Conserving the

ALTAMAHA RIVER WATERSHED

CONSERVATION ACTION PLAN

November 2005

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

SOUTHEAST AQUATIC RESOURCES PARTNERSHIP
SARP
"Saving Aquatic Resources Proactively"

Preface

As stated in *Conservation by Design*, The Nature Conservancy's conservation goal is "the long term survival of all viable native species and community types" within portfolios of sites by ecoregion. In order to accomplish the ambitious goal of conserving all native biodiversity, the Conservancy has developed many tools for conservation planning at the ecoregional and site-based scale. The Altamaha River Watershed has long been a priority for The Nature Conservancy (TNC) based on its freshwater resources, rare species and critical ecological linkage to its rich estuary and Atlantic Ocean. The rivers and much of the terrestrial landscape found within the project have been identified as significant sites through the South Atlantic Coastal Plain ecoregional planning process.

The Nature Conservancy has been involved in conservation planning for the Altamaha River Watershed since 1997. During this time, TNC has utilized a series of workshops to address conservation strategies at the site scale. The goal of these workshops was to apply The Nature Conservancy's site conservation "5-S Framework" to the Altamaha River Watershed project area, thereby developing a conservation blueprint for action and a baseline from which to measure its success over time. During calendar year 2005, the TNC-Georgia Conservation staff revised the Altamaha plan through another series of workshops in collaboration with the Southeast Aquatic Resource Partnership (SARP). The SARP chose the Altamaha River as one of four pilot watersheds in the Southeastern U.S. (the Altamaha in GA, the Roanoke River in NC & VA, the Duck River in TN, and the Pascagoula River in MS) to test the development of a Southeastern Aquatic Habitat Plan. TNC's "5-S Framework" is outlined below:

- **Systems**: the conservation targets occurring at a site, and the natural processes that maintain them, that will be the focus of site-based planning.
- **Stresses**: the types of degradation and impairment afflicting the system(s) at a site.
- **Sources**: the agents generating the stresses.
- **Strategies**: the types of conservation activities deployed to abate sources of stress (threat abatement) and persistent stresses (restoration).
- **Success**: measures of biodiversity health and threat abatement at a site.

Through the guidance of workshops and supplemental staff meetings, the TNC-GA conservation planning team selected conservation targets (systems), analyzed and ranked stresses and sources of stress for each target, and identified conservation strategies to abate threats. A comprehensive conservation plan and strategy for implementation has been developed and updated to focus and direct the TNC-GA's conservation efforts for the next 5 to 10 years. This report presents the conservation action plan that resulted from these workshops and meetings.

Executive Summary

Georgia's Altamaha River watershed is the third largest watershed on the eastern seaboard of the United States. Draining roughly one quarter of the state, the river begins in the Piedmont as the Ocmulgee and Oconee Rivers. The Altamaha River begins in the Coastal Plain with the confluence of these rivers and addition of several small blackwater rivers and streams. As the Altamaha branches at the delta, the vegetation changes from bottomland hardwood and cypress swamps to brackish marsh, to tidal mudflats and saltmarsh. The Altamaha estuary is a highly productive biological system. With reservoirs located only in the upper watershed, the Altamaha is the longest free-flowing system on the Atlantic Coast.

The Altamaha River watershed supports a wide array of biologically diverse ecosystems. The watershed boasts the highest documented number of rare plants, animals and natural community occurrences in the state of Georgia (see Appendices). Over 100 rare plants and animals occur here. Of these 15 are federally listed as threatened or endangered, 17 are state listed and are considered globally rare or imperiled. More than 50 natural communities are found in the area, and two extremely rare plants occur no where else in the world but Georgia - hairy rattleweed (*Baptisia arachnifera*) and Radford dicerandra (*Dicerandra radfordiana*). The Altamaha River supports the largest southern population of the Atlantic sturgeon and shortnose sturgeon and probably the largest population of Atlantic sturgeon in US waters. Seven of Georgia's eight endemic mussels are found in the Altamaha. The Altamaha spiny mussel has been nominated as a candidate for listing and two other mussels, the Arc mussel and inflated floater are considered to be imperiled species. Freshwater and nutrient transport from the Altamaha supports a globally important marine area that is one of the largest near shore live-bottom reefs in the southeastern US. Sediments and water from the Altamaha help maintain two barrier island complexes and numerous marsh islands. The Altamaha River contains globally important terrestrial, riverine, estuarine and marine systems. The incredible biological diversity of the Altamaha River watershed is important to both the economic and the ecological health of the surrounding region and the state as a whole.

Conservation planning history

As one of the 75 Last Great Places and an early landscape-level project for The Nature Conservancy (TNC), the Altamaha River has been a focal project as TNC developed conservation planning methodologies. The first Conservation Plan was produced in 1994 at the conclusion of the Altamaha River Bioreserve Inventory and Ecosystem Initiative. The conservation plan was updated in 1997 and 2001. The Altamaha River was selected as one of TNC's pilot projects to apply the first version of the Conservation Area Planning Excel Workbook. The current conservation planning effort, in collaboration with the SARP's pilot rivers project, t is the third version of the Workbook to be used. In addition to the Excel Workbook, an Altamaha River Conservation Plan Report has been produced for each update and has proved to be a valuable tool. Due to the complexity of the Altamaha system ranging from terrestrial to marine components, the estuarine and marine targets are being addressed in a separate conservation Excel Workbook and will be added in 2006.

Conservation targets

Eight conservation targets were selected to best capture the biodiversity and ecological processes in the Altamaha River Watershed project area. The terrestrial ecosystem targets (Longleaf Pine Mosaic, Isolated Sand Ridges and Their Wetlands, and Forested Bluff Communities) represent the dominant vegetation and unique features of the South Atlantic Coastal Plain in which the aquatic targets are embedded. Although the aquatic ecosystem targets could be considered to be one target, they were divided into three targets (Medium and Large Coastal Plain Alluvial Rivers, Small Coastal Plain Rivers, Streams, and Floodplains, and Floodplains and Tidal Freshwater Wetlands) that were subject to different threats. Maintenance of the processes and functions and abatement of threats of the targets will sustain the rich plant and animal diversity they support. The two species targets (Diadromous Fish and Rare Freshwater Mussels) were selected as focal targets because their sustainability depends on conservation strategies that go beyond those for the ecosystem targets. Little is known about the life cycles and threats of these species, therefore research about their life requirements and thresholds is a primary strategy.

Priority threats

Sixteen threats were identified for the eight conservation targets in the Altamaha River Watershed. The six highest ranked threats are listed below:

- Dam Construction and Operation
- Forestry Practices
- Excessive Groundwater/Surface Water Withdrawals
- Commercial/Residential Development
- Invasive/Alien Species
- Fire Suppression

Conservation objectives and strategies

The planning team developed 20 conservation strategies to fulfill conservation and threat abatement goals for the Altamaha River Watershed. For each conservation strategy, a list of implementation or action steps is presented and incorporated in the TNC-GA annual strategic plan and staff goals and objectives. Lead staff members and time lines for implementation are noted for each step. The 20 strategies are summarized in 10 broad objectives below:

- Improve flow regimes and fish passage past Fall Line dams
- Minimize impacts on conservation targets of forestry operations by industrial landowners
- Research impacts of state permitted water withdrawals on thermal refuges
- Research toxicity of wastewater discharges and stormwater runoff on mussels
- Control or eliminate terrestrial and aquatic invasive species from watershed
- Facilitate ecological management through management agreements with public and private landowners
- Secure conservation easements on or acquisition of priority lands
- Minimize impacts of current and future commercial and residential development

- Minimize the effects of groundwater and surface water withdrawal by influencing the water management planning processes
- Protect spawning habitat, foraging habitat and thermal refugia for sturgeon and mussels

Conservation success measures and adaptive management

The Altamaha River Watershed project is a large and complex area that would require tremendous resources to adequately monitor all system and species targets. As resources are limited, measurement of conservation success has been largely in partnership with ongoing efforts that complement the objectives of this plan. The project measures fall into three general categories with lead partners in parentheses:

General Conservation Status

1. South Atlantic Coastal Plain ecoregional planning (TNC)
2. Protected areas (TNC)
3. Area burned (TNC/Georgia Department of Natural Resources [GADNR])
4. Location and extent of invasive species (TNC)

Species Targets

1. Rare freshwater mussels (GADNR)
2. Diadromous fish (GADNR)

Reference Coastal Plain River

1. Hydrologic analyses (TNC)
2. Floodplain macroinvertebrate community (University of Georgia)
3. Fish utilization of floodplain (U.S. Geological Survey)

Adaptive management is ongoing in Altamaha River Watershed project. Results of the project monitoring efforts as well as continually developing information are used to re-evaluate objectives and actions on a frequent basis.

Stakeholders and Partners

Primary partners include the Georgia Department of Natural Resources (Coastal Resources Division, Wildlife Resources Division and Environmental Protection Division), US Fish and Wildlife Service, University of Georgia, Middle Georgia College, Georgia Power, Rayonier, International Paper, Plum Creek, Sapelo Island Estuarine Research Reserve, Altamaha Riverkeeper, Georgia River Network, landowners, local governments and organizations.

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Introduction: The Altamaha River

Georgia's Altamaha River watershed, the third largest watershed on the eastern seaboard of the United States, drains 19,400 square kilometers (7,760 square miles) of Piedmont terrain and 28,800 square kilometers (11,520 square miles) of Coastal Plain (Georgia Department of Natural Resources, Environmental Protection Division, 1986). This area covers approximately one-quarter of the state. The Altamaha River begins at the confluence of the Oconee and Ocmulgee Rivers near Hazlehurst, Georgia, then flows 220 kilometers (137 miles) southeasterly across the lower Coastal Plain before draining into the Atlantic Ocean. The floodplain of the Altamaha is is up to 9.6 kilometers (6 miles) wide. The main stem is unobstructed by dams, and with reservoirs located only in the upper watershed, the Altamaha is the longest free-flowing system on the Atlantic Coast.

The headwaters of the Altamaha River are vegetated primarily by southern mixed hardwood-pine forest. Both the Ocmulgee and Oconee Rivers are impounded, but all of the dams in the main stream channels are located at or above the fall line, 540 kilometers (337 miles) and 441 kilometers (275 miles) upstream of the ocean. As the river system leaves the Piedmont, the upland landscape changes to a sandier, southern pine ecosystem in the Coastal Plain. Several small blackwater rivers enter the Altamaha River in the lower Coastal Plain. As the Altamaha branches at the delta, the vegetation changes from bottomland hardwood and cypress swamps to brackish marsh, to tidal mudflats and saltmarsh. The Altamaha delta is a highly productive biological system. Its estuarine nursery supports significant commercial and recreational harvests of finfish and crustaceans. This highly productive area provides important resting, feeding and reproductive habitat for a wide diversity of waterfowl, wading birds and mammals.

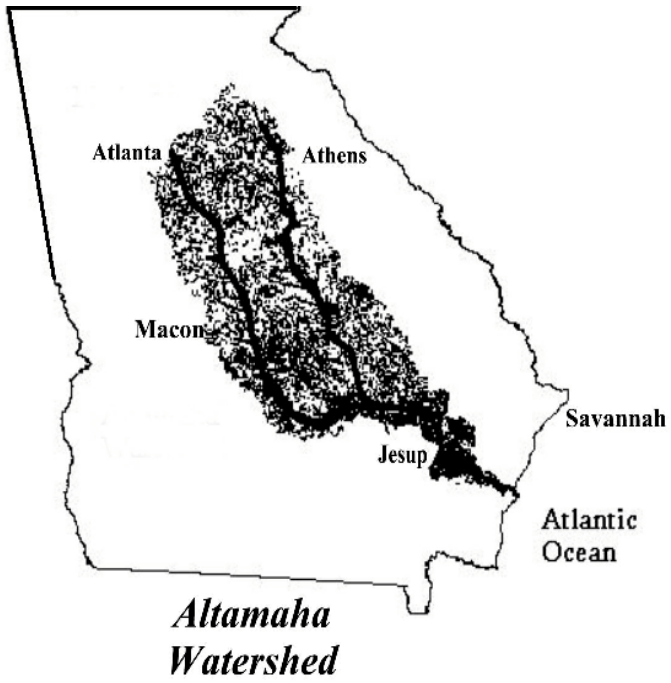


Figure 2. Location of the Greater Altamaha River Basin in Georgia.

The Altamaha River's origins in the southern Piedmont classify it as an alluvial or brown water river. The river has a large watershed and a high average rate of discharge (Georgia Department of Natural Resources, Environmental Protection Division, 1986). The Altamaha River transports an average of 3.2 trillion gallons of water to the Atlantic Ocean every year, making it the largest river discharge south of the Chesapeake Bay (Van der Leeden, 1993). The Altamaha River accounts for just over one-sixth (or 18 percent) of the freshwater inputs to the South Atlantic continental shelf (Menzel, et al., 1993). The lower watershed falls in elevation from approximately 30 meters (90 feet) above sea level on the Hazlehurst North quad to sea level on the Darien quad, dropping on average 0.13 meters per kilometer (Wharton, 1978). The tidal influence of the Atlantic Ocean extends from the estuarine boundary upriver to a variable point approximately 50 river kilometers (80 miles) from the mouth (Georgia Department of Natural Resources, Environmental Protection Division, 1986).

The Altamaha River watershed supports a wide array of biologically diverse ecosystems. The watershed boasts the highest documented number of rare plants, animals, and natural community occurrences in the state of Georgia (see Appendices). Over 100 rare plants and animals occur here. Of these 15 are federally listed as threatened or endangered, 17 are state listed and are considered globally rare or imperiled. More than 50 natural communities are found in the area, and two extremely rare plants occur no where else in the world but Georgia - hairy rattleweed (*Baptisia arachnifera*) and Radford dicerandra (*Dicerandra radfordiana*). The Altamaha River supports the largest southern population of the Atlantic sturgeon and the endangered shortnose sturgeon (*Acipenser brevirostrum*) and probably the largest population of Atlantic sturgeon in US waters. Seven of Georgia's eight endemic mussels are found in the Altamaha. The Altamaha spiny mussel has been nominated as a candidate for listing and two

other mussels, the Arc mussel and inflated floater are considered to be imperiled species. The watershed is also home to, red-cockaded woodpecker (*Picoides borealis*), the gopher tortoise (*Gopherus polyphemus*) and the eastern indigo snake (*Drymarchon corias couperi*). The watershed provides critical habitat for nesting, breeding and feeding Neotropical migratory birds (e.g., vireos, warblers) and colonial water birds (e.g., wood storks, brown pelicans, terns). Endangered West Indian manatees (*Trichechus manatus*) are also frequent visitors to the lower Altamaha River in the spring and summer (The Nature Conservancy of Georgia, 1995).

In cooperation with the USFWS, research was conducted to study habitat use by neotropical migratory breeding birds within the forest corridor along the Altamaha River. Forty-two species of birds were recorded, 18 of which were neotropical migratory breeding birds. The 1993 and 1994 field seasons provided results which clarify the importance of Altamaha River bottomlands to neotropical migratory breeding birds requiring extensive, mature forests in which to nest. Based on these results, the Altamaha River provides the most important migratory bird habitat corridor in the state's coastal plain. In conjunction with the neotropical migratory breeding bird survey, a year-long survey in a variety of habitats throughout the basin was conducted. During the survey, 35,292 individual birds of 160 species were documented. The Altamaha River provides important habitat for breeding and wintering birds, and vital routes and stopover points for spring and fall migrants. The Western Hemisphere Shorebird Reserve Network recognized the Altamaha River Delta as the 40th major reserve for shorebirds highlighting its importance as a stopover for migratory and wintering birds traveling between the Arctic and South America. Supporting at least 55,000 seabirds and shorebirds annually, the rich Altamaha provides nutrients and isolated habitat.

Freshwater and nutrient transport from the Altamaha supports a globally important marine area that is one of the largest near shore live-bottom reefs in the southeastern US. Gray's Reef National Marine Sanctuary is located 17.5 nautical miles off Sapelo Island. Sediments and water from the Altamaha help maintain two barrier island complexes, Sapelo and St. Simon's and numerous marsh islands. The Altamaha River is a world class river including globally important terrestrial, riverine, estuarine and marine systems. The incredible biological diversity of the Altamaha River watershed is important to both economic and the ecological health of the surrounding region and the state as a whole.

The incredible biological diversity of the lower Altamaha River watershed is important to both the economic and the ecological health of the surrounding region and the state as a whole. The river and its surrounding lands provide critical habitat and food sources needed for the survival of a variety of plants and animals. For example, the wetlands and uplands surrounding the river are home to game species (e.g., waterfowl, white-tailed deer, wild turkeys and wild hogs) and rare nongame species (e.g., gopher tortoises, red-cockaded woodpeckers, southern bald eagles, wood storks and eastern indigo snakes). The waters of the Altamaha River are also home to many species of finfish (e.g., bass, bream, catfish, red drum, seatrout, shad and sturgeon), shellfish (e.g., shrimp, blue crabs, mussels, oysters and clams) and other important aquatic organisms. These species, in turn, support a multimillion-dollar commercial and recreational fishery and tourist industry, making fishing a staple of the economy of the region. The economic and ecological well being of the lower Altamaha River watershed are, therefore, closely linked and interdependent (The Nature Conservancy, 1997).

Through the initial support of the Woodruff Foundation, the Georgia Power Company, Savannah Electric Power Company, and the Environmental Protection Agency, The Nature Conservancy began development of a system-wide conservation plan to protect the lower Altamaha River basin in 1992. Information from early inventories provided the framework for strategic planning. Stresses that affected the health of the Altamaha River and their sources were identified. Strategies to mitigate the sources were developed. While the Altamaha River ecosystems have been isolated from many stresses in the past, development, forestry and water use pressures have increased in this valuable area, and the resources are even more threatened. While current conditions appear to be are relatively healthy when compared to other large river systems, cumulative threats are degrading the health of the system. Proactive and restorative actions are needed to maintain and improve ecosystem functions and target health. This is a critical time to engage multiple stakeholders in the implementation of multiple conservation actions. This report represents an update to the original plan, as new information and knowledge has been obtained to lend to the greater understanding of the important features and threats of this unique ecosystem.

Stakeholder Assessment

To accurately develop strategies that address threats to the Altamaha River targets, it is necessary to identify the primary stakeholders related to each threat. The following is the procedure which the Altamaha River Bioreserve staff followed in 2000 to assess stakeholder attitudes and their relationships to the seven highest ranked of the critical threats and to each other. The Stakeholder Assessment was revaluated in 2005 during the update of the Conservation Action Plan. As of October 21, 2005, the results of Expert Meetings were being compiled and will be incorporated.

During 2005, The Nature Conservancy hosted or participated in thirteen meetings that have been used to solicit input on targets, threats and strategies for the update of the Altamaha River Conservation Action Plan. Meetings were conducted throughout the watershed in Darien, Brunswick, Macon, Athens, Balls Ferry, Jesup, Hazlehurst and Milledgeville. The number of participants attending the meetings ranged from 3 to 35. Participants included the Georgia Department of Natural Resources (Coastal Resources Division, Wildlife Resources Division and Environmental Protection Division), US Fish and Wildlife Service, University of Georgia, Middle Georgia College, Georgia Power, Rayonier, International Paper, Plum Creek, Sapelo Island Estuarine Research Reserve, Altamaha Riverkeeper and Georgia River Network. Six aquatic workshops, in addition to these meetings, were hosted 2003 – 2005. Participants included local governments, landowners, agencies, industries and communities (water and land users and managers).

Situational Mapping

In the first phase of the Stakeholder Assessment, the Bioreserve staff used a Situational Mapping exercise to identify stakeholders who are contributing to the threat in a physical or socio-political way, benefiting from the threat economically or taking action to eliminate the threat. The exercise involved using a flip chart on which was written the name of the threat. From that point, the group systematically identified stakeholders, using the chart to diagram relationships between the stakeholders and the threat as well as relationships between stakeholders. The staff did this for each of the seven threats.

Stakeholder Matrix Tool

Being developed for site conservation planning throughout the Conservancy, the Stakeholder Matrix Tool is a visual graph to assess the degrees by which primary stakeholders have an affect on or derive a benefit from the source of the threat. The first step of this exercise involved identifying the 10 primary stakeholders for each threat based on the results of the Situational Mapping diagrams. [In some cases, more or less than 10 primary stakeholders were identified and some stakeholders were grouped together.] The following stakeholders were identified in 2000 and revaluated in 2005 during the update of the Altamaha Conservation Action Plan:

Groundwater/Surface Water Withdrawl

- GA Environmental Protection Division
- Paper mills
- Proposed wildlife park and north Glynn
- Macon & other Piedmont communities
- Appling, Wayne, Toombs and Tattnall counties
- Plant Hatch
- TSG (based on current proposal)
- Small cities on Floridian (north bank cities)
- Individual Farmers

Commercial/Residential Development

- Chambers of commerce
- County and City governments
- Development authorities
- Real estate developers
- Landowners
- Business owners
- GA Environmental Protection Division
- U.S. Army Corps of Engineers
- GA Department of Community Affairs
  GA Dept. of Industry, Trade and Tourism
- Regional Development centers

Forestry Practices

- Private non-industrial landowners
- Investment groups
- Forest products industries
- Loggers
- Forestry consultants
- GA Forestry Commission
- U.S. Army Corps of Engineers
- Public landowners
- U.S. EPA and GA EPD
- Forestry associations
- Chemical industry

Dam Construction and Operation

- GA Environmental Protection Division
- NRS groups
- U.S. Army Corps of Engineers
- Academics
- ACF negotiators
- Farmers
- Piedmont municipalities
- Coastal Plains municipalities
- State legislature/governments
- Consultants for EPD (CDM)

Non-native Invasive Species

- GA DNR (fisheries and WRD)
- Private landowners
- Exotic Pest Council
- GA Dept. of Transportation
- Altamaha Wildlife Management Area staff
- Fisherman and fishing businesses
- Nurseries and retail stores
- Academic researchers
- Hunters

Fire Suppression

- Public landowners
- Private non-industrial landowners
- Investment groups (landowners)
- Pulp mills
- GA Prescribed Burn Council
- Forestry associations
- Communities/home owners
- Forest products industry landowners
- Forestry consultants
- GA Forestry Commission

Once the primary stakeholders were identified and entered into the matrix, the group discussed each stakeholder's influence/impact in the watershed based on the following criteria:

Physical Contribution: How a stakeholder's physical actions or activities contribute to the source of stress.

Socio-Political Influence: Assesses a stakeholder's ability or decision-making power to drive actions that contribute to the source of stress.

Economic Benefit/Stake: Assesses how a stakeholder benefits economically from the source of stress.

Unwillingness to Engage: Assesses the stakeholder's willingness or unwillingness to engage in strategy implementation.

Lands in Conservation: Lower Altamaha River Watershed

Since the first Altamaha acquisition in 1969, The Nature Conservancy has played a role in protecting more than 40,600 acres in the Lower Altamaha River basin through acquisitions, easements and management agreements.

Table 1. Lower Altamaha lands in conservation.

Conservancy Preserves:	**Acres**
Cathead Creek, 1992	752
Carr's Island, 1996	367
Moody Forest Natural Area, 2001, 2003, 2004	4,368
(*DNR owns 2,368 acres; TNC owns 2,000 acres)	
Penholloway Conservation Easement, est. 2006	705
Total	6,192
Conservancy Assisted Projects:	
Wolf and Egg Islands (Savannah Refuge), 1969	4,572
Big Hammock Natural Area, 1972	801
Lewis Island Natural Area (Altamaha WMA), 1972	5,633
Hofwyl-Broadfield Plantation, 1974	1,268
Altamaha-Rayonier Area (Altamaha WMA), 1977	1,331
Cathead Tract (Altamaha WMA), 1982	1,021
Audley Farms Tract (Altamaha WMA), 1994	324
Griffin Ridge WMA, 1996	5,616
Long County DOT Mitigation, 1996	1,300
Long County DOT Mitigation, 2000	3,970
Potosi Island (Altamaha WMA), 1998	1,945
Tillman Tract (Big Hammock WMA), 1998	581
International Paper & The Timber Company Conservation Easement, 2000	1,300
Montgomery DOT Mitigation, 1997	898
Clayhole Swamp WMA, 2005	5,492
Penholloway Swamp WMA, 2005	4,552
Total	40,604
Cooperative Management Agreements:	
International Paper Dicerandra site, 1998	200
International Paper Coreopsis site, 1998	70
The Timber Company Sansavilla Springhead, 1998	8
The Timber Company Leitneria site, 1998	30
Total	38
Additional Lands:	
Bullard Creek WMA, 1961	8,442
Altamaha Wildlife Management Area, 1957, 1959	12,478
Big Hammock WMA, 1973, 1989	5,566
Total	26,486
Grand Total	**73,320**

Overview of Methods

Clearly defining conservation targets is the first and most critical step in the site conservation planning process. Conservation targets are the basis for all subsequent steps in the planning process and ultimately determine what conservation actions will be taken. The goal of selecting targets is to represent the biodiversity of the site and capture its "functionality"—or the ecological processes that sustain diversity. Therefore, conservation targets should occur at multiple scales across all ecological systems such that the long term functionality or collective viability of the site is ensured if they are conserved (Richter and Poiani 2000). The list of "focal" targets is limited to eight in order to encourage a systematic approach towards developing a succinct list that is "indicative of threats and viability of the biodiversity of interest" at the site (TNC 2000).

The viability of each conservation target is then ascertained based on an evaluation of the ecological processes and attributes necessary for the target's long term persistence. This information is crucial to establish a viability baseline for each target by which to analyze stresses to the targets, set conservation goals, determine conservation strategies, and ultimately, to measure success of conservation actions over time. To accomplish this, specific viability attributes have been developed for each conservation target. Size, condition and landscape context are the factors used to indicate the viability of a target system, community, or species. They are defined as follows (TNC 2000):

- **Size**: A measure of the area or abundance of the conservation target's occurrence.
- **Condition**: An integrated measure of the composition, structure and biotic interactions that characterize an occurrence
- **Landscape context**: An integrated measure of two factors: the dominant environmental regimes and processes that establish and maintain the target occurrence and connectivity

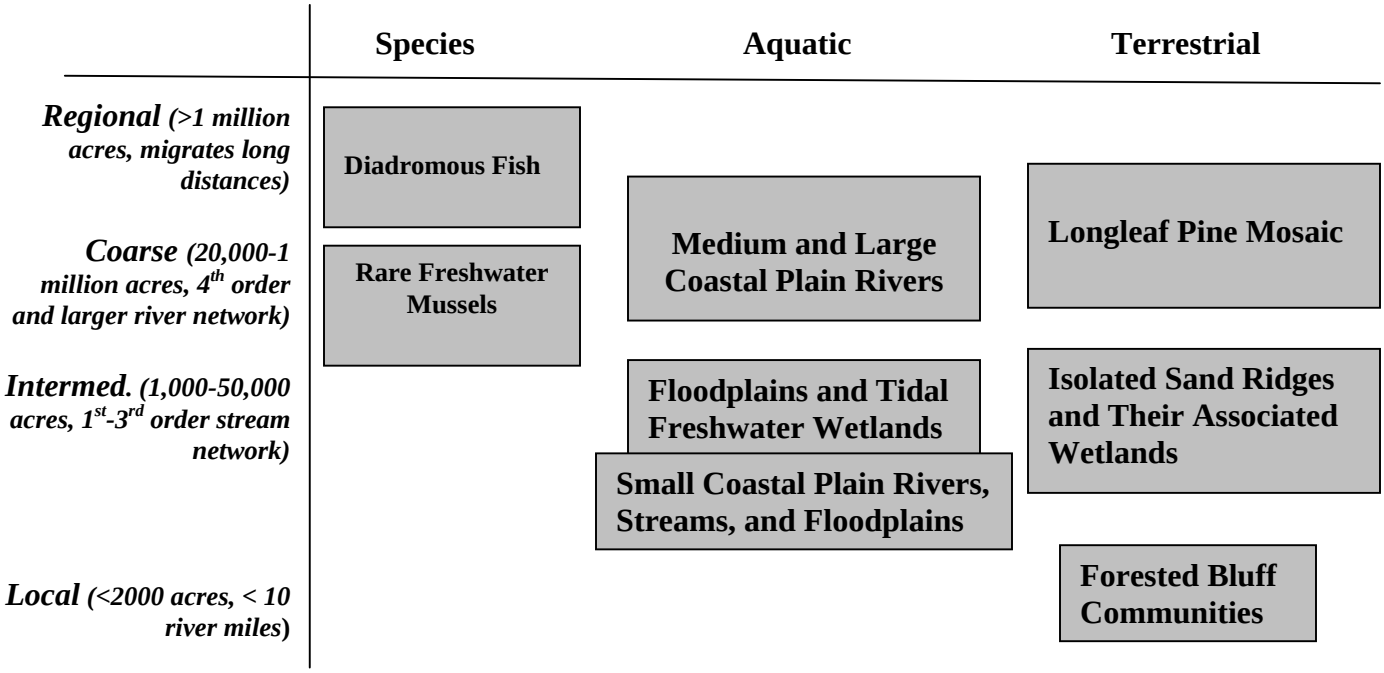
Size, condition and landscape context are indicators of viability but do not necessarily equal viability. They are a more accurate measurement of current status from which we project or infer the target's ability to persist and be resilient over the long term.

For each of the Altamaha River Watershed focal conservation targets, qualitative criteria have been developed to rank the target's size, condition and context, and in turn the target's overall viability. The ranking system consists of four general categories: "Very Good", "Good", "Fair" and "Poor". Therefore, each of the three variables (size, condition and context) is attributed with specifications that define the 4 quality ranks. The target viability attributes are found in the associated Conservation Action Plan workbook that is updated on a regular basis. An overall viability rank per target is derived from averaging the size, condition and context ranks for all occurrences throughout the site. Individual viability "scores" for the targets are then aggregated to develop a biodiversity health rank for the site as a whole, establishing a baseline from which to measure future success towards conserving the site (TNC 2000).

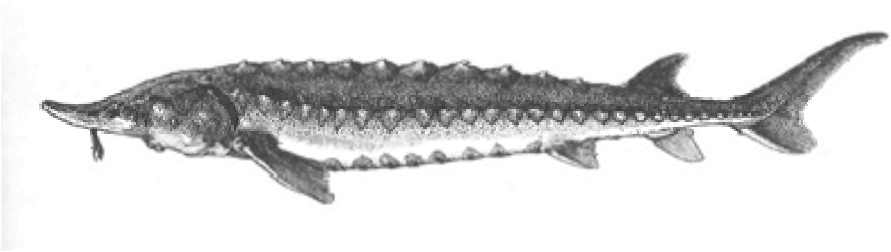
Conservation Targets

Eight conservation targets were selected to best capture the biodiversity and ecological processes in the Altamaha River Watershed project area (Figures 1 and 2). The terrestrial ecosystem targets (Longleaf Pine Mosaic, Isolated Sand Ridges and Their Wetlands, and Forested Bluff Communities) represent the dominant vegetation and unique features of the South Atlantic Coastal Plain in which the aquatic targets are embedded. Although the aquatic ecosystem targets could be considered to be one target, they were divided into three targets (Medium and Large Coastal Plain Alluvial Rivers, Small Coastal Plain Rivers, Streams, and Floodplains, and Floodplains, and Tidal Freshwater Wetlands) that were subject to different threats. Maintenance of the processes and functions of the terrestrial and aquatic targets will sustain the rich plant and animal diversity they support. The two species targets (Diadromous Fish and Rare Freshwater Mussels) were selected as focal targets because their sustainability depends on conservation strategies that go beyond those for the ecosystem targets. So little is known of these threatened species that research about their life requirements is a primary strategy.

Figure 2. Altamaha River Watershed conservation targets represented across different levels of biological organization at multiple scales.



Diadromous Fish



Target type: Aquatic species group
Target scale: Coarse to regional

Included Species and/or communities: Focal species are the shortnose sturgeon (*Acipenser brevirostrum;* G3/S2) and Atlantic sturgeon (*A. oxyrhynchus;* G3/S3). Conservation of sturgeon and their habitat also helps conserve other diadromous species with similar habitat needs (e.g., clear passage to upstream spawning locations) or which use the same sites as sturgeon for thermal refugia (e.g., American shad, striped bass) or spawning (e.g., blueback herring, hickory shad, sea lamprey, possibly American shad).

Target Justification

Shortnose and Atlantic sturgeon are rare big river species that are dependent on limited critical habitat widely spaced along the entire distance of the Altamaha River and its two major tributaries and spanning a variety of aquatic community types. Sturgeon, like all diadromous species, depend on clear passage from estuarine nursery and foraging areas to spawning sites located between tidewater and the Fall Line. Research indicates that long-term viability of spawning sites is linked in part to land use in adjacent floodplain and terrestrial (e.g., forested bluff) communities, high quality examples of which are also conservation targets for the Altamaha. The sturgeon, as well as many other diadromous fishes (particularly shad and striped bass) depend on thermal refuge areas. These areas providing thermal refugia may be groundwater-fed and are only found at a limited number of over-summering sites in the lower Altamaha and perhaps in the upper coastal plain. Both sturgeon species feed on freshwater mollusks and mussels, some of which are themselves important conservation targets for the Altamaha.

Sturgeon are ancient species that are often considered ecological relicts from earlier geologic eras and sea level regimes, and as such may be vulnerable to a unique set of stresses not specifically addressed by conservation of the larger aquatic system. The Altamaha River supports the largest southern populations of the Atlantic and shortnose sturgeon. It may contain the largest population of the Atlantic sturgeon in US waters and it supports the largest population of shortnose sturgeon south of the Chesapeake Bay. Found historically in 24 Atlantic coast rivers ranging from the St. John River, New Brunswick, to the Indian River, Florida (Weber et al. 1998), shortnose sturgeon has declined range wide and is federally-listed as an

endangered species. Once found in all major coastal rivers in Georgia, shortnose sturgeon are now believed to be limited to the Altamaha, Ogeechee and Savannah rivers. The decline of both species of sturgeon may be the result of the decrease or absence of summer refuges, bycatch mortality in the shad fishery and habitat degradation of water quality and spawning substrate. Based on Doug Peterson's research, the annual run size of adult Atlantic sturgeon was 353 in 2004 and 542 in 2005. These data suggest that the federal ban on the Atlantic sturgeon fishery has benefited the Altamaha population. Peterson (Peterson, pers. com 2005) has documented significant numbers of bottom set gill nets during the 2004 and 2005 commercial shad seasons (January through March) and seeks to initiate a comprehensive evaluation of bycatch in the Altamaha commercial shad fishery, with particular emphasis on quantifying the incidental catch of Atlantic sturgeon. They have also estimated the shortnose population at approximately 6000 and have identified a spawning site at the confluence of the Ocmulgee and Oconee rivers. They think that Atlantic sturgeon are spawning in the Ocmulgee River, ~ 175 – 200 miles from the estuary and are seeking funds to conduct a three-year study of the life history variation of the Atlantic sturgeon in the Altamaha River.

Location in Altamaha basin: Habitat needs of this species group historically spans the entire river from the headwaters in the Piedmont to estuary and some tributaries, but critical habitat is widely spaced and extremely limited. The Fall Line dams limit passage of these species to more than half of their historic spawning areas in the Piedmont portion of their natural range.

Table 2. Key Ecological Attributes and Indicators for Sturgeon and Other Diadromous Fish.

KEA	Description	Indicators for monitoring program
Connectivity among communities & ecosystems Stress Rank – Very High	Presence of mainstem dams reduces availability of spawning areas by blocking many diadromous fish from their historic spawning areas in the Piedmont	Fish passage past barriers
Water/soil temperature Stress Rank – High	Cool water discharges into deep holes and springs along the rivers provide thermal refuges from hot summer river water for diadromous fish, particularly for stripped bass and Atlantic sturgeon	Water temperature in deep holes and springs
Population size and dynamics Stress Rank – High	Characteristics of a species age class distribution can indicate patterns of recovery, stability, or decline of populations	Age class distribution by species
	Numbers of individuals over time can indicate patterns of recovery, stability, or decline of populations	Abundance by species
Hydrologic regime - (timing, duration, frequency, extent) Stress Rank – Medium	Large ranges of daily water level fluctuations below mainstem dams reduces available habitat for spawning and causes stranding of eggs	Range of daily water level fluctuations
	Reduced flows during spawning periods reduces spawning habitat availability and currents to carry eggs downstream	Seasonal flow rates below dams
Soil / sediment stability & movement Stress Rank – Medium	Sediments embed coarse substrates and reduce flows and dissolved oxygen in substrates that are required for egg survival	Availability of suitable spawning habitat on coarse substrates
Water chemistry Stress Rank - Medium	Location of the salinity-freshwater interface determines availability of habitat for diadromous fish, particularly shortnose sturgeon when they are not spawning	Number of canals connecting channels in the estuary

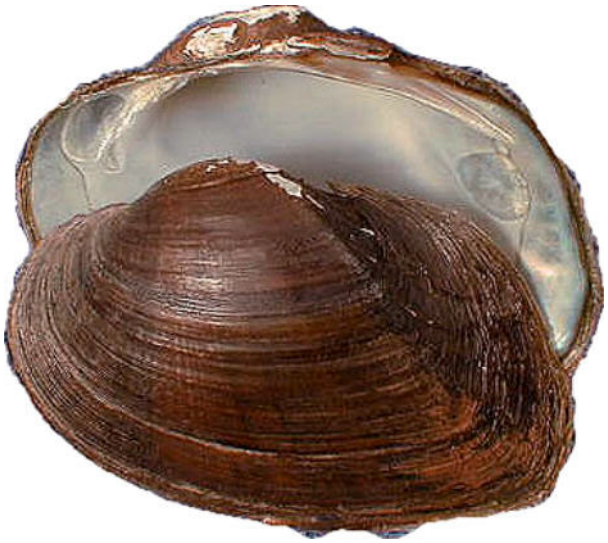
Critical threats

Threat rank Very High - Dam construction and operations (blocks passage to spawning areas and alters hydrologic regime of limited spawning habitat)

Threat rank High - Excessive groundwater withdrawal (alters thermal and salinity refugia)

Threat rank Medium – Over-fishing (diminishes populations below sustainable levels)

Rare Freshwater Mussels



Target type: Aquatic species group
Target scale: Intermediate

Included Species and/or communities: Includes eleven rare species of the Altamaha watershed: Altamaha spinymussel (*Elliptio spinosa;* G1/S1S3 – candidate for listing), Altamaha arc mussel (*Alasmidonta arcula;* G2/S1S2), Altamaha lance (*Elliptio shepardiana;* G2/S), Altamaha pocketbook (*Lampsilis dolabraeformis;* G2/S?), Altamaha slabshell (*Elliptio hopetonensis;* G2/S?), inflated floater (*Pyganodon gibbosa;* G1G2/S?), barrel floater (*Anodonta couperiana;* G3/S?), eastern creekshell (*Villosa delumbis;* G3/S?), Georgia elephant-ear (*Elliptio dariensis;* G3/S?), rayed pink fatmucket (*Lampsilis splendida;* G3/S?), Savannah shore lilliput (*Toxolasma pullus;* G3/S1S3). This target in theory also includes larval host fishes for the identified mussel species. However, at present few of the larval host fishes are known for Altamaha mussel species. Based on mussel reproductive strategies and knowledge of Altamaha fish community composition, it is suspected that *Centrarchids* and other sunfish allies are the mostly likely candidates. The *Centrarchids* are among the most abundant and diverse fish taxa in the south Atlantic coastal plain, comprising a large part of what many researchers have called a "characteristic coastal plain fish community." Other fish hypothesized as larval hosts for Altamaha mussels include striped mullet (*Mugil cephalus*).

Target Justification

The Altamaha River basin harbors eleven species of G1-G4 mussels, seven of which are endemic to the river and its larger tributaries. While little historic data exists to quantify changes, many mussel experts believe that some species are declining. Three endemics, the Altamaha spiny mussel (*Elliptio spinosa*), Altamaha arcmussel (*Alasmidonta arcula*) and inflated floater (*Pyganodon gibbosa*) are thought to be declining (Wisniewski et al. 2005). The Altamaha spiny mussel was recognized as a candidate for listing in 2002 and the Altamaha arc mussel and the inflated floater are considered to be imperiled species. GA DNR analysis of data indicates the percentage of sites occupied within that the percentage sites occupied within the

Altamaha has declined since the early 1990s. They recommend the development of a long-term monitoring program for Altamaha basin mussels (Wisniewski et al. 2005). Research to determine host fish species, water and sediment analysis and habitat protection are also needed.

Freshwater mussels are one of the most imperiled groups of animals in North America and are highly sensitive to degradation of water quality, habitat, and hydrologic regime. Rarity, shared habitat preferences and taxonomic uncertainty among several of the included mussel genera, especially *Elliptio* and *Pyganodon/Anodonta*, support combining these species as a single target. Research has shown that distribution and community structure of freshwater mussel species within watersheds is highly dependent on the distribution of fishes that serve as hosts for larval mussels. Many of the larval hosts for Altamaha mussels are not yet known while others are known to be threatened by degradation of habitat and predation by non-native flathead catfish. Therefore these two groups of interrelated species – mussels and larval host fishes – are combined here as one target.

Location in Altamaha basin: Populations of endemic mussels occur throughout the Altamaha watershed, especially on the Altamaha River and larger tributaries. Highest quality areas occur on the Altamaha River in the vicinity of Big Hammock WMA and on the Ohoopee River, though recent occurrence information from the latter is lacking. Greatest concentration of species appears to be in Appling, Long, Wayne, Tattnall, and Toombs Counties, but perhaps this is a product of relatively high sampling effort in those areas compared to other parts of the watershed.

Table 3. Key Ecological Attributes and Indicators for Rare Freshwater Mussels.

KEA	Description	Indicators for monitoring program
Population structure & recruitment Stress rank – Very High	Characteristics of a species age class distribution can indicate patterns of recovery, stability, or decline of populations	Age distribution of rare mussels by species
Population size & dynamics Stress rank – Very high	Trends in numbers of individuals over time can indicate patterns of recovery, stability, or decline of populations	Abundance of rare mussels by species
Species composition / dominance Stress rank - High	Presence of larval mussel host fish species in adequate numbers on mussel beds is necessary for mussel reproduction	Presence of host fish
	Invasive species (e.g., flathead catfish) that impair host fish would impair mussel reproduction	Evidence of impacts of invasive species on host fish
Soil / sediment stability & movement Stress rank - High	Sediments can bury existing mussel beds	Bank erosion rate
	Sediments embed coarse substrates and reduce flows and dissolved oxygen in substrates that are required for juvenile mussel survival	Turbidity in priority areas
Water chemistry Stress rank - High	Mussel respiration and reproduction rates are impaired by absorption of heavy metals from water and organic matter	Levels of heavy metals in water and sediments
	Nitrogen acts as an endrocrine disruptor in mussels	Nitrogen concentrations in water
Hydrologic regime - (timing, duration, frequency, extent) Stress rank - Medium	The amount of water is related to stage and extent of available mussel habitat on banks and toe of slopes	Percentage of mean annual flow withdrawn
	Large ranges of daily water level fluctuations below mainstem dams reduces available habitat for mussels	Rate of daily change of water levels
Size / extent of characteristic communities / ecosystems Stress rank - Medium	Trends in presence/absence of species from suitable habitat indicates recovery, stability, or decline of populations	Percent of historic sites with live rare mussels by species

Critical threats

Threat rank Very High - Stormwater and wastewater management (discharges of heavy metals and nitrogen); Invasive/alien species (impairment of host fish and mussel reproduction)

Threat rank High – Agricultural crops (non-point sources of chemicals and toxins); Industrial discharge (discharge of heavy metals and other toxins); Dam construction and operation (altered hydrologic regime and blocked passage of host fish)

Threat rank Medium – Forestry (increased erosion and sedimentation from logging along streams and river banks); Submerged log recovery (increased sedimentation of mussel beds)

Medium and Large Coastal Plain Alluvial Rivers

Target type: Aquatic system
Target scale: Coarse

Included Species and/or communities: Includes all aquatic communities of coastal plain portions of the Altamaha, Oconee, and Ocmulgee Rivers. Includes A3 large river and B2 medium river (coastal plain origin) systems in the Freshwater Conservation Area classification system for the South Atlantic Basin (Smith et al. 2002). This target includes all mainstem habitat from tidewater to the Fall Line and provides habitat for many rare or significant aquatic species, including freshwater mussels and their larval hosts (see Rare Freshwater Mussel target description), sturgeon and a variety of other anadromous fishes (see Sturgeon target description), big river minnows such as Bannerfin shiner (*Cyprinella leedsi*; G3/S3S4) and Ocmulgee shiner (*Cyprinella callisema*; G3/S3), and suckers such as Robust redhorse (*Moxostoma robustum*; G?/S?). The aquatic system is characterized by relatively swift currents. Although historically described as blackwater rivers (Lyle 18XX), these rivers now carry high suspended sediment loads with a high proportion of flows derived from surface water runoff, except during the dry season when less turbid groundwater flows dominate. Riverine substrates are largely coarse sands, with only a few small remaining shoal areas below the mainstem dams near the transition between the upper and lower coastal plain on the Altamaha, Ocmulgee, and Oconee Rivers.

Target Justification: This system target is the overarching freshwater target for the Altamaha River. Represents habitat for the two species targets (sturgeon and mussels) along with other listed rare species in the watershed, which include the bald eagle (Haleaeetus leucocephalus), and swallow-tailed kite (*Elanoides forficatus*).

Location in Altamaha basin: Occurs from the Fall Line on Ocmulgee, and Oconee Rivers to tidewater on the Altamaha River.

Table 4. Key Ecological Attributes and Indicators for Medium and Large Coastal Plain Rivers.

KEA	Description	Indicator for monitoring program
Connectivity among communities & ecosystems Stress rank - High	Dams fragment habitats and reduce availability of spawning areas by blocking many fish from their historic spawning areas in the Piedmont	Fish passage past barriers
	Floods allow fish to access floodplains to feed in preparation for spawning	Season and duration of flood events
Hydrologic regime - (timing, duration, frequency, extent) Stress rank - High	The amount of water is related to state and extent of available habitat on banks and toes of slopes.	Percentage of mean annual flow withdrawn
	Large ranges of daily water level fluctuations below mainstem dams reduces available habitat and causes stranding of fish and eggs.	Range of daily water level fluctuations
Species composition / dominance Stress rank – High	Trends in numbers of fish species can indicate recovery, stability, or decline of aquatic habitat conditions.	Abundance of native fish species
	Trends in numbers of individuals can indicate recovery, stability, or decline of mussel populations	Abundance of native freshwater mussels by species
	Trends in numbers of individuals can indicate recovery, stability, or decline of native fish populations	Number of native fish species present
	Trends in numbers of individuals can indicate recovery, stability, or decline of invasive catfish populations	Population size of flathead catfish
Soil / sediment stability & movement Stress rank – Medium	Sediments from failing banks buries shallow habitats	Bank erosion rate
Water / soil temperature Stress rank - Medium	High water temperatures can block passage of fish and degrade habitat	Maximum water temperature below Plant Hatch
	Cool water discharges into deep holes and springs along the rivers provide thermal refuges from hot summer river water for fish, particularly diadromous fish	Water temperature in deep holes and springs
Water chemistry Stress rank – Medium	Absorption of heavy metals from water and organic matter disrupts physiological and reproductive processes of aquatic biota	Levels of heavy metals in water and sediment
	Nitrogen acts as an endrocrine disruptor in aquatic biota, particularly in mussels	Nitrogen concentration
	Pollution from wastewater treatment plants is a primary source of nutrients and other pollutants.	Percent of permitted wastewater discharge from plants with sufficient treatment capacity.
	Suspended solids impair many aquatic biota by clogging gills, reducing visibility, and embedding coarse sediments.	Turbidity
Community architecture Stress rank – Medium	Forested riparian buffers stabilize banks and provide coarse woody debris for bank habitat.	Average width of forested riparian buffer
	Coarse woody debris on banks and in channel provides substrate and hydraulic refuges for fish and macroinvertebrates.	Distribution of coarse woody debris
Size / extent of characteristic communities / ecosystems Stress rank - Medium	Trends in extent and locations of sand bars over time indicates availability of suitable shallow water habitat	Acreage of sand bars

Critical threats

Threat rank High - Dam construction and operation (alters hydrologic regime); forestry operations (increased erosion and sedimentation from inappropriate practices along streams and river banks); invasive/alien species (flathead catfish are voracious predators that reduce diversity and alter community composition); submerged log removal (increased erosion and sedimentation)

Threat rank Medium – Excessive groundwater or surface water withdrawal (alters hydrologic regime, alters thermal regime and degrades thermal refugia); occurrence of ditches and drains (accelerate drainage of uplands and alter salinity gradients at saltwater-freshwater interface)

Floodplains and Tidal Freshwater Wetlands

Target type: Aquatic system with included wetland communities
Target scale: Intermediate to coarse

Included species and/or communities: This target includes a variety of forested swamp and bottomland hardwood community types subject to varying frequencies and durations of river flooding, including such communities that are predominantly tidally influenced. Includes rare species occurring in or utilizing these communities, including Coreopsis integrifolia and a variety of neo-tropical migratory birds and isolated occurrences of rare community types such as canebrake thicket. Includes rare species such as swallow-tail kite, which make use of isolated upland habitat within the floodplain. Also includes all tidally influenced wetland (freshwater and brackish) communities and associated species of the Altamaha delta. The included tidal freshwater wetlands comprise all extant natural wetland communities (e.g. bald cypress-tupelo swamp, southern wild rice fringe marsh) and former rice fields located in the portion of the lower Altamaha with a freshwater, tidal hydrologic regime. By incorporation, this target would also include other rare species occurring or making use of these communities for habitat (e.g., West Indian manatee, Phystostegia leptophylla).

Target justification

The target also includes aquatic habitat within oxbow lakes, historically one of the most productive habitats in the Altamaha basin for game fish such as largemouth bass as well as non-game fish, waterfowl, aquatic mammals, reptiles, and invertebrates. The river aquatic system is intimately linked with adjacent wetland and riparian communities in the floodplain of the river. Accordingly this target also includes a variety of forested swamp and bottomland hardwood community types subject to varying frequencies and durations of river flooding, but

does not include such communities that are predominantly tidally influenced. Includes rare species occurring in or utilizing these communities, including *Coreopsis integrifolia* and a variety of neo-tropical migratory birds and isolated occurrences of rare community types such as canebrake thicket. Includes rare species such as swallow-tail kite, which make use of isolated upland habitat within the floodplain.

Location in Altamaha basin: Occurs from the Fall Line to tidewater on the Altamaha, Ocmulgee, and Oconee Rivers.

Table 5. Key Ecological Attributes and Indicators of Floodplain and Tidal Freshwater Wetlands.

KEA	Description	Indicator for monitoring program
Hydrologic regime - (timing, duration, frequency, extent) Stress rank - High	Rapidly changing levels of water level do not allow adequate time for utilization of floodplain habitats and strand fish that are unable to leave shallow habitats	Rate of daily change of water levels
	Long periods of floodplain inundation during the late winter and spring allow fish and other biota access to feeding areas in preparation for reproduction and growth of young of the year	Season and duration of flood events
Community architecture Stress rank -High	Floodplain forests are comprised of many types of communities that provide a diversity of habitats and food sources	Diversity and distribution of floodplain forest communities
	Floodplain tree species form multi-aged stands that provide a diverse structure and habitats	Diversity and distribution of age classes
	Coarse woody debris naturally collects on channel banks and within floodplains and provides diverse habitats and food sources	Distribution of coarse woody debris
Presence of key communities or seral stages Stress rank -High	The future structure of the floodplain forest depends on the availability of seed trees	Presence of representative plant species and natural communities
Size / extent of characteristic communities / ecosystems Stress rank - Medium	Many animals that use floodplains depend on large, undisturbed tracts of land to escape predators and find appropriate habitat structure.	Median acreage of contiguous, intact floodplain forest
Connectivity among communities & ecosystems Stress rank - Medium	Presence of native fish species in the floodplain indicates that there are connections between the floodplain and river	Fish species using floodplain during inundation
	Bermed roads within floodplains restrict the flow of water and block exchanges with the river	Length of road restricting flow in floodplain
Species composition / dominance Stress rank - Medium	Presence of Chinese tallow indicates the possibility of future dominance of the floodplain forest by an invasive species	Acreage with chinese tallow present
	Flood tolerance of regeneration is similar to canopy species if they develop under similar hydrologic regimes	Similarity of flood tolerance index between canopy species and understory
	An active population of kites indicates a healthy habitat and good conditions to maintain their populations	Number of active swallow-tailed kite nests
	Aquatic macroinvertebrates are good indicators of water quality and flow regime.	Presence of representative macroinvertebrates
	An active population of bear indicates a healthy habitat and good conditions for other floodplain forest inhabitants.	Number of black bears

Critical threats

Threat rank High - Dam operation (alters hydrologic regime on mainstems and connectivity with the river); forestry operations (incompatible practices remove structural diversity and alter species composition); excessive groundwater or surface water withdrawal (alters hydrologic regime and connectivity with the river)

Threat rank Medium –Occurrence of ditches and drains (accelerate drainage of floodplains and alters species composition); Roads (accelerate drainage through associated ditches and block flow of water through floodplains)

Small Coastal Plain Rivers, Streams, and Floodplains

Target type: Aquatic and wetland system
Target scale: Intermediate

Included species and/or communities

This target includes 1st-3rd order groundwater-influenced tributaries originating wholly within the coastal plain, including both aquatic habitat and riparian wetland communities previously referred to as the "small stream swamp system." Includes two major categories of small streams: blackwater tributaries to the Altamaha River in the lower coastal plain, including the Ohoopee River, and spring-fed tributaries to the lower Ocmulgee and Oconee Rivers in the upper coastal plain. The Ohoopee River, a third-order blackwater river draining directly to the Altamaha River, is included in this target for the present; however, given the biological uniqueness of this stream and its surrounding uplands, it is anticipated that a separate site conservation plan will be developed for the Ohoopee at a later date.

Blackwater tributaries are classified as D10 coastal plain blackwater creek/headwater in South Atlantic Basin aquatic systems classification. This incorporates the typical "coastal plain small stream fish community" which is dominated by members of the sunfish (Centrarchidae) and minnow (Cyprinidae) families. Other rare or significant blackwater species covered by this target include eastern creekshell, eastern silvery minnow, American eel, mud sunfish, sailfin shiner, and sawcheek darter. Blackwater streams are characterized by stable groundwater-derived flows, low gradient, and high amounts of organic matter over sand or loamy substrates resulting in low pH and dark, tannin-stained surface water.

Spring-fed tributaries include high quality and/or hydrologically functioning examples of spring head and spring run aquatic communities on first to third order tributaries of the lower Ocmulgee and Oconee Rivers within the discharge zone of the Floridan Aquifer; classified as D20 & D21 headwater/creek systems in South Atlantic Basin aquatic classification. Includes

occurrences of several rare species associated with spring heads and spring-fed tributaries, including red-eye chub, Christmas darter, and Atlantic sturgeon (thermal refugia).

Target justification

This target incorporates high quality examples of small stream swamp, springs and aquatic habitat in the small watersheds that drain directly to river floodplains. Not only does this system harbor communities and species needing conservation action in their own right, but it also represents the primary biohydrologic link between river floodplain and upland land uses. Runoff and flow in these watersheds are major drivers of the hydrology of floodplain swamps, perhaps just as influential as overbank flooding from the main river, and are potentially the primary sources of chemical contaminants and sediment as well. The health of this system is an indicator of the integrity of the groundwater flow regimes of the Surficial and Floridan aquifers. Spring discharge from these tributaries comprises an important and ecologically-significant portion of the baseflow to the Ocmulgee, Oconee and Altamaha Rivers. The spring-fed tributaries harbor several rare fish species that are only found in association with groundwater flows and may provide critical thermal refuge for others.

Location in Altamaha basin

The best defined occurrences of blackwater streams are those tributary to the lower Altamaha River, including the Ohoopee River, Penholoway, Doctors, Beard's, Battle (tributary to the Ohoopee River), Ten-mile, Goose, and Cowpen Creeks. Other occurrences include Rocky/Turkey Creeks on the Oconee River, Tenmile/Bluff Creeks on the Ocmulgee River, and portions of the Little Ocmulgee River. Better quality examples probably occur in the Satilla River basin than in the Altamaha basin.

Springhead tributaries occur below the Fall Line and upstream of the geologic feature known as the Gulf Trough, which cuts across the basin near the confluence of the Ocmulgee and Oconee Rivers. This region corresponds roughly to the portion of the watershed underlain by Altamaha Grit sandstone formation. Tributaries in this region are in need of surveys to identify and evaluate spring heads, hydrologic significance, high quality habitat, and species occurrences; however, a number of prominent spring-fed tributaries are known to occur in this area, including portions of the Little Ocmulgee River, House and Sturgeon Creeks in Ben Hill Co., Rocky, Turkey, and Ochwalkee Creeks in Laurens Co. and numerous others.

Table 6. Key Ecological Attributes and Indicators of Small Rivers, Streams, and Floodplains.

KEA	Description	Indicator for monitoring program
Hydrologic regime - (timing, duration, frequency, extent) Stress rank - High	Ditches and other types of drains in wetlands in and adjacent to the floodplains accelerate runoff into streams, resulting in less water storage and higher flood peaks	Length of ditches and drains in subwatershed
	Dams impair the hydrologic, chemical, physical, and biological nature of streams.	Number of dams
	Pollution from wastewater treatment plants is a primary source of nutrients and other pollutants.	Percent of permitted wastewater discharge from plants with sufficient treatment capacity.
Soil / sediment stability & movement Stress rank - High	Sediments from bank erosion are a primary cause of aquatic habitat degradation	Bank erosion rate
	Roads are conduits for runoff and pollution into streams and rivers	Road density in subwatershed
	Suspended solids impair many aquatic biota by clogging gills, reducing visibility, and embedding coarse sediments.	Turbidity
Connectivity among communities & ecosystems Stress rank - Medium	All native fish species are adapted to riverine conditions and are migratory to some degree. Length of free-flowing streams indicates the extent of habitat.	Length of free-flowing streams
Water chemistry Stress rank - Medium	Absorption of heavy metals from water and organic matter disrupts physiological and reproductive processes of aquatic biota	Levels of heavy metals
	Nitrogen acts as an endrocrine disruptor in aquatic biota, particularly in mussels	Nitrogen concentration
	Pollution from wastewater treatment plants is a primary source of nutrients and other pollutants.	Percent of permitted wastewater discharge from plants with sufficient treatment capacity.
Community architecture Stress rank - Medium	Coarse woody debris naturally collects on channel banks and within floodplains and provides diverse habitats and food sources	Distribution of coarse woody debris
	Streams and floodplain forests are comprised of many types of communities that provide a diversity of habitats and food sources	Representative range of habitat types
Species composition / dominance Stress rank - Medium	A range of age classes indicates continual reproduction in the past	Age distribution of rare mussels by species
	Representative numbers of native fish indicate healthy populations and good habitat conditions	Abundance of native fish by species
	Representative numbers of native mussels indicate healthy populations and good habitat conditions	Abundance of native freshwater mussels by species

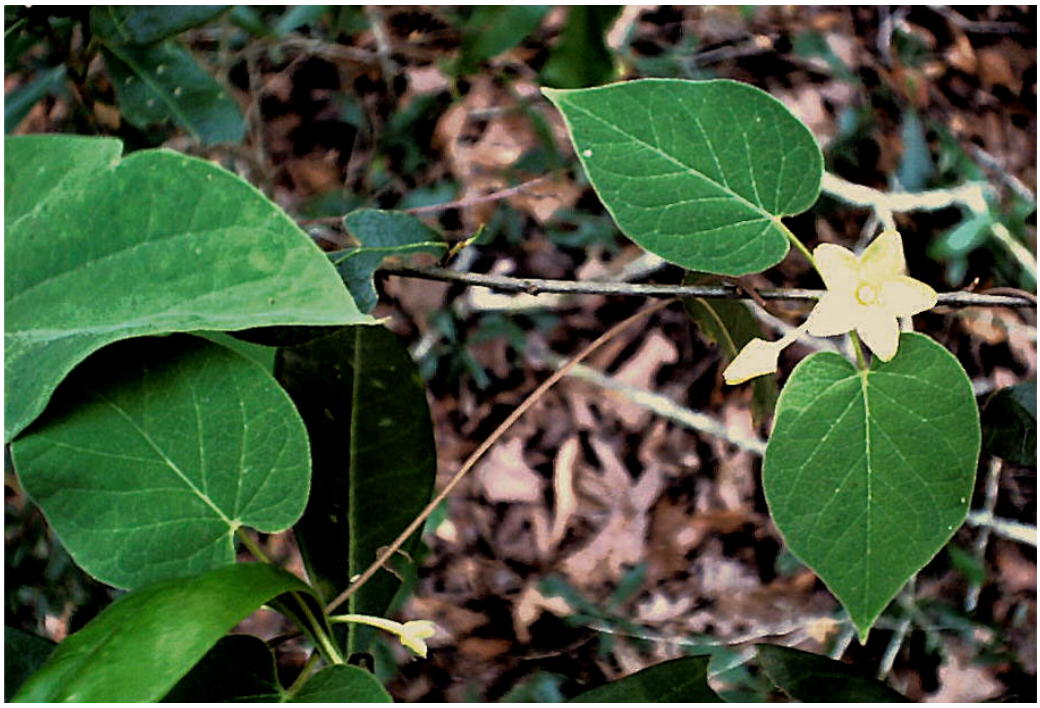
	Representative native trees indicate healthy communities and good habitat conditions	Floodplain forest species composition
	High IBI's indicate healthy populations and habitat conditions	Index of Macroinvertebrate Integrity
	The majority of native fish species rely on riverine conditions. Representative species and abundance indicates healthy populations and good habitat conditions	Density of fluvial specialist fish species
Size / extent of characteristic communities / ecosystems Stress rank - Medium	Many animals that use floodplains depend on large, undisturbed tracts of land to escape predators and find appropriate habitat structure.	Median acreage of contiguous, intact floodplain forest

Critical threats

Threat rank High – Dam construction (direct habitat conversion, fragmentation, alteration of community composition, blocks fish movement, alters hydrologic, thermal and geomorphic regimes)

Threat rank Medium - Excessive groundwater or surface water withdrawal (alteration of hydrologic and thermal regimes of streams and springs), forestry (alters community composition, introduction of sediment and contaminants), stormwater & wastewater management (alters hydrologic regime, especially extreme wet and extreme dry weather flows, introduction of nutrients and other contaminants), dam operations, occurrence of ditches and drains, roads, loss of riparian buffer, mining

Forested Bluff Communities



Target type: Terrestrial community
Target scale: Local

Included species and/or communities: Target includes extant high quality examples of forested limestone or sandstone bluff community, primarily occurring along south bank of the Altamaha floodplain and its major tributaries. For clarification, the forested bluff community is not typically considered to include low sandy bank communities on the north bank of these rivers, even though these features are sometimes locally referred to as "bluffs." The forested bluff target includes associated groundwater seep communities and occurrences of rare species such as Say's spiketail, relict trillium, Alabama milkvine, and trailing milkvine.

Target justification: High quality examples of this community type are rare. Includes or incorporates several rare species. Provides important functionality (and potentially also stresses) to adjacent hydrologic systems through inputs of groundwater and geological material.

Location in Altamaha basin: Found in several isolated locations on along south banks of Altamaha and Ocmulgee Rivers from the upper portions of the estuary upstream to the Fall Line. Best examples are in Wayne, Appling and Jeff Davis Counties.

Table 7. Key Ecological Attributes and Indicators of Forested Bluffs.

KEA	Indicator for monitoring program
Landscape pattern (mosaic) & structure Stress rank – High	Presence of adequate buffer at top of priority bluff
Species composition / dominance Stress rank - Medium	
Community architecture Stress rank – Low	Presence of dead wood
Size / extent of characteristic communities / ecosystems Stress rank - Low	Percentage of total linear extent of bluff that is protected

Critical threats

Threat rank High – Stormwater and wastewater management

Threat rank Medium – Forestry practices (alters community composition, fragmentation, increases erosion)

Threat rank Low – Solid waste

Isolated Sand Ridges and their Wetlands

Target type: Terrestrial and inclusive wetlands
Target scale: Intermediate

Included species and/or communities: This target includes inland maritime forests on island ridges within the floodplain. It is restricted to the South Atlantic and East Gulf coastal plains. Rare natural communities found there include Sand Laurel Oak - Sand Live Oak Hammock (G2) and Georgia River Dune Myrtle Oak Scrub (G1Q). These forests are restricted to fire-protected islands of high ground surrounded by riverine swamps. Wood storks and other wading birds typically utilize the embedded isolated wetlands associated with this target to roost and nest. List of sand ridges: Bug Island, Casino Ridge, Joyner Island, Buck Island, Honey Island, Fort Barrington, Fulton Ridge, Gill Island, Board Pile Ridges, Howard Ridge, Durham Ridge, Sand Mine Ridge, Griffin Ridge, and Big Hammock.

Table 8. Key Ecological Attributes and Indicators of Isolated Sand Ridges and Their Wetlands.

KEA	Indicator for monitoring program
Species composition / dominance Stress rank - High	Presence of representative species
Presence of key communities or seral stages Stress rank - High	Number of community types
Connectivity Stress rank - High	

Critical threats

Threat rank High – Forestry practices; mining

Threat rank Medium – Invasive/alien species

Longleaf Pine Mosaic

Target type: Terrestrial system with embedded wetland communities
Target scale: Coarse to regional

Included species and/or communities: This target is defined to include all extant examples of communities that would have naturally occurred within the Southeastern longleaf pine forest, regardless of the quality of those communities. This definition also includes pine plantations under certain conditions: (1) pine plantations with intact native groundcover, (2) rare species formerly associated with longleaf pine forest, but now occurring in pine plantations. Examples of notable incorporated communities include sand hills, pine flatwoods, Altamaha Grit outcrops (e.g., Broxton Rocks), isolated wetlands (e.g., Carolina bays, cypress domes, etc.), and pitcher plant bogs. Target also includes rare and keystone species associated with longleaf pine habitat, including, gopher tortoise, gopher frog, eastern indigo snake, eastern diamondback rattlesnake, striped newt, flatwoods salamander, red-cockaded woodpecker, Radford dicerandra and hairy rattleweed.

Target justification: This target historically was the overarching upland matrix system of the Altamaha River basin. Critically imperiled. Many included communities are unique, imperiled or contain rare species.

Location in Altamaha basin: Historically occurred throughout the "upland" portion of the Altamaha River basin. Existing occurrences are now scattered throughout.

Table 9. Key Ecological Attributes and Indicators of Longleaf Pine Mosaics.

KEA	Indicator for monitoring program
Fire regime - (timing, frequency, intensity, extent) Stress rank - High	Number of acres burned every 1-5 yrs.
Presence / abundance of keystone species Stress rank - High	Presence of wiregrass, mature longleaf pine, gopher tortoises, others
Size / extent of characteristic communities / ecosystems Stress rank - High	Number of acres in longleaf pine forest

Critical threats

Threat rank High – fire suppression (alters successional patterns), forestry practices (affects community composition and health)

Threat rank Medium – commercial/residential development (direct conversion, fragmentation)

Threat rank Low – invasive/alien species

Overview of Methods

A threat is defined as a combination of the stress on the target and the source(s) of stress. A stress is defined as an "impairment or degradation of the size, condition, and landscape context of a conservation target, and results in reduced viability of the target" (TNC 2000). Stresses are identified and ranked for each conservation target based on the severity of damage to the target and the scope or scale of damage over the next 10 years. Consideration of a given target's viability attributes and ranks informs the process of identifying and ranking stresses. For instance, a target with "fair viability" indicates that there are severe and widespread stresses to the target having deleterious effects on its size, condition and context.

Each stress is attributed to one or more source for a given target. A source of stress is defined as "an extraneous factor, either human or biological, that infringes upon a conservation target in a way that results in stress" (TNC 2000). Sources may be cited as historical or active. A historical source is currently inactive, but its past impacts remain persistent today (e.g. historical clearing of upland terrestrial forest for conversion to agriculture). An active source contributes to the stresses on a target presently and into the future (e.g. development). Sources are ranked based on both their degree of contribution to the stresses and the irreversibility of impacts over the next 10 years. Stresses and sources of stress are ranked as "very high", "high", "medium" or "low". The active and historical threats are ranked for all targets both individually and collectively across the site.

Sixteen threats were identified for the eight conservation targets in the Altamaha River Watershed (Table 10). The eight highest ranked threats are described below. More information about scoring the stresses and sources of stress for these targets can be found in the Conservation Action Plan Workbook for the Altamaha River Watershed.

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Table 10. Threats across all the systems of the Altamaha River Watershed Common taxonomy: Project-specific threats		Altamaha, Ocmulgee and Oconee Rivers	Ohoopee River, Small Streams and Floodplains	Rare Freshwater Mussels	Diadromous Fish	Floodplain and Freshwater Tidal Wetlands	Forested Bluff Communities	Longleaf Pine Matrix System	Isolated Sand Ridges and their Wetlands	Overall Threat Rank
1	Logging: Forestry practices	High	Medium	Medium	Low	High	Medium	High	High	High
2	Housing & Urban Development: Stormwater and wastewater management	Low	Medium	Very High	Low	-	High	-	-	High
3	Invasive Species: Invasive/alien species	High	-	Very High	-	-	-	Low	Medium	High
4	Altered Hydrologic Regime: Dam Operation	High	Medium	High	High	High	-	-	-	High
5	Altered Hydrologic Regime: Dam Construction	High	High	High	-	-	-	-	-	High
6	Altered Hydrologic Regime: Excessive Ground and Surface Water Withdrawals	Medium	Medium	-	High	High	-	-	-	High
7	Altered Fire Regime	-	-	-	-	-	-	High	Medium	Medium
8	Mining	-	Medium	-	-	-	-	-	High	Medium
9	Chemicals & Toxins: Crop production practices	Low	-	High	Low	-	-	-	-	Medium
10	Commercial and Industrial Development: Industrial discharge	Low	-	High	Low	-	-	-	-	Medium
11	Motor-Powered Recreation	-	-	High	-	-	-	-	-	Medium
12	Logging: Deadhead logging	High	-	-	-	-	-	-	-	Medium
13	Altered Hydrologic Regime: Occurrence of ditches and drains	Medium	Medium	-	-	Medium	-	-	-	Medium
14	Roads: Roads	-	Medium	-	-	Medium	-	-	-	Medium
15	Natural System Modifications: Submerged Log Removal	-	-	Medium	-	-	-	-	-	Low
16	Farms & Plantations: Loss of riparian habitat	-	Medium	-	-	-	-	-	-	Low
Threat Status for Targets and Site		High	High	Very High	High	High	Medium	High	High	Very High

Dam Operations
Overall Threat Rank – Very High

Dam operations refers to the effects of dam releases on downstream flow patterns. The large hydropower dams on the Ocmulgee and Oconee Rivers at the Fall Line affect downstream flow patterns in several ways. The daily release of water during power generation results in large water level fluctuations that reduce availability of stable habitat for many miles downstream. The rapid, frequent change in water levels destabilizes the banks. Within bank habitat quality is reduces as the native biota are not adapted to the daily wetting and drying cycles. Spawning habitat quality on downstream shoals and coarse gravel beds is also reduced with wetting and drying. Fish can be stranded in areas where water levels drop more rapidly than the fish can escape. The Fall Line dams are large enough to store water and alter the range and seasonality of flows downstream. High flows are not as high and low flows are not as low as they were before the dams were in place. Since the greatest power demands are in the summer for air conditioning, summer flows are higher as well. These hydrologic impacts affect all the native riverine biota to some degree, leaving a less diverse fauna below the dams. The hydrologic impacts are evident the entire length of the Oconee River and may explain in part the absence of healthy mussel populations on that river.

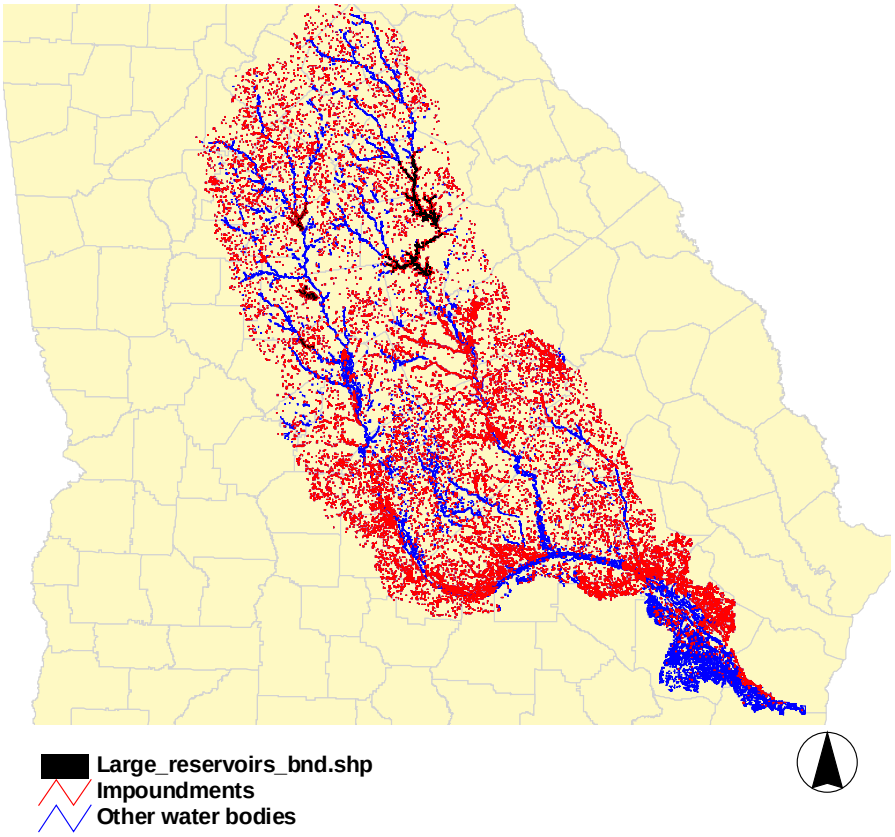

Figure 3. Large impoundments of the Greater Altamaha River basin (National Inventory of Dams).

Forestry Practices
Overall Threat Rank – High

For the purposes of conservation planning, forestry practices refer to activities related to growing (primarily pines) or harvesting trees in the Altamaha River watershed. This threat includes activities related to clear-cutting or thinning of existing pine plantations (e.g. road-building, tree harvest), re-planting (e.g. site preparation), and on-going management activities of existing pine plantations (e.g. fertilizer or herbicide application). It also includes clear-cutting or thinning of bottomland hardwood forests and small stream forests that are allowed to naturally regenerate. It does not include conversion of naturally regenerated forests to pine plantation, or any activities related to such conversion. A large portion of the uplands of the Altamaha River watershed are currently in slash, loblolly or sand pine plantation. Also, there has been a large increase in the past several years in the level of clear-cutting of bottomland hardwood forests.

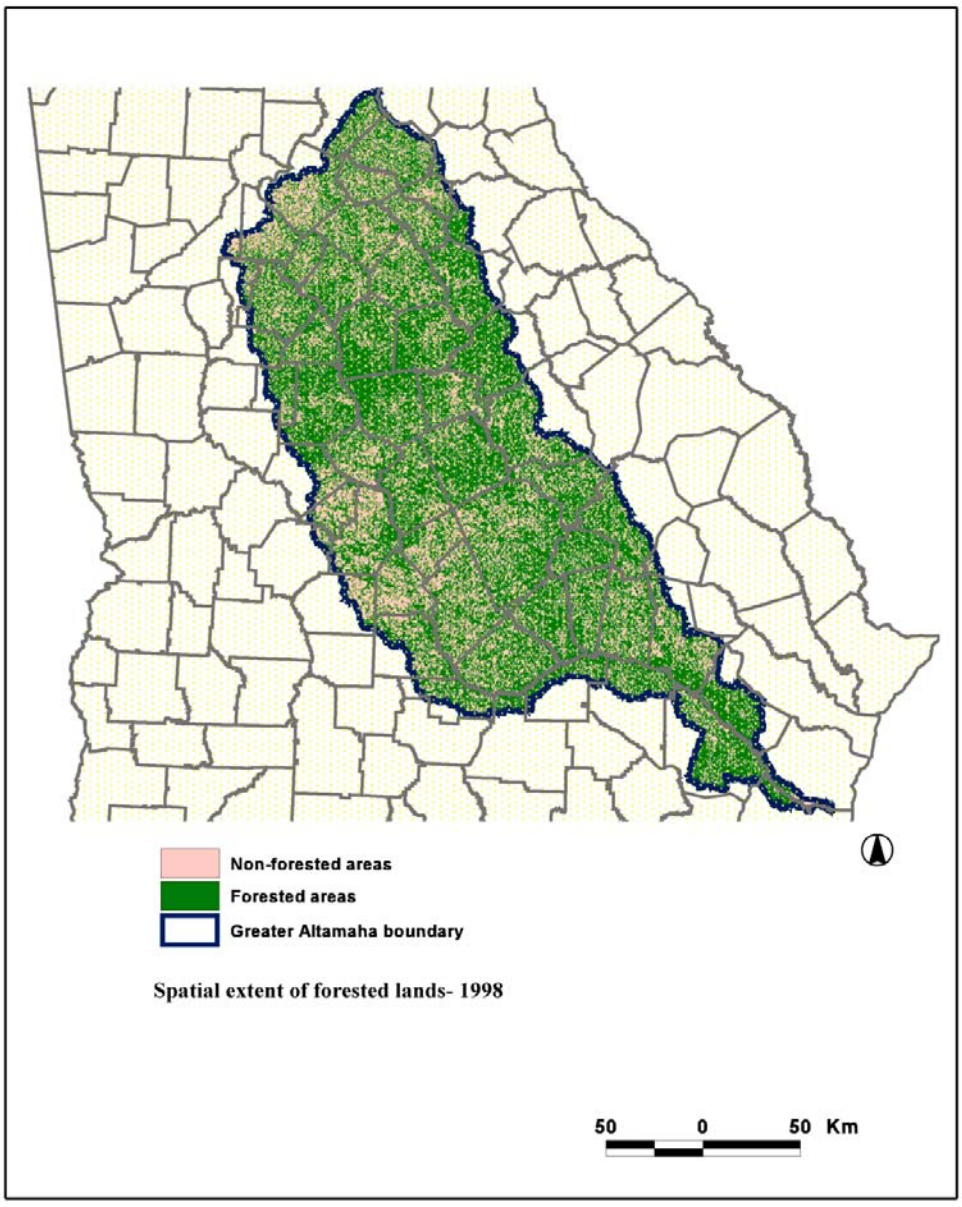

Figure 4. Forested land cover in the Greater Altamaha River basin in 1998.

Wastewater and Stormwater Management
Overall Threat Rank - High

Within the lower Altamaha River Watershed, the threat of commercial/residential development exists on uplands adjacent to the floodplain, and in coastal areas where marsh-front home development is attractive. It is specifically associated with stresses to conservation targets related to the development and operation of both residential and commercial properties. This threat is sporadic in nature, and has not been as widespread as in other parts of the coastal plain. It has mainly occurred near existing communities within the watershed. This threat deals with issues such as:

- Habitat loss/fragmentation due to land clearing for structure pads and related infrastructure design (roads, stormwater, utilities)
- Thermal alteration due to forest clearing and impermeable surface construction
- Nutrient/contaminant loading and sedimentation due to development operation

Targets that are affected by this stress include Atlantic and shortnose sturgeon, rare freshwater mussels, estuary system, longleaf pine matrix system, maritime forests/associated isolated wetlands, forested bluff communities and coastal plain tributaries and small stream riparian communities.

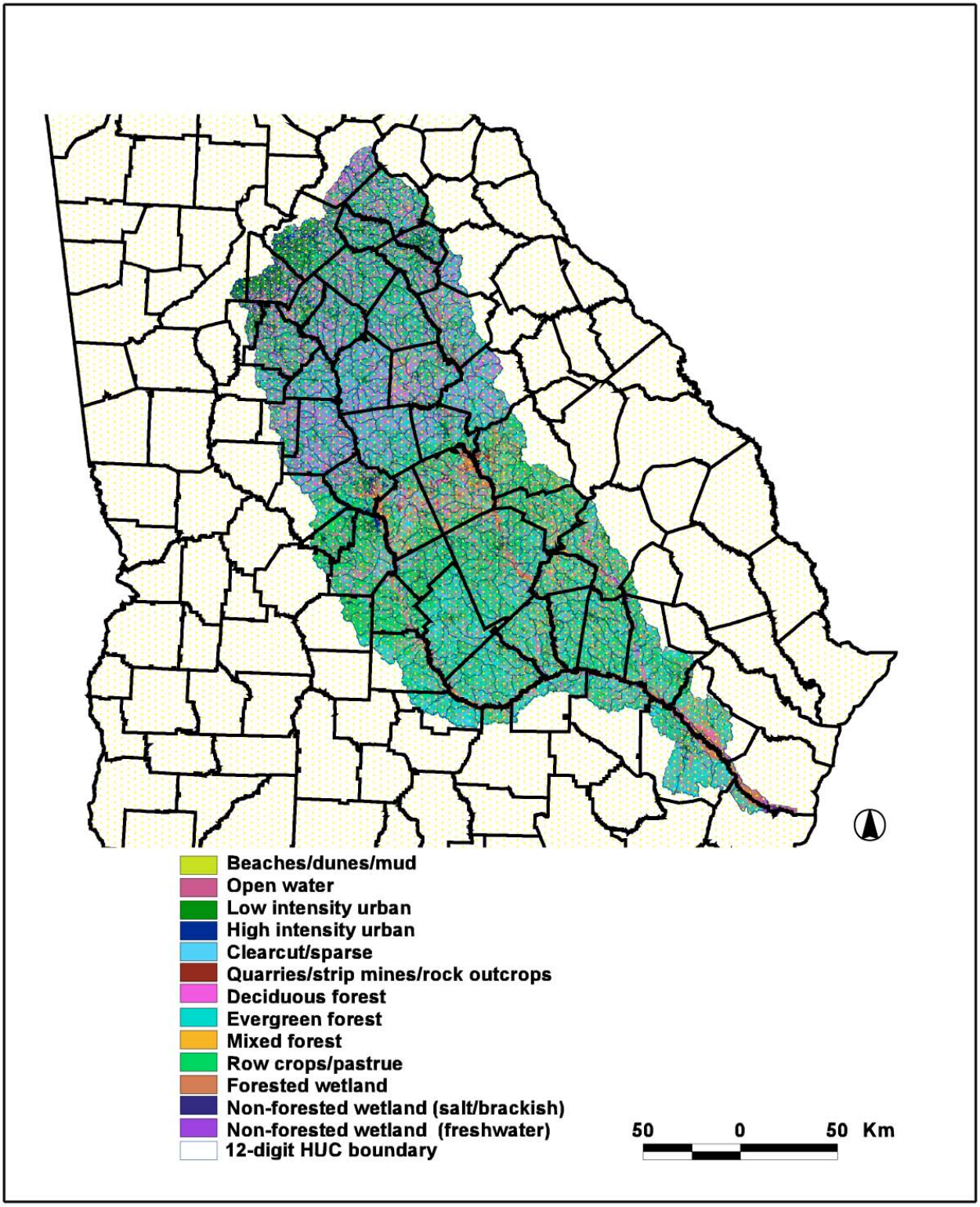

Figure 5. Land use in Greater Altamaha River basin in 1998. Urban and agricultural areas are generally associated with large water withdrawals.

Invasive/Alien Species
Overall Threat Rank - High

Within the lower Altamaha River Watershed, the presence of invasive/alien species is on the increase, or those flora and fauna that are not native to either this ecoregion or the United States in general. These non-native flora and fauna have been introduced by man from foreign countries over the last two hundred years, or have made it into this system naturally. These species are opportunistic and can populate, adapt and thrive more efficiently than natives under certain conditions. It is for these reasons that they are especially obvious in disturbed habitats where human impacts have occurred. This threat is not widespread in the watershed, however it is abundant locally in various locations. This threat deals with issues such as:

- Habitat disturbance and altered composition due to invasive reproductive rates and ability to dominate a location or habitat
- Predation/parasitism of flora/faunal native species (especially mussel larvae host fishes, and herbivory by feral hogs)

Targets that are affected by this stress include large coastal plain alluvial river and floodplain communities, rare freshwater mussels, estuary system, longleaf pine matrix system and maritime forests/associated isolated wetlands.

Dam Construction
Overall Threat Rank - High

Dam construction refers to the creation of new instream dams, reservoirs and impoundments on the main stem or tributaries of the Altamaha River. Present proposals for increasing water supplies for Georgia rely heavily on the construction of numerous small- to medium-sized reservoirs, mostly on tributaries of the larger rivers, in both the Piedmont (to support growth in the metro Atlanta area) and in the coastal plain (to support agriculture and growth of small cities presently dependent on). For the purpose of conservation planning, this threat does not include construction of offstream impoundments, except where such impoundments result in a reduction of runoff to streams, nor does it include *operation* of existing dams and reservoirs (e.g., hydropower operations of fall line reservoirs).

Ecological effects of dam construction include alteration or fragmentation of aquatic and wetland habitat, alteration of hydrologic regime, alteration of fish community composition (due to altered predator-prey relationships that favor proliferation of large game fish), restriction of fish (including fishes that serve as larval hosts for mussels) passage to critical habitat, alteration of thermal regime, and alteration of stream geomorphology.

Excessive Groundwater/Surface Water Withdrawals
Overall Threat Rank - High

Excessive groundwater withdrawal refers to pumping from the Floridan, Miocene (Brunswick) or Surficial Aquifers that result in ecologically significant reductions in the amount and/or quality of groundwater available to sustain river and stream baseflow, spring discharge, isolated wetlands, seepage communities, thermal and salinity refugia and habitat in the hyporheic zone. Pumping from different source aquifers can have different implications for aquatic ecosystems in different parts of the Altamaha watershed:

- Withdrawals from the Floridan Aquifer in the upper coastal plain (up-gradient of the Gulf Trough) have the greatest influence on springflow to the lower Oconee and Ocmulgee Rivers and their tributaries and hence on the baseflow of the Altamaha River. Excessive withdrawals in this region are anticipated mainly as a result of increased development of irrigated agriculture.
- Withdrawals from the Surficial (and perhaps the Miocene) Aquifer have the greatest influence on direct groundwater discharge to the Altamaha River and its floodplain, lower coastal plain blackwater tributaries, seeps and isolated wetlands within the Bioreserve. Excessive withdrawals in this region are anticipated as water suppliers begin to develop these shallow aquifers as alternatives to the heavily over-pumped Floridan Aquifer. The river and other conservation targets are largely buffered from the effects of heavy use of the Floridan Aquifer in this region due to the great depth of the aquifer and thickness of confining layers.
- Withdrawals from all three aquifers affect upwelling and seepage of fresh groundwater to the Altamaha estuary and offshore marine habitat, greatly reducing the distribution of thermal and salinity refugia and hence decreasing the ecosystem's ability to cope with drought. Excessive withdrawals in this region are occurring largely as a result of heavy pumping from the Floridan Aquifer in the lower coastal plain (primarily from a few large pulp and paper mills) and have resulted in drastically reduced areas of artesian pressure, reduced leakage to shallow aquifers, reduced freshwater flow to offshore springs and reefs and increased saltwater intrusion through faults, solution features and springs.

Excessive surface water withdrawal refers to consumptive withdrawal or diversion of surface water from the Altamaha River and its tributaries that results in ecologically significant alteration of streamflow, inundation, thermal or salinity regimes of the river, floodplains and the estuary. For site conservation planning purposes, this threat does not include reduction in flows caused by excessive withdrawal from reservoirs and impoundments. Present threats from excessive surface water withdrawal stem from two sources:

- Withdrawal for water supply purposes by public water suppliers, private water wholesale firms, large industries and farms.
- Withdrawal for cooling water purposes by power generating facilities that results in large evaporative losses (e.g., the Plant Hatch nuclear facility is the largest user of surface water in the Altamaha basin, due to large evaporative losses in the plant cooling system, even though this use is typically considered "non-consumptive").

Targets that are affected by this stress include large coastal plain alluvial river and floodplain communities, Atlantic and shortnose sturgeon, rare freshwater mussels, longleaf pine matrix system, maritime forests/associated isolated wetlands, forested bluff communities and coastal plain tributaries and small stream riparian communities.

Fire Suppression
Overall Threat Rank – Medium

Fire, once a regular occurrence on the southeastern landscape, has since been limited in occurrence within the lower Altamaha River watershed. Historically, natural events such as lightning strikes ignited fires that traveled through the southern pine forests and maintained a community that consisted of widely spaced stately pines with an understory of scattered oaks, various shrubs and a vast carpet of wiregrass and native flowering legumes. Even man historically used fire as a tool for maintaining natural communities and lands of importance. Man has since suppressed the naturally occurring fire events and largely discontinued the use of fire as a land management tool. This suppression allows for the development of thick understory vegetation and heavy fire fuel loads on forest floors, increasing the potential for large uncontrollable wildfires. These two developments also alter the structure of the various pine community types by allowing pine densities to increase and hardwoods to grow. The limiting of the growth of native grasses and legumes is also a result of fire suppression. This threat is widespread in the watershed and deals with issues such as altered habitat composition, alteration of natural fire regimes and habitat fragmentation. Targets that are affected by this stress include longleaf pine matrix system, and isolated sand ridges and their wetlands. The overall threat rank for fire suppression was medium.

Overview of Methods

The next step in the site conservation planning process is to decide how best to protect and conserve the conservation targets, given the analyses of their viability and threats. The general goals of the site conservation plan are to improve the viability and abate the threats to the conservation targets. Conservation strategies are means by which we meet these goals.

As a prelude to determining the most effective conservation strategies for the Altamaha River, the team set both conservation goals and threat abatement goals. A ***conservation goal*** is defined as the desired viability of a given conservation target. General conservation goals specify the aspect (i.e. size, condition or context) of viability to be maintained or improved and the intended degree (i.e. "fair" to good) of improvement. These goals are based on a consideration of the key attributes that are most vulnerable to threats in combination with the feasibility of taking effective conservation action (i.e. it may be possible to improve the condition of a given target but not the size or context). More specific and quantitative management goals will be determined as part of a monitoring program for the conservation targets to be completed in the next year. A ***threat abatement goal*** articulates the desired future reduction of a given threat or the restoration of a target that will in turn improve its viability. Threat abatement goals are based on the threats with medium to very high ranks only in order to concentrate energies on areas of immediate need.

Based on these conservation and threat abatement goals, the planning team developed 20 conservation strategies to fulfill conservation and threat abatement goals for the Altamaha River Watershed. For each conservation strategy, a list of implementation or action steps are presented that are incorporated in the TNC-GA annual strategic plan and staff goals and objectives. Lead staff members and time lines for implementation are noted for each step. As of October 2005, strategies are still under development and will be finalized for the January 2006 version of the plan.

Objectives and Strategic Actions

1. Secure management agreements, easements, or acquisition on priority lands.

    - Identify priority landowners in target areas.
    - Identify target areas for improved forestry practices.
    - Locate and secure funding for priority parcels for fee simple purchases and conservation easements.

2. Improve understanding about sources of threats to targets (rivers, tribs, mussels, estuary) through compilation and assessment of pertinent information.

    - Compare current distribution of mussels to historic records.
    - Develop the research program to assess impacts of forestry practices on conservation targets.
    - Establish a monitoring program to assess successional change/stages in formerly clear-cut areas.

- Analyze impact of suspected threats (due to lack of adequate info) to conservation targets, incorporate into assessment and refine threat map.
- Assess spatial extent of clear-cutting and ditching in the bottomlands.
- Compare current distribution of tidal freshwater wetlands to historic records.
- Identify location of and threats to important nursery habitat in estuary.
- Identify location of and threats to spawning sites for shortnose sturgeon.

3. Protect thermal refuges for diadromous fish.

    - Identify areas of high concentrations of summering sturgeon and characterize for indicators of groundwater influence.
    - Identify users of groundwater that would affect thermal refuges.
    - Identify opportunities for acquisition, easements or management of areas around thermal refuges.
    - Work with groundwater users to minimize impacts on groundwater discharge.

    - Work with groundwater and surface decision-makers to minimize water use impacts.

4. Restore important riverine and estuarine habitats for diadromous fish.

    - Restore salinity barriers that have been breached by rice canals.
    - Reduce sediment load by restoring riparian areas.
    - Increase accessibility to thermal refuge via spring runs by removing excess sediments.
    - Reduce rate of wetland drainage by restoring streams to natural stream patterns.
    - Increase ingress and egress of fish to tidal wetlands by restoring rice field hydrology and vegetation.

5. Improve understanding of habitat use by striped bass, Atlantic and shortnose sturgeon and American shad.

    - Identify sturgeon spawning sites.
    - Track movements of sturgeon to define behavior in thermal refuges and other riverine habitats.
    - Identify, classify and rank key river reaches used by American shad.
    - Identify areas of high concentrations of summering sturgeon and characterize for indicators of groundwater influence.

6. Restock American shad above Fall Line dams.

    - Release fingerlings in priority habitats.
    - Monitor adult movements.
    - Monitor for shad recruitment.

7. Restock striped bass above and below Fall Line dams.

    - Release fingerlings in priority habitats.
    - Monitor adult movements.
    - Monitor for striped bass recruitment.

8. Improve fish passage at Fall Line dams by 2015.

    - Support DNR position for fish Passage at Juliette Dam under FERC relicensing.
    - Identify and implement process to obtain fish passage at lakes Sinclair and Jackson.

9. Develop regional water supply reservoir plan for Altamaha basin by 2007 and influence reservoir development in the basin.

    - Develop partnership with Georgia Soil and Water Conservation Commission and state Water Policy Centers
    - Participate in regional reservoir planning meetings
    - Develop environmental data to support recommendations for number and distribution of new reservoirs.
    - Lobby for environmentally friendly regional reservoir plan.
    - Develop formal partnership with timber companies and state and local forestry agencies.

10. Improve hydropower dam operations to more closely resemble natural flow patterns.

    - Approach power companies for ESWM process
    - Facilitate expert-driven process to develop ecological flow recommendations.
    - Work with power companies to implement flow recommendations.

11. Catalyze a change in forestry management practices of industrial landowners to minimize impacts to conservation targets.

    - Strengthen Altamaha Cooperative for research and stewardship.
    - Develop demonstration sites for forestry management on both private and public lands.
    - Develop the research program to assess impacts of forestry practices on conservation targets.
    - Secure conservation interest in priority conservation sites.
    - Get industrial landowners to select and manage conservation sites as "Forest of Exceptional Conservation Value" under SFI

12. Develop models and other technical products to demonstrate how and where groundwater interacts with surface water and ecological features.

    - Influence actions and implementation of Georgia Coastal Sound Science Initiative.
    - Overlay Initiative results with target maps to refine threat map for groundwater withdrawals.

13. Prevent ground and surface water withdrawals from decreasing viability of conservation targets.

    - Perform IHA analyses to determine areas of hydrologic impact.
    - Analyze impact of suspected threats (due to lack of adequate info) to conservation targets, incorporate into assessment and refine threat map.
    - Develop demonstration ecological flow recommendations and safe yields.

- Influence actions and implementation of Georgia Coastal Sound Science Initiative.
- Provide science info to local stakeholders and advocacy groups to allow them to influence govt. actions
- Develop and export predictive model based on SSI recommendations and flow/species response
- Develop instream flow guidelines for Altamaha rivers.

14. Minimize impacts of municipal and industrial discharge on aquatic targets.

    - Conduct surveys of mussel populations below discharge points.
    - Compare current distribution of mussels to historic records.
    - Obtain information from DNR and UGA about sturgeon impacts.
    - Partner with industrial interests to obtain information and develop strategies to minimize impacts.

15. Prevent residential and commercial development from decreasing the viability of conservation targets.

    - Determine most effective strategies and roles of stakeholders (DNR, SINERR, NOAA, NMFS, local govts., NGOs, landowners, academia).
    - Develop and export predictive models and impacts to conservation targets based on county land use plans and growth predictions.
    - Provide science info to local stakeholders and advocacy groups to allow them to influence govt. actions
    - Work with stakeholders and experts to establish and implement compatible development practices.

16. By 2008, eliminate seed-bearing Chinese tallow trees from floodplain forests, reduce by 75% the acreage of Chinese tallow seedlings and develop a plan to eliminate the remaining acreage of seedlings.

    - In fall 2005, map the extent of the current Chinese tallow population in the floodplain.
    - Eliminate all seed-bearing Chinese tallow trees from Whittington and NeSmith tracts in 2006.
    - In FY2006, secure at least $100K for control/eradication efforts.
    - In 2006 and 2007, identify and eliminate primary sources of Chinese tallow in Jesup.
    - Work with GR and the GA Exotic Pest Plant Council to eliminate the selling of Chinese tallow at nurseries.

17. Decrease population of flathead catfish by x% by date TBD.

    - Obtain advice on effective actions to control flathead catfish.
    - Promote control programs.

18. By January 2006, limit the river segments from which logs can be removed and decrease the negative impact to aquatic targets and water quality.

    - Contact Corps, NMFS and FWS for federal laws and permit needs regulating deadhead logging in river and associated river disturbance.
    - Influence DNR rule making and implementation (including monitoring) by working with DNR staff to determine and minimize potential impact to conservation targets by January 2006.
    - Provide technical expertise to partners and others on type and extent of impact in the Altamaha River watershed and the importance of the health of the river system.

19. Keep an eye on watershed ecotourism efforts to ensure minimal impacts to conservation targets.

    - Participate in the Altamaha River Partnership.

The Altamaha River Watershed project is a large and complex area that would require tremendous resources to adequately monitor all system and species targets. As resources are limited, measurement of conservation success has been largely in partnership with ongoing efforts that complement the objectives of this plan. The project measures fall into three general categories with lead partners in parentheses:

General Conservation Status

1. South Atlantic Coastal Plain ecoregional planning (TNC)
2. Protected areas (TNC)
3. Area burned (TNC/DNR/GFC)
4. Location and extent of invasive species (TNC)

Species Targets

4. Rare freshwater mussels (DNR)
5. Diadromous fish (DNR)

Reference Coastal Plain River

6. Hydrologic analyses (TNC)
7. Floodplain macroinvertebrate community (UGA)
8. Fish utilization of floodplain (USGS)

Adaptive management is ongoing in Altamaha River Watershed project. Results of the project monitoring efforts as well as continually developing information are used to re-evaluate objectives and actions on a frequent basis. For example, a recent state law passed that would allow recovery of submerged logs (otherwise known as deadhead logging) in the Altamaha River. This activity would have potentially adverse and irreversible impacts on the rare mussels and other biota – particularly sessile species. The conservation staff has redirected some time to rule making as well as ways to reverse the law.

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A. SUMMARY LIST OF RARE ANIMAL SPECIES RECORDED IN THE ALTAMAHA RIVER BIORESERVE STUDY AREA

Scientific Name	Common Name	Rank	Federal Status
Mussels			
Alasmidonta arcula	Altamaha Arc Mussel	G2/S1S3	Candidate for listing
Anodonta couperiana	Barrel Floater	G3/S?	None
Anodonta gibbosa	Inflated Floater	G1G2/S?	None
Elliptio dariensis	Georgia Elephant-ear	G3/S?	None
Elliptio hopetonesis	Altamaha Slabshell	G2/S?	None
Elliptio shepardiana	Altamaha Lance	G2/S	None
Elliptio spinosa Candidate for listing	Altamaha Spiny Mussel		G1/S1S3
Lampsilis dolabraeformis	Altamaha Pocketbook	G2/S?	None
Lampsilis splendida	Rayed Pink Fatmucket	G3/S?	None
Toxolasma pullus (*Carunculina pulla*)	Savannah Shore Lilliput	G3/S1S3	None
Villosa delumbis	Eastern Creekshell	G3/S?	None
Fishes			
Acantharchus pomotis	Mud Sunfish	G5/S3	None
Acipenser brevirostrum	Shortnose Sturgeon	G3/S2	Endangered
Acipenser oxyrhynchus	Atlantic Sturgeon	G3/S3	None
Cyprinella leedsi	Bannerfin Shiner	G3/S3S4	None
Cyprinella callisema	Ocmulgee Shiner	G3/S3	None
Hybognathus regius	Eastern Silvery Minnow	G5S2?	None
Reptiles and Amphibians			
Ambystoma cingulatum	Flatwoods Salamander	G4/S3	Threatened
Caretta caretta	Loggerhead Sea Turtle	G3/S3	Threatened
Drymarchon corais couperi Threatened	Eastern Indigo Snake		G4T3/S3
Eurycea longicauda	Longtail Salamander	G5/S2	None

Scientific Name	Common Name	Rank	Federal Status
Farancia erytrogramma	Rainbow Snake	G5/S3	None
Gopherus polyphemus	Gopher Tortoise	G2/S3	Candidate for listing
Kinosternon baurii	Striped Mud Turtle	G5/S3	None
Lampropeltis triangulum elapsoides	Scarlet Kingsnake	G5/S2	None
Micrurus fulvius	Eastern Coral Snake	G5/S3	None
Ophisaurus attenuatus	Slender Glass Lizard	G5/S3	None
Ophisaurus compressus	Island Glass Lizard	G4/S2	Candidate for listing
Ophisaurus mimicus	Mimic Glass Lizard	G3/S2	None
Pituophis melanoleucus mugitus	Florida Pine Snake	G5T?/S?	Candidate for listing
Pseudobranchus striatus	Dwarf Siren	G5/S3	None
Pseudotriton montanus	Mud Salamander	G5/S3	None
Rana capito capito (*Rana areolata capito*)	Gopher Frog	G4/S3	Candidate for listing
Rhadinaea flavilata	Pine Woods Snake	G4/S2	None
Seminatrix pygaea	Black Swamp Snake	G5/S3	None
Birds			
Aimophila aestivalis	Bachman's Sparrow	G3/S3	Candidate for listing
Ammodramus henslowii	Henslow's Sparrow	G4/S3	None
Aramus guarauna	Limpkin	G5/S1S2	None
Charadrius melodus	Piping Plover	G3/S1S2	Threatened
C*haradrius wilsonia*	Wilson's Plover	G5/S2S3	None
Elanoides forficatus	American Swallow-tailed Kite	G5/S2	None
Falco sparverius paulus	American Kestrel		G5T3T4/S? None
Haematopus palliatus	American Oystercatcher	G5/S2S3	None
Haliaeetus leucocephalus leucocephalus	Southern Bald Eagle	G3TU/S2	Endangered
Himantopus mexicanus	Black-necked Stilt	G5/S1S2	None
Limnothlypis swainsonii	Swainson's Warbler	G4/S3S4	None

Scientific Name	Common Name	Rank	Federal Status
Mycteria americana	Wood Stork	G5/S2	Endangered
Nycticorax nycticorax	Black-crowned Night-Heron	G5/S3S4	None
Pandion haliaetus	Osprey	G5/S3	None
Pelecanus occidentalis	Brown Pelican	G5/S2	None
Picoides borealis	Red-cockaded Woodpecker	G2/S2	Endangered
Plegadis falcinellus	Glossy Ibis	G5/S2S3	None
Rynchops niger	Black Skimmer	G5/S2	None
Sterna antillarum	Least Tern	G4/S2S3	None
Sterna maxima	Royal Tern	G5/S5	None
Sterna nilotica	Gull-billed Tern	G5/S1	None
Sterna sandvicensis	Sandwich Tern	G4/S4	None
Tyrannus dominicensis	Gray Kingbird	G5/S2S3	None
Vermivora bachmanii	Bachman's Warbler	G1/S1	Endangered
Mammals			
Myotis austroriparius	Southeastern Bat	G4/S3S4	Candidate for listing
Plecotus rafinesquii Candidate for listing	Rafinesque's Big-eared Bat		G4/S3?
Sciurus niger shermani	Sherman's Fox Squirrel	G5T2/S?	Candidate for listing
Trichechus manatus	West Indian Manatee	G2?/S1S2	Endangered

Total animal species: 63

B. SUMMARY LIST OF RARE PLANT SPECIES RECORDED IN THE ALTAMAHA RIVER BIORESERVE STUDY AREA

Scientific Name	Common Name	Rank	Federal Status
Agrimonia incisa	Cutleaf Harvest Lice	G3/S2S3	Candidate for listing
Amphicarpum muhlenbergianum	Blue Maidencane	G?/S1?	None
Apteria aphylla	Nodding Nixie	G3G4/S3	None
Asclepias pedicellata	Savanna Milkweed	G3G4/S2	None
Astragalus michauxii	Sandhill Milkvetch	G3/S2?	Candidate for listing
Baccharis glomeruliflora	Southern Groundsel-Tree	G4/S2?	None
Baptisia arachnifera	Hairy Rattleweed	G1/S1	Endangered
Befaria racemosa	Tarflower	G3G4/S3	None
Bumelia species 3	Ohoopee Bumelia	G2Q/S?	None
Calamintha ashei	Ashe Savory	G3/S1	Candidate for listing
Carex dasycarpa	Velvet Sedge	G?/S3	None
Chrysoma pauciflosculosa	Woody Goldenrod	G4G5/S3	None
Coreopsis integrifolia	Tickseed		G1G2/S1? None
Dalea feayi	Feay Pink-Tassels	G4G5/S1	None
Dicerandra radfordiana	Radford Dicerandra	G1Q/S1	Candidate for listing
Eleocharis albida	White Spikerush	G4G5/S1?	None
Elliottia racemosa	Georgia Plume	G2G3/S2S3	None
Elytraria caroliniensis	Carolina Scalystem	G4/S3	None
Epidendrum conopseum	Green-Fly Orchid	G3G4/S3	None
Eryngium aromaticum	Fragrant Snakeroot	G5/S2S3	None
Evovulus sericeus var. *sericeus*	Creeping Morning-Glory	G5T?/S1	None
Forestiera segregata	Florida Privet	G2/S2	None
Fothergilla gardenii	Dwarf Witch-Alder	G4/S2	None

Species	Common Name	Rank	Federal Status
Hibiscus grandiflorus	Swamp Hibiscus	G?/SU	None
Ilex amelanchier	Sarvis Holly	G3G4/S2	None
Ipomoea pes-caprae	Railroad Morning-Glory	G5?/SU	None
Krameria lanceolata	Sandbur	G5/S3?	None
Lechea deckertii	Deckert Pinweed	G4G5/S1?	None
Lechea torreyi	Piedmont Pinweed	G4G5/SU	None
Leitneria floridana	Florida Corkwood	G3G4/S1	None
Liatris pauciflora	Few-flower Gay-Feather	G4G5/S1?	None
Litsea aestivalis	Pondspice	G3G4/S2	Candidate for listing
Magnolia pyramidata	Pyramid Magnolia	G4/S3	None
Marshallia ramosa	Pineland Marshallia	G2/S2	None
Matelea alabamensis	Alabama Milkvine	G1/S1	Candidate for listing
Matelea flavidula	Yellow Milkvine	G3?/S2?	None
Matelea pubiflora	Trailing Milkvine	G3G4/S2	None
Palafoxia integrifolia	Palafoxia	G?/S2?	None
Peltandra sagittifolia	Spoonflower	G3G4/S2?	None
Penstemon dissectus	Dissected Beardtongue	G2?/S2	None
Phaseolus sinuatus	Trailing Bean-Vine	G2G3/S1	None
Physostegia leptophylla	False Dragon-Head	G4G5/SH	Candidate for listing
Pieris phyllyreifolia	Climbing Heath	G3?/S3	None
Pinckneya pubens	Hairy Fever-Tree	G3G5/S3	None
Plantago sparsiflora	Pineland Plantain	G2/SH	Candidate for listing
Polanisia tenuifolia	Slenderleaf Clammy-Weed	G5/S3	None
Polygala leptostachys	Georgia Milkwort	G?/S1	None
Psilotum nudum	Whisk Fern	G5/S1	None
Quercus austrina	Bluff White Oak	G5/S2S3	None
Quercus chapmanii	Chapman's Oak	G4G5/S2	None

Species	Common Name	Rank	Federal Status
Rhapidophyllum hystrix	Needle Palm	G4/S3	None
Sageretia minutiflora	Tiny-Leaf Buckthorn	G4/S1	None
Sarracenia flava	Yellow Flytrap	G4G5/S3S4	None
Sarracenia minor	Hooded Pitcherplant	G4G5/S4	None
Sarracenia purpurea	Purple Pitcherplant	G5/S1	None
Sarracenia rubra	Sweet Pitcherplant	G3/S2	None
Selaginella arenicola	Spiny Spikemoss	G?T?/S3	None
Sium suave	Water Parsnip	G5/S2?	None
Sophronanthe hispida	Narrowthroat Foxglove	G3G5/S3	None
Stillingia aquatica	Corkwood	G4G5/S3?	None
Stylisma pickeringii	Pickering Morning-Glory	G4?T2/S1S2	None
Tephrosia chrysophylla	Scurf Hoary-Pea	G4G5/S1	None
Thalia dealbata	Flag	G3G5/S1	None
Tillandsia bartramii	Bartram's Air Plant	G4/S2?	None
Tillandsia recurvata	Small Ballmoss	G5/S1	None
Vernonia pulchella	Georgia Ironweed	G2?/S2	None
Vigna luteola	Piedmont Pea	G5/S2?	None
Warea cuneifolia	Nuttall Warea	G4/S3	None
Xyris serotina	Yellow-Eyed Grass	G3G4/S1	None

Total Plant Species: 69

C. G1-G3 ELEMENTS WITHIN THE ALTAMAHA RIVER BIORESERVE

Animals

SCIENTIFIC NAME	COMMON NAME	G-RANK
Mussels		
Elliptio spinosa	Georgia Spiny-Mussel	G1
Anodonta gibbosa	Inflated Floater	G1G2
Alasmidonta arcula	Altamaha Arc Mussel	G2
Elliptio hopetonensis	Altamaha Slabshell	G2
Elliptio shepardiana	Altamaha Lance	G2
Lampsilis dolabraeformis	Altamaha Pocketbook	G2
Anodonta couperiana	Barrel Floater	G3
Elliptio dariensis	Georgia Elephant-Ear	G3
Lampsilis splendida	Rayed Pink Fatmucket	G3
Toxolasma pullus	Savannah Lilliput	G3
Villosa delumbis	Eastern Creekshell	G3
Fish		
Acipenser brevirostrum	Shortnose Sturgeon	G3
Acipenser oxyrhynchus	Atlantic Sturgeon	G3
Notropis callisema	Ocmulgee Shiner	G3
Notropis leedsi	Bannerfin Shiner	G3
Reptiles		
Gopherus polyphemus	Gopher tortoise	G2
Caretta caretta	Loggerhead	G3
Ophisaurus mimicus	Mimic Glass Lizard	G3
Birds		
Vermivora bachmanii	Bachman's Warbler	G1
Picoides borealis	Red-cockaded Woodpecker	G2
Aimophila aestivalis	Bachman's Sparrow	G3
Haliaeetus l. leucocephalus	Southern Bald Eagle	G3
Charadrius melodus	Piping Plover	G3
Mammals		
Trichechus manatus	West Indian Manatee	G2?
Plants		
Dicerandra radfordiana	Radford Dicerandra	G1
Matelea alabamensis	Alabama Milkvine	G1
Baptisia arachnifera	Hairy Rattleweed	G1
Coreopsis integrifolia	Tickseed	G1G3
Forestiera segregata	Florida Privet	G2
Marshallia ramosa	Pineland Marshallia	G2

Plantago sparsiflora	Pineland Plantain	G2	
Penstemon dissectus	Dissected Beardtongue	G2?	
Vernonia pulchella	Georgia Ironweed	G2?	
Bumelia sp. 3	Ohoopee Buckthorn	G2Q	
Phaseolus sinuatus	Trailing Bean-Vine	G2G3	
Elliottia racemosa	Georgia Plume		G2G3
Agrimonia incisa	Cutleaf Harvest-Lice	G3	
Astragalus michauxii	Sandhills Milkvetch	G3	
Calamintha ashei	Ohoopee Dunes Savory	G3	
Pieris phyllyreifolia	Climbing Heath	G3	
Sarracenia rubra	Sweet Pitcherplant	G3	
Asclepias pedicellata	Savanna Milkweed	G3G4	
Befaria racemosa	Tarflower	G3G4	
Leitneria floridana	Florida Corkwood	G3G4	
Litsea aestivalis	Pondspice	G3G4	
Matelea pubiflora	Trailing Milkvine	G3G4	
Peltandra sagittifolia	Spoonflower	G3G4	
Ilex amelanchier	Sarvis Holly	G3G4	
Epidendrum conopseum	Green-fly Orchid	G3G4	
Xyris serotina	Yellow-eyed Grass	G3G4	
Apteria aphylla	Nodding-Nixie		G3G4

Natural Communities

Maritime Shrub Swamp	G2	
Barrier Island Depression Forest	G2	
South Atlantic Inland Maritime Forest	G2	
South Atlantic Barrier Island Forest	G2	
Spruce Pine - Mixed Hardwoods Forest	G3	
Atlantic Barrier Island Dune Scrub Woodland	G3	
Freshwater Tidal Bald Cypress - Tupelo Swamp	G3	
Maritime Wet Grassland	G3	
Tidal Freshwater Marsh	G3	
Barrier Island Pond Complex	G3	
Temperate Shell Midden Woodland	G3G4	
Atlantic Maritime Dry Grassland	G3G4	
Atlantic Dune Grassland	G3G4	
High Pocosin	G3G4	

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D. FEDERAL AND STATE LISTED PLANT SPECIES IN THE ALTAMAHA RIVER BIORESERVE

Federally Listed

Species Name	Common Name	Federal Status	Georgia Status
Agrimonia incisa	Cutleaf Harvest Lice	C2	None
Baptisia arachnifera	Hairy Rattleweed	LE	E
Calamintha ashei	Ashe savory	C1	T
Carex decomposita	Epiphytic Sedge	3C	None
Dicerandra radfordiana	Radford Dicerandra	C2	None
Elliottia racemosa	Georgia Plume	3C	T
Fothergilla gardenii	Dwarf Witch-alder	3C	T
Leitneria floridana	Florida Corkwood	3C	None
Litsea aestivalis	Pondspice	C2	T
Matelea alabamensis	Alabama Milkvine	C2	T
Pentemon dissectus	Dissected Beardtongue	3C	R
Physostegia leptophylla	False Dragon-head	C2	T
Pieris phyllyreifolia	Climbing Heath	3C	None
Pinckneya pubens	Hairy Fever-tree	3C	None
Plantago sparsiflora	Pineland Plantain	C2	None
Rhapidophyllum hystrix	Needle Palm	3C	None
Sageretia minutiflora	Tiny-leaf Buckthorn	3C	T
Sporobolus teretifolius	Wire-leaf Dropseed	C2	None
Vernonia pulchella	Ironweed	3C	None

Totals: 1 LE, 1 C1, 7 C2, 10 3C for a total of 19.

State Listed

Species Name	Common Name	Federal Status	Georgia Status
Baptisia arachnifera	Hairy Rattleweed	LE	E
Calamintha ashei	Ashe savory	C1	T
Carex dasycarpa	Velvet Sedge	None	R
Elliottia racemosa	Georgia Plume	3C	T
Epidendrum conopseum	Green-fly Orchid	None	U
Evolvulus sericeus	Creeping Morning-glory	None	E
Fothergilla gardenii	Dwarf Witch-alder	3C	T
Litsea aestivalis	Pondspice	2C	T
Matelea alabamensis	Alabama Milkvine	C2	T
Matelea pubiflora	Trailing Milkvine	None	R
Pentemon dissectus	Dissected Beardtongue	3C	R
Physostegia leptophylla	False Dragon-head	C2	T
Sarracenia flava	Yellow Flytrap	None	U
Sarracenia minor	Hooded Pitcherplant	None	U
Sageretia minutiflora	Tiny-leaf Buckthorn	3C	T
Tillandsia recurvata	Small Ballmoss	None	T

Totals: 2 E, 8 T, 3 R, 3 U for a total of 16.