Building a foundation for managing for tipping points in marine ecosystems

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Abstract

An increasing number of examples of tipping points in social-ecological systems around the world have begun to raise concern among scientists and policymakers. In the oceans, diverse ecosystems ranging from estuaries to reefs 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 often unexpected and can be very difficult, if not impossible, to reverse. The Ocean Tipping Points project seeks to understand and characterize thresholds, or "tipping points," in coastal and ocean systems, in which small changes in human use or environmental conditions result in large, and sometimes abrupt, impacts to marine ecosystems. Our ultimate goal is to help agencies and decision-makers anticipate and manage for these tipping points. But we cannot do so without a strong scientific foundation. This session will feature some early, foundational results of our project – focusing primarily on ecological aspects of the complex, social-ecological problem of analyzing and anticipating abrupt ecosystem change and coming to grips with how to actively or passively manage for that change.

Courtney Scarborough will begin the session by presenting results of a comprehensive, global synthesis of ocean tipping points, aimed at identifying where and when abrupt shifts in marine ecosystems tend to occur, their drivers and underlying mechanisms, factors that confer more or less resilience to such shifts, and implications for ecosystem goods and services. From this broad, ecosystem-level overview, we will then dive deep into individual responses of ecological components to physical, biological and anthropogenic stressors. In the absence of detailed information about how the ecosystem will respond to stressors, a common assumption is that these relationships are linear. Yet, growing evidence suggests that many of these stressor-ecosystem relationships are non-linear. Dr. Mary Hunsicker will present a new analysis of existing data in which she has characterized the shapes of these relationships and measured the strengths of nonlinearities to glean general lessons across systems and stressors in an attempt to identify critical targets for management that may help us to avoid tipping points. Vital to avoiding undesirable ecosystem shifts is having advance warning that your system may be approaching a threshold. Recent studies have proposed a suite of statistical methods for identifying leading indicators (or early warning indicators) of such state changes, and experiments in model systems suggest the potential efficacy of...
these new tools for managers in the real world. Our final talk is by Dr. Adrian Stier, who will present early results from tests of early warning indicators using real world data from marine ecosystems with documented state shifts.

**Format:** Traditional

**Speakers:**

Courtney Scarborough, A global review of marine ecosystem regime shifts

Mary Hunsicker, Threshold responses to environmental stressors: a meta-analysis

Adrian Stier, Testing early warning indicators of marine ecosystem regime shifts

**Theme:** Analyzing and promoting change and transformation

**Keywords:** Marine ecosystem, ocean tipping point, early warning indicators, regime shift, non-linearities, stressor