THE SKIMMER ON MARINE ECOSYSTEMS AND MANAGEMENT

Published on *Marine Ecosystems and Management (MEAM)* (**https://meam.openchannels.org**)

Interview on the Ocean Tipping Points project

MEAM followed up with Carrie Kappel and Ben Halpern of the Ocean Tipping Points project to ask about examples of tipping points being incorporated in management, and what advice they have for others working to link science to management.

MEAM: In your perspective piece, Carrie and Ben, you talk about the need for managers to change the way they think about and manage ecosystem dynamics to account for tipping points. Do you know of any examples where this is being done?

Carrie Kappel: We asked ourselves that same question when we first started the Ocean Tipping Points project. So several individuals on our team dug through the literature to see. They searched management documents and reports and found lots of successful examples from around the world. The results from that work have just been published (http://rstb.royalsocietypublishing.org/content/370/1659/20130276). We also just posted a guest blog on this paper at OpenChannels.org (https://www.openchannels.org/node/8381).

Ben Halpern: Back in the 1980s, Florida Bay in the southeastern US was experiencing mass die-offs of seagrass and declining water quality. Understanding the cause of the die-offs was difficult, but eventually scientists and managers discovered that declining freshwater inputs due to upstream diversions for agriculture and other uses were primarily to blame. They were able to quantify the threshold level of freshwater that must flow into the bay to maintain seagrass, and set hard management targets to avoid dipping below that level. Since they implemented the program, there have been no further seagrass die-offs in the bay.

MEAM: Is there always a tipping point or do some ecosystems just continue to degrade without an abrupt change occurring?

Kappel: There is not necessarily always a tipping point. Many ecological responses to increasing stress are actually linear and manifest as a gradual, steady degradation. But species interactions (including human ones) and other ecosystem linkages mean that a single nonlinear response to stress can cascade through a system and lead to abrupt changes. Many of those species interactions also take nonlinear forms, which can further contribute to abrupt ecosystem level shifts in response to changing environmental conditions. Even if you don't know for sure that your system is prone to tipping points, we think it's important to pay attention to the potential risk of dramatic change in your system. Given how common nonlinear responses are, how they can cascade through systems, and the risks associated with crossing tipping points, precaution argues for assuming that there may be a tipping point in the absence of evidence to the contrary. Investing in understanding the true underlying dynamics of your ecosystem can allow you to relax that assumption if you don't find evidence of thresholds.

MEAM: Your project is working to span the gap between science and management. What advice do you have for others who want to do the same?

Kappel: We are definitely still learning, but there are a number of things that have worked well. Our team is quite large and diverse, which means we have broad expertise in house, including legal, social science, economic and ecological disciplines. This diversity helps us tackle tipping point questions from many angles and thus strengthens our understanding and the potential for uptake. We also have engaged managers and outside experts via advisory groups to our project, and both have provided invaluable feedback and insight along the way as we think about how to translate our science into practical solutions.

Halpern: Most importantly, we are working in two case study regions - Hawaii (US) and Haida Gwaii (Canada) - to help us focus, refine and explore how general results apply in specific, and very different, contexts. Case studies always force one to face reality rather than remain in the realm of theory. As we've listened to people who live and work in these regions, we have learned what kind of science would be useful to them. It is about meeting them where they are, and providing advice when asked, rather than expecting them to simply adopt our ideas.