6 Chapter Six: Ecological Impacts

Ecological impacts from the hurricanes of 2005 affected both vegetation and the animals that depend on coastal habits on land and in water. Discussed in this section are migratory birds, coastal marsh vegetation, chenier forests, coastal floodplain forests, mangrove forests, estuaries, and the endangered manatee.

Impacts of Hurricane Katrina on Floodplain Forests of the Pearl River

By Stephen Faulkner, Wylie Barrow, Brady Couvillion, William Conner, Lori Randall, and Michael Baldwin

Floodplain forests are an important habitat for Neotropical migratory birds. Hurricane Katrina passed through the Pearl River flood plain shortly after making landfall. Field measurements on historical plots and remotely sensed data were used to assess the impact of Hurricane Katrina on the structure of floodplain forests of the Pearl River.

Introduction

Floodplain forests, also known as bottomland hardwood or riparian forests, inhabit the natural levees, bottoms, low ridges, sloughs, and backswamps of the major and minor rivers in the Southern and Southeastern United States (Putnam and others, 1960). These wetland forests provide many important functions and ecosystem services including flood storage, recreation, timber production, carbon storage, water-quality maintenance, and fish and wildlife habitat (Messina and Conner, 1998).

The largest intact blocks of these forests in southern Louisiana are found in the Atchafalaya River, Pearl River, and Lake Ponchartrain basins, all of which lie within a major corridor for migrating North American landbirds. Virtually all of the eastern landbird species in the United States and numerous species from the Western United States migrate through the coastal forests of Louisiana (Lowery, 1974; Barrow and others, 2000). These forests also provide critical habitats for the swallow-tailed kite (*Elanoides forficatus*), listed as a Species of Conservation Concern by the State of Louisiana as it is imperiled because of its rarity (Lester and others, 2005). A total of 42 nests and nest starts have been found on or near the Pearl River Wildlife Management Area (WMA) and Sherburne WMA, as well as in the region of the Joyce WMA and Manchac WMA in the Lake Pontchartrain basin in Louisiana (Coulson and Sherry, 2004).

The path of Katrina following landfall on August 29, 2005, led directly through the Pearl River basin (fig. 1)

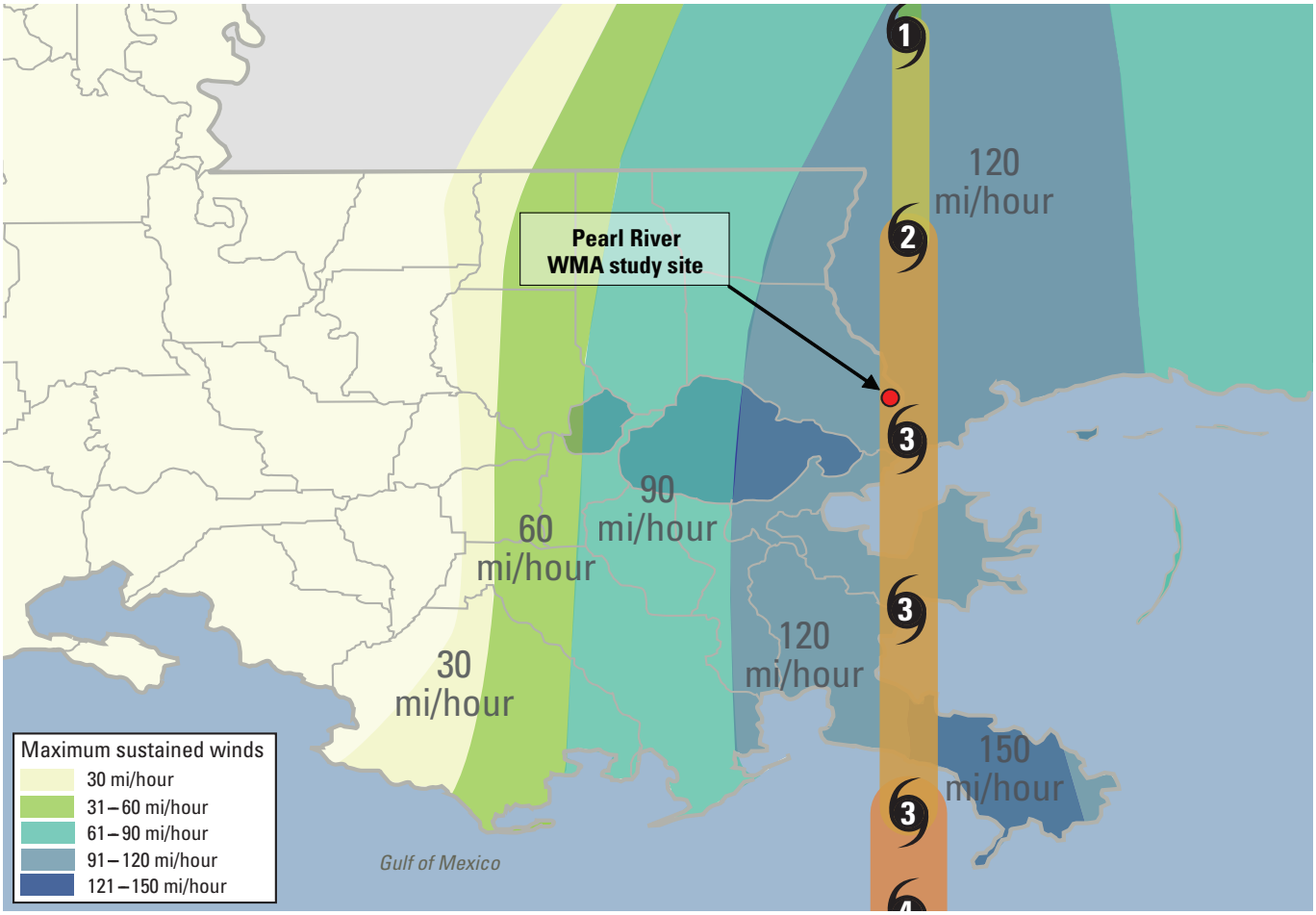

Figure 1. Study site location in the Pearl River Wildlife Management Area, La., in relation to the path and category progression of Hurricane Katrina (shown in orange).

with maximum sustained winds of up to 120 mi/hour (193 km/hour). Fifty-six percent of the forests in St. Tammany, Washington, and Tangipahoa Parishes were damaged, with the loss of over 719 million board ft (1.70 million m^3) of timber worth approximately $335 million (C. LeJeune, Associate State Forester, written commun., 2006). The purpose of this study was to assess the impact of Katrina on the structure of floodplain forests of the Pearl River.

Methods and Procedures

Both field and remotely sensed data were used to assess the impact of Katrina on forests in the Pearl River basin. Long-term data on forest community structure were available from study plots (fig. 1) established on the Pearl River WMA in the 1980s (Faulkner and others, 1991; Faulkner and Patrick, 1992) and updated annually (Conner and others, 2002). Paired plots that measured 65 by 82 ft (20 by 25 m) were located on rarely flooded, periodically flooded, and nearly permanently flooded sites representative of the local flooding gradient. In September 2005, these permanent plots were remeasured to assess tree mortality and potential effects on wildlife habitat resulting from Katrina. Since all trees on a given plot were tagged and numbered, damage could be measured by individual trees. Each tagged tree on each plot was assessed to determine whether it was snapped, blown over, or still standing. If a tagged tree could not be found, it was assumed to have been blown over and covered by the volume of wood on the ground.

Satellite imagery was used to assess damage to the forest canopy. The Advanced Very High Resolution Radiometer (AVHRR) multispectral sensor was chosen as the best sensor for the vegetative analyses involved in this study. The temporal resolution of AVHRR data allows for evaluation of fine-scale temporal events, and current data can be compared with historical long-term averages. The AVHRR weekly composites were used to calculate a Normalized Difference Vegetation Index (NDVI). The NDVI is widely used to characterize vegetative density, health, and vigor as it contrasts the absorption of red wavelengths, caused by chlorophyll, with the considerable reflectance of near-infrared wavelengths, caused

by mesophyll leaf structure. As a result, vigorously growing healthy vegetation has low red-light reflectance and high near-infrared reflectance. The 2005 weekly NDVI composites were compared to the "average" NDVI weekly composites for the same week during the period 1989–2003 to create a "departure from average" statistic. This comparison was made to minimize variations in plant phenology (seasonal changes in plant growth) and to isolate the change in the NDVI caused by Katrina. Negative numbers indicate less leaf area than the average NDVI weekly composite.

Results and Discussion

Consistent with the regional damage estimates, the most heavily damaged site (site A) had 65 percent of the trees snapped, blown over, or with broken tops (fig. 2). Over 55 percent of the trees were damaged at site B, while site C suffered only 19 percent damage. Plant community composition in riparian forests changes along a flooding gradient since the ability to tolerate flooding varies among tree species (Hook, 1984; Hodges, 1997). This condition is reflected in the species composition of the study sites. The sites with the most damage (A and B) were dominated by American hornbeam (*Carpinus caroliniana*), red maple (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua*), while the least damaged site (C) was dominated by flood-tolerant water tupelo (*Nyssa aquatica*) and baldcypress (*Taxodium distichum*) (table 1). The ability of baldcypress to withstand hurricane-force winds has been previously identified and is thought to be a result of the extensive rooting system including the aboveground "knees" (Hook and others, 1991; Doyle and others, 1995).

We observed a drastic change in the vegetative health and vigor based on the NDVI analysis in the weeks following Katrina (fig. 3). Below-average NDVI values occurred throughout the study area, with particularly low NDVI values concentrated in the floodplain forests of the Pearl River basin and surrounding tributaries. These results are consistent with the defoliation observed on the site. These below-average NDVI values persisted for approximately 5 weeks following Katrina.

Conclusions and Recommendations

The catastrophic destruction of the floodplain forests of the Pearl River WMA will have both short- and long-term consequences. The immediate structural changes will have significant impacts on migratory birds (see Barrow, Buler, and others, this volume). Additional studies will be necessary to determine the specific effects of this event on forest species composition. While hurricanes are a natural phenomenon that generally contribute to increased species richness and diversity in coastal forests (Battaglia and Sharitz, 2005), the increasing occurrence of Chinese tallow tree (*Triadica sebifera*) along the Gulf Coast is a particular concern (Bruce and others, 1997; Wall and Darwin, 1999). Conner and others (2002) found that Chinese tallow became the dominant tree species on plots measured in the Atchafalaya Basin, La., following the removal of large portions of the forest canopy by Hurricane Andrew. The impact on the important ecosystem functions of these floodplain forests resulting from the replacement of native tree species with an invasive, exotic species like the Chinese tallow tree requires additional research.

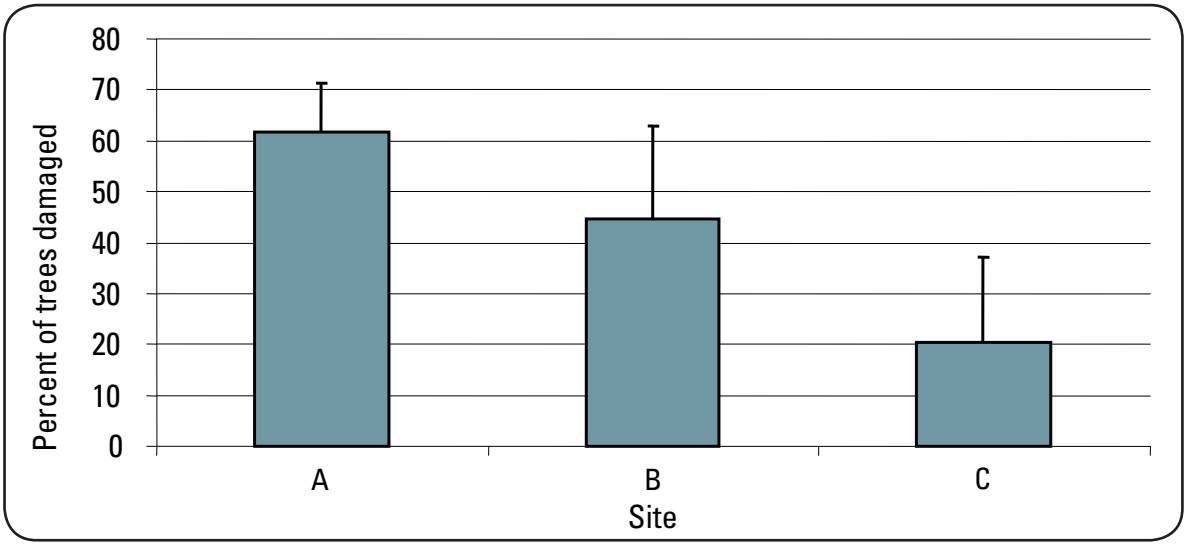

Figure 2. Percentage of trees damaged on rarely flooded (site A), periodically flooded (site B), and nearly permanently flooded (site C) sites in the Pearl River Wildlife Management Area, La.

Table 1. Mean number of trees by species on rarely flooded (A), periodically flooded (B), and nearly permanently flooded (C) plots at Pearl River Wildlife Management Area, La.

	Plot		
Species	**A**	**B**	**C**
American hornbeam (*Carpinus caroliniana*)	10.5	3.5	1.0
Sweetgum (*Liquidambar styraciflua*)	9.5	6.0	4.0
Red maple (*Acer rubrum*)	1.0	3.5	0.0
Southern magnolia (*Magnolia grandiflora*)	0.5	0.0	0.0
Hawthorn (*Crataegus* sp.)	0.0	0.0	0.5
Loblolly pine (*Pinus taeda*)	1.5	0.0	0.0
Eastern cottonwood (*Populus deltoides*)	1.5	0.0	0.0
Water oak (*Quercus nigra*)	0.5	3.5	0.0
American elm (*Ulmus americana*)	2.0	0.5	0.5
Water elm (*Planera aquatica*)	0.5	0.0	0.0
Black gum (*Nyssa sylvatica*)	0.0	2.0	4.0
Water tupelo (*Nyssa aquatica*)	1.0	0.0	7.5
Baldcypress (*Taxodium distichum*)	0.0	0.0	6.0

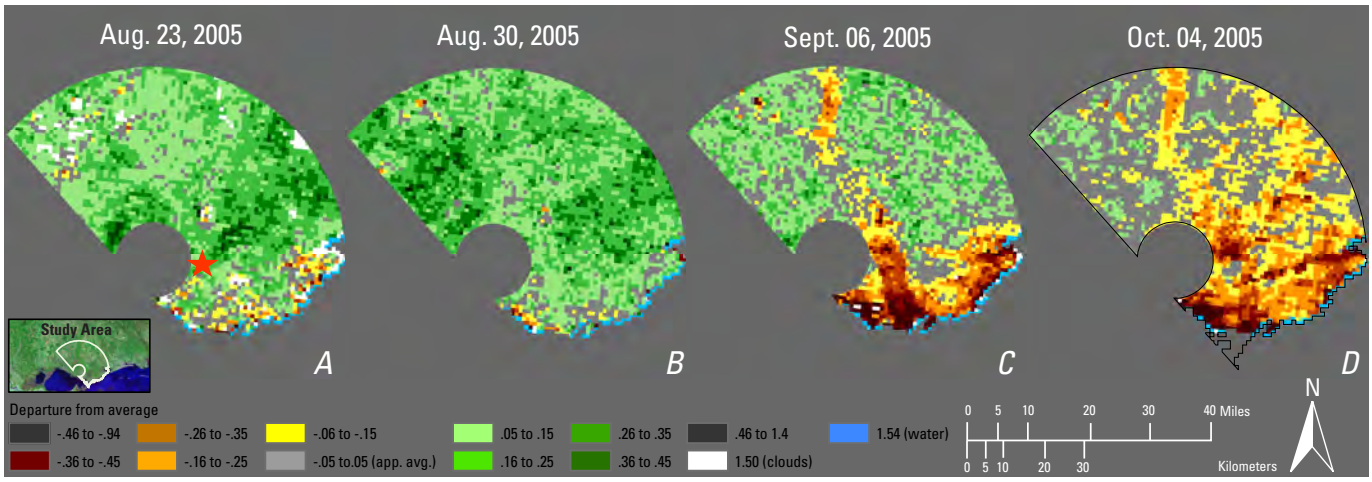

Figure 3. Normalized Difference Vegetation Index (NDVI) composites of the Pearl River Wildlife Management Area, La., study area showing the departure from average before (*A* and *B*) and after (*C* and *D*) Hurricane Katrina. Red star denotes approximate location of field plots on Pearl River Wildlife Management Area. Negative numbers indicate lower than average NDVI in the Pearl River basin following Hurricane Katrina. Original Advanced Very High Resolution Radiometer (AVHRR) data were provided by the U.S. Geological Survey EROS Data Center. Original "departure from average" NDVI data were provided by U.S. Department of Agriculture Forest Service, Wildland Fire Assessment System. "App. avg." refers to approximate long-term weekly NDVI average.

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