CURRENT COASTAL RESOURCE MANAGEMENT PRIORITIES AND CLIMATE ADAPTATION PLANNING IN CALIFORNIA

Report from the workshop held in Los Angeles, CA, August 20, 2019

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Preliminary Report from the Workshop held in Los Angeles, CA, August 20, 2019

Published July 14, 2020

Suggested Citation:

Fard, E., R. Ambrose, and G.M. MacDonald. 2020. Current coastal resource management priorities and climate adaptation planning in California. University of California, Los Angeles: Institute of the Environment and Sustainability.

Content

Acknowledgements

This workshop was supported with funding from the United States Geological Survey (USGS) and Southwest Climate Adaptation Science Center (SW CASC), as well as support from the Department of Geography and the Institute of Environmental Sustainability (IoES) Department at the University of California, Los Angeles (UCLA). We thank the following individuals and their organizations for their support on workshop planning, development, implementation, logistics, and follow-up suggestions: Kasi McMurray (UCLA), Matt Lebrowski (UCLA), Tanner Waters (UCLA), Jason Kindinger (UCLA). Lastly, we thank the SW CASC, and especially Gregg M. Garfin, Sarah R. LeRoy, Anita J. Govert, and Alison Meadow, for essential logistical and administrative support.

Executive summary

Background and Motivation. The one-day workshop, *Current Coastal Resource Management and Planning Priorities – How does Climate Fit In?,* was held in Los Angeles, California, at the University of California, Los Angeles (UCLA) on August 20, 2019, and brought together SW CASC scientists and coastal resource managers. This effort is part of a 5-year subgrant through UCLA and the SW CASC which focuses on coastal ecosystem physical and biological responses to climate and extreme climatic events. Over the 5-year period, three biennial regional and multi-disciplinary stakeholder meetings, organized by UCLA, will be held, focusing on issues of climate change and its impacts on California coastal environments, with a focus on marshes and estuaries. The first meeting, described in this report, set priorities and research aims, the second meeting will provide an interim assessment by a smaller select group of engaged stakeholders, and the final larger meeting will focus on communication of results and framing of management and planning actions required for current and future needs and priorities.

Climate change presents increasing challenges for vulnerable ecosystems, including coastal ecosystems. Scientists and managers are striving to meet these challenges through more collaborative approaches. This workshop brought together local, state, and federal coastal resource managers to share their current priorities and discuss where information and tools related to climate, climate variability and climate change fit into tackling those priority issues. The workshop was by invitation only, with workshop participants invited based on their broad knowledge of and experience with coastal resource management issues in California; in some cases, the invited participant recommended alternates or additional participants. This report highlights the priorities and research aims identified in this workshop.

Workshop Goals

1. Highlight the current and top priorities in coastal planning and decision making.
2. Gain insight into anticipated 21st century sea level rise and other climate variability as a factor in decision making.
3. Gain a better understanding of uses and gaps in current adaptation methods, science products and analyses, and identify the needs and barriers to implementation and use of sea level and climate data.
4. Identify and document barriers and opportunities to networking and collaboration, or science co-production, between managers and scientists.

This executive summary incorporates answers from a pre-workshop survey and conversations from the workshop to highlight major themes, current and future concerns, as well as recommendations with regards to coastal management priorities and decision-making.

Key Challenges. Workshop participants identified current challenges and research needs:

- There is a large need for greater understanding as well as increased institutional support and governance of all coastal habitats, including but not exclusive to wetlands, sea cliffs, kelp forests, rocky shores, fisheries, sandy beaches, archaeological sites, and other protected areas.

- There is an increasing need for better communication of science to stakeholders, as well as transparency with data set availability between scientists and managers, and managers and other managers.
- Research needs for many specific data and modeling related to climate change in coastal ecosystems, as well as translation of research into interactive tools adapted for protection, restoration, and conservation of coastal processes and ecosystem services for the public, managers, policy makers and other scientists.
- Improved networking opportunities for coordination, communication and collaboration among managers, scientists, tribal leaders, and other stakeholders. Current opportunities for interactions, such as conferences and project discussions, rarely attract the full range of stakeholders (e.g., focus mainly on scientists or managers) and don't provide opportunities for the types of discussions that could lead to co-production of knowledge.

Recommendations. Workshop participants identified multiple issues, as well as some possible solutions to enhance management priorities and strategies moving forward:

1. *Current top priorities in planning and decision making*. Throughout the workshop, concerns of ecosystem management in the form of protection, restoration, and conservation of coastal processes and ecosystem services were echoed by all participants.
    a. Participants focused on the threat of sea level rise to coastal wetlands. Wetland migration and the concept of 'elevation capital' (area at relatively high elevation that helps a salt marsh be resilient to sea level rise) were identified as the most important needs for wetlands to persist in the face of future sea level rise. Acquisition of upland adjacent areas and coastal properties were frequently touted as solutions to counter coastal squeeze and aid wetland inland migration.
    b. Sediment management, and particularly sediment supply, was also identified as high priority. Not only is sand a scarce resource, but not all sands are equal. When designing restoration projects, alternatives for restoring sediment pathways include removing dams, reconnecting water sources, and artificial sediment addition. Additionally, adaptation strategies to future sea level rise can be designing wetland restoration projects to emphasize higher elevations.
    c. There is a need for data showing local to regional changes in the abundance and distribution of some focal intertidal species that are perceived to be largely driven by changes in atmospheric and oceanographic patterns.
    d. The disconnect between management in freshwater and ocean systems was highlighted by the participants. While the participants manage coastal systems, there was an understanding of the importance of incorporating watershed management into coastal management decisions.
2. *Strategic monitoring and science tools and product uses and needs related to sea level rise and climate change*. Participants recognized that while there are many tools and data that are currently being used, there are current gaps for specific data and modeling related to climate change.
    a. Tools and software: 1) a common, query-enabled database, 2) specific approaches for evaluation of questions of special interest (e.g. endangered species, disease, climate change, impacts of pollution, fisheries management, coastal resilience), and 3) a set of web-based visualization tools for the public, managers, policy makers and other scientists.

b. Modeling: Regional and higher-resolution localized data and modeling (e.g. sea level rise, storm surge and coastal inundation, modeling sediment loss and pathways, ocean acidification and hypoxia, sea-surface temperatures, rainfall and water supply, range shifts and tracking data, anthropogenic vs natural background influences)
c. Management: 1) nature-based management tools demonstrating project-site selection criteria for nature-based approaches, and 2) better tools for communicating issues faced by managers, including science and solutions.

3. *Needs and barriers to implementation and use of sea level or climate data*. Communication, or lack thereof, was among the most important barriers identified by workshop participants.
    a. Workshop participants expressed a need for better pre-project research that can help reduce unnecessary expenditures of time and money. There is a growing need here for more guidance in managerial project efforts, both pre- and post-project efforts.
    b. Participants recognize the need for external expertise as a great opportunity to collaborate with university scientists. Collaboration on project efforts and science co-production between university scientists and managers can provide the opportunity to meet these needs in a mutually beneficial way.
    c. Another approach offered to improve coastal ecosystem management planning is through peer review by university researchers. Workshop participants expressed a lack of clarity and confidence in applying these tools to their own datasets. They identified a need for guidance and training in tool implementation and use. These needs can be met in part through more networking opportunities where managers, staff and university scientists can meet to engage in collaborative efforts.
4. *Participant-inspired recommendations*. Workshop participants were asked to provide recommendations that could improve stakeholder management and collaboration.
    a. By far, the biggest impediment to sound management and conservation of coastal ecosystems is a lack of understanding about those systems. Certain coastal ecosystems, such as wetlands, are widely recognized as ecologically and economically important, and have institutional support and governance, including agencies focused on managing wetlands, and established programs for funding wetland research. In contrast, open coast ecosystems such as rocky shores and sandy beaches do not have similar institutional support, with few agencies focused on managing these ecosystems and fewer opportunities for research funding. Thus, there is a substantial need for research on rocky intertidal, subtidal, sandy beach, and other coastal ecosystems.
    b. Workshop participants emphasized the need to create more opportunities for networking and collaboration among managers, scientists, tribal leaders, and other stakeholders. Current opportunities for interactions, such as conferences and project discussions, rarely attract the full range of stakeholders (e.g., focus mainly on scientists or managers) and don't provide opportunities for the types of discussions that could lead to co-production of knowledge. Workshops, such as the one held at UCLA for coastal ecosystems, create opportunities for participants to think about potential collaboration projects as well as identifying funding opportunities and developing proposals.

c. Co-production of knowledge often results from long-term relationships between researchers and managers. Although it doesn't require decades, frequent interactions between resource managers and scientists helps each group understand the other's needs and capabilities, and co-production can grow organically from this understanding.

Next steps. The workshop organizers will be following up with the participants in a year to see if co-production efforts have developed out of the first meeting. The second of three biennial regional and multi-disciplinary stakeholder meetings, organized by UCLA, will be held during the summer of 2021. This second workshop meeting will provide an interim assessment by a smaller select group of engaged stakeholders. The third, and final, larger meeting will be held during the summer of 2023 to focus on communication of results and framing of management and planning actions required for current and future needs and priorities. These workshops are developed to facilitate on-going engagement among managers, scientists, tribal leaders, and other stakeholders in California coastal management. Observations and assessments of the workshops, as well as related science co-production efforts, will be reported to the SW CASC to support general operations and structure and efforts to connect communities in future science co-production projects.

Introduction

To begin a dialog between climate scientists and resource managers, the University of California, Los Angeles (UCLA) and the Southwest Climate Adaptation Science Center (SW CASC) held a workshop on August 20, 2019, with coastal resource managers, non-profit organizations, federal and state agencies, and university scientists to identify management issues and priorities related to the impacts of climate change on coastal ecosystems. The workshop, titled *Current Coastal Resource Management and Planning Priorities – How does Climate Fit In?*, used an informal conversation format to foster an atmosphere of collaboration and engagement focused on addressing current specific needs as well as bridging the gap and creating a network of coastal practioners and researchers. Local, state, and federal coastal resource managers gathered to share their current priorities and discuss where information and tools related to climate, climate variability and climate change fit into tackling those priority issues.

This effort is part of a 5-year subgrant through UCLA and the SW CASC which focuses on coastal ecosystem physical and biological responses to climate and extreme climatic events. Over the 5-year period, three biennial regional and multi-disciplinary stakeholder meetings, organized by UCLA, will be held to focus on issues of climate change and its impacts on California coastal environments, with a focus on marshes and estuaries. The first meeting, described here, set priorities and research aims, the second meeting will provide an interim assessment by a smaller select group of engaged stakeholders, and the final larger meeting will focus on communication of results and framing of management and planning actions required for current and future needs and priorities.

Workshop Goals

1. Highlight the current and top priorities in coastal planning and decision making.
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3. Gain a better understanding of uses and gaps in current adaptation methods, science products and analyses, and identify the needs and barriers to implementation and use of sea level or climate data.
4. Identify and document barriers and opportunities to networking and collaboration, or science co-production, between managers and scientists.

Background

Climate change will present challenges for the management of all Earth's ecosystems, but perhaps nowhere will the challenge be greater than for coastal ecosystems. Coastal ecosystems, found along continental margins, include wetlands (seagrass meadows, tidal freshwater or salt marshes, mangrove forests), sea cliffs, kelp forests, rocky shores, fisheries, sandy beaches, archaeological sites, and other protected areas. While coastal ecosystems total only 6 percent of global surface area, they provide an estimated 38% of global ecosystem services (Costanza et al. 1997; Watanabe et al. 2018). Despite their societal value, coastlines and coastal habitats are increasingly threatened by overdevelopment (Feagin et al. 2005). Currently, around 40 percent of the population live within 60 miles of the coast, a trend expected to continue with rapid population growth (Neumann et al., 2015). Climate change, in addition to these impending risks, will exacerbate potential impacts on what are already considered vulnerable coastal ecosystems. In addition to impacts from changing temperature and precipitation regimes, coastal ecosystems will be affected by rising sea levels (Thorne et al. 2018) and ocean acidification (Haigh et al. 2015).

Sea levels are very likely to continue rising in more than 95 percent of the oceans by the end of the 21st century [Figure 1], affecting 70 percent of coastlines worldwide (IPCC AR5). Sea-level rise (SLR) plays an important role in the long-term sustainability of tidal ecosystems. Estimates for future SLR rates range anywhere from 29 cm up to 1 m by the end of the 21st century (DeConto & Pollard 2016), with global scale projections anticipating between 20 and 90 percent of coastal wetland loss (Schuerch et al. 2018). However, current rates of sea level rise are not uniform across the globe. For example, throughout the U.S. Pacific region tectonics can play a role in producing high rates of land subsidence or uplift that can hinder or assist coastal marshes in keeping up with current sea-level estimates. Throughout the Atlantic, the slowing Gulf stream, as well as the effects of the North Atlantic Oscillation make the coast more susceptible to rising sea levels. Thus, in some locations, SLR rates may exceed the rate at which coastal ecosystems can adapt.

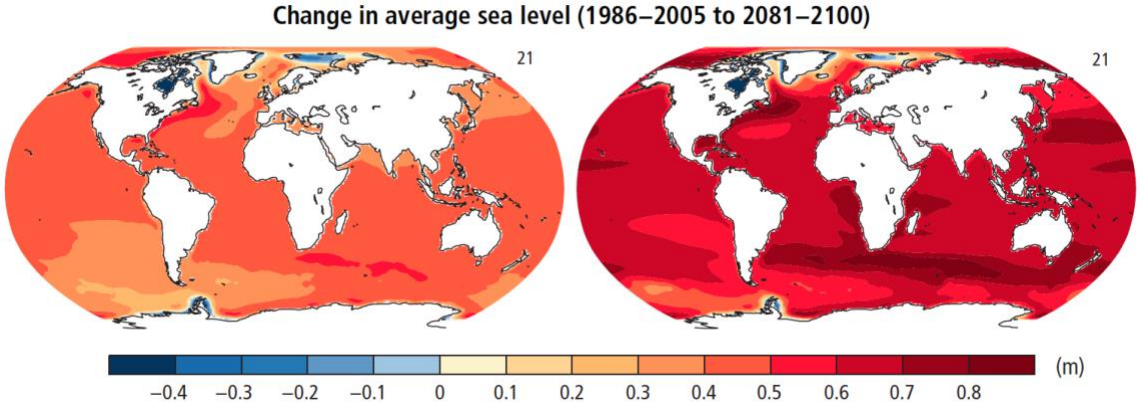

Figure 1: Coupled Model Intercomparison Project Phase 5 (CMIP5) multi-model mean projections (i.e., the average of the model projections available) for the 2081–2100 period under the RCP2.6 (left) and RCP8.5 (right) scenarios for change in average sea level. Changes are shown relative to the 1986–2005 period. The number of CMIP5 models used to calculate the multi-model mean is indicated in the upper right corner. Source: IPCC 2014

Challenges in management efforts for protection, restoration and conservation of coastal ecosystems are exacerbated by climate change and SLR impacts, which are projected to occur with the highest 'velocity' in the coastal zone (Loarie et al. 2009). These challenges have created opportunities for modelers to try and understand the dynamics of these ecosystems. The most important questions modelers are trying to answer with respect to these ecosystems are, 1) which are the most vulnerable?, 2) are they changing, and if so, what is driving this change?, and 3) what are the likely future scenarios for these ecosystems? (Wiberg et al., 2019). There has been a lot of research in answering these questions both through model outputs and through field observations, however consensus has not been reached. While many factors contribute to this lack of clarity with regards to future trajectories, climate scientists and resource managers recognize the need for more research and better understanding of the many different types of coastal ecosystems.

Geomorphological models are used widely in the scientific community to understand and project future changes in the coastal landscape, as well as in management and policy settings to make site-specific predictions that can be incorporated into future adaptation strategies. For the latter, these models tend to incorporate constant accretion rates and static topographies (Kirwan et al. 2016). In the academic community, the broader dynamic interactions between ecogeomorphic feedback systems are incorporated into models, leaving out the more localized, site-specific predictions that are required for management decisions (Kirwan et al. 2016). While these models provide benefits independently, their reliability is compromised from their own set of limitations. Coastal morphology strives to achieve equilibrium as sea levels rise, which may significantly reshape the coastal landscape. In the case of wetlands, marsh characteristics such as geomorphic setting (sediment, topographic), morphology (elevation, vegetation and tidal channel network), inundation frequency (tidal range, SLR and storm activity), and anthropogenic infrastructure influence feedback systems and play a role in landscape reshaping (Perillo et al. 2019, Kearney & Turner 2016). A better understanding of the ecogeomorphic feedback processes between the physical and ecological environment under SLR must be taken into consideration in marsh modeling and site comparisons. Ideally, models and field measurements would be incorporated and used in tandem to inform management and policy settings.

As climate change brings new challenges to coastal ecosystem management, scientists and managers are striving to meet these challenges through more collaborative approaches. Environmental scientists are increasingly motivated to search for outcomes that serve the needs of natural resource managers and decision makers (Enquist et al. 2017). However, these partnerships require the appropriate institutional arrangements, as well as active, collaborative, and trust-based engagement from both scientists and managers to develop research that informs on-the-ground management issues (Enquist et al. 2017).

About the Workshop

Who participated?

The focus of this effort was a workshop between SW CASC scientists and coastal resource managers. The workshop was by invitation only, with workshop participants invited based on their broad knowledge of and experience with coastal resource management issues in California; in some cases, the invited participant recommended alternates or additional participants. Participants represented the major federal and state agencies responsible for coastal resource management, including the Bureau of Ocean Energy Management, U.S. Fish and Wildlife Service, U.S. Navy, National Park Service, National Marine Sanctuaries Program, California Ocean Protection Council, California Coastal Conservancy, and California Coastal Commission. In addition, organizations with broad participation in coastal management issues were invited, including Heal the Bay, Santa Monica Bay Restoration Commission, and the University of Southern California Sea Grant Program. For a complete list of participants, see Appendix A.

What was discussed?

We elicited initial thoughts from workshop participants through a pre-workshop survey and workshop discussions. The survey (see Appendix B) was distributed to participants several weeks before the workshop and asked about the following topics: Top present priorities in coastal planning and decision making; Anticipated 21st century sea level rise and other climate variability as a factor in decision making; Current adaptation methods, science products and analyses used with regard to sea level and climate; Strategic monitoring and science tools and product needs related to sea level rise and climate change; and Needs and barriers to implementation and use of sea level or climate data. This summary incorporates answers from the survey and conversations from the workshop to highlight major themes, current and future concerns, as well as recommendations with regards to coastal management priorities and decision-making.

Presentations

The one-day workshop, held on August 20, 2019 at the University of California, Los Angeles, was structured to provide all participants with an opportunity to communicate personal or agency perspectives, with ample time for group discussion. Most of the 19 participants were placed on one of four panels: coastal, marine, CA state agencies, and federal agencies and other organizations. For each panel, panelists were given twenty minutes to present their organization's perspective on coastal management issues and climate change, with group discussion after each panelist's presentation. After the panel discussions, the SW CASC director gave an overview of the SW CASC and led a Q&A on how the Center could interact with stakeholders. The workshop concluded with a general discussion aimed at synthesizing the previous discussions and identifying priorities for future research or actions. We have summarized the highlights of the survey responses and workshop discussions into themes, spanning from emerging needs to implementation barriers.

Participant Insights

Current top priorities in planning and decision making

Throughout the workshop, concerns of ecosystem management in the form of protection, restoration, and conservation of coastal processes and ecosystem services were echoed by all participants. Management priorities are to protect natural resources, make sure the public has access to the coast, and to balance these with development. Coastal squeeze, the loss of beaches and wetlands, and lack of migration opportunities create future management challenges.

Participants focused on the threat of sea level rise to coastal wetlands. Wetland migration and the concept of 'elevation capital' (area at relatively high elevation that helps a salt marsh be resilient to sea level rise) were identified as the most important needs for wetlands to persist in the face of future sea level rise. Acquisition of upland adjacent areas and coastal properties were frequently touted as solutions to counter coastal squeeze and aid wetland inland migration. However, participants cautioned against the assumption that if wetlands are allowed to migrate, they will. One possibility is that it could end up being a ring of vegetation around a pothole of water. In addition, watersheds should be managed to ensure wetlands have sufficient sediment supply to keep pace with sea level rise. In scenarios with scarce sediment resources, nature-based approaches such as building horizontal levees can be implemented. In addition to concerns about responses to sea level rise, participants noted the role that coastal wetlands can play in carbon sequestration. However, more research is needed to develop standardized methods for quantifying carbon uptake in coastal estuaries, wetlands, seagrass beds, and other coastal ecosystems to allow cross-comparison and large-scale quantification efforts.

Sediment management, and particularly sediment supply, was also identified as high priority. Not only is sand a scarce resource, but not all sands are equal. Natural beach sediment sorting is managed through the interaction between the land and ocean. This is why finer grain-sized sediments, such as sand from desert regions, aren't suitable for beaches, as the finer particles can be washed away quickly. When designing restoration projects, alternatives for restoring sediment pathways include removing dams, reconnecting water sources, and artificial sediment addition. Additionally, adaptation strategies to future sea level rise can be designing wetland restoration projects to emphasize higher elevations. A need for research is looking at the ecological impacts of beach nourishment projects, a topic that is still in its infancy.

Climate impacts will affect habitats and species in those habitats in varied capacities. Coastal species ranges will shift and adapt in unparalleled fashion, and there is a growing need for understanding those localized shifts as well aid in adaptation prioritization for each species, which will affect future project design and monitoring programs. For example, as with coastal wetlands, sea level rise will require rocky intertidal and sand beach habitats to migrate landward to maintain their current area. However, it is unclear the extent to which this will be possible, and little work has been done on this topic compared to analyses of coastal wetlands. There is a need for data showing local to regional changes in the abundance and distribution of some focal intertidal species that are perceived to be largely driven by changes in atmospheric and oceanographic patterns.

The concepts of habitat conversion and habitat tradeoff were discussed in the context of managing landscapes that are changing, with the question being posed if the two are synonymous. For example, some agencies see a project as restoration while others may view it as a habitat tradeoff and/or conversion. An example of this can be seen at Mission Bay, California, where, as one participant stated, "historical tidal wetlands were lost to dredging; it was dredged to provide recreation and habitat but then facilitated more eelgrass habitat. Perhaps some of those historically dredged areas may need to get filled in to provide some sea level rise resiliency to the wetland habitats. We are thinking we need to have tradeoffs and restore some of the tidal marsh". This poses some important questions, such as: If it is known that a site is going to be gone by the end of the century, do you just let it go or do a full-scale rescue? How do you choose which sites to restore? There are certain sites where, before the sea gently comes in and washes over these sites, storms can come in and destroy these areas first. How can this be incorporated into the decision-making process? These and similar questions can be better addressed in collaborative settings with both university scientists and coastal managers.

The disconnect between management in freshwater and ocean systems was highlighted by the participants. While the participants manage coastal systems, there was an understanding of the importance of incorporating watershed management into coastal management decisions. In the case of wetlands, one participant stated, it is "clear we were looking at wetlands, but we need to look at them as systems…you have water going into groundwater systems in the upper areas, and you have riparian habitat that helps keep water there, and sediments getting into estuaries that need that". Questions arose as to the importance of understanding how much water needs to go out to the sea to make a healthy system, how much water can be stored for other ecological priorities, and what are the best ways to manage these systems so that the natural resources can be protected.

Strategic monitoring and science tools, and product uses and needs, related to sea level rise and climate change

While there are many tools and data that are currently being used, and recognition that more are needed, the most highlighted needs at the workshop are: a common, query enabled database; specific approaches for evaluation of questions of special interest (e.g. endangered species, disease, climate change, impacts of pollution, fisheries management, coastal resilience); and a set of web-based visualization tools for the public, managers, policy makers and other scientists. Participants noted the importance of having a network of monitoring sites that provide a baseline from which to judge a change in ecological community or dynamics. Participants also noted the challenges of funding the needed work, and recommended a diverse and buffered funding model. Participants currently use environmental models, vulnerability studies, and data acquisition through environmental and biological monitoring as methods used for information policy decisions. Some of the current tools utilized by participant agencies include CoSMos, CenCOOS observing data, WARMER model, NOAA and USGS SLR interactive maps, Climate Vulnerability Index, OPC projections, FEMA flood maps, King Tides Initiative, CCC's SLR Policy Guidance, Venice SLR vulnerability Assessment, Ocean Protection Councils 2018 update on SLR, and the species database on iNaturalist. These tools come from diverse sources, including ongoing government efforts, grant-funded research, and citizen science. Many agencies also have monitoring stations and collect fine-scaled data measurements used in

vulnerability and risk assessments. However, some participants voiced that all their information was provided from scientists and university institutions.

While many resources are already available for coastal management use, there are still many needs and opportunities for collaboration. Workshop participants voiced needs for many specific data and modeling related to climate change; some of these are listed below.

Data needs include:

- Regional and local ocean acidification data coupled with long term intertidal species data
- Regional scale impacts quantifying loss of beaches and areas for successful beach replenishment projects
- Coastal inundation and storm surge impacts on coastal habitats, specifically wetlands
- Geospatial data on elevation capital in salt marshes
- Better science or modelling on wetlands migration patterns and higher elevation restoration projects
- More data on high/low sea surface temperatures (SST), including marine heat waves
- More data on ocean acidification and hypoxia
- Improved data for marine fisheries-related climate change effects and potential ecosystem changes
- More data on storms and rainfall and projections of changes due to climate change, including impacts on water supply and polluted runoff
- More data on local finer-scale marine layer and cloud cover
- Better tools and analyses for gathering and synthesizing disparate sources of data to model marine habitat future states
- Range shift tracking data and projections, including tropicalization of cold temperate middle CA area
- Improved data and modeling on anthropogenic vs natural background of coastal ecosystems
- Better understanding of impacts of oil and gas facilities
- Research on alternative approaches for constructing revetments and other coastal infrastructure with higher ecological value
- Research on approaches to replace coastal infrastructure with nature-based approaches, such as living shorelines

Modeling needs include:

- Modeling sediment loss and sediment pathways
- Enhanced sea level rise projections, models of response, and a synthesis describing appropriate uses of different models
- Models of sea level rise impacts on infrastructure
- Enhanced modeling of ocean acidification and hypoxia, particularly at finer spatial scales
- Improved models for predicting changes in Pacific coast rocky intertidal habitats with regards to climate change, sea-level rise, and microclimate influences of community shifts

Management tool needs include:

- Nature-based management tools demonstrating project site selection criteria for nature-based approaches
- Better tools for communication of issues faced by managers, science and solutions

For decision-making support, managers attending the workshop recommended the following characteristics for useful tools: transparency of data sources; ease of use; combining multiple data sources in one database; ability to interact and customize data outputs; finer scale biological data; comparable resolution across different habitats and better synthesis across data sources; standardized protocols and methodologies; generation of products usable for NOAA condition reports; ability to visualize and contrast alternatives; comparison of tools, including guidance on assumptions, uncertainties, and caveats of existing models.

More general recommendations for useful decision-making support products included: more development of legislation and incentives for nature-based adaptation strategies; products and methods for science communication; generic communication tools for public outreach and communication; lists of key players (stakeholders, sources of research, working groups) on some of the key questions identified; specific guidance for national parks; scientific publication to fuel policy planning.

Needs and barriers to implementation and use of sea level or climate data

Communication, or lack thereof, was among the most important barriers identified by workshop participants, who made a distinction between internal and external barriers. An example of internal barriers was provided by one participant, who noted that they have 30 years of continuous data that remains unused due to staff capacity and knowledge limitations, as well as lack of proper scientific connections. For many projects, funding for project implementation, management, and/or data analysis and evaluation is not available. One participant noted: "We are on a conveyor belt…Our shortfall is in evaluation…Often, we don't get the annual report to look at if [projects] are meeting their criteria…we are trying to get information on how to do the next [project] better". For example, in restoration projects, due to lack of time and resources, most projects don't have a post-project review to ensure they were built to requirements. Another example of this can be seen in early project implementation stages. Workshop participants expressed a need for better pre-project research that can help reduce unnecessary expenditures of time and money. There is a growing need here for more guidance in managerial project efforts, both pre- and post- project efforts. However, it is important to acknowledge the challenges of funding such efforts. Funding for project implementation can be difficult to acquire, some agencies do not have the ability to pursue external funding, and necessary external supplemental expertise from consultants or university scientists requires additional funding.

Participants recognize the need for external expertise as a great opportunity to collaborate with university scientists. Collaboration on project efforts and science co-production between university scientists and managers can provide the opportunity to meet these needs in a mutually beneficial way. Nonetheless, managers commented on gaps in their knowledge of the scientific capabilities within academic institutions and their role in actionable science. Managers have also expressed frustration when seeking out this information, which can be formal and dissuasive.

There is a need for spaces where scientists and managers can meet to create better connections and increase opportunities for collaborations with university scientists. There are examples where these connections have been made with success, but they are not common.

Another approach offered to improve coastal ecosystem management planning is through peer review by university researchers. Some managers express uncertainty in correct implementation of models or data usage. More often, the staff using certain models or data analysis tools are not coming from a background in academia and do not collaborate with scientists who use a variety of these environmental analysis tools on a more frequent basis. Workshop participants expressed a lack of clarity and confidence in applying these tools to their own datasets. They identified a need for guidance and training in tool implementation and use. Although this training could be achieved through formal classes or workshops, informal guidance from knowledgeable scientists would also be helpful. These needs can be met in part through more networking opportunities where managers, staff and university scientists can meet to engage in collaborative efforts.

Participant-inspired recommendations

Workshop participants were asked to provide recommendations that could improve stakeholder management and collaboration. This section summarizes the collection of those recommendations:

By far, the biggest impediment to sound management and conservation of coastal ecosystems is a lack of understanding about those systems. As noted earlier, there is a need for greater understanding of all coastal habitats, including but not exclusive to wetlands, sea cliffs, kelp forests, rocky shores, fisheries, sandy beaches, archaeological sites, and other protected areas. Many specific needs for research and management tools related to climate change were mentioned earlier in the section on *Strategic monitoring and science tools*. This is not only a science issue, but also a social science issue that applies both locally and globally. This issue can be seen in the case of the coastal habitats discussed at the workshop. Wetlands, which are widely recognized as ecologically and economically important, have institutional support and governance, including agencies focused on managing wetlands, and established programs for funding wetland research. Although important scientific and management questions remain, many years of research on coastal wetlands and how they will be affected by climate change has resulted in a solid scientific basis for making management decisions. In contrast, open coast ecosystems such as rocky shores and sandy beaches do not have similar institutional support, with few agencies focused on managing these ecosystems and fewer opportunities for research funding. Thus, there is a substantial need for research on rocky intertidal, subtidal, sandy beach, and other coastal ecosystems. Besides basic ecological questions, more specific research is needed on how these ecosystems will respond to the different dimensions of climate change and the efficacy of potential adaptation and restoration techniques.

Workshop participants also emphasized the need to create more opportunities for networking and collaboration among managers, scientists, tribal leaders, and other stakeholders. Current opportunities for interactions, such as conferences and project discussions, rarely attract the full range of stakeholders (e.g., focus mainly on scientists or managers) and don't provide opportunities for the types of discussions that could lead to co-production of knowledge. Workshops, such as the one held at UCLA for coastal ecosystems, create opportunities for

participants to think about potential collaboration projects as well as identifying funding opportunities and developing proposals. The UCLA workshop was unusual by its inclusion of managers, scientists and other stakeholders focused on the full range of coastal habitats, but more narrowly focused gatherings could also be productive. For example, a special council could be created for particular projects that would bring in multiple perspectives to allow for prioritization of ideas.

In our experience, co-production of knowledge often results from long-term relationships between researchers and managers. For example, for the past 25 years university researchers and coastal managers have been participating in the Multi-Agency Rocky Intertidal Network (MARINe), a consortium of state and federal agencies and others interested in rocky intertidal monitoring and management (see www.pacificrockyintertidal.org). Management needs and the current status of rocky intertidal communities and rocky intertidal research along the west coast of North America are discussed at annual meetings. Long-term monitoring data identified the decline of rockweeds throughout much of California, which led to a successful proposal, funded by the California Ocean Protection Council, from university researchers and scientists at the Channel Islands National Park to restore rockweed populations within the Park and other regions in southern California. The genesis of this proposal stemmed from the shared concerns about conserving rocky intertidal communities, and the actual proposal was facilitated by regular interactions through MARINe meetings. Although it doesn't require decades, frequent interactions between resource managers and scientists helps each group understand the other's needs and capabilities, and co-production can grow organically from this understanding.

Summary and Next Steps

Through the collective workshop experience, guided by presentations, discussion, and thematic panel discussions, workshop participants identified the most current needs in coastal management settings, as well as prioritized the key needs and strategies for further enhancing knowledge, engagement, and collaboration in addressing and preparing for future coastal challenges in California.

Workshop participants identified multiple issues, as well as some possible solutions to enhance management priorities and strategies moving forward. The biggest impediment to sound management and conservation of coastal ecosystems is a lack of understanding about those systems. There is a large need for greater understanding, as well as increased institutional support and governance of all coastal habitats, including but not exclusive to wetlands, sea cliffs, kelp forests, rocky shores, fisheries, sandy beaches, archaeological sites, and other protected areas. In addition, there is need to create more opportunities for networking and collaboration among managers, scientists, tribal leaders, and other stakeholders. Creating spaces to attract the full range of stakeholders provides opportunities for discussion that can lead to science co-production. Finally, workshop participants emphasized the need for better communication of science to stakeholders, and transparency with data set availability across and between scientists and managers.

Next steps

The workshop organizers will be following up with the participants in a year to see if co-production efforts have developed out of the first meeting. The second of three biennial regional and multi-disciplinary stakeholder meetings, organized by UCLA, will be held during the summer of 2021. This second workshop meeting will provide an interim assessment by a smaller select group of engaged stakeholders. The third, and final, larger meeting will be held during the summer of 2023 to focus on communication of results and framing of management and planning actions required for current and future needs and priorities. These workshops are developed to facilitate on-going engagement between among managers, scientists, tribal leaders, and other stakeholders in California coastal management. Insights from this workshop could assist management and adaptation strategy implementation in coastal ecosystems as well as other regions and ecosystems with similar challenges. Observations and assessments of the workshops, as well as related science co-production efforts, will be reported to the SW CASC to support general operations and structure, and efforts to connect communities in future science co-production projects.

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Appendices

Appendix A: List of workshop participants

Participant	Agency
Coastal Wetlands Perspectives	
Evyan Sloane	California Coastal Conservancy
Valeria Vartanian	Mugu Lagoon - US Navy
Jonna Engel	California Coastal Commission
Marine Perspectives	
Lisa Gilbane	Bureau of Ocean Management
Steve Whitaker	Channel Islands NPS
Keith Lombardo	NPS Mediterranean Coast Network
Steve Lonhart	Monterey Bay National Marine Sanctuary
Tom Ford	Santa Monica Bay Restoration Commission
California State Agency Perspectives	
Dani Ziff	California Coastal Commission
Denise Truong	California Coastal Commission
Travis Buck	California Department of Fish & Wildlife
Justine Kimball	Ocean Protection Council
Federal and Other Perspectives	
Shelley Luce	Heal the Bay
Kristin Hoppa	National Park Service
Nick Sadropore	USC Sea Grant
Other	
Kyle Cavanaugh	UCLA Geography
Greg Garfin	University of Arizona - PI of the SW CASC
Richard Ambrose	UCLA Environmental Health Sciences and Institute of Environment & Sustainability
Glen MacDonald	UCLA Geography and Institute of Environment & Sustainability

Appendix B: Workshop agenda

US DEPARTMENT OF INTERIOR SW CASC WORKSHOP AGENDA

August 20, 2019

9:00 am	Continental Breakfast
9:45 am	Introduction and Workshop Overview
10:00 am – 10:40 am	Coastal Wetlands Perspectives Panelist Priorities (20 Min) Open Discussion (20 min)
10:40 am – 11:40 am	Marine Perspectives Panelist Priorities (30 min) Open Discussion (30 min)
12:00 pm – 1:00 pm	Lunch
1:00 pm – 1:40 pm	California State Agency Perspectives Panelists Priorities (20 min) Open Discussion (20 min)
1:40 pm – 2:20 pm	Federal and Other Perspectives Panelist Priorities (20 min) Open Discussion (20 min)
2:20 pm -	Coffee Break
2:30 pm – 3:00 pm	Overview of DoI SW CASC and Questions (Gregg Garfin)
3:00 pm -	Group Discussion and Identification of Priorities
4:00 pm -	Adjourn

Appendix C: Pre-workshop survey

UCLA SW CASC Coastal Workshop Survey

Name: _____

Agency: _____

1) What are your top priorities in planning and decision making at present?

_____

_____

_____

_____

2) Is anticipated 21st century sea level rise a factor in your decision making?

Yes No

3) Are other aspects of climate variability and change a factor in your decision making?

Yes No

4) If you answered yes, how does sea level or climate adaptation play into your work?

_____

_____

_____

_____

Appendix B: (continued)

UCLA SW CASC Coastal Workshop Survey

5) What sea level and climate-related science products or analyses are you using at present?

_____

_____

_____

6) What climate-related tools or analyses would you find most useful that you currently don't have?

_____

_____

_____

7) What are the biggest barriers to your use of sea level or climate data?

_____

_____

_____

_____

8) What are the most important ways the Department of Interior SW Climate Adaptation Science Center might help you?

_____

_____

_____

_____