The Synapse: Intercollegiate science magazine

Volume 10 | Issue 1 Article 16

2016

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At eight years old, I watched with absolute terror as my hometown was swept away by the forces of nature. I remember standing in my uncle's living room in Lafayette, watching the news broadcasts from only 135 miles away: torrential downpours, skyscrapers swaying in the 174 miles-per-hour winds. But most horrifying of all were the images of the water breaching the protective levees, flooding the streets of New Orleans and leaving a trail of absolute devastation in its wake. I'd been on evacuation plenty of times, I'd seen bad hurricanes before — but not like this. The hurricanes I'd seen didn't destroy cities. At the end of every evacuation had been a return home — but what if, this time, I had no home to return to? What if it was just gone? What if my family would have to keep hopping from town to town with no end in sight? At eight years old, that scared me more than anything. Exiled by evacuation, we waited for the remnants of the deluge to drain away and eventually enough displaced families were able to resettle, including mine. Now, among the questions on the minds of our city's politicians, scientists, and engineers were: How could such a disaster have occurred? How had the storm reached the mainland so easily? How had it pushed past the barriers erected to prevent a catastrophe like this from happening in the first place?

As well as uncovering a myriad of problems such as rising global temperatures and faulty infrastructure, investigations also revealed that the continued depletion of Louisiana's wetlands had stripped us of our primary barrier of defense against the hurricane. The wetlands act as a buffer against powerful storm surges, taking the full brunt of the rain and wind so that the storm is diminished by the time it reaches the mainland. However, since the construction of levees in 1927, Louisiana's wetlands have been rapidly eroding away. The levees block the deposit of new sediment from the Mississippi River into the wetlands, meaning that as the Gulf's tide drags away land from Louisiana's coast, there's no way to replenish it.

It sounds like a slow process, but in reality, Louisiana's coast loses a football field's worth of land per hour. This makes the whole state exponentially more vulnerable to disasters like Katrina and results in habitat loss and damage to the fishing industry, which is vital to Louisiana's economy and many of its residents' livelihoods. It's no exaggeration to say that the integrity of the wetlands is crucial to the survival of the state, which is why I undertook research with the Pontchartrain Institute for Environmental Sciences to track wetland health from 2012 to 2015.

The wetland I observed in this study was Bayou Sauvage Refuge, an integral part of the wetlands surrounding the greater New Orleans area and one of the most important safe havens for Louisiana wildlife. To figure out how the marsh's health had progressed over the years, I decided that the best starting point would be to track the overall trajectory of the

marsh's health using three large-scale indices of ecological integrity. These indices have very simple parameters: higher scores on the index indicate a healthier marsh while lower scores indicate a declining marsh. If I could plot the values of these indices from 2012 to 2015, I could see in which direction the marsh's health was going.

The first indicator was the Floristic Quality Index (FQI), an index of the marsh's integrity based on how many of its plant species are native. The second was the marsh's hydrologic index, based on the combined influences of average annual salinity and flood duration. The third was the Normalized Difference Vegetation Index (NDVI), an index determining how much live vegetation is present in an observed area. When looked at together, all of these indices demonstrated the same pattern: from 2012 to 2014, the scores on all three indices steadily increased, but then took a downturn from 2014 to 2015. This meant that from conditions of relatively poor marsh health in 2012, the marsh had been consistently recovering, but between 2014 and 2015, something had disrupted this trajectory and caused it to reverse. The marsh was declining in health again. Why?

To find an answer, I took a look at some of the finer details of the marsh's ecology: its mean soil porewater temperature, mean annual surface elevation, water level, and plant reflectance — that is, how much light a plant reflects. When looked at individually, none of these phenomena could single-handedly account for the decline in the marsh's health, but when analyzed in tandem, the data revealed a fascinating interplay of ecological phenomena that fit together like pieces of a puzzle. Between 2012 and 2015, both water level and plant reflectance were consistently in decline, which made sense: as the water level gets lower, marsh plants will be more and more exposed to the open air, and more water will evaporate out of their tissues, causing them to wither and reflect less light. However, that didn't match what our three indices showed. Despite the declining health of the plants, the marsh as a whole had gotten healthier over the first three years studied. It seemed that the adverse effects on reflectance hadn't been enough to skew the trajectory of the marsh's health during these years — but perhaps the withering plants had brought the marsh's health to a threshold, and only in 2014 did some trigger finally push it over the edge. That trigger turned out to be a spike in soil porewater temperature, which correlates directly with the temperature of the air. Under excessive heat, the already stressed plants lost even more water, causing them to finally die and disappear from the marshland. With no roots to anchor the marsh's soil layer, the soil eroded away, surface elevation decreased, and the marshland converted into open water. This is a phenomenon called marsh dieback, which is symptomatic of a drought or drought-like conditions. The spike in temperature and the declining water levels also attested to this. It was this chain reaction of phenomena and subsequent disappearance of the marsh that likely caused the three indices to reverse trajectory from 2014 to 2015.

These kinds of studies are important to the Pontchartrain Institute so that they can figure out what's happening in the marsh at a given time. However, short-term ecological surveys like mine are barely a fraction of the institute's work, and nowhere near the most important. The institute's main focus is on large-scale restoration projects, with remediation efforts spanning vast regions of wetlands and entire islands in the Gulf. For example, one of their highest-priority projects involves the restoration of the Chandaleur Islands, a chain of barrier islands (islands that serve as buffers against storm surge, much like the wetlands do) that have been severely eroded by hurricanes and the 2010 BP oil spill. Following the spill, miles and miles of sand berm — large, robust walls of sand — were constructed around the islands; the Pontchartrain Institute looks to see if the sand berm effectively prevents further erosion, while at the same time developing a plan to restore the land that's already been lost. By monitoring the effects of these kinds of remediation efforts, the Pontchartrain Institute is able to determine how much attention needs to be given to the area studied, and what changes need to be made to remediation projects if they're not working in the way they need to.

The institute isn't only interested in the effects of engineering projects, however. Habitat conservation is also high on their list of priorities. Wetland loss destroys the habitat of one of the most biodiverse communities of organisms on Earth, including a plethora of bird species, a near-endless variety of flora, and all manner of fish and crustaceans. After inventorying the members of this vast community, the Pontchartrain Institute develops a plan to restore their habitat, sustain organismal populations, and make sure that invasive species don't wreak too much havoc on the ecosystem. In addition, the institute is currently developing a model to evaluate the impact of land restoration projects on local animal and plant populations; after all, development carried out with even the best intentions can have detrimental effects on the wildlife. The institute is dedicated to preserving the wetlands for the sake of the ecosystem and its intrinsic value just as much as it is for the well-being of the people living on the mainland.

To effectively complete these projects, collaboration is key. The Pontchartrain Institute draws an extremely eclectic team of scientists, all with vastly different specialties. Many are ecologists, of course, but just as common and are geologists, plant systematists, and animal biologists. The kinds of projects conducted by the institute rely on interdisciplinary knowledge and scientists from all of these disciplines collaborate within the institute to develop effective solutions to the problems the wetlands face every day. To get those solutions to actually be put into effect, the institute needs to collaborate with external organizations; The Pontchartrain Institute has worked with the U.S. Fish and Wildlife Service, the Army Corps of Engineers, and the National Marine Fisheries Service for the purposes of wetland restoration, wildlife conservation, and preservation of Louisiana's fishing industry. It also partners with Benjamin Franklin High School — my alma mater — to teach practical skills in tackling environmental problems, and to introduce students to the research methods employed by the institute. The disappearance of the wetlands is a problem that will affect Louisianians for decades to come, and educating the next generation of environmental scientists is going to be crucial if we want to develop a long-term solution.

Indeed, the restoration of the wetlands is ultimately going to be a long-term collaborative process. It's a problem that affects everyone who lives in the Gulf Coast region and it's going to take an input from all of us if it's going to get solved. Hopefully, the efforts of the Pontchartrain Institute, its partner organizations, and all the aspiring environmental scientists out there will pay off in the long run and prevent another Katrina from ever happening again.