

OCEAN TIPPING POINTS

EMBEDDING THE SCIENCE OF TIPPING POINTS IN OCEAN MANAGEMENT



Tim Laman, National Geographic Society

The Ocean Tipping Points collaborative research project seeks to understand and characterize tipping points in ocean ecosystems. This idea is not new. Many scientists before us have studied the complex dynamics of marine ecosystems, highlighting the potential for rapid, dramatic changes in ocean conditions. However, past science has done little to influence 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.



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Connecting Tipping Points Science to Ocean Management

Tipping points occur when small shifts in human pressures or environmental conditions bring about large, sometimes abrupt changes in a system – whether in a human society, a physical system, an ecosystem or our planet’s climate.

A growing problem

An increasing number of examples of tipping points in ecosystems around the world are raising concern among scientists and policymakers. In the oceans, diverse ecosystems ranging from reefs to estuaries to pelagic systems have undergone sudden, dramatic shifts. Changes in ocean climate, the abundance of key species, nutrients and other factors drive these shifts, with resulting effects on ocean food webs, habitats, and ecosystem functions that have direct impacts on people’s livelihoods and well-being. Ocean tipping points may be cause for particular concern because they are hard to anticipate and can be very difficult, if not impossible, to reverse.

Tipping points change the rules

For managers of marine ecosystems, 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, respond differently to management interventions, and provide different levels and types of benefits to people. 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.

Tipping Points on Land

In the native longleaf pine forests of the US Southeast, the tipping point involves fire. Without frequent enough wildfire, fast-growing shortleaf pine invades, and the forest shifts rapidly into one that no longer functions in the same way – one that can’t, for example, provide essential habitat for the endangered red-cockaded woodpeckers that live only there.

Tipping Points in the Ocean

In the Baltic Sea, a series of threats pushed the system over a tipping point in the 1980s, from which it has yet to recover. Overfishing of top predators and fifty years of nutrient pollution combined with climate change to shift the Baltic from a productive and highly valuable, cod-dominated ecosystem to one dominated instead by inedible jellyfish.



James Thompson Photography

Our research team is tackling this multi-faceted problem through research, policy analysis, communication and practical implementation. We are synthesizing when, where and how marine ecosystem shifts occur.

Overarching research goals

- Improve knowledge and understanding of ocean tipping points, their potential impacts and their relevance to management.
- Develop and disseminate a toolbox of tested approaches for management of ecosystems prone to tipping points, which will allow managers to identify the “safe operating space” for decision-making to avoid undesirable tipping points, set targets, monitor using early warning indicators, prioritize management actions and evaluate progress toward ecosystem objectives.

Building up to practical application

Throughout the two phases of this project, we aim to advance scientific understanding of the complex ecological and social dynamics within marine ecosystems. Ultimately, our goal is to move beyond basic science to develop, test and vet practical approaches and tools that can help managers really use this innovative science as they implement marine ecosystem-based management.

Phase One - Foundational activities: Our focus is on synthesizing the research literature and analyzing existing data to build the foundation for applying this information to decision making. We are

- analyzing what leads to better ecological outcomes in management that accounts for tipping points;
- systematically reviewing examples of tipping points in coastal and marine ecosystems from around the globe;
- quantifying threshold responses of ecosystem components to key stressors like nutrient input, temperature and harvest; and

- conducting legal and policy analyses to reveal the most likely routes for incorporating these concepts, results and tools into management.

Phase Two - Case study application: With partners from our two case study locations – the Hawaiian Islands Humpback Whale National Marine Sanctuary, and Gwaii Haanas National Marine Conservation Area Reserve and Haida Heritage Site – we will

- characterize existing ecosystem regimes and analyze the factors that drive differences in the state of the ecosystem;
- quantify the thresholds that mark the boundary between one ecosystem regime and others;
- identify leading indicators of ecosystem shifts to serve as an early warning system for managers; and
- analyze the tradeoffs associated with managing for tipping points while trying to maximize the benefits that humans derive from the coast and ocean in these places.

The final product of this collaboration will be a toolbox, general framework and guide to setting targets for place-based management of multiple human activities within the context of ecosystem tipping points.

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About Us

The Ocean Tipping Points project brings together experts from many fields. We are natural and social scientists, law and policy experts, resource managers, communicators and educators, each offering a critical piece of the puzzle. Our collective expertise covers population and community ecology, mathematical modeling, environmental law, marine policy, cultural anthropology, sociology, geography, economics, oceanography, fisheries biology and marine resource management. This project represents a unique opportunity to share that expertise through a truly transdisciplinary collaboration where our ultimate goal is to develop tools and insights that are useful and usable by managers to improve the condition of marine ecosystems. Our work is further guided by policymakers, managers and scientists from around the world through a Management Advisory Group and Science Working Group.

This collaboration, with seed funding from the Gordon and Betty Moore Foundation, brings together government, non-profit and university partners. Core partners include the University of California Santa Barbara and the National Center for Ecological Analysis and Synthesis; Stanford University's Center for Ocean Solutions; the National Ocean and Atmospheric Administration's Northwest Fisheries Science Center; Environmental Defense Fund; Cal Poly San Luis Obispo; Parks Canada; Fisheries and Oceans Canada; the Council of the Haida Nation; and the Hawaiian Islands Humpback Whale National Marine Sanctuary, which is co-managed by NOAA and the State of Hawaii.

We will measure our success by how readily the results and tools we develop are adopted and deemed useful by on-the-ground practitioners.

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