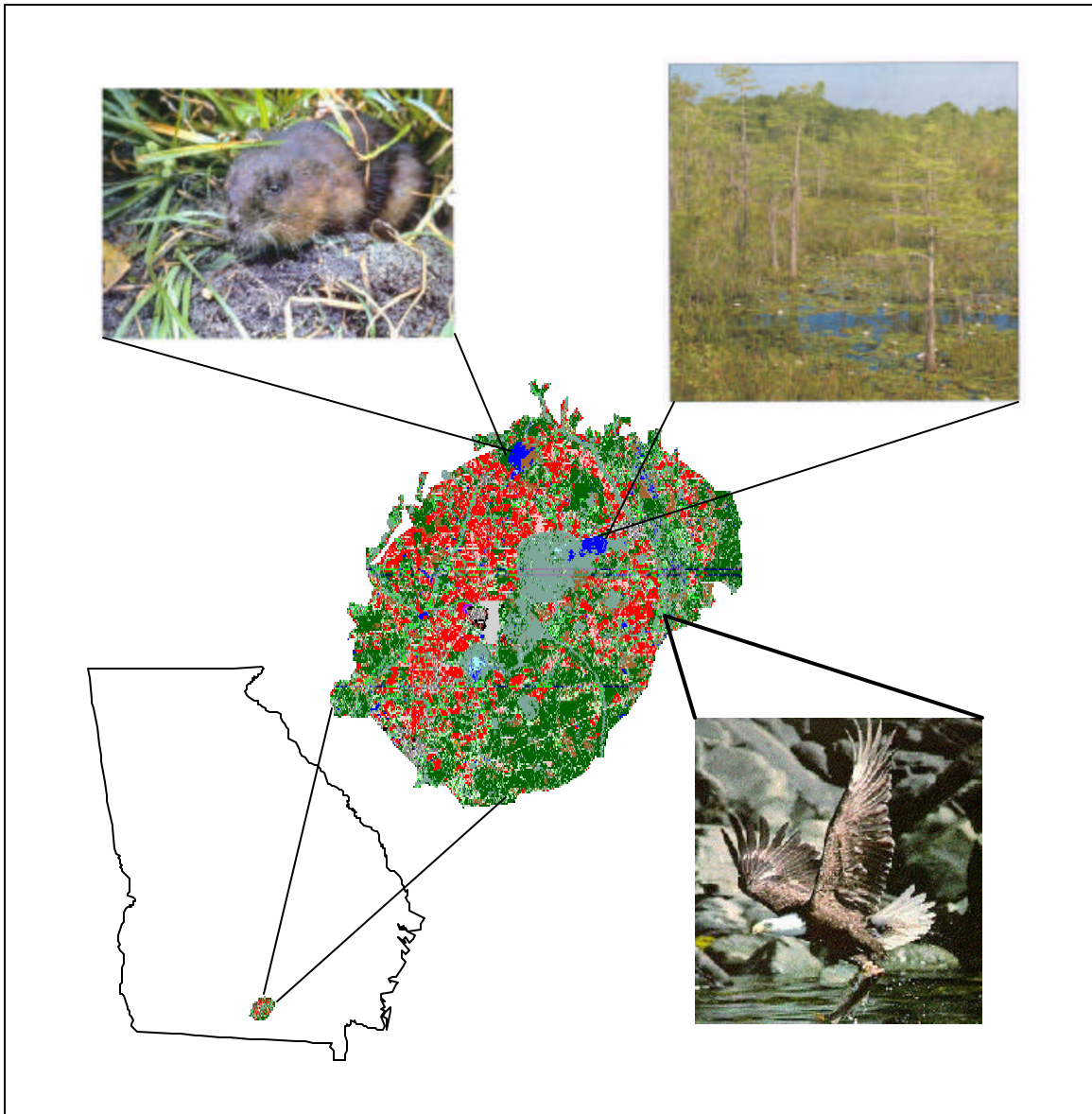


**Grand Bay-Banks Lake Stewardship Partnership-Phase I Final Report:
The Grand Bay-Banks Lake Ecosystem Site Conservation Plan**



*The Nature
Conservancy* 

SAVING THE LAST GREAT PLACES ON EARTH

December 2003

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I. Table of Contents

Section	Page Number
Cover Page	
List of Participants	2
I. Table of Contents	3
II. Executive Summary	4
III. Introduction	5
Site Location	5
Site Contacts	5
Figure 1: Grand Bay - Bay Lakes ecosystem	6
Site Context	7
Site Boundary and Size	7
IV. Methodology	8
V. Conservation Targets	9
Table 1: Conservation target justification	10
Figure 2: Conservation target distribution	14
Table 2: Conservation target creation methodologies	15
VI. Biodiversity Health Assessment	16
Table 3: Biodiversity health assessment	16
Figure 3: Historical & current longleaf pine distribution	20
VII. Threats Analysis	21
Table 4: Conservation target stresses	22
Table 5: Conservation target sources of stress	23
VIII. Conservation Goals	24
Table 6: Conservation goals	24
IX. Conservation Objectives	29
Table 7: Conservation objectives	29
X. Conservation Strategies and Actions	32
Table 8: Conservation target strategies and actions	32
XI. Success Measures	35
Table 9: Conservation target monitoring plans	35
XII. Literature Cited	39
Appendices	
Appendix 1: GBBL documented species of special concern	
Appendix 1a: Documented species of special concern occurring in the Grand Bay - Bay Lakes area	
Appendix 1b: Rare Herpetofauna of the GBBL Ecosystem (Palis)	
Appendix 1c: Reptile and Amphibian Species at Moody Air Force Base (BHE)	
Appendix 1d: Ichthyofaunal Survey of Banks Lake, Grand Bay, Grand Bay Creek, and Shiner Pond (Vives)	
Appendix 2: GBBL cooperative stewardship plan initial agreement	
Appendix 3: Natural Communities at Grand Bay-Banks Lake (TNC)	
Appendix 4: Literature Review Summary	
Appendix 5: Index of Files on CD (including GIS Data)	

II. Executive Summary

The Grand Bay - Banks Lake area (GBBL) comprises the second-largest freshwater wetland system in Georgia¹ and contains a number of unique ecological systems (Longleaf Pine / Wiregrass), communities (Dudley's Hammock), and globally imperiled species (Bachman's Sparrow, *Aimophila aestivalis*; Gopher Tortoise *Gopherus polyphemus*; Round-tailed muskrat, *Neofiber alleni*) (MAFB 2001, TNC 2002c). A Cooperative Stewardship Council comprised of regional land management agencies has identified six ecoregional conservation targets: Carolina Bays / Isolated Wetlands, Hardwood Hammocks, Longleaf Pine, Migratory Birds, Riverine Aquatic Systems, and Wading Birds (TNC 2002a). The proactive management of each would greatly lead to progress on protecting the overall GBBL ecosystem.

Falling within the political boundaries of Berrien, Lanier, and Lowndes counties Georgia, and within range of nearby cities including Valdosta (2000 Census: pop. 43,724; pop. growth rate 1990-2000 9.2%) and Lakeland (2000 Census pop. 2,730; pop. growth rate 1990 - 2000 10%), the biggest threat to GBBL appears to be human encroachment and associated habitat conversion and destruction. Overall, the population of the Tri-County Area has increased 33% since 1980. Approximately 6,100 hectares in the northern portion of the site are in public ownership (Moody AFB, Grand Bay WMA, Banks Lake NWR). Future land use estimates indicate that within ten years, agricultural and silvicultural practices will decline by 26%, while urban areas increase by over 110%.

Conservation management strategies in the area must include habitat restoration to remediate the effects of past and current agricultural (incompatible chemical use; incompatible livestock production practices), silvicultural (fire suppression; incompatible timber harvest), and hydrological (incompatible water control structures) practices, as well as address the current and future threat of urbanization (incompatible commercial and residential development). Conservation easement agreements and the establishment of public education programs that convey the uniqueness of the GBBL ecoregion will be key to preserving this system.

Site Conservation Planning methodology developed by The Nature Conservancy (2000) was used to conduct a GIS-based analysis of stresses and sources of stress for each of six conservation targets. From this analysis, the following top three conservation strategies were developed: 1) Enhance or restore essential habitat for species of special concern; 2) Prohibit additional residential, commercial, and agricultural development within 150 meters of wetlands / rivers; and 3) Collaborate with neighboring landowners to promote and establish conservation easements, and to promote habitat protection. Implementation of these strategies will require the combined effort of all council members, as well as public commitment to conservation of this unique ecosystem.

¹Some people have questioned if the Chickasawhatchee Swamp ecosystem is larger than GBBL, but we have not found that to be the case. Our searches indicate the area of the Chickasawhatchee Swamp is between 7,975 - 8,110 hectares, while the area of GBBL under Council management is 9,480 hectares.

III. Introduction

Site Location

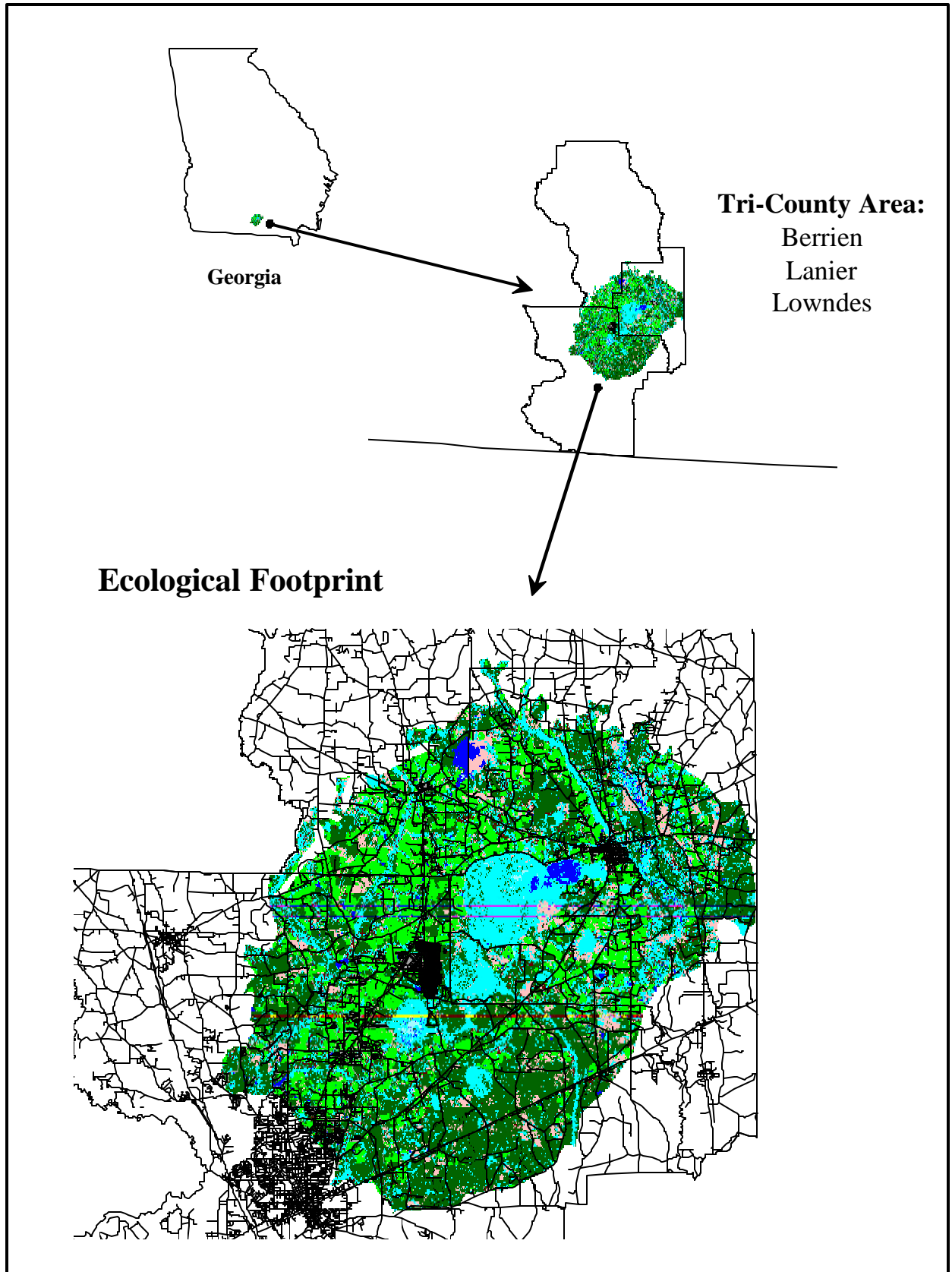
The Grand Bay - Banks Lake area (Figure 1) comprises the second-largest freshwater wetland system in Georgia. This ~42,500 hectare site is located at the westernmost edge of the South Atlantic Coastal Plain ecoregion within the Suwannee River Basin and lies within the Tifton Upland District of the East Gulf Coastal Plain Section of Georgia (TNC 2002c). Bordered by the Withlacoochee River on the west and the Alapaha River on the east, the Grand Bay - Banks Lake ecoregion is characterized by flat to sloping plateaus separated by shallow river valleys, broad wetland depressions, and karst topography. In general, soils on uplands in this region were formed in deep sedimentary sands and clays (MAFB 2001). Pleistocene-Pliocene sand and gravels include, in part, Sunderland, Coharie, and Brandywine formations of Cooke, 1939 (Anonymous 2002). Alluvial soils near streams and tributaries generally originated from material eroded from the uplands (MAFB 2001). Elevation in the area is approximately 61 meters above sea level (Anonymous 2002). The northwestern and northern boundary of this area is the base of the Pelham Escarpment that rises as much as 61 meters above the Dougherty Plain. The dominant landforms of the area include Carolina Bays, limesinks, creek swamps, open water shallow lakes, ponds, flatwoods, and an elevated hammock (Dudley's Hammock). Three globally rare (G3) animal species are found in the area: Bachman's Sparrow (*Aimophila aestivalis*), Gopher Tortoise (*Gopherus polyphemus*), Round-tailed muskrat (*Neofiber alleni*). The site also supports a total of 23 species tracked by the natural heritage program (Appendix 1) (MAFB 2001, TNC 2002c).

Site Contacts

GBBL falls within the political boundaries of Berrien, Lanier, and Lowndes Counties (referred to as the "Tri-County Area" throughout our GIS analyses and this report), Georgia. A voluntary, cooperative stewardship council comprised of people from the Georgia Department of Natural Resources (Wildlife Resources Division), Moody Air Force Base, The Nature Conservancy (Georgia Field Office), and U.S. Fish and Wildlife Service (Banks Lake National Wildlife Refuge), has been established to develop a management plan for GBBL (Appendix 2) that will ensure integrity of the ecosystem and long-term viability of native flora and fauna, in the context of compatible human use (TNC2002a). Current contacts within this partnership include Wes Abler (GDNR), Jim Burkhardt (USFWS), Tip Hon (GDNR), John Kasbohm (USFWS), Greg Lee (MAFB), Alison McGee (TNC) and Skippy Reeves (USFWS).

To make progress on protecting this significant ecosystem, the partnership has identified six ecoregional conservation targets within the Grand Bay - Banks Lake system. These conservation targets include Carolina Bays, Hardwood Hammocks, Longleaf Pine, Migratory Birds, Riverine Aquatic Systems, and Wading Birds (TNC 2002a). This report assesses the stresses and sources of stress that impact each of the six conservation targets as well as puts forth a plan for future conservation management and system monitoring.

Figure 1. The Grand Bay - Bay Lakes ecosystem



Site Context

The Grand Bay - Banks Lake ecoregion is dominated by three of the largest (1.6 - 6.4 kilometers in diameter) Carolina Bays in the southeastern United States. Found throughout the southeastern Coastal Plain, Carolina Bays are oval-shaped depressional wetlands that are oriented in a northwest to southeast direction. Pond cypress and bald cypress-black gum comprise the dominant tree species along the margins of the Carolina Bays, while water lily, water shield, fanwort, and floating heart characterize the vegetation found in open water areas (MAFB 2001).

Carolina Bays are separated by broad drainage-ways containing lowland mixed hardwoods (black gum, water oak, red maple, and sweet bay) and bordered by stands of pond pine and thickets of evergreen shrubs. Moderately well-drained upland areas in the GBBL complex are dominated by longleaf and slash pine forests. The site also contains one of the only evergreen hammocks remaining in Georgia's Coastal Plain - Dudley's Hammock. Dudley's Hammock is a relatively undisturbed, elevated area of approximately 61 hectares in size. The hammock rises two to three meters above the surrounding pine flatwoods and gum swamps. Predominant vegetation includes spruce pine, southern magnolia, water oak and live oak. The rare, epiphytic green-fly orchid and needle palm is found within Dudley's Hammock (MAFB 2001, Bergstrom *et al.* 1994). See Appendix 3 for an inventory of natural communities within the GBBL area.

Nearby cities include Valdosta (2000 Census: pop. 43,724; pop. growth rate 1990 - 2000 9.2%) and Lakeland (2000 Census pop. 2,730; pop. growth rate 1990 - 2000 10%). Overall, the population of the Tri-County Area has increased 33% since 1980. More proximally, there are roughly 10-15 large (200+ hectares) landowners in the Grand Bay - Banks Lake area and hundreds of smaller landowners scattered throughout the site. Approximately 6,100 hectares in the northern portion of the site are in public ownership (Moody AFB, Grand Bay WMA, Banks Lake NWR). Current land usage includes agriculture (west side), forestry (east side), and an urban center (south side) (INRMP 2001, TNC 2002c). Future land use estimates indicate that within ten years, agricultural and silvicultural practices will decline by 26%, while urban areas increase by over 110%.

Site Boundary and Size

Using GIS data layers we analyzed the impact of human activities on each of the six TNC ecoregional conservation targets described above. Our first objective was to establish a functional ecological area of interest for our spatial analyses. Our goal was to capture an area large enough to encompass the ecological structure, composition, and function of all conservation targets. The current GBBL boundary was used as a starting point. Based on natural history data for threatened, rare, and endangered species known to use or inhabit the GBBL ecoregion (an abbreviated example: gopher tortoises were reported to have home ranges of 0.04 - 1.44 hectares [McRae *et al.* 1981], 0.01 - 2.88 hectares [Diemer 1992], 0.06 - 0.42 hectares [Butler *et al.* 1995], and 0.01 - 1.4 hectares [Smith 1995], with daily movements of 8 - 168 meters [Diemer 1992], 0.3 - 33 meters [Butler *et al.* 1995], and 10.2 - 375 meters [Smith 1995]), we established an eight kilometer buffer around the entire current GBBL jurisdictional boundary. We then took into consideration the presence of ecologically significant hydrological and terrestrial features lying outside of the buffered area. The buffer was modified to include various isolated wetlands, the main tributaries of the Alapaha and Withalacoochee Rivers, and complete forest stands. The resultant area is ~75,000 hectares in size. This functional area is referred to as the "Ecological Footprint" throughout our GIS analyses and this report.

IV. Methodology*

Site Conservation Planning

TNC's Site Conservation Planning (SCP) methodology (The Nature Conservancy 2000) was used to develop this plan. This planning methodology provides a framework for identifying the highest priority conservation actions and most significant land and water areas needed to conserve selected conservation targets. For the GBL area, this framework was used to identify the most effective, timely and cost efficient actions that would conserve biodiversity through management of land and water while supporting the military mission.

The SCP process is based on five themes:

1. Selected focal conservation targets structure the planning process and become the starting point to conserve biodiversity and ecosystem function.
2. An assessment of ecological integrity (called desired future conditions in this document), using the best available ecological information, identifies the spatial and temporal ecological needs of the focal conservation targets and provides the basis for measuring management success. Another component of this theme is the biodiversity health assessment, which determines the current status of each target.
3. Information on the human context, including mission, stakeholders and surrounding communities, is integrated in the planning process. A detailed stakeholder analysis, as was done in this plan, is sometimes conducted.
4. Critical threats to targets structure the development of conservation strategies.
5. The planning process is iterative and adaptive, incorporating adaptive management to evaluate the success of conservation strategies.

Selection of Focal Conservation Targets

Focal conservation targets are indicators of imperiled species, biodiversity, and ecological systems. If protected these targets are assumed to conserve all elements of conservation concern and a significant portion of biodiversity at a conservation area. Focal conservation targets are usually ecological systems or assemblages that maintain a suite of constituent species and communities, but also can be species that are indicators of ecological systems. Focal conservation targets are central to planning, reducing the total number of communities or species assessed in the planning process to an efficient number, which is essential for streamlining planning efforts in large, complex conservation areas that have many rare species and natural communities.

The process of selecting focal conservation targets has two steps. It begins by assessing all conservation targets, i.e. all species and communities of conservation concern, and grouping into ecological systems those that are related by ecological processes, underlying environmental features, or environmental gradients. An example of a system level target at Fort Stewart is the longleaf pine system. This system is ecologically driven by fire. The working assumption is that as fire is properly used to manage this system, all embedded natural communities and all rare species will be conserved.

Once system targets are identified, a review of the selected conservation targets focuses on the following questions:

- Do any conservation targets need species or community-specific management?
- Are any of the conservation targets so rare that they need special management attention?
- Are there regional-scale species that use multiple systems over a wide area?

These questions identify species or communities that would not be adequately conserved by focusing solely on system level targets, and therefore should be added as focal conservation targets.

Focal Conservation Targets

Six focal conservation targets were selected for the GBL Conservation Area:

- Carolina Bays

* *Methodology excerpted in part from Call and Sutter, Working Draft Jan. 2003*

- Hardwood Hammocks
- Riverine Aquatic Systems
- Longleaf Pine
- Wading Birds
- Migratory Birds

V. Conservation Targets

As discussed above, the Partnership has identified six conservation targets whose future health is considered to be crucial to maintaining the ecological integrity of the GBBL ecosystem. A brief justification for their inclusion and list of representative species found within each target are presented in Table 1. Figure 2 is a graphical representation of the six conservation targets, while Table 2 summarizes the methodologies and sources of data used to create each map.

Table 1. Summary and justification of conservation targets

Site Conservation Planning Target	Justification for Site Target Selection	Representative Species
<p>Wading Birds</p>	<p>Half of the world’s wetlands are estimated to have been lost during the 20th century, with more than half having already been destroyed in the United States (TNC 2003). Bergstrom <i>et al.</i> (1994) lists a total of five wading birds that rank as species of special concern at the state or federal level due to such habitat loss. These five species (American Bittern, Florida Sandhill Crane, Greater Sandhill Crane, Little Blue Heron, and Wood Stork) either nest or over-winter (or both) in the Ecological Footprint. Preservation of viable population sizes and structures of these species also encompasses preservation of wetland habitat - one of the most imperiled ecotypes in the world.</p>	<p><u>Birds</u> American bittern (<i>Botaurus lentiginosus</i>) Florida sandhill crane (<i>Grus canadensis pratensis</i>) Greater sandhill crane (<i>Grus canadensis tabida</i>) Little blue heron (<i>Egretta cauerula</i>) Wood stork (<i>Mycteria americana</i>)</p>
<p>Longleaf Pine / Wiregrass</p>	<p>Longleaf pine ecosystems are among the most threatened in North America. Once covering a reported 36.4 million hectares in the Southeastern United States, less than 1.2 million hectares of longleaf remain today (USFWS 2003). A 97% decline in the longleaf pine/wiregrass ecosystem has occurred in the Coastal Plains of the Carolinas, Georgia, Florida, Alabama, Louisiana, and Texas. In southeastern Georgia, the longleaf pine forest declined 36% (to ~93,000 hectares) between 1981 and 1988 (Johnson 1988). Most of this conversion has been from second- or third-growth longleaf pine stands to slash or loblolly pine plantation forestry (USFWS 2003).</p> <p>Analyses of the Ecological Footprint indicate that there has been a 24 - 35% loss in longleaf pine forest stands since 1977 and perhaps at least a 50% decrease in the ratio of area to perimeter since 1990. With roughly 19% (and rising) of remaining longleaf pine forests affected directly by urban sprawl, it is extremely important to conserve this unique ecosystem. Doing so would also protect the 30-plus plant and animal species associated with longleaf pine ecosystems which are threatened or endangered, including the red-cockaded woodpecker and gopher tortoise (USFWS 2003). See Appendix 3 for a</p>	<p><u>Reptiles</u> Eastern indigo snake (<i>Drymarchon corais couperi</i>) Gopher tortoise (<i>Gopherus polyphemus</i>) <u>Birds</u> Bachman’s sparrow (<i>Aimophila aestivalis</i>)</p>

	description of longleaf pine at GBBL.	
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Site Conservation Planning Target	Justification for Site Target Selection	Representative Species
<p>Carolina Bays / Isolated Wetlands</p>	<p>The Carolina Bays found on Moody Air Force Base are the largest and most biologically intact Carolina Bays in the region and comprise the bulk of the Grand Bay/Banks Lake wetland complex. Exclusive of the Okefenokee Swamp, this wetland complex of over 5,250 hectares is the largest freshwater lake-swamp system in the Coastal Plain of Georgia (MAFB 2001, Anonymous 2002). The Carolina Bay / Isolated wetland complex supports a wide array of wading birds, reptiles, and amphibians (see nested species box).</p> <p>Another type of isolated wetland, limesinks, was originally planned to be the seventh unique conservation target. It has since been determined that not enough information exists to include limesinks in the overall analysis. Additionally, known major limesinks are found much further south of the Ecological Footprint making inclusion impractical.</p>	<p><u>Plants</u> Green-fly orchid, (<i>Epidendrum conopseum</i>)</p> <p>Hooded pitcher plant (<i>Sarracenia minor</i>)</p> <p><u>Fish</u> Golden topminnow (<i>Fundulus chrysotus</i>)</p> <p>Mud sunfish (<i>Acanthrarchus potomis</i>)</p> <p><u>Amphibians</u> Dwarf siren (<i>Pseudobranchius striatus</i>)</p> <p><u>Mammals</u> Round-tailed muskrat (<i>Neofiber alleni</i>)</p> <p><u>Reptiles</u> American alligator (<i>Alligator mississippiensis</i>)</p> <p>Eastern indigo snake (<i>Drymarchon corais couperi</i>)</p> <p><u>Birds</u> American bittern (<i>Botaurus lentiginosus</i>)</p> <p>Florida sandhill crane (<i>Grus canadensis pratensis</i>)</p> <p>Greater sandhill crane (<i>Grus canadensis tabida</i>)</p> <p>Little blue heron (<i>Egretta cauerula</i>)</p> <p>Loggerhead shrike (<i>Lanius ludovicianus migrans</i>)</p> <p>Southern bald eagle (<i>Haliaeetus leucocephalus leucocephalus</i>)</p>

Site Conservation Planning Target	Justification for Site Target Selection	Representative Species
Migratory Birds	<p>A variety of insectivorous and frugivorous migratory birds are known to use habitat within the GBBL complex, including at least two federal candidate species: the Veery and the Willow Flycatcher and possibly the Black-billed Cuckoo. Bergstrom <i>et al.</i> (1994) has determined that the site is also an important breeding habitat for a number of globally declining neotropical migrant songbirds including Wood Thrush, Red-eyed Vireo, and Hooded Warbler. All of these species are edge sensitive. This is important to note because since 1990, the ratio of area to perimeter has decreased by roughly 56%.</p>	<p>Wood stork (<i>Mycteria americana</i>)</p> <p><u>Birds</u> Loggerhead shrike (<i>Lanius ludovicianus migrans</i>)</p>
Riverine Aquatic Systems	<p>Any changes in riverine hydrology and/or, water quality may directly impact the Carolina Bay wetland complex (also listed as a conservation target), the main reason Riverine Aquatic Systems should be considered as a conservation target.</p> <p>The riverine systems flowing through the GBBL complex are exposed to two of the main causes of freshwater biodiversity decline cited by TNC (2003): 1) hydrologic alteration from dams, small impoundments, and diversions, and 2) water quality degradation largely from agriculture. Over the last 100 years, the scope of these threats has increased exponentially.</p>	<p><u>Fish</u> Golden topminnow (<i>Fundulus chrysotus</i>) Mud sunfish (<i>Acanthrarchus potomis</i>)</p>
Hardwood Hammocks	<p>Two of the highest quality hardwood hammocks in Georgia occur on Moody Air Force Base: Dudley's Hammock, a ~50 hectare site in the south-central part of the installation, and Hickory Hammock, a ~11 hectare site located just south of the Grand Bay Weapons Range bomb target (MAFB 2001).</p> <p>Dudley's Hammock is noted as the most significant (and potentially only) evergreen hammock remaining in the state. Dudley's hammock contains the Spruce Pine and is one of the few locations in Georgia containing the epiphytic Green-Fly Orchid (<i>Epidendrum conopseum</i>) (Anonymous 2002).</p>	<p><u>Plants</u> Green-fly orchid, (<i>Epidendrum conopseum conopseum</i>)</p> <p><u>Reptiles</u> American alligator (<i>Alligator mississippiensis</i>) Eastern indigo snake (<i>Drymarchon corais couperi</i>)</p>

Site Conservation Planning Target	Justification for Site Target Selection	Representative Species
<p>Hardwood Hammocks (continued)</p>	<p>The diversity of mature hardwood trees and woody shrubs within hardwood hammocks provides an important stopover habitat for insectivorous and frugivorous migratory birds, including at least two federal candidate species: Veery and Willow Flycatcher and possibly the Black-billed Cuckoo. The site is also an important breeding habitat for certain globally declining neotropical migrant songbirds that are edge-sensitive, including Wood Thrush, Red-eyed Vireo, and Hooded Warbler. There is also an historic record of an indigo snake from Dudley's Hammock (Bergstrom <i>et al.</i> 1994, MAFB 2001).</p>	<p><u>Birds</u> Wood stork (<i>Mycteria americana</i>)</p>

Figure 2. Distribution of the six GBBL conservation targets (see Table 2 for figure source and creation methodology)

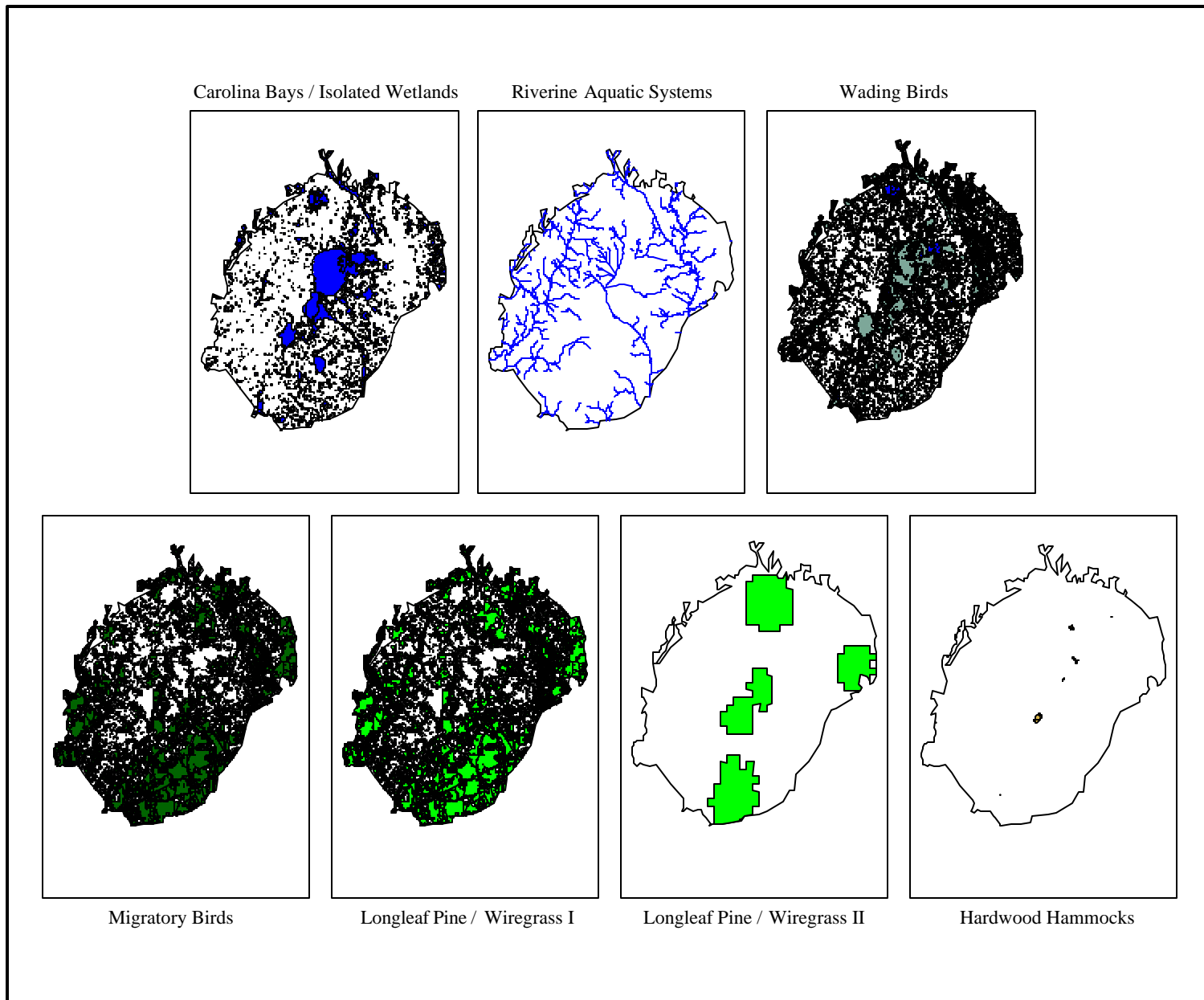


Table 2. Summary of sources and methodologies for creation of conservation target GIS maps

Conservation Target	Source of GIS Data Layers	GIS Data Layers Creation Methodology/Assumptions
Wading Birds	Georgia Data Clearinghouse, Georgia GAP Project, National Wetlands Inventory, Original Content, South Georgia Regional Development Center	Land use types analyzed included emergent wetlands, forested wetlands, non-forested wetlands, open water, scrub wetlands, and shrub wetlands, with the assumption that these habitats were essential for wading bird feeding, nesting, and other natural history aspects.
Longleaf Pine / Wiregrass I	Georgia Data Clearinghouse, Georgia GAP Project, Original Content, South Georgia Regional Development Center	Because high-quality, forest type-specific data layers do not exist, we analyzed evergreen and mixed forest habitat data. This certainly overestimated the area of longleaf pine forests and interpretation of our results by the reader should reflect that.
Longleaf Pine / Wiregrass II	The Nature Conservancy, Original Content	A second analysis was undertaken using a 1998 TNC large-scale map delineating longleaf pine forests. This, too, overestimates the area of longleaf pine, but to a lesser extent than our first analysis. However, the scale is too large to compare results with data from other years (as with our first analysis) and must stand alone.
Carolina Bays / Isolated Wetlands	Georgia Data Clearinghouse, Georgia GAP Project, National Wetlands Inventory, Original Content, South Georgia Regional Development Center	Land use types analyzed included forested wetlands, non-forested wetlands, open water, reservoirs, scrub wetlands, and shrub wetlands.
Migratory Birds	Georgia Data Clearinghouse, Georgia GAP Project, Original Content, South Georgia Regional Development Center	Land use types analyzed included deciduous, evergreen, and mixed forests, with the assumption that these habitats were essential for wading bird feeding, nesting, and other natural history aspects. Migratory wading birds are analyzed within the Wading Bird section.
Riverine Aquatic Systems	Georgia Data Clearinghouse, Georgia GAP Project, National Wetlands Inventory, Original Content, South Georgia Regional Development Center, United States Census Bureau	Land use types analyzed included rivers and streams.
Hardwood Hammocks	Georgia Data Clearinghouse, Georgia GAP Project, Original Content, South Georgia Regional Development Center	Known hardwood hammocks and forest stands delineated as islands were analyzed.

VI. Biodiversity Health Assessment

A biodiversity health assessment was undertaken for each of the conservation targets based on three ecological integrity categories: size, condition, and landscape scale context, all of which help to determine the viability of each conservation target. *Size* is a measure of the area or abundance of the conservation target's occurrence. For ecological systems and communities, size is simply a measure of the occurrence's patch size or geographic coverage. For animal and plant species, size takes into account the area of occupancy and number of individuals. Another aspect of size is the minimum dynamic area, or the area needed to ensure survival or re-establishment of a target after natural disturbance. *Condition* is an integrated measure of the composition, structure, and biotic interactions that characterize the occurrence of the conservation target. This includes factors such as reproduction, age structure, biological composition (e.g., presence of native versus exotic species; presence of characteristic patch types for ecological systems), structure (e.g., canopy, understory, and groundcover in a forested community; spatial distribution and juxtaposition of patch types or seral stages in an ecological system), and biotic interactions (e.g., levels of competition, predation, and disease). *Landscape context* is an integrated measure of two factors: the dominant environmental regimes and processes that establish and maintain the target occurrence, and connectivity. Dominant environmental regimes and processes include herbivory, hydrologic and water chemistry regimes (surface and groundwater), geomorphic processes, climatic regimes (temperature and precipitation), fire regimes, and many kinds of natural disturbance. Connectivity includes such factors as species targets having access to habitats and resources needed for life cycle completion, fragmentation of ecological communities and system, and the ability of any target to respond to environmental change through dispersal, migration, or re-colonization. A ranking (Very Good, Good, Fair, or Poor) was assigned for each category based on an "ad hoc" scale. Rankings and their justifications, as well as an overall biodiversity health score for each conservation target are presented in Table 3 A corresponding color scheme is included to simplify reading the table: Poor is colored red, Fair is colored yellow, and Good is colored Green. There were no Very Good rankings assigned. The overall biodiversity health ranking for the Ecological Footprint is fair. For a more detailed justification of the ecological integrity categories, please refer to the 'Viability' tab located in the Microsoft Excel spreadsheet named GBBL_XL_TOOL.xls.

Table 3. Biodiversity health assessment

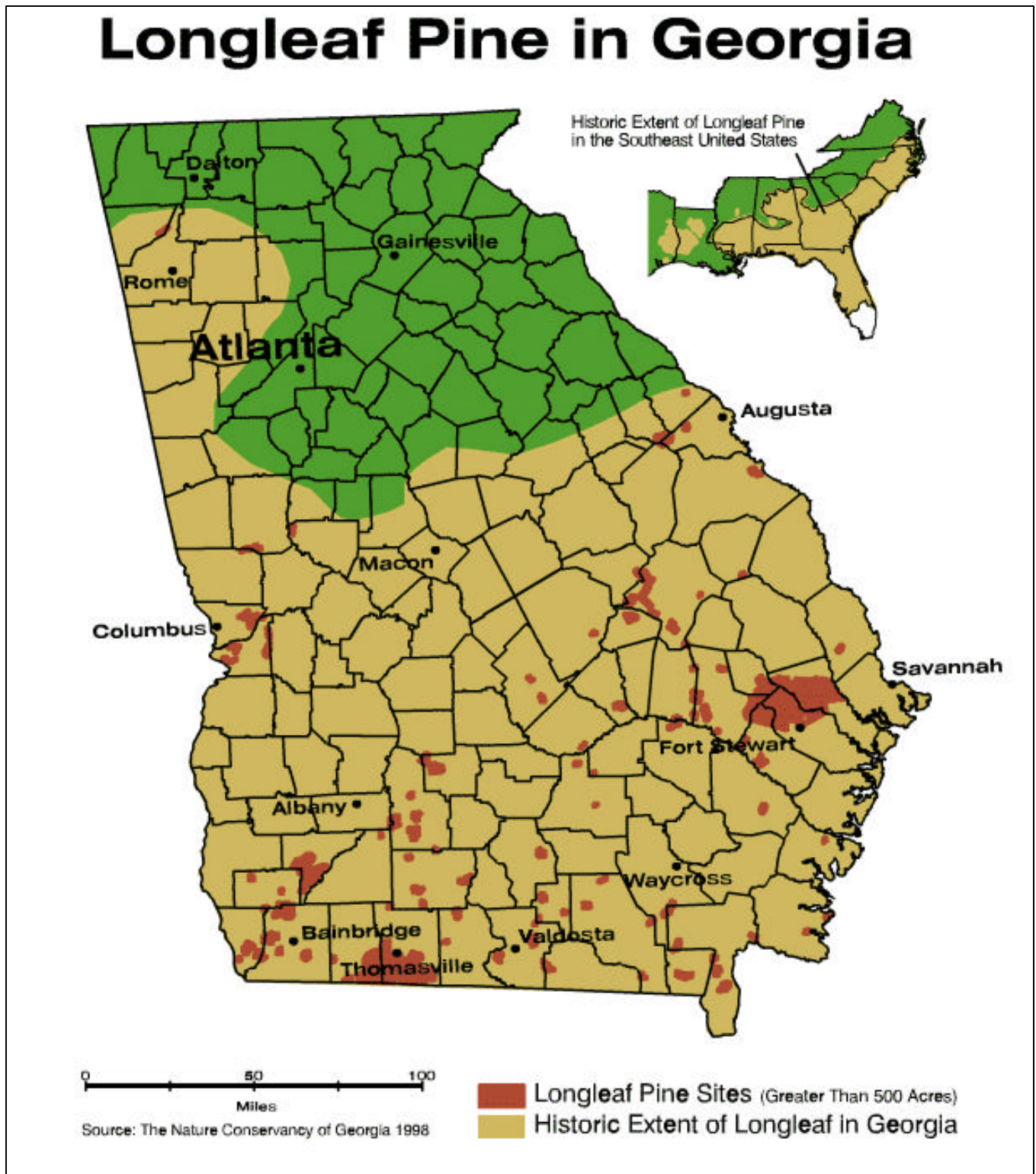
Site Conservation Target	Ecological Integrity Categories and Ranks	Ranking Justification	Overall Biodiversity Health Score
Wading Birds	<u>Size</u>	Although there have been no recent studies into population size of the 16 GBBL documented wading bird species, conversations with regional biologists and personal observations indicate that wading birds occur in high numbers and utilize most available habitats.	Good
	Good		
	<u>Condition</u>	New field studies are needed for confirmation, but it appears that wading birds are not succumbing to overwhelming disease, predation, introduced competitors, etc. Many species are known to nest here and it appears that there is normal distribution of age and sex classes. 5 of 16 GBBL wading bird species are listed as species of special concern by the federal government, state of Georgia, or Natural Heritage Survey, indicating that the majority of GBBL wading bird species are able to maintain a viable population size and structure.	
	Good		
<u>Landscape Context</u>	Because wetlands, rivers, and areas of open water are pervasive throughout the Ecological Footprint, there are sufficient areas available for wading bird feeding, nesting, and other natural history aspects. This high level of connectivity benefits wading birds in the event of local damage/disturbance, allowing easy opportunities for dispersal or recolonization.		
Good			

Site Conservation Target	Ecological Integrity Categories and Ranks	Ranking Justification	Overall Biodiversity Health Score
Longleaf Pine / Wiregrass	<u>Size</u>	In southeastern Georgia, longleaf pine forests declined 36% (to 93,000 hectares) between 1981 and 1988 (Johnson 1988). Within the Ecological Footprint, our first analysis show that forests that may contain longleaf pine (mixed and evergreen) have declined by 35% between 1977 and 1998. Due to the nature of the data, we were not able to perform the exact same analysis using a second set of forest data obtained from TNC. However, it does appear that longleaf pine forests may have declined by 29.5% between 1977 and 1998.	Poor
	Poor		
	<u>Condition</u>	Much of the site is being maintained through controlled burning, however, longleaf pine forest understory and ground cover are in varying stages of suppression/succession depending upon the uniformity of fire. The area has historically undergone a high degree of fire suppression, the effects of which are still manifest on current longleaf pine stands. 1998 - 2001 MAFB fire management practices resulted in burning 45 - 65% of the total possible longleaf pine area. Fires have been suppressed more frequently & to a greater extent on non-Moody lands. Regional fire ecologists are aware of this and in conversation, seem to be committed to rectifying past thoughts and actions on the benefits of fire.	
	<u>Landscape Context</u>	At a landscape scale longleaf pine ecosystems are among the most threatened in North America (Figure 3). Once covering a reported 36.4 million hectares in the Southeastern United States, today less than 1.2 million hectares of longleaf remain (USFWS 2003). A 97% decline in the longleaf pine / wiregrass ecosystem has occurred in the Coastal Plains of the Carolinas, Georgia, Florida, Alabama, Louisiana, and Texas. Additionally, landscape-scale fire suppression has had and continues to have a negative impact on longleaf pine ecosystems. Remnant longleaf pine ecosystems are extremely fragmented at the landscape scale (increasing 55% from 1990 to 1998) and often at the scale of individual stands.	
Carolina Bays / Isolated Wetlands	<u>Size</u>	The Carolina Bays found on Moody Air Force Base are the largest and most biologically intact Carolina Bays in the region and comprise the bulk of the Grand Bay/Banks Lake wetland complex (MAFB 2001, Anonymous 2002). At a local scale, hydrarch succession appears to be the biggest threat to the size of existent Carolina Bays (<i>sensu</i> Bergstrom <i>et al.</i> 1994). Certain areas (Grand Bay) are also exposed to human / residential development and shoreline encroachment.	Fair
	Good		
	<u>Condition</u>	72.2% of the 150 meter buffer zone (a distance chosen to be large enough to go beyond federal wetland buffer minimums, but be small enough to capture only the nearest neighbors of the wetlands) surrounding the Carolina Bay ecotype within GBBL is ranked within a low to moderate risk of toxins and contaminants - meaning that 27.8% or, over a quarter of land within the 150 meter buffer zone surrounding Carolina Bays is at moderate to high risk of toxins or contaminants. Hydrarch succession due to infrequent fire intervals is occurring over part of the Carolina Bay range - particularly in Grand Bay. MAFB burned only 34 - 40% of the possible Carolina Bay habitat during 1998 - 2001.	
	Fair		

Site Conservation Target	Ecological Integrity Categories and Ranks	Ranking Justification	Overall Biodiversity Health Score
Carolina Bays / Isolated Wetlands (continued)	<u>Landscape Context</u>	Exclusive of the Okefenokee Swamp, this wetland complex of over 5,250 hectares is the largest freshwater lake-swamp system in the Coastal Plain of Georgia (MAFB 2001, TNC 2002f). The majority of large Carolina Bays in this region are captured within GBBL Council boundaries. Therefore these bays and the connectivity between them are fairly well protected. In addition, within the Ecological Footprint, ~28% of land within 150 meters of Carolina Bays or Isolated Wetlands is within moderate to high risk of toxins or contaminants, a potential threat to normal water chemistry levels.	Fair
	Fair		
Migratory Birds	<u>Size</u>	As with the wading birds conservation target, there have been no recent field studies to determine population sizes, extent, or overall general health of the various migratory birds that utilize GBBL areas. It is thought that migratory birds are utilizing a variety of habitats throughout the Ecological Footprint, usually in healthy numbers. Such species include (TNC 2001) the Veery, Willow Flycatcher, possibly Black-billed Cuckoo, Wood Thrush, Red-eyed Vireo, Hooded Warbler, woodpeckers, kinglets, thrushes, vireos, warblers, finches, Swainson's Warblers, Bachman's Sparrows, and Loggerhead Shrikes.	Good
	Good		
	<u>Condition</u>	Again, there are no concrete field data on which to base this ranking. It comes solely from conversations with regional biologists as well as incidental observations that a variety of threatened and non-threatened bird species (see Size Justification for examples) are utilizing the Ecological Footprint and are able to maintain a viable population size and structure in the area.	
	Good		
<u>Landscape Context</u>	Indirect evidence of migratory bird health at the landscape scale comes from GIS analysis of forest change. Roughly 60% of forested area (mixed, evergreen, and deciduous forest types) has been lost from 1977 - 1998. In addition, forest fragmentation has increased 55% in the Ecological Footprint from 1990 to 1998.		
Fair			
Riverine Aquatic Systems	<u>Size</u>	There is a broad geographic coverage of rivers and streams of varying sizes.	Good
	Good		
	<u>Condition</u>	Although neighbored in some places by urban or agricultural areas, rivers appear to be in good condition. Within the Ecological Footprint, 80.1% of land lying within 150 meters of riverine areas is at low to moderate risk of toxins and contaminants. Urban development within 150 meters of rivers has not increased dramatically since 1977.	
	Good		
<u>Landscape Context</u>	Around 20% of the area within 150 meters of riverine areas within the Ecological Footprint falls within the moderate to high toxin or contaminant risk category, a potential threat to normal water chemistry levels. Urban development within 150 meters of rivers has not increased dramatically since 1977, reducing the chances of river channelization or diversion.		
Fair			

Site Conservation Target	Ecological Integrity Categories and Ranks	Ranking Justification	Overall Biodiversity Health Score
Hardwood Hammocks	<u>Size</u> Poor	Very few hardwood hammock stands still exist. However, there is relatively low risk of size reduction for Dudley's Hammock or Hickory Hammock at the present time. Although some hunting is allowed in Hickory Hammock, neither hammock is exposed to heavy human use, or development encroachment. Accidental fire caused by a nearby active EOD range is the greatest potential threat to the size of Dudley's Hammock. Logging may pose the greatest potential threat to size of Hickory Hammock (Bergstrom <i>et al.</i> 1994).	Poor
	<u>Condition</u> Good	Dudley's Hammock is one of the best examples of a low hammock in Georgia. It is completely isolated by surrounding bayswamp, and much of it has not been significantly disturbed for many years (Bergstrom <i>et al.</i> 1994). Access is limited by locked gates. At present, it receives little use and human impact is minimal (Bergstrom <i>et al.</i> 1994). By contrast, Hickory Hammock, a remnant hardwood hammock similar in composition to Dudley's Hammock, has apparently burned more frequently and more recently than Dudley's Hammock (Bergstrom <i>et al.</i> 1994). Bergstrom <i>et al.</i> (1994) suggests that Dudley's and Hickory Hammocks should be protected from wildfire.	
	<u>Landscape Context</u> Poor	Very few hardwood hammock stands still exist and there is a low level of connectivity between individual hammocks. In the event of localized disturbance or destruction, it is unlikely that hardwood hammock-dependent species would be able to disperse, migrate, or recolonize other hardwood hammocks. Accidental fire caused by a nearby active EOD range is the greatest potential threat to Dudley's Hammock, while logging (and its associated human disturbance) may pose the greatest potential threat to Hickory Hammock (Bergstrom <i>et al.</i> 1994).	
Overall Biodiversity Health Score			Fair

Figure 3. Remaining stands of Longleaf Pine Forest in Georgia



VII. Threats Analysis

An integral part of assessing biodiversity health is recognizing the stresses on a particular conservation target, as well as the sources of the stresses. Stresses are judged on the severity and scope of their damage, while the sources of stresses are ranked by their contribution and irreversibility.

Severity of Damage is the level of damage to the conservation target that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing management/conservation situation) of a particular stress. Rankings are assigned as either Very High, High, Medium, or Low, with the following criteria: Very High indicates the stress is likely to destroy or eliminate the conservation target over some portion of the target's occurrence at the site; High indicates the stress is likely to seriously degrade the conservation target over some portion of the target's occurrence at the site; Medium indicates the stress is likely to moderately degrade the conservation target over some portion of the target's occurrence at the site; and low indicates the stress is likely to only slightly impair the conservation target over some portion of the target's occurrence at the site

Scope of Damage is the geographic scope of impact on the conservation target at the site that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation) of a particular stress. Rankings have the same nomenclature as above: Very High indicates the stress is likely to be very widespread or pervasive in its scope, and affect the conservation target throughout the target's occurrences at the site; High indicates the stress is likely to be widespread in its scope, and affect the conservation target at many of its locations at the site; Medium indicates the stress is likely to be localized in its scope, and affect the conservation target at some of the target's locations at the site; and low indicates the stress is likely to be very localized in its scope, and affect the conservation target at a limited portion of the target's location at the site.

Contribution is defined as the expected role of the source, acting alone, to the full expression of a stress (as determined in the stress assessment) under current circumstances (i.e., given the continuation of the existing management/conservation situation). The rankings are again the same: Very High denotes the source is a very large contributor of the particular stress; High denotes the source is a large contributor of the particular stress; Medium denotes the source is a moderate contributor of the particular stress; and Low denotes the source is a low contributor of the particular stress.

Irreversibility is a measure of the reversibility of the stress caused by the source of stress. The rankings are again the same: Very High denotes the source produces a stress that is not reversible (e.g. wetlands converted to a shopping center); High denotes the source produces a stress that is reversible, but not practically affordable (e.g. wetland converted to agriculture); Medium denotes the source produces a stress that is reversible with a reasonable commitment of additional resources (e.g. ditching and draining of wetland); and Low denotes the source produces a stress that is easily reversible at relatively low cost (e.g. off-road vehicles trespassing in a wetland).

Two summary tables are included below to facilitate the assessment of major stresses on the GBBL ecosystem (Table 4), as well as the sources of those stresses (Table 5). Each table contains a corresponding color scheme to simplify reading the table: Very High is colored red, High is colored yellow, Medium is colored light-green, and Low is colored dark-green. Sources of stress were also numerically weighted by individual conservation target rankings (Very High is worth 1.50, High is worth 1.00, Medium is worth 0.40, and Low is worth 0.03) and then summed to obtain an estimate of the contribution to the threat to the ecosystem-level. For justifications and more detailed analyses of stresses and sources of stress, please refer to the Microsoft Excel spreadsheet named GBBL_XL_TOOL.xls.

Table 4. Major stresses, their severity, and their scope for each of the six GBBL conservation targets

Conservation Target	Stresses	Severity	Scope
Wading Birds	Habitat destruction or conversion	High	High
	Modification of water levels	High	High
	Nutrient loading	High	Medium
	Alteration of natural fire regimes	High	High
Longleaf Pine Wiregrass	Habitat destruction or conversion	Very High	High
	Habitat fragmentation	Very High	High
	Alteration of natural fire regimes	Medium	High
Carolina Bays / Isolated Wetlands	Alteration of natural fire regimes	High	High
	Nutrient loading	High	High
	Sedimentation	Medium	High
	Modification of water levels	High	High
	Habitat destruction or conversion	Medium	High
Migratory Birds	Habitat destruction or conversion	High	High
	Habitat fragmentation	Medium	High
	Alteration of natural fire regimes	Medium	High
	Tower trauma	Low	Low
Riverine Aquatic Systems	Habitat destruction or conversion	High	High
	Nutrient loading	Medium	High
	Sedimentation	Medium	High
	Modification of water levels	Low	High
	Toxins/contamination	Medium	High
Hardwood Hammocks	Alteration of natural fire regimes	High	High
	Toxins/contaminants	Medium	Medium

Table 5. Summary of the major sources of stress for the six GBBL conservation targets and their overall threat status

Systems and Threats	Wading Birds	Longleaf Pine Wiregrass	Carolina Bays / Isolated Wetlands	Migratory Birds	Riverine Aquatic Systems	Hardwood Hammocks	Critical Threat Rank	Total Score
Incompatible primary home development	Very High	High	Very High	High	High	-	Very High	6.00
Incompatible forestry practices	Medium	High	Medium	High	Medium	-	High	2.60
Fire suppression	-	Medium	High	Medium	-	High	High	2.40
Conversion for agriculture / silviculture	-	High	-	High	Medium	-	High	2.20
Incompatible crop production practices	Medium	-	High	-	Low	-	Medium	1.23
Incompatible commercial development	-	-	-	High	-	-	Medium	1.00
Incompatible operation of water control structures	-	-	High	-	-	-	Medium	1.00
Ordinance disposal site / toxins leeching	-	-	-	-	-	High	Medium	1.00
Construction of ditches, dikes, and drainage systems	Medium	-	Medium	-	-	-	Medium	0.40
Incompatible livestock production practices	-	-	-	-	Low	-	Low	0.03
Threat Status for Targets and Site	High	High	Very High	High	Medium	High	Very High	

VIII. Conservation Goals

The council has developed and implemented a voluntary and cooperative stewardship plan (Table 6) for the GBBL ecosystem. The goals of the plan will ensure the long-term viability of the native flora and fauna, and the integrity of the ecosystem, while providing for compatible human uses. The status of each objective & goal as of the date of this publication is also included.

Table 6. Council conservation goals, objectives, implementation methodologies, and status (Georgia Department of Natural Resources *et al.* 1998)

Conservation Goals	Objectives	Strategies	Tasks and Actions Steps	Completed?
Create a comprehensive database for the GBBL ecosystem	Complete a Natural Areas Inventory of GBBL ecosystem	Identify and describe the physical features, vegetative communities, and other biological components of GBBL ecosystem	Compile existing data for GBBL ecosystem	Yes (update annually)
			Determine central location for data storage	Yes (MAFB)
			Summary report of known features and data gaps	Yes
			Inventory GBBL areas to fill data gaps	No (come back to later)
			Name and describe GBBL ecosystem vegetative communities	Yes
			Maintain GBBL database	Yes (ongoing)
			Complete GIS database with complementary coverages	Yes (ongoing)
			Summarize annually inventory findings	No
	Develop GIS standards for GBBL ecosystem		Set existing GIS standards	Yes
			Ensure systems compatibility between agencies	Yes
			Define and describe tiered ranking system	Yes
	Develop a ranking system for vegetative communities identified through the Natural Areas Inventory and incorporate this information into GBBL ecosystem database		Identify/rank ecological condition of communities	Yes
			Map vegetative communities and incorporate ranking information into GIS	No

Conservation Goals	Objectives	Strategies	Tasks and Actions Steps	Completed?	
Create a comprehensive database for the GBBL ecosystem (continued)	Develop ecologically acceptable management options, guidelines, and constraints for each vegetative classification and tier		General literature review and summary report on management options for species of special interest and natural communities	Yes	
			Council meeting to discuss management options, guidelines, and constraints	No	
Maintain or restore representative ecological components of the GBBL ecosystem, utilizing appropriate management tools	Establish management priorities for the identified components of GBBL ecosystem utilizing appropriate management tools		Identify ecological components that merit further study	Yes (for conservation targets; additional inventory needed)	
			Produce literature review of (a)biotic needs of identified components	Yes (for conservation targets; additional inventory needed)	
			Report on existing mandates and plans for identified components	No	
			Quantify information from previous two steps to set management priorities	No	
	Develop appropriate management plans based on established priorities	Develop a fire management program for GBBL ecosystem		Identify management units	No
				Determine appropriate burn season	No
				Establish burn priorities	No
		Develop a hydrological program for GBBL ecosystem		Analyze water levels, present and historic	No
				Attempt correlation between community types and water levels through photo interpretation	No
				Determine changes in current water management practices	No
			Establish permanent plots in water regimes to determine outcomes	No	

Conservation Goals	Objectives	Strategies	Tasks and Actions Steps	Completed?
Maintain or restore representative ecological components of the GBBL ecosystem, utilizing appropriate management tools (continued)	Develop appropriate management plans based on established priorities (continued)	Develop a hydrological program for GBBL ecosystem (continued)	Provide information to interested landowners regarding water management options	No
		Consolidate forest management plans for GBBL ecosystem landowners	Compile existing management plans	No
			Identify differences in management strategies and make recommendations	No
			Determine potential for demonstration areas	No
		Develop other plans as needed for GBBL ecosystem Agencies	Review needs	No
Maintain or enhance habitats that support Special Concern Species	Develop Special Concern Species management plan for GBBL		Identify Special Concern Species and their needs	Yes
			Identify ecological objectives for resident Special Concern Species	No
			Ensure Special Concern Species needs are incorporated in management plans	No
			Develop species specific plans	No
	Develop and implement management activities for identified species		Review needs	No
Monitor ecological components to identify progress toward goals, using adaptive management process	Develop research program for GBBL ecosystem		Determine research needs and set priorities	Yes
			Solicit, develop, and evaluate research proposals	As needed
			Coordinate and support research on GBBL	As needed

Conservation Goals	Objectives	Strategies	Tasks and Actions Steps	Completed?
Monitor ecological components to identify progress toward goals, using adaptive management process (continued)	Develop monitoring program to evaluate management activities on GBBL ecosystem		Determine monitoring needs and set priorities	Yes
			Develop and coordinate exact monitoring activities	No
	Use research and monitoring data to periodically revise GBBL Council Stewardship Plan		Modify actions steps according to annual research and monitoring reports	No
			Revise Plan every 5 years	Yes (ongoing)
Increase awareness and support for the GBBL ecosystem	Establish a landowner program for GBBL ecosystem		Identify landowners within Ecological Footprint	Yes
			Hold periodic landowner functions	Yes (ongoing)
	Develop and participate with a landowner organization to promote conservation of GBBL ecosystem		Choose two landowners for Council representation	No
			Host GBBL Stewardship Plan workshops	Yes
	Educate VIPs and media on the goals of the Plan		Identify VIPs	Yes (stakeholder analysis)
			Inform VIPs of significance of GBBL and Stewardship Plan	Yes (ongoing)
			Hold GBBL field trips	Yes
			Hold GBBL significance and species workshops	No
			Produce GBBL species and significance literature	No
	Issue press releases	As needed		
	Establish volunteer program for GBBL		Review needs	No
	Provide opportunities for appropriate public use of designated areas within the GBBL ecosystem	Develop Public Use Management Plan for GBBL ecosystem		Determine compatible recreational usages of GBBL
Review existing public use plans and incorporate into unified plan				No

Conservation Goals	Objectives	Strategies	Tasks and Actions Steps	Completed?
Provide opportunities for appropriate public use of designated areas within the GBBL ecosystem (continued)	Develop Public Use Management Plan for GBBL ecosystem (continued)		Develop user map(s)	No
			Determine public information needs and avenues for dissemination	No
	Develop Environmental Education Plan for GBBL ecosystem		To be determined	As needed
	Evaluate options for use of Banks Lake National Wildlife Refuge Building		Discuss usage options	Yes
			Select preferences and involve stakeholders	Yes

IX. Conservation Objectives

The response, or failure to respond, to critical threats is often the most significant factor affecting the long-term health of the conservation targets. Thus, it is imperative that land managers be able to identify and prioritize conservation objectives. Table 7 provides a prioritized list of critical broad-level conservation objectives for each of the six GBBL conservation targets. Each objective has a ranking (Very High, High, Medium, and Low) and corresponding color scheme (dark-green, light-green, yellow, and red, respectively) to simplify reading the table. Objectives were also numerically weighted by individual conservation target rankings (Very High is worth 1.50, High is worth 1.00, Medium is worth 0.40, and Low is worth 0.03) and then summed to obtain a priority estimate of conservation objectives.

Table 7. Prioritized list of conservation objectives for the Ecological Footprint

Objectives Across Systems	Wading Birds	Longleaf Pine / Wiregrass	Carolina Bays / Isolated Wetlands	Migratory Birds	Riverine Aquatic Systems	Hardwood Hammocks	Strategy Benefit Rank	Total Score
Enhance or restore essential habitat for species of special concern.	Very High	High	High	Very High	High	High	High	7.00
Restore fire regimes within the natural ranges of variation for 100% of the GBBL complex.	High	Very High	Very High	Medium	Low	High	High	5.23
Limit logging to minimal selective timber harvest.	Low	High	High	High	Medium	Very High	High	4.73
Enhance and restore landscape connectivity between and within ecotypes.	Medium	Very High	High	Very High	Medium	Medium	Medium	4.60
Prohibit additional residential, commercial, and agricultural development within 150 meters of wetlands / rivers.	Very High	-	Very High	-	Very High	-	Very High	4.50

Objectives Across Systems	Wading Birds	Longleaf Pine / Wiregrass	Carolina Bays / Isolated Wetlands	Migratory Birds	Riverine Aquatic Systems	Hardwood Hammocks	Strategy Benefit Rank	Total Score
Identify specific sources of toxins / contaminants and reduce or eliminate emittance.	High	Low	Very High	Medium	Very High	Medium	High	4.43
Collaborate with neighboring landowners to promote and establish conservation easements, and to promote habitat protection.	High	High	High	Medium	High	Low	High	4.23
Coordinate an effort among Council members to restore natural hydrological regimes across the GBBL area.	High	-	Very High	-	Very High	Medium	High	4.20
Prohibit grazing of livestock within 150 meters of wetland / riverine areas.	High	-	High	-	High	-	High	3.0
Establish a long-term, annual monitoring program for species of special concern within GBBL boundaries.	High	-	-	Very High	-	-	High	2.50
Prohibit use of motor boats.	High	-	High	-	-	-	High	2.00
Manage 100% of the forests containing Longleaf Pine to maintain or restore Longleaf Pine as the primary species.	-	Very High	-	Low	-	-	Low	1.53

X. Conservation Strategies and Actions

Based on the broad-level rankings of Table 7, Table 8 attempts to prioritize specific conservation strategies and actions for each conservation target. A color scheme is again utilized: strategies and actions in green should have first priority, strategies and actions in yellow should have second priority, and strategies and actions in red should have the last priority for enactment. Strategies and actions of one conservation target that share the same color are listed (top to bottom) in a prioritized manner.

Table 8. Overview of conservation strategies and actions for each of the six GBBL conservation targets

Conservation Target	Conservation Strategies and Actions
Wading Birds	Enhance or restore essential habitat for wood storks.
	Reduce the percentage of land within (at least) 150 meters of wetland areas that has a moderate to high risk of toxins and contaminants to less than 20% (currently 27.8%).
	Restore fire regimes within the natural ranges of variation for Carolina Bays and associated forests (return intervals of 7 - 25 years).
	Establish a long-term, annual monitoring program for wading birds within the Ecological Footprint.
	Maintain wading bird populations at +/- two standard errors of their current size (determine through research surveys).
	Prohibit or minimize the construction of additional towers (especially radio, cellular and television towers) in and around the Ecological Footprint.
Longleaf Pine / Wiregrass	Restore fire regimes within the natural ranges of variation (return intervals of 1 - 3 years) over the full extent of areas containing Longleaf Pine to maintain and enhance open longleaf pine stands and groundcover. A fuel reduction burn should be conducted followed by summer burning on a 1-3 year rotation. The timing of these burns should take into consideration the breeding period of the Bachman's Sparrow and include isolated shallow pond wetlands (Bergstrom <i>et al.</i> 1994).
	Restore or enhance connectivity between remnant stands of Longleaf Pine.
	Manage 100% of the forests containing Longleaf Pine to maintain or restore Longleaf Pine as the primary species (currently 27.8% on MAFB).
	Limit logging to thinning operations for smaller diameter trees (Bergstrom <i>et al.</i> 1994).
	Restore an area of Longleaf Pine within the Ecological Footprint to its pre-1980 levels, a 36%+ increase over current levels.
	Hold workshops as well as produce and distribute literature informing landowners of the significance of Longleaf Pine / Wiregrass ecosystems.

Conservation Target	Conservation Strategies and Actions
<p align="center">Carolina Bays / Isolated Wetlands</p>	<p>Restore fire regimes within the natural ranges of variation (return intervals of 7 - 25 years) over the full extent of areas containing Carolina Bays, Isolated Wetlands, and associated forest stands.</p>
	<p>Reduce the percentage of land within (at least) 150 meters of wetland areas that has a moderate to high risk of toxins and contaminants to less than 20% (currently 27.8%) through land purchases, land use conversion, and/or reduction of incompatible land use practices.</p>
	<p>Restore natural hydrological regimes to maintain historical hydrological connectivity extents between the bays.</p>
	<p>Prohibit logging with the exception of minimal selective timber harvest (Bergstrom <i>et al.</i> 1994).</p>
	<p>Remove any fire breaks in existence between uplands and wetlands to eliminate unnatural transitions or disturbance within these ecotones (Bergstrom <i>et al.</i> 1994).</p>
	<p>Discontinue dredging, channelization, and mechanized disturbance activities at Cooter Creek (Bergstrom <i>et al.</i> 1994).</p>
	<p>Establish monitoring programs for green-fly orchid, blue maidencane, climbing heath, striped mud turtles, and nesting American bittern (Bergstrom <i>et al.</i> 1994).</p>
<p align="center">Migratory Birds</p>	<p>Enhance or restore essential habitat for Bachman's sparrows and loggerhead shrikes (both candidates either for federal listing, globally declining species, or species of special concern).</p>
	<p>Restore forested area (~60% loss of forested area - mixed, evergreen, and deciduous - between 1977 and 1998) such that connectivity between, and heterogeneity in vertical structure existing forest stands is increased.</p>
	<p>Maintain current migratory bird populations at +/- two standard errors of their current sizes (determine through research surveys).</p>
	<p>Prohibit or minimize the construction of additional towers (especially radio, cellular and television towers) in and around the Ecological Footprint area to reduce the chance of tower-induced mortality of migratory birds using the area.</p>
<p align="center">Riverine Aquatic Systems</p>	<p>Prohibit additional residential, commercial, and agricultural development within (at least) 150 meters of riverine areas.</p>
	<p>Reduce the percentage of land within (at least) 150 meters of riverine areas that has a moderate to high risk of toxins and contaminants to less than 15% (currently 19.9%).</p>

Conservation Target	Conservation Strategies and Actions
<p>Riverine Aquatic Systems (continued)</p>	<p>Restore natural hydrology in areas where rivers are dammed and/or have been rechanneled.</p>
	<p>Prohibit grazing of livestock within (at least) 150 meters of riverine areas.</p>
<p>Hardwood Hammocks</p>	<p>Prevent the spread of wildfire from surrounding forests to Dudley's and Hickory Hammocks (other than within the natural ranges of variation: return intervals of less than 7 - 25 years) by maintaining a sufficiently high water level in the surrounding wetlands (Bergstrom <i>et al.</i> 1994).</p>
	<p>Limit human disturbance of hardwood hammocks (Bergstrom <i>et al.</i> 1994) by:</p> <ul style="list-style-type: none"> - Prohibiting expansion or activity on Bemiss field that would negatively impact the wetland buffer surrounding Dudley's Hammock, - Allowing access to Dudley's Hammock only for educational and research activities, - Prohibiting hunting in Dudley's Hammock and limit hunting in Hickory Hammock (due to risk of fire), and - Limiting road maintenance / improvement and transport of material through Dudley's Hammock.
	<p>Monitor Dudley's Hammock for indigo snakes.</p>

XI. Success Measures - Monitoring Plan

The stewardship of GBBL cannot be considered complete after only determining the conservation targets, identifying the stresses (and sources), and planning and implementing the goals, objectives, strategies & actions. Management must be adaptive, and monitoring is vital to making that possible. The following table (Table 9) presents threat-based monitoring suggestions for each of the six GBBL conservation targets. Indicators that can be used to monitor threat-abatement management techniques are included, as well as suggested monitoring methods and frequencies.

Table 9. Monitoring plans for each of the six GBBL conservation targets

Conservation Target	Biodiversity Health / Threat Abatement Attribute Measured	Indicator	Methods	Timing / Frequency
Wading Birds	Size	Population sizes	Point counts for wading birds at random points equally distributed throughout potential wading bird habitat.	Quarterly
		Number of species of special concern	Review federal, state, and natural heritage lists for species-specific wading bird status.	Annually
	Condition	Water quality	Conduct water quality tests placing testing and monitoring emphasis on toxins and contaminants known to be endocrine disruptors.	Quarterly
		Reproductive success	Monitor number of breeding pairs and number of fledglings for all species of special concern.	Breeding season of each species
		Abundance and distribution of prey species	Sample invertebrate and fish species at random points equality distributed throughout potential wading bird habitat.	Annually, prior to the onset of wading bird breeding season
	Landscape Context	Percent known wading bird habitat with fire frequency of 7 - 25 years	Review prescribed burn and wildfire records for the wetland areas within the Ecological Footprint.	Annually at the end of the burning season
		Amount and distribution of land uses surrounding wetland areas	GIS analysis of land use change over time.	As new GIS layers become available
Longleaf Pine / Wiregrass	Size	Percent of total forested area containing Longleaf Pine having Longleaf Pine as the primary species	Ground-truth Longleaf Pine distribution and abundance maps. Review forestry and silviculture inventory records.	Every three years

Conservation Target	Biodiversity Health / Threat Abatement Attribute Measured	Indicator	Methods	Timing / Frequency
Longleaf Pine / Wiregrass (continued)	Condition	Abundance of Longleaf Pine in each age class	Monitor age-class composition in all stands containing Longleaf Pine.	Every three years
		Percent of forested areas containing Longleaf Pine that have a fire return interval of 1 - 3 years	Review prescribed burn and wildfire records for the Ecological Footprint areas containing Longleaf Pine.	Annually at the end of the burning season
		Presence of competitive / invasive species and disease within Longleaf Pine stands	Line-transect surveys of all forested areas containing Longleaf Pine.	Annually
	Landscape Context	Amount and distribution of land uses surrounding forests containing Longleaf Pine	GIS analysis of land use change over time.	As new GIS layers become available
		Connectivity	Utilize landscape ecology metrics to calculate the connectivity of Longleaf Pine stands throughout the Ecological Footprint.	One time for use in planning Longleaf Pine restoration areas
Carolina Bays / Isolated Wetlands	Size	Total hectares undergoing hydrarch succession	Delineation of historical wetland boundaries using remote sensing images and comparing the historical wetland extents with current wetland extents.	Delineation comparison - one time with annual calculation of hydrarch succession area after the burn season.
	Condition	Invasive species	Conduct surveys for invasive species throughout the Carolina Bay / Isolated Wetland areas of the Ecological Footprint, recording the number and distribution of invasives.	Quarterly and opportunistically
		Water quality	Conduct water quality tests placing testing and monitoring emphasis on toxins and contaminants known to be endocrine disruptors.	Quarterly
	Landscape Context	Amount and distribution of surrounding land uses	GIS analysis of land use change over time	As new GIS layers become available
		Percent target area with a 7 - 25 year fire return interval	Review prescribed burn and wildfire records for the wetland areas within the Ecological Footprint.	Annually at the end of the burning season

Conservation Target	Biodiversity Health / Threat Abatement Attribute Measured	Indicator	Methods	Timing / Frequency
Carolina Bays / Isolated Wetlands (continued)	Landscape Context (continued)	Presence and abundance of water control structures	Operate water control structures to mimic historical hydrological connectivity among the Ecological Footprint's Carolina Bay / Isolated Wetland areas. Eliminate water control structures that disrupt historical hydrological connectivity among the Ecological Footprint's Carolina Bays / Isolated Wetlands.	Always
Migratory Birds	Size	Population sizes	Randomly distributed point counts for migratory birds throughout potential migratory bird habitat.	Annually during the fall migration
		Number of species of special concern	Review federal, state, and natural heritage lists for species-specific migratory bird status.	Annually
	Condition	Vertical heterogeneity	Develop an index of vertical heterogeneity (high heterogeneity equals high bird diversity) for forest stands and select random plots within migratory bird habitat to rate according to this index.	Annual characterization of forest stands once index is developed
		Reproductive success	Monitor number of breeding pairs and number of fledglings for all species of special concern.	Breeding season of each species
	Landscape Context	Forest fragmentation	Calculate area via perimeter ratios from GIS forest coverage data or perform field measurements on forest areas and perimeters.	Every three years
		Percent forested area within historical fire return intervals	Review prescribed burn and wildfire records for the wetland areas within the Ecological Footprint.	Annually at the end of the burning season
Riverine Aquatic Systems	Size	Total length of river	Analyze updated GIS hydrological data for changes in total length of river within the Ecological Footprint.	As new GIS layers become available

Conservation Target	Biodiversity Health / Threat Abatement Attribute Measured	Indicator	Methods	Timing / Frequency
Riverine Aquatic Systems (continued)	Condition	Water quality	Conduct water quality tests placing testing and monitoring emphasis on toxins and contaminants known to be endocrine disruptors.	Quarterly
		Sedimentation loads	Collect sediment sample from rivers adjacent to areas believed to contain major sources of sediment run-off (near agricultural and silvicultural activities).	Quarterly
	Landscape Context	Presence and abundance of water control structures	Operate water control structures to mimic historical hydrological connectivity among riverine areas. Eliminate water control structures that disrupt historical hydrological connectivity.	Always
		Amount and distribution of surrounding land uses	GIS analysis of land use change over time.	As new GIS layers become available
Hardwood Hammocks	Size	Total area of Dudley's and Hickory Hammock	Calculate total area from most recent GIS data.	As new GIS layers become available
	Condition	Presence of indigo snake, green-fly orchid, climbing heath, and needle palm	Conduct line-transect surveys for these species in Dudley's and Hickory Hammocks.	Annually
		Human use and road construction / improvement	Monitor hammocks for frequency of human use, road construction and/or improvement, and associated signs of impact. Mitigate negative ecological impacts from such activities.	Bi-annually, before and after hunting season
	Landscape Context	Water depth in Cooter's Creek	Maintain sufficient depth to prevent wildfire from reaching Dudley's Hammock	Throughout fire season

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APPENDICES AVAILABLE UPON REQUEST.
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