

MPA NEWS



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MPAs and ecosystem tipping points: What do managers need to know?

Scientists now recognize that ecosystems can sometimes undergo abrupt, dramatic changes in response to human use or environmental conditions. When a *tipping point* like this is crossed, we can witness upheaval in ecosystem structure and function and in ecosystem benefits to people. These tipping points can be hard to reverse due to feedbacks that reinforce the new state.

The crossing of such tipping points – and the shift to a new ecosystem state – has been observed in a wide range of marine habitats, from kelp forests, to coral reefs, to open ocean systems and more. This includes inside some MPAs. The northern section of the Great Barrier Reef Marine Park, for example, has experienced significant coral death as a result of high temperatures in 2016 and 2017. Different from coral bleaching, which results in white corals and can reverse in a few years, dead corals quickly [get covered with mats of non-symbiotic algae](#). The algae mats make it difficult for baby corals to re-establish. (A non-MPA example: in the early 1900s, overhunting of sea otters along the Pacific coast of North America caused a boom in sea urchins – the otters' prey – which in turn led to destruction of kelp forests as abundant urchins overgrazed them.)

For MPA practitioners and other ecosystem managers, an understanding of tipping points is critical because they change the rules of the game. The new ecosystem state may function quite differently from the previous one, and respond differently to management interventions.

The Ocean Tipping Points collaborative research project, based at the University of California, Santa Barbara, seeks to understand and characterize tipping points in ocean ecosystems. [The project website](#) is a trove of information on the subject, including how management can anticipate tipping points and what tools and resources are useful to avoid crossing them.

Carrie Kappel, principal investigator of the Ocean Tipping Points project, provides her thoughts here on what MPA managers need to know about this topic.

What MPA practitioners need to know about ocean tipping points

"MPAs, because they protect and rebuild biodiversity, have increased resilience and probably decreased the risk of tipping points. But they are not immune. Lots of the drivers of dramatic ocean change, including a warming climate, are happening rapidly and at large enough scales to threaten MPAs with crossing tipping points, too."

On predicting or preventing the crossing of tipping points

"We have been working with ocean and coastal managers, including MPA managers, to try to develop tools that can help predict, prevent, or cope with such changes. The first step is working to understand and quantify the potential thresholds in your ecosystem – where a human or environmental driver has the potential to induce disproportionate changes in the system if it exceeds the threshold level. [Editor's note: the terms *threshold* and *tipping point* are used interchangeably.] This can yield valuable reference points for monitoring and management. Then based on the potential risks and risk tolerance, one can establish a precautionary buffer around the undesirable tipping point and try to manage the driver to avoid reaching the threshold.

"It is important to recognize that tipping points may be operating at scales larger than your MPA. So try to account for that in monitoring and management. For example, if you are trying to measure the effectiveness of your MPA over time but during that same period the surrounding area shifts into an entirely different set of conditions, then detecting the MPA's effect will be quite difficult. This is why it is so crucial we are investing in ecosystem monitoring and forecasting at multiple scales.

"Most of what we know about tipping points comes from looking back after they have already been crossed, which will not help much if your system hasn't crossed a threshold yet. But looking to similar systems to learn by analogy can help. For example [Kendra Karr](#) and colleagues, and [Tim McClanahan](#) and his coauthors, have shown that the fraction of total unfished fish biomass remaining on a coral reef provides a good indicator of how close that reef might be to crossing a tipping point. This is a much better leading indicator than coral cover, which tends to respond only when it is essentially too late. They have shown that this has promise across Indian Ocean and Caribbean reefs so far."

On hope for recovery after tipping points are crossed

"There are numerous examples of coral reefs and kelp forests within MPAs that have rebounded after crossing a tipping point. MPAs can be critical in rebuilding sufficient populations of herbivores to control seaweeds on coral reefs or predators of urchins in kelp forests so that they can interrupt the feedback loops that impede recovery. This process may take a long time. Across different kinds of systems, the timeline of recovery tends to be on the order of decades."

On whether warming could involve a worldwide ocean tipping point

"There is still so much we don't know about how quickly marine species will be able to adapt or move to deal with our rapidly warming and acidifying oceans. But it is certain that there will be winners and losers and that many parts of the globe will become uninhabitable for their current suite of species. I am willing to bet that these dramatic ecological changes will have profound consequences for human communities that depend on the ocean for food, livelihoods, sociocultural practices, etc. We will not have to wait to see these kinds of changes, either. They are upon us. Species are already on the move, habitats are under stress, and people are losing access to the species on which they once depended."

For more information:

Carrie Kappel, Ocean Tipping Points project, UCSB. Email: kappel@nceas.ucsb.edu

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