UC SANTA BARBARA

THE Current

November 24, 2014
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A Midterm Report Card

Tipping points occur when small shifts in human pressures or environmental conditions bring about large, sometimes abrupt changes in a system. Such tipping points can exist in a human society, a physical system, an ecosystem or our planet's climate.

The Ocean Tipping Points (OTP) collaborative research project seeks to characterize tipping points in ocean ecosystems and provide ocean resource managers with practical guidance to help avoid abrupt change. Several associates with UC Santa Barbara's National Center for Ecological Analysis and Synthesis (NCEAS) as well as the campus's Bren School of Environmental Science & Management are participating in projects that are part of this joint effort.

"Many scientists before us have studied the complex dynamics of marine ecosystems, highlighting the potential for rapid, dramatic changes in ocean conditions," said Carrie Kappel, principal investigator of the OTP collaborative and center associate at NCEAS. "However, past science has done little to change the way we manage marine ecosystems. We have an opportunity to change this, as promising new science converges with a paradigm shift toward ecosystem-based management of our coasts and oceans."

At the midpoint of the four-year project, the OTP collaboration presented its initial findings in five scientific papers, two published last week, in the journals Nature Communications and Scientific Reports, and three appearing today in Philosophical Transactions of the Royal Society B: Biological Sciences. The first two studies

analyze the factors that drive differences in the state of the ecosystem.

The paper published in Nature Communications examines predator and prey fish diversity across the coral reefs of the Pacific. Investigators studied differences in the dispersal patterns of predators and their prey and how those differences affect geographic patterns of community trophic structure.

“Our study shows that the ability of predators to disperse long distances allows their diversity to remain relatively high on isolated islands,” said lead author Adrian Stier, a postdoctoral fellow with the OTP project and visiting researcher at the National Oceanic and Atmospheric Administration’s (NOAA’s) Northwest Fisheries Science Center. “These results add to a growing body of evidence suggesting that careful consideration of organisms’ movement may help explain how ecological communities are structured across the globe. Given the suite of threats facing reef ecosystems and top predators more generally, a renewed focus on the mechanisms governing community structure is essential.”

The study appearing in Nature Scientific Reports was conducted in British Columbia and analyzed tradeoffs among the harvest of Pacific herring roe-on-kelp for cultural and subsistence uses, the commercial harvest of spawning adult herring for export of their roe and the role of unharvested herring as forage for seabirds, marine mammals and other fish.

“Our work shows that both roe-on-kelp and adult herring fisheries can be managed sustainably, but the two necessarily trade off against each another — there is no scenario that results in high catches for both fisheries,” explained lead author Ole Shelton, a staff scientist with NOAA’s Northwest Fisheries Science Center. “However, there is a range of harvest rates that can lead to successful fisheries catches for both while maintaining sufficient numbers of herring to support herring predators. Our work points to the importance of jointly considering the risks posed by multiple fisheries and the broader ecosystem value of herring.”

Three additional studies published today in the Royal Society’s special issue titled “Marine regime shifts around the globe: theory, drivers and impacts” address individual topics related to ocean ecosystems. The first evaluates management success in case studies involving ecological tipping points across the globe. The second provides additional guidance for marine managers on how to incorporate the risk of reaching a tipping point into current ecosystem-based management

frameworks. The third considers the role tipping points play in changes from coral- to algae-dominated reefs examined throughout the Hawaiian archipelago.

The OTP alliance brings together scientists from a number of institutions, including UC Santa Barbara, Stanford University, NOAA, Cal Poly San Luis Obispo, the Environmental Defense Fund and the University of Hawaii. The four-year effort is funded primarily by a grant from the Gordon and Betty Moore Foundation.

The group’s mandate is to study changes in ocean climate and the abundance of key species, nutrients and other factors that drive dramatic shifts in ocean food webs, habitats and ecosystem functions that can have direct impacts on people’s well-being.

At two case study sites — the Hawaiian Islands Humpback Whale National Marine Sanctuary and British Columbia’s Gwaii Haanas National Marine Conservation Area Reserve and Haida Heritage Site — OTP scientists are characterizing existing ecosystem regimes and developing practical tools to help managers predict, avoid or recover from abrupt ecosystem shifts. Although there have been many critical advances in the science of ecosystem tipping points in recent years, managers still lack practical tools and information to help them anticipate and respond to ecosystem shifts.

“Ocean tipping points are cause for concern because they are hard to anticipate and can be very difficult to reverse,” Kappel said. “For managers of marine ecosystems, an understanding of tipping points is critical because they change the rules of the game.”

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.