RSR Award Detail

Research Spending & Results

Award Detail

Awardee:	RECTOR & VISITORS OF THE UNIVERSITY OF VIRGINIA
Doing Business As Name:	University of Virginia Main Campus
PD/PI:	Karen McGlathery (434) 924-0558 kjm4k@virginia.edu
Co-PD(s)/co-PI(s):	John Porter Patricia Wiberg
Award Date:	12/06/2006
Estimated Total Award Amount:	$ 4,919,999
Funds Obligated to Date:	$ 4,555,927 FY 2011=$820,000 FY 2010=$960,761 FY 2009=$935,000 FY 2008=$913,998 FY 2007=$926,168
Start Date:	12/15/2006
End Date:	11/30/2011
Transaction Type:	Grant
Agency:	NSF
Awarding Agency Code:	4900
Funding Agency Code:	4900
CFDA Number:	47.074
Primary Program Source:	490100 NSF RESEARCH & RELATED ACTIVIT
Award Title or Description:	Long-Term Drivers, State Change and Disturbance on the Virginia Coast Reserve: LTER V
Federal Award ID Number:	0621014
DUNS ID:	065391526
Parent DUNS ID:	065391526
Program:	LONG TERM ECOLOGICAL RESEARCH
Program Officer:	Nancy J. Huntly (703) 292-8061 nhuntly@nsf.gov

Awardee Location

Street:	P.O. BOX 400195
City:	CHARLOTTESVILLE
State:	VA

ZIP:	22904-4195
County:	Charlottesville
Country:	US
Awardee Cong. District:	05

Primary Place of Performance

Organization Name:	University of Virginia Main Campus
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Abstract at Time of Award

Humans are altering ecosystems at unprecedented rates, especially in the coastal zone. The Virginia Coast Reserve (VCR) LTER aims to develop predictive understanding of how long-term environmental change and short-term disturbances control the dynamic nature of coastal barrier landscapes. The landscape is heterogeneous, comprised of mainland watersheds, tidal marshes, lagoons and barrier islands. The central hypothesis is that ecosystem dynamics and pattern on the landscape are controlled by the interactions of vertical positions of the land, sea, and groundwater free surfaces, and the fluxes of organisms and materials across the landscape. Proposed and continuing research is organized around synthetic questions: (1) How do long-term drivers of change (climate, rising sea level, and land-use change) and short-term disturbances interact to alter ecosystem dynamics and state change, and how is their effect modified by internal processes and feedbacks at the local scale? (2) How do fluxes of organisms and materials across the landscape influence ecosystem dynamics and state change? (3) In the future, what will be the structure of the landscape and what processes will drive state changes? The first question is a continuation of past VCR research, while the latter questions are new. Modeling and process-level studies also address the biogeochemical and trophic consequences of state change on the landscape. The project uses a combination of long-term monitoring and experiments, shorter-term process studies, and modeling. Patterns, processes and interactions are examined within landscape units (watershed, tidal marsh, lagoon, barrier island), within mainland-lagoon-island box transects, and across the entire system of islands and lagoons. Processes are considered at temporal scales from hours (e.g., element cycling) to decades (e.g., succession) to more than a century (e.g., sea-level rise). Research includes ecologists, hydrologists, biogeochemists, atmospheric scientists, oceanographers, modelers, and specialists in remote sensing and informatics.

Understanding and predicting how multiple factors influence ecosystems and their services are critical challenges for environmental scientists and resource managers. VCR is a relatively pristine coastal system that can be compared with other sites to understand how coastal systems in general respond to drivers of global change. VCR has been very active in outreach, training and network activities. Its Schoolyard Program contributes important training and infrastructure to the primary and secondary schools in the local county, which is one of the poorest in the state; over half the students are women and minorities. Training of future environmental scientists through graduate programs at participating institutions is one of the priorities of the program. Each funding cycle VCR trains over 40 graduate students and about 20 undergraduates, about half of which are women and minorities. Scientific findings and technical information are broadly disseminated through the VCR website, scientific publications and presentations, and the media. VCR has developed links with conservation organizations, and local, state, and federal agencies through outreach efforts. VCR also has a strong partnership with The Nature Conservancy to address the important management and conservation problems facing this region. This puts VCR in an excellent position to provide a solid, scientific foundation for making decisions related to planning, management, and ecosystem restoration. This partnership can also serve as a model for science-based management of other dynamic coastal barrier systems.

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Project Outcomes Report

Disclaimer

The Virginia Coast Reserve Long-Term Ecological Research project focused barrier island, salt marsh, watershed and lagoon systems located on the Atlantic Coast of the Delmarva Peninsula (Figure 1). We investigated whether ecosystem dynamics and pattern on the landscape are controlled by the interaction between the vertical positions of the land, sea, and groundwater surfaces, and the movements of organisms and materials across the landscape. The project monitored the processes, such as plant growth, movement of nutrients and organisms, organic matter dynamics, population growth and disturbance, which will determine the future landscape of the Virginia Coast Reserve.

Images (1 of 4)

In 2007, a large-scale seagrass experiment was initiated, with the planting of seagrass in a 509-acre set-aside area in Hog Island Bay, which had been unoccupied by seagrass since the 1930s. We documented the recovery of key ecosystem functions related to primary productivity, carbon and nitrogen sequestration, increased water column clarity, and bottom stabilization with the growth of seagrass, with full recovery expected in a decade. The showed that the positive feedback of seagrass on water clarity is sufficient to induce bistable dynamics between bare and seagrass-vegetated states.

Our long-term record of salt-marsh elevation indicates that some of the mainland marshes are accumulating new material at a rate sufficient to keep up with existing rates of sea-level rise (Fig. 2), but that bay marshes are more vulnerable to submergence, which has adverse effects on waterbirds. Additionally, disturbance promotes fragmentation and pond formation, which in turn causes dynamic changes in salt-marsh food webs.

On the barrier islands, we showed that controls on plant community distribution can be explained by two key environmental parameters: distance from the shoreline (beach face) and elevation above sea level (Fig 3). These two parameters integrate a number of important physical and biotic variables. For example, distance from the shoreline affects exposure to sea spray, burial by windblown sand, and vulnerability to storm-related disturbance (i.e., overwash) and, as a result, the extent to which ecological succession can take place. Elevation above sea level determines disturbance vulnerability, and influences groundwater and nutrient availability. The presence of plants feeds back to influence elevation by trapping and accumulating sand, or by maintaining low elevations. These relationships can be used to assess changes in species distribution with variations in island geomorphology and with climate change scenarios of accelerating sea-level rise and altered storm frequencies. Over the last 30 years, we have observed a dramatic increase in shrub thickets by >400% as shrubs encroach onto grasslands (Fig. 4).

Additionally, we used our observations to develop several quantitative models. A model of the seagrass ecosystem was used to explore the role of depth, water clarity and temperature on seagrass. Results from this model can be used to predict areas where seagrass reestablishment might occur in future scenarios of climate and land-use change. We also developed a model that describes the strong coupling between the evolution of marshes and tidal flats. Marsh edge erosion and sediment transport influence the dynamics of these alternative states. Our decadal scale (1957 – 2009) and detailed short-term measurements show that erosion rates vary more than an order of magnitude (0.1 m to 1.5 m per year). We showed that wave attack at the marsh boundary increases with tidal elevation until the marsh is submerged and then rapidly decreases. Wave energy at the marsh boundary produces a wide array of marsh edge morphologies (wave-cut gullies, terraces, overhanging root mats) that influence edge erosion rates and are related to local vegetation and sediment characteristics, and the presence of crab burrows and bivalves.

The inter- and multi-disciplinary nature of our research teaches students how to operate in a collaborative environment. The project provided abundant opportunities for training, with support for 63 graduate students, 10 undergraduate students and 1 post-doc. We also partnered with local high schools to provide resources and expertise in science. Each year, over 200 local high-school students were exposed to LTER science.

The scientific literature was the primary way the VCR/LTER disseminated information from the project. VCR/LTER researchers published 164 papers in scientific journals, with an additional 19 book chapters and 42 theses or dissertations. Additionally, over 160 datasets were made available.

We also developed links with conservation organizations, and local, state, and federal agencies through outreach efforts. The LTER has a strong partnership with The Nature Conservancy, and through this we addressed the important management and conservation problems that face the region. This put us in an excellent position to provide a solid, scientific foundation for making decisions related to planning, management, and ecosystem restoration. A good example of this was our collaboration on the seagrass restoration in the coastal lagoons. Additionally, our Outreach/Education Coordinator was a member of the Eastern Shore Climate Adaptation Working group, a partnership between The Nature Conservancy, local, regional and federal agencies.

Last Modified: 02/26/2015
Modified by: John H Porter

For specific questions or comments about this information including the NSF Project Outcomes Report, contact us.