# Conservation Area Plan

**For the**

# Pearl River

**The Nature Conservancy**

**August 2004**

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The Nature Conservancy

Pearl River Field Office

New Orleans, Louisiana

August 2004

Submitted to the
Louisiana Department of Environmental Quality
CFMS Cooperative Agreement No. 583066

## Pearl River Conservation Area Plan

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The Joe W. and Dorothy Dorsett Brown Foundation

Many thanks to the numerous experts who participated in the planning workshops by providing their valuable knowledge and expertise.

## Experts and Partners that Participated in the Planning Meetings

| Participant | | Affiliation at the Time of Meetings |
|---|---|---|
| Diane | Altsman | EPA/Gulf of Mexico Program |
| Hank | Bart, Jr. | Tulane University and Tulane Museum of Natural History |
| Jay | Boyd | Mississippi Department of Marine Resources |
| Jan | Boydstun | Louisiana Department of Environmental Quality |
| Jeff | Clark | Mississippi Department Marine Resources |
| Carol | Crapanzano | Louisiana Department of Environmental Quality |
| Steve | Goff | Mississippi Department of Environmental Quality |
| Jim | Grace | USGS National Wetlands Research Center |
| James | Harris | United States Fish and Wildlife Service, South East Refuge |
| Paul | Hartfield | United States Fish and Wildlife Service |
| Vernon | Hartley | Mississippi Department of Environmental Quality |
| Mark | LaSalle | Mississippi State University Extension Service |
| Ronald | Magee | National Aeronautics Space Administration |
| Melanie | Magee | EPA/Gulf of Mexico Program |
| Tom | Mann | Mississippi Natural Heritage Program |
| Larry | Marcy | United States Army Corps of Engineers, Vicksburg Office |
| Charlotte | Parker | United States Fish and Wildlife Service, South East Refuge |
| Bobby | Reed | Louisiana Department of Wildlife and Fisheries |
| Kenny | Ribbeck | Louisiana Department of Wildlife and Fisheries |
| Dugan | Sabins | Louisiana Department of Environmental Quality |
| Steve | Shively | Louisiana Department of Wildlife and Fisheries, Natural Heritage Program |
| Cathy | Shropshire | Mississippi Natural Heritage Program |
| Todd | Slack | Mississippi Natural Heritage Program |
| Susan | Smith | United States Army Corps of Engineers, Vicksburg Office |
| Nancy | Walters | United States Fish and Wildlife Service, South East Refuge |
| David | White | Loyola University, Department of Biology |
| Ronald | Wieland | Mississippi Natural Heritage Program |
| Mark | Woodrey | Mississippi Natural Heritage Program/Grand Bay NERR |

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## 1. Conservation Area Summary

**TNC Ecoregions:** East Gulf Coastal Plain
Upper East Gulf Coastal Plain
Northern Gulf of Mexico
Gulf Coast Prairies and Marshes

**Megasite Name:** Pearl River Watershed

**Site Name:** Pearl River

**States:** Louisiana, Mississippi

**Parishes, Louisiana:** St. Tammany, Washington

**Counties, Mississippi:** Hancock, Pearl River, Lamar, Marion, Jefferson Davis, Lawrence, Simpson, Rankin, Madison, Hinds, Copiah, Lincoln, Pike, Walthall, Smith, Scott

**Managed Areas:**

United States Fish and Wildlife Service
- Bogue Chitto National Wildlife Refuge, 37,000 acres

USDA Forest Service
- Bienville National Forest, 178,400 acres

Mississippi Department of Marine Resources
- Hancock County Coastal Preserves, 15,000 acres

Louisiana Department of Wildlife and Fisheries
- Pearl River Wildlife Management Area, 35,031 acres
- Ben's Creek Wildlife Management Area, 13,856 acres

MS Department of Wildlife, Fisheries and Parks
- Marion County Wildlife Management Area, 7,200 acres
- Old River Wildlife Management Area, 15,408 acres
- Caney Creek Wildlife Management Area, 28,000 acres
- Wolf River Wildlife Management Area, 10,801 acres

Mississippi State Parks
- LeFleur's Bluff State Park, 305 acres
- Lake Lincoln State Park, 1,000 acres

The Nature Conservancy
- Mike's Island Conservation Area, 2,775 acres
- White Kitchen Preserve, 586 acres
- Charter Oak Preserve, 160 acres
- Talisheek Pine Wetlands Preserve, 1,500 acres

## 2. Executive Summary

The Pearl River is one of the most intact river systems in the southeast U.S. with a great diversity of wildlife species and habitats (TNC 2001). A relatively natural, unleveed system, it supports seven federally listed species including the ringed map turtle (*Graptemys oculifera*), which is endemic to the Pearl River basin, Gulf sturgeon (*Acipenser oxyrinchus desotoi*), inflated heelsplitter mussel (*Potamilus inflatus*), Bald Eagle (*Haliaeetus leucocephalus*), dusky gopher frog (*Rana sevosa*), gopher tortoise (*Gopherus polyphemus*) and Louisiana black bear (*Ursus americanus luteolus*). At least twelve natural communities (Smith 1999) of conservation importance are known to occur within the Pearl River Basin.

Prior to settlement by Europeans, the Pearl River and its major tributaries were traveled, hunted and fished by native groups, most notably the Choctaw Indians (Mississippi Department of Environmental Quality 2000). After settlement, the river was used for navigation, transportation of timber, and food supplies (game and fishing). Today, the river is still important for navigation and is popular for fishing, hunting and recreation. The river is a significant source of water for public water supplies and industry. The watershed, with its associated riverine, palustrine, estuarine and terrestrial communities, provides crucial habitat for many types of wildlife and supports a significant assemblage of native biodiversity.

The lower Pearl River has one of the healthiest marsh complexes in the Southeast and supports between 120-140 species of fishes (H. Bart, Jr. pers. commun. 2004, T. Slack, pers. commun. 2004) and approximately 40 species of mussels (Mississippi Department of Wildlife, Fisheries and Parks 2004) making it one of the most species-rich river systems in North America. The area contains large blocks of contiguous forest, which provides habitat for many interior-sensitive species such as the Swallow-tailed Kite (*Elanoides forficatus*) and resident migratory songbirds. The Pearl River is one of the top ten sites in coastal Louisiana for Neotropical migratory birds. The area is an important stopover area for trans-gulf migrant songbirds. Within the context of The Nature Conservancy's (TNC) ecoregional planning areas, the Pearl River has been identified as a high priority focus for conservation attention within the East Gulf Coastal Plain and Northern Gulf of Mexico ecoregions because of its high biodiversity significance. The Pearl River is also within two other ecoregions, the Upper East Gulf Coastal Plain and Gulf Coast Prairies and Marshes.

This Conservation Area Plan for the Pearl River has been formulated as a first iteration to identify important conservation elements within the system. The primary boundary conservation area for this plan includes the Pearl River floodplain North to the Ross Barnett Reservoir, laterally to top of the slopes adjacent to the floodplain and along major tributaries within the Pearl River watershed, and South to the Rigolets. The area also captures adjacent slope forests to conserve an important conservation target. The secondary boundary includes the Pearl River, its tributaries and the entire watershed up to the Ross Barnett Reservoir.

Conservation planning steps were undertaken by an interdisciplinary team of experts at a series of three workshops (November 2000, January 2001 and November 2002) hosted by TNC and partners. In these three preliminary planning meetings many threats to the Pearl River were identified and prioritized. Conservation planning is an ongoing process and therefore needs to be

continually updated and modified as new information and data are obtained. As the project moves forward, TNC will continue to incorporate relevant data into the conservation area plan, such as hydrology, monitoring projects and community stakeholders' interests.

The Pearl River faces many threats that must be addressed to restore and protect the system. The Conservation Area Planning process uses a prescribed series of steps to identify and rank threats to a set of focal conservation targets (systems and species) that are selected to represent the range of native biodiversity in the planning area. Strategies and actions for abating threats are then developed and ranked in order to prioritize and focus efforts where they will be most beneficial to long-term viability of the native biodiversity at the site. The information gathered at the three workshops was entered into a software program designed to process data and rank the threats, strategies and other data. The process used is known as the "Five-S Framework" which assesses contextual information about a site (i.e., Systems, Stresses, Sources) and results in two specific products – conservation Strategies and measures of conservation Success.

**Conservation Targets**

The targets selected include species and communities that are representative and measurable. After careful review and consideration of all potential targets, the planning team chose the following seven conservation targets for the conservation area plan for the Pearl River.

**Pearl River Conservation Targets**

- Resident Riverine Aquatic Fauna
- Anadromous/Catadromous Fishes
- Lateral Aquatic Habitats
- Swallow-tailed Kite
- Bottomland Forest Complex
- Emergent Marsh Complex
- Slope Forest Complex

Threats or sources of stress are conditions or activities that negatively impact conservation targets. Under TNC methodology, threats are made up of two parts: the stress (e.g., barriers to fish movement), and the sources of the stress (e.g., low water sills). After identifying the conservation focal targets, the planning team then identified seventeen stresses to those targets. The following are the stresses noted.

**Primary Stresses to the Pearl River**

- Sedimentation
- Altered Hydrology
- Altered Composition/Structure
- Toxins/Contaminants
- Substrate Destabilization
- Nutrient Loading
- Barriers to Movement/Dispersal
- Extraordinary Mortality
- Excessive Herbivory
- Habitat Destruction or Conversion
- Habitat Disturbance
- Habitat Fragmentation
- Changes in Water Levels or Flows
- Competition for Resources
- Parasitism/Predation/Disease
- Salinity Alteration
- Non-native Species

After examining the Pearl River conservation area through the Five-S conservation planning process, the following highly ranked threats emerged. These are threats that ranked high enough across all target systems and species to warrant special attention.

**Highly Ranked Sources of Stress (Threats) to the Long-term Viability of the Pearl River**

- Incompatible Sand and Gravel Mining
- Incompatible Operation of Dams and Reservoirs
- Construction of Ditches, Dikes, Drainage or Diversion Systems
- Incompatible Commercial/Industrial Development
- Incompatible Forestry Practices
- Low Water Sills
- Proposed New Dam Construction

Strategies and actions to abate these threats were then developed and ranked according to their potential effectiveness in solving the problems in the next ten years. As a result, the following are the seven highest ranked strategies.

**Very High Ranked Strategies for Threat Abatement in the Pearl River**

- Hold Symposium for Experts and Stakeholders to tell the Story of the Pearl to Generate Interest in Forming a Pearl River conservation alliance

- Facilitate and Support the Development of a conservation alliance for the Lower Pearl as a Network to Deliver Information and Cultivate Understanding and Appreciation of the Pearl

- Encourage Appropriate Land Zoning through Participating in Land Use Planning Efforts such as 2025 process in St. Tammany Parish

- Partner with Aggregate Industry and Regulatory Agencies to Promote BMPs for Sand and Gravel Mining Practices by Sharing Expertise and Through Workshops

- Promote Acquisition and Management of Public and Private Conservation Areas to Conserve Important Habitats and to Serve as Models to Demonstrate Ecological Management

**High Ranked Strategies for Threat Abatement in the Pearl River**

- Obtain Funding to Conduct a Geomorphic Study

- Assist U.S. Army Corps of Engineers in Getting Monies for Restoration Projects

**Strategy Implementation Capacity**

TNC's overall capacity for successfully implementing strategies in the Pearl River was ranked "Medium." This score was obtained by ranking capacity in the following areas: a. Project Leadership and Support; b. Strategic Approach; and c. Project Funding.

**Measures of Conservation Success**

Criteria used to measure conservation success include biodiversity health, threat status, and overall conservation capacity. The conservation targets rated "good" in terms of site biodiversity health. The overall threat status for the Pearl River Basin is "very high" and the overall conservation capacity is "medium." Efforts will be made to improve these rankings over time as a measure of conservation success.

## 3. Introduction

**Vision**

*"Within the foreseeable future, restore and conserve the native biodiversity and ecological health of the Pearl River and its tributaries at multiple geographic scales. Working with partners, actions taken will perpetually conserve species, communities and systems that represent the diversity of life native to the Pearl River watershed in Louisiana and Mississippi."*

**Background**

The Pearl River Basin is located in east-central and southwest Mississippi and in southeastern Louisiana. The Pearl River has been identified as a high priority focus for conservation attention within the East Gulf Coastal Plain and Northern Gulf of Mexico ecoregions because of its high biodiversity significance. The Pearl River Conservation Area is also within two other ecoregions, the Upper East Gulf Coastal Plain and Gulf Coast Prairies and Marshes (Figure 1.). The primary boundary conservation area for this plan includes the Pearl River floodplain, North to the Ross Barnett Reservoir, laterally to top of the slope adjacent to the floodplain and along major tributaries within the Pearl River watershed, and South to the Rigolets. The primary boundary encompasses 575,285 acres (232,811 hectares). The secondary boundary includes the Pearl River, its tributaries and the entire watershed up to the Ross Barnett Reservoir, an area 3,586,990 acres (1,451,609 hectares) in size (Figure 2.). There are 16 protected areas within the Pearl River Conservation Area, a total of 347,044 acres or 10% of the secondary boundary (Figure 3.). A description of the many of the protected areas in the Pearl River conservation area is listed in Appendix A.

The sand- and gravel-bottomed river is approximately 490 miles long and drains an area of 8,760 square miles (Mississippi Department of Environmental Quality 2000). The Pearl River is formed by the confluence of the Tallahaga and Nanawaya creeks in Neshoba County, Mississippi. The Pearl River flows southwesterly past Jackson for about 146 miles, then 217 miles in a southerly direction to the head of its outlet channels, the Pearl and West Pearl Rivers (Mississippi Department of Environmental Quality 2000). These channels continue in the same general direction for 48 and 44 miles, respectively, and empty into the Mississippi Sound and Lake Borgne. The West Pearl River lies entirely within the State of Louisiana. The lower 61 miles of the Pearl River form a boundary between Louisiana and Mississippi. Streams in most of the Lower Pearl sub-basins usually have a fast deep base flow. Near the Mississippi Gulf Coast, the Pearl River becomes estuarine where it is bounded by salt marsh and is tidally influenced.

The initial Conservation Area Planning meetings were hosted by TNC and attended by a variety of experts on the Pearl River system. Non-point source pollution was found to be the primary

threat to the ecological health of the system and many of the species it supports. Key sources of this threat include sediment loading from sand and gravel operations, changes in the geomorphology of the river, low water sills, and forestry, agriculture, and urban runoff.

Despite these pressures on the Pearl River ecosystem, the river and watershed are believed to remain ecologically viable. The challenges in implementing a landscape-scale conservation approach are multi-faceted. This conservation plan also focuses on community-based conservation. Community-based conservation is defined as "working with local residents to protect our natural heritage, while taking into account the values and economic needs of the people." TNC will foster ecologically compatible development and growth throughout the Pearl River Basin. It is a cooperative, science-based approach that demonstrates the value of conservation and builds consensus for it in the community.

**Figure 1. Pearl River Conservation Planning Area and Ecoregions**

**Figure 2. Pearl River Tributaries**

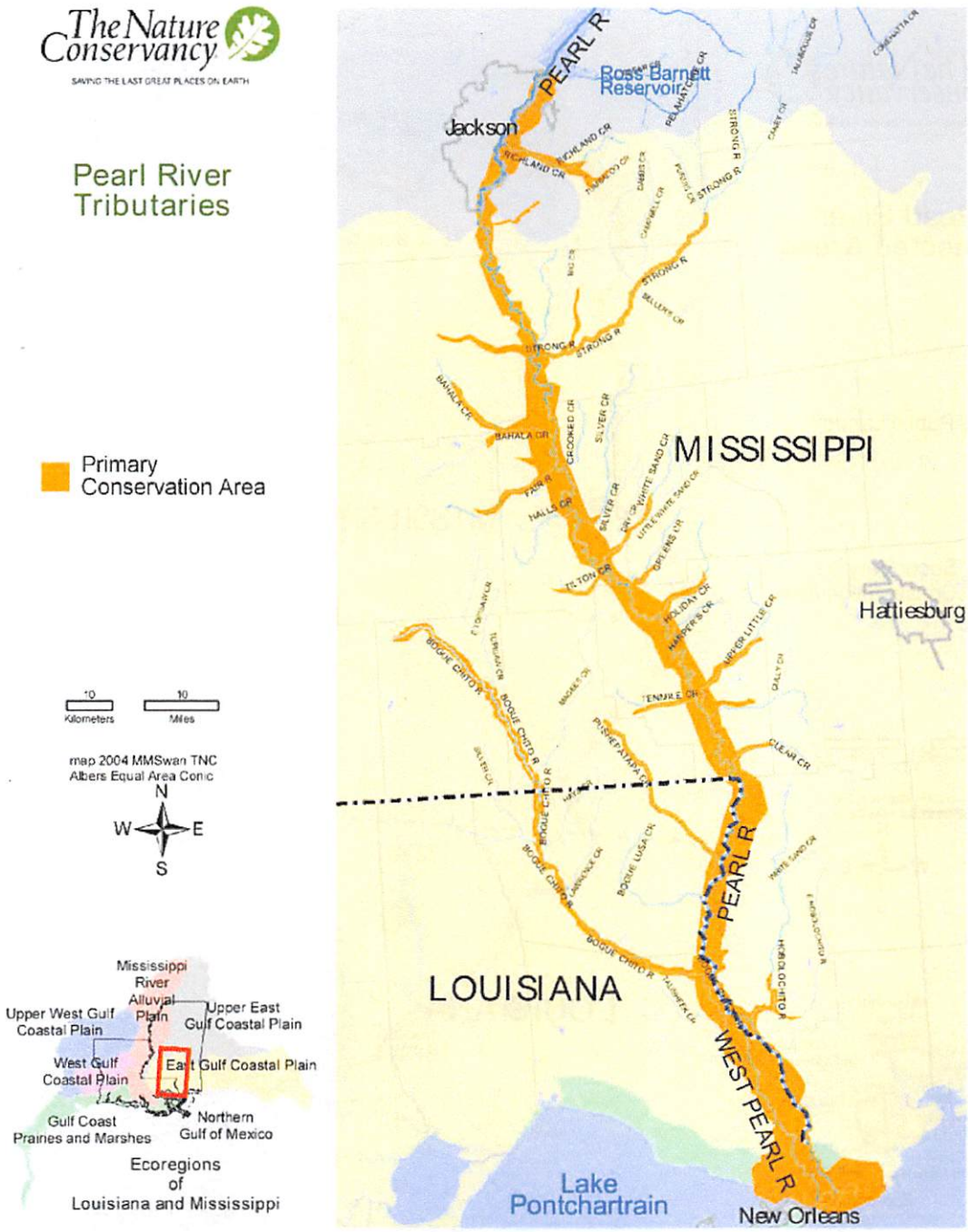
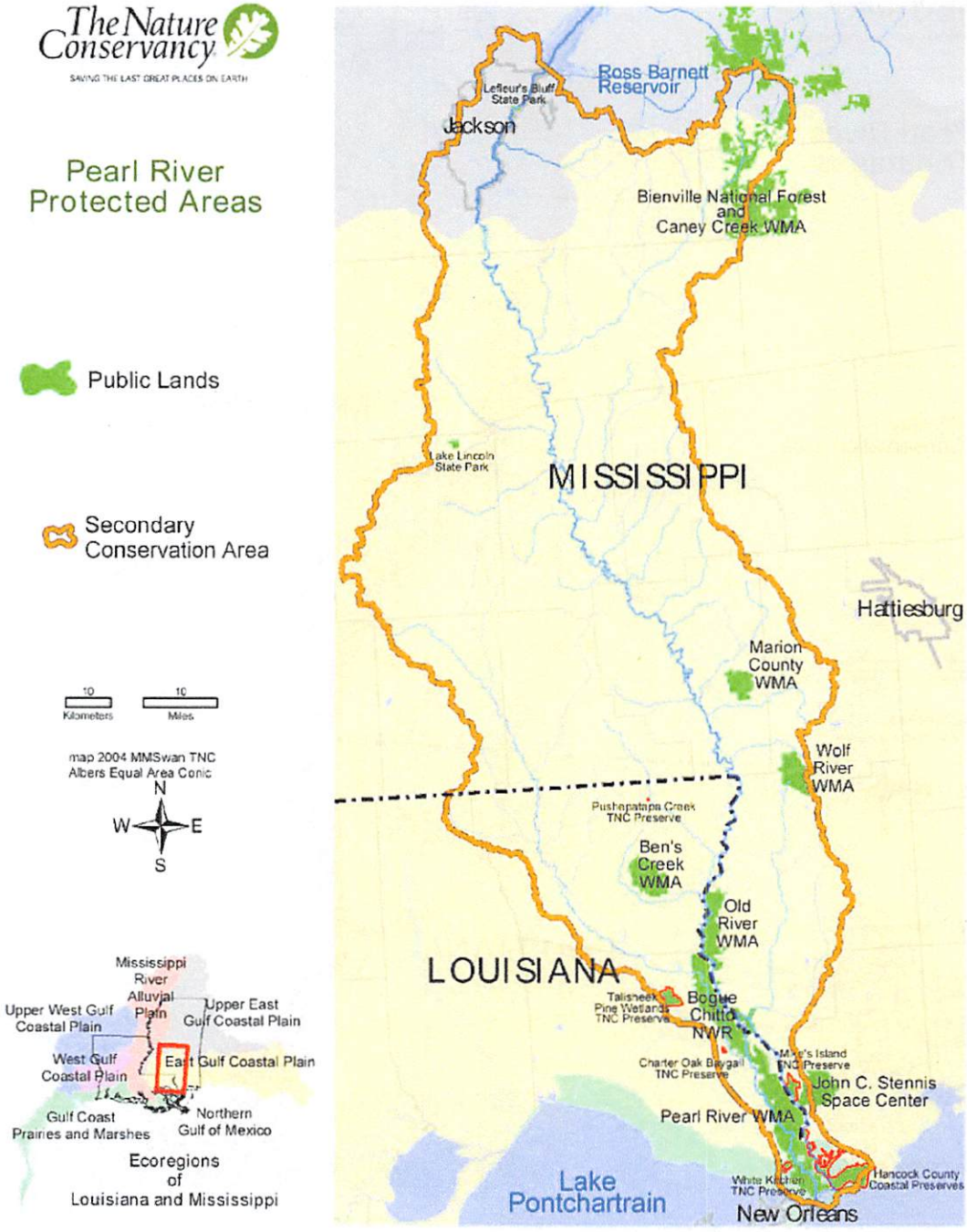


**Figure 3. Pearl River Protected Areas**



**Partners/Stakeholders**

TNC is committed to working with communities to achieve conservation goals. As part of this commitment the Conservancy formed The Lower Pearl Partnership. TNC received grants from the Louisiana and Mississippi Departments of Environmental Quality to work with landowners, communities, scientific experts and agencies in the Lower Pearl River. All parties agreed to work together to address water quality issues along the Pearl River and its major tributaries for three years. This partnership offers a unique opportunity to cross state and cultural borders to achieve conservation goals in the Pearl River Basin at a landscape scale. Collaborators are stakeholders, experts or other entities that have an interest in the project and contribute time, funds or expertise. The following includes a list of some of the partners/stakeholders:

**Federal Agencies**
U.S. Fish and Wildlife Service (USFWS)
NASA Environmental Office
National Oceanic and Atmospheric Administration
Environmental Protection Agency (Gulf of Mexico Program)
U.S. Navy – SBT 22 at Stennis Space Center
U.S. Army Corps of Engineers

**State Agencies**
LA Department of Environmental Quality
MS Department of Environmental Quality
LA Department of Wildlife and Fisheries (Natural Heritage Program, Forestry Section and Inland Fisheries)
MS Department of Wildlife, Fisheries and Parks (Natural Heritage Program)
MS Department of Marine Resources
LA Department of Agriculture and Forestry
MS Department of Agriculture and Forestry
LA Department of Agriculture and Forestry
LA Farm Bureau Local Offices
MS Farm Bureau Local Office
MS Department of Transportation
LA Department of Transportation

**Business/Industrial**
Sand and Gravel/Surface Mining Operations
Forestry
Agriculture
Developers
Commercial Fishermen

**Academia**
Tulane University, Dept. of Ecology and Evolutionary Biology
Louisiana State University, Dept. of Biology
University of New Orleans
University of Southern Mississippi, Dept. of Biological Services
Loyola University
Mississippi Southern University, Coastal Basin Watershed Forum
Gulf Coast Geospatial Center

**Local Groups**
Parish and County governments and planning departments
Private Landowners
Audubon Mississippi
Mississippi Coast Audubon Society
Orleans Audubon Society
Sierra Club
Leadership Slidell
Military Road Alliance
Swamp Tour Operators
Pearl River Coalition
Northshore Birding Club
Sport Fisherman
Recreationists

## 4. Conservation Area Description

Much of the lower Pearl River floodplain has remained relatively undisturbed (Gosselink et. al 1990), unlike the great majority of other similar streams in the region. Most of the original floodplain remains forested. The types of ecologically significant natural communities include: bottomland hardwood forests (numerous sub-types), slope forests, lateral aquatic forests, cypress-tupelo swamps, and various emergent marsh types near the terminus of the river. These areas provide diverse habitats for a wide variety of plants and animals.

Wetland systems found along the Pearl River provide valuable functions, such as absorbing excess nutrients, recharging aquifers, controlling erosion and helping to reduce flooding. The Pearl River floodplain, at least in its lower reaches, is one of the last remaining, intact, overflow swamp systems along major rivers in the southeastern United States. The lower Pearl River supports one of the healthiest marsh complexes in the Southeast. The marsh consists of high-quality examples of fresh, intermediate and brackish marshes that are among the most stable in the Louisiana and Mississippi coastal zone. The Pearl River supports between 120-140 species of fishes (H. Bart, Jr. pers. commun. 2004, T. Slack, pers. commun. 2004) and approximately 40 species of mussels (Mississippi Department of Wildlife, Fisheries and Parks 2004), making it one of the most species-rich river systems in North America. A 1991 mussel survey near Walkiah Bluff by the U.S. Army Corps of Engineers Waterways Experiment Station revealed 29 species of bivalves, including the threatened inflated heelsplitter (*Potamilus inflatus*; U.S. Army Corps of Engineers 1995).

The Pearl River is a critical stopover site for trans-gulf Neotropical migratory birds. The Swallow-tailed Kite, a bird species of conservation concern, breeds in the area and is often seen soaring over the river. Gulf sturgeon (*Acipenser oxyrinchus desotoi*), an anadromous fish with ancestry dating to prehistoric times, makes a summer journey from salty gulf waters to freshwater spawning areas in the Pearl. In February of 2003, the Pearl River was designated as Critical Habitat for the threatened Gulf sturgeon (U.S. Fish and Wildlife Service 2003). The conservation area also supports the threatened ringed map turtle (*Graptemys oculifera*), which is endemic to the Pearl River Basin.

### The Human Context

The people in the Pearl River Basin have a rich heritage and cultural linkage to the land, water and natural resources. Historically, many have farmed, fished, hunted, trapped and boated the land. These traditional uses continue today with an increasing emphasis on recreational activity. The greatest concentration of people in the Pearl River Basin conservation area is found in the Upper Pearl River, which includes the Jackson, Mississippi metropolitan area, and along the lower Pearl River in St. Tammany Parish, Louisiana. These areas also have some of the highest per capita income, highest high school graduate rates and lowest poverty rates. Population, education, poverty level and per capita income statistics (U.S. Census 2004) for the two parishes and sixteen counties in the conservation area are summarized in Table 1.

**Table 1. Census Data for Parishes and Counties in the Conservation Area**

| County/Parish | Population Estimate (2003) | Population % Change 1990-2000 | High School Graduate (age 25+yrs.) 2000 | Persons below Poverty (1999) | Per Capita Income (1999) |
|---|---|---|---|---|---|
| St. Tammany Parish | 207,743 | 32.4% | 83.9% | 9.7% | $22,514 |
| Washington Parish | 43,947 | 1.7% | 68.2% | 24.7% | $12,915 |
| Hancock County | 45,145 | 35.3% | 77.9% | 14.4% | $17,748 |
| Pearl River County | 50,894 | 25.6% | 74.6% | 18.4% | $15,160 |
| Lamar County | 41,957 | 28.4% | 83.0% | 13.3% | $18,849 |
| Marion County | 25,090 | 0.2% | 66.5% | 24.8% | $12,301 |
| Jefferson Davis County | 9,533 | 12.6% | 66.4% | 28.2% | $11,974 |
| Lawrence County | 13,520 | 6.4% | 72.9% | 19.6% | $14,469 |
| Simpson County | 27,592 | 15.4% | 68.8% | 21.6% | $13,344 |
| Rankin County | 124,695 | 32.3% | 81.8% | 9.5% | $20,412 |
| Madison County | 79,758 | 38.8% | 83.0% | 14.0% | $23,469 |
| Hinds County | 249,087 | -1.4% | 80.4% | 19.9% | $17,785 |
| Copiah County | 28,928 | 4.2% | 69.3% | 25.1% | $12,408 |
| Lincoln County | 33,549 | 9.5% | 72.0% | 19.2% | $13,961 |
| Pike County | 38,935 | 5.6% | 70.3% | 25.3% | $14,040 |
| Smith County | 15,834 | 9.4% | 70.8% | 16.9% | $14,752 |
| Scott County | 28,450 | 17.8% | 62.0% | 20.7% | $15,853 |
| Walthall County | 15,191 | 5.6% | 67.0% | 27.8% | $12,563 |

# 5. TNC Conservation Planning

## Ecoregional Planning

The conservation planning approach utilized in this planning effort is based on methodology developed by TNC. TNC's mission is to conserve land and water habitats that will ensure the long-term survival of all native plant, animals and natural communities. TNC works in partnership with others to protect networks of functional conservation areas that together are designed to conserve the biodiversity, i.e., the systems, communities and species, that characterize ecoregions. Ecoregions are large landscapes defined by their distinct climate, geology, physiography and dominant vegetation types. The Pearl River Basin lies within four ecoregions, the East Gulf Coastal Plain ecoregion, the Upper East Gulf Coastal Plain, Gulf Coast Prairies and Marshes, and the Northern Gulf of Mexico.

Using a collaborative, science-based approach to conservation, TNC and partners conduct a conservation assessment for each ecoregion (called an "Ecoregional Assessment" or Ecoregional Plan") that results in the identification of important places for conservation action on the ground (the "portfolio"). Ecoregional Assessments form the conservation blueprint that guides TNC's actions in any geographic area.

## Conservation Area Planning Methodology

Once Ecoregional Assessments have identified the priority places for conservation action in each ecoregion, conservation area plans are then developed for each identified high priority site within the ecoregion. The Conservancy uses conservation area plans to develop site-specific conservation strategies and prepare for taking action and measuring success. These plans follow the **5-S Framework**, outlined below:

- **Systems**: The conservation area planning team identifies the species, natural communities and systems, and other elements that will be the focal conservation targets for the area that, in theory, if protected will conserve all native biodiversity in the project area. This is done through review of the ecoregional targets developed during ecoregional assessment and consideration of site-specific conservation targets.
  - All native ecological communities present in an area
  - Spatial assemblages of ecological communities (ecological "systems")
  - Rare species or species of concern in need of special attention
  - Keystone, wide-ranging and umbrella species
  - Globally or regionally significant aggregations of species
  - Species groups or "guilds" of concern (e.g., Neotropical migrant songbirds)
  - Critical habitats for species/species groups of concern

Once focal targets are identified, an evaluation of the viability of each in the project area is conducted to provide an estimate of the long-term prospects for survival of the target in the area, and to provide information that will be instrumental in developing a comprehensive ecological health monitoring program for each.

- **Stresses**: The team determines how selected targets are compromised by proximal stresses, such as by habitat conversion or fragmentation, or altered composition/structure of natural communities (Appendix C.).
- **Sources**: The team then identifies and ranks the causes, or sources, of stress for each target. The analysis of stresses and sources together make up the threat assessment (Appendix D.).
- **Strategies**: Perhaps the most critical step in the process is finding practical cooperative ways to mitigate or eliminate the identified threats and enhance biodiversity health.
- **Success**: Each plan outlines methods for assessing our effectiveness in reducing threats and improving biodiversity health. This is usually accomplished by monitoring our progress toward established biological and programmatic goals.

An understanding of the cultural, political and economic situation behind the threats is essential for developing sound strategies. This human context (Situation) is often referred to as the sixth "S".

## 6. Description and Status of Conservation Targets

After much discussion and evaluation the planning team chose seven conservation targets, four natural communities and three groups of representative species, as targets for the conservation area plan for the Pearl River.

**Pearl River Conservation Targets**
- Resident Riverine Aquatic Fauna
- Anadromous/Catadromous Fishes
- Lateral Aquatic Habitats
- Swallow-tailed Kite
- Bottomland Forest Complex
- Emergent Marsh Complex
- Slope Forest Complex

### a. Resident Riverine Aquatic Fauna

Resident Riverine Aquatic Fauna in the Pearl River Basin include a variety of fish, turtle, and mussel species and other aquatic life. Ecological needs of these species include swift flowing water over firm, large gravel substrates. These suitable substrate areas are decreasing in the Pearl River possibly due to anthropogenic alterations of stream areas, such as substrate destabilization (from head-cutting) and excess sediment input from sand and gravel mining. Evidence of geomorphic instability in the Pearl River has been observed and is contributing to habitat degradation (Bart and Rios 2003). Primary factors that were identified as affecting habitat of resident riverine aquatic fauna are incompatible sand and gravel mining, barriers to movements, such as low water sills, and alteration of hydrology of the river system due to incompatible operation of reservoirs and incompatible commercial/industrial development.

There are 36 mussel species in the Pearl River and 40 species in the Pearl River watershed (Mississippi Department of Wildlife Fisheries and Parks 2004). The six primary mussel species

of concern in the Pearl River watershed include the threatened inflated heelsplitter (*Potamilus inflatus*) and five species that are listed as imperiled by the Mississippi Natural Heritage Program. These five mussel species include, the delicate spike (*Elliptio arctata*), which is officially listed by the state of Mississippi as endangered, the rayed creekshell (*Anodontoides radiatus*), the rock pocketbook (*Arcidens confragosus*), the white heelsplitter (*Lasmigona complanta complanata*) and the tapered pondhorn (*Uniomerus declivis*).

The inflated heelsplitter, like many freshwater mussel species, requires stable sand or silt bottom with slow to moderate currents. Under the right conditions, some mussel species live from ten up to100 years, making them some of the oldest creatures on earth. While mussels can be found singly on a stream or river bottom, they often live closely together in communities or beds. A single bed may contain many species of mussel.

Many factors affect the health of freshwater mussels. Excessive silt can cover a mussel or a mussel bed smothering the smaller species and preventing feeding in the larger individuals. Channel modifications (in-stream mining) and impoundments (dams) built for navigation or flood control change the nature of the river and alters the stream bottom. Pollution destroys the freshwater environment and kills the mollusks, their food, and any fish-host needed for reproduction. Over-harvesting severely limits the viability of the population. Introduced species, such as the zebra mussel, compete for limited food resources.

Primary fish species of concern in the Pearl River watershed include the Gulf sturgeon, Alabama shad, paddlefish (*Polyodon spathula*), frecklebelly madtom (*Noturus munitus*), crystal darter (*Crystallaria asprella*), silverjaw minnow (*Ericymba buccata*), flagfin shiner (*Pteronotropis signipinnis),* bluenose shiner (*Pteronotropis welaka*), southeastern blue sucker (*Cycleptus meridionalis*), river redhouse (*Moxostoma carinatum*), frecklebelly madtom (*Noturus munitus*) and freckled darter (*Percina lenticula*; H. Bart Jr. pers. commun. 2004; Bart and Rios 2003). The Gulf sturgeon is federally listed as threatened and the Alabama shad and Pearl darter are candidates for listing. Benthic fish species such as the frecklebelly madtom and the crystal darter need firm substrate on river bottoms. Piller et al. (2004) stated that the frecklebelly madtom populations have significantly declined since the 1960s. They suggested that the loss of appropriate gravel substrate and changes in the channel contributed to these declines.

The pearl darter (*Percina aurora*) was extirpated from the Pearl River in the early 1970s. Some possible reasons for the demise of the pearl darter in the Pearl include impoundments (sills and dam) and the instability in the channel (H. Bart Jr. pers. commun. 2004). When the fish spawn the young are swept down river and unable to migrate back up the river due to low water sills and varied water flow that affected the channel. Their limited success year after year finally caused the population to crash (H. Bart, Jr. pers. commun. 2004).

Primary turtle species in the Pearl River watershed include the ringed (sawback) map turtle (*Graptemys oculifera*), alligator snapping turtle (*Macroclemys temminckii*), Pascagoula map turtle (*Graptemys gibbonsi*) and the Mississippi diamondback terrapin (*Malaclemys terrapin pileata*; T. Mann pers. commun. 2004). The ringed map turtle, designated as a threatened species in 1986 under the Endangered Species Act, is only found in the Pearl, West Pearl and Bogue Chitto Rivers. These turtles inhabit clean rivers with a moderate current. They prefer sunny areas with many basking logs. Ideal nesting habitat is sandbars with clean, fine-grain

sand, a minimum vegetative cover, and a slight elevation (1-3 m) above the river level (Louisiana Department of Wildlife and Fisheries 2004). The largest populations have been found above the Ross Barnett Reservoir, below Jackson on the Pearl River in Mississippi, and below Franklinton, Louisiana on the Bogue Chitto (Chaney 2003). They are uncommon south of Bogalusa on the Pearl River. Declines to the ringed map turtle populations in the Pearl and Bogue Chitto Rivers are attributed to habitat modifications, such as destruction of sandbars and natural and man-made changes in river hydrology (channel modification for flood control and navigation and impoundments). These alterations decrease the availability of basking and nesting sites, change water flow and increase sedimentation and turbidity, which lowers water quality and decreases food supply. Habitat modification has occurred in 21% of the turtle's range in the Pearl River system (U.S. Fish and Wildlife Service 1992).

**b. Anadromous/Catadromous Fishes**

Anadromous fishes require migratory routes through the Pearl River to reach suitable spawning areas, whether upstream or down, to complete their life cycle. The Gulf sturgeon was selected by the team of experts as a key nested species for anadromous/catadromous fishes in the Pearl River because of their rarity, specific habitat needs and recognized critical threats. The Gulf sturgeon, a subspecies of the Atlantic sturgeon (*Acipenser oxyrinchus*), can grow longer than nine feet and weigh more than 300 pounds. The sturgeon's diet consists mostly of bottom dwelling organisms, such as amphipods, isopods, crustaceans, and marine worms. The Gulf sturgeon was fished almost to extinction for it's prized roe and meat. Today, they are protected under the Endangered Species Act and were listed as threatened in 1991. Other migratory aquatic species of concern are the Alabama shad (*Alosa alabamae*) and American eel (*Anguilla rostrata*). The eel is a catadromous species, spawning in salt water, while the shad, similar to the sturgeon is anadromous, and ascend rivers from the sea to spawn in freshwater.

The Gulf sturgeon historically ranged from Tampa Bay, Florida to the Mississippi River and possibly farther west. The fish inhabits coastal rivers from Louisiana to Florida during the warmer months and overwinter in estuaries, bays and the Gulf of Mexico. Mature Gulf sturgeon move into freshwater from the ocean in early spring to spawn and migrate back to saltwater in the autumn or early winter. Immature sturgeon may participate in these yearly migrations, but apparently do not move as far upriver as adults. The sturgeon appear to return as adults to spawn in the same river in which they hatched. In the Pearl River, the Gulf sturgeon currently range as far upstream as the Ross Barnett Reservoir.

The Gulf sturgeon is long-lived, living up to 70 years, and takes many years to become sexually mature (U.S. Fish and Wildlife Service 2003). Most sturgeon are nine to twelve years of age when they first reproduce, making them extremely vulnerable to over harvest and habitat changes. Primary habitat features needed for survival and successful reproduction of the Gulf sturgeon include, but are not limited to, abundant food and prey items within estuarine and marine habitats for sub-adult and adult life stages, riverine spawning sites with substrates suitable for egg deposition and development, flow regime suitable for growth and reproduction, water and sediment quality conducive to viability of all life stages and unobstructed pathways necessary for passage within and between riverine, estuarine and marine habitats (U.S. Fish and Wildlife Service 2003).

Some activities affecting the habitat of the Gulf sturgeon and other aquatic species include incompatible sand and gravel mining (dredging, channelization, substrate destabilization, near and in-stream mining), impoundments (e.g., low water sills or dams), incompatible operation of reservoirs or dams and land uses which cause excessive turbidity or sedimentation, such as incompatible commercial/industrial development (U.S. Fish and Wildlife Service 2003).

Declines of the Gulf sturgeon populations have been attributed to overexploitation, blockages to migration routes (dams and sills), habitat loss, and deterioration of water quality (Morrow et al. 1998).

- Overexploitation: Although the Gulf sturgeon has been protected from harvest since 1990, declines in mean size of samples from the Lower Pearl River coincides with a 4.6-fold increase in commercial license sales in three parishes bordering the Lower Pearl and Lake Pontchartrain (Morrow et al. 1998).

- Blockages to Migration Routes: This includes impoundments (dams), water diversion, and dam operation (U.S. Fish and Wildlife Service 2003). Potential barriers to Gulf sturgeon migration on the Pearl and Bogue Chitto Rivers include the Ross Barnett Dam, the Poole's Bluff Sill, and the Bogue Chitto Sill (Morrow et al. 1998).

- Poor Water Quality: Including land-use practices that cause excessive turbidity or sedimentation (dredging, channelization, in-stream mining) and the release of chemicals, biological pollutants and heated effluents into surface water.

On March 19, 2003, The U.S. Fish and Wildlife Service and the National Marine Fisheries Service designated the Pearl River, up to the Ross Barnett Dam, and the Bogue Chitto River as Critical Habitat for the Gulf sturgeon.

### c. Lateral Aquatic Habitats

Lateral aquatic habitats are oxbows, sloughs, side channels or other areas connected to the main channel in high water times. These areas provide additional habitat for many aquatic wildlife, particularly lateral stream dependent species. Oxbows are former bends of the main river channels that have been cut-off by siltation. Deepwater alluvial swamps often develop into oxbow lakes. Sloughs are abandoned main-stream channels that flood in high water. Sloughs can hold water for long periods of time but may eventually dry out and form in meander scrolls. Deepwater swamps, characterized in the Pearl basin by bald cypress and water tulepo, can also form in permanently flooded sloughs (Sharitz and Mitsch1993). The key process regulating the condition of these habitats is the delivery and routing of water, sediment and debris primarily during high water events (Haring 1999). The river channel meanders through the floodplain transporting, eroding and depositing sediments.

These habitats provide clearer water, protected habitat for juvenile fish, and more plankton. The overall character of these habitats is more lentic or lake-like. The pools are deeper and cooler and there is not as much variance in depth. Since the water is not flowing, there is less abiotic turbidity and more biological turbidity. This high level of biological turbidity, which provides more plankton is better habitat for plankton eaters. Some resident fish species in these habitats are cypress minnow (*Hybognathus hayi*), iron color shiner (*Cyprinella whipplei*), flagfin shiner

(*Pteronotropis signipinnis*), bluenose shiner (*Pteronotropis welaka*). All of these fish species favor blackwater streams and habitats (Bart and Rios 2003).

Stresses to these habitats include destruction or conversion, altered composition, increased sedimentation, changes in water levels and flow and competition for resources by invasive species. Highly ranked sources of these stresses include construction of ditches, dikes, drainage or diversion systems, incompatible operation of dams or reservoirs, dam construction and incompatible commercial/industrial development.

**d. Swallow-tailed Kite**

The team of experts selected the Swallow-tailed Kite (*Elanoides forficatus*) as a conservation target and umbrella species because of its precarious status and specific habitat needs for large blocks of contiguous forest. Its area and habitat requirements are shared by many other wildlife species, including many Neotropical migratory birds and the Louisiana Black Bear. The American Bird Conservancy (2000) considers the Swallow-tailed Kite along with Swainson's Warbler (*Limnothlypis swainsonii*), Cerulean Warbler (*Dendroica cerulea*), Prothonotary Warbler (*Protonotaria citrea*), Kentucky Warbler (*Oporornis formosus*), and Yellow-billed Cuckoo (*Coccyzus americanus*) to be forested wetland bird species of high concern in the East Gulf Coastal Plain. The Louisiana Black Bear historically occurred in the Pearl River Basin. Today, individuals are only occasionally observed passing through the area. Targeting the Swallow-tailed Kite for management and ecosystem restoration efforts will not only ensure that species requiring vast continuous forest are protected, but many other species with less rigorous habitat and area requirements will be conserved as well.

The Swallow-tailed Kite is one of the most striking raptors in North America. The forked tail, for which it is named, makes up over half of the body length. It is a Nearctic–Neotropical migrant of local and national conservation interest. Near the turn of the twentieth century, this kite species suffered the most dramatic reduction of any still-extant land-bird in eastern North America (Meyer 1995). Probable reasons for the decline were extensive logging and agricultural development of suitable breeding habitat. This kite that once bred in 21 states in the U.S. now only breeds in seven states: Louisiana, Mississippi, Florida, Alabama, Georgia, South Carolina, and Texas, although a few pairs may also nest in Arkansas and North Carolina (J. Coulson pers. commun. 2004). The North American subspecies of the Swallow-tailed Kite was much more widespread and populations were more numerous prior to the late 1800s.

The Swallow-tailed Kite is locally known as "critically imperiled" by the Louisiana Natural Heritage Program and "imperiled" by the Mississippi Natural Heritage Program. The Biological Resources Division of the USGS considers it a "Species at Risk." Partners In Flight lists the Swallow-tailed Kite as a Category I species of highest priority and in need of immediate management. Swallow-tailed Kites are wide-ranging on the nesting grounds. Sightings of vagrants have occurred as far away as Oklahoma, Nova Scotia, and Great Britain.

Swallow-tailed Kites may require a minimum of 100,000 acres of bottomland hardwood forest for stable nesting populations of 80 to 85 pairs (Cely and Sorrow 1990). Within these large tracts in Louisiana and Mississippi, kites prefer to nest in loblolly pine, sweetgum (*Liquidambar styraciflua*), and eastern cottonwood (*Populus deltoides*) trees that are at least 30 m (J. Coulson,

pers. commun. 2004). Swallow-tailed Kites can be tolerant of human activity and sometimes nest in moderately wooded suburban areas in the Pearl River Basin. Nonetheless, in some instances nesting territories were abandoned due to clearing and selective cutting. However, nesting of this species can be compatible with timber harvest if managers avoid disturbing pairs during the nesting period. As Swallow-tailed Kites are easily spooked while at roost, roost sites are also prone to human disturbance (Meyer 1995, J. Coulson, pers. commun. 2003).

This species has delayed age at first breeding. Because of this, a substantial portion of the population consists of non-breeders (J. Coulson, pers. commun. 2004). They are rare enough in Louisiana that suitable nesting habitat is not saturated. Within the lower East Gulf Coastal Plain sizeable breeding populations of Swallow-tailed Kites occur in the lower Pearl River, Pascagoula River, and the Florida panhandle rivers (J. Coulson, pers. commun. 2003). They are known to nest and roost in the Pearl River and Old River Wildlife Management Areas, the Bogue Chitto National Wildlife Refuge and the vicinity. Approximately 24 nesting pairs of Swallow-tailed Kites have been observed in the lower Pearl River Basin in 2004 (J. Coulson, pers. commun. 2004).

Timber harvesting on private and public land may pose the greatest threat to Swallow-tailed Kites because they nest in large trees. Other sources of stress to Swallow-tailed Kites in the Pearl River are incompatible recreational use, the Great Horned Owl and incompatible primary home development, which can cause forest fragmentation. Potential predators of eggs and young include mid-sized to large nocturnal and diurnal raptors, corvids, rat snakes, and possibly, herons and raccoons (Palis 2000, J. Coulson, pers. commun. 2004). In the Pearl River Basin, the Great Horned Owl (*Bubo virginianus*) is the most frequent predator of nesting Swallow-tailed Kites (J. Coulson, pers. commun. 2003).

### e. Bottomland Forest Complex

The bottomland forest complex includes a variety of bottomland hardwoods forest types and cypress/cypress-tupelo forested wetlands. These forested floodplain natural communities are mixtures of broadleaf deciduous, needleleaf deciduous and evergreen trees and shrubs. They are typically associated with large river systems, occurring in the floodplain of the main river and side channels. These wetlands are inundated by surface water during high-water periods of the year, typically in the spring, and often for weeks at a time. They are crucial natural communities for maintenance of water quality, providing habitat for a variety of plants and wildlife, and are important in the regulation of flooding and stream recharge (Smith 1999). They are extremely productive areas due in part to periodic flood-transported and deposited particulate and dissolved organic matter and nutrients (Smith 1999). It is typified by shrubby vegetation. Typical bottomland hardwood types along the lower Pearl include (K. Ribbeck, pers. commun., 1999):

Laurel oak - red maple - bald cypress - green ash Forest
(*Quercus laurifolia - Acer rubrum - Taxodium distichum - Fraxinus pennsylvanica*)

Laurel oak - sweetgum - swamp black gum - green ash - nuttall oak - overcup oak - bitter pecan Forest
(*Quercus laurifolia - Liquidambar styraciflua - Nyssa sylvatica var. biflora - Fraxinus pennsylvanica - Quercus Texana - Quercus lyrata - Carya aquatica*)

Laurel oak - water oak - sweetgum - southern magnolia - sweetbay - american holly Forest (*Quercus laurifolia - Quercus nigra - Liquidambar styraciflua - Magnolia grandiflora - Magnolia virginiana - Ilex opaca*)

Water oak – sweetgum - southern magnolia - american holly - ironwood Forest (*Quercus nigra - Liquidambar styraciflua - Magnolia grandiflora - Ilex opaca - Carpinus caroliniana*)

Sycamore - river birch - silver maple Forest (streamside forest in upper floodplain) (*Platanus Occidentalis - Betula nigra - Acer saccharinum*)

Although these communities are common, old-growth examples in St. Tammany Parish are very rare. Bottomland hardwood forests are estimated to be declining at a slow rate (Smith 1999). Major causes of the decline of bottomland hardwood forest are fragmentation, habitat destruction or conversion, alteration of composition/structure, and invasive species.

Cypress/cypress-tulepo swamps are common on the lower Pearl River, generally south of the bottomland hardwood zones. Bald cypress swamps and bald cypress-tupelo swamps are forested, alluvial swamps growing on intermittently exposed soils. The soils are inundated or saturated by surface water or groundwater on a nearly permanent basis throughout the growing season except during periods of extreme drought. There is a relatively low floristic diversity. Bald cypress is the dominant overstory species, often mixed prominently with water tupelo. At times, water tupelo may be dominant. Other common associates are swamp red maple, black willow (*Salix nigra*), water ash (*Fraxinus caroliniana*), green ash, water elm (*Planera aquatica*), water locust (*Gleditsia aquatica*), Virginia willow (*Itea virginia*), and buttonbush (*Cephalanthus occidentallis*). Composition of associate species vary from site to site. Undergrowth is often sparse because of low light intensity and long hydroperiod. Although the type is not rare, old-growth examples are very rare. This type is estimated to be declining at a slow to very slow rate.

### f. Emergent Marsh Complex

The broad floodplain of the lower Pearl River valley is occupied by bottomland hardwood forest and swamp that give way to fresh, intermediate, brackish and salt marshes of the Pearl River delta. Our planning area includes this lower marsh area, encompassing all of the marshes influenced by the Pearl River, including Fritchie Marsh and the ridges of forested high ground adjacent to Fritchie Marsh. In an easterly direction, the area extends into Hancock County, Mississippi, where long, linear ridges rise above the marsh. These remnants of the Pine Island barrier island, which have been mostly buried by the deposition of more recent sediment from the Pearl River, create unusual areas of maritime live oak and pine forest.

Coastal marshes provide important habitat for wide a variety of wildlife species, in particular water birds, waterfowl, furbearers, fishes and other estuarine organisms, because of their abundant, tidally-enhanced food supply, vegetative cover, and superior nesting habitat. The emergent marsh complex at the lower reaches of the Pearl River includes a variety of intermediate and brackish types (Visser and Sasser 1999, National Wetlands Research Center 2004).

Fresh Marsh is present in a limited amount at the far north of the marsh zone at the lower end of the Pearl. It can be seen, for example, at TNC's White Kitchen Preserve. The type of fresh marsh present may be primarily described as the following:

*Fresh Bulltongue Marsh*
The type is dominated by *Sagittaria lancifolia*, with *Typha* spp. and *Ludwigia* spp. as the most common associates. Species richness in this marsh type is relatively high. Common species present include *Eleocharis Baldwinii*, *Leersia* spp., *Myrica cerifera*, *Polygonum* spp., Lythrum lineare, *Scirpus californicus*, *Panicum hemitomon* and others.

Intermediate Marsh or Oligohaline Marsh is the most common marsh type at the lower end of the Pearl River. These types are estimated to be stable to very slowly declining (Smith 1999) in the area. Two basic types have been recognized by Visser and Sasser (1999) in the area:

*Oligohaline Wiregrass Marsh*
The type is dominated by *Spartina patens* with *Vigna luteola* as a frequent co-dominant. Numerous other species are present. Species richness is relatively high in the type. Additional common species include *Scirpus americanus, Lpomea sagittata, Sagittaria lancifolia,* Cyperaceae, *Polygonum* spp., *Baccharis halimifolia, Juncus roemerianus, Bacopa monnierie* and others.

*Oligohaline Spikerush Marsh*
The type is dominated by *Eleocharis rostellata, E. cellulosa, Eleocharis* sp. and *Sagittaria lancifolia*, but numerous other species are present. Species richness in this marsh type is moderate. Additional common species include *Typha* spp., *Ludwigia* spp., *Myrica cerifera, Spartina patens, Hydrocotyle* spp., *Leersia* spp., *Thelypteris thelypteroides, Scirpus americanus* and others.

Brackish Marsh, or Mesohaline Marsh, is found in the lower marsh zone near the mouth of the Pearl River and along the Rigolets. This type is estimated to be stable to very slowly declining in the area. Visser and Sasser (1999) recognize one major type in the area:

*Mesohaline Wiregrass Marsh.*
This is the second most common marsh type found on the lower Pearl according to Visser and Sasser. It has been considered to be a salt marsh type by some. It is found in the lower marsh zone near the mouth of the Pearl River. The type is clearly dominated by *Spartina patens* with *Scirpus americanus* (= *S. olneyi*) as the most common associate. Species richness in the type is low. Additional common species include *Juncus roemerianus, Vigna luteola, Typha* spp., *Spartina alterniflora, Lythrum lineare, Kosteletzkya virginica, Spartina cynosuroides, Distichlis spicata, Baccharis halimifolia, Scirpus robustus, Ipomea sagittata, Eleocharis parvula* and others.

Near the Mississippi Gulf Coast, the Pearl River becomes estuarine where it is bounded by salt marsh and is tidally influenced. The Hancock County Coastal Preserves are part of the estuarine system that borders the Mississippi Sound from the Pearl River to Point Clear. These marshes are a Gulf Ecological Management Site (GEMS). This 13,570-acre preserve is the second largest continuous marsh in Mississippi. Salt Marshes are usually dominated by two species, needle

rush (*Juncus roemerianus*) that covers about 90% of the marsh, and smooth cordgrass (*Spartina alterniflora)* covering about 5% of the marsh. Smooth cordgrass normally occurs in narrow bands along the tidal creek (J. Clark, pers. commun., 2003).

Within these marshes are several low ridges and small hummocks which are above mean high tides and Point Clear Island and Campbell Island are sandy areas similar to barrier islands. Cedar Island has a small shell midden. Natural Communities known to occur in this area include: estuarine subtidal (large tidal creek; estuarine intertidal), sand shore, mesohaline marsh, oligohaline marsh and shell middens. The islands support several rare plant species including the tiny-leaved buckthorn (*Sageretia minutiflora*), one of the rarest shrubs in the United States, which is found on the shell midden.

The largely mesohaline area of Bayou Caddy Point Clear Island consists of a mosaic of elevation zones bordering both sides of old dune/ridge systems (Point Clear Island and Campbell Island to the west) that are forested (pines, cedar, oak). The marshes along Bayou Caddy are dominated by needle rush (*Juncus roemerianus*) in almost pure stands (marsh between Bayou Caddy and Point Clear Island) while those near Ansley are mixed with big cordgrass *(Spartina cynosuroides)*. Smooth cordgrass *(Spartina alterniflora),* occurring as a narrow fringe but forming a larger expanse of marsh along creeks and bayous, to the south and southwest of the "islands." Salt-meadow grass *(Spartina patens)* occurs as narrow (2-5 m) bands along the upland edges and bulrush (*Scirpus robustus*) forms pure and mixed stands as does the saltgrass (*Distichlis spicata*). Common reed *(Phragmites australis)* also occurs on the high spots.

The Pearl River and associated river swamp are tidally influenced with bald-cypress *(Taxodium distichum),* blackgum (*Nyssa sylvatica var biflora* and *Nyssa aquatica*) balancing the swamp canopy. The shallow areas of the swamp are comprised of dense stands of southern wild-rice *(Zizaniopsis miliacea*) and the deeper (10-20 m) pools are vegetated largely by pickerelweed *(Pontederia cordata)*. The river's fringe contains large beds of cow-lily *(Nuphar luteum macrophyllum)* and the banks contain scattered patches of southern wild-rice (*Zizaniopsis*), pickerelweed (*Pontederia*) and occasionally wild-rice (*Zizania aquatica*). The oligohaline marsh of Cowan Bayou is dominated by sawgrass (*Cladium jamaicense*) but contains a variety of freshwater and brackish water species, including duck-potato *(Sagittaria latifolia)*, seashore mallow (*Kosteletzkya virginica*), and groundsel bush (*Baccharis angustifolia*).

### g. Slope Forest Complex

The slope forest complex is comprised of forests that occupy slopes rising out of the Pearl River floodplain. These forests are most commonly naturally bounded by floodplain forests downslope and fire-frequented upland longleaf pine forests or longleaf flatwood savannas (at least historically) upslope. These forests are also known as beech-magnolia forest, mixed hardwood or hardwood-pine forest, upland hardwood forest, hardwood hammock, or mixed mesic hardwood (-pine) forest. Soils are characteristically mesic, acidic, and vary from quite sandy to clayey. Soil moisture increases downslope.

Canopy dominants typically include a wide variety of upland hardwoods mixed with loblolly and spruce pine (*Pinus taeda, P. glabra,* respectively). Some common hardwoods include beech (*Fagus grandifolia*), southern magnolia (*Magnolia grandiflora*), white oak (*Quercus alba*),

swamp white oak (*Q. michauxii*), water oak (*Q. nigra*), sweetgum (*Liquidambar styraciflua*), black cherry (*Prunus serotina*), blackgum (*Nyssa sylvatica*), tulip tree (*Liriodendron tulipifera*), and red maple (*Acer rubrum*). The herb layer of high-quality examples supports populations of "rich-woods" herbs, such as Christmas fern (*Polystichum acrostichoides*), lady fern (*Athyrium felix-femina),* broad beech fern (*Thelypteris hexagonoptera*), grape-ferns (*Botrychium spp.),* Indian pink (*Spigelia marilandica*), beech-drops (*Epifagus virginiana*), sanicle (*Sanicula canadensis*), may-apple (*Podophyllum peltatum*), Virginia dutchman's-pipe (*Aristilochia serpentaria*), partridge-berry (*Mitchella repens*), jack-in-the-pulpit (*Arisaema triphyllum*), and fetid wake-robin (*Trillium foetidissimum*). High-quality examples of natural mixed hardwood-pine forests are very rare today. This community continues to decline at a slow to moderate rate (Smith 1999).

## 7. Viability/Biodiversity Health Assessment

Identifying the primary elements of conservation concern, i.e., focal targets, is the first critical step planning for conservation action in an identified area of conservation importance. The next step is to examine the viability of the chosen conservation targets and the biodiversity health of the area as a whole. Viability is the likelihood that a target will persist long-term. Biodiversity health is the aggregation of the viability of all conservation targets, the likelihood that the conservation area will remain an ecologically functional landscape over time (The Nature Conservancy 2000a). The viability assessment of a target is based on current conditions of the target in the project area.

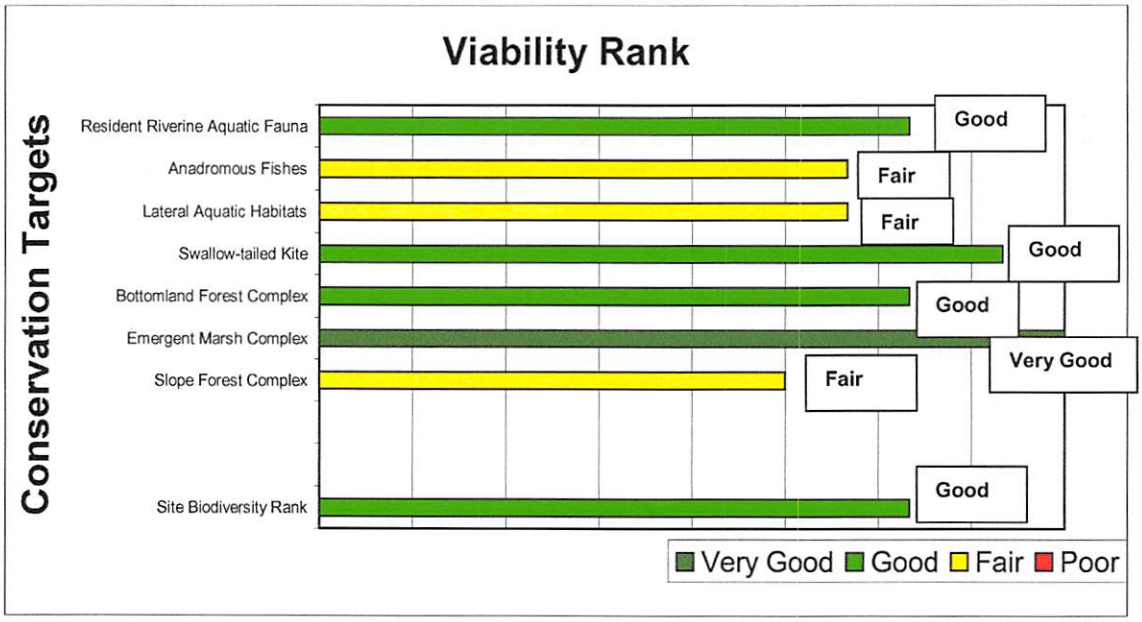
To assess biodiversity health, the viability of each target is evaluated, ranked, and the ranks aggregated to provide a biodiversity health rank for the conservation area. The assessment of viability is based on three criteria: size, condition, and landscape context. Size is a measure of the area or abundance of a target's occurrence. Condition is an integrated measure of the composition, structure, and biotic interactions that characterize its occurrence. Landscape context is an integrated measure of the dominant environmental regimes and processes that establish and maintain the target, and connectivity across the landscape.

According to the planning team, the current site biodiversity health rank for the Pearl River Conservation Area is good (Table 2.). Three of the seven conservation targets received fair viability ranks, meaning they are at or below the desired threshold, but recoverable (Figure 4.).

**Table 2. Viability Assessment Table for the Pearl River Conservation Area**

| Systems Viability | Size | Condition | Landscape Context | Viability Rank |
|---|---|---|---|---|
| Resident Riverine Aquatic Fauna | Good | Fair | Good | Good |
| Anadromous Fishes | Fair | Fair | Good | Fair |
| Lateral Aquatic Habitats | Fair | Fair | Good | Fair |
| Swallow-tailed Kite | Very Good | Good | Good | Good |
| Bottomland Forest Complex | Good | Fair | Good | Good |
| Emergent Marsh Complex | Very Good | Very Good | Very Good | Very Good |
| Slope Forest Complex | Fair | Fair | Fair | Fair |
| **Site Biodiversity Health Rank** | | | | **Good** |

**Figure 4. Viability Rank**



## 8. Primary Threats to the Pearl River Basin

A threat to a focal conservation target is a highly ranked source of stress. The rank is determined by a combination of one or more stresses caused by a source of stress. A highly ranked threat is an active source of stress with high ranking. The threat ranking is achieved by entering all sources of stress information into the workbook. The workbook uses the threat to system rank for all stresses and sources for each of the targets to calculate the overall threat rank, shown in Table 3. This ranking of threats identifies the highest ranked threats for which strategies must be developed.

The overall threat status for the Pearl River project area is very high. Across the conservation area there are seven critical sources of stress: sand and gravel mining (associated incompatible practices), incompatible operation of dams or reservoirs, construction of ditches, dikes, drainage or diversion systems, incompatible commercial and/or industrial development, incompatible forestry practices, low water sills (substrate destabilization and target movement impacts), and dam construction (impediments to water flow and fish movements; habitat destruction). The three targets most affected by these threats are the resident riverine aquatic fauna, anadromous/catadromous fishes, and lateral aquatic habitats. It is obvious that the highest level of threats pertains to water quality and flow conditions.

The following threats ranked high enough across focal conservation targets to be considered critical to the ecological health of the Pearl River Basin. All highly ranked threats are priority action items.

### a. Incompatible Sand and Gravel Mining

A high level stress to the Pearl River system is excess sedimentation. The team of experts identified incompatible sand and gravel mining as the highest ranking threat to the Pearl River system because of the large number of mines in the area. Sediment runoff affects water quality and causes increased sedimentation in the river. Sediments loads can also change water flow and become a barrier to fish movements. There are at least 643 mining operations in the Pearl River drainage within Mississippi (Mississippi Department of Environmental Quality 2000). There are over 129 active and abandoned mining operation sites in the Pearl River Basin area in Louisiana (Lyles 2002).

This source was believed to be a major threat to resident riverine aquatic fauna and anadromous/catadromous fishes, and a moderate threat to lateral aquatic habitats and bottomland forest complex. Sand and gravel mining can cause major local changes to the earth's surface and can significantly affect surface and ground water quality and flow patterns (Mississippi Department of Environmental Quality 2000). If Best Management Practices are not used, the mining activity disturbs topography, vegetation and flow patterns of streams and creeks. Water quality impacts of concern are excessive sedimentation, metals and changes in pH (Mississippi Department of Environmental Quality 2000).

At the conservation planning meeting held in November of 2000, the experts noted that riverine aquatic fauna need a consolidated river bottom substrate, including gravel and grain size. The Louisiana Department of Environmental Quality's Non-point Source Management Plan for

Louisiana (2000) states that "although sediments from these sites consist of biologically inert materials, the constituents can also have detrimental impacts to the aquatic habitat." Excess sediments can smother bottom-dwelling aquatic organisms, such as mussels, and can degrade a stream for fish species by depleting the food supply. Sedimentation may interfere with the life cycle of fishes by covering their eggs.

There can be a decrease of photosynthetic action due to turbidity causing reduction of a water body's capacity to assimilate organic matter. Direct or indirect changes to a stream channel can limit migratory fish movements and cause unnatural flood circumstances to palustrine communities such as bottomland hardwood forests. Continued sedimentation at high concentrations can make it impossible for a stream to recover (Louisiana Department of Environmental Quality 2000).

### b. Incompatible Operation of Dams or Reservoirs

One of the most critical threats to freshwater ecosystems is ecologically incompatible water management. The system may not receive enough water or too much water at the wrong time. Dams and other flow control structures within a river can disrupt the natural flow patterns. These disruptions can cause changes in vegetative cover, including unnatural flooding to downstream palustrine and estuarine communities such as bottomland hardwood forests and emergent marsh. Alterations also cause sediment loads, hydrology, and other factors influencing stream habitat quality. The experts identified incompatible operation of dams and reservoirs to be a major threat to resident riverine aquatic fauna, anadromous/catadromous fishes, and lateral aquatic habitats, a moderate threat to bottomland forest complex and a low threat to emergent marsh complex.

These changes in turn can cause channel degradation and erosion that directly impact aquatic life habitat as well as reduce the capacity of the stream to carry water. Natural and manmade fluctuations in water volume and depth are also a significant contributor in incidents of riverbank sloughing. Streams with highly altered flow regimes often become wide, shallow, and homogeneous, resulting in poor habitat for many fish species (Environmental Protection Agency 2003). Managers of conservation areas in the lower Pearl have noted unnatural water levels due to operation of the Ross Barnett Reservoir.

### c. Construction of Ditches, Dikes, Drainage or Diversion Systems

This source covers a variety of hydrologic alterations and has been identified as a major source of stress for lateral aquatic habitats, a moderate source for bottomland hardwood forests and low source to the emergent marsh complex. These constructed features disconnect channels from the floodplain. Riparian forests are typically reduced or eliminated as levees and dikes are constructed. This can eliminate off-channel habitats such as sloughs and side channels. Flow velocity during flood events increases due to constriction of the channel (Haring 1999). Alterations such as canals, logging ditches, airboat runs and power line rights of way all create additional or optional routes for water to flow, thus altering natural flow patterns.

### d. Incompatible Commercial and Industrial Development

Incompatible commercial and industrial development can contribute to direct habitat loss and non-point source pollution in the form of sedimentation and increased nutrient loads. This pollution is mainly from stormwater runoff that picks up pollutants over an area and washes them into nearby streams or waterbodies. These increased amounts of sediment can cause silt buildup in the river and degraded faunal habitat and water quality. Urban runoff has been shown to introduce pathogens, metals, oil and grease, excess nutrients and other pollutants to water bodies. Commercial and industrial development was identified as a major source of stress to resident riverine aquatic fauna, anadromous/catadromous fishes and lateral aquatic habitats, and a low source of stress for bottomland forest complex.

### e. Incompatible Forestry Practices

About 43% of the total Pearl River basin's 8,760 square miles are forested. Forested land provides many important roles including, absorbing rain, refilling aquifers, cleansing water, slowing storm runoff, reducing flooding, maintaining the watershed and providing critical habitat for fish and wildlife (Mississippi Department of Environmental Quality 2000). Incompatible forestry practices affect many of the focal conservation targets and are a major threat to the bottomland forest complex and slope forest complex, and a moderate threat to resident riverine aquatic fauna, anadromous/catadromous fishes, lateral aquatic habitats and Swallow-tailed Kites. Some incompatible forestry practices that affect Pearl River drainages or watershed aquatic habitats include clear-cutting the bottomland hardwood forests, logging too close to the stream bank, and forest fragmentation.

Incompatible logging and road building may cause excessive runoff into streams and contribute to fragmentation of forested areas. The principal non-point source pollution concern regarding improper forestry practices include runoff of pesticides, herbicides, fertilizers, organic matter, excessive sediment and woody debris in watercourses. Thermal pollution from increased water temperatures where trees along streams have been removed. Invasive species such as Chinese tallow (*Sapium sebiferum*) and Japanese privet (*Ligustrum sinense*) are a problem especially in areas that have been clear-cut. Invasive vegetation replaces or chokes native flora thus altering the native composition and structure of natural communities and significantly affective native biodiversity.

Forest fragmentation, at least temporarily, breaks up contiguous forest used by migratory birds and other wildlife and creates small forested island habitats. These forest fragments may not support viable wildlife populations in the area. Fragmentation may deleteriously impact the composition and structure of the forest communities themselves over time. Habitat fragmentation also favors the Brown-headed Cowbird (*Molothrus ater*), a brood parasite of concern to conservationists. These birds generally occupy open habitats but will travel up to a mile into a forest to lay its eggs in another bird's nest (Sibley 2001). This type of parasitism results in other bird species raising the young of the cowbirds rather than their own. Fragmented forests contain more edge habitats, making many bird species more vulnerable to brood parasitism than birds in large forest tracks.

### f. Low Water Sills

Low water sills are a major threat to anadromous/catadromous fishes and resident riverine aquatic fauna. There are three sills in the Lower Pearl River basin (Figure 5.). The Poole's Bluff Sill south of Bogalusa on the Pearl, the Bogue Chitto Sill (Figure 6.) on the Navigation Canal where the Bogue Chitto River meets with the West Pearl, and an unnamed sill north of Lock 1 and between the West Pearl and the Navigation Canal. This last sill is unofficially called the "Talisheek Sill" by locals. Although, the effect of these structures on water flow, sedimentation and fish movements needs to be studied further, they are believed to be a barrier to fish movements, change water flow and the hydrology of the system and create sediment traps. The Gulf sturgeon is unable to migrate past the sills except during times of high water levels. However, it is suspected that most fish are not moving past the sills even at that time due to the velocity of the water moving in the downstream direction. This impediment may prevent the fish from moving to spawning grounds or areas that appear to be suitable for spawning. The sills and other flow control structures in the Pearl and West Pearl are suspected to be the cause of decline of other anadromous/catadromous fish such as the Alabama shad.

### g. Dam Construction

Dam construction is a major threat to anadromous/catadromous fishes and lateral aquatic habitats. The team of experts identified the proposed Twin Lakes project as a potential threat to the Pearl River. The impacts of this proposed dam project to the ecological integrity to the Pearl River are currently unknown and the U.S. Corps of Engineers will complete a feasibility study and Environmental Impact Statement of this proposed project by October 2005.

**Table 3. Summary of Threats by Target for the Pearl River Conservation Area**

| Active Threats Across Systems | Resident Riverine Aquatic Fauna | Anadro-mous Fishes | Lateral Aquatic Habitats | Swallow-tailed Kite | Bottomland Forest Complex | Emergent Marsh Complex | Slope Forest Complex | Overall Threat Rank | Total Score |
|---|---|---|---|---|---|---|---|---|---|
| Sand and Gravel Mining | Very High | High | Medium | - | Medium | - | - | **High** | **3.70** |
| Incompatible Operation of Dams or Reservoirs | High | High | High | - | Medium | Low | - | **High** | **3.12** |
| Construction of Ditches, Dikes, Drainage or Diversion Systems | - | - | Very High | - | - | Low | - | **High** | **3.02** |
| Incompatible Commercial/Industrial Development | High | High | High | - | Low | - | - | **High** | **3.02** |
| Incompatible Forestry Practices | Medium | Medium | Medium | Medium | High | - | High | **High** | **2.80** |
| Low Water Sills | High | High | - | - | - | - | - | **High** | **2.00** |
| Dam Construction | - | High | High | - | - | - | - | **High** | **2.00** |
| Conversion to Agriculture or Silviculture | - | - | - | - | Medium | - | Medium | **Medium** | **0.40** |
| Incompatible Recreational Use | Medium | - | - | Low | Low | Low | Low | **Low** | **0.32** |
| Invasive/Alien Species | - | - | Medium | - | - | Low | - | **Low** | **0.23** |
| Land uses that affect hydrology | - | Medium | - | - | - | - | - | **Low** | **0.20** |
| Incompatible Development of Roads or Utilities | - | - | Medium | - | - | - | - | **Low** | **0.20** |
| Channelization of Rivers or Streams | - | - | - | - | Medium | - | - | **Low** | **0.20** |
| Incompatible Grazing/Livestock | Low | - | - | - | Low | - | Low | **Low** | **0.09** |
| Incompatible Primary Home Development | - | - | - | Low | - | Low | - | **Low** | **0.06** |
| Great Horned Owl | - | - | - | Low | - | - | - | **Low** | **0.03** |
| **Threat Status for Targets and Site** | **Very High** | **High** | **Very High** | **Low** | **Medium** | **Low** | **Medium** | **Very High** | |

**Figure 5. Location of Flow Control Structures on the Lower Pearl River**

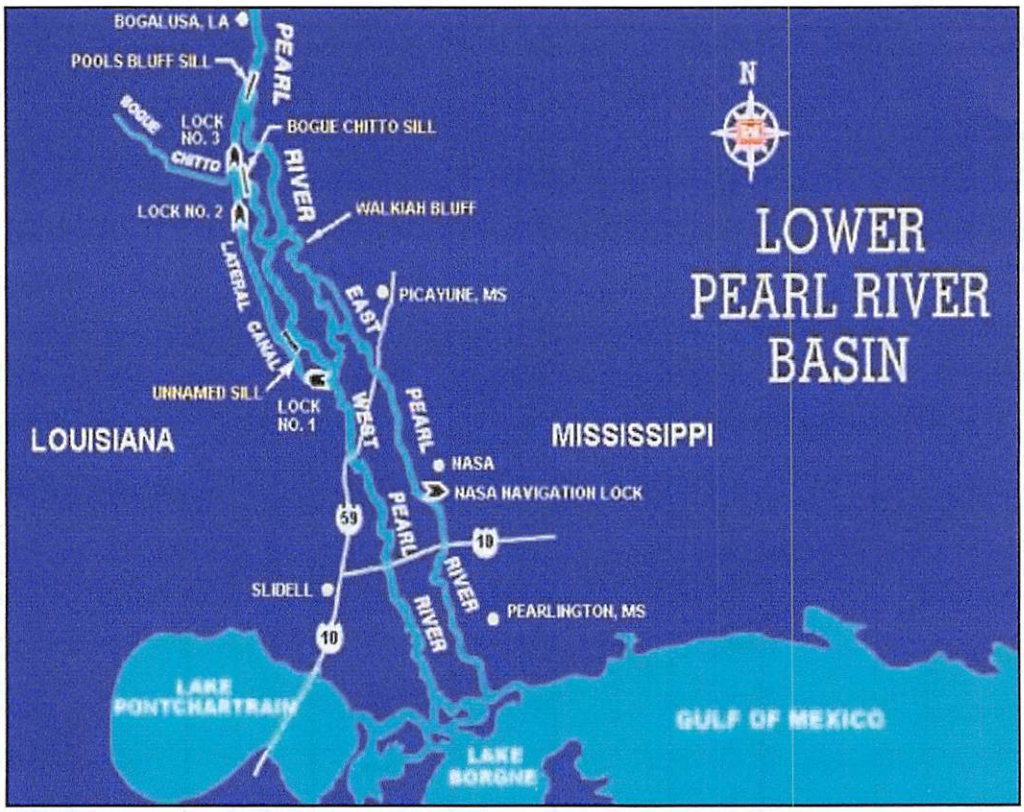



**Figure 6. Bogue Chitto Sill**

## 9. Conservation Strategies

Conservation strategies are the action steps outlined and taken to ensure that we reach our desired goals. These strategies were devised by planning team members with the objectives of abating critical threats to the area, and achieving long-term conservation goals that could be implemented within the confines of time, staffing and funding. Table 4. shows the highest ranking strategies by conservation target.

Other strategies may be devised throughout the life of the plan as new information and resources are acquired. A summary of the strategies and the benefit rank of each are shown in Table 5. The benefit rank is a summary of abatement benefit. The abatement benefit is a function of the number of targets addressed and the degree of benefit to the target.

**Top Ranking Strategies for Threat Abatement in the Pearl River Basin**

**Hold Symposium for Experts and Stakeholders to tell the Story of the Pearl to Generate Interest in Forming a Pearl River conservation alliance**

The Louisiana and Mississippi chapters of The Nature Conservancy formed the Lower Pearl Partnership in 2002 to improve the understanding and appreciation of the river, and work towards its conservation (Appendix B.). The primary goal of the Lower Pearl Partnership is to collaborate with partners to preserve, protect and restore the ecological integrity of the Pearl River and its watershed.

TNC will plan a two-day workshop to include presentations by conservation experts and community stakeholders for the Pearl River based on the Pascagoula River model. Experts (regulatory and academic) and interested community and corporate citizens will be invited to participate. The Pearl River Symposium will focus on the conservation targets as defined by experts through the planning meetings hosted by TNC in 2000, 2001 and 2002.

The Symposium will tell the story of the conservation importance and natural resource value of the Pearl River and demonstrate the connectivity of marine, estuarine, freshwater and terrestrial conservation. The Symposium will be organized around TNC's Five-S model: (1) systems, (2) stresses to the system, (3) sources of stress, (4) strategies to reduce stress, and (5) measures of success. The final session of the two day workshop will contain a facilitated session designed to identify community conservation strategies and appropriate organizational needs for an alliance that can disseminate the experts' stories, educate and provide a focused forum for needs of the Pearl River today and tomorrow. The symposium will strive to cultivate an appreciation of the Pearl River and explain how watershed systems affect the community.

**Facilitate and Support the Development of a Conservation Alliance for the Lower Pearl River as a Network to Deliver Information and Cultivate Understanding and Appreciation of the Pearl**

A symposium for experts and stakeholders will tell the story of the Pearl River and generate interest in forming a Pearl River conservation alliance. The symposium will be the official "kick-off" for the alliance. The alliance will be used as a network to generate interest and deliver

information about the ecological, economic and cultural significance of the Pearl River and it's watershed. By bringing the interested parties together, we plan to work towards community-based conservation. The alliance will provide a way to address conservation issues and involve the community in working toward conservation strategies. Relationship building with stakeholders is an on-going process and meetings and workshops with landowners and cooperation with federal and state agency partners will continue.

**Partner with Aggregate Industry and Regulatory Agencies to Promote Best Management Practices for Sand and Gravel Mining Practices by Sharing Expertise and Through Workshops**

TNC will work to partner with aggregate industry and promote "green mining" by reviewing, developing and encouraging Best Management Practices for mining. The goal is to possibly hold a workshop on sustainable mining practices and a publication of Best Management Practices. Work with the Louisiana and Mississippi Departments of Environmental Quality and other partners to explore best methods for restoring abandoned sites will be emphasized.

**Promote Acquisition and Management of Public and Private Conservation Areas to Conserve Important Habitats and to Serve as Models to Demonstrate Ecological Management**

TNC will work with public and private partners to protect ecologically important areas throughout the Pearl River Conservation Area. Conservation easements, acquisition and other tools will be used to conserve the biological integrity of the area.

**Encourage Appropriate Land Zoning through Participating in Land Use Planning Efforts such as the 2025 process in St. Tammany Parish and Hancock County Greenways**

Many habitats along streams in the Pearl River are under pressure from urban development. Efforts should be made to support land use planning and growth management in parishes and counties to ensure that issues and areas of high biological significance are incorporated into land use plans. One example of a program that is striving to balance economic land uses with conservation and environmental needs is the St. Tammany Parish New Directions 2025, which was initiated in December 1998. This comprehensive plan is intended to guide the future growth and development of St. Tammany Parish. The citizen driven plan identified green space as one of St. Tammany's "most valuable assets", and calls for the parish to develop a plan to conserve strategic landscapes. The Hancock County Greenways is part of the Hancock County's adopted Strategic Plan for smart growth. The project is a coordinated effort between the Hancock County Board of Supervisors and the Hancock County Chamber of Commerce and they work together to understand that environmental issues in the County translate to economic issues.

**Obtain Funding to Conduct a Geomorphic Study**

A comprehensive geomorphological, hydrological and ecological assessment of the entire river will provide critical information on how specialized management of the river can potentially restore a more natural hydrologic regime and reduce threats to targets. Conducted by hydrologic engineers, a geomorphic assessment will provide a physical picture of the ecosystem and insight

on special restoration needs and sources of stress to the river system. The assumption is that the majority of the threats to the Pearl River Basin are physical and can be abated.

The assessment will address issues related to low water sills (impacts on anadromous/ catadromous fish movements), incompatible dam management (identified threat to resident riverine aquatic fauna, anadromous/catadromous fishes, lateral aquatic habitats and bottomland forest complex). Data will be used to develop a comprehensive management plan for the protection and restoration of natural resources while insuring continued availability of water resources for ecologically compatible human uses. Efforts will be made to search out appropriate partners to assist with funding the study. This is one of the highest strategies suggested by the planning team of experts.

**Assist U.S. Army Corps of Engineers in Getting Monies for Restoration Projects (1135, 206 funds)**

Assist the U.S. Army Corps of Engineers with organizing and obtaining funds for the geomorphic study and investigating restoration projects, such as the proposed removal of low water sills and dam management.

**Table 4. Highest Ranking Strategies by Target**

| Strategy | Resident Riverine Aquatic Fauna | Anadro-mous Fishes | Lateral Aquatic Habitats | Swallow-tailed Kite | Bottomland Forest Complex | Emergent Marsh Complex | Slope Forest Complex | Strategy Benefit Rank |
|---|---|---|---|---|---|---|---|---|
| Obtain Funding to conduct Geomorphologic Study | Very High | Very High | High | - | Medium | Low | - | **Very High** |
| Facilitate and support the development of a conservation alliance for the Lower Pearl as a network to deliver information and cultivate understanding and appreciation of the Pearl | Very High | High | Medium | - | Medium | - | - | **High** |
| Hold Symposium for experts and stakeholders to tell the story of the Pearl to generate interest in forming a Pearl River conservation alliance | Very High | High | Medium | - | Medium | - | - | **High** |
| Partner with aggregate industry and regulatory agencies to promote BMP's for Sand and Gravel mining practices by sharing expertise and through workshops | Very High | High | Medium | - | Medium | - | - | **High** |
| Promote acquisition and management of public and private conservation areas to conserve important habitats and to serve as models to demonstrate ecological management | Very High | High | Medium | - | Medium | - | - | **High** |
| Assess proposed uses of river for effects on hydrology | - | High | Very High | - | Medium | - | - | **High** |
| Obtain resources for GIS technical support to better understand land use in the Pearl River Basin | Very High | - | Medium | - | Medium | - | - | **High** |
| Partner with residential and commercial developers to encourage use of BMPs | High | High | High | Low | Low | Low | - | **High** |
| Encourage appropriate Local zoning through participating in land use planning efforts such as 2025 process in St. Tammany Parish | High | High | High | - | Low | - | - | **High** |
| Promote implementation of Phase II Storm water plans | High | High | High | - | Low | - | - | **High** |
| Encourage establishment of conservation easements by holding conservation easement workshops and partnering with other organizations (such as Ducks Unlimited, Local Land Trust) | High | High | High | - | Low | - | - | **High** |
| Work with major industries to minimize impacts due primarily to new construction | High | High | High | - | Low | - | - | **High** |
| Assist USCOE in getting monies for restoration projects (1135, 206 funds) | - | - | Very High | - | - | - | - | **High** |
| Abate faunistic habitat degradation due to low water sills | High | High | - | - | - | - | - | **High** |
| Work with MDEQ, Pearl River Water Supply District, Pearl River Basin District to include endangered species to their modeling | High | High | - | - | Medium | - | - | **High** |

**Table 5. Summary and Benefit Ranking of Strategies**

| Strategies for Threat Abatement and Restoration | Benefits | | | | Feasibility | | | Cost | Overall | Rank # | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Threat Abatement Benefit | Restoration Benefit | Leverage (default = Low) | Overall Benefits | Lead Individual/ Institution | Ease of Implementation | Overall Feasibility | Overall Cost * | Overall Strategy Rank | | |
| Encourage appropriate Local zoning through participating in land use planning efforts such as 2025 process in St. Tammany Parish and Hancock County Greenways Project | High | - | High | High | Medium | Medium | Medium | Low | **Very High** | 1 | A |
| Facilitate and support the development of a conservation alliance for the Lower Pearl as a network to deliver information and cultivate understanding and appreciation of the Pearl | High | - | Very High | Very High | High | High | High | Low | **Very High** | 1 | B |
| Hold Symposium for experts and stakeholders to tell the story of the Pearl to generate interest in forming a Pearl River conservation alliance | High | - | High | High | High | High | High | Low | **Very High** | 1 | C |
| Partner with aggregate industry and regulatory agencies to promote BMP's for Sand and Gravel mining practices by sharing expertise and through workshops | High | - | Very High | Very High | Medium | Medium | Medium | Medium | **Very High** | 1 | D |
| Promote acquisition and management of public and private conservation areas to conserve important habitats to serve as models to demonstrate ecological management | High | | Very High | Very High | High | High | High | High | **Very High** | 1 | E |
| Assist USCOE in getting monies for restoration projects (1135, 206 funds) | High | - | High | High | High | High | High | High | **High** | 2 | A |
| Obtain Funding to conduct Geomorphic Study | Very High | Very High | High | Very High | High | High | High | Very High | **High** | 2 | B |

## 10. Project Capacity and Measures of Success

Criteria used to measure conservation success included biodiversity health, threat status, and overall conservation capacity. The conservation targets rated "good" in terms of biodiversity health. The overall threat status for the Pearl River is "very high" and the overall conservation capacity is "medium." Efforts will be made to improve these rankings over time as a measure of conservation success.

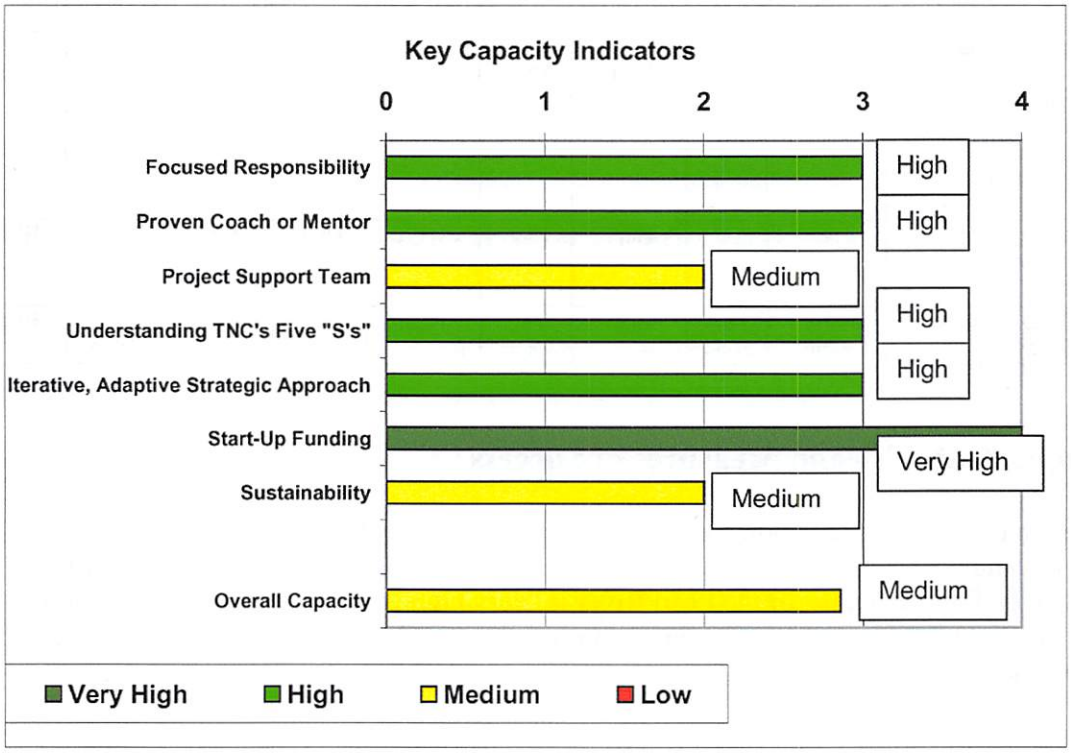
Overall capacity for successfully implementing strategies in the Pearl River Basin was medium (Figure 7.). This score was obtained by ranking capacity in the following areas:

a. Project Leadership and Support
   Focused responsibility for action site; Conservation manager or mentor; and Project support team.
b. Strategic Approach
   Understanding/application of TNC's Five S's; and Iterative, adaptive approach to developing key conservation strategies.
c. Project Funding
   Start-up funding; and Sustainable support.

Some examples of biological measures of success include the following: improvement and maintenance of water quality and hydrological function within the watershed, reduced forest fragmentation, enhancement of wildlife corridors, resolution of impediments to fish movements, ecologically functional habitat conditions on cooperating lands, re-growth of native flora on restoration sites and decreases of invasive flora and fauna.

Some overall project measures of conservation success include obtaining funding for a geomorphic assessment of the Pearl River, the formation of the Pearl River alliance as a result of the Symposium and use of Best Management Practices by aggregate, forestry and development entities.

**Figure 7. Project Capacity**



## 11. Monitoring

A comprehensive adaptive management/monitoring program will be devised to assess viability/biodiversity health of focal targets and threat abatement. TNC, partners and members of the planning team still need to complete a monitoring plan that will include each of the seven conservation targets. For each conservation target there are two monitoring components: ecological/biodiversity health monitoring and threat abatement monitoring. The ecological/ biodiversity health monitoring includes viability parameters, key ecological attributes and monitoring indicators. Threat abatement monitoring includes key threats to the conservation targets, parameters defining the threat and indicators to monitor.

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# Glossary

**Action Site**: A site where The Nature Conservancy has chosen to focus attention and resources.

**Anadromous**: Fish that migrate to freshwater spawning grounds, but reside in salt water during non-breeding seasons. The Gulf sturgeon is anadromous.

**Basin**: The area of land that drains water, sediment and dissolved materials to a common point along a stream channel.

**Biodiversity:** The variety of life forms and ecological systems, the genetic variability they contain and the ecological processes that maintain them.

**Brackish marsh:** Marsh with water between about 8 and 20 parts per thousand of salt.

**Brood Parasitism:** Reproduction by laying eggs in the nests of other birds, leaving the nest owners to provide parental care.

**Catadromous:** Applied to the migratory behavior of fish that spend most of their lives in freshwater but travel to sea in order to breed there.

**Channelization:** Straightening the meanders of a river; often accompanied by placing riprap or concrete along banks to stabilize the system.

**Channelized Stream:** A stream that has been straightened, runs through pipes or revetments, or is other-wise artificially altered from its natural, meandering course.

**Channel Stability:** Tendency of a stream channel to remain within its existing location and alignment.

**Community:** Ecological communities are interdependent assemblage of plant and animal species

**Connectivity:** Unbroken linkages in a landscape, often referred to in the context of mainstem connection with side-channels.

**Degradation:** The lowering of the streambed or widening of the stream channel by erosion. The breakdown and removal of soil, rock and organic debris.

**Deposition:** The settlement of material out of the water column and onto the streambed.

**Diversity:** Variation that occurs in plant and animal taxa (i.e., species composition), habitats, or ecosystems.

**Ecological Restoration:** Involves replacing lost or damaged biological targets (populations, species) and reestablishing ecological processes (dispersal, succession) at historical rates.

**Ecological System:** A dynamic assemblage or complex of plant and/or animal communities that 1) occur together on the landscape, 2) are linked by similar ecological processes (e.g. fire, hydrology), underlying environmental features (e.g. soils, geology), or environmental gradients (e.g. elevation) and 3) form a distinguishable often repeating unit on a landscape

**Ecoregion:** A relatively large area of land and water characterized by similar climate, vegetation and geology, and other ecological and environmental patterns.

**Ecosystem:** Biological community together with the chemical and physical environment with which it interacts.

**Ecosystem Management:** Management that integrates ecological relationships with sociopolitical values toward the general goal of protecting or returning ecosystem integrity over the long term.

**Endangered Species Act:** A 1973 Act of Congress that mandated that endangered and threatened species of fish, wildlife and plants be protected and restored.

**Functional Conservation Area:** An area that maintains the target or focal species, communities, and/or systems and their supporting ecological processes within their natural ranges of variability. Some supporting ecological processes are often applies directly through management, e.g. fire.

**Endangered Species:** Any species which is in endanger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta as determined by the Secretary to constitute a pest whose protection under would provide an overwhelming and overriding risk to man.

**Estuarine:** A partly enclosed coastal body of water that has free connection to open sea, and within which seawater is measurably diluted by fresh river water.

**Extirpated:** The elimination of a species from a particular local area.

**Flood:** An abrupt increase in water discharge; typically flows that overtop stream banks.

**Floodplain:** Lowland areas that are periodically inundated by the lateral overflow of streams or rivers.

**Flow Regime:** Characteristics of stream discharge over time. Natural flow regime is the regime that occurred historically.

**Geomorphology:** Study of the form and origins of surface features of the Earth.

**Highly Ranked Threat (Critical Threat):** A threat to the conservation targets that ranks high enough across targets to be considered critical to the health of the conservation planning area.

**Hydrology:** Study of the properties, distribution, and effects of water on the Earth's surface, subsurface, and atmosphere.

**Keystone species:** A species whose presence in an ecological system is so important that its removal would lead to the extinction of other species.

**Native:** Occurring naturally in a habitat or region; not introduced by humans.

**Nested Species:** Species, groups, associations or communities that occur within a target system, and are therefore benefited by strategies and actions that abate threats to the target.

**Non-point Source Pollution:** Pollution that comes mainly from stormwater runoff that picks up pollutants over an area and washes them into nearby streams and lakes, polluted runoff from sources that cannot be defined as discrete points, such as areas of timber harvesting, surface mining, agriculture, and livestock grazing.

**Oligohaline:** Water with salt content of 0.05 to 5 ppt. (roughly synonymous with intermediate).

**Palustrine:** Palustrine systems include any inland wetland, which lacks flowing water and contains ocean derived salts in concentrations of less than 0.05%.

**Riparian:** Type of wetland transition zone between aquatic habitats and upland areas. Typically, lush vegetation along a stream or river.

**Riprap:** Large rocks, broken concrete, or other structure used to stabilize stream banks and other slopes.

**Salt Marsh:** Vegetation showing regular zonation reflecting the length of time different areas are inundated by tides. Only plants adapted to a saline environment (halophytes) can survive.

**Scrub-shrub:** A wetland community that is going through transition or ecological succession (often from emergent marsh to forested wetland). It is typified by shrubby vegetation.

**Sediment:** Material carried in suspension by water, which will eventually settle to the bottom.

**Side Channel:** A portion of an active channel that does not carry the bulk of stream flow. Side channels may carry water only during high flows, but are still considered part of the total active channel.

**Sources:** Extraneous factors, either human (e.g., policies or land uses) or biological (e.g., non-native species), that infringe upon a target in a way that results in stress.

**Stakeholder:** An individual, group or institution whose activities affect the conservation area, either positively or negatively, and who will be impacted by the strategies implemented to abate threats.

**Strategies:** Activities designed to abate threats to conservation targets and nested targets.

**Stresses:** Impairments or degradation of size, condition, and landscape context of a conservation target that result in the reduction of the viability of the target.

**System:** A collection of interdependent living and non-living targets and the natural processes that maintain them.

**TMDL:** Total Maximum Daily Load – defined by EPA as written plans and analysis established to ensure that the water body will attain and maintain water quality standards. The TMDL should establish pollutant level reductions that will cause the impaired use to be fully supported.

**Umbrella Species:** A species that, if protected, in turn will protect other species.

**Watershed:** Entire area that contributes both surface and underground water to a particular lake or river.

## APPENDIX A. Protected Areas Description:

A description of many of the protected areas within the Pearl River Conservation Secondary Boundary is listed below.

**Bogue Chitto National Wildlife Refuge - United States Fish and Wildlife Service**

Background: Bogue Chitto National Wildlife Refuge is one of seven federal wildlife refuges in southeast Louisiana. The refuge boundary extends through both Louisiana and Mississippi and is located on the Pearl and Bogue Chitto Rivers floodplains south of Bogalusa. The mission of the refuge system is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. The refuge was formed in 1980 and encompasses 36,800 acres of the Pearl River Basin.

Ecological significance: Several endangered and threatened species live on the refuge, including the Bald Eagle (*Haliaeetus leucocephalus*), ringed map turtle, inflated heelsplitter and Gulf sturgeon. The refuge habitat is mostly bottomland hardwood forest and cypress-tupelo swamp characterized by a number of sloughs and bayous. A variety of woody plant species occur in these periodically flooded areas, and all exhibit some degree of survival in soils that are inadequately drained and aerated. Vegetation in the Refuge includes bald cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*) communities associated with longer periods of flooding to the live oak (*Quercus virginiana*) and loblolly pine (*Pinus taeda*) communities on the highest floodplain areas. The area is rich in wildlife with 150 species of birds, 40 species of mammals, 131 species of reptiles and amphibians and 140 species of fish.

**Hancock County Coastal Preserves – Mississippi Department of Marine Resources**

Background: In May of 1992, the Mississippi Department of Marine Resources (MDMR) established the Coastal Preserves Program to protect sensitive coastal habitats. The Mississippi Secretary of State Office is an active partner in the program through an established cooperative agreement whereby both agencies agree to work together towards effectively managing and protecting Mississippi's coastal wetlands. This preserve is part of GEMS (Gulf Ecological Management Site), which are a program developed in coordination with the EPA and the Gulf of Mexico Program. The Hancock County Marsh Coastal Preserve is the second largest continuous marsh area in Mississippi. The 13,570-acre preserve includes all marshlands bordering the Mississippi Sound and the Pearl River to Point Clear. Under this program, wetland habitat is acquired and protected forever as a state natural area preserve for the preservation, protection, restoration and sustenance of its natural coastal marsh and associated habitats.

Ecological Significance: The land thus far acquired in the program encompasses large, unfragmented coastal ecosystems - marshes, islands, and maritime forests. The ecological communities expected or known to occur are: estuarine subtidal, 1) large tidal creek; estuarine intertidal, 1) sand shore 2) mesohaline marsh 3) oligohaline marsh; and other shell middens. The preserve program protects native plant communities and critical habitat for rare, threatened or endangered species. These areas also provide nursery habitat for shrimp, blue crab, oysters, redfish, speckled trout, mullet and other finfish species. The islands support several rare plant species including one of the rarest shrubs in the United States, the tiny-leaved buckthorn (*Sageretia minutiflora*) found on the shell midden.

**Pearl River Wildlife Management Area – Louisiana Department of Wildlife and Fisheries**
Background: The Pearl River Wildlife Management Area encompasses 35,031 acres and is located six miles east of Slidell and one mile east of Pearl River town. The terrain is flat, interrupted by ridges, bayous, sloughs and marshes. Drainage is poor, and the area is subject to annual flooding.
Ecological Significance: The forest cover varies from an all-age hardwood stand in the northern 60% of the area, to cypress-tupelo in the next 25% and an intermediate marsh in the southern 15%. The mixed hardwoods are made up of water oak, nuttall oak, cow oak, obtusa oak, overcup oak, live oak, bitter pecan, hickory, beech, magnolia, sweetgum, and elm. There are numerous streams and bayous on the area and several ponds are located on the northern end of the area along I-59. Several rare species are present in this managed area. The Bald Eagle occurs along the streams and lakes in the fall and winter and the Golden Eagle (*Aquila chrysaetos)* is occasionally seen. Swallow-tailed Kites and Ospreys (*Pandion haliaetus*) are frequently seen.

**Ben's Creek Wildlife Management Area – Louisiana Department of Wildlife and Fisheries**
Background: This area is located west of Bogalusa in Washington Parish and encompasses 13,856 acres. The terrain is rolling hills managed primarily for pine timber. Many wildlife food plots have been established and will benefit deer, turkey, quail and rabbits and other non-game species.
Ecological Significance: Loblolly pine is the dominant overstory species. To lesser extent, long leaf pine, red maple, black cherry, persimmon and red oak can be found in the overstory. Frequent burning and cutting affect the vegetation composition of the area. Yaupon, broomsedge, French mulberry, blackberry and wax myrtle are found in the understory. There are several small creeks in the area with blackgum, yellow poplar, and sweetbay magnolia are the dominant overstory species and wax myrtle, titi, green briar, gallberry, and swithcanes are found in the understory.

**Marion County Wildlife Management Area – Mississippi Department of Wildlife, Fisheries and Parks**
Background: This 7,200-acre management area is located in Marion County, Mississippi. The area is used for game hunting of deer, dove, rabbit, squirrel, quail and turkey.
Ecological significance: According to the Mississippi Natural Heritage Program, the area is one of the better gopher tortoise sites in Mississippi. The area is also listed as an East Gulf Coastal Plain conservation portfolio site.

**Old River Wildlife Management Area, Mississippi Department of Wildlife, Fisheries and Parks**
Background: The area consists of 15,408 acres of forests, swamps and fields. It is open to the public for wildlife viewing and seasonal hunting and fishing. The area is about 20 miles from Picayune, Mississippi.
Ecological Significance: This tract of bottomland hardwood borders the Pearl River on the Louisiana/Mississippi state line. The Wildlife Management area contains more than 40 species of birds, the American alligator (*Alligator mississippiensis)* and 13 species of endangered reptiles.

**Mike's Island - The Nature Conservancy**
Background: Mike's Island is a collaborative project on the lower Pearl River, in Hancock County, Mississippi, just a few river miles north of Interstate 10 and the Hancock County Marshes. The marshes are a Gulf Ecological Management Site (GEMS). Mike's Island is planned as a multi-phase project with several proposed funding partnerships to acquire, restore and manage 2,600 acres of seasonally flooded, lateral aquatic habitat and bottomland hardwood forest. TNC closed on the property July 25, 2003 and restoration plans began in August 2003.
Ecological significance: The ecological health of the lower Pearl River is of primary importance to the long-term viability of the Hancock County Marshes. Proposed ecological restoration activities at Mike's Island will enhance the native vegetation and hydrologic function of these bottomlands. These restoration activities will help improve water quality in the lower Pearl River benefiting critical habitat for the Gulf sturgeon, Hancock County Marshes, Mississippi Sound and Gulf of Mexico. Over the next three years, TNC and the Mississippi Department of Marine Resources have committed to work collaboratively to develop a conservation corridor, providing a link from Hancock County Marshes to Mike's Island.

**White Kitchen Preserve - The Nature Conservancy**
Background: White Kitchen was the first preserve to be established by TNC in Louisiana. The preserve is located within the Pearl River Basin south of Slidell and encompasses 586 acres of wetland habitat. The boardwalk is the highlight of this preserve and offers the community a chance to walk out over the marsh. There is also access to the preserve via swamp boat tours.
Ecological Significance: This biologically diverse site consists of cypress-tupelo swamp integrated with freshwater marsh. It occurs in one of the last remaining, intact, overflow swamp systems in the Southeast and supports a large rookery of wading birds. A Bald Eagle nest that has been used for more than eighty years is also located on the preserve and can be viewed from the boardwalk. The eagles are usually present from mid-October through mid-May. White Kitchen is one of 15 priority sites of conservation focus in Louisiana for the Conservancy.

**Charter Oak Preserve - The Nature Conservancy**
Background: The Charter Oak Preserve is located along the western limit of the historic floodplain Pearl River in St. Tammany Parish. This preserve encompasses 160 acres and is not open to the public.
Ecological Significance: The preserve sustains a high-quality bayhead swamp and a portion of a local pond cypress-blackgum savanna. It supports a diversity of evergreen shrubs and the buckwheat tree (*Cliftonia monophylla*), which occurs nowhere else naturally in Louisiana.

**Talisheek Pine Wetlands Preserve – The Nature Conservancy**
Background: This 1,500-acre preserve is located in St. Tammany Parish.
Ecological Significance: This preserve supports the largest tract of intact pine wetlands in Southeast Louisiana and many rare plant and animal species including the federally threatened gopher tortoise and state-rare mud salamander.

**Pushepatapa Creek Preserve – The Nature Conservancy**
Background: Located in Northern Washington Parish, Louisiana, this 22-acre preserve is adjacent to land owned by John James Audubon Foundation.
Ecological Significance: The preserve contains a high quality riverfront forest and is the only officially protected area for a state-rare plant, the mountain laurel. The Conservancy is conducting stewardship work to control privet shrubs on the preserve.

## APPENDIX B. Overview of The Lower Pearl Partnership:

**Goal of the Lower Pearl Partnership:**
Focusing on conservation action at the community level, the Lower Pearl Partnership works to restore, preserve and protect ecologically significant areas of the Pearl River and its tributaries at multiple and geographic scales. Working with partners, actions taken will perpetually conserve species, communities and systems that represent the diversity of life native to the Pearl River watershed in Mississippi and Louisiana.

**Conservation Goals for the Lower Pearl Partnership:**

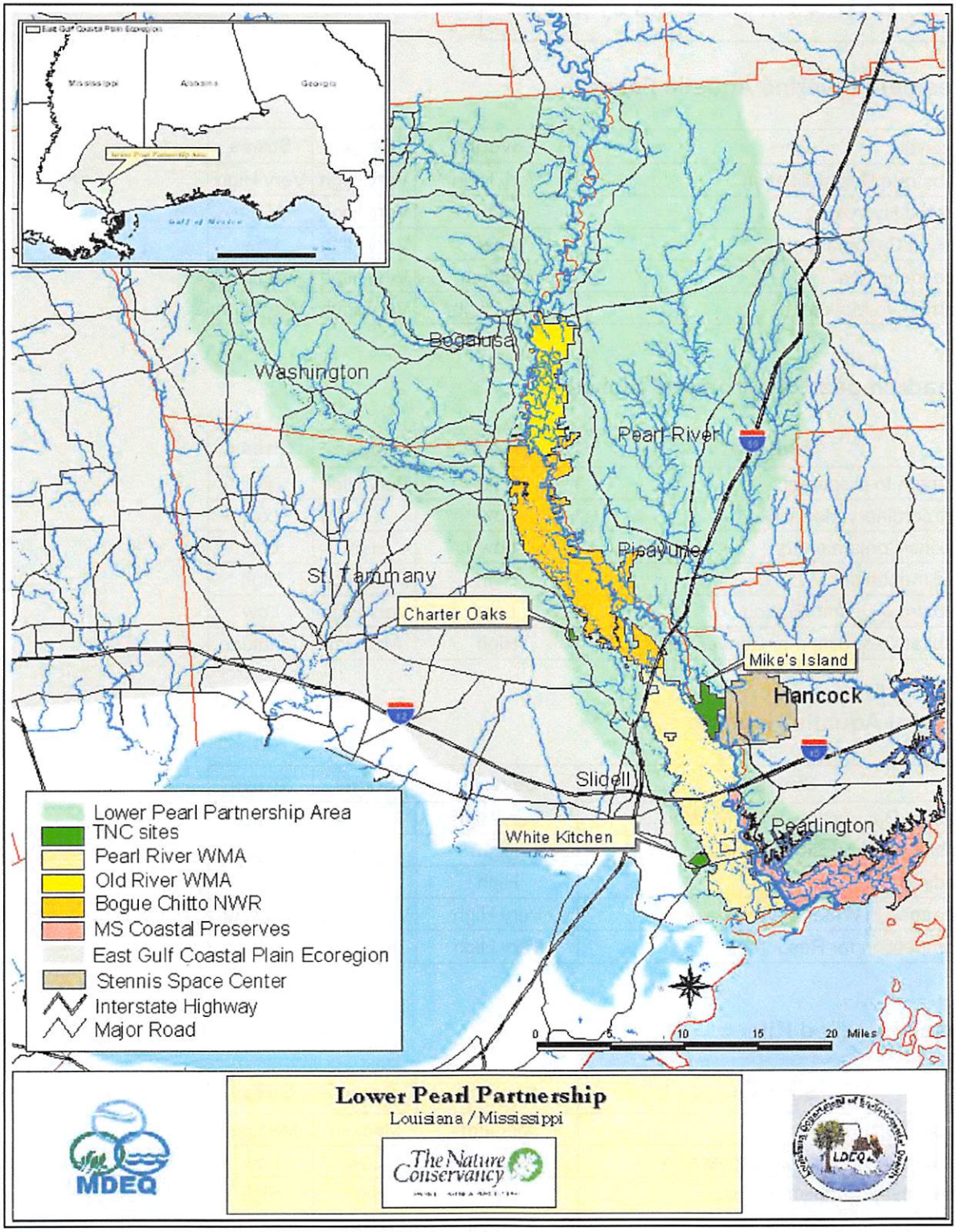
- Develop and implement a Conservation Area Plan (CAP) for the Pearl River floodplain via cooperative endeavors with individuals from local, state and federal agencies, the academic community and local conservation groups. Regularly review measures of success and keep CAP iterative and updated.

- Identify, prioritize and map conservation actions and restoration needs within the Lower Pearl River floodplain, areas that are deemed to best contribute to the improvement of the ecological integrity of the system.

- Identify public and private stakeholders, create partnership opportunities and develop an action plan to implement priority conservation strategies identified in the CAP.

- Facilitate an appreciation of the ecological significance of the Pearl River system, its associated riverine fauna and habitat needs as well as the value of clean water and the use of Best Management Practices (BMP's) to reduce water quality degradation. Work at the grassroots level to develop a stronger sense of pride in place and local involvement and ownership of a healthier river community for the future.

## APPENDIX B. Lower Pearl Partnership Map



# APPENDIX C. Stresses by Target

## Resident Riverine Aquatic Fauna

| Stresses | Severity | Scope | Stress |
|---|---|---|---|
| Substrate Destabilization | Very High | Very High | Very High |
| Altered Hydrology | High | Very High | High |
| Toxins/Contaminants | Low | Very High | Low |
| Sedimentation | Medium | Very High | Medium |
| Barriers to Movement | Very High | Very High | Very High |

## Anadromous/Catadromous Fishes

| Stresses | Severity | Scope | Stress |
|---|---|---|---|
| Barriers to Dispersal | High | Very High | High |
| Extraordinary Mortality | Low | Low | Low |
| Toxins/Contaminants | Low | High | Low |
| Sedimentation | High | Very High | High |
| Substrate Destabilization | Low | Very High | Low |
| Habitat Destruction or Conversion | High | Medium | Medium |

## Lateral Aquatic Habitats

| Stresses | Severity | Scope | Stress |
|---|---|---|---|
| Habitat Destruction or Conversion | Very High | Medium | Medium |
| Altered Composition/Structure | High | High | High |
| Sedimentation | High | High | High |
| Changes in Water Levels/Flow | Very High | Very High | Very High |
| Competition for Resources | Very High | Medium | Medium |

## Swallow-tailed Kite

| Stresses | Severity | Scope | Stress |
|---|---|---|---|
| Habitat Disturbance | Medium | Medium | Medium |
| Habitat Destruction or Conversion | Medium | Low | Low |
| Parasitism/Predation/Disease | High | High | High |
| Altered Composition/Structure | Medium | High | Medium |
| Altered Hydrology | Low | Low | Low |

# APPENDIX C. Stresses by Target

## Bottomland Forest Complex

| Stresses | Severity | Scope | Stress |
|---|---|---|---|
| Habitat Fragmentation | Medium | Medium | Medium |
| Habitat Destruction or Conversion | Very High | Low | Low |
| Altered Composition/Structure | High | Very High | High |
| Habitat Disturbance | Low | High | Low |
| Non-native Species | Medium | High | Medium |

## Emergent Marsh Complex

| Stresses | Severity | Scope | Stress |
|---|---|---|---|
| Changes in Water Levels/Flow | Low | Very High | Low |
| Nutrient Loading | Low | Medium | Low |
| Habitat Destruction or Conversion | Low | Low | Low |
| Excessive Herbivory | Low | High | Low |
| Habitat Disturbance | Low | High | Low |
| Salinity Alteration | Low | Medium | Low |

## Slope Forest Complex

| Stresses | Severity | Scope | Stress |
|---|---|---|---|
| Habitat Fragmentation | Medium | High | Medium |
| Habitat Destruction or Conversion | Very High | Medium | Medium |
| Altered Composition/Structure | High | Very High | High |
| Habitat Disturbance | Low | High | Low |
| Non-native Species | Low | High | Low |

## APPENDIX D.
## Sources of Stress by Target:
## Resident Riverine Aquatic Fauna

| Sources of Stress | | Substrate Destabilization | | Altered Hydrology | | Toxins/ Contaminants | | Sedimentation | | Barriers to Movement | | Threat to System |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Very High* | | *High* | | *Low* | | *Medium* | | *Very High* | | **Rank** |
| Sand and Gravel Mining | Contribution | High | Very High | | - | | - | Very High | Medium | | - | Very High |
| | Irreversibility | Very High | | | | | | High | | | | |
| | Override | | | | | | | | | | | |
| | Source | High | | - | | - | | Very High | | - | | |
| Incompatible Forestry Practices | Contribution | Low | Medium | Medium | Medium | Medium | Low | Medium | Low | | - | Medium |
| | Irreversibility | Low | | Medium | | Medium | | Medium | | | | |
| | Override | | | | | | | | | | | |
| | Source | Low | | Medium | | Medium | | Medium | | - | | |
| Incompatible Commercial/ Industrial Development | Contribution | Low | High | Medium | High | High | Low | High | Medium | | - | High |
| | Irreversibility | Very High | | Very High | | Very High | | High | | | | |
| | Override | | | | | | | | | | | |
| | Source | Medium | | High | | High | | High | | - | | |
| Incompatible Recreational Use | Contribution | Low | Medium | | - | | - | Low | Low | | - | Medium |
| | Irreversibility | Medium | | | | | | Low | | | | |
| | Override | | | | | | | | | | | |
| | Source | Low | | - | | - | | Low | | - | | |
| Low Water Sills | Contribution | Medium | High | | - | | - | | - | High | High | High |
| | Irreversibility | Medium | | | | | | | | Medium | | |
| | Override | | | | | | | | | | | |
| | Source | Medium | | - | | - | | - | | Medium | | |
| Incompatible Operation of Dams or Reservoirs | Contribution | Medium | High | High | Medium | | - | | - | | - | High |
| | Irreversibility | Medium | | Low | | | | | | | | |
| | Override | | | | | | | | | | | |
| | Source | Medium | | Medium | | - | | - | | - | | |
| Incompatible Grazing/Livestock | Contribution | | - | | - | | - | Low | Low | | - | Low |
| | Irreversibility | | | | | | | Low | | | | |
| | Override | | | | | | | | | | | |
| | Source | - | | - | | - | | Low | | - | | |

## APPENDIX D. Sources of Stress by Target: Anadromous/Catadromous Fishes

| Sources of Stress | | Barriers to Dispersal | | Extraordinary Mortality | | Toxins/ Contaminants | | Sedimentation | | Substrate Destabilization | | Habitat Destruction | | Threat to System Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *High* | | *Low* | | *Low* | | *High* | | *Low* | | *Medium* | | |
| Commercial Fishing Bycatch | Contribution | | - | Very High | Low | | - | | - | | - | | - | Low |
| | Irreversibility | | | High | | | | | | | | | | |
| | Override | | | | | | | | | | | | | |
| | Source | - | | Very High | | - | | - | | - | | - | | |
| Low Water Sills | Contribution | Very High | High | | - | | - | | - | | - | | - | High |
| | Irreversibility | Medium | | | | | | | | | | | | |
| | Override | | | | | | | | | | | | | |
| | Source | High | | - | | - | | - | | - | | - | | |
| Land uses that affect hydrology | Contribution | Low | Medium | | - | | - | | - | | - | | - | Medium |
| | Irreversibility | Very High | | | | | | | | | | | | |
| | Override | | | | | | | | | | | | | |
| | Source | Medium | | - | | - | | - | | - | | - | | |
| Incompatible Forestry Practices | Contribution | | - | | - | Medium | Low | Medium | Medium | | - | | - | Medium |
| | Irreversibility | | | | | Medium | | Medium | | | | | | |
| | Override | | | | | | | | | | | | | |
| | Source | - | | - | | Medium | | Medium | | - | | - | | |
| Incompatible Commercial/Industrial Development | Contribution | | - | | - | High | Low | High | High | | - | | - | High |
| | Irreversibility | | | | | Very High | | High | | | | | | |
| | Override | | | | | | | | | | | | | |
| | Source | - | | - | | High | | High | | - | | - | | |
| Sand and Gravel Mining | Contribution | | - | | - | | - | Very High | High | High | Low | | - | High |
| | Irreversibility | | | | | | | High | | High | | | | |
| | Override | | | | | | | | | | | | | |
| | Source | - | | - | | - | | Very High | | High | | - | | |
| Incompatible Operation of Dams or Reservoirs | Contribution | High | High | | - | | - | | - | Medium | Low | | - | High |
| | Irreversibility | Very High | | | | | | | | Medium | | | | |
| | Override | | | | | | | | | | | | | |
| | Source | High | | - | | - | | - | | Medium | | - | | |
| Dam Construction | Contribution | High | High | | - | | - | | - | | - | High | Medium | High |
| | Irreversibility | Very High | | | | | | | | | | Very High | | |
| | Override | | | | | | | | | | | | | |
| | Source | High | | - | | - | | - | | - | | High | | |

## APPENDIX D. Sources of Stress Table: Lateral Aquatic Habitats

| Sources of Stress | | Habitat Destruction or Conversion | | Altered Composition/ Structure | | Sedimentation | | Changes in Water Levels/Flow | | Competition for Resources | | Threat to System Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Medium* | | *High* | | *High* | | *Very High* | | *Medium* | | |
| Construction of Ditches, Dikes, Drainage or Diversion Systems | Contribution | High | Medium | High | High | Low | Low | High | Very High | | - | Very High |
| | Irreversibility | Very High | | Very High | | Medium | | Very High | | | | |
| | Override | | | | | | | | | | | |
| | Source | High | | High | | Low | | High | | - | | |
| Sand and Gravel Mining | Contribution | Low | Low | | - | Low | Medium | | - | | - | Medium |
| | Irreversibility | High | | | | High | | | | | | |
| | Override | | | | | | | | | | | |
| | Source | Medium | | - | | Medium | | - | | - | | |
| Incompatible Operation of Dams or Reservoirs | Contribution | High | Low | High | Medium | High | Medium | High | High | | - | High |
| | Irreversibility | Medium | | Medium | | Medium | | Medium | | | | |
| | Override | | | | | | | | | | | |
| | Source | Medium | | Medium | | Medium | | Medium | | - | | |
| Dam Construction | Contribution | Medium | Medium | | - | | - | Low | High | | - | High |
| | Irreversibility | Very High | | | | | | Very High | | | | |
| | Override | | | | | | | High | | | | |
| | Source | High | | - | | - | | | | - | | |
| Invasive/Alien Species | Contribution | | - | Medium | Medium | | - | | | Very High | Medium | |
| | Irreversibility | | | High | | | | | | High | | |
| | Override | | | | | | | | | | | |
| | Source | - | | Medium | | - | | - | | Very High | | |
| Incompatible Forestry Practices | Contribution | | - | | - | High | Medium | | - | | - | Medium |
| | Irreversibility | | | | | Medium | | | | | | |
| | Override | | | | | | | | | | | |
| | Source | - | | - | | Medium | | - | | - | | |
| Incompatible Commercial/Industrial Development | Contribution | | - | | - | High | High | Low | Medium | | - | High |
| | Irreversibility | | | | | High | | Medium | | | | |
| | Override | | | | | | | | | | | |
| | Source | - | | - | | High | | Low | | - | | |
| Incompatible Development of Roads or Utilities | Contribution | | - | | - | Medium | Medium | | - | | - | Medium |
| | Irreversibility | | | | | Medium | | | | | | |
| | Override | | | | | | | | | | | |
| | Source | - | | - | | Medium | | - | | - | | |

## APPENDIX D.
## Sources of Stress Tables:
## Swallow-tailed Kite

| Sources of Stress | | Habitat Disturbance | | Habitat Destruction | | Parasitism/ Predation/ Disease | | Altered Composition/ Structure | | Threat to System Rank |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Medium* | | *Low* | | *High* | | *Medium* | | |
| Incompatible Forestry Practices | Contribution | Low | Low | High | Low | | - | Very High | Medium | Medium |
| | Irreversibility | Low | | Medium | | | | Medium | | |
| | Override | | | | | | | | | |
| | Source | Low | | Medium | | - | | High | | |
| Incompatible Recreational Use | Contribution | Medium | Low | | - | | - | | - | Low |
| | Irreversibility | Low | | | | | | | | |
| | Override | | | | | | | | | |
| | Source | Low | | - | | - | | - | | |
| Great Horned Owl | Contribution | | - | | - | Very High | Low | | - | Low |
| | Irreversibility | | | | | High | | | | |
| | Override | | | | | Low | | | | |
| | Source | - | | - | | Low | | - | | |
| Incompatible Primary Home Development | Contribution | Low | Low | Low | Low | | - | Low | Low | Low |
| | Irreversibility | High | | High | | | | High | | |
| | Override | | | | | | | | | |
| | Source | Medium | | Medium | | - | | Medium | | |

**APPENDIX D.**
**Sources of Stress per Target:**
**Bottomland Forest**

| Sources of Stress | | Habitat Fragmentation | | Habitat Destruction or Conversion | | Altered Composition/ Structure | | Habitat Disturbance | | Non-native Species | | Threat to System Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Medium* | | *Low* | | *High* | | *Low* | | *Medium* | | |
| Incompatible Forestry Practices | Contribution | High | Low | Low | - | Very High | High | Medium | - | Very High | Medium | High |
| | Irreversibility | Low | | Low | | Low | | Low | | Medium | | |
| | Override | | | | | | | | | | | |
| | Source | Medium | | Low | | High | | Low | | High | | |
| Conversion to Agriculture or Silviculture | Contribution | Medium | Low | Very High | Low | Medium | Medium | Medium | - | High | Low | Medium |
| | Irreversibility | Medium | | Medium | | Medium | | Low | | Medium | | |
| | Override | | | | | | | | | | | |
| | Source | Medium | | High | | Medium | | Low | | Medium | | |
| Incompatible Recreational Use | Contribution | Low | Low | Low | - | Low | Low | Very High | Low | Medium | Low | Low |
| | Irreversibility | Low | | Low | | Low | | Low | | Low | | |
| | Override | | | | | | | | | | | |
| | Source | Low | | Low | | Low | | High | | Low | | |
| Incompatible Commercial/Industrial Development | Contribution | Low | Low | | - | | - | | - | Medium | Low | Low |
| | Irreversibility | Very High | | | | | | | | Medium | | |
| | Override | | | | | | | | | | | |
| | Source | Medium | | - | | - | | - | | Medium | | |
| Incompatible Operation of Dams or Reservoirs | Contribution | | - | | - | Medium | Medium | | - | | - | Medium |
| | Irreversibility | | | | | Medium | | | | | | |
| | Override | | | | | | | | | | | |
| | Source | - | | - | | Medium | | - | | - | | |
| Sand and Gravel Mining | Contribution | | - | Low | Low | Low | Medium | | - | Low | Low | Medium |
| | Irreversibility | | | High | | High | | | | Medium | | |
| | Override | | | | | | | | | | | |
| | Source | - | | Medium | | Medium | | - | | Low | | |
| Channelization of Rivers or Streams | Contribution | | - | | - | Low | Medium | | - | Low | Low | Medium |
| | Irreversibility | | | | | Very High | | | | Very High | | |
| | Override | | | | | | | | | | | |
| | Source | - | | - | | Medium | | - | | Medium | | |
| Incompatible Grazing/Livestock | Contribution | | - | | - | Low | Low | Low | - | | - | Low |
| | Irreversibility | | | | | Low | | Low | | | | |
| | Override | | | | | | | | | | | |
| | Source | - | | - | | Low | | Low | | - | | |

**APPENDIX D.**
**Sources of Stress Table:**
**Emergent Marsh Complex**

| Sources of Stress | | Changes in Water Levels/Flow | | Nutrient Loading | | Habitat Destruction | | Excessive Herbivory | | Habitat Disturbance | | Salinity Alteration | | Threat to System Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Low* | | *Low* | | *Low* | | *Low* | | *Low* | | *Low* | | |
| Incompatible Operation of Dams or Reservoirs | Contribution | Low | - | | - | | - | | - | | - | Medium | Low | Low |
| | Irreversibility | Medium | | | | | | | | | | Medium | | |
| | Override | | | | | | | | | | | | | |
| | Source | Low | | - | | - | | - | | - | | Medium | | |
| Construction of Ditches, Dikes, Drainage or Diversion Systems | Contribution | High | Low | | - | | - | | - | | - | Medium | Low | Low |
| | Irreversibility | Medium | | | | | | | | | | Medium | | |
| | Override | | | | | | | | | | | | | |
| | Source | Medium | | - | | - | | - | | - | | Medium | | |
| Incompatible Livestock Production Practices (Dairy) | Contribution | | - | Very High | Low | | - | | - | | - | | - | Low |
| | Irreversibility | | | Medium | | | | | | | | | | |
| | Override | | | | | | | | | | | | | |
| | Source | - | | High | | - | | - | | - | | - | | |
| Incompatible Wastewater Treatment | Contribution | | - | High | Low | | - | | - | | - | | - | Low |
| | Irreversibility | | | Medium | | | | | | | | | | |
| | Override | | | | | | | | | | | | | |
| | Source | - | | Medium | | - | | - | | - | | - | | |
| Incompatible Primary Home Development | Contribution | | - | | - | Very High | Low | | - | | - | | - | Low |
| | Irreversibility | | | | | High | | | | | | | | |
| | Override | | | | | | | | | | | | | |
| | Source | - | | - | | Very High | | - | | - | | - | | |
| Invasive/Alien Species | Contribution | | - | | - | | - | Very High | Low | Medium | Low | | - | Low |
| | Irreversibility | | | | | | | Medium | | Medium | | | | |
| | Override | | | | | | | | | | | | | |
| | Source | - | | - | | - | | High | | Medium | | - | | |
| Incompatible Recreational Use | Contribution | | - | | - | Low | - | | - | High | Low | | - | Low |
| | Irreversibility | | | | | Low | | | | Low | | | | |
| | Override | | | | | | | | | | | | | |
| | Source | - | | - | | Low | | - | | Medium | | - | | |

**APPENDIX D.**
**Sources of Stress Tables:**
**Slope Forest Complex**

| Sources of Stress | | Habitat Fragmentation | | Habitat Destruction or Conversion | | Altered Composition/ Structure | | Habitat Disturbance | | Non-native Species | | Threat to System |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Medium* | | *Medium* | | *High* | | *Low* | | *Low* | | Rank |
| Incompatible Forestry Practices | Contribution | Medium | Low | Low | Low | Very High | High | Low | - | Very High | Low | High |
| | Irreversibility | Low | | Low | | Low | | Low | | Medium | | |
| | Override | | | | | | | | | | | |
| | Source | Low | | Low | | High | | Low | | High | | |
| Conversion to Agriculture or Silviculture | Contribution | Very High | Medium | Very High | Medium | Medium | Medium | Low | - | High | Low | Medium |
| | Irreversibility | Medium | | Medium | | Medium | | Low | | Medium | | |
| | Override | | | | | | | | | | | |
| | Source | High | | High | | Medium | | Low | | Medium | | |
| Incompatible Recreational Use | Contribution | Low | Low | Low | Low | Low | Low | Very High | Low | Low | - | Low |
| | Irreversibility | Low | | Low | | Low | | Low | | Low | | |
| | Override | | | | | | | | | | | |
| | Source | Low | | Low | | Low | | High | | Low | | |
| Incompatible Grazing/Livestock | Contribution | | - | | - | Low | Low | Low | - | | - | Low |
| | Irreversibility | | | | | Low | | Low | | | | |
| | Override | | | | | | | | | | | |
| | Source | - | | - | | Low | | Low | | - | | |

**APPENDIX E. Pearl River Primary Boundary Species of Concern (Data provided by the Louisiana and Mississippi Natural Heritage Programs)**

| STATE COMMON NAME | SCIENTIFIC NAME | USESA | GRANK | LOUISIANA SRANK | MISSISSIPPI SRANK |
|---|---|---|---|---|---|
| Alabama Hickorynut | Obovaria unicolor | | G3 | S1 | S3 |
| Alabama Shad | Alosa alabamae | C | G3 | S1 | S1 |
| Alligator Snapping Turtle | Macroclemys temminckii | | G3G4 | S3 | S3 |
| Alluvial Creek/River | Alluvial Creek/River | | | | S3 |
| Alternate-leaf Dogwood | Cornus alternifolia | | G5 | | S2 |
| American Alligator | Alligator mississippiensis | LT(S/A) | G5 | | S4 |
| Bachman's Sparrow | Aimophila aestivalis | | G3 | S3 | S3?B,SZN |
| Bald Eagle | Haliaeetus leucocephalus | PS:LT,PDL | G4 | S2N,S3B | S1B,S2N |
| Baltzell's Sedge | Carex baltzellii | | G3 | | S1 |
| Barn Owl | Tyto alba | | G5 | | S4B,S4N |
| Bayhead Swamp | Bayhead swamp | | GNR | S3 | |
| Bearded Grass-pink | Calopogon barbatus | | G4? | S1 | |
| Beech-Magnolia Forest-American beech-southern/bigleaf magnolia-tuliptree-witchhazel-broad beechfern | Beech-magnolia forest-american beech-southern/bigleaf magnolia-tuliptree-witchhazel-broad beechfern | | | | S1 |
| Bird-bill Spikegrass | Chasmanthium ornithorhynchum | | G4 | S2 | |
| Black Buffalo | Ictiobus niger | | G5 | | S3 |
| Black Pine Snake | Pituophis melanoleucus lodingi | C | G4T3 | | S2 |
| Black Sandshell | Ligumia recta | | G5 | | S2 |
| Black-crowned Night-heron | Nycticorax nycticorax | | G5 | | S3?B,SZN |
| Blueberry Hawthorn | Crataegus brachyacantha | | G4 | | S1? |
| Bluenose Shiner | Pteronotropis welaka | | G3G4 | S1S2 | S3 |
| Bog Moss | Mayaca fluviatilis | | G5 | S2 | |
| Bottomland Hardwood Forest | Bottomland hardwood forest | | GNR | S4 | |
| Brillant Hibiscus | Hibiscus coccineus | | G4? | | S2 |

**APPENDIX E. Pearl River Primary Boundary Species of Concern (Data provided by the Louisiana and Mississippi Natural Heritage Programs)**

| SCIENTIFIC NAME | | USESA | GRANK | LOUISIANA SRANK | MISSISSIPPI SRANK |
|---|---|---|---|---|---|
| Broad-leaf Barbara's Button | Marshallia trinervia | | G3 | | S3 |
| Buckwheat-tree | Cliftonia monophylla | | G4G5 | S1 | |
| Carolina Redroot | Lachnanthes caroliniana | | G4 | S2 | |
| Carpenter's Ground-cherry | Physalis carpenteri | | G3 | S1 | |
| Chapman Beakrush | Rhynchospora chapmanii | | G4 | S2 | |
| Ciliate Beakrush | Rhynchospora ciliaris | | G4 | S2 | |
| Coal Skink | Eumeces anthracinus | | G5 | | S3S4 |
| Coastal False-asphodel | Tofieldia racemosa | | G5 | S2S3 | |
| Coastal Live Oak-hackberry Forest | Coastal live oak-hackberry forest | | G1G2Q | S1S2 | |
| Common Water-willow | Justicia americana | | G5 | S2 | |
| Creekgrass | Potamogeton epihydrus | | G5 | | S1 |
| Crested Fringed Orchid | Platanthera cristata | | G5 | | S3 |
| Crystal Darter | Crystallaria asprella | | G3 | S2S3 | S1 |
| Cypress-knee Sedge | Carex decomposita | | G3 | S1 | |
| Cypress-tupelo Swamp | Cypress-tupelo swamp | | GNR | S4 | |
| Deertoe | Truncilla truncata | | G5 | | S3 |
| Delicate Spike | Elliptio arctata | | G3G4 | | S1 |
| Diamondback Terrapin | Malaclemys terrapin | | G4 | S2 | |
| Dusky Gopher Frog | Rana sevosa | LE | G1 | SH | |
| Dwarf Filmy-fern | Trichomanes petersii | | G4G5 | S2 | |
| Eared Greenbrier | Smilax auriculata | | G4? | S1? | |
| Eastern Coral Snake | Micrurus fulvius fulvius | | G5T5(G5) | S2 | S3S4 |
| Eastern Diamondback Rattlesnake | Crotalus adamanteus | | G4 | S1 | |
| Eastern Glass Lizard | Ophisaurus ventralis | | G5 | S3 | |
| Eastern Harvest Mouse | Reithrodontomys humulis | | G5 | S3S4 | |
| Eastern Leatherwood | Dirca palustris | | G4 | | S2 |
| Eastern Longleaf Pine Savannah | Eastern longleaf pine savannah | | GNR | S1 | |

**APPENDIX E. Pearl River Primary Boundary Species of Concern (Data provided by the Louisiana and Mississippi Natural Heritage Programs)**

| SCIENTIFIC NAME | | USESA | GRANK | LOUISIANA SRANK | MISSISSIPPI SRANK |
|---|---|---|---|---|---|
| Eastern Purple Coneflower | Echinacea purpurea | | G4 | | S3 |
| Ebonyshell | Fusconaia ebena | | G4G5 | S3 | |
| Elephant-ear | Elliptio crassidens | | G5 | S2S3 | |
| Fairy Wand | Chamaelirium luteum | | G5 | S2S3 | |
| Fawnsfoot | Truncilla donaciformis | | G5 | | S4 |
| Flame Flower | Macranthera flammea | | G3 | S2 | |
| Flatwoods Digger | Fallicambarus oryktes | | G4 | S2S3 | |
| Flax-leaf False-foxglove | Agalinis linifolia | | G4? | S1 | |
| Florida Keys Hempvine | Mikania cordifolia | | G5 | | S3 |
| Florida Panther | Puma concolor coryi | LE | G5T1 | | SH |
| Frecklebelly Madtom | Noturus munitus | | G3 | S2S3 | S2 |
| Freckled Darter | Percina lenticula | | G2 | S1 | S2 |
| Freshwater Marsh | Freshwater marsh | | GNR | S1S2 | |
| Fringed Yellow-eyed Grass | Xyris fimbriata | | G5 | S2? | |
| Georgia Tickseed | Coreopsis nudata | | G3? | S2 | |
| Golden Aster | Chrysopsis gossypina ssp. hyssopifolia | | G5T3T5 | S1 | |
| Golden Crest | Lophiola aurea | | G4 | S2S3 | |
| Gopher Tortoise | Gopherus polyphemus | PS:LT | G3 | S1 | S2 |
| Gopher-apple | Licania michauxii | | G4G5 | SH | |
| Green-fly Orchid | Epidendrum conopseum | | G4 | | S2 |
| Gulf Coast Mud Salamander | Pseudotriton montanus | | G5 | S1 | |
| Gulf Coast Toad | Bufo nebulifer | | S3 | | G5 |
| Gulf Sturgeon | Acipenser oxyrinchus desotoi | LT | G3T2 | S1S2 | S1 |
| Gull-billed Tern | Sterna nilotica | | G5 | S2B,S2S3N | |
| Hardwood Slope Forest | Hardwood slope forest | | GNR | S3S4 | |
| Hemlock Water-parsnip | Sium suave | | G5 | S1S2 | |
| Hooker Milkwort | Polygala hookeri | | G3 | S1 | |

**APPENDIX E. Pearl River Primary Boundary Species of Concern (Data provided by the Louisiana and Mississippi Natural Heritage Programs)**

| | | USESA | GRANK | LOUISIANA SRANK | MISSISSIPPI SRANK |
|---|---|---|---|---|---|
| Indian Cucumber-root | Medeola virginiana | | G5 | S1 | |
| Inflated Heelsplitter | Potamilus inflatus | LT | G1 | S1 | SH |
| Intermediate Marsh | Intermediate marsh | | GNR | S3S4 | |
| Ironcolor Shiner | Notropis chalybaeus | | G4 | | S2 |
| Lady Lupine | Lupinus villosus | | G5 | S2 | |
| Lesser Ladies-Tresses | Spiranthes ovalis | | G5? | | S2S3 |
| Loggerhead Shrike | Lanius ludovicianus | (PS) | G4 | | S4B,SZN |
| Louisiana Black Bear | Ursus americanus luteolus | LT | G5T2 | S2 | |
| Louisiana Trillium | Trillium ludovicianum | | G3 | | S1? |
| Louisiana Waterthrush | Seiurus motacilla | | G5 | S3S4B | |
| Manatee | Trichechus manatus | LE | G2 | SNA | |
| Maryland's Black Snake-root | Sanicula marilandica | | G5 | S2? | |
| Michaux Milkweed | Asclepias michauxii | | G4G5 | S2 | |
| Mississippi Diamondback Terrapin | Malaclemys terrapin pileata | | G4T3 | | S2 |
| Mississippi Pigtoe | Pleurobema beadleianum | | G2G3 | S2 | S3? |
| Mottled Duck | Anas fulvigula | | G4 | | S3B,S4N |
| Mountain Laurel | Kalmia latifolia | | G5 | S3 | |
| Myrtle Holly | Ilex myrtifolia | | G5? | S2 | |
| Narrowleaf Aster | Sericocarpus linifolius | | G5 | S2 | |
| Natchez Stonefly | Alloperla natchez | | G2 | | S2 |
| Needle Palm | Rhapidophyllum hystrix | | G4 | | S3 |
| New York Fern | Thelypteris noveboracensis | | G5 | S1 | |
| Night-flowering Ruellia | Ruellia noctiflora | | G2 | | S2 |
| Odorless Bayberry | Myrica inodora | | G4 | S2 | |
| Ornate Chorus Frog | Pseudacris ornata | | G5 | S1 | |
| Osprey | Pandion haliaetus | | G5 | S2B,S3N | |
| Paddlefish | Polyodon spathula | | G4 | S3 | S3 |

**APPENDIX E. Pearl River Primary Boundary Species of Concern (Data provided by the Louisiana and Mississippi Natural Heritage Programs)**

| | | USESA | GRANK | LOUISIANA SRANK | MISSISSIPPI SRANK |
|---|---|---|---|---|---|
| Painted Sedge | Carex picta | | G4G5 | | S3S4 |
| Paronychia Corymbosa | Paronychia erecta var. corymbosa | | G3G4T2T4 | S1 | |
| Parrot Pitcherplant | Sarracenia psittacina | | G4 | S3 | |
| Pascagoula Map Turtle | Graptemys gibbonsi | | G3G4 | S3 | |
| Pearl Blackwater Crayfish | Procambarus penni | | G3 | | S3 |
| Pearl Darter | Percina aurora | C | G1 | SH | S1 |
| Perennial Sandgrass | Triplasis americana | | G5 | S1 | |
| Piedmont Bladderwort | Utricularia olivacea | | G4 | | S1 |
| Pine Barren Ruellia | Ruellia pedunculata ssp. pinetorum | | G5T3 | | S3 |
| Pineland Scaly-pink | Stipulicida setacea | | G4G5 | S1 | |
| Pine-woods Milkweed | Asclepias humistrata | | G4G5 | S1 | |
| Pondhorn | Uniomerus tetralasmus | | G4 | | S5 |
| Purple False-foxglove | Agalinis filicaulis | | G3G4 | S1 | |
| Pyramid Magnolia | Magnolia pyramidata | | G4 | S2 | |
| Rainbow Snake | Farancia erytrogramma | | G5 | S2 | S2 |
| Rayed Creekshell | Anodontoides radiatus | | G3 | S2 | |
| Red Oak | Quercus rubra | | G5 | S1S3 | |
| Red-shouldered Hawk | Buteo lineatus | | G5 | | S4B |
| Ribbon Crawfish | Procambarus bivittatus | | G4 | S1S2 | |
| Ringed Map Turtle | Graptemys oculifera | LT | G2 | S2 | S2 |
| River Redhorse | Moxostoma carinatum | | G4 | S1S3 | |
| Riverweed | Podostemum ceratophyllum | | G5 | S1 | |
| Rock Pocketbook | Arcidens confragosus | | G4 | | S2 |
| Rock Riffle | open water/barren substrate supporting aquatic organisms; sparse vegetation attached to substrate | | | | S3 |

**APPENDIX E. Pearl River Primary Boundary Species of Concern (Data provided by the Louisiana and Mississippi Natural Heritage Programs)**

| | | USESA | GRANK | LOUISIANA SRANK | MISSISSIPPI SRANK |
|---|---|---|---|---|---|
| Royal Tern | Sterna maxima | | G5 | | S1B,S4N |
| Sand Hickory | Carya pallida | | G5 | S2 | |
| Sand Rose-gentian | Sabatia arenicola | | G3G5 | S1 | |
| Sarvis (Juneberry) Holly | Ilex amelanchier | | G4 | S2 | S3 |
| Saw Palmetto | Serenoa repens | | G4G5 | S1 | |
| Scarlet Snake | Cemophora coccinea | | G5 | | S4 |
| Shell Midden Shrub/Woodland | southern redcedar-false buckthorn | | | | S1 |
| Shortleaf Sneezeweed | Helenium brevifolium | | G3G4 | S1 | |
| Silky Camellia | Stewartia malacodendron | | G4 | S2S3 | S3S4 |
| Silverjaw Minnow | Ericymba buccata | | G5 | S2S4 | |
| Single-headed Pussytoes | Antennaria solitaria | | G5 | | S3? |
| Slash Pine/post Oak | Slash pine/post oak | | GNR | S3S4 | |
| Slash Pine-cypress/hardwood Forest | Slash pine-cypress/hardwood forest | | GNR | S2S3 | |
| Slim Spike-rush | Eleocharis elongata | | G5? | S1? | |
| Small Pondweed | Potamogeton pusillus var tenuissimus | | G5T5 | | S3S4 |
| Small Stream Forest | Small stream forest | | GNR | S3 | |
| Southeastern Blue Sucker | Cycleptus meridionalis | | G3G4 | S1 | |
| Southeastern Panic Grass | Panicum tenerum | | G4 | S2S3 | |
| Southern Pocketbook | Lampsilis ornata | | G5 | S3 | |
| Southern Rainbow | Villosa vibex | | G4Q | S2 | |
| Southern Red Salamander | Pseudotriton ruber | | G5 | S2 | S3 |
| Southern Umbrella-sedge | Fuirena scirpoidea | | G5 | SH | |
| Spoon-leaved Sundew | Drosera intermedia | | G5 | S2 | |
| Spreading Pogonia | Cleistes divaricata | | G4 | S1 | |
| Staghorn Clubmoss | Lycopodiella cernua var. cernua | | G5T5 | S2 | |
| Swallow-tailed Kite | Elanoides forficatus | | G5 | S1S2B | S2B |

**APPENDIX E. Pearl River Primary Boundary Species of Concern (Data provided by the Louisiana and Mississippi Natural Heritage Programs)**

| | | | | LOUISIANA | MISSISSIPPI |
|---|---|---|---|---|---|
| | | USESA | GRANK | SRANK | SRANK |
| Swamp-forest Beakrush | Rhynchospora decurrens | | G3G4 | | S1 |
| Tapered Pondhorn | Uniomerus declivis | | G5 | | S2 |
| Three-way Sedge | Dulichium arundinaceum | | G5 | S1 | |
| Tiny-leaved Buckthorn | Sageretia minutiflora | | G4 | | S2 |
| Turkey Oak | Quercus laevis | | G5 | S1 | |
| Viperina | Zornia bracteata | | G5? | S2 | |
| Waterbird Nesting Colony | Waterbird nesting colony | | GNR | SNR | |
| Western Umbrella-grass | Fuirena simplex | | G5 | S1 | |
| Western Xeric Sandhill Woodland | Western xeric sandhill woodland | | GNR | S2S3 | |
| White Heelsplitter | Lasmigona complanata | | G5 | | S3? |
| White Ibis | Eudocimus albus | | G5 | | S3B,SZN |
| White-faced Ibis | Plegadis Chihi | | G5 | | SZN |
| Wild Coco | Pteroglossaspis ecristata | | G2 | S2 | |
| Wolf Spikerush | Eleocharis wolfii | | G3? | S1? | |
| Yellow Butterwort | Pinguicula lutea | | G4G5 | S2 | |
| Canada Horsebalm, Richweed, Hardhack, Heal-All, Horseweed, Ox-Balm, and Stone Root | Collinsonia canadensis | | G5 | S2? | |
| Summer Farewell | Dalea pinnata | | G5 | S1 | |
| Chapman's Milkwort | Polygala chapmanii | | G3G5 | S1 | |
| Sprawling Hoarypea | Tephrosia hispidula | | G4G5 | S2? | |

# Appendix F.

**EXPLANATION OF RANKING CATEGORIES EMPLOYED BY NATURAL HERITAGE PROGRAMS NATIONWIDE**

Each element is assigned a single global rank as well as a state rank for each state in which it occurs. Global ranking is done under the guidance of NatureServe, Arlington, VA. State ranks are assigned by each state's Natural Heritage Program, thus a rank for a particular element may vary considerably from state to state. Federal ranks are designated by the U.S. Fish & Wildlife Service under the provisions of the Endangered Species Act of 1973.

**FEDERAL RANKS (USESA FIELD):**

LE = Listed Endangered

LT = Listed Threatened

PE = Proposed endangered

PT = Proposed Threatened

C = Candidate

PDL = Proposed for delisting

E (S/A) or T (S/A) = Listed endangered or threatened because of similarity of appearance

XE = Essential experimental population

XN = Nonessential experimental population

No Rank = Usually indicates that the taxon does not have any federal status. However, because of potential lag time between publication in the Federal Register and entry in the central databases and state databases, some taxa may have a status which does not yet appear.

(Rank, Rank) = Combination values in parenthesis = The taxon itself is not named in the Federal Register as having U.S. ESA status; however, all of its infraspecific taxa (worldwide) do have official status. The statuses shown in parentheses indicate the statuses that apply to infraspecific taxa or populations within this taxon. *THE SPECIES IS CONSIDERED TO HAVE A COMBINATION STATUS IN LOUISIANA*

(PS) = partial status= Status in only a portion of the species' range. Typically indicated in a "full" species record where an infraspecific taxon or population has U.S. ESA status, but the entire species does not. *THE SPECIES DOES NOT HAVE A STATUS IN LOUISIANA*

(PS: Rank) = partial status= Status in only a portion of the species' range. The value of that status appears because the entity with status does not have an individual entry in Natureserve. *THE SPECIES MAY HAVE A STATUS IN LOUISIANA*

**GLOBAL ELEMENT RANKS:**

G1 = critically imperiled globally because of extreme rarity (5 or fewer known extant populations) or because of some factor(s) making it especially vulnerable to extinction

G2 = imperiled globally because of rarity (6 to 20 known extant populations) or because of some factor(s) making it very vulnerable to extinction throughout its range

G3 = either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single physiographic region) or because of other factors making it vulnerable to extinction throughout its range (21 to 100 known extant populations)

G4 = apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery (100 to 1000 known extant populations)

G5 = demonstrably secure globally, although it may be quite rare in parts of its range, especially at the periphery (1000+ known extant populations)

GH = of historical occurrence throughout its range; i.e., formerly part of the established biota, with the possibility that it may be rediscovered (e.g., Bachman's Warbler)

GU = possibly in peril range-wide, but status uncertain; need more information

G? = rank uncertain. Or a range (e.g., G3G5) delineates the limits of uncertainty

GQ = uncertain taxonomic status

GX = believed to be extinct throughout its range (e.g., Passenger Pigeon) with virtually no likelihood that it will be rediscovered

T = subspecies or variety rank (e.g., G5T4 applies to a subspecies with a global species rank of G5, but with a subspecies rank of G4)

**STATE ELEMENT RANKS:**

S1 = critically imperiled in Louisiana because of extreme rarity (5 or fewer known extant populations) or because of some factor(s) making it especially vulnerable to extirpation

S2 = imperiled in Louisiana because of rarity (6 to 20 known extant populations) or because of some factor(s) making it very vulnerable to extirpation

S3 = rare and local throughout the state or found locally (even abundantly at some of its locations) in a restricted region of the state, or because of other factors making it vulnerable to extirpation (21 to 100 known extant populations)

S4 = apparently secure in Louisiana with many occurrences (100 to 1000 known extant populations)

S5 = demonstrably secure in Louisiana (1000+ known extant populations)

(B or N may be used as qualifier of numeric ranks and indicating whether the occurrence is breeding or nonbreeding)

SA = accidental in Louisiana, including species (usually birds or butterflies) recorded once or twice or only at great intervals hundreds or even thousands of miles outside their usual range

SH = of historical occurrence in Louisiana, but no recent records verified within the last 20 years; formerly part of the established biota, possibly still persisting

SR = reported from Louisiana, but without conclusive evidence to accept or reject the report

SU = possibly in peril in Louisiana, but status uncertain; need more information

SX = believed to be extirpated from Louisiana

SZ = transient species in which no specific consistent area of occurrence is identifiable