Monitoring Indicators of Climate Change along Long Island Sound: A Simple Protocol for Collecting Baseline Data on Marsh Migration

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The 2014 release of the Fifth Assessment Report by the Intergovernmental Panel on Climate Change makes clear that if we are to adapt to a changing climate we need a comprehensive monitoring system that will not only describe how conditions are changing, but also enable us to assess what the consequences of those changes will be. Coastal areas, in particular, warrant attention as sea-level rise and changes in storm intensity are likely to alter flooding patterns in ways that greatly affect both natural and built environments (Woodruff et al. 2013).

Coastal wetlands are likely to be among the places where the effects of climate change interact most severely with other human activities that cause environmental change. In the USA, for example, nearly 40% of the population lives in coastal areas (NOAA 2013). The Long Island Sound ecosystem – lying between Connecticut and Long Island, New York, in the north-eastern USA, with the city of New York at its western end, over 4 million people living in its coastal communities, and one of the most highly developed coastlines on the continent – is a poster child for such conditions (Tedesco et al. 2014). Coastal wetlands in this area have a long history of human modification (altered hydrology, introduced species, pollution, etc.), usually to the detriment of native species. But, there is also a long history of land protection and tidal marsh restoration in the region (Warren et al. 2002; Rozsa 2012).

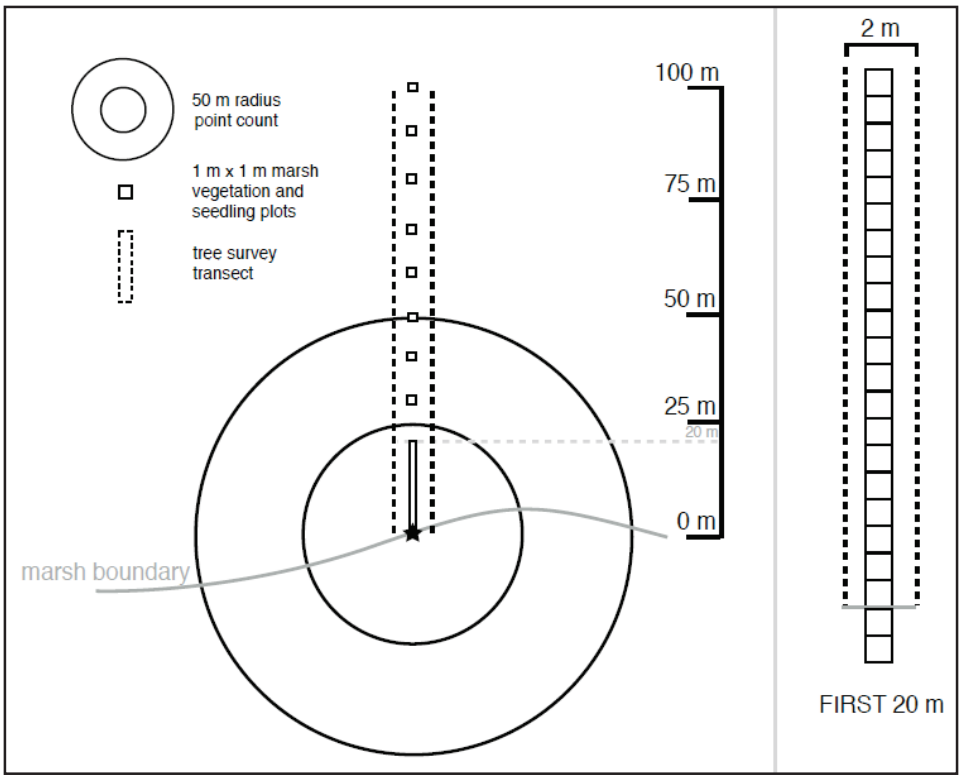

Figure 1. chematic diagram for simple transects used to create a baseline for tracking marsh migration in Long Island Sound, USA. Each transect runs for up to 100 m inland from the marsh boundary. Vegetation plots are surveyed for marsh plants in the first 20 m, at 10 m intervals thereafter, and for 2 m seaward into the marsh. Trees are surveyed within a 2 m band along the entire transect. Birds are surveyed with a 50 m radius point count centered on the marsh boundary end of the transect.

Developing a Monitoring Program for Long Island Sound

Developing a comprehensive monitoring program requires both that one assess what information is already available and what data gaps should be filled. In an ideal world, monitoring would build off existing data sets, using historical information to provide a baseline for tracking change, and this approach is a core principle of efforts to develop climate change monitoring for coastal Long Island Sound (Barrett et al. 2011). We recently compiled ecological data sets for the region's coastal wetlands to assess what information is available for key climate change "sentinels" that have been identified by the Long Island Sound Study (Barrett et al. 2011). Most existing data sets are far from ideal. In general, ecological time series are too short or incomplete to assess the past effects of climate change with confidence, although this may change in the future if sustained monitoring is put in place. Many historical data sets also lack sufficient meta-data (e.g., precise locations)

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to allow direct comparisons with contemporary data, or were not collected with sufficiently consistent (or documented) methods to draw clear conclusions. Additionally, few studies involve data collection at multiple sites, making it difficult to assess whether any trends that have been observed represent general phenomena rather than just local changes. Nonetheless, these data provide an important first step in identifying baseline conditions and provide a strong foundation around which to build a more comprehensive monitoring program.

Perhaps the biggest shortcoming of the available data is the lack of information on contemporary marsh migration. Several data sets allow one to examine vegetation change within coastal marshes, or to examine the responses of animal populations to those changes, but few data are available on conditions right at the marsh-upland boundary. Addressing this knowledge gap is especially important given that vegetation within marshes appears to be changing in a manner consistent with marshes getting wetter (Warren and Niering 1993; Donnelly and Bertness 2001; Field and Elphick, unpublished data), and the potential for both widespread loss of contemporary tidal habitats and increased marsh transgression in coming decades (Kirwan and Megonigal 2013).

With all this in mind, we developed a simple protocol to generate baseline data for long-term monitoring of marsh migration. We opted for a protocol that would be cheap and easy to replicate, allowing us to generate a high level of spatial replication and to increase the ease with which repeat surveys would be possible in the future. Consequently, we decided that we could not collect data on all variables of potential interest; that our methods should not require expensive, specialized equipment; and that the methods should not require considerable specialized knowledge but be simple enough for field technicians to learn with just a few days of training. These constraints further required that we could not conduct complete species inventories or collect much of the information that would be needed to fully understand the mechanisms behind change.

We settled on a plan that focused on three questions: (1) is the marsh moving inland, which we determined by measuring how far saltmarsh plants encroach terrestrial habitat; (2) are terrestrial plants being affected by saltwater encroachment, which we assessed by documenting evidence for elevated tree mortality at the marsh edge; and (3) is the fauna changing, which we quantified by describing the bird community.

Establishing the Baseline

First, to test whether marshes are actually migrating, we created transects that run inland from the marsh-upland boundary (Figure 1). We operationally pinpointed the boundary as the seaward frontier of the upland vegetation, providing field technicians with a list of saltmarsh species and defining any other plants as being part of the upland vegetation. After precisely georeferencing a transect's start location, we ran a line inland and perpendicular to the marsh edge and examined the vegetation within each meter-square for the first 20 m and for 2 additional meters in the direction of the marsh. Within each quadrat along a transect, we recorded the presence or absence of a pre-defined list of the major saltmarsh and marsh-boundary species characteristic of the region. After 20 m, we continued the transect inland, with additional quadrats at 10 m intervals

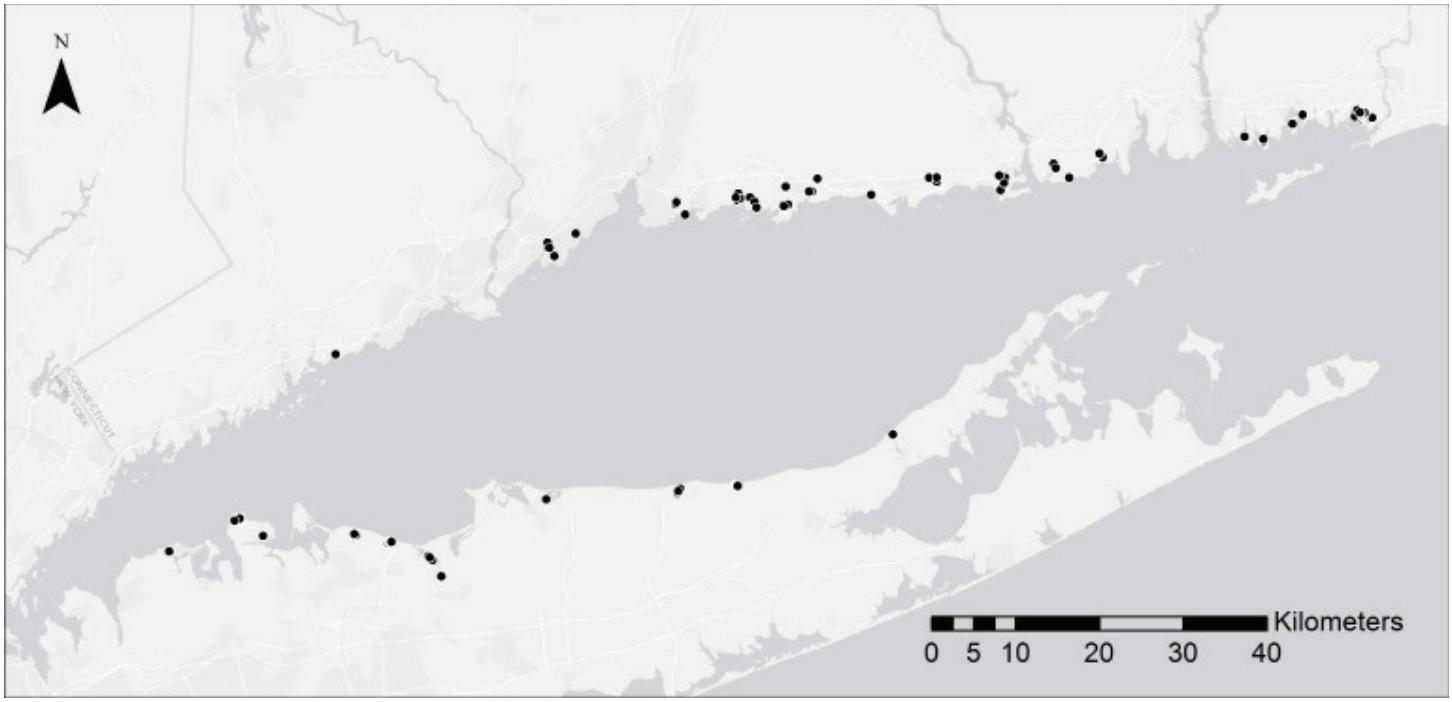

Figure 2. Distribution of 170 marsh migration sampling locations around Long Island Sound, USA. At each site we have collected baseline data on marsh vegetation encroachment into the uplands, tree mortality, and bird species occurrence.

for up to 100 m. To simplify the design, we did not attempt exhaustive vegetation surveys, nor did we attempt to quantify the abundance of each species.

To determine whether saltmarsh encroachment is affecting upland vegetation, we recorded all trees within 1 m of the transect lines that we created to assess the transgression of marsh vegetation into the uplands. For each tree, we determined the species, whether it was alive, what proportion of the crown showed evidence of dieback, the diameter at breast height, and whether there was any direct evidence for the cause of death or damage (e.g., Hurricane Sandy). Finally, to assess whether there are effects on wildlife we conducted a 50 m radius avian point count at the start point of each transect to document the bird species present right at the marsh-upland boundary. Copies of all of our field protocols are available at http://elphick.lab.uconn.edu/ and http://www.tidalmarshbirds.org/.

During the summer of 2013, we implemented this protocol at 170 sites around the coast of Long Island Sound (Figure 2). To ensure that our sampling is representative of the entire coastline, we selected sites randomly from locations where marsh migration is projected to occur based on topography and sea-level rise projections. This protocol cannot tell us with confidence what change has already occurred, although better information on the presence of saltmarsh plants in the forest understory and on tree mortality rates at the forest edge do provide insight into the transgression process. More important is that the creation of this baseline data set will allow comparisons in decades to come. Moreover, the basic protocol is easily repeatable and can be extended to other regions with little modification.

Expanding the Study Area

This summer, we are expanding our sampling beyond the Long Island Sound coast, and our hope is that, in future years, we – or others – will expand the sampling into other coastal areas in order to lay the groundwork to better document the ways in which the coastline is changing in response to altered tidal flooding patterns.

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sentatives from the New England chapter and our venue is perfectly designed to let us explore the wetland science of global climate change. There are a number of field trips lined up to New England barrier islands, bogs, coastal marshes, and restored wetland sites. Plenary speakers from around the globe will be joining us. This is going to be an exciting meeting, so I hope that you can join us there!

In the meantime, the Future Meeting group is busy at work. The South Central chapter has provided a successful bid for the 2016 meetings and it will be held in Corpus Christi, Texas. They are currently looking for a 2017 venue. One question that we are asking, and would like our member's feedback on, is how often should we schedule international meetings? Do international meetings eliminate many of our core members because of costs? Could we hold international meetings closer to home, such as Mexico or Canada?

Finally, please remember that this organization exists because of you, its members. It is important not only that you are kept informed, but also that you are enabled to take part in the processes of defining what is important to SWS. Please let us know if there is something that you feel we can we could do to make our society stronger or more meaningful. My email is open to you (but beware my spelling – it's atrocious!).

Stay Cool! ■