Ecologists test stability of Maine ecosystem over two decades

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A team of researchers from Northeastern University and Oregon State University has published results of an investigation of the effects of climate change on coastal ocean upwelling, the process by which deep, cold waters rise toward the surface, bringing nutrients. The results indicate that by the end of the 21st century, periods of annual upwelling in particular coastal areas will lengthen and intensify, while the differences in upwelling across latitudes will diminish. The findings are the product of a unique comparison of 22 state-of-the-art climate models from research groups all over the globe, and represent one of the first studies in coastal upwelling to use multi-model or ensemble modeling. Instead of running a single model or averaging the results of several models, the

researchers carefully compared the output of 22 climate models charting changes over 150 years (from the mid-20th to the end of the 21st century) to find places of agreement and disagreement. The places of agreement, like the changes in ocean upwelling, represent high-confidence projections shared independently by most climate models. The study, led by Daiwei Wang, a postdoctoral researcher at Northeastern University, predicts an increase in the duration of upwelling periods by as much as one to two months by the end of the 21st century. Credit: Tarik C. Gouhier, Marine Science Center, Northeastern University

Working on a lobster boat in Swan's Island, Maine, typically means an early wake-up call. The boats head out around 5:30 in the morning.

For University of Pennsylvania ecologist Peter Petraitis, California State Northridge biologist Steve Dudgeon and their team, it's not much later when they head out as well. But they're used to it. Petraitis and Dudgeon, along with Cheverus High School teacher Erika Rhile and her students, have been returning to this rocky intertidal zone every spring and summer for nearly two decades!

With support from the National Science Foundation (NSF), they survey a network of 60 experimental plots all around the island. The big question that brings them back year after year: Is an ecosystem like this a stable and permanent fixture, or, under harsh conditions, could it reach a tipping point? The idea is that changes in conditions could cause a switch from one community to another, such as from mussel beds to rockweed, and then back again.

In the Gulf of Maine, winter ice scour often removes mussels and rockweed, but it is not known if the species re-establishment is accidental (that is, ice scour can switch a rockweed stand into a mussel bed and vice versa) or deterministic (mussel beds always return to mussel beds). In ecology, the idea that disturbances such as fires,

hurricanes, and even oil spills can abruptly switch one community type into another is known as the theory of alternative stable states.

When restoring coastal wetlands, common practice calls for leaving space between new plants to prevent overcrowding and reduce competition for nutrients and sunlight. That's likely all wrong. A November 2015 study, conducted to restore degraded salt marshes in Florida and the Netherlands, has found that clumping newly planted marsh grasses next to each other, with little or no space in between, can spur positive interactions between the plants. The finding, which is applicable to a wide array of coastal restoration efforts worldwide, upends a 40-year-old theory borrowed from forestry: New plants, called "out-plants" by restoration ecologists, need to be spaced well apart from each other to reduce competition and generate the highest growth rates. "In a low-stress field or forest that makes sense," Brian Silliman, a marine ecologist at Duke University, said. "But in the tough, volatile environment of redeveloping coastal wetlands, it's a different story. …The bottom-line message is: A coastal wetland plant that is close to its neighbors will grow better than a plant that isn't. The findings clearly demonstrate that planting closely does not spur negative competition. It allows positive interactions to flourish, so plants can work

together to survive," he added. Credit: USGS

Ecologists have watched such switches all over the country and sometimes, switches have undesirable consequences, such as when human activities impact coral reef communities or the loss of productive edible grasslands in the Southwest. The experimental approach of Petraitis and his colleagues has never been used to test for alternative states under natural conditions and the research has broad implications for studies of alternative states in other ecological communities.

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