

SWS Research Brief

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Katrina's Dance of Destruction and Renewal

Background

Our memory of Hurricane Katrina is of the chilling devastation of New Orleans and other cities along the Gulf Coast of the United States. While hurricanes devastate human infrastructure, we should not assume that these storms also destroy coastal wetlands. The majority of these wetlands sprang back within weeks or months of the storm. My studies assess the regrowth of vegetation in coastal marshes and forests following Hurricanes Katrina and Rita in 2005. The full studies are reported in the March 2009 Wetlands Special Issue on Hurricanes.

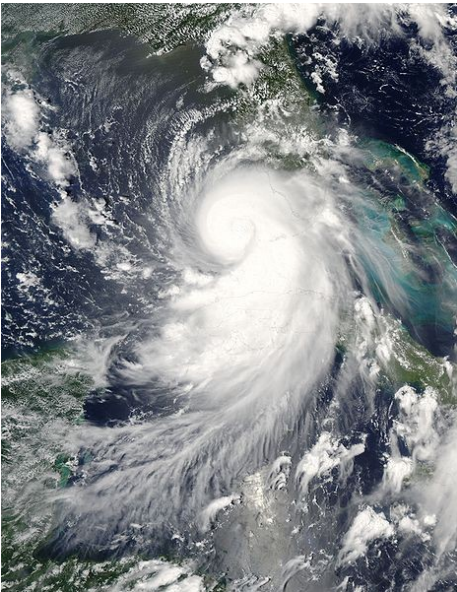


Figure 1. Hurricane Katrina with its devastation of New Orleans may have been the most destructive hurricane in history. The question is: How much did the storm affect the natural vegetation of the Gulf Coast of the United States? This satellite imagery is courtesy of NOAA.

Destruction and Renewal

Vegetation reestablishment following hurricanes depends on the plant surviving the hurricane, the availability of seeds and underground stems (rhizomes), and the nature of the environment in coastal wetlands after the storm. Hurricanes can cause the deposition or erosion of sediments, increases or decreases in salinity, and sudden flooding of wetlands. These environmental factors influence which species can reestablish following hurricanes.

To determine how wetland plant species regrew following Hurricanes Katrina (Fig. 1) and Rita in 2005, I documented the amount of vegetation destroyed, and the seeds and seedlings available for revegetation. These studies were conducted in baldcypress forests and coastal fresh, brackish, and salt marsh.

Study Goal

Coastal Marsh

The objective of the marsh study was to determine if the revegetation of wetlands could be altered by post-storm environments. Seeds and seedlings were examined to see if different species composition was present at various distances from the shoreline of the wetland. If species differed with distance from the shoreline, then differences in flooding or salinity could cause species composition to shift from the original composition. For example, an intense storm such as Hurricane Katrina might increase flooding and salinity in a freshwater marsh, and favor the regrowth of saltwater species after the storm.

Because species have different inherent abilities to germinate and grow under flooded, saline conditions, the nature of the storms and/or sea level rise could ultimately cause changes in the vegetation of these marshes. These studies were conducted in various marsh types including fresh, brackish, and salt marsh.

Baldcypress Swamp

The objective of this swamp study was to determine if tree and shrub species varied in their ability to survive and regenerate in post-storm environments. Dead and live woody materials were assessed in mixed baldcypress swamps, which received low, medium and high amounts of wind damage in Hurricane Katrina (Cat Island National Wildlife Refuge (NWR; LA), Jean Lafitte National Historic Park and Preserve (NHP; LA) (Fig. 2), and Pearl River Wildlife Management Area (WMA; MS), respectively). Tree regeneration was also assessed and related to post-storm environments.



Figure 2. Downed trees in a mixed cypress swamp at Jean Lafitte National Historic Park and Preserve, south of New Orleans. Damage to baldcypress was negligible due to Hurricane Katrina, even though certain other species were devastated.

HURRICANES CAUSE SHIFTS IN SPECIES COMPOSITION OF COASTAL FORESTS TO GREATER BALDCYPRESS DOMINANCE

Study Area

Coastal Marsh Regeneration

The reestablishment of vegetation was studied in fresh, brackish, and salt marshes along the coasts of Louisiana and Mississippi. The fresh marshes, Big Branch NWR, and Jean Lafitte NHP were dominated by grasses and had low salinity (< 3 ‰). Brackish marshes in Pearl River WMA were dominated by *Spartina patens* and the site had moderate salinity (4-15‰). *Spartina alterniflora* dominated salt marsh in the Sabine NWR and was interspersed with *Avicennia germinans* in Bayou Lafourche. Both sites had higher salinity (pore water salinity > 12‰).



Figure 3. Study sites in coastal wetlands in the paths of Hurricanes Katrina and Rita.

Baldcypress Structure and Regeneration

Mixed baldcypress forests were studied with high, medium and low levels of hurricane wind impacts (Fig. 3). The forests at Pearl River WMA bore the full force of Hurricane Katrina, because of their position in the right front quadrant of the storm. The forests at Jean Lafitte NHP received a moderate amount of wind damage as these were seaward of Hurricane Katrina and New Orleans. The forests at Cat Island NWR, which were west of New Orleans were slightly wind damaged even though they were inland and to the west of Hurricane Katrina.

Methods

Coastal Marsh

Seedlings of freshwater, brackish and salt marsh were monitored at various distances from the shoreline in the field (Fig. 4). Soil with seed banks (seeds in soil) were collected at these same distances, and subjected to water level and salinity treatments in the greenhouse.

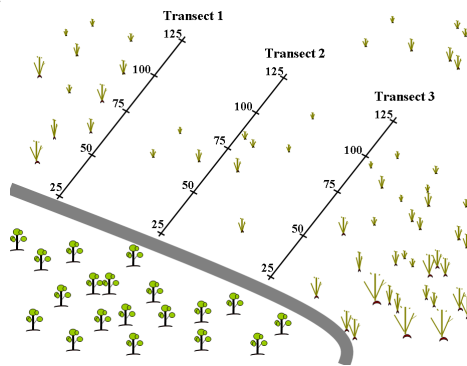


Figure 4. Plot layout for seedling and seed bank studies in coastal marshes. Seedlings were monitored at permanent markers at distances (meters) from the shoreline. Seed banks were collected and transported to the greenhouse.

Baldcypress Swamp

Five mixed baldcypress swamps dominated by baldcypress (*Taxodium distichum*) were chosen for study in low, medium, and high impact areas at Cat Island NWR, Jean Lafitte NHP, and Pearl River WMA, respectively. Within one permanent 10 x 10 m plot in each wetland, both the volumes of trees and shrubs damaged and undamaged were estimated, and the number of tree seedlings counted by species. Canopy (branches overhead) damage was estimated with a digital camera with a hemispherical (fisheye) lens.

Findings

- The recovery of hurricane-damaged vegetation began immediately following the hurricane with the regrowth of surviving plants, plant fragments and seeds.

Coastal Marsh

- Species recruitment was dependent on post-hurricane conditions of water and salinity. The response was flexible, so that at least some seeds were able to germinate at any water depth or salinity (Fig. 5).
- Coastal freshwater marsh may have been more affected by salinity from storm surge than brackish and salt marsh because most freshwater species did not germinate or grow well in salt water.

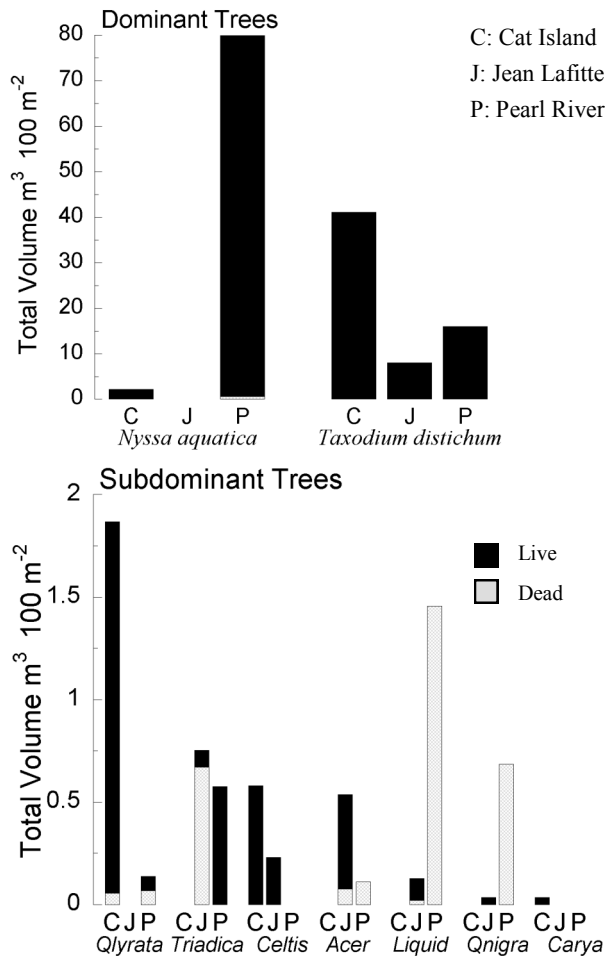
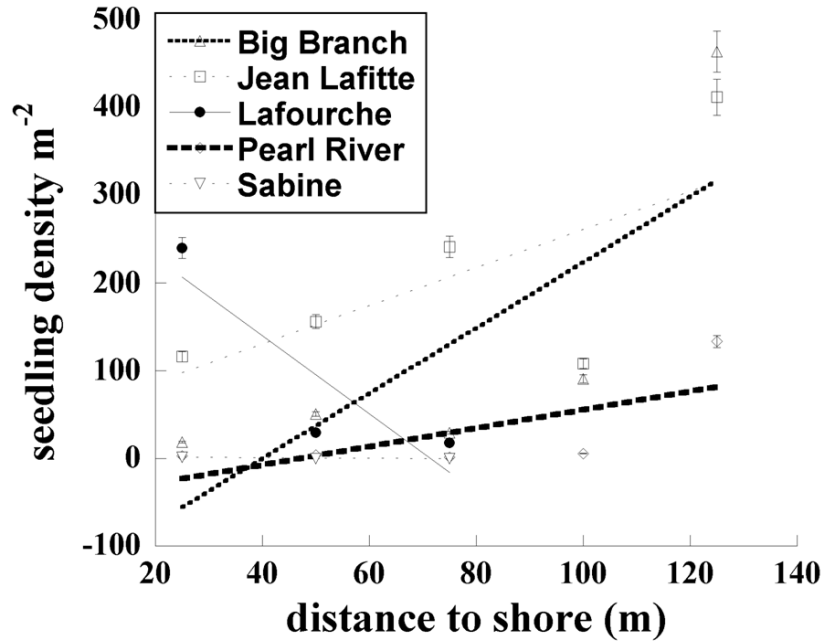
Baldcypress Swamp

- Hurricane Katrina pushed mixed forest toward a dominance of baldcypress, water tupelo (*Nyssa aquatica*), and button-bush (*Cephalanthus occidentalis*).
- Pearl River WMA was in the right front quadrant of Hurricane Katrina, and so had a high amount of structural damage to subdominant species but not to dominant species such as baldcypress and water tupelo (Fig. 6).
- Satellite optical data (Ramsey et al. 2009) and ground surveys showed that baldcypress were little damaged while other forest types were severely damaged. More forest damage occurred nearer the coast than farther inland for forests other than baldcypress (Fig. 7).
- Seedling recruitment was high in openings created by the loss of subdominant tree species after Hurricane Katrina.
- Most recruitment was of dominant tree species such as baldcypress and water tupelo, with some recruitment of Chinese tallow (*Triadica sebifera*).

Coastal Marsh



Figure 5. After Hurricanes Katrina and Rita, more seedlings and seeds were present away from the shoreline in freshwater coastal marshes (Big Branch WMA and Jean Lafitte NHP). The species germinating from the seed bank varied depending upon post-hurricane environments of water and salinity.



Baldcypress Swamp



Cat Island National Wildlife Refuge, Louisiana, USA

Figure 6. Dominant species such as baldcypress and water tupelo were little damaged by Hurricane Katrina (*Taxodium distichum* and *Nyssa aquatica*, respectively). The majority of the adults of subdominant species were destroyed by the storm in Pearl River WMA. Surprisingly, many shrubs were also toppled during the storm, but tough shrubs such as buttonbush (*Cephalanthus*) were little damaged.



Vegetation grows back quickly after hurricanes.

Regeneration

Wetlands damaged by hurricanes can regenerate quickly if seeds or propagules are abundant and readily dispersed into canopy openings or exist in the seedbank. This study found that seedlings were abundant in canopy openings of baldcypress swamps after Hurricane Katrina. The majority of seedlings were of dominant species such as baldcypress and water tupelo.

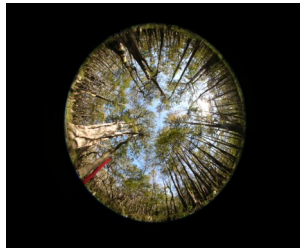


Overcup Oak seeds

- Gap Regeneration**
- baldcypress**
- water tupelo**
- swamp red maple**
- overcup oak**
- water hickory**
- Chinese tallow**

Low Damage

Cat Island NWR
high % canopy
low salinity
low seedling number



Moderate Damage

Jean Lafitte NP&P
low % canopy
some salinity
low seedling number



Severe Damage

Pearl River WMA
low % canopy
low salinity
low seedling number



Figure 7. Photos taken with a hemispherical camera lens show the amount of canopy damage in baldcypress swamps after Hurricane Katrina in Cat Island, Jean Lafitte NHP, and Pearl River WMA. Seedlings of baldcypress and water tupelo were abundant in these canopy gaps. Some seedlings of the invasive Chinese tallow also were found in Pearl River WMA..

Significance

The vegetation of coastal wetlands renewed itself quickly after Hurricane Katrina, even though this hurricane devastated the cities of the US Gulf Coast. From the perspective of coastal wetlands, hurricanes should be viewed simply as a natural disturbance. Of these coastal wetlands, freshwater marsh can be most affected by storms, because the species composition may shift in response to flooding and salinity. In baldcypress swamps, hurricane winds may favor the “invincible” baldcypress and tupelo. At the same time, huge numbers of seedlings of these dominant species were recruited into canopy openings. As a process, hurricanes of the intensity of Katrina are perhaps best viewed as a renewing force of nature, and not a force of permanent destruction.



Hurricanes are the Earth's way of cooling off!

Additional Information

- Middleton, B.A. 2009. Regeneration of coastal marsh vegetation impacted by Hurricanes Katrina and Rita. *Wetlands* 29: 54-65.
- Middleton, B.A. 2009. Effects of Hurricane Katrina on the forest structure of baldcypress swamps of the Gulf Coast. *Wetlands* 29: 80-87.
- Middleton, B.A. 2009. Effects of Hurricane Katrina on tree regeneration in baldcypress swamps of the Gulf Coast. *Wetlands* 29: 135-141.
- Ramsey, E. III, A. Rangoonwala, B. A. Middleton and Z. Lu. 2009. Satellite optical, radar and high altitude image data of Hurricane Katrina wetland forest impact and short-term recovery in the lower Pearl River floodplain of Louisiana, USA. *Wetlands* 29: 66-79.

About the Author

B.A. Middleton is a research ecologist at the U.S. Geological Survey, National Wetlands Research Center, Lafayette, LA USA. Her main research area is wetland plant ecology. Current research focuses on climate change, hurricanes, and invasive species in a worldwide context. She works to bridge the gap between science and nature.

Contact Information: Dr. Beth A. Middleton, USGS National Wetlands Research Center, 700 Cajundome Blvd., Lafayette, LA 70506 USA
middletonb@usgs.gov



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Karen L. McKee
karenmckee1@me.com