

FOREWORD

Abundant fish and wildlife, unbroken coastal vistas, miles of scenic rivers, swamps and mountains open to exploration, and well-tended forests and fields...these resources enhance the quality of life that makes South Carolina a place people want to call home. We know our state's natural resources are a primary reason that individuals and businesses choose to locate here. They are drawn to the high quality natural resources that South Carolinians love and appreciate.

The quality of our state's natural resources is no accident. It is the result of hard work and sound stewardship on the part of many citizens and agencies. The 20th century brought many changes to South Carolina; some of these changes had devastating results to the land. However, people rose to the challenge of restoring our resources. Over the past several decades, deer, wood duck and wild turkey populations have been restored, striped bass populations have recovered, the bald eagle has returned and more than half a million acres of wildlife habitat has been conserved. We in South Carolina are particularly proud of our accomplishments as we prepare to celebrate, in 2006, the 100th anniversary of game and fish law enforcement and management by the state of South Carolina.

Since its inception, the South Carolina Department of Natural Resources (SCDNR) has undergone several reorganizations and name changes; however, more has changed in this state than the department's name. According to the US Census Bureau, the South Carolina's population has almost doubled since 1950 and the majority of our citizens now live in urban areas. The stewardship of our land has also passed to a new generation that has different needs and faces new problems. As our rural lands are converted to developed areas, South Carolina's citizens continue to seek the high-quality natural resources that characterize this state. The SCDNR strives to support a broader array of wildlife species and habitats while providing more opportunities for outdoor recreation. We must once again rise to a challenge: we need to find a way to manage our resource base in order to do more things for more people, while enhancing the values that sustain our quality of life.

New challenges call for new approaches. In response to a congressional mandate, the SC DNR has concluded a major planning effort to identify the challenges facing the state's diverse wildlife species and devise strategies to conserve those species and their habitats. Known as South Carolina's Comprehensive Wildlife Conservation Strategy, the result is a guide to conserving the 1,240 species of fish and wildlife that have immediate conservation needs or are key indicators of the diversity and health of the state's wildlife. Without attention, many of these species could become endangered or disappear altogether.

The Comprehensive Wildlife Conservation Strategy emphasizes a cooperative, proactive approach to conservation, inviting local governments, businesses and conservation-minded organizations and individuals to join in the task of maintaining the fish and wildlife resources that are so important in our lives. I hope you will study the Strategy carefully and join us in working to protect our fish and wildlife for current and future generations.

John Frampton
Director
South Carolina Department of Natural Resources

EXECUTIVE SUMMARY

In May of 2002, the South Carolina Department of Natural Resources (SCDNR) began a process to develop the Comprehensive Wildlife Conservation Strategy (CWCS) that was funded through the State Wildlife Grants (SWG) program. The SCDNR committed to developing the Strategy and begin implementing the conservation actions by October 1, 2005. The goal of the Strategy is to emphasize a cooperative, proactive approach to conservation while working with federal, state and local governments; local businesses; and conservation-minded individuals to join in the effort of maintaining the fish and wildlife resources of South Carolina.

In order to sustain South Carolina's diverse wildlife resources in the future, the following actions are critical: (1) increase baseline biological inventories with emphasis on natural history, distribution and status of native species; (2) increase commitment by natural resource agencies, conservation organizations and academia toward establishing effective conservation strategies; (3) increase financial support and technological resources for planning and implementation of these strategies; and (4) create public-private partnerships and educational outreach programs for broad-scale conservation efforts. South Carolina's CWCS is a first step toward instituting these actions.

The diversity of animals in South Carolina is vast. Habitats in this state range from the mountains to the ocean and include many different taxonomic animal groups. SCDNR wanted to address as many of those groups as possible for inclusion in the list of priority species for the CWCS; as such, twelve taxonomic groups are included in the Strategy: mammals, birds, reptiles, amphibians, freshwater fishes, diadromous fishes, marine fishes, marine invertebrates, crayfish, freshwater mussels, freshwater snails, and insects (both freshwater and terrestrial).

The SCDNR identified 1,240 species to include on the state's Priority Species List. Reports were prepared for each species, guild or indicator; in these reports, authors described the species, their status, population and abundance, habitat needs, challenges, conservation accomplishments and conservation actions. This approach allows for identification of both general conservation strategies for wildlife and habitats in South Carolina, as well as development of species-based conservation strategies. The latter allows for management of particular species within a given habitat. A separate volume, Supplemental Volume: Species and Habitat Accounts, contains these reports in their entirety. The SCDNR also identified habitats critical for the priority species considered in the CWCS. Both terrestrial and aquatic habitats were considered and reports were prepared for 38 habitats (terrestrial and marine) organized within five ecoregions, as well as 13 ecobasins, which characterize the freshwater aquatic habitats of the state. These reports are also presented in the Supplemental Volume.

As conservation strategies were developed for each species, it became evident that they could be separated into eight categories, which we have designated as Conservation Action Areas (CAAs). These eight CAAs are: Education and Outreach; Habitat Protection; Invasive and Non-native Species; Private Land Cooperation; Public Land Management; Regulatory Actions; Survey and Research Needs; and Urban and Developing Lands. Within each CAA, conservation actions were condensed from the recommendations prepared for each animal on South Carolina's Priority Species List. Some of the actions identified will affect all species included in the

CWCS; others may affect only a few species. Each of these actions was prioritized and measures that indicate success of implementing the action were identified.

It is also critical that we monitor priority species, their habitats and the effectiveness of the actions that are implemented to conserve them. With the information gathered in this program, project leaders will be required to produce annual progress reports for review by a steering committee and the CWCS coordination team. These reports will be evaluated for insight into adaptive management needs and reassessments of the CWCS.

From the beginning of the CWCS effort, SCDNR and the planning team sought to realize successful partnerships and public involvement in the development of the strategy. It is understood that successful conservation is furthered by the existence of a strong collaborative involvement between all resource stakeholders, private or public, governmental or nongovernmental. Task forces were convened to assist in determining important natural resource issues in South Carolina. Taxa teams were assembled to determine challenges to species and conservation actions to address those challenges. Public meetings were held to gather input from the citizens of the state. Prior to submission of the CWCS, the SCDNR began creating Conservation Action Committees around the CAAs identified above; two of these committees have convened and have begun working toward identifying statewide strategies for species and habitat conservation. Partnerships will continue to be critical in implementing the actions identified in South Carolina's CWCS.

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CHAPTER 1: INTRODUCTION

Problem and Need

Wildlife conservation responds to the challenges of the times. The original wildlife conservation movement began in the first half of the twentieth century in response to unregulated harvest for sporting and commercial purposes. During this period, a number of landmark federal laws were enacted, notably the Migratory Bird Treaty Act, the Pittman-Robertson Federal Aid in Wildlife Restoration Act, the Lacey Act, and the Dingell-Johnson Sport Fisheries Restoration Act. All were created following education campaigns by the conservation community.

State and federal fish and wildlife agencies grew rapidly, supported by increases in state and federal conservation funding. The US Bureau of Sport Fisheries and Wildlife (now the US Fish and Wildlife Service) was formed and state fish and wildlife agencies either developed from scratch or became greatly centralized and expanded, using revenue from a combination of state license fees and federal funding from excise taxes on sporting equipment. The resulting state fisheries and wildlife management programs were well established by the late 1960's and early 1970's and were largely game-oriented.

Beginning in the 1970's, the challenges associated with sustaining wildlife populations began to change dramatically. Many states, including South Carolina, entered a period of rapid economic expansion and human population growth. During this period, the state's economy began to shift away from agriculture. Migration into the state increased greatly and a shift away from rural communities toward urban population dominance began.

Statewide, over 100,000 acres per year were converted to urban uses from 1992 to 1997, making South Carolina the ninth-ranked state in terms of total land area developed annually (USDA 1997). According to the same report, the growth rate from 1982 to 1992 was only 40,000 acres per year. The recent urban land conversion rates represent a major burst of growth; this development trend continues today.

Strong economic forces are also transforming South Carolina's agricultural economy. Rising costs, coupled with falling prices are creating hardships for many family farms. As of 1997, there were approximately 4.5 million acres in agricultural production in South Carolina, representing an 18 percent drop since 1982. Long-term declines in farmland are even more dramatic: in 1954, 124,203 farms were producing goods in South Carolina and 57.1 percent of the land in the state consisted of farms. By 1992, the number of farms in the state had been reduced to 20,242, representing 23.2 percent of South Carolina's land use (SC Department of Research & Statistical Services 1998).

As land use is converted from rural to urban uses and the population of South Carolina increases, new challenges are evident to fish and wildlife species in the state. Additionally, long-standing downward trends in numbers of some species that previously had been overlooked have become evident. In a recent state-by-state analysis of biodiversity conducted for The Nature Conservancy, South Carolina ranked 14th among all states in total number of native plant and animal species and 15th in terms of risks to native species (NatureServe 2002). In a planning

exercise conducted in 1994, DNR biologists estimated that as many as one third of the state's vertebrate species are now, or soon will be, experiencing serious declines (SCDNR 1994).

As times and conditions changed, new laws were enacted. In the early 1970's, the Endangered Species Act, Clean Water Act and Clean Air Act all were developed and companion state laws and programs were enacted. In order to provide early direction to the South Carolina Department of Natural Resources (SCDNR) Nongame and Endangered Species Program, a statewide symposium on endangered species was held in 1976. At that meeting, committees of specialists in vertebrate taxa (mammals, birds, reptiles and amphibians, fish) were formed to provide information about species that had uncertain status or were believed to be in jeopardy (Forsythe and Ezell 1976). These expert committees have continued to meet periodically and update these lists.

The SCDNR continues to support a large number of conservation initiatives on public and private lands, including habitat protection; technical guidance and cost sharing; and education. A statewide wildlife strategy would align all conservation activities with common goals that can be consulted by all South Carolinians, especially resource managers, local governments, and the scientific community. The State Wildlife Grants program provides a vehicle to create such a strategy.

In order to sustain South Carolina's diverse wildlife resources in the future, the following actions are critical: (1) increase baseline biological inventories with emphasis on natural history, distribution and status of native species; (2) increase commitment by natural resource agencies, conservation organizations and academia toward establishing effective conservation strategies; (3) increase financial support and technological resources for planning and implementation of these strategies; and (4) create public-private partnerships and educational outreach programs for broad-scale conservation efforts. This Strategy is a first step toward instituting these actions.

Legislative Mandate and Guidance

The charge to state wildlife agencies to develop comprehensive strategies has its origins in the Wildlife Conservation and Recreation Program (WCRP) that was created in the federal Appropriations Act of 2001. Appropriations language provided that funds may be used for "...the planning and implementation of [a state's] wildlife conservation and restoration program and wildlife conservation strategy, including wildlife conservation, wildlife conservation education, and wildlife-associated recreation projects" (114 STAT. 2762A -118 PUBLIC LAW 106-553 — APPENDIX B — Title IX).

The WCRP appropriations language challenged the states to develop projects in the three major areas anticipated in the Teaming with Wildlife initiative: conservation, education and recreation. WCRP appropriations language also provided that "Within five years of the date of the initial apportionment, [the states shall] develop and begin implementation of a wildlife conservation strategy based upon the best available and appropriate scientific information and data ..."

Specific criteria for the wildlife conservation strategies were developed. South Carolina committed to developing its Wildlife Conservation Strategy within the required five years in order to qualify for WCRP funds.

WCRP was only funded for one year and was replaced in 2002 and subsequent years by the State Wildlife Grants Program (SWG), also through the appropriations process. Unlike WCRP, the SWG program emphasizes conservation projects alone and charges the states “...to develop by October 1, 2005, a comprehensive wildlife conservation plan [strategy], consistent with criteria established by the Secretary of the Interior, that considers the broad range of the State, territory, or other jurisdiction’s wildlife and associated habitats, with appropriate priority placed on those species with the greatest conservation need and taking into consideration the relative level of funding available for the conservation of those species...” (115 STAT. 414 PUBLIC LAW 107-63 — APPENDIX A). The document that all states ultimately prepared in response to this mandate is referred to as a Comprehensive Wildlife Conservation Strategy (CWCS).

Roadmap to Required Elements in South Carolina’s CWCS

Congress identified the required elements of the strategies in the WCRP legislation and the USFWS adopted those same elements to also apply to the SWG required CWCS, so one document will satisfy both needs. The CWCS must identify and be focused on the “species in greatest need of conservation,” yet address the “full array of wildlife” and wildlife-related issues. They must provide and make use of the elements identified in Box 1-1: The Eight Required Elements. This original guidance has been expanded considerably during the course of CWCS preparation; however the eight elements remain the core standard for the strategies.

Box 1-1: The Eight Required Elements

- 1) Information on the distribution and abundance of species of wildlife, including low and declining populations as the State fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the State’s wildlife.
- 2) Descriptions of locations and relative condition of key habitats and community types essential to conservation of species identified in (1).
- 3) Descriptions of problems, which may adversely affect species identified in (1) or their habitats, and priority research and survey efforts needed to identify factors, which may assist in restoration and improved conservation of these species and habitats.
- 4) Descriptions of conservation actions determined to be necessary to conserve the identified species and habitats and priorities for implementing such actions.
- 5) Descriptions of the proposed plans for monitoring species identified in (1) and their habitats, for monitoring the effectiveness of the conservation actions proposed in (4), and for adapting these conservation actions to respond appropriately to new information or changing conditions.
- 6) Descriptions of procedures to review the Strategy/Plan at intervals not to exceed ten years.
- 7) Descriptions of the plans for coordinating, to the extent feasible, the development, implementation, review, and revision of the Plan/Strategy with Federal, State, and local agencies and Indian tribes that manage significant land and water areas within the State or administer programs that significantly affect the conservation of identified species and habitats.
- 8) Descriptions of the necessary public participation in the development, revision, and implementation of the Plan/Strategy.

As part of the additional guidance received, States were instructed to highlight the location of information specific to the eight elements for reviewers of the CWCS. Therefore, Table 1-1: Roadmap to the Required Elements presents this information. As will become more evident in later chapters of this CWCS, the Supplemental Volume submitted with this Strategy contains reports for the species included on South Carolina's Priority Species List as well as reports for the habitats of each of the five ecoregions in this state. Each of these reports includes a description of the distribution and abundance of the species/habitat, the challenges that the species/habitats face and specific conservation actions for addressing those challenges. Additionally, some of these reports discuss ways to work with public and private entities toward conservation as well as strategies for monitoring species, habitats and effectiveness of conservation actions. All of the information presented in these reports is summarized in the body of South Carolina's CWCS in the chapters and, in some cases, page numbers identified in Table 1-1.

TABLE 1-1: ROADMAP TO THE REQUIRED ELEMENTS

Element	NAAT Statement	SC CWCS Chapter	Page Number
1: Distribution and abundance of species	a. Sources of information	Chapter 2; Supplemental Volume	Throughout chapter; Entire Supplemental Volume
	b. Abundance and distribution	Chapter 2; Supplemental Volume	Throughout chapter; Entire Supplemental Volume
	c. Low and declining populations	Chapter 2; Supplemental Volume	Throughout chapter; Entire Supplemental Volume
	d. All wildlife groups included or statement of why not included	Chapter 2; Supplemental Volume	Page 2-1, 2-2; Entire Supplemental Volume
	e. Processes for species selection	Chapter 2	Pages 2-6, 2-9, 2-13, 2-17, 2-21, 2-24, 2-28, 2-32, 2-34, 2-36
2: Location/relative condition of key habitats	a. Explanation of level of detail	Chapter 3; Supplemental Volume	3-3, 3-5 Habitat Accounts
	b. Key habitats and their condition described	Chapter 3; Supplemental Volume	3-4 through 3-15 Habitat Accounts
3: Problems that affect species	a. Sources of information	Chapter 2; Supplemental Volume	Throughout chapter Literature Cited in Supplemental Volume
	b. Threats described in detail to allow focused conservation actions	Chapter 4; Supplemental Volume	Throughout chapter; Entire Supplemental Volume
	c. Considers threats regardless of origins	Chapter 4; Supplemental Volume	Throughout chapter; Entire Supplemental Volume
	d. Research and survey efforts identified	Chapter 4; Supplemental Volume	Page 4-15 through 16; Entire Supplemental Volume
	e. Priority research and survey needs described to allow development of projects	Chapter 4; Chapter 5; Supplemental Volume	Page 4-15 through 16 Page 5-3 through 5-6 Entire Supplemental Volume

TABLE 1-1: ROADMAP TO THE REQUIRED ELEMENTS (CONTINUED)

Element	NAAT Statement	SC CWCS Chapter	Page Number
4: Conservation actions described	a. Conservation actions address threats to species and habitats	Chapter 5; Supplemental Volume	Throughout chapter; Entire Supplemental Volume
	b. Conservation actions guide implementation through development and execution of projects and programs	Chapter 7 Supplemental Volume	7-3 through 7-5 Entire Supplemental Volume
	c. Conservation actions linked to objectives and indicators	Chapter 4; Supplemental Volume	Table 4-3, pages 4-20 through 4-34; Entire Supplemental Volume
	d. Conservation actions that can be addressed by other agencies described	Chapter 4; Supplemental Volume	Entire Chapter Entire Supplemental Volume
	e. Research or survey needs for obtaining information to develop actions is described	Chapter 4; Chapter 5; Supplemental Volume	Page 4-15 through 16 Page 5-3 through 5-6 Entire Supplemental Volume
	f. Priority of conservation actions	Chapter 4; Chapter 7	Table 4-3, pages 4-20 through 4-34 Pages 7-1 through 7-3
5: Plans for monitoring and adaptive management	a. Monitoring species and habitats	Chapter 5; Supplemental Volume	Pages 5-6 through 5-8 Supplemental Volume
	b. Monitoring outcomes of conservation actions	Chapter 5; Supplemental Volume	Page 5-10 Supplemental Volume
	c. Explanation for not monitoring a species or species group	Chapter 5	Pages 5-6 through 5-10
	d. Levels of monitoring	Chapter 5	Pages 5-6 through 5-10
	e. Utilizing existing programs or obtaining new information for effectiveness of conservation actions	Chapter 5; Appendix 4	Pages 5-2 through 5-3 Appendix 4
	f. Monitoring considers geographic scale	Chapter 5	Page 5-5
	g. Strategy is adaptive	Chapter 5; Chapter 7	Pages 5-6 through 5-10 Page 7-5
6: Review/revise Strategy	a. Process for reviewing Strategy	Chapter 7	Pages 7-5 through 7-6
7: Coordinating with federal, state and local agencies and Indian tribes	a. Coordination efforts for development of the Strategy described	Chapter 6	Entire Chapter
	b. Continued coordination efforts described	Chapter 6	Entire Chapter

TABLE 1-1: ROADMAP TO THE REQUIRED ELEMENTS (CONTINUED)

Element	NAAT Statement	SC CWCS Chapter	Page Number
8: Public participation	a. Efforts to involve the public in development of the Strategy described	Chapter 6	Page 6-1 through 6-2
	b. Continued public involvement is described	Chapter 6; Supplemental Volume	Pages 6-2 through 6-4

CWCS Organization

The CWCS is organized to first make the reader aware of the need for the Strategy then to discover how the actual CWCS was developed and presented. In the **Introduction**, a discussion of the need for the CWCS and the legislative mandate that allows SCDNR to develop and implement the strategy is presented. The selection of South Carolina's priority wildlife species is discussed in the **Priority Species** chapter, along with the methods for prioritizing those species and the challenges they face. The condition and location of habitats and challenges to management of those habitats is presented in **South Carolina's Landscape**. The conservation strategies that will be implemented to address the challenges identified in the two previous chapters is discussed in detail in **Statewide Conservation Strategies**; the eight conservation action areas around which strategies will be constructed are also presented in that chapter. After listing conservation actions to address species and habitat challenges, the manner in which they will be monitored is contained in the **Comprehensive Monitoring Program** chapter. Strategies for monitoring the effectiveness of conservation actions are also discussed. SCDNR has formed extensive partnerships during development of the CWCS; these partnerships are discussed in the **Partnership Development** chapter. The manner in which SCDNR prioritized conservation actions, will implement the conservation actions in the CWCS and adapt the Strategy as new information becomes available is presented in the **Prioritization, Implementation and Adaptive Management** chapter. Finally, we include a list of references in the **Literature Cited**, a **Glossary** and **Appendices** associated with the CWCS.

As stated above, a **Supplemental Volume: Species and Habitat Accounts** is submitted with this Strategy. The Supplemental Volume contains reports for the species included on South Carolina's Priority Species List as well as reports for the habitats of each of the ecoregions in this state. Each of these reports includes a description of the distribution and abundance of the species/habitat, the challenges that the species/habitats face and specific conservation actions for addressing those challenges. Additionally, some of these reports discuss ways to work with public and private entities toward conservation as well as strategies for monitoring species, habitats and effectiveness of conservation actions.

The Supplemental Volume to South Carolina's CWCS provides a unique look into challenges and conservation actions that pertain to each of the species on this state's Priority Species List. By providing species-specific actions, the SC DNR can use the CWCS in two ways: 1) to manage species of concern over large areas or habitat and 2) to manage particular species in any

habitat where that species occurs, no matter the size of the management area. Further, the species-specific approach in the Supplemental Volume allowed for development of very concise conservation actions for each species, which are expected to permit SC DNR or its partners to easily convert those actions to project proposals/plans.

Authority and Capability of the SCDNR to Prepare and Implement the CWCS

Article III, Section 34, South Carolina Constitution, 1895, as revised, states in relevant part: “that the General Assembly is empowered to divide the State into as many game zones as may appear practicable, and to enact legislation that may appear proper for the protection of game in the several zones.”

Legislation creating the SC Department of Natural Resources and governing its activities is covered under Titles 48 and 50 of the SC Code of Laws. The entire code covers the generalities of operating the agency, as well as special laws pertaining to certain species, penalties and subdivisions of the state. The most concise, broad charge to the SCDNR is found in the following sections:

§48-4-10 provides that “The South Carolina Department of Natural Resources is created to administer and enforce the laws of this State relating to wildlife, marine resources, and natural resources and other laws specifically assigned to it.”

§48-4-80. Provides for the creation of a Board to serve as “the governing body of the agency.”

§50-3-80 provides that the Department shall continuously investigate the game and fish conditions of the State and the laws relating thereto. It shall annually make report of its activities to the General Assembly and recommend legislation and other action by the General Assembly in its judgment conducive to the conservation of wildlife.

Subsequent legislation provides assent to federal fish and wildlife restoration acts and authorizes the SCDNR to “perform such acts as they be necessary to the conduct and establishment of cooperative fish and wildlife restoration project(s) as defined in such act(s) of Congress...” Authorities under Title 50 include jurisdiction over saltwater fish and related activities.

In addition, Title 50 authorizes SCDNR to promulgate regulations relating to hunting, fishing, taking and possession of wildlife and provides for penalties relating thereto. Authorization is further extended to SCDNR to acquire and dispose of property, conduct hearings, and “own, sell, lease, exchange, transfer or rent real property” for purposes of carrying out its authorities. Concerning recreation, this authority extends to “furnishing the people of the State with hunting areas and fishing facilities.”

The South Carolina Nongame and Endangered Species Conservation Act (§50-15-10 et seq.) authorizes the Department to “...conduct investigations on nongame wildlife in order to develop

information relating to population, distribution, habitat, needs, limiting factors and other biological and ecological data to determine management measures necessary for their continued ability to sustain themselves successfully.” The Act further authorizes SCDNR to issue regulations and “develop management programs designed to insure the continued ability of nongame wildlife to perpetuate themselves successfully.”

Subsequent sections of the Act set forth administrative procedures for developing regulations, penalties for taking and possession of nongame wildlife considered by SCDNR under this Act to be endangered. The Act also provides that the agency will maintain lists of endangered species and amend them periodically. The Act further authorizes SCDNR to establish programs, including “acquisition of land or aquatic habitat, as are deemed necessary for management and endangered wildlife.” Further, SCDNR is authorized to enter into cooperative agreements for purposes of carrying out its responsibilities under the Act.

Criteria for listing species as endangered under the state statute closely follow those for the federal Endangered Species Act. A second category, “Species in Need of Management,” is also provided for recognizing and providing less stringent protection for species whose status does not warrant listing as endangered. Under the “species in need of management” category, SCDNR is charged with conducting ongoing investigations of nongame wildlife in order to determine which species are in need of management and for developing programs for their management in order to “sustain themselves successfully.” This section of the statute roughly parallels that of the federal statute dealing with threatened species; however, the intent of the state statute is not only to provide listing authority, but also to establish authority for SCDNR to engage in conservation activities in addition to or in lieu of, formal listing and regulatory actions.

A closely related statute establishes the South Carolina Heritage Trust Program (§51-17-10 et seq.). This legislation designates SCDNR as the lead agency to develop and conduct a program whose purpose is “protecting lands and making them available to state agencies, educational institutions and public and private groups” for a number of conservation purposes. The statute authorizes SCDNR to conduct inventories of lands having natural significance, acquire fee simple lesser interest in land, and establish strong legal protections for property thus acquired.

In 1994, the legislative mandate of the SCDNR was updated in a general reorganization of state government. Subsequently, SCDNR adopted the following mission statement:

The South Carolina Department of Natural Resources (SCDNR) is the advocate for and the steward of the state’s natural resources.

Within five divisions are 34 individual programs that are responsible for executing the mission in areas such as wildlife and fisheries management, endangered species management, marine fisheries conservation, education, ground and surface water management, soil and water conservation, habitat protection, and a broad array of law enforcement activities in addition to enforcement of fish and game laws. Therefore, from a legal and organizational standpoint, SCDNR is well equipped to lead the development and execution of the CWCS.

CHAPTER 2: SOUTH CAROLINA PRIORITY SPECIES

The State Wildlife Grants program established funding for species not traditionally covered under federal funding programs. To qualify for these funds, each state was mandated to develop a Strategy with a focus on “species of greatest conservation concern;” guidance was provided to the states to begin identifying these species. SCDNR recognized the importance of including species that are currently rare or designated as at-risk, those for which we have knowledge deficiencies and those that have not received adequate conservation attention in the past. Additionally, SCDNR included species for which South Carolina is “responsible,” that is, species that may be common in our state, but are declining or rare elsewhere. SCDNR also included species that could be used as indicators of detrimental conditions. These indicator species may be common in South Carolina; as such, changes in their population status are likely to indicate stress to other species that occur in the same habitat.

The diversity of animals in South Carolina is vast. Habitats in this state range from the mountains to the ocean and include many different taxonomic animal groups. SCDNR wanted to address as many of those groups as possible for inclusion in the list of priority species for the CWCS; as such, twelve taxonomic groups are included in the Strategy: mammals, birds, reptiles, amphibians, freshwater fishes, diadromous fishes, marine fishes, marine invertebrates, crayfish, freshwater mussels, freshwater snails, and insects (both freshwater and terrestrial). However, taxonomic groups that are excluded from this version of the SC CWCS may be included in future revisions of the Strategy, as additional information and experts specific to those groups are identified.

After the twelve taxonomic groups were identified, a taxa leader was appointed that managed the process for identifying priority species within that group. This leader formed a committee of experts for the particular taxa. First, the committee reviewed a list of all known species within that group that are found in South Carolina. The SCDNR maintains lists of rare, threatened and endangered plants and animals as part of the Heritage Trust and Endangered Species programs. One list comprises species that are officially designated as endangered or in need of management (threatened). This list was created under the S.C. Nongame and Endangered Species Act, and applies only to animals; it can only be modified through the regulatory process. The second list comprises species, both plants and animals, thought to be rare, declining or their population status is unknown. These are termed “Species of Concern,” and correspond to the “Watch List” species in other states. The Species of Concern list does not carry the weight of law and is used only as a conservation tool to assist in protection planning and to direct research and survey efforts.

Next, SCDNR developed a list of criteria for consideration in determination of priority species. Eight criteria were developed for this process and are presented in Box 2-1.

The process for determining priority species by each taxa committee is identified herein. After determining which species would be included on South Carolina’s Priority Species List, taxa committees categorized species into three groups: Highest, High and Moderate Priority. The species in two taxa groups, marine fishes and marine invertebrates were not categorized into priority groups due to the large number of species and the limited knowledge for those species.

Further, the insect taxa committee did not develop a comprehensive list of priority insects in South Carolina. Because even the number of species of insects in this state is not known, the taxa committee completed their work by developing a table indicating the number of species within each insect order in South Carolina. As such, numbers of insect species are not included in the total number of species on South Carolina's Priority Species List, which is presented in its entirety in Appendix 1.

BOX 2-1: EIGHT CRITERIA USED FOR DETERMINATION OF PRIORITY SPECIES

- State and federal protection status: endangered, threatened, rare or special concern
- South Carolina Natural Heritage Program state rank: S1 through S5
- Degree of exploitation/harvest: high, medium or low
- Availability of past or current funding to address species challenges
- Feasibility measure: the likelihood that conservation activities in South Carolina can make a difference for this species
- Knowledge of the species' population status: status mostly known, slightly known or unknown
- Knowledge of species' distribution in the state: distribution mostly known, slightly known or unknown
- Knowledge of limiting factors affecting the species: limiting factors mostly known, slightly known or unknown
- Population status (trend): population decreasing, stable or increasing

The total number of species included in South Carolina's CWCS is 1,240. Table 2-1 identifies the number of species included in each taxa group. Additionally, Table 2-2 presents the list of species that were prioritized by taxa committees; this list excludes marine fishes, marine invertebrates and insects. Refer to Appendix 1 for lists of marine fishes and marine invertebrates.

TABLE 2-1: NUMBER OF SOUTH CAROLINA PRIORITY SPECIES

Taxa	Number of Species
Mammals (Terrestrial and Marine)	24
Birds	111
Reptiles and Amphibians	52
Freshwater Fishes	56
Diadromous Fishes	6
Crayfish (Freshwater and Terrestrial)	23
Freshwater Mussels	26
Freshwater Snails	4
Marine Fishes	163
Marine Invertebrates	775
Total Number of Species	1,240

TABLE 2-2: CATEGORIZED PRIORITY SPECIES

Taxa	Highest Priority	High Priority	Moderate Priority
Mammals	Black Bear Florida Manatee Northern Yellow Bat	Appalachian Cottontail Atlantic Right Whale Bottlenose Dolphin Carolina Red-backed Vole Dwarf Sperm Whale Eastern Small-footed Myotis Hairy-tailed Mole Humpback Whale Masked Shrew Meadow Vole Mink Pygmy Sperm Whale Rafinesque's Big-eared Bat Southeastern Bat Star-nosed Mole Swamp Rabbit	Eastern Fox Squirrel Eastern Spotted Skunk Eastern Woodrat Southern Pygmy Shrew Woodland Jumping Mouse
Birds	American Avocet American Bittern American Coot American Golden Plover American Kestrel American Oystercatcher Bachman's Sparrow Black-crowned Night Heron Black Duck Black Rail Black Skimmer Black-throated Green Warbler Brown-headed Nuthatch Buff-breasted Sandpiper Common Ground-dove Common Loon Dunlin Eastern Brown Pelican Eastern Meadowlark Eastern Wood Peewee Field Sparrow Glossy Ibis Grasshopper Sparrow Gull-billed Tern Henslow's Sparrow Kentucky Warbler King Rail Least Bittern Least Sandpiper Least Tern Lesser Scaup Lesser Yellowlegs Little Blue Heron Loggerhead Shrike Long-billed Curlew Mallard Marbled Godwit Northern Bobwhite Northern Pintail Painted Bunting Pied-billed Grebe	Acadian Flycatcher Bald Eagle Barn Owl Black-bellied Plover Black Scoter Black-throated Blue Warbler Blue-winged Teal Canvasback Forster's Tern Peregrine Falcon Redhead Semipalmated Plover Spotted Sandpiper White-winged Scoter	American Woodcock Bewick's Wren Chestnut-sided Warbler Common Loon Common Raven Dark-eyed Junco Golden-crowned Kinglet Gray Kingbird Great Blue Heron Great Egret Greater Scaup Greater Yellowlegs Green Heron Horned Grebe Long-billed Dowitcher Louisiana Waterthrush Mottled Duck Pectoral Sandpiper Purple Sandpiper Red-breasted Nuthatch Red Crossbill Ringneck Ruffed Grouse Scarlet Tanager Tundra Swan White-rumped Sandpiper Wood Duck

Taxa	Highest Priority	High Priority	Moderate Priority
Birds (continued)	Prairie Warbler Purple Gallinule Red-cockaded Woodpecker Red Knot Royal Tern Rusty Blackbird Sanderling Sandwich Tern Seaside Sparrow Semipalmated Sandpiper Short-billed Dowitcher Snowy Egret Solitary Sandpiper Stilt Sandpiper Swaison's Warbler Swallow-tailed Kite Tricolor Heron Western Sandpiper Whimbrel White Ibis Willet Wilson's Plover Wilson's Snipe Wood Stork Wood Thrush Worm-eating Warbler Upland Sandpiper Yellow-crowned Night Heron Yellow Rail		
Reptiles and Amphibians	Bog Turtle Broad-striped Dwarf Siren Carolina Gopher Frog Chamberlain's Dwarf Salamander Coal Skink Coral Snake Eastern Milk Snake Flatwoods Salamander Florida Green Watersnake Florida Pine Snake Green Salamander Green Turtle Gopher Tortoise Hawksbill Turtle Island Glass Lizard Kemp's Ridley Turtle Leatherback Turtle Loggerhead Turtle Pine Barrens Treefrog Shovel-nosed Salamander Southern Hognose Snake Tiger Salamander Timber Rattlesnake Webster's Salamander	Black Swamp Snake Canebreak Rattlesnake Chicken Turtle Diamondback Terrapin Eastern Diamondback Rattlesnake Florida Cooter Florida Softshell Turtle Four-toed Salamander Gulf Coast Mud Salamander Hellbender Mimic Glass Lizard Pickerel Frog Pine Snake Pine Woods Snake River Cooter Seepage Salamander Spiny Softshell Turtle Striped Mud Turtle Upland Chorus Frog Wood Frog Yellowbelly Turtle	American Alligator Bird-voiced Treefrog Common Snapping Turtle Northern Cricket Frog Slender Glass Lizard Southern Dusky Salamander Spotted Turtle
Freshwater and Diadromous Fishes	American Eel American Shad Atlantic Sturgeon Blueback Herring Bluebarred Pygmy Sunfish Bridle Shiner	Bannerfin Shiner Blackbanded Sunfish Carolina Darter Carolina Fantail Darter "Carolina" Redhorse Greenhead Shiner	Banded Darter Banded Killifish Blacknose Dace Bluefin Killifish Central Stoneroller Comely Shiner

Taxa	Highest Priority	High Priority	Moderate Priority
Freshwater and Diadromous Fishes (continued)	“Broadtail” Madtom Carolina Pygmy Sunfish Christmas Darter Hickory Shad Highfin Carpsucker Redeye Bass Robust Redhorse Saluda Darter Sandhills Chub Savannah Darter Shortnose Sturgeon “Thinlip” Chub	Piedmont Darter Pinewoods Darter Quillback Santee Chub Seagreen Darter Smoky Sculpin Turquoise Darter	Eastern Brook Trout Fireblack Shiner Flat Bullhead Florida Gar Greenfin Shiner Highback Chub Longnose Dace Lowland Shiner Mirror Shiner Mud Sunfish Notchlip Redhorse Pugnose Minnow Redlip Shiner River Chub Rosyface Chub Satinfish Shiner Snail Bullhead Striped Bass Tennessee Shiner Thicklip Chub V-lip Redhorse Warpaint Shiner White Catfish Whitemouth Shiner Whitetail Shiner
Crayfish	Mimic Crayfish Oconee Stream Crayfish <i>Cambarus reflexus</i> <i>Cambarus</i> sp. “B” <i>Distocambarus hunteri</i> <i>Distocambarus youngineri</i> <i>Procambarus echinatus</i> Red Burrowing Crayfish	Broad River Spiny Crayfish <i>Distocambarus crockeri</i> Pee Dee Lotic Crayfish Sandhills Crayfish Waccamaw Crayfish	Ditch Fencing Crayfish Edisto Crayfish <i>Procambarus barbatus</i> <i>Procambarus chacei</i> <i>Procambarus enoplosternum</i> <i>Procambarus hirsutus</i> <i>Procambarus lunzi</i> <i>Procambarus pubescens</i> Rocky River Stream Crayfish Santee Crayfish
Freshwater Mussels	Atlantic Pigtoe Barrel Floater Brook Floater Brother Spike Carolina Creekshell Carolina Heelsplitter Creeper Notched Rainbow Savannah Lilliput Southern Rainbow Triangle Floater Waccamaw Spike Yellow Lampmussel	Alewife Floater Eastern Pondmussel Northern Lance Pod Lance Rayed Pink Fatmucket/ Eastern Lampshell Roanoke Slabshell Tidewater Mucket	Atlantic Spike Carolina Lance Carolina Slabshell Eastern Creekshell Eastern Elliptio Variable Spike
Freshwater Snails	<i>Somatogyrus</i> spp.	Buffalo Pebblesnail Ridged Lioplax	<i>Physa</i> sp. nov “A”

Once the lists were complete, species, group or guild accounts were prepared for each animal on South Carolina’s Priority Species List, with the exception of marine animals and insects. Specific accounts were not prepared for every animal on the marine fishes and invertebrate and insect lists due to the large number of species and the limited knowledge for those species. Reports were prepared for marine and insect species with known threats and/or for species that are considered indicators of challenges in a specific habitat.

In each account, authors described the species, their status, population and abundance, habitat needs, challenges, conservation accomplishments and conservation actions. This approach allows for identification of both general conservation strategies for wildlife and habitats in South Carolina, as well as development of species-based conservation strategies. The latter allows for management of particular species within a given habitat. A separate volume, Supplemental Volume: Species and Habitat Accounts, contains these reports in their entirety.

This chapter contains an introduction to each taxonomic group considered in the Strategy. The species selection process used by each committee is also included. Finally, a summary of the threats for each taxonomic group is listed in this chapter. Lack of knowledge of population size, distribution and life histories was considered a challenge to many of the species in South Carolina's CWCS.

Mammals

State and regional experts periodically review rankings and designations for all mammal species in South Carolina. The last terrestrial mammal review, conducted in 2001, had 39 species listed for discussion. Included among those were four subspecies, an extirpated species, some species never reported in South Carolina but found in neighboring states and all of the mammalian species tracked by the SCDNR's Heritage Trust database. For the purposes of the Strategy, the list was narrowed to 27 mammals and was sent to experts for review in this conservation planning process. Ultimately, 24 mammals were chosen for inclusion on South Carolina's Priority Species List.

Species Selection Process

Many of the experts contacted in this process have previously participated in reviews of mammal rankings and designations for South Carolina; several were involved in conservation prioritization in neighboring states. The information about mammals contained in the Strategy was supplied by the expertise of several biologists who formed our Mammal Taxonomic Committee. The members of that committee invested considerable time to the development of the Strategy and are graciously thanked for their efforts; these individuals are listed in Table 2-3. Other sources of information included published literature and unpublished data from a number of sources.

Because South Carolina started the prioritization process after the same process was well underway in North Carolina and Georgia, we were able to benefit from the information those states had accumulated and shared.

Reviewers were asked to rank each species using the eight criteria for consideration in species prioritization. Species or subspecies were added or dropped from the list if two or more reviewers suggested the addition/deletion. If one reviewer clearly stated we should keep a species on the list and another suggested dropping the species, the species remained on the list. Potential species (those without museum records in South Carolina) were dropped from the list. The intent of the conservation planning process is to periodically revisit the priority list and adjust it as more is learned about each species.

TABLE 2-3: MAMMAL TAXONOMIC COMMITTEE

Name	Affiliation
Craig Allen	SC Cooperative Fish and Wildlife Res. Unit
Mary Bunch	South Carolina Department of Natural Resources
John Cely	South Carolina Department of Natural Resources
David Cupka	South Carolina Department of Natural Resources
Rudy Mancke	University of South Carolina
Alex Menzel	US Fish and Wildlife Service
Sally Murphy	South Carolina Department of Natural Resources
Tom Murphy	South Carolina Department of Natural Resources
Jim Ozier	Georgia Department of Natural Resources
Toni Piaggio	University of Colorado, Boulder
Perry Shatley	US Forest Service
Oscar Stewart	US Forest Service
Johnny Stowe	South Carolina Department of Natural Resources
Heather Thomas	Auburn University

Challenges

One of the major challenges to mammals in South Carolina is loss, fragmentation and/or alteration of habitat. As urban development expands in this state, changes to forests and grasslands often lead to loss of foraging, roosting (bats) and denning/nesting habitat. Additionally, habitats are fragmented by development. Roads can limit movement of many species and often result in mortality to individuals. Coastal development can adversely affect marine mammals by increasing exposure to pollutants in stormwater runoff.

Pollutants from a variety of sources can impact mammals. The mink occupies a niche at or near the top of the food chain; therefore, this species is especially vulnerable to environmental contamination, particularly from mercury and PCBs. Contamination in stormwater runoff can pollute feeding grounds for marine mammals. Trash and litter pose challenges to both terrestrial and aquatic mammals. Small mammals can become trapped in bottles and other litter while foraging. Marine mammals can mistake plastic debris for food items; ingestion of this litter can result in death.

Two diseases, raccoon roundworm and Sudden Oak Death (SOD) can adversely affect mammals in South Carolina. Raccoon roundworm can infect other mammals, resulting in death. SOD attacks and destroys oak trees; these trees produce mast used as food sources for several mammals on South Carolina's Priority Species List.

Introduced and non-native species can adversely affect South Carolina's mammals. Predation by domestic or feral cats and dogs can reduce population numbers. Feral hogs can destroy habitat for many species, particularly those found in wetland habitats. Gypsy moths, like SOD can eliminate food sources for mammals.

Several species of mammals are regarded by humans as "pests;" this view can lead to persecution of these species.

One of the greatest challenges to marine mammals and manatees is boat strikes. An additional threat to these animals is entrapment in fishing devices, including hook and line and trawls.

Birds

As of 2001, 390 species of birds have been documented in South Carolina of which 179 are classified as breeders (Cely 2003). This number may be higher due to the lack of coverage of the Breeding Bird Atlas to adequately survey the breeding distribution of colonial nesting wading birds and shorebirds. The total number of species present is comprised of resident and migrant birds with the majority of taxonomic orders of birds found in the United States being represented (Sibley 2000). South Carolina supports a high diversity of birds during breeding, wintering and migration likely due to the state's varied environments and habitats (Cely 2003). Ultimately, 111 bird species were chosen for inclusion on South Carolina's Priority Species List.

Three different bird conservation regions (BCRs) transect South Carolina: southeastern coastal plain, Appalachian Mountains and piedmont. Bird conservation regions are a single application of a scale-flexible hierarchical framework of nested ecological units based upon the Commission for Environmental Cooperation. BCRs were adopted to provide a single map of biological units for all bird initiatives to use to attain a regional-based approach to bird conservation (US NABCI 2000). BCRs can be partitioned into smaller ecological units to facilitate finer scale planning and implementation or aggregated to facilitate greater cooperation and partnerships across political boundaries in order to recognize the migratory nature and vast annual ranges of some species.

The Appalachian Mountain BCR spans the Blue Ridge, the Ridge and Valley Region, the Cumberland Plateau, the Ohio Hills, and the Allegheny Plateau (US NABCI 2000). A portion of the Blue Ridge transects three counties in the northwestern corner of South Carolina; this diverse temperate forest ecosystem supports habitats found nowhere else in the state (Barry 1980). A number of bird species are found in this portion of South Carolina that are not found elsewhere in the state including peregrine falcon, ruffed grouse, common raven, red-breasted nuthatch, golden-crowned kinglet, black-throated blue warbler, yellow warbler, chestnut-sided warbler, red crossbill and dark-eyed junco (Cely 2003). This region also supports some of the highest breeding densities in the state of scarlet tanager, Louisiana waterthrush, worm-eating warbler and black-throated green warbler (Cely 2003). The Appalachian mountain BCR is not as important for waterfowl and shorebirds as coastal regions but it does contain the headwaters of several major river systems (US NABCI 2000).

The Piedmont BCR is geographically part of Southern Appalachia and makes up the transitional area between the mountains and the flat coastal plain spanning from New Jersey to Alabama (US NABCI 2000). Approximately one-third of the state of South Carolina is comprised of this ecological unit (Cely 2003). This area is best characterized by oak-hickory dominated forests with associations of short-leaf and loblolly pine, black gum and sweetgum (Barry 1980). The once fertile and highly productive soils have been reduced due to past mismanagement and the area is now subject to intensified agriculture and forest management practices (Barry 1980). The piedmont is the main breeding area in South Carolina for several grassland and scrub/shrub birds such as killdeer, house wren, American goldfinch, song sparrow, field sparrow and grasshopper

sparrow (Cely 2003). Interior wetlands, reservoirs and riverine systems provide migration and wintering habitat for waterfowl and some shorebirds (US NABCI 2000).

The Southeastern Coastal Plain is a huge area comprised of the South Atlantic Coastal Plain and the East Gulf Coastal Plain physiographic areas (Pashley et al. 2000). In South Carolina, the western boundary is at the fall line marking the edge of the hilly piedmont; the eastern boundary is the Atlantic Ocean (Pashley et al. 2000). The major habitat types include longleaf and loblolly pine interspersed with Carolina bays and pocosins, bottomland hardwoods and maritime forests (Barry 1980). Priority species dependent upon pine habitats include red-cockaded woodpecker, Bachman's sparrow, brown-headed nuthatch, Henslow's sparrow and painted bunting (Pashley et al. 2000). Bottomland forests support high breeding densities of many neotropical migrants including Acadian flycatcher, white-eyed vireo, prothonotary warbler, hooded warbler and northern parula (Cely 2003). The coastal intertidal habitats provide critical wintering and breeding areas for American oystercatcher, important wintering and spring migration for short-billed dowitcher and dunlin, and important fall staging areas for red knot (US NABCI 2000). Offshore islands and coastal areas provide important nesting and foraging habitats for brown pelicans, various ducks, terns, herons, egrets, ibis and other species (US NABCI 2000).

Species Selection Process

The information about birds contained in the Strategy was mostly supplied by the expertise of several biologists who formed our Bird Taxonomic Committee. The members of that committee invested considerable time to the development of the Strategy and are graciously thanked for their efforts; these individuals are listed in Table 2-4. Other sources of information included published literature and unpublished data from a variety of sources.

TABLE 2-4: BIRD TAXONOMIC COMMITTEE

Name	Affiliation
John Cely	South Carolina Department of Natural Resources (retired)
Elizabeth Ciuizio	Kentucky Dept for Natural Resources
Nathan Dias	Cape Romain Bird Observatory
Dennis Forsythe	The Citadel
Lex Glover	South Carolina Department of Natural Resources
Anna Huckabee Smith	North Carolina Department of Environmental and Natural Resources
Chuck Hunter	US Fish and Wildlife Service
Drew Lanham	Clemson University
Steve Lohr	US Forest Service
Laurel Moore-Barnhill	South Carolina Department of Natural Resources
Tom Murphy	South Carolina Department of Natural Resources
Bob Perry	South Carolina Department of Natural Resources
Felicia Sanders	South Carolina Department of Natural Resources
Craig Watson	US Fish and Wildlife Service

Species prioritization for birds relied heavily upon the Partners in Flight prioritization process. Partners in Flight (PIF) was initiated in the early 1990's and drew together many groups and individuals focused on bird conservation, knowledge and people to keep common birds common

(Pashley et al. 2000). The first step in the PIF planning process was to set priorities (Pashley et al. 2000). The conservation assessment process evaluates species vulnerability and was developed based entirely on biological criteria (Hunter et al. 1993; Carter et al. 2000; Panjabi et al. 2001). The prioritization process is based upon six factors that measure aspects of vulnerability and the scores for each factor reflect the degree of each species' risk of significant population decline or range wide extinction at the global level (Rich et al. 2004). In some cases, global assessment scores do not provide accurate prioritization lists at the bird conservation region or smaller ecological unit level. In order to accurately develop smaller scale priority lists; regional scores based on local data are needed (Hunter and Demarest 2005).

The PIF prioritization process allows species to be ranked into conservation tiers based upon combined scores. Species are also assigned a conservation action level that indicates the relative level and immediacy of conservation action based upon the sum of the assessment scores. For the purposes of this plan, the majority of the species selected are Tier I species of high concern and Tier II species needing additional stewardship with a conservation action level of immediate, management or long-term planning and responsibility. Species selected that are in Tier III and IV represent species that are state or federally listed and/or are of local or regional interest. The PIF scores and conservation tiers for South Carolina's priority bird species are summarized in Appendix 3: Bird Prioritization Table.

Waterbird, shorebird and waterfowl conservation priority selections depended heavily on national and international conservation plans. Birds were chosen based on their continental priorities as well as professional review of South Carolina's ecological role in the continued conservation of these birds. Plans consulted include the North American All Bird Conservation Initiative (NABCI), South Atlantic Migratory Bird Initiative (SAMBI), North American Waterfowl Management Plan (NAWMP), North American Waterbird Conservation Plan (NAWCP) and the United States Shorebird Conservation Plan (USSCP). Thirty-year continental population trend data for waterfowl species was also obtained from the USFWS and professionally reviewed by committee to establish conservation priorities for migratory waterfowl. More detailed justifications for selections are included in species accounts for individuals and guilds of birds.

Challenges

One of the major challenges to birds in South Carolina is loss, fragmentation and/or alteration of habitat. Birds in this state depend upon varied habitats from the mountains to the coast; changes to habitats can result in loss of feeding, breeding or nesting habitat for these species. Wetland habitats, which are important to many members of this taxa have been destroyed by draining and filling throughout the state. Even small alterations to wetlands can make the habitat unsuitable for use by these species. Conversion of habitat for birds to agricultural purposes poses another challenge to birds. For example, longleaf pine habitat has been greatly reduced both in extent and in quality; vast acreages of longleaf pine have been converted to agriculture and/or loblolly pine plantation in South Carolina. The loss, or degradation of longleaf pine habitat results in the loss of key components necessary for success of the animals that live in that habitat. Habitat can also be lost or fragmented as a result of urban development.

Fire suppression contributes to habitat loss for bird species that require an understory with a diverse herbaceous plant layer that is maintained by routine burning. However, in recent years, use of adequate fire management has decreased in the state, which has resulted in successional changes that render the habitat unsuitable for some animal species.

Human disturbance represents a significant challenge to birds in South Carolina. Nesting success of many birds can decrease when people frequent breeding bird congregation areas. Further, wakes from boats can destroy nests and interrupt feeding for many shorebirds.

Chemical contamination threatens many carnivorous birds, particularly those that consume fish. Persistent organo-chlorine pesticides, such as DDT and heavy metals, such as lead and mercury can result in poisoning.

Several diseases and parasites can affect bird populations and/or food sources for birds. These include West Nile virus, Avian Vacuolar Myelinopathy, cholera, botulism, soft tick infestation and hemlock wooly adelgid infestations.

Non-native predators can also decimate bird populations; predation by domestic and feral cats is particularly problematic for songbirds.

Amphibians and Reptiles

Currently, 142 species of amphibians and reptiles are known to occur in South Carolina. Continued controversy over the taxonomic status of certain species or species complexes results in a lack of certainty in a fixed number of species for the state. New species have been recently discovered or described, which results in a dynamic species list.

To emphasize the way in which the species list can change, consider the following recent additions. Just in the past 30 years, the striped mud turtle, bog turtle and seepage salamander have been verified as occurring in South Carolina. In addition, two newly described species, the mimic glass lizard and Chamberlain's dwarf salamander have been added to the state's list of native herpetofauna.

More changes may be in store for South Carolina's lists of amphibians and reptiles. Several taxonomic issues involving herpetofauna in South Carolina are currently unresolved, including the slimy salamander complex, the southern Appalachian salamander and the milk snake/scarlet kingsnake relationship. An unidentified species of the genera *Desmognathus* has been found in Jasper County, within the range of *Desmognathus auriculatus*, that more closely resemble either *Desmognathus apalachicolae* or *Desmognathus fuscus conanti*, neither of which has been documented for coastal South Carolina.

Ultimately, 52 reptile and amphibian species were chosen for inclusion on South Carolina's Priority Species List.

South Carolina's rich herpetofaunal diversity is likely due to the diversity of habitat in our state. Though small in land area, South Carolina comprises portions of three major physiographic

provinces, the Blue Ridge, piedmont and coastal plain. Within each of these provinces numerous sub-provinces, or distinct ecological regions occur. A variety of unusual or rare habitats are found within these regions, and many support populations of unusual or rare amphibians and reptiles.

South Carolina is particularly important with regards to amphibian diversity. Salamander diversity in our state is very high in the Blue Ridge and coastal plain provinces. One area of South Carolina's southern coastal plain supports more frog species (25) than any other place in North America (Duellman 1999).

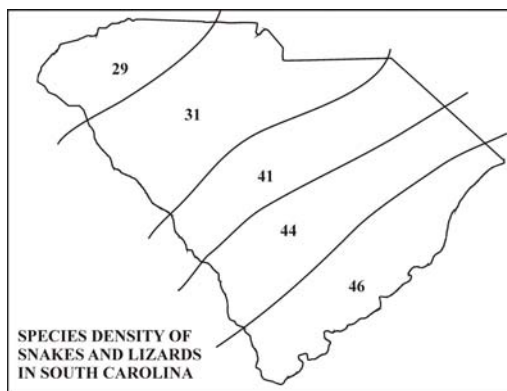


FIGURE 2-1: Species density of snakes and lizards in ecological regions of South Carolina

The Blue Ridge, upper piedmont (referred to colloquially as the foothills) and coastal plain are collectively rich in herpetofauna. Rock outcrops in the Blue Ridge and upper piedmont provide habitat for the green salamander and the timber rattlesnake. Bogs in this same region may provide habitat for the bog turtle. Several species of amphibians and reptiles found in South Carolina's Blue Ridge are peripheral to our state as the core of their geographic range is farther north.

The piedmont of South Carolina is not as rich in herpetofauna as the other physiographic provinces, but there are areas of this province that are important. The Savannah River Valley, for instance, is home to the Webster's salamander, a rare species endemic to this region, at least in South Carolina. Numerous species that are found primarily in the coastal plain intrude into the piedmont along the Savannah River.

The coastal plain is a very important region overall for herpetofauna in South Carolina, with high species diversity, habitat diversity and several rare, threatened and endangered species. Of the 142 species of amphibians and reptiles found in the state, 113 occur in the coastal plain and 50 of these are endemic to this province, at least in South Carolina.

The diversity of reptiles in South Carolina is significantly higher in the coastal plain than in other areas of the state. Within this province, longleaf pine habitat plays a vital role in the life history of many species, including such rarities as the pine snake, southern hognose snake and the gopher tortoise.

Isolated, temporary wetlands such as Carolina bays, flatwoods ponds and limesinks provide breeding habitat for numerous amphibians, including the flatwoods salamander, tiger salamander and gopher frog. Seeps and shrub bogs, embedded in xeric longleaf pine habitat in the fall line sand hills, are home to the pine barrens treefrog.

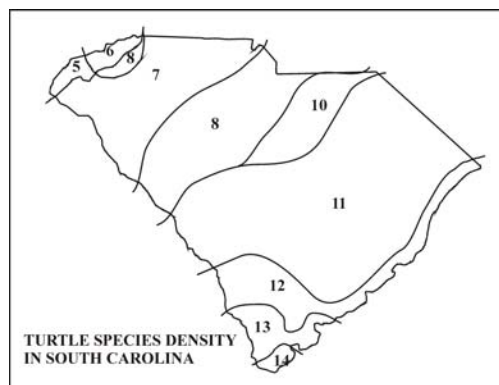


FIGURE 2-2: Species density of turtles in ecological regions of South Carolina

Species Selection Process

The amphibian and reptile portion of the Strategy has been written in a manner that incorporates a regional as well as a species specific and/or guild specific approach. These priority species were identified by herpetological experts in the state. The members of that committee invested considerable time to the development of the Strategy and are graciously thanked for their efforts; these individuals are listed in Table 2-5.

TABLE 2-5: AMPHIBIAN AND REPTILE TAXONOMIC COMMITTEE

Name	Affiliation
C.L. Abercrombie	Wofford College
Steve Bennett	South Carolina Department of Natural Resources
Eric Billings	
Denise Billings	
Kurt Buhlmann	South Carolina Department of Natural Resources
Jeffrey Camper	Francis Marion University
Heyward Clamp	Edisto Island Serpentarium
John Fauth	Central Florida University
Dr. J.W. Gibbons	Savannah River Ecology Laboratory
Judy Greene	Savannah River Ecology Laboratory
Julian R. Harrison	College of Charleston (ret.)
Joey Holmes	
Jeff Humphries	Clemson University
Kevin Messenger	North Carolina State University
Brian Metts	Savannah River Ecology Laboratory
Tony Mills	Savannah River Ecology Laboratory
Richard Montanucci	Clemson University (ret.)
Zach Orr	
Gene Ott	
Corey Roelke	
David Scott	Savannah River Ecology Laboratory
Keith Taylor	
Tracey Tuberville	Savannah River Ecology Laboratory
Jayne Waldron	Clemson University
John D. Willson	Savannah River Ecology Laboratory
Chris Winne	Savannah River Ecology Laboratory

These experts grouped many of the species into guilds (functional groupings) to indicate common habitat requirements, management needs, life history traits, threats and/or other characteristics. Many of these groups align with habitat regions of the state. A number of species did not fit easily into a functional group and are addressed individually in the CWCS. All species, whether addressed individually or in a functional group are related to a specific habitat type or several habitat types.

The initial list of amphibians and reptiles designated as endangered, threatened or species of concern was developed at the First South Carolina Endangered Species Symposium, held in 1976. As a result of this symposium 16 species of amphibians and 20 species of reptiles were proposed for listing under an appropriate category. Species recommended for endangered or threatened statuses were incorporated into the official list promulgated under South Carolina

Regulation. The designation Threatened was changed to Species in Need of Management under the Act. A justification for listing was given for each species in the symposium volume.

The list of amphibian and reptile species that resulted from the 1976 symposium was also used to develop a list of “elements of concern” for the SCDNR’s Heritage Trust Program. Listed species are “tracked” by this program through a computer database, developed initially by The Nature Conservancy. Occurrence records for these species are stored in this database. Archived data is very similar to that of a museum collection record and includes location, date, collector/observer, as well as other pertinent data.

The Heritage Trust Program, as part of its routine operation, established taxa review committees to periodically review the species lists and make recommendations for changes. The Amphibian and Reptile Taxa Review Committee met initially in 1983. Subsequent meetings of this group occurred in 1987, 1996, and most recently in 2004. A number of additions have been made to the original list as a result of these meetings and several changes in nomenclature or taxonomy have occurred since the initial list was developed.

On January 30, 2004 the Department and Riverbanks Zoo sponsored the first annual South Carolina Herpetology Conference. The conference was open to both professional and amateur herpetologists with approximately 130 attendees. One presentation at the conference concerned the CWCS as it pertained to amphibians and reptiles. At the close of the meeting, SCDNR personnel distributed a packet of questionnaires concerning the status of amphibians and reptiles in South Carolina that was based on the matrix developed for the CWCS. Attendees who volunteered to fill out the questionnaires were asked to evaluate all of the amphibian and reptile species currently listed as either endangered, in need of management, or species of concern. In addition they were asked to evaluate 16 additional species that were selected based on suggestions from knowledgeable individuals, unknown status, or because the species were representative of habitats that are believed to be rare, uncommon or potentially threatened.

A total of 52 species of amphibians and reptiles in South Carolina have been identified as priority species, representing 37 percent of the state's species. While these 52 species have been identified as requiring immediate conservation attention, this is by no means an indication that the remaining species are stable and secure. All inventory projects originating as the result of this plan must take the full spectrum of South Carolina's amphibian and reptile fauna into account, documenting occurrences for all species. There are a number of amphibian and reptiles species in South Carolina for which adequate data on their status is lacking, but there is no immediate indication that they are threatened. Species such as the many-lined salamander, southern Appalachian salamander, mole kingsnake and glossy crayfish snake are examples of species that are not well known in the state and that may be of future conservation concern.

The species reports detail the amphibian and reptile priority species and provide information on their life history, status, threats they are facing and detailed recommendations for conservation actions. Priority species are associated with key habitats, as well as specific descriptions of those habitats. The conservation needs of the species or functional groups are identified for the regions of the state and habitats in which the actions need to take place.

Challenges

One of the major challenges to amphibians and reptiles in South Carolina is loss of habitat. Wetland habitats, which are important to many members of this taxa have been destroyed by draining and filling throughout the state. Even small alterations to wetlands can make the habitat inhospitable for reptiles and amphibians. Pond breeding amphibians are known to require adequate upland habitat around breeding ponds. Populations of amphibians may be extirpated by the elimination of adequate upland habitat despite the protection of the breeding pond.

Conversely, the drainage or alteration of ponds in an otherwise unaltered forest may result in the extirpation of local amphibian populations. Many wetlands that still exist are now unsuitable for breeding because they have been left isolated in the landscape as a result of farming or timber operations.

Conversion of habitat for these species to agricultural purposes represents a significant challenge to reptiles and amphibians. For example, longleaf pine habitat has been greatly reduced both in extent and in quality subsequent to European settlement of the southeast (Noss 1989). Vast acreages of longleaf pine have been converted to agriculture and/or loblolly pine plantation in South Carolina. The loss, or degradation of longleaf pine habitat results in the loss of key components necessary for success of the animals that live in that habitat.

Habitat can also be lost to urban development. Nesting habitat for marine turtles is lost as coastal development expands. Even if a suitable sandy beach is available, nesting can be aborted because of beach furniture and equipment blocking access to nest sites. Further, lighting in coastal area can disorient turtles and result in nesting failure. Road mortality is also a significant threat; urban development requires that additional roads be constructed. These roads are frequently constructed through amphibian and reptile habitat; mortality occurs as animals attempt to migrate across roadways.

Fire suppression contributes to habitat loss for many amphibian and reptile species. Many species in this taxa group require an understory that contains a diverse herbaceous plant layer that is maintained by routine burning. However, in recent years, use of adequate fire management has decreased in the state, which has resulted in successional changes that render the habitat unsuitable for some animal species.

Another significant challenge to amphibians and reptiles is unregulated harvest. Currently, collection and/or harvest are regulated for only a few reptiles and amphibians in South Carolina. Collection of salamanders for the bait industry is a threat to some salamander species; collectors do not discriminate among species. Further, the salamander bait trade is unregulated. Generally, all salamander species collected are lumped together and referred to as “spring lizards.” Several species of snakes in the state are collected for the pet trade; such collection is also unregulated.

Freshwater turtles can be adversely affected by many factors including habitat destruction and poor water quality. An additional challenge to these animals comes from unregulated harvest. Continuing unregulated harvest in South Carolina could result in drastic population declines for these turtles, which are currently common to abundant.

Introduced species, both plant and animal, can adversely affect South Carolina's reptiles. Beach vitex, an exotic introduced plant has recently taken over areas in northern Georgetown and Horry Counties. Its aggressive growth and impenetrable roots quickly cover the dunes, making them unsuitable for turtle nesting (R. Westbrook pers. com.).

The presence of nonnative fire ants throughout the southeastern United States has been implicated as a potential reason for the apparent decline of the southern hognose snake (Tuberville and Jensen, in press). Fire ants may also be adversely affecting populations of other fossorial and egg-laying snakes. Further, fire ants are suspected to affect the probability of turtle hatchling survival.

Red-eared sliders (*Trachemys scripta elegans*) impact the population stability of yellowbelly turtles through hybridization. This nonnative species has been released in South Carolina resulting in concerns about the genetic integrity of the yellowbelly turtle as established red-eared sliders interbreed with this species, shifting the genetics of local populations.

Entrapment in fishing devices, including hook and line, trawls and crab pots represents a significant challenge to turtle species throughout the state. Florida softshell and spiny softshell turtles are often captured incidentally on hook and line and are either killed to retrieve the tackle, or later die due to complications from the ingested hook. Major challenges to the diamondback terrapin in the marine environment include recreational, commercial and abandoned/ghost crab pots. Incidental take of loggerhead turtles from commercial fishing operations also constitutes a major challenge to this species. In a 1990 study, the National Academy of Sciences estimated that between 5,000 and 50,000 loggerheads were killed annually by the shrimping fleet in the southeastern Atlantic and Gulf of Mexico (National Research Council 1990). The shark longline fishery, which operates all year long off the south Atlantic, may impact loggerheads in the neritic environment (Lewison et al. 2004).

Freshwater Fishes

South Carolina has an abundant and diverse aquatic community. There are 146 fish species that are known to inhabit the freshwaters of South Carolina or are seasonally dependent on freshwater habitats to complete their life cycle, such as shad and sturgeons. Several other fish taxa have not been scientifically described, but may warrant species status review and would increase the number of species native to South Carolina. South Carolina's diverse fish fauna is largely due to the myriad of aquatic habitats that can be found throughout the state. Small high gradient Blue Ridge streams, large fertile piedmont rivers and the "blackwater" streams and bays of the coastal plain are just a few of the aquatic habitats that contain numerous and diverse fish communities. South Carolina's freshwater fish fauna also boasts a relatively high degree of endemism with the distributions of approximately 22 species, including the Carolina darter and the Sandhills chub, that are restricted to South Carolina or more often restricted to a few drainages that South Carolina shares with one or more of its neighboring states.

The southeastern US is rich in aquatic fauna diversity, but some species are increasingly at risk of extinction. More than two decades ago a fish assessment of the southeastern US identified 85 fishes in jeopardy of imperilment (Deacon et al. 1979). A decade later, Williams et al. (1989)

recognized 109 southeastern fishes as in jeopardy. The most recent assessment of southeastern fishes (Warren et al. 2000) identified 187 taxa as extinct, endangered, threatened or vulnerable, which represents a 125 percent increase in imperiled fish taxa in only 21 years. Eighteen fish species that inhabit South Carolina were identified as endangered, threatened or vulnerable to imperilment in the latest assessment of southeastern fishes (Warren et al. 2000). An additional 38 fish species were determined to be of conservation concern in South Carolina; a total of 56 freshwater fishes are included on South Carolina's Priority Species List. Although many of those species may not be in jeopardy globally, they warrant conservation concern if the goal is to maintain South Carolina's rich and diverse fish fauna.

Species Selection Process

The information about freshwater fishes contained in the Strategy was supplied by the expertise of the biologists who formed our Freshwater Fish Technical Team (FFTT). The members of that team invested considerable time to the development of the Strategy and are graciously thanked for their efforts; these individuals are listed in Table 2-6. Other sources of information included published literature and unpublished SCDNR and Clemson University data.

TABLE 2-6: FRESHWATER FISHES TECHNICAL TEAM

Name	Affiliation
Ron Ahle	South Carolina Department of Natural Resources
Jason Bettinger	South Carolina Department of Natural Resources
Jeff Foltz	Clemson University
Eric Krueger	The Nature Conservancy
Doug Martin	Savannah River National Laboratory
Joe Quattro	University of South Carolina
Fritz Rohde	North Carolina Division of Marine Fisheries
Jeannie Riley	United States Forest Service
Mark Scott	South Carolina Department of Natural Resources
Wayne Starnes	North Carolina State Museum of Natural Sciences
Lora Zimmerman	United States Fish and Wildlife Service

During December 2003, twelve biologists were asked to review a list of South Carolina fish species and comment on the conservation status, conservation needs and knowledge deficiencies of each species. Each reviewer was given an Excel data sheet with 18 questions accompanied by a set of criteria and instructions for conducting their review. Nine of the questions were multiple-choice and nine were designed for comments. There were two categories of multiple-choice questions: those dealing with the current knowledge of a given species and those dealing with the species conservation status.

The responses from all reviewers were then summarized to develop a preliminary list of species having the greatest conservation need in South Carolina. The summarization process was as follows. Initial trimming of the list was facilitated by asking reviewers to eliminate species that did not warrant special conservation status in South Carolina or were not primarily restricted to freshwater. A species was eliminated from the list when at least two reviewers suggested elimination and none of the other reviewers provided information for that species. All letter responses (multiple-choice questions) were assigned a numerical value (1 to 3). Within the

knowledge category, higher numbers were assigned to species with the least amount of knowledge (Knowledge of species population status; high (H) = 1, Medium (M) = 2, and Low (L) = 3). Within the conservation category, higher numbers were assigned to the species in greater conservation need (Population status; Increasing (I) = 1, Stable (S) = 2, and Decreasing (D) = 3). Among individual reviewers, the responses were averaged by species for the knowledge category and status category questions. The mean scores in both categories were then ranked by species for each reviewer. Mean ranks were then calculated for each category of questions by species when at least two reviewers provided input for that species.

The initial review by the FFTT resulted in a list of 68 freshwater fish species that warranted further discussion as to their conservation needs and status. FFTT members met on August 11, 2004 in Columbia, South Carolina to review the revised species list, make changes (species additions and deletions) and categorize the conservation needs of each fish species. The FFTT members, by consensus, ultimately identified 56 freshwater fish species of conservation concern in South Carolina and categorized them into three different levels of conservation need (highest, high, and moderate). The 56 species represent roughly 38 percent of the freshwater fishes in the state. While the fish species addressed here are thought to be the most imperiled or likely to become imperiled fish species in the state, it is not an indication that the other species that inhabit the state are stable and secure.

Challenges

One of the major challenges to freshwater fishes in South Carolina is degradation and loss of habitat. As development and urbanization occurs, waterbodies are altered in ways that change both the topography and hydrology of streams, rivers, wetlands, lakes and ponds. Removing riparian vegetation can result in siltation, increases in nutrient and pollutant loading, increases in velocity of flow both into and within the waterbody and temperature increases.

Erosion from agriculture and silviculture (logging) can significantly lower water quality and cause drastic adverse reactions in aquatic life (Butler 1968). Runoff carries silt, chemicals and nutrients into wetlands that, acting alone or in combination, can be lethal to aquatic life, and particularly to larval forms (Matthews et al. 1980; Aust et al. 1997). Runoff can cause sedimentation and nutrients can encourage algal blooms, both leading to eutrophication and possible dissolved oxygen (DO) depletion (Matthews et al. 1980; Lockaby et al. 1997). Siltation can also cause increased water temperature (Aust and Lea 1991; Perison et al. 1993). Forestry BMPs for bottomland forests are recommendations to landowners in order to conserve site productivity, primarily for silviculture, and are voluntary (South Carolina Forestry Commission 1998). When BMPs are not used, braided streams may be obstructed by plant material and disturbed soils, excessive ruts may channel eroded sediments into streams, partially stagnated waters may become nutrient-rich and promote algal growth that can die under extended periods of cloud-cover (J.W. McCord, SCDNR, pers. obs.). These factors contribute to increased water temperature and reduced DO.

Rapid development in some parts of South Carolina also contributes to siltation in many ways. Impervious surfaces such as roads, buildings and parking lots increase erosion in adjacent areas and contribute to flooding. Clearing riparian vegetation also destabilizes stream and riverbanks

allowing excessive siltation. Clear cutting in a substantial part of a watershed can also contribute to siltation even if a riparian buffer is maintained. In a study of several watersheds in the Georgia piedmont, streams in urban and agricultural watersheds had much higher nutrient and suspended sediment concentrations than watersheds that remained mostly forested. Suburban watersheds had intermediate levels of nutrients and suspended sediments when compared with watersheds dominated by forested or urban and agricultural land use (Meyer and Couch 1999). The use of motor vehicles in streams and along banks can also degrade the stability of banks, stir up benthic sediments and increase siltation. Factors that contribute to siltation can also change the topography of the stream or river, by changing the slope of the bank and eliminating heterogeneity in the channel.

Siltation from agricultural, silvicultural and other land use practices can also reduce spawning success by causing mortality of eggs or by coating substrates needed for attachment of adhesive eggs (NMFS 1998). Pollution, runoff and siltation input contaminants and pollutants into sturgeon habitat that can cause lowered pH or lowered DO, which can reduce survival of eggs, larvae or juveniles (Rogers and Weber 1995; NMFS 1998; USFWS 1998). Bioaccumulation of contaminants may reduce productivity or increase susceptibility to diseases or stress (Cooper 1989; Sindermann 1994; Varanasi 1992; NMFS 1998).

Hydrologic alterations to waterbodies can be detrimental to freshwater fishes. Dams prevent upstream migration fish (ASMFC 1990; NMFS 1998; USFWS 2001). Dams can block spawning migrations and severely restrict the availability of spawning and nursery habitat. In the event of a catastrophic event along a stream section, such as the diesel spill on a portion of the Reedy River in 1996, dams can make it very difficult for fishes and other aquatic animals to recolonize areas devastated by the catastrophe. Dewatering streams and rivers for anthropogenic purposes can result in reduced flows, elimination of critical habitats and reduced water quality by concentrating nonpoint source pollution and increasing water temperature.

Nonnative fish species, particularly, the nonnative flathead catfish (*Pylodictis olivaris*) and the blue catfish (*Ictalurus furcatus*), can severely impact native fish populations through competition for resources and predation. Flathead catfish are voracious predators that have decimated ictalurid and other fish populations throughout the southeastern United States (Guire et al. 1984; Jenkins and Burkhead 1994; Bart et al. 1994).

Diadromous Fishes

Diadromous fishes are species with complicated life histories, including partial growth and development in fresh and brackish and/or marine waters. These species are dependent on access to a wide diversity of habitats, particularly relative to water salinity or salt content, to most successfully complete their life cycle (McDowall 1988). There are several basic life history patterns within this group.

Anadromous fishes spawn in freshwater, but typically spend much of their developmental life in marine waters (McDowall 1988). In the southeast, the classic anadromous life history is exemplified in the three alosine herrings or alosines (all members of the genus *Alosa* and the family Clupeidae): American shad, hickory shad and blueback herring. The alosines are highly

migratory species that occur along much of the Atlantic coast of North America and spawn in freshwater during late winter and spring. Genetically distinct populations occur in most coastal, freshwater drainage basins throughout the range of these species, including in South Carolina (ASMFC 1985; ASMFC 1999). Because of similarities in life history, the alosines face similar threats and are often included in single comprehensive management plans. These species will be addressed in a guilded approach.

Atlantic sturgeon is the largest species of fish found in freshwaters of eastern North America (Robins and Ray 1986). The Atlantic sturgeon is also anadromous, but both juveniles and non-sexually-mature adults may move between fresh, brackish and marine habitats during much of their lifespan (ASMFC 1990; McCord 2003). Atlantic sturgeon may not occur in genetically segregated stocks to the extent as do alosines, but sturgeon are genetically dissimilar by Atlantic coastal region (North Atlantic, Mid-Atlantic and South Atlantic) (Wirgin et al. 2000). The extent of genetic mixing between drainage basin-specific populations or stocks is unknown.

The shortnose sturgeon displays a variant anadromous life cycle in southern populations (Dudley et al. 1977; Kynard 1997; McDowall 1988; NMFS 1998). Shortnose sturgeons move into Atlantic Ocean coastal waters, though with much less frequency than do Atlantic sturgeons (NMFS 1998). Both species generally move between waters over a broad salinity range within particular drainage basins and occasionally move into high salinity estuarine or nearshore marine waters (McDowall 1988; NMFS 1998). This semi-anadromous life cycle has been termed “freshwater amphidromous” (Kynard 1977; NMFS 1998). Such species typically occur in relatively unique genetic populations or population segments since there is limited opportunity for mixing between riverine populations (NMFS 1998). Genetic mixing between populations is likely rather limited. A potentially dam-locked population of shortnose sturgeon occurs in the Santee-Cooper lakes (Collins et al. 2003). Evidence to date indicates that this population is stressed, possibly because of lack of access to habitats with more appropriate food resources (Collins et al. 2003).

The striped bass is anadromous in basins along the north Atlantic and most of the mid-Atlantic coast, but is marginally anadromous, or freshwater amphidromous, in much of the southeast (Dudley et al. 1977).

Catadromous fishes have a life history opposite that of anadromous fishes (McDowall 1988). This unusual life history strategy occurs in American eel (McDowall 1988; ASMFC 2000). The American eel is distributed along much of the Atlantic Coast from Canada to South America in a single population (ASMFC 2000). Adults spawn in the Sargasso Sea, a region of the central North Atlantic, south of Bermuda and east of the Bahamas. Adults die after spawning; juveniles migrate across the Atlantic continental shelf and populate many estuarine and freshwater habitats, where they remain until sexually mature (ASMFC 2000).

Ultimately, all seven diadromous fish species described here are included on South Carolina’s Priority Species List. However, the striped bass is included on the list of freshwater fishes because the populations for which there is concern are located inland.

Since most diadromous species are highly migratory and use, or even require, a vast diversity of habitats, management of such species is much more problematic than for more habitat-specific species. Management is particularly complicated for species such as alosines and sturgeons that occur as individual populations (genetic races) by river basin, or even by major tributary within a basin (as has been indicated for American shad). Most diadromous species are potentially impacted by threats both within and outside of a particular state's jurisdiction; for example, American shad from South Carolina rivers occur in coastal bays of Canada during part of each year (Neves and Depres 1979). All portions of the life cycle are equally important for long-term sustainability of stocks. Accordingly, diadromous species generally require management through interstate or interjurisdictional plans.

Species Selection Process

The information about diadromous fishes contained in the Strategy was supplied by the expertise of biologists who formed our Diadromous Fishes Taxonomic Committee. The members of that committee invested considerable time to the development of the Strategy and are graciously thanked for their efforts; these individuals are listed in Table 2-7. Other sources of information included published literature and unpublished SCDNR data.

TABLE 2-7: DIADROMOUS FISHES TAXONOMIC COMMITTEE

Name	Affiliation
Mel Bell	South Carolina Department of Natural Resources
Jason Bettinger	South Carolina Department of Natural Resources
Mark Collins	South Carolina Department of Natural Resources
Doug Cooke	South Carolina Department of Natural Resources
Billy McCord	South Carolina Department of Natural Resources
Bill Post	South Carolina Department of Natural Resources
David Whitaker	South Carolina Department of Natural Resources

The six diadromous species (American shad, hickory shad, blueback herring, Atlantic sturgeon, shortnose sturgeon, and American eel) for which species reports are written are considered to be high priority species. All perform integral roles in the diverse habitats and ecosystems in which they reside during all portions of their complicated life cycles and all have faced impacts that have caused stock declines, sometimes dramatic, in at least some river basins, both in South Carolina and across their broader ranges (ASMFC 1985; ASMFC 1990; ASMFC 1999; ASMFC 2000; NMFS 1998). The ecological functions of these species are described in detail within the species profiles. These species are all currently covered by dynamic management plans developed through the ASMFC or the NMFS. Such management plans are primarily guidance documents that require action and cooperation by individual states. Several plans include mandates to the states that require specific monitoring or management actions. Unfortunately, funding associated with such plans and mandates has been insufficient to support actions necessary to collect information essential to assess and protect most basin-specific populations.

The shortnose sturgeon is a federally endangered species under the ESA. However, individual basin-specific stocks of other anadromous species may be more imperiled than are many shortnose sturgeon stocks. All of the state's priority diadromous species are currently, or have

been, targeted by commercial and/or recreational fisheries. Management of these species has generally been limited to control of fisheries, oftentimes based on limited data, perceived population levels and regulatory actions presumed to produce desired positive effects. Currently, all take of shortnose sturgeon is prohibited because of its endangered status. The Atlantic sturgeon is also under a fishery moratorium that began in 1985 and is to remain in effect for an undetermined period based on the ASMFC plan. State law has closed commercial gear fisheries for alosines in several rivers and has limited such fisheries, as well as recreational creel limits, in other areas within the past decade. Prudent, effective, and responsive management of all of these species is dependent upon surveys and monitoring that can establish current distribution and stock status for all six priority diadromous species.

Challenges

There is a paucity of information on all species, particularly in regard to current population trends or distribution. For most of the priority diadromous species, information concerning presence or absence of these fishes is lacking for many state river basins. Also, the known or perceived status of individual populations for which there are data is variable, ranging from secure to apparently depleted.

Dams that block or limit access of migratory fishes to historical habitats and prevent free movement both up- and downstream, have been indicated as major contributors to stock declines for all diadromous species (ASMFC 1985; ASMFC 1990; ASMFC 1999; ASMFC 2000; NMFS 1998). Information on current distribution and stock status of all six high priority species is highly applicable to FERC-relicensing considerations for dams and other water diversion facilities. Many dams on drainage basins within South Carolina are currently, or soon will be, undergoing the FERC-relicensing process. Both the NMFS and the USFWS have primary authority over fish passage and diadromous fish restoration issues related to FERC-relicensing (ASMFC 1985; ASMFC 1990; ASMFC 1999; ASMFC 2000; NMFS 1998). However, state natural resource agencies generally participate in such activities as well.

Because of the broad diversity of life history characteristics and habitat utilization displayed by diadromous species, and because of their complicated life cycles, survey and monitoring techniques must be diverse and performed for a decade or more to establish meaningful trends indicative of stock status. Most survey and monitoring to gather information on stock status of diadromous species in South Carolina over the past two decade or more has been funded by various federal grants and has been primarily performed in response to mandates in ASMFC management plans. Funds have not been sufficient to allow for either comprehensive studies of all populations in South Carolina or for the accumulation of sufficiently long-term data to provide for conclusive indications of stock status for even any single population. Furthermore, mandated data collection is most extensive for American shad, and such data collection is not required for all populations since participants in the ASMFC management plan development process understood (and currently understand) funding limitations. Generally, small rivers are not covered by mandates within the ASMFC plan for alosines (ASMFC 1999; ASMFC 2002). ASMFC management plans for the Atlantic sturgeon and the American eel include few mandates, but like all ASMFC plans, the NMFS recovery plan for shortnose sturgeon (NMFS 1998) and other management plans, make numerous recommendations for data collection needs

to establish population status and conservation actions needed to restore or enhance individual populations or population segments.

In many South Carolina river basins, basic surveys must be conducted to determine either presence or absence of these species. Population surveys in some rivers may be useful as indicators of probable stock trends in similar basins. Perhaps among the highest priorities should be the continuation or expansion of existing surveys (i.e., a survey of sturgeons in the Edisto River initiated in 1996) for sufficient duration to allow for characterization of stock status.

Other important issues in diadromous fish management include the determination of the extent of genetic isolation of populations or population segments using tributaries within larger drainage basins. For example, detailed and expensive genetics studies may be required to determine the relationships of alosines spawning within various tributaries of the greater Waccamaw-Pee Dee Basin. Similar relationships may exist for alosines in the ACE Basin rivers. Genetic relationships and the extent of genetic isolation of Atlantic sturgeon in riverine spawning populations are also poorly understood. Genetic implications are also very important with regard to the development of some fish passage and fish restoration programs when the integrity of genetically distinct populations may be negatively affected. For effective management of the Atlantic Coast American eel population, it is of utmost importance to better understand the contribution of various riverine or regional sub-populations or population segments to the current and long-term productivity of the entire continental population.

Marine Fishes and Invertebrates

Most marine fishes and invertebrate species have rather broad geographical distributions that extend outside of South Carolina's jurisdictional boundaries to the north or south and/or offshore, outside of the 3-mile state territorial limit. Many species, particularly marine and diadromous fishes, are highly migratory and some occur in state marine waters only during portions of the calendar-year or during portions of their life cycle. Efficient and effective management of migratory species and species with complicated life cycles is dependent upon management plans that have coverage outside of any individual state's jurisdiction.

Many marine fish species and some invertebrate species, particularly those of recreational and commercial fishery importance, are currently addressed by state and/or federal or regional plans, laws and/or regulations. However, the population status of most species remains poorly understood. For most species, the genetic relationships of stocks or sub-populations throughout their distribution are also poorly understood. Understanding such relationships is of utmost importance in the identification of individual management units. In general, existing management does not identify individual management units, but attempts to establish a framework for managing commercial and recreational harvest as a surrogate to population management to prevent excessive directed fishing mortality over a broad geographic range. Many management plans identify potential threats and conservation actions to mitigate such threats, but plans do not include sufficient links to funding needed to provide comprehensive population-based management by specific stocks or management units.

The numbers of marine species, both fishes and invertebrates that can be found in the boundaries and/or jurisdiction of South Carolina is vast. Prior to the beginning the process of preparing South Carolina's Strategy, lists for these taxonomic groups did not exist. Development of completed species lists for these taxa represent a major accomplishment for the SCDNR.

Species Selection Process

Initial species selected for review included all marine fishes and invertebrates identified on computer code species lists that are maintained by SCDNR's Marine Resources Division (MRD). A total of 1,059 species were included in the initial list: 256 fishes and 803 invertebrates. The first step was to remove species that had not been recorded in cumulative surveys conducted within South Carolina's marine waters from tidal, brackish river reaches to the 3-mile territorial jurisdictional limit of the Atlantic continental shelf.

The information about marine and brackish fishes and marine invertebrates contained in the Strategy was supplied by the expertise of biologists who formed the Marine Taxonomic Committees. The members of these committees invested considerable time to the development of the Strategy and are graciously thanked for their efforts; these individuals are listed in Table 2-8 and Table 2-9. Other sources of information included published literature, and unpublished data from various sources.

TABLE 2-8: MARINE FISHES TAXONOMIC COMMITTEE

Name	Affiliation
William Anderson	College of Charleston
Mel Bell	South Carolina Department of Natural Resources
Jason Bettinger	South Carolina Department of Natural Resources
Mark Collins	South Carolina Department of Natural Resources
Don Hammond	South Carolina Department of Natural Resources
Phil Maier	South Carolina Department of Natural Resources
Bob Martore	South Carolina Department of Natural Resources
Billy McCord	South Carolina Department of Natural Resources
John McGovern	National Oceanic and Atmospheric Administration
Charles Moore	South Carolina Department of Natural Resources
Fred Rohde	NC Division of Marine Fisheries
Bill Roumillat	South Carolina Department of Natural Resources
George Sedberry	South Carolina Department of Natural Resources
Dustin Smith	Native fish enthusiast
Glenn Ulrich	South Carolina Department of Natural Resources
Pearse Webster	South Carolina Department of Natural Resources
David Whitaker	South Carolina Department of Natural Resources

It was clear early in this process that data and knowledge available for most marine species in South Carolina were largely qualitative or of limited scope. MRD staff suggested that most reviewers would have difficulty supplying input related to stock or population status for most species of fish and certainly for most invertebrates. Regardless, all identified experts were to be contacted for their input via an Excel data sheet or matrix with 18 questions. Nine of the questions were multiple-choice and nine questions were designed for comments. There were two categories of multiple-choice questions: questions dealing with knowledge of a given species

and questions dealing with the species conservation status. Initial trimming of the lists would be facilitated by asking reviewers to eliminate species that did not warrant special conservation concern in South Carolina. A species was to be eliminated from the list if at least two of the reviewers suggested elimination and none of the other reviewers provided information for that species.

TABLE 2-9: MARINE INVERTEBRATES TAXONOMIC COMMITTEE

Name	Affiliation
Dennis Allen	University of South Carolina – Baurch Institute
Bill Anderson	South Carolina Department of Natural Resources
Loren Coen	South Carolina Department of Natural Resources
Stacie Crowe	South Carolina Department of Natural Resources
Larry Delancey	South Carolina Department of Natural Resources
Arnie Eversole	Clemson University
Pam Jutte	South Carolina Department of Natural Resources
David Knott	South Carolina Department of Natural Resources
Marty Levisen	South Carolina Department of Natural Resources
Billy McCord	South Carolina Department of Natural Resources
Jennifer Price	South Carolina Department of Natural Resources
Steve Stancyk	University of South Carolina
Betty Wenner	South Carolina Department of Natural Resources
David Whitaker	South Carolina Department of Natural Resources
Bob Van Dolah	South Carolina Department of Natural Resources

All identified experts were contacted for their input via an Excel data sheet or matrix with 18 questions. Nine of the questions were multiple-choice and nine questions were designed for comments. There were two categories of multiple-choice questions: questions dealing with knowledge of a given species and questions dealing with the species conservation status. Initially, reviewers were asked to eliminate species that did not warrant special conservation concern in South Carolina. A species was to be eliminated from the list if at least two of the reviewers suggested elimination and none of the other reviewers provided information for that species.

Experts suggested that marine fishes would be best protected by managing essential habitats for species or species groupings as the marine fishes group was a poor fit for the matrix treatment. Accordingly, all core (non-peripheral) marine fish species found in South Carolina marine and brackish water were retained on South Carolina's Priority Species List. Many of these species may be monitored as indicators of habitat health or changes or as indicators of population health for other species associated with similar habitats. The final list of marine and brackish fishes includes 163 species.

The marine invertebrate grouping was more problematic, as there is generally very limited information available relative to population status of practically all species in South Carolina. The invertebrate list was revised by MRD staff using similar methodologies as were used for developing a marine fish 'list of concern.' Input was solicited via email from several identified marine invertebrate experts. The final list of marine and brackish invertebrates includes 775 species, or better, types. The classification of some "species" remains in question.

Challenges

There are a number of potential challenges to marine fishes and invertebrates. However, it is difficult to assess the degree to which each species is vulnerable until habitat associations, population trends and distributions are better understood for each species.

One of the major challenges to marine organisms in South Carolina is degeneration and loss of habitat. As development and urbanization occurs along the coast, beaches and waterbodies are altered in ways that change both topography and hydrology of coastal systems. Removing riparian vegetation can result in siltation and increases in nutrient and pollutant loading.

Habitat loss can affect all life stages of marine organisms. Salt marsh is an extremely productive habitat and is often used by larval forms of both fishes and invertebrates. Degradation of this habitat would be especially detrimental to marine organisms. Coastal development continues to encroach upon salt marshes in South Carolina.

Habitat alterations in marine waters also include damage resulting from trawling, dredging and dredge disposal. These types of habitat alterations are particularly detrimental to benthic fishes and invertebrates.

All marine organisms are affected to some degree by water quality. Stormwater runoff from developed areas contains sediment, nutrients and contaminants. These substances can substantially degrade water quality. As coastal areas are developed, more contaminants are carried in stormwater. Sedimentation can impair the ability of many marine organisms to feed. Nutrification can result in harmful algal blooms that substantially reduce dissolved oxygen in the water. Chemical pollution can be detrimental to all species; but can be particularly detrimental to benthic species, even in small amounts. Some species, such as fiddler crabs have been shown to bioaccumulate contaminants; bioaccumulation can result in contamination being passed up the food chain.

Several marine fishes may be adversely affected by fishing pressure. Many marine fishes are not managed as either commercial or recreational species, but are targeted by recreational fishermen. If unchecked, such fishing pressure can reduce populations. Also, many species, both fish and invertebrate, are harvested as by-catch in commercial fishing operations. Even if alive when discovered and released, many animals can die due to damage sustained during harvest or stress related to harvest.

Unregulated harvest threatens some marine species. For example, South Carolina does not currently regulate a commercial cannonball jellyfish fishery. However, this fishery does exist in other portions of the cannonball's range. Asian countries are developing fisheries management plans to conserve jellyfish because populations are unstable or declining due to pollution, overfishing or climate change. Consequently, dealers are looking for new sources of jellyfish (Hsieh et al. 2001). Interest in cannonball jellyfish from the United States increased recently because of high consumer demand in Asia (Hsieh et al. 2001). Rising demand in Japan and Southeast Asia may create an international market for cannonball jellyfish from South Carolina

coastal waters. Likewise, some marine species are collected for the aquarium trade; many of these collections are also unregulated.

Crayfish

Crayfish are freshwater decapod crustaceans of the superfamily Astacoidea. Representatives of two of the three families, Astacidae and Cambaridae are found in North America. About 75 percent of the total known species of crayfish are endemic to North America (Lodge et al. 2000a). The southeastern United States exhibits by far the greatest species diversity of any region (Taylor et al. 1996). South Carolina is the home to a diverse crayfish fauna of at least 36 native species. Nine of the known species appear to be endemic to the state; many others are found only in South Carolina and an adjacent state. Of the five species of the burrowing genus *Distocambarus*, four are South Carolina endemics.

Crayfish play several important ecological roles in aquatic habitats. These animals make up a large portion of the invertebrate biomass and the diet of several game fish species in some water bodies (Probst et al. 1984; Rabeni 1992; Roell and Orth 1993). Some South Carolina snakes also rely heavily on crayfish for food. Crayfish also have a drastic effect upon the biomass and species composition of aquatic macrophytes and snails (Lodge et al. 1994). Despite their abundance and importance in many North American freshwater habitats, both the taxonomy and natural history of many species of crayfish are poorly understood. New species are frequently being discovered and existing species are often reclassified. In fact, two of the species on our list are in the process of being described.

Commonly thought to inhabit strictly aquatic environments, crayfish can utilize a variety of aquatic, semiaquatic and terrestrial habitats. All species rely on water for reproduction, but many burrowers are terrestrial and either access the water table by digging deep enough or by constructing the burrow with compact soil around the walls, allowing it to retain moisture from rainfall and runoff. Some crayfish are obligate burrowers and rely on habitat such as farm fields, prairies and forests. Others inhabit streams, small lakes or temporary ponds but may dig terrestrial burrows during dry periods. Still other species are restricted to aquatic habitats. The habitat requirements of many species, particularly primary burrowers, are not well understood.

Hobbs (1981) distinguished freshwater crayfish as primary, secondary and tertiary burrowers. Primary burrowers spend almost their entire lives in the burrow. Secondary burrowers spend much of their lives in a burrow, but may move to open waters during rainy periods. Tertiary burrowers live primarily in open water but may move into a burrow to escape frost or drought and when brooding eggs.

The conservation of American crayfishes has received little attention by regulatory agencies. The American Fisheries Society considered 65 species (19.2 percent) of North American crayfish as endangered, 45 (13.3 percent) as threatened and 50 (14.8 percent) as special concern (Taylor et al. 1996). Listing with the American Fisheries Society does not give species any protection. The US Fish and Wildlife service only lists four species as federally endangered, none of which are in South Carolina. No crayfish species are currently listed as threatened by the US Fish and Wildlife Service.

Species Selection Process

The information about aquatic and terrestrial crayfish contained in the Strategy was supplied by the expertise of five biologists. These people invested considerable time to the development of the Strategy and are graciously thanked for their efforts; these individuals are listed in Table 2-10. Other sources of information included published literature and museum records.

TABLE 2-10: CRAYFISH TAXONOMIC COMMITTEE

Name	Affiliation
John Cooper	NC Museum of Natural Sciences
Arnold Eversole	Clemson University
Daniel Jones	Clemson University
Jennifer Price	South Carolina Department of Natural Resources
Shane Welch	Clemson University

During December 2003, biologists were asked to review a list of 42 crayfish species and comment on the conservation status, conservation needs and knowledge deficiencies of each species. Each reviewer was given an Excel data sheet with 18 questions accompanied by a set of criteria and instructions for conducting their review. Nine of the questions were multiple-choice and nine were designed for comments. There were two categories of multiple-choice questions: those dealing with the current knowledge of a given species and those dealing with the species conservation status. There were several species for which no one could provide any information. These species were retained on the conservation concern list due to lack of status information; data on these species was provided through museum records and publications. Ultimately, 23 crayfish species were included on South Carolina's Priority Species List.

In South Carolina's CWCS, crayfish are addressed in two groups. One is entitled "Primarily Aquatic Species Group;" in this group, all aquatic species are treated together, including secondary and tertiary burrowers, based upon our best knowledge. The second group is entitled "Terrestrial Burrowing Crayfish Group;" primary burrowers are addressed in this group as the challenges these species face may be somewhat different than those to species inhabiting open water.

Challenges

There are a number of potential challenges to crayfish. However, it is difficult to assess the degree to which each species is vulnerable to particular threats until the habitat associations, population trends and distributions are better understood for each species. Genetic and taxonomic work is also very important where there are questions regarding classification because misidentification or the lumping of species complexes may obscure the presence of rare species in need of conservation. The case of *Cambarus* species "B," which was mistaken for an introduced species, is an excellent example.

The arrival of introduced species is probably the greatest challenge to crayfish (Lodge et al. 2000 a,b). The ranges and abundances of many native crayfish may have been reduced by invasive crayfish, both in the United States and in Europe (Lodge et al. 2000a; Hobbs et al. 1989). In

Europe, crayfish introduced from North America appear to be responsible for the spread of diseases to native species (Lodge et al. 2000a). Other potential mechanisms for the deleterious effects of invasive crayfish include predation upon natives, competition and genetic hybridization with native species (Lodge et al. 2000a).

The red swamp crawfish, *Procambarus clarkii*, has been introduced from the Mississippi drainage into South Carolina (Hobbs et al. 1989). While few studies have documented the effects of the red swamp crawfish on native species, potential negative effects of its introduction include the spread of fungal diseases to other crayfish and the spread of human helminth parasites, for which this species is an intermediate host (Hobbs et al. 1989). Prevention of future introductions is most likely the only effective way to deal with the challenges caused by non-native crayfish. No methods for eliminating invasive species without also harming native species are currently available. Even if effective biological control methods are developed, preventing introductions will still be much easier than eradicating an established species. Lodge et al. (2000b) proposed federal legislation that, if enacted and enforced, would drastically reduce the risk of future introductions. They include banning the use of live crayfishes as bait, and adopting a “white list” approach for the sale of all crayfish in the aquarium, garden pond and educational trade.

Additionally, the “white list” approach should govern the species allowed for use in aquaculture. This approach restricts the sale of crayfish to only those species that have been extensively researched and demonstrated to pose minimal risk as potential invaders. We may not always be able to predict whether a species is likely to become invasive; even those thought to pose minimal risks should not be released.

Physical alteration of habitat also represents a challenge to the survival of crayfish. Some aquatic crayfishes are quite adaptable and can live in ponds, impoundments and roadside ditches, while others are more sensitive to habitat alteration. Some crayfishes are oxygen regulators and are able to increase ventilation rates in response to reduced oxygen conditions, while others, the oxygen conformers, are unable to do this (Hobbs 1991). Therefore, some species are better equipped to survive when the flow of water slows and oxygen levels decline. Some species, such as *Cambarus* species “B” have been eliminated from parts of their range as a result of damming activities associated with reservoir construction. Channelization and dredging can also be very detrimental to aquatic crayfish that require rocks, crevices or tree roots along undercut banks as hiding places (Hobbs and Hall 1994). In general, crayfish are not as sensitive to siltation as some aquatic invertebrates such as mussels, but severe siltation has caused declines in or the extirpation of many populations of crayfish (Hobbs and Hall 1974).

The most serious known challenge to terrestrial burrowing crayfish is the alteration of soil hydrology. These species appear to be able to coexist with some agriculture and timber harvest practices, although they may not survive frequent tilling of soil. In some areas, fire suppression or the lack of fire management may be a threat, since some species appear to prefer piedmont prairies, savannahs and other open canopy habitats to densely wooded areas.

Crayfish are fairly sensitive to pH (Hobbs and Hall 1974; Hobbs 1991). It appears that stream dwelling species tend to have a lower tolerance for low pH than those from shallow lentic

habitats (Hobbs and Hall 1974). Observations of diverse crayfish fauna at neutral pH (7.0) and the absence of crayfish at a high pH (11.4) in otherwise similar streams in Georgia suggest that crayfish may also be sensitive to high pH (Hobbs and Hall 1974).

Pollution has been known to eliminate crayfish from streams. Ortmann (1909) noted the extirpation of crayfish from some sections of streams and rivers due to mining and oil refineries. Crayfish are harmed by a variety of insecticides, herbicides and industrial chemicals (Eversole et al. 1996). Juvenile crayfish are generally about four times as sensitive to water borne pollution than adults; early instars are about three times as sensitive as juveniles (Eversole and Sellers 1996). There is little knowledge of the differences in sensitivity to toxins among species. Nutrient enrichment is less likely to harm crayfish than other aquatic life because they are omnivorous and can act as scavengers as well as primary and secondary consumers. Hobbs and Hall (1974) noted several casual observations in which crayfish were actually more abundant downstream of areas with large amounts of garbage or animal remains. Enrichment may be harmful to crayfish, however, when it results in oxygen depletion (Hobbs and Hall 1974). Pollution of groundwater may impact terrestrial burrowers, because they inhabit water trapped in their burrows.

Freshwater Mussels

Freshwater mussels native to the United States are bivalve mollusks, belonging to the order Unionoida and superfamily Unionoidea. There are two families within Unionoidea: Unionidae and Margaritiferidae. All of South Carolina's species belong to the family Unionidae. The southeastern portion of the United States is the most diverse region in the world for freshwater mussels (Lydeard and Mayden 1995). The taxonomic identification of mussels to species can be difficult; more work, particularly genetic research, is necessary to determine if species designations currently in use are correct.

The conservation of North American freshwater mussels has many broad implications beyond the survival of individual mussel species. As filter-feeders, mussels clean the water of suspended particles and can improve water quality. They are also important food sources for fish, waterfowl, turtles, muskrats, raccoons and river otters. Other invertebrates use mussels as hosts; two fish species are known to use mussels as brooding sites (Bogan 2001). Since mussels are sometimes found at densities as high as 200 to 400 per m² (19 to 37 per foot²), removing them from our rivers and streams can have drastic consequences for these ecosystems, particularly in terms of water filtering (Bogan 2001). The tolerance for pollution may differ somewhat between species and we have little information on reactions to specific pollutants by species, since most evidence is anecdotal. Laboratory toxicology studies have been conducted on a few species. In general, mussels are quite sensitive to pollutants and are recognized as indicator species; they are often the first to decline when streams and rivers become polluted. Protection and restoration of freshwater ecosystems to support a diverse mussel fauna will also result in improving the health of these ecosystems, to the benefit of other aquatic organisms and humans.

Historically, mussels have been used for a variety of commercial purposes. In the mid to late 1800's harvesting mussels for pearls was common. From the 1890's until the 1950's, there were large commercial operations to harvest mussels for their shells, which were used to make

buttons. Today, there is still some demand for mussel shells for use in the cultured pearl industry and large-scale commercial harvesting still occurs in the US. However, no large-scale commercial harvesting currently occurs in South Carolina.

As a group, freshwater mussels are found in a variety of environments throughout South Carolina. A few species are widespread and found throughout the east coast, but many are endemic to one or a few river drainages. Many species are endemic to only North and South Carolina or only to South Carolina and Georgia (Bogan and Alderman 2004).

Most freshwater mussels are dioecious (separate sexes), although a few species are hermaphroditic. After fertilization and hatching within the female, the larvae, called glochidia, are expelled and must attach themselves to the skin, gills or fins of a fish host or, in a few cases a salamander, in order to complete development. Some species will only parasitize a single host species, while others can develop within any of several species. Therefore, the presence of the required fish or salamander host at the appropriate time of the year represents an additional habitat requirement for most species. A few species, such as *Strophitus undulatus*, are able to complete larval development without the assistance of a host fish.

Freshwater mussels are among the most threatened groups of organisms in North America. There are nearly 300 recognized species and subspecies in the United States, and 189 of them are currently on the IUCN Red List (Lydeard et al. 2004). At least 30 species are presumed extinct. Many more may be functionally extinct; some long-lived individuals have survived, but that populations are not reproducing (Bogan 1997). In 1993, the American Fisheries Society evaluated the conservation status of freshwater mussels in the United States and Canada (Williams et al. 1993). They determined that 7.1 percent of mussel species were endangered and possibly extinct, 20.6 percent were endangered and extant, 14.5 percent were threatened, 24.2 percent were of special concern, 4.7 percent had an undetermined status; only 23.6 percent of mussel species were determined to be stable. A panel of experts from the southeast concluded that only three of 33 native mussel species in South Carolina are stable and abundant enough not to be included as conservation priority species.

Records from the mid and early 1800's indicate that mussels were once plentiful in most North American rivers and streams (Parmalee and Bogan 1998). Mussels have completely disappeared from many bodies of water and rarely reach densities approaching those from historic times. Qualitative records of the decline of mussels are abundant, but there is little detailed quantitative information to document the rate of decline of these species.

Difficulty in identifying mussels has added to challenges quantifying their decline. Historic species identifications are often questioned and the extent of a species' historic range is uncertain. Museum specimens are also especially lacking in South Carolina, because there is no state natural history museum and collections are not in a centralized location. Temporal gaps in data exist because surveys have not been conducted at regular intervals. While there seems to be a growing interest in freshwater mussel conservation, conducting surveys is difficult due to the lack of researchers skilled in mussel identification and taxonomy, especially in South Carolina.

Species Selection Process

The information about freshwater mussels contained in the Strategy was supplied by the expertise of biologists who formed our Freshwater Mussel Taxonomic Expertise Committee. The members of that committee invested considerable time to the development of the Strategy and are graciously thanked for their efforts; these individuals are listed in Table 2-11. Other sources of information included published literature and museum records.

TABLE 2-11: FRESHWATER MUSSEL TAXONOMIC EXPERTISE COMMITTEE

Name	Affiliation
John Alderman	Alderman Environmental Services
Art Bogan	NC Museum of Natural Sciences
Tom Dickinson	The Catena Group
John Fridell	US Fish and Wildlife Service
Eugene Keferl	Coastal Georgia Community College
Eric Krueger	The Nature Conservancy
Tim Savidge	The Catena Group
Jennifer Price	South Carolina Department of Natural Resources
James Williams	US Geological Survey
Lora Zimmerman	US Fish and Wildlife Service

During December 2003, biologists were asked to review a list of 29 mussel species and comment on the conservation status, conservation needs and knowledge deficiencies of each species. Each reviewer was given an Excel data sheet with 18 questions accompanied by a set of criteria and instructions for conducting their review. Nine of the questions were multiple-choice and nine were designed for comments. There were two categories of multiple-choice questions: those dealing with the current knowledge of a given species and those dealing with the species conservation status.

The Freshwater Mussel Taxonomic Expertise Committee members met on 6 August 2004 to review the revised species list, make changes and categorize the distribution and conservation needs of each mussel species. The committee reached consensus that 26 out of 29 of the species known to occur in South Carolina were rare and/or declining and in need of some conservation action.

Challenges

Siltation appears to inhibit the reproduction of many mussels and the survival of juveniles (Ellis 1931). Siltation is usually considered the biggest challenge to the survival of freshwater mussels. Ellis (1936) found that silt accumulation on the substrate at a depth of 6 mm to 25 mm (0.25 to 1 inch) over several months caused mortality in several species of mussels in the laboratory, possibly by reducing oxygen levels near the substrate and by silt build up in the mantle cavity and gill chambers. Sediments suspended in the water column also harmed mussels by reducing the amount of time that they remained open for feeding (Ellis 1936).

Historically, siltation results from clearing land for farming, mining operations and by the construction of dams. Farming continues to be a challenge when too much bare soil is exposed,

when sufficient riparian buffers are not maintained, and when cattle are allowed to enter streams. Feral pigs contribute to siltation by digging along streambanks and channels and uprooting vegetation in search of food. Rapid development in some parts of South Carolina also contributes to siltation in many ways. Impervious surfaces such as roads, buildings and parking lots increase erosion in adjacent areas and contribute to flooding. Clearing riparian vegetation also destabilizes stream and riverbanks allowing excessive siltation. Clear cutting in a substantial part of a watershed can also contribute to siltation even if a riparian buffer is maintained. The use of motor vehicles in streams and along banks can also degrade the stability of banks, stir up benthic sediments and increase siltation. Factors that contribute to siltation can also change the topography of the stream or river, by changing the slope of the bank and eliminating heterogeneity in the channel. Eliminating structural heterogeneity may also slow the flow of water and reduce its oxygen content, therefore harming species that require highly oxygenated water.

Freshwater mussels have long been recognized as sensitive species that respond more quickly to pollution and siltation than other aquatic fauna. Ortmann (1909) recognized the rapid disappearance of mussels from streams polluted by coal mining, sewage, oil wells, oil refineries and dam construction. Acidification appears to have drastic effects upon the survival and shell structure of mussels (Fuller 1974). Point source pollution from paper mills, dye factories, gasoline byproducts, and chlorinated hydrocarbon pesticides are extremely toxic to mussels (Fuller 1974). Mercury appears to have significant negative effects on mussel growth (Beckvar et al. 2000). A recent review paper discussing the effects of ammonia concentration on ten species of mussels indicated that current EPA criteria maximum guidance concentrations for ammonia may be too high to offer protection to many mussels, particularly juveniles and glochidia (Augspurger et al. 2003).

Dam construction has caused the decline of mussels in many locations. Dams can slow the speed of water, thereby reducing the oxygen content and allowing the buildup of additional fine sediment. Dams may interfere with the reproduction of mussels by restricting the travel of host fish or by preventing the travel of sperm through the water to reach female mussels. Impoundments also result in habitat fragmentation and isolation of populations by preventing up and downstream recruitment, making populations more vulnerable to extirpation from other environmental impacts.

Hydroelectric power plants can also harm mussels by causing sudden variation in water volumes, which could leave shallow water mussels stranded. Peak flows can physically dislodge mussels, which may later become stranded when flows suddenly recede. Rapid changes in water temperature may also occur and can cause additional stress on mussels. Some mussel species are fairly tolerant of damming; mussel diversity may be reduced downstream of dams when a few tolerant species replace a previously diverse community of mussels.

Interbasin water transfer can also cause the degradation of streams and rivers and can be harmful to mussels. Such transfers can cause changes in the variability of flow, the speed of water through the channel and the composition of the substrate. The effects of interbasin transfers on mussels are similar to those caused by dams and siltation.

The Asian clam, *Corbicula fluminea*, has been introduced and has spread throughout the United States. While it often co-occurs in large numbers with native mussels, it may sometimes contribute to their decline. In the St. John's River basin, Belanger et al. (1990) found that the density of *Corbicula* was inversely correlated with the density of native mussels. Further, mussels of the genus *Elliptio* experienced slower growth rates when they among high densities of *Corbicula*.

The zebra mussel, *Dreissena polymorpha*, was introduced into the United States and has become well established in the northeast and in the Great Lakes area. This is a much more problematic bivalve than *Corbicula*, but has not yet reached South Carolina. The zebra mussel can cause the decline of native mussels by competing for food or by overcrowding. Overgrowth by zebra mussels may interfere with the feeding or locomotion of native mussels. It has invaded nearby parts of Tennessee and may eventually spread into South Carolina.

Feral hogs, *Sus scrofa*, have been roaming the southeastern United States and have gradually become widespread throughout the southeastern and south-central United States and California. The species has become the most abundant free-ranging introduced ungulate in the United States (Sweeney et al. 2003). They are primarily found on floodplains along rivers, but occasionally populations will become established in other areas due to the capture and release for hunting purposes. In addition to contributing to siltation by uprooting streambank vegetation, feral hogs also directly consume mussels.

The identity of the host fish species is known for fewer than half of South Carolina's mussels (Bogan and Alderman 2004). Conservation of specific mussel species by protecting the host fish can only be practiced efficiently if the identity of the host fish is known. Conserving healthy aquatic environments will benefit both fish and mussels.

Freshwater Snails

Mollusks of the class Gastropoda, commonly known as snails and slugs, are found in freshwater, terrestrial and marine habitats. Terrestrial snails are not being included at this time because little is known about the distribution and status of these organisms. Further, we have been unable to identify any regional experts who can provide substantial information about South Carolina's land snails. As with all invertebrate groups, snails and other gastropods are in need of taxonomic and genetic work.

Species Selection Process

Robert Dillon of the College of Charleston and Paul Johnson of the Tennessee aquarium were contacted regarding the species status of South Carolina's freshwater snails in November of 2003. At that time, South Carolina Department of Natural Resources did not even have a working list of the freshwater snails that occurred in South Carolina. A tentative list was provided by Paul Johnson and edited by Robert Dillon. Both biologists invested considerable time to the development of the Strategy and are graciously thanked for their efforts. Other sources of information included published and unpublished literature. Ultimately, four freshwater snails were included on South Carolina's Priority Species List.

Challenges

The lack of knowledge and information about life histories and habitat requirements for freshwater snails represents the most significant challenge to these species.

Siltation of streams and rivers through agricultural runoff and erosion of unstable streambanks appears to be the main threat to freshwater snails. Historically, siltation has occurred due to land clearing for farming, residential development, forestry practices, mining operations and construction of dams. Absence of sufficient riparian buffers significantly contributes to siltation (Moglen 2000). Clear-cutting a substantial part of a watershed can also contribute to siltation, even if a riparian buffer is maintained. Livestock and feral pigs degrade stream banks and bottoms as they drink and search for food. Impervious surfaces, such as roads, buildings and parking lots, increase erosion in adjacent areas and contribute to flooding (NCWRC 2002). Use of motor vehicles in streams and along banks can also disturb stream flow and increase siltation. All of these factors that contribute to siltation can also alter the topography of streams and rivers by changing the slope of the bank and eliminating heterogeneity in the channel.

Insects

While insects are certainly numerous, broadly represented, and widely encountered in South Carolina, incorporating insects into the Strategy presented many challenges, most of which were unique to insects.

The foremost reason for treating insects differently from other, better-known taxa is the much larger number of insect species currently known. Approximately 1.5 million species of living organisms presently are known in the world, from bacteria to oak trees to blue whales (Hoffman and Frodsham 1993). Animals comprise 1.1 million described species; approximately three-quarters of those animal species (about 825,000) are insects. Not only are insects the single largest component of world biodiversity (Erwin 1982; 1983), they are important in human and environmental health.

Insects are divided into 32 orders, with the largest order, beetles, comprising around 500,000 different species in 125 families. It is estimated that one out of every four known animals is a beetle. Furthermore, scientists estimate that 10 percent of the animal biomass of the world is ants and another 10 percent is termites; therefore, “social insects” may account for an incredible 20 percent of the total animal biomass of our planet.

The most widely used estimate for the total number of living species is roughly three times the number currently described, around 3 to 5 million (Berry 1992). However, extrapolations of local diversity that include world rain forests elevates that figure to somewhere between 30 and 50 million (Erwin 1988, 1997; Odegaard 2000). This estimate is controversial because the larger the estimated number of species, the larger the estimated rate of species loss. It is important to note that Erwin did not present this as a definitive number, but provided his estimate in an effort to spur further research.

Species Selection Process

Ten biologically significant arthropod taxa for which sufficient knowledge exists to build a minimal database were selected, including beetles, (Coleoptera); flies (Diptera); mayflies (Ephemeroptera); true bugs (Hemiptera); wasps, ants, and their relatives (Hymenoptera); butterflies (Lepidoptera); dragonflies and damselflies (Odonata); stoneflies (Plecoptera); caddisflies (Trichoptera); and spiders (Araneae).

The task was to compile a comprehensive, multi-taxa list of South Carolina's insect species of concern, including those currently not having any listing status, those already having a State or Global Natural Heritage Ranking, and those listed as sensitive, threatened and/or endangered. Ideally, the list should include all known species within the state from which only the species of concern would be included in the CWCS. However, the lack of sufficient data to provide a valid ranking system made this master list impossible. Therefore, insect species were only tabulated and summarized, not categorized into the structured hierarchical system used for the other taxa groups. This tabulating was done for only selected taxa. The total number of species in those taxa reported in South Carolina is presented in Table 2-12.

There is a significant lack of data about insect species distribution, habitat requirements and life histories. This data deficiency made development of conservation actions highly problematic, since knowledge of a species' distribution and living requirements are fundamental to those actions. Additionally, serious data deficiency was also encountered at the genus and family levels. Therefore, this necessitated the following working model: insects will be protected whenever they live in habitats being protected for non-insects species. Rather than planning protections for a particular insect species, most of the very few State- or Federally-listed insect species are afforded protections by having their general habitat protected.

The data deficiency is complicated further by the small number of insect experts available for consultation. The members of the Insect Expert Committee invested considerable time to the development of the Strategy and are graciously thanked for their efforts; these individuals are also presented in Table 2-12.

Because of the paucity of data for most insect species, several taxonomic experts were concerned that their estimate of an insect species' rank (likelihood for survival) would be construed as legally binding and considered as "law." The consensus of the Insect Expert Committee was that this ranking would only indicate a working approximation of a species' status and range. The "S" ranking (species status in South Carolina) included in the insect species reports represents a best estimate at an insect species' status and range and has no legal standing. The number of times a species was cited from the literature, known from collection data, or was known by an acknowledged expert to occur in one or more locations would be the working basis for determining an insect's "S" ranking. This method has been used by others in similar endeavors and serves very effectively as a rough guide to the extent and level of knowledge of a species' status and range. While a low number of observations does not imply that a species is "a species of concern," the number does assist in making allocations for future research efforts.

TABLE 2-12: INSECT EXPERT COMMITTEE

Taxa Group	Family	Expert	Affiliation	Reported Species
Odonata	Dragonflies	Wade Worthen Lynn Smith	Furman University Columbia University	155
Plecoptera	Stoneflies	Boris Kondraieff	Colorado State University	84
Hemiptera	Lace Bugs	Al Wheeler	Clemson University	38
Lepidoptera	Butterflies	Brian Scholtens	College of Charleston	158
	Moths	John Snyder	Furman University	1,510
Ephemeroptera	Mayflies	Pat McCafferty	Purdue University	76
Trichoptera	Caddisflies	John Morse	Clemson University	243
		Bradley Goettle	Clemson University	
Diptera	Mosquitoes	Bill Willis	Clemson University	62
	Midge Flies	John Epler	Private Researcher	392
	Long-legged Flies	Harold Robinson	Smithsonian Institution	91
	Fruit Flies	Allen Norrbom	Smithsonian Institution	10
	Black Flies	Peter Adler	Clemson University	54
	Horseflies	Bruce Ezell	UNC Pembroke	113
	Net-winged Midges	Greg Courtney	Iowa State University	12
Coleoptera	Ground and Tiger Beetles	Janet Ciegler	Private Researcher	415
	Scarab Beetles	Phil Harpootlian	Private Researcher	746
	Bark Beetles	Don Bright	Agriculture Canada	64
	Fireflies	Jim Lloyd	University of Florida	37
Hymenoptera	Sawflies	David Smith	Smithsonian Institution	52
	Ants	Tim Davis	Clemson University	103
Araneae	Spiders	Robert Wolff	Private Researcher	432
Total Number of Reported Species				4,847

Due to the large numbers of insect species, fifteen were chosen for which detailed species reports were prepared. Protection of species in other taxa and ultimate protection of ecosystems and habitats is expected to protect insects in South Carolina.

Challenges

Although we know little about most individual species, we do know that insects are incredibly adaptable and have evolved to live successfully in most environments on earth. Insects are by far the most diverse groups of animals and are a significant part of most ecosystems (Samways 1994). Yet insects are insufficiently studied and have received minimal attention from the scientific community. Insect biodiversity is being irreversibly lost through extinction caused by the alteration, degradation and destruction of natural habitats.

Identification of species is only the beginning, a fundamental necessity for all subsequent studies. Discovery of biological characteristics and living requirements of each species is the next step. Data are very scarce for most insect species beyond those observed and provided with their initial discoveries and descriptions. Closing the large data deficiency for insects is a necessary to fully understanding this taxa group.

CHAPTER 3: SOUTH CAROLINA'S LANDSCAPE

Introduction

Atop Sassafras Mountain, the highest peak in the state of South Carolina, a visitor can catch a glimpse of the splendid vistas of this state from above 3,000 feet. Mountains to the sea, South Carolina has a wide diversity of habitats, environmentally important areas and scenic resources within the boundaries of its 19.9 million acres of land and water (USDA 2000). It is the diversity of the lands and waters of South Carolina that create the myriad environments for South Carolina's varied fish and wildlife.

Demographics and Economics

In 1790, South Carolina's total resident population numbered 249,073 people. According to data collected in 2003, the US Census Bureau estimated the population of South Carolina to be 4,147,152 people, a 3.4 percent increase from 2000. South Carolina saw a 15.1 percent population increase from 1990 to 2000. The average population density in this state is 133.2 people per square mile (US Census Bureau 2005).

Of the over 19 million acres of land in the state, seven percent (over 1.3 million acres) is publicly owned, while 93 percent (17,912,789 acres) is privately owned. The vast majority of the state is characterized as nonfederal rural lands ('nonfederal' referring to all lands in private, municipal, state or tribal ownership). Land use on nonfederal lands in the state, which total 18,115,500 acres, is primarily forestland. South Carolina saw a twenty percent increase in developed lands between 1992 and 1997 (USDA 2000) and continues to see similar rates of conversion in land use.

As of 2002, there were approximately 4.85 million acres in agricultural production in South Carolina (USDA 2003). In 1982 there were approximately 5.5 million acres in agricultural production which amounts to a 12 percent drop in twenty years. The average farm in South Carolina was approximately 197 acres in size in 2002; up two percent from an average of 193 acres in 1997 (USDA 2003). The market value of agricultural products sold in 2003 totaled over \$1.6 billion with top outputs in poultry, tobacco and greenhouse/nursery production. Counties in South Carolina with the highest agricultural yields in 2002 were Lexington, Kershaw, York, Dillon and Orangeburg (USDA 2003).

South Carolina is rich in non-fuel raw minerals with a total of over \$506 million produced in 1997 (US Department of the Interior 1998). The most common minerals produced in South Carolina are: cement, clays, gemstones, peat, sand, gravel and crushed stone. In 1997, South Carolina was the top producer of vermiculite, ranked fourth in masonry cement, sixth in common clays, third in kaolin, and fifth in crude mica. Portland cement and crushed stone was estimated at \$193 and \$155 million respectively for 1997.

According to results of the US Forest Service Forest Inventory Analysis (FIA) published in 2000, 12.3 million acres of land in South Carolina is forested (Conner and Sheffield 2000).

(Figure 3-1). Nonindustrial private owners, including individual and corporate timberland owners not associated with the forest product industry, own 74 percent of these lands. Timberland ownership under corporate control has increased in recent years to 19 percent or 2.0 million acres. The percentage of forests managed by the forest products industry has decreased 14 percent, from 2.3 million to 2.0 million acres over the FIA study period. Public land ownership increased to 1.2 million acres. Total softwood production increased 14 percent to 9.2 billion cubic feet while hardwood production increase just over 4 percent to 10.2 billion cubic feet.

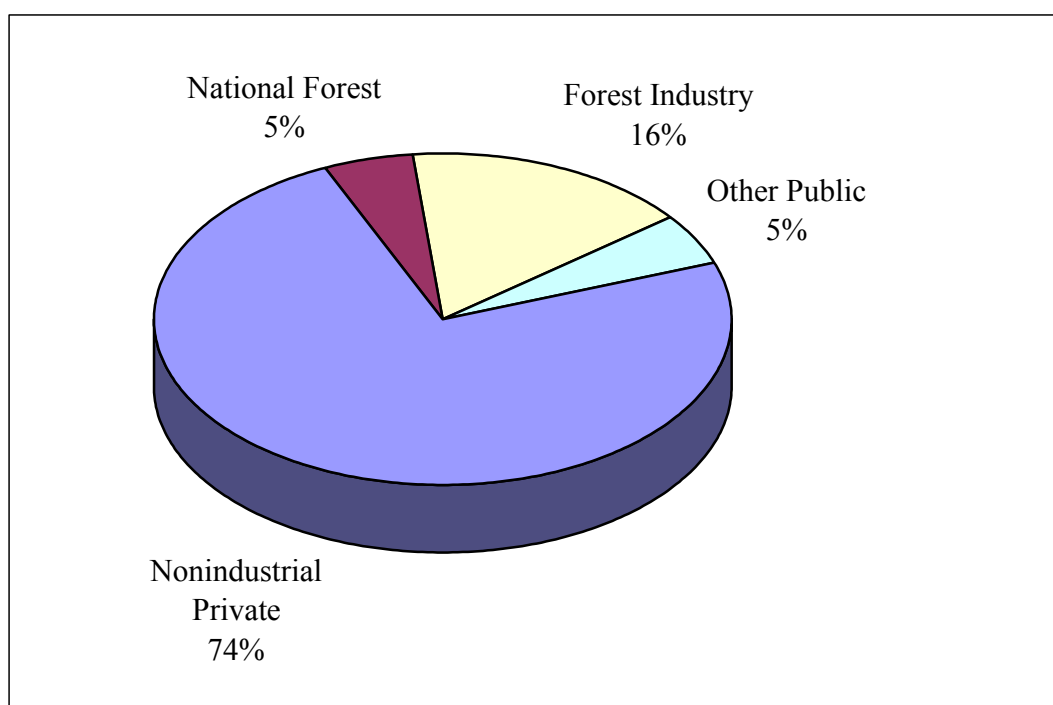


FIGURE 3-1: Distribution of forested land by ownership class in South Carolina (Conner and Sheffield 2000)

Climate

South Carolina has a humid subtropical climate. Average annual precipitation is about 49 inches per year with the coast receiving 48 to 50 inches while the Blue Ridge receives up to 80 inches per year. Average January temperatures range from 50 degrees near the coast to 38 degrees in the mountains; July temperatures average 81 near the coast and 71 in the mountains. The growing season ranges from 200 to 290 growing days. During the winter months, the state is typically under a continental air mass that is cold and dry, while during summer, the Bermuda high-pressure cell in the Atlantic drives much of the weather. Heat and humidity prevail when clockwise circulation around the Bermuda High brings a southerly flow of air from the Gulf of Mexico, a pattern that becomes rather stable as the mountains in the northwestern part of the state block any cool fronts which might arrive from the north.

The precipitation that falls in South Carolina is drained by four major river systems. All the streams and rivers that drain a region are collectively called a drainage basin. The drainage basins of South Carolina and the rivers involved are presented in Box 3-1.

BOX 3-1: MAJOR DRAINAGES OF SOUTH CAROLINA

- *Pee Dee River Basin* - Pee Dee, Lynches, Little Pee Dee, Black, Waccamaw and Sampit Rivers; drains 25 percent of South Carolina at the rate of 10.5 billion gallons per day.
- *Santee River Basin* - Santee, Congaree, Catawba-Wateree, Broad and Saluda Rivers; drains 34 percent of South Carolina at the rate of 7.5 billion gallons per day.
- *Ashley-Combahee-Edisto River Basin* - Ashley, Cooper, Edisto, Combahee, Coosawhatchie and New River; drains 26 percent of South Carolina at the rate of 5 billion gallons per day.
- *Savannah River Basin* - Savannah, Chattooga, Seneca, Little River, Stevens Creek, Rocky and Tugaloo Rivers; drains 15 percent of South Carolina at the rate of 8 billion gallons per day.

Introduction to South Carolina's Ecoregions

Many habitat types in South Carolina are strongly associated with certain geographic areas or physiographic regions within the state. Habitats in this strategy have been grouped according to five widely recognized regions, called "ecoregions" (Figure 3-1). The primary source of information on the ecoregions of South Carolina and surrounding states is the map and accompanying definitions from Griffith et al. (2002), with supplementary information for South Carolina taken from Myers et al. (1986). This chapter provides a summary of the general landscape and current condition of the five ecoregions of South Carolina. Further detailed descriptions of habitats, both terrestrial and aquatic, are provided in a separate volume, Supplement: Species and Habitat Accounts.

Habitat Classification

The principal source of information for terrestrial habitat definitions is Nelson's (1986) classification of South Carolina's natural communities. Since the viewpoint of Nelson's classification is primarily vegetation rather than wildlife, some exceptions are made. For instance, early successional upland habitat (grassland, shrubland, etc.) is extremely important to many species of wildlife. However, as a successional stage, it is not typically treated as a separate type of habitat as it is in the CWCS.

In addition, Nelson's treatment covers only terrestrial habitats, whereas many of the species covered in this plan occupy freshwater, estuarine or marine habitats. Techniques used to classify terrestrial habitats are often inadequate to describe aquatic or marine environments especially for habitats within the water column. For this strategy iteration, South Carolina habitats are divided into terrestrial, freshwater aquatic, and marine treatments. Terrestrial habitats include those found in the Blue Ridge, piedmont, sandhills and coastal plain ecoregions. Freshwater aquatics are classified by individual drainage basins and sub-basins, called ecobasins (see Table 3-1). Finally, all habitats influenced to any degree by saltwater are treated separately within marine descriptions.

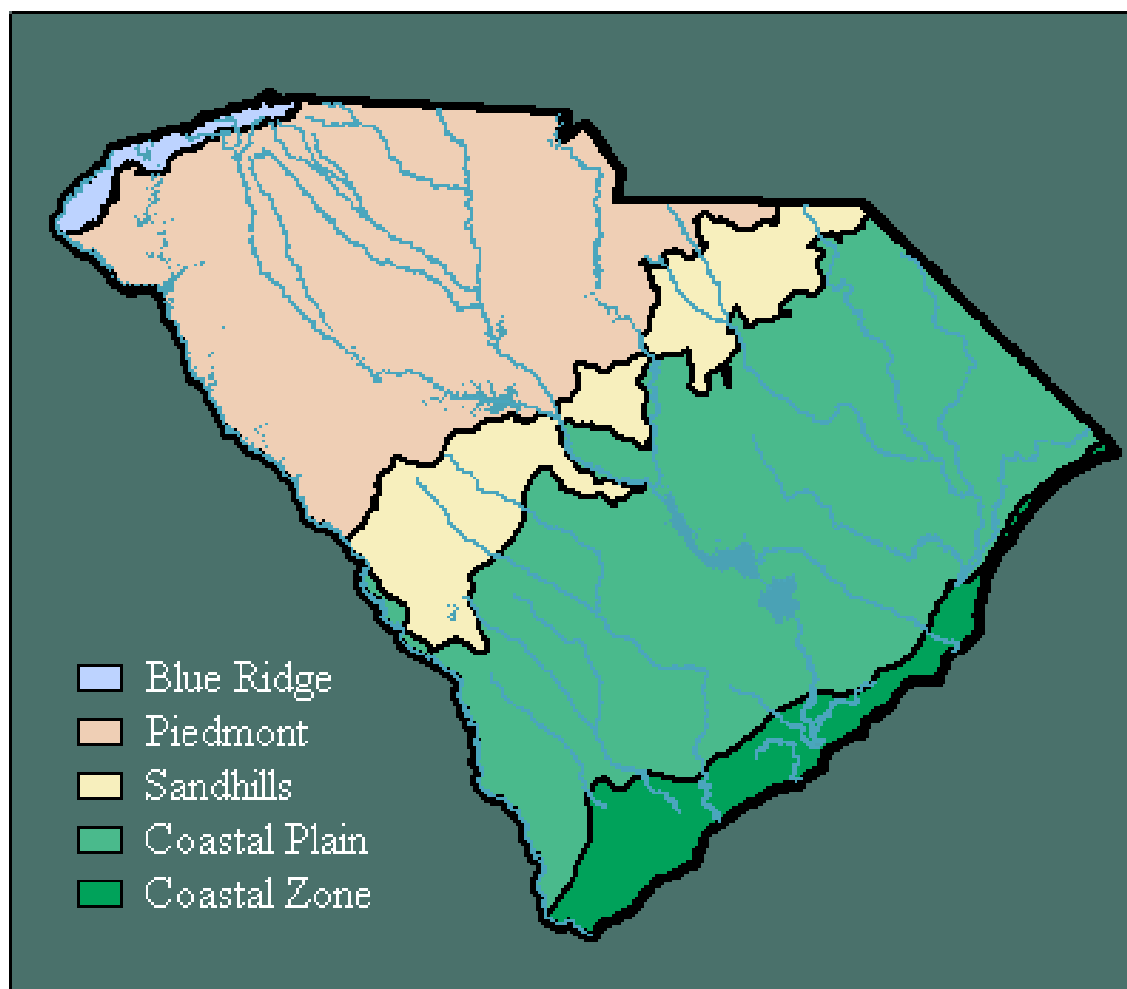


FIGURE 3-2: The five ecoregions of South Carolina. Source: Griffith et al. (2002). The Coastal Plain-Coastal Zone boundary is modified to conform to the legal delineation of the boundary between freshwater and saltwater zones for fisheries management purposes.

TABLE 3-1: Freshwater Aquatic Ecobasins by watersheds

Blue Ridge Watershed	Santee – Blue Ridge Ecobasin Savannah – Blue Ridge Ecobasin
Piedmont Watershed	Santee – Piedmont Ecobasin Savannah – Piedmont Ecobasin PeeDee – Piedmont Ecobasin
Southeastern Plains Watershed	Santee – Southeastern Plains Ecobasin Savannah – Southeastern Plains Ecobasin PeeDee – Southeastern Plains Ecobasin ACE – Southeastern Plains Ecobasin
Coastal Plain Watershed	Santee – Coastal Plain Ecobasin Savannah – Coastal Plain Ecobasin PeeDee – Coastal Plain Ecobasin ACE – Coastal Plain Ecobasin

Location Maps and Data

Ideally, information on the location and relative condition of the state's habitats would be available in the form of maps for all relevant habitats. Despite ongoing work by South Carolina's Gap Analysis Project to provide such a map from satellite-based vegetation data, the results available to date are not sufficiently accurate to provide the required information (Schmidt et al. 2001). Therefore, the descriptions of the locations and relative locations of habitats are mainly in narrative form, supported by maps and aerial photos of local areas where they are available and useful. These descriptions are included in the Supplemental Volume: Species and Habitat Accounts. An early implementation objective for the CWCS will be to make substantial improvements in the state's habitat mapping capabilities.

Blue Ridge Ecoregion

South Carolina's mountains are part of a multi-state region within the Southern Appalachians known as the Southern Blue Ridge Escarpment. The Escarpment forms an abrupt transition between higher mountains in adjoining states and the piedmont. High-gradient streams fed by high annual rainfalls carve the mountain landscape (Griffith et al. 2002). A portion of the region's northern boundary in South Carolina is formed by the Eastern Continental Divide, which provides resource managers with the rare opportunity of working with ecological and jurisdictional boundaries.

Beginning in the mid-twentieth century, a round of land consolidations began, which shifted ownership toward public and quasi-public purposes. In 1963, the Jocassee Gorges property was purchased by the Duke Power Company for hydropower development, a transfer that set the stage for the property's ultimate acquisition by the SCDNR in 1998. Other significant transfers in modern times include: Sumter National Forest, Pickens and Oconee Counties, Poinsett and Table Rock Reservoirs, Greenville County, Table Rock, Jones Gap and Caesars Head State Parks, and several acquisitions by the SCDNR. Comparison of public versus private ownership in the Blue Ridge is illustrated in Figure 3-3.

Although the Blue Ridge in South Carolina constitutes a small portion of the state's land area (328,500 acres or 1.69 percent of the total area), it supports the most extensive upland hardwood forest complex in the state. The region is rich in floral diversity, best expressed in the Mixed Mesophytic Forest vegetation community (Braun 1950), described as moist broadleaved forests that can harbor over 30 different tree species and many more types of fungi and ferns. Other biological resources unique to the region include a viable black bear (*Ursus americanus*) population extending across the North Carolina, Georgia and South Carolina state lines, sustained nesting of peregrine falcons (*Falco peregrinus*) following

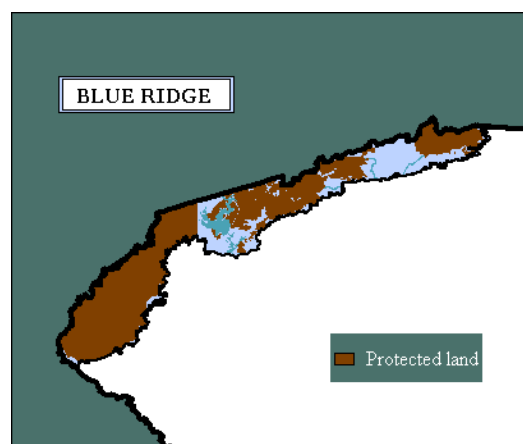


FIGURE 3-3. Major public and private lands in conservation status in the Blue Ridge. Management practices vary according to agency missions and goals. Inholdings are not shown

reintroduction in the 1980s and self-sustaining populations of native brook trout (*Salvelinus fontinalis*).

Overstory, understory, shrub and herbaceous plant communities of the Blue Ridge are generally related to topography, elevation, slope, soil type and other particular aspects of a site (Abella 2002). A few specialized habitat types, such as bogs or rock faces, are present due to unique geological formations. Habitat types in the region generally blend from one type to the next with the rare abrupt transition. Because of this integration of communities, very few animal species are strictly associated with any single habitat type. Species-habitat associations are presented in Appendix 7: Terrestrial Species Associations and described in more detail in the species and habitat accounts found in Supplemental Volume: Species and Habitat Accounts.

At higher elevations, the present Blue Ridge landscape consists of large tracts of unbroken forest. Overall condition of the forest trends toward mid-successional; both early- and late-successional ("old growth") stages tend to be lacking in the Blue Ridge. Major biological changes to forest community composition within historic times include removal of the American chestnut (*Castanea dentata*) as the dominant canopy tree species, removal of the Eastern cougar (*Felis concolor*) as the top predator and extinction of the Carolina parakeet (*Conuropsis carolinensis*).

Forest condition and age on public lands varies with ownership. Although the Sumter National Forest is managed under a multiple-use approach, recent legal challenges have significantly altered forestry operations. Current plant community composition on the National Forest is primarily a mixture of mid-successional pine-hardwood stands and managed pine-dominated stands of various ages. The SCDNR-owned Jocassee Gorges tract was heavily logged before acquisition by the SCDNR and US Forest Service was completed in 1998. Greenville Watershed and SC PRT lands have a long history of passive management.

Fire management practices also occur variably across the region, ranging from regular use of prescribed fire on the Sumter National Forest to total fire exclusion on Greenville Watershed and SC PRT lands. Current burning practices are contradictory to historic descriptions of widespread wildfires that created relatively open forest stands with sparse woody understory vegetation (Brose et al. 2001).

Habitats at lower elevations in the Blue Ridge are ecologically similar to those of the adjoining Piedmont Ecoregion. Settlement and land use patterns at these elevations are also similar to those of the piedmont; most land is in private ownership and, as such, land uses have become highly fragmented with agriculture, managed woodlands and residential uses separating tracts of natural forests. Further, many historic farming communities are undergoing rapid development as land values are increase rapidly. Amenities such as Highway 11, a scenic highway running along the base of the escarpment, SC PRT properties and Lakes Keowee and Jocassee contribute to the Blue Ridge region's popularity for recreation and development.

TABLE 3-2: Summary and brief description of habitat types found in the Blue Ridge Ecoregion

Habitat Type	General Description and Location
Appalachian Oak & Oak-Pine Forest.	Important to wildlife as the most extensive cover type in the region; vegetation composition and structure highly variable.
High-elevation Forest.	Limited in SC to the highest peaks; supports numerous species at their Southern range limits.
Moist or wet types due to unique landform	Wet places embedded within primary habitat types such as spray zones at the bases of waterfalls, waterslides, and bogs.
Vertical or Horizontal Rock Outcrop	Open rock faces ranging from nearly horizontal to nearly vertical, embedded within primary habitat types.
Riverbanks, Stream-banks, and Alder Zones	Restricted to scattered locations on relatively stable alluvium, generally along larger, lower-gradient streams; supports several riparian wildlife species.
Basic Mesic Forest	Well-developed hardwood forest on rich sites; limited in extent; important habitat for certain priority species. Equivalent to the Mixed Mesophytic Forest of Braun (1950).
Acidic Mesic Forest	Dominated by hemlock and rhododendron; common along streams and lower slopes; key habitat for wildlife species associated with riparian habitats.

Piedmont Ecoregion

The Piedmont Ecoregion occupies a hundred-mile-wide area between the Southern Blue Ridge Escarpment and the Sandhills Ecoregion. The northwestern boundary is generally considered to be the base of the Blue Ridge Escarpment; the division between the crystalline rocks of the piedmont and the sedimentary rocks of the sandhills represents the southeastern boundary of this ecoregion. The piedmont-sandhill contact zone is marked in many river channels by shoals and rock ledges that collectively form the “fall line.” Gently rolling hills with many stream-cut valleys characterize the region with only a few level floodplains. In the lower piedmont, there are relatively few sharp breaks in topography except along major river valleys.

A considerably smaller portion of forestland is in public ownership in the piedmont than in the Blue Ridge region. The U.S. Forest Service is the primary agent of land protection in the piedmont, with two large Ranger Districts of the Sumter National Forest, the Long Cane and the Enoree, located within the region. Most of the land in the piedmont is held by corporate or other private ownerships not associated with the forest product industry (Conner and Sheffield 2000).

To a greater degree than in other regions, the vegetation in the piedmont has been altered by human activity. Cotton agriculture changed much of the original hardwood and shortleaf pine (*Pinus echinata*) forests into fields. Subsequently, fields eroded due to poor agricultural practices, often losing all topsoil. By the 1930's, various factors including the Great Depression and boll weevil outbreaks as well as severe erosion led to widespread farmland abandonment. Although agricultural practices improved while farming declined during the 20th century, floodplain sediments persist, overlying former piedmont wetlands. These wetlands probably featured numerous depressions of swamp tupelo (*Nyssa biflora*) and Willow oak (*Quercus*

phellos) that served as natural 'green-tree reservoirs' for ducks and other wildlife (Ron Ahle, SCDNR, pers. comm.). Loblolly pine (*Pinus taeda*) was introduced to the piedmont during the nineteenth century as a cash lumber crop; this pine now dominates much of the region.

TABLE 3-3: Summary and brief description of habitat types found in the Piedmont Ecoregion

Habitat Type	General Description & Location
Upland Forest	Oak & hickory-dominated forest with dominant & associated tree species varying with position on slope and soil moisture. This is the primary potential vegetation type on the Piedmont. On a majority of sites it exists mostly in closed canopy pine-dominated stages that are not suitable habitat for many priority species.
Piedmont Small Stream Forest River Bottoms.(See Coastal Plain)	Hardwood-dominated forest occurring on narrow floodplains, includes elements of Coastal Plain River bottoms, although not as well developed as on the broader floodplains of the Coastal Plain. Included within the type are ponds immediately upland or within the floodplain that have some connectivity with the floodplain forest.
Cove Forest	Well-developed hardwood forests on scattered rich, generally small (<200 acre) sites, usually on protected bluffs in association with stream or river bottoms; important habitat for some priority species, notably amphibians.
Grassland & early Successional habitats (See Coastal Plain)	A variety of open-land habitats, including agricultural land, recently abandoned farmland, recently cleared land, and a matrix of managed open pine forest and grassland. Also included are golf courses and urban yards and open spaces. Generally occurs on upland sites, and the potential vegetation on most sites is Upland Forest.

Sandhills Ecoregion

The Sandhills Ecoregion is the inland portion of the coastal plain that borders the fall line. This ecoregion is frequently recognized as a physiographic province distinct from the coastal plain, although some researchers incorporate the sandhills within a broader area known as the "inner coastal plain." The sandhills form a discontinuous belt of varying width of deep sands across the middle of the state (Porcher and Rayner 2001).

Pliocene and Pleistocene sands deposited up to ten million years ago by strong southwest prevailing winds form the top layer of the sandhills (Murray 1995). These sands are a very pure and high quality source of silica; they are mined throughout the sandhills, especially in Lexington County (Murray 1995). These deep sands have created a xeric environment that supports a distinctive type of vegetation dominated by longleaf pines (*Pinus palustris*) and turkey oaks (*Quercus cerris*). This fire-adapted community burns with a frequency interval of 5 to 10 years and may be one of the oldest communities of this type in the southeast (Wharton 1978).

Major brownwater rivers that cut their way through the sandhills on their way from the mountains and piedmont to the sea include the Lynches, Wateree, Congaree and Savannah Rivers. The North and South Forks of the Edisto River are the only major rivers that originate in the sandhills.

Deep sand ridges ranging from 300 to over 600 feet above mean sea level are one of the most striking and dominant features of the Sandhills. Ridge tops of pure Lakeland and Kershaw Sands, some up to 30 feet deep (Wharton 1978), support the most extreme xeric scrub communities of longleaf pine and turkey oaks. The sandy soils on the ridges, excessively drained with low available water capacity, are low in fertility due to rapid leaching and possess little to no leaf litter (Lawrence 1976). The drier sand ridges are suitable for agriculture only when managed through fertilization and irrigation. These ridges can support timber production, particularly of longleaf pine, which is well adapted to deep, dry sandy soils.

Fire is a dominant factor in the ecology of this region. Sandhills pine forests are a fire climax community; as such, these forests are dependent on frequent ground fires to reduce hardwood competition and to perpetuate pines and grasses.

Sand ridges that have more clay and silt mixed with sand support subxeric sandhill scrub vegetation and mesic pine flatwoods. Increased plant diversity is a result of the more moderate growing conditions. Due to the increase in leaf litter, fire is an important factor in the maintenance of the subxeric scrub forest and woodlands. These subxeric to mesic communities can grade into oak-hickory forests or, in the absence of fire, they may succeed to oak-hickory forests.

Rainwater rapidly percolates through the sand ridges until it reaches hardpan, at which point it moves laterally until emerging at the surface on side slopes or near the base of sand ridges. These natural seepage areas result in distinctive wetland habitats embedded within the xeric forests and woodlands. The community type that develops is determined by the amount of water, the position on the slope and, especially, by fire. In the absence of fire, this wetland habitat can be forested with longleaf or pond pines (*Pinus serotina*) growing over a dense evergreen pocosin-like shrub layer or, with frequent fire, it can be an open hillside herb bog. Seepage accumulating at the base of the sand ridges results in a saturated zone that supports a streamside pocosin forest.

Compared to the adjoining Piedmont and Upper Coastal Plain Ecoregions, upland forest cover in the sandhills is relatively unbroken. However, numerous cycles of pine removals and exclusion of fire have left a vast, rather monotonous forest cover on much of the landscape, consisting of small longleaf pines, turkey oak and other oaks such as scrub oak (*Quercus berberidifolia*). Forests in this condition are not only unsuitable habitat for the priority species considered in this Strategy, the prevalence of forest in this condition is a primary source of concern for priority species.

Considerable effort is being made by the forestry community to encourage production of saw timber-size longleaf pines and more liberal application of fire. Encouraged by successful efforts to restore the red-cockaded woodpecker (RCW) (*Picoides borealis*) populations on public lands and extensive enrollment of private lands in the RCW Safe Harbor program, landowner interest in longleaf pine-wiregrass forest restoration seems to be increasing. Longleaf pine seedlings and technical guidance for establishing longleaf stands are also increasingly becoming more available.

Significant public land holdings in the sandhills include the US Army base Fort Jackson and the Army National Guard Leesburg Training Site; the Sandhills National Wildlife Refuge; Sandhills State Forest; major portions of the Savannah River Site; and Hitchcock Woods (operated by a private foundation). Although the impetus for conservation-oriented management on many of these facilities stems from the listing status of the RCW, the intended future condition of many forested tracts on these lands is a longleaf pine wiregrass community, with a significant portion of longleaf pine stands attaining older age classes.

TABLE 3-4: Summary and brief description of habitat types found in the Sandhills Ecoregion

Habitat Type	General Description & Location
Grassland and early successional habitats (See Coastal Plain)	Grasslands or early successional fields, with cover provided by grasses and/or weeds and with few, if any, trees. Also managed open areas such as meadows, pastures, golf courses, or expansive lawns with or without damp depressions.
Sandhills Pine Woodland	A complex of xeric pine and pine-hardwood forest types adapted to sandy soils. Principally in the Sandhills but also on fluvial sand ridges in the Coastal Plain. Absent frequent fire, a canopy of longleaf pine and a sub canopy of turkey oak prevails, interspersed with scrub oak species and scrub-shrub cover. Frequent burning leads to development of longleaf pine-wiregrass communities. On lower slopes sufficiently protected from fire, succession can proceed to oak-hickory forests similar to those of the Piedmont
Seepage Slopes	Steep slopes with a hard clay pan or fragipan below the sandy soil. Water percolating downhill is forced to the surface, which results in seasonally or permanently saturated soils. Vegetation is variable, depending on position on the slope, the amount of peat accumulation and fire history. Pond pine shrubland is representative, intergrading with fire-maintained hillside herb bogs on wetter seeps
Ponds and Depressions (See Coastal Plain)	A variety of permanently and semi-permanently flooded isolated freshwater wetlands, with open or closed canopy forest cover, including Depression Meadows, Pond Cypress Ponds, Swamp Tupelo Ponds, Pocosins, and Pond Pine Woodlands. Landforms include natural and artificial ponds dominated by cypress and/or swamp tupelo, and Carolina Bays.
Blackwater Stream Systems	Hardwood forests of narrow floodplains on tributary streams rising in the sandhills and coastal plain, supporting variants of bottomland hardwood and cypress-tupelo swamps. Headwaters and wet flats immediately above the floodplain can support dense, pocosin-like shrub thickets, or under suitable fire conditions, pure stands of Atlantic white cedar.
River Bottoms (See Coastal Plain)	Hardwood-dominated woodlands with moist soils that are usually associated with the floodplains of major rivers that dissect sandhills strata and form a floodplain on underlying sediments extending into the Coastal Plain. As in the coastal plain, characteristic trees include sweetgum, loblolly pine, water oak, willow oak, laurel oak, cherrybark oak, and American holly. The Cypress-tupelo swamp subtype occurs on lower elevation sites as seasonally flooded swamps. It is usually transected by tannic-acid rivers and creeks and contain oxbow lakes and pools. Dominant trees are bald cypress and water tupelo swamp gum, water elm and red maple .

Coastal Plain Ecoregion

The coastal plain is the largest ecoregion in South Carolina. Land elevation in this ecoregion begins at 270 to 300 feet at the inland boundary with the sandhills and reaches nearly to sea level at the coastal zone boundary. Although the Sandhills Ecoregion shares some of the geological history and physical features and is included in some definitions of the coastal plain, wildlife habitats in the two regions differ in some important respects. Therefore, the coastal plain and sandhills are treated as separate regions in the CWCS.

From a land use standpoint, the coastal plain consists of two significantly different landscapes. An inner belt is predominantly composed of cropland, with forest limited to small patches and hardwood “stringers” along creeks. An outer belt, sometimes called the “flatwoods” is primarily pine-dominated forest. Bisecting both belts are major floodplains, which are largely forested.

Eight major habitat types are defined for the coastal plain, of which six are either unique to the region or reach their greatest extent there. The predominant habitat types that most casual observers associate with the coastal plain are 1) grassland and early successional habitats, 2) pine woodland, and 3) river bottoms. Although the remaining types are less extensive, they provide habitat diversity that is important to a number of species, especially wetland species.

Grasslands or early successional fields include those with cover provided by grasses and/or weeds and with few, if any, trees. These sites also include managed open areas such as meadows, pastures, golf courses, or expansive lawns with or without damp depressions. These fields occur throughout the region; more extensively in the inner “agriculture belt.” Pine woodlands include all pine-dominated forests throughout the ecoregion. They include tracts that occupy a variety of soil moisture characteristics except floodplains. The canopy is dominated by one or several species of pine, generally loblolly (*Pinus taeda*), or longleaf (*Pinus palustris*), depending on elevation, soil type and silvicultural history. Dense shrub thickets of hollies (*Ilex* spp.) and wax myrtle (*Morella cerifera*) may be found throughout stands. Finally the river bottoms of the coastal plain include a variety of hardwood and hardwood-pine communities occupying the floodplains of small streams and infrequently flooded flats in association with streams or rivers. These flats are often characterized by the presence of American beech (*Fagus grandifolia*) and occur in scattered locations on sheltered sites with moist soils, particularly on north-facing river bluffs and on slopes of drains and creeks.

The coastal plain has been predominantly used for agricultural purposes since settlement by Europeans in the 18th century. Uplands and the better-drained terraces were cleared for fields at the same time that extensive longleaf pine and swamp hardwood forests on mesic and wet sites were cleared to supply timber, generally for export to the north. Several cycles of short-rotation pine forest were favored, along with agricultural practices that often provided substantial edge habitat for game species such as quail, but also deep woods or swamp habitat for deer, turkey, and waterfowl. By the late 20th century, economic conditions began to favor consolidation of land into larger holdings and the practice of clean field agriculture, along with shorter rotations of both upland and lowland timber. Extensive holdings in the flatwoods belt were also assembled as recreational hunting reserves and managed primarily for production of game species, with timber production to offset management expenses.

TABLE 3-5: Summary and brief description of habitat types found in the Coastal Plain Ecoregion

Habitat Type	General Description & Location
Grassland and early successional habitats	Grasslands or early successional fields, with cover provided by grasses and/or weeds and with few, if any, trees. Also managed open areas such as meadows, pastures, golf courses, or expansive lawns with or without damp depressions. Occurs throughout the region; more extensively in the inner “agriculture belt.”
Pine Woodland	Includes all pine-dominated forests throughout the region, including those occupying a variety of soil moisture characteristics except floodplains. The canopy is dominated by one or several species of pine, generally loblolly (<i>Pinus taeda</i>), or longleaf (<i>Pinus palustris</i>), depending on elevation, soil type and silvicultural history. Dense shrub thickets of hollies (<i>Ilex</i> spp.) and wax myrtle (<i>Morella cerifera</i>) may be. Higher elevation Pine Woodlands have abundant grasses and herbs, particularly when burning is frequent.
Sandhill Pine Woodland (See Sandhills)	A complex of xeric pine and pine-hardwood forest types adapted to sandy soils. Occurs principally in the Sandhills but also on fluvial sand ridges in the Coastal Plain. Absent frequent fire, a canopy of longleaf pine and a subcanopy of turkey oak prevails, interspersed with scrub oak species and scrub-shrub cover. Frequent burning leads to development of longleaf pine-wiregrass communities.
Upland Forest (See Piedmont)	Forests dominated by hardwoods, primarily with oaks and hickories, and typically on fire-suppressed upland slopes near river floodplains or between rivers and tributaries. Vegetation composition is similar to oak-hickory forest in the Piedmont, where it is a major vegetation type. Upland forest is rare in the Coastal Plain. It Intergrades with River Slopes and is lumped with this type for species treatments (see below). Representative canopy trees are: white oak (<i>Quercus alba</i>), black oak (<i>Quercus velutina</i>), post oak (<i>Quercus stellata</i>), mockernut hickory (<i>Carya tomentosa</i>), pignut hickory (<i>Carya glabra</i>), loblolly pine (<i>Pinus taeda</i>), flowering dogwood (<i>Cornus florida</i>) and black gum (<i>Nyssa sylvatica</i>).
Ponds and Depressions	A variety of permanently and semi-permanently flooded isolated freshwater wetlands, with open or closed canopy forest cover, including Depression Meadows, Pond Cypress Ponds, Swamp Tupelo Ponds, Pocosins, Limestone Sinks and Pond Pine Woodlands. Landforms include natural and artificial ponds dominated by cypress and/or swamp tupelo, limestone sinks, and Carolina Bays. Occur extensively throughout the region, more extensively in the outer “Atlantic Coast Flatwoods” belt.
River Bottoms	Hardwood-dominated woodlands with moist soils that are usually associated with major river floodplains and creeks. May contain small creeks or pools and may be seasonally flooded. Characteristic trees include: sweetgum (<i>Liquidambar styraciflua</i>), loblolly pine (<i>Pinus taeda</i>), water oak (<i>Quercus nigra</i>), willow oak (<i>Quercus phellos</i>), laurel oak (<i>Quercus laurifolia</i>), cherrybark oak (<i>Quercus pagoda</i>) and American holly (<i>Ilex opaca</i>). In the Southern coastal counties on drier sites, spruce pine (<i>Pinus glabra</i>) may be an associate. The Cypress-tupelo swamp subtype occurs on lower elevation sites as seasonally flooded swamps. It is usually transected by tannic-acid rivers and creeks and contains oxbow lakes and pools. Dominant trees are bald cypress (<i>Taxodium distichum</i>) and water tupelo (<i>Nyssa aquatica</i>), swamp gum (<i>Nyssa biflora</i>), Carolina ash (<i>Fraxinus caroliniana</i>), water elm (<i>Planera aquatica</i>) and red maple (<i>Acer rubrum</i>).

Habitat Type	General Description & Location
River Slopes and Stream Bottoms	A variety of hardwood and hardwood-pine communities occupying the floodplains of small streams and infrequently flooded flats in association with streams or rivers. Several mixed mesophytic subtype characterized by the presence of American beech occur in scattered locations on sheltered sites with moist soils, particularly on north-facing river bluffs and on slopes of drains and creeks. The calcareous cliff and marl forest subtype occurs on circumneutral soils derived from limestone or unconsolidated calcareous substrates such as marl.

Coastal Zone and Marine Ecoregion

The coastal zone is that portion of the lower coastal plain that lies seaward of US Highway 17. This region includes a small portion of the mainland, but is primarily comprised of tidal marshlands and associated uplands that include large sea islands that are greater in size than 1,000 acres (404.69 hectares) and extends eastward to include barrier islands, Atlantic Ocean beaches and the Atlantic Ocean shallow continental shelf offshore to South Carolina's 4.8-kilometer (3-mile) jurisdictional boundary. The lower approximately 32 to 48 kilometers (20 to 30 miles) of all of the State's coastal rivers is included in the coastal zone.

The inland boundary of the coastal zone is somewhat arbitrary relative to mainland habitats, but is particularly relevant to riverine and alluvial habitats since Section 50-5-80 of the Code of Laws of South Carolina establishes boundaries for fresh and 'marine' waters that generally are associated with US Highway 17. These boundaries were established primarily for wildlife law enforcement concerns related to the enforcement of freshwater and marine fishery laws and regulations. The actual point at which riverine waters change from fresh (less than 0.5 parts per thousand salt) to brackish or 'marine' (greater than 0.5 parts per thousand salt) is highly variable, even daily, depending on the combined impacts of tides and river discharge as determined by rainfall or water releases from dams. During each approximately six-hour tide cycle from maximum ebb or low tide to maximum flood or high tide, the point of change from fresh to slightly brackish water may move several miles upriver, only to return downriver during the next ebb tide period.

The coastal zone contains the most diverse myriad of habitats of any of the ecoregions of the state and is treated somewhat separately from the other ecoregions because of this complexity. Many habitats within the region that are very important to wildlife species are completely dependent upon the influence of salt water and direct management action, such as coastal impoundments. In some cases it was inappropriate to classify the habitats solely based on vegetation. Further detail on habitats within the ecoregion are included in the Supplemental Volume: Species and Habitat Accounts.

Diverse forest types are distributed throughout the extreme eastern portion of the lower coastal plain mainland that is adjacent to estuaries and tidal river basins. Due to this proximity, large coastal zone islands, including barrier islands, sea islands and many hammock islands, also support forested habitats very similar to those found in the lower coastal plain. Forested habitats distributed within both the coastal zone and coastal plain include the following: bottomland hardwood, pine woodland, oak-hickory or hardwood dominated, mixed mesic hardwood and bald cypress-tupelo gum swamp. Larger landmasses within the coastal zone also contain

grassland and early successional habitats and wet flatwood. Ponds and depressions, or wetlands isolated from tidal waterways, occur in the coastal zone as well, including interdune ponds that are restricted to dune systems along the Atlantic Ocean beaches.

Much of the South Carolina coastal zone ecoregion has been affected by human population growth and associated development. By the early 1990's, about 50 percent of the total United States' human population lived in coastal areas (Moore et al. 1995); the trend of concentrated growth along coasts is expected to continue into the next century (Cullitan et al. 1990). About 88 miles (48.6 percent) of South Carolina's beachfront is currently developed (Kana 1988). The high concentration of human population growth and development in the coastal zone has fragmented forests and reduced other valuable habitats, such as shrub thickets and isolated wetlands.

TABLE 3-6: Summary and brief description of habitat types found in the Marine and Coastal Zone Ecoregion

Habitat Type	Habitat Definition
Forested Habitats of the Coastal Plain	Typical Coastal Plain pine and hardwood forests that extend into the Coastal Zone, sometimes with variations due to coastal influences or land management practices peculiar to the Coasts: Included Pine Woodland, Bottomland Hardwoods, Upland Oak-hickory forest, Southern Mixed Hardwood Forest, Marl Forest and Calcareous Cliff, and Cypress-tupelo swamp types. Cypress-tupelo swamps within the Coastal Zone may be influenced more by tidal activity than by river flows, but the water is typically fresh or nearly so. Cypress-Tupelo swamps may also be isolated from rivers and may be remnants of relict ricefield reserves.
Maritime Forest	Forests of the immediate Coastal Zone and typically occurring on barrier islands and immediately inland of dune systems and the Atlantic Ocean coast. Characteristic trees include live oak, laurel oak, cabbage palmetto, southern magnolia and southern red cedar. These evergreen-dominated forests are salt-tolerant and often support shrub thickets with yaupon holly, red bay and wax myrtle.
Early successional habitats of the Coastal Plain	Typical Coastal Plain upland grasslands or early successional fields extending into the Coastal Zone, with cover provided by grasses and/or weeds and with few, if any, trees. Also Meadows, pastures, golf courses, or expansive lawns with or without damp depressions.
Ponds & Depressions	Isolated wetlands including both natural and manmade ponds, pools, ditches and depressions. Some pools, called vernal pools, hold water only temporarily or seasonally vernal pools. Depression pools may occur in low areas or depressions. Interdune ponds are associated with Atlantic Coast beach dune systems. This is a highly variable habitat group in both water quality and vegetation. Such isolated wetlands may be imbedded within forest or other upland habitats.
Managed Impoundments	Impounded marshlands that are generally relict ricefields. Most of such impoundments are managed for waterfowl. Water quality, seasonality of water coverage and vegetation type are dependent upon management activity. Relict impoundments with breached or eroded, nonfunctional dikes are considered tidal marshlands.
Tidal Fresh and Brackish Systems	A complex of marshlands, sandbars, mud flats, sand flats, and waterways that are subject to mixing of salt and freshwater flows, usually in association with a freshwater source such as a river delta. Marsh vegetation is predominantly grasses, sedges and herbs with few trees; species makeup depends on salinity. Submerged vegetation may occur as well.

Habitat Type	Habitat Definition
Estuarine systems	A complex of marshlands, exposed flats of sand and/or mud, and tidal creeks that make up the coast's estuarine zone. Smooth cordgrass (<i>Spartina alterniflora</i>) is the dominant marsh plant, with black needlerush (<i>Juncus roemerianus</i>) and various shrub species occupying zones of slightly higher elevation and lower salinity. Salt flats vegetated with various salt-tolerant plant species are interspersed throughout the marsh. Oyster Bars or reefs composed primarily of live and dead eastern oysters occur throughout, usually in flats between tidal channels and salt marsh.
Isolated nonforested uplands	Generally small islands of mostly sand and isolated within sounds and bays or inlets. 'Inlet islands' usually have beaches and variably developed dune systems. 'Bay islands' are more protected from salt spray and wave action and may support salt-shrub plants. Can include manmade or man-altered islands with dikes to contain dredged material. Can also include sandbars and shell rakes that are at least partially exposed during all tide cycles and river stages, except under unusually high tides or flows. More stable sandbars may be partly colonized by grasses and shrubs.
Hammock Island	Vegetated islands within tidal marshlands that are <1000 acres in size. These islands, and particularly larger islands of higher elevation and variable topography, often support diverse habitat types, including isolated low-salinity wetlands.
Ocean beaches and transition zones	That portion of the Atlantic Ocean beach dune system vegetated by grasses and herbs or by a maritime shrub thicket. Dune habitat includes sand dunes and swales, flats and pools between dunes and between dunes and other features. Characteristic plants include sea oats, bitter panicgrass, seabeach evening primrose and dune waterpennywort. Seaward of the dune system, sandy flats may occur in areas where dunes have been eroded. These areas are influenced by windblown salt spray and sand and may be occasionally flooded, particularly during storms.
Marine Ecosystem	Habitats directly influenced by Atlantic Ocean seawater, including the intertidal beach, the surf zone, and the waters, sediments and structures of the Atlantic continental shelf extending offshore to the 3-mile State territorial limit. The surf zone, or submerged portion of the beach area is heavily influenced by turbulence from wave action. Seaward of the surf zone, the shallow shelf is composed of soft bottom, live (hard) bottom and pelagic (water column) habitats.
Man-made structures	Submerged structures including piles, jetties and artificial reefs. In estuarine and fresh and brackish systems, a broad variety of manmade items may occur in submerged or intertidal areas and/or extend above the water

CHAPTER 4: STATEWIDE CONSERVATION STRATEGIES

Having identified 1,240 priority species within South Carolina and, using currently available data, the current condition (including the condition of “unknown”) of these species and their habitats, as well as the challenges to those species and habitats, the focus now moves to conservation strategies to address those challenges. As conservation strategies were developed for each species, it became evident that they could be separated into eight categories, which we have designated as Conservation Action Areas (CAAs). These CAAs are presented in Box 4-1.

Because major challenges to species and habitats are similar across taxonomic groups and habitats, conservation strategies to address those challenges are also similar. In order to simplify the strategies South Carolina will employ to address threats, recommended species and habitat strategies are consolidated in this chapter by CAA. The specific conservation actions proposed for each species are presented in a separate volume, Supplemental Volume: Species and Habitat Accounts.

BOX 4-1: EIGHT CONSERVATION ACTION AREAS

- Education and Outreach
- Habitat Protection
- Invasive and Non-native Species
- Private Land Cooperation
- Public Land Management
- Regulatory Actions
- Survey and Research Needs
- Urban and Developing Lands

Within each CAA, conservation actions were condensed from the recommendations prepared for each animal on South Carolina’s Priority Species List. Some of the actions identified will affect all species included in the CWCS; others may affect only a few species. In this chapter, the priority of each action is identified in brackets after each action. A brief discussion of conservation action prioritization is presented at the end of this chapter; a more complete discussion is presented in Chapter 7: Prioritization, Implementation and Adaptive Management.

Additionally, SCDNR recognized that there are overarching conservation strategies that are likely to assist in protecting wildlife and habitats statewide. Therefore, SCDNR determined that formation of Conservation Action Committees around each of the CAAs identified above would assist in determining these overarching strategies. Conservation Action Committees would provide an excellent opportunity to work with partners to develop comprehensive statewide strategies for South Carolina that were not tied specifically to a single species or habitat. The strong partnerships between SCDNR and other state and federal agencies, organizations, academic institutions and industries within the state demonstrate dedication to overcoming challenges inherent in implementing conservation strategies. Two Conservation Action Committees, those for Education and Outreach and Urban and Developing Lands, were convened prior to completion of the CWCS; the resulting conservation strategies are contained herein. Additional committee meetings will be held for the remaining CAAs as the CWCS is being implemented; resulting conservation strategies will be included in future revisions of the South Carolina CWCS.

Education and Outreach

Education and outreach programs positively affect conservation activities by involving the broader community in these activities. As such, education and outreach programs are critical to successful wildlife and habitat conservation. In times of budgetary crises, when funding, personnel and resources become limited, education and outreach programs are often supplanted by more imminent needs associated with species and habitat protection. However, it may be most critical during such times to ensure that education and outreach programs are functioning; such programs can produce an informed public that can assist in achieving the goals of environmental conservation.

SCDNR currently has two education sections: one is based in Columbia and is managed by the Outreach and Support Services Division (OSS); the other is based in Charleston and is managed by the Marine Resources Division (MRD). Both sections are involved with formal education programs and public outreach programs. Many other sections throughout the SCDNR conduct outreach and education efforts specific to their program areas. Box 4-2 outlines current programs that are based in SCDNR and programs for which SCDNR is a major contributor or partner.

BOX 4-2: SCDNR EDUCATION AND OUTREACH PROGRAMS

FORMAL EDUCATION PROGRAMS

- **Animal Program:** This program is designed to introduce students K-12 to the DNR and how the DNR protects and conserves our state natural resources. This program involves the use of live animals, mounts and “hands on” learning.
- **Aquatic Project WILD:** An interdisciplinary environmental and conservation education program of instructional workshops and supplementary curriculum materials for K-12 teachers emphasizing aquatic wildlife and ecosystems.
- **Boater Education Program:** This program teaches basic boating safety including proper safety equipment, navigation rules, boat trailering and preventive routine boat maintenance.
- **Becoming an Outdoors Woman:** This program exposes women over 18 years old to nature related outdoor activities such as hunting, fishing, bird watching, camping and more.
- **Camp Wildwood:** A week-long camp designed for high school students to increase their knowledge and experience with natural resources management.
- **Carolina Coastal Adventure:** A weekend workshop for high school students to study the coastal environment.
- **Coastal Discovery Cruise Program:** Cruise the coastal habitats on SCDNR’s educational vessel, *Discovery* and learn about immediate areas of concern within the coastal and inland regions of South Carolina, such as water quality, endangered species, and threatened habitats. Groups have the opportunity to discuss the biology of estuarine animals and plants with hands-on learning when the trawl drags in an array of marine species.
- **Earth Science Education Program:** Promotes the understanding of South Carolina’s geology, mineral resources and the principles of Earth Science.

BOX 4-2: SCDNR EDUCATION AND OUTREACH PROGRAMS (CONTINUED)**FORMAL EDUCATION PROGRAMS (CONTINUED)**

- **ENVIROTHON:** A hands-on learning experience in the form of a team competition to stimulate high school students and provide incentive to learn about their role in nature.
- **Graduate Student Guidance and Training:** This program provides logistical and staff support to state colleges and universities for graduate and undergraduate training of marine science students.
- **Hunter Education Program:** This program provides instruction in hunter safety and techniques. Students also learn about hunting ethics, hunter/landowner relations and basic conservation and wildlife management principles.
- **Minorities in Marine and Environmental Science:** This program is a mentor-based summer program that provides college level minorities with training opportunities in marine and environmental science.
- **Project WET:** An interdisciplinary water education program of instructional workshops and supplementary curriculum materials for K-12 teachers emphasizing water related topics.
- **Project WILD:** An interdisciplinary environmental and conservation education program of instructional workshops and supplementary curriculum materials for K-12 teachers emphasizing terrestrial wildlife and ecosystems.
- **South Carolina Institute for Natural Resource Conservation:** This workshop provides hands-on studies in topics such as soils, forestry, land and water management, reclamation, wildlife, conservation leadership and career opportunities.
- **Trapper Education Program:** This program includes discussions on furbearer biology, history of the fur trade, wildlife management principles, fur harvest regulations and ethical conduct.
- **Weather and Climate Science Education:** Resources are provided to teacher through access to real-time weather and climate data, student interactions, teacher workshops and more.

OUTREACH PROGRAMS

- **4-H FACE for Wildlife Contest:** FACE (Food and Cover Establishment) for Wildlife is an annual statewide contest for youth that consists of planting and establishing food plots.
- **Audio/Visual Programs:** All programs within the SCDNR have representatives available to provide audio/visual presentations about the goals and objectives of those programs at the request of partners, educational facilities and private citizen groups.
- **Beach Sweep/River Sweep:** In partnership with the South Carolina Sea Grant Consortium, SCDNR coordinates an annual, nationwide cleanup of inland and coastal waterways.
- **Coastal Workshops:** These workshops are offered to teachers, students, lawmakers and business and community leaders to learn more about salt marsh ecology and estuarine animals.
- **Fishing Rodeos:** Youth fishing rodeos promote fishing as a positive alternative to the dangerous influences that abound in our society.
- **Jr. Duck Stamp Contest:** This contest enables students in grades K-12 to express their feelings of natural resources through their art and increases awareness of environmental concerns in an artistic manner.
- **Reel Art:** This contest enables students in grades K-12 to express their feelings of natural resources through their art and increases awareness of the aquatic environment in an artistic manner.
- **Reel Kids:** This program allows students to work toward goals like catching their first fish, learning about fish and improving their habitats.
- **Take One Make One Program:** An outdoor education and mentoring program aimed at developing South Carolina's youth and young adults into lifetime participants in conservation, hunting, angling and shooting sports activities through conservation education and adult mentoring.

BOX 4-2: SCDNR EDUCATION AND OUTREACH PROGRAMS (CONTINUED)**OUTREACH PROGRAMS (CONTINUED)**

- **Young Outdoor Writers' Competition:** This is a natural resource magazine-article writing contest for students in grades 5 through 12.
- **Youth Hunts:** These hunts allow youth to have an educational hands-on experience in hunter safety and hunting techniques and exposes youth to basic wildlife management practices and hunting ethics.

OUTREACH EVENTS

SCDNR participates in many events throughout the state that allow education and outreach about the agency's mission and its programs including the following:

Legislative Outreach Expo	Palmetto Sportsmen's Classic
Shallow Water Expo	Festival Hispano
Myrtle Beach Show	Southeastern Wildlife Exposition
Charleston Boat Show	Charleston In-Water Boat Show
Greenville Boat Show	

PUBLICATIONS

SCDNR provides many publications around all programs including the following:

Brochures	In-depth Reports
Newsletters	Books
Websites	<i>South Carolina Wildlife Magazine</i>

Although education and outreach may not directly contribute to management of resources, these programs can assist in garnering support for environmental programs. Public support can assist in ensuring the outstanding natural resources of South Carolina are conserved for future generations. In public meetings held throughout the state, SCDNR discovered that the public would genuinely like to assist in protecting natural resources, but that they were unsure what they could do to help. Additionally, the goals and mission of the SCDNR were unknown to some segments of South Carolina's population. Discovery of this information underscores the need for natural resource education and outreach programs throughout South Carolina.

Conservation Actions

- 1) Develop and enhance education and outreach programs that highlight the importance and value of the species on South Carolina's Priority Species List and their contribution to the unique natural resource diversity of this state. [Highest priority]
- 2) Develop and enhance education and outreach programs that encourage land stewardship values, particularly to private landowners in priority habitats. [Highest priority]
- 3) Develop and enhance education and outreach programs that inform the public about the importance of prescribed burning to benefit wildlife species. [Highest priority]
- 4) Ensure that accurate information about priority species and their habitats is made available, both within SCDNR and to any interested parties outside of the department. Interested parties can include state and federal agencies, academic institutions, private landowners, local municipalities, organizations and industry. [Highest priority]

- 5) Promote partnerships, both in development and implementation of education and outreach programs. [High priority]
- 6) Promote volunteer participation, both in education and outreach programs as well as in data collection. [High priority]
- 7) Develop and enhance education and outreach programs that inform the public about the detrimental impacts of litter on priority species. [Moderate priority]
- 8) Educate motor vehicle operators of the negative affects of crossing streams at multiple locations and using stream bottoms as trails. [Moderate priority]
- 9) Develop and enhance programs that educate fishermen about employing correct techniques for capture and release of marine mammals, fish and invertebrates and programs that educate fishermen about the importance of reporting ship strikes and entanglements to authorities. [Moderate priority]
- 10) Utilize a variety of methods for information dissemination including:
 - a. Printed materials
 - b. Websites
 - c. Formal education/outreach programs
 - d. Updates to existing education curricula
 - e. Demonstration sites
 - f. Landowner workshops
 - g. Media[Moderate priority]
- 11) Develop and enhance education and outreach programs that discourage stocking, release and transplanting nonnative animal and plant species throughout South Carolina. [Moderate priority]

Education and Outreach Conservation Action Committee

SCDNR recognized that there are many education/outreach programs being conducted throughout the state. Many public agencies, private organizations, educational institutions and industries provide such programs to the citizens of South Carolina. SCDNR further recognized that it would be impossible to achieve our goals without the valuable assistance offered by these entities and their programs. Therefore, partners were invited to participate in workshops to discuss natural resource education in South Carolina. Two Education and Outreach Committee workshops were held: one in Columbia and one in Charleston. Table 4-1 contains a list of participants and their affiliation.

At these meetings, partners were asked to identify major overarching education and outreach recommendations that would affect activities throughout the state of South Carolina. Both groups independently determined that in order to better insure consolidated and uniform messages are

being presented to the public, a catalogue of all natural resources programs offered in the state is badly needed. This catalogue should include contact persons for each program offered. The amount of information that this catalogue could contain is huge; further, programs are constantly being developed, contact people change routinely and information that needs to be included in individual programs constantly needs to be updated. Both groups also determined that partnerships between all natural resource education and outreach programs could be bolstered by development of South Carolina's CWCS.

TABLE 4-1: EDUCATION/OUTREACH CONSERVATION ACTION COMMITTEE ATTENDEES

Name	Affiliation
Wendy Allen	National Estuarine Research Reserve
Neil Bartley	South Carolina Department of Natural Resources
Steve Bates	South Carolina Department of Natural Resources
Dana Beach	South Carolina Coastal Conservation League
Devon Beaty	South Carolina Department of Health and Environmental Control
Melissa Bimbi	US Fish and Wildlife Service
Joy Boswell	South Carolina Department of Natural Resources
Warren Chavous	University of South Carolina - Salkehatchie
Jody Childs	University of South Carolina - Aiken
Janet Clark	South Carolina Department of Health and Environmental Control
Amy Curran	South Carolina Department of Health and Environmental Control
Larry DeLancey	South Carolina Department of Natural Resources
Caroline Foster	South Carolina Department of Natural Resources
Elaine Freeman	South Carolina State Park Service
Lex Glover	South Carolina Department of Natural Resources
Karen Hall	Clemson University
BeBe Harrison	South Carolina Department of Natural Resources
Sara Hartman	The Nature Conservancy
Will Haynie	Low Country Land Trust
Mischa Hey	The Nature Conservancy
Paula Keener-Chavis	National Oceanic and Atmospheric Administration
Susan Lovelace	National Oceanic and Atmospheric Administration
Whit McMillan	South Carolina Aquarium
Jennie Morris	South Carolina Forestry Commission
Lori Nowell	Sandhill Research Center
Michael Provost	The Nature Conservancy
Virginia Roberson	Centers for Ocean Sciences Education Excellence
Al Segars	South Carolina Department of Natural Resources
Lundie Spence	Centers for Ocean Sciences Education Excellence
Anna Toline	National Estuarine Research Reserve
Ernie Wiggers	Nemours Wildlife Foundation

As stated above, SCDNR is aware that information about our priority species is scarce and has currently not been provided to all partners throughout the state; SCDNR will strive to provide that information in the future. A suggestion was made to develop a map that would identify the locations of priority species and habitats to allow educators throughout the state to pick species and habitats for new program development. This map should be provided to all education and outreach entities in South Carolina.

Creation of a natural resource information database was also determined by the groups to be of major importance. As part of the CWCS process, SCDNR will be developing a department-wide database that will house all available data and information for the species on the priority list and their habitats. Although SCDNR cannot require all outside entities to submit data they collect on these species, all partners will be encouraged to submit data for inclusion in the SCDNR database. This database will allow anyone access to view this information. Quick and easy access to such data will enhance existing education and outreach programs throughout South Carolina.

Because there are 1,240 species on South Carolina's Priority Species List, it will be very difficult to develop separate education and outreach programs for each one. Therefore, it seems prudent to limit programs to a few "poster species" that will highlight conservation messages in each ecoregion of South Carolina. Further, existing programs should be enhanced to include priority species and their habitats into existing programs.

Education and Outreach Conservation Action Committee Recommendations

- 12) Ensure that all SCDNR employees are working to provide education and outreach information to partners and citizens of South Carolina by doing the following:
 - a. Dissemination of information to partners;
 - b. Cataloguing education and outreach programs in the state;
 - c. Updating the website catalogue annually; and
 - d. Coordination of priority species education and outreach efforts throughout the state.[Highest priority]
- 13) In consultation with SCDNR biologists, identify "poster species" that will highlight conservation messages in each ecoregion of South Carolina. Enhance existing education and outreach programs in SCDNR to include priority species and their habitats. [Highest priority]
- 14) Create a map that identifies locations of South Carolina's priority species and their habitats and distribute the map to all natural resource education and conservation entities. [High priority]
- 15) Create a database that contains available data and information for the species on our priority list and their habitats. Ensure that this database is available through the SCDNR website. [High priority]
- 16) Develop a catalogue of all natural resources education and outreach programs offered in South Carolina, including educational curricula. This catalogue will include a description of program/curricula content and contact information for the person(s) responsible for program development and implementation. The catalogue should be updated annually and made available on the SCDNR website. [Moderate priority]

Habitat Protection

Habitat protection has been identified as one of the most important actions to assist in the protection of South Carolina's priority species by SCDNR biologists, species experts and attendees at the public information meetings held throughout the state (for a thorough discussion of these meetings, see Chapter 6: Partnership Development). The importance that SCDNR places on habitat protection for the benefit of South Carolina's wildlife is evident in the many programs currently in place at the SCDNR and in the partnerships SCDNR has forged with other state and federal agencies, organizations, academic institutions and industries. A list of SCDNR habitat protection programs and partnerships is presented in Box 4-3.

BOX 4-3: SCDNR HABITAT PROTECTION PROGRAMS

- **The Heritage Trust Program:** Established to preserve those natural features and cultural remains. The purpose of the program is to inventory, evaluate and protect the elements considered the most outstanding representatives of South Carolina's heritage.
- **Forest Legacy Program:** The purpose of the program is to identify and protect environmentally important forest land from conversion to non-forest uses, through the use of conservation easements and fee purchases.
- **Focus Area Program:** The purpose of this program is to conduct landscape level conservation efforts that include private lands conservation. There are 12 habitat conservation focus area task forces in South Carolina; these are operated through the Atlantic Coast Joint Venture. Further description of the Focus Area Program is provided below in the discussion of the ACE Basin Project.
- **ACE Basin Project:** The first of SCDNR's Focus Areas, the ACE Basin Project is a unique partnership of state and federal governmental representatives, nonprofit conservation organizations, and private landowners that works to maintain the natural character of the Basin by promoting wise resource management and continuing traditional uses with improved public access. While encouraging traditional land uses such as agriculture, timber production, hunting, and fishing, the overall management goal is to maintain the area's ambiance while restricting industrial and resort development. To date, well over 316,160 ha (128,000 ac) in the Basin have been protected through conservation easements, management agreements, and fee title purchases.
- **Scenic Rivers Program:** The goal of this program is the conservation of South Carolina's river heritage through the proper management of the natural and cultural character of the state's river corridors. This program has the purpose of protecting "unique or outstanding scenic, recreational, geologic, botanical, fish, wildlife, historic or cultural values" of selected rivers or river segments in the state.
- **Forest Stewardship Program:** In partnership with the South Carolina Forestry Commission, Clemson Extension Service and the Natural Resource Conservation Service, SCDNR provides a technical service program designed to encourage multiple resource management on private non-industrial forestlands.
- **The South Carolina Conservation Bank Act:** Preserves the most significant natural and historic lands in our state by either purchasing the land outright or buying conservation easements from willing sellers. Dedicated funding is provided for the protection of wildlife habitat, parks, greenways, prime farmlands, historic sites, wildlife habitat and other biologically sensitive areas in the state. Funds come from a percentage of South Carolina's deed-recording fees, which are collected when real estate is sold in the state. A volunteer board made up of conservationists, sportsmen, scientists and business leaders from across the state will oversee the disbursement of grants to protect land. SCDNR acts as an advisor to this board.

BOX 4-3: SCDNR HABITAT PROTECTION PROGRAMS (CONTINUED)

- **National Estuarine Research Reserve System:** In partnership with the National Oceanic and Atmospheric Administration, SCDNR helps communities develop strategies to deal successfully with coastal resource issues including habitat restoration.
- **South Carolina Land Trust Network:** SCDNR is a member of this network, which facilitates the preservation of the natural and cultural character of South Carolina through the exchange of information among land trusts. The network creates awareness and seeks support of the general public to conserve natural resources of the state.
- **Beach Sweep/River Sweep:** In partnership with the South Carolina Sea Grant Consortium, SCDNR coordinates an annual, nationwide cleanup of inland and coastal waterways.

Historically, species conservation and management efforts have been employed to address single species to the exclusion of others occurring in the same habitat. However, SCDNR has recognized the importance of employing habitat or ecosystem-based conservation. By focusing on whole habitats or ecosystems, we are able to protect several species in a more cost-effective manner.

Loss and fragmentation of habitat have been identified as a major threat to many of the species included in South Carolina's Plan. There are many ways to prevent habitat loss and reduce the effects of past losses and fragmentation. One of the most expensive conservation tools is land acquisition; further land acquisition is frequently driven by land availability, not by what is required for high priority species. However, acquiring land is likely the most beneficial method of ensuring wildlife and habitat protection. Conservation easements are also extremely beneficial for habitat protection. It is imperative that SCDNR partner with other agencies and organizations to acquire and manage lands that are available for conservation.

Even if SCDNR or partners do not own lands, there are ways of protecting habitats.

Coordination of wildlife goals and strategies during land planning processes and ability of SCDNR to review development and environmental impact plans for relevance to priority species can also assist in protecting habitats. An ever-present theme throughout the Strategy, education and outreach is imperative in the protection of the state's habitats.

Conservation Actions

- 1) Acquire property for protection of priority species and to ensure habitat linkage through fee simple acquisition and conservation easements in the following habitats:

Terrestrial Habitats

- a. Appalachian Oak and Oak-Pine Forest
- b. Basic Mesic Forest
- c. Acidic Mesic Forest
- d. High-elevation Forest
- e. Riverbanks, Streambanks and Alder Zones
- f. Moist or Wet Types
- g. Vertical or Horizontal Rock Outcrop
- h. Upland Forest
- i. Piedmont Small Stream Forest

- j. River Bottoms
- k. Cove Forest
- l. Grassland and Early Successional Habitats
- m. Sandhills Pine Woodland
- n. Seepage Slopes
- o. Ponds and Depressions
- p. Blackwater Stream Systems
- q. Pine woodland
- r. Upland Forest
- s. Wet Flatlands
- t. River Slopes and Stream Bottoms

Watersheds

- a. Santee River Watershed
- b. Savannah River Watershed
- c. Pee Dee River Watershed
- d. ACE Basin Watershed

Coastal and Marine Habitats

- a. Forested Habitats of the Coastal Plain
- b. Maritime Forest
- c. Early Successional Habitats of the Coastal Plain
- d. Managed Impoundments
- e. Tidal Fresh and Brackish Systems
- f. Isolated Nonforested Uplands
- g. Estuarine Systems
- h. Hammock Islands
- i. Ocean Beaches and Transition Zones
- j. Marine Ecosystem
- k. Man-made Structures

[Highest priority]

- 2) Continue to partner with private entities and other state and federal agencies to acquire land for habitat protection. Develop additional partnerships for land acquisition.

[Highest priority]

- 3) Restore and enhance impaired habitat, where feasible and cost-effective. Habitat enhancements include:

- a. Encourage nest/roost site retention/restoration
- b. Employ prescribed burning
- c. Restore natural stream courses and flows
- d. Eliminate or reduce invasive and non-native species from habitats
- e. Replant native plants
- f. Wetland restoration

[Highest priority]

- 4) Promote the importance of habitat protection and participation in conservation easement programs through education and outreach programs. [Highest priority]

- 5) Partner with other state and federal agencies, to promote habitat protection and provide technical support to private landowners. [Highest priority]
- 6) Develop and implement protective Best Management Practices (BMPs) for habitats and land uses throughout South Carolina. [Highest priority]
- 7) Participate in development and review of environmental plans (including FERC relicensing projects) to ensure appropriate habitat protection. [Highest priority]
- 8) Mitigate habitat threats that are caused by human practices such as entanglement in fishing gear, by-catch, boat strikes, dredging, chemical exposure, tower strikes, powerline strikes, nest disturbance, boat wakes, artificial light sources, and dewatering of streams. [Highest priority]
- 9) Encourage city, county and state planning entities to consider habitat protection in all development projects. [Highest priority]
- 10) Where possible, manage wildlife species and promote habitat protection on an ecoregions-wide and/or watershed-wide scale. [High priority]
- 11) Continue to partner with private entities, private landowners and other state and federal agencies to protect riparian areas from degradation. [High priority]
- 12) Continue SCDNR participation in Emergency Response training programs to ensure that SCDNR has the most current information on planning logistics and technology for dealing with coastal oil and hazardous material releases, as well as the most effective program to deal with the aftermath. [Moderate priority]

Invasive and Non-Native Species

There are an estimated 50,000 non-native species in the U.S., and the number is steadily increasing. Many of these represent serious threats to agriculture, horticulture or forestry. Other non-native species are more likely to impact natural communities and individual populations of native wildlife species. Approximately 42 percent of the species listed as endangered or threatened under the federal Endangered Species Act are significantly impacted by invasive exotic species. On a national basis, the economic losses and environmental damage caused by exotic species total approximately \$120 billion per year (Pimentel et al. 2005). A recent survey of managers of 430 national wildlife refuges indicated that 80 percent of the refuges recognized problems with invasive exotic organisms. Refuge managers reported more than 790 invasive organisms, including 507 nonnative plants, 208 nonnative animals and 76 plant and animal diseases (Simonson et al. 2004).

Invasive and non-native species constitute a significant threat to South Carolina's biological diversity. Many native species are declining due to increasing competition or habitat degradation from invasive and non-native species. A list of those known to be located in South Carolina is

presented in Box 4-4. Feral hogs, feral cats, blue catfish, flathead catfish, red crayfish and fire ants are examples of animals that can cause serious impacts to natural communities and native species. Additionally, invasive and non-native plants such as beach vitex, hydrilla, water hyacinth, and Chinese privet pose threats to South Carolina's species and habitats. Non-native disease organisms have also been shown to impact wildlife species.

Invasive and non-native species that do not directly harm wildlife species can harm animals indirectly by reducing or eliminating food sources for those species. For example, gypsy moths can eliminate mast for birds and mammals. An exotic forest pest in the Blue Ridge Ecoregion of South Carolina, the hemlock wooly adelgid, is causing decline of hemlock populations; loss of streamside hemlocks can result in water temperature increases.

BOX 4-4: INVASIVE AND NON-NATIVE SPECIES KNOWN TO THREATEN SOUTH CAROLINA'S NATIVE WILDLIFE

ANIMALS

Feral Hogs
Feral Cats
Feral Dogs
Blue Catfish
Flathead Catfish
Grass Carp
Aquarium Fish
Ornamental Pond Fish
Red Crayfish
Asian Clams
Zebra Mussel
Rapana Whelk
Green Mussel
Fire Ants
Hemlock Wooly Adelgid
Gypsy Moth

DISEASES

Avian Vacuolar Myelinopathy (AVM)
West Nile Virus
Sudden Oak Death
Raccoon Roundworm
Fish, Shellfish and Shrimp Diseases

AQUATIC PLANTS

Hydrilla
Water Hyacinth
Water Lettuce
Giant Salvinia
Common Reed
Alligatorweed
Brazilian Elodea
Water Primrose

TERRESTRIAL PLANTS

Beach Vitex
Chinese Tallow Tree
Russian Olive
Thorny Olive
Autumn Olive
Japanese Privet
Chinese Privet
Multiflora Rose
Japanese Honeysuckle
Kudzu
Chinese Wisteria
Asian Wisteria
Japanese Stilt Grass
Wart Removing Herb

Impacts from invasive non-native species have been documented in South Carolina; control measures have been implemented to address these impacts. SCDNR is currently working to control aquatic invasive plant species in lakes and rivers throughout the state. Further, SCDNR has partnered with other organizations to investigate ways to reduce invasive and non-native species in South Carolina.

Conservation Actions

- 1) Prevent the spread of existing invasive and non-native species, eliminating them, where possible. [Highest priority]
- 2) Determine the impacts of invasive and non-native species on South Carolina's priority species and habitats used by those species. [Moderate priority]

- 3) Strive to prevent the import of additional invasive and non-native species to South Carolina. [Moderate priority]
- 4) Develop and conduct an education and outreach campaign to raise awareness of the impacts of introducing non-native species into South Carolina. [Moderate priority]
- 5) Develop partnerships with other entities in South Carolina to address impacts associated with invasive and non-native species. [Moderate priority]

Private Land Cooperation

Currently, 93 percent of the land in South Carolina is under private ownership. As such, SCDNR has little authority over habitat conservation and wildlife management on those lands. It is important that SCDNR enlist the cooperation of private landowners to protect priority species and their habitats. Encouragingly, many citizens in South Carolina recognize the importance of natural resources and the value of these resources to our quality of life. A number of programs are currently available to landowners through SCDNR as well as other state and federal agencies and public and private entities. A list of the private land programs provided by SCDNR, both independently and with partners is presented in Box 4-5.

BOX 4-5: SCDNR PRIVATE LAND PROGRAMS

- **Wildlife Program:** SCDNR Wildlife Biologists conduct site visits and formal consultations with landowners and assist with management plan preparation and technical guidance for all species.
- **Forest Stewardship Program:** In partnership with the South Carolina Forestry Commission, Clemson Extension Service and the Natural Resource Conservation Service, SCDNR provides a technical service program. SCDNR Wildlife Biologists conduct site visits and assist with management plan preparation and technical guidance for the wildlife component of forest management plans.
- **Conservation District Program:** SCDNR personnel provide technical assistance and cost-share for farmland improvements, including water quality and erosion management and wildlife habitat improvement.
- **Red-cockaded Woodpecker Safe Harbor Program:** Allows for formal enrollment of qualifying private lands in a management program to enhance red-cockaded woodpecker populations.
- **Farm Bill Technical Support Program:** As an official member of the NRCS State Technical Committee, SCDNR participates in policy development and Farm Bill program priority setting. Additionally, SCDNR Wildlife Biologists provide technical guidance on Farm Bill program plans.
- **Landowner Incentive Program:** SCDNR directs federal cost share funds to qualifying lands for management practices benefiting red-cockaded woodpeckers and other “species at risk.”
- **US Fish and Wildlife Service Partners for Fish and Wildlife Program:** SCDNR works with this program on various habitat restoration projects on private lands (example: Partners for Trout in South Carolina’s upstate).
- **Focus Area Program:** The purpose of this program is to conduct landscape level conservation efforts that include private lands conservation. There are 12 habitat conservation focus area task forces in South Carolina; these are operated through the Atlantic Coast Joint Venture (example: ACE Basin Project).

Despite the number of programs available in South Carolina, the changing urban landscape mandates that other programs are likely necessary. Further, many private landowners are not aware of the current programs available to them.

Conservation Actions

- 1) Develop or expand partnerships with other entities to provide landowner assistance programs that focus on conservation of priority species and their habitats. [Highest priority]
- 2) Conduct outreach efforts to private landowners to:
 - a. Explain the ecological importance of protecting natural resources on private lands and the benefits of protecting those resources to all citizens of South Carolina.
 - b. Encourage voluntary participation in natural resource conservation activities.
 - c. Encourage natural resource stewardship by utilizing Best Management Practices (BMPs) on private lands.
 - d. Explain the mission of the SCDNR and the programs conducted by the department.[High priority]
- 3) Develop or modify landowner education and outreach programs to include information about South Carolina's priority species and habitats. [High priority]

Public Land Management

Only seven percent of the land in South Carolina is in public ownership by federal, state and local governmental agencies. Much of that land is not directly managed by the SCDNR; however, these lands provide critical protection for the state's priority species and their habitats. Agencies who manage ecologically important public lands in South Carolina, including SCDNR, SC Forestry Commission, SC Parks, Recreation and Tourism, US Fish and Wildlife Service, National Park Service and the US Forest Service are mandated to conserve native wildlife species and their habitats. Additionally, other public agencies, such as the US Department of Defense, US Department of Energy and some city and county park facilities manage ecologically important lands for protection of wildlife and their habitats.

The SCDNR has an excellent working relationship with other public land managers throughout the state. However, the conservation goals of these separate agencies may differ slightly, resulting in different conservation strategies and efforts. In order to provide the most efficient management of our priority species and their habitats, it is important to continue and enhance partnerships between SCDNR and other agencies.

Conservation Actions

- 1) Provide key information about management requirements for priority species and habitats in South Carolina to partners responsible for public land management. [Highest priority]
- 2) Continue to work with partners to manage and protect priority species and their habitats in South Carolina through other agency's funding programs. [Highest priority]

- 3) Ensure that priority species and their habitats on SCDNR lands are managed in accordance with the conservation actions provided in the CWCS. [Highest priority]

Regulatory Actions

Within South Carolina, there are several state and federal entities with regulatory authority governing certain aspects of wildlife and habitat conservation. State and federal regulations in South Carolina govern conservation of rare, threatened and endangered species; protection of natural areas and specific natural habitats; take of game and nongame wildlife species; water and air quality; review and permitting of mining, dam construction, surface water discharge and groundwater withdrawal; dock and pier construction and other project developments.

As SCDNR biologists and other experts prepared species accounts, they identified areas where existing laws and regulations may need to be changed in order to protect priority species and habitats. They also identified areas for which no laws or regulatory authority exists to protect these species.

Conservation Actions

- 1) Enhance SCDNR Law Enforcement capability to address priority wildlife species law enforcement needs. [Highest priority]
- 2) Develop Fisheries Management Plans for marine species that are not currently targeted in commercial or recreational fisheries and for species that are targeted, but for which no plan currently exists. [Highest priority]
- 3) Investigate the need to amend existing SCDNR regulations and/or develop additional SCDNR regulations to address conservation status of South Carolina's priority species. [High priority]
- 4) Investigate the need to amend existing SCDNR regulations and/or develop additional SCDNR regulations to address the effects of collecting and/or harvesting South Carolina's priority species. [Moderate priority]

Survey and Research Needs

When preparation of South Carolina's CWCS was initiated, it quickly became apparent that SCDNR and other entities in South Carolina are lacking data for many of the priority species and their habitats. Historically, research and survey activities have focused on managed species, federally or state listed species, and activities funded by grants and private funds. In order to adequately manage for priority species in South Carolina, it is imperative that baseline research be conducted for these species.

Within this CWCS, Chapter 5: South Carolina Comprehensive Monitoring Program will specifically address survey and research needs as they apply to the priority species. The

conservation actions here are presented to illustrate the type of information that needs to be gathered.

Conservation Actions

- 1) Conduct surveys to determine the presence and extent of priority species populations and their habitat. [Highest priority]
- 2) Monitor the condition of priority species populations and their habitat, once discovered. [Highest priority]
- 3) Determine the impacts of contaminants (including thermal discharges) on South Carolina's priority species. [Highest priority]
- 4) Conduct research to identify the habitat requirements for South Carolina's priority species and determine whether existing habitats meet those requirements. [High priority]
- 5) Determine genetic relationships of new species and those species with questionable taxonomic designations. [Moderate priority]
- 6) Determine the effects of plant and animal invasive and nonnative species (including diseases) on South Carolina's priority species and their habitats. [Moderate priority]
- 7) Determine the effects of hunting/fishing on South Carolina's priority species. [Moderate priority]

Urban and Developing Lands

Since the 1950s, the United States had experienced a mass migration to the suburbs. Fueled by the proliferation of the automobile, residential and commercial growth has expanded into the far reaches of what once were pristine wetlands, uplands and forestlands. Many have determined that nationally land consumption has outpaced population growth two to one.

Anthony Downs of the Brookings Institute defines sprawl as "a specific form of suburbanization that involves extremely low-density settlement at the far edges of the settled area, spread out far into previously undeveloped land." Sprawl development began to take place in the last half of the 20th Century. However, when it arrived to South Carolina, it proceeded quickly. Land conversion in the state ranked ninth in the nation between 1992 and 1997, with over 539,700 acres converted for development. During this time period, South Carolina population increase was 5.3 percent while the percent of developed land was 30.2 for almost a six-fold increase. This dramatic growth has occurred primarily on the outskirts of the state's larger metropolitan areas, as well as Charlotte, North Carolina and in the coastal/tourism centers of Hilton Head Island, Charleston and Myrtle Beach. Much of this growth has come in the form of sprawl development. The impact of sprawl on wildlife has not been measured.

As previously natural lands are converted to urban lands, wildlife and habitat are undoubtedly affected. Obviously, habitat is lost or fragmented in this process. However, the impacts of development on South Carolina's priority species and their habitats can be mitigated, if efforts are made to do so. Effective planning is imperative in protecting natural resources during development.

Conservation Actions

- 1) Encourage responsible land use planning throughout South Carolina that ensures protection of natural resources. [Highest priority]
- 2) Collaborate with city and county municipalities and communities to reduce the impacts of development through the following:
 - a. Implementation of Best Management Practices
 - b. Planned development communities
 - c. Low impact development[Highest priority]
- 3) Participate in the environmental review process for development projects throughout South Carolina. [High priority]
- 4) Collaborate with partners to establish appropriate recommendations for riparian buffer widths to assist in protection of coastal and inland water quality. [High priority]
- 5) Collaborate with the South Carolina Department of Transportation (SCDOT) to protect priority species and their habitats during and after road construction. [High priority]
- 6) Partner with other state and federal agencies, conservation organizations, industries and permitting agencies to deter development in important breeding, feeding and roosting/nesting sites that are important to South Carolina's priority species. [Moderate priority]
- 7) Discourage development in habitats for South Carolina's priority species. [Moderate priority]

Urban and Developed Lands Conservation Action Committee

In April 2005, the Urban and Developed Lands Conservation Action Committee met to discuss priority species, their habitats and the overarching actions that could affect urban and developing lands in South Carolina. Table 4-2 contains a list of all attendees and their affiliation.

**TABLE 4-2: URBAN AND DEVELOPED LANDS CONSERVATION ACTION COMMITTEE
ATTENDEES**

Name	Affiliation
John Cone	Home Builders Association of South Carolina
Mike Dawson	River Alliance
Paul Gettys	Katawba Valley Land Trust
John Hicks	Mayor, Town of Blythewood, South Carolina
Carolyn Jebailey	Sierra Club & Wildlife Action
Bill Molnar	Clemson University
Brad Wyche	Upstate Forever

The group identified five areas for conservation action opportunities. These areas are presented in Box 4-6.

BOX 4-4: FIVE AREAS FOR CONSERVATION ACTION OPPORTUNITIES

- Protection of habitat through acquisition and easements.
- Habitat (corridor and buffer) research and public education.
- Strengthen comprehensive planning through research, enforcement and public education. Coordinate the development process between the developer and local level stakeholders in a one-stop-shop manner.
- Promote better storm water management regulations and techniques on impervious surfaces. Develop constructive wetlands education and incentives.
- Develop a higher-level coordination and training program for all levels of government and professionals, appointed and elected officials.

The group then developed strategies that would address the five identified areas for conservation action in the urban/wildlife interface.

Urban and Developed Lands Action Committee Recommendations

- 8) Develop wildlife/development win-win situations and disseminate information to local governments and the development community. [Highest priority]
- 9) Assist local governments in drafting meaningful comprehensive plans, as they relate to the Natural Resources section of local comprehensive plans. [Highest priority]
- 10) Act as a repository for best management practices relating to natural resources. [Highest priority]
- 11) Encourage SCDNR staff to provide wildlife/habitat educational information to communities. Inform elected and appointed officials about environmental issues relating

to local development and wildlife/habitat issues and disseminate information on the following:

- a. Support the creation of local habitat protection capabilities.
- b. Work with local land trusts on the location of priority habitats.
- c. Promote and educate about transfer of development rights.
- d. Collaborate with local governments to develop best management practices for storm water run-off: education, incentives, and awards.

[Highest priority]

12) Provide wildlife/habitat research and demonstration projects. These could include:

- a. A buffer demonstration project that provides a win-win for both developers and the environment.
- b. Research projects on the impact of buffers and corridors on wildlife and habitat.
- c. A storm water demonstration project.

[Moderate priority]

Prioritized Conservation Actions and Measures of Success

As discussed at the beginning of this chapter, all the conservation actions presented herein were prioritized; a complete discussion of this process is presented in Chapter 7: Prioritization, Implementation and Adaptive Management. In very general terms, conservation action priorities were determined based on six criteria presented in Box 4-5.

BOX 4-5: SIX CRITERIA USED FOR DETERMINATION OF PRIORITY CONSERVATION ACTIONS

- **Feasibility:** Challenges can be mitigated, solutions are apparent. SCDNR can feasibly staff and implement the action and the results will be beneficial.
- **Opportunity:** SCDNR is able to implement the conservation action (i.e., opportunities exist; SCDNR has the authority to carry out the action).
- **Benefit:** Implementation of the action will result in benefits to the natural diversity of South Carolina. Benefits are considered in terms of unit of effort to achieve those benefits; that is, implementation results in multiple benefits to a given species or multiple species are benefited by a single action.
- **Proactive:** Implementation will result in proactive changes to address challenges; actions are more than a reactive response to ongoing challenges.
- **Partnerships:** Partnership opportunities exist for implementation, which provides the ability to leverage other resources.
- **Funding:** Implementation is eligible for SWG funding and/or matching funds exist.

Additionally, measures of success were developed for each of the conservation actions presented in South Carolina's CWCS. Conservation actions, a list of the highest priority species that area affected by implementation of the action, whether the action is proposed or ongoing (or both), the priority of the action and the measures of success that will be used to rate implementation of that action are all included in Table 4-3: Prioritized Conservation Actions and Measures of Success.

TABLE 4-3: Prioritized Conservation Actions and Measures of Success

Conservation Action Area	Conservation Action	Species/Habitat Affected¹	Ongoing/Proposed	Priority	Measures of Success
Education/ Outreach	Develop and enhance education and outreach programs that highlight the importance and value of the species on South Carolina's Priority Species List and their contribution to the unique natural resource diversity of this state.	All Species	Ongoing	Highest	# of web-products developed/updated; # of media/outreach products developed/updated; # of reports/publications developed/distributed; # of audiences reached; # of participants/volunteers reached; # of programs given
	Develop and enhance education and outreach programs that encourage land stewardship values, particularly to private landowners in priority habitats.	All Species and Habitats	Ongoing	Highest	# of web-products developed/updated; # of media/outreach products developed/updated; # of reports/publications developed/distributed; # of audiences reached; # of participants/volunteers reached; # of programs given
	Develop and enhance education and outreach programs that inform the public about the importance of prescribed burning to benefit wildlife species.	American Kestrel, Northern Bobwhite, Red-cockaded woodpecker, Bachman's Sparrow, Brown-headed Nuthatch, Henslow's Sparrow, Gopher Tortoise, Pine Barrens Treefrog	Ongoing and Proposed	Highest	# of web-products developed/updated; # of media/outreach products developed/updated; # of reports/publications developed/distributed; # of audiences reached; # of participants/volunteers reached; # of programs given

¹ In consideration of space, not all species affected by the conservation action are listed. Selected highest priority species affected by each action will be presented in this table. The species and habitat accounts presented in their entirety in **Supplemental Volume: Species and Habitat Accounts** includes actions for all species in South Carolina's CWCS.

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Education/ Outreach (Continued)	Ensure that accurate information about priority species and their habitats is made available, both within SCDNR and to any interested parties outside of the department. Interested parties can include state and federal agencies, academic institutions, private landowners, local municipalities, organizations and industry.	All Species and Habitats	Ongoing	Highest	# of web-products developed/updated; # of media/outreach products developed/updated; # of reports/publications developed/distributed; # of audiences reached; # of participants/volunteers reached; # of programs given
	Promote partnerships, both in development and implementation of education and outreach programs.	All Species and Habitats	Ongoing	High	# of partnerships created/supported; # of programs/products produced by partners; Feedback from partnerships
	Promote volunteer participation, both in education and outreach programs as well as in data collection.	Florida Manatee, Northern Bobwhite, Painted Bunting, American Kestrel, Loggerhead Shrike, Wood Thrush, Coral Snake, Loggerhead Turtle, Southern Hognose Snake	Ongoing	High	# of new volunteers; # of in-kind support hours; # of citizen supported programs
	Develop and enhance education and outreach programs that inform the public about the detrimental impacts of litter on priority species.	Leatherback Turtle, Little Blue Heron, Snowy Egret, White Ibis, Glossy Ibis, Tricolored Heron, Yellow-crowned Night Heron	Ongoing	Moderate	# of web-products developed/updated; # of media/outreach products developed/updated; # of reports/publications developed/distributed; # of audiences reached; # of participants/volunteers reached; # of programs given

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Education/ Outreach (Continued)	Educate motor vehicle operators of the negative affects of crossing streams at multiple locations and using stream bottoms as trails.	American Shad, Atlantic Sturgeon, Shortnose Sturgeon, American Eel, Blueback Herring, Hickory Shad, All Freshwater Fish, Mussels and Snails	Proposed	Moderate	# of web-products developed/updated; # of media/outreach products developed/updated; # of reports/publications developed/distributed; # of audiences reached; # of participants/volunteers reached; # of programs given
	Develop and enhance programs that educate fishermen about employing correct techniques for capture and release of marine mammals, fish and invertebrates and programs that educate fishermen about the importance of reporting ship strikes and entanglements to authorities.	Florida Manatee, Atlantic Sturgeon, Shortnose Sturgeon, Humpback Whale, Right Whale, Freshwater and Marine Fish and Invertebrates	Proposed	Moderate	# of web-products developed/updated; # of media/outreach products developed/updated; # of reports/publications developed/distributed; # of audiences reached; # of participants/volunteers reached; # of programs given
	Utilize a variety of methods for information dissemination including: printer materials, websites, formal education/outreach programs, updates to existing education curricula, demonstration sites, landowner workshops, media.	All Species and Habitats	Ongoing	Moderate	# of web-products developed/updated; # of media/outreach products developed/updated; # of reports/publications developed/distributed; # of audiences reached; # of participants/volunteers reached; # of programs given

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Education/ Outreach (Continued)	Develop and enhance education and outreach programs that discourage stocking, release and transplanting nonnative animal and plant species throughout South Carolina.	All Species and Habitats	Ongoing	Moderate	# of web-products developed/updated; # of media/outreach products developed/updated; # of reports/publications developed/distributed; # of audiences reached; # of participants/volunteers reached; # of programs given
	Ensure that all SCDNR employees are working to provide education and outreach information to partners and citizens of South Carolina.	All Species and Habitats	Ongoing	Highest	Management review of employee compliance; # of employee training seminars conducted; # of employees attending seminars
	In consultation with SCDNR biologists, identify “poster species” that will highlight conservation messages in each ecoregion of South Carolina. Enhance existing education and outreach programs in SCDNR to include priority species and their habitats.	All Species and Habitats	Ongoing and Proposed	Highest	Completed review and update of existing SCDNR education programs; selection of “poster species” by ecoregions; # of programs/media created around those species; # of audiences reached; # of participants reached; # of programs/media given
	Create a map that identifies locations of South Carolina’s priority species and their habitats and distribute the map to all natural resource education and conservation entities.	All Species and Habitats	Proposed	High	Final map created and distributed to partners, public; feedback from partners/public collected and considered

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Education/ Outreach (Continued)	Create a database that contains available data and information for the species on our priority list and their habitats. Ensure that this database is available through the SCDNR website.	All Species and Habitats	Proposed	High	Final database created and implemented; database access available on-line to partners and public; feedback from partners/public collected and considered
	Develop a catalogue of all natural resources education and outreach programs offered in South Carolina, including educational curricula. This catalogue will include a description of program/curricula content and contact information for the person(s) responsible for program development and implementation. The catalogue should be updated annually and made available on the SCDNR website.	All Species and Habitats	Proposed	Moderate	Final catalog created and distributed to partners and public; feedback from partners/public collected and considered
Habitat Protection	Acquire property for protection of priority species and to ensure habitat linkage through fee simple acquisition and conservation easements all priority habitats.	All Species and Habitats	Ongoing	Highest	# of acres acquired or protected; # of long-term cooperative habitat protection projects; # of completed site inventories; # of acquisition processes that incorporate considerations/priorities identified in the CWCS
	Continue to partner with private entities and other state and federal agencies to acquire land for habitat protection. Develop additional partnerships for land acquisition.	All Species and Habitats	Ongoing	Highest	# of acres acquired or protected; # of long-term cooperative habitat protection projects; # of completed site inventories; # of acquisition processes that incorporate considerations/priorities identified in the CWCS

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Habitat Protection (Continued)	Restore and enhance impaired habitat, where feasible and cost-effective. Habitat enhancements include encouraging nest/roost site retention/restoration; employing prescribed burning; restoring natural stream courses and flows; eliminating or reducing invasive and non-native species from habitats; replanting native plants; and wetland restoration.	Northern Yellow Bat, Black Duck, Mallard, Northern Bobwhite, Eastern Meadowlark, Red-cockaded Woodpecker, American Kestrel, Northern Pintail, Bachman's Sparrow, Brown-headed Nuthatch, Pine Barrens Treefrog, Loggerhead Turtle, Hawksbill Turtle, Kemp's Ridley Turtle, Robust Redhorse, American Eel, American Shad, Atlantic Sturgeon, Shortnose Sturgeon, Savannah Lilliput	Proposed	Highest	# of acres/sites restored; species/population response to restoration; % improvement in measures of species diversity/composition; % increase in nesting and roosting activities; ; # of acres burned; # acres/miles of stream positively affected by management; measures of habitat quality/water quality improvements; % reduction of invasive/non-native species;
	Promote the importance of habitat protection and participation in conservation easement programs through education and outreach programs.	All Species and Habitats	Ongoing	Highest	# of web-products developed/updated; # of media/outreach products developed/updated; # of reports/publications developed/distributed; # of audiences reached; # of participants/volunteers reached; # of programs given
	Partner with other state and federal agencies to promote habitat protection and provide technical support to private landowners.	All Species and Habitats	Ongoing	Highest	# of technical guidance/support interactions
	Develop and implement protective Best Management Practices (BMPs) for habitats and land uses throughout South Carolina.	Florida Manatee, American Oystercatcher, Prairie Warbler, All Freshwater, Marine and Diadramous Fish, All Freshwater and Marine Invertebrates	Proposed	Highest	# of BMPs developed; # of BMP recommendations made; % of recommendations implemented; measures of degree of compliance; quality of compliance

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Habitat Protection (Continued)	Participate in development and review of environmental plans (including FERC relicensing projects) to ensure appropriate habitat protection.	All Species and Habitats	Ongoing	Highest	# of site visits; # of comments forwarded; # of plans/permits commented on; # of partnerships developed
	Mitigate habitat threats that are caused by human practices such as entanglement in fishing gear, by-catch, boat strikes, dredging, chemical exposure, tower strikes, powerline strikes, nest disturbance, boat wakes, artificial light sources, and dewatering of streams.	Florida Manatee, Black-crowned Night Heron, Eastern Wood Peewee, Wood Thrush, Leatherback Turtle, Loggerhead Turtle, American Eel, American Shad, Atlantic Sturgeon, Shortnose Sturgeon	Ongoing and Proposed	Highest	# of species for which threats are identified and mitigated; # of threats mitigated; % increase in priority species numbers; % decrease in effects of threats on priority species
	Encourage city, county and state planning entities to consider habitat protection in all development projects.	All Species and Habitats	Proposed	Highest	# of entities participating; # of land use plans developed; # of technical guidance created; # of land owner agreements/participants in programs aimed at listed species recovery; # of data requests and exchanges; project-specific results of collaborative efforts
	Where possible, manage wildlife species and promote habitat protection on an ecoregions-wide and/or watershed-wide scale.	All Species and Habitats	Ongoing	High	Measures of degree of compliance; % ecoregions protected; % watersheds protected
	Continue to partner with private entities, private landowners and other state and federal agencies to protect riparian areas from degradation.	Florida Manatee; American Oystercatcher; Black-crowned Night Heron; Glossy Ibis; Little Blue Heron; Prairie Warbler; Bog Turtle; All Freshwater Fish, Crayfish, Mussels and Snails; All Marine Fish and Invertebrates; All Diadramous Fish	Ongoing	High	# of decision-making protocols adapting aquatic conservation priorities; # of acres of riparian habitat protected; # of acres/miles of stream/wetland positively affected; # of active partnerships; # of new partnerships developed; # of information exchanges

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Habitat Protection (Continued)	Continue SCDNR participation in Emergency Response training programs to ensure that SCDNR has the most current information on planning logistics and technology for dealing with coastal oil and hazardous material releases, as well as the most effective program to deal with the aftermath.	Florida Manatee, Black Skimmer, Eastern Brown Pelican, Lesser Scaup, Wilson's Plover, Willet, All Marine Fish, All Marine Invertebrates	Ongoing	Moderate	# of trainings attended; # of individuals trained; # of programs developed
Invasive and Non-Native Species	Prevent the spread of existing invasive and non-native species, eliminating them, where possible.	Bald Eagle, Black Duck, Eastern Meadowlark, Wood Thrush, Florida Pine Snake, Loggerhead Turtle	Ongoing and Proposed	Highest	% of invasive/non-native species populations decreased; # of areas surveyed; # of species/populations located; # of individuals removed
	Determine the impacts of invasive and non-native species on South Carolina's priority species and habitats used by those species.	Black Duck, Bald Eagle, Northern Pintail, Eastern Wood Peewee, Gopher Tortoise, Loggerhead Turtle, Atlantic Sturgeon, Shortnose Sturgeon	Ongoing and Proposed	Moderate	# of areas surveyed; # of species/populations located; identification of causal factors in population change
	Strive to prevent the import of additional invasive and non-native species to South Carolina.	All Species and Habitats	Ongoing and Proposed	Moderate	# of species protocols established; # of areas surveyed; # of species/populations located; identification of causal factors in population change
	Develop and conduct an education and outreach campaign to raise awareness of the impacts of introducing non-native species into South Carolina.	All Species and Habitats	Ongoing and Proposed	Moderate	# of web-products developed/updated; # of media/outreach products developed/updated; # of reports/publications developed/distributed; # of audiences reached; # of participants/volunteers reached; # of programs given

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Invasive and Non-Native Species (Continued)	Develop partnerships with other entities in South Carolina to address impacts associated with invasive and non-native species.	All Species and Habitats	Ongoing and Proposed	Moderate	# of partnerships developed; # of information exchanges; # of Memoranda of Agreement/Understanding developed
Private Land Programs	Develop or expand partnerships with other entities to provide landowner assistance programs that focus on conservation of priority species and their habitats.	Black Bear, Swamp Rabbit, American Kestrel, Swallow-tailed Kite, Red-cockaded Woodpecker, Henslow's Sparrow, Northern Bobwhite, Bog Turtle	Ongoing	Highest	# of partnerships developed; # of information exchanges; # of Memoranda of Agreement/Understanding developed; # of programs implemented
	Conduct outreach efforts to private landowners to: explain the ecological importance of protecting natural resources on private lands and the benefits of protecting those resources to all citizens of South Carolina; encourage voluntary participation in natural resource conservation activities; encourage natural resource stewardship by utilizing Best Management Practices (BMPs) on private lands; and explain the mission of the SCDNR and the programs conducted by the department.	All Species and Habitats	Ongoing	High	# of audiences reached; # of participants in programs; # of volunteers recruited; # of positive/negative comments from public; # of public interactions/programs offered
	Develop or modify landowner education and outreach programs to include information about South Carolina's priority species and habitats.	All Species and Habitats	Ongoing	High	# of audiences reached; # of participants in programs; # of volunteers recruited; # of positive/negative comments from public; # of public interactions/programs offered
Public Land Management	Provide key information about management requirements for priority species and habitats in South Carolina to partners responsible for public land management.	All Species and Habitats	Proposed	Highest	# of information exchanges; database completed and published on the internet; # of educational efforts; # of CWCS recommendations implemented on public lands

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Public Land Management (Continued)	Continue to work with partners to manage and protect priority species and their habitats in South Carolina through other agency's funding programs.	All Species and Habitats	Ongoing and Proposed	Highest	# of partnerships formed; amount of money spent and in-kind services conducted by partners on public lands
	Ensure that priority species and their habitats on SCDNR lands are managed in accordance with the conservation actions provided in the CWCS.	All Species and Habitats	Ongoing	Highest	# of CWCS recommendation implemented on DNR lands; # of management plans influenced by CWCS research projects
Regulatory Actions	Enhance SCDNR Law Enforcement capability to address priority wildlife species law enforcement needs.	All Species and Habitats	Ongoing	Highest	Review law enforcement capabilities conducted; # of calls/responses to priority species concerns
	Develop Fisheries Management Plans for marine species that are not currently targeted in commercial or recreational fisheries and for species that are targeted, but for which no plan currently exists.	Many Marine Fish and Invertebrates	Ongoing	Highest	# of plans developed; # of proposed recommendations implemented
	Investigate the need to amend existing SCDNR regulations and/or develop additional SCDNR regulations to address conservation status of South Carolina's priority species.	American Oystercatcher, Many Freshwater Mussels and Crayfish, Eastern Brook Trout	Ongoing	High	Adherence to schedules for rules review and updates; # of regulation change proposals; # of species protected from unregulated use or impact; # of regulation changes that enhance or protect wildlife or habitat; amount of habitat affected
	Investigate the need to amend existing SCDNR regulations and/or develop additional SCDNR regulations to address the effects of collecting and/or harvesting South Carolina's priority species.	Eastern Fox Squirrel, Eastern Spotted Skunk, Shovel-nosed Salamander, Atlantic Sturgeon, Shortnose Sturgeon	Ongoing	Moderate	Adherence to schedules for rules review and updates; # of regulation change proposals; # of species protected from unregulated use/impact; # of regulation changes that enhance or protect wildlife or habitat; amount of habitat affected

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Survey and Research Needs	Conduct surveys to determine the presence and extent of priority species populations and their habitat.	All Species and Habitats	Ongoing and Proposed	Highest	# of areas surveyed; # of new survey sites; # of species/populations located; compilation of new information on distribution and population size estimates
	Monitor the condition of priority species populations and their habitat, once discovered.	All Species and Habitats	Ongoing and Proposed	Highest	# of new monitoring sites or species protocols established; # of species for which trend information can be assessed; # of species for which population targets can be assigned; compilation of habitat trend information
	Determine the impacts of contaminants (including thermal discharges) on South Carolina's priority species.	All Species and Habitats	Ongoing and Proposed	Highest	# of areas surveyed; # of species/populations influenced located; compilation of new data collected on impacts and life history
	Conduct research to identify the habitat requirements for South Carolina's priority species and determine whether existing habitats meet those requirements.	All Species and Habitats	Ongoing and Proposed	High	# of areas surveyed; # of new survey sites; # of species/populations located; compilation of new data collected on life history requirements
	Determine genetic relationships of new species and those species with questionable taxonomic designations.	Northern Yellow Bat, Eastern Milk Snake, Atlantic Sturgeon, Carolina Pygmy Sunfish, "Broadtail" Madtom, Robust Redhorse, Highfin Carpsucker, Barrel Floater, Brother Spike,	Ongoing and Proposed	Moderate	# of species surveyed; # of genetic analyses conducted; # of taxonomic issues resolved; compilation of new data collected on genetic and taxonomic relationships

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Survey and Research Needs (Continued)	Determine the effects of plant and animal invasive and nonnative species (including diseases) on South Carolina's priority species and their habitats.	Bald Eagle, Black Duck, Eastern Wood Peewee, Mallard, Worm-eating Warbler, Northern Pintail, Loggerhead Turtle, Atlantic Sturgeon, Florida Softshell Turtle,	Ongoing and Proposed	Moderate	# of areas surveyed; # of new survey sites; # of species populations located; compilation of data collected on survival, competition, predation, response to management
	Determine the effects of hunting/fishing on South Carolina's priority species.	All Marine Fish and Invertebrates, All Diadramous Fish, Appalachian Cottontail, Swamp Rabbit, Eastern Fox Squirrel, Eastern Brook Trout	Ongoing and Proposed	Moderate	# of areas surveyed; # of new survey sites; # of species populations affected; compilation of data collected on survival, competition, predation, response to management
Urban and Developing Lands	Encourage responsible land use planning throughout South Carolina that ensures protection of natural resources.	All Species and Habitats	Ongoing and Proposed	Highest	# of cooperators; # of technical guidance interactions; # of land owner/agency contacts; % of recommendations implemented; # of instances of DNR participation in review processes
	Collaborate with city and county municipalities and communities to reduce the impacts of development through the following: implementation of Best Management Practices; planned development communities; and low impact development.	All Species and Habitats	Ongoing and Proposed	Highest	# of collaborators; # of BMPs developed; # of BMP recommendations made; % of recommendations implemented; measures of degree of compliance; quality of compliance
	Participate in the environmental review process for development projects throughout South Carolina.	All Species and Habitats	Ongoing	High	# of site visits; # of comments forwarded; # of plans/permits commented on; # of partnerships developed

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Urban and Developing Lands (Continued)	Collaborate with partners to establish appropriate recommendations for riparian buffer widths to assist in protection of coastal and inland water quality.	All Species and Habitats	Ongoing	High	# of decision-making protocols adapting aquatic conservation priorities; # of acres/miles of stream/wetland positively affected; # of active partnerships; # of new partnerships developed; # of information exchanges
	Collaborate with the South Carolina Department of Transportation (SCDOT) to protect priority species and their habitats during and after road construction.	Diamondback Terrapin, Rafinesque's Big-eared Bat, Coral Snake, Florida Pine Snake, Southern Hognose Snake, Mimic Glass Lizard, Slender Glass Lizard, Northern Pine Snake	Ongoing and Proposed	High	# of plans/permits commented on; # of site visits; # of collaborative efforts; # of project partnerships established; # of species protection measures implemented
	Partner with other state and federal agencies, conservation organizations, industries and permitting agencies to deter development in important breeding, feeding and roosting/nesting sites that are important to South Carolina's priority species.	All Species and Habitats	Ongoing and Proposed	Moderate	# of partnerships developed; # of information exchanges; # of sites protected; # of roosts/sites surveyed; project-specific results of collaborative efforts
	Discourage development in habitats for South Carolina's priority species.	All Species and Habitats	Ongoing and Proposed	Moderate	# of species for which threats are conclusively identified and abated; # of partnerships developed; # of information exchanges; # of sites protected; # of sites surveyed; project-specific results of collaborative efforts

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Urban and Developing Lands (Continued)	Develop wildlife/development win-win situations and disseminate information to local governments and the development community.	All Species and Habitats	Proposed	Highest	# of information requests received and responded to; % of recommendations implemented; # of mitigation scenarios developed; # of species/habitats affected; # of programs conducted
	Assist local governments in drafting meaningful comprehensive plans, as they relate to the Natural Resources section of local comprehensive plans.	All Species and Habitats	Ongoing and Proposed	Highest	# of partnerships developed; # of information exchanges; # of comprehensive plans prepared; % of recommendations implemented; # of comprehensive plans commented on
	Act as a repository for best management practices relating to natural resources.	All Species and Habitats	Proposed	Highest	Development of database and information infrastructure; # of information exchanges; # of partnerships formed; user evaluations and comments
	Encourage SCDNR staff to provide wildlife/habitat educational information to communities. Inform elected and appointed officials about environmental issues relating to local development and wildlife/habitat issues and disseminate information on the following: support the creation of local habitat protection capabilities; work with local land trusts on the location of priority habitats; promote and educate about transfer of development rights; and collaborate with local governments to develop best management practices for storm water run-off: education, incentives, and awards.	All Species and Habitats	Ongoing and Proposed	Highest	Management review of employee compliance; # of employee training seminars conducted; # of employees attending seminars; public surveys of outreach; # of partnerships developed; # of public/educational interactions

Conservation Action Area	Conservation Action	Species/Habitat Affected	Ongoing/Proposed	Priority	Indicators of Success
Urban and Developing Lands (Continued)	Provide wildlife/habitat research and demonstration projects. These could include: a buffer demonstration project that provides a win-win for both developers and the environment; research projects on the impact of buffers and corridors on wildlife and habitat; and a storm water demonstration project.	All Species and Habitats	Proposed	Moderate	# of projects/products developed; # of audiences reached; # of participants in programs; # of presentations/programs offered

CHAPTER 5: SOUTH CAROLINA COMPREHENSIVE MONITORING PROGRAM

Purpose and Justification for Monitoring

Throughout the history of natural resource conservation, managers and scientists have based most of their efforts on single species management. More recently, efforts have targeted threatened or endangered species management, drawing on much of the time and capital available to resource managers. Further, the literature of wildlife management provides testament to the effects of missed indices and unanticipated events on successful conservation.

Interestingly, in an effort to move to a more proactive framework for conservation, SCDNR is, in this CWCS planning process, tasked with streamlining management and stepping back to focus on a broader vision. The animals included on South Carolina's Priority Species List each have individual ecological roles connected in myriad ways to others. From this perspective, multi-species and systems approaches to conservation become the clearer path to accomplishing the many goals and strategies that SCDNR has identified.

It seems apparent that this view of management will require constant and consistent adaptation to change. Single alterations in community function, from the loss of a species like white beach tiger beetles on a dune to the invasion of feral hogs in key sea turtle nesting areas can produce ripple effects that confound the most complete systems model. Without perfect knowledge, however, management must move forward if conservation is to succeed. And as the system evolves, so does the method of management. Adaptive management cannot proceed without vigilant attention to these changes. Monitoring and evaluation then become the essential tools for detecting, measuring and interpreting these changes over time.

Assessing changes in populations and habitats over time, especially in response to applied conservation actions, requires monitoring at multiple levels (species, guilds, natural communities, implementation activities) and across multiple scales (local, statewide, regional, national). Through varying styles of monitoring, SCDNR can detect species-specific trends from estimates of population size, relative abundance or distributional shifts. Similarly, by measuring species associations such as longleaf pine associated reptiles, we can assess habitat-level responses. Monitoring of habitats leads to identification of challenges or impacts of management activities or landscape alterations. Finally, monitoring must be inherent in simply understanding the effects, intended or otherwise, of any management approach.

Earlier this year, CWCS project leaders received guidance from partners, including USFWS, USGS, NPS and USFS, aimed at identifying essential elements in the design of effective monitoring programs to support the CWCS and its subsequent implementation. South Carolina's team attended meetings to discuss collaborative efforts and structural design of CWCS monitoring programs. Paul Dressler, USGS, presented a list of the basic elements of a monitoring program. Representatives of USFS and NPS provided descriptions of current monitoring programs instituted at varied scales by their agencies. This information has proved invaluable in considering the framework and strategies SCDNR will employ through

implementation of the CWCS to create a more effective and efficient statewide monitoring program.

Monitoring Programs in South Carolina

An extensive list of monitoring efforts currently employed across the state and region is included in Appendix 4 of this Strategy. Cooperative efforts remain essential to accomplishing the goals of these programs. SCDNR will work first to ensure that existing programs remain effective where they meet the needs of conservation strategies within the CWCS. Monitoring continues to be a necessary component of most SCDNR efforts outside of the CWCS as well. The structure of the South Carolina Monitoring Program will build on existing SCDNR monitoring efforts and where appropriate those monitoring programs of partners. Additional partnerships and support will be researched during the development of the monitoring program.

Current Species Monitoring Programs

Monitoring programs are not a novel approach in successful conservation. International and domestic efforts to monitor migratory bird species provide excellent resources for developing species-level monitoring programs. The North American Breeding Bird Survey (BBS) is a well-known, long-term, continental sentinel monitoring program. The Christmas Bird Count similarly provides documentation of winter distribution and abundance for bird species. Such efforts set precedents in data collection and distribution that map possible roads other taxa monitoring programs might use. Other bird surveys established in South Carolina include the International Migratory Bird Day and Backyard Feeder Watch. Of important note is the consistent effective use of volunteers to conduct these assessments.

In South Carolina, current monitoring projects include the following:

- The U.S. Army Corps of Engineers and South Carolina Ocean and Coastal Resource Management (OCRM) have provided essential monitoring efforts for marine invertebrates.
- SCDHEC monitors water quality while surveying some freshwater invertebrate species.
- SCDNR assesses commercial fisheries and State Shellfish Grounds on an annual basis to evaluate shellfish population status.
- The South Carolina Estuarine and Coastal Assessment Program (SCECAP) monitors habitat quality of estuarine waters statewide and identifies specific sites with degraded water or sediment quality.
- The SCDNR-SEAMAP program currently monitors abundance of fishes and decapod crustaceans using a trawl survey of coastal waters (4 to 10 m; 13 to 33 ft.), from North Carolina to Florida.
- South Carolina participates in the Harvest Information Program (HIP) that has been fully implemented nationwide, allowing for comparisons of migratory game bird numbers and harvest levels in South Carolina.
- Comprehensive hunter harvest surveys have been conducted for all species in South Carolina periodically since 1963. Eleven surveys have been completed spanning 40

years. (1963–64; 1966–67; 1975–76; 1978–79; 1981–82; 1984–85; 1991–92; 1993–94; 1999–2000; 2002–03; 2004–05).

- The South Atlantic Fishery Management Council (SAFMC) monitors annual landings of many species.
- Reproductive effort and fledging success of South Carolina nesting bald eagles has been documented on an annual basis for 28 years.
- A spring whistling call count survey for Northern Bobwhite has been conducted annually since 1979.
- South Carolina has participated in Mourning Dove Call Count Surveys since 1966.

Additionally, the Freshwater Fisheries section of the Wildlife and Freshwater Fisheries Division of the SCDNR has run continued surveys of user preferences and user impact on the fisheries of the state. The following are the most current programs completed.

- 1990 - Freshwater fishing study
- 1998 - South Carolina fishing license holders opinions and attitudes toward fisheries management and the South Carolina Department of Natural Resources, results of largemouth bass and smallmouth bass anglers
- 1998 - South Carolina fishing license holders opinions and attitudes toward fisheries management and the South Carolina Department of Natural Resources
- 1999 - Youth and fishing in South Carolina
- 2000 - Striped bass anglers' attitudes toward fisheries management on Lake Murray
- 2001 - South Carolina youth aquatic survey
- 2003 - South Carolina residents' attitudes and behaviors toward aquatic resources
- 2003 - South Carolina and Georgia anglers' on fishing regulations on Lake Russell
- 2004 - South Carolina fishing license holders opinions and attitudes toward fisheries management and the South Carolina Department of Natural Resources
- 1991, 1996 and 2001 - The 2001 Economic Benefits of Freshwater Fishing in South Carolina

This list only briefly describes some of the monitoring efforts SCDNR undertakes in current management programs. A more complete list of monitoring efforts in South Carolina is provided in Appendix 4.

Monitoring Needs for Taxa Groups

Authors of the CWCS species accounts identified monitoring, survey and research needs for priority species. Recommendations for individual species can be located in a separate volume, Supplement: Species and Habitat Accounts. Some of the general needs for monitoring efforts are described here.

General Aquatic Monitoring Needs

Many freshwater species, especially invertebrates such as crayfish, snails and mussels lack distribution and survey information for baseline data upon which a monitoring program could be built. Similarly, many of the marine fish and marine invertebrates on South Carolina's Priority

Species List have only recently received initial survey attention and will require further study to create effective tracking programs. Where baseline data is available for freshwater aquatic species, there is a strong need to improve long-term monitoring across species groups. Presently, SCDNR biologists are developing a system for stream habitat monitoring and assessment. Otherwise, monitoring is needed to assess specific management actions such as buffer establishment and species restoration projects. Impacts of introduced or exotic species on priority species remain a concern for many freshwater systems.

General Terrestrial Monitoring Needs

A pressing issue for monitoring terrestrial species is the establishment of taxa relevant monitoring protocols such as those already established for birds. Efforts to expand monitoring on public lands and initiate monitoring on key private lands where possible should be addressed.

Mammals

A monitoring protocol for small mammals and bats should be developed. Survey and data needs are most pressing for all species of bats on South Carolina's Priority Species List. Therefore, it may be most important to survey and institute long-term monitoring programs at roosting locations.

Birds

Continue ongoing monitoring coordination and support of recommendations of national and regional planning bodies such (PIF, SAMBI, NABCI, NAWMP and others). Primary landbird species identified for specific monitoring programs include Swainson's warbler, Henslow's sparrow, Bachman's sparrow, Wayne's black-throated green warbler, loggerhead shrikes and painted buntings. Key habitats of concern include pine savannah and pine woodland, early successional and grasslands and forested wetlands. Efforts to continue monitoring of migratory and resident waterbirds and waterfowl are also recommended.

Amphibians and Reptiles

Development of monitoring protocols for amphibians and reptiles is of primary importance. SE PARC has already begun drafting such protocols and guidelines. SCDNR's continued involvement in this process is important for both development of reptile guidelines and continued refinement of existing amphibian guidelines.

Strategies for South Carolina's Comprehensive Monitoring Program

The following are specific strategies outlined for the development of the South Carolina Comprehensive Natural Resources Monitoring Program (South Carolina Monitoring Program).

Strategy 1: *Initiate a comprehensive monitoring program to coordinate monitoring efforts including establishment of a collaborative working group staffed with agents both from SCDNR and partner agencies.*

- Coordinate monitoring efforts across scales and jurisdictions through partnerships, defining scope as a function of the monitoring subject.
- Provide a means to share information, provide advice and coordinate state monitoring efforts to be nationally and internationally compatible.
- Develop an ecologically based framework considering the incorporation of an ecosystem-based approach to allow for regional compatibility.
- Use monitoring results to prepare the next iteration of the CWCS.
- Build on existing state monitoring systems.
- Support local planning initiatives, regional planning teams and existing cooperative agreements where appropriate (Appendix 5: Existing SCDNR Partnerships).
- Develop a monitoring process that is easily understood, sustainable, cost-effective and relevant to all parties involved and paced appropriately.
- Include assessments of cumulative impacts and, where possible, an interdisciplinary approach (geologic, genetic, ecologic, climatic).
- Maintain participation in monitoring networks as established between states during the national CWCS planning efforts.

Strategy 2: *Create a South Carolina Comprehensive Natural Resources Data Initiative.*

- Develop a standard system to facilitate species, habitat and monitoring data collection for storage and dissemination across the agency and partnerships.
- Create a CWCS project monitoring system to link tracking of conservation actions with recommendations and appropriate species of concern.
- Establish standard operating procedures for project reporting and provide access to templates for web based data input that will support research and monitoring efforts.
- Provide public and partner access to information collected and maintained to increase ownership and collaborative efforts.
- Examine the ability to link previous databases with new information through consistent species and habitat codes.
- Collaborate with neighboring and regional states to create standardized platforms, enabling information exchange at broader scales.
- Spatially relate all database information where appropriate to provide summarizations through geographic information systems (GIS) software capabilities.
- Track distribution and status of all priority species with intent to expand database for tracking non-priority species as well.
- Design the database with the intent to facilitate future reporting and revisions of the CWCS.

Strategy 3: *Translate species level goals and objectives to habitat and landscape scales for implementation and monitoring.*

- Accomplish long-term objectives of monitoring key habitats using existing and new GIS programs.
- Update and analyze the existing GAP databases and crosswalk this information with a statewide habitat characterization as provided in the CWCS.
- Design and implement an aquatic GAP initiative to support aquatic monitoring.
- Complete periodic updates of land use and land cover in the state to help translate threats from species to habitat scale.
- Evaluate the existing CWCS species goals for feasibility and applicability at broadening scales.
- Utilize landscape-level remote sensing and other mapping techniques, of particular value given the proportion of key habitats and priority species that are located on private lands.
- Monitor partnerships and public involvement such as conservation easements, stewardship agreements and volunteer efforts at the habitat scale.

Strategy 4: *Augment monitoring group efforts by developing or expanding citizen science partnerships, where appropriate.*

- Consider the efficacy of developing and training citizen science groups to expand data gathering capability across the state.
- Build public understanding of ecological issues and meet the varied educational and public outreach recommendations for priority species by involving increasing numbers of citizens and institutions in basic status and trends monitoring efforts.
- Encourage partnerships with secondary and higher education institutions to provide students with opportunities to integrate classroom learning with practical experiences.
- Increase the use of graduate training programs in creating and implementing response monitoring, an excellent opportunity for standard graduate level research.

While presented last, it is important to consider the potential benefits of citizen-based programs. The Breeding Bird Survey and Christmas Bird Counts are citizen initiatives; these programs provide some of the most complete data on bird distributions. Support for continued conservation efforts can only benefit from a sense of ownership and collaboration among partners and the public. For more information regarding public input and partnership development, see Chapter 6: Partnership Development.

Monitoring Program Defined

As SCDNR proceeds with the development of the South Carolina Monitoring Program in support of the CWCS, several elements of design must be considered; these are outlined in Box 5-1 and adapted from guidance provided to the states by federal partners.

BOX 5-1: BASIC ELEMENTS OF A MONITORING PROJECT AND PROGRAM

- Identification of monitoring goals and objectives
 - What is the question and why; identify existing information; conceptual model
- Identification of targets to monitor
 - Selection based on above results and availability of resources (fiscal/human)
- Establishing monitoring protocol (peer reviewed)
 - All elements documented (question; sampling design; methodology; anticipated analysis/analytic tools; data management and reporting strategy; schedule)
- Quality assurance and quality control
 - How you assure and control quality; training and potential certification of users
- Data management and archiving
 - Scheme to ensure data are documented, maintained, archived, and accessible
- Data analysis and assessment
 - Anticipated analysis including estimates of confidence
- Reporting
 - Reporting formats and schedule (useable, understandable, responsive) to user
- Periodic review and evaluation
 - Ensure project is responsive to need and reflects best available science

Monitoring targets will be dictated during the program implementation and adaptive management process; this process is more thoroughly described in Chapter 7: Prioritization, Implementation, and Adaptive Management. In most cases, one or more of the following types of programs will be developed:

- 1) Targeted species or habitat status and trends. This type of monitoring tracks the status and trends of selected species, habitats and communities and how they respond to management.
- 2) Multi-species context or habitat condition. Context or condition monitoring for either species or habitats allows us to track change at the ecosystem level to understand patterns of change.
- 3) Cause and effect or response. Cause and effect or response monitoring in reality mimics traditional research on the underlying explanation of observed events.
- 4) Management action effectiveness. Effectiveness monitoring relates directly to adaptive management as it assesses how well management actions undertaken achieve desired results.

Effective monitoring must integrate trend data with cause and effects for successful adaptive measures to be taken. Likewise, it must integrate habitat description with species measures. Viewing either as a surrogate for the other is inappropriate. Habitat-species relationships are not always well understood; often, quality habitat will lack presence of expected species. Species trends, conversely, cannot provide direct insight into changes in habitat composition.

Targeted Monitoring

Targeted species status and trends monitoring might assess species presence/absence, population density, productivity (number of offspring), breeding success, offspring and adult survival, and/or use of treated areas. In general, this form of monitoring is very similar to existing efforts to monitor harvested species. Targeted monitoring focuses on species or primary habitats selected due to risk, concern or interest. Strengths of this facet of monitoring are first, the ability to narrow perspective to those elements likely to change, and second, to tie monitoring efforts to management actions. However, a drawback of such a focused effort is the very assumption that a relationship truly exists between the target and the attributed management action or threat. It is necessary then to conduct targeted monitoring within a contextual frame produced in the second division of monitoring efforts: condition and context monitoring.

For comparatively well-studied species, targeted monitoring protocols have been described, often in great detail, in recovery plans, conservation plans, published literature and gray literature; SCDNR will use these if available. If no established protocol exists, SCDNR will adapt protocols from similar species or develop its own protocols based on what is known about the species. In developing protocols, we will follow Oakley et al. (2003). For species deemed important to target but with disparate information, inventories must first be conducted. When presence data are assembled, distributions of the species, along with population conditions can be mapped and used to direct future efforts.

Context and Condition Monitoring

Context monitoring is not restricted to particular species or system elements. Rather it provides status and trend information on a wide range of related facets of an ecosystem. With context monitoring, managers may detect unanticipated effects on a system that would have been lost in a targeted approach. It is a necessary link between targeted and response monitoring. In contextual monitoring, data may be collected for species not identified in specific targeted studies as described above. Additionally, monitoring of communities can provide context documentation against which targeted trends can be evaluated. Context based monitoring extends to the habitat or landscape level when possible to further explain trend relationships between populations and habitats. When appropriate, context and condition monitoring will rely heavily on identification of indicators. For example, with their large home range, swallow-tailed kites can serve as umbrella species for other area-sensitive wetland wildlife including Neotropical migrants, barred owls, red-shouldered hawks, pileated woodpeckers, river otters and black bears. Selection of appropriate indicators is challenging. SCDNR will rely on the guidance provided by Schoonmaker and Luscombe (2005) (see Box 5-2 for additional definition and discussion of indicators). It is important to stress that context and condition monitoring is not intended to follow every component of a system but rather provide a picture of the system from a broader perspective.

BOX 5-2: DEFINITION AND SELECTION OF INDICATORS**Categories for Indicator Evaluation:**

- Relevance – the degree to which the indicator measures the issue of concern
- Practicality – the feasibility of measuring the indicator
- Scientific merit – the extent to which the indicator is supported by science
- Ecological breadth – the number of ecological components the indicator includes
- Usability – the ability of decision makers to make decisions using the indicator

Qualities of Valid Indicators

- Intended use is clear
- Simplifies status of a complex system
- Sensitive to known stressors
- Able to distinguish between anthropogenic stressors and natural variation
- Provide early warning of change
- Not greatly sensitive to sample size
- Low variability in response
- Easy and inexpensive to measure
- Easy to understand and translate into decision making
- Represents cause and effect relationships

Pressure-State-Impact-Response Indicator Framework

- **Pressure indicators** represent the level of a pressure or stressor that affect a natural resource
- **State (or condition) indicators** describe the current state or condition of a natural resource
- **Impact indicators** indicate the change in natural resource as a result of a pressure
- **Response indicators** indicate the level of human action taken to reduce the pressure on a value of interest

Response Monitoring

Response monitoring or cause and effect monitoring (Holthausen in press) dovetails tightly with the objectives of targeted and condition/context monitoring and is the monitoring of species responses to management changes at the project (or several projects) level. It can be further described as the collection and assessment of observations to evaluate changes in condition in relationship to actions (Elzinga et al. 2001). Response monitoring of relationships between targets and conditions integrates monitoring with research. For this reason, efficiency may be increased where researchers and managers work closely to identify objectives for management. With proper choice of management goals and well-identified expectations that are defensibly quantifiable, response monitoring lends itself easily to the collaborative development of research efforts.

Effectiveness Monitoring

A final necessary division of monitoring includes efforts to quantify the effects of management actions in relation to management goals, rather than the effectiveness of an action taken. Effectiveness monitoring will be essential to adaptive management and future revision of the CWCS. It involves not only looking at outcomes but at processes. This type of monitoring can determine whether the treatments were applied as they were conceptualized and prescribed. In order to adapt management efforts effectively, managers must be able to evaluate why an action is successful or unsuccessful and be able to gain a clear understanding of actions implemented so that future assessments are based on actual occurrences.

Proposed quantifiable criteria of management actions include net increases in partner and public involvements, removal of threats to priority species or successful completion of conservation actions. Additional qualitative measures will be important as well and included in annual project reviews (see Chapter 7: Prioritization, Implementation and Adaptive Management, for further descriptions of implementation and review). Of course, the long-term measure of effectiveness would be a reduction in the number of species of priority conservation concern.

The balance between these four forms of monitoring is an important consideration in the design of conservation actions and projects at all scales. Additional attention will be given to the appropriate use of each facet of monitoring to most effectively meet the goals of the CWCS.

Experimental Design for Monitoring Programs

As successful research is typically built on detailed experimental design, so shall design efforts benefit the CWCS monitoring process. Attention to statistical design will improve the applicability of most monitoring outputs. While not all facets of the program need to be rigorously treated, an understanding of traditional scientific reasoning may increase the effectiveness of the program as a whole. Additionally, response monitoring endeavors would likely rely on sound analytical design due to their relationship to research.

Analyzing monitoring data most effectively will require the use of several techniques including traditional hypothesis testing, as well as less traditional techniques such as information theoretic methods (Burnham and Anderson 2001) and meta-analysis (Franklin and Shenk 1995). The object will be to determine whether actions do or do not produce their intended effect. Model comparisons and comparisons of treatments across differing areas and scales may require extended analysis of non-traditional statistical testing and inference.

Setting Monitoring Objectives

The proposed South Carolina Monitoring Program working group will establish measurable monitoring objectives through the planning of the monitoring program and selection of individual projects. These objectives will closely tie with priorities for conservation actions as provided in Chapter 4: Statewide Conservation Strategies. Statistically defensible design will be employed if applicable to the measurements made. Attention in these decisions should also be

given to the provision of opportunities for local and community involvement as well as cooperation among agencies and stakeholders. Similarly, a primary directive for selection of objectives within the outlined framework should be the ability to acquire and use information for adaptive management.

CHAPTER 6: PARTNERSHIP DEVELOPMENT

The Initial Stages: Drawing Plans

From the beginning of the CWCS effort, SCDNR and the planning team sought to realize successful partnerships and public involvement in the development of the strategy. It is understood that successful conservation is furthered by the existence of a strong collaborative involvement between all resource stakeholders, private or public, governmental or nongovernmental.

Early in the process, the team identified the issues of most prominent concern for wildlife conservation both from the perspective of agency staff and that of individuals and groups outside of SCDNR. First, focus groups were developed in order to determine the wildlife conservation priorities of SCDNR's partners. Representatives from partner groups were invited to share their ideas with the planning team. These partner organizations included federal and state agencies such as the US Fish and Wildlife Service, the US Forest Service, Clemson University and the SC Forestry Commission. Likewise, non-governmental organizations like The Nature Conservancy, Katawba Valley Land Trust, SC Sporting Protection League, SC Native Plant Society and Safari Club International were also involved. To ensure that SCDNR received input from partners with more diverse interests in wildlife conservation, other non-governmental organizations also participated in the focus groups including developers, local and county planners, professional foresters and representatives from the agricultural community.

Five focus group meetings were held throughout the state. The goal of these meetings was to identify general actions that would protect priority species in South Carolina. After discussing current wildlife conservation methods in the state and the factors contributing to wildlife and wildlife habitat decline, the participants determined that three broad general actions should be considered high priority by the SCDNR in conserving priority species; these three actions are:

- Public education
- Land use planning
- Habitat acquisition and protection

In addition, the following four actions were given slightly less priority but were mentioned at all focus group meetings:

- Greater research and monitoring - (population and species monitoring; exotic/invasive species management; investigate and verify the decline of species)
- Water quality - (better water quality management programs; wetland protection)
- Agency collaboration - (Inter- and intra-agency collaboration; public-private cooperation; collaborate with neighboring states; enforce existing regulations)
- Land owner incentives_- (land owner incentives; improved; ecological restoration on private lands; cost-sharing programs)

After the focus group meetings, SCDNR conducted four public meetings throughout South Carolina in order to allow all segments of the population to provide their opinions on priorities

for wildlife conservation in the state. The information obtained through the focus groups allowed SCDNR to be better prepared to answer questions that might arise during public meetings. Public meetings were held at four locations around the state and were attended by representatives of groups similar to those present at that focus group meetings as well as members of the general public. The public meetings brought together a wider array of people and concerns. However, the dominant actions were similar to those stated in the focus groups: public education, land use planning and habitat acquisition and protection.

A complete list of partners established throughout the planning process, including those identified through the initial public and partner involvement process, is included in Appendix 5: Nonexhaustive List of SCDNR Partnerships and Existing Collaborative Agreements.

Planning the Strategies: Building Bridges

Partnerships and collaborations were essential to the development of this plan. Not only were partners identified and sought for technical advice in creating the extensive compilation of species and habitat background accounts, but also further connections were built in the process of defining threats to SCDNR's priority species and developing conservation recommendations and strategies for abating these threats.

The development of the South Carolina Priority Species List as well as the accounts for listed species was a broad collaborative effort that involved partners from all over the southeastern United States and from every facet of natural history background. The taxa teams responsible for creating the species lists were seated by agency staff as well as individuals from state universities and other agencies. Taxa leaders often sought input from taxa experts from all over the country. Lists were also reviewed extensively both inside the agency as well as outside. Over 100 individuals were contacted in the creation and review of the bird priority list alone. The varying approaches to taxa priority list creations reflected the varying degree of expertise available and the efforts necessary to employ their help.

The habitat characterization of the state helped to identify potential partners well beyond the doors of research institutions. Concerned individuals from myriad groups were also given opportunities to provide input for defining the key habitats, threats to their continued health, and potential conservation actions. Additionally, as the coordination team worked to develop the South Carolina Comprehensive Natural Resources Data Initiative, technical assistance was pursued to create a proper vegetative classification and develop mapping capabilities.

Conservation recommendations provided by species account contributors and taxa groups were refined in a process of identifying concrete strategies, plausible actions to carry out those strategies and potential partners for proposed measures. As conservation strategies were developed for each species, it became evident that they could be separated into eight categories, which we have designated as Conservation Action Areas (CAAs). These CAAs are presented in Box 6-1.

Additionally, SCDNR recognized that there are overarching conservation strategies that are likely to assist in protecting wildlife and habitats statewide. Therefore, SCDNR determined that

formation of Conservation Action Committees around each of the CAAs identified would assist in determining these overarching strategies. Conservation Action Committees would provide an excellent opportunity to work with partners to develop comprehensive statewide strategies for South Carolina that were not tied specifically to a single species or habitat. The strong partnerships between SCDNR and other state and federal agencies, organizations, academic institutions and industries within the state demonstrate dedication to overcoming challenges inherent in implementing conservation strategies. Two Conservation Action Committees, those for Education and Outreach and Urban and Developing Lands, were convened prior to completion of the CWCS; additional committee meetings will be held for the remaining CAAs as the CWCS is being implemented; resulting conservation strategies will be included in future revisions of the South Carolina CWCS.

BOX 6-1: EIGHT CONSERVATION ACTION AREAS

- Education and Outreach
- Habitat Protection
- Invasive and Non-native Species
- Private Land Cooperation
- Public Land Management
- Regulatory Actions
- Survey and Research Needs
- Urban and Developing Lands

The two Conservation Action Committees that were convened were facilitated by planning team members but attendees were otherwise allowed to discuss the technical process and elaborate as a group. Typical information derived from these working groups included not only specific identification of interested parties and stakeholders but also histories of related actions and leads for further partnering efforts. Perhaps most exciting were the instances where working groups reached consensus on issues and began brainstorming innovative solutions. Additional discussion of the fruits of the working groups efforts is included within each CAA discussion in Chapter 4: Statewide Conservation Strategies.

Late in the planning process, a representative of the Catawba Indian Nation was briefed on the CWCS to explore partnership opportunities. Potential actions identified for future discussion are based on four broad goals. Support for aquatic resource conservation, education and recreation activities where the Catawba reservation borders the Catawba River could be broadened through financial and technical assistance from SCDNR. Similarly, SCDNR could help Reservation land managers develop biological resource inventories and site-specific management plans for priority species. The Catawba Nation could also support expanding outreach to other Native American bands and groups. In return, SCDNR could assist in developing new and existing cooperative conservation projects with neighboring landowners where objectives cross the Reservation boundaries.

Implementation: Shaking Hands and Cutting Ribbons

With the collaborative foundations built during the initial stakeholder input and the planning stages of the project, the focus now turns to the future and the potential to continue these efforts. As the plan moves into implementation stages, partnering will become even more important in

reaching successful outcomes. Financially, the ability to collaborate can only improve the efficiency of all partner efforts.

As implementation begins and planning for future revisions continues, the CWCS coordinating team will be tasked with maintaining the network of partnerships. The team plans to put in place streamlined measures including a Wildlife Initiative newsletter with listserve capabilities, continued use of web-based contacts and media, presentations and popular news media publications. *South Carolina Wildlife*, the SCDNR magazine publication, will release a supplemental issue concurrent with the submission of this plan to the USFWS. The supplement details the background and fundamentals of the development of the CWCS. The magazine has over 52,000 subscribers; SCDNR research indicates that each issue is read by three to four individuals, resulting in the supplement having an audience of well over 150,000 individuals. Additionally, 10,000 copies of the supplement will be available to serve as an informational tool as the team begins developing liaisons to coordinate partnerships throughout the state.

Finally, as the development of data tools to support the CWCS continues, the team will continue soliciting involvement and interest from partners throughout the state and region, in creating a dynamic user interface for collaborative input on projects, species and habitat information and demographics and, ultimately, future CWCS iterations. A novel approach to information collection, the collaborative interface will allow field biologists access to the SCDNR's information storehouse in an effort to make data updates fluid and almost instant. This open information gathering, while closely moderated for technical accuracy, will allow planners and managers to actively adapt their land use decisions with the most current knowledge of species needs and threat characterizations.

The mission of the SCDNR defines our role as one of stewards of the state's natural resources. Essentially, that role depends on the support and involvement of those groups and individuals with vested interests in the continued health and wealth of South Carolina's natural heritage. Public and partner involvement must and will continue to be a focus of the Strategy as the program strives to meet the needs of present and future interests.

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APPENDIX 1: PRIORITY CONSERVATION SPECIES OF SOUTH CAROLINA

Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Mammals					
Black Bear	<i>Ursus americanus</i>	Highest	Of Concern, State	G5	S3?
Florida Manatee	<i>Trichechus manatus</i>	Highest	Federal and State Endangered	G2	S1S2
Northern Yellow Bat	<i>Lasiurus intermedius</i>	Highest	Of Concern, State	G4G5	S?
Appalachian Cottontail	<i>Sylvilagus obscurus</i>	High		G4	S3
Atlantic Right Whale	<i>Eubaleana glacialis</i>	High	Federal and State Endangered	G1	SA
Bottlenose Dolphin	<i>Tursiops truncatus</i>	High	Of Concern, State	G5	S4
Carolina Red-backed Vole	<i>Clethrionomys gapperi</i>	High	Of Concern, State	G5	S3
Dwarf Sperm Whale	<i>Kogia sima</i>	High	Of Concern, State	G4	S?
Eastern Small-footed Myotis	<i>Myotis leibii</i>	High	State Threatened	G3	S1
Hairy-tailed Mole	<i>Parascalops breweri</i>	High	Of Concern, State	G5	S?
Humpback Whale	<i>Megaptera novaeangliae</i>	High	Federal and State Endangered	G3	S1
Masked Shrew	<i>Sorex cinereus</i>	High	Of Concern, State	G5	S?
Meadow Vole	<i>Microtus pennsylvanicus</i>	High	Of Concern, State	G5	S?
Mink	<i>Mustela vison</i>	High		G5	S?
Pygmy Sperm Whale	<i>Kogia breviceps</i>	High	Of Concern, State	G4	SA
Rafinesque's Big-eared Bat	<i>Corynorhinus rafinesquii</i>	High	State Endangered	G3G4	S2?
Southeastern Bat	<i>Myotis austroriparius</i>	High	Of Concern, State	G3G4	S1
Star-nosed Mole	<i>Condylura cristata</i>	High	Of Concern, State	G5	S3?
Swamp Rabbit	<i>Sylvilagus aquaticus</i>	High	Of Concern, State	G5	S2S3
Eastern Fox Squirrel	<i>Sciurus niger</i>	Moderate	Of Concern, State	G5	S4
Eastern Spotted Skunk	<i>Spilogale putorius</i>	Moderate	Of Concern, State	G5	S4
Eastern Woodrat	<i>Neotoma floridana</i>	Moderate	Of Concern, State	G5	S3S4
Southern Pygmy Shrew	<i>Sorex hoyi</i>	Moderate		G5	S3
Woodland Jumping Mouse	<i>Napaeozapus insignis</i>	Moderate	Of Concern, State	G5	S4?

AP 1: Priority Species List

SC CWCS

Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Birds					
American Avocet	<i>Recurvirostra americana</i>	Highest		G5	S?
American Bittern	<i>Botaurus lentiginosus</i>	Highest	Of Concern, State	G4	S?
American Coot	<i>Fulica americana</i>	Highest		G5	SHB,SNRN
American Golden Plover	<i>Pluvialis dominica</i>	Highest		G5	SNA
American Kestrel	<i>Falco sparverius paulus</i>	Highest		G5	SNR
American Oystercatcher	<i>Haematopus palliates</i>	Highest	Of Concern, State	G5	S?
Bachman's Sparrow	<i>Aimophila aestivalis</i>	Highest	Of Concern, State	G3	S3
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	Highest		G5	SNRB,SNRN
Black Duck	<i>Anas rubripes</i>	Highest		G5	SNRN
Black Rail	<i>Laterallus jamaicensis</i>	Highest	Of Concern, State	G4	S?
Black Skimmer	<i>Rynchops niger</i>	Highest	Of Concern, State	G5	S2
Black-throated Green Warbler	<i>Dendroica virens waynei</i>	Highest		G5	S4
Brown-headed Nuthatch	<i>Sitta pusilla</i>	Highest		G5	S4
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>	Highest		G4	SNA
Common Ground-dove	<i>Columbina passerine</i>	Highest	State Threatened	G5	S?
Common Tern	<i>Sterna hirundo</i>	Highest			
Dunlin	<i>Calidris alpina</i>	Highest		G5	SNR
Eastern Brown Pelican	<i>Pelicanus occidentalis carolinensis</i>	Highest		G4	SNR
Eastern Meadowlark	<i>Sturnella magna</i>	Highest		G5	SNR
Eastern Wood Peewee	<i>Contopus virens</i>	Highest		G5	S5B
Field Sparrow	<i>Spizella pusilla</i>	Highest		G5	S5?
Glossy Ibis	<i>Plegadis falcinellus</i>	Highest	Of Concern, State	G5	S?
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	Highest		G5	SNRB,SNRN
Gull-billed Tern	<i>Sterna nilotica</i>	Highest	Of Concern, State	G5	S?
Henslow's Sparrow	<i>Ammodramus henslowii</i>	Highest	Of Concern, State	G4	SZN
Kentucky Warbler	<i>Oporornis formosus</i>	Highest		G5	S4B
King Rail	<i>Rallus elegans</i>	Highest		G4	SNR
Least Bittern	<i>Ixobrychus exilis</i>	Highest		G5	SNRB,SNRN
Least Sandpiper	<i>Calidris minutilla</i>	Highest		G5	SNRN
Least Tern	<i>Sterna antillarum</i>	Highest	State Threatened	G4	S3
Lesser Scaup	<i>Aythya affinis</i>	Highest		G5	SNRN

AP 1: Priority Species List
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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Lesser Yellowlegs	<i>Tringa flavipes</i>	Highest		G5	SNRN
Little Blue Heron	<i>Egretta caerulea</i>	Highest	Of Concern, State	G5	S?
Loggerhead Shrike	<i>Lanius ludovicianus</i>	Highest	Of Concern, State	G4	S3
Long-billed Curlew	<i>Numenius americanus</i>	Highest		G5	SNA
Mallard	<i>Anas platyrhynchos</i>	Highest		G5	SNRB,SNRN
Marbled Godwit	<i>Limosa fedoa</i>	Highest		G5	SNRN
Northern Bobwhite	<i>Colinus virginianus</i>	Highest		G5	S4
Northern Pintail	<i>Anas acuta</i>	Highest		G5	SNRN
Painted Bunting	<i>Passerina ciris</i>	Highest		G5	SNRB
Pied-billed Grebe	<i>Podilymbus podiceps</i>	Highest		G5	SNRB,SNRN
Prairie Warbler	<i>Dendroica discolor</i>	Highest		G5	SRB
Purple Gallinule	<i>Porphyrio martinica</i>	Highest	Of Concern, State	G5	S4
Red-cockaded Woodpecker	<i>Picoides borealis</i>	Highest	Federal and State Endangerd	G3	S2
Red Knot	<i>Calidris canutus</i>	Highest		G5	SNRN
Royal Tern	<i>Sterna maxima</i>	Highest		G5	SNRB,SNRN
Rusty Blackbird	<i>Euphagus carolinus</i>	Highest		G4	SNRN
Sanderling	<i>Calidris alba</i>	Highest		G5	SNRN
Sandwich Tern	<i>Sterna sandvicensis</i>	Highest		G5	SNRB
Seaside Sparrow	<i>Ammospiza maritima</i>	Highest			
Semipalmated Sandpiper	<i>Calidris pusilla</i>	Highest		G5	SNA
Short-billed Dowitcher	<i>Limnodromus griseus</i>	Highest		G5	SNRN
Snowy Egret	<i>Egretta thula</i>	Highest		G5	SNRB,SNRN
Solitary Sandpiper	<i>Tringa solitaria</i>	Highest		G5	SNA
Stilt Sandpiper	<i>Calidris himantopus</i>	Highest		G5	SNA
Swaison's Warbler	<i>Limnithlypis swainsonii</i>	Highest	Of Concern, State	G4	S4
Swallow-tailed Kite	<i>Elanoides forficatus</i>	Highest		G5	S2
Tricolor Heron	<i>Egretta tricolor</i>	Highest		G5	SNRB,SNRN
Western Sandpiper	<i>Calidris mauri</i>	Highest		G5	SNRN
Whimbrel	<i>Numenius phaeopus</i>	Highest		G5	SNRN
White Ibis	<i>Eudocimus albus</i>	Highest		G5	
Willet	<i>Catoptrophorus semipalmatus</i>	Highest		G5	SNR
Wilson's Plover	<i>Charadrius wilsonia</i>	Highest	State Threatened	G5	S3?

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Wilson's Snipe	<i>Gallinago gallinagodelicata</i>	Highest			
Wood Stork	<i>Mycteria americana</i>	Highest	Federal and State Endangerd	G4	S1S2
Wood Thrush	<i>Hylocichla mustelina</i>	Highest		G5	S3?B
Worm-eating Warbler	<i>Helmitheros vermivorus</i>	Highest		G5	S4B
Upland Sandpiper	<i>Bartramia longicauda</i>	Highest		G5	SNA
Yellow-crowned Night Heron	<i>Nyctanassa violacea</i>	Highest		G5	SNRB,SNRN
Yellow Rail	<i>Coturnicops noveboracensis</i>	Highest		G4	
Acadian Flycatcher	<i>Empidonax virescens</i>	High		G5	S4B
Bald Eagle	<i>Haliaeetus leucocephalus</i>	High	Federal Threatened/ State Endangered	G4	S2
Barn Owl	<i>Tyto alba</i>	High	Of Concern, State	G5	S4
Black-bellied Plover	<i>Pluvialis squatarola</i>	High		G5	SNRN
Black Scoter	<i>Melanitta nigra</i>	High		G5	SNRN
Black-throated Blue Warbler	<i>Dendroica caerulescens</i>	High		G5	S4B
Blue-winged Teal	<i>Anas discors</i>	High		G5	SNRB,SNRN
Canvasback	<i>Aythya valisineria</i>	High		G5	S4
Forster's Tern	<i>Sterna forsteri</i>	High		G5	SNRN
Peregrine Falcon	<i>Falco peregrinus</i>	High		G4	SHB,SNRN
Redhead	<i>Aythya Americana</i>	High		G5	SNRN
Semipalmated Plover	<i>Charadrius semipalmatus</i>	High		G5	SNRN
Spotted Sandpiper	<i>Actitis macularia</i>	High		G5	SNA
White-winged Scoter	<i>Melanitta deglandi</i>	High		G5	SNRN
American Woodcock	<i>Scolopax minor</i>	Moderate		G5	S4
Bewick's Wren	<i>Thryomanes bewickii</i>	Moderate	State Endangered	G5	S1?
Chestnut-sided Warbler	<i>Dendroica pensylvanica</i>	Moderate		G5	SNRB
Common Loon	<i>Gavia immer</i>	Moderate		G5	SNRN
Common Raven	<i>Corvus corax</i>	Moderate		G5	S4
Dark-eyed Junco	<i>Junco hyemalis</i>	Moderate		G5	SNRB,SNRN
Golden-crowned Kinglet	<i>Regulus satrapa</i>	Moderate		G5	S4
Gray Kingbird	<i>Tyrannus dominicensis</i>	Moderate		G5	SNRB,SNRN
Great Blue Heron	<i>Ardea herodias</i>	Moderate		G5	SNRB,SNRN
Great Egret	<i>Ardea alba</i>	Moderate		G5	SNRB,SNRN
Greater Scaup	<i>Aythya marila</i>	Moderate		G5	SNRN

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Greater Yellowlegs	<i>Tringa melanoleuca</i>	Moderate		G5	SNRN
Green Heron	<i>Butorides virescens</i>	Moderate		G5	SNRB,SNRN
Horned Grebe	<i>Podiceps auritus</i>	Moderate		G5	SNRN,SNRM
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	Moderate		G5	SNRN
Louisiana Waterthrush	<i>Seiurus motacilla</i>	Moderate		G5	S4B
	<i>Top of Form</i>				
Mottled Duck	<i>Anas fulvigula</i>	Moderate		G4	S?
Pectoral Sandpiper	<i>Calidris melanotos</i>	Moderate		G5	SNA
Purple Sandpiper	<i>Calidris maritima</i>	Moderate		G5	
Red-breasted Nuthatch	<i>Sitta Canadensis</i>	Moderate		G5	S4B
Red Crossbill	<i>Loxia curvirostra</i>	Moderate		G5	S4
Ringneck	<i>Aythya collaris</i>	Moderate		G5	SNRN
Ruffed Grouse	<i>Bonasa umbellus</i>	Moderate		G5	S4
Scarlet Tanager	<i>Piranga olivacea</i>	Moderate		G5	SNRB
Tundra Swan	<i>Cygnus columbianus</i>	Moderate		G5	SNRN
White-rumped Sandpiper	<i>Calidris fuscicollis</i>	Moderate		G5	SNA
Wood Duck	<i>Aix sponsa</i>	Moderate		G5	SNRB,SNRN,SNRM
Herpetofauna					
Bog Turtle	<i>Glyptemys muhlenbergii</i>	Highest	Federal and State Threatened	G3	S1
Broad-striped Dwarf Siren	<i>Pseudobranchius striatus striatus</i>	Highest		G5	S2
Carolina Gopher Frog	<i>Rana capito capito</i>	Highest	Federal Threatened/ State Endangered	G3/G4	S1
Chamberlain's Dwarf Salamander	<i>Eurycea chamberlainii</i>	Highest			
Coal Skink	<i>Eumeces anthracinus</i>	Highest	State Threatened	G5	S1
Coral Snake	<i>Micrurus fulvius</i>	Highest	Of Concern, State	G5	S2
Eastern Milk Snake	<i>Lampropeltis triangulum</i>	Highest	Of Concern, State	G5	S2
Flatwoods Salamander	<i>Ambystoma cingulatum</i>	Highest	Federal Threatened/ State Endangered	G2G3	S1
Florida Green Watersnake	<i>Nerodia floridana</i>	Highest	Of Concern, State	G5	S2
Florida Pine Snake	<i>Pituophis melanoleucus mugitus</i>	Highest	Of Concern, State	G4T3?	S2
Green Salamander	<i>Aneides aeneus</i>	Highest	Of Concern, State	G3G4	S1
Green Sea Turtle	<i>Chelonia mydas</i>	Highest	Federal and State Endangered	G3	SNR
Gopher Tortoise	<i>Gopherus polyphemus</i>	Highest	State Endangered	G3	S1

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Hawksbill Sea Turtle	<i>Eretmochelys imbricata</i>	Highest	Federal and State Endangered	G3	SNR
Island Glass Lizard	<i>Ophisaurus compressus</i>	Highest	Of Concern, State	G3G4	S1S2
Leatherback Sea Turtle	<i>Demochelys coriacea</i>	Highest	Federal and State Endangered	G2	S?
Loggerhead Sea Turtle	<i>Caretta Caretta</i>	Highest	Federal and State Endangered	G3	S3
Kemp's Ridley Sea Turtle	<i>Lepidochelys kempii</i>	Highest	Federal and State Endangered	G1	S?
Pine Barrens Treefrog	<i>Hyla andersonii</i>	Highest	State Threatened	G4	S2S3
Shovel-nosed Salamander	<i>Desmognathus marmoratus</i>	Highest	Of Concern, State	G4	S2
Southern Hognose Snake	<i>Heterodon simus</i>	Highest	Of Concern, State	G2	S?
Tiger Salamander	<i>Ambystoma tigrinum</i>	Highest	Of Concern, State	G5	S?
Webster's Salamander	<i>Plethodon websteri</i>	Highest	State Endangered	G3	S2
Black Swamp Snake	<i>Seminatrix pygaea</i>	High	Of Concern, State	G5	S?
Chicken Turtle	<i>Deirochelys reticularia</i>	High		G5	SNR
Diamondback Terrapin	<i>Malaclemys terrapin</i>	High		G4	S?
Eastern Diamondback Rattlesnake	<i>Crotalus horridus</i>	High	Of Concern, State	G4	S?
Florida Cooter	<i>Pseudemys floridana</i>	High		G5	SNR
Florida Softshell Turtle	<i>Apalone ferox</i>	High	Of Concern, State	G5	S?
Four-toed Salamander	<i>Hemidactylium scutatum</i>	High	Of Concern, State	G5	S?
Gulf Coast Mud Salamander	<i>Pseudotriton montanus flavissimus</i>	High	Of Concern, State	G5T4	S3S4
Hellbender	<i>Cryptobranchus alleganiensis</i>	High	Of Concern, State	G3G4	S?
Mimic Glass Lizard	<i>Ophisaurus mimicus</i>	High	Of Concern, State	G3	S?
Pickerel Frog	<i>Rana palustris</i>	High	Of Concern, State	G5	S?
Pine Snake	<i>Pituophis melanoleucus</i>	High	Of Concern, State	G4	S3S4
Pine Woods Snake	<i>Rhadinea flavilata</i>	High	Of Concern, State	G4	S?
River Cooter	<i>Pseudemys concinna</i>	High		G5	SNR
Seepage Salamander	<i>Desmognathus aeneus</i>	High	Of Concern, State	G3G4	S?
Spiny Softshell Turtle	<i>Apalone spinifera</i>	High		G5	SNR
Striped Mud Turtle	<i>Kinosternon baurii</i>	High	Of Concern, State	G5	S?
Timber Rattlesnake	<i>Crotalus horridus</i>	High	Of Concern, State	G4	S?
Upland Chorus Frog	<i>Pseudacris triseriata</i>	High	Of Concern, State	G5	S3S4
Wood Frog	<i>Rana sylvatica</i>	High	Of Concern, State	G5	S3

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Yellowbelly Turtle	<i>Trachemys scripta</i>	High		G5	SNR
American Alligator	<i>Alligator mississippiensis</i>	Moderate	Federal Threatened	G5	S5
Bird-voiced Treefrog	<i>Hyla avivoca</i>	Moderate	Of Concern, State	G5	S5
Common Snapping Turtle	<i>Chelydra serpentina</i>	Moderate		G5	SNR
Northern Cricket Frog	<i>Acris crepitans</i>	Moderate	Of Concern, State	G5T5	S5
Slender Glass Lizard	<i>Ophisaurus attenuatus</i>	Moderate		G5	S4
Southern Dusky Salamander	<i>Desmognathus auriculatus</i>	Moderate		G5	SNR
Spotted Turtle	<i>Clemmys guttata</i>	Moderate	State Threatened	G5	S5
Freshwater Fish					
American Eel	<i>Anguilla rostrata</i>	Highest		G5	SNR
American Shad	<i>Alosa sapidissima</i>	Highest		G5	S5
Atlantic Sturgeon	<i>Acipenser oxyrinchus</i>	Highest	Of Concern, State	G3	S3
Blueback Herring	<i>Alosa aestivalis</i>	Highest	Of Concern, State	G3	S3
Bluebarred Pygmy Sunfish	<i>Elassoma okatie</i>	Highest	Of Concern, State	G2G3	S?
Bridle Shiner	<i>Notropis bifrenatus</i>	Highest	Of Concern, State	G5	S?
“Broadtail” Madtom	<i>Noturus</i> spp [c.f. <i>insignis</i>]	Highest	State Threatened	G2	S1
Carolina Pygmy Sunfish	<i>Elassoma boehlkei</i>	Highest	State Threatened	G2	S1
Christmas Darter	<i>Etheostoma hopkinsi</i>	Highest	Of Concern, State	G4G5	S4
Hickory Shad	<i>Alosa mediocris</i>	Highest	Of Concern, State	G5	S4
Highfin Carpsucker	<i>Carpoides velifer</i>	Highest			
Redeye Bass	<i>Micropterus coosae</i>	Highest		G5	
Robust Redhorse	<i>Moxostoma robustum</i>	Highest		G1	SNR
Saluda Darter	<i>Etheostoma saludae</i>	Highest			
Sandhills Chub	<i>Semotilus lumbee</i>	Highest	Of Concern, State	G3	S2
Savannah Darter	<i>Etheostoma fricksium</i>	Highest		G4	SNR
Shortnose Sturgeon	<i>Acipenser brevirostrum</i>	Highest	Federal and State Endangerd	G3	S3
“Thinlip” Chub	<i>Cyprinella</i> spp. [c.f. <i>insignis</i>]	Highest			
Bannerfin Shiner	<i>Cyprinella leedsi</i>	High		G4	S2
Blackbanded Sunfish	<i>Enneacanthus chaetodon</i>	High		G4	S1
Carolina Darter	<i>Etheostoma collis</i>	High	Of Concern, State	G3	S?
Carolina Fantail Darter	<i>Etheostoma flabellare brevispina</i>	High		G5	S1

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“Carolina” Redhorse	<i>Moxostoma</i> sp.	High		G1G2Q	SNR
Greenhead Shiner	<i>Notropis chlorocephalus</i>	High	Of Concern, State	G4	S?
Piedmont Darter	<i>Percina crassa</i>	High		G4	SNR
Pinewoods Darter	<i>Etheostoma mariae</i>	High	State Endangered	G3	S1
Quillback	<i>Carpionodes cyprinus</i>	High		G5	SNR
Santee Chub	<i>Cyprinella zanema</i>	High		G4	SNR
Seagreen Darter	<i>Etheostoma thalassinum</i>	High		G4	SNR
Smoky Sculpin	<i>Cottus bairdii</i>	High		G5	
Turquoise Darter	<i>Etheostoma inscriptum</i>	High		G4	SNR
Banded Darter	<i>Etheostoma zonale</i>	Moderate	Of Concern, State	G5	S1?
Banded Killifish	<i>Fundulus diaphanus</i>	Moderate	Of Concern, State	G5	S1
Blacknose Dace	<i>Rhinichthys atratulus</i>	Moderate	Of Concern, State	G5	S1
Bluefin Killifish	<i>Lucania goodei</i>	Moderate	Of Concern, State	G5	S1?
Central Stoneroller	<i>Camptostoma anomalum</i>	Moderate		G5	SNR
Comely Shiner	<i>Notropis amoenus</i>	Moderate		G5	S?
Eastern Brook Trout	<i>Salvelinus fontinalis</i>	Moderate	Of Concern, State	G5	S2
Fireyblack Shiner	<i>Cyprinella pyrrhomelas</i>	Moderate		G4	S4
Flat Bullhead	<i>Ameiurus platycephalus</i>	Moderate		G5	SNR
Florida Gar	<i>Lepisosteus platyrhincus</i>	Moderate		G5	S1
Greenfin Shiner	<i>Cyprinella chloristia</i>	Moderate		G4	S4
Highback Chub	<i>Hybopsis hypsinotus</i>	Moderate		G4	SNR
Longnose Dace	<i>Rhinichthys cataractae</i>	Moderate	Of Concern, State	G5	S?
Lowland Shiner	<i>Pteronotropsis stonei</i>	Moderate			
Mirror Shiner	<i>Notropis spectrunculus</i>	Moderate	Of Concern, State	G4	S?
Mud Sunfish	<i>Acantharchus pomotis</i>	Moderate		G5	
Notchlip Redhorse	<i>Moxostoma collapsum</i>	Moderate			
Pugnose Minnow	<i>Opsopoeodus emiliae</i>	Moderate		G5	
Redlip Shiner	<i>Notropis chiliticus</i>	Moderate		G5	S1
River Chub	<i>Nocomis micropogon</i>	Moderate	Of Concern, State	G5	S?
Rosyface Chub	<i>Hybopsis rubrifrons</i>	Moderate		G4	SNR
Satinfin Shiner	<i>Cyprinella analostana</i>	Moderate		G5	SNR
Snail Bullhead	<i>Ameiurus brunneus</i>	Moderate		G4	SNR
Striped Bass	<i>Morone saxatilis</i>	Moderate		G5	SNR

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Tennessee Shiner	<i>Notropis leuciodus</i>	Moderate	Of Concern, State	G5	S?
Thicklip Chub	<i>Cyprinella labrosa</i>	Moderate		G4	SNR
V-lip Redhorse	<i>Moxostoma pappillosum</i>	Moderate	Of Concern, State	G4	S?
Warpaint Shiner	<i>Luxilus coccogenis</i>	Moderate	Of Concern, State	G5	S?
White Catfish	<i>Ameiurus catus</i>	Moderate		G5	SNR
Whitemouth Shiner	<i>Notropis alborus</i>	Moderate		G4	
Whitetail Shiner	<i>Cyprinella galactura</i>	Moderate		G5	SNR
Crayfish					
Mimic Crayfish	<i>Distocambarus carlsoni</i>	Highest		G3	SNR
Oconee Stream Crayfish	<i>Cambarus chaugaensis</i>	Highest		G2	S2S3
No Common Name	<i>Cambarus reflexus</i>	Highest		G4	S3
No Common Name	<i>Cambarus</i> sp. "B"	Highest			
No Common Name	<i>Distocambarus hunteri</i>	Highest		G1?	SNR
No Common Name	<i>Distocambarus youngineri</i>	Highest	Of Concern, State	G1	S1
No Common Name	<i>Procambarus echinatus</i>	Highest		G3	S3
Red Burrowing Crayfish	<i>Cambarus carolinus</i>	Highest		G4	S2?
Broad River Spiny Crayfish	<i>Cambarus spicatus</i>	High		G3	S3
No Common Name	<i>Distocambarus crockeri</i>	High		G3	S3
Pee Dee Lotic Crayfish	<i>Procambarus lepidodactylus</i>	High		G4	S4
Sandhills Crayfish	<i>Procambarus pearsei</i>	High		G4	S3
Waccamaw Crayfish	<i>Procambarus braswelli</i>	High		G2G3	SNR
Ditch Fencing Crayfish	<i>Faxonella clypeata</i>	Moderate		G5	S2?
Edisto Crayfish	<i>Procambarus ancylus</i>	Moderate		G4G5	S4S5
No Common Name	<i>Procambarus barbatus</i>	Moderate		G5	S4
No Common Name	<i>Procambarus chacei</i>	Moderate		G4	S4
No Common Name	<i>Procambarus enoplosternum</i>	Moderate		G4G5	SNR
No Common Name	<i>Procambarus hirsutus</i>	Moderate		G4	S4
No Common Name	<i>Procambarus lunzi</i>	Moderate		G4	S2S3
No Common Name	<i>Procambarus pubescens</i>	Moderate		G4G5	S3?
Rocky River Stream Crayfish	<i>Cambarus hobbsorum</i>	Moderate		G3G4	S3S4
Santee Crayfish	<i>Procambarus blandingii</i>	Moderate		G4	S4

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Freshwater Mussels					
Atlantic Pigtoe	<i>Fusconaia masoni</i>	Highest	State Endangered	G2	S?
Barrel Floater	<i>Anodonta couperiana</i>	Highest	Of Concern, State	G4	S?
Brook Floater	<i>Alasmidonta varicosa</i>	Highest	Of Concern, State	G3	S?
Brother Spike	<i>Elliptio fraterna</i>	Highest	State Endangered	G1	S1
Carolina Creekshell	<i>Villosa vagniana</i>	Highest		G2	
Carolina Heelsplitter	<i>Lasmigona decorata</i>	Highest	Federal and State Endangerd	G1	S1
Creeper	<i>Strophitus undulatus</i>	Highest	Of Concern, State	G5	S?
Notched Rainbow	<i>Villosa constricta</i>	Highest	Of Concern, State	G3	S?
Savannah Lilliput	<i>Toxolasma pullus</i>	Highest	Of Concern, State	G2	S1S3
Southern Rainbow	<i>Villosa vibex</i>	Highest	Of Concern, State	G4Q	S?
Triangle Floater	<i>Alasmidonta undulate</i>	Highest		G4	
Waccamaw Spike	<i>Elliptio waccamawensis</i>	Highest		G2	S1
Yellow Lampmussel	<i>Lampsilis cariosa</i>	Highest		G5	
Alewife Floater	<i>Anodonta implicate</i>	High			
Eastern Pondmussel	<i>Ligumia nasuta</i>	High		G4G5	
Northern Lance	<i>Elliptio fisheriana/nasutilus</i>	High		G4	
Pod Lance	<i>Elliptio folliculate</i>	High		G2G3	
Rayed Pink Fatmucket/Eastern Lampshell	<i>Lampsilis radiate/splendida</i>	High	Of Concern, State	G3	S?
Roanoke Slabshell	<i>Elliptio roanokensis</i>	High		G2G3	
Tidewater Mucket	<i>Leptodea ochracea</i>	High		G4	
Atlantic Spike	<i>Elliptio producta</i>	Moderate		G4	
Carolina Lance	<i>Elliptio angustata</i>	Moderate		G4	
Carolina Slabshell	<i>Elliptio congarea</i>	Moderate	Of Concern, State	G4	S?
Eastern Creekshell	<i>Villosa delumbis</i>	Moderate	Of Concern, State	G4	S?
Eastern Elliptio	<i>Elliptio complanata</i> complex	Moderate		G5	
Variable Spike	<i>Elliptio icterina</i> complex	Moderate		G4Q	

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Freshwater Snails					
Pebblesnail	<i>Somatogyrus</i> spp.	Highest			
Buffalo Pebblesnail	<i>Gillia altilis</i>	High		G5	SNR
Ridged Lioplax	<i>Lioplax subcarinata</i>	High		G5	S1
Snail	<i>Physa</i> sp. nov "A"	Moderate			
Marine Fish					
American Conger	<i>Conger oceanicus</i>				
Atlantic Bumper	<i>Chloroscombrus chrysurus</i>				
Atlantic Croaker	<i>Micropogonias undulatus</i>			G5	
Atlantic Cutlassfish	<i>Trichiurus lepturus</i>				
Atlantic Guitarfish	<i>Rhinobatos lentiginosus</i>				
Atlantic Menhaden	<i>Brevoortia tyrannus</i>				
Atlantic Moonfish	<i>Selene setapinnis</i>				
Atlantic Needlefish	<i>Strongylura marina</i>				
Atlantic Silverside	<i>Menidia menidia</i>				
Atlantic Spadefish	<i>Chaetodipterus faber</i>			G5	
Atlantic Stingray	<i>Dasyatis sabina</i>				
Atlantic Thread Herring	<i>Opisthonema oglinum</i>				
Atlantic Tripletail	<i>Lobotes surinamensis</i>				
Banded Drum	<i>Larimus fasciatus</i>				
Bank Cusk-eel	<i>Ophidion holbrooki</i>				
Bay Anchovy	<i>Anchoa mitchilli</i>			G5	
Bay Whiff	<i>Citharichthys spilopterus</i>				
Belted Sandfish	<i>Serranus subligarius</i>				
Bighead Searobin	<i>Prionotus tribulus</i>				
Black Drum	<i>Pogonias cromis</i>				
Black Grouper	<i>Mycteroperca bonaci</i>				
Black Sea Bass	<i>Centropomus striata</i>				
Blackcheek Tonguefish	<i>Symphurus plagiusa</i>				
Blacknose Shark	<i>Carcharhinus acronotus</i>				
Blacktip Shark	<i>Carcharhinus limbatus</i>				
Blotched Cusk-eel	<i>Ophidion grayi</i>				

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Blue Runner	<i>Caranx crysos</i>				
Bluefish	<i>Pomatomus saltatrix</i>				
Bluntnose Stingray	<i>Dasyatis say</i>				
Bonnethead	<i>Sphyrna tiburo</i>				
Broad Flounder	<i>Paralichthys squamilentus</i>				
Bull Pipefish	<i>Syngnathus springeri</i>				
Bull Shark	<i>Carcharhinus leucas</i>				
Bullnose Ray	<i>Myliobatis freminvillei</i>				
Butterfish	<i>Peprilus triacanthus</i>				
Carolina Hake	<i>Urophycis earllii</i>				
Chain Pipefish	<i>Syngnathus louisianae</i>				
Clearnose Skate	<i>Raja eglanteria</i>				
Cobia	<i>Rachycentron canadum</i>			GNR	
Cownose Ray	<i>Rhinoptera bonasus</i>				
Crested Blenny	<i>Hypleurochilus geminatus</i>				
Crevalle Jack	<i>Caranx hippos</i>			G5	
Darter Goby	<i>Ctenogobius boleosoma</i>				
Dotterel Filefish	<i>Aluterus heudelotii</i>				
Dusky Anchovy	<i>Anchoa lyolepis</i>				
Dusky Flounder	<i>Syacium papillosum</i>				
Dwarf Goatfish	<i>Upeneus parvus</i>				
Emerald Goby	<i>Ctenogobius smaragdus</i>				
Fat Sleeper	<i>Dormitator maculatus</i>				
Feather Blenny	<i>Hypsoblennius hentz</i>				
Finetooth Shark	<i>Carcharhinus isodon</i>			GNR	
Florida Pompano	<i>Trachinotus carolinus</i>				
Freckled Blenny	<i>Hypsoblennius ionthas</i>				
Freshwater Goby	<i>Ctenogobius shufeldti</i>				
Fringed Flounder	<i>Etropus crossotus</i>				
Gafftopsail Catfish	<i>Bagre marinus</i>				
Gag	<i>Mycteroperca microlepis</i>			GNR	
Goliath Grouper	<i>Epinephelus itajara</i>				
Gray Snapper	<i>Lutjanus griseus</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Green Goby	<i>Microgobius thalassinus</i>				
Guaguanche	<i>Sphyræna guachancho</i>				
Gulf Flounder	<i>Paralichthys albigutta</i>				
Gulf Kingfish	<i>Menticirrhus littoralis</i>			GNR	
Gulf Pipefish	<i>Syngnathus scovelli</i>				
Hardhead Catfish	<i>Arius felis</i>			G5	
Harvestfish	<i>Peprilus paru</i>				
Highfin Goby	<i>Gobionellus oceanicus</i>				
Hogchoker	<i>Trinectes maculatus</i>				
Horse-eye Jack	<i>Caranx latus</i>				
Inland Silverside	<i>Menidia beryllina</i>				
Inshore Lizardfish	<i>Synodus foetens</i>				
King Mackerel	<i>Scomberomorus cavalla</i>				
Ladyfish	<i>Elops saurus</i>				
Lane Snapper	<i>Lutjanus synagris</i>				
Largescaled Spinycheek Sleeper	<i>Eleotris amblyopsis</i>				
Lemon Shark	<i>Negaprion brevirostris</i>				
Leopard Searobin	<i>Prionotus scitulus</i>				
Lesser Electric Ray	<i>Narcine bancroftii</i>				
Lined Seahorse	<i>Hippocampus erectus</i>		VULNERABLE	G5	
Lookdown	<i>Selene vomer</i>				
Lyre Goby	<i>Evorthodus lyricus</i>				
Marsh Killifish	<i>Fundulus confluentus</i>				
Mummichog	<i>Fundulus heteroclitus</i>			G5	
Mutton Snapper	<i>Lutjanus analis</i>				
Naked Goby	<i>Gobiosoma bosc</i>			G5	
Naked Sole	<i>Gymnachirus melas</i>				
Northern Kingfish	<i>Menticirrhus saxatilis</i>			GNR	
Northern Pipefish	<i>Syngnathus fuscus</i>				
Northern Puffer	<i>Sphoeroides maculatus</i>				
Northern Searobin	<i>Prionotus carolinus</i>				
Northern Stargazer	<i>Astroscopus guttatus</i>				
Nurse Shark	<i>Ginglymostoma cirratum</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Ocellated Flounder	<i>Ancyloperetta quadrocellata</i>				
Off-shore Tonguefish	<i>Symphurus civitatum</i>				
Opossum Pipefish	<i>Microphis brachyurus</i>				
Orange Filefish	<i>Aluterus schoepfii</i>				
Oyster Toadfish	<i>Opsanus tau</i>				
Palespotted Eel	<i>Ophichthus puncticeps</i>				
Permit	<i>Trachinotus falcatus</i>				
Pigfish	<i>Orthopristis chrysoptera</i>				
Pinfish	<i>Lagodon rhomboides</i>				
Planehead Filefish	<i>Stephanolepis hispidus</i>				
Rainwater Killifish	<i>Lucania parva</i>				
Red Drum	<i>Sciaenops ocellatus</i>				
Red Grouper	<i>Epinephelus morio</i>				
Red Snapper	<i>Lutjanus campechanus</i>				
Rock Sea Bass	<i>Centropristis philadelphica</i>				
Rough Silverside	<i>Membras martinica</i>				
Roughtail Stingray	<i>Dasyatis centroura</i>				
Round Herring	<i>Etrumeus teres</i>				
Sailfin Molly	<i>Poecilia latipinna</i>			G5	SNR
Sand Perch	<i>Diplectrum formosum</i>				
Sand Tiger Shark	<i>Carcharias taurus</i>				
Sandbar Shark	<i>Carcharhinus plumbeus</i>				
Scaled Sardine	<i>Harengula jaguana</i>				
Scalloped Hammerhead	<i>Sphyrna lewini</i>				
Scup	<i>Stenotomus chrysops</i>				
Sea Lamprey	<i>Petromyzon marinus</i>				
Seaboard Goby	<i>Gobiosoma ginsburgi</i>				
Sharksucker	<i>Echeneis naucrates</i>				
Sharpnose Atlantic Shark	<i>Rhizoprionodon terraenovae</i>				
Sheepshead	<i>Archosargus probatocephalus</i>			G5	
Sheepshead Minnow	<i>Cyprinodon variegatus</i>				
Shelf Flounder	<i>Etropus cyclosquamus</i>				
Shrimp Eel	<i>Ophichthus gomesii</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Silver Jenny	<i>Eucinostomus gula</i>				
Silver Perch	<i>Bairdiella chrysoura</i>				
Silver Seatrout	<i>Cynoscion nothus</i>				
Skilletfish	<i>Gobiesox strumosus</i>				
Smooth Butterfly Ray	<i>Gymnura micrura</i>				
Smooth Dogfish	<i>Mustelus canis</i>				
Smooth Puffer	<i>Lagocephalus laevigatus</i>				
Southern Flounder	<i>Paralichthys lethostigma</i>			G5	
Southern Hake	<i>Urophycis floridana</i>				
Southern Kingfish	<i>Menticirrhus americanus</i>			GNR	
Southern Stargazer	<i>Astroscopus y-graecum</i>				
Southern Stingray	<i>Dasyatis americana</i>				
Spanish Mackerel	<i>Scomberomorus maculatus</i>				
Spanish Sardine	<i>Sardinella aurita</i>				
Speckled Worm Eel	<i>Myrophis punctatus</i>				
Spinner Shark	<i>Carcharhinus brevipinna</i>				
Spiny Dogfish	<i>Squalus acanthias</i>				
Spot	<i>Leiostomus xanthurus</i>			G5	
Spotfin Killifish	<i>Fundulus luciae</i>				
Spotfin Mojarra	<i>Eucinostomus argenteus</i>				
Spotted Hake	<i>Urophycis regia</i>				
Spotted Seatrout	<i>Cynoscion nebulosus</i>				
Spotted Whiff	<i>Citharichthys macrops</i>				
Star Drum	<i>Stellifer lanceolatus</i>				
Striped Anchovy	<i>Anchoa hepsetus</i>				
Striped Blenny	<i>Chasmodes bosquianus</i>				
Striped Burrfish	<i>Chilomycterus schoepfi</i>				
Striped Cusk-eel	<i>Ophidion marginatum</i>				
Striped Killifish	<i>Fundulus majalis</i>			G5	
Striped Mullet	<i>Mugil cephalus</i>			G5	
Striped Searobin	<i>Prionotus evolans</i>				
Summer Flounder	<i>Paralichthys dentatus</i>				
Tarpon	<i>Megalops atlanticus</i>			G5	

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Tiger Shark	<i>Galeocerdo cuvieri</i>				
Tomtate	<i>Haemulon aurolineatum</i>				
Weakfish	<i>Cynoscion regalis</i>				
White Mullet	<i>Mugil curema</i>				
Windowpane	<i>Scophthalmus aquosus</i>				
Marine Invertebrates					
a bush coral	<i>Oculina arbuscula</i>				
Alternate tellin	<i>Tellina alternata</i>				
American grass shrimp	<i>Periclimenes americanus</i>				
Tulip mussel	<i>Modiolus americanus</i>				
American tellin	<i>Tellina americana</i>				
American tube-dwelling anemone	<i>Ceriantheopsis americanus</i>				
Amethyst gemclam	<i>Gemma gemma</i>				
Angelwing	<i>Cyrtopleura costata</i>				
Angular brittle star	<i>Ophiothrix angulata</i>				
Antillean fireclam	<i>Lima pellucida</i>				
Antillean sphenia	<i>Sphenia antillensis</i>				
Arrow shrimp	<i>Tozeuma carolinense</i>				
Atlantic abra	<i>Abra aequalis</i>				
Atlantic awningclam	<i>Solemya velum</i>				
Atlantic brief squid	<i>Lolliguncula brevis</i>				
Atlantic diplodon	<i>Diplodonta punctata</i>				
Atlantic ghost crab	<i>Ocypode quadrata</i>				
Atlantic giant cockle	<i>Dinocardium robustum</i>				
Atlantic jackknife clam	<i>Ensis directus</i>				
Atlantic mud crab	<i>Panopeus herbstii</i>				
Atlantic mud piddock	<i>Barnea truncata</i>				
Atlantic nutclam	<i>Nucula proxima</i>				
Atlantic oyster drill	<i>Urosalpinx cinerea</i>				
Wedge rangia	<i>Rangia cuneata</i>				
Atlantic rock crab	<i>Cancer irroratus</i>				
Atlantic rupellar	<i>Rupellaria typica</i>				
Atlantic sand crab	<i>Emerita talpoida</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Atlantic sand fiddler crab	<i>Uca pugilator</i>				
Atlantic seabob	<i>Xiphopenaeus kroyeri</i>				
Atlantic surf clam	<i>Spisula solidissima</i>				
Atlantic wing-oyster	<i>Pteria colymbus</i>				
Bamboo worm	<i>Clymenella torquata</i>				
Banded dwarf hermit crab	<i>Pagurus annulipes</i>				
Banded porcelain crab	<i>Petrolisthes galathinus</i>				
Banded snapping shrimp	<i>Alpheus armillatus</i>				
Banded tulip	<i>Fasciolaria hunteria</i>				
Bay barnacle	<i>Balanus improvisus</i>				
Beach sowbug	<i>Chiridotea caeca</i>				
Beautiful topsnail	<i>Calliostoma pulchrum</i>				
Bee spionid	<i>Spiophanes bombyx</i>				
Biform ghost shrimp	<i>Biffarius biformis</i>				
Bigclaw snapping shrimp	<i>Alpheus normanni</i>				
Blisterworm	<i>Polydora websteri</i>				
Blood ark	<i>Anadara ovalis</i>				
Bloodworm	<i>Glycera americana</i>				
Blotched swimming crab	<i>Portunus spinimanus</i>				
Blue crab	<i>Callinectes sapidus</i>				
Boa scaleworm	<i>Sthenelais boa</i>				
Brackish grass shrimp	<i>Palaemonetes intermedius</i>				
Brilliant sea fingers	<i>Titanideum frauenfeldii</i>				
Bristled river shrimp	<i>Macrobrachium olfersii</i>				
Mangrove mud crab	<i>Eurytium limosum</i>				
Brown fanworm	<i>Notaulax nudicollis</i>				
Brown glass shrimp	<i>Leander tenuicornis</i>				
Brown shrimp	<i>Farfantepenaeus aztecus</i>				
Mottled dog whelk	<i>Nassarius vibex</i>				
Bryozoan shrimp	<i>Thor floridanus</i>				
Burrowing brittle star	<i>Hemipholis elongata</i>				
Shame faced crab	<i>Hepatus epheliticus</i>				
Canonball jellyfish	<i>Stomolophus meleagris</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Capitellid threadworm	<i>Capitella capitata</i>				
Caribbean spiny lobster	<i>Panulirus argus</i>				
Carolina marshclam	<i>Polymesoda caroliniana</i>				
Carolinian ghost shrimp	<i>Callichirus major</i>				
Carolinian squareback crab	<i>Speocarcinus carolinensis</i>				
Cayenne keyhole limpet	<i>Diodora cayenensis</i>				
Channeled barrel-bubble	<i>Acteocina canaliculata</i>				
Channeled whelk	<i>Busycotypus canaliculatus</i>				
Christmas tree hydroid	<i>Halocordyle disticha</i>				
Cinnamon river shrimp	<i>Macrobrachium acanthurus</i>				
Coarsehand lady crab	<i>Ovalipes stephensoni</i>				
Coastal mud shrimp	<i>Upogebia affinis</i>				
Cock shrimp	<i>Exhippolysmata oplophoroides</i>				
Cockscomb hydrobe	<i>Littoridinops monroensis</i>				
Colorful sea whip	<i>Leptogorgia virgulata</i>				
Combclaw shrimp	<i>Leptochela serratorbita</i>				
Common Atlantic sandhopper	<i>Americorchestia longicornis</i>				
Common Atlantic slippersnail	<i>Crepidula fornicata</i>				
Common jingle	<i>Anomia simplex</i>				
Common mantis shrimp	<i>Squilla empusa</i>				
Common Atlantic octopus	<i>Octopus vulgaris</i>				
Common sea mat	<i>Membranipora tenuis</i>				
Common sea pansy	<i>Renilla reniformis</i>				
Common sheep's-wool bryozoan	<i>Amathia convoluta</i>				
Common southern clamworm	<i>Nereis succinea</i>				
Concentric ervilia	<i>Ervilia concentrica</i>				
Contracted corbula	<i>Corbula contracta</i>				
Coquina Clam	<i>Conax variabilis</i>				
Coral shrimp	<i>Sicyonia laevigata</i>				
Corrugate jewelbox	<i>Chama congregata</i>				
Crab barnacle	<i>Chelonibia patula</i>				
Crested oyster	<i>Ostrea equestris</i>				
Cristate pea crab	<i>Austinia cristata</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Cross-hatched lucine	<i>Divaricella quadrisulcata</i>				
Crumb-of-bread sponge	<i>Halichondria bowerbanki</i>				
Cryptic teardrop crab	<i>Pelia mutica</i>				
Culver's sandworm	<i>Laeonereis culveri</i>				
Cupped shipworm	<i>Bankia gouldii</i>				
Daggerblade shrimp	<i>Palaemonetes pugio</i>				
Decorator crab	<i>Cryptodromiopsis antillensis</i>				
Delicate sheep's-wool bryozoan	<i>Amathia distans</i>				
Disk clam	<i>Dosinia discus</i>				
Divided tunicate	<i>Styela partita</i>				
Dusky stiliger	<i>Ercolania fuscata</i>				
Dwarf sandworm	<i>Aglaophamus verrilli</i>				
Dwarf surfclam	<i>Mulinia lateralis</i>				
Eastern aligena	<i>Aligena elevata</i>				
Eastern auger	<i>Terebra dislocata</i>				
Eastern bearded chiton	<i>Chaetopleura apiculata</i>				
Duck snail	<i>Melampus bidentatus</i>				
Mud dog whelk	<i>Nassarius obsoletus</i>				
Eastern oyster	<i>Crassostrea virginica</i>				
Eastern tube crab	<i>Polyonyx gibbesi</i>				
Eastern white slippersnail	<i>Crepidula plana</i>				
Elongate narrowed macoma	<i>Macoma tenta</i>				
Emerson's cerith	<i>Cerithiopsis emersoni</i>				
Estuarine longeye shrimp	<i>Ogyrides alphaerostris</i>				
Estuarine mud crab	<i>Rhithropanopeus harrisi</i>				
Eteone worm	<i>Eteone heteropoda</i>				
False angelwing	<i>Petricola pholadiformis</i>				
False arrow crab	<i>Metoporphaphis calcarata</i>				
Fat dovesnail	<i>Parvanachis obesa</i>				
Fine-lined hydrobe	<i>Onobops jacksoni</i>				
Fiona	<i>Fiona pinnata</i>				
Depressed mud crab	<i>Eurypanopeus depressus</i>				
Flatclaw hermit crab	<i>Pagurus pollicaris</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Florida rocksnail	<i>Thais haemastoma floridana</i>				
Florida stone crab	<i>Menippe mercenaria</i>				
Foliaceous shipworm	<i>Nototeredo knoxi</i>				
Forbes' sea star	<i>Asterias forbesii</i>				
Forceps shrimp	<i>Leptalpheus forceps</i>				
Fragile star barnacle	<i>Chthamalus fragilis</i>				
Fringed scaleworm	<i>Lepidonotus variabilis</i>				
Fringe-gilled mudworm	<i>Paraprionospio pinnata</i>				
Garlic sponge	<i>Lissodendoryx isodictyalis</i>				
Giant hermit crab	<i>Petrochirus diogenes</i>				
Glassy lyonsia	<i>Lyonsia (Entodesma) hyalina</i>				
Golden acorn worm	<i>Balanoglossus aurantiacus</i>				
Granulate shellback crab	<i>Hypoconcha arcuata</i>				
Gravel scud	<i>Lysianopsis alba</i>				
Gray pygmy venus	<i>Chione grus</i>				
Greedy dovesnail	<i>Costoanachis avara</i>				
Green colonial tunicate	<i>Perophora viridis</i>				
Green jackknife clam	<i>Solen viridis</i>				
Green sea urchin	<i>Lytechinus variegatus</i>				
Green snapping shrimp	<i>Alpheus heterochaelis</i>				
Green's cerith	<i>Cerithiopsis greeni</i>				
Hairy sea cucumber	<i>Sclerodactyla briareus</i>				
Half-smooth odostome	<i>Boonea seminuda</i>				
Hard Clams	<i>Mercenaria mercenaria</i>				
Northern quahog	<i>Mercenaria campechiensis</i>				
Hauff's alcyonidium	<i>Alcyonidium hauffi</i>				
Mud urchin	<i>Moira atropos</i>				
Purple marsh crab	<i>Sesarma reticulatum</i>				
Snail fur	<i>Hydractinia echinata</i>				
Hidden sea cucumber	<i>Pseudothyone belli</i>				
Hitchhiking anemone	<i>Calliactis tricolor</i>				
Honeycomb tubeworm	<i>Sabellaria floridensis</i>				
Horseshoe Crab	<i>Limulus polyphemus</i>				

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Horseshoe-crab flatworm	<i>Bdelloura candida</i>				
Ice cream cone worm	<i>Cistenides gouldii</i>				
Impressed odostome	<i>Boonea impressa</i>				
Incongruous ark	<i>Anadara brasiliana</i>				
Interrupted tunicate	<i>Ascidia interrupta</i>				
Iridescent shrimp	<i>Periclimenes iridescent</i>				
Iridescent swimming crab	<i>Portunus gibbesii</i>				
Ivory barnacle	<i>Balanus eburneus</i>				
Knobbed Whelk	<i>Busycon carica</i>			GNR	
Ocellate lady crab	<i>Ovalipes ocellatus</i>				
Lateral mussel	<i>Musculus lateralis</i>				
Lemon drop	<i>Doriopsilla pharpha</i>				
Lesser blue crab	<i>Callinectes similis</i>				
Lettered olive	<i>Oliva sayana</i>				
Lettuce bryozoan	<i>Thalamoporella floridana</i>				
Lightning whelk	<i>Busycon sinistrum</i>				
Crozier's flatworm	<i>Pseudoceros crozieri</i>				
Lined sea star	<i>Luidia clathrata</i>				
Lion's mane jellyfish	<i>Cyanea capillata</i>				
Long-armed hermit	<i>Pagurus longicarpus</i>				
Longnose spider crab	<i>Libinia dubia</i>				
Long-palped sandworm	<i>Ceratonereis irritabilis</i>				
Longtail grass shrimp	<i>Periclimenes longicaudatus</i>				
Loosanoff's haliclona	<i>Haliclona loosanoffi</i>				
Lunar dovesnail	<i>Astyris lunata</i>				
Lunz pea crab	<i>Pinnixa lunzi</i>				
Mahogany datemussel	<i>Lithophaga bisulcata</i>				
Mangrove tunicate	<i>Ecteinascidia turbinata</i>				
Many-lined lucine	<i>Parvilucina multilineata</i>				
Crowded wentletrap	<i>Epitonium multistriatum</i>				
Many-scaled worm	<i>Lepidametria commensalis</i>				
Marsh grass shrimp	<i>Palaemonetes vulgaris</i>				
Marsh periwinkle	<i>Littoraria irrorata</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Martinique crassinella	<i>Crassinella martinicensis</i>				
Masked swimming crab	<i>Callinectes larvatus</i>				
Medusa worm	<i>Loimia medusa</i>				
Milky ribbon worm	<i>Cerebratulus lacteus</i>				
Miniature moonshell	<i>Tectonatica pusilla</i>				
Moon jelly	<i>Aurelia aurita</i>				
Mottled encrusting tunicate	<i>Distaplia bermudensis</i>				
Mottled purse crab	<i>Persephona mediterranea</i>				
Sooty seahare	<i>Aplysia brasiliana</i>				
Mottled shore crab	<i>Pachygrapsus transversus</i>				
Mud brittle star	<i>Ophiophragmus wurdemanni</i>				
Mud fiddler crab	<i>Uca pugnax</i>				
Muddy-tuft bryozoan	<i>Anguinella palmata</i>				
Multi-tentacled sea wasp	<i>Chiropsalmus quadrimanus</i>				
Mushroom jelly	<i>Rhopilema verrilli</i>				
Neapolitan spurilla	<i>Spurilla neapolitana</i>				
Northern big-eyed sandhopper	<i>Americorchestia megalophthalma</i>				
Northern dwarf tellin	<i>Tellina agilis</i>				
Nut semele	<i>Semelina nuculoides</i>				
Oblong tunicate	<i>Clavelina oblonga</i>				
Obscure corambe	<i>Doridella obscura</i>				
Ohio river shrimp	<i>Macrobrachium ohione</i>				
Olivepit porcelain crab	<i>Euceraeus praelongus</i>				
One-tooth simnia	<i>Simnialena uniplicata</i>				
Onion anemone	<i>Paranthus rapiformis</i>				
Opal worm	<i>Arabella iricolor</i>				
Orange telesto	<i>Telesto fruticulosa</i>				
Ornate worm	<i>Amphitrite ornata</i>				
Oyster flatworm	<i>Stylochus ellipticus</i>				
Oyster pea crab	<i>Zaops ostreum</i>				
Oyster piddock	<i>Diplothyra smithii</i>				
Pale anemone	<i>Aiptasia pallida</i>				
Parasitic scalesnail	<i>Cochliolepis parasitica</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Parchment worm	<i>Chaetopterus variopedatus</i>				
Pearly lyonsia	<i>Lyonsia (Entodesma) beana</i>				
Pentagonal porcelain crab	<i>Megalobrachium soriatum</i>				
Peppermint shrimp	<i>Lysmata wurdemanni</i>				
Pink hydroid	<i>Eudendrium carneum</i>				
Northern pink shrimp	<i>Farfantepenaeus duorarum</i>				
Leathery tunicate	<i>Styela plicata</i>				
Plicate mangelia	<i>Pyrgocythara plicosa</i>				
Periscope tubeworm	<i>Diopatra cuprea</i>				
Ponderous ark	<i>Noetia ponderosa</i>				
Portly spider crab	<i>Libinia emarginata</i>				
Punctate mangelia	<i>Kurtziella limonitella</i>				
Purple tuft bryozoan	<i>Bugula neritina</i>				
Purple-spined sea urchin	<i>Arbacia punctulata</i>				
Purplish tagelus	<i>Tagelus divisus</i>				
Radial-ridged corbula	<i>Corbula swiftiana</i>				
Rainbow tellin	<i>Tellina iris</i>				
Red beard sponge	<i>Microciona prolifera</i>				
Red nemertean worm	<i>Micrura leidyi</i>				
Red threadworm	<i>Scoloplos rubra</i>				
Red-jointed fiddler crab	<i>Uca minax</i>				
Ribbed mussel	<i>Geukensia demissa</i>				
Roofing worm	<i>Owenia fusiformis</i>				
Rough shellback crab	<i>Hypoconcha parasitica</i>				
Roughneck shrimp	<i>Rimapenaeus constrictus</i>				
Rugose swimming crab	<i>Callinectes exasperatus</i>				
Saltmarsh mud crab	<i>Panopeus obesus</i>				
Sand dollar	<i>Mellita isometra</i>				
Sand longeye shrimp	<i>Ogyrides hayi</i>				
Sand-dollar pea crab	<i>Dissodactylus mellitae</i>				
Sapelo okenia	<i>Okenia sapelona</i>				
Sargassum nudibranch	<i>Scyllaea pelagica</i>				
Sargassum shrimp	<i>Latreutes parvulus</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Sargassum swimming crab	<i>Portunus sayi</i>				
Say mud crab	<i>Dyspanopeus sayi</i>				
Scorched mussel	<i>Brachidontes exustus</i>				
Florida top shell	<i>Calliostoma euglyptum</i>				
Sea grape	<i>Molgula manhattensis</i>				
Sea nettle	<i>Chrysaora quinquecirrha</i>				
Sea pork	<i>Aplidium stellatum</i>				
Sea wasp	<i>Tamoya haplonema</i>				
Seashore springtail	<i>Anurida maritima</i>				
Seaweed sowbug	<i>Erichsonella filiformis</i>				
Seawhip shrimp	<i>Neopontonides beaufortensis</i>				
Serpulid odostome	<i>Fargoa dianthophila</i>				
Shaggy parchment tubeworm	<i>Onuphis eremita</i>				
Shark eye	<i>Neverita duplicata</i>				
Short-armed brittle star	<i>Ophioderma brevispinum</i>				
Silkworm of the sea	<i>Polyodontes lupina</i>				
Slandered tellin	<i>Tellina probrina</i>				
Slender sargassum shrimp	<i>Latreutes fucorum</i>				
Smooth goose-neck barnacle	<i>Lepas anatifera</i>				
Smooth mud crab	<i>Hexapanopeus angustifrons</i>				
Southern lugworm	<i>Arenicola cristata</i>				
Southern quahog	<i>Mercenaria campechiensis</i>				
Speckled snapping shrimp	<i>Synalpheus fritzmuelleri</i>				
Speckled swimming crab	<i>Arenaeus cribrarius</i>				
Spineback hairy crab	<i>Pilumnus sayi</i>				
Sponge slug	<i>Doris verrucosa</i>				
Sponge threadworm	<i>Haplosyllis spongicola</i>				
Spotted porcelain crab	<i>Porcellana sayana</i>				
Squareback marsh crab	<i>Armases cinereum</i>				
Squatter pea shrimp	<i>Tumidotheres maculatus</i>				
Stout tagelus	<i>Tagelus plebeius</i>				
Striate tellin	<i>Tellina aequistriata</i>				
Striped sea cucumber	<i>Thyonella gemmata</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Subovate softshell clam	<i>Paramya subovata</i>				
Sunray venus	<i>Macrocallista nimbosa</i>				
Dall's dwarf tellin	<i>Tellina sybaritica</i>				
Tellin semele	<i>Cumingia tellinoides</i>				
Texas tellin	<i>Tellina texana</i>				
Thick-lip drill	<i>Eupleura caudata</i>				
Green-stripe hermit crab	<i>Clibanarius vittatus</i>				
New England dog whelk	<i>Nassarius trivittatus</i>				
Three-line pandora	<i>Pandora trilineata</i>				
Tiger armina	<i>Armina tigrina</i>				
Tinted cantharus	<i>Pisania tincta</i>				
Toothed crust bryozoan	<i>Parasmittina nitida</i>				
Tranverse ark	<i>Anadara transversa</i>				
Parchment-worm pea crab	<i>Pinnixa chaetoptera</i>				
Turtle barnacle	<i>Chelonibia testudinaria</i>				
Twelve-scaled worm	<i>Lepidonotus sublevis</i>				
Variable coquina (delete clam)	<i>Donax variabilis</i>				
Variable crust bryozoan	<i>Schizoporella errata</i>				
Variable dwarf olive	<i>Olivella mutica</i>				
American warty anemone	<i>Bunodosoma cavernata</i>				
Webster's mole crab	<i>Lepidopa websteri</i>				
Wedge piddock	<i>Martesia cuneiformis</i>				
Well-ribbed dovesnail	<i>Costoanachis lafresnayi</i>				
Western dondice	<i>Dondice occidentalis</i>				
Sandy sea squirt	<i>Molgula occidentalis</i>				
Northern white shrimp	<i>Litopenaeus setiferus</i>				
White strigilla	<i>Strigilla mirabilis</i>				
Worm reef hermit crab	<i>Pagurus carolinensis</i>				
Yellow boring sponge	<i>Cliona celata</i>				
Yellow pricklycockle	<i>Trachycardium muricatum</i>				
Zebra oyster flatworm	<i>Stylochus zebra</i>				
Zebra worm	<i>Trypanosyllis zebra</i>				
Eelgrass broken-back shrimp	<i>Hippolyte zostericola</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Acanthohaustorius intermedius</i>				
No common name	<i>Acanthohaustorius millsii</i>				
No common name	<i>Acartia tonsa</i>				
No common name	<i>Acetes americanus</i>				
No common name	<i>Achelia sawayai</i>				
No common name	<i>Acteocina candei</i>				
No common name	<i>Adocia tubifera</i>				
No common name	<i>Aegathoa oculata</i>				
No common name	<i>Aeverrillia armata</i>				
No common name	<i>Aeverrillia setigera</i>				
No common name	<i>Aiptasia eruptaurantia</i>				
No common name	<i>Albunea catherinae</i>				
No common name	<i>Amakusanthura magnifica</i>				
No common name	<i>Amathia vidovici</i>				
No common name	<i>Americamysis almyra</i>				
No common name	<i>Americamysis bahia</i>				
No common name	<i>Americamysis bigelowi</i>				
No common name	<i>Americhelidium americanum</i>				
No common name	<i>Americorophium aquafuscum</i>				
No common name	<i>Ameroculodes edwardsi</i>				
No common name	<i>Ampelisca abdita</i>				
No common name	<i>Ampelisca vadorum</i>				
No common name	<i>Ampelisca verrilli</i>				
No common name	<i>Amphinema dinema</i>				
No common name	<i>Amphinome rostrata</i>				
No common name	<i>Amphiodia atra</i>				
No common name	<i>Amphioplus abditus</i>				
No common name	<i>Amphipholis gracillima</i>				
No common name	<i>Amphiporeia virginiana</i>				
No common name	<i>Amphiporus cruentatus</i>				
No common name	<i>Amphiporus ochraceus</i>				
No common name	<i>Ampithoe valida</i>				
No common name	<i>Ancinus depressus</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Ancistrostylis commensalis</i>				
No common name	<i>Ancistrostylis jonesi</i>				
No common name	<i>Ancula evelinae</i>				
No common name	<i>Anisodoris prea</i>				
No common name	<i>Anoplodactylus lentus</i>				
No common name	<i>Anoplodactylus petiolatus</i>				
No common name	<i>Anoplodactylus pygmaeus</i>				
No common name	<i>Aphelochaeta marioni</i>				
No common name	<i>Aphelochaeta sp.</i>				
No common name	<i>Aplidium constellatum</i>				
No common name	<i>Aplysilla sulphurea</i>				
No common name	<i>Apocorophium acutum</i>				
No common name	<i>Apocorophium lacustre</i>				
No common name	<i>Apocorophium simile</i>				
No common name	<i>Arabella mutans</i>				
No common name	<i>Archidistoma aggregatum</i>				
No common name	<i>Aricidea bryani</i>				
No common name	<i>Aricidea fragilis</i>				
No common name	<i>Aricidea wassi</i>				
No common name	<i>Armandia agilis</i>				
No common name	<i>Armandia maculata</i>				
No common name	<i>Asabellides sp. A</i>				
No common name	<i>Astrangia poculata</i>				
No common name	<i>Asychis elongata</i>				
No common name	<i>Atylus minikoi</i>				
No common name	<i>Autolytus dentalius</i>				
No common name	<i>Autolytus prolifera</i>				
No common name	<i>Axiognathus squamatus</i>				
No common name	<i>Axiothella mucosa</i>				
No common name	<i>Balanoglossus gigas</i>				
No common name	<i>Balanus subalbidus</i>				
No common name	<i>Balanus venustus</i>				
No common name	<i>Barentsia laxa</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Batea catharinensis</i>				
No common name	<i>Bathyporeia parkeri</i>				
No common name	<i>Bemlos unicornis</i>				
No common name	<i>Berghia benteva</i>				
No common name	<i>Berghia coerulescens</i>				
No common name	<i>Bhawania goodei</i>				
No common name	<i>Bhawania heteroseta</i>				
No common name	<i>Bimeria brevis</i>				
No common name	<i>Boccardiella hamata</i>				
No common name	<i>Bougainvillia rugosa</i>				
No common name	<i>Bowerbankia gracilis</i>				
No common name	<i>Bowerbankia imbricata</i>				
No common name	<i>Bowmaniella dissimilis</i>				
No common name	<i>Bowmaniella mexicana</i>				
No common name	<i>Branchioasychis americana</i>				
No common name	<i>Branchiostoma sp.</i>				
No common name	<i>Brania clavata</i>				
No common name	<i>Brasilomysis castroi</i>				
No common name	<i>Bugula fulva</i>				
No common name	<i>Bugula stolonifera</i>				
No common name	<i>Calcarea sp. A</i>				
No common name	<i>Calliobdella vivida</i>				
No common name	<i>Callipallene brevirostris</i>				
No common name	<i>Caprella equilibra</i>				
No common name	<i>Caprella penantis</i>				
No common name	<i>Carazziella hobsonae</i>				
No common name	<i>Carcinonemertes carcinophila</i>				
No common name	<i>Carinoma tremaphoros</i>				
No common name	<i>Carinomella lactea</i>				
No common name	<i>Cassidinidea ovalis</i>				
No common name	<i>Catriona perca</i>				
No common name	<i>Caulleriella killariensis</i>				
No common name	<i>Caulleriella sp.</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Cerapus tubularis</i>				
No common name	<i>Cerebratulus lineolatus</i>				
No common name	<i>Cerebratulus sp. A</i>				
No common name	<i>Chione elevata</i>				
No common name	<i>Chiridotea almyra</i>				
No common name	<i>Chiridotea arenicola</i>				
No common name	<i>Cirriformia filigera</i>				
No common name	<i>Cirriformia grandis</i>				
No common name	<i>Cirrophorus lyriformis</i>				
No common name	<i>Cirrophorus sp.</i>				
No common name	<i>Cleantoides planicauda</i>				
No common name	<i>Cliona lobata</i>				
No common name	<i>Cliona robusta</i>				
No common name	<i>Cliona spirilla</i>				
No common name	<i>Cliona vastifica</i>				
No common name	<i>Clytia coronata</i>				
No common name	<i>Clytia cylindrica</i>				
No common name	<i>Clytia hemispherica</i>				
No common name	<i>Clytia kincaidi</i>				
No common name	<i>Colomastix halichondriae</i>				
No common name	<i>Conjuguterus parvus</i>				
No common name	<i>Conopea galeata</i>				
No common name	<i>Conopeum seurati</i>				
No common name	<i>Conopeum tenuissimum</i>				
No common name	<i>Coronadena mutabilis</i>				
No common name	<i>Coronis excavatrix</i>				
No common name	<i>Craniella laminaris</i>				
No common name	<i>Cratena pilata</i>				
No common name	<i>Crisia eburnea</i>				
No common name	<i>Cryptosula pallasiana</i>				
No common name	<i>Ctenodrilus serratus</i>				
No common name	<i>Cupuladria doma</i>				
No common name	<i>Cyathura burbancki</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Cyathura polita</i>				
No common name	<i>Cyclaspis pustulata</i>				
No common name	<i>Cyclaspis unicornis</i>				
No common name	<i>Cyclaspis varians</i>				
No common name	<i>Cyclostremiscus pentagonus</i>				
No common name	<i>Cymadusa compta</i>				
No common name	<i>Dasybranchus lumbricoides</i>				
No common name	<i>Demonax microphthalmus</i>				
No common name	<i>Dentatisyllis carolinae</i>				
No common name	<i>Dexiospira corrugata</i>				
No common name	<i>Didemnum candidum</i>				
No common name	<i>Digynopora americana</i>				
No common name	<i>Diplosoma macdonaldi</i>				
No common name	<i>Discoporella umbellata</i>				
No common name	<i>Dispio uncinata</i>				
No common name	<i>Dodecaceria concharum</i>				
No common name	<i>Dorvillea sociabilis</i>				
No common name	<i>Doto sp. A</i>				
No common name	<i>Drilonereis magna</i>				
No common name	<i>Drilonereis monroi</i>				
No common name	<i>Dulichella appendiculata</i>				
No common name	<i>Dynamena cornicina</i>				
No common name	<i>Echinaster brasiliensis</i>				
No common name	<i>Ectopleura dumortieri</i>				
No common name	<i>Edotia triloba</i>				
No common name	<i>Edwardsia leidy</i>				
No common name	<i>Elasmopus levis</i>				
No common name	<i>Electra monostachys</i>				
No common name	<i>Enchytraeidae sp. A</i>				
No common name	<i>Enoplobranchus sanguineus</i>				
No common name	<i>Entovalva sp. A</i>				
No common name	<i>Entovalva sp. B</i>				
No common name	<i>Eobrolgus spinosus</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Erichthonius brasiliensis</i>				
No common name	<i>Eteone lactea</i>				
No common name	<i>Eudendrium ramosum</i>				
No common name	<i>Eudendrium tenellum</i>				
No common name	<i>Eudevenopus honduranus</i>				
No common name	<i>Eudistoma carolinense</i>				
No common name	<i>Eudistoma hepaticum</i>				
No common name	<i>Eulalia sanguinea</i>				
No common name	<i>Eunice antennata</i>				
No common name	<i>Eusyllis lamelligera</i>				
No common name	<i>Euterpina acutifrons</i>				
No common name	<i>Exogone dispar</i>				
No common name	<i>Exogone verugera</i>				
No common name	<i>Exosphaeroma diminutum</i>				
No common name	<i>Fabricia sabella</i>				
No common name	<i>Fargoa bushiana</i>				
No common name	<i>Gammaropsis sutherlandi</i>				
No common name	<i>Gammarus daiberi</i>				
No common name	<i>Gammarus mucronatus</i>				
No common name	<i>Gammarus palustris</i>				
No common name	<i>Gammarus tigrinus</i>				
No common name	<i>Garveia franciscana</i>				
No common name	<i>Garveia humilis</i>				
No common name	<i>Gibbesia neglecta</i>				
No common name	<i>Gilvossius setimanus</i>				
No common name	<i>Gitanopsis tortugae</i>				
No common name	<i>Globosolembos smithi</i>				
No common name	<i>Glottidia pyramidata</i>				
No common name	<i>Glycera dibranchiata</i>				
No common name	<i>Glycera robusta</i>				
No common name	<i>Glycera sphyrabrancha</i>				
No common name	<i>Glycinde solitaria</i>				
No common name	<i>Goniada littorea</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Halecium gracile</i>				
No common name	<i>Halecium tenellum</i>				
No common name	<i>Haliclona permollis</i>				
No common name	<i>Halmyrapseudes bahamensis</i>				
No common name	<i>Haloclava producta</i>				
No common name	<i>Hargeria rapax</i>				
No common name	<i>Harmothoe aculeata</i>				
No common name	<i>Harmothoinae sp. A</i>				
No common name	<i>Haustorius canadensis</i>				
No common name	<i>Haustorius longirostris</i>				
No common name	<i>Hebella scandens</i>				
No common name	<i>Heteromastus filiformis</i>				
No common name	<i>Heteromysis formosa</i>				
No common name	<i>Hippoporida janthina</i>				
No common name	<i>Hippoporina verrilli</i>				
No common name	<i>Hyale plumulosa</i>				
No common name	<i>Hyalella azteca</i>				
No common name	<i>Hyboscolex longiseta</i>				
No common name	<i>Hydroides dianthus</i>				
No common name	<i>Hymeniacidon heliophila</i>				
No common name	<i>Idotea balthica</i>				
No common name	<i>Incisocalliope aestuarius</i>				
No common name	<i>Jaeropsis rathbunae</i>				
No common name	<i>Jassa marmorata</i>				
No common name	<i>Keratosa sp. A</i>				
No common name	<i>Kinbergonuphis jenneri</i>				
No common name	<i>Kupellonura formosa</i>				
No common name	<i>Learchis poica</i>				
No common name	<i>Leitoscoloplos fragilis</i>				
No common name	<i>Leitoscoloplos robustus</i>				
No common name	<i>Lembos hypacanthus</i>				
No common name	<i>Lepidactylus dytiscus</i>				
No common name	<i>Lepidasthenia varia</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Lepton sp. A</i>				
No common name	<i>Leptosynapta tenuis</i>				
No common name	<i>Leucon americanus</i>				
No common name	<i>Leucosolenia canariensis</i>				
No common name	<i>Leucothoe spinicarpa</i>				
No common name	<i>Lineus bicolor</i>				
No common name	<i>Lineus socialis</i>				
No common name	<i>Lineus sp. A</i>				
No common name	<i>Linvillea agassizi</i>				
No common name	<i>Listriella barnardi</i>				
No common name	<i>Listriella clymenellae</i>				
No common name	<i>Livoneca redmanii</i>				
No common name	<i>Livoneca reniformis</i>				
No common name	<i>Loimia viridis</i>				
No common name	<i>Lomanotus sp. A</i>				
No common name	<i>Lovenella gracilis</i>				
No common name	<i>Loxosomella cricketae</i>				
No common name	<i>Loxosomella tethyae</i>				
No common name	<i>Lucifer faxoni</i>				
No common name	<i>Lumbrineris coccinea</i>				
No common name	<i>Lysidice ninetta</i>				
No common name	<i>Lysilla alba</i>				
No common name	<i>Macroclymene zonalis</i>				
No common name	<i>Maera caroliniana</i>				
No common name	<i>Maera williamsi</i>				
No common name	<i>Magelona papillicornis</i>				
No common name	<i>Magelona phyllisae</i>				
No common name	<i>Magelona sp.</i>				
No common name	<i>Malmgrenia lunulata</i>				
No common name	<i>Manayunkia aestuarina</i>				
No common name	<i>Mancocuma altera</i>				
No common name	<i>Marphysa sanguinea</i>				
No common name	<i>Mediomastus ambiseta</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Mediomastus californiensis</i>				
No common name	<i>Megalomma lobiferum</i>				
No common name	<i>Melinna maculata</i>				
No common name	<i>Melita nitida</i>				
No common name	<i>Membranipora arborescens</i>				
No common name	<i>Mesochaetopterus taylori</i>				
No common name	<i>Metamysidopsis swifti</i>				
No common name	<i>Metharpinia floridana</i>				
No common name	<i>Microprotopus raneyi</i>				
No common name	<i>Microprotopus shoemakeri</i>				
No common name	<i>Miesea evelinae</i>				
No common name	<i>Mnemiopsis leidyi</i>				
No common name	<i>Monocorophium acherusicum</i>				
No common name	<i>Monocorophium tuberculatum</i>				
No common name	<i>Monopylephorus rubroniveus</i>				
No common name	<i>Montacutidae sp. A</i>				
No common name	<i>Montecellina sp.</i>				
No common name	<i>Mooreonuphis nebulosa</i>				
No common name	<i>Myscale cecilia</i>				
No common name	<i>Myscale sp. A</i>				
No common name	<i>Myrianida pachycera</i>				
No common name	<i>Myriochele oculata</i>				
No common name	<i>Mysella sp. B</i>				
No common name	<i>Mysella sp. C</i>				
No common name	<i>Mysidopsis furca</i>				
No common name	<i>Nemertopsis bivittata</i>				
No common name	<i>Neohaustorius biarticulatus</i>				
No common name	<i>Neohaustorius schmitzi</i>				
No common name	<i>Neomysis americana</i>				
No common name	<i>Nephtys bucera</i>				
No common name	<i>Nephtys picta</i>				
No common name	<i>Nereiphylla fragilis</i>				
No common name	<i>Nereis acuminata</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Nereis falsa</i>				
No common name	<i>Nolella stipata</i>				
No common name	<i>Notomastus hemipodus</i>				
No common name	<i>Notomastus latericeus</i>				
No common name	<i>Notomastus lobatus</i>				
No common name	<i>Nymphopsis duodorsospinosa</i>				
No common name	<i>Obelia bidentata</i>				
No common name	<i>Obelia dichotoma</i>				
No common name	<i>Obelia geniculata</i>				
No common name	<i>Octolasmis mulleri</i>				
No common name	<i>Odontosyllis fulgurans</i>				
No common name	<i>Oerstedia dorsalis</i>				
No common name	<i>Okenia impexa</i>				
No common name	<i>Okenia sp. A</i>				
No common name	<i>Okenia sp. B</i>				
No common name	<i>Oligoclado floridanus</i>				
No common name	<i>Ophryotrocha puerilis</i>				
No common name	<i>Ophryotrocha sp. A</i>				
No common name	<i>Orbinia ornata</i>				
No common name	<i>Orbinia riseri</i>				
No common name	<i>Orchestia grillus</i>				
No common name	<i>Oxyurostylis smithi</i>				
No common name	<i>Pantionemertes agricola</i>				
No common name	<i>Paracalanus crassirostris</i>				
No common name	<i>Paracaprella tenuis</i>				
No common name	<i>Paracerceis caudata</i>				
No common name	<i>Parahaustorius longimerus</i>				
No common name	<i>Parahesione luteola</i>				
No common name	<i>Paranais (frici?)</i>				
No common name	<i>Paranaitis gardineri</i>				
No common name	<i>Paranaitis speciosa</i>				
No common name	<i>Paranemertes biocellatus</i>				
No common name	<i>Paraonis fulgens</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Parapionosyllis longicirrata</i>				
No common name	<i>Parapionosyllis sp.</i>				
No common name	<i>Parhyale hawaiiensis</i>				
No common name	<i>Paysa quadridentata</i>				
No common name	<i>Pedicellina cernua</i>				
No common name	<i>Peloscolex sp. A</i>				
No common name	<i>Pentamera pulcherrima</i>				
No common name	<i>Persephona aquilonaris</i>				
No common name	<i>Phascolion strombus</i>				
No common name	<i>Phoronis architecta</i>				
No common name	<i>Phoronis ovalis</i>				
No common name	<i>Photis pugnator</i>				
No common name	<i>Phyllodoce arenae</i>				
No common name	<i>Pinnixa retinens</i>				
No common name	<i>Pinnixa sayana</i>				
No common name	<i>Piromis eruca</i>				
No common name	<i>Pista palmata</i>				
No common name	<i>Plagiosomum sp. A</i>				
No common name	<i>Platynereis dumerilii</i>				
No common name	<i>Plumularia floridana</i>				
No common name	<i>Podarke obscura</i>				
No common name	<i>Podarkeopsis levifuscina</i>				
No common name	<i>Poecilosclerida sp. A</i>				
No common name	<i>Polycera hummi</i>				
No common name	<i>Polycerella emertoni</i>				
No common name	<i>Polycirrus carolinensis</i>				
No common name	<i>Polycirrus eximius</i>				
No common name	<i>Polycirrus sp.</i>				
No common name	<i>Polydora colonia</i>				
No common name	<i>Polydora cornuta</i>				
No common name	<i>Polydora socialis</i>				
No common name	<i>Potamilla reniformis</i>				
No common name	<i>Potamilla torelli</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Prionospio cirrifera</i>				
No common name	<i>Prionospio cristata</i>				
No common name	<i>Prionospio dayi</i>				
No common name	<i>Probopyrinella latreuticola</i>				
No common name	<i>Proceraea fasciata</i>				
No common name	<i>Prosthiostomum pulchrum</i>				
No common name	<i>Prosuberites microsclerus</i>				
No common name	<i>Protohaustorius deichmannae</i>				
No common name	<i>Pseudeurythoe ambigua</i>				
No common name	<i>Pseudione upogebiae</i>				
No common name	<i>Pseudodiptomus coronatus</i>				
No common name	<i>Pseudohhaustorius caroliniensis</i>				
No common name	<i>Pycnogonum cessaci</i>				
No common name	<i>Rhepoxynius epistomus</i>				
No common name	<i>Rhepoxynius hudsoni</i>				
No common name	<i>Sabellaria vulgaris vulgaris</i>				
No common name	<i>Saccoglossus kowalevskii</i>				
No common name	<i>Schistomeringos rudolphi</i>				
No common name	<i>Schizocardium brasiliense</i>				
No common name	<i>Schizoporella unicornis</i>				
No common name	<i>Schizotricha tenella</i>				
No common name	<i>Scolecoplepides viridis</i>				
No common name	<i>Scolecopsis squamata</i>				
No common name	<i>Scolecopsis texana</i>				
No common name	<i>Scoletoma impatiens</i>				
No common name	<i>Scoletoma tenuis</i>				
No common name	<i>Scypha barbadensis</i>				
No common name	<i>Seila adamsi</i>				
No common name	<i>Sextonia sp. A</i>				
No common name	<i>Sphaeroma quadridentatum</i>				
No common name	<i>Sphaerosyllis longicauda</i>				
No common name	<i>Spilocuma watlingi</i>				
No common name	<i>Spio multioculata</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Spio setosa</i>				
No common name	<i>Spiochaetopterus costarum oculatus</i>				
No common name	<i>Stenothoe georgiana</i>				
No common name	<i>Stenothoe minuta</i>				
No common name	<i>Stenothoe valida</i>				
No common name	<i>Streblospio benedicti</i>				
No common name	<i>Streptosyllis arenae</i>				
No common name	<i>Stylochus oculiferus</i>				
No common name	<i>Sundanella sibogae</i>				
No common name	<i>Syllis cornuta</i>				
No common name	<i>Syllis gracilis</i>				
No common name	<i>Syllis hyalina</i>				
No common name	<i>Synelmis ewingi</i>				
No common name	<i>Synnotum aegyptiacum</i>				
No common name	<i>Tanaissus psammophilus</i>				
No common name	<i>Tanystylum orbiculare</i>				
No common name	<i>Telmatogeton japonicus</i>				
No common name	<i>Tenaciella obliqua</i>				
No common name	<i>Tenellia pallida</i>				
No common name	<i>Terebella rubra</i>				
No common name	<i>Tetrastemma candidum</i>				
No common name	<i>Thalassema hartmani</i>				
No common name	<i>Tharyx acutus</i>				
No common name	<i>Tharyx setigera</i>				
No common name	<i>Thecacera pennigera</i>				
No common name	<i>Thelepus setosus</i>				
No common name	<i>Themiste alutacea</i>				
No common name	<i>Theristus polychaetophilus</i>				
No common name	<i>Thysanozoon brocchi</i>				
No common name	<i>Tortanus setacaudatus</i>				
No common name	<i>Trapania sp. A</i>				
No common name	<i>Travisia parva</i>				
No common name	<i>Tridentata distans</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
No common name	<i>Triticella elongata</i>				
No common name	<i>Tritonia bayeri</i>				
No common name	<i>Tubificoides brownae</i>				
No common name	<i>Tubificoides heterochaetus</i>				
No common name	<i>Tubificoides wasselli</i>				
No common name	<i>Tubulanus pellucidus</i>				
No common name	<i>Tubulanus rhabdotus</i>				
No common name	<i>Tubularia crocea</i>				
No common name	<i>Turbonilla acicula</i>				
No common name	<i>Turbonilla buteonis</i>				
No common name	<i>Turbonilla wrightsvillensis</i>				
No common name	<i>Turritopsis nutricula</i>				
No common name	<i>Uhlorchestia spartinophila</i>				
No common name	<i>Uhlorchestia uhleri</i>				
No common name	<i>Unciola dissimilis</i>				
No common name	<i>Unciola irrorata</i>				
No common name	<i>Unciola serrata</i>				
No common name	<i>Vitrinellidae sp. A</i>				
No common name	<i>Xestospongia halichondrioides</i>				
No common name	<i>Zoobotryon verticillatum</i>				
No common name	<i>Zygeupolia rubens</i>				
No common name	<i>Zygonemertes virescens</i>				
Insects					
American Sand Burrowing Mayfly	<i>Dolania Americana</i>			G4	S3
Black Fly	<i>Ectemnia invenusta</i>				
Calvert's Emerald	<i>Somatochlora calverti</i>			G3	SNR
Coyle's Purseweb Spider	<i>Sphodros coylei</i>		Of Concern, State	G4?	S?
Diana Fritillary	<i>Speyeria diana</i>			G3G4	S3?
Elephant (or Treehole) Predatory Mosquito	<i>Toxorhynchites rutilus rutilus/ T.r.septentrionalis</i>			GNR	
Forestiera Lace Bugs	<i>Leptoypha elliptica/L. ilicis</i>				
Moretti's Caddisfly	<i>Protophila moretti</i>			G1G2	SNR
Moth sp.	<i>Agnorisma bollii</i>			G4?	
Pointy-lobed Firefly	<i>Photinus acuminatus</i>				

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Common Name	Scientific Name	Priority	Legal Status	G Rank	S Rank
Pyramid Ants	<i>Dorymyrmex bureni/D. medeis</i>				
Sandhills Earth Boring Scarab Beetle	<i>Mycotrupes retusus</i>				
Smokies Needlefly	<i>Megaleuctra williamsae</i>			G2	
White Beach Tiger Beetle	<i>Cicindela dorsalis media</i>			G4T4	S4
Zigadenus Sawfly	<i>Rhadinoceraea zigadenusae</i>				