Georgia Coastal Ecosystems LTER

Estuaries and marshes provide food and refuge for organisms, protect the shoreline, help keep water clean, and store carbon. The Georgia Coastal Ecosystems (GCE) LTER, based at the University of Georgia Marine Institute on Sapelo Island, was established to study long term change in coastal ecosystems. Researchers track the major drivers of long term change, such as altered freshwater input and sea level rise, and conduct experiments to assess how coastal ecosystems will respond to anticipated changes in climate and human activities. The program has made major contributions to understanding patterns of primary production, community interactions, and ecosystem services in intertidal wetlands, as well as the flow of carbon across the coastal landscape and out to the ocean. Disturbances are particularly important in the context of long term background changes such as increasing sea level. Researchers at GCE LTER will work over the coming years to systematically quantify perturbation patterns in intertidal marshes and estimate the effect of disturbance on ecosystem properties.

Between 2008-2018:

66 investigators

9 institutions represented

124 graduate students

Coastal

Principal Investigator:
Merryl Alber
University of Georgia

Est. 2000
Funding Cycle:
LTER IV

NSF Program:
Geosciences / Division of Ocean Sciences

Key Findings

Estuaries play an outsized role in the global carbon budget. Estuaries are net sources of CO_2 to the atmosphere and coastal ocean, and net sinks for oceanic and atmospheric O_2. This finding challenges the simplistic treatment of estuaries in global carbon models, and suggests that interactions between river discharge, changes in marsh area, and increasing atmospheric CO_2 will alter shelf-ocean carbon exchange in the future. [Products 1, 2]

Ammonia oxidizers transform the nitrogen cycle. Ammonia-oxidizing archaea (AOA) convert ammonium into nitrite, but little is known about the population dynamics of this relatively new addition to the nitrogen cycle. Research from GCE LTER found that mid summer blooms of AOA coincide with a peak in nitrite concentration. Field data from 29 estuaries showed similar summer peaks in nitrite, suggesting that summer blooms of AOA are widespread and play a previously unrecognized role in driving estuarine nitrogen cycling [3].

Sea level rise alters wetland function. Sea level rise is expected to cause salt marshes to extend upstream at the expense of freshwater wetlands, dramatically altering the intertidal landscape. Experimental salinization reduces primary production, reduces plant species diversity, decreases respiration, and leads to loss of marsh elevation. [4, 5]

River flow supports marsh production. Long term monitoring, remote sensing, and field experiments showed that dominant estuarine plants grow up to 3 times better in years with low salinities, and that salinity is driven most strongly by river discharge. A high frequency of drought in 1998-2012 led to declines in plant biomass relative to the 28-year period of record for Landsat 8. [6-8]

Mobile predators structure communities. Mobile predators like alligators move between fresh and marine habitats, consume a variety of estuarine prey, and alter the behavior of intermediate predators such as blue crabs. A predator exclusion experiment initiated in 2016 indicated that blue crabs and large fish alter the abundance of marsh invertebrates such as snails and fiddler crabs, which in turn mediate plant production and soil biogeochemistry. [9]

Synthesis

Effects of shoreline armoring vary among coastal systems. Building on site specific work on coastal armoring, investigators from four coastal LTER sites developed a conceptual model of armoring and synthesized the literature, which showed that the effects of coastal armoring varied strongly and predictably among systems.

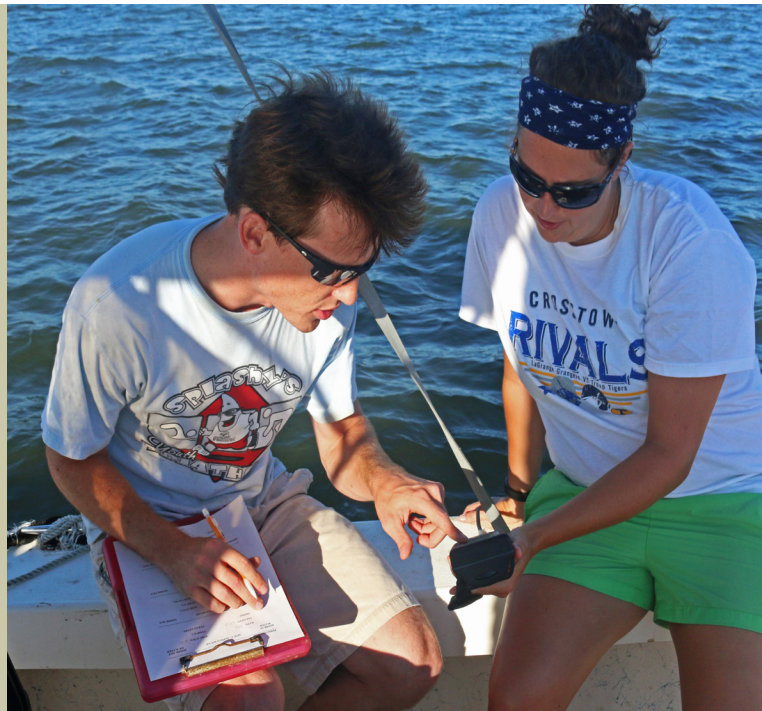
Historical analyses inform salt marsh processes. A photographic analysis of historical changes in salt marsh extent was part of an NSF Coastal SEES (Science, Engineering and Education for Sustainability) project in collaboration with two other coastal LTER sites. Topography and residential development patterns has influenced salt marsh extent over the past 70 years.

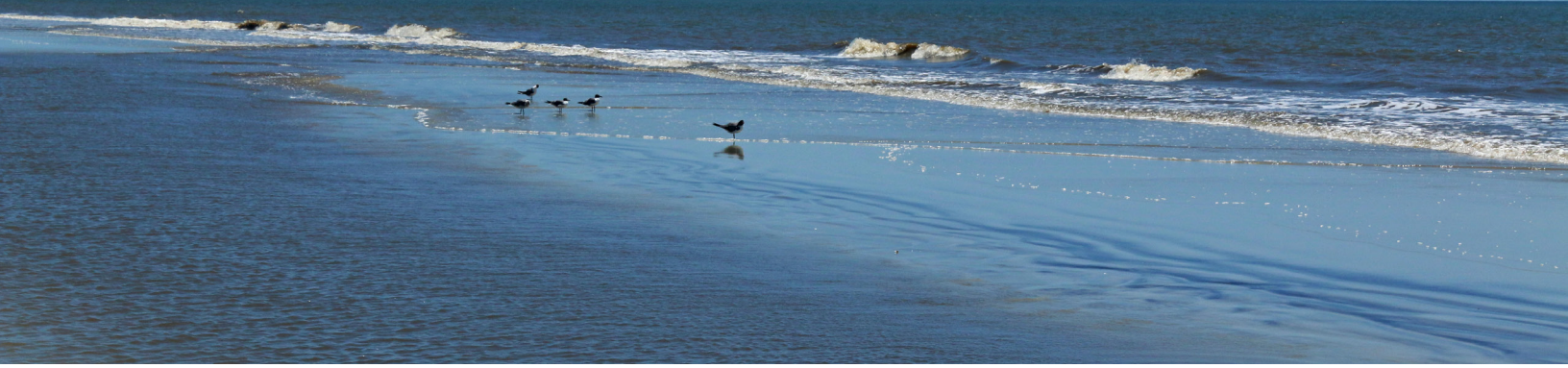
Introduced Spartina is changing coastal habitats in China. Introduced to China in 1979, Spartina alterniflora now covers almost the entire Chinese coastline. Collaborations with Chinese colleagues showed that *S. alterniflora* has far-reaching consequences for wetland processes, and that it has developed latitudinal clines in morphology and reproduction [10].

Sediment supply determines tidal marsh response to sea level rise. A collaborative NSF RUI (Research Undergraduate Institutions) project with Plum Island LTER investigated how historical and contemporary sediment delivery in east coast salt marshes regulates tidal marsh accretion in urban, agricultural, and forested landscapes.

Data Accessibility

The GCE LTER Data Catalog provides online access to datasets and is regularly synchronized to EDI and BCO-DMO data repositories, which are searchable through DataONE. Users have logged over 154,000 downloads of the site's 603 datasets. Information managers at GCE LTER have also developed several innovative software products, database systems, and web applications. The Data Toolbox for MATLAB has been downloaded by over 4,100 registered users and is actively used for sensor data harvesting and analysis at 9 other LTER sites.





Broader Impacts

Georgia Coastal Research Council (GCRC). Established in 2002, the GCRC facilitates science-based management of coastal resources for Georgia and the southeast region through workshops, scientific assessments, and synthesis of coastal research. Researchers from GCE LTER collaborate closely with the 168 scientists and managers of the GCRC.

Distributed graduate courses. A model for distributed graduate courses taught live on the internet allows GCE LTER to leverage personnel across the LTER network and beyond. This program has reached 150 students at more than 40 institutions and provides a level of expertise that no single institution could match.

Long term partnerships with educators. Students and educators in the GCE LTER Schoolyard program return year after year to be immersed in hands on research activities alongside researchers. One long time participant (Halley Page) received the prestigious Presidential Award for Excellence in Science and Mathematics Teaching.

Partnerships

National PhenoCam Network | USGS | National Atmospheric Deposition Program | Sapelo Island National Estuarine Research Reserve

Top Products

1. Cai, WJ 2011. Estuarine and Coastal Ocean Carbon Paradox: CO2 Sinks or Sites of Terrestrial Carbon Incineration? **Annual Review of Marine Science.** doi: 10.1146/annurev-marine-120709-142723
2. Wang, S et al. 2017. Inorganic carbon and oxygen dynamics in a marsh-dominated estuary. **Limnology and Oceanography.** doi: 10.1002/lno.10614
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4. Craft, CB et al. 2009. Forecasting the effects of accelerated sea level rise on tidal marsh ecosystem services. **Frontiers in Ecology and the Environment.** doi: 10.1890/070219
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6. Wieski, K and Pennings, SC. 2014. Climate Drivers of Spartina alterniflora Saltmarsh Production in Georgia, USA. **Ecosystems.** doi: 10.1007/s10021-013-9732-6
7. O'Donnell, J and Schalles, JF. 2016. Examination of Abiotic Drivers and Their Influence on Spartina alterniflora Biomass over a Twenty-Eight Year Period Using Landsat 5 TM Satellite Imagery of the Central Georgia Coast. Special Issue: Remote Sensing in Coastal Environments. **Remote Sensing.** doi: 10.3390/rs8060477
8. Di Iorio, D and Castelao, R. 2013. The Dynamical Response of Salinity to Freshwater Discharge and Wind Forcing in Adjacent Estuaries on the Georgia Coast. Special Issue: Coastal Long Term Ecological Research. **Oceanography.** doi: 10.5670/oceanog.2013.44
9. Nifong, JC et al. 2015. Size, sex, and individual-level behavior drive intra-population variation in cross-ecosystem foraging of a top-predator. **Journal of Animal Ecology.** doi: 10.1111/1365-2656.12306
10. Liu, W et al. 2017. Provenance-by-environment interaction of reproductive traits in the invasion of Spartina alterniflora in China. **Ecology.** doi: 10.1002/ecy.1815

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