NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

The Polar Bear of the Salt Marsh?

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Part I – What's Going On?

Katie was horrified. A sudden feeling of unease overtook her. Looking at the drowned nestlings floating in a tangle of saltmarsh grass made her sick to her stomach. This was the fifth drowned saltmarsh sparrow nest she had discovered this breeding season. Katie had been exploring the wetland adjacent to her house in coastal Connecticut since her dad had given her a set of binoculars for her eighth birthday ten years ago. A competent naturalist, she knew that saltmarsh sparrows were ground-nesting birds, endemic to the tidal marshes of the eastern United States and were decreasing in population size throughout southern New England. She noted another drowned nest in her field notebook and asked herself, *What could be going on here?*

Question

1. What factors could lead to drowned nests in a tidal salt marsh?

Part II – Rising Sea Levels

Since it was low tide, Katie decided to tromp through the marsh to the Barn Island Wildlife Management Area headquarters to see if she could talk with somebody who might have more information. Different salt marsh plants can tolerate different amounts of flooding and salt concentrations. This variation in physical stress tolerance leads to vegetation zones or bands, each dominated by different grass-like plants. Katie traversed the band of vegetation closest to the ocean where cordgrass *(Spartina alterniflora)* exclusively dominates the daily flooded low-marsh elevations. In southern New England salt marshes, marsh hay *(Spartina patens)* dominates the intermediately flooded band, and black rush *(Juncus gerardii)* occupies the higher, drier, and less salty marsh elevations. Marsh hay and black rush are excluded from the low marsh by low soil oxygen levels and high salt concentrations. Cordgrass has the ability to oxygenate its root zone and has physiological adaptations to deal with high salinity, allowing it to tolerate the frequently flooded and salty low-marsh zone.

After a hot slog through the marsh, Katie was relieved to arrive at the Barn Island headquarters and see Chris Smith, a natural resource manager for the Connecticut Department of Energy and Environmental Protection (DEEP). Katie blurted out, "Chris, I found another drowned nest of saltmarsh sparrows this afternoon. That's the fifth one this season! Have you heard reports from other people like this?"

Chris laughed, "Hi Katie, nice to see you too." In a more serious tone, he added, "Actually, I've had several birders report nest drownings this breeding season, and it seems like more and more are documented each year." Chris was thoughtful for a moment and then pulled out a recent issue of a preeminent scientific journal and said, "Check out this article. Maybe there's something in here."

"Wow, I didn't know global mean sea-level has risen 14–22cm in the last century. That's crazy!" exclaimed Katie as she skimmed the article. "Actually, their models suggest that about 70% of sea-level rise since 1970 is attributable to human activities, especially greenhouse gas emissions."

Chris responds, "So sea levels are rising, but I'm unclear how…"

As Katie continued reading the article she responded, "The two biggest contributors to sea-level rise are thermal expansion of the oceans—as water warms, it takes up more volume—and glacier mass loss. Basically, the earth is warming up due to our use of fossil fuels and causing water to expand and ice to melt." Katie continued, "But what's going on in Connecticut? Is that what's drowning all these saltmarsh sparrow nests?"

Questions

2. What kind of information, either biotic or abiotic, could Katie and Chris use to determine whether sea-level rise is occurring in salt marshes in Connecticut?

3. Sea-level rise of 14–22 cm over 100 years may not seem like much (1.4–2.2mm per year), but consider how the slope of the land determines how much will be inundated. Will steeply or gently sloped areas be more impacted? Try sketching the two situations.

4. Make a diagram showing the three dominant vegetation zones of the salt marsh, indicating relative elevation and distance to the ocean. Based on salt and flooding tolerance thresholds of the dominant plant species, predict how plants will shift in response to sea-level rise; show this on your diagram.

Part III – Vegetation

"There's a researcher at the University of Connecticut that monitored vegetation in 55, 1-hectare plots in 12 different salt marsh complexes along the Connecticut coastline in 2003 and 2013," Chris said pensively. "I wonder whether we could determine if sea-level is rising here by comparing the change in occurrence of the different plant species."

Katie jumped at the suggestion and exclaimed, "Let's do it!"

Question

5. Do the data in Figure 1 provide support for rising sea levels in coastal Connecticut? Why or why not? What other information would support this hypothesis?

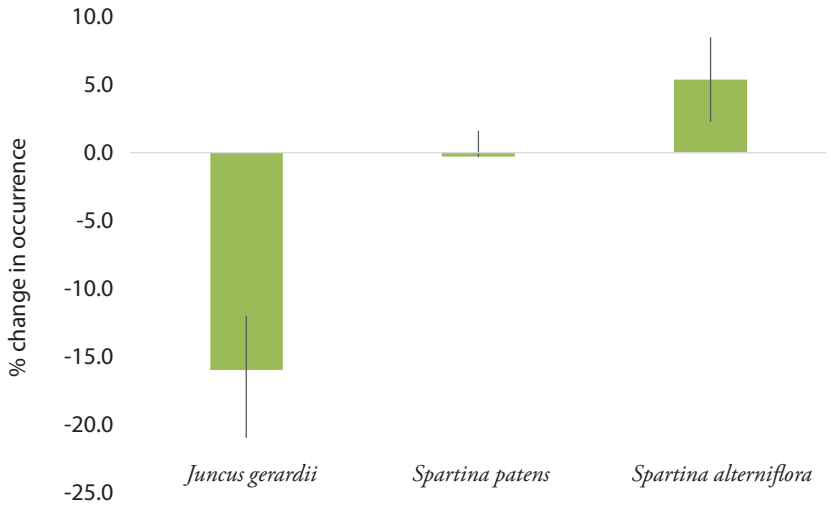

Figure 1. Mean percentage change in occurrence for the dominant plant species in 55, 1-ha plots in Connecticut salt marshes surveyed in 2003 and 2013 (data adapted from Field *et al.,* 2016).

Part IV – The Future

While Katie was data crunching, Chris looked into the literature and found that sea-level rise in southern New England is predicted to be much higher than the global average (Yin *et al.,* 2009; Boon, 2012; Sallenger e*t al.,* 2012). Observed sea-level trends at tide stations in southern New England range from 2.44 to 2.87 mm/year over the past 50 years (NOAA; www.tidesandcurrents.noaa.gov) and from 1980 to 2009 increases in the rate of sea-level rise have been 3–4 times the global average (Sallenger *et al.,* 2012). Even with no future carbon emissions, coastal areas face over 0.5 m of sea-level rise over the next century, with more than 1 m possible (Schaeffer *et al.,* 2012).

"Yikes!" exclaimed Katie. "Well, couldn't saltmarsh plants move in response to increased flooding? Can't we just expect marshes to migrate landward?"

Chris responded, "Maybe. Let's look at some satellite images of coastal Connecticut and think about it."

Question

6. Brainstorm three potential challenges to marsh migration.

References

Boon, J.D. 2012. Evidence of sea level acceleration at US and Canadian tide stations, Atlantic Coast, North America. *Journal of Coastal Research* 28(6): 1437–45.

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Sallenger, Jr, A.H., K.S. Doran, and P.A. Howd. 2012. Hotspot of accelerated sea-level rise on the Atlantic coast of North America. *Nature Climate Change* 2(12): 884.

Schaeffer, M., W. Hare, S. Rahmstorf, and M. Vermeer. 2012. Long-term sea-level rise implied by 1.5 C and 2 C warming levels. *Nature Climate Change* 2(12): 867.

Yin, J., M.E. Schlesinger, and R.J. Stouffer. 2009. Model projections of rapid sea-level rise on the northeast coast of the United States. *Nature Geoscience* 2: 262–6.

Part V – How to Respond?

Imagine that you own a $1.5 million house in Old Saybrook in the marsh migration zone. What would you do in the face of sea-level rise?

You will be assigned one of the following five sea-level response strategies to research for the next class meeting. Spend about thirty minutes researching your assigned strategy and develop a list of pros and cons and bring it with you to class next time.

- Beach nourishment
- Sea wall construction
- Conservation easement
- Sell property
- Put house on stilts (adaptation)

You will share your list with others so make sure that you are prepared!