates in 2010 were higher than those recorded in 1984, densities of adult *D. antillarum* continue to remain low in Bonaire.

**Strathmann, R.R.**, **Oyarzun, F.X.**, **Brante, A.**

REGULATION OF PARTICLE CAPTURE BY SWIMMING VELIGERS AND TROCHOPHORES; DIFFERENT METATROCHAL BEHAVIOR OF MOLLUSCS AND ANNELIDS

1 - Friday Harbor Laboratories, 2 - Universidad de Concepción, Chile, 3 - Universidad Católica de la Santísima Concepción, Chile

In molluscan and annelid larvae that feed with opposed ciliary bands, a preoral prototrochal band of long cilia creates a current for both swimming and feeding. A postoral metatrochal band of shorter cilia beats toward the prototroch and aids capture of food particles. The larvae regulate particle capture while swimming in water with non-nutritious particles or with satiating concentrations of food. Larvae of a gastropod reduced but did not stop capture of algal cells while swimming with the velum extended. In observations thus far, arrests of the metatrochs were less obvious in mollusc larvae than in annelid larvae (Polygordiidae, Serpulidae, Capitellidae). The molluscs’ metatrochs arrested while cilia were in several positions of the beat cycle, whereas metatrochs of the annelids arrested with cilia aligned. Continued observations are testing the hypothesis that metatrochal behavior is similar within molluscs and annelids but different in the two phyla. If the opposed band feeding mechanism originated separately but only once in each phylum, then consistent differences between phyla in metatrochal behavior would be expected. If the opposed band mechanism arose several times across each phylum, consistent differences would not be expected.


TOXICITY RESPONSES OF KILLIFISH EMBRYOS EXPOSED TO SATURATED, AROMATIC, AND POLAR FRACTIONS OF LOUISIANA SWEET CRUDE OIL

1 - University of California, Davis, 2 - US EPA Atlantic Ecology Division, 3 - Bigelow Laboratory for Ocean Sciences, 4 - NOAA Office of Response and Restoration

Most oil spill damage assessments focus on the presence of polycyclic aromatic hydrocarbons (PAHs) because they have traditionally been linked to toxicity; however, oxyhydrocarbons and other organic constituents are prominent in crude oils, especially weathered oils. These compounds also persist in the environment, but their toxicity is not well understood. We analyzed developmental and transcriptomic responses of killifish (*Fundulus heteroclitus*) embryos exposed to whole and fractionated Louisiana sweet crude (LSC) to discover how polarity and functional groups affect oil toxicity. High-energy water-accommodated fractions (HEWAFs) were prepared for animal exposures using whole LSC and 3 LSC fractions: saturated, aromatic, and polar. Embryos were exposed to daily HEWAF renewals for 6 days post-fertilization and assessed for heart rate, *in ovo* ethoxyresorufin-O-deethylase (EROD) activity, developmental abnormalities, hatching, and survival. Early-to-mid-development embryos were also archived for RNA-seq. HEWAFs produced relatively similar sublethal toxic effects, despite being made with differing amounts of LSC by weight. This result suggests fraction potencies may vary widely, though the bioavailability of compound classes in HEWAFs is not yet known. Ongoing transcriptomic analyses will support mechanistic interpretations that help explain how oil damages living resources and post-video analysis of heart rates may reveal subtle, but potentially important, differences between fractions.

† **Suesatpanit, T.**, **Eernisse, D.J.**

IS LUCILINA LAMELLOSA (CHITONIDAE) WIDESPREAD AND VARIABLE OR A CRYPTIC SPECIES

1 - Chiang Mai University, 2 - California State University, Fullerton

The chiton species, *Lucilina lamellosa* (Quoy and Gaimard, 1835), is reported to be widely distributed ranging from even east of its type locality of Tonga in the Central Pacific, throughout the Indo-Pacific as far north as Okinawa Island in southern Japan and south to northernmost Australia, and west to at least Thailand. In ongoing studies of specimens representing a small part of this range, we have so far examined samples collected from Krabi province in western Thailand, Batangas province in the Philippines, and Okinawa Island, Japan, sequencing mitochondrial 16S and COI gene regions and comparing external morphology. While specimens were at least superficially similar, we found three distinct mitochondrial clades corresponding to each region with sequenced individuals. Our preliminary results indicate that what has been interpreted as morphological variation might instead correspond to distinct cryptic species. One morphological difference that could reflect these distinctions could be the strength and numbers of shingle-like ledges in the sculpturing of the tegument in the central areas of the intermediate valves.
Our results have implications for the discovery of currently unrecognized diversity in the extremely diverse seas of this part of the world. This study was funded by NSF grant to DJE (DEB-1355230).

† Sugano, C.S.1*, Bachhuber, S.M.1, Kelly, M.W.2, Rivest, E.B.3, Yu, P.C.4, Hofmann, G.E.1
EFFECTS OF ELEVATED pCO2 ON THE EARLY DEVELOPMENT OF RED ABALONE, HALIOTIS RUFESCENS
1 - University of California, Santa Barbara, 2 - Louisiana State University, 3 - University of California, Davis, 4 - The Evergreen State College
Oceanic uptake of anthropogenic CO2 reduces seawater pH and calcium carbonate saturation state with consequences for marine biota. A growing body of research has shown that the physiological response and tolerance of calcifying marine invertebrates to elevated pCO2 is highly variable. In a laboratory experiment, larval red abalone (Halioitis rufescens) from a local aquaculture facility were reared from 1.5 hours to 5 days under high and low pCO2 conditions to assess the impact of ocean acidification on early development. Results show that larval shell area was significantly smaller under elevated pCO2. Additionally, larvae exhibited higher rates of delayed and abnormal development when reared under high pCO2 compared to those in the low pCO2 treatments. Lipid analysis of larvae including composition and total amount will provide insight into how larvae utilize resources under different conditions. The negative impact of elevated pCO2 on size and development of larval red abalone indicates that ocean acidification may threaten aquaculture and field populations of this economically valuable mollusc.

† Sun, S.*, Whitcraft, C.R.
DETERMINING ECOSYSTEM FUNCTIONS OF BRACKISH VS. SALT MARSH IN THE HUNTINGTON BEACH WETLANDS
California State University, Long Beach
Wetlands are known to exhibit high primary productivity and play significant roles in the carbon cycle. High productivity provides habitat, and food web support for wildlife. Southern California has a variety of coastal wetland habitat types, including both brackish and salt marshes. Brackish marshes typically support higher soil nutrient content and higher plant diversity when compared to their salt marsh counterparts; however, restoration project design does not often compare ecosystem function between these two habitat types. Many restoration plans reintroduce full tidal flow, eliminating remnant brackish marsh habitat and any ecosystem function they may provide. My study compared vegetation, leaf litter decomposition, and carbon sequestration via gas flux in two marshes of the Huntington Beach Wetlands Complex: Newland (brackish and salt) and Brookhurst (salt). Denser and taller vegetation in brackish marshes suggests more aboveground carbon storage and increased nesting habitat for wildlife than found in the neighboring salt marshes. Preliminary gas flux data indicate important differences in CO2 flux among the sites with potential connection to type of vegetation present. Ecosystem functions and values for brackish versus salt marshes may differ significantly and should be factored into restoration design.

† Swezey, D.S.1*, Bean, J.R.1,2, Ninokawa, A.T.1, Sanford, E.1
BRYOZOAN MORPHOLOGY AND MINERALOGY IN A HIGH-CO2 OCEAN: PLASTIC RESPONSES AND NEW OCEANOGRAPHIC PROXIES
1 - Bodega Marine Laboratory, University of California, Davis, 2 - Museum of Paleontology, University of California, Berkeley
Studies of ocean acidification are now considering how marine invertebrates alter skeletal structures and carbonate mineralogy in response to changing ocean chemistry. We tested whether three laboratory-reared lineages of the bryozoans Membranipora serrilamella, M. tuberculata and Celleporella cornuta showed differences in growth, calcification, and isotopic and elemental compositions in response to simulated future ocean acidification. Under elevated pCO2 (1200 µatm), bryozoans grew significantly faster than clones reared under current atmospheric values (400 µatm). However, colonies reared under high CO2 were significantly lighter, with less carbonate per zooid compared to colonies grown in present-day conditions. Quantitative electron microprobe analyses revealed that M. tuberculata zooids grown in elevated pCO2 reduced the size of Mg-rich structures, or stopped growing them altogether. Mg-rich layers in skeletal growth put on prior to exposure to high pCO2 seawater gradually dissolved over time when colonies were cultured at 1200 µatm, despite a significant increase in the number of new zooids grown by these colonies. Isotopic records from cultured colonies indicate that skeletal δ13C and δ18O also reflect clear patterns in temperature and dissolved inorganic carbon. Bryozoans appear to plasticly adjust skeletal structures and mineralogy under changing conditions. Moreover, bryozoan skeletal chemistry reliably archives environmental history.

† Swieca, K.S.1*, Hettinger, A.2
ARE JUVENILE PISASTER OCHRACEUS LIKELY TO RESTORE ADULT POPULATIONS POST SEASTAR WASTING SYNDROME?
1 - Oregon Institute of Marine Biology, 2 - University of Oregon
Sea Star Wasting Syndrome (SSWS) is having significant effects on the keystone predator, Pisaster ochraceus, at rocky intertidal sites along the U.S. west coast. Given the role that this species plays in rocky intertidal communities, it is necessary to consider the ecological consequences of the reduction or loss of this species. This study examined the potential for juvenile Pisaster ochraceus to restore adult populations. In this survey conducted at Oregon Institute of Marine Biology, I investigated the prevalence of SSWS in individuals with >45mm arm length, estimated growth rates, prey source, preferred microhabitat, and adult association. SSWS prevalence was low in juvenile Pisaster ochraceus (10.73%) compared to adults. Juvenile growth rates were 0.048mm/day, on average. Juveniles preferentially associated with adults, possibly facilitating pathogen transport among stars as juveniles age and become potentially more susceptible to SSWS. Given juveniles slow growth rates, high post settlement mortality, and intense but infrequent recruitment, the likelihood of juvenile Pisaster ochraceus restoring adult populations is improbable. If high SSWS resistance is a character of the juvenile life stage, as juvenile’s age they could contract SSWS with the same propensity as adults, however, further work is needed to determine the nature of this resistance.

Thomas, I.M.¹, Meagher, K.²

SEDIMENT AND TANAIDACEANS: IS THERE A CORRELATION?
1 - California State University, Monterey Bay, 2 - Moss Landing Marine Laboratories

Catalina Island is home to 7 rhodolith beds. Rhodoliths are free-living coralline red algae that form beds on the seafloor, little is known of their infauna. Tanaidaceans are crustaceans that are commonly found in sandy sediments of deep marine environments. The purpose of this study was to identify if there was a relationship between tanaidaceans abundance and sediment characteristics. Here samples were collected from three sediment types in Isthmus Cove on Catalina Island: sand, >90% dead rhodolith cover and >90% live rhodolith cover. The samples were sieved and invertebrates were removed. Tanaidaceans were identified to the species level whenever possible. Six species were found between the three sediments. Five of the six species were found in high abundance in the samples of live rhodolith, four were in the dead rhodolith, and two were in sand. Higher species richness and diversity of tanaidaceans observed in live rhodolith beds than in other sediments suggest rhodolith beds offer benefits to the tanaidaceans, such as shelter and access to food sources. The primary habitat of tanaidaceans is thought to be tubes or burrows in sandy sediment. These findings are contrary to that and further study is needed to assess the benefits of rhodolith habitat.

Trego, M.L.¹,²,³, Hoh, E.², Dodder, N.G.⁴, Catelani, K.N.¹, Allen, C.D.¹, Kellar, N.M.¹, Lewison, R.L.²

A NOVEL APPROACH TO CONTAMINANT-RELATED HEALTH ASSESSMENT IN MARINE MAMMALS
1 - Southwest Fisheries Science Center, 2 - San Diego State University, 3 - University of California, Davis, 4 - Southern California Coastal Water Research Project

Environmental pollutants in marine mammals have been correlated with changes in endocrine hormones, which are commonly associated with reproductive health and stress response. Despite many studies characterizing differences in serum hormone levels with changes in contaminant concentrations, existing research has been unable to link contaminant exposure to changes in endocrine biomarkers in situ. These studies typically target few compounds and do not allow for the early detection of contaminants of emerging concern (CECs) before they pose a health risk. An innovative technique enables the detection of a broad spectrum of contaminants using a non-targeted analytical approach. Additionally, quantification of hormones in blubber has the ability to assess endocrine health in free-ranging marine mammals. We integrated these two molecular methods for the first time to validate the use of this approach for contaminant risk-assessment in marine mammals. We are currently identifying a range of contaminants in the blubber of bycaught male short-beaked common dolphins (Delphinus delphis) of known maturity status from the Southern California Bight. The results will then be compared with two hormone biomarkers (cortisol and testosterone). The application of this novel approach will allow for the identification of CECs and assessment of contaminant-related endocrine disruption in free-ranging marine mammals.

† Tucker, E.C.¹,², Perkin, H.R.¹, Raimondi, P.T.¹, Serrão, E.A.², Bernardi, G.¹

SPATIAL GENETIC STRUCTURE: SMALL SCALE, HIGH DENSITY SAMPLING WITHIN A POSIDONIA OCEANICA MEADOW
1 - University of California, Santa Cruz, 2 - University of Algarve, Campus of Gambelas

Posidonia oceanica is a slow-growing, clonal, marine angiosperm that is widely distributed across the Mediterranean and plays a crucial role in primary production and creating habitat complexity in the Mediterranean. P. oceanica meadows are highly susceptible to anthropogenic disturbance, and continue to diminish every year. While there have been numerous restoration efforts, they have proven widely unsuccessful. As a clonal organism, P. oceanica is capable of vegetative propagation as well as sexual reproduction. This study focuses on the conditions that facilitate these two growth forms and their relative contribution to meadow stability. The study took place in the Bay of Calvi, Corsica, France. Our results indicate that (1.) depth affects the spatial signature of clones more heavily than mere distance between samples, (2.) the maximum extent of clones...
increases with increasing depth, and (3.) greater non-clonal relatedness than expected can be found in the shallow regions of a meadow but no such relationship is found in the deep. Our findings can guide conservation efforts of P. oceanica and other seagrasses through the recognition of spatially explicit tradeoffs between clonal and sexual reproduction, and will help to direct spatially appropriate restoration and protection efforts.

† Valdez, A.D.*, Nguyen, A.T.*, Hofmann, G.E.2
IDENTIFICATION OF MICROBIAL COMMUNITIES ON SEA STARS WITH WASTING DISEASE
1 - California State University, Monterey Bay, 2 - University of California, Santa Barbara
Recent declines in Pisaster ochraceus populations along the west coast of North America have been attributed to a wasting syndrome event. To better understand the relationship between microbial communities’ and wasting syndrome, we conducted a study to identify the bacterial species found exclusively on sea stars with wasting disease. Microbial communities were sampled from the aboral surface of healthy and infected sea stars. Microbes were then grown on different selective media at 15°C for 48 hours. Restriction fragment length polymorphism (RFLP) analysis of the PCR-amplified fragment of 16S rRNA was performed on the resulting bacterial colonies. PCR amplicons, 1.5-2 Kbp in length, were digested with six restriction endonucleases (HaeIII, DdeI, Hhal, RsaI, HinfI, and Sau3AI). In conjunction with PCR-RFLP analysis, a subset of the samples was sequenced to identify bacterial colonies. Characterizing and comparing the microbial communities found on healthy versus sick sea stars will contribute to the current understanding of the relationship between a host microbiome and marine infectious diseases.

† Villalobos, C.1*, Schoo, K.2, Keister, J.3, McLaskey, A.3, Olson, B.2, Love, B.2
OCEAN ACIDIFICATION IMPACTS ON COPEPOD RESPIRATION RATES
1 - California State University, Monterey Bay, 2 - Shannon Point Marine Center, 3 - University of Washington
Ocean acidification (OA), the lowering of ocean pH due to increases in anthropogenic CO2, has emerged as a significant environmental threat for marine organisms. Under lowered pH, organisms may experience acute physiological changes, such as increased metabolic and respiration demand, possibly leading to decreased reproductive performance. Organisms that have received little research attention yet play an important ecological role in marine food webs are copepods. Copepods constitute 70-90% of zooplankton biomass in the world’s oceans and they are responsible for transferring primary productivity of phytoplankton to higher trophic levels. The goal of this study was to examine how increases in pCO2 reduced reproductive performance of the copepod, Calanus pacificus, through changes in energy allocation as indicated by changes in respiration. Adult, female C. pacificus were acclimated to laboratory conditions (400, 800, or 1200ppm) a week prior to testing. Female respiration rates were measured using a PreSens Microx TX3 oxygen meter during a four hour time period. Results of this study will improve our understanding of how zooplankton populations and marine food webs will be affected by ocean acidification.

† Voigt, E.P.*, Hovel, K.A.
THE INTERACTIVE EFFECTS OF STRUCTURAL COMPLEXITY AND BIODIVERSITY ON SEAGRASS ECOSYSTEM FUNCTION
Coastal and Marine Institute, San Diego State University
Seagrass habitats are an integral part of coastal marine ecosystems, promoting increased species diversity and high primary productivity. Both top-down (grazing, predation) and bottom-up (nutrient loading) processes may regulate seagrass growth, abundance, and structural complexity. Epiphytic algae, which grow on seagrass blades, are capable of outcompeting and effectively smothering seagrasses when nutrient loads are high. However, mesograzers, small invertebrate herbivores, consume epiphytic algae, promoting seagrass growth. In turn, dense, structurally complex seagrass may house diverse and abundant mesograzer assemblages, potentially resulting in a positive feedback loop that maintains dense seagrass patches. In light of this, we assessed how structural complexity (shoot density) affects the functional roles of mesograzers in terms of their effect on epiphytic algae abundance and seagrass productivity. We transplanted eelgrass (Zostera marina) from San Diego Bay, CA into laboratory mesocosms at two shoot densities; 400 and 1200 shoots m-2 and quantified the grazing impact of three prevalent seagrass species on epiphyte abundance and seagrass productivity: the carinate dove shell snail, Alia carinata; grass shrimp, Hippolyte californiensis; and amphipods, Gammaridae spp. Our data strongly supports that shoot density affects grazing rates across both species composition and richness. This study is pertinent to seagrass conservation as well as understanding the principles governing consumer-prey interactions.

† Voss, K.M.*, Scheel, D.
SOCIAL AWARENESS AND BEHAVIORAL SYNDROMES IN GIANT PACIFIC OCTOPUS (ENTEROCOTOPUS DOFLEINII)
Alaska Pacific University
Octopuses are not known to regularly interact with conspecifics, though some octopus species have higher population densities where shelter is a limited resource. Recently, accounts of potential social awareness in aggregations of octopuses have emerged, but are yet to be fully described. Giant Pacific Octopuses (Enteroctopus dofleini) are not known to aggregate, but anecdotal observation suggests that individuals change their behavior in the presence of conspecifics, relative to the size of the other octopus. Using high-definition video playback as a stimulus, we recorded the reactions of six octopuses to footage of a crab, a sea lion, a novel object, and two sizes of conspecifics to analyze individuals’ behaviors across functional contexts. Preliminary analysis shows that video playback elicits expected behavioral responses, with different behavioral patterns in each individual. Subjects showed different reactions to video of a predator and a conspecific, with size-dependent reactions to relatively larger and smaller conspecifics. Future sampling and analysis will elucidate whether conspecific interactions are distinct from reactions to predators or prey, indicating their capacity for social awareness. Determining the overall consistency of each octopus' behaviors across contexts will provide quantitative evidence as to whether E. dofleini have behavioral syndromes with predictable actions and reactions.

Walker, B.J.1*, Catton, C.A.2, Rogers-Bennett, L.1,2
CRITICAL TEMPERATURE THRESHOLDS CAN BE USED TO SELECT OPTIMAL WHITE ABALONE OUTPLANTING SITES
1 - University of California, Davis, 2 - California Department of Fish and Wildlife
White abalone were fished to the brink of extinction and listed as endangered in 2001. As broadcast spawners, these invertebrates are unlikely to successfully reproduce given their small population sizes. In an effort to restore populations of this endangered species, the white abalone recovery plan lists captive breeding as a top priority. A partnership led by the University of California Davis is currently breeding this species with the intention of restocking. In order to isolate optimal sites for potential outplanting, we have collected and analyzed temperature data for several sites along the coast of California. We analyzed these data according to temperature thresholds for adult white abalone reproduction, larval survival, and disease susceptibility. Using data from a congener, we determined the temperature limits for egg and sperm production in adults. We exposed white abalone larvae to a range of temperatures to evaluate the best conditions for development. Finally, using information to elucidate what temperature triggers the onset of withering syndrome in RLP positive abalone, we estimated the climate at which these critical conditions intersect to provide successful white abalone habitat. We can now prioritize which potential outplanting sites will be optimal for the restoration of the critically endangered white abalone.

† Whalen, M.A.*, Toy, J.A., Stachowicz, J.J.
CONSUMER DIVERSITY AND FLOW VARIABILITY INFLUENCE WATER FILTRATION IN FOULING COMMUNITIES
Bodega Marine Laboratory, University of California, Davis
Environmental heterogeneity is predicted to influence biodiversity-ecosystem functioning relationships. When environmental conditions vary across space or time key trait differences between community members can be expressed, potentially enhancing resource complementarity. In this study we investigated how temporal heterogeneity in water flow rates interacts with sessile suspension feeding invertebrate diversity to determine clearance rates of phytoplankton. In the absence of flow nine individual consumer species differentially filtered seven cultured phytoplankton species across a cell size range of 2.6 to 72 µm, providing evidence for feeding trait differentiation. We conducted a series of 24-hour feeding experiments using recirculating flow chambers, supplied with cultured phytoplankton, and run under constant and variable flow rates across a range of consumer diversity (1-6 species). Preliminary results suggest that suspension feeder diversity enhanced filtration, but this relationship saturated quickly and depended on specific combinations of consumer traits. However, consumer polyculture treatments tended to filter a greater range of phytoplankton cell sizes than most monocultures. Flow rate treatments evoked more subtle responses and depended on consumer composition, reinforcing the idea that in order for heterogeneity to enhance complementarity it must be coupled with sufficient trait diversity.

† Williamson, L.L.*, Smith, J.R.
EFFECTS OF HUMAN VISITATION ON SHOREBIRD ABUNDANCE AND FORAGING BEHAVIOR IN ROCKY INTERTIDAL HABITATS OF SOUTHERN CALIFORNIA
California State Polytechnic University, Pomona
Human visitation of rocky intertidal shores in urbanized areas, such as southern California, can have detrimental effects on marine invertebrates and algae. Often ignored are the effects of visitors on shorebirds that forage within rocky intertidal ecosystems. Visitors have the capacity to either drive birds away or affect shorebird foraging, such as increasing vigilance and reducing feeding time for birds that are naturally restricted to feeding during short low-tide periods. To examine visitation impacts on both resident and migratory shorebirds, surveys were conducted at 6 sites in southern California, a region where rocky shorelines are limited, during low-tide periods in winter and spring 2014. Bird counts and behavioral focal observations were used in combination with human presence or absence to
assess the effects of visitors on bird abundances and foraging behavior. The abundance of obligate rocky intertidal foragers was driven by human presence, whereas non-obligate intertidal foraging bird abundances were driven by different factors. Foraging behavior varied among species, with the impact of visitation on feeding remaining unclear. Ongoing surveys through 2015 will provide a comprehensive look at visitation effects, with the potential for this information to be used by coastal managers to aid in the protection of shorebird species.

SEA STAR POPULATION DECLINES AFTER THE ONSET OF WASTING SYNDROME IN CENTRAL CALIFORNIA KELP FORESTS
University of California, Santa Cruz
In fall 2013, a malady in several species of sea stars was reported from Alaska to Southern California. We aimed to assess how sea star populations are affected when exposed to wasting syndrome. This was achieved by comparing current populations exposed to wasting syndrome, to past populations. We performed subtidal surveys, recording the density of nine species of sea stars at four sites in November, 2013. We compared our data to long term population data collected by the Partnership of Interdisciplinary Studies of Coastal Oceans, for the past 13 years to examine species- specific population trends. We also examined the relationship between sea surface temperature (SST) and the onset of wasting syndrome, using daily SST recorded at Hopkins Marine Station from 1919-2013. Our results suggest that Pisaster giganteus, Orthasterias koehleri, and Pycnopodia helianthoides decreased in density in 2013. All of these species are in the order Forcipulatida, suggesting that differences in reactions to the syndrome may be attributed to differences between orders. Before the syndrome was first observed, an abnormally high SST occurred during August and September; the large change in temperature may have been related to the onset of this event.

Wilson, T.M.¹*, Thuesen, E.V.¹, Haddock, S.H.D.²
ECOPHYSIOLOGICAL CHARACTERISTICS IN THE PHYLM CTENOPHORA UTILIZING MORPHOMETRIC, ENZYMATIC AND HABITAT DATA
¹ - The Evergreen State College, 2 - Monterey Bay Aquarium Research Institution
Ctenophores comprise a phylum of mostly pelagic gelatinous animals found throughout the world’s oceans. Due to their fragility and the constraints of their environment, collection of intact specimens requires specialized equipment and methods. Such methods have been widely unavailable until the development of suitable remotely operated vehicles (ROV) and advancements in blue water SCUBA within the last few decades. Ctenophores are unique members of the Metazoa, as they are the largest organisms that utilize cilia for locomotion and predation. There are large gaps in our understanding of their ecological physiology. The metabolic demands responsible for driving locomotion in these organisms is little understood. This study investigated physiological parameters as both a function of minimum depth of occurrence and number/characteristics of ciliated comb plates. Specimens representing species across a broad spectrum of habitat depths, morphological characters, and functional diversity were collected, photographed and frozen in liquid nitrogen for later measurements of enzymatic activities (citrate synthase and creatine kinase). Correlations between biochemical parameters and ctenophore morphometrics are analyzed.

† Won, C.J.*, Allen, L.G.
SPAWNING AGGREGATION DYNAMICS OF THE BARRED SAND BASS, PARALABRAX NEBULIFER, USING ACTIVE ACOUSTIC TECHNOLOGY
California State University, Northridge
Aggregation-based fisheries have long been essential to commercial and recreational harvest around the world due to predictable fishing times and locations allowing for plentiful yield with relatively low fishing effort. However, this places certain species at risk of overharvest. One such species, the Barred Sand Bass (Paralabrax nebulifer), may demonstrate the effect of this intense fishery pressure on spawning aggregations, as annual catch estimates have shown a greater than 90% decrease in the last decade. As fishery-dependent stock assessments do not generally account for spatial heterogeneity, population declines may not be effectively detected by these methods and a different methodology may be needed to estimate standing stock. This study set out to investigate the spatial and temporal dynamics of spawning in the Barred Sand Bass at Huntington Flats, California. Boat-based transect surveys were conducted using split-beam SONAR to examine spatio-temporal variability of spawning aggregations in relation to environmental factors (e.g., temperature, thermocline, lunar phase). Spawning activity during the summer of 2014 appeared to be minimal and is mostly likely explained by environmental conditions associated with El Niño Southern Oscillation. Future plans involve more extensive SONAR surveys, coupled with examination of courtship and spawning behaviors using videography.

† Wyse, O.*, Windell, S., Garza, C.
A GEOSPATIAL CLASSIFICATION APPROACH FOR ASSESSING LONG TERM SHIFTS IN INTERTIDAL HABITAT COMPOSITION

California State University, Monterey Bay

In recent years Marine Protected Areas (MPAs) have become widely used in the management of fishery species. However the performance of an individual MPA, is closely related to the type of habitat incorporated in its design. The southern California spiny lobster (*Panulirus interruptus*) is an example of an exploited species in which MPAs have been used to conserve and manage standing populations. Although often recognized as subtidal organisms, recent studies have revealed that the intertidal habitat is a potentially important foraging habitat for spiny lobster populations, owing to the availability of mussels, their preferred prey. In this study I will use panoramic photos taken inside and outside of an MPA on Santa Catalina Island. Using Geographic Information System (GIS), a supervised classification will be run of the intertidal habitat. This particular methodology provides a method to rapidly assess broad scale changes in the intertidal habitat that may relate to variation in the demographics of spiny lobster populations. Given its low cost and relative speed of assessment this method may aid in the design of future lobster management strategies that incorporate intertidal habitat as a key foraging habitat.

† Yates, D.C.*, Hamilton, S.L.

SPATIAL VARIATION IN INVERTEBRATE SURVIVORSHIP IN CENTRAL CALIFORNIA KELP FORESTS

Moss Landing Marine Laboratories

The importance of predators in structuring terrestrial and marine ecosystems has been intensely studied around the globe. However, the effects of predator recovery on prey populations, which often occurs with reduced harvest inside marine protected areas, has received less attention. Seven experimental dive locations were selected along the Monterey Peninsula and Carmel Bay, four inside and three outside of marine no-take reserves. At each location, shrimp (*Pandalus spp.*), and spider crabs (*Pugettia spp.*) were tethered to rocky reefs inside kelp beds for up to seven days to quantify spatial differences relative mortality rates as a function of predator density. Tethered individuals were revisited every 24 hrs to record survivorship and video cameras were employed to record predator visitation and attack rates. The majority of predation events on *Pandalus spp.* was from sculpins (family Cottidae) and kelp greenling (*Hexagrammos decagrammus*), while the majority of predation events on *Pugettia spp.* was by red octopus (*Octopus rubescens*). In general, predation rates on *Pugettia spp.* were higher inside of marine no-take reserves. Thus, areas protected from fishing and which house greater populations of both predatory fish may result in changes in the community structure these habitats.

† Yeager, M.E.*, Hovel, K.A.

INTERACTIVE EFFECTS OF BODY SIZE AND EELGRASS STRUCTURAL COMPLEXITY ON FISH HABITAT PREFERENCE AND PREDATION RISK

Coastal and Marine Institute, San Diego State University

Seagrass beds provide critical nursery habitats for fishes to forage and take refuge throughout their early life history stages. During a fish’s seagrass residency, their body size dramatically increases from when they first recruit to when they reach maturation and shift to adult associated habitats. Increasing body size may also be associated with changes in predation risk from gape-limited predators. Additionally, density of seagrass may mediate both strength of predation risk and growth rate for juvenile fishes. Furthermore with changing body size, varying densities of seagrass may ultimately create a predation risk to growth tradeoff. In this study, we measured eelgrass (*Zostera marina*) density preference of four size classes of juvenile giant kelpfish (*Heterostichus rostratus*) with mesocosm experiments and the survival of those size classes in high or low density eelgrass beds near Shelter Island in San Diego Bay, California. We found that the smallest size class (40-60mm) spent significantly more time in high density eelgrass, while the largest size class (100-120mm) spent significantly more time in low density eelgrass. Results from the predation risk experiment will be discussed and compared to the density preference experiment in attempt to understand how varying predation risk through ontogeny may mediate habitat preference.

† Zeman, S.M.*, Sutherland, K.R.*, Brodeur, R.D.*, Daly, E.A.*

FEEDING PATTERNS AND PREDATION IMPACT OF A LARGE SCYPHOMEDUSAE IN THE NORTHERN CALIFORNIA CURRENT

† - University of Oregon, 2 - Northwest Fisheries Science Center, NOAA Fisheries

*Chrysaora fuscescens*, a large and abundant cnidarian Scyphomedusa, is a key predator in the California Current System. In this study, we used a combination of laboratory and field work to examine the predation potential of *C. fuscescens*. Laboratory clearance rates were calculated by varying prey abundance and flow velocity using *Artemia salina* as prey. Clearance rate was higher at lower prey concentrations, while flow velocities did not have a significant effect. These experiments represent baseline measurements of *C. fuscescens* clearance potential, especially in high prey concentrations, which can occur at convergent zones where jellies are known to aggregate. Field data were collected by dip-netting jellies at survey stations from Brookings, Oregon to Grays Harbor,
Washington during June, July, August, and September 2014. At each collection site, zooplankton samples were also collected to quantify ambient plankton concentrations. Gut contents of the preserved medusae were analyzed in the lab and ingestion rate and an electivity index were calculated to estimate trends. Preliminary findings suggest that early stage euphausiids and fish eggs make up a large portion of the *C. fuscescens* diet in the early summer months. Understanding seasonal feeding patterns will identify when prey items are most vulnerable and how feeding rates change over the course of the *C. fuscescens* life cycle. Feeding patterns will also clarify the possible direct and indirect impact of *C. fuscescens* on commercially important fish species in this highly productive upwelling region.

† Zuercher, R.E.¹, Donahue, R.², Gentry, C.M.³, Hamilton, V.S.⁴, Savage, K.⁵, Underwood, C.A.⁶, Wils, T.H.G.⁷, Black, B.A.⁵

**USING OTOLITH CROSSDATING TO UNDERSTAND BIOTIC AND ABIOTIC FACTORS INFLUENCING GROWTH IN THE GENUS SEBASTES**

1 - University of California, Santa Cruz, 2 - Indiana State University, 3 - Austin Peay State University, 4 - University of Tasmania, 5 - University of Texas at Austin, 6 - Lincoln Memorial University, 7 - Rotterdam University of Applied Sciences

The ability to reconstruct growth chronologies for managed fish populations is pivotal to our understanding of fisheries population dynamics. Both biotic and abiotic forces can influence fish growth in a given year, and it is difficult to distinguish their relative effects on growth patterns. Challenges arise when using otoliths to examine past fish growth, as it is often difficult to assign a specific year to each otolith increment. In this study, we use tree-ring crossdating to produce a multi-decadal growth and otolith luminance time series for Pacific Ocean perch (*Sebastes alutus*) from the Bering Sea. Statistically verified crossdating revealed synchronous growth patterns across otolith samples. We detected significant (p < 0.01) correlations between growth and luminance chronologies and climate data (sea surface temperature, the Multivariate ENSO Index, and sea ice extent). Preliminary observations from four species of nearshore rockfish (*Sebastes melanops, S. mystinus, S. atrovirens*, and *S. chrysomelas*) suggest that crossdating will also allow an in-depth look at the factors that influence growth in localized populations of kelp forest fishes in California. Further application of otolith crossdating can provide additional time-series for long-lived fish species, allowing investigation into the effects of environmental variability on growth.

† Zupcic, J.R.¹*, Ruiz-Cooley, I.R.¹,², McCarthy, M.D.¹, Koch, P.L.¹

**USING STABLE ISOTOPES OF SPERM WHALES TO INVESTIGATE EFFECTS OF THE EL NIÑO SOUTHERN OSCILLATION ON A MESOPELAGIC FOOD WEB IN PERU**

1 - University of California, Santa Cruz, 2 - National Oceanic and Atmospheric Administration

The Peru Coastal Upwelling system is one of the most productive ocean regions in the world. This region is particularly sensitive to the El Niño Southern Oscillation, which strongly affects upwelling strength, and thus nutrient availability, regional productivity, and likely food web structure. Female sperm whales (*Physeter macrocephalus*) exhibit site fidelity and as top predators, they can be used as sentinel species to investigate variation in ecosystem structure. Carbon and nitrogen isotopic values from sperm whale teeth have previously been used to identify dietary differences between sexes and ontogenetic movements, but have never been applied to examine effects of El Niño events on mesopelagic food webs. We sampled annual growth bands from teeth of 10 female sperm whales from Paita, Peru to obtain a time series of carbon and nitrogen isotopic signatures at the top of the food web. We use this data to evaluate the isotopic similarity of these versus previously studied whales from other regions as well as the potential impact of El Niño events on trophic structure and isotopic baselines of the mesopelagic food web. Preliminary data analysis does not indicate overwhelming isotopic changes linked to El Niño, but hints at longer-term shifts in ecosystem baseline values.
**Film title:** “Shadow Reef"
**Filmmaker name:** Elke Specker
**Affiliation:** IN2 Focus Media
**Length:** 4:56
“Shadow Reef” is a film about the importance of ocean and coral reef conservation, from a child’s perspective. The future of our oceans is in serious trouble, NOW is the time to take action, to create awareness, to teach our children that worldwide protection is needed for marine ecosystems to survive and restore, and having this story told by a child adds another level of urgency. I’m hoping Shadow Reef to be the first of a series of ocean awareness short films, narrated by Bryce.

**Film title:** “Stress Physiology of Sharks in Fishing”
**Filmmaker name:** Christine Shepard
**Affiliation:** University of Miami
**Length:** 3:32
“Stress Physiology of Sharks in Fishing” is a scientific video abstract about recent research from University of Miami’s Ph.D. Candidate Austin Gallagher on the stress responses and survival of five shark species during and after catch-and-release fishing. Using blood samples, reflex tests and satellite tags, Gallagher found that a clear species-based ranking of vulnerability to fishing pressure emerged (from most to least vulnerable): Hammerhead > Blacktip > Bull > Lemon > Tiger. This film discusses the research as well as the greater conservation context of this work.

**Film Title:** Sponges of the Caribbean: What ecological factors most affect them?
**Filmmaker Name:** Joseph Pawlik
**Affiliation:** UNC Wilmington
**Length:** 3:00
This video was a finalist in the Ocean 180 Video Challenge, which seeks to make scientific discoveries more accessible to the public, and is sponsored by COSEE Florida and funded by the National Science Foundation. The challenge is to present a published scientific study in 180 seconds at the 6th-grade level. Here is the 6th-grade level abstract for the video: Sponges are animals that eat tiny food particles as they pump water through their bodies. They are very common on Caribbean coral reefs, and come in all shapes, sizes and colors. Previous research concluded that sponge growth is most limited by food particle availability. But sponges are also used as food by angelfishes that nibble on them, decreasing their growth. Which is more important, food or predation? We tested both possibilities by putting sponge pieces inside and outside of protective cages in shallow water, and in deep water where there are more food particles. After a year, sponges in cages grew a lot more because they were protected from angelfishes, but sponges did not grow more in deep water. Therefore, sponges are more affected by predation than food. Removal of angelfishes by fishing may result in sponges overgrowing and killing the corals that build coral reefs.

**Film title:** "Ecosystem Science: Facing Trade-offs in ocean management"
**Filmmaker name:** Phillip Levin
**Affiliation:** NOAA Fisheries
**Length:** 3:34
The oceans provide us with food, medicines, transportation, recreation and spiritual well-being. Yet, many of our uses of the oceans are in conflict. A key to restoring and maintaining our ocean’s health is to recognize that we face trade-offs and to develop the means to address these. Through conversations with the users and managers of the U.S. Pacific Ocean, we highlight the need to make investments in the health of ecosystems. We can have it all, but we need to re-define what prosperity means. We need to set ourselves up so that this new definition of prosperity serves the needs of our oceans and the people who rely on them.

**Film title:** Oceans: a silent world?
**Filmmaker name:** Marta Bolgan
**Affiliation:** Marine and Freshwater Research Centre, Department of Life and Physical Science, Galway-Mayo Institute of Technology
**Length:** 8 minutes
“Oceans: a silent world?” is a film about the problem of anthropogenic noise pollution in the aquatic environments. Anthropogenic noise is now recognized as a significant pollutant and the potential consequences for animals survival are of international concern. This film aims to raise awareness around this topic: starting with considerations and examples about the importance of acoustic communication for aquatic species and the relevance of acoustic cues for orientation and
navigation, we have taken in consideration the main sources of anthropogenic noise and we have presented some evidences about the effects of this type of pollution on aquatic life. The aim of this documentary is therefore to present some of the relevant studies carried out worldwide around this topic to an open public, and it’s the results of a collaboration between a PhD student in Marine Biology and a photographer, joined in an independent and self-funded project called Artemis Eyes.

Film title: “Postcard from the Oregon Coast”
Filmmaker name: Trip Jennings
Affiliation: Balance Media
Length: 5:33
Mark Wygard is an oyster farmer on the Oregon coast and over the past few years he has seen some astonishing changes in the ocean, which nearly destroyed his business. One day he showed up to incubator tanks that were completely absent of oyster larvae. The changing pH balance in the ocean has affected his business as well as oyster farmers depending on Mark’s larvae. Hear how Mark is adapting in, “Postcard from the Oregon Coast.”

Film Title: A Tale of Two Urchins
Filmmaker Names: Sofia Castello y Tickell, Robert Lamb, Jon Witman, Casey Dunn
Affiliation: Brown University
Length: (02:47)
“A Tale of Two Urchins” is a short animation made for Creaturecast, about sea urchins in the Galapagos Islands. The green urchin and the pencil urchin may seem comparable at first glance, but the Witman Lab has found that differences between the two could have a big impact on the ecosystem around them…
The video was featured in the Science section of The New York Times.

Film Title: “Harbor Heroes: Little Oysters in the Big Apple”
Filmmaker Name: Jaclyn Yeary
Affiliation: Produced as a senior honors capstone while at American University
Length: 9:53
On October 29, 2012, Superstorm Sandy rocked the east coast of the United States leaving an estimated 8 million people without power and causing over $50 billion in damages. New York City was bombarded by 25-foot waves that flooded the city. Sandy’s aftermath caused many to ask questions about the effects of climate change and to seek solutions for protecting our cities from future storms.
“Harbor Heroes” outlines how some New York City residents are turning to oysters—not only to create a natural wave barrier against future storms, but also to restore the health of the waters in New York’s harbor. The solution is deeply seeded in New York’s maritime history and it has the potential to restore what was once the largest oyster population in the world. It features interviews with everyday community members who care for the future of the environment as well as leaders in the ocean-conservation community such as Philippe Cousteau, grandson of the world-renowned ocean-explorer, Jacques Cousteau. These individuals will speak to oyster restoration as a multi-faceted solution: If completed properly, it will have positive impacts in a variety of areas including environmental health, local economy, and education. These little oysters have a mighty role to play in “The Big Apple.”
This film was produced by Jaclyn Yeary and Taryn Stansbury as their Senior Honors Capstone for the American University Honors Program. Jaclyn graduated in May 2013, and Taryn graduated in May 2014.

Film title: The Immigrant
Filmmaker name: Omar Malik, Monte Kawahara, Ben Goldfarb, Geoffrey Giller, Mwanzaa Brown
Affiliation: Yale School of Forestry & Environmental Studies
Length: 3:00
What’s a polar bear doing in an industrial port city? A candid look at the challenges of migrating and adapting to an unfamiliar place. Weaving together themes of marginalization, climate change, and corporate banality, we follow a polar bear who just can’t catch a break in a sterile, uncaring world.

Film title: “Plate Tectonics”
Filmmaker name: Dorota Szuta & Christine Mann
Affiliation: Moss Landing Marine Laboratories
Length: 7:56
The video “Plate Tectonics” explores the fundamental concepts behind plate tectonics. Using primarily paper-cut stop motion animation, the video starts with a brief history of the theory itself. It then segues into the actual physical processes,
focusing on the tectonic motion that occurs at plate boundaries. This film was made by Dorota Szuta and Christine Mann for the graduate class MS 141: Geological Oceanography at Moss Landing Marine Labs in Fall 2012.

Film title: “Pinto Abalone Restoration”
Filmmaker name: Paul Hillman
Affiliation: NOAA
Length: 1:53
Pinto Abalone is a species of concern on the Pacific coast, and efforts are underway to restore its population. This short film documents a recent outplanting effort in March 2011 during which over 2000 abalone were released into the Puget Sound.

Film title: “The Reef”
Filmmaker name: Jessica Hamel
Affiliation: UC Berkeley
Length: 9:55
On a remote atoll in Micronesia, the reefs are changing. Faced with a declining fish population and rapidly changing environment, community members are working to revitalize their reefs and save their islands.

Film Title: The Science Behind - Harbor Seal Monitoring in Puget Sound
Filmmaker names: Paul Hillman & Tara Smithee
Affiliation: NOAA Ocean Media Center
Film Length: 4:10
Harriet Huber, a wildlife biologist with NOAA’s National Marine Mammal Laboratory, studies harbor seals in Puget Sound. Follow her to the viewing blind on McNeil Island where she monitors the population recovery. Forty years ago, the Washington State population of harbor seals was down to 2000-3000. Since then it has rebounded following the passing of the Marine Mammal Protection Act in 1972.

Film title: Two Fish
Filmmaker name: Sarah Curry
Affiliation: Fish Navy Films
Length: 7:48
The seas are running out of fish, and aquaculture has stepped in to meet rising global demand for seafood. But not all fish farms are created equal. Join fish ecologist Dr. Andy Danylchuk as he compares two fish: the Atlantic Bluefin tuna and the common carp. How are these fish different and what does that mean for the consumer?

Film Title: “Michael and the Peppermints”
Filmmaker names: Michael Crandall and Chelsey Crandall
Affiliation: Independent, University of Florida
Length: 8:17
Michael and the Peppermints follows University of Florida graduate student Michael Dickson as he studies Gulf of Mexico peppermint shrimp. Peppermint shrimp are a popular species in the aquarium trade but little is known about their ecology or population dynamics, something Michael hopes to rectify through his graduate research. In the film we tag along as Michael first collects peppermint shrimp in the field aboard a commercial bait shrimp boat then returns to the lab to conduct his studies. Aquarium peppermint shrimp are currently primarily collected from the wild, and Michael hopes his research will lay the fundamental baseline to ensure sustainable harvest of this species in the future.
Local Restaurants (all within walking distance (1-2 mi) of the hotel)

1. Simply Panini (1135 Broadway (253) 627-8220)
2. Galanga Thai Cuisine (1129 Broadway (253) 272-3393)
3. Fujiya Japanese Restaurant (1125 Court C #1 (253) 627-5319)
4. Pita Pit (921 Pacific Ave (253) 572-7482)
5. Mad Hat Tea Company (1130 Commerce St (253) 441-2111)
6. The Forum, sandwiches & burgers (815 Pacific Ave (253) 830-2151)
7. The Matador (721 Pacific Ave (253) 627-7100)
8. Pho Than Brothers (1712 Pacific Ave (253) 272-2249)
9. Savor Creperie (916 Pacific Ave (253) 365-5534)
10. Indochine Asian Dining Lounge (1924 Pacific Ave, Tacoma (253) 272-8200)
11. The Social Bar & Grill (1715 Dock St (253) 301-3835)
12. Harmon Brewing Co. (1938 Pacific Ave (253) 383-2739)
13. The Swiss Restaurant & Pub (1904 Jefferson Ave (253) 572-2821)
14. Metro Coffee (1901 Jefferson Ave (253) 627-8152)