Chapter 16 - Conservation and Use of Coastal Wetland Forests in Louisiana

Stephen P. Faulkner[1], Jim L. Chambers[2], William H. Conner[3], Richard F. Keim[2], John W. Day[4], Emile S. Gardiner[5], Melinda S. Hughes[2], Sammy L. King[6], Kenneth W. McLeod[7], Craig A. Miller[2], J. Andrew Nyman[2], and Gary P. Shaffer[8]

[1]*U.S. Geological Survey, National Wetlands Research Center, 700 Cajundome Blvd., Lafayette, LA 70506*
[2]*School of Renewable Natural Resources, Louisiana State University Ag Center, Renewable Natural Resources Building, Baton Rouge, LA 70803*
[3]*Baruch Institute of Coastal Ecology and Forest Science, Clemson University, Department of Forestry and Natural Resources, PO Box 596, Georgetown, SC 29442*
[4]*Department of Oceanography and Coastal Sciences, Louisiana State University, 1002-Y Energy, Coast and Environment Building, Baton Rouge, LA 70803*
[5]*Center for Bottomland Hardwoods Research, USDA-Forest Service Southern Hardwoods Laboratory, PO Box 227, Stoneville, MS 38776*
[6]*USGS Louisiana Cooperative Fish and Wildlife Research Unit, Louisiana State University Ag Center, School of Renewable Natural Resources, Baton Rouge, LA 70803*
[7]*Savannah River Ecology Laboratory, PO Drawer E, Aiken, SC 29802*
[8]*Department of Biological Sciences, Southeastern Louisiana University, Box 10736, Hammond, LA 70402*

16.1. Introduction

The natural ecosystems of coastal Louisiana reflect the underlying geomorphic processes responsible for their formation. The majority of Louisiana's wetland forests are found in the lower reaches of the Mississippi Al-

luvial Valley and the Deltaic Plain. The sediments, water, and energy of the Mississippi River have shaped the Deltaic Plain as natural deltas have been formed and abandoned over the last 5,000 years (Coleman et al. 1998). During the regressive or constructional phase of the delta cycle, the system is dominated by freshwater riverine inputs with the formation of corresponding freshwater marshes and swamps, which then deteriorate during the marine-dominated transgressive phase (Roberts 1997). These processes have resulted in the current coastal landscape of bottomland hardwood forests on the remnant natural levees of the distributary channels with swamps dominated by baldcypress (*Taxodium distichum* (L.) L.C. Rich.), pondcypress (*Taxodium ascendens* Brongn.) and water tupelo (*Nyssa aquatica* L.) occupying lower elevations (Penfound 1952; Mitsch and Gosselink 2003).

Historically, the coastal wetland forests in the Deltaic Plain were intimately connected to the Mississippi River and its distributaries. Annual pulses of freshwater, sediments, and nutrients that sustained these forests were dispersed during flood events. The construction of flood-control levees, however, has isolated these forests from these flood pulses. The cumulative effects of human activity (e.g., levees), eustatic (actual) sea-level rise, and tectonic activity, have resulted in high rates of subsidence that dominate the surface elevation and geomorphology of the Deltaic Plain (Saucier 1994; DeLaune et al. 2004). Deltaic Plain subsidence rates range from 0.3 to 0.9 cm yr^{-1} (Gagliano 1998) with relative (eustatic + subsidence) sea-level rise predicted to range from 50 to >100 cm over the next 100 years (Twilley et al. 2001). Since over half of the 809,000 ha of Louisiana's forested wetlands occur in the coastal parishes (Figure 16.1), these natural and anthropogenic changes in hydrology and geomorphology have reduced productivity in many coastal wetland forest areas and have caused the complete loss of forest cover in some places.

Nearly all of the cypress-tupelo forest in Louisiana today are second growth, originating as natural regeneration after logging about 100 years ago (Norgress 1947; Mancil 1972). The area of greatest commercial timber production included all of the alluvial floodplain of the Mississippi River, but was mainly concentrated in the area south of Baton Rouge. The period of maximum harvest was the 1890s through the 1930s (Figure 16.2) and many of these forests have not regenerated with cypress-tupelo (Mattoon 1915; Norgress 1947; Mancil 1972).

Little is known about the present state of cypress ecosystems at the scale of the entire coastal Louisiana region. This knowledge gap has developed because of physical inaccessibility, lack of active forest management following the period of intense logging in the early 20th century, and the

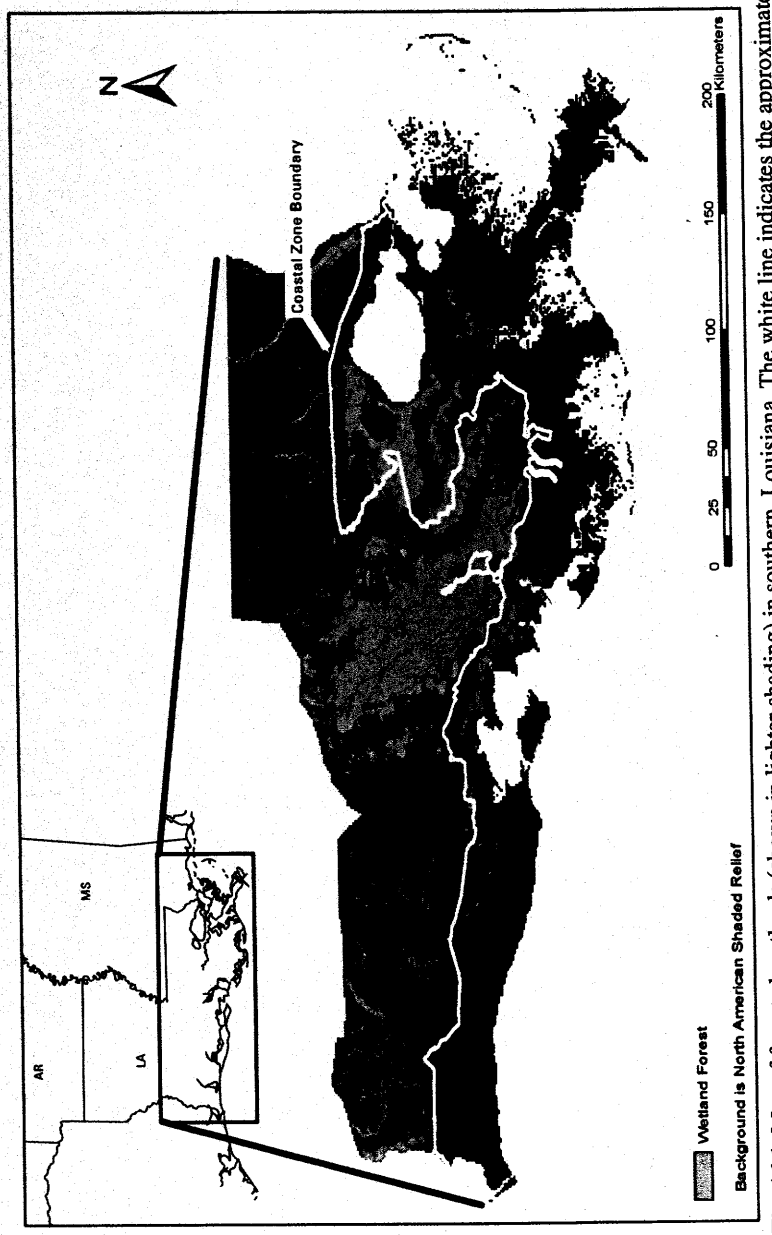

Fig. 16.1. Map of forested wetlands (shown in lighter shading) in southern Louisiana. The white line indicates the approximate northern boundary of the coastal zone.

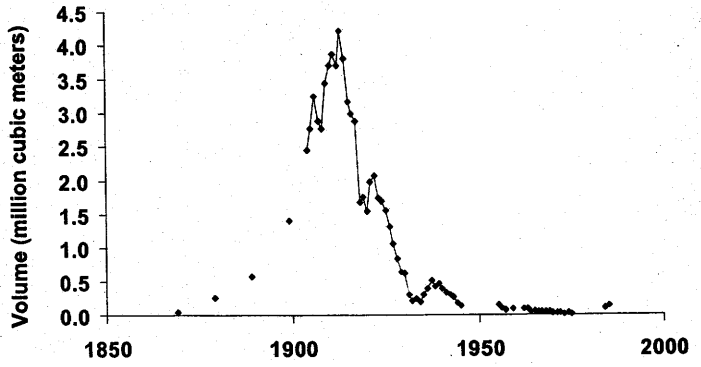

Fig. 16.2. Volume of baldcypress cut in Louisiana from the late 1870's to the 1980's (Data from Louisiana Department of Conservation 1943; Steer 1948; Louisiana Forestry Commission 1957; Louisiana Forestry Commission Progress Reports 1956-76; Mistretta and Bylin 1987).

emphasis on coastal marshes in coastal restoration planning. Conner and Toliver (1990) reported that cypress-dominated ecosystems of coastal Louisiana have experienced widespread hydrological, biogeochemical, and biological changes over the past century, and declines in some populations have been apparent. Numerous scientific reports of cypress-tupelo forest death and decline beginning in the 1980s have raised concerns regarding the long-term viability of Louisiana's coastal wetland forests (Brinson et al. 1985; DeLaune et al. 1987; Pezeshki et al. 1990; Allen 1992; Conner 1993; Gresham 1993; Williams 1993; Krauss et al. 2000; Conner and Inabinette 2003).

Consequently, concern over the decline of swamp forests in south Louisiana has increased in recent years and scientists are examining if harvesting under inappropriate conditions can result in nonviable regeneration preventing long-term establishment of new forests. Demand for forest products such as cypress mulch has spurred new investments and interest in harvesting cypress swamps. Approximately 60% of the landscape mulch sold in Florida is made from cypress (Duryea 2001). Quantitative data on cypress logging are not readily available for Louisiana; however, a new cypress sawmill was opened in Roseland, Louisiana in 2005 (Louisiana Department of Agriculture and Forestry 2005). Both the U.S. Army Corps of Engineers (ACE) and the U.S. Environmental Protection Agency (EPA) have reported increased interest in cypress logging in south Louisiana in-

cluding a proposed 20,000 ha cypress mulching operation (Bruza 2006; Ettinger 2006). The Louisiana Coastal Wetlands Conservation and Restoration Task Force (1998) concluded that up to 93,000 ha of swamps in coastal Louisiana would be lost by 2050, despite current restoration efforts. This figure does not include additional losses that may occur with the renewed interest in harvesting existing baldcypress forest in south Louisiana or losses to development and agriculture.

A multidisciplinary approach summarizing the available science and providing management recommendations was needed to address these issues. In response, the Louisiana Governor's office formed the Coastal Wetland Forest Conservation and Use Science Working Group (SWG) and an associated Advisory Panel in early 2004 to provide the Governor with information and suggestions of strategies for environmental and economic utilization, conservation, and protection of Louisiana's coastal wetland forest ecosystem. The SWG was comprised of coastal scientists representing a variety of disciplines and expertise in coastal wetland forest issues.

The mission of the SWG was to provide information and guidelines for the long-term utilization, conservation, and protection of Louisiana's coastal wetland forest ecosystem, from both environmental and economic perspectives. To accomplish this mission, the following objectives were developed by the SWG (Chambers et al. 2005):

(1) Gather and synthesize scientific information available on regeneration, growth, and potential harvesting effects on coastal wetland forests.
(2) Gather and summarize field information on general characteristics of previously harvested cypress and tupelo forest stands to evaluate their potential to regenerate, become established, and remain vigorous.
(3) Review existing laws, regulations, policy, and guidelines affecting coastal forestry activities (and current forest conditions).
(4) Develop science-based, interim guidelines for the conservation and utilization of coastal wetland forests.
(5) Identify critical areas of priority research needed to refine these interim guidelines.

A policy oriented Advisory Panel on Coastal Wetland Conservation and Use was also established by the Governor's Office to advise the SWG. The SWG was able to hear concerns and needs of various interest groups within the Advisory Panel, including private landowners, environmental

groups, forest industry, nongovernmental organizations, and state and federal agencies through regular input from the Advisory Panel. Regular interaction between the SWG and the Advisory Panel encouraged a balance between conservation, restoration, and use of coastal renewable natural forest resources.

The SWG published a draft report and solicited comments from the Governor's Advisory Panel and the public. The comments submitted to the SWG and to the Governor's office were reviewed by the SWG, and a revised final report was submitted to the Governor's office in 2005 (Chambers et al. 2005). This chapter summarizes the primary issues and findings of the SWG and those readers wanting a more complete understanding of these issues are referred to the full report (Chambers et al. 2005). The efforts and findings of the SWG represent a case study in applying scientific data and ecological concepts to help resolve complex resource management issues in landscapes that include tidal freshwater swamp ecosystems in Louisiana.

16.2. Science Working Group findings

Louisiana's coastal wetland forests are of tremendous economic, ecological, cultural, and recreational value to the people of Louisiana and the United States. They provide flood protection, water quality improvement, storm protection, and mitigate greenhouse gas emissions through carbon sequestration. The coastal wetland forests are habitat for threatened species such as the Louisiana black bear (*Ursus americanus luteolus*) and the bald eagle (*Haliaeetus leucocephalus*). Virtually all of the eastern neotropical migrant land bird species in the United States and numerous species from the western United States migrate through the coastal forests of Louisiana during spring and fall migration (Lowery 1974; Barrow et al. 2000). These forests also support billions of dollars of economic benefits from fishing, crawfishing, hunting, timber harvesting, and ecotourism. Based on current stumpage volumes and rates, the value of the standing cypress-tupelo timber in the area delineated by the SWG has been estimated by the Louisiana Department of Agriculture and Forestry to be $3.3 billion.

The functions and ecosystem services of Louisiana's coastal wetland forests are threatened by both large- and small-scale hydrologic and geomorphic alterations and by conversion of these forests to other uses. Subsidence, sea-level rise, canal dredging, and levee construction are the principal large-scale hydrologic and geomorphic alterations responsible for the loss of Louisiana's coastal wetland ecosystems including coastal wetland

forests. The cumulative effects of small-scale or local factors can be of equal or greater importance in coastal wetland forest loss and degradation than large-scale alterations. These factors include increased depth and duration of flooding, saltwater intrusion, nutrient and sediment deprivation, herbivory, invasive species, and direct loss caused by conversion. Under less severe impacts, many of the important functions and ecosystem services are lost or degraded even though the trees may be intact and the forest may appear unaffected. Without appropriate human intervention to alleviate the factors causing degradation, most of coastal Louisiana will inevitably experience the loss of coastal wetland forest functions and ecosystem services through conversion to open water, marsh, or other land uses.

Spatially explicit data of coastal wetland forest conditions necessary to guide restoration, regulatory, and management efforts are scarce. While there are several inventory and classification programs [e.g., U.S. Forest Service (FS) Forest Inventory and Analysis, National Land Cover and Data, U.S. Fish and Wildlife Service (FWS) National Wetlands Inventory), there is no single, spatially explicit database that provides an accurate assessment of historic and current coastal wetland forest conditions. The actual acreage and amount of cypress-tupelo forests loss through time in south Louisiana has not been well documented mainly because of the various ways the resource has been measured in the past (Norgress 1947; Mancil 1972; Conner and Toliver 1990). Some of the limitations of the currently available datasets include changing definitions of forest cover type through time and lack of adequate sample points throughout the entire range of the cypress-tupelo forest cover type. The current Louisiana Coastal Zone Boundary, which is a programmatic boundary established by legal statute, does not accurately reflect the full extent of Louisiana's coastal wetland forests. As a result, these forest areas are more vulnerable to loss and degradation from detrimental impacts since large-scale restoration and protection activities are focused on those areas inside the Louisiana Coastal Zone.

Regeneration is a critical process of specific concern in maintaining coastal wetland forest resources. Successful natural regeneration of this resource following harvesting in the early 1900's was due to more favorable conditions existing at that time (primarily a drier hydrologic regime since 100 years of subsidence had not lowered the soil elevation). The hydrologic and geomorphic alterations identified above have led to increased flooding depths and durations under current conditions resulting in a lack of regeneration following harvesting in coastal cypress-tupelo forests today. In those areas where flooding prevents or limits the natural regeneration of the cypress-tupelo forest, artificial regeneration through tree plant-

ing is the only currently viable mechanism to regenerate the forest. Some swamps are altered to such a significant extent that even artificial regeneration is not possible. A review of the available scientific literature and a field survey of eighteen previously harvested sites indicate that coppice or stump sprouting does not provide sufficient numbers of viable trees to reliably regenerate the forest, even under optimum conditions, e.g., trees less than 60 years old harvested during the dormant season (Mattoon 1915; Williston et al. 1980; Kennedy 1982; Conner et al. 1986; Gardiner et al. 2000; Chambers et al. 2005).

Conditions affecting the potential for forest regeneration and establishment are recognizable based upon existing site-based biological and physical factors. The SWG developed a set of condition classes for the dominant wetland forest type in Louisiana's coastal cypress-tupelo forests. Assuming average rainfall conditions and no extreme or unusual events, the SWG set the general description of the three condition classes for cypress-tupelo as follows (see Chambers et al. 2005 for more details and discussion):

SWG Condition Class I: Sites with Potential for Natural Regeneration

Sites that are generally connected to a source of fresh surface or ground water and flooded or ponded periodically on an annual basis. These sites must have seasonal flooding and dry cycles (pulsing), have both sediment and nutrient inputs, and are not subsiding.

SWG Condition Class II: Sites with Potential for Artificial Regeneration Only

These sites may have overstory trees with full crowns and few signs of canopy deterioration but are either permanently flooded (which prevents seed germination and seedling establishment of cypress and tupelo) or are flooded deeply enough that when natural regeneration does occur during low water, seedlings cannot grow tall enough between flood events for at least 50% of their crown to remain above the high water level during the growing season. Water depth is restricted to a maximum of two feet for practical reasons related to planting and production of tree seedlings. These conditions require artificial regeneration (i.e., planting of tree seedlings).

SWG Condition Class III: Sites with No Potential for Either Natural or Artificial Regeneration

These sites are either flooded for periods long enough to prevent natural regeneration and practical artificial regeneration, or they are subject to saltwater intrusion with salinity levels that are toxic to

cypress-tupelo forests (two ppt for tupelo; four ppt for cypress). Two trajectories are possible for these two conditions: (1) freshwater forests transitioning to either floating marsh or open fresh water, or (2) forested areas with saltwater intrusion that are transitioning to open brackish or saltwater (marsh may be an intermediate condition).

16.3. Science Working Group recommendations

The SWG made recommendations to the Governor's Office regarding actions that the state could take to conserve and protect these forests (J.L. Chambers et al. 2005). In general terms, the SWG recommended the following:

- Make conserving, restoring, and managing these coastal wetland forests a state priority.
- Recognize the set of three condition classes outlined by the SWG relative to regeneration of specific sites.
- Place priority on maintaining the hydrological regime of the most productive sites while avoiding loss of the more sensitive sites.
- Place a moratorium on harvesting state-owned Condition Class III forests, and seek ways to delay harvesting those private forest lands not likely to regenerate until site environmental conditions are changed (consider use of incentives).
- Help to ensure proper management and regeneration through written forest management plans with specific actions to ensure regeneration of cypress-tupelo forest.
- Develop spatially explicit databases, and establish and maintain long-term monitoring efforts to guide management decisions.
- Recognize an expanded area for coastal forest conservation beyond the current Louisiana Coastal Zone Boundary.
- Ensure that all agencies and organizations share and coordinate information, develop practices

to prevent coastal wetland forest loss, and actively pursue restoration of degraded forests.
- Enhance ecosystem functions through hydrological management decisions related to construction and other activities in wetland areas.

16.4. Summary and conclusions

Establishment of the SWG is an important example of developing a multidisciplinary, science-based solution to address resource management problems. The SWG consolidated the scientific knowledge related to the functions, ecosystem services, and underlying processes affecting the condition of Louisiana's coastal wetland forests and made recommendations based on that science-based assessment. The collaboration between scientists, resource managers, and policy makers continues in the effort to implement the SWG recommendations. An outside group composed of members of the Advisory Panel is currently working on a set of Interim Forest Practices Guidelines relative to harvesting and regeneration of coastal wetland forests in Louisiana. A coastal forest regeneration research meeting was held in November 2005 to prioritize research related to regeneration of coastal wetland forests. The state of Louisiana has conducted public hearings and taken public comments on the SWG's final report. Future actions include recommendations from the Advisory Panel regarding the SWG report and balancing conservation, restoration, and use of coastal wetland forest resources; developing methods to identify the SWG Condition Classes on the ground and map them using remotely sensed data; providing a set of incentives to encourage landowner conservation of coastal wetland forests; and developing and implementing methods to restore coastal wetland forests.

Hydrology in much of south Louisiana has been altered over the years by several factors including levee construction, pipeline operations, oil and natural gas exploration, shipping concerns, and subsidence. Current forestry best management practices have failed to take into account the impact of these changes on the regeneration and productivity of coastal wetland forests in Louisiana. Established forestry activities in wetlands (including harvesting) are generally exempt from permit requirements under Section 404 of the Clean Water Act, however, concerns over the viable regeneration of cypress-tupelo forests have arisen regarding these exemptions. Based in part on the findings of the SWG, the EPA has recently ruled that a landowner in Louisiana would not be exempt from the Section

404 permit requirement unless he could establish that the cypress forest would successfully regenerate (EPA 2006; Mississippi Interstate Cooperative Resource Association 2006). Sustainable and long-term use of coastal wetland forests will require major changes in the state's efforts to restore ecosystem processes (e.g. sediment and nutrient input, flood pulsing) and the careful coordination among agencies (local, state, and federal), landowners, and industries working in coastal areas to ensure that the best scientific knowledge is used to develop management practices that result in the viable regeneration of these forest ecosystems. A concerted effort expanding sound research knowledge of these forests and their restoration is also critical to their future.

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Edited by

William H. Conner
Clemson University
Georgetown, SC
USA

Thomas W. Doyle
US Geological Survey
Lafayette, LA
USA

and

Ken W. Krauss
US Geological Survey
Lafayette, LA
USA

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Hermit crab on base of baldcypress tree in South Carolina.
Tidal freshwater baldcypress stand on Turkey Creek, South Carolina.
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