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Planning MPAs in an era of warming oceans: How practitioners are preparing for future ecosystem shifts

As the 2020 deadline grows nearer for nations to set aside 10% of waters in well-managed MPAs (Aichi Target 11), planners are being challenged to provide advice on what to protect and where to protect it. Climate change is making those decisions harder. As evidence mounts that warming oceans are already having effects on ecosystems, planners are faced with forecasting the changes the future could hold – then figuring how MPAs could account for those changes.

Warming-related shifts in species and habitats are among the most visible impacts. Sperm whales are now showing up in the Canadian Arctic, where they had not been observed prior to 2014. Humpback whales – the keystone species in the Hawaiian Islands Humpback Whale National Marine Sanctuary – appear to be starting to go somewhere else, although it's unknown where. Countless smaller species are shifting poleward or to deeper waters.

If you are planning an MPA and want your site to be relevant and resilient 100 years from now – or even after 50 years – how can you take potential ecosystem shifts into account?

This month we pose that question to MPA planners and others who are already wrestling with the challenge. (Please note that there are already a number of existing guides on this topic, which often focus on designating networks of MPAs to allow for shifts over time, an ideal strategy. See box below, "Guidance on designing MPAs for climate change resilience".)

This article continues our climate change coverage from last month, in which we examined how MPA *managers* are adjusting to climate-related impacts that are already happening at their existing sites.

Guidance on designing MPAs for climate change resilience

Harnessing Ecological Spatial Connectivity for Effective Marine Protected Areas and Resilient Marine Ecosystems: Scientific Synthesis and Action Agenda. Marine Protected Areas Federal Advisory Committee (US). 2017

Designing Marine Protected Area Networks to Achieve Fisheries, Biodiversity and Climate Change Objectives in Tropical Ecosystems: A Practitioner Guide. Coral Triangle Initiative. 2013.

Scientific Guidelines for Designing Resilient Marine Protected Area Networks in a Changing Climate. Commission for Environmental Cooperation. 2012.

Coral reef module: Resilient MPA design. Reef Resilience Network.

Consider how ecological connectivity will change

MPAs are often designed in relative isolation from one another. The goal is simply to protect a particular key habitat or biodiversity hotspot. Preferably, new MPAs are considered as part of larger networks that are genetically linked via ocean currents where known. The currents can help disperse the larvae of fish, invertebrates, and other marine species beyond an MPA's borders. With good ecological connectivity among reserves, one area can help maintain healthy biodiversity in other sites, or even help repopulate them in the case of a mass bleaching event, destructive cyclone, or other climate-related disaster. (As noted in the box on page 1 of this issue, there are several guides available on designing networks of MPAs that are resilient to climate change.)

However, warming waters introduce a new and unfortunate kink to this kind of conservation planning, says Jorge Álvarez-Romero, a research fellow at James Cook University in Australia. In warmer water, emerging research shows that the larvae developmental stage of many species is generally shorter. A shorter larvae stage may also shorten the distance that larvae disperse in the ocean, threatening existing connectivity between protected regions.

Working closely with a local conservation group called COBI (Comunidad y Biodiversidad, A.C.) in Mexico's northern Gulf of California rocky reef ecosystems, Álvarez-Romero led a 2017 study to design a network of reserves around the Midriff Islands. The study accounted both for current and future connectivity under climate change. Three ecologically and commercially important species were used for the modeling (leopard grouper, rock scallop, and blue crab), and the analysis also considered socioeconomic concerns of local fishers. The goal was to create an economically realistic network of protected areas that would offer ecological connectivity – even under climate-changed conditions.

“If we are going to consider connectivity we need to consider how that could change under global warming,” he says. “That is something that hasn't really been examined before.”

The results of the work show that larval connectivity would be significantly decreased in the Midriff Islands region – at least for the three species chosen. As a result, to maintain healthy genetic exchange, the paper's proposed network design made its MPAs both closer together and somewhat larger than they would be if climate change were not considered. “There were some areas that may not have been important to protect the system as a whole,” he says, “but they were selected in our exercise because they acted as stepping stones, essentially making the system connected and closer together.”

Álvarez-Romero says this proposed network design is informing active, ongoing discussions among COBI, local communities, and the local, state, and federal governments to plan a system of reserves in the region and improve management throughout the area. He believes planners in other regions of the world could adapt his framework for incorporating climate change in connectivity design.

He adds there is another potential side effect of the Midriff Islands climate-resilient design. “Because you have more areas and more reserves, you also potentially have to talk to more people and work with more communities,” he says. “From a practical point of view, that's also a big change.”

Continually integrate the latest science in your planning

With relatively bleak projections (like here and here) for the future of coral reefs as oceans warm, it is important for MPA planners to use data and modeling to create resilient designs, as Álvarez-Romero did. Even with a good plan, however, designations often take longer to come to fruition than planners might hope. That has been the case in the Lesser Sunda region of Indonesia, a group of islands at the southern end of the Coral Triangle that hosts diverse coral habitat, migrating cetaceans, and sea turtles. Due to its location in a cold water upwelling area, the region is thought to be relatively resilient to climate change.

According to Glaudy Perdanahardja, senior ocean protection manager at The Nature Conservancy Indonesia, a network of MPAs in Lesser Sunda has been under planning for more than a decade. There has been progress but it has been slow. The upside is that the delays have allowed the plans to be updated as new climate information and data improve, and such science has improved substantially.

“In 2017, we helped the government to refine the 2009 scientific design with more reliable data and information,” says Perdanahardja. “Historical and projected future exposure to coral bleaching was applied to identify conservation priorities in the region. And a revised habitat and coastal ecosystem map was derived from much higher resolution of satellite imagery, along with a ground-truth survey. The information gathered – including human interactions in the sea space – was incorporated into the biophysical and socio-economic principles for a refined network design,” he said.

This updated design contains 77 individual MPAs covering 75,000 km^2. Of the 77 sites, 35 are already formally designated MPAs, 28 are proposed areas that lack formal designation, and another 14 are called “areas of interest.” According to a report from The Nature Conservancy, the design includes a mix of reefs with high historical exposures to thermal stress – so they have already proven resilient – as well as reefs with relatively low projected future exposures to thermal stress. The latter areas may act as refuges for larvae from adjacent reefs that bleach and die. (According to their criteria, reefs projected to have fewer than 13 thermal stress events between the years 2040 and 2060 were considered to have low projected future exposures.)

Formal designations will help each MPA access government funding and management. Perdanahardja notes, however, that designating an MPA in Lesser Sunda is a long process, especially because the region spans three provinces (Bali, West Nusa Tengara, and East Nusa Tengara) and lacks a collaborative management body to engage all stakeholders and levels of government.

Given that formal MPA designations can take years to happen, Perdanahardja says The Nature Conservancy in Indonesia is also working with communities in the area on climate change adaptation in general. While it is impossible to control climate change locally, effective management of local stressors can improve resilience against climate impacts.

“We are now focused on identifying more good practices performed by the local community to manage marine spaces and their natural resource management,” he says. This includes formalizing local customary practices that may set traditional rules for who can fish, when, and where. “We use science to help the community develop the zoning and planning over marine spaces and obtain acknowledgement from the government. It can be in the form of local marine management areas or rights-based fisheries management or something else. This approach may help to foster the MPA network in the region and improve ‘paper park’ status of existing MPAs.”

Hedging bets with deeper ecosystems

Warming waters are imperiling coral ecosystems at the tropical end of their range. Australia’s Great Barrier Reef Marine Park, for example, experienced widespread coral mortality in a heatwave in 2016: averaged across the whole Great Barrier Reef, 30% of the corals were lost.

Some scientists have placed hope in deeper coral ecosystems called mesophotic reefs. While these deeper reefs (starting 30m below the surface and extending down to 150m depth) are usually less diverse than shallow coral reefs, and often harbor different species, there has been some evidence they might serve as refuges as near-surface corals struggle. If that is the case, it could provide an argument for protecting mesophotic reefs.

Pedro Frade, a researcher at the Center of Marine Sciences in Portugal, is the lead author of a recent study that examined this emerging concept. During the Great Barrier Reef bleaching in 2016, his study found that, while initially protected by cooler upwelling waters, deeper reefs at upper mesophotic depths (about 40 meters) eventually succumbed to prolonged high temperatures. Just like shallow reef counterparts, many deep corals bleached – albeit not quite as extensively. The study showed that even deep reefs are more vulnerable to rising ocean temperatures than had previously been thought.

Still, Frade believes mesophotic reefs could serve as biodiversity refuges under specific conditions. These could include when there is strong genetic connectivity between shallow and deep systems, and when there is frequent upwelling of colder water from deeper depths. “If both cases are met, this would represent a reef where the deeper populations are more likely to be protected from high temperatures caused by thermal anomalies,” he says.

He suggests that MPAs should be designed to protect both shallow and deep reef zones – the latter of which often harbor unique biodiversity in their own right that is still relatively unexplored. When it comes to climate change, he says MPA planners might want to hedge their bets by protecting a variety of reef conditions and zones. “Perhaps the best strategy is to protect as many different kinds of coral reefs as possible, both in regards to the biodiversity they hold and the topography that shapes them,” he says.

MPAs in a changing climate

Whether in the tropics, the poles, or in between, the momentum to protect more of the ocean is inextricably linked to the climate changes the planet will experience in coming decades.

As former US Secretary of State John Kerry and former UK Prime Minister David Cameron – co-chairs of the new Pew Bertarelli Ocean Ambassadors group – wrote in an opinion piece in October, significantly increasing the protected percentage of the ocean is important at a time when the oceans are warming and acidifying, coral reefs are bleaching and dying, and more extreme weather events are battering coasts. They write:

> “[MPAs] can replenish fish stocks and build resilience to climate change by giving marine flora and fauna places where they can adapt to changing conditions…. They go hand in hand with our global efforts to combat climate change and ensure sustainable fisheries.”

The question of where to plan and how to design climate-resilient MPAs will be important to keep refining – although these questions can’t be done in scientific isolation. As Kerry and Cameron state, political leaders need to engage with these questions: “We know that for any elected leader who has promised to support jobs and grow the economy, there will be no blue economy if we don’t solve the threat to the oceans themselves.”

- This article was reported by Jessica Leber.

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More resources on climate change, MPAs, and ocean management

- The landmark 2016 IUCN report Explaining Ocean Warming reviewed the effects of ocean warming on species and ecosystems, and on ecosystem benefits to humans.
- The lead article in the October 2018 issue of MPA News covered how managers are responding to impacts of ocean warming at their sites, with cases from Hawaii, Mediterranean, Caribbean, and Madagascar. It also included several links to previous climate change coverage in MPA News.
- The July/August 2018 issue of our sister publication Marine Ecosystems and Management (MEAM) covered how ocean managers in general, beyond just MPAs, are responding to climate change impacts.
- The June 2018 issue of MEAM covered how weather and climate extremes are affecting the ocean.
- This 2017 article in PNAS journal described how no-take marine reserves could help mitigate and promote adaptation to climate change.
