

Summary of Academic Roadshow Stop #1
Coastal and Marine Science Institute & Bodega Marine Lab
University of California Davis
January 22, 2020

The Coastal and Marine Science Institute (CMSI) is a multi-college, multi-department program of the University of California, Davis that coordinates diverse activities of marine and coastal science from many different disciplines. CMSI has three main goals: 1) transform scientific understanding of coastal and marine systems; 2) educate and inspire future leaders; and 3) engage stakeholders, colleagues, and policymakers. CMSI's 100+ affiliated faculty and staff and over 120 graduate students and postdoctoral scholars are internationally recognized for their expertise across the full spectrum of modern marine science, including ecology, evolutionary biology, conservation biology, microbiology, coastal oceanography, environmental toxicology, geochemistry, political science, natural resource management, economics, law, corporate sustainability, and marine wildlife health.



UCDAVIS

Coastal and Marine Sciences Institute

UC Davis/CMSI Roadshow Stop Highlights

Main topics

- Presentations by UC Davis faculty and staff covered a wide range of topics connected to all four Goals of the Strategic Plan. Researchers highlighted multiple projects that were interdisciplinary, tackling research questions from multiple perspectives, with a deeper understanding of the socio-ecological linked system. Researchers noted that the interdisciplinary nature of projects was being driven in part by their students, utilizing advisors from different departments for their projects.
- Discussion noted that graduate research grants and postdoctoral opportunities present a great return on investment, and can be focused on questions relevant to State needs. Connecting postdocs/fellows to OPC SAT working groups was a proposed avenue for research and partnership with Sea Grant and other funding.
- Research topics included sea-level rise and adaptation planning, living shorelines for restoration and coastal protection, ocean acidification, physiological ecology, MPA science supporting management decisions, partnering with Indigenous Nations and under-represented communities, community citizen science, marine debris, disease in marine organisms and their impacts on public health, ecosystem-based fisheries management, and aquaculture.
- An idea was proposed that at the end of the Academic Roadshow, the local hosts and Project Team convene to discuss lessons learned and ways to continue the connections going forward.

(Find detailed summaries of each talk starting on page 2)

Needs and issues of concern

- Participants noted that breaking down silos is important. For example: there is no watershed policy for California, and information sharing across the land-sea interface is challenging. [Sierra to Sea](#) was one initiative highlighted as a model.
- Data management and centralizing data are challenges for research institutions and the State.
- Long-term monitoring is difficult to fund, both privately and publicly. OAH monitoring and MPA network monitoring are examples of some success.
- Solutions-based science was emphasized by the Project Team, encouraging researchers to get out of their comfort zone and suggest solutions even as their work is ongoing and may not be ready for publishing.
- Researchers noted that funding is running out for applied science, which puts pressure on the State and Federal governments for support.

Data gaps

- Inventories: what is wetland acreage in California? How much beach acreage is threatened by sea-level rise?
- Siting: where are the best places for offshore wind? Site suitability analysis for wetland restoration.

Detailed summary of each talk

1. Goal 1: Safeguard Coastal and Marine Ecosystems and Communities in the Face of Climate Change

Mark Lubell (Dept of Environmental Science and Policy) presented his work on governance issues in sea-level rise adaptation in the Bay Area. His talk addressed seven governance challenges and proposed the following recommendations: 1) a Climate Adaptation Vision or Commission (Eg. Delta Vision, Governor's Commission for a Sustainable South Florida). 2) a Vision Plan and next step recommendations in planning. 3) a "Local-First" funding portfolio: parcel taxes, increase in fees, special taxation districts. 4) a new integrated permitting strategy for green infrastructure. 5) a Climate Science Service Center at the nexus of science and policy. 6) an integrated strategy from in-person to digital for civic engagement. 7) state and federal legislative caucus groups focused on climate adaptation.

John Largier (Dept of Environmental Science and Policy) presented his research in the effect of sea-level rise on lagoons and estuaries, including the effects of ocean water intrusions in Tomales Bay and San Francisco Bay, leading to habitat loss, intermittent closures of estuaries and flooding. His sea-level rise research also addresses the impacts of sediment, pathogens and plastic plumes (due to land run-off) on people and wildlife, as well as the effects of storm surge and river flow on infrastructures and marshes. John Largier's research also includes work on the relationship between upwelling and space-time patterns on OAH, MPAs and HABs.

Ted Groshol (Dept of Environmental Science and Policy) presented his research on living shorelines and species invasion in the face of climate change. Ted Grosholz highlighted the benefits of habitat restoration to native ecosystems while providing significant shoreline protection to coastal habitats and human infrastructure. He also presented on biological invasions and how non-native species tend to better tolerate climate stressors (such as ocean acidification, temperature, salinity and dissolved oxygen) and are more likely to outperform native species as the climate continues to change.

Brian Gaylord (Bodega Marine Laboratory) presented his research on using kelps as potential tools for coastal protection. Kelp restoration efforts allow for direct before-after tests to assess whether kelp forests can decrease wave energy. To test this hypothesis, Brian Gaylor is undertaking an initial study in collaboration with Kerry Nichols (CSUN), Tom Ford (TBF) and USC Sea Grant. This work addresses Goal 1. Objective 1.1 of the Strategic Plan. Brian Gaylord is also conducting research on the potential of kelp forests to buffer pH and store carbon. This research is in collaboration with Eric Sanford and Tessa Hill and addresses Goal 1. Objective 1.2.

Eric Sanford (Bodega Marine Laboratory) presented as a co-PI of the Bodega Ocean Acidification Research (BOAR) - an interdisciplinary research and training program (co-directed by Brian Gaylord and Tessa Hill). His research focuses on the geography of stress, quantifying changes in seawater chemistry via coast-wide syntheses, including a project analyzing and mapping shellfish vulnerability to OA and other stressors

along the West Coast. Other areas of Eric Sanford's research include understanding the impact of climate change on: key species (including aquaculture and shellfish), conservation implications (for native fish), genome function and evolution in changing environments, and evolutionary and distributional responses.

Nann Fangué (Dept of Wildlife, Fish and Conservation Biology) is a physiological ecologist and applies physiological tools (such as genomics) to address problems of immediate conservation concern. Using movement ecology and acoustic biotelemetry, her research focuses on native fish species in California, including Chinook Salmon, Green Sturgeon and Delta Smelt. Some of her current research questions include: 1) have reintroduction efforts of previously extirpated San Joaquin River Spring-run Chinook Salmon been successful? 2) Where are the mortality hotspots for juvenile salmon in the Delta? 3) Can novel habitats be used as a tool to improve juvenile salmon growth and out-migration survival?

Andrew Whitehead (Dept of Environmental Toxicology) presented his work on genome functions and evolutions in changing environments. His research investigates how physiology can impact resilience in human-altered environments by estimating persistence potential for species facing climate change through phenotypic plasticity (acclimatation), trans-generational plasticity and evolutionary adaptation. This work can help better understand managed relocation and inform management decisions for species such as the Delta Smelt and the White Abalone.

Rachael Bay (Dept of Evolution and Ecology) presented her research on evolutionary responses to climate change, she uses genomic data combined with ecological and physiological experiments to predict evolutionary response to climate change. Her research on range shifts and climate change specifically addresses Goal 3. Objective 3.1.3 and is investigating the following questions: 1) what is the source of new recruits? 2) are new populations uniquely adapted to northern environments? 3) are we likely to see further range expansion?

Group discussion following Goal 1 presentations

Discussion began on State efforts to sequence genomes of species of concern. Efforts to partner funding of the sequencing to interesting research questions was encouraged. This led to discussion of the benefits and challenges of centralizing data for ease of use and research ([GenBank](#) given as an example). An idea proposed would use funds to bring together data scientists and CMSI for a 1-2 workshop to catalyze the discussion (e.g. framework for database structure), leveraging the culture of sharing at UC Davis.

2. Goal 2: Advance Equity Across Ocean and Coastal Policies and Actions

Beth Rose Middleton (Dept of Native American Studies, member of the SW Climate Adaptation Science Center) presented on "Considerations for Building Partnerships with Indigenous Nations and Underrepresented Communities." Professor Middleton highlighted some best-practices for developing research/policy collaborations with Tribes, including: 1. Knowledge of context, 2. Recognizing government-to-government relationships (Tribes are partners, not stakeholders), 3. Recognition of Tribal leadership in the field, 4. Agreed upon principle for ethical research, 5. Compensation for time, and 6. Developing opportunities for research implementation, restoration, and policy change on issues of

importance. For diverse and underrepresented communities, best-practices include: 1. Foregrounding equity as a consideration in every research and policy initiative, 2. Understand the unique exposure pathways and barriers to participation, and 3. Acknowledging and respecting difference (Tribal nations vs underrepresented communities). Two resources Professor Middleton suggested (as part of leveraging opportunities) were the [Tribal and Indigenous Communities summary report](#), part of CA's Fourth Climate Change Assessment, and the [Tribal Climate Change Adaptation Planning Toolkit](#).

Jim Sanchirico (Dept of Environmental Science and Policy, OPC SAT member) presented as the lead PI for "Sustainable Oceans: From Policy to Science to Decisions," an NSF funded program to train the next generation of PhD marine scientists a new paradigm that combines graduate training with immersion into the policy process and politics on the sustainable use of living marine resources. The goal of the program is to put the policy focus on the front-end of the research training enterprises to build more effective links between science and decisions. This program emphasizes the co-production of knowledge that occurs when the entire community of researchers, stakeholders, and managers come together. Professor Sanchirico has funding for five cohorts (they are on their third now). Students study under professors from multiple disciplines, and there is a direct engagement component that gets students into the communities they work with.

Ryan Meyer (Center for Community and Citizen Science) presented on "Linking equity to community and citizen science." Professor Meyer explained UC Davis' Center for Community and Citizen Science is "based on a foundation of research excellence, the Center helps scientists, communities, and citizens collaborate on science to address environmental problems as part of civic life." This includes engaged, partnerships-based research, training and capacity building, assessment and planning, curriculum, and campus engagement. Using the lessons of the MPA Baseline period (of which OPC was a major funder/partner), Professor Meyer highlighted four opportunities for applying community and citizen science (CCS) going forward: 1. Training and support (clear guidelines and incentives to make CCS a part of science practice in CA), 2. Building capacity: recognize the value of networks that result from CCS, 3. Sustain and iterate: recognize that efforts like MPA Watch only happen with slow building and are to be treated as long-term partnerships in need of sustained investment, and 4. Meaningful evaluation: what has it meant to have 14 CCS efforts under the MPA baseline program? What has been learned?

Group discussion following Goal 2 presentations

Project Team members shared that the State wants to do the right thing on equity, both concerning Tribal Nations and under-represented communities, there is good intent, but also there is a struggle around action and creating change. A number of strategies were discussed, including: 1. Engaging statewide and regional leadership (e.g. Christina Snider, the Governor's Tribal Advisor, EPA's Pacific Southwest Region (Region 9)), 2. Secretary Crowfoot will be adding two Assistant Secretary positions (Tribes-focused and under-represented communities-focus), 3. Better communication and coordination between each agency's Tribal liaisons, and 4. Leveraging the relationships built during the MPA baseline monitoring period, and expanding those relationships to partner on other climate threats like sea-level rise.

With regards to CCS, strategies discussed to increase engagement and use were creating an inventory, or statewide database, of CCS activities to leverage for different topics like sea-level rise ([SciStarter](#) and [iNaturalist](#) were mentioned as resources). Elements of a statewide database would include adding metadata on how CCS efforts connect to address local/regional/statewide needs.

3. Goal 3: Enhance Coastal and Marine Biodiversity

Steven Morgan (Dept of Environmental Science and Policy) presented on his lab's extensive work relating to the establishment and evaluation of the MPA network. Professor Morgan touched on these specific Objectives:

- Objective 3.1, 3.3: connectivity of the MPAs using four approaches (larval surveys, robot larvae, biophysical modeling, and natural elemental markers); long-term monitoring projects on sandy beach habitat; support of the Monitoring Action Plan
- Objective 3.4: quantified microplastic accumulation of biomagnification in Bodega Bay
- Objective 3.5: develop early warning system for planktonic dispersal of invasive species by DNA fingerprinting
- Objective 1.3: impact of seastar wasting disease, and impact of climate change on rocky intertidal communities

Alan Hastings (Dept of Environmental Science and Policy) presented on "Transient Dynamics of Ecology," or the importance of understanding ecological timescales with regards to conservation outcomes. As many ecological systems exhibit transient dynamics, they are particularly important for management considerations. Professor Hastings shared key papers on these specific Objectives:

- Objective 3.6: key paper, Wilson et al. 2015. A typology of time-scale mismatches and behavioral interventions to diagnose and solve conservation problems. *Conservation Biology*, 30:1.
- Objective 3.1: key paper, Hastings et al. 2018. Transient phenomena in ecology. *Science*, 361.

Louis "Loo" Botsford (Dept of Wildlife, Fish, and Conservation Biology) presented on "Spatial Management of Marine Resources Under Climate Change," and his lab's extensive work on the MPA network. Specifically, Professor Botsford's work examines population dynamics, modeling to predict fish population change, supporting sound management decisions. Professor Botsford's lab is also examining MPAs and resilience (depends on how sensitive populations are to environmental frequencies). Key papers for Objective 3.1:

- [White et al. 2013. Transient responses of fished populations to marine reserve establishment. *Conservation Letters* 6:3.](#)
- White et al. (2013, *Ocean Cons Mgmt*);
- [Botsford et al. 2014. Chapter Six - Marine Protected Area Networks in California, USA. *Advances in Marine Biology*. 69.](#)
- [White et al. 2016. Fitting state-space integral projection models to size-structured time series data to estimate unknown parameters. *Ecological Applications*. 26:8.](#)
- [Kaplan et al. 2019. Model-based assessment of persistence in proposed marine protected area designs. *Ecological Applications*. 19:2.](#)
- [Nickols et al. 2019. Setting ecological expectations for adaptive management of marine protected areas. *Journal of Applied Ecology*. 56:10.](#)

Marissa Baskett (Dept of Environmental Science and Policy, OPC SAT member) presented "Marine community and evolutionary conservation," with an emphasis on restoring and protecting kelp habitat. Professor Baskett touched on these specific Objectives:

- Objective 3.1: How species interactions affect MPA design and expectations
- Objective 3.3: Protection against fisheries-based selection for earlier maturity & smaller fish
- Objective 3.2: Socio-ecological kelp restoration: new multidisciplinary collaboration examining drivers of the efficacy of interventions across the social and natural systems

- Objective 3.3.3: Restoration considerations: protection alone may not be enough, exploring interventions like captive breeding, assisted gene flow, assisted migration and their risks/benefits (decision frameworks) are worth considering.
- Objective 1.4 (new work): The capacity for MPAs to buffer against climate change

Kiva Oken (Dept of Wildlife, Fish, and Conservation Biology) presented work from her quantitative fisheries ecology lab, using tools of stock assessment science and applying them to new factors like species interactions, vessel dynamics and socio-economic implications. Professor Oken's work applies to Objectives 3.3, 2.5, and 4.1. Current research questions: 1. How selective does lingcod fishing gear need to be to allow sensitive rockfish populations to continue to recover?, 2. What is the effect of temperature on productivity of marine fish populations?, and 3. How do synchrony of productivity (environment) and permit access (management) interact to influence profitability and revenue stability?

Peter Moyle (Dept of Wildlife, Fish, and Conservation Biology) presented on his extensive work in the Suisun Marsh and San Francisco Estuary and the connection to the marine environment (Objective 3.3). Suisun Marsh is a highly modified (novel) environment, with novel fish assemblages and many non-natives. Although this is a highly studied area, there is a need for integration of that information to provide a bigger picture. Professor Moyle is also examining the South SF Bay restored tidal wetlands and the spawning and recruitment of longfin smelt (listed endangered).

Kirsten Gilardi (UC Davis Veterinary Medicine) presented on the veterinary school's efforts related to Objective 3.3, 3.4. The school handles the recovery and care of birds impacted by oil spill in California. They also tackle marine debris, ghost fishing gear, and wildlife entanglement (lost fishing gear is half of all marine macroplastics), and coordinate multiple entities in the California Lost Fishing Gear Recovery Project. Future directions: 1. Engagement of additional fisheries ALDFG mitigation, 2. Research and development for gear-loss prevention, and 3. Impacts of marine plastics (biological, toxicological, and ecological).

Jay Stachowicz (Dept of Evolution and Ecology, OPC SAT member) presented on restoration considerations of eelgrass habitats, and the importance of genetic diversity in sustaining the many benefits of these habitats. Using Tomales Bay as a laboratory (high spatial variability): when thinking about restoration, eelgrasses are specialized to temperature, so you need to think about which areas you are transplanting from and transplanting to. Important when mapping possible restoration locations. Across their ranges, eelgrasses have incredible genetic diversity. Professor Stachowicz is also examining eelgrass wasting disease, through monitoring and assessment by machine learning (scoring disease intensity from pictures).

Christine Kreuder Johnson (UC Davis Veterinary Medicine) presented on "Tracking Disease in Marine Food Webs and Investigating Impacts of Disease on Population Health," as part of Objective 3.4. Specifically on long-term monitoring of threatened southern sea otters (as indicators of coastal change and land-sea processes) and effects of land-based pathogens, and the epidemiologic investigations into domoic acid exposure and health impacts.

Tracey Goldstein (UC Davis Veterinary Medicine) presented on the efforts of the One Health Institute (OHI) Research and Diagnostic Lab as part of Objective 3.4. Centralized health diagnostic testing for marine mammals (sentinels for ocean health receiving, 1,000-plus samples from over 90 centers); supporting unusual mortality event response (e.g sea star wasting disease); and tracking disease in the face of climate change.

Group discussion following Goal 3 presentations

Discussion was wide-ranging, touching on long-term monitoring, data integration and meta analysis, infectious disease, and postdoctoral opportunities. In terms of long-term monitoring, Project Team members noted that the State is good at seed-funding projects, less so for long-term monitoring. In connection with infectious disease (pathogens that can cross species) and other public health threats like domoic acid, perhaps reframing long-term monitoring as crucial to emergency response and protecting public health is one way to address this need. Relatedly, and in terms of postdoctoral opportunities, an idea was proposed: linking a science project to science synthesis working groups. For example, OPC funds their Science Advisory Team to produce science guidance and syntheses on emerging topics, like sea-level rise and ocean acidification. Could Sea Grant fund a postdoctoral researcher/fellow to complement the working group, and perform analyses alongside the working group effort to support action on the issue?

4. Goal 4: Improve Ocean Health through a Blue Economy

Jim Sanchirico (Dept of Environmental Science and Policy) presented on the ecological and economic implications of ecosystem-based fisheries management on forage fish in the California Current and the following questions: 1) what are the economic and ecological gains from optimal food-web management? 2) what are the implications of synchronous and anti-synchronous environmental variation between anchovy and sardine stocks? 3) what are the economic and ecological impacts of pairing anchovy and sardine? Jim Sanchirico's work also examines the social and economic implications of fishery management over time, using the halibut and sablefish fisheries as case studies.

Matthew Reimer (Dept of Agricultural and Resource Economics) presented on "designing and evaluating public policy for sustainable fisheries and communities" and highlighted some challenges for policy evaluation including the fact that people respond to policy change in unanticipated ways; that is difficult to measure causal impacts in dynamic and interconnected environments and that policy changes induce general-equilibrium effects that can spill over into other fisheries and other aspects of the economy. Some of Matthew Reimer's research objectives include: addressing policy evaluation challenges through rigorous theory and empirical designs and understanding causal mechanisms to inform policy-making decisions to advance sustainable seafood and thriving fishing communities.

The work of Jim Sanchirico and Matthew Reimer addresses Goal 4. Objective 4.1.

Andrea Schreier (Dept of Animal Science) presented the work of the Genomic Variation Lab and her research using and developing genetic and genomic tools to increase sustainability of commercial and conservation aquaculture. Recent projects include: determining the causes, costs and benefits of triploidization in sturgeon culture; the genetic basis of domestication selection in the delta smelt; and the development of parentage based tagging for the Kootenai River white sturgeon conservation aquaculture program. This research could be used to improve genomic resources and develop genetic selection programs and use marker assisted selection for favorable traits to increase aquaculture sustainability. Some challenges associated with these uses include the fact that applying long read sequencing platforms to large fish with complex genomes would require cutting edge genomics tools.

Jackson Adam Gross (Dept of Animal Science) presented his research on ways to improve sustainable aquaculture production by using recirculating aquaculture systems and land-based systems. These systems could repurpose desalination brine to grow low trophic species (such as mussels) and use aquaculture effluents to fertilize crops (e.g. aquaponic systems). Other areas of his research include conducting reproductive and developmental biology studies to improve fish and bivalve culture, humane harvest of fish, habitat utilization, and water quality.

Anne Todgham (Dept of Animal Science) presented on “Future-proofing aquaculture in a changing climate”. Her work focuses on managing stress in sustainable aquaculture, especially in shellfish production where stress tolerance to changing ocean conditions is critical. Following the important loss in oyster, mussel and scallop production in the Pacific Coast between 2005-2009, this research is an opportunity for collaboration between the universities and industry to uncover the causes of decline. Anne Todgham’s work also addresses the aquatic food demand-supply gap and how to address the deficit by optimizing the species to suit the environment. Finally Anne Todgham presented on ways UC Davis is building capacity for sustainable oceans, including the Sustainable Marine Resources Initiative (SMRI) and a Sustainable Oceans graduate group.

The work of Andrea Schreier, Jackson Adam Gross and Anne Todgham addresses Goal 4. Objective 4.2.

Group discussion following Goal 4 presentations

Discussion centered on wild-caught fisheries management and aquaculture. Project team members shared that a State-sponsored sustainable seafood program is of interest (a previous effort was unsuccessful). It was suggested that perhaps this would be a good project for the OPC SAT to tackle. Project team members also shared that the State is concentrated on shellfish and kelp aquaculture at this time (both marine and terrestrial based), and that finfish aquaculture is politically more difficult. Faculty share that industry is ready for both and is eager to partner with the State and researchers. Whatever effort goes forward, the vision of ecosystem restoration and restorative (not just sustainable) seafood production should be the bar.

Note: plenary discussion at the end of the day was summarized in the "Highlights" section on page 1.