SPARROWS, MARSH MOVEMENT AND GRASS GENETICS

The latest salt marsh research from Connecticut scientists

by Owen Placido

The team of researchers from The Maritime Aquarium at Norwalk hold the mallets used to secure the miniature greenhouses into place as part of Sarah Crosby's research project. Photo: Sarah Crosby

Salt marshes are in-between places.

Tucked behind a beach front, along a tidal creek, between dry land and open water, they are Connecticut's liminal ecosystems.

When conditions are just right, marsh grasses can establish themselves in sheltered coves and embayments, and these transitional ecosystems are formed. Once common along the Connecticut coast, the remaining marshes have become a research passion for three scientists and their partners who are trying to do what they can to help preserve these essential waterscapes.

"The marshes are spectacular, in terms of their beauty and complexity," said one of the researchers, Shimon Anisfeld of the Yale School of the Environment.

In addition to being some of the most productive ecosystems in the world, salt marshes perform critical ecosystem services. They remove excess nutrients from water, sequester carbon in layers of peat and are critical habitat for hundreds of key species. Salt marshes can protect our communities from flooding by soaking up storm surges like a sponge, and they lessen storm damage by softening the blows from waves to the coast.

Despite the value we now recognize, the salt marshes in Connecticut have a long history of mismanagement and degradation. A brief comparison of aerial photos from the 1930's to present shows acres of this invaluable habitat drained, filled, or eroded away.

These practices weren't merely tolerated. State laws promoted marsh draining in a misguided effort to drive down the mosquito nuisance. Even today the effects of this practice can be seen in many marshes: linear ditches dug throughout the 20th century that crisscross the marsh surface.

While the drainage ditches left many marshes a disturbed habitat, draining and filling destroyed other marshes altogether. These historical land management decisions, in concert with the impacts of climate change, have led to the current conditions in which the remaining salt marshes in Connecticut are threatened.

The salt marsh ecosystem is finely balanced on a range of elevations and saline gradients—an equilibrium that is being disrupted by rising seas. Marshes in Connecticut have been

able to shift with the changing sea levels during the past few thousand years, but the acceleration of sea level rise this century may be too quick for them to keep up. On the landward edge, many marshes have nowhere to go, hemmed in by development that has crept up against marsh systems.

In this context, salt marshes have become a priority for coastal ecosystem restoration. Millions of dollars have been devoted to protecting these critical habitats. Wanting to restore a marsh is one thing—figuring out the best practices another. When every day counts, using methods backed by science is critical. Researchers Chris Elphick, Sarah Crosby and Anisfeld are working hard with their colleagues to understand how to effectively protect and restore salt marshes in the state.

THE SPARROW IN THE SALT MARSH

Restoration and research, while they might seem synergistic, are not always integrated in the same project. Elphick, a scientist with the University of Connecticut Department of Ecology and Evolutionary Biology, led a team of research partners who took advantage of a unique opportunity to change that at Great Meadows marsh in Stratford. Audubon Connecticut, the Connecticut Department of Energy and Environmental Protection and the town of Stratford received more than $4.5 million to restore the marsh habitat. With Elphick and other scientists involved in the design of the restoration plan, the project had an experimental design from the start. Additional funding from the EPA's Long Island Sound Study ensured that not only would the habitat concerns be addressed in the short term, but long term, systematic monitoring could be conducted to understand which restoration techniques yielded the best results.

The strategies employed at Great Meadows revolved around the Saltmarsh Sparrow, a species of keen concern in the region. Squeezed by habitat loss and rising sea levels, this bird has experienced precipitous decline in the past decades. The critical thing for the sparrows, Elphick said, is elevation. At Great Meadows, a novel technique was employed to raise the surface of the marsh. "Hummocks" (mounds of fill material) were placed throughout the marsh to provide elevated patches of ground where Saltmarsh Sparrows can nest safe from sea level rise. Some projects to elevate marshes to cope with sea level rise take a blanket approach, in which sediment or dredged material is deposited on the marsh surface in a thin layer (on a much more limited scale than previous marsh-destroying fill projects) and then replanted grasses are allowed to revegetate on their own. This might work well for elevating the marsh surface, but for the sparrows, Elphick said, the bare sandy material post-restoration

Top: Elevated hummocks were created at Great Meadows in Stratford to provide nesting areas for these and other Saltmarsh Sparrows. Photo: Chris Elphick

Center: Two 'ghost trees' in the Barn Island marsh are visible evidence about how the habitat is changing. Photo: Shimon Anisfeld.

Bottom: An aerial view of the south end of Great Island at the mouth of the Connecticut River shows the grid of ditches dug for drainage and mosquito control. Photo: Long Island Sound Resource Center

is a "wasteland." In contrast, these smaller hummocks elevate the marsh in small patches, which can revegetate more quickly to allow for sparrows to use them immediately. This is less impactful to the habitat and more cost-effective than large scale sediment additions.

Great Meadows was an ideal site to pilot this technique. The population of Saltmarsh Sparrows there is at a level that will ensure the scientists get relevant data, but there are not so many birds that disturbing the site would be dangerous for the species overall. The early results Elphick and his team have discovered have been promising. Birds have been found nesting on the hummocks, especially willets and killdeer, a type of plover, but many nests have failed due to predation. The plants are doing well too: Elphick says that on the mounds the team found "some of the lushest growth of *Spartina patens* I've ever seen." While this is not unexpected given the nutrient-rich fill used to create the hummocks, it is still an encouraging start. Unfortunately, some invasive *Phragmites* (common reed) have returned to the disturbed areas, but that is unsurprising given nearby populations of the plant.

SEEN AND UNSEEN

The marshes that line the Connecticut coast have always been on the move, a phenomenon called salt marsh migration. The question now, as sea level rise rapidly accelerates due to climate change, is whether the marshes will keep up, or be drowned in place. Two Yale School of the Environment researchers, Anisfeld and Craig Brodersen, combined their expertise in marsh ecology and forestry to study how marshes migrate into coastal forests, funded by a Connecticut Sea Grant research initiative. Their research took place at Barn Island in Stonington, Connecticut.

The "migration" of salt marshes can be understood as a process in which physical conditions over time influence the plant communities that can grow in a specific spot. If a portion of land that isn't currently marsh gets flooded by tides over and over, the non-salt-tolerant plants will slowly die off, and marsh grasses can move in to fill the space. As Anisfeld describes, it is a fluid progression from one stage to another—it takes occasional inundation over a period of decades for the edge of a salt marsh to push into the upland.

Gradual sea level rise and tidal flooding aren't the only forces that can make a marsh move. Coastal storms like hurricanes play a key role in causing marsh migration. Storm events leave marks on the ecosystem that can't always be seen with the eye. The damage is ingrained in the growth rings of trees for the rest of their life, because of the salt water doused over the forest from surging seas in a hurricane. This type of "invisible migration" (a term Anisfeld came up with) is there if you know where to look. It can clue us into exactly how quickly some of these habitats are changing, which isn't visible from aerial imagery. Storm events open gaps for the marsh to move in a couple ways. Sudden tree death from wind will immediately clear a space, but saltwater inundation can also hamper a tree's growth for an entire growing season. What did he find most surprising about the project?

Researchers erect miniature greenhouses on a salt marsh to measure how marsh grass responds to elevated temperatures. Photo: Sarah Crosby

"The importance of historic events to driving change on the landscape," Anisfeld said. "I expected this to be a story of the last few decades."

But, as he and his collaborators found, marshes have been migrating due to sea level rise and storms for the past century. Storms as far back as the '38 Hurricane left a noticeable mark. In fact, Hurricane Sandy, which the team would have expected to jumpstart migration in some areas, had less of an impact on tree growth because it hit outside of the growing season, they found.

WHICH PLANTS TO USE

Restoration can be thought of as two main stages: physical alterations to a marsh, and revegetation afterwards. Crosby, the director of conservation and policy for The Maritime Aquarium at Norwalk, is focused on getting that second step right.

Crosby has been researching different aspects of salt marshes for many years, but recently her projects are centered on figuring out how different sources of cordgrass influence the success of a restoration project. This is critical—even if a marsh is elevated to account for sea level rise, it is the ecological community that springs from the plants that will

ultimately decide how effectively a marsh functions as an ecosystem.

After the system is modified in a restoration project, there is often a concentrated replanting effort, which, in Crosby's words, leads to important questions.

"Where are those plants coming from, and does it matter where we're sourcing these plantings from?" she asked.

Plants sourced from southern nurseries, she noted, might be genetically different than plants of the same species found in a natural Connecticut marsh.

Results of the first project, funded by Connecticut Sea Grant, a study of marsh grasses of different genotypes, is in review for publication right now. It also yielded a wealth of valuable data, she said. The surplus of information, while daunting, potentially provided insight on how plant resources impact marsh restorations. The six natural marshes sampled for the project generally had more peat buildup and marsh resident species than the six restored sites which displayed more genetic diversity but equaled the natural sites in transient species and live below-ground biomass.

In a follow-up to that work, funded by the EPA's Long Island Sound Study, Crosby and her team moved to studying the ways differently sourced plants might respond to stressors from climate change. Under rising summer temperatures, it is reasonable to think that *Spartina alterniflora* southern genotypes might be better adapted. To figure this out, they constructed 144 miniature greenhouse cubes out of PVC pipe and greenhouse plastic, which raise the ambient temperature 2 to 3 °C during hot summer days. These are being placed in marshes throughout the state, four that have been restored in the past and four that remain unaltered by restoration. Marshes bordering communities with exposure to coastal flooding and environmental justice concerns such as Bridgeport, Stratford, Milford, and New Haven were selected.

"It's fascinating what is happening in the cubes," said Crosby, who is eager to share the findings once the study concludes this year.

A UNITED FRONT

It's no secret that the future holds challenges for Connecticut's marshes. Historic land use practices, sea level rise and development all threaten to continue the decline of this vital habitat in the state. There is good news, though. Passionate scientists like Elphick, Anisfeld, and Crosby are learning all they can about these issues. Their projects are led by investigators of different expertise linked by a shared passion for marshes.

Elphick's interest in the Saltmarsh Sparrow is born of his childhood exploring the marshes of northern England, where he grew up.

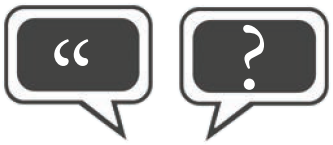
"It's a chance to learn something cool about how the world works and apply it to a specific problem," he said of connecting the welfare of one species to the entire ecosystem.

Crosby has cultivated a love of salt marshes since she was introduced to tidal ecosystems at a young age, and now she wants to contribute "anything I can do to help us restore these sites more efficiently and effectively for the future" with her research.

Anisfeld expresses an inspiration that will resonate with everyone captivated by Connecticut's marshes.

"There is a complex interplay of physical, chemical, and biological forces that is kind of magical," he said.

UConn Avery Point students learn about local birds and mammals from a Denison Pequotsepos Nature Center staff member at the campus EcoHusky Club's Earth Day celebration on April 22. Photo: Judy Benson



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