Monitoring Resilience to Climate Change in Temperate Marine Ecosystems

Focus Group Summary Report
International Marine Conservation Congress (IMCC)
May 16, 2011
Victoria, British Columbia

Overview

Marine ecosystems are a major focus of concern regarding the potential impacts of anthropogenic climate change. While “alerting signals” and recommendations for monitoring resilience to climate change have been developed for coral reefs, in temperate marine ecosystems relatively little guidance exists for developing feasible approaches to monitor climate change effects. In California, a statewide network of marine protected areas (MPAs) is being implemented to, among other things, protect ecosystem structure, function, and integrity. Monitoring plans for these MPAs are being developed, creating a timely opportunity to build in an early warning system and measure the resilience of temperate marine ecosystems to climate change. During the IMCC conference in Victoria, British Columbia, the MPA Monitoring Enterprise and EcoAdapt hosted a two hour focus group entitled *Monitoring resilience to climate change in temperate marine ecosystems*. Here we provide a summary of the discussion during the focus group session.

Objectives and Intended Outcomes

The goal of the focus group was to gather experts from temperate and tropical marine ecosystems to discuss and recommend feasible approaches for monitoring climate change effects within Pacific nearshore rocky marine ecosystems. Approximately 28 experts from federal and state agencies, universities, and NGOs were tasked with:

- Identifying aspects of nearshore rocky marine environments that could confer resilience to climate change effects;
- Recommending aspects of these ecosystems, including sentinel species, that should be targets of monitoring to alert to climate change effects; and
- Identifying feasible and practical monitoring approaches.

Focus Group Discussion

The discussion portion of the focus group focused around the following points:

- Characteristics of Pacific nearshore rocky marine ecosystems
- Climate change impacts likely to affect Pacific nearshore rocky ecosystems

- Aspects of climate change that are already incorporated into MPA monitoring
- Aspects of nearshore rocky ecosystems that should be monitored in light of climate change

Characteristics of Pacific nearshore rocky marine ecosystems

Focus group participants discussed the key components of Pacific nearshore rocky ecosystems as they relate to potential climate change effects. Key ecosystems, species, and habitats that were discussed include rocky intertidal zones, kelp forests, and nearshore pelagic waters that are strongly influenced by tides, strong wave action, and upwelling currents. Intertidal zones are populated with sessile invertebrates and algae. In shallow subtidal systems, kelp forests and subcanopy macroalgae form diverse, highly functional habitats that provide food and refuge for a variety of organisms, including demersal species like rockfish and lingcod. These nearshore ecosystems are home to a variety of fishes, invertebrates, marine mammals, and sea and shorebirds.

Climate change impacts of importance to Pacific nearshore rocky marine ecosystems

Participants also discussed the range of climate change impacts likely to be seen in Pacific nearshore rocky ecosystems, including physical impacts and biological responses:

Physical Impacts	Biological Responses
• Temperature (air and water) changes • Ocean acidification • Increased frequency and intensity of storm events and subsequent issues, such as erosion and runoff • Sea level rise, exacerbating erosion and flooding, leading to loss or changes in habitat availability and type • Changes in salinity • Changes in both frequency and strength of coastal upwelling • Increasing wave height and changes in mean wave patterns • Alterations in seasonal precipitation • Changes in circulation patterns and currents • Changes in stratification from precipitation, salinity, and temperature changes • Deoxygenation and hypoxia • Changes in sediment load and substrate	• Phenological shifts – timing of spawning, changes in development and behavior, delays associated with productivity • Changes in species distribution and range (deeper, northward) • Increases in number of invasions as well as in number of invasive species • Population decline from decreased food availability and habitat loss • Distributions along intertidal gradient that may change with flooding and temperature changes • Disease outbreaks • Decreased productivity due to changes in coastal upwelling • Trophic cascades

Participants noted that the aforementioned climate change impacts should be observed within the context of:

- *Naturally occurring climatic variability*, like interannual ENSO (El Niño/ Southern Oscillation) and interdecadal PDO (Pacific Decadal Oscillation) events, which are characterized by warm and cool phases and changes in sea surface temperatures and wind patterns;
- *Extremes* in air and water temperatures and pH levels;
- *Anomalies* in temperature and salinity, which have been extremely useful indicators in predicting and responding to bleaching events in coral reef ecosystems; and
- *Non-climate stressors*, such as overexploitation of fisheries, habitat degradation, disease, non-native or invasive species, and pollution that may interact with and exacerbate the impacts of climate change.

Participants stressed the following in this section:

1. Temperate marine systems are characterized by a high degree of environmental variability, therefore tracking anomalies may be difficult.
2. Variability may not necessarily increase with the advance of climate change; climate change could force lower variability in marine systems.
3. Listing climate change impacts is not as important as considering predictions of the direction of changes (e.g., increasing, decreasing).
4. A matrix of predictive changes may be helpful in assisting the MPA Monitoring Enterprise identify key species and habitats within a system, which can then be used to prioritize monitoring for climate change.
5. Choose indicator species that can serve as early warning signals of climate change.

<u>Aspects of climate change that are already incorporated into MPA monitoring</u>

MPAs are regularly perceived as control sites and can serve as reference points for climate change effects. Participants were asked to list existing indicators of climate change that are monitored within MPAs. Among those metrics listed were water temperatures, storm patterns, and upwelling patterns. Participants from coral reef ecosystems noted that managers monitor for pulse events that can serve as early warning alerts; the same type of monitoring could work for temperate marine systems. For example, in 2005, a delay in coastal upwelling of the California current resulted in a major monitoring push by scientists and managers in the region. This event-based monitoring approach found reduced plankton abundance, breeding failures, mortality and migrations of salmon and birds, and decreased salmon runs. If another pulse type event happened again in the California region, participants suggested that monitoring for changes in krill and other planktonic species should be prioritized.

Early warning alerting system examples from the Pacific coast:

- Integrated Ocean Observing System (IOOS) (www.ioos.gov)
- Mussel temperature measurements (e.g., Brian Helmuth's group at the University of South Carolina, http://tbone.biol.sc.edu/forecasting_test/index.html)
- Informal oceanographer network
- ENSO Alert System from NOAA's Climate Prediction Center (http://www.cpc.noaa.gov)

Participants stressed the following in this section:

1. Pulse event monitoring is as important in temperate systems as in tropical systems; however, it is also important to monitor for press/long-term trends.
2. Monitoring for indicators of process versus indicators of patterns in changes to the system has proven important in coral systems and could apply to temperate marine systems; while biological processes are more difficult to measure than patterns, process monitoring should be prioritized in any framework.
3. Event-based monitoring for rapid management response is necessary, but long-term data collection should not be neglected.
4. Indicator-based monitoring may find beneficial or detrimental changes; indicators of changes versus indicators of trouble will require value judgments on a case-by-case basis.

Aspects of nearshore rocky ecosystems that should be monitored in light of climate change

Physical characteristics (e.g., SST) are important to monitor, although these are likely under the monitoring mandates of other agencies and programs. As far as biological monitoring, participants noted that rockfish and kelp are two options for monitoring targets in the face of climate change. *Rockfish* are very sensitive to episodic and long-term perturbations; measuring rockfish recruitment can help managers understand population response rates in the context of MPAs. *Kelp* act as a structural base for many organisms and there is a strong relationship between kelp density and productivity rates; by pinpointing climate change effects that may alter kelp forest structure, managers could monitor for those changes.

Other species that could be monitoring targets in the region should be based on six criteria as determined by the focus group. Species should meet at least some of the following:

1. Have a key ecological/foundational role (e.g. if the response of *Pisaster* is known, then mussel response and cascading effects can be predicted)
2. Be known to be sensitive to change
3. Have associated historical data against which to measure change
4. Be easy to quantify
5. Have a low natural level of variability
6. Respond to MPA performance

Participants stressed the following in this section:

1. Both physical and biological monitoring should consider the frequency, magnitude, and direction of change in both spatial and temporal contexts.
2. Consider the "other" in light of climate change. With the onset of global climate change, there may be many unanticipated effects. Monitoring programs should be flexible enough to allow detection and recording of anomalous events; these may yield the most informative measures of climate change effects.
3. Monitoring needs to pay attention to the lag effect (e.g., time between change and response to change).

Summary

The focus group yielded the following primary recommendations for the MPA Monitoring Enterprise to consider:

- Examine how monitoring is already done within MPAs and consider mechanisms to <u>analyze existing data in a new context</u> with respect to climate change.
- Consider <u>directional predictions</u> (e.g., increasing, decreasing) of climate change impacts when applying monitoring framework.
- Monitor <u>episodic events and long-term changes</u> within the context of interannual and interdecadal events like ENSO and PDO. Early warning alerts may be key.
- <u>Make value judgments</u> when it comes to evaluating indicators of change.
- Pay attention to the <u>scope of physical and biological monitoring</u> and pass off monitoring to agencies or other groups if possible.
- Identify species that <u>meet some of the six criteria for biological monitoring</u> derived by focus group.
- <u>Consider the "other"</u> in all monitoring.

Next steps

The MPA Monitoring Enterprise, with the assistance of EcoAdapt, is working to create a framework for climate change monitoring in temperate systems. Focus group participants are invited to continue on in this process in an advisory capacity, including review of this focus group summary report and future documents.

<u>Focus Group Agenda</u>

Monitoring resilience to climate change in temperate marine ecosystems
2:15 – 4:15
Sidney Room (Level 2 of the Conference Center)

Agenda:
2:15 – 2:20 Introductions

2:20 – 2:30 Overview of the questions and our approach to monitoring

2:30 – 3:45 Discussion

- How is climate change affecting temperate marine systems? Are MPAs likely to respond differently and, if so, in what ways?
- How can climate-related changes be effectively monitored?
- Can we identify specific aspects of nearshore rocky marine ecosystems that could confer resilience to climate change effects?
- What aspects of these ecosystems (function, composition and process), including sentinel species, should be monitored to alert to climate change effects?
- How can temperate ecosystem monitoring incorporate monitoring of ecosystem resilience that is feasible and practical?
- Do any of these answers change given the effects of ocean acidification or sea level rise?

3:45 – 4:00 Summarize results of discussion

4:00 – 4:15 Next steps and focus group close

Focus Group Participant List

Name	Affiliation
Jahson Alemu	Institute of Marine Affairs - Trinidad and Tobago
Jessica Blythe	University of Victoria
Eric Bjorkstedt	NOAA SWFSC
Tanya Bryan	The Nature Conservancy
Shallin Busch	NOAA NMFS/NWFSC
Stuart Campbell	Wildlife Conservation Society
Eira Carballo	Wageningen University
Mark Carr	UC Santa Cruz
Jenn Caselle	UC Santa Barbara
John Cigliano	Cedar Crest College
Isabelle Côté	Simon Fraser University
Phil Fenberg	
Melissa Foley	Center for Ocean Solutions
Heather Galindo	COMPASS
Alison Green	The Nature Conservancy
Chris Harley	University of British Columbia
Kelley Higgason	Gulf of the Farallones National Marine Sanctuary
Ibrahim Khan	Dalhousie University
Phil Levin	NOAA NWFSC
Carolyn Lundquist	National Institute of Water and Atmospheric Research
Jeff Maynard	University of Melbourne
Tim McClanahan	Wildlife Conservation Society
Steven Murray	California State University - Fullerton
Michelle Paddack	Santa Barbara City College
Dan Robinette	PRBO Conservation Science
Astrid Scholz	EcoTrust
Jennifer Sunday	Simon Fraser University
Peter Stevick	
Brian Tissot	Washington State University