Podcast Interview: Jonathan Lefcheck and Robert Orth

PNAS: Welcome to Science Sessions. I'm Taylor Gedeon.

Nutrient pollution causes widespread degradation of coastal ecosystems, yet the effectiveness of large-scale nutrient reduction efforts has not been empirically demonstrated. Jonathan Lefcheck, of the Smithsonian Institution, and Robert Orth, of the Virginia Institute of Marine Science at the College of William and Mary, and colleagues evaluated the relationship between nutrient pollution and submerged aquatic vegetation in the Chesapeake Bay from 1984 to 2014. To do this, the team employed aerial surveys, biogeochemical data, and watershed and historical land use information. They found that during the study period, reduced nitrogen and phosphorus inputs to the bay increased submerged vegetation cover, by both increasing water clarity and reducing fouling algal blooms. The results also hinted at a positive relationship between the species richness and total cover of submerged aquatic vegetation. The work, published in PNAS, earned the authors the 2018 Cozzarelli Prize in Applied Biological, Agricultural, and Environmental Sciences. I spoke with Lefcheck and Orth about the effects of nutrient reduction on coastal ecosystem recovery. Orth begins by explaining why the team focused on the Chesapeake Bay.

Orth: The motivation really started probably 400 years ago when the Chesapeake Bay was first colonized and the bay started changing, has changed more rapidly in the last century. And with the explosion of people comes the explosion of all the things that come with people: nutrients, sediments, herbicides. What we've seen in the Bay in the 50s and 60s was a rapid change and many of the living resources: fish, shellfish, and underwater grasses – part of what we have been doing is looking at the recovery of these grasses after 30 years of nutrient reductions because grasses declined precipitously in the 60s and 70s. We focused on the period 1984 through the present because this is when most of the major monitoring programs began. So the aerial surveys that were instrumental for studying underwater grasses began on an annual basis in 1984 and we were able to couple that information with all of the other databases monitoring programs that were going on concurrently with the program.

Lefcheck: I think really this is an important example of having the information to actually test to what degree are our efforts actually having an effect. We can sort of see the recovery maybe on an anecdotal basis. But taking the big picture perspective and then having the data to link that back to the changes that are happening in watersheds, and nutrient reduction measures, I mean this is really the first, or I should say one of the first, really important empirical examples, where we can link all that together using actual data.

PNAS: Orth explains why the researchers focused on underwater grasses as an indicator of ecosystem health.

Orth: One of the key resources were these underwater grasses because they respond very, very rapidly to small changes in the environment. And so while we've seen large decreases because of changes in the water quality, the pollution, we've also seen increases over time. And so as we saw these increases over time because of the way we measured using these aerial surveys, the light goes on and we say ok how can we assess exactly what's driving those increases?

Lefcheck: I think the question is why now? We finally have a critical mass of information where we can start to make these linkages, match up these large datasets in ways that are informative. We've applied some very fancy statistical models, but what those do is allow us to say yes when you put more fertilizer on a field, that fertilizer gets into our waterways, that changes what's going on in the water and then that's gonna trickle down and have an impact on these grasses. So not only are we able to address the mechanism by which these changes occur, but then also link them up with this time series of information, from the 80s to the present, to show that in fact the changes we've made in some of those driving forces, like fertilizer application, has led to a huge increase in underwater grasses.

PNAS: The researchers used this information to build statistical models. These models demonstrated the link between successful management strategies and ecological recovery. Lefcheck explains the team's findings.

Lefcheck: What we found is that over time, we've seen tremendous recovery of underwater grasses. So we've seen over 250 percent increase since 1984. Again linked that recovery back to changes in land use, nutrient mitigation measures, things called TMDLs, or Total Maximum Daily Loads, so this is a technique meant to try to control the amount of nutrients that can be applied by say farmers to their crops, which will then limit how many of those nutrients find their way into Chesapeake Bay. And so we've shown that those measures through time have limited that input and again led to that recovery. Another really interesting part of this study, and something we didn't expect to find at all, is that there are many different species of underwater grasses in the Bay. So about 15 or 16. And it turns out that the more species you have together, the more successful recovery occurred. And so when you get these very diverse, very speciose beds, such as those in the Susquehanna Flats which is in the middle of the Bay up in the upper Bay, it's been a runaway success, it's been a huge increase. And so, what our model showed us it that, you can contrast that to other parts of the Bay that had maybe just one or two species of underwater grass, and those unfortunately are not doing as well. So biodiversity, or the number of species that are present in these underwater meadows, actually turns out to be a pretty significant positive force, for promoting recovery.

PNAS: I asked Orth about the practical implications of these findings.

Orth: Well, everyone likes to eat crabs, and eat oysters, and catch fish. And so we really feel that the habitat that we are working on is sort of the canary in the coal mine. It tells us what's happening with the Bay. And as the grasses improve, so will the crabs and the fish, it's part of this whole ecosystem. People want to know that the efforts that we're putting in to cleaning up the Bay really make a difference.

Lefcheck: I think the question is why do we care at all? We're interested as scientists because we study these organisms very closely, and so we have a deep appreciation. They're hugely important nurseries. The value of these ecosystems is tremendous. They protect shorelines, the hurricanes and wave action, they buffer our shorelines against erosion, protect your property from being washed away into the sea. And we know now that some underwater grasses actually store as much carbon as temperate forests. So they're really important perhaps in global carbon dynamics. So they have a lot of impact and relevance for people in ways that I didn't even understand when I first started studying them.

PNAS: Lefcheck and Orth say they are gratified by the recognition the work received.

Lefcheck: It's an incredible honor. I don't think anybody starts out to write an award winning paper. We're scientists, we want to understand nature, our motivation is to untangle the mysteries that nature provides. But in linking that to human activities I think then we've got a personal stake in it. I think for me, it's great to have this recognition by the Academies because then that says that our understanding actually means something for people and I think that's really important.

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