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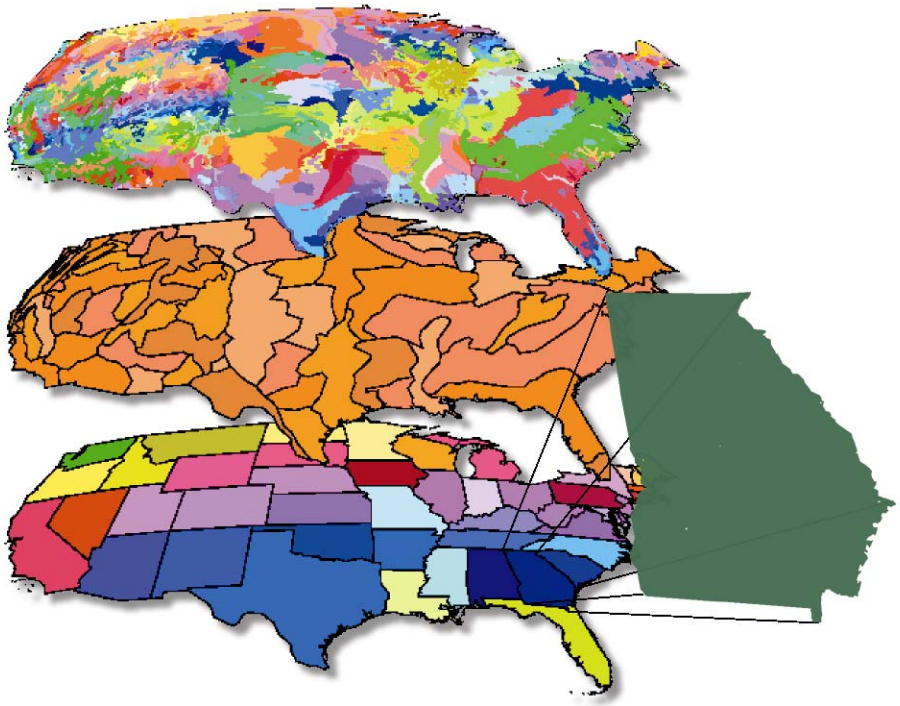
GAP

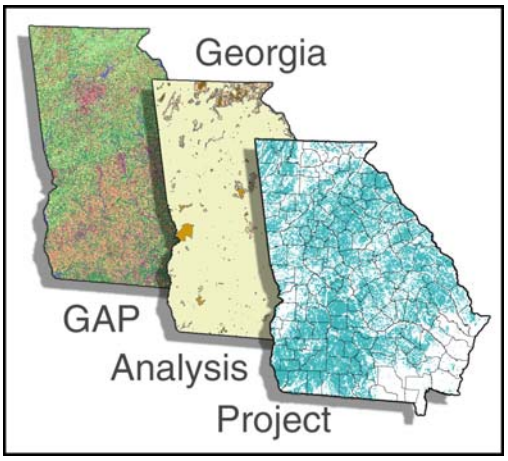
A GAP ANALYSIS OF GEORGIA

August 2003 Final Report



A GEOGRAPHIC APPROACH TO PLANNING FOR BIOLOGICAL DIVERSITY

U.S. Department of the Interior
U.S. Geological Survey



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U.S. Geological Survey
Biological Resources Division
Gap Analysis Program

A Geographic Approach to Planning for Biological Diversity

U.S. Department of the Interior
U.S. Geological Survey

The Georgia Gap Analysis Project

Final Report

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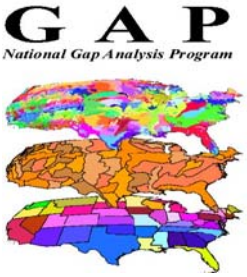

Project Affilliates:

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The Warnell School of Forest Resources, University of Georgia
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EXECUTIVE SUMMARY

Gap analysis is a scientific method for identifying the degree to which native animal species and natural communities are represented in our present-day mix of conservation lands. Those species and communities not adequately represented in the existing network of conservation lands constitute conservation "gaps." The purpose of the Gap Analysis Program (GAP) is to provide broad geographic information on the status of ordinary species (those not threatened with extinction or naturally rare) and their habitats in order to provide land managers, planners, scientists, and policy makers with the information they need to make better-informed decisions (Scott et al. 1993).

The Georgia Gap Analysis Project (hereafter GA-GAP) is part of the National Gap Analysis Program coordinated by the USGS Biological Resources Division. GA-GAP is a cooperative effort at the University of Georgia between the Natural Resources Spatial Analysis Laboratory (NARSAL) in the Institute of Ecology and the Georgia Cooperative Fish and Wildlife Research Unit at the Warnell School of Forest Resources. The project was cosponsored by the Georgia Department of Natural Resources – Wildlife Resources Division. Other project affiliates included the U.S. Environmental Protection Agency, Turner Foundation, Sapelo Foundation, The Nature Conservancy and the Georgia Museum of Natural History. The objectives of the project were to: 1) map the natural land cover of the state, natural vegetation initially being defined as alliances (Federal Geographic Data Committee 1997), and later modified to a level similar to ecological systems (Comer et al 2003); 2) predict the potential occurrence of terrestrial vertebrate species across Georgia; 3) produce a database of protected lands within the state; 4) document the occurrence of natural communities and vertebrate species in lands managed for the long-term conservation of biodiversity; 5) make all GA-GAP information available to decision-makers, researchers, and all other interested persons; and 6) build partnerships during the development of this data.

The GA-GAP land cover contains forty-four classes, and maps natural cover types as well as man-made features. The land cover map was created from 1998 Landsat Thematic Mapper (TM) satellite data at a resolution of 30 by 30 meters, and over two iterations: the first iteration was a general 18-class map intended for use in applications requiring less detailed analysis of vegetation types, such as analysis of land cover change (Natural Resources Spatial Analysis Laboratory 2001b), land use planning, and water and air quality monitoring; the second was more detailed, and made finer distinctions between natural vegetation types and a few human-dominated cover types. Results of the mapping process found that 71% of Georgia is presently in a forested condition. The most common forest types were pine, most of which are only in a semi-natural state. Wetlands make up 12% of Georgia's land cover, and agricultural or pasture areas cover 20%. Some type of urban development may be found on 3% of the land area of Georgia; this figure has nearly doubled since 1974 (Natural Resources Spatial Analysis Laboratory 2001b). We estimate that 36% of the state is in some type of natural vegetation, such as natural forest, wetland, or marsh. The Blue Ridge ecoregion has 78% of its land area in natural communities, whereas the Piedmont and Coastal Plain are 35% and 33%, respectively.

Accuracy of the first map was assessed through aerial videography and aerial photography. Use of aerial videography and photography involve the collection of images during low altitude flights. Land cover classes are then identified in these images and compared with those mapped from the satellite images. Accuracy of the second map was assessed through a combination of ground assessment points, aerial videography, and aerial photography. Overall accuracy for the first map was 84.7%. Overall accuracy for the second map was 75.5%.

We predicted distributions throughout Georgia for a total of 405 terrestrial vertebrate species. This included 78 amphibians, 167 breeding birds, 78 mammals, and 82 reptiles. Distributions were created by combining known ranges with habitat associations; both were derived through a combination of thorough literature review,

examination of occurrence records, and expert input. Accuracy of predicted vertebrate distributions was assessed by comparing GA-GAP results with Breeding Bird Survey results from 1988-1998 and confirmed species lists compiled for specific areas. On areas averaging 15,191 ha, GA-GAP predictions had omission error rates of 4.0% and commission error rates of 16.1%. Omission errors indicate where our models failed to predict actual species occurrence; commission errors indicate where our models predicted a species to occur, but it actually did not.

Species richness of vertebrates was examined across land cover types and by Environmental Monitoring and Assessment Program (EMAP) hexagons. Analysis by cover type was intended to highlight habitat types that occur over a small area, yet contain a high diversity of animals. Analysis by hexagon illustrated species diversity from a landscape perspective.

Species richness, or number of species, by cover type varied by taxa: amphibian and bird richness were highest in the bottomland hardwood cover type; mammal richness was highest in deciduous cove hardwoods, submesic hardwoods, and mixed pine-hardwoods; reptile richness was highest in the mixed pine-hardwood and clearcut-sparse vegetation classes. Overall species richness was highest in bottomland hardwoods. Notably rich natural cover types found over small portions of the state included mesic hardwoods, deciduous cove hardwoods, mixed cove forest, and longleaf pine.

There were on average of 245 species found in each hexagon. However, species richness by EMAP hexagon varied by taxa. Amphibian richness was highest on the Coastal Plain, particularly southwest Georgia; bird richness was highest in the Blue Ridge and along the coast; mammal richness was highest in the Blue Ridge; reptile richness was highest in the Coastal Plain, especially southwest Georgia. Total species richness was highest in the Coastal Plain, with the coast, Fall Line, Savannah River valley, and southwest Georgia all highly diverse.

The land stewardship database was the final primary data layer of GA-GAP. Protected areas in this database included both public and private lands, with lands protected through fee simple ownership, lease, and conservation easement. Lands were ranked according to National Gap standards, which consider the primary management objectives of an area as well as the permanence of protection. Rankings of GAP status 1 or 2 indicate permanent protection from conversion of natural land cover types, as in federally designated Wilderness or National Scenic Areas. Other lands, GAP status 3, allow activities that may degrade natural landscapes, but still can afford some protection. Examples of this include the many leased Wildlife Management Areas (WMA's) found throughout the state. According to our analysis, about 8% of Georgia, or 1.2 million hectares, is protected as some sort of conservation land. Less than half of this figure, or 543,000 hectares, is protected in GAP status 1 or 2 lands.

The primary objective of GAP is to provide information on the distribution and protection status of several elements of biological diversity. Intersecting the land stewardship map with the land cover and the species distributions resulted in tables showing the relative proportions of each cover type and habitat for each species in some kind of protection. Less than 1% protection indicates a species or cover type that is essentially unprotected. Levels of 10%, 20%, and 50% have been recommended in the literature as necessary for conservation (Odum and Odum 1972; Specht et al. 1974; Ride 1975; Miller 1994; Noss 1991; Noss and Cooperrider 1994). We provided breakdowns along these lines for each species and cover type.

No natural land cover types had less than 1% of their total area protected on GAP status 1 or 2 lands. A number of cover types had less than 10% protected on 1 or 2 lands. This category included bottomland hardwoods, which also contained the highest species richness of any land cover type, sandhills, and a number of hardwood forest types. The best-protected cover types (more than 20% of their area in GAP status 1 or 2) were found

mainly at the highest elevations of the Blue Ridge and on the barrier islands. GAP status 3 lands provided some protection for a number of land cover types, albeit with fewer restrictions and less permanence. In examining the protection status of land cover types, it is important to remember that GA-GAP figures do not historic distributions of cover types. Some types, such as longleaf pine, formerly covered much greater areas than they do at present, and amount of longleaf pine currently protected is but a small fraction of what existed historically.

Most of the vertebrate species with less than 1% of their habitat protected in status 1 or 2 lands were those associated with human-dominated landscapes. However, there were several of conservation concern, including the loggerhead shrike and the Alabama map turtle. Over 60% of the species in all four taxa were protected in less than 10% of their habitat. Species with more than 20% of their habitat protected on GAP status 1 or 2 lands tended to be restricted to high elevations or coastal areas. An example is the common raven, found only at the highest elevations in Georgia, and at 99.7% on GAP status 1 and 2 lands, the best-protected species in the state.

This project has provided Georgia with the most spatially refined and thematically detailed statewide compilation of information on land cover types, vertebrate species distributions, and land cover status information to date. Although there remain updates and improvements to be made, we believe that GA-GAP data should provide an excellent starting point for many important conservation decisions. In addition, GA-GAP fostered unique opportunities for partnerships and cooperation between agencies and individuals. It is hoped that this cooperation will continue long into the future.

ACKNOWLEDGMENTS

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Chapter 1 - INTRODUCTION

How This Report is Organized

This report is a summation of a scientific project. While we endeavor to make it understandable for as general an audience as practicable, it will reflect the complexity of the project it describes. A glossary of terms is provided to aid the reader in its understanding, and for those seeking a detailed understanding of the subjects, the cited literature should be helpful. The organization of this report follows the general chronology of project development, beginning with the production of the individual data layers and concluding with analysis of the data. It diverges from standard scientific reporting by embedding results and discussion sections within individual chapters. This was done to allow the individual data products to stand on their own as testable hypotheses and provide data users with a concise and complete report for each data and analysis product.

We begin with an overview of the Gap Analysis mission, concept, and limitations. We then present a synopsis of how the current biodiversity condition of the project area came to be, followed by land cover mapping, animal species distribution prediction, species richness, and land stewardship mapping and categorization. Data development leads to the Analysis section which reports on the status of the elements of biodiversity (natural community alliances and terrestrial vertebrate species) for Georgia. Finally, we describe the management implications of the analysis results and provide information on how to acquire and use the data.

The Gap Analysis Program Mission

The mission of the Gap Analysis Program is to prevent conservation crises by providing conservation assessments of animals and their habitats and to facilitate the application of this information to land management activities.

This is accomplished through the following five objectives:
1) map actual land cover as closely as possible to the Alliance level (FGDC 1997).
2) map the predicted distribution of those terrestrial vertebrates that spend any important part of their life history in the project area and for which adequate distributional habitats, associations, and mapped habitat variables are available. Map other taxa as cooperative opportunities allow.
3) document the representation of natural land cover types and animal species in areas managed for the long-term maintenance of biodiversity.
4) make all GAP Project information available to the public and those charged with land use research, policy, planning, and management.
5) build institutional cooperation in the application of this information to state and regional management activities.

To meet these objectives, it is necessary that GAP be operated at the state level but maintain consistency with national standards. Within the state, participation by a variety of cooperators is necessary and desirable to ensure understanding and acceptance of the data and forge relationships that will lead to cooperative conservation planning.

The Gap Analysis Concept

The Gap Analysis Program (GAP) brings together the problem-solving capabilities of federal, state, and private scientists to tackle the difficult issues of land cover mapping, vertebrate habitat characterization, assessment, and biodiversity conservation at the state, regional, and national levels. The program seeks to facilitate cooperative development and use of information. Throughout this report we use the terms “GAP” to describe

the national program, “GAP Project” to refer to an individual state or regional project, and “gap analysis” to refer to the gap analysis process or methodology.

Much of the following discussion was taken verbatim from Edwards et al. 1995, Scott et al. 1993, and Davis et al. 1995. The gap analysis process provides an overview of the distribution and conservation status of several components of biodiversity. It uses the distribution of actual vegetation and terrestrial vertebrates and, when available, invertebrate taxa. Digital map overlays in a GIS are used to identify individual species, species-rich areas, and vegetation types that are not represented or underrepresented in existing management areas. It functions as a preliminary step to the more detailed studies needed to establish actual boundaries for potential biodiversity management areas. These data and results are then made available to institutions as well as individual land owners and managers so that they may become more effective stewards through more complete knowledge of the management status of these elements of biodiversity. GAP, by focusing on higher levels of biological organization, is likely to be both cheaper and more likely to succeed than conservation programs focused on single species or populations (Scott et al. 1993).

Biodiversity inventories can be visualized as "filters" designed to capture elements of biodiversity at various levels of organization. The filter concept has been applied by The Nature Conservancy, which has established Natural Heritage Programs in all 50 states, most of which are now operated by state government agencies. The Nature Conservancy employs a fine filter of rare species inventory and protection and a coarse filter of community inventory and protection (Jenkins 1985, Noss 1987). It is postulated that 85-90% of species can be protected by the coarse filter, without having to inventory or plan reserves for those species individually. A fine filter is then applied to the remaining 15-10% of species to ensure their protection. Gap analysis is a coarse filter method because it can be used to assess the other 85-90% of species quickly and cheaply.

The intuitively appealing idea of conserving most biodiversity by maintaining examples of all natural community types has never been applied, although numerous approaches to the spatial identification of biodiversity have been described (Kirkpatrick 1983; Margules et al.1988; Pressey and Nicholls 1989; Nicholls and Margules 1993). Furthermore, the spatial scale at which organisms use the environment differs tremendously among species and depends on body size, food habits, mobility, and other factors. Hence, no coarse filter will be a complete assessment of biodiversity protection status and needs. However, species that fall through the pores of the coarse filter, such as narrow endemics and wide-ranging mammals, can be captured by the safety net of the fine filter. Community-level (coarse-filter) protection is a complement to, not a substitute for, protection of individual rare species.

Gap analysis is essentially an expanded coarse-filter approach (Noss 1987) to biodiversity protection. The vegetation types mapped in GAP serve directly as a coarse filter, the goal being to assure adequate representation of all types in biodiversity management areas. Landscapes with great vegetation diversity often are those with high edaphic variety or topographic relief. When elevation diversity is very great, a nearly complete spectrum of vegetation types known from a biological region may occur within a relatively small area. Such areas provide habitat for many species, including those that depend on multiple habitat types to meet life history needs (Diamond 1986; Noss 1987). By using landscape-sized samples (Forman and Godron 1986) as an expanded coarse filter, gap analysis searches for and identifies biological regions where unprotected or underrepresented vegetation types and animal species occur.

A second filter uses combined species distribution information to identify a set of areas in which all, or nearly all, mapped species are represented. There is a major difference between identifying the richest areas in a region (many of which are likely to be neighbors and share essentially the same list of species) and identifying areas in which all species are represented. The latter task is most efficiently accomplished by selecting areas whose species lists are most different or complementary. Areas with different environments tend to also have

the most different species lists for a variety of taxa. As a result, a set of areas with complementary sets of species for one higher taxon (e.g. mammals) often will also do a good job representing most species of other higher taxa (e.g. trees, butterflies). Species with large home ranges, such as large carnivores or species with very local distributions may require individual attention. Additional data layers can be used for a more holistic conservation evaluation. These include indicators of stress or risk (e.g. human population growth, road density, rate of habitat fragmentation, distribution of pollutants) and the locations of habitat corridors between wildlands that allow for natural movements of wide-ranging animals and the migration of species in response to climate change. These more detailed analyses were not part of this project, but are areas of research that GAP as a national program is pursuing.

General Limitations

Limitations must be recognized so that additional studies can be implemented to supplement GAP. The following are general project limitations; specific limitations for the data are described in the sections that describe them:

1. GAP data are derived from remote sensing and modeling to make general assessments about conservation status. Any decisions based on the data must be supported by ground-truthing and more detailed analyses.

2. GAP is not a substitute for threatened and endangered species listing and recovery efforts. A primary argument in favor of gap analysis is that it is proactive: it seeks to recognize and manage sites of high biodiversity value for the long-term maintenance of populations of native species and natural ecosystems before individual species and plant communities become critically rare. Thus, it should help to reduce the rate at which species require listing as threatened or endangered. Those species that are already greatly imperiled, however, still require individual efforts to assure their recovery.

3. GAP data products and assessments represent a snapshot in time generally representing the date of the satellite imagery. Updates are planned on a 5-10 year cycle, but users of the data must be aware of the static nature of the products.

4. GAP is not a substitute for a thorough national biological inventory. As a response to rapid habitat loss, gap analysis provides a quick assessment of the distribution of vegetation and associated species before they are lost, and provides focus and direction for local, regional, and national efforts to maintain biodiversity. The process of improving knowledge in systematics, taxonomy, and species distributions is lengthy and expensive. That process must be continued and expedited, however, in order to provide the detailed information needed for a comprehensive assessment of our nation's biodiversity. Vegetation and species distribution maps developed for GAP can be used to make such surveys more cost-effective by stratifying sampling areas according to expected variation in biological attributes

The Study Area - A Brief Discription of the State of Georgia

With an area of approximately 57,000 square miles, Georgia is the largest state east of the Mississippi River. The Georgia landscape runs from the mountains in the north and northeast to the Coastal Plain in the southeast. Georgia's highest point is Brasstown Bald at 4784 feet about sea level and its lowest is sea level along the coast. Georgia experiences a humid and subtropical climate with fairly mild winters and hot moist summers. The annual precipitation varies from forty inches in central Georgia to more than seventy-four inches in northeast Georgia.

The state is divided into 5 physiographic provinces, or ecoregions (Keyes et al. 1995): the Cumberland Plateau (also known as the Appalachian Plateau), the Ridge and Valley, the Blue Ridge, the Piedmont, and the Coastal Plain (Map 1.1). The vegetation varies within and among these provinces depending upon soil type, elevation, moisture, and disturbance regimes. In addition to these provinces we found distinct differences in areas such as the Fall Line and coast and used these areas when modeling animal distributions and vegetation mapping.

The Cumberland Plateau is found in the extreme northwestern corner of Georgia. It includes Lookout, Pigeon, and Sand Mountains. The provience is mostly forested, primarily with mixed oak and oak-hickory communities. The geologic strata include Mississippian-age limestone, sandstone, shale, and siltstone, and Pennsylvanian-age shale, siltstone, sandstone, and conglomerates.

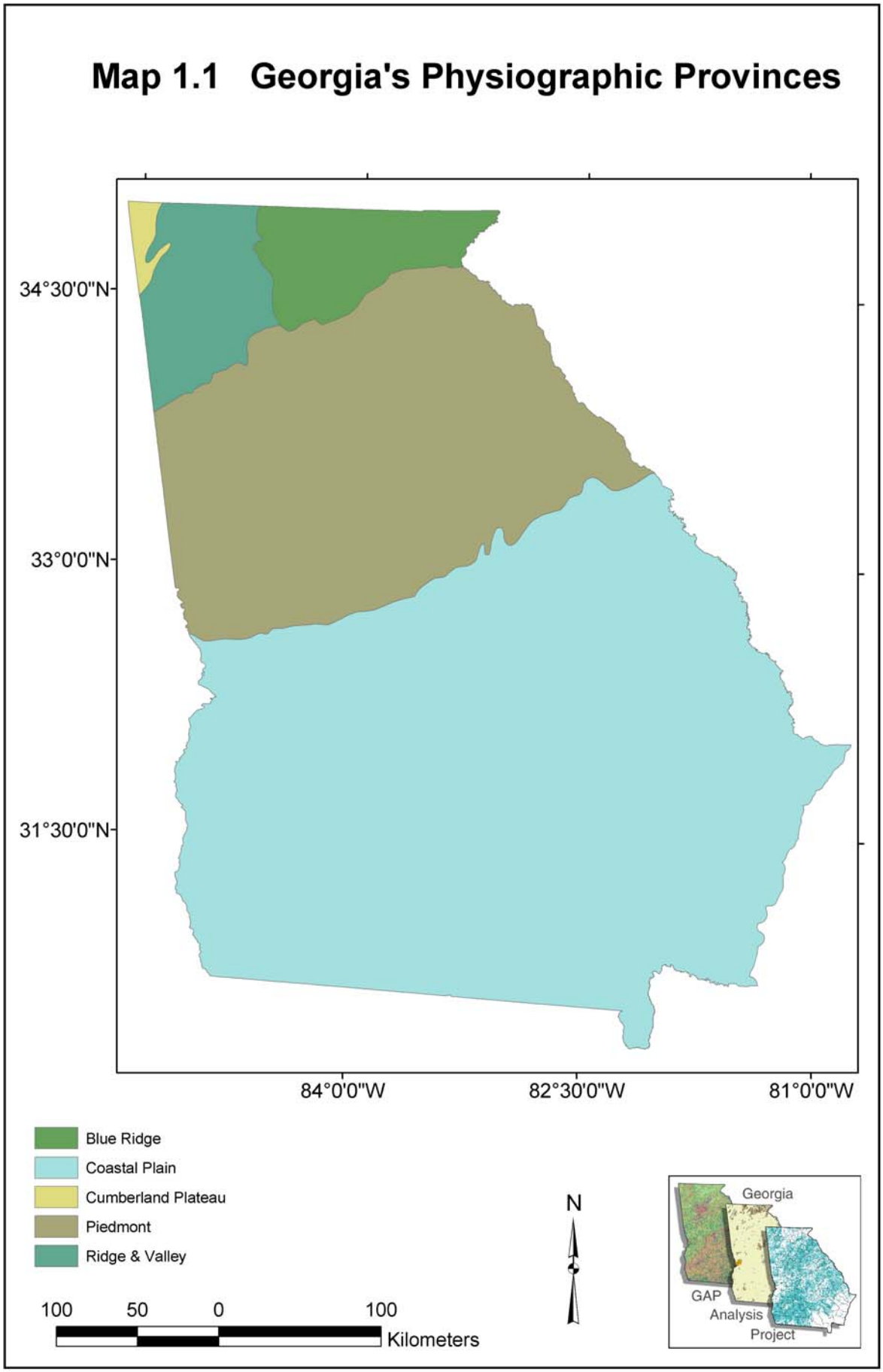
The Ridge and Valley Province occupies most of the northwestern area of Georgia. It came about as a result of extreme folding and faulting events creating a series of roughly parallel ridges and valleys that come in a variety of widths, heights, and geologic materials. These materials include limestone, dolomite, shale, siltstone, sandstone, chert, mudstone, and marble. Caves are relatively numerous in this area. The area includes the Chickamauga Valley, Armuchee Ridges, and the Great Valley. The ridge areas are predominantly forested with stands of oak-hickory and oak-pine. The valleys are mostly agricultural, including a mix of row crop and pasture.

The Blue Ridge Province occupies the northeastern portions of Georgia. The mountain peaks range between 2,000 and 5,000 feet, and are the highest in the state. The southern Blue Ridge is one of the richest centers of biodiversity in the US. The underlying geology is predominantly a mix of igneous, metamorphic and sedimentary geology. A large portion of Blue Ridge in Georgia is Precambrian-age igneous and high-grade metamorphic rocks, the common crystalline rock types including gneiss, schist, and quartzite, covered by well-drained, acidic brownish, loamy soils. Some mafic and ultramafic rocks occur here, producing more basic soils. The vegetation is predominantly made up of oak-hickory and oak-pine communities, with heath balds, hemlock, cove hardwood forests, and some shrub and grass areas. The lower elevation areas of the Blue Ridge are predominantly used for agriculture; large areas are in pasture and used for cattle, hog, and poultry operations. Much of the Blue Ridge is under the ownership of the U.S.D.A. Forest Service in the Chattahoochee National Forest. Urban development has been on the increase in privately-owned portions of the Blue Ridge.

The Piedmont Province cuts across the central portion of Georgia. The region is considered the nonmountainous portion of the Appalachian Highlands and comprises of a transitional area between the Appalachian Mountains and the coastal plain. It is a complex mosaic of Precambrian and Paleozoic metamorphic and igneous rocks with moderately dissected irregular plains and some hills. The Piedmont contains a series of rolling hills and occasional isolated mountains such as Pine Mountain. The soils of the piedmont tend to be fine textured and in many areas are highly erodable. The area was once highly cultivated but has mostly reverted to pine and hardwood woodlands, and, more recently, to urban and suburban settlement.

The Coastal Plain Province cuts across Georgia below the fall line. The Coastal Plain landscape is a low, flat region of well-drained soils with some areas of gently rolling hills and poorly drained flatwoods. The parent material for these soils area Cretaceous or Tertiary-age sands and sandy clays that are marine in origin and usually acidic. The Coastal Plain vegetation is a complex mix of upland flatwoods and many wetland communities including bottomland hardwoods and the Okefanokee Swamp. Much of the current land use is row crop agriculture and intensively managed pine forest. The coastal area is currently experiencing rapid urbanization.

Map 1.1 Georgia's Physiographic Provinces



Chapter 2 - LAND COVER CLASSIFICATION AND MAPPING

Introduction

Mapping natural land cover requires a higher level of effort than the development of data for animal species, agency ownership, or land management, yet it is no more important for gap analysis than any other data layer. Generally, the mapping of land cover is done by adopting or developing a land cover classification system, delineating areas of relative homogeneity (basic cartographic "objects"), then labeling these areas using categories defined by the classification system. More detailed attributes of the individual areas are added as more information becomes available, and a process of validating both polygon pattern and labels is applied for editing and revising the map. This is done in an iterative fashion, with the results from one step causing re-evaluation of results from another step. Finally, an assessment of the overall accuracy of the data is conducted. The final assessment of accuracy will show where improvements should be made in the next update (Stoms 1994).

In its "coarse filter" approach to conservation biology (e.g., Jenkins 1985, Noss 1987), gap analysis relies on maps of dominant natural land cover types as the most fundamental spatial component of the analysis (Scott et al. 1993) for terrestrial environments. For the purposes of GAP, most of the land surface of interest (natural) can be characterized by its dominant vegetation.

Vegetation patterns are an integrated reflection of the physical and chemical factors that shape the environment of a given land area (Whittaker 1965). They also are determinants for overall biological diversity patterns (Franklin 1993, Levin 1981, Noss 1990), and they can be used as a currency for habitat types in conservation evaluations (Specht 1975, Austin 1991). As such, dominant vegetation types need to be recognized over their entire ranges of distribution (Bourgeron et al. 1994) for beta-scale analysis (*sensu* Whittaker 1960, 1977). These patterns cannot be acceptably mapped from any single source of remotely sensed imagery; therefore, ancillary data, previous maps, and field surveys are used. The central concept is that the physiognomic and floristic characteristics of vegetation (and, in the absence of vegetation, other physical structures) across the land surface can be used to define biologically meaningful biogeographic patterns.

Land Cover Classification

Land cover classifications must rely on specified attributes, such as the structural features of plants, their floristic composition, or environmental conditions, to consistently differentiate categories (Küchler and Zonneveld 1988). The criteria for a land cover classification system for GAP are: (a) an ability to distinguish areas of different actual dominant vegetation; (b) a utility for modeling animal species habitats; (c) a suitability for use within and among biogeographic regions; (d) an applicability to LANDSAT Thematic Mapper (TM) imagery for both rendering a base map and from which to extract basic patterns (GAP relies on a wide array of information sources, TM offers a convenient meso-scale base map in addition to being one source of actual land cover information); (e) a framework that can interface with classification systems used by other organizations and nations to the greatest extent possible; and (f) a capability to fit, both categorically and spatially, with classifications of other themes such as agricultural and built environments.

A system used by many GAP projects is referred to as the National Vegetation Classification System (NVCS) (FGDC 1997; see also http://www.fgdc.gov/standards/status/sub2_1.html). The origin of this system was referred to as the UNESCO/TNC system (Lins and Kleckner 1996) because it is based on the structural characteristics of vegetation derived by Mueller-Dombois and Ellenberg (1974), adopted by the United Nations Educational, Scientific, and Cultural Organization (UNESCO 1973) and later modified for application to the United States by Driscoll et al. (1983, 1984). The Nature Conservancy and the Natural Heritage Network

(Grossman et al. 1994) have been improving upon this system in recent years with partial funding supplied by GAP. The basic assumptions and definitions for this system have been described by Jennings (1993).

While GAP projects in the western states have had some success creating thematic maps of vegetation distributions using this classification system, its use in the east is more problematic. This is due to several factors, including the spatial complexity and tendency of communities in the east to grade into one another rather than adhere to strict boundaries. In addition, the coarse spectral and spatial resolution of the source data, LANDSAT TM, as well as the paucity of adequate ancillary data such as detailed soil maps, makes classification of many alliances difficult at best. While advances in vegetation community sampling using videography, classification procedures, ancillary data sources, and image stratification may ultimately ameliorate this situation, at present accurate statewide mapping of alliances from LANDSAT TM data in the eastern U.S. is probably impossible. However, adherence to a classification system compatible with more detailed classes that might be mapped in the future has many benefits. We approached our classification system at GA-GAP with this in mind. More recently, broader mapping units have been drawn that are more suitable to efforts on the scale of GAP. These mapping units are known as ecological systems (Comer et al. 2003). We believe that our GA-GAP land cover classes can be easily crosswalked into ecological systems.

Methods

The Georgia land cover map was created in two iterations. First, a general, 28-class land cover map of the state was made. The information classes for the first land cover map are presented in Table 2.3. This map was accuracy assessed and released in an 18-class version in 2001 (Natural Resources Spatial Analysis Laboratory 2001a).

The general land cover map was modified using a variety of techniques to create the final land cover map for the Georgia Gap Analysis Project. The information classes for the final land cover map are presented in Table 2.4. This map was evaluated in a separate accuracy assessment.

Land Cover Map Development – First Iteration

The general land cover mapping of Georgia was undertaken using 30-meter satellite imagery, through unsupervised classifications. In addition, a variety of ancillary data was used to assist in the interpretation of the ISODATA clusters. Relying on the fine resolution of the ancillary data and a great deal of digital and manual processing, interpreters built a classification system that included 35 classes. During the quality control process it was determined that it was necessary to combine several classes to increase the database's consistency and accuracy, resulting in an accuracy-assessed version of 28 classes. Several classes were created using methods that involved GIS processing, hand editing, and reliance on ancillary datasets. Each of these methods, along with the general methodology, which are described in detail in Payne et al. (2003), will be discussed in this section.

Imagery Used

The primary imagery acquired for the Georgia GAP land-cover mapping project was 1998 Landsat Thematic Mapper (TM) provided by the Multi-Resolution Land Characteristics Consortium (MRLC). Fourteen scenes cover the state (Figure 2.1). For each scene in the statewide mosaic, three dates were acquired (Table 2.1): two leaf-on images (spring and summer) and one leaf-off image (winter). Occasionally 1996 scenes substituted when no serviceable 1998 images were available. Numerous sets of statewide ancillary data were used to assist in interpreting the satellite imagery. These include 1993 black-and-white digital ortho-quarter quads (DOQQ's) with a 1-meter pixel resolution (U.S. Geological Survey 1993a), GIS Arc/Info vector coverages of roads,

(Georgia Department of Transportation 1997b) railroads (U.S. Geological Survey 1996b), utility swaths (Georgia Department of Transportation 1997c), airports and runways (U.S. Geological Survey 1996a), county boundaries (Georgia Department of Transportation 1997a) and hydrology (linear and polygonal) (GA Department of Transportation 1997d), as well as the 1993 National Land Cover Database (NLCD) for Georgia (U.S. Geological Survey 1999a), the National Wetlands Inventory (NWI) (U.S. Fish and Wildlife Service 2002), and point coverages of mines and quarries (U.S. Geological Survey 1998). All of these datasets were available on the website of the Georgia GIS Clearinghouse (http://www.gis.state.ga.us/Clearinghouse/clearinghouse.html). Image interpretation was carried out using ERDAS Imagine 8.6, while much of the initial processing was done in Arc/Info 8.1.

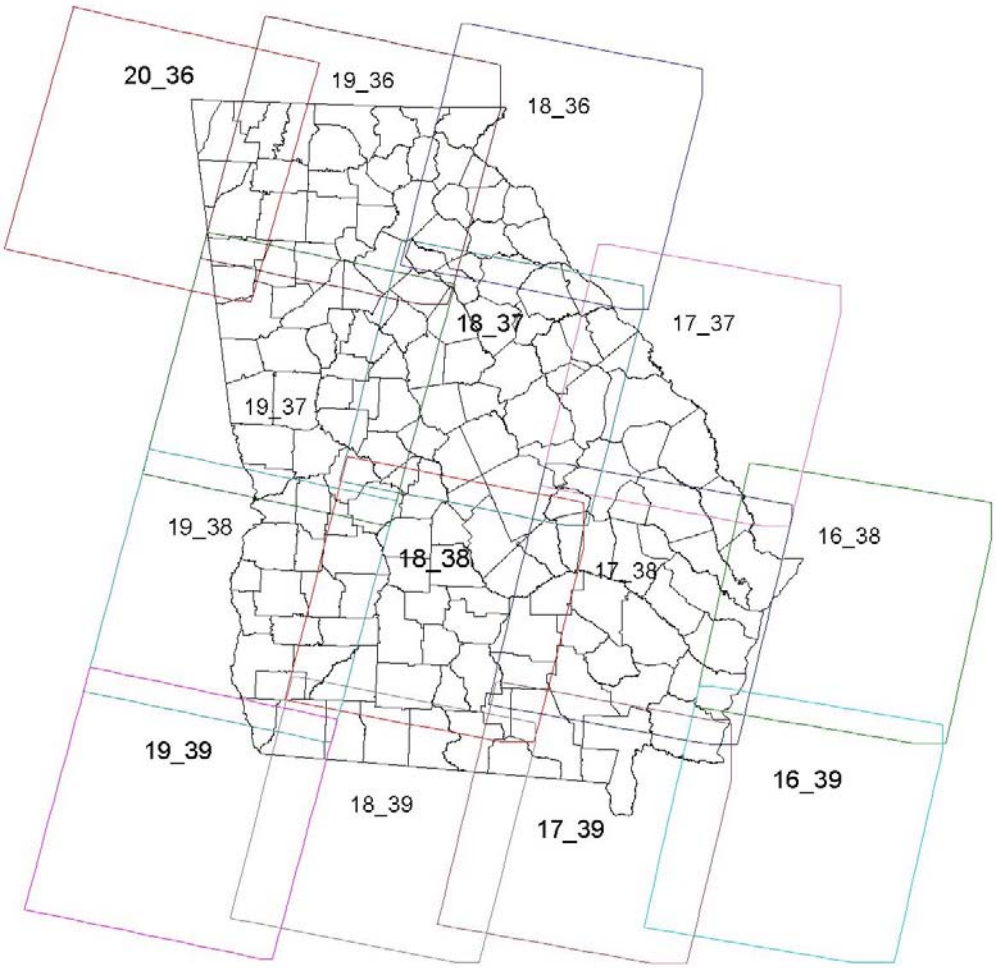


Figure 2.1 The path and row numbers of 14 LANDSAT scenes that cover the state of Georgia. Information about the acquisition dates is provided below.

Table 2.1 Acquisition dates for 42 LANDSAT scenes available to the GA-GAP project.

Path ------ Row	36		37		38		39	
	Leaf on	Leaf off	Leaf on	Leaf off	Leaf on	Leaf off	Leaf on	Leaf off
16					3/12/96	1/26/97	3/12/96	1/26/97
17			6/23/96 5/12/98	11/17/97	6/23/96 5/12/98	12/19/97	4/20/96 5/12/98	12/19/97
18	4/27/96 6/20/98	11/24/97	4/27/96 5/19/98	1/11/98	4/27/96 5/19/98	1/11/98	4/27/96 5/19/98	1/11/98
19	9/25/96 10/17/98	1/2/98	6/27/98 9/25/96	1/2/98	4/2/96 6/27/98	1/2/98	4/2/96 6/27/98	1/2/98
20	7/17/97 8/2/97	3/30/98						

Each scene consists of six bands of data: bands 1-5 and band 7 of LANDSAT 5 Thematic Mapper imagery. The spatial resolution of the picture elements for each of the bands described is 30 meters. Table 2.2 lists the range of the electromagnetic spectrum sampled in each band.

Table 2.2 LANDSAT 5 TM sensor characteristics.

BAND	WAVELENGTH (MICROMETERS)	SPECTRAL REGION
1	0.45 - 0.52	blue-green
2	0.52 - 0.60	green
3	0.63 - 0.69	red
4	0.76 - 0.90	near infrared
5	1.55 - 1.75	mid infrared
7	2.08 - 2.35	mid infrared

The TM imagery provided from the MRLC was subject to the following preprocessing steps for noise removal and geometric registration with terrain correction.

Noise removal

In an effort to remove or attenuate the 16-detector banding pattern found in some TM imagery, a debanding algorithm was applied to all scenes. After debanding is performed, all scenes were inspected for line and pixel drops. Scenes found to have multiple line drops or severe pixel drops were rejected and replacement scenes were ordered. Single line drops are replaced by averaging the line above and the line below.

Geometric Registration

The TM images were precision corrected and registered to a map base. This entailed the selection of image and planimetric source control points for use in developing the model for precision correction. Control point sources included 1:100,000-scale USGS digital line graph (DLG) data and 1:24,000-scale USGS topographic maps for areas within the U.S. and 1:50,000-scale maps for areas of the included scenes that fall outside the U.S. borders.

The DLGs are components of the National Digital Cartographic Data Base (NDCDB), and they are comprised of the various thematic layers (transportation, hydrography, hypsography, political boundaries, etc.) depicted on the 1:100,000-scale topographic map series (U.S. Geological Survey 1989).

The DLGs were interactively overlaid onto the imagery to facilitate visual correlation of area features in the imagery and the DLG data. Once a feature match was achieved, the image (line, sample) and DLG (latitude, longitude) coordinates for a specific point along the feature were extracted and compiled in a control point file. Approximately 20 to 30 points were extracted, and the corresponding elevation values for these points retrieved from the digital elevation model (DEM) data, which were derived from the Defense Mapping Agency (DMA) Level 1 Digital Terrain Elevation Data (DTED) (U.S. Geological Survey 1987). The image and map/DLG ground control points were then used to compute the coefficients for a first order polynomial model used to geometrically correct and reproject the image to a Universal Transverse Mercator (UTM) ground control coordinate system.

The map control points contain X, Y, and elevation values and were corrected for relief displacement. The image was rectified and resampled, using cubic convolution, to a UTM-projected output image comprised of 30- by 30-meter pixels. A full terrain correction was applied by correcting for the effects of relief displacement, on a pixel-by-pixel basis, using the DEM image previously created. A verification of registration quality was performed using control points selected from a map source. Scenes must meet quality restrictions of total RMSEs of less than 1.0 pixel. Approximately 12-plus control points were used to verify the image-to-map registration accuracy.

Automated cross-correlation procedures (Bernstein 1983; Scambos et al. 1992) were used to extract control points from the multitemporal pairs to compute coefficients for image-to-image registration. A full terrain correction was applied as previously described. Verification of the image-to-image registration quality was performed using control points selected from the two registered scenes. Multitemporal registrations must meet quality restrictions of total RMSEs of less than 1.0 pixel. Approximately 12-plus control points were used to verify the image-to-image registration accuracy.

All images were geometrically corrected to the following default specifications:

- UTM projection (either zone 16 or 17)
- GRS1980 Spheroid
- NAD83 datum
- Terrain correction applied
- 30-meter pixels
- Cubic convolution resampling

Registration accuracy meets the requirements of plus or minus one pixel (30 meters) RMSE.

After acquiring the TM image data scenes they were visually inspected. Along the edges of most scenes there were aberrant pixels with remnant values in certain bands. Because these values would confound our methods we simply clipped the images by three pixels inward from the true data boundary. This represented a loss in very little data at the edges, yet assured us that no aberrant pixels would be used in the classification protocol. While clipping the TM scenes we created a vector coverage of the data boundary in order to query which counties would be entirely or partially covered for each individual scene in a given year.

Processing

A flow chart outlining the process for creation of the first iteration land cover is illustrated in Figure 2.2.

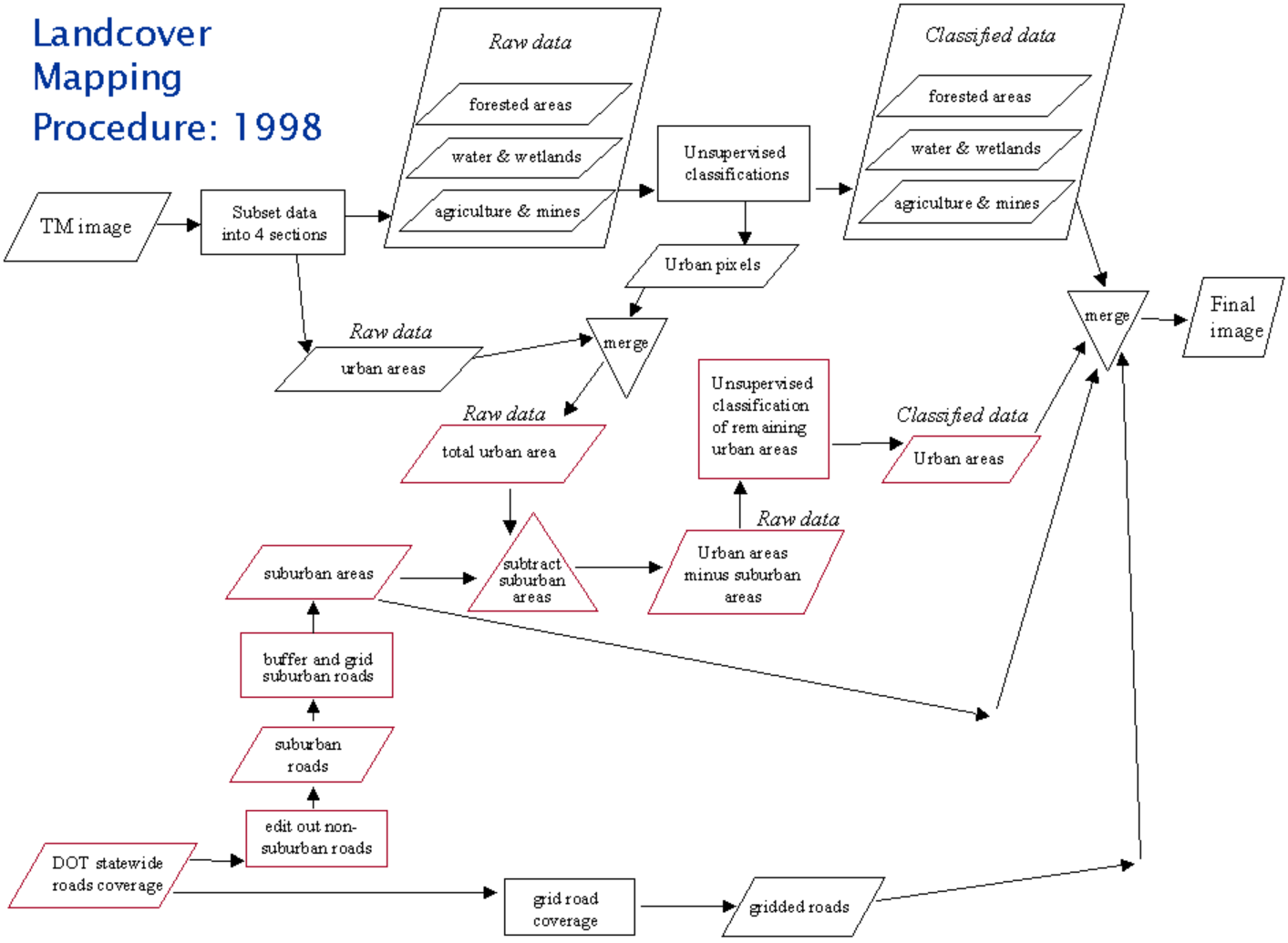


Figure 2.2. Procedures in creating first iteration land cover. From Epstein et al. (2002).

The data was first divided into five ecoregions: mountains, Piedmont, Fall Line, Coastal Plain and coast, based on Keyes et al. (1995) ecoregion delineation, but with some modification. A 13-county metropolitan area for Atlanta was separated from the piedmont ecoregion, creating a sixth region. Partitioning the data by region minimized confusion between similar signatures in different regions that represented different plant communities. This allowed operators to approach the landscape with accurate assumptions about local plant communities.

After subsetting by region, the imagery was partitioned by county. This later progressed to clustering two or three counties at a time. For each county, or cluster of counties, several layers of ancillary data were prepared before classification of the satellite imagery was undertaken. Railroads, utility swaths and airports and runways for each county were located on the imagery and edited for positional accuracy. The edited vector coverages were then converted to grids and given the attribute of the class they represented. Next, the image for each area was prepared using an Arc/Info Arc Macro Language program (AML), which partitioned the TM image in several steps. The area to be mapped was clipped from a leaf-off scene, and the road coverage was also clipped, converted to a grid with a width of one pixel, and used as a mask to remove roads from the image. Edited

utility swath and railroad grids were also removed from the imagery, as was the polygonal hydrography coverage of water and wetlands.

The AML then clipped the 1993 NLCD to the county boundary, and condensed its attributes into four classes: forested, urban, water and wetlands, and agriculture, pasture and mines. These four general classes were used to subset the leaf-off satellite imagery to be used in unsupervised classifications. Masking the imagery using the NLCD map reduced the dimensionality of the dataset, allowing operators to work with smaller, more homogenous sets of data. Most unsupervised classifications were run with 25 to 75 classes. Subsequent unsupervised classifications on groups of pixels that remained difficult to classify, or cluster busts, were used regularly, but were often much smaller in size – usually 12 to 25 classes. Busts were performed using leaf-on data when leaf-off scenes did not provide sufficient information to make a judgment. Operators viewed both leaf-on and leaf-off imagery, as well as the DOQQ's and the vector datasets to assist in interpreting the data.

Pixels classified as urban in the three non-urban subsets were appended to the urban subset, which was classified last. In the process of defining a methodology to map each class as accurately as possible in a reasonable amount of time, it was determined that the standard strategy for mapping low-density urban would not adequately address a class which was playing an increasingly prominent role in the Georgia landscape. A new method for delineating low-density residential areas was created to offset the inherent mixed signature pixel problem that is due to the class existing at a resolution that is below that of a single pixel – 30 meters. A discussion of the necessity for a new method is presented in Epstein et al. (2002).

The new method is a relatively time-consuming, but more accurate way to locate low-density residential areas. The Georgia Department of Transportation roads coverage was clipped to the county extent. Roads in the dataset labeled as state highways, interstates and ramps were removed in Arc/Info's ArcEdit module. The remaining roads were overlaid on the satellite scene and those that existed in areas that were apparently commercial/industrial or rural non-urbanized areas were removed. The coverage was then overlaid on the DOQQs and scrutinized on a finer level. Those roads that did not occur in single-family housing areas were removed. The final coverage was buffered to a width of 45 meters, resulting in a total width of 90 meters, or 3 pixels. The buffered coverage was converted to a grid and given an attribute of low-density urban.

To classify the remaining area masked with the NLCD, the buffered areas were subtracted from masked urban areas. The remaining pixels from the NLCD mask and those pixels which were interpreted as urban in unsupervised classifications from other masks, were combined, and an unsupervised classification was performed on them as a whole. The results of that unsupervised classification were re-joined with the buffered areas. When all of the masked areas are joined, the urban area was overlaid on the others, and the gridded roads, railroads and utility swaths coverages, were overlaid on top. The buffered areas, originally three pixels wide, then appeared as roads sandwiched between rows of low-density urban.

Above average rainfall in the months preceding the dates of the leaf-off imagery prompted us to take additional measures to isolate piedmont wetland areas and check the authenticity of scattered wetland pixels immersed in deciduous forest. The NWI indicated wetland areas and wetlands and open water from the original unsupervised classification bust that were not included in the NWI were masked separately from the spring leaf-on TM imagery, resulting in three raw imagery datasets per scene. All pixels that fell out of predefined ranges of wetlands (created from pixel values of known wetlands) were eliminated from each mask. An unsupervised classification was then performed on each masked image to determine if what remained was truly wetland. Open water was included in this wetland bust because of the likelihood of inclusion of wetlands in the open water category due to ephemeral flooding from heavy rains.

Leaf-off imagery for the mountains exhibited two characteristics which made it impractical to use: extensive shadowing on north-facing slopes and valleys, and extremely high reflectance on south facing slopes due to bare trees and thin soils. To overcome these problems, leaf-on imagery was used primarily for the entire mountain region.

Interpretation of the Okefenokee Swamp was based on a previous high-resolution mapping project carried out by the Florida Cooperative Fish and Wildlife Research Unit in 1997. This land cover map was cross-walked to a classification system similar to that of the GA-GAP classification system, and used to mask the satellite imagery for unsupervised classifications.

The inclusion of several classes relied on the use of ancillary data and hand digitizing to incorporate them into the database. Golf courses and recreational lands were often noticed in unsupervised classifications, but were too small to drop out as individual classes. Close scrutiny of the DOQQ's allowed operators to add these classes by hand. Each airport and runway, and each mine and quarry marked in those point coverages were verified using the DOQQ's and the satellite imagery, and were often hand digitized into the database. The demarcation line between freshwater and brackish wetlands was determined using the NWI map. The sandhill communities of the fall line and coastal plain regions, which are often spectrally confused with clear cuts, were identified using the work of Ivester et al. (2001). Their boundaries were also hand digitized into the database and they were labeled as mixed woodland.

The map was compiled, scene-by-scene, on an ecoregion basis. Several map-wide quality control measures were put into place to ensure consistency and improve accuracy. Scene boundaries were examined for dramatic edge differences or scene-wide disparities due to dissimilar interpretation styles. The mixed forest class was determined to be a catch-all category for pixels which were difficult to categorize, and were masked out of whole scenes and reclassified using cluster busts. Single pixels of clearcut found in agriculture/pasture were coded to agriculture/pasture, while single pixels of agriculture/pasture surrounded by clearcut were recoded to clearcut. Single pixels of clearcut surrounded by evergreen, deciduous forest or mixed forest, were recoded to those classes. Statewide cluster busts were performed on deciduous forest to diminish confusion with wetlands and clearcuts. Cluster busts were performed on clearcuts on a region-wide basis to reduce confusion with agriculture/pasture and deciduous forest. Forested wetlands were busted across the state to decrease confusion with all forest types, water and non-forested wetlands.

When the 13-county Atlanta metropolitan area was checked, several small problems emerged which were remedied as follows. Stray water pixels and low-density residential pixels were found in highly commercial/industrial areas and were removed. Due to the high rate of development in the Atlanta area, a number of subdivisions were built later than 1993 – the date of the Georgia Department of Transportation roads coverage which was used to identify areas of low-density residential. As a result, the TM images and the air photos were visually scanned for clear-cuts and new developments that were not included in the buffered roads coverage. When found, they were hand-digitized into the database. Additionally, one operator noticed a specific signature for apartment housing complexes, or high-density residential areas. These contained a large amount of asphalt, resulting in a deep purple signature. Because this signature did not fall out in an unsupervised classification, patches were hand-digitized from the imagery. An overall check of the entire Atlanta area was conducted to resolve any other small problems that could be found.

Finally, the single class of agriculture/pasture was separated into two: agriculture and pasture. Statistics on cropland usage by county were found in the USDA's National Agricultural Statistics Service Census of Agriculture (1997). In counties that had 85% or more of farmland in pasture, all agriculture/pasture was set to pasture. The reverse was true for counties with 85% or more of farmland in agriculture – in those counties all agriculture/pasture was set to agriculture. Counties with less than 85% in agriculture or pasture were clustered

together by region and an unsupervised classification with only 10 to 12 classes was performed to differentiate between the two classes.

A description of classes used in the first iteration of the land cover is given in Table 2.3. Following accuracy assessment, several of the 28 classes of the first iteration land cover were collapsed to create the 18 class map that was released initially as the 1998 land cover of Georgia (Natural Resource Spatial Analysis Laboratory 2001a) (Map 2.1).

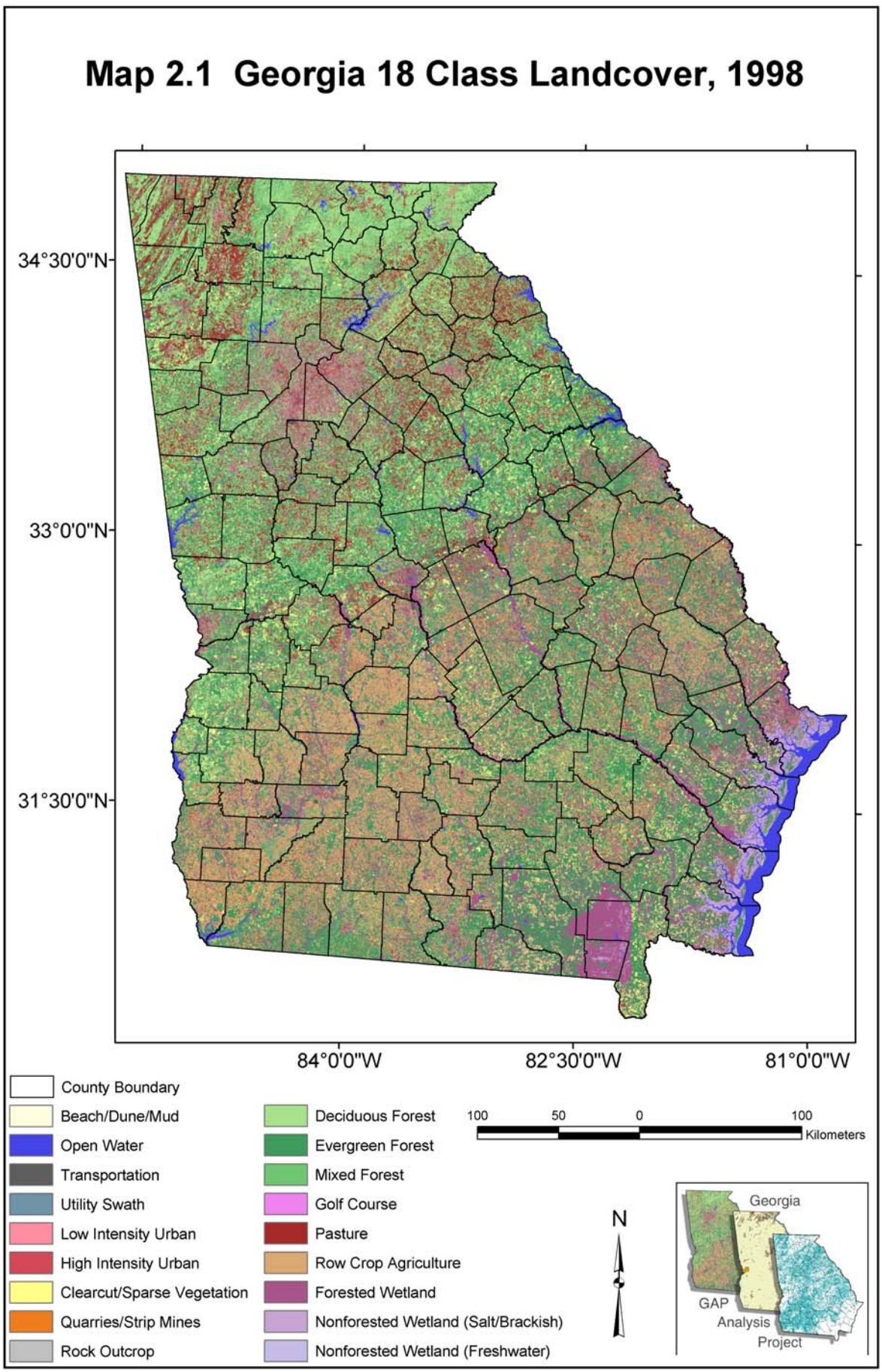
Table 2.3. List of classes in first iteration of land cover.

Code	Class Name	Description
7	Beaches	Open sand, sandbars, sand dunes, mud - natural environments as well as exposed sand from dredging and other activities. Mainly in coastal areas, but also inland, especially along the banks of reservoirs.
9	Dunes	Sand dunes and associated vegetation.
11	Open Water	Lakes, rivers, ponds, ocean, industrial water, aquaculture.
19	Airports	Airports and runways.
20	Utility Swaths	Open swaths maintained for transmission lines.
22	Low Intensity Residential	Single-family dwellings.
23	High Intensity Residential	Muti-family dwellings.
24	Commercial/Industrial	Areas used in commerce, trading, building, manufacturing, and office spaces. Includes confined animal operations (e.g. chicken houses).
28	Railroads	Railroads.
29	Roads	Roads.
31	Clearcut - Sparse Vegetation	Recent clearcuts, sparse vegetation, and other early successional areas.

33	Quarries, Stripmines	Exposed rock and soil from industrial uses, gravel pits, landfills.
34	Rock Outcrop	Rock outcrops and mountain tops.
41	Deciduous Forest	Forest composed of at least 75% deciduous trees in the canopy.
42	Evergreen Forest	Forest composed of at least 75% evergreen trees in the canopy.
43	Mixed Forest	Mixed deciduous/coniferous forest. Evergreen and deciduous species contribute to 25-75% of total tree cover.
51	Shrub/Scrub	Natural scrub communities (no more than 6m in height) with a closed canopy.
61	Deciduous Woodland	Open canopy, low stature forests of at least 75% deciduous trees.
62	Evergreen Woodland	Open canopy, low stature forests of at least 75% evergreen trees.
63	Mixed Woodland	Open canopy, low stature forests of mixed trees. Evergreen and deciduous species contribute to 25-75% of total tree cover.
72	Recreation	Cemeteries, playing fields, campus-like institutions, parks, schools.
73	Golf Courses	Golf courses.
80	Pasture	Pasture, non-tilled grasses.
83	Row Crop	Row crops, orchards, vineyards, groves, horticultural businesses.
90	Forested Wetlands	Deciduous, evergreen, and mixed forested wetlands.

92	Salt Marsh	Emergent brackish or saltwater wetlands dominated by *Spartina* or *Juncus*.
93	Freshwater Marsh	Emergent freshwater wetlands found throughout the state. May be dominated by grasses or sedges.
98	Shrub Wetland	Closed canopy, low stature woody wetland.

Map 2.1 Georgia 18 Class Landcover, 1998



Land Cover Map Development – Second Iteration

The second iteration of the Georgia GAP land cover expanded the original 28-class map into 44 classes. This was achieved by employing a variety of techniques. A description of the final land cover classes is given in Table 2.4. These classes were selected based on information contained in Wharton (1978), Braun (1950), and Weakley et al. (1998), as well as a judgement as to what would be most useful for the vertebrate models and still mappable. Crosswalking to ecological systems (Comer et al. 2003) should be possible.

Table 2.4. List of classes in second iteration of land cover.

Code	Class Name	Description
7	Beach	Open sand, sandbars, mud, and some sand dunes - natural environments as well as exposed sand from dredging and other activities. Mainly in coastal areas, but also inland, especially along the banks of reservoirs.
9	Coastal Dune	Sand dunes and associated vegetation.
11	Open Water	Lakes, rivers, ponds, ocean, industrial water, aquaculture.
18	Transportation	Roads, railroads, airports, and runways.
20	Utility swaths	Open swaths maintained for transmission lines.
22	Low Intensity Urban - Nonforested	Low intensity urban areas with little or no tree canopy.
24	High Intensity Urban	Commercial/industrial and multi-family residential areas.

31	Clearcut - Sparse Vegetation	Recent clearcuts, sparse vegetation, and other early successional areas.
33	Quarries, Strip Mines	Exposed rock and soil from industrial uses, gravel pits, landfills.
34	Rock Outcrop	Rock outcrops and mountain tops.
72	Parks, Recreation	Cemeteries, playing fields, campus-like institutions, parks, schools.
73	Golf Course	Golf courses.
80	Pasture, Hay	Pasture, non-tilled grasses.
83	Row Crop	Row crops, orchards, vineyards, groves, horticultural businesses.
201	Forested Urban - Deciduous	Low intensity urban areas containing mainly deciduous trees.
202	Forested Urban - Evergreen	Low intensity urban areas containing mainly evergreen trees.
203	Forested Urban - Mixed	Low intensity urban areas containing mixed deciduous and evergreen trees.

410	Mesic Hardwood	Mesic forests of lower elevations in the mountain regions (Blue Ridge, Cumerland Plateau, and Ridge and Valley) and upper Piedmont. Includes species such as yellow-poplar, sweetgum, white oak, northern red oak, and American beech.
411	Sub-mesic Hardwood	Moderately mesic forests of the mountain regions and upper Piedmont. Includes typical oak-hickory forests. The dominant natural cover class in most mountain areas.
412	Hardwood Forest	Mesic to moderately mesic forests of the lower Piedmont and Coastal Plain. Includes non-wetland floodplain forests of yellow-poplar and sweetgum, ravines of oaks and American beech, and many upland oak-hickory stands.
413	Xeric Hardwood	Dry hardwood forests found throughout the state, although most common in the mountain regions, and progressively more rare southward. Includes areas dominated by southern red oak, scarlet oak, post oak, and blackjack oak.
414	Deciduous Cove Hardwood	Mesic forests of sheltered valleys in the Blue Ridge and Cumberland Plateau at moderate to high elevations. Typically includes northern red oak, basswood, buckeye, and yellow-poplar.
415	Northern Hardwood	Restricted to the highest elevations of the Blue Ridge. Dominant tree species may include yellow birch, black cherry, and American beech.
420	Live Oak	Forests dominated by live oak. Most common in maritime strands along the Atlantic Coast. Also may occur in strip along southern border into southwest Georgia.
422	Open Loblolly-Shortleaf Pine	Only mapped in the Piedmont. Includes older, fairly open stands that may be almost savanna-like in appearance.
423	Xeric Pine	Very dry evergreen forests restricted to the mountain regions and upper Piedmont. Includes Virginia, shortleaf, pitch, and table mountain pines.
424	Hemlock-White Pine	Mesic evergreen forests frequently associated with riparian areas. Restricted to Blue Ridge and Cumberland Plateau.

425	White Pine	Moderately mesic evergreen forests of the Blue Ridge, usually dominated by white pine.
431	Montane Mixed Pine-Hardwood	Moderately mesic mixed forests of the Blue Ridge. Typical species include white pine, white oak, hickories, and yellow-poplar.
432	Xeric Mixed Pine-Hardwood	Dry mixed forests found throughout the state, although most common in the mountain regions, and progressively more rare southward. Includes areas dominated by a mix of pines (most frequently shortleaf or Virginia in the mountains, and shortleaf or longleaf elsewhere) and hardwood species such as southern red oak, scarlet oak, post oak, and blackjack oak.
433	Mixed Cove Forest	Mesic mixed forests of sheltered valleys and riparian areas in the Blue Ridge and Cumberland Plateau at moderate to high elevations. Typically includes eastern hemlock, yellow-poplar, and black birch.
434	Mixed Pine-Hardwood	Mesic to moderately dry forests of mixed deciduous and evergreen species found throughout the state at lower elevations. May include areas dominated by sweetgum, yellow-poplar, various oak species, and loblolly or shortleaf pine.
440	Loblolly-Shortleaf Pine	Found from the upper Coastal Plain northward (rare in the Blue Ridge except at the lowest elevations). Includes many stands heavily managed for silviculture as well as areas regenerating from old field conditions.
441	Loblolly-Slash Pine	Found on the lower Coastal Plain. Includes many heavily managed stands as well as a few natural areas.
511	Shrub Bald	Restricted to mountain tops at high elevations of the Blue Ridge. May be dominated by mountain laurel, rhododendron, or blueberry.
512	Sandhill	Areas of scrub vegetation on deep, sandy soils on the Coastal Plain, especially near the Fall Line and along larger streams. May be dominated by turkey oak, blackjack oak, live oak, holly, and longleaf pine.
513	Coastal Scrub	Thickets between coastal dunes, typically dominated by wax myrtle. Sometimes found adjacent to saltmarsh areas.

620	Longleaf Pine	Open, savanna-type stands. Heavily managed plantations would likely be classed with 440 or 441. Most common on the lower Coastal Plain, although found up to the lower Piedmont and historically in the Ridge and Valley.
890	Cypress-Gum Swamp	Regularly flooded swamp forests mainly found on the Coastal Plain. May include either riparian or depressional wetlands. Usually dominated by pond or baldcypress and/or tupelo gum.
900	Bottomland Hardwood	Less frequently flooded wetland forests found throughout the state, but most common on the Coastal Plain. To the north, may be dominated by sweetgum, elms, and red maple. To the south, wetland oaks (water oak, willow oak, overcup oak, swamp chestnut oak), black gum, and even spruce pine become more common.
920	Saltmarsh	Emergent brackish or saltwater wetlands dominated by *Spartina* or *Juncus*.
930	Freshwater Marsh	Emergent freshwater wetlands found throughout the state. May be dominated by grasses or sedges.
980	Shrub Wetland	Closed canopy, low stature woody wetland. Found throughout the state, although most common on the Coastal Plain. May be result of clearcutting of wetland forests. Frequently includes willows, alders, and red maple.
990	Evergreen Forested Wetland	Restricted to the Coastal Plain. Includes forests dominated by bay species, wet pine forests (typically slash or pond pine), or Atlantic white cedar.

Processing

Several classes from the 28-class map were combined into other classes for the second iteration map. These included classes 19, 28, and 29 (airports, railroads, and roads, respectively in the first iteration map), which were subsumed into class 18 (transportation in the second iteration map), and class 23, which was was subsumed into class 24.

A number of classes, particularly those associated with human influence, were not altered between the first and second iterations of the land cover. These crosswalked directly into the second iteration land cover. Others, mainly those associated with natural communites (even if heavily human-altered), were considered available for editing. Low density residential areas (22 on the first iteration land cover) were only available for classification into classes 22 and 201-203 in the second iteration. A summary is contained in Table 2.5.

Table 2.5. Summary of availability of classes for editing between first and second iterations of land cover.

Code	Class Name	Available for Editing
7	Beach	No
9	Dunes	No
11	Open Water	No
19	Airports	Subsumed
20	Utility Swaths	No
22	Low Intensity Residential	Yes
23	High Intensity Residential	Subsumed
24	Commercial/Industrial	No
28	Railroads	Subsumed
29	Roads	Subsumed
31	Clearcut - Sparse Vegetation	Yes
33	Quarries, Stripmines	No
34	Rock Outcrop	No
41	Deciduous Forest	Yes
42	Evergreen Forest	Yes
43	Mixed Forest	Yes
51	Shrub/Scrub	Yes
61	Deciduous Woodland	Yes
62	Evergreen Woodland	Yes
63	Mixed Woodland	Yes
72	Recreation	No
73	Golf Courses	No
80	Pasture	No
83	Row Crop	No
90	Forested Wetlands	Yes
92	Salt Marsh	No
93	Freshwater Marsh	Yes
98	Shrub Wetland	Yes

Primarily in the mountain regions (Blue Ridge, Cumberland Plateau, and Ridge and Valley) and portions of the upper Piedmont, detailed forest classes were derived mainly through decision rules and and a topographic relative moisture index (TRMI). TRMI was derived from the National Elevation Dataset (NED) (U.S. Geological Survey 1999b) using methods described by Parker (1982) and Halpin (1999), which incorporate slope, aspect, relative slope position, and curvature. Values range from 0 to 60, with 0 denoting the most dry sites and 60 the most moist. Using thresholds set through literature review (especially Wharton (1978)), field visits and some point data, general forest categories (deciduous, mixed, and evergreen) were grouped into more specific classes (e.g hemlock – white pine, deciduous cove hardwoods, etc.). In addition, elevation was used in consideration of some thresholds, as were proximity to streams, and ecoregion. A summary of the use of topographic modelling is given in Table 2.6. Some hand editing was applied to eliminate areas known to be erroneous, especially for classes 423, 424, 425, 431, and 433. Significant areas of 424 and 433 were added through the use of hand digitizing.

Table 2.6. Summary of the use of topographic modeling in classifying vegetation.

Code	Class Name	Min trmi	Max trmi	Min elev (m)	Max elev (m)	Applied 30 m stream buffer	Ecoregions	Used range maps
410	Mesic Hardwood	40	n/a	y	600 (320 in Cumb.)	no	Blue Ridge, Cumb., Pied., Ridge & Valley	yes
411	Sub-mesic Hardwood	13	40	n/a	n/a	no	Blue Ridge, Cumb., Pied., Ridge & Valley	yes
413	Xeric Hardwood	n/a	12	n/a	n/a	no	Statewide	no
414	Deciduous Cove Hardwood	40	n/a	600 (320 in Cumb.)	1155	no	Blue Ridge, Cumb.	no
415	Northern Hardwood	40	n/a	1155	n/a	no	Blue Ridge	no
423	Xeric Pine	n/a	18	365	1066	no	Blue Ridge, Cumb., Pied., Ridge & Valley	yes
424	Hemlock-White Pine	42	n/a	450 m (370 m in Cumb.)	n/a	except in Rabun and NE Towns counties	Blue Ridge, Cumb.	yes
425	White Pine	19	41	n	n/a	no	Blue Ridge	yes
431	Montane Mixed Pine-Hardwood	16	40	450	n/a	no	Blue Ridge	yes
432	Xeric Mixed Pine-Hardwood	n/a	19	n/a	n/a	no	Statewide	no
433	Mixed Cove Forest	42	n/a	370 m in Cumb.	n/a	no	Blue Ridge, Cumb.	yes
434	Mixed Pine-Hardwood	16	40	n/a	450	no	Statewide	no
440	Loblolly-Shortleaf Pine	19	n/a	n/a	365	no	Statewide	yes
511	Shrub Bald	n/a	19	1066	n/a	no	Blue Ridge	no

Other classes were derived through exclusively spectral means. After the first iteration of the land cover, forested wetland classes , as well as deciduous forests, were regrouped in the lower Piedmont, along the Fall Line, and throughout the Coastal Plain. These areas were subjected to new unsupervised classifications, separating them into classes 890, 900 (except in the Blue Ridge), and 990, as well as newly delineated areas of non-wetland deciduous forests. The newly mapped deciduous forests were later split into classes 412 and 413 using TRMI. Class 22 from the first iteration map was split into new classes 22, 201, 202, and 203 (essentially separating the original urban class into forested and non-forested classes) using unsupervised classifications. Class 513 was also created through unsupervised classifications, using Wharton (1978) and information obtained from field visits as guides.

Class 420 was derived through a supervised classification, using a maximum-likelihood classifier, of evergreen forest areas from the first iteration land cover. Areas of live oak found on aerial videography were used as a training set. Class 422 was also derived through a supervised classification of Piedmont evergreen forests. Areas mapped as mature, open pine on the Piedmont National Wildlife Refuge (Moore, *unpublished data*) and Oconee National Forest (U.S.D.A. Forest Service 1997) were used as training sets.

Range maps were used extensively. The overall distribution of classes 420, 423, 424, 425, 440, 441, and 890 were limited by maps found in Critchfield and Little (1966) and Brown and Kirkman (1990).

In addition to ways described for the first iteration of the land cover, NWI (U.S. Fish and Wildlife Service 2002) provided a great deal of the information necessary in mapping classes 900, 930, and 980. Specifically, class 900 in the Blue Ridge was derived excelusively through NWI. If a given area was mapped as forested in the first iteration land cover and NWI indicated a forested wetland, class 900 was the result. Classes 930 and 980 were derived similarly throughout the state. If the first iteration land cover indicated either clearcut (31) or a forest type other than evergreen forest (42), and NWI indicated a shrub or emergent wetland, classes 980 or 930 (respectively) were the result. Evergreen forest was not included in this crosswalk, as NWI was often mapped in the early 1980's, and it was assumed that many wetland areas in shrubs or emergents (especially those in that condition as a result of clearcutting) at that time have since been drained and converted to pine silviculture.

As mentioned, class 512 (sandhill) was derived largely through on-screen digitizing. Sandhills possess a unique appearance in the infrared bands of TM data, but are frequently confused with clearcuts during unsupervised or even supervised classifications. Using maps in Ivester et al. (2001) as guides, an operator manually digitized this class 512 along rivers and streams and to some extent along the Fall Line. Many areas of 512 along the Fall Line were crosswalked directly from classes 61, 62, and 63 in the first iteration land cover.

Class 620 (longleaf pine) was derived partially through manual digitizing, and partially through use of a database which previously mapped the extent of longleaf pine in Georgia (Nature Conservancy 2002). Areas within the property boundaries delineated by the Nature Conservancy map were subjected to an unsupervised classification to extract actual stands of longleaf.

In two areas, Fort Benning (Natureserve 2001) and the Okefenokee National Wildlife Refuge (Florida Cooperative Fish and Wildlife Research Unit 1997), previous mapping exercises were also incorporated into the Georgia GAP land cover. Using decision rules, the Fort Benning and Okefenokee maps were combined with the first iteration land cover to crosswalk into the GAP cover classes.

Results

The final Georgia GAP land cover map contains 44 classes, and reflects a balanced effort to document both the existence of natural communities and human-dominated landscapes. Additional detail would be possible within some of the natural communities, but likely at the expense of accuracy. In addition, it is generally not necessary for most of the vertebrate models.

Row crop agriculture is the most common cover type in the Georgia GAP land cover map, occupying over 12% of the state and nearly 2 million hectares. Loblolly-shortleaf pine and loblolly-slash pine are the most common cover forest types, both occupying over 10% of the state, and over 1.6 million hectares each. Urban areas occupy about 2.8% of the state. Wetlands, including both forested and nonforested, comprise around 12% of Georgia.

Some general figures reflecting groupings of land cover types, are given in Figure 2.3. The evergreen forest grouping contains classes 420, 422, 423, 424, 425, 440, 441, and 620. The mixed forest grouping contains classes 431, 432, 433, and 434. The deciduous forest grouping contains classes 410, 411, 412, 413, 414, and 415. Agriculture/pasture contains 80 and 83. Forest wetland contains 890, 900, 980, and 990. Non-forest wetland contains 920 and 930. Urban/industrial contains 22, 24, 33, 72, 73, 201, 202, and 203. Early succession/shrub/rock contains 7, 9, 31, 34, 511, 512, and 513. Open water contains 11 and transportation contains 18.

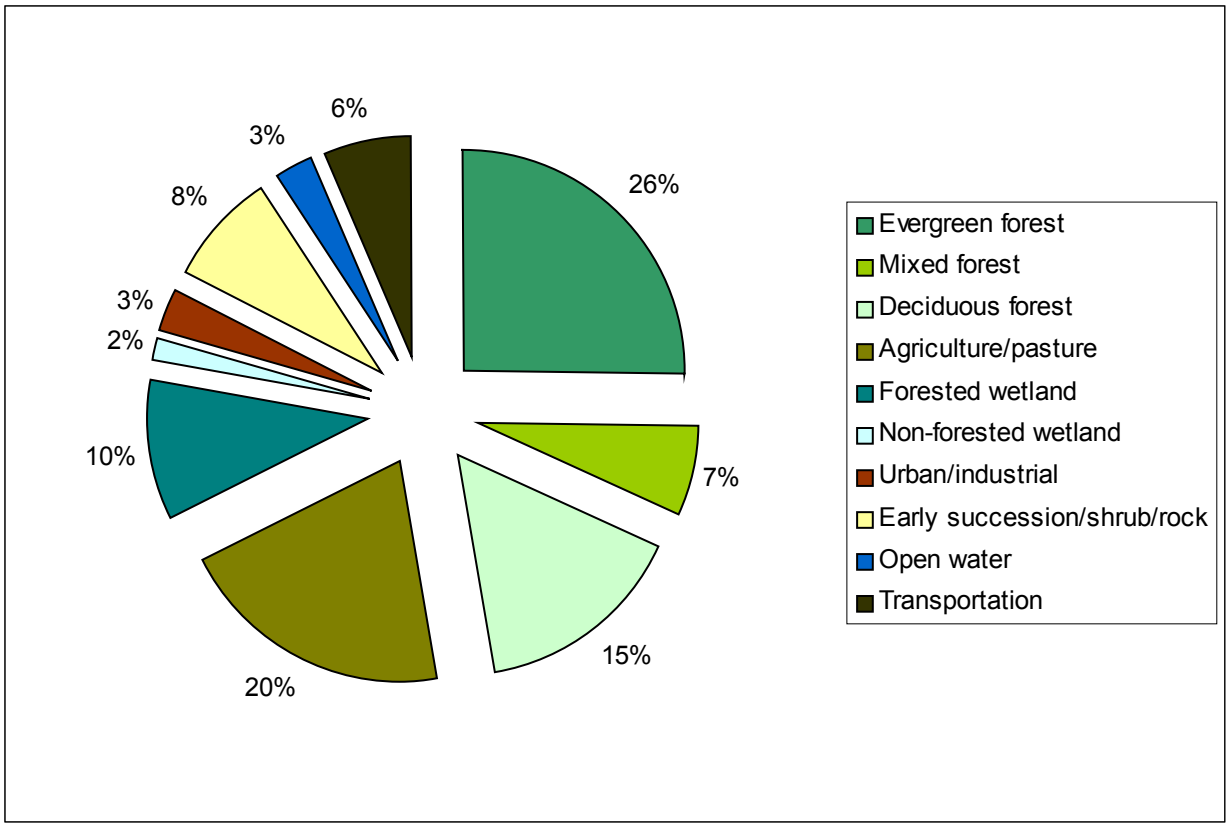


Figure 2.3. Grouped land cover classes and percentages of total area of Georgia.

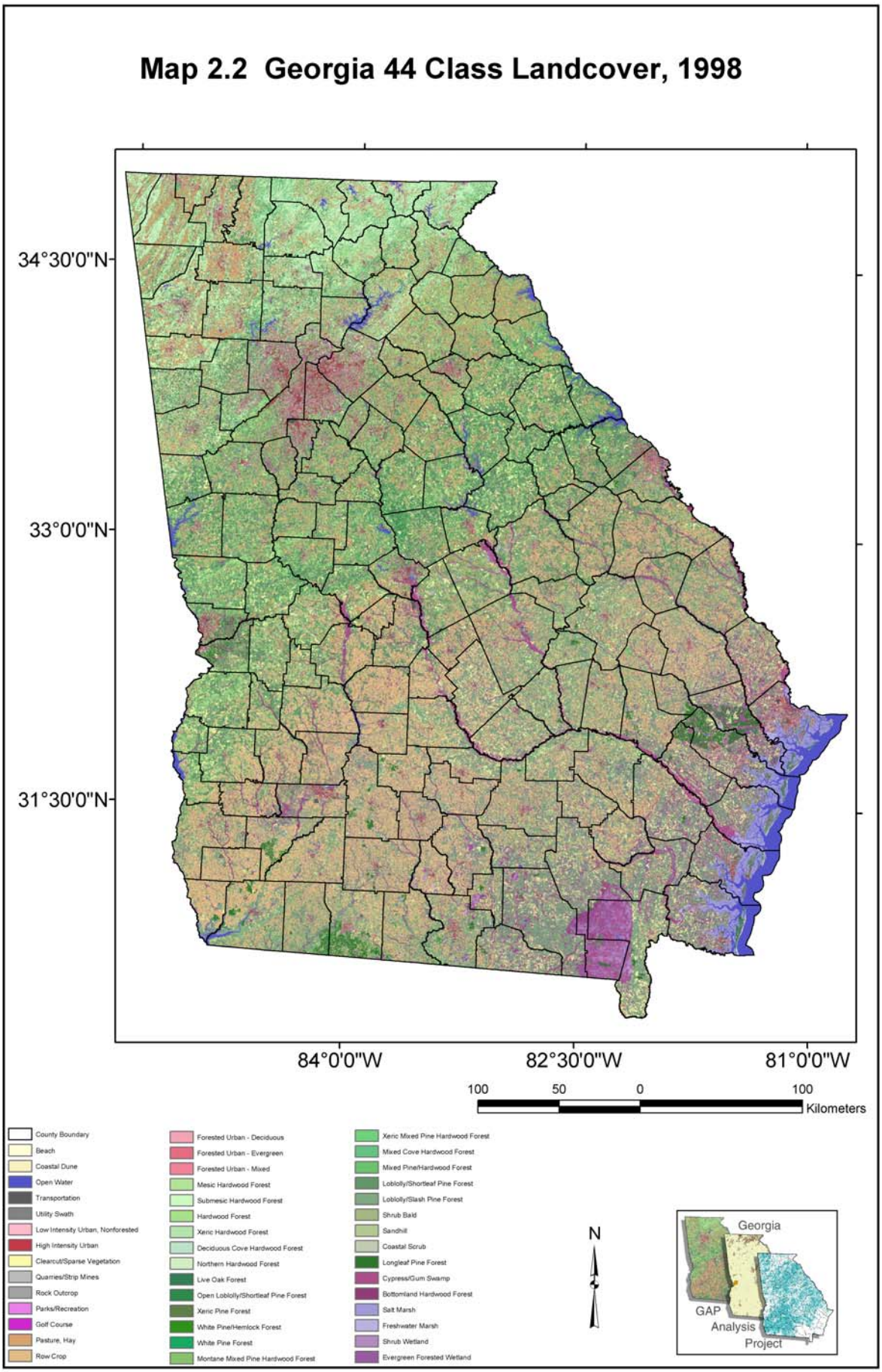
The distribution of all land cover types in the second iteration map is given in Table 2.7. The final Georgia GAP land cover may be seen in Map 2.2

Table 2.7. Types of land cover mapped, their area in hectares, and percent of the state's total area represented by cover type.

Code	Class Name	Area (in ha)	% of State
7	Beach	4118.49	0.02673
9	Coastal Dune	587.88	0.00382
11	Open Water	449171.01	2.91559
18	Transportation	971106.66	6.30350
20	Utility Swaths	50331.78	0.32671
22	Low Intensity Urban - Nonforested	90487.35	0.58736
24	High Intensity Urban	122486.85	0.79507
31	Clearcut – Sparse Vegetation	1160820.81	7.53495
33	Quarries, Stripmines	15841.44	0.10283
34	Rock Outcrop	1150.92	0.00747
72	Parks, Recreation	13262.4	0.08609
73	Golf Course	14089.86	0.09146
80	Pasture, Hay	1179212.04	7.65432
83	Row Crop	1945561.77	12.62874
201	Forested Urban - Deciduous	94298.13	0.61209
202	Forested Urban - Evergreen	64576.8	0.41917
203	Forested Urban - Mixed	56080.8	0.36402
410	Mesic Hardwood	137939.49	0.89537
411	Sub-mesic Hardwood	674146.08	4.37592
412	Hardwood forest	1367980.38	8.87963
413	Xeric Hardwood	101637.63	0.65973
414	Deciduous Cove Hardwood	36324.63	0.23578
415	Northern Hardwood	108.27	0.00070
420	Live Oak	30816.45	0.20003
422	Open Loblolly-Shortleaf Pine	328356.18	2.13138
423	Xeric Pine	18065.07	0.11726
424	Hemlock-White Pine	4288.77	0.02784
425	White Pine	25675.92	0.16666
431	Montane Mixed Pine-Hardwood	70017.3	0.45449
432	Xeric Mixed Pine-Hardwood	47809.35	0.31033
433	Mixed Cove Forest	9968.94	0.06471
434	Mixed Pine-Hardwood	916774.29	5.95083
440	Loblolly-Shortleaf Pine	1686403.8	10.94653
441	Loblolly-Slash Pine	1668311.91	10.82909
511	Shrub Bald	114.03	0.00074
512	Sandhill	73032.39	0.47406
513	Coastal Scrub	1269.63	0.00824
620	Longleaf Pine	131933.25	0.85639
890	Cypress-Gum Swamp	627486.12	4.07304
900	Bottomland Hardwood	515952.45	3.34907
920	Saltmarsh	146394.99	0.95026

930	Freshwater Marsh	87086.43	0.56528
980	Shrub Wetland	125568.9	0.81507
990	Evergreen Forested Wetland	339181.92	2.20165

Map 2.2 Georgia 44 Class Landcover, 1998



Accuracy Assessment

Introduction

GAP land cover maps are primarily compiled to answer the fundamental question in gap analysis: what is the current distribution and management status of the nation's major natural land cover types and wildlife habitats? Besides giving a measure of overall reliability of the land cover map for Gap Analysis, the accuracy assessment also identifies which general classes or which regions of the map do not meet the accuracy objectives for the Gap Analysis Program. Thus, the assessment identifies where additional effort will be required when the map is updated. We report the results of the accuracy assessment, believing that the map is the best map currently available for the project area.

The purpose of accuracy assessment is to allow a potential user to determine the map's "fitness for use" for their application. It is impossible for the original cartographer to anticipate all future applications of a land cover map, so the assessment should provide enough information for the user to evaluate fitness for their unique purpose. This can be described as the degree to which the data quality characteristics collectively suit an intended application. The information reported includes details on the database's spatial, thematic, and temporal characteristics and their accuracy.

Assessment data are valuable for purposes beyond their immediate application to estimating accuracy of a land cover map. The reference data is therefore made available to other agencies and organizations for use in their own land cover characterization and map accuracy assessments (see Data Availability for access information). The data set will also serve as an important training data source for later updates.

Even though we have reached an endpoint in the mapping process, the gap analysis process should be considered dynamic. We envision that maps will be refined and updated on a regular schedule. The assessment data will be used to refine GAP maps iteratively by identifying where the land cover map is inaccurate and where more effort is required to bring the maps up to accuracy standards. In addition, the field sampling may identify new classes that were not identified at all during the initial mapping process.

General Methods

Similar to the map itself, accuracy assessment of the land cover was accomplished in two iterations. For the initial 28-class map, we used both color infrared aerial photographs and aerial videography. Accuracy assessment of the second map was accomplished through a combination of aerial videography and collection of actual ground points. Much of the description of the accuracy assessment of the first iteration of the land cover map may also be obtained in Payne et al. (2003).

First Iteration

During the first iteration of accuracy assessment, random clumps of land cover classes were selected for verification, stratified by ecoregion and land cover class. Stratifying by ecoregions allowed for several interpreters to conduct the assessment as well as a statistically sound assessment for each ecoregion. Georgia was divided into six ecoregions, which consisted of the coast, Coastal Plain, Fall Line, Piedmont, mountains (including Blue Ridge, Ridge and Valley and Cumberland Plateau), and Atlanta regions. The number of random clumps to be selected by ecoregion was calculated from the formula $n = \frac{p(1-p)}{s^2}$, where p is the

presumed accuracy (Cochran 1977) and s is the standard error. GAP requires a standard error of 8%, therefore with a presumed accuracy of 50%, 40 clumps per cover class (as an average) were necessary in each ecoregion. Within an ecoregion, 40 was multiplied by the number of cover classes, giving the total number of points for assessment. Aerial extent per class was calculated, and the final number of clumps assessed per class was based on the percent of aerial extent for that class in the region. A minimum of 5 points in a region were selected for any given class. Only clumps of four or more pixels were considered.

In all of Georgia except the Atlanta area, the assessment was done by means of aerial videography. 3101 points were accuracy assessed through video. A flight plan was designed to maximize coverage of each ecoregion (Map 2.3). Video acquisition was conducted over four days: October 31, November 1, 2, and 3, 2000. During fall color change, this time period allowed individual tree species to be more easily distinguished. The setup of aircraft, video equipment, gps, and dual cameras followed that of Slaymaker et al. (1996).

The equipment used for the assessment consisted of a Canon GL1 Digital Video Camcorder, a Horita FP-50/TR GPC GPS3 SMPTE Time Code Reader, a 13" television, and a computer using ArcView. The video was provided on 38, 60-minute mini digital videocassette tapes— 19 wide angle and 19 zoom. The videocassettes were viewed on the television using the camcorder in VCR mode. The Horita Time Code Reader was connected between the camcorder and television so that it pulled the time code data from the audio track and displayed the time code on the television screen.

The flight data was acquired in several computer text files divided by date. These files were processed into a readable format to be used in ArcInfo and ArcView with programs provided by Dana Slaymaker. A point coverage was created using the easting and northing from the flight data with each point representing a frame from the flight video. The flight lines were subset by ecoregion excluding the thirteen county metropolitan Atlanta area. The general land cover classification was associated with each corresponding point on the flight line and each clump within the land cover was given a unique identifier number. This clump identifier was then linked to the corresponding points on the flight line.

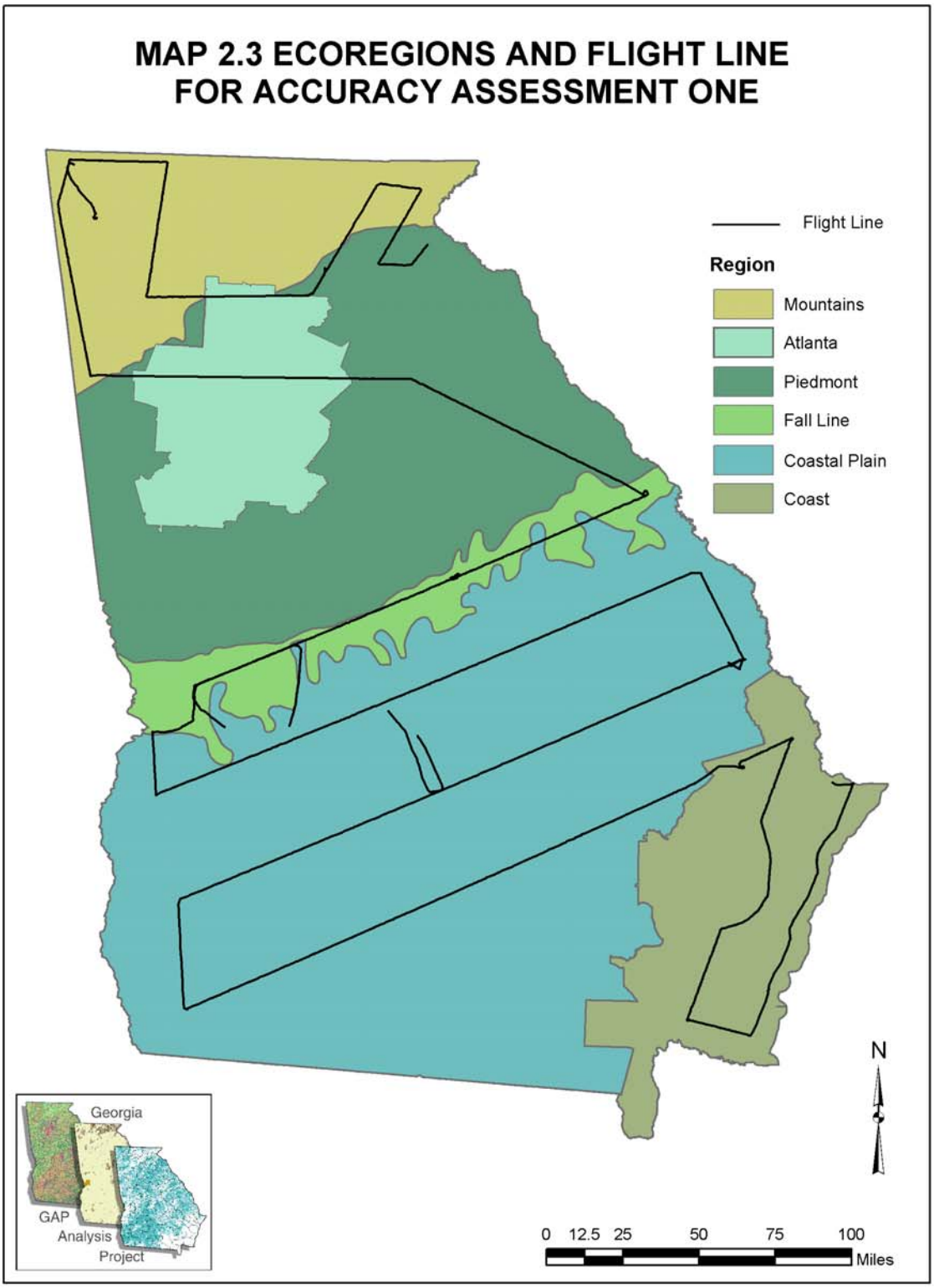
Four new attribute columns were added to the random clumps: two reference columns for the interpreter's first and second choice, a comment column, and an interpreter's locational confidence column. Because positional errors are often introduced into flight data due to the nature of videography (tilt, tip, etc.), we generated the locational confidence field. Interpreters assigned a one (1) for an interpretation where they could reasonably identify the location of the clump on the video and a zero (0) if the interpreter had very little confidence in the location.

By their nature thematic maps condense an infinitely variable, or continuous, land cover into a finite number of classes. Often, the interpreter cannot readily distinguish differences between two classes during mapping or accuracy assessment. For example, low density residential development encompasses single family homes, lawns, and trees. Therefore, it is difficult to distinguish the break between forest or pasture and residential classes because they all have shared landscape elements; a solution is to use fuzzy set theory, which requires the interpreter to record two observations (Gopal and Woodcock 1994).

In the Atlanta area, verification was accomplished by using 1999 color infrared digital orthophoto quarter quads (Georgia Institute of Technology 1999), which cover the thirteen county metropolitan area. A blind interpretation of the orthophoto point locations was conducted with only the land cover polygons overlaying the photographs and the interpreter having no knowledge of the corresponding land cover. The formula for sselecting points was the same as that employed for the areas assessed with videography. 807 points were accuracy assessed in the Atlanta area.

The error matrix for the first iteration accuracy assessment allows for a correct interpretation on either of the interpreter's observations, and ignores observations where the interpretation had little confidence in the location (Appendix A). A total of 4240 points were assessed across the state.

MAP 2.3 ECOREGIONS AND FLIGHT LINE FOR ACCURACY ASSESSMENT ONE



Second Iteration

For the second accuracy assessment, the state was divided into three regions: mountains (including Blue Ridge, Cumberland Plateau, and Ridge and Valley), Piedmont (including the Atlanta region), and Coastal Plain (including the Fall Line and coast regions). The number of clumps per cover class was again based on aerial extant, and followed the methods outlined under the description for the first iteration accuracy assessment. Again, only contiguous clumps of a similar land cover type of 4 pixels or larger were considered.

For land cover classes that were not altered between the first and second iterations of the land cover, points were randomly selected from previously interpreted (from the first iteration assessment) video or color infrared DOQQ's (Georgia Institute of Technology 1999). These included categories 7, 9, 11, 19, 20, 24, 28, 29, 33, 34, 72, 73, 80, 83, and 92.

In the mountains and Piedmont, accuracy assessment for other classes was accomplished through collection of actual ground points. Transects were set up along roads through areas believed to encompass the diversity of the regions being assessed. Points (clumps) were randomly selected along the routes (Map 2.4).

Interpreters traveled the routes with topographic maps and aerial photographs depicting the points and clump outlines to be assessed. Using descriptions of each class and a list of tree species likely to occur in a given class, an interpreter attempted to place the accuracy assessment clump into the most fitting class. As in the first iteration assessment, a two-choice fuzzy matrix was utilized. Reasons given under the first iteration description became even more apparent during the second accuracy assessment. Vegetation classes seldom had sharp lines distinguishing them. In addition, the locational confidence field was again utilized. Clumps were often not completely visible, most frequently due the presence of private property but also due to concerns about traffic safety.

On the Coastal Plain, all accuracy assessment was accomplished through the use of aerial videography. Video data was the same as described for the first iteration. Interpreters learned to identify tree species and classes through several training exercises and field visits. Again, the two-choice fuzzy matrix and the locational confidence field were utilized.

For the second iteration video assessment, video data was digitally captured to a computer and rectified into one minute and ten second mosaics for wide angle and zoom data (respectively). Captured images were converted to a .tif format, with resolutions of 1 meter for wide angle data and 0.1 meter for zoom. The .tif's allowed interpreters move between the captured video and color infrared DOQQ's (Georgia Institute of Technology 1999) and Digital Raster Graphics (U.S. Geological Survey 1993b) to better identify the context of the clumps in question.

Incorrect clumps retained from the first interpretation were re-visited using video and DOQQ's where the interpreted category fell within the range of classes altered for the second iteration map. In both cases, the two-choice fuzzy matrix and the locational confidence field were utilized.

A total of 4124 points were used in the second iteration accuracy assessment. 2000 came from aerial videography, 1868 from ground points, and 256 from DOQQ's. The distribution of points across the state may be seen in Map 2.5.

The error matrix for the second iteration accuracy assessment allows for a correct interpretation on either of the interpreter's observations, and ignores observations where the interpreter had little confidence in the location (Appendix B).

Accuracy Assessment Results

Overall accuracy for the first iteration land cover (28 classes) was 83.9858% (kappa = .8204). For the 18-class version that was later released (Natural Resource Spatial Analysis Laboratory 2001), overall accuracy was 84.717% (kappa = .8270). The slightly higher accuracy reflected the collapsing of several inaccurate classes into larger ones. Overall accuracy for the 44-class second iteration Georgia GAP land cover was 75.4612% (kappa = .7272).

The kappa statistic, or k_hat, estimates "the proportion of agreement after chance agreement is removed" (Rosenfeld and Fitzpatrick-Lins 1986). It is calculated by

$K\_hat = (p_o - p_c)/(1 - p_c)$

where

p_o = proportion of units which agree = sum of X_{ij}/N
p_c = proportion of units for expected chance agreement = sum of $x_{i.}x_{.i}/N^2$.

Kappa is bounded by –1 and 1 with 0 being chance agreement between classification and accuracy data. A value of 1 indicates perfect agreement.

The following discussion pertains mainly to the second iteration map, or final GAP map. For detailed discussion of the first map, see Payne et al. (2003).

User's accuracies, which estimate the probability that a mapped class is correct on the ground (and the inverse number of which reflects the commission error rate), ranged from 33.7% for class 423 (xeric ridge pine) to 100% for classes 9, (coastal dune), 415 (northern hardwood) and 513 (coastal shrub). These last three classes, however, had only 3, 2, and 3 accuracy assessment points, however. Other classes with user's accuracy rates at or near 95% included 11 (open water), 18 (transportation), 20 (utility swaths), 33 (quarries, strip mines), and 920 Producer's accuracies, which are calculated by dividing the number of times a class is correctly mapped by the number of times it occurs in the accuracy assessment (and the inverse number of which reflects the omission error rate), ranged from 21.05% for class 423 (xeric ridge pine) to 100% for classes 7 (beach), 9 (coastal dune), 34 (rock outcrop), 415 (northern hardwood), and 920 (salt marsh).

Classes with the highest user's accuracy rates tended to be either those mapped from extremely accurate ancillary data sources (such as 18 and 20) (Payne et al. 2003) or those with clearly distinguishable spectral signatures (such as 920). Not surprisingly, those with few assessment points tended to have very high or relatively low (e.g. 420 – live oak, and 424 – hemlock-white pine) accuracy rates.

The classes with the lowest user's accuracy rates, 423 (xeric ridge pine) and 422 (open loblolly-shortleaf pine), reflect the difficulties in mapping either different pine species or stand age and structure. We determined early into the mapping process that mapping pine species spectrally would not be possible without strong ancillary data. Class 423 was attempted through topographic means, but this proved difficult as well.

Class 512 (sandhill) had a user's accuracy rate of 80%, but a producer's accuracy of only 21.05%. This class was derived mainly through on-screen digitizing along river systems, and through unsupervised classifications in the Fall Line area. The discrepancy between accuracy rates reflects the likelihood that this category, while largely accurate where it was mapped, was missed in a large number of cases, and is more prevalent than

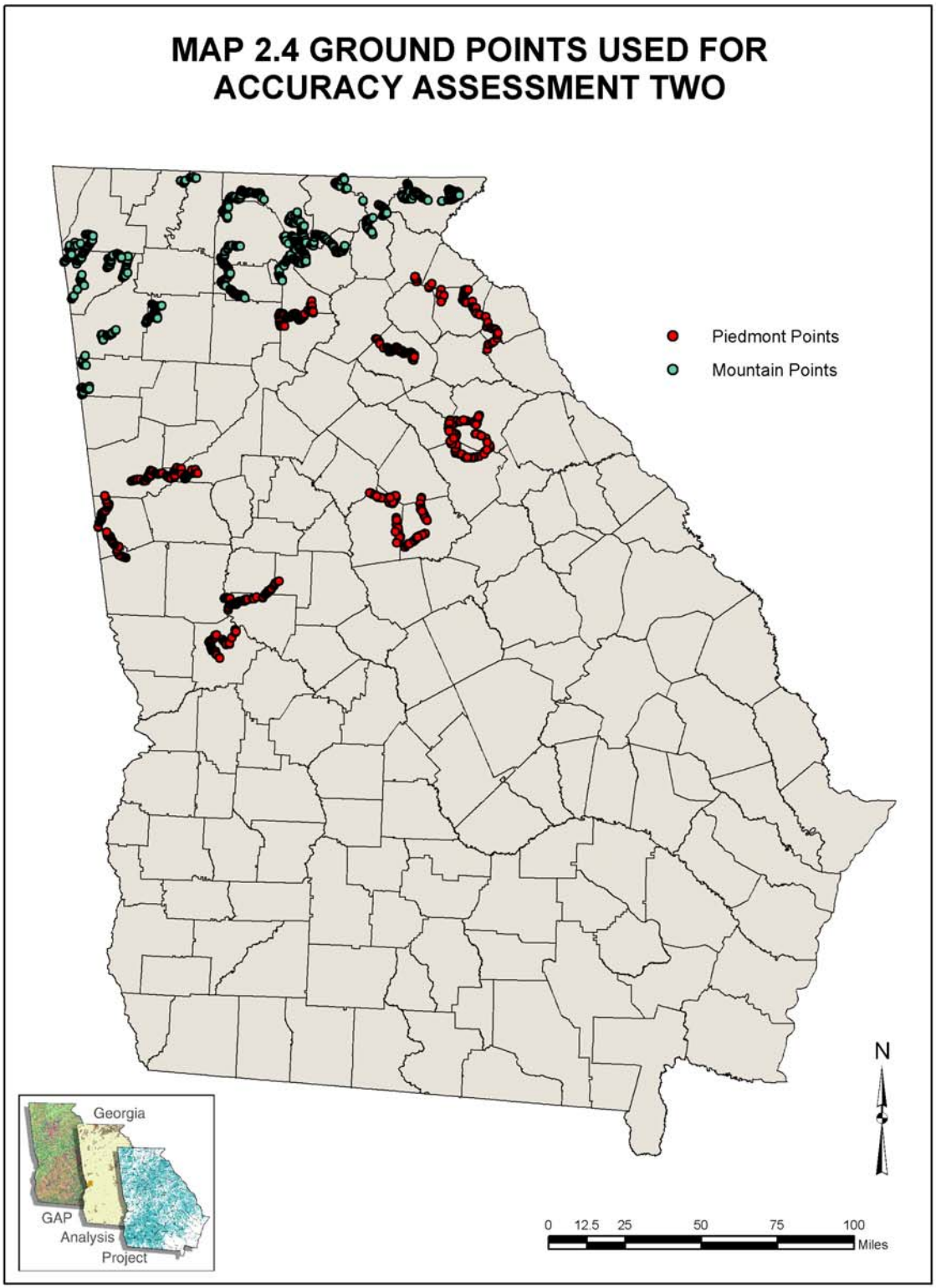
indicated in our land cover map. However, the classes with which it was most frequently confused, 31 (clearcut – sparse vegetation) and 412 (hardwood forest), do have some overlap in terms of stand conditions and species composition.

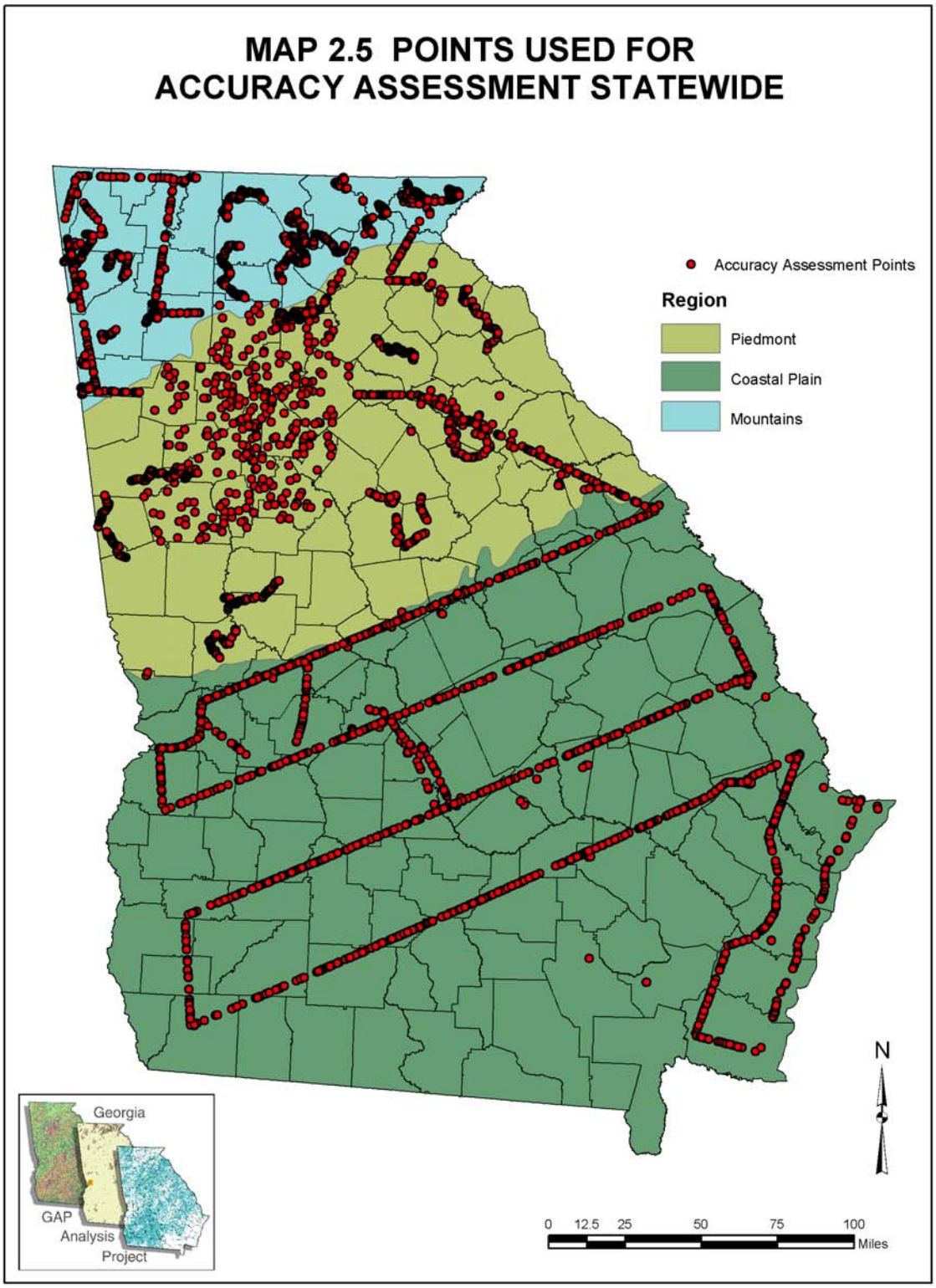
With the exception of classes 11 (spectrally very distinct) and 18 (which was obtained entirely from ancillary data sources), the most common land cover types had accuracies generally in line with the overall accuracy of the map. These common types include classes 80 (row crop), 83 (pasture), 411 (submesic hardwood), 412 (hardwood forest), 434 (mixed pine–hardwood), 440 (loblolly–shortleaf pine), 441 (loblolly-slash pine), and 900 (bottomland hardwood). Accuracies for these classes ranged from 68.75% for hardwood forest to 85.00% for row crop. Rare categories were more hit-or-miss.

Limitations and Discussion

The Georgia GAP land cover is a satellite imagery derived map of generally coarse nature; it is not intended to be used at scales finer than approximately 1:100,000. The accuracy of the map varies by class, and users interested in particular classes should consult tables listing specific class accuracies. There are rarely sharp lines delineating natural land cover types in Georgia. Some of those that appear in the Georgia GAP land cover are artifacts of the rather abrupt range lines that we used for a few classes (e.g., the line between classes 440 and 441, loblolly/shortleaf and loblolly/slash pine). In Georgia, we mapped areas of open ocean seven miles out from the coast line. All land cover figures include these areas of open ocean.

MAP 2.4 GROUND POINTS USED FOR ACCURACY ASSESSMENT TWO




MAP 2.5 POINTS USED FOR
ACCURACY ASSESSMENT STATEWIDE
Accuracy Assessment Points
Region
Piedmont
Coastal Plain
Mountains
N
0 12.5 25 50 75 100
Miles
Georgia
GAP
Analysis
Project

Chapter 3 - PREDICTED ANIMAL SPECIES DISTRIBUTIONS AND SPECIES RICHNESS

Introduction

All species range maps are predictions about the occurrence of those species within a particular area (Csuti 1994). Traditionally, the predicted occurrences of most species begin with samples from collections made at individual point locations. Most species range maps are small-scale (e.g., >1:10,000,000) and derived primarily from point data to construct field guides. The purpose of the GAP vertebrate species maps is to provide more precise information about the current predicted distribution of individual native species within their general ranges. With this information, better estimates can be made about the actual amounts of habitat area and the nature of its configuration.

GAP maps are produced at a nominal scale of 1:100,000 or better, and are intended for applications at the landscape or "gamma" scale (homogeneous areas generally covering 1,000 to 1,000,000 hectares and made up of more than one kind of natural community). Applications of these data to site- or stand-level analyses (site—a microhabitat, generally 10 to 100 square meters; stand—a single habitat type, generally 0.1 to 1,000 ha; Whittaker 1977, see also Stoms and Estes 1993) are likely to be compromised by the finer-grained patterns of environmental heterogeneity that are resolved at those levels.

Gap analysis uses the predicted distributions of animal species to evaluate their conservation status relative to existing land management (Scott et al. 1993). However, the maps of species distributions may be used to answer a variety of management, planning, and research questions relating to individual species or groups of species. In addition to the maps, great utility may be found in the consolidated specimen collection records and literature that are assembled into databases used to produce the maps.

Previous to this effort there were no maps available, digital or otherwise, showing the likely present-day distribution of species by habitat type across their ranges. Because of this, ordinary species (i.e., those not threatened with extinction or not managed as game animals) are generally not given sufficient consideration in land-use decisions in the context of large geographic regions or in relation to their actual habitats. Their decline because of incremental habitat loss can, and does, result in one threatened or endangered species "surprise" after another. Frequently, the records that do exist for an ordinary species are truncated by state boundaries. Simply creating a consistent spatial framework for storing, retrieving, manipulating, analyzing, and updating the totality of our knowledge about the status of each animal species is one of the most necessary and basic elements for preventing further erosion of biological resources.

Mapping Standards

GA-GAP predicted species distributions in accordance with the GAP Handbook as of 13 January 2000.

Methods

General

Modeling of vertebrate distributions for GA-GAP generally followed a 7-step process. First, we compiled a list of species to be modeled in Georgia. Second, we collected occurrence and habitat association data for each species. Third, we used the occurrence data to approximate the range boundaries of each species in Georgia. Next we assembled the habitat association information into a Microsoft Access database and produced printed copies of initial range maps. Fifth, biologists familiar with the distribution of Georgia's wildlife reviewed the

models and range boundaries. Sixth, we combined the range approximations with habitat associations to produce a GIS model of the predicted distribution of each species. Finally, we conducted an accuracy assessment of the predicted distributions.

Georgia Species List

GAP seeks to map distributions for all species "known to breed in the project area and that are regularly occurring non-accidentals" (Csuti and Crist 1998). Csuti and Crist (1998) suggest, as a general definition, that "regular breeders" are those species breeding in the state at least 5 of the past 10 years. "Breeding" is often difficult to document, especially for taxa other than birds. Thus, we enlisted experts and reviewed literature (Burleigh 1958; Golley 1962; Georgia Ornithological Society 1986; Williamson and Moulis 1994) and occurrence records to determine species likely to breed regularly in Georgia.

Our final list of 405 species modeled for Georgia GAP included 78 amphibians, 82 reptiles, 167 birds, and 78 mammals. A complete list of species may be found in Appendix C.

Occurrence Data

Specific occurrence data for species were acquired from a variety of sources. For birds, our primary source was the Georgia Breeding Bird Atlas (Georgia Department of Natural Resources, /in prep/). We supplemented this with some records from U.S. Forest Service point counts (U.S.D.A. Forest Service, Southern Region 1999). For reptiles and amphibians, we developed a database based upon specimens found in the University of Georgia Museum of Natural History (GMNH) (Georgia Museum of Natural History 2002), records collected by the Savannah Science Museum (Williamson and Moulis 1994), the Georgia Herp Atlas (Jensen, *in prep*), and a number of literature records. For mammals, we relied heavily on GMNH records, but also received county distribution maps from DNR for some species, specimen records from Valdosta State University and Clemson University, and a number of literature records. For all taxa, we also obtained Georgia Natural Heritage Program element occurrence data for rare or unusual species.

General ranges were hand-delineated for all species based on existing range maps, expert opinion, and informal use of occurrence data as a guide. Range maps for individual species were sent out to expert reviewers, and changes were incorporated as appropriate. Based on overlap, hand-delineated ranges and occurrence records were later converted to EMAP hexagons, a system of equal-area polygons. Each species was assigned a status of "predicted absent", "predicted present", or "confirmed present" in each hexagon.

Habitat Affinities

A habitat affinities database was created through a thorough literature review. Each species was coded in a Microsoft Access table as being likely "present" or "absent" within each land cover class. In addition, other associations between species and easily mappable features were recorded in Access. These included:

1. Elevation and elevation model derivatives, including slope.
2. Streams, including size (many literature sources refer to affinities for "small", "medium-sized" streams, etc.).
3. Seepages, or very small streams unmapped at 1:24,000.
4. Other water features, including affinities for salt vs. fresh water.
5. Wetlands.
6. Road density or distance to roads. This served as a surrogate in some cases for negative associations with human population density (e.g. black bear).

7. Geology.
8. Forest tract or other habitat patch size.
9. Proximity of one habitat type to another (e.g. longleaf pine adjacent to cypress-gum wetlands).
10. A mix of habitats (e.g. forest and early successional areas).

An interactive form was designed in Access that allowed reviewers to make corrections and comments to the habitat affinities. In addition, hard copy reports of the same database were distributed to some reviewers. Their changes to habitat affinities were recorded as appropriate. In many cases, model inputs were changed after experts viewed an initial model output.

The list of all persons who either reviewed models or contributed information incorporated into species models may be found in Appendix D.

Modelling Procedure

The primary Access table of species presence or absence within habitat types was converted to a text file. A basic model was created in the form of an AML script that read the text file, placed the species into appropriate habitat types based on the land cover map, and masked out areas outside the digitized ranges. Species were split into groups based on whether the basic model was sufficient for predicting distributions, or more refined modeling involving other features was necessary. Models for species for which the basic model was not sufficient were run via keyboard commands in Arc/Info or in ArcView. Descriptions of individual models may be found in Appendix E.

Methods Developed Specifically for Stream Salamanders

Stream salamanders are an important element of Georgia's vertebrate fauna. In order to successfully predict their presence on a statewide scale, it is necessary to have accurate data representing their favored habitat types. Many species prefer very small headwater rills and seepages that are seldom mapped even at 1:24,000 scale.

Unsatisfied with previous approaches to mapping stream salamanders, we investigated methods for improving these models. Using an estimate of flow accumulation in conjunction with a land cover, we believe we were successful. We calculated flow accumulation by processing a digital terrain model with CRWR-PrePro (http://civil.ce.utexas.edu/prof/olivera/esri98/p400.htm), an ArcView module distributed by the University of Texas Center for Research in Water Resources (Olivera et al. 1998).

The module operates similarly to flow accumulation methods devised by Jensen and Domingue (1988) in that it uses the terrain model to first calculate downhill direction, or flow path, for every pixel, and then counts the number of pixels contributing to flow in the downhill direction. The highest flow values are found at the bottoms of drainages, where streams are located. While many software modules are capable of creating this flow accumulation parameter, CRWR-PrePro is advantageous in that it "burns in" a pre-existing line coverage of streams by raising elevation values for surrounding terrain, allowing the user to keep the positional accuracy of an existing stream coverage.

The key to using flow accumulation in predicting the occurrence of salamanders is setting the proper thresholds for streams. If the proper values are selected (especially for minimum flow) many miles of previously unmapped streams may be added to a predicted habitat map. We used field reconnaissance observations to determine the minimum and maximum values of flow accumulation suitable for various species of stream salamanders.

Results

405 individual species models were produced in Georgia. The result of all models was a binary grid, with 1's denoting predicted species presence, and 0's denoting predicted species absence. Models were originally produced at a resolution of 30 x 30 meters, and all calculations are based on the original 30 x 30 meter data. Vertebrate data was resampled to 90 x 90 meters, using the RESAMPLE function in Arc/Info GRID, for distribution on CD. The original 30 meter data may be obtained through the National GAP website (ftp:/gap.uidaho.edu/products/georgia/gis/vertebrates/30mdata). Maps depicting the model results may be found in Appendix G.

Species Richness

GAP has often been associated with the mapping of species-rich areas or "hotspots." Richness maps identify where the same numbers of elements co-occur in the same geographic locations or cover types. While we continue to perform this useful pattern analysis, it is only one of many that may be conducted using the data. Richest areas may or may not indicate the best conservation opportunities. They may provide a useful starting point for examining conservation opportunities, in combination with other analyses. They do not provide consideration of rare environments important for individual species, and do not capture the unique species assemblages of certain communities. We calculated species richness both by land cover type and by the U.S. Environmental Protection Agency's EMAP hexagons.

By Cover Type

Measures of species richness within cover types, or alpha diversity (Whittaker 1960; Whittaker 1977) are simple aggregates. We counted a species as being present if it was found within any pixel of a given land cover. For species that were primarily modeled around other features such as streams, this may be somewhat misleading. For example, a species may be counted as present along an entire stretch of stream within some otherwise unsuitable land cover types (e.g. a turtle in category 18 – transportation). However, we generally excluded a species from land cover types that truly interfered with its likelihood of presence. For an example, see the model for the hellbender (Appendix E).

The purpose of calculating species richness by land cover type is to identify communities which may have a large number of animals, but cover a relatively small percentage of the state. These may represent species richness "hotspots". The broader land cover classes which cover a large percentage of the state, or which are distributed across a large area of the state, will often have more species present merely by virtue of the fact that they intersect the ranges of more species, especially generalists.

For amphibians (Table 3.1), bottomland hardwoods represent the most species-rich cover type. This class is distributed across the entire state, and covers a moderately large area. However, it only amounts to about half the area of the next richest class, mixed pine-hardwood, which also occurs statewide. Notably rich but covering small areas are mesic hardwoods, mixed cove forest, and deciduous cove hardwoods. These classes are all restricted to mountain regions or the upper Piedmont, which possess very high salamander diversity. Saltmarshes and coastal dunes had the lowest amphibian diversities, with 0 species.

Table 3.1. Amphibian species richness by cover type.

Code	Class Name	% of State	Amphibians
900	Bottomland Hardwood	3.34907	53
434	Mixed Pine-Hardwood	5.95083	48
410	Mesic Hardwood	0.89537	44
411	Sub-mesic Hardwood	4.37592	43
890	Cypress-Gum Swamp	4.07304	42
433	Mixed Cove Forest	0.06471	39
414	Deciduous Cove Hardwood	0.23578	39
412	Hardwood Forest	8.87963	38
980	Shrub Wetland	0.81507	36
990	Evergreen Forested Wetland	2.20165	35
424	Hemlock-White Pine	0.02784	33
431	Montane Mixed Pine-Hardwood	0.45449	31
31	Clearcut – Sparse Vegetation	7.53495	31
425	White Pine	0.16666	30
930	Freshwater Marsh	0.56528	30
11	Open Water	2.91559	30
620	Longleaf Pine	0.85639	26
440	Loblolly-Shortleaf Pine	10.94653	26
441	Loblolly-Slash Pine	10.82909	25
20	Utility Swaths	0.32671	22
422	Open Loblolly-Shortleaf Pine	2.13138	20
420	Live Oak	0.20003	18
415	Northern Hardwood	0.0007	17
73	Golf Course	0.09146	16
203	Forested Urban - Mixed	0.36402	16
201	Forested Urban - Deciduous	0.61209	16
72	Parks, Recreation	0.08609	15
202	Forested Urban - Evergreen	0.41917	15
413	Xeric Hardwood	0.65973	15
432	Xeric Mixed Pine-Hardwood	0.31033	14
80	Pasture, Hay	7.65432	14
512	Sandhill	0.47406	12
22	Low Intensity Urban - Nonforested	0.58736	12
33	Quarries, Stripmines	0.10283	6
7	Beach	0.02673	5
34	Rock Outcrop	0.00747	4
24	High Intensity Urban	0.79507	3
83	Row Crop	12.62874	3
513	Coastal Scrub	0.00824	2
423	Xeric Pine	0.11726	2
18	Transportation	6.3035	2
511	Shrub Bald	0.00074	1
9	Coastal Dune	0.00382	0
920	Saltmarsh	0.95026	0

For breeding birds (Table 3.2), bottomland hardwoods again possess the highest species richness. Notably rich but covering small areas are montane mixed pine-hardwoods and deciduous cove hardwoods (two categories again restricted to the mountain areas). The clearcut-sparse vegetation class has a high richness score, but occurs statewide and covers a very large area. Nonetheless, this class may provide suitable habitat for species requiring early successional areas, which are currently rare in a natural state in Georgia. This is borne out by the fact that utility swaths, which cover a much small area (although they also occur statewide), also have a relatively bird species richness. Transportation (e.g. roads), rock outcrops, and quarries have the lowest breeding bird species richness.

Table 3.2. Breeding bird species richness by cover type.

Code	Class Name	% of State	Birds
900	Bottomland Hardwood	3.34907	74
31	Clearcut – Sparse Vegetation	7.53495	71
431	Montane Mixed Pine-Hardwood	0.45449	66
411	Sub-mesic Hardwood	4.37592	65
414	Deciduous Cove Hardwood	0.23578	64
412	Hardwood Forest	8.87963	64
20	Utility Swaths	0.32671	63
434	Mixed Pine-Hardwood	5.95083	63
410	Mesic Hardwood	0.89537	62
890	Cypress-Gum Swamp	4.07304	62
80	Pasture, Hay	7.65432	61
420	Live Oak	0.20003	59
990	Evergreen Forested Wetland	2.20165	57
433	Mixed Cove Forest	0.06471	56
73	Golf Course	0.09146	56
620	Longleaf Pine	0.85639	53
980	Shrub Wetland	0.81507	52
422	Open Loblolly-Shortleaf Pine	2.13138	51
203	Forested Urban - Mixed	0.36402	50
201	Forested Urban - Deciduous	0.61209	50
415	Northern Hardwood	0.0007	49
72	Parks, Recreation	0.08609	49
432	Xeric Mixed Pine-Hardwood	0.31033	49
202	Forested Urban - Evergreen	0.41917	49
425	White Pine	0.16666	48
930	Freshwater Marsh	0.56528	48
11	Open Water	2.91559	48
424	Hemlock-White Pine	0.02784	47
413	Xeric Hardwood	0.65973	47
440	Loblolly-Shortleaf Pine	10.94653	47
512	Sandhill	0.47406	43
441	Loblolly-Slash Pine	10.82909	43
7	Beach	0.02673	39
22	Low Intensity Urban - Nonforested	0.58736	39
513	Coastal Scrub	0.00824	38
83	Row Crop	12.62874	38
423	Xeric Pine	0.11726	33
920	Saltmarsh	0.95026	33

9	Coastal Dune	0.00382	27
24	High Intensity Urban - Nonforested	0.79507	20
511	Shrub Bald	0.00074	17
34	Rock Outcrop	0.00747	17
33	Quarries, Stripmines	0.10283	13
18	Transportation	6.3035	13

For mammals (Table 3.3), deciduous cove hardwoods, submesic hardwoods, and mixed pine-hardwoods have the highest richness values. Of these, deciduous cove hardwoods are the most notable, as they cover the smallest area. Submesic hardwoods cover a relatively large area, but are fairly restricted in their distribution, occurring only in the mountain areas and upper Piedmont. Bottomland hardwoods have just one species less than the top three classes. Also containing notable mammal richness in small areas are mixed cove forest, montane mixed pine-hardwood, and hemlock-white pine. Northern hardwoods have a relatively high mammal richness score and cover the smallest area of any land cover class in the state. Transportation, quarries/strip mines, and high intensity urban areas have the lowest mammal species richness.

Table 3.3. Mammal species richness by cover type.

Code	Class Name	% of State	Mammals
414	Deciduous Cove Hardwood	0.23578	46
411	Sub-mesic Hardwood	4.37592	46
434	Mixed Pine-Hardwood	5.95083	46
410	Mesic Hardwood	0.89537	45
900	Bottomland Hardwood	3.34907	45
433	Mixed Cove Forest	0.06471	44
431	Montane Mixed Pine-Hardwood	0.45449	43
31	Clearcut – Sparse Vegetation	7.53495	43
424	Hemlock-White Pine	0.02784	41
415	Northern Hardwood	0.0007	39
20	Utility Swaths	0.32671	38
80	Pasture, Hay	7.65432	38
412	Hardwood Forest	8.87963	38
420	Live Oak	0.20003	37
422	Open Loblolly-Shortleaf Pine	2.13138	35
440	Loblolly-Shortleaf Pine	10.94653	35
620	Longleaf Pine	0.85639	34
990	Evergreen Forested Wetland	2.20165	34
930	Freshwater Marsh	0.56528	33
441	Loblolly-Slash Pine	10.82909	33
425	White Pine	0.16666	32
413	Xeric Hardwood	0.65973	32
203	Forested Urban - Mixed	0.36402	31
202	Forested Urban - Evergreen	0.41917	31
201	Forested Urban - Deciduous	0.61209	31
890	Cypress-Gum Swamp	4.07304	30
432	Xeric Mixed Pine-Hardwood	0.31033	29
512	Sandhill	0.47406	26
513	Coastal Scrub	0.00824	23
980	Shrub Wetland	0.81507	22
511	Shrub Bald	0.00074	21

34	Rock Outcrop	0.00747	18
72	Parks, Recreation	0.08609	18
423	Xeric Pine	0.11726	18
73	Golf Course	0.09146	17
11	Open Water	2.91559	16
7	Beaches/Dunes/Mud	0.02673	15
22	Low Intensity Urban - Nonforested	0.58736	14
83	Row Crop	12.62874	14
9	Coastal Dune	0.00382	9
920	Saltmarsh	0.95026	8
24	High Intensity Urban	0.79507	7
33	Quarries, Stripmines	0.10283	5
18	Transportation	6.3035	1

For reptiles (Table 3.4), mixed pine–hardwoods and clearcut–sparse vegetation have the highest richness scores. Although these are broadly distributed classes covering large areas, they may provide habitat for snakes and lizards requiring either xeric forest or open areas. Classes having notably high richness scores and covering small areas are xeric hardwood, longleaf pine, xeric mixed pine-hardwood, and sandhill, all important habitats for many snakes and lizards. Bottomland hardwoods also have a relatively high reptile richness score. Unlike the other classes, bottomland hardwoods are more important in providing habitat for aquatic snakes and turtles. Shrub balds, salt marsh, and coastal dunes have the lowest reptiles richness scores. However, both salt marsh and coastal dunes may provide important habitat for rare species such as the diamondback terrapin (*Malaclemys terrapin*).

Table 3.4.. Reptile species richness by cover type.

Code	Class Name	% of State	Reptiles
434	Mixed Pine-Hardwood	5.95083	59
31	Clearcut – Sparse Vegetation	7.53495	59
413	Xeric Hardwood	0.65973	51
441	Loblolly-Slash Pine	10.82909	51
620	Longleaf Pine	0.85639	50
432	Xeric Mixed Pine-Hardwood	0.31033	49
900	Bottomland Hardwood	3.34907	49
412	Hardwood forest	8.87963	47
440	Loblolly-Shortleaf Pine	10.94653	45
512	Sandhill	0.47406	44
422	Open Loblolly-Shortleaf Pine	2.13138	42
420	Live Oak	0.20003	40
990	Evergreen Forested Wetland	2.20165	40
411	Sub-mesic Hardwood	4.37592	40
20	Utility Swaths	0.32671	39
410	Mesic Hardwood	0.89537	38
202	Forested Urban - Evergreen	0.41917	35
201	Forested Urban - Deciduous	0.61209	35
890	Cypress-Gum Swamp	4.07304	35
203	Forested Urban - Mixed	0.36402	33
11	Open Water	2.91559	32
7	Beaches/Dunes/Mud	0.02673	31
930	Freshwater Marsh	0.56528	31

980	Shrub Wetland	0.81507	31
80	Pasture, Hay	7.65432	29
433	Mixed Cove Forest	0.06471	27
424	Hemlock-White Pine	0.02784	26
414	Deciduous Cove Hardwood	0.23578	26
423	Xeric Pine	0.11726	25
72	Parks, Recreation	0.08609	23
513	Coastal Scrub	0.00824	22
425	White Pine	0.16666	22
431	Montane Mixed Pine-Hardwood	0.45449	22
22	Low Intensity Urban - Nonforested	0.58736	22
73	Golf Course	0.09146	18
33	Quarries, Stripmines	0.10283	17
83	Row Crop	12.62874	17
24	High Intensity Urban	0.79507	16
34	Rock Outcrop	0.00747	15
18	Transportation	6.30350	14
415	Northern Hardwood	0.00070	11
9	Coastal Dune	0.00382	11
920	Saltmarsh	0.95026	9
511	Shrub Bald	0.00074	6

Overall (Table 3.5), bottomland hardwoods have the highest species richness by cover class, with 221 species total, 54.6% of all species analyzed in Georgia GAP. Other classes with high richness scores tend to be general classes covering large areas distributed across large portions of the state, such as mixed pine-hardwood, clearcut-sparse vegetation, and hardwood forest. Exceptions include submesic hardwoods (covers large area but limited in distribution), mesic hardwoods, deciduous cove hardwoods, and mixed cove forest. Cypress-gum swamps cover a fairly large area of the state and possess a high richness score. Transportation, quarries/strip mines, shrub balds, and high intensity urban areas had the lowest richness scores. Of these, only shrub balds are not human-dominated.

Table 3.5. Total species richness for species analyzed by GA_GAP, by cover type.

Code	Class Name	% of State	Species
900	Bottomland Hardwood	3.34907	221
434	Mixed Pine-Hardwood	5.95083	216
31	Clearcut – Sparse Vegetation	7.53495	204
411	Sub-mesic Hardwood	4.37592	194
410	Mesic Hardwood	0.89537	189
412	Hardwood forest	8.87963	187
414	Deciduous Cove Hardwood	0.23578	175
890	Cypress-Gum Swamp	4.07304	169
433	Mixed Cove Forest	0.06471	166
990	Evergreen Forested Wetland	2.20165	166
620	Longleaf Pine	0.85639	163
20	Utility Swaths	0.32671	162
431	Montane Mixed Pine-Hardwood	0.45449	162
420	Live Oak	0.20003	154
440	Loblolly-Shortleaf Pine	10.94653	153

441	Loblolly-Slash Pine	10.82909	152
422	Open Loblolly-Shortleaf Pine	2.13138	148
424	Hemlock-White Pine	0.02784	147
413	Xeric Hardwood	0.65973	145
930	Freshwater Marsh	0.56528	142
80	Pasture, Hay	7.65432	142
432	Xeric Mixed Pine-Oak	0.31033	141
980	Shrub Wetland	0.81507	141
425	White Pine	0.16666	132
201	Forested Urban - Deciduous	0.61209	132
203	Forested Urban - Mixed	0.36402	130
202	Forested Urban - Evergreen	0.41917	130
11	Open Water	2.91559	126
512	Sandhill	0.47406	125
415	Northern Hardwood	0.00070	116
73	Golf Course	0.09146	107
72	Parks, Recreation	0.08609	105
7	Beaches/Dunes/Mud	0.02673	90
22	Low Intensity Urban - Nonforested	0.58736	87
513	Coastal Scrub	0.00824	85
423	Xeric Pine	0.11726	78
83	Row Crop	12.62874	72
34	Rock Outcrop	0.00747	54
920	Saltmarsh	0.95026	50
9	Coastal Dune	0.00382	47
24	High Intensity Urban	0.79507	46
511	Shrub Bald	0.00074	45
33	Quarries, Stripmines	0.10283	41
18	Transportation	6.30350	30

By EMAP Hexagon

EMAP hexagons are a system of equal-area polygons developed by the U.S. Environmental Protection Agency. Calculating species richness by hexagon involves tabulating the total number of species occurring within each polygon. This is useful in determining specific geographic areas containing a large number of species. There are a couple of problems inherent in this type of analysis. When calculating hexagon richness for a single state such as Georgia, hexagons lying on the edge of the state will tend to have fewer species, since they have a smaller physical area in which species may occur. Although this could be partially ameliorated by simply summing the totals from the range hexagons discussed on page 40, this would not allow for consideration of available habitat in the determination of presence of a species, and would tend to inflate richness estimates in many areas. Finally, another potential problem is the tendency of this analysis to emphasize areas of heavy range overlap, such as the edge of ecoregions. Thus, a hexagon may end up with a high richness score, but not necessarily have a high species richness at any particular location.

Seventy-eight amphibians were considered for analysis by hexagon in Georgia (Map 3.1). Of these, 47 (63% of total) were the most predicted to occur within a hexagon. Average predicted richness was 36.6 with a standard deviation of 5.6. Areas of highest richness were found on the Coastal Plain. In particular, southwest Georgia and the Savannah River valley have high amphibian species richess. Species in these areas tend to have wider ranges than those in the mountain areas, which possess many salamander species with limited geographic distribution. An area along the Fall Line east of Columbus also ranked highly, due at least in part to its location

along the boundaries of ecoregions. The eastern Piedmont has the lowest amphibian species richness, along with an area of hexagons off the coast consisting of much open water.

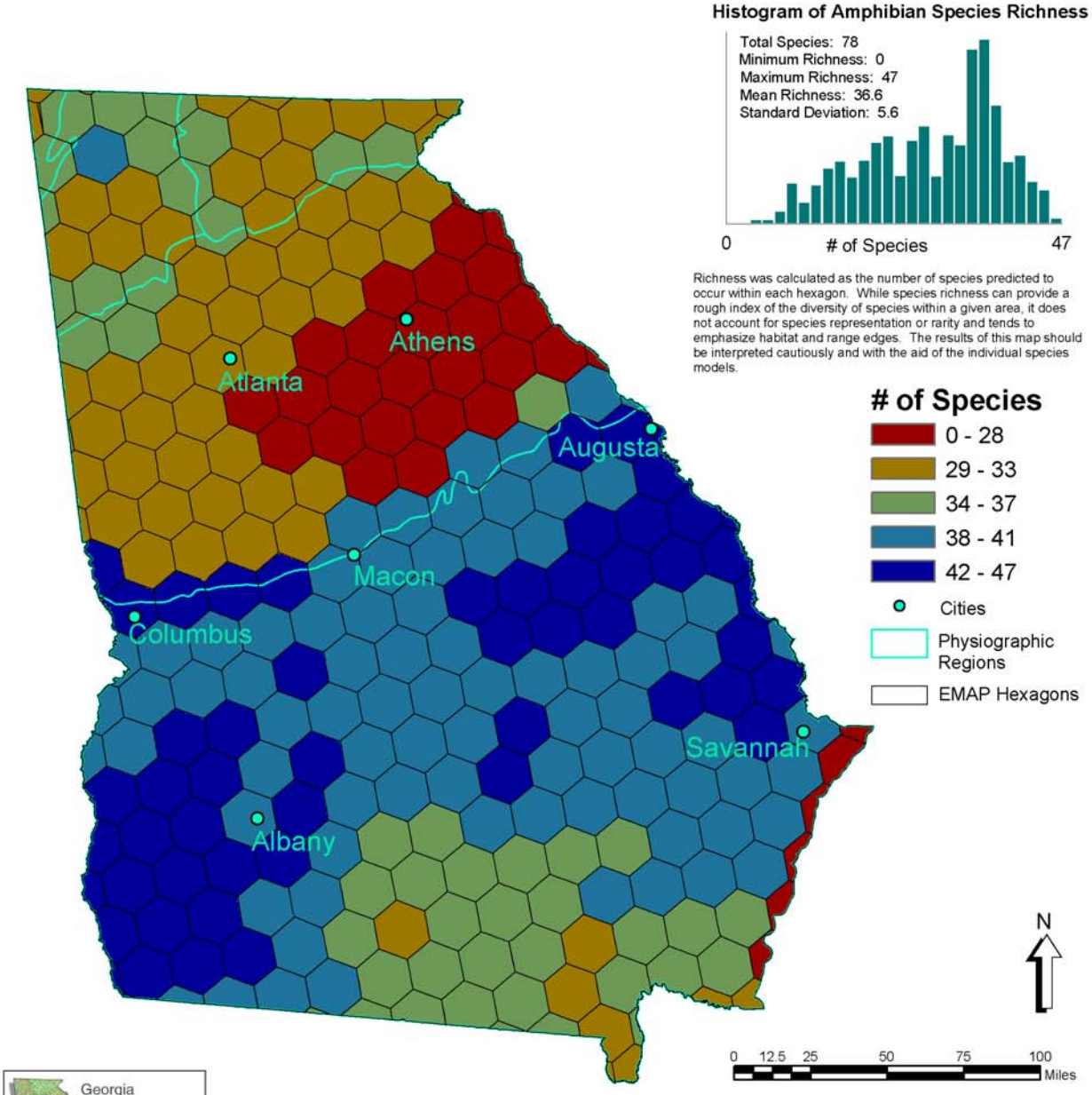
Of the 167 breeding birds analyzed in Georgia (Map 3.2), 121 (72.5%) were the most predicted to occur in a single hexagon. This occurred along the crest of the Blue Ridge near the borders of White, Towns, Union, and Lumpkin counties. The high Blue Ridge in general, including the Cohutta mountains, had very high breeding bird richness, as well as the border region between the Blue Ridge and Piedmont. Many northern species reach the southern end of their breeding range in this area. Coastal areas, with many shorebirds found nowhere else in the state, also had very high richness. An area of high richness on the Fall Line may be the result of ecoregion boundaries. Average richness was 108.7 with a standard deviation of 4.2. Lowest predicted breeding bird richness was in far southern Georgia around the Okefenokee Swamp.

Seventy-eight mammals were analyzed in Georgia (Map 3.3). Of these, 59 (75.6%) were the most predicted to occur in a single hexagon. This occurred along the high Blue Ridge in Rabun county. Average richness was 46.8 with a standard deviation of 3.1. Species richness in the Blue Ridge was higher than in the rest of the state. This is largely due to the many northern species that reach the southern end of their range in this area, especially shrews. Mammalian species richness was lowest in the area off the coast, in the eastern Piedmont, and in an area just northwest of the Okefenokee Swamp.

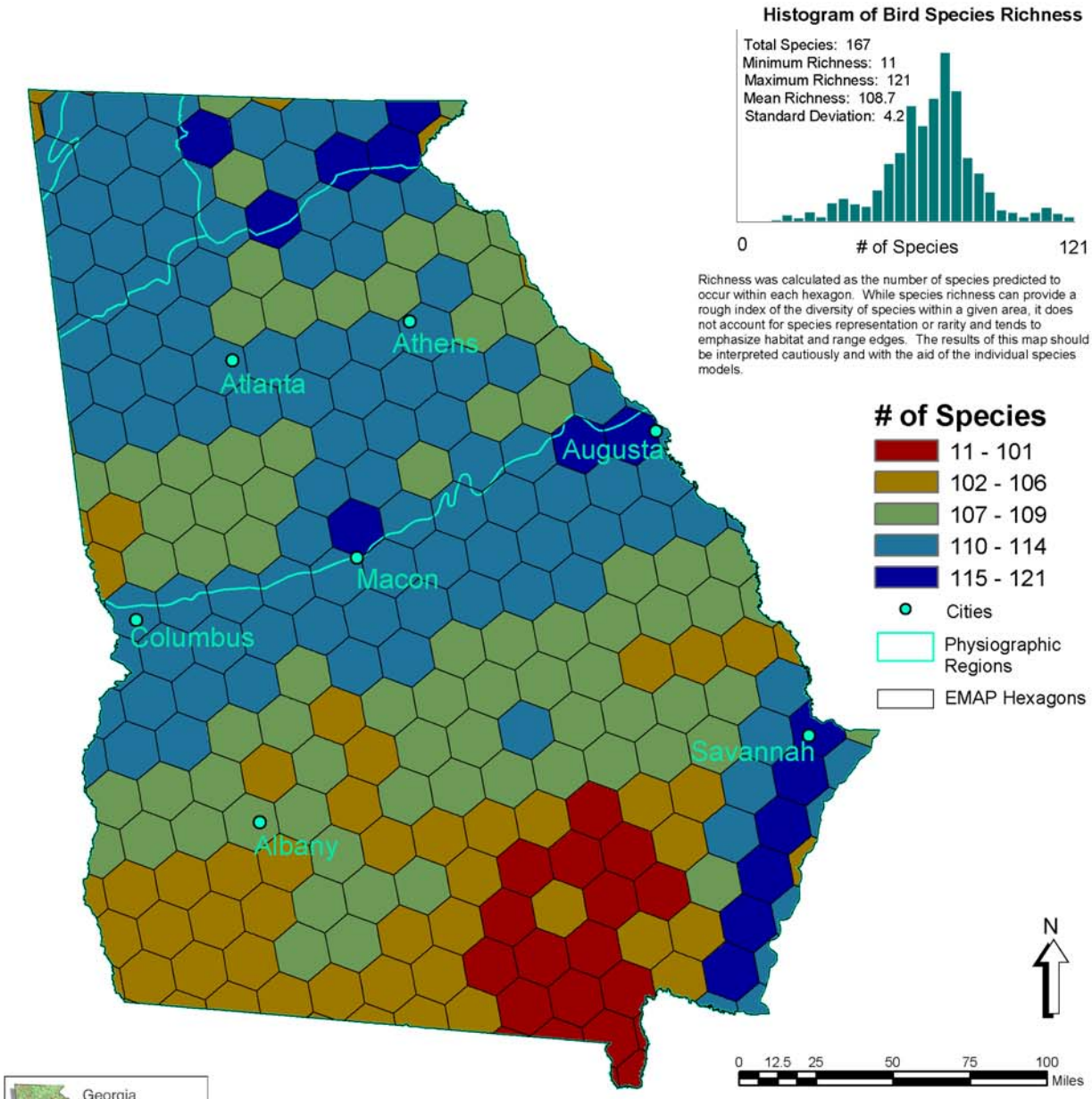
Of the 82 reptiles analyzed in Georgia (Map 3.4), 64 (78.0%) were the most predicted to occur in a single hexagon. Average predicted richness per hexagon was 52.8 with a standard deviation of 8.1. Interestingly, the distribution of this data was bimodal. Highest numbers were in southwest Georgia, especially in the areas around Albany and Valdosta. Another hotspot occurred in the lower Coastal Plain, particularly in the vicinity of Fort Stewart. On the other hand, the northern reaches of the state were rather reptile-poor. The high Blue Ridge area had the lowest predicted reptile species richness. In general, a pattern of increasing richness from north to south is to be expected for reptiles.

When all taxa were analyzed in total (Map 3.5), 267 (65.9%) of Georgia's 405 species were the most predicted to occur in any single hexagon. This occurred near the coast around the mouth of the Altamaha River. Average predicted richness was 244.9, with a standard deviation of 13.5. In general, the highest numbers were in the Coastal Plain, with the exceptions of the Okefenokee area and the region off the coast. Areas along the coast and Fall Line tended to have the highest scores. Lowest scores were found in the eastern Piedmont and off the coast.

MAP 3.1 AMPHIBIAN SPECIES RICHNESS



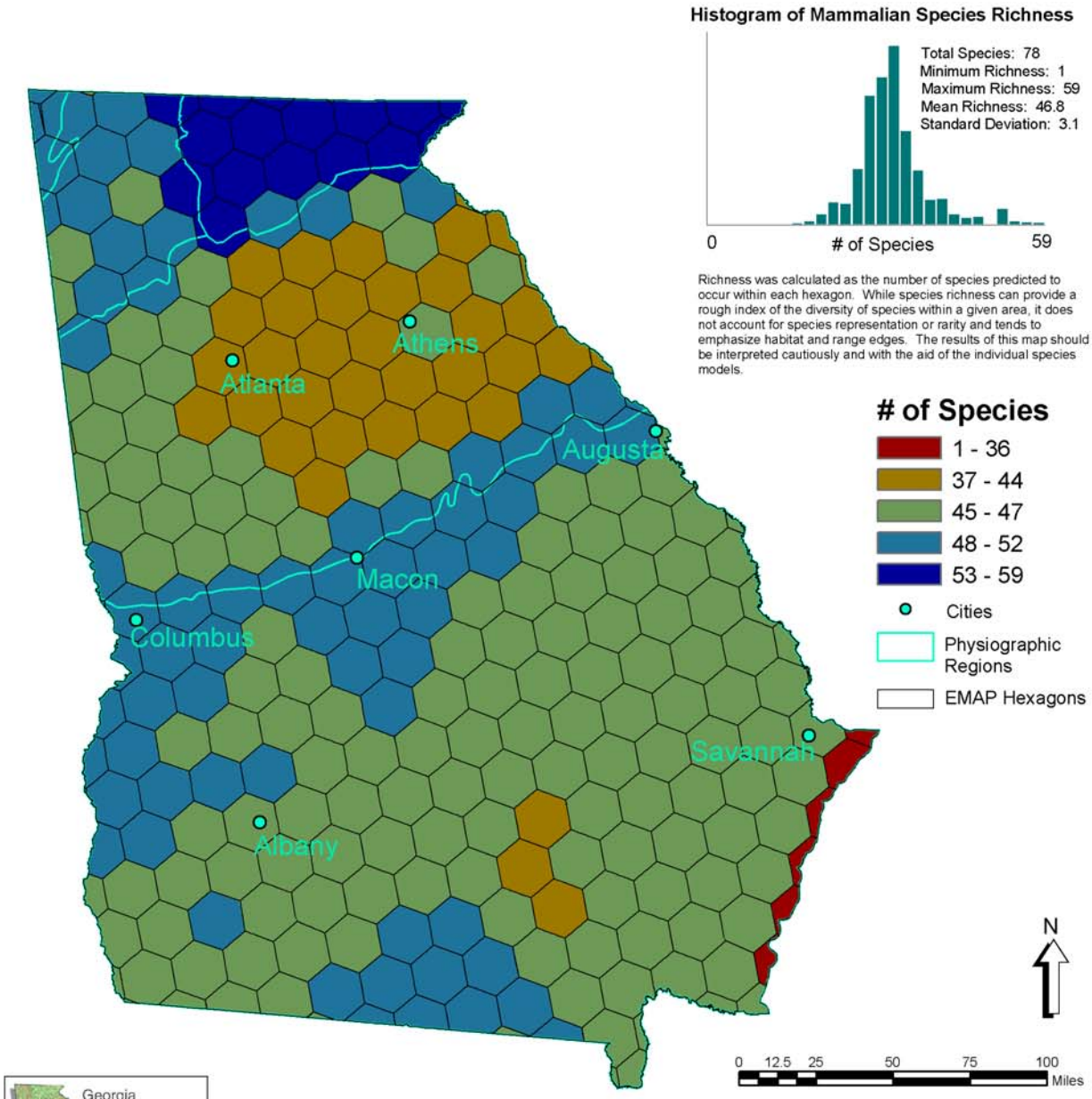
MAP 3.2 BREEDING BIRD SPECIES RICHNESS



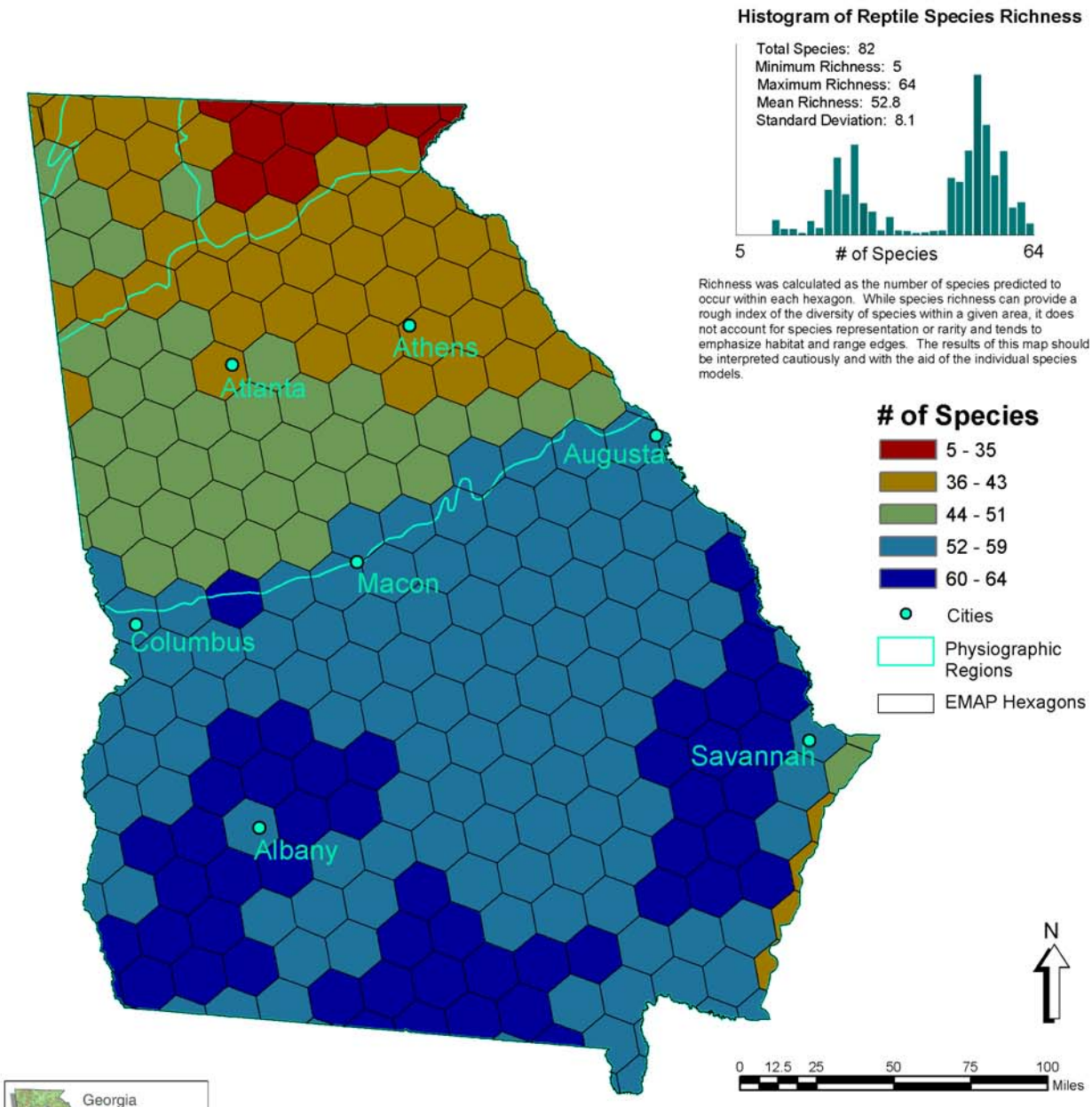
Projection: UTM zone 17, Datum NAD83, Units Meters
Map created on 7/27/03

Map and data prepared by the NARSAL Lab, Institute of Ecology, University of Georgia

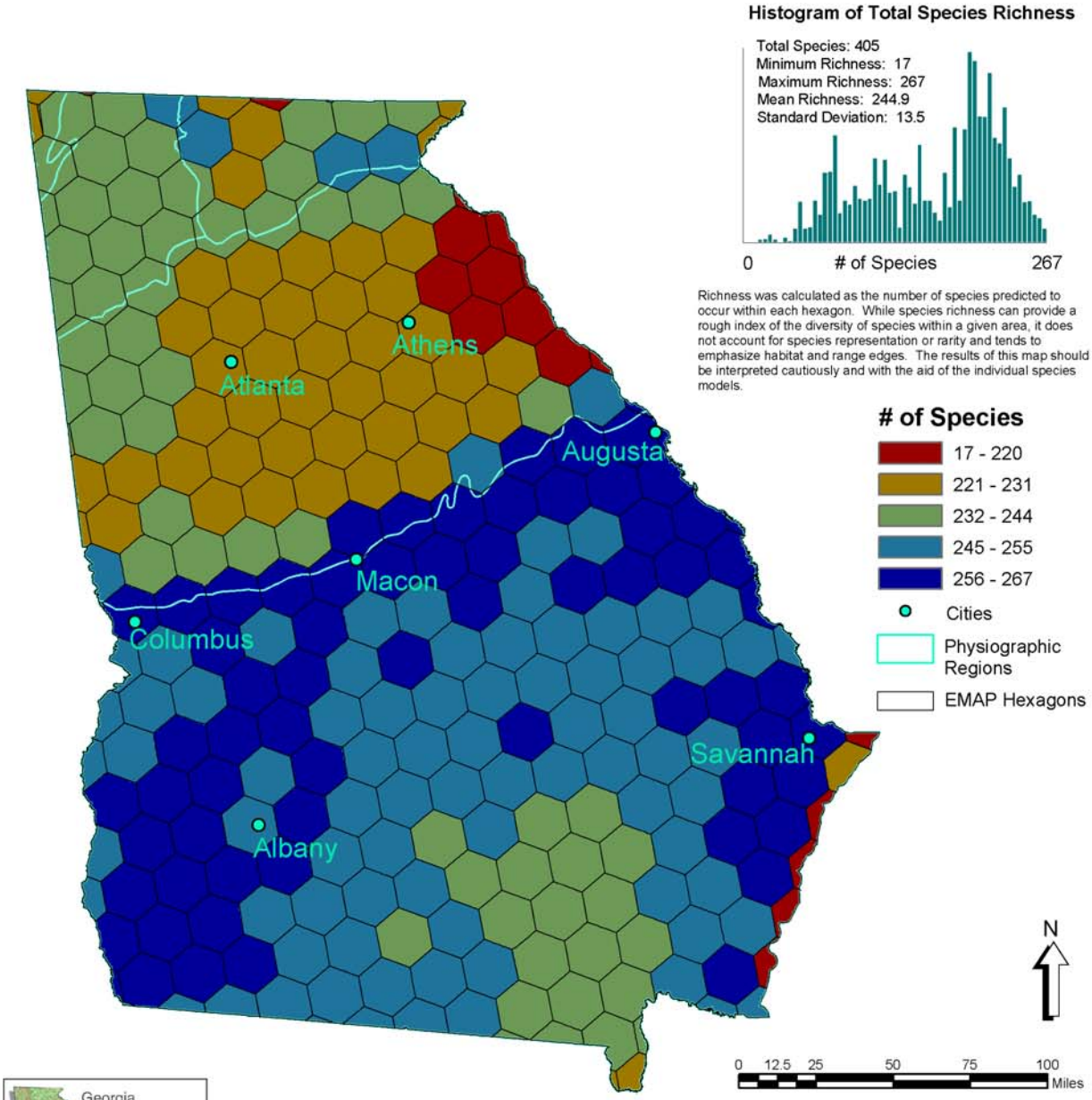
MAP 3.3 MAMMALIAN SPECIES RICHNESS



MAP 3.4 REPTILE SPECIES RICHNESS



MAP 3.5 TOTAL SPECIES RICHNESS



Accuracy Assessment

Assessing the accuracy of the predicted vertebrate distributions is subject to many of the same problems as assessing land cover maps, as well as a host of more serious challenges related to both the behavioral aspects of species and the logistics of detecting them. These are described further in the Background section of the GAP Handbook on the national GAP home page. We do, however, feel it is important to provide users with a statement about the accuracy of GAP predicted vertebrate distributions within the limitations of available resources and practicalities of such an endeavor. We acknowledge that distribution maps are never finished products, but are continually updated as new information is gathered. However, we feel that assessing the accuracy of their current iteration provides useful information about their reliability to potential users. We especially encourage wildlife biologists and amateur naturalists to treat the predicted distributions as testable hypotheses and engage the process of validation and iterative modeling. Our goal was to produce maps that predict distribution of terrestrial vertebrates and from that, total species richness and species content with an accuracy of 80% or higher. Failure to achieve this accuracy indicates the need to refine the data sets and models used for predicting distribution.

One of the most important questions surrounding the GAP vertebrate models involves scale. At a broad scale, the models are likely to be extremely accurate (at the level of an EMAP hexagon, for example). At fine scales, they will be less accurate, and may not be suitable for many uses. Using the limited data available, we attempted in this accuracy assessment to broadly set a scale at which the model results are likely to be of useful accuracy (around 80%).

Methods

Our approach to assessing the accuracy of the GAP vertebrate distribution models was similar to that of other GAP projects (Schmidt et al. 2001; Scott et al. 2002). We sought to identify a representative subset of the state that had been surveyed for wildlife species and compare recorded detections with the models. Ideally, these survey tracts would contain current species detection records, include a range of acreages, be evenly distributed across the physiographic provinces of the state and maintain comprehensive species lists of wildlife species resident on the property. After contacting several public agencies as well as private conservation organizations to inquire about obtaining species lists for various management areas, we discovered that no such list exists for some management areas while others possess lists compiled by volunteers or unknown surveyors of unknown expertise using unknown methods that cannot be considered complete and are of questionable accuracy themselves. An exhaustive search for tracts with reliable wildlife survey data resulted in a collection of 22 tracts for inclusion in the accuracy assessment that are well distributed across the physiographic provinces of Georgia. The distribution of these tracts is shown in Map 3.6 and they are identified by name and acreage in Table 3.6.

In addition to the 22 tracts already mentioned, we also used lists compiled from Breeding Bird Survey data (Sauer et al. 2003). Using 0.25 mile as a buffer within birds might be detected (Hamel et al. 1996), we included species detected between 1988 and 1998 from all five routes in the mountain areas, and five randomly chosen routes in the Coastal Plain, both areas with apparent gaps in available lists. Thus, we ended up with 32 species lists in total. Breeding Bird Survey routes are also shown in Map 3.6 and Table 3.6.

Map 3.6 Georgia GAP Vertebrate Distribution Model Accuracy Assessment Survey Tracts

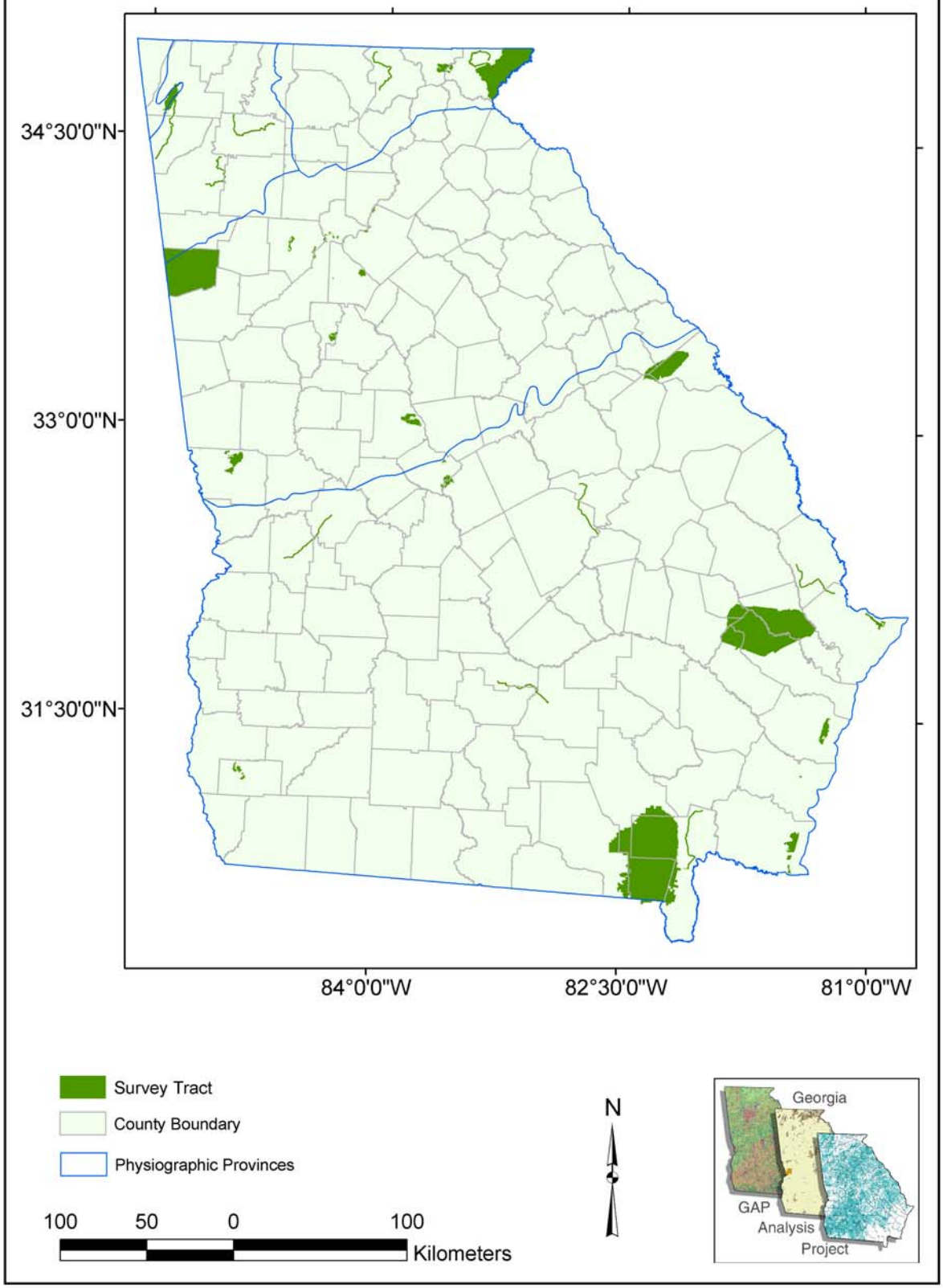


Table 3.6 Survey areas with wildlife species lists used in the Georgia GAP vertebrate distribution model accuracy assessment

Survey Area	Area (ha)
Fernbank Forest	54
Fort Fredrica National Monument	125
Ocmulgee Mounds National Monument	258
Tallulah Gorge State Park	1,143
Kennesaw Mountain National Battlefield	1,153
Stone Mountain State Park	1,284
Clayton County Water Authority	1,632
Bond Swamp National Wildlife Refuge	1,761
Mayhaw Wildlife Management Area	1,913
Fort Pulaski National Monument	2,152
Kelly Ridge Roadless Area	3,556
Chattahoochee River National Recreation Area	3,564
Rum Creek Wildlife Management Area	4,288
Sapelo Island National Wildlife Refuge	4,319
Callaway Foundation	5,834
Cumberland Island National Seashore	6,146
Pigeon Mountain Wildlife Management Area	6,696
Fort Gordon Military Reservation	21,489
Chattooga River Watershed	42,082
Haralson County	73,556
Fort Stewart Military Reservation	111,014
Okefenokee National Wildlife Refuge	160,204
Breeding Bird Survey Routes (0.25 mile buffer)	
7	3,120
13	3,207
26	3,340
37	3,265
38	3,233
39	2,893
40	3,109
41	2,834
102	3,591
111	3,290

We compared the obtained wildlife species lists for each of the 32 tracts with GAP vertebrate distribution models to calculate error rates for each taxon individually and all taxa collectively (Table 3.7). Most lists acquired were considered to be incomplete because the area had not been surveyed extensively enough to instill confidence that no species would have been overlooked. Fort Stewart, Fort Gordon, Fernbank Forest, The Callaway Foundation, and Sapelo Island National Wildlife refuge provided complete species lists for at least one taxon. In addition, Breeding Bird Survey lists were considered complete for certain species. We calculated error of omission rates using all lists acquired, whether considered complete or incomplete (Table 3.7). Errors of commission were calculated only using lists that were considered to be complete (Table 3.7).

Table 3.7 Georgia GAP vertebrate distribution model accuracy assessment by species survey area

Survey area	Taxa	# of Species		Omission Error		Commission Error	
		Census	Predicted	Count	%	Count	%
Fernbank Forest							
(54 ha)	Birds	75	83	9	12.0	17	20.5
	Amphibians	NA	NA	NA	NA	NA	NA
	Reptiles	NA	NA	NA	NA	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*75*	*83*	*9*	*12.0*	*17*	*20.5*
Fort Fredrica							
National Monument	Birds	NA	NA	NA	NA	NA	NA
(125 ha)	Amphibians	5	23	0	0.0	NA	NA
	Reptiles	12	40	1	8.3	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*17*	*63*	*1*	*5.9*	*NA*	*NA*
Ocmulgee Mounds							
National Monument	Birds	NA	NA	NA	NA	NA	NA
(258 ha)	Amphibians	20	39	1	5.0	NA	NA
	Reptiles	30	53	1	3.3	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*50*	*92*	*2*	*4.0*	*NA*	*NA*
Tallulah Gorge							
State Park	Birds	NA	NA	NA	NA	NA	NA
(1,143 ha)	Amphibians	NA	NA	NA	NA	NA	NA
	Reptiles	21	34	1	4.8	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*21*	*34*	*1*	*4.8*	*NA*	*NA*
Kennesaw Mountain							
National Battlefield	Birds	NA	NA	NA	NA	NA	NA
(1,153 ha)	Amphibians	21	29	1	4.8	NA	NA
	Reptiles	20	41	0	0.0	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*41*	*70*	*1*	*2.4*	*NA*	*NA*
Stone Mountain							
State Park	Birds	NA	NA	NA	NA	NA	NA
(1,284 ha)	Amphibians	23	27	1	4.3	NA	NA
	Reptiles	22	41	0	0.0	NA	NA
	Mammals	19	40	1	5.3	NA	NA
	Total	*64*	*108*	*2*	*3.1*	*NA*	*NA*
Clayton County Water Authority							
(1,632 ha)	Birds	88	107	4	4.5	NA	NA
	Amphibians	15	26	0	0.0	NA	NA
	Reptiles	23	44	1	4.3	NA	NA
	Mammals	20	41	0	0.0	NA	NA
	Total	*146*	*218*	*5*	*3.4*	*NA*	*NA*
Bond Swamp							
National Wildlife Refuge	Birds	96	109	3	3.1	NA	NA
(1,761 ha)	Amphibians	NA	NA	NA	NA	NA	NA
	Reptiles	NA	NA	NA	NA	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*96*	*109*	*3*	*3.1*	*NA*	*NA*

Survey area	Taxa	# of Species		Omission Error		Commission Error	
		Census	Predicted	Count	%	Count	%
Mayhaw							
Wildlife Management Area	Birds	NA	NA	NA	NA	NA	NA
(1,913 ha)	Amphibians	24	45	1	4.2	NA	NA
	Reptiles	19	59	0	0.0	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*43*	*104*	*1*	*2.3*	*NA*	*NA*
Fort Pulaski							
National Monument	Birds	NA	NA	NA	NA	NA	NA
(2,152 ha)	Amphibians	8	35	0	0.0	NA	NA
	Reptiles	16	52	1	6.3	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*24*	*87*	*1*	*4.2*	*NA*	*NA*
Kelly Ridge							
Roadless Area	Birds	NA	NA	NA	NA	NA	NA
(3,556 ha)	Amphibians	12	27	0	0.0	NA	NA
	Reptiles	NA	NA	NA	NA	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*12*	*27*	*0*	*0.0*	*NA*	*NA*
Chattahoochee River							
National Recreation Area	Birds	NA	NA	NA	NA	NA	NA
(3,564 ha)	Amphibians	24	29	0	0.0	NA	NA
	Reptiles	39	41	3	7.7	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*63*	*70*	*3*	*4.8*	*NA*	*NA*
Rum Creek							
Wildlife Management Area	Birds	83	108	0	0.0	NA	NA
(4,288 ha)	Amphibians	NA	NA	NA	NA	NA	NA
	Reptiles	NA	NA	NA	NA	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*83*	*108*	*0*	*0.0*	*NA*	*NA*
Sapelo Island							
National Wildlife Refuge	Birds	NA	NA	NA	NA	NA	NA
(4,319 ha)	Amphibians	14	21	0	0.0	7	33.3
	Reptiles	30	32	1	3.3	9	28.1
	Mammals	29	33	0	0.0	5	15.2
	Total	*73*	*86*	*1*	*1.4*	*21*	*24.4*
Callaway Foundation							
(5,834 ha)	Birds	88	102	3	3.4	17	16.7
	Amphibians	24	28	1	4.2	NA	NA
	Reptiles	43	45	2	4.7	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*155*	*175*	*6*	*3.9*	*17*	*16.7*
Cumberland Island							
National Seashore	Birds	77	112	3	3.9	NA	NA
(6,146 ha)	Amphibians	20	22	2	10.0	NA	NA
	Reptiles	42	41	7	16.7	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*139*	*175*	*12*	*8.6*	*NA*	*NA*

Survey area	Taxa	# of Species Census	# of Species Predicted	Omission Error Count	Omission Error %	Commission Error Count	Commission Error %
Pigeon Mountain							
Wildlife Management Area	Birds	51	106	1	2.0	NA	NA
(6,696 ha)	Amphibians	12	36	1	8.3	NA	NA
	Reptiles	NA	NA	NA	NA	NA	NA
	Mammals	5	50	0	0.0	NA	NA
	Total	*68*	*192*	*2*	*2.9*	*NA*	*NA*
Fort Gordon							
Military Reservation	Birds	NA	NA	NA	NA	NA	NA
(21,489 ha)	Amphibians	35	41	2	5.7	8	19.5
	Reptiles	44	56	1	2.3	12	21.4
	Mammals	33	47	4	12.1	NA	NA
	Total	*112*	*144*	*7*	*6.3*	*20*	*20.6*
Chattooga River Watershed							
(42,082 ha)	Birds	NA	NA	NA	NA	NA	NA
	Amphibians	12	35	0	0.0	NA	NA
	Reptiles	NA	NA	NA	NA	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*12*	*35*	*0*	*0.0*	*NA*	*NA*
Haralson County							
(73,556 ha)	Birds	73	112	2	2.7	NA	NA
	Amphibians	10	35	0	0.0	NA	NA
	Reptiles	6	44	0	0.0	NA	NA
	Mammals	19	49	0	0.0	NA	NA
	Total	*108*	*240*	*2*	*1.9*	*NA*	*NA*
Fort Stewart							
Military Reservation	Birds	NA	NA	NA	NA	NA	NA
(111,014 ha)	Amphibians	38	42	0	0.0	4	9.5
	Reptiles	60	60	0	0.0	0	0.0
	Mammals	29	47	0	0.0	NA	NA
	Total	*127*	*149*	*0*	*0.0*	*4*	*3.9*
Okefenokee							
National Wildlife Refuge	Birds	80	112	5	6.3	NA	NA
(160,204 ha)	Amphibians	37	45	0	0.0	NA	NA
	Reptiles	57	64	0	0.0	NA	NA
	Mammals	NA	NA	NA	NA	NA	NA
	Total	*174*	*221*	*5*	*2.9*	*NA*	*NA*
Breeding Bird Survey Routes							
(0.25 mile buffer)	Route						
(2,834 ha)	41	65	67	3	4.6	5	7.46
(2,893 ha)	39	60	67	3	5.0	10	14.9
(3,109 ha)	40	66	67	3	4.5	4	5.97
(3,120 ha)	7	57	62	3	5.3	8	12.9
(3,207 ha)	13	62	63	1	1.6	3	4.76
(3,233 ha)	38	59	63	3	5.1	7	11.1
(3,265 ha)	37	60	66	2	3.3	8	12.1
(3,290 ha)	111	56	59	3	5.4	6	10.2
(3,340 ha)	26	56	67	3	5.4	14	20.9
(3,591 ha)	102	46	55	4	8.7	13	23.6
	Total	*587*	*636*	*28*	*4.8*	*78*	*12.3*

Survey area	Taxa	# of Species		Omission Error		Commission Error	
		Census	Predicted	Count	%	Count	%
Overall Accuracy							
(508,516 ha total survey area)	**Birds**	**1298**	**1587**	**58**	**4.5**	**117**	**14.3**
(15,191 ha average survey area)	**Amphibians**	**354**	**585**	**10**	**2.8**	**19**	**18.3**
	Reptiles	**484**	**747**	**19**	**3.9**	**21**	**14.2**
	Mammals	**135**	**267**	**4**	**3.0**	**5**	**15.2**
	Total	**2271**	**3186**	**91**	**4.0**	**162**	**16.1**

We generally made a direct comparison between the species list and the vertebrate distribution model results but special considerations were made a couple of cases. The Sapelo Island mammal list was modified to reflect the loss of black bear (*Ursus americanus*) from the island (Carlock et al. 1999). We also adapted the application of the Breeding Bird Survey records by reviewing the list of birds modeled by GAP and limiting the assessment only those species likely to be consistently detected by such a survey (Table 3.8). This review was conducted by Todd Schneider of the Georgia Department of Natural Resources.

Table 3.8 Georgia GAP bird species assessed by Breeding Bird Survey records

Common Name	Included in Breeding Bird Survey Assessment
Acadian flycatcher	Y
American crow	Y
American goldfinch	N
American kestrel	N
American oystercatcher	N
American redstart	Y
American robin	Y
American woodcock	N
Anhinga	N
Swallow-tailed kite	N
Bachmans sparrow	N
Bald eagle	N
Barred owl	N
Barn swallow	Y
Black-and-white warbler	Y
Black-crowned night-heron	N
Belted kingfisher	Y
Blue-gray gnatcatcher	Y
Brown-headed cowbird	Y
Brown-headed nuthatch	N
Blackburnian warbler	N
Blue grosbeak	Y
Blue jay	Y
Black skimmer	N
Black vulture	N
Black-necked stilt	N
Brown pelican	N
Brown thrasher	Y
Black-throated blue warbler	Y
Boat-tailed grackle	N
Black-throated green warbler	Y
Broad-winged hawk	N
Blue-winged warbler	N
Carolina chickadee	Y
Cattle egret	N
Carolina wren	Y
Canada warbler	N
Cedar waxwing	N
Cerulean warbler	N
Common ground-dove	Y
Chipping sparrow	Y
Chimney swift	Y
Clapper rail	N
Cliff swallow	N
Common barn-owl	N
Common grackle	Y
Coopers hawk	N

Common Name	Included in Breeding Bird Survey Assessment
Common moorhen	N
Common nighthawk	N
Common raven	N
Common yellowthroat	Y
Chestnut-sided warbler	Y
Chuck-wills-widow	N
Dickcissel	N
Downy woodpecker	Y
Eastern bluebird	Y
Eastern kingbird	Y
Eastern meadowlark	Y
Eastern phoebe	Y
Eastern screech-owl	N
Eastern towhee	Y
Eastern wood-pewee	Y
Tufted titmouse	Y
European starling	Y
Fish crow	Y
Field sparrow	Y
Gull-billed tern	N
Great crested flycatcher	Y
Great horned owl	N
Glossy ibis	N
Green heron	N
Gray catbird	Y
Great egret	N
Grasshopper sparrow	Y
Great blue heron	N
Golden-winged warbler	N
Hairy woodpecker	Y
House finch	Y
Horned lark	N
House sparrow	Y
Hooded warbler	Y
House wren	Y
Indigo bunting	Y
Kentucky warbler	Y
Killdeer	Y
King rail	N
Little blue heron	N
Least bittern	N
Least flycatcher	N
Least tern	N
Laughing gull	N
Loggerhead shrike	Y
Louisiana waterthrush	N
Mallard	N
Marsh wren	N
Mississippi kite	N

Common Name	Included in Breeding Bird Survey Assessment
Mourning dove	Y
Northern bobwhite	Y
Northern cardinal	Y
Northern flicker	Y
Northern mockingbird	Y
Northern parula	Y
Northern rough-winged swallow	N
Orchard oriole	Y
Osprey	N
Ovenbird	Y
Painted bunting	N
Pied-billed grebe	N
Peregrine falcon	N
Pine warbler	Y
Pileated woodpecker	Y
Prairie warbler	Y
Prothonotary warbler	Y
Purple gallinule	N
Purple martin	Y
Rose-breasted grosbeak	Y
Red-breasted nuthatch	N
Red-bellied woodpecker	Y
Red-cockaded woodpecker	N
Red-eyed vireo	Y
Red-headed woodpecker	Y
Rock dove	Y
Royal tern	N
Red-shouldered hawk	N
Red-tailed hawk	N
Ruby-throated hummingbird	N
Ruffed grouse	N
Red-winged blackbird	Y
Sandhill crane	N
Sandwich tern	N
Dark-eyed junco	N
Scarlet tanager	Y
Seaside sparrow	N
Snowy egret	N
Song sparrow	Y
Solitary vireo	Y
Sharp-shinned hawk	N
Summer tanager	Y
Swainsons warbler	N
Tree swallow	N
Tricolored heron	N
Turkey vulture	N
Veery	N
Virginia rail	N
White-breasted nuthatch	N

Common Name	Included in Breeding Bird Survey Assessment
White-eyed vireo	Y
Worm-eating warbler	N
White ibis	N
Willow flycatcher	N
Willet	N
Wilsons plover	N
Wild turkey	N
Winter wren	N
Wood duck	N
Wood stork	N
Wood thrush	Y
Whip-poor-will	N
Yellow-breasted chat	Y
Yellow-billed cuckoo	Y
Yellow-crowned night-heron	N
Yellow-throated vireo	Y
Yellow-throated warbler	Y
Yellow warbler	N
Canada goose	N
Eurasian collared-dove	N
Red crossbill	N
Gray kingbird	N

Results

Our accuracy results are broken down in to errors of omission and commission and displayed in Table 3.7. Our overall error of omission, 4.0%, contains variation by taxa from 2.8% for amphibians to 4.5% for birds. Our overall error of commission, 16.2%, contains variation by taxa from 14.2% for reptiles to 18.3% for amphibians. Errors of commission tend to be higher than errors of omission in all cases. This is typical of GAP vertebrate models (Peterson et al. 2001). Errors of omission show a very weak inverse relationship to survey tract size. GAP data is intended for application at no finer than a 1:100,000 scale, or 100 hectare minimum mapping unit. Our accuracy assessment appears to indicate that our vertebrate distribution models should meet this standard.

Limitations and Discussion

The vertebrate distribution maps are predictions of potential occurrence; they in no way guarantee presence or absence of an animal. The vertebrate accuracy assessment was conducted on species richness estimates. Individual models were not necessarily evaluated, and likely vary in accuracy. These data are largely dependent on the land cover map. Errors in the land cover will be propogated throughout the vertebrate models. The vertebrate data should not be used at scales finer than those recommended for the land cover (1:100,000), and in fact are likely to be less accurate than the land cover, despite lower reported error rates. These data are best used at broad scales, such as the landscape. Although model accuracies undoubtedly differ between projects, analyses of Idaho GAP vertebrate models indicated that models were very accurate at 3600 hectare minimum mapping unit size (around 85%), but accuracies at fine scales (2 hectare area) were only 39% (Peterson et al. 2001).

In further research associated with GA-GAP, Howell et al. (2003) explored the effects of scale and model uncertainty on model performance and potential applications, using the 18-class Georgia land cover (Natural Resources Spatial Analysis Laboratory 2001a) and other GIS sources in building models for a set of 10 avian species. Vectors of habitat measurements were taken at four spatial scales (90,000 hectares, 3600 hectares, 144 hectares, and 5.6 hectares), and models were then fit using hierarchical logistic regression and Gibbs sampling through the program WinBugs. The best performing models contained variables from multiple scales. Simulations run using the best models in potential management scenarios showed decision-making to be possible, but that incorporating uncertainty had an impact on optimal decisions.

Chapter 4 - LAND STEWARDSHIP

Introduction

The first GA-GAP product is a map of the conservation lands throughout the state, and was put together prior to the other data layers. Assembling the conservation lands database before putting together a land-cover and vertebrate distribution maps offers us an important advantage. Since many of the lands included in the database support native plant communities, the conservation lands database will provide us with a sampling frame of lands which allow public access for ground-truthing both vegetation and vertebrate occurances.

To fulfill the analytical mission of GAP, it is necessary to compare the mapped distribution of elements of biodiversity with their representation in different categories of land ownership and management. As will be explained in the Analysis section, these comparisons do not measure viability, but are a start to assessing the likelihood of future threat to a biotic element through habitat conversion—the primary cause of biodiversity decline. We use the term "stewardship" in place of "ownership" in recognition that legal ownership does not necessarily equate to the entity charged with management of the resource, and that the mix of ownership and managing entities is a complex and rapidly changing condition not suitably mapped by GAP. At the same time, it is necessary to distinguish between stewardship and protection status in that a single category of land stewardship such as a national forest may contain several degrees of management for biodiversity.

The purpose of comparing biotic distribution with stewardship is to provide a method by which land stewards can assess their relative amount of responsibility for the management of a species or plant community, and identify other stewards sharing that responsibility. This information can reveal opportunities for cooperative management of that resource, which directly supports the primary mission of GAP to provide objective, scientific information to decision makers and managers to make informed decisions regarding biodiversity. It is also possible that a steward that has previously borne the major responsibility for managing a species may, through such analyses, identify a more equitable distribution of that responsibility. We emphasize, however, that GAP only identifies private land as a homogenous category and does not differentiate individual tracts or owners, unless the information was provided voluntarily to recognize a long-term commitment to biodiversity maintenance.

After comparison to stewardship, it is also necessary to compare biotic occurrence to categories of management status. The purpose of this comparison is to identify the need for change in management status for the distribution of individual elements or areas containing high degrees of diversity. Such changes can be accomplished in many ways that do not affect the stewardship status. While it will eventually be desirable to identify specific management practices for each tract, and whether they are beneficial or harmful to each element, GAP currently uses a scale of 1 to 4 to denote relative degree of maintenance of biodiversity for each tract. A status of "1" denotes the highest, most permanent level of maintenance, and "4" represents the lowest level of biodiversity management, or unknown status. This is a highly subjective area, and we recognize a variety of limitations in our approach, although we maintain certain principles in assigning the status level. Our first principle is that land ownership is not the primary determinant in assigning status. The second principle is that while data are imperfect, and all land is subject to changes in ownership and management, we can use the intent of a land steward as evidenced by legal and institutional factors to assign status. In other words, if a land steward institutes a program backed by legal and institutional arrangements that are intended for permanent biodiversity maintenance, we use that as the guide for assigning protection status.

The characteristics used to determine protection status are as follows:

- Permanence of protection from conversion of natural land cover to unnatural (human-induced barren, exotic-dominated, arrested succession).
- Relative amount of the tract managed for natural cover.
- Inclusiveness of the management, i.e., single feature or species versus all biota.
- Type of management and degree that it is mandated through legal and institutional arrangements.

The four status categories can generally be defined as follows (after Scott et al. 1993, Edwards et al. 1995, Crist et al. 1995):

Status 1: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, and intensity) are allowed to proceed without interference or are mimicked through management.

Status 2: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive use or management practices that degrade the quality of existing natural communities.

Status 3: An area having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type or localized intense type. It also confers protection to federally listed endangered and threatened species throughout the area.

Status 4: Lack of irrevocable easement or mandate to prevent conversion of natural habitat types to anthropogenic habitat types. Allows for intensive use throughout the tract. Also includes those tracts for which the existence of such restrictions or sufficient information to establish a higher status is unknown.

Mapping Standards

The U.S. Environmental Protection Agency, Region 4, provided the funds to create the Georgia Conservation lands database. Additional partners include the Wildlife Resources Division of the Georgia Department of Natural Resources and the Georgia Environmental Policy Institute. The database is an amalgam of a number of disparate digital sources all created at 1:24,000 or greater scale, which were appended and edge-matched using Arc/Info version 7.0.4. It is projected to the Universal Transverse Mercator projection, zone 17 using the NAD83 datum and the GRS1980 spheroid.

Methods

The parcels for this dataset were digitized in one of the following three ways:

1. Using Arc-Cogo to create shapes from bearings and distances given on plats or in legal descriptions.
2. Digitizing shapes directly on DOQQs in Arcview when the source is a survey laid directly over an aerial photo.
3. Digitizing shapes from scanned-in plats.

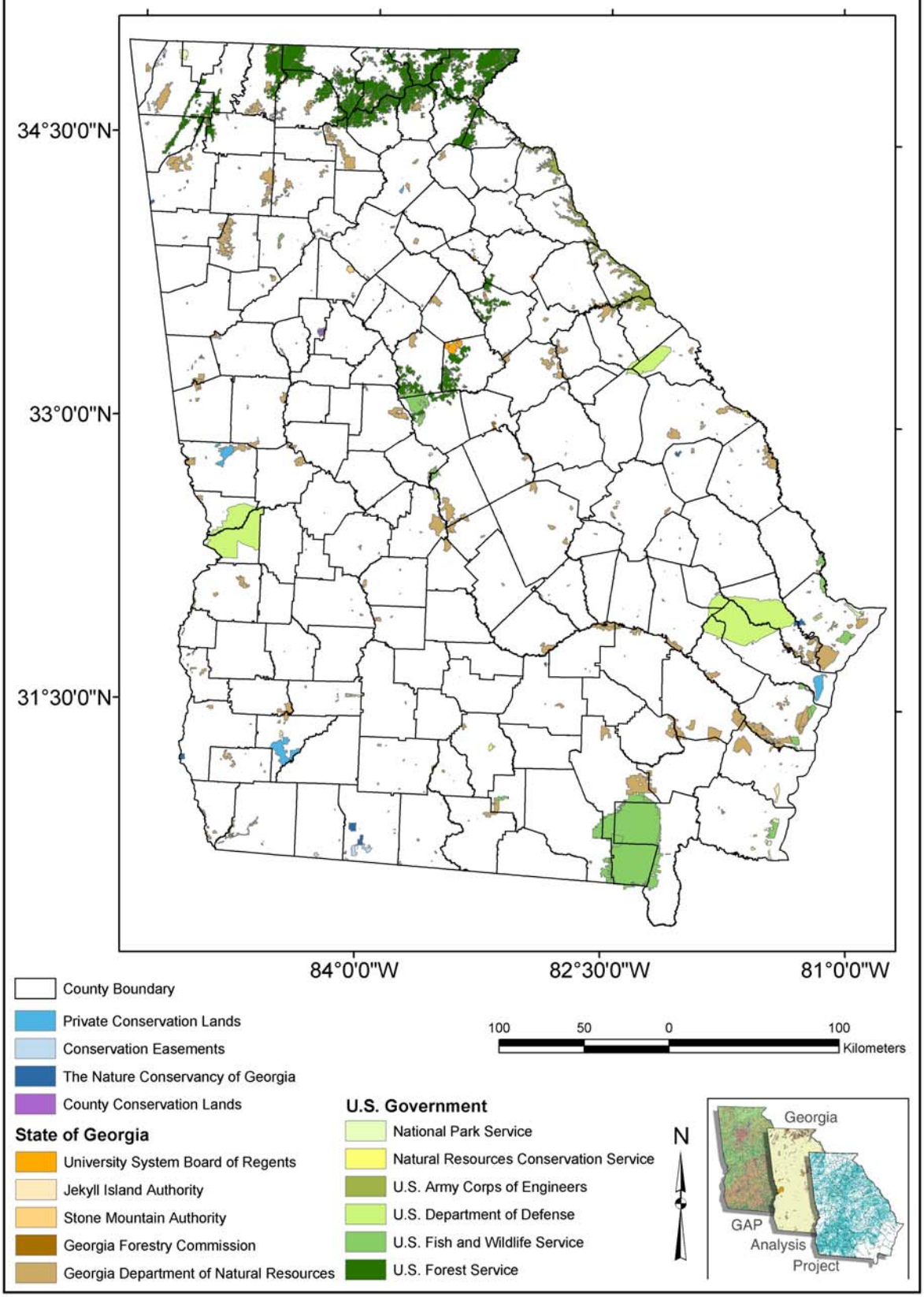
In all three cases, shapes are placed accurately on digital orthophoto quarter quads (DOQQs) using Arcview.

Quality assessment/quality control: Quality assessment and control was achieved in three ways. First, a single supervisor reviewed all parcels digitized by GA-GAP staff, visually inspected the polygons against the DOQQs and corrected any errors that were detected. Second, the area of the digitized parcels was calculated and checked against the acreage reported by the entity or institution that provided the map or plat. Third, the database was sent to the Georgia Department of Natural Resources for review. His comments were incorporated into the final draft.

Stewardship Mapping: The Georgia conservation lands data layer is composed of ownership boundary polygons for lands managed for conservation in Georgia (Map 4.1). This dataset was created from a number of disparate digital sources all created at 1:24,000 or greater (finer) scale which were appended and edge-matched: Forest Service ownership boundaries are from the U.S.Forest Service. Chattahoochee National Recreation Area, Kennessaw National Battlefield Park, Chickamauga and Chattanooga National Military Park, and Andersonville National Historic Site boundaries are from the National Park Service. Boundaries for all state lands are from the Wildlife Resources Division of the Georgia Department of Natural Resources. Boundaries for National Wildlife Refuges (except for Piedmont NWR and Okefenokee NWR) and military bases boundaries are from the state lands dataset produced by the University of Georgia's Information Technology Outreach Services for the Georgia Department of Transportation (to view metadata see the Georgia GIS Clearinghouse at http://www.gis.state.ga.us/). Okefenokee NWR and wilderness boundaries are from the Okefenokee NWR. Piedmont NWR boundaries are from Warnell School of Forest Resources, UGA. Boundaries for Board of Regents lands are from University Architects at the University of Georgia. All other parcels were digitized by Georgia GAP employees either from registered survey plats, legal descriptions using coordinate geometry, or from "roughed in" boundaries drawn onto USGS topographic maps. In all three cases, the resulting polygons were placed accurately over 1:12,000 scale DOQQs.

Salt marsh stewardship in Georgia is a complex pattern of federal, state and private ownership scattered across several counties. While most salt marsh was never disposed of and remains in public ownership, some private ownership exists dating to Georgia’s colonial status under British rule. Salt marsh ownership records are not readily available due to the widely scattered pattern of ownership and lack of modern land ownership records with coordinate geometry for many parcels. For these reasons, salt marshes are not formally included in our analysis.

Map 4.1 Georgia Land Stewardship



Protection Status Categorization: The four GAP protection status levels were assigned to each conservation land management unit in consultation with the Georgia Department of Natural Resources by considering stewardship and preservation goals contained in legally binding management mandates or conservation agreements (Map 4.2). A GAP protection status of "1" was assigned to lands permanently protected through fee simple ownership or perpetual conservation easement from conversion of natural land cover and under a management plan or stated organizational mission to maintain a natural state within which natural disturbance events are allowed to proceed without interference or are mimicked through management. Examples of "status 1" lands are wilderness areas, couty greenspace parcels and parcels under perpetual conservation easements held by established land trusts. A GAP protection status of "2" was assigned to lands permanently protected through fee simple ownership, perpetual conservation easement, or restrictive covenant from conversion of natural land cover and under a management plan or stated organizational mission to maintain a primarily natural state while allowing use or management practices that degrade the quality of existing natural communities. Examples of "status 2" lands include state parks and state wildlife management areas (WMA). A GAP protection status of "3" was assigned to lands permanently protected through fee simple ownership, perpetual conservation easement, restrictive covenant or state-held lease from conversion of natural land cover over a majority of the area but subject to extractive uses of either a broad, low-intensity type or localized intense type. Examples of "status 3" lands include national forests and military reservations. GAP protection status "4" lands are not protected from conversion of natural land cover by legally binding management mandate or conservation agreement. Other "status 4" lands include properties where too little or nothing is known about management to place the property in a higher category. All lands in Georgia not considered "status 1 – 3" are considered "status 4" including a wide variety of undeveloped and developed lands in private and public ownership. "Status 4" lands range from existing residential subdivisions and commercial/industrial developments to farmland and even large tracts of undeveloped private parcels with no clear future development plans but no explicit exclusion from it either. The assignment of GAP protection status for Georgia conservation lands is summarized in Table 4.1.

Map 4.2 Protection Status of Georgia Conservation Lands

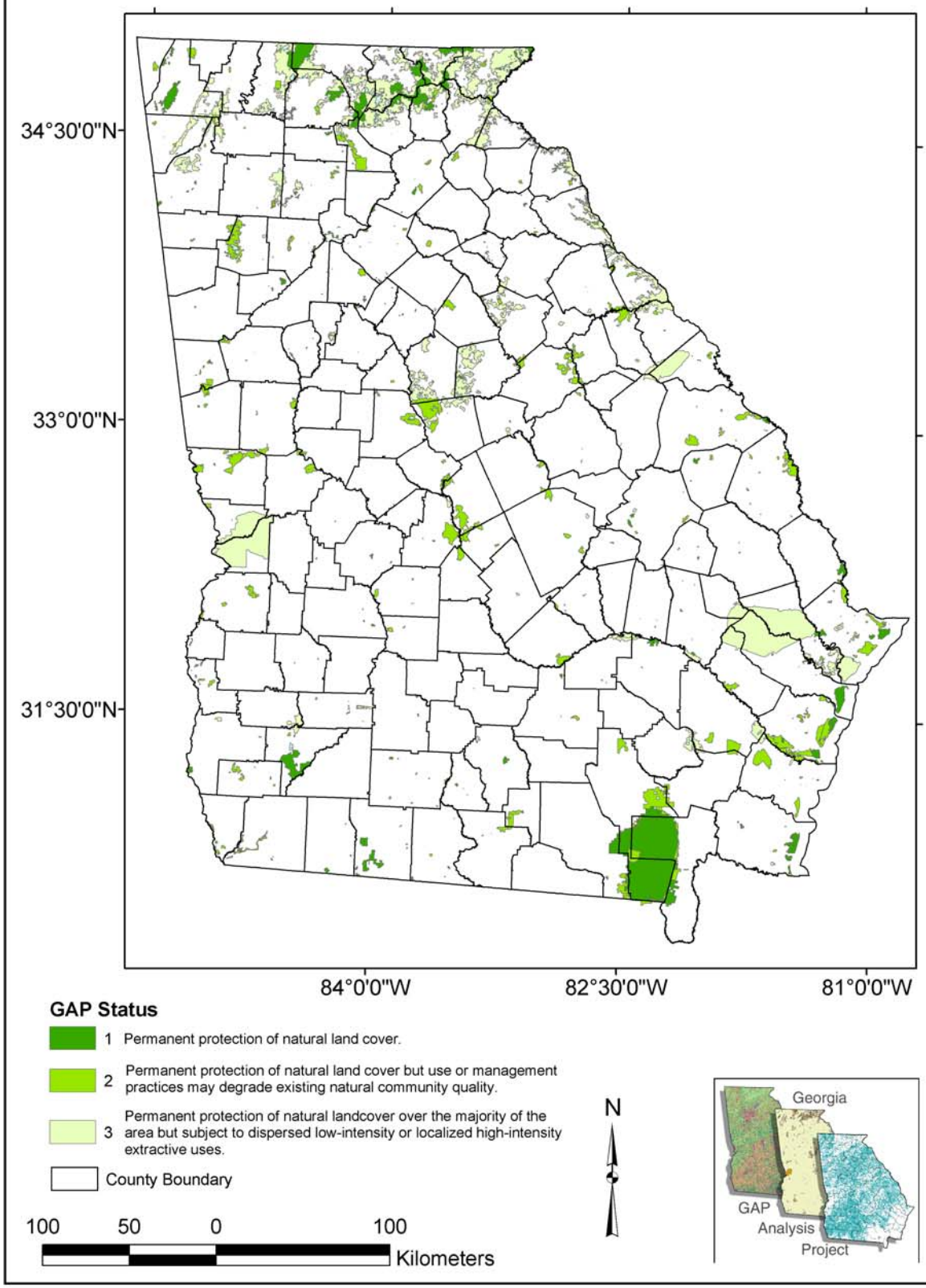


Table 4.1 Assignment of GAP status by management authority and conservation type

Managing Authority	Conservation Type	GAP Status
Athens-Clarke County		
	County Nature Preserve	2
Atlanta Audubon Society		
	Private Conservation Land	2
Bibb County		
	Greenspace	2
Board of Regents		
	Board of Regents Lands	3
Broad River Watershed Association		
	Conservation Easement	1
Bulloch County		
	Greenspace	2
Calloway Foundation		
	Private Conservation Land	2
Chatham County		
	Greenspace	2
Chattowah Open Land Trust		
	Conservation Easement	1
Clayton County Water Authority		
	County Water Treatment Facility	3
Coastal Georgia Land Trust		
	Conservation Easement	1
Cobb County		
	Greenspace	2
Coffee County		
	Greenspace	2
Coweta County		
	Greenspace	2
Dekalb County Parks		
	County Nature Preserve	1
Douglas County		
	Greenspace	2
Ducks Unlimited		
	Conservation Easement	1
Effingham County		
	Greenspace	2
Elachee Nature Center		
	County Nature Preserve	1
Fayette County		
	Greenspace	2
Floyd County		
	Greenspace	2
Fulton County		
	Greenspace	2
Georgia Coastal Land Trust		
	Conservation Easement	1
Georgia Department of Natural Resources		
	Conservation Park	1
	Greenway	1/2
	Scenic Easement	1/3
	State Boat Ramp	3
	State Conservation Area	1
	State Environmental Education Center	2
	State Fish Hatchery	3
	State Historic Park	3
	State Historic Site	3
	State Natural Area	1
	State Park	2/3
	State Public Fishing Area	3
	State Wildlife Center	3
	State Wildlife Management Area	1/2/3
Georgia Forestry Commission		
	State Forest	3
Georgia Wildlife Federation		
	Private Conservation Land	1

Managing Authority	Conservation Type	GAP Status
Gwinnett County		
	Greenspace	2
Gwinnett County Parks and Recreation Department		
	County Park	2
Hall County		
	Greenspace	2
Jekyll Island Authority		
	State Park	2
Lowndes County		
	Greenspace	2
Lula Lakes Land Trust		
	Private Conservation Land	1
Mountain Conservation Trust		
	Conservation Easement	1
National Park Service		
	National Historic Site	2
	National Military Park	2
	National Monument	2
	National Recreation Area	1
	National Seashore	1
Natural Resources Conservation Service		
	Conservation Easement	1
New York Zoological Society		
	Private Conservation Land	1
Newton County Land Trust		
	Conservation Easement	1
North American Land Trust		
	Conservation Easement	1
Red Hills Conservation Program		
	Conservation Easement	1
Richmond County		
	Greenspace	2
Sautee-Nacoochee Community Assn. Land Trust		
	Conservation Easement	1
Southeast Land Preservation Trust		
	Conservation Easement	1
Southern Conservation Trust		
	Private Conservation Land	1
Stone Mountain Authority		
	State Park	2
The Nature Conservancy of Georgia		
	Conservation Easement	1
	Management Agreement	1
	Nature Conservancy Preserve	1
U.S. Army Corps of Engineers		
	Conservation Easement	1
	Restrictive Covenant	1/2
	U.S. Army Corps of Engineers Land	3
U.S. Department of Defense		
	Military Reservation	3
U.S. Fish and Wildlife Service		
	Conservation Easement	1
	National Battlefield Park	2
	National Wildlife Refuge	1/2
	Wilderness Area	1
U.S. Forest Service		
	Botanical Area	1
	National Forest	3
	National Recreation Area	1
	National Scenic Area	1
	National Wild and Scenic River	1
	Research Natural Area	1
	Scenic Area	2
	Wilderness Area	1
Whitfield County		
	Greenspace	2
Woodruff Foundation		
	Private Conservation Land	1

Completeness: Information is complete and up-to-date as of June, 2003, for parcels of federal and state lands, conservation easements, and U.S. Army Corps of Engineers mitigation lands. However, many gaps may exist with respect to county conservation parks, easements, and covenants less than 10 acres in size. In addition, we were unable to get location information on a number of sizable lands owned by the state Board of Regents. We hope these gaps will be filled as the database is continually updated. Also, the U.S. Army Corps of Engineers (COE) owns a number of large tracts bordering the reservoirs it maintains on the lower Chattahoochee River. These are lands of significant conservation value. Some of these lands have been leased to the state for parks and wildlife management areas and therefore appear in this database. The rest of the Lower Chattahoochee COE lands are in the process of being digitized and should be added to the database when they become available. This database has been turned over to the Georgia Department of Natural Resources, who are responsible for its maintenance, which will require continual addition of new parcels as government agencies acquire lands and conservation easements and restrictive covenants are established on private lands.

Results

Conservation lands by GAP status

Most of Georgia falls into GAP protection status 4 with only 8% of the state under status 3 or higher (Table 4.2), and only 3.5% protected as status 1 or 2. The federal government is the managing authority responsible for the greatest amount of status 3 or higher lands in Georgia, followed by the state, private conservation groups, and local governments (Figure 4.1). Of lands under some type of protection in Georgia, slightly more than half are status 3 lands, with the other half split nearly evenly between status levels 1 and 2 (Figure 4.2). Although status 3 lands may contribute to the conservation matrix, GAP considers only status 1 and 2 lands to be protected.

Table 4.2 Land Area by Managing Authority and GAP Status

Managing Authority	Total Area (ha)	% of All Conservation Lands	% of Entire State	Gap Status 1		2		3	
				Area (ha)	%	Area (ha)	%	Area (ha)	%
Athens-Clarke County	220	< 1	< 1	0	0	220	100	0	0
Atlanta Audubon Society	9	< 1	< 1	0	0	9	100	0	0
Bibb County	2	< 1	< 1	0	0	2	100	0	0
Board of Regents	6,775	1	< 1	0	0	0	0	6,775	100
Broad River Watershed Association	58	< 1	< 1	58	100	0	0	0	0
Bulloch County	2	< 1	< 1	0	0	2	100	0	0
Calloway Foundation	5,834	< 1	< 1	0	0	5,834	100	0	0
Chatham County	81	< 1	< 1	0	0	81	100	0	0
Chattowah Open Land Trust	143	< 1	< 1	143	100	0	0	0	0
Clayton County Water Authority	1,632	< 1	< 1	1,632	100	0	0	0	0
Coastal Georgia Land Trust	3	< 1	< 1	3	100	0	0	0	0
Cobb County	19	< 1	< 1	0	0	19	100	0	0
Coffee County	20	< 1	< 1	0	0	20	100	0	0
Coweta County	46	< 1	< 1	0	0	46	100	0	0
Dekalb County Parks	214	< 1	< 1	214	100	0	0	0	0
Douglas County	92	< 1	< 1	0	0	92	100	0	0
Ducks Unlimited	320	< 1	< 1	320	100	0	0	0	0
Effingham County	15	< 1	< 1	0	0	15	100	0	0
Elachee Nature Center	566	< 1	< 1	566	100	0	0	0	0
Fayette County	20	< 1	< 1	0	0	20	100	0	0
Floyd County	21	< 1	< 1	0	0	21	100	0	0
Fulton County	40	< 1	< 1	0	0	40	100	0	0
Georgia Coastal Land Trust	257	< 1	< 1	257	100	0	0	0	0
Georgia Department of Natural Resources	298,143	25	2	19,451	7	196,710	66	81,983	27
Georgia Forestry Commission	873	< 1	< 1	0	0	0	0	873	100
Georgia Wildlife Federation	45	< 1	< 1	45	100	0	0	0	0
Gwinnett County	172	< 1	< 1	0	0	172	100	0	0
Gwinnett County Parks and Recreation Department	211	< 1	< 1	0	0	211	100	0	0
Hall County	21	< 1	< 1	0	0	21	100	0	0
Jekyll Island Authority	1,839	< 1	< 1	0	0	1,839	100	0	0
Lowndes County	40	< 1	< 1	0	0	40	100	0	0
Lula Lakes Land Trust	1,020	< 1	< 1	1,020	100	0	0	0	0
Mountain Conservation Trust	451	< 1	< 1	451	100	0	0	0	0
National Park Service	11,405	1	< 1	6,436	56	4,968	44	0	0
Natural Resources Conservation Service	1,849	< 1	< 1	1,849	100	0	0	0	0
New York Zoological Society	6,026	1	0	6,026	100	0	0	0	0
Newton County Land Trust	60	< 1	< 1	60	100	0	0	0	0
North American Land Trust	768	< 1	< 1	768	100	0	0	0	0
Red Hills Conservation Program	3,998	< 1	< 1	3,998	100	0	0	0	0
Richmond County	53	< 1	< 1	0	0	53	100	0	0
Sautee-Nacoochee Community Assn. Land Trust	13	< 1	< 1	13	100	0	0	0	0
Southeast Land Preservation Trust	13	< 1	< 1	13	100	0	0	0	0
Southern Conservation Trust	294	< 1	< 1	294	100	0	0	0	0
Stone Mountain Authority	1,284	< 1	< 1	0	0	1,284	100	0	0
The Nature Conservancy of Georgia	8,471	1	< 1	8,471	100	0	0	0	0
U.S. Army Corps of Engineers	52,708	4	< 1	545	1	736	1	51,426	98
U.S. Department of Defense	201,951	17	1	0	0	0	0	201,951	100
U.S. Fish and Wildlife Service	201,058	17	1	153,072	76	47,984	24	0	0
U.S. Forest Service	351,583	30	2	63,859	18	1,114	< 1	286,610	82
Whitfield County	254	< 1	< 1	0	0	254	100	0	0
Woodruff Foundation	11,775	1	< 1	11,775	100	0	0	0	0
Total	1,172,766	100	8	281,340	24	261,587	22	629,617	54

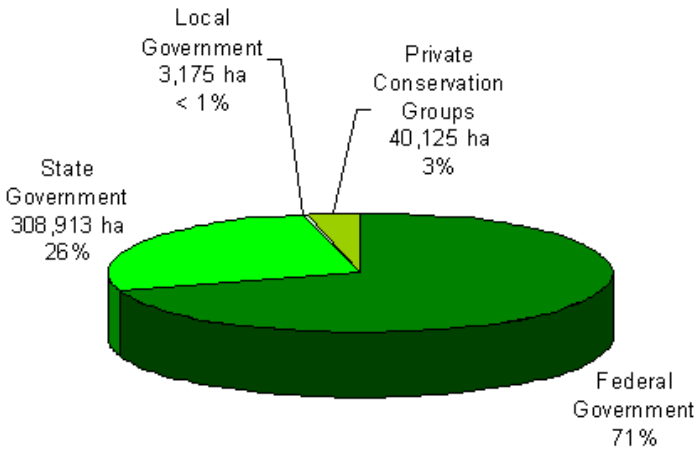


Figure 4.1 Land ownership of GAP status 1 , 2, and 3 lands in Georgia

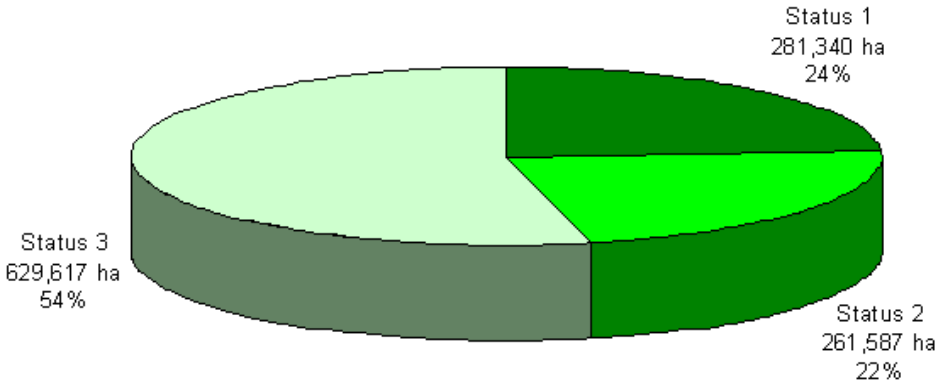


Figure 4.2 Distribution of Status 1, 2, and 3 lands in Georgia

Limitations and Discussion

The Georgia Conservation Lands Database is a compilation of ownership maps provided by a variety of sources who are individually responsible for their accuracy. It was created solely for the purpose of conducting the analyses described in this report and it is not suitable for locating boundaries on the ground or determining precise area measurements of individual tracts. The Georgia Department of Natural Resources has reviewed the database for accuracy and contributed to corrections.

Land stewardship and management goals are dynamic. As land ownership changes and management plans are updated, stewardship and protection status may change. The Georgia Conservation Lands Database should be viewed as a snapshot of conditions at the time of this report.

Acreage values may be inaccurate for military bases, Chattahoochee National Forest polygons and wildlife refuges (excluding the Piedmont and Okefenokee refuges), because acreage values were not provided for these 3 categories by the source and they were generated from the digitized shapes. GAP-status values may be subject to revision.

Information is complete and up-to-date for parcels of federal and state lands, conservation easements, and U.S. Army Corps of Engineers mitigation lands. However, many gaps may exist with respect to county conservation parks, easements, and restrictive covenants. In addition, we were unable to get location information on a number of sizable lands owned by the state Board of Regents. We hope these gaps will be filled as the database is continually updated. Also, the U.S. Army Corps of Engineers (COE) owns a number of large lands bordering the reservoirs it maintains on the lower Chattahoochee River. These are lands of significant conservation value. Some of these lands have been leased to the state for parks and wildlife management areas and therefore appear in this database. The rest of the Lower Chattahoochee COE lands are in the process of being digitized and should be added to the database when they become available. This database has been turned over to the Georgia Depatment of Natural Resources, who is responsible for its maintenance, which will require continual addition of new parcels as government agencies acquire lands and conservation easements and restrictive covenants are established on private lands.

Chapter 5 - ANALYSIS BASED ON STEWARDSHIP AND MANAGEMENT STATUS

Introduction

As described in the general introduction to this report (see pg. 7), the primary objective of GAP is to provide information on the distribution and status of several elements of biological diversity. This is accomplished by first producing maps of land cover (see Chapter 2), predicted distributions for selected animal species (see Chapter 3), and land stewardship and management status (see Chapter 4). Intersecting the land stewardship and management map with the distribution of the elements results in tables that summarize the area and percent of total mapped distribution of each element in different land stewardship and management categories.

Although GAP "seeks to identify habitat types and species not adequately represented in the current network of biodiversity management areas" (GAP Handbook, Preface, Version 1, page I), it is unrealistic to create a standard definition of "adequate representation" for either land cover types or individual species (Noss et al. 1995). A practical solution to this problem is to report both percentages and absolute area of each vegetation type in biodiversity management areas (as described above) and allow the user to determine which types are adequately represented in natural areas. There are many other factors that should be considered in such determinations such as (a) historic loss or gain in distribution, (b) nature of the spatial distribution, (c) immediate versus long term risk, and (d) degree of local adaptation among populations of the biotic elements that are worthy of individual conservation consideration. In a state such as Georgia, with a long history of human manipulation, loss of habitat from historic levels may be a particularly important issue. Such analyses are beyond the scope of this project, but we encourage their application coupled with field confirmation of the mapped distributions. As a coarse indicator of the status of the elements, we do provide a breakdown along three levels of representation (10%, 20%, and 50%) that have been recommended in the literature as necessary amounts of conservation (Noss and Cooperider 1994; Noss 1991; Odum and Odum 1972; Specht et al. 1974; Ride 1975; Miller 1994).

The network of Conservation Data Centers (CDCs) and Natural Heritage Programs (NHPs) established cooperatively by The Nature Conservancy and various state agencies maintain detailed databases on the locations of rare elements of biodiversity. GAP cooperatively uses these data to develop predicted distributions of potentially suitable habitat for these elements, which may be valuable for identifying research needs and preliminary considerations for restoration or reintroduction. Conservation of such elements, however, is best accomplished through the fine-filter approach. It is not the role of GAP to duplicate or disseminate Heritage Program or CDC Element Occurrence Records. Users interested in more specific information about the location, status, and ecology of populations of such species are directed to their state Heritage Program or CDC.

Currently, land cover types and terrestrial vertebrates are the primary focus of GAP's mapping efforts. However, other components of biodiversity, such as aquatic organisms or selected groups of invertebrates may be incorporated into GAP distributional data sets. Where appropriate, GAP data may also be analyzed to identify the location of a set of areas in which most or all land cover types or species are predicted to be represented. The use of “complementarity” analysis, that is, an approach that additively identifies a selection of locations that may represent biodiversity rather than “hot spots of species richness” may prove most effective for guiding biodiversity maintenance efforts. Several quantitative techniques have been developed recently that facilitate this process (see Pressey et al. 1993, Williams et al. 1996, Csuti et al. 1997, Soule and Sanjayan 1998). These areas become candidates for field validation and may be incorporated into a system of areas managed for the long-term maintenance of biological diversity.

Land Cover Analysis

The protection status for land cover types was derived through adding together the land cover map and a raster version of the stewardship map. The land cover analysis table in Table 5.1 shows the area in hectares for each land cover type and its representation in a management status. For example, the mesic hardwood category occurs on 137, 939 hectares in Georgia. Of this, 3.46% occurs on GAP status 1 or 2 lands and 8.54% on GAP status 3. 88.0% is unprotected, or GAP status 4.

Table 5.1. Land cover types by protection status.

CODE	COVER TYPE	STATUS 1		STATUS 2		STATUS 3		STATUS 4		TOTAL AREA	% IN STATUS
		HA	%	HA	%	HA	%	HA	%	HA	1 & 2
7	Beaches/Dunes/Mud	625	15.16	120	2.92	364	8.83	3,010	73.09	4,118	18.08
9	Coastal Dune	102	17.27	123	20.97	72	12.25	291	49.51	588	38.24
11	Open Water	4,196	0.93	9,671	2.15	35,367	7.87	399,916	89.04	449,150	3.09
18	Transportation	2,974	0.31	9,926	1.02	27,180	2.80	931,047	95.87	971,128	1.33
20	Utility swaths	106	0.21	633	1.26	653	1.30	48,939	97.23	50,332	1.47
22	Low Intensity Urban - Nonforested	108	0.12	141	0.16	1,067	1.18	89,171	98.55	90,487	0.27
24	High Intensity Urban - Nonforested	124	0.10	276	0.23	2,064	1.69	120,023	97.99	122,487	0.33
31	Clearcut - Sparse Vegetation	2,021	0.17	12,692	1.09	19,650	1.69	1,126,458	97.04	1,160,821	1.27
33	Quarries, Stripmines	43	0.27	18	0.12	151	0.95	15,629	98.66	15,841	0.38
34	Rock Outcrop	227	19.70	139	12.03	160	13.91	626	54.36	1,151	31.73
72	Parks, Recreation	32	0.24	86	0.65	181	1.36	12,964	97.75	13,262	0.89
73	Golf Course	35	0.25	684	4.86	231	1.64	13,140	93.26	14,090	5.10
80	Pasture, Hay	1,228	0.10	3,099	0.26	6,270	0.53	1,168,615	99.10	1,179,212	0.37
83	Row Crop	3,276	0.17	2,184	0.11	1,528	0.08	1,938,575	99.64	1,945,562	0.28
201	Forested Urban - Deciduous	95	0.10	143	0.15	249	0.26	93,811	99.48	94,298	0.25
202	Forested Urban - Evergreen	86	0.13	166	0.26	486	0.75	63,838	98.86	64,577	0.39
203	Forested Urban - Mixed	21	0.04	86	0.15	245	0.44	55,729	99.37	56,081	0.19
410	Mesic Hardwood	1,483	1.07	3,284	2.38	11,786	8.54	121,387	88.00	137,939	3.46
411	Sub-mesic Hardwood	37,630	5.58	12,557	1.86	117,878	17.49	506,081	75.07	674,146	7.44
412	Hardwood forest	5,071	0.37	20,539	1.50	32,099	2.35	1,310,271	95.78	1,367,980	1.87
413	Xeric Hardwood	8,737	8.60	2,509	2.47	23,647	23.27	66,744	65.67	101,638	11.07
414	Deciduous Cove Hardwood	6,636	18.27	546	1.50	15,223	41.91	13,920	38.32	36,325	19.77
415	Northern Hardwood	57	52.87	0	0.00	51	47.13	0	0.00	108	52.87
420	Live Oak	4,853	15.75	2,615	8.48	4,266	13.84	19,083	61.92	30,816	24.23
422	Open Loblolly-Shortleaf Pine	432	0.13	16,606	5.06	20,284	6.18	291,035	88.63	328,356	5.19
423	Xeric Pine	1,385	7.66	500	2.77	5,817	32.20	10,363	57.37	18,065	10.43
424	Hemlock-White Pine	645	15.04	97	2.26	1,831	42.68	1,716	40.01	4,289	17.31
425	White Pine	3,713	14.46	415	1.62	10,590	41.24	10,958	42.68	25,676	16.08
431	Montane Mixed Pine-Hardwood	8,905	12.72	922	1.32	26,320	37.59	33,870	48.37	70,017	14.04
432	Xeric Mixed Pine-Oak	1,879	3.93	1,205	2.52	7,527	15.74	37,198	77.81	47,809	6.45
433	Mixed Cove Forest	1,320	13.24	181	1.82	3,838	38.50	4,630	46.44	9,969	15.06
434	Mixed Pine-Hardwood	3,004	0.33	17,667	1.93	29,322	3.20	866,781	94.55	916,774	2.25
440	Loblolly-Shortleaf Pine	1,823	0.11	37,150	2.20	63,181	3.75	1,584,250	93.94	1,686,404	2.31
441	Loblolly-Slash Pine	3,975	0.24	23,510	1.41	17,146	1.03	1,623,681	97.32	1,668,312	1.65

511	Shrub Bald	76	66.54	1	0.47	32	27.86	6	5.13	114	67.01
512	Sandhill	438	0.60	1,057	1.45	9,408	12.88	62,129	85.07	73,032	2.05
513	Coastal Scrub	309	24.37	193	15.22	330	25.97	437	34.44	1,270	39.59
620	Longleaf Pine	13,489	10.22	3,167	2.40	58,898	44.64	56,380	42.73	131,933	12.62
890	Cypress-Gum Swamp	40,342	6.43	24,375	3.88	20,308	3.24	542,462	86.45	627,486	10.31
900	Bottomland Hardwood	20,931	4.06	15,994	3.10	22,496	4.36	456,532	88.48	515,952	7.16
920	Saltmarsh	10,665	7.29	12,412	8.48	11,865	8.11	111,452	76.13	146,395	15.76
930	Freshwater Marsh	9,634	11.06	6,718	7.71	2,321	2.67	68,413	78.56	87,086	18.78
980	Shrub Wetland	27,136	21.61	5,089	4.05	2,479	1.97	90,866	72.36	125,569	25.66
990	Evergreen Forested Wetland	49,785	14.68	10,819	3.19	16,394	4.83	262,184	77.30	339,182	17.87

As explained in the chapter introduction, we provide results according to thresholds provided in the literature to conserve biodiversity. The digital data or values in the table will allow users to set any desirable threshold and perform their own analyses. The following section provides a description of the stewardship status of Georgia land cover types by group (less than 1%, 1 – 10%, 10 – 20%, 20 – 50%, and greater than 50% in GAP status 1 and 2). See Chapter 2 for descriptions of each cover class.

Land cover types with less than 1% representation in GAP status 1 and 2: 22, 24, 33, 72, 80, 83, 201, 202, and 203. These are all human-dominated cover types. Of them, only the agricultural areas (classes 80 and 83), which may provide habitat for early successional species, are of any conservation concern. By their nature as manipulated areas, agricultural habitats should not be prevalent in status 1 and 2 lands. They are, however, also poorly represented in status 3 lands (only 0.53% and 0.08% protected, respectively).

Land cover types with 1 – 10% representation in GAP status 1 and 2: 11, 18, 20, 31, 73, 410, 411, 412, 422, 432, 434, 440, 441, 512, and 900. Of these, categories 18 (transportation) and 73 (golf course) are completely human-dominated and not appropriate for protection in status 1 and 2 lands. The presence here of golf courses may indicate the need to refine conservation lands boundaries to exclude inappropriate uses from the conservation matrix. 31 (clearcut-sparse vegetation), although an important habitat for many early successional species, is by its nature as a manipulated class not prevalent in status 1 or 2, either. Other than open water, the other categories are all forest types. Some of these, such as 411 (submesic hardwoods), 432 (xeric pine-hardwood), and 512 (sandhill) receive some protection as status 3 lands. Others, such as 900 (bottomland hardwoods), receive relatively little protection despite their importance to species conservation (see Chapter 2).

Land cover types with 10 – 20% representation in GAP status 1 and 2: 7, 413, 414, 423, 424, 425, 433, 620, 890, 920, 930, and 990. This list is dominated by mainly montane classes (413, 414, 423, 424, 425, and 433) which all receive some additional protection on status 3 lands. Class 620, longleaf pine, also receives additional protection on status 3 lands, but is presently found on only a fraction of the lands where it occurred historically (Wharton 1978). Class 890, cypress-gum swamp, receives a high level of protection in the Okefenokee Swamp, but little protection elsewhere. Class 920 (saltmarsh) is protected to some degree by Georgia law, and the figure shown here may be low. Class 7 includes exposed sand and mud of reservoirs, as well as coastal beach.

Land cover types with 20 – 50% representation in GAP status 1 and 2: 9, 34, 513, 980. These relatively well-protected classes include categories found mainly on the barrier islands (9 and 513), rocky mountaintops (34), and common within the Okefenokee Swamp (980). Although they do not generally possess high vertebrate species richness, they are important for individual species, such as shorebirds (in habitat 9), that are not found elsewhere. The rock outcrop category may have been undermaped, and is not as well-protected as indicated, particularly with respect to small outcrops on the Piedmont.

Land cover types with greater than 50% representation in GAP status 1 and 2: 415 and 511. These categories, northern hardwoods and shrub balds, respectively, are found exclusively on high mountaintops over very small areas in the Blue Ridge. Both have high scenic values, and northern hardwoods have a relatively high species richness for the very small land area they cover.

Vertebrate Distribution Analysis

The protection status for vertebrate species was derived through adding each individual predicted species habitat map to a raster version of the stewardship map. The vertebrate species analysis tables in Appendix H show the area in hectares and the percentage of each species' predicted habitat in each management status.

As explained in the chapter introduction, we provide results according to thresholds provided in the literature to conserve biodiversity. The digital data or values in the table will allow users to set any desirable threshold and perform their own analyses. The following section provides a description of the stewardship status of each taxon by group (less than 1%, 1 – 10%, 10 – 20%, 20 – 50%, and greater than 50% in GAP status 1 and 2) as summarized in Figure 5.1. In reviewing these descriptions or Appendix H, it is important to remember that many species (such as the red-cockaded woodpecker or flatwoods salamander) currently possess a small fraction of their historic habitat, and may not be as well-protected as the numbers would indicate.

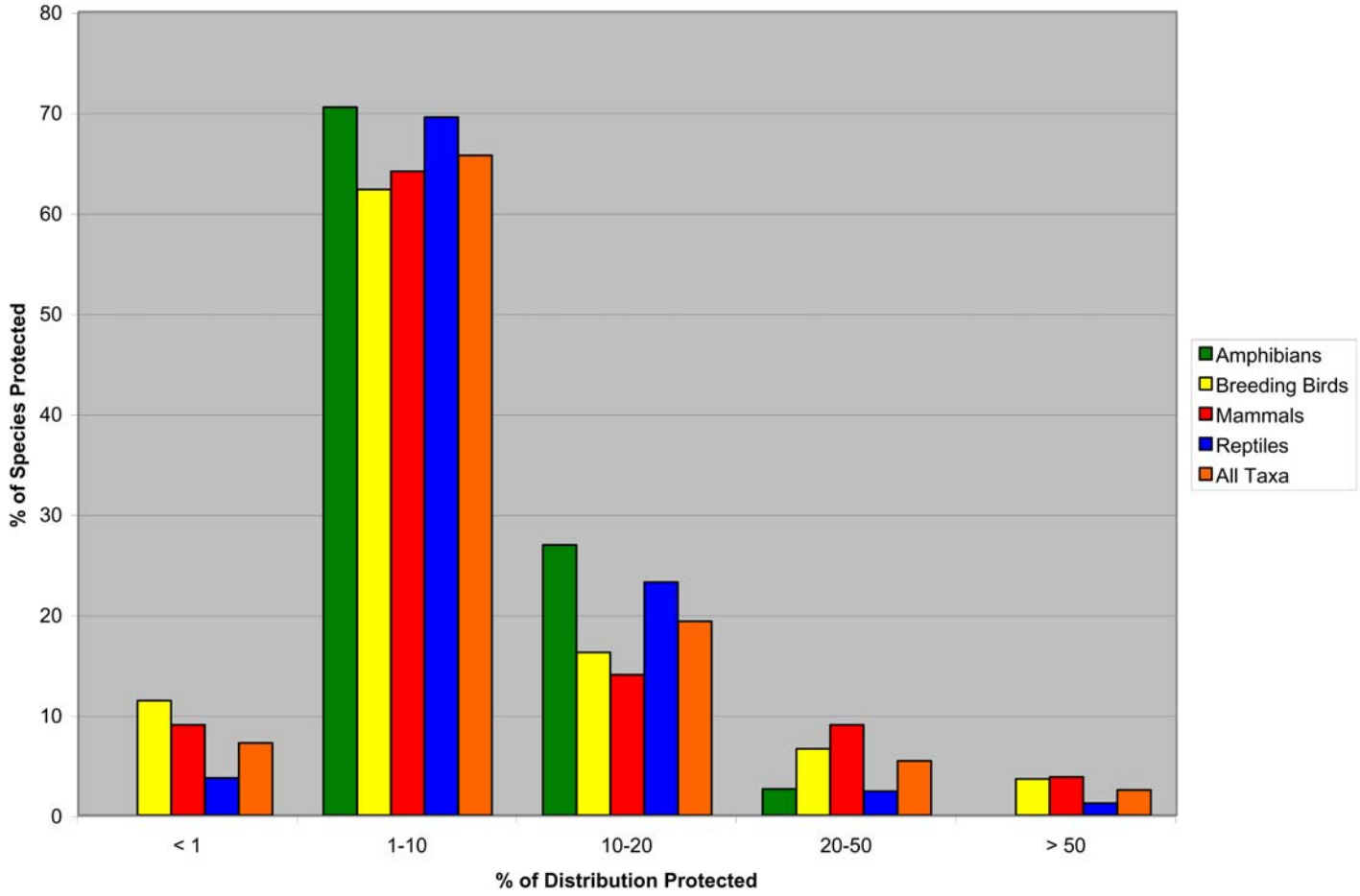


Figure 5.1 Percent of predicted vertebrate distributions on GAP status 1 or 2 Lands, by taxa.

Amphibians

Amphibian species with less than 1% representation in GAP status 1 and 2: There are no amphibian species with less than 1% of their predicted habitat in GAP status 1 and 2 lands.

Amphibian species with 1 – 10% representation in GAP status 1 and 2: 55 of 78 amphibian species (70.5%) are predicted to fall into this category. This includes such species of concern as the Apalachicola dusky salamander, tiger salamander, Alabama waterdog, one-toed amphiuma, Georgia blind salamander, gopher frog, dwarf waterdog, Brimley's chorus frog, and hellbender. Particularly notable among these is the one-toed amphiuma, a status G3/S1 species with only 1.69% of its predicted habitat protected in status 1 and 2, and no additional habitat protected in status 3.

Amphibian species with 10 – 20% representation in GAP status 1 and 2: 21 of 78 amphibian species (26.9%) are predicted to fall into this category. This includes such species of concern as the striped newt, flatwoods salamander, dwarf blackbelly salamander, Tennessee cave salamander, green salamander and shovelnose salamander.

Amphibian species with 20-50% representation in GAP status 1 and 2: Only two amphibian species (2.6%), the wood frog and the Pigeon Mountain salamander are predicted to fall into this category.

Amphibian species with greater than 50% representation in GAP status 1 and 2: There are no amphibian species with greater than 50% of their predicted habitat in GAP status 1 and 2 lands.

Breeding Birds

Breeding bird species with less than 1% representation in GAP status 1 and 2: 19 of 167 breeding bird species (11.4%) are predicted to have less than 1% of their habitat protected in status 1 and 2 lands. Many of these are currently associated with human-dominated landscapes, including the endangered peregrine falcon. Species of conservation concern in this category include the grasshopper sparrow, common barn-owl, and loggerhead shrike, all of which may be associated with pastures or grasslands (few of which remain in Georgia).

Breeding bird species with 1 – 10% representation in GAP status 1 and 2: 104 (62.3%) of breeding birds species in Georgia are predicted to fall into this category. This includes a number of species of conservation concern, including: American kestrel, northern bobwhite, golden-winged warbler, Virginia rail, Mississippi kite, Bachman's sparrow, yellow-billed cuckoo, bald eagle, painted bunting, worm-eating warbler, Swainson's warbler, Louisiana waterthrush, and prothonotary warbler. Some of these are early-successional species (especially American kestrel, northern bobwhite, and painted bunting) that may require at least some habitat manipulation for persistence. However, the American kestrel and northern bobwhite are also poorly protected in status 3 lands (5.0% and 2.6%, respectively). The others include forested wetland, emergent wetland, hardwood forest, and aquatic associates.

Breeding bird species with 10 – 20% representation in GAP status 1 and 2: This moderately-protected category includes 27 species (16.2% of breeding birds). Species of concern are wood stork, swallow-tailed kite, ruffed grouse, and red-cockaded woodpecker. These latter two species have a substantial percentage of their predicted habitat (> 40%) with some protection in status 3 lands, although in the case of the red-cockaded woodpecker that may be small fraction of their historic habitat.

Breeding bird species with 20-50% representation in GAP status 1 and 2: 11 species (6.6%) are predicted to fall into this category. They include yellow-crowned night-heron, cerulean warbler, Wilson's plover, and Blackburnian warbler.

Breeding bird species with greater than 50% representation in GAP status 1 and 2: Six species (3.6% of birds) fall into this well-protected category, including winter wren, dark-eyed junco, veery, sandhill crane, Canada warbler, and common raven, all either associated with very high elevations in the Blue Ridge or the Okefenokee Swamp (sandhill crane).

The Georgia GAP land cover included open ocean out to seven miles from the coast line. Thus, for shore birds, some of the figures in the initial protection status table may be a bit misleading, as open ocean areas are very rarely ever included in the matrix of protected lands. A table calculated for these species without open ocean may be found in Table H2 of Appendix H.

Mammals

Mammal species with less than 1% representation in GAP status 1 and 2: Seven of 78 mammal species (9.0%) are predicted to fall into this category. Most of them are associated with human-dominated cover types. Two of them, the southern bog lemming and least weasel, barely range into Georgia.

Mammal species with 1 – 10% representation in GAP status 1 and 2: 50 (64.1%) mammal species are predicted to fall into this category. This includes several bat species of conservation concern, including the gray myotis, silver-haired bat, northern myotis, southeastern myotis, and eastern small-footed myotis. The northern myotis and Eastern small-footed myotis do have some protection in fairly large percentages of status 3 lands.

Mammal species with 10 – 20% representation in GAP status 1 and 2: This category is predicted to include 11 (14.0%) of mammal species. Species of concern are Rafinesque's big-eared bat, New England (Appalachian) cottontail, pygmy shrew, and Indiana bat.

Mammal species with 20-50% representation in GAP status 1 and 2: Seven (9.0%) mammal species are predicted to be in this category, including black bear, star-nosed mole, and longtail shrew.

Mammal species with greater than 50% representation in GAP status 1 and 2: Three species (3.8% of total) are predicted to be in this category: round-tailed muskrat, horse (an exotic), and water shrew.

Reptiles

Reptile species with less than 1% representation in GAP status 1 and 2: Three species (3.7% of reptiles in Georgia) are predicted to fall into this category. Two are exotics. The third, the Alabama map turtle, is a G4/S1 species that has only 4.6% of its habitat protected in status 3 lands.

Reptile species with 1 – 10% representation in GAP status 1 and 2: 57 of 82 (69.5%) reptiles are predicted to be in this category. Species of conservation concern include: Florida worm lizard, Central Florida crowned snake, mimic glass lizard, eastern diamondback rattlesnake, mole skink, Alligator snapping turtle, bog turtle, Barbour's map turtle, gopher tortoise, and southern hognose snake. The latter two species have some protection on status 3 lands, but this likely represents a relatively small percentage of their historic habitat. Loggerhead turtles end up in this category, but a good deal of their habitat consists of open ocean and salt marsh, and the figure listed here may not reflect their true status.

Reptile species with 10 – 20% representation in GAP status 1 and 2: 19 species (23.2% of reptiles) are in this category, including coal skink, American alligator, spotted turtle, indigo snake, and diamondback terrapin.

Reptile species with 20-50% representation in GAP status 1 and 2: Two species (2.4% of total), Florida green water snake, and striped crayfish snake are in this category.

Reptile species with greater than 50% representation in GAP status 1 and 2: A single species (1.2% of total), the Florida redbelly turtle, is in this class.

All Taxa

29 (7.2%) of the 405 species analyzed for Georgia GAP were protected on status 1 and 2 lands on les than 1% of their predicted habitat. 266 (65.7%) were protected on between 1 and 10% of their habitat, and 78 (19.3%) were protected on between 10 and 20%. 22 (5.4%) were protected on between 20 and 50% of their habitat, and just 10 (2.5%) had more than 50% protection on status 1 and 2 lands.

Limitations and Discussion

When applying the results of our analyses, it is critical that the following limitations are considered: 1) the limitations described for each of the component parts (land cover mapping, animal species mapping, stewardship mapping) of the analyses, 2) the spatial and thematic map accuracy of the components, and 3) the suitability of the results for the intended application (see Appropriate and Inappropriate Use below). Refer to chapters 2, 3, and 4 and the Limitations and Discussions of those chapters for more information.

Our analyses do not take into consideration the protection status of species and communities that extend outside of Georgia. Many species with limited distributions in Georgia range widely in other states. To fully consider protection status, a rangewide analysis would need to take place.

Species that require specific types of management may not necessarily be well-served by GAP status rankings of 1 or 2 if proper management does not take place. For example, red-cockaded woodpeckers require regular burnings of pine stands. This may or may not occur on any lands, including those with high GAP status rankings. Georgia GAP does not attempt to evaluate specific management strategies.

Chapter 6 – CONCLUSIONS AND MANAGEMENT IMPLICATIONS

The Georgia Gap Analysis Program represents the most spatially refined and thematically detailed analysis of Georgia's land cover and vertebrate species distributions to date. Georgia GAP data should provide a myriad of uses, and should be a valuable starting point in answering a variety of conservation questions.

Georgia has had a long history of human influence and has suffered from a wide variety of abuses, ranging from massive soil erosion due to poor agricultural practices in the first half of the 20th century (Trimble 1974) to the more recent rapid conversion of forest and farm lands to urban uses (Natural Resources Spatial Analysis Lab 2001). Through all this, it continues to possess very high biodiversity, although likely declines in many species since pre- European settlement have not been well-documented. We calculated an average species richness per EMAP hexagon in Georgia of 245 species.

Despite possessing very high biodiversity, Georgia is not a very well-protected state. Only 8% of Georgia does not fall into the "unprotected" category. Like most eastern states, the only significant public lands are for the most part found in places too steep or wet to be extensively developed. A number of important habitats receive very little protection, including bottomland hardwoods, non-wetland hardwood forests outside of the mountains, and early successional areas. Together, these areas provide habitat for a significant portion of Georgia's biodiversity. Without an increase in protection, population declines for many species are likely.

Although most land in Georgia is not in any kind of protection, the acreage that is continues to increase every year. For this reason, the conservation lands database should be regularly updated. Many recent purchases have occurred at the county level, and efforts should be made to ensure that all of these lands, and more of those protected under conservation easements, are included in the database.

There are a number of vertebrate species in Georgia whose distributions are still poorly understood. This is especially true for reptiles and amphibians, as well as some mammals, particularly bats. All of these tend to be difficult to observe and require specific survey methods. In the case of amphibians, there are even likely to be entirely new species to be discovered. Future updates to Georgia GAP, and conservation efforts in general, would benefit greatly from improved distribution information for all taxa. Additionally, population trends are unknown for the vast majority of species covered in this analysis. The type of information gathered in monitoring programs is absolutely essential to successful conservation efforts.

Complete species inventories, although seemingly one of the first steps in conservation management, do not exist even for most long-established conservation areas. This makes accuracy assessment of vertebrate models difficult. Recent efforts by the National Park Service to document the species present on their lands have been one of the first comprehensive efforts to acquire this type of information.

Forest successional stage and structure are considered to be important factors for many vertebrate species. However, mapping these characteristics has proven to be a challenge in broad-scale efforts. Research directed in these areas might allow them to be incorporated into future Georgia GAP updates. This would undoubtedly lead to an increase in accuracy for many of the vertebrate models.

Georgia is one of the most rapidly urbanizing states in the nation. Georgia GAP has provided a snapshot in time, current as of 1998, but our landscape is changing daily. According to recent data from the Georgia Land Use Trends (GLUT) project (Natural Resources Spatial Analysis Lab 2001b), low intensity urban areas (which include most residential areas) increased 130 percent in the land area they covered between 1974 and 1998. High intensity urban areas increased 34 percent. On the other hand, deciduous forest acreage decreased by 18 percent; forested wetlands decreased by 16 percent; and agricultural and pasture lands decreased by 12 percent.

These changes present great challenges to conservation managers. Future mapping efforts in Georgia should attempt to combine the detailed land cover mapping and species distributions of GAP with land use change data from GLUT. This would allow a consideration of threats in the evaluation of protected status of species and communities.

Chapter 7 – PRODUCT USE AND AVAILABILITY

How to Obtain the Products

It is the goal of the Gap Analysis Program and the USGS Biological Resources Division (BRD) to make the data and associated information as widely available as possible. Use of the data requires specialized software called geographic information systems (GIS) and substantial computing power. Additional information on how to use the data or obtain GIS services is provided below and on the GAP home page (URL below). While a CD-ROM of the data will be the most convenient way to obtain the data, it may also be downloaded via the internet from the national GAP home page at:

http://www.gap.uidaho.edu

The home page will also provide, over the long term, the status of our state's project, future updates, data availability, and contacts. Within a few months of this project's completion, CD-ROMs of the final report and data should be available at a nominal cost--the above home page will provide ordering information. To find information on this state GAP project's status and data, follow the links to "project information" and then to the particular state of interest.

In addition, data should be available through the Georgia GIS Data Clearinghouse via the internet at:

http://gis1.state.ga.us/index.asp

or on the NARSAL website at:

http://narsal.ecology.uga.edu

Minimum GIS required for Data Use

These data were created on Dell 410 and 420 workstations with 750 or 800 MHz dual and single processors running Windows NT or Windows 2000 with ESRI ArcGIS 8.1 and ArcView 3.2, and ERDAS Imagine 8.6. These data may be successfully used on ESRI ArcGIS 8.x and ArcView 3.x, and ERDAS Imagine 8.x.

These are large data layers and will require several gigabytes of hard drive space to store all data at once. Obviously, the data will be easier to use on computers with faster processors and more RAM, but any machine meeting the minimum hardware requirements for the ESRI software listed above should suffice.

Disclaimer

Following is the official Biological Resources Division (BRD) disclaimer as of 29 January, 1996, followed by additional disclaimers from GAP. Prior to using the data, you should consult the GAP home page (see How to Obtain the Data, above) for the current disclaimer.

Although these data have been processed successfully on a computer system at the BRD, no warranty expressed or implied is made regarding the accuracy or utility of the data on any other system or for general or scientific purposes, nor shall the act of distribution constitute any such warranty. This disclaimer applies both to individual use of the data and aggregate use with other data. It is strongly recommended that these data are directly acquired from a BRD server [see above for approved data providers] and not indirectly through other sources which may have changed the data in some way. It is also strongly recommended that careful attention

be paid to the content of the metadata file associated with these data. The Biological Resources Division shall not be held liable for improper or incorrect use of the data described and/or contained herein.

These data were compiled with regard to the following standards. Please be aware of the limitations of the data. These data are meant to be used at a scale of 1:100,000 or smaller (such as 1:250,000 or 1:500,000) for the purpose of assessing the conservation status of animals and vegetation types over large geographic regions. The data may or may not have been assessed for statistical accuracy. Data evaluation and improvement may be ongoing. The Biological Resources Division makes no claim as to the data's suitability for other purposes. This is writable data which may have been altered from the original product if not obtained from a designated data distributor identified above.

Metadata

Proper documentation of information sources and processes used to assemble GAP data layers is central to the successful application of GAP data. Metadata documents the legacy of the data for new users. The Federal Geographic Data Committee (FGDC 1994, 1995) has published standards for metadata and NBII (<http://www.nbii.gov>) has updated those standards to include biological profiles. Executive Order 12906 requires that any spatial data sets generated with federal dollars will have FGDC-compliant metadata.

Each spatial data layer submitted must be accompanied by its metadata (*.html file) in the same directory. You must also include an additional directory (called "meta_master') which will include each metadata file in three forms (*.txt, *.html, and *.sgml). These are readily created in MetaMaker (<http://www.nbii.gov/about/factsheet/factsheet5.html>). The redundancy in format is to provide one file for error checking (*.txt), one for presentation on the Internet (*.html), and one for indexing elements for the spatial data clearinghouse (*.sgml). Remember, metadata describes the development of the spatial data set being documented. If there are companion files to the GIS data, use metadata to reference (reports, spreadsheet, another GIS layer).

USGS personnel conduct metadata training to meet FGDC standards and to include biological data. See the Internet site, <http://www.nbii.gov/metadata/training/index.html> for more information.

Appropriate and Inappropriate Use of These Data.

All information is created with a specific end use or uses in mind. This is especially true for GIS data, which is expensive to produce and must be directed to meet the immediate program needs. For GAP, minimum standards were set (see A Handbook for Gap Analysis, Scott et al. 1993) to meet program objectives. These standards include: scale or resolution (1:100,000 or 100 hectare minimum mapping unit), accuracy (80% accurate at 95% confidence), and format (ARC/INFO coverage tiled to the 30' x 60' USGS quadrangle).

Recognizing, however, that GAP would be the first, and for many years likely the only, source of statewide biological GIS maps, the data were created with the expectation that they would be used for other applications. Therefore, we list below both appropriate and inappropriate uses. This list is in no way exhaustive but should serve as a guide to assess whether a proposed use can or cannot be supported by GAP data. For most uses, it is unlikely that GAP will provide the only data needed, and for uses with a regulatory outcome, field surveys should verify the result. In the end, it will be the responsibility of each data user to determine if GAP data can answer the question being asked, and if they are the best tool to answer that question.

Scale: First we must address the issue of appropriate scale to which these data may be applied. The data were produced with an intended application at the ecoregion level, that is, geographic areas from several hundred

thousand to millions of hectares in size. The data provide a coarse-filter approach to analysis, meaning that not every occurrence of every plant community or animal species habitat is mapped, only larger, more generalized distributions. The data are also based on the USGS 1:100,000 scale of mapping in both detail and precision. When determining whether to apply GAP data to a particular use, there are two primary questions: do you want to use the data as a map for the particular geographic area, or do you wish to use the data to provide context for a particular area? The distinction can be made with the following example: You could use GAP land cover to determine the approximate amount of oak woodland occurring in a county, or you could map oak woodland with aerial photography to determine the exact amount. You then could use GAP data to determine the approximate percentage of all oak woodland in the region or state that occurs in the county, and thus gain a sense of how important the county's distribution is to maintaining that plant community.

Appropriate Uses: The above example illustrates two appropriate uses of the data: as a coarse map for a large area such as a county, and to provide context for finer-level maps. Specific case-study examples are provided in Appendix H, but following is a general list of applications:

- Statewide biodiversity planning
- Regional (Councils of Government) planning
- Regional habitat conservation planning
- County comprehensive planning
- Large-area resource management planning
- Coarse-filter evaluation of potential impacts or benefits of major projects or plan initiatives on biodiversity, such as utility or transportation corridors, wilderness proposals, regional open space and recreation proposals, etc.
- Determining relative amounts of management responsibility for specific biological resources among land stewards to facilitate cooperative management and planning.
- Basic research on regional distributions of plants and animals and to help target both specific species and geographic areas for needed research.
- Environmental impact assessment for large projects or military activities.
- Estimation of potential economic impacts from loss of biological resource-based activities.
- Education at all levels and for both students and citizens.

Inappropriate Uses: It is far easier to identify appropriate uses than inappropriate ones, however, there is a "fuzzy line" that is eventually crossed when the differences in resolution of the data, size of geographic area being analyzed, and precision of the answer required for the question are no longer compatible. Examples include:

- Using the data to map small areas (less than thousands of hectares), typically requiring mapping resolution at 1:24,000 scale and using aerial photographs or ground surveys.
- Combining GAP data with other data finer than 1:100,000 scale to produce new hybrid maps or answer queries.
- Generating specific areal measurements from the data finer than the nearest thousand hectares (minimum mapping unit size and accuracy affect this precision).
- Establishing exact boundaries for regulation or acquisition.
- Establishing definite occurrence or non-occurrence of any feature for an exact geographic area (for land cover, the percent accuracy will provide a measure of probability).
- Determining abundance, health, or condition of any feature.
- Establishing a measure of accuracy of any other data by comparison with GAP data.
- Altering the data in any way and redistributing them as a GAP data product.
- Using the data without acquiring and reviewing the metadata and this report.

LITERATURE CITED

Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964. U.S. Geological Survey, Washington, DC.

Austin, M.P. 1991. Vegetation: Data collection and analysis. Pages 37-41 in: C.R. Margules and M.P. Austin, eds. Nature conservation: Cost effective biological surveys and data analysis. Australia CSIRO, East Melbourne.

Bernstein, R. 1983. Image geometry and rectification. Pages 881-884 in Colwell, R.N., ed. Manual of remote sensing. American Society of Photogrammetry, Falls Church, VA.

Bourgeron, P.S., H.C. Humphries, R.L. DeVelice, and M.E. Jensen. 1994. Ecological theory in relation to landscape and ecosystem characterization. Pages 58-72 in M.E. Jensen and P.S. Bourgeron, eds. Ecosystem management: Principles and applications, Volume II. Gen. Tech. Rep. PNW-GTR-318. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. 376p.

Braun, E.L. 1964. The deciduous forests of North America. Blakiston, Philadelphia. 596p.

Brown, C.L. and L.K. Kirkman. 1990. Trees of Georgia and adjacent states. Timber Press, Portland, OR. 292p.

Burleigh, T.D. 1958. Georgia birds. Univ. of Oklahoma Press, Norman, OK. 746 pp.

Carlock, D., J. Ezell, G. Balkcom, W. Abler, B. Dupree, and D. Forster. 1999. Black bear management plan for Georgia. Georgia Department of Natural Resources, Social Circle, GA. 24 p.

Cochran, W.G. 1977. Sampling techniques. 3rd ed. John Wiley and Sons, Inc, New York. 428 p.

Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological systems of the United States: A working classification of U.S. terrestrial systems. NatureServe, Arlington, VA.

Crist, P., Thompson, B., Prior-Magee, J., 1995. A dichotomous key of land management categorization, unpublished. Las Cruces, NM. New Mexico Cooperative Fish and Wildlife Research Unit.

Critchfield, W.B. and E.L. Little. 1966. Geographic distribution of the pines of the world. U.S. Department of Agriculture, Forest Service, Washington, DC. 97 p.

Csuti, B., S. Polasky, P. H. Williams, R. L. Pressey, J. D. Camm, M. Kershaw, A. R. Kiester, B. Downs, R. Hamilton, M. Huso, and K. Sahr. 1997. A comparison of reserve selection algorithms using data on terrestrial vertebrates in Oregon. *Biological Conservation* 80:83-97.

Csuti, B. 1994. Methods for developing terrestrial vertebrate distribution maps for Gap Analysis (version 1). In J.M. Scott and M.D. Jennings, eds. A handbook for Gap Analysis. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, ID.

Davis, F.W., P.A. Stine, D.M. Stoms, M.I. Borchert, and A.D. Hollander. 1995. Gap analysis of the actual vegetation of California - 1. The southwestern region. Madroño 42:40-78.

Diamond, J. 1986. The design of a nature reserve system for Indonesian New Guinea. Pages 485-503 in M.E. Soulé, ed. Conservation biology: The science of scarcity and diversity. Sinauer Associates, Sunderland, MA. 584 p.

Driscoll, R.S., D.L. Merkel, D.L. Radloff, D.E. Snyder, and J.S. Hagihara. 1984. An ecological land classification framework for the United States. Miscellaneous Publication 1439. USDA Forest Service, Washington, DC.

Driscoll, R.S., D.L. Merkel, J.S. Hagihara, and D.L. Radloff. 1983. A component land classification for the United States: Status report. Technical Note 360. U.S. Department of the Interior, Bureau of Land Management, Denver.

Edwards, T.C., Jr., C.H. Homer, S.D. Bassett, A. Falconer, R.D. Ramsey, and D.W. Wight. 1995. Utah Gap Analysis: An environmental information system. Technical Report 95-1. Utah Cooperative Fish and Wildlife Research Unit, Utah State University, Logan, UT.

Epstein, J., K. Payne, and L. Kramer. 2002. Techniques for mapping urban sprawl in the Southeast. Photogrammetric Engineering and Remote Sensing 63:913-918.

Federal Geographic Data Committee (FGDC). 1994. Content standards for digital geospatial metadata. 8 June 1994. Federal Geographic Data Committee, Washington, DC.
Federal Geographic Data Committee. 1995. Content standards for digital geospatial metadata workbook. , Federal Geographic Data Committee, Washington, DC.
Federal Geographic Data Committee, Vegetation Subcommittee. 1997. FGDC Vegetation Classification and Information Standards--June 3, 1996 Draft. FGDC Secretariat, Reston, VA. 35 pp.
Florida Cooperative Fish and Wildlife Research Unit. 1997. 21-class vegetation classification of a 1990 merged, rectified SPOT satellite image, at 10m resolution, swamp matrix combined with reclassified upland islands. University of Florida, Gainesville.
Forman, R.T.T., and M. Godron. 1986. Landscape ecology. John Wiley and Sons, New York. 619 p.
Franklin, J.F. 1993. Preserving biodiversity: Species, ecosystems, or landscapes? Ecological Applications 32:202-205.
Georgia Department of Natural Resources. *Unpublished data*. Breeding Bird Atlas.
Georgia Department of Natural Resources. /In prep/. Georgia Herp Atlas.
Georgia Department of Transportation. 1997a. County Boundaries – DOT, 1:31,680. URL: http://www.gis.state.ga.us/.
Georgia Department of Transportation. 1997b. Georgia DLG-F Roads and Highways. 1:12,000, URL: http://www.gis.state.ga.us/.
Georgia Department of Transportation. 1997c. Georgia Utilities - DOT, 1:31,680, URL: http://www.gis.state.ga.us/.
Georgia Department of Transportation. 1997d. Polygonal Hydrography – DOT, 1:24,000. URL: http://www.gis.state.ga.us/.
Georgia Institute of Technology. 1999. 1999 Color-Infrared Digital Orthophoto Quarter Quadrangles for the State of Georgia. Georgia Institute of Technology Center for GIS, Atlanta, GA. URL: www.gis.state.ga.us/.
Georgia Museum of Natural History. 2002. Specimen records. University of Georgia Museum of Natural History, Athens, GA.
Georgia Ornithological Society. 1986. Annoted check-list of Georgia birds. Georgia Ornithological Society, Atlanta. 49 p.
Golley, F.B. 1962. Mammals of Georgia: a study of their distribution and functional role in the ecosystem. University of Georgia Press, Athens, GA. 218 p.
Gopal, S., and C. Woodcock. 1994. Theory and methods for accuracy assessment of thematic maps using fuzzy sets. Photogrammetric Engineering and Remote Sensing 60:181-188.
Grossman, D., K.L Goodin, X. Li, C. Wisnewski, D. Faber-Langendoen, M. Anderson, L. Sneddon, D. Allard, M. Gallyoun, and A. Weakley. 1994. Standardized national vegetation classification system. Report by The Nature Conservancy and Environmental Systems Research Institute for the NBS/NPS Vegetation Mapping Program. National Biological Service, Denver, CO.
Halpin, P.N. 1999. GIS analysis for conservation site design. A short course developed for The Nature Conservancy. Nicholas School of the Environment. Landscape Ecology Lab. Duke University.
Hamel, P.B. W.P. Smith, D.J. Twedt, J.R. Woehr, E. Morris, R.B. Hamilton, and R.J. Cooper. 1996. The land manager's guide to point counts of birds in the Southeast. General Technical Report SO-I 20. U.S.D.A. Forest Service, Southern Research Station, Asheville, NC.
Howell, J., M. Conroy, and J. Peterson. 2003. Modeling the statewide distributions of birds: model building and application. Presented at the National Meeting of The Wildlife Society, Burlington, VT.
Ivester, A.H., D.S. Leigh, and D.I. Godfrey-Smith. 2001. Chronology of inland eolian dunes on the Coastal Plain of Georgia, U.S.A. Quaternary Research 55:293-302.

Jenkins, R.E. 1985. Information methods: Why the Heritage Programs work. The Nature Conservancy News 35:21-23.

Jennings, M.D. 1993. Natural terrestrial cover classification: Assumptions and definitions. Gap Analysis Technical Bulletin 2. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow.

Jensen, S. K., and J. O. Domingue. 1988. Extracting topographic structure from digital elevation data for geographic information system analysis. Photogrammetric Engineering and Remote Sensing 54:1593-1600.

Keyes, Jr., J., C. Carpenter, S. Hooks, F. Koeing, W.H. McNab, W.E. Russell and M-L. Smith. 1995. Ecological Units of the Eastern United States – first approximation (map and booklet of map unit tables). Presentation scale 1:3,500,000, colored. Technical Publication R8-TP 21. US Department of Agriculture Forest Service, Atlanta, GA.

Kiester, A.R., J.M. Scott, B. Csuti, R.F. Noss, and B. Butterfield. 1996. Conservation prioritization using GAP data. Conservation Biology 10:1332-1342.

Kirkpatrick, J.B. 1983. An iterative method for establishing priorities for the selection of nature reserves: An example from Tasmania. Biological Conservation 25:127-134.

Küchler, A.W., and I.S. Zonneveld, eds. 1988. Vegetation mapping. Kluwer Academic Publishers, Dordrecht, The Netherlands. 635p.

Levin, S.A. 1981. The problem of pattern and scale in ecology. Ecology 73:1942-1968.

Lins, K.S., and R.L. Kleckner. 1996. Land cover mapping: An overview and history of the concepts. In: J.M. Scott, T.H. Tear, and F. Davis, eds., Gap Analysis: A landscape approach to biodiversity planning. American Society for Photogrammetry and Remote Sensing, Bethesda, MD.

Margules, C.R., A.O. Nicholls, and R.L. Pressey. 1988. Selecting networks of reserves to maximize biological diversity. Biological Conservation 43:63-76

Miller, K.R. 1994. In J.A. McNeely and K.R. Miller, eds. National parks conservation and development. Smithsonian Institution, Washington, D.C. 825 p.

Moore, C. *Unpublished data*. Piedmont National Wildlife Refuge GIS.

Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley & Sons, New York. 547p.

Natural Resources Spatial Analysis Laboratory. 2001a. 1998 land cover map of Georgia. Institute of Ecology, Athens, GA.

Natural Resources Spatial Analysis Laboratory. 2001b. Georgia Land Use Trends (GLUT). Institute of Ecology, Athens, GA.

Nature Conservancy. 2002. Coverage of longleaf pine stands in Georgia, 1:24,000. The Nature Conservancy, Darien, GA.

Natureserve. 2002. Land cover of Fort Benning, 1:24,000. Natureserve, Durham, NC.

Nicholls, A.O., and C.R. Margules. 1993. An upgraded reserve selection algorithm. Biological Conservation 64:165-169.

Noss, R.F. 1987. From plant communities to landscapes in conservation inventories: A look at The Nature Conservancy (USA). Biological Conservation 41:11-37

Noss, R.F. 1990. Indicators for monitoring biodiversity: A hierarchical approach. Conservation Biology 4:355-364.

Noss, R.F. 1991. Report to the Fund for Animals in Washington, D.C.

Noss, R.F., and A.Y. Cooperrider. 1994. Saving nature's legacy. Island Press, Washington, D.C. 416 p.

Noss, R. F., E. T. LaRoe III, and J. M. Scott. 1995. Endangered ecosystems of the United States: A preliminary assessment of loss and degradation. Biological Report 28, National Biological Service, Washington, D.C.

Odum, E.D., and H.T. Odum. 1972. Proceedings of the North American Wildlife and Natural Resources Conference 39:178.

Olivera, F., D. Maidment, and S. Reed. 1998. HEC-PrePro v. 2.0: An ArcView pre-rocessor for HEC's Hydrologic Modeling System. Presented at the 1998 ESRI User Conference. San Diego, California, July 1998.

Parker, A.J. 1982. The topographic relative moisture index: an approach to soil moisture assessment in mountain terrain. Physical Geography 3: 160-168.

Payne, K., K. Samples, J. Epstein, A. Ostrander, J.. Lee, J. Schmidt, S. Mathes, M. Elliott, J. Nackone, S. Sand, F. Hay, M. Merrill, M. Golabdi, M. Higgins, J. Howell, and L. Kramer. 2003. Multi-source data integration for Georgia land-cover mapping. Southeastern Geographer 43:27-53.

Peterson, C.R., S.R. Burton, D.S. Pilliod, J.R. Lee, J.O. Cossel, Jr., and R.L. Llewellyn. 2001. Assessing the accuracy of GAP analysis predicted distributions of Idaho amphibians and reptiles. Gap Analysis Program Bulletin 10: 25-28.

Pressey, R.L.,and A.O. Nicholls. 1989. Application of a numerical algorithm to the selection of reserves in semi-arid New South Wales. Biological Conservation 50:263-278.

Pressey, R.L., C. J. Humphries, C. R. Margules, R. I. Vane-Wright, and P. H. Williams. 1993. Beyond opportunism: Key principles for systematic reserve selection. Trends in Ecology and Evolution 8:124-128.

Ride, W.L.D. 1975. In F. Fenner, ed. A national system of ecological reserves in Australia. 64 p.

Rosenfeld, G.H. and K. Fitzpatrick-Lins. 1986. A coefficient of agreement as a measure of thematic classification accuracy. Photogrammetric Engineering and Remote Sensing 52:223-227.

Sauer, J.R., J.E. Hines, and J. Fallon. 2003. The North American Breeding Bird Survey, Results and Analysis 1966 - 2002. Version 2003.1. USGS Patuxent Wildlife Research Center, Laurel, MD.

Scambos, T.A., Dutkiewicz, M.J., Wilson, J.C., and Bindschadler, R.A. 1992, Application of image cross-correlation to the measurement of glacier velocity using satellite image data: Remote Sensing ofEnvironment 42:177-186.

Schmidt, E.V., D. Otis, C. Aulbach, F. Tian, J.D. Scurry, Y. Alger, F.G.F. Smith, D. Fairey, and D. Gordon. 2001. The South Carolina Gap Analysis Project – Final Report. South Carolina Cooperative Fish and Wildlife Research Unit, Clemson, SC.

Scott, J.M., F. Davis, B. Csuti, R. Noss, B. Butterfield, C. Groves, H. Anderson, S. Caicco, F. D'Erchia, T.C. Edwards, Jr., J. Ulliman, and G. Wright. 1993. Gap analysis: A geographic approach to protection of biological diversity. Wildlife Monographs 123.

Scott, J.M., C.R. Peterson, J.W. Karl, E. Strand, L.K. Svancara, and N.M. Wright. 2002. A Gap Analysis of Idaho: Final Report. Idaho Cooperative Fish and Wildlife Research Unit, Moscow, ID.

Slaymaker, D.M., K.M.L. Jones, C.R. Griffin, and J.T. Finn. 1996. Mapping deciduous forests in southern New England using aerial videography and hyperclustered multi-temporal Landsat TM imagery. Pages 87-101 in J.M. Scott, T.H. Tear, and F.W. Davis, eds. Gap analysis: a landscape approach to biodiversity planning. American Society for Photogrammetry and Remote Sensing, Bethesda, MD.

Specht, R.L. 1975. The report and its recommendations. Pages 11-16 in F.Fenner, ed. A national system of ecological reserves in Australia. Australian Academy of Sciences Report No. 19. Canberra, Australia

Specht, R.L., E.M. Roe, and V.H. Boughlon. 1974. Australian Journal of Botany Supplement Series. Supplement No. 7.

Stoms, D., and J. Estes. 1993. A remote sensing research agenda for mapping and monitoring biodiversity. International Journal of Remote Sensing 14:1839-1860.

Stoms, D.M. 1994. Actual vegetation layer. In J.M. Scott and M.D. Jennings, eds. A handbook for Gap Analysis. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, ID.

Trimble, S.W. 1974. Man-induced soil erosion on the southern Piedmont. Soil Conservation Society of America, Ankeny, IA. 180 p.

U.S. Department of Agriculture. 1997. National Agricultural Statistics Service Census of Agriculture. URL: http://www.nass.usda.gov/census.
U.S.D.A. Forest Service. 1997. Continuous Inventory of Stand Conditions – Chattahoochee-Oconee National Forest, 1: 24, 000. Gainesville, GA, U.S. Forest Service.
U.S.D.A. Forest Service, Southern Region. 1999. Chattahoochee-Oconee R8Bird database. Atlanta, GA, U.S. Forest Service.
UNESCO. 1973. International classification and mapping of vegetation. Paris.
U.S. Fish and Wildlife Service. 2002. 7.5-minute National Wetlands Inventory, 1:24,000, URL: http://wetlands.fws.gov/.
U.S. Geological Survey. 1987. Digital elevation models, US GeoData Users. U.S. Geological Survey, Reston, VA. 38 p.
U.S. Geological Survey. 1989. Digital line graphs from 1:100,000-scale maps. U.S. GeoData Users Guide 2. U.S. Geological Survey, Reston, VA. 88 p.
U.S. Geological Survey. 1993a. County Set of Multiple 3.75-minute DOQQ (tiff), 1:12,000. URL: http://www.gis.state.ga.us/Clearinghouse/clearinghouse.html.
U.S. Geological Survey. 1993b. Digital Raster Graphics, 1:24, 000. URL: http://www.gis.state.ga.us/Clearinghouse/clearinghouse.html.
U.S. Geological Survey. 1996a. Miscellaneous transportation of Georgia, 1:100,000. URL: http://www.gis.state.ga.us/Clearinghouse/clearinghouse.html.
U.S. Geological Survey. 1996b. Georgia Railways – DLG, 1:100,000. URL: http://www.gis.state.ga.us/Clearinghouse/clearinghouse.html.
U.S. Geological Survey. 1998. USBM Mineral Availability System (MAS)/Mineral Industry Location in CONUS, 1:100,000. URL: http://www.gis.state.ga.us/Clearinghouse/clearinghouse.html.
U.S. Geological Survey. 1999a. Georgia Land Cover Data Set, from The National Land Cover Dataset. U.S. Geological Survey, Sioux Falls, SD. URL: http://landcover.usgs.gov/natllandcover.html.
U.S. Geological Survey. 1999b. National Elevation Database, 1:24,000. U.S. Geological Survey, Sioux Falls, SD.
Wharton, C.H. 1978. The natural environments of Georgia. Atlanta, Ga., Georgia Department of Natural Resources. 227 pp.
Williams, P. H., D. Gibbons, C. Margules, A. Rebelo, C. Humphries, and R. Pressey. 1996. A comparison of richness hotspots, rarity hotspots, and complementary areas for conserving diversity of British birds. Conservation Biology 10:155-174.
Weakley, A. S., K. D. Patterson, S. Landaal, M. Pyne, and others (compilers). 1998. International classification of ecological communities: Terrestrial vegetation of the Southeastern United States. Working Draft of March 1998. The Nature Conservancy, Southeast Regional Office, Southern Conservation Science Department, Community Ecology Group. Chapel Hill, North Carolina.
Whittaker, R.H. 1960. Vegetation of the Siskiyou mountains, Oregon and California. Ecological Monographs 303:279-338.
Whittaker, R.H. 1965. Dominance and diversity in land plant communities. Science 147: 250-259.
Whittaker, R.H. 1977. Species diversity in land communities. Evolutionary Biology 10:1-67.
Willamson, G.K. and R.A. Moulis. 1994. Distribution of amphibians and reptiles in Georgia. Savannah Science Museum, Savannah.

GLOSSARY

aerial videography - video images of the land surface taken from an airplane

algorithm - a procedure to solve a problem or model a solution (In GAP typically refers to a GIS procedure used to model animal distributions.)

alliance level - a land unit made up of an "alliance" of natural communities that have the same dominant or co-dominant plant species or, in the absence of vegetation, by the dominant land cover typically described according to the Anderson land cover classification (see "Natural Community Alliance" in Grossman et al. 1995)

alpha diversity - a single within-habitat measure of species diversity regardless of internal pattern, generally over an area of 0.1 to 1,000 hectares (see Whittaker 1960, 1977) -

Anderson Level II - the second hierarchical level in the Anderson land cover classification system (see Anderson et al. 1976)

anthropogenic - caused by man

assemblages - a group of ecologically interrelated plant and animal species

band, spectral - a segment of the electromagnetic spectrum defined by a range of wavelengths (e.g. blue, green, red, near infrared, far infrared) that comprise the LANDSAT TM imagery

beta diversity - the change in species diversity among different natural communities of a landscape; an index of between-habitat diversity (see Whittaker 1960, 1977)

biodiversity - generally, the variety of life and its interrelated processes

biogeographic - relating to the geographical distribution of plants and animals

biological diversity - see biodiversity

cartographic - pertaining to the art or technique of making maps or charts

classify - to assign objects, features, or areas on an image to spectral classes based upon their appearance as opposed to ‘classification’ referring to a scheme for describing the hierarchies of vegetation or animal species for an area

coarse filter - the general conservation activities that conserve the common elements of the landscape matrix, as opposed to the "fine filter" conservation

activities that are aimed at special cases such as rare elements (see Jenkins 1985)

community - a group of interacting plants and animals

cover type - a non-technical higher-level floristic and structural description of vegetation cover

cross-walking - matching equivalent land cover categories between two or more classification systems

delineate - identifying the boundaries between more or less homogenous areas on remotely sensed images as visible from differences in tone and texture

delta diversity - the change in species diversity between landscapes along major climatic or physiographic gradients (see Whittaker 1977)

digitization - entering spatial data digitally into a Geographic Information System

ecoregion - a large region, usually spanning several million hectares, characterized by having similar biota, climate, and physiography (topography, hydrology, etc).

ecosystem - a biological community (ranging in scale from a single cave to millions of hectares), its physical environment, and the processes through which matter and energy are transferred among the components

edge-matching - the process of connecting polygons at the boundary between two independently created maps, either between TM scenes or between state GAP data sets

element - a plant community or animal species mapped by GAP. May also be referred to as "element of biodiversity".

error of commission - the occurrence of a species (or other map category) is erroneously predicted in an area where it is in fact absent

error of omission - when a model fails to predict the occurrence of a species that is actually present in an area

exact set coverage - a basic optimization problem to determine the best method for identifying general areas that, when selected sequentially, would have the greatest positive cumulative impact on attaining adequate representation of any or all biotic elements of interest

extinction - disappearance of a species throughout its entire range

extirpation - disappearance of a species from part of its range

fine filter - see "coarse filter"

floristic - pertaining to the plant species that make up the vegetation of a given area.

formation level - the level of land cover categorization between Group and Alliance describing the structural attributes of a land unit, for example, "Evergreen Coniferous Woodlands with Rounded Crowns" (see Jennings 1993)

gamma diversity - the species diversity of a landscape, generally covering 1,000 to 1,000,000 hectares, made up of more than one kind of natural community (see Whittaker 1977)

gap analysis - a comparison of the distribution of elements of biodiversity with that of areas managed for their long-term viability to identify elements with inadequate representation

geographic information systems - computer hardware and software for storing, retrieving, manipulating, and analyzing spatial data

Global Positioning System (GPS) - an instrument that utilizes satellite signals to pinpoint its location on the earth's surface

greedy heuristic - an algorithm for exact set cover analysis (see Kiester et al. 1996)

ground truthing - verifying maps by checking the actual occurrence of plant and animal species in the field at representative sample locations

habitat - the physical structure, vegetation composition, and physiognomy of an area, the characteristics of which determine its suitability for particular animal or plant species

hectare - a metric unit of area of 10,000 square meters and equal to 2.47 acres

hex/hexagon - typically refers to the EPA EMAP hexagonal grid of 635 square kilometer units

hyperclustering - a efficient, interactive method for accurately analyzing and classifying remotely-sensed data that reduces data size and computational requirements while retaining the integrity of the original data

lotic - flowing, e.g., water in a stream or river

metadata - information about data, e.g., their source, lineage, content, structure, and availability

minimum mapping unit - the smallest area that is depicted on a map

neotropics - the zoo-geographic region stretching southward from the tropic of Cancer and including southern Mexico, Central and South America, and the West Indies

phenology - the study of periodic biological phenomena, such as flowering, breeding, and migration, especially as related to climate

phenotype - the environmentally and genetically determined observable appearance of an organism, especially as considered with respect to all possible genetically influenced expressions of one specific character

physiognomic - based on physical features

physiographic province - a region having a pattern of relief features or land forms that differ significantly from that of adjacent regions

pixel - the smallest spatial unit in a raster data structure

polygon - an area enclosed by lines in a vector-based Geographic Information System data layer or a region of contiguous homogeneous pixels in a raster system

preprocessing - those operations that prepare data for subsequent analysis, usually by attempts to correct or compensate for systematic, radiometric, and geometric errors

pro-active - acting in anticipation of an event as opposed to reacting after the fact

range - the geographic limit of the species

range unit - a spatial, geographic unit to record and display species geographic range.

reach - a stream or river segment between inflowing tributaries

registration, spatial - matching different images to each other by finding points on the images that can be matched to known points on the ground

remote sensing - deriving information about the earth's surface from images acquired at a distance, usually relying on measurement of electromagnetic radiation reflected or emitted from the feature of interest

resolution - the ability of a remote sensing system to record and display fine detail in a distinguishable manner or: the smallest feature that can be distinguished or resolved on a map or image, such as a TM pixel

scale, map - the ratio of distance on a map to distance in the real word,

expressed as a fraction; the smaller the denominator, the larger the scale, e.g. 1:24,000 is larger than 1:100,000

sensitivity analysis - the consideration of a number of factors involved in the mathematical modeling of an ecosystem and its components. These include feedback and control, and the stability and sensitivity of the system as a whole to changes in some part of the system. Predictions can be made from the analysis.

simulated annealing - an algorithm used for set coverage analysis (see Kiester et al. 1996)

species richness - the number of species of a particular interest group found in a given area

spectral cluster - a group of adjacent pixels that are uniform with respect to their brightness values

supervised classification - the process of classifying TM pixels of unknown identity by using samples of known identity (i.e., pixels already assigned to informational classes by ground truthing or registration with known land cover) as training data

synoptic - constituting a brief statement or outline of a subject; presenting a summary

tessellation - the division of a map into areas of equal and uniform shape such as the EPA- EMAP hexagon

Thematic Mapper - a sensor on LANDSAT 4 and 5 satellites that records information in seven spectral bands, has a spatial resolution of about 30 m x 30 m, and represents digital values in 256 levels of brightness per band

transect - a transversely cut line along which physical and biological observations are made

trophic structure - the various levels in a food chain, such as producers (plants), primary consumers (herbivores), and secondary consumers (carnivores)

Universal Transverse Mercator - one of several map projections or systems of transformations that enables locations on the spherical earth to be represented systematically on a flat map

Universal Transverse Mercator grid - a geographic reference system used as the basis for worldwide locational coding of information in a GIS or on a map

unsupervised classification - the definition, identification, labeling, and mapping of natural groups, or classes, of spectral values within a scene. These spectral

classes are reasonably uniform in brightness in several spectral channels.

vector format - a data structure that uses polygons, arcs (lines), and points as fundamental units for analysis and manipulation in a Geographic Information System

virtual reality - a computer-generated simulation of reality with which users can interact using specialized peripherals such as data gloves and head-mounted computer graphic displays

wildlife habitat relationship model - a method of linking patterns of known habitat use by animal species with maps of existing vegetation, thereby identifying the spatial extent of important habitat features for use in conservation and management.

GLOSSARY OF ACRONYMS

ACSM	American Congress on Surveying and Mapping
ADAMAS	Aquatic Database Management System
ADEM	Alabama Department of Environmental Management
AML	ARC/INFO Macro Language
ASPRS	American Society for Photogrammetry & Remote Sensing
AVHRR	Advanced Very High Resolution Radiometer (satellite system)
BBS	Breeding Bird Survey
BEST	Biomonitoring of Environmental Status and Trends
BLM	Bureau of Land Management
CAFF	Conservation of Arctic Flora and Fauna
C-CAP	Coastwatch Change Analysis Program (NOAA)
CDC	Conservation Data Center
CEC	Council on Environmental Cooperation
CENR	Committee on Environment and Natural Resources
CERES	California Environmental Resources Evaluation System
CIESIN	Consortium for Internat'l Earth Science Information Network
CODA	Conservation Options and Decision Analysis (software)
COE	Army Corps of Engineers
CRMP	Coordinated Resource Management Plan
CRT	Cathode ray tube
CRUC	Cooperative Research Unit Center
DLG-E	Digital line graph - enhanced
DOI	Department of the Interior
DOQQ	Digital Orthophoto Quarter Quad
DNR	Department of Natural Resources (Georgia)
EDC	EROS Data Center
ECOMAP	The National Hierarchical Framework of Ecological Units
EMAP	Environmental Monitoring & Assessment Program
EMAP-LC	EMAP-Landscape Characterization (USEPA)
EMSL	Environmental Monitoring & Systems Laboratory (USEPA)
EMTC	Environmental Management Technical Center (NBS)
EOS	Earth Observing System
EOSAT	Earth Observation Satellite Company (the commercial operator of the Landsat satellite system)
EOSDIS	EOS Data & Information System
EPA	Environmental Protection Agency
ERDAS	A GIS software
ERL	Environmental Research Laboratory, Corvallis (USEPA)
EROS	Earth Resources Observation Systems (USGS)
ESRI	Environmental Systems Research Institute
ETM+	Enhanced Thematic Mapper plus
FGDC	Federal Geographic Data Committee
FTP	file transfer protocol
FY	Fiscal Year
GA-GAP	Georgia Gap Analysis Program
GAO	General Accounting Office (Congress)
GAP	Gap Analysis Program
GCDIS	Global Change Data and Information System

GLIS	Global Land Information System (USGS)
GLOBE	Global Learning and Observations to Benefit the Environment
GMNH	Georgia Museum of Natural History
GPS	Global Positioning System
GRASS	Geographic Resources Analysis Support System
GRIS	Geographic Resource Information Systems
HRMSI	High Resolution Multispectral Stereo Imager
IALE	International Association of Landscape Ecology
IDRISI	A GIS developed by Clark University
ISODATA	Iterative Self-organizing Data Analysis Technique
ITOS	Information Technology Outreach Service (University system of Georgia)
LAPS	Land Acquisition Priority System
LC/LU	Land Cover/Land Use (USGS)
MIPS	Map and Image Processing System
MOU	Memorandum of Understanding
MMU	Minimum mapping unit
MRLC	Multi-Resolution Land Characteristics Consortium
MSS	Multi-Spectral Scanner
MTPE	Mission to Planet Earth
NAFTA	North American Free Trade Agreement
NALC	North American Landscape Characterization (USEPA, USGS)
NAWQA	National Water Quality Assessment (USGS)
NBII	National Biological Information Infrastructure
NBS	National Biological Service
NCCP	Natural Communities Conservation Planning program (in CA)
NDCDB	National Digital Cartographic Data Base
NERC	National Ecology Research Center (Ft. Collins, CO)
NLCD	National Land Cover Dataset
NMD	National Mapping Division
NPS	National Park Service
NSDI	National Spatial Data Infrastructure
NSTC	National Science and Technology Council
NWI	National Wetlands Inventory (USFWS)
OMB	Office of Management and Budget (Administration)
OSIS	Oregon Species Information System
PARC	Public Access Resource Center
PI	Principal Investigator
SAB	Science Advisory Board (USEPA)
SDTS	Spatial Data Transfer Standard
SGID	State Geographic Information Database
SNEP	Sierra Nevada Ecosystem Project
SOFIA	Southern Forest Inventory and Analysis
SPOT	Système Pour l'Observation de la Terre
RMSE	Root mean square error
TIGER	Topologically Integrated Geographic Encoding and Referencing system (used for U.S. census)
TM	Thematic Mapper
TNC	The Nature Conservancy
UNESCO	United Nations Educational, Scientific, and Cultural Organization
URISA	Urban and Regional Information Systems Association.

URL	Universal Resource Locator
USDA	US Department of Agriculture
USFS	US Forest Service
USFWS	US Fish & Wildlife Service
USGS	US Geological Survey
UTM	Universal Transverse Mercator
UVM	University of Vermont
UGA	University of Georgia
WHRM	Wildlife/habitat relationship model
WMA	Wildlife Management Area
WRD	Wildlife Resources Division (Georgia)

APPENDICES

Appendix A - Error Matrix for First Iteration of Land Cover

Statewide 1st or 2nd Choice Location 1

CLASS	V7	V9	V11	V19	V20	V22	V23	V24	V28	V29	V31	V33	V34	V41	V42	V43	V51	V61	V62	V63	V72	V73	V80	V83	V90	V92	V93	V98	TOTAL	USER_ACCUR	CLASS_2	K_HAT
7	11	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	78.57	7	
9	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	100.00	9	
11	0	0	115	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	120	95.83	11	
19	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	100.00	19	
20	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	100.00	20	
22	0	0	0	0	0	124	0	6	0	1	0	0	0	5	4	4	0	0	0	0	0	0	4	1	0	0	0	0	149	83.22	22	
23	0	0	0	0	0	3	15	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	75.00	23	
24	0	0	0	0	0	4	1	72	0	0	3	0	0	1	2	2	0	0	0	0	1	0	2	1	1	0	0	0	90	80.00	24	
28	0	0	0	0	1	0	0	0	32	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	94.12	28	
29	0	0	0	0	0	0	0	1	0	360	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	364	98.90	29	
31	0	0	1	0	1	6	0	5	0	0	193	1	0	11	6	5	0	1	1	2	0	0	20	4	6	0	0	0	263	73.38	31	
33	0	0	0	0	0	0	0	2	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	90.00	33	
34	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	100.00	34	
41	0	0	0	0	0	1	1	1	0	0	16	0	0	444	34	23	1	1	1	0	0	1	8	1	10	0	6	0	549	80.87	41	
42	0	1	7	0	1	2	0	0	0	0	19	0	0	24	843	15	0	0	0	2	0	0	6	0	19	0	0	0	939	89.78	42	
43	0	2	0	0	0	2	0	1	0	0	10	0	0	20	25	189	0	0	0	1	0	0	3	1	9	0	5	1	269	70.26	43	
51	0	0	0	0	0	0	0	0	0	0	2	0	0	2	5	0	9	0	0	2	0	0	1	1	1	0	0	0	23	39.13	51	
61	0	0	0	0	0	0	0	0	0	0	3	0	0	1	7	0	0	10	0	4	0	0	0	0	1	0	0	0	26	38.46	61	
62	0	0	0	0	0	1	0	0	0	0	2	0	0	0	2	1	0	0	12	3	0	0	1	0	1	0	0	0	23	52.17	62	
63	0	0	0	0	0	0	0	1	0	0	5	0	0	1	7	1	0	0	3	16	0	0	1	0	4	0	0	0	39	41.03	63	
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	12	0	1	0	0	0	0	0	14	85.71	72	
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	11	100.00	73	
80	0	0	0	0	1	4	0	1	0	0	9	0	0	5	14	0	0	1	0	1	1	1	317	1	4	0	0	0	360	88.06	80	
83	0	0	0	0	0	1	0	6	0	0	16	0	0	3	7	2	0	1	0	1	0	0	27	269	0	0	0	0	333	80.78	83	
90	0	1	2	0	0	1	1	0	0	0	14	0	0	8	21	10	0	0	0	4	0	0	4	1	336	0	0	0	403	83.37	90	
92	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52	0	0	56	92.86	92	
93	2	0	1	0	0	0	0	0	0	0	0	0	0	3	2	1	0	0	0	0	0	0	0	0	2	0	16	0	27	59.26	93	
98	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	3	0	0	0	0	0	0	0	0	4	0	0	23	32	71.88	98	
Total	17	7	128	9	49	149	18	96	32	364	299	19	5	528	981	256	10	14	17	36	14	13	397	280	399	52	27	24	4240			
Producers	64.71	42.86	89.84	100.00	91.84	83.22	83.33	75.00	100.00	98.90	64.55	94.74	100.00	84.09	85.93	73.83	90.00	71.43	70.59	44.44	85.71	84.62	79.85	96.07	84.21	100.00	59.26	95.83			83.9858	0.820423

Appendix B - Error Matrix for Second Iteration of Land Cover

MAP CLASS	7	9	11	18	20	22	24	31	33	34	72	73	80	83	201	202	203	410	411	412	413	414	415	420	422	423	424	425	431	432	433	434	440	441	512	513	620	890	900	920	930	980	990	TOTAL	Users	OBSERVED CLASS	K_HAT
7	11		2																																									13	84.62	7	
9		3																																											3	100.00	9	
11			16					1																										1		1				1			1		111	95.50	11	
18				385	1	4	1	1					3		1	4	2															3	2											407	94.59	18	
20					45								1																																46	97.83	20	
22						15	2				1		1		2	2	1		2			1			1			1				1												30	50.00	22	
24			1	2		8	14	3			1		4	1																				1										125	83.20	24	
31						6	5	81	1				18	6	3	2		2	5	1				1	1				2		3	6	9	6			2	7		1	3	1	172	47.09	31	
33							2		18																																			20	90.00	33	
34										5			1									1																							7	71.43	34	
72						1					11		1			1																													14	78.57	72	
73												11																																	11	100.00	73	
80					1	13	1	1			1	1	36	2	4	1	2	1	3	4													1	6	2	1								360	85.00	80	
83						1	8	18					23	275		1																	2	3										331	83.08	83	
201						1		1					2	1	21	2				1									1			1	1											32	65.63	201	
202													1		2	12			1									2	3	1		2	2											26	46.15	202	
203						1											7			2									1			2	1											14	50.00	203	
410				1				1										64	23									1		1	1							1						93	68.82	410	
411			2			2		9					5	1	1	1		26	368		3	7				3	3	21	8	1	17	15						4		1	1			508	72.44	411	
412			1			3		17				1	3	1		2	1			187	1				1						23	1	3	6		1	2	6			2	1	272	68.75	412	
413								1					1						18	2	34				1				2	3		3	1										66	51.52	413	
414																		2	7			24								1														34	70.59	414	
415																							2																						2	100.00	415	
420																								2										1										3	66.67	420	
422								3					1		2	1									31	1						2	32						1					92	33.70	422	
423																										6		1	2			1	7											17	35.29	423	
424																						1				1	3		1															6	50.00	424	
425																			3			1					1	17		1	1		1											25	68.00	425	
431								1											7		1	4				3			44	2	2	1											65	67.69	431	
432																			5		2							1	3	13		6	1						1				32	40.63	432	
433																		1	1			1							2	5														10	50.00	433	
434			1					8					5	2	1		2	3	1	18	1			1	4	2			1			162	8	2	1			2	8					242	66.94	434	
440			5				1						3			1			3	1					14	7	1	1	1	4		31	373						8					463	80.56	440	
441								2					1	1		3				2												3		176		2	7	3	3		1	3	1	208	84.62	441	
512																																1			4									5	80.00	512	
513																																				4								4	100.00	513	
620								1																										1			14							16	87.50	620	
890			1											1	1					3													4	1				41	6		1	2	1	62	66.13	890	
900			1					4					1			1	1			2												1	1	2				2	57			1	2	76	75.00	900	
920																																				1				19				20	95.00	920	
930													1																												9	2	1	16	56.25	930	
980								1										1															1						1	1			16	21	76.19	980	
990								2												2				1								1		5			2	2	5			2	18	40	45.00	990	
Total	11	3	120	388	47	55	124	165	19	5	14	13	382	291	38	34	16	100	456	234	42	40	2	5	52	21	8	27	82	34	20	284	475	206	19	7	24	55	112	19	13	33	25	4120		**Overall accuracy**	
Producers	100.00	100.00	88.33	99.23	95.74	27.27	83.87	49.09	94.74	100.00	78.57	84.62	80.10	94.50	55.26	35.29	43.75	64.00	80.70	79.91	80.95	60.00	100.00	40.00	59.62	28.57	37.50	62.96	53.66	38.24	25.00	57.04	78.53	85.44	21.05	57.14	58.33	74.55	50.89	100.00	69.23	48.48	72.00			**75.4612**	0.73722

Appendix C - Vertebrates Modeled During Georgia GAP

TAXA	SCI_ NAME	COM_NAME	ELCODE
Amphibians	Acris crepitans	Northern cricket frog	AAABC01010
Amphibians	Acris gryllus	Southern cricket frog	AAABC01020
Amphibians	Ambystoma cingulatum	Flatwoods salamander	AAAAA01030
Amphibians	Ambystoma maculatum	Spotted salamander	AAAAA01090
Amphibians	Ambystoma opacum	Marbled salamander	AAAAA01100
Amphibians	Ambystoma talpoideum	Mole salamander	AAAAA01120
Amphibians	Ambystoma tigrinum	Tiger salamander	AAAAA01140
Amphibians	Amphiuma means	Two-toed amphiuma	AAAAB01010
Amphibians	Amphiuma pholeter	One-toed amphiuma	AAAAB01020
Amphibians	Aneides aeneus	Green salamander	AAAAD01010
Amphibians	Bufo americanus	American toad	AAABB01020
Amphibians	Bufo fowleri	Fowler's toad	AAABB01180
Amphibians	Bufo quercicus	Oak toad	AAABB01130
Amphibians	Bufo terrestris	Southern toad	AAABB01160
Amphibians	Cryptobranchus alleganiensis	Hellbender	AAAAC01010
Amphibians	Desmognathus aeneus	Seepage salamander	AAAAD03010
Amphibians	Desmognathus apalachicolae	Apalachicola dusky salamander	AAAAD03120
Amphibians	Desmognathus auriculatus	Southern dusky salamander	AAAAD03020
Amphibians	Desmognathus conanti	Spotted dusky salamander	AAAAD03040
Amphibians	Desmognathus folkertsi	Dwarf blackbelly salamander	DESMOGFOLK
Amphibians	Desmognathus marmoratus	Shovelnose salamander	AAAAD10010
Amphibians	Desmognathus monticola	Seal salamander	AAAAD03060
Amphibians	Desmognathus ocoee	Mountain dusky salamander	AAAAD03140
Amphibians	Desmognathus quadramaculatus	Blackbelly salamander	AAAAD03080
Amphibians	Eleutherodactylus planirostris	Greenhouse frog	AAABD04080
Amphibians	Eurycea aquatica	Brownback salamander	EURYCEAQUA
Amphibians	Eurycea cirrigera	Southern two-lined salamander	AAAAD05140
Amphibians	Eurycea guttolineata	Three-lined salamander	AAAAD05290
Amphibians	Eurycea longicauda	Long- tailed salamander	AAAAD05040
Amphibians	Eurycea lucifuga	Cave salamander	AAAAD05050
Amphibians	Eurycea quadridigitata	Dwarf salamander	AAAAD05090
Amphibians	Eurycea wilderae	Blue Ridge two-lined salamander	AAAAD05150
Amphibians	Gastrophryne carolinensis	Eastern narrowmouth toad	AAABE01010
Amphibians	Gyrinophilus palleucus	Tennessee cave salamander	AAAAD06010
Amphibians	Gyrinophilus porphyriticus	Spring salamander	AAAAD06020
Amphibians	Haideotriton wallacei	Georgia blind salamander	AAAAD07010
Amphibians	Hemidactylium scutatum	Four-toed salamander	AAAAD08010
Amphibians	Hyla avivoca	Bird-voiced Treefrog	AAABC02030
Amphibians	Hyla chrysoscelis	Cope's gray treefrog	AAABC02050
Amphibians	Hyla cinerea	Green treefrog	AAABC02060
Amphibians	Hyla femoralis	Pine woods treefrog	AAABC02090
Amphibians	Hyla gratiosa	Barking treefrog	AAABC02100
Amphibians	Hyla squirella	Squirrel treefrog	AAABC02120
Amphibians	Necturus alabamensis	Alabama waterdog	AAAAE01010

TAXA	SCI_ NAME	COM_NAME	ELCODE
Amphibians	Necturus maculosus	Mudpuppy	AAAAE01040
Amphibians	Necturus punctatus	Dwarf waterdog	AAAAE01050
Amphibians	Notophthalmus perstriatus	Striped newt	AAAAF01020
Amphibians	Notophthalmus viridescens	Red-spotted/Central newt	AAAAF01030
Amphibians	Plethodon dorsalis	Zigzag salamander	AAAAD12030
Amphibians	Plethodon glutinosus complex	Slimy salamander complex	AAAAD12070
Amphibians	Plethodon jordani	Jordan's salamander	AAAAD12090
Amphibians	Plethodon petraeus	Pigeon Mountain salamander	AAAAD12310
Amphibians	Plethodon serratus	Southern redback salamander	AAAAD12160
Amphibians	Plethodon teyahalee (oconaluftee)	Southern Appalacian salamander	AAAAD12300
Amphibians	Plethodon websteri	Webster's salamander	AAAAD12210
Amphibians	Pseudacris brachyphona	Mountain chorus frog	AAABC05010
Amphibians	Pseudacris brimleyi	Brimley's chorus frog	AAABC05020
Amphibians	Pseudacris crucifer	Spring peeper	AAABC05090
Amphibians	Pseudacris feriarum	Upland chorus frog	AAABC05070
Amphibians	Pseudacris nigrita	Southern chorus frog	AAABC05040
Amphibians	Pseudacris ocularis	Little grass frog	AAABC05110
Amphibians	Pseudacris ornata	Ornate chorus frog	AAABC05050
Amphibians	Pseudobranchus striatus	Dwarf siren	AAAAG01010
Amphibians	Pseudotriton montanus	Mud salamander	AAAAD13010
Amphibians	Pseudotriton ruber	Red salamander	AAAAD13020
Amphibians	Rana capito	Gopher frog	AAABH01270
Amphibians	Rana catesbeiana	Bullfrog	AAABH01070
Amphibians	Rana clamitans	Green frog/bronze frog	AAABH01090
Amphibians	Rana grylio	Pig frog	AAABH01110
Amphibians	Rana heckscheri	River frog	AAABH01120
Amphibians	Rana palustris	Pickerel frog	AAABH01160
Amphibians	Rana sphenocephala	Southern leopard frog	AAABH01220
Amphibians	Rana sylvatica	Wood frog	AAABH01200
Amphibians	Rana virgatipes	Carpenter frog	AAABH01230
Amphibians	Scaphiopus holbrookii	Eastern spadefoot toad	AAABF01040
Amphibians	Siren intermedia	Lesser siren	AAAAG02010
Amphibians	Siren lacertina	Greater siren	AAAAG02020
Amphibians	Stereochilus marginatus	Many-lined salamander	AAAAD14010
Birds	Accipiter cooperii	Coopers hawk	ABNKC12040
Birds	Accipiter striatus	Sharp-shinned hawk	ABNKC12020
Birds	Agelaius phoeniceus	Red-winged blackbird	ABPBXB0010
Birds	Aimophila aestivalis	Bachmans sparrow	ABPBX91050
Birds	Aix sponsa	Wood duck	ABNJB09010
Birds	Ammodramus maritimus	Seaside sparrow	ABPBXA0060
Birds	Ammodramus savannarum	Grasshopper sparrow	ABPBXA0020
Birds	Anas platyrhynchos	Mallard	ABNJB10060
Birds	Anhinga anhinga	Anhinga	ABNFE01010
Birds	Archilochus colubris	Ruby-throated hummingbird	ABNUC45010
Birds	Ardea alba	Great egret	ABNGA04040
Birds	Ardea herodias	Great blue heron	ABNGA04010

TAXA	SCI_ NAME	COM_NAME	ELCODE
Birds	Baeolophus bicolor	Tufted titmouse	ABPAW01110
Birds	Bombycilla cedrorum	Cedar waxwing	ABPBN01020
Birds	Bonasa umbellus	Ruffed grouse	ABNLC11010
Birds	Branta canadensis	Canada goose	ABPBX16030
Birds	Bubo virginianus	Great horned owl	ABNSB05010
Birds	Bubulcus ibis	Cattle egret	ABNGA07010
Birds	Buteo jamaicensis	Red-tailed hawk	ABNKC19110
Birds	Buteo lineatus	Red-shouldered hawk	ABNKC19030
Birds	Buteo platypterus	Broad-winged hawk	ABNKC19050
Birds	Butorides striatus	Green heron	ABNGA08010
Birds	Caprimulgus carolinensis	Chuck-wills-widow	ABNTA07010
Birds	Caprimulgus vociferus	Whip-poor-will	ABNTA07070
Birds	Cardinalis cardinalis	Northern cardinal	ABPBX60010
Birds	Carduelis tristis	American goldfinch	ABPBY06110
Birds	Carpodacus mexicanus	House finch	ABPBY04040
Birds	Cathartes aura	Turkey vulture	ABNKA02010
Birds	Catharus fuscescens	Veery	ABPBJ18080
Birds	Catoptrophorus semipalmatus	Willet	ABNNF02010
Birds	Ceryle alcyon	Belted kingfisher	ABNXD01020
Birds	Chaetura pelagica	Chimney swift	ABNUA03010
Birds	Charadrius vociferus	Killdeer	ABNNB03090
Birds	Charadrius wilsonia	Wilsons plover	ABNNB03040
Birds	Chordeiles minor	Common nighthawk	ABNTA02020
Birds	Cistothorus palustris	Marsh wren	ABPBG10020
Birds	Coccyzus americanus	Yellow-billed cuckoo	ABNRB02020
Birds	Colaptes auratus	Northern flicker	ABNYF10020
Birds	Colinus virginianus	Northern bobwhite	ABNLC21020
Birds	Columba livia	Rock dove	ABNPB01010
Birds	Columbina passerina	Common ground-dove	ABNPB06020
Birds	Contopus virens	Eastern wood-pewee	ABPAE32060
Birds	Coragyps atratus	Black vulture	ABNKA01010
Birds	Corvus brachyrhynchos	American crow	ABPAV10010
Birds	Corvus corax	Common raven	ABPAV10110
Birds	Corvus ossifragus	Fish crow	ABPAV10080
Birds	Cyanocitta cristata	Blue jay	ABPAV02020
Birds	Dendroica caerulescens	Black-throated green warbler	ABPBX03100
Birds	Dendroica cerulea	Cerulean warbler	ABPBX03240
Birds	Dendroica discolor	Prairie warbler	ABPBX03190
Birds	Dendroica dominica	Yellow-throated warbler	ABPBX03130
Birds	Dendroica fusca	Black-throated blue warbler	ABPBX03050
Birds	Dendroica pensylvanica	Chestnut-sided warbler	ABPBX03020
Birds	Dendroica petechia	Yellow warbler	ABPBX03010
Birds	Dendroica pinus	Pine warbler	ABPBX03170
Birds	Dendroica virens	Blackburnian warbler	ABPBX03120
Birds	Dryocopus pileatus	Pileated woodpecker	ABNYF12020
Birds	Dumetella carolinensis	Gray catbird	ABPBK01010

TAXA	SCI_ NAME	COM_NAME	ELCODE
Birds	Egretta caerulea	Little blue heron	ABNGA06040
Birds	Egretta thula	Snowy egret	ABNGA06030
Birds	Egretta tricolor	Tricolored heron	ABNGA06050
Birds	Elanoides forficatus	Swallow-tailed kite	ABNKC04010
Birds	Empidonax minimus	Least flycatcher	ABPAE33070
Birds	Empidonax traillii	Willow flycatcher	ABPAE33040
Birds	Empidonax virescens	Acadian flycatcher	ABPAE33020
Birds	Eremophila alpestris	Horned lark	ABPAT02010
Birds	Eudocimus albus	White ibis	ABNGE01010
Birds	Falco peregrinus	Peregrine falcon	ABNKD06070
Birds	Falco sparverius	American kestrel	ABNKD06020
Birds	Gallinula chloropus	Common moorhen	ABNME13010
Birds	Geothlypis trichas	Common yellowthroat	ABPBX12010
Birds	Grus canadensis	Sandhill crane	ABNMK01010
Birds	Guiraca caerulea	Blue grosbeak	ABPBX63010
Birds	Haematopus palliatus	Ameriacan oystercatcher	ABNNC01010
Birds	Haliaeetus leucocephalus	Bald eagle	ABNKC10010
Birds	Helmitheros vermivorus	Worm-eating warbler	ABPBX08010
Birds	Himantopus mexicanus	Black-necked stilt	ABNND01010
Birds	Hirundo rustica	Barn swallow	ABPAU09030
Birds	Hylocichla mustelina	Wood thrush	ABPBJ19010
Birds	Icteria virens	Yellow-breasted chat	ABPBX24010
Birds	Icterus spurius	Orchard oriole	ABPBXB9070
Birds	Ictinia mississippiensis	Mississippi kite	ABNKC09010
Birds	Ixobrychus exilis	Least bittern	ABNGA02010
Birds	Junco hyemalis	Dark-eyed junco	ABPBXA5020
Birds	Lanius ludovicianus	Loggerhead shrike	ABPBR01030
Birds	Larus atricilla	Laughing gull	ABNNM03010
Birds	Limnothlypis swainsonii	Swainsons warbler	ABPBX09010
Birds	Loxia curvirostra	Red crossbill	ABPBY05010
Birds	Melanerpes carolinus	Red-bellied woodpecker	ABNYF04170
Birds	Melanerpes erythrocephalus	Red-headed woodpecker	ABNYF04040
Birds	Meleagris gallopavo	Wild turkey	ABNLC14010
Birds	Melospiza melodia	Song sparrow	ABPBXA3010
Birds	Mimus polyglottos	Northern mockingbird	ABPBK03010
Birds	Mniotilta varia	Black-and-white warbler	ABPBX05010
Birds	Molothrus ater	Brown-headed cowbird	ABPBXB7030
Birds	Mycteria americana	Wood stork	ABNGF02010
Birds	Myiarchus crinitus	Great crested flycatcher	ABPAE43070
Birds	Nyctanassa violacea	Yellow-crowned night-heron	ABNGA13010
Birds	Nycticorax nycticorax	Black-crowned night-heron	ABNGA11010
Birds	Oporornis formosus	Kentucky warbler	ABPBX11010
Birds	Otus asio	Eastern screech-owl	ABNSB01030
Birds	Pandion haliaetus	Osprey	ABNKC01010
Birds	Parula americana	Northern parula	ABPBX02010
Birds	Passer domesticus	House sparrow	ABPBZ01010

TAXA	SCI_ NAME	COM_NAME	ELCODE
Birds	Passerina ciris	Painted bunting	ABPBX64060
Birds	Passerina cyanea	Indigo bunting	ABPBX64030
Birds	Pelecanus occidentalis	Brown pelican	ABNFC01020
Birds	Petrochelidon pyrrhonota	Cliff swallow	ABPAU09010
Birds	Pheucticus ludovicianus	Rose-breasted grosbeak	ABPBX61030
Birds	Picoides borealis	Red-cockaded woodpecker	ABNYF07060
Birds	Picoides pubescens	Downy woodpecker	ABNYF07030
Birds	Picoides villosus	Hairy woodpecker	ABNYF07040
Birds	Pipilo erythrophthalmus	Eastern towhee	ABPBX74030
Birds	Piranga olivacea	Scarlet tanager	ABPBX45040
Birds	Piranga rubra	Summer tanager	ABPBX45030
Birds	Plegadis falcinellus	Glossy ibis	ABNGE02010
Birds	Podilymbus podiceps	Pied-billed grebe	ABNCA02010
Birds	Poecile carolinensis	Carolina chickadee	ABPAW01020
Birds	Polioptila caerulea	Blue-gray gnatcatcher	ABPBJ08010
Birds	Porphyrula martinica	Purple gallinule	ABNME12010
Birds	Progne subis	Purple martin	ABPAU01010
Birds	Protonotaria citrea	Prothonotary warbler	ABPBX07010
Birds	Quiscalus major	Boat-tailed grackle	ABPBXB6060
Birds	Quiscalus quiscula	Common grackle	ABPBXB6070
Birds	Rallus elegans	King rail	ABNME05020
Birds	Rallus limicola	Virginia rail	ABNME05030
Birds	Rallus longirostris	Clapper rail	ABNME05010
Birds	Rynchops niger	Black skimmer	ABNNM14010
Birds	Sayornis phoebe	Eastern phoebe	ABPAE35020
Birds	Scolopax minor	American woodcock	ABNNF19020
Birds	Seiurus aurocapillus	Ovenbird	ABPBX10010
Birds	Seiurus motacilla	Louisiana waterthrush	ABPBX10030
Birds	Setophaga ruticilla	American redstart	ABPBX06010
Birds	Sialia sialis	Eastern bluebird	ABPBJ15010
Birds	Sitta canadensis	Red-breasted nuthatch	ABPAZ01010
Birds	Sitta carolinensis	White-breasted nuthatch	ABPAZ01020
Birds	Sitta pusilla	Brown-headed nuthatch	ABPAZ01040
Birds	Spiza americana	Dickcissel	ABPBX65010
Birds	Spizella passerina	Chipping sparrow	ABPBX94020
Birds	Spizella pusilla	Field sparrow	ABPBX94050
Birds	Stelgidopteryx serripennis	Northern rough-winged swallow	ABPAU07010
Birds	Sterna antillarum	Least tern	ABNNM08100
Birds	Sterna maxima	Royal tern	ABNNM08030
Birds	Sterna nilotica	Gull-billed tern	ABNNM08010
Birds	Sterna sandvicensis	Sandwich tern	ABNNM08050
Birds	Streptopelia decaocto	Eurasian collared-dove	ABNPB02030
Birds	Strix varia	Barred owl	ABNSB12020
Birds	Sturnella magna	Eastern meadowlark	ABPBXB2020
Birds	Sturnus vulgaris	European starling	ABPBT01010
Birds	Tachycineta bicolor	Tree swallow	ABPAU03010

TAXA	SCI_ NAME	COM_NAME	ELCODE
Birds	Thryothorus ludovicianus	Carolina wren	ABPBG06130
Birds	Toxostoma rufum	Brown thrasher	ABPBK06010
Birds	Troglodytes aedon	House wren	ABPBG09010
Birds	Troglodytes troglodytes	Winter wren	ABPBG09050
Birds	Turdus migratorius	American robin	ABPBJ20170
Birds	Tyrannus dominicensis	Gray kingbird	ABPAE52070
Birds	Tyrannus tyrannus	Eastern kingbird	ABPAE52060
Birds	Tyto alba	Common barn-owl	ABNSA01010
Birds	Vermivora chrysoptera	Golden-winged warbler	ABPBX01030
Birds	Vermivora pinus	Blue-winged warbler	ABPBX01020
Birds	Vireo flavifrons	Yellow-throated vireo	ABPBW01170
Birds	Vireo griseus	White-eyed vireo	ABPBW01020
Birds	Vireo olivaceus	Red-eyed vireo	ABPBW01240
Birds	Vireo solitarius	Solitary vireo	ABPBW01160
Birds	Wilsonia canadensis	Canada warbler	ABPBX16030
Birds	Wilsonia citrina	Hooded warbler	ABPBX16010
Birds	Zenaida macroura	Mourning dove	ABNPB04040
Mammals	Blarina brevicauda	Northern short-tailed shrew	AMABA03010
Mammals	Blarina carolinensis	Southern short-tailed shrew	AMABA03020
Mammals	Canis latrans	Coyote	AMAJA01010
Mammals	Castor canadensis	American beaver	AMAFE01010
Mammals	Clethrionomys gapperi	Southern red-backed vole	AMAFF09020
Mammals	Condylura cristata	Star-nosed mole	AMABB05010
Mammals	Corynorhinus rafinesquii	Rafinesque's big-eared bat	AMACC08020
Mammals	Cryptotis parva	Least shrew	AMABA04010
Mammals	Dasypus novemcinctus	Nine-banded armadillo	AMADA01010
Mammals	Didelphis virginiana	Virginia opossum	AMAAA01010
Mammals	Eptesicus fuscus	Big brown bat	AMACC04010
Mammals	Equus caballus	Horse	AMATA01010
Mammals	Geomys pinetis	Southeastern pocket gopher	AMAFC02040
Mammals	Glaucomys volans	Southern flying squirrel	AMAFB09010
Mammals	Lasionycteris noctivagans	Silver-haired bat	AMACC02010
Mammals	Lasiurus borealis	Eastern red bat	AMACC05010
Mammals	Lasiurus cinereus	Hoary bat	AMACC05030
Mammals	Lasiurus intermedius	Northern yellow bat	AMACC05040
Mammals	Lasiurus seminolus	Seminole bat	AMACC05020
Mammals	Lutra canadensis	Northern river otter	AMAJF08010
Mammals	Lynx rufus	Bobcat	AMAJH03020
Mammals	Marmota monax	Woodchuck	AMAFB03010
Mammals	Mephitis mephitis	Striped skunk	AMAJF06010
Mammals	Microtus pennsylvanicus	Meadow vole	AMAFF11010
Mammals	Microtus pinetorum	Woodland vole	AMAFF11150
Mammals	Mus musculus	House mouse	AMAFF22010
Mammals	Mustela frenata	Long-tailed weasel	AMAJF02030
Mammals	Mustela nivalis	Least weasel	AMAJF02020
Mammals	Mustela vison	Mink	AMAJF02050

TAXA	SCI_ NAME	COM_NAME	ELCODE
Mammals	Myocastor coypus	Nutria	AMAFK01010
Mammals	Myotis austroriparius	Southeastern myotis	AMACC01030
Mammals	Myotis grisescens	Gray myotis	AMACC01040
Mammals	Myotis leibii	Eastern small-footed myotis	AMACC01130
Mammals	Myotis lucifugus	Little brown myotis	AMACC01010
Mammals	Myotis septentrionalis	Northern myotis	AMACC01150
Mammals	Myotis sodalis	Indiana bat	AMACC01100
Mammals	Napaeozapus insignis	Woodland jumping mouse	AMAFH02010
Mammals	Neofiber alleni	Round-tailed muskrat	AMAFF14010
Mammals	Neotoma floridana	Eastern woodrat	AMAFF08010
Mammals	Nycticeius humeralis	Evening bat	AMACC06010
Mammals	Ochrotomys nuttalli	Golden mouse	AMAFF04010
Mammals	Odocoileus virginianus	White-tailed deer	AMALC02020
Mammals	Ondatra zibethicus	Muskrat	AMAFF15010
Mammals	Oryzomys palustris	Marsh rice rat	AMAFF01010
Mammals	Parascalops breweri	Hairytail mole	AMABB03010
Mammals	Peromyscus gossypinus	Cotton mouse	AMAFF03080
Mammals	Peromyscus leucopus	White-footed mouse	AMAFF03070
Mammals	Peromyscus maniculatus	Deer mouse	AMAFF03040
Mammals	Peromyscus polionotus	Oldfield mouse	AMAFF03060
Mammals	Pipistrellus subflavus	Eastern pipistrelle	AMACC03020
Mammals	Procyon lotor	Common raccoon	AMAJE02010
Mammals	Rattus norvegicus	Norway rat	AMAFF21020
Mammals	Rattus rattus	Black rat	AMAFF21010
Mammals	Reithrodontomys humulis	Eastern harvest mouse	AMAFF02020
Mammals	Scalopus aquaticus	Eastern mole	AMABB04010
Mammals	Sciurus carolinensis	Eastern gray squirrel	AMAFB07010
Mammals	Sciurus niger	Eastern fox squirrel	AMAFB07040
Mammals	Sigmodon hispidus	Hispid cotton rat	AMAFF07010
Mammals	Sorex cinereus	Masked shrew	AMABA01010
Mammals	Sorex dispar	Longtail shrew	AMABA01210
Mammals	Sorex fumeus	Smoky shrew	AMABA01180
Mammals	Sorex hoyi	Pygmy shrew	AMABA01250
Mammals	Sorex longirostris	Southeastern shrew	AMABA01060
Mammals	Sorex palustris	Water shrew	AMABA01150
Mammals	Spilogale putorius	Eastern spotted skunk	AMAJF05010
Mammals	Sus scrofa	Wild pig	AMALA01010
Mammals	Sylvilagus aquaticus	Swamp rabbit	AMAEB01080
Mammals	Sylvilagus floridanus	Eastern cottontail	AMAEB01040
Mammals	Sylvilagus palustris	Marsh rabbit	AMAEB01030
Mammals	Sylvilagus transitionalis (obscurus)	New England (Appalachian) cottontail	AMAEB01050
Mammals	Synaptomys cooperi	Southern bog lemming	AMAFF17010
Mammals	Tadarida brasiliensis	Brazilian free-tailed bat	AMACD01010
Mammals	Tamias striatus	Eastern chipmunk	AMAFB02230
Mammals	Tamiasciurus hudsonicus	Red squirrel	AMAFB08010
Mammals	Urocyon cinereoargenteus	Common gray fox	AMAJA04010

TAXA	SCI_ NAME	COM_NAME	ELCODE
Mammals	Ursus americanus	Black bear	AMAJB01010
Mammals	Vulpes vulpes	Red fox	AMAJA03010
Mammals	Zapus hudsonius	Meadow jumping mouse	AMAFH01010
Reptiles	Agkistrodon contortrix	Copperhead	ARADE01010
Reptiles	Agkistrodon piscivorus	Cottonmouth	ARADE01020
Reptiles	Alligator mississippiensis	American alligator	ARABA01010
Reptiles	Anolis carolinensis	Green anole	ARACF01010
Reptiles	Anolis sagrei	Brown anole	ARACF01060
Reptiles	Apalone ferox	Florida softshell	ARAAG01010
Reptiles	Apalone spinifera	Spiny softshell	ARAAG01030
Reptiles	Caretta caretta	Loggerhead	ARAAA01010
Reptiles	Carphophis amoenus	Worm snake	ARADB02010
Reptiles	Cemophora coccinea	Scarlet snakae	ARADB03010
Reptiles	Chelydra serpentina	Snapping turtle	ARAAB01010
Reptiles	Chrysemys picta	Painted turtle	ARAAD01010
Reptiles	Clemmys guttata	Spotted turtle	ARAAD02010
Reptiles	Clemmys muhlenbergii	Bog turtle	ARAAD02040
Reptiles	Cnemidophorus sexlineatus	Six-lined racerunner	ARACJ02110
Reptiles	Coluber constrictor	Black racer	ARADB07010
Reptiles	Crotalus adamanteus	Eastern diamondback rattlesnake	ARADE02010
Reptiles	Crotalus horridus	Canebrake/timber rattlesnake	ARADE02040
Reptiles	Deirochelys reticularia	Chicken turtle	ARAAD03010
Reptiles	Diadophis punctatus	Ringneck snake	ARADB10010
Reptiles	Drymarchon corais	Indigo snake	ARADB11010
Reptiles	Elaphe guttata	Corn snake	ARADB13020
Reptiles	Elaphe obsoleta	Yellow/black/gray rat snake	ARADB13030
Reptiles	Eumeces anthracinus	Coal skink	ARACH01010
Reptiles	Eumeces egregius	Mole skink	ARACH01040
Reptiles	Eumeces fasciatus	Five-lined skink	ARACH01050
Reptiles	Eumeces inexpectatus	Southeastern five-lined skink	ARACH01070
Reptiles	Eumeces laticeps	Broadhead skink	ARACH01080
Reptiles	Farancia abacura	Mud snake	ARADB14010
Reptiles	Farancia erytrogramma	Rainbow snake	ARADB14020
Reptiles	Gopherus polyphemus	Gopher tortoise	ARAAF01030
Reptiles	Graptemys barbouri	Barbour's map turtle	ARAAD05010
Reptiles	Graptemys geographica	Common map turtle	ARAAD05040
Reptiles	Graptemys pulchra	Alabama map turtle	ARAAD05090
Reptiles	Hemidactylus turcicus	Mediterranean gecko	ARACD03020
Reptiles	Heterodon platirhinos	Eastern hognose snake	ARADB17020
Reptiles	Heterodon simus	Southern hognose snake	ARADB17030
Reptiles	Kinosternon baurii	Striped mud turtle	ARAAE01010
Reptiles	Kinosternon subrubrum	Eastern mud turtle	ARAAE01050
Reptiles	Lampropeltis calligaster	Mole kingsnake	ARADB19010
Reptiles	Lampropeltis elapsoides	Scarlet kingsnake	ARADB19054
Reptiles	Lampropeltis getula	Black/eastern kingsnake	ARADB19020
Reptiles	Lampropeltis triangulum	Milk snake	ARADB19050

TAXA	SCI_ NAME	COM_NAME	ELCODE
Reptiles	Macroclemys temminckii	Alligator snapping turtle	ARAAB02010
Reptiles	Malaclemys terrapin	Diamondback terrapin	ARAAD06010
Reptiles	Masticophis flagellum	Coachwhip	ARADB21020
Reptiles	Micrurus fulvius	Coral snake	ARADC02010
Reptiles	Nerodia erythrogaster	Redbelly/yellowbelly water snake	ARADB22020
Reptiles	Nerodia fasciata	Banded water snake	ARADB22030
Reptiles	Nerodia floridana	Florida green water snake	ARADB22080
Reptiles	Nerodia sipedon	Midland water snake	ARADB22060
Reptiles	Nerodia taxispilota	Brown water snake	ARADB22070
Reptiles	Opheodrys aestivus	Rough green snake	ARADB23010
Reptiles	Ophisaurus attenuatus	Slender glass lizard	ARACB02010
Reptiles	Ophisaurus compressus	Island glass lizard	ARACB02020
Reptiles	Ophisaurus mimicus	Mimic glass lizard	ARACB02040
Reptiles	Ophisaurus ventralis	Eastern glass lizard	ARACB02030
Reptiles	Pituophis melanoleucus	Pine snake	ARADB26010
Reptiles	Pseudemys concinna	River cooter	ARAAD07020
Reptiles	Pseudemys floridana	Florida cooter	ARAAD07030
Reptiles	Pseudemys nelsoni	Florida redbelly turtle	ARAAD07040
Reptiles	Regina alleni	Striped crayfish snake	ARADB27010
Reptiles	Regina rigida	Glossy crayfish snake	ARADB27030
Reptiles	Regina septemvittata	Queen snake	ARADB27040
Reptiles	Rhadinaea flavilata	Pine woods snake	ARADB28010
Reptiles	Rhineura floridana	Florida worm lizard	ARACA01010
Reptiles	Sceloporus undulatus	Fence lizard	ARACF14130
Reptiles	Scincella lateralis	Ground skink	ARACH03010
Reptiles	Seminatrix pygaea	Black swamp snake	ARADB31010
Reptiles	Sistrurus miliarius	Pigmy rattlesnake	ARADE03020
Reptiles	Sternotherus minor	Stripeneck/loggerhead musk turtle	ARAAE02030
Reptiles	Sternotherus odoratus	Common musk turtle	ARAAE02040
Reptiles	Storeria dekayi	Brown snake	ARADB34010
Reptiles	Storeria occipitomaculata	Red-bellied snake	ARADB34030
Reptiles	Tantilla coronata	Southeastern crowned snake	ARADB35020
Reptiles	Tantilla relicta	Central Florida crowned snake	ARADB35080
Reptiles	Terrapene carolina	Box turtle	ARAAD08010
Reptiles	Thamnophis sauritus	Ribbon snake	ARADB36120
Reptiles	Thamnophis sirtalis	Eastern garter snake	ARADB36130
Reptiles	Trachemys scripta	Slider	ARAAD09010
Reptiles	Virginia striatula	Rough earth snake	ARADB39010
Reptiles	Virginia valeriae	Smooth earth snake	ARADB39020

Appendix D - List of Reviewers and Other Contributors to Vertebrate Models

Birds	
Giff Beaton	Georgia Ornithological Society
Malcolm Hodges	The Nature Conservancy
Eddie Morris	Chattahoochee National Forest
Todd Schneider	Georgia Department of Natural Resources
E.J. Williams	Georgia Department of Natural Resources
Brad Winn	Georgia Department of Natural Resources
Reptiles and Amphibians	
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Mark Dodd	Georgia Department of Natural Resources
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John Jensen	Georgia Department of Natural Resources
Liz McGhee	Georgia Museum of Natural History
Bruce Means	Coastal Plains Institute
Paul Moler	Florida Fish and Wildlife Conservation Commission
Bobby Moulis	Savannah-Ogeechee Canal Museum
Dirk Stevenson	Fort Stewart
Mammals	
Wes Abler	Georgia Department of Natural Resources
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Mary Bunch	South Carolina Department of Natural Resources
Stephen Castleberry	University of Georgia
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Liz McGhee	Georgia Museum of Natural History
Nick Nicholson	Georgia Department of Natural Resources
Dirk Stevenson	Fort Stewart

Appendix E - Vertebrate Species Habitat Affinities and Models

Amphibians
Alabama Waterdog, *Necturus alabamensis*, AAAAE01010, G2, S2

Habitat and distribution: Alabama waterdogs may be found in watersheds in the western part of Georgia. They are fully aquatic, and are most often found in medium-sized to large streams in locations that have abundant hiding places of rocks, sunken logs, or other debris.

Model: Kept all rasterized 1:100, 000 streams, as well as clumps of habitat 11 < 100 ha. Clipped by digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Jensen and Moulis 1999, Mount 1975, Neill 1963, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

American Toad, *Bufo americanus*, AAABB01020, G5, S5

Habitat and distribution: American toads are common residents of Georgia mainly north of the Fall Line. They are adaptable in their habitat requirements and may be found in forests, floodplains, and suburban areas. They require shallow bodies of water for breeding, and moist hiding places such as leaf litter, rocks, or logs for daytime shelter.

Model: Applied 90 meter buffer to 1:24, 000 stream coverage and 120 meter buffer to National Wetlands Inventory (NWI) freshwater wetlands. Kept habitats 22, 72, 73, 80, 201, 202, and 203 within buffers. Kept habitats 11 (shallow freshwater only), 410, 411, 412, 414, 415, 422, 424, 425, 431, 433, 434, 440, 900, 930, and 980 in all cases. Clipped by digitized range.

References: Barbour 1971, Conant and Collins 1998, Huheey and Stupka 1967, Jensen and Moulis 1999, Kolozsvary and Swihart 1999, Lacy 1997, Martof et al. 1980, Mount 1975, Petranka et al. 1994, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Apalachicola Dusky Salamander, *Desmognathus apalachicolae*, AAAAD03120, G3, S2

Habitat and distribution: Apalachicola dusky salamanders are known in Georgia from drainages of the Chattahoochee and Ochlockonee rivers in the southwestern part of the state. They are most numerous in forested, steep-sided ravines with permanent seepages.

Model: Created flowaccumulation grid from Digital Elevation Model (DEM). Kept pixels where flowaccumulation values were between 45 and 10, 000. Used resultant grid as a mask for habitats 412 and 900. Clipped by digitized range.

References: Bartlett and Bartlett 1999, Conant and Collins 1998, Means 1993, Means and Karlin 1989, Petranka 1998, Wilson 1995

Barking Treefrog, *Hyla gratiosa*, AAABC02100, G5, S5

Habitat and distribution: Chiefly associated with swampy forested areas, barking treefrogs are relatively widespread in the Coastal Plain and Ridge and Valley sections of Georgia. Habitats include cypress swamps, pine savannas and flatwoods, and hardwood forest with willow oak and blackgum.

Model: Habitats 11 (shallow freshwater only), 20, 31, 420, 422, 434, 440, 441, 512, 620, 890, 900, 980, and 990 within digitized range.

References: Ashton and Ashton 1988, Caldwell 1982, Conant and Collins 1998, Defauw and Kinsey 1994, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Bird-voiced Treefrog, *Hyla avivoca*, AAABC02030, G5, S4

Habitat and distribution: Residents of wooded, swampy habitats, bird-voiced treefrogs occur in Georgia along the edges of tupelo-cypress swamps, in floodplains, and in other damp forested areas, almost always very near water.

Model: Habitats 890 and 900 within digitized range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Neill 1948, Smith 1966, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Blackbelly Salamander, *Desmognathus quadramaculatus*, AAAAD03080, G5, S5

Habitat and distribution: Abundant in the Blue Ridge of Georgia, blackbelly salamanders may be observed in or along the banks of rocky, swift-moving streams, normally within forested conditions. They are typically found in or near flowing water, and may be common near cascades or waterfalls.

Model: From flowaccumulation grid, kept pixels where values were between 50 and 40, 000 at elevations > 548 m, and between 50 and 10, 000 at elevations < 548 m. Used resultant grid as mask for habitats 410, 411, 413, 414, 424, 425, 431, 432, 433, and 434. Clipped by digitized range.

References: Camp and Lee 1996, Camp and Lovell 1989, Conant and Collins 1998, Davic and Orr 1987, Hairston 1949, Hairston 1986, Martof et al. 1980, Organ 1961, Petranka 1998, Petranka et al. 1994, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Blue Ridge Two-lined Salamander, *Eurycea wilderae*, AAAAD05150, G5, S3S4

Habitat and distribution: Restricted to the Blue Ridge and Piedmont foothills, adult Blue Ridge two-lined salamanders may be found in and around small streams during the breeding season. The aquatic larval stage remains in streams, while adults migrate into surrounding deciduous or mixed forests after breeding.

Model: Kept habitats 410, 414, 415, 424, and 433 in all cases. From flowaccumulation grid, created stream grid based on minimum values in different precipitation zones. Where annual precipitation is between 80 and 100 inches, minimum value for stream is 25. Where precipitation is between 60 and 80, minimum value for stream

is 35. Where precipitation is < 60, minimum value for stream is 45. Used maximum value of 10, 000 in all cases. Used resultant grid as mask for habitats 411, 425, 431, 432, and 434. Clipped by digitized range.

References: Camp et al. 2000, Conant and Collins 1998, Jacobs 1987, Martof et al. 1980, Petranka 1998, Sever 1999, Thompson 1982, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Brimley's Chorus Frog, *Pseudacris brimleyi* , AAABC05020, G5, S2

Habitat and distribution: Occurring in Georgia chiefly in the Savannah and Ogeechee River Drainages, Brimley's chorus frogs are inhabitants of cypress-tupelo swamps and bottomland hardwood forests.

Model: Kept habitats 11 (shallow freshwater only), 890, 900, and 980. Kept habitats 20 and 31 where they intersect with NWI freshwater wetlands. Clipped by digitized range.

References: Conant and Collins 1998, Gosner and Black 1958, Hoffman 1983, Martof et al. 1980, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Brownback Salamander, *Eurycea aquatica*, No elcode (temp. elcode EURYCEAQUA), G2Q, SU

Habitat and distribution: Occupying a limited geographic range, brownback salamanders are known in Georgia only from the Ridge and Valley physiographic province, where they sometimes occur in moist hardwood forests or in bottomland hardwoods, usually near flowing water. Their status as a species distinct from the Southern two-lined salamander is in question.

Model: From flowaccumulation grid, kept pixels where values were between 45 and 10, 000. Used resultant grid as mask for habitats 410, 411, 434, 900, and 980. Clipped by digitized range.

References: Conant and Collins 1998, Jacobs 1987, Mount 1975, Petranka 1998, Rose and Bush 1963, Sever 1999, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Bullfrog, *Rana catesbeiana*, AAABH01070, G5, S5

Habitat and distribution: Widespread in the eastern U.S., bullfrogs occur throughout Georgia in aquatic habitats. They need relatively permanent bodies of water for breeding, and may be found in lakes, ponds, and medium to large-sized streams.

Model: Applied 90 meter buffer to habitat 11 (shallow freshwater only). Kept habitats 7, 20, 22, 31, 33, 72, 73, 80, 201, 202, 203, 410, 411, 412, 414, 420, 422, 424, 425, 431, 433, 434, 440, 441, 512, 513, and 620 within buffer. Kept habitats 11 (shallow freshwater only), 890, 900, 930, 980, and 990 in all cases. Statewide range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Carpenter Frog, *Rana virgatipes*, AAABH01230, G5, S3

Habitat and distribution: Chiefly occupants of Atlantic Coast drainages, carpenter frogs occur in Georgia in the lower Coastal Plain. These aquatic frogs are most often associated with the acid, coffee-colored water of sphagnum bogs and cypress ponds.

Model: Kept habitats 890, 900, 930, and 990. Kept habitat 31 where it intersects with NWI freshwater wetlands. Clipped by digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Gosner and Black 1968, Martof et al. 1980, Neill 1952, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Cave Salamander, *Eurycea lucifuga*, AAAAD05050, G5, S3

Habitat and distribution: Restricted to limestone regions, cave salamanders are residents of the Ridge and Valley and Cumberland Plateau of Georgia. Although most often associated with caves, typically occurring around entrances, they are not restricted in their habitat, and may also be observed on moist limestone or occasionally sandstone outcrops and ledges in forested areas.

Model: Created grid of likely limestone bedrock from geologic map of Georgia. Used as mask for habitats 34, 410, 411, 414, 424, 433, and 434. Clipped by digitized range.

References: Conant and Collins 1998, Green et al. 1967, Hutchison 1966, Martof et al. 1980, Mount 1975, Neill 1957, Peck and Richardson 1976, Petranka 1998, Williams 1980, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Cope's Gray Treefrog, *Hyla chrysoscelis*, AAABC02050, G5, S5

Habitat and distribution: Widespread in the eastern U.S., Cope's gray treefrogs are found throughout Georgia, with the exception of the area immediately in and around the Okefenokee swamp. Grey treefrogs often inhabit hardwood or mixed pine-hardwood forests containing small ponds, roadside ditches or other standing water for breeding.

Model: Habitats 73, 201, 202, 203, 410, 411, 412, 414, 420, 422, 424, 425, 431, 433, 434, 440, 441, 620, 890, 900, 980, and 990 within digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Ritke et al. 1991, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Dwarf Blackbelly Salamander, *Desmognathus folkertsi*, No elcode or rankings (temp. elcode DESMOGFOLK)

Habitat and distribution: Apparently restricted to the Nottely River drainage in the Blue Ridge of Georgia, dwarf blackbelly salamanders occupy small rocky streams in the upper ends of watersheds.

Model: From flowaccumulation grid, kept pixels where values were between 50 and 10, 000. Used resultant grid as mask for habitats 410, 411, 414, 415, 424, 425, 431, and 433. Clipped by digitized range.

References: Camp et al. 2002

Dwarf Salamander, *Eurycea quadridigitata*, AAAAD05090, G5, S5

Habitat and distribution: Dwarf salamanders occur in Georgia south of the Fall Line in a variety of low, swampy habitats, where they may be observed at water's edge under leaf litter, logs or other shelter.

Model: Habitats 412, 890, 900, 980, and 990 within digitized range.

References: Carr and Goin 1959, Conant and Collins 1998, Folkerts 1971, Gibbons and Semlitsch 1991, Martof et al. 1980, Mittleman 1967, Mount 1975, Petranka 1998, Powders and Cate 1980, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Dwarf Siren, *Pseudobranchus striatus*, AAAAG01010, G5, S3

Habitat and distribution: These eel-like salamanders are inhabitants of the Coastal Plain of Georgia, occurring in shallow, acidic freshwater habitats such as cypress ponds. They may sometimes be encountered among roots of floating vegetation or in litter at the water's edge.

Model: Kept habitats 11 (shallow freshwater only), 890, 900, 930, 980, and 990. Kept habitat 31 where it intersects with NWI freshwater wetlands. Clipped by digitized range.

References: Conant and Collins 1998, Martof 1972, Martof et al. 1980, Moler and Kezer 1993, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Dwarf Waterdog, *Necturus punctatus*, AAAAE01050, G4, S2

Habitat and distribution: Associated chiefly with the Atlantic Coastal Plain, dwarf waterdogs occur in Georgia as far west as the Ocmulgee and Altamaha River drainages. These aquatic salamanders may be found in a variety of swampy habitats including slow-moving, blackwater streams and creeks, and tupelo-cypress or willow oak-blackgum swamps.

Model: Habitats 890 and 900 within digitized range.

References: Conant and Collins 1998, Folkerts 1971, Gibbons and Semlitsch 1991, Martof et al. 1980, Meffe and Sheldon 1987, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Eastern Narrowmouth Toad, *Gastrophryne carolinensis*, AAABE01010, G5, S5

Habitat and distribution: Eastern narrowmouth toads are found throughout Georgia, with the exception of the Blue Ridge. They may occur in a variety of situations that provide moisture and shelter. Suitable habitats include pinewoods, bottomland hardwoods, maritime forests and cypress swamps. They typically breed in aquatic habitats with shallow water.

Model: Applied 30 meter buffer to 1:24, 000 stream coverage and 120 meter buffer to NWI freshwater wetlands. Kept habitats 20, 22, 31, 72, 73, 80, and 201, 202, and 203 within buffers. Kept habitats 410, 411, 412, 414, 420, 433, 440, 441, 512, 620, 890, 900, 930, and 990 in all cases. Clipped by digitized range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Delis et al. 1996, Dodd and Cade 1998, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Eastern Spadefoot Toad, *Scaphiopus holbrookii*, AAABF01040, G5, S5

Habitat and distribution: Although they are less common north of the Fall Line, eastern spadefoot toads occur throughout Georgia in forested areas. Fossorial toads, they prefer areas with sandy soil in which they can burrow. Eastern spadefoot toads typically breed after heavy rains in temporary pools or ponds of rainwater.

Model: Habitats 410, 412, 420, 434, 440, 441, 620, and 900 within digitized range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Defauw and English 1994b, Delis et al. 1996, Gibbons and Semlitsch 1991, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Flatwoods Salamander, *Ambystoma cingulatum*, AAAAA01030, G2G3, S3

Habitat and distribution: In Georgia, flatwoods salamanders occur on the lower Coastal Plain, where they inhabit damp longleaf pine flatwoods usually having a ground cover of wire grass. Flatwoods salamanders breed in shallow, fishless ponds within or adjacent to longleaf areas.

Model: Applied 120 meter buffer to habitat 620. Eliminated from buffer areas within 30m of 1:24, 000 streams. Kept habitats 11 and 890 within buffer. Applied 120 meter buffer to suitable pixels of habitats 11 and 890. Kept habitat 620 within this buffer. Clipped by digitized range.

References: Anderson and Williamson 1976, Ashton 1992, Bury et al. 1980, Conant and Collins 1998, Jensen 1999, Martof 1968, Martof et al. 1980, Means et al. 1996, Mount 1975, Palis 1996, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Four-toed Salamander, *Hemidactylium scutatum*, AAAAD08010, G5, S2

Habitat and distribution: Four-toed salamanders may be observed in scattered locations throughout much of Georgia in swamps, bogs, or marshy areas within hardwood or mixed forest. Although terrestrial or fossorial as adults, four-toed salamanders are aquatic as larvae, and require a breeding habitat near water, preferably with sphagnum or other mosses present.

Model: Applied 90 meter buffer to mosaic of habitats 410, 411, 412, 414, 431, and 434. Kept habitat 900 within buffer. Applied 120 meter to suitable pixels of habitat 900. Kept habitats 410, 411, 412, 414, 431, and 434 within this buffer. Clipped by digitized range.

References: Camp and Jensen 2000, Conant and Collins 1998, Defauw and English 1994a, Herrington 1997, Martof 1955, Martof et al. 1980, Means 1992c, Mount 1975, Neill 1948, Neill 1963, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Fowler's Toad, *Bufo fowleri*, AAABB01180, G5, S5

Habitat and distribution: Widespread in the eastern U.S., Fowler's toads occur in Georgia as far south as the southern Coastal Plain. These adaptable toads may be present in many habitat types: hardwood, mixed or pine forests, farmlands, and in gardens and residential areas. Fowler's toads require a breeding habitat of small ponds, shallow areas in lakes or rivers, wet ditches or streams.

Model: Applied 30 meter buffer to 1:24, 000 stream coverage and 120 meter buffer to NWI freshwater wetlands. Kept habitats 22, 31, 72, 73, 80, 201, 202, and 203 within buffers. Kept habitats 410, 411, 412, 414, 422, 424, 425, 431, 433, 434, 440, 900, and 980 in all cases. Clipped by digitized range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Georgia Blind Salamander, *Haideotriton wallacei*, AAAAD07010, G2, S1
Habitat and distribution: Currently known from only a few caves in the Dougherty Plain region of Georgia and adjoining Florida, Georgia Blind Salamanders occur in a few counties in southwestern Georgia. These translucent salamanders are specialized in their habitat requirements, and are known to exist only in subterranean streams or pools within limestone caves.

Model: Habitats 412, 413, 432, 434, 440, 441, and 620 within digitized range. This overestimates habitat for this animal, but allows for its potential occurrence within karst features in a natural state throughout its range.

References: Brandon 1967, Bury et al. 1980, Conant and Collins 1998, Jensen 1999, Means 1992, Petranka 1998, Pylka and Warren 1958, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Gopher Frog, *Rana capito*, AAABH01270, G3G4, S3

Habitat and distribution: Gopher frogs occur in Georgia south of the Fall Line in sandhill and scrub oak habitats, such as sandy pine flatwoods or sandhills with pine and turkey oak. They are most frequently encountered near gum or cypress ponds within this habitat. Nocturnal and secretive, gopher frogs take cover by day in the burrows of gopher tortoises or crayfish, under logs, and in other hidden places that provide shelter.

Model: Using model for gopher tortoise (recoded habitats 512 and 620 to 1 and all else to 0; applied 3x3 moving window (FOCALMEAN using rectangle); kept areas where values were greater than .33; used results of this as a mask for suitable habitats 413, 432, 441, 512, and 620); expanded these areas 3 pixels), expanded suitable habitat 5 pixels. Kept habitats 890 and 930 within expanded area. Clipped by digitized range.

References: Ashton and Ashton 1988, Bailey 1991, Conant and Collins 1998, Conant and Collins 1998, Gibbons and Semlitsch 1991, Jensen and LaClaire 1995, Kent et al. 1997, Martof et al. 1980, Mount 1975, Palis and Fischer 1997, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Greater Siren, *Siren lacertian*, AAAAG02020, G5, S5

Habitat and distribution: These eel-like salamanders occur in Georgia south of the Fall Line. Most frequently encountered in muddy, weed-choked water, greater sirens may inhabit rivers or streams, cypress swamps, oxbows, ditches, rice fields, and other similar sites.

Model: Kept habitats 11 (shallow freshwater only), 890, 900, 930, 980, and 990. Kept habitat 31 where it intersects with NWI freshwater wetlands. Clipped by digitized range.

Rerferences: Ashton and Ashton 1988, Conant and Collins 1998, Gibbons and Semlitsch 1991, Hanlin and Mount 1978, Jensen and Moulis 1999, Martof 1973, Martof et al. 1980, Mount 1975, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Green Frog/Bronze Frog, *Rana clamitans*, AAABH01090, G5, S5

Habitat and distribution: Widely distributed throughout the eastern U.S., green frogs occur statewide in Georgia in a variety of habitats. Semi-aquatic amphibians, they may occupy just about any place where there is shallow, semi-permanent water: springs, creeks, bogs, ditches, etc.

Model: Applied 90 meter buffer to 1:24, 000 stream coverage, 120 meter buffer to NWI freshwater wetlands, and 90 meter buffer to habitat 11 (shallow freshwater only). Kept habitats 7, 20, 22, 31, 33, 72, 73, 80, 201, 202, 203, 411, 420, 422, 425, 434, 440, 441, 512, and 620 within buffers. Kept habitats 11 (shallow freshwater only), 410, 412, 414, 424, 433, 890, 900, 930, 980, and 990 in all cases. Clipped by digitized range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Jensen and Moulis 1999, Lamourex and Madison 1999, Martof 1953, Martof et al. 1980, Mount 1975, Stewart 1983, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Green Salamander, *Aneides aeneus*, AAAAD01010, G3G4, S2

Habitat and distribution: Occurring in Georgia only on the Cumberland Plateau and the far northeastern Blue Ridge, green salamanders occupy a restricted habitat, surviving in damp but not wet crevices in shaded rock outcrops or ledges. In addition, they may occasionally be found on adjacent trees or downed woody material, especially in mature forests.

Model: Using a DEM, created a mask of slopes > 15 % in Cumberland Plateau region and 18% in Blue Ridge region. Kept habitats 34, 410, 411, 414, 424, 425, 431, 433, and 434 within mask. Clipped by digitized range.

References: Bruce 1968, Conant and Collins 1998, Corser 2001, Elliott 2001, Gordon 1952, Gordon 1967, Jensen 1999, Martof et al. 1980, Mount 1975, Petranka 1998, Snyder 1991, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Green Treefrog, *Hyla cinerea*, AAABC02060, G5, S5

Habitat and distribution: These relatively widespread treefrogs are residents of forested areas and swamps in the Coastal Plain and Piedmont of Georgia. They may be expanding their range further northward.

Model: Applied 30 meter buffer to 1:24, 000 stream coverage and 30 meter buffer to NWI freshwater wetlands. Kept habitats 20, 31, 72, 73, 201, 202, 203, and 434 within buffers. Kept habitats 410, 412, 441, 620, 890, 900, 930, 980, and 990 in all cases. Clipped by digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Gibbons and Semlitsch 1991, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Greenhouse Frog, *Eleutherodactylus planirostris*, AAABD04080, G5, NE

Habitat and distribution: An exotic species indigenous to the Caribbean, greenhouse frogs have been introduced into Florida, and have been reported from a few sites on the Georgia coast, especially in urban areas.

Model: Habitats 20, 22, 31, 72, 73, 201, 202, 203, 420, 441, 512, and 990 within digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Delis et al. 1996, Dundee and Rossman 1989, Schwartz 1974, Winn et al. 1999, Wright and Wright 1949

Hellbender, *Cryptobranchus alleganiensis*, AAAAC01010, G4, S3

Habitat and distribution: Entirely aquatic, hellbenders inhabit large, fast-moving streams in the Tennessee River drainage of northern Georgia. They are most abundant in water that is clear and has many large, flat rocks for shelter. Stream siltation and chemical or thermal pollution pose possible threats for this species.

Model: From flowaccumulation grid, kept pixels where values were between 1000 and 200, 000. Used resultant grid as mask for habitats 20, 31, 33, 34, 72, 73, 80, 83, 410, 411, 413, 414, 415, 423, 424, 425, 431, 432, 433, 434, 900, 930, and 980. Clipped by digitized range.

References: Bury et al. 1980, Conant and Collins 1998, Dundee 1971, Jensen 1999, Martof et al. 1980, Mount 1975, Neill 1957, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Jordan's Salamander, *Plethodon jordani*, AAAAD12090, G5, S4

Habitat and distribution: Jordan’s salamanders are restricted to mainly higher elevations in the extreme northeastern part of Georgia, where they may be found in moist woodland habitats, taking refuge by day under rotting logs, leaf litter or rocks, and prowling the forest floor by night. Jordan’s salamanders may also inhabit crevices in shaded rock outcrops.

Model: Habitats 411, 414, 415, 424, 425, 431, 433, and 511 within digitized range.

References: Ash 1988, Ash 1997, Bruce 1967, Conant and Collins 1998, Hairston and Pope 1948, Highton 1973, Highton and Peabody 2000, Madison 1969, Martof et al. 1980, Petranka 1998, Petranka et al. 1994b, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Lesser Siren, *Siren intermedia*, AAAAG02010, G5, S5

Habitat and distribution: Lesser sirens occur in Georgia south of the Fall Line, where they inhabit warm, shallow water in swamps or weedy ponds, Carolina Bays, ditches, ponds in pine flatwoods, and similar aquatic environments having abundant vegetation. They may occasionally be found in flowing water such as rivers or streams.

Model: Kept habitats 11 (shallow freshwater only), 890, 900, 930, 980, and 990. Kept habitat 31 where it intersects with NWI freshwater wetlands. Clipped by digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Funderburg and Lee 1967, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Martof 1973, Martof et al. 1980, Mount 1975, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Little Grass Frog, *Pseudacris ocularis*, AAABC05110, G5, S4S5

Habitat and distribution: The smallest of North American frogs, little grass frogs are found on the Coastal Plain in damp or wet habitats in swamps, pine savannas or flatwoods, and bottomland hardwoods. They are frequently encountered in grasses and sedges at the edge of water.

Model: Kept habitats 11 (shallow freshwater only), 441, 620, 890, 930, and 990. Kept habitats 20 and 31 where they intersect with NWI freshwater wetlands. Clipped by digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Delis et al. 1996, Franz and Chantell 1978, Gibbons and Semlitsch 1991, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Long- tailed Salamander, *Eurycea longicauda*, AAAAD05040, G5, S2

Habitat and distribution: Long-tailed salamanders occur in the Ridge and Valley and Cumberland Plateau of Georgia in damp places around streams, seepages or springs. In general, they prefer mesic, forested habitats with an abundance of leaf litter, rocks, and other debris.

Model: From flowaccumulation grid, kept pixels where values were between 45 and 10, 000. Expanded resultant grid 30m, using this as mask for habitats 410, 411, 413, 414, 424, 425, 431, 432, 433, and 434.

References: Barbour 1971, Carlin 1997, Conant and Collins 1998, Huheey and Stupka 1967, Ireland 1979, Martof et al. 1980, Mount 1975, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Many-lined Salamander, *Stereochilus marginatus*, AAAAD14010, G5, S4

Habitat and distribution: These primarily aquatic salamanders may be found in Georgia along the lower Coastal Plain, where they typically inhabit small ponds in pine flatwoods and shallow gum or cypress ponds in swamps.

Model: Applied 60 meter buffer to mosaic of habitats 890 and 900. Kept habitat 11 (shallow freshwater only) within buffer. Clipped by digitized range.

References: Bruce 1971, Christman 1992, Christman and Kochman 1975, Conant and Collins 1998, Ford and Auth 1990, Martof et al. 1980, Petranka 1998, Rabb 1966, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Marbled Salamander, *Ambystoma opacum*, AAAAA01100, G5, S5

Habitat and distribution: Marbled salamanders are residents of the Piedmont and most of the Coastal Plain. They may be abundant in floodplains in a variety of forested habitats, but are sometimes also observed in drier situations, usually near breeding areas. Marbled salamanders require a breeding habitat characterized by winter flooding.

Model: Applied 120 meter buffer to mosaic of habitats 890, 900, 980, and 990. Kept habitats 410, 411, 412, 422, 434, 440, 441, and 620 within buffer. Kept habitats 890, 900, 980, and 990 in all cases. Clipped by digitized range.

References: Anderson 1967, Conant and Collins 1998, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Petranka 1998, Petzing and Phillips 1998a, Williams 1973, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Mole Salamander, *Ambystoma talpoideum*, AAAAA01120, G5, S5

Habitat and distribution: Found throughout the Coastal Plain and in scattered localities in the rest of the state, mole salamanders breed in shallow, semi-permanent ponds with abundant vegetation. Mole salamanders are highly fossorial in upland habitats throughout the rest of the year.

Model: Applied 90 meter buffer to mosaic of habitats 410, 411, 412, 420, 434, and 620. Kept habitats 890, 900, 930, 980, 990 within buffer. Applied 120 meter buffer to suitable pixels of habitats 890, 900, 930, 980, 990. Kept habitats 410, 411, 412, 420, 434, and 620 within this buffer. Clipped by digitized range.

References: Conant and Collins 1998, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Petranka 1998, Raymond and Hardy 1991, Semlitsch 1981, Shoop 1964, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Mountain Chorus Frog, *Pseudacris brachyphona*, AAABC05010, G5, S4

Habitat and distribution: Woodland amphibians with a patchy geographic distribution in the mountains and hills of the Southeast, mountain chorus frogs are occasionally observed in Georgia in forested habitats in locations with damp leaf litter. They need a breeding environment of shallow pools, seepages, roadside ditches or other ephemeral water.

Model: Applied 120 meter buffer to mosaic of habitats 900, 930, and 980. Kept habitats 20, 31, 422, 411, 425, 431, 434, and 440 within buffer. Kept habitats 410, 412, 414, 424, 433, 900, 930, and 980 in all cases. Clipped by digitized range.

References: Barbour 1958, Barbour 1971, Conant and Collins 1998, Hoffman 1980, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Mud Salamander, *Pseudotriton montanus*, AAAAD13010, G5, S4

Habitat and distribution: Although not commonly observed, mud salamanders have a wide distribution in Georgia, occurring throughout the Coastal Plain and Piedmont. They are most often encountered in muddy springs, sluggish floodplain streams, swampy wooded areas, and other damp, low-lying situations.

Model: Habitats 890, 900, 980, and 990 within digitized range.

References: Bruce 1975, Bruce 1978, Conant and Collins 1998, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Jensen and Moulis 1999, Martof 1955, Martof 1975, Martof et al. 1980, Mount 1975, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Mudpuppy, *Necturus maculosus*, AAAAE01040, G5, S1

Habitat and distribution: Mudpuppies may be found in far northern Georgia in the Tennessee River drainage. Completely aquatic, they may occur in lakes, ponds, rivers, or other permanent bodies of water.

Model: Kept all rasterized 1:100, 000 streams and large reservoirs within digitized range.

References: Bishop 1926, Conant and Collins 1998, Green and Pauley 1987, Martof et al. 1980, Mount 1975, Petranka 1998, Reigle 1967, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Northern Cricket Frog, *Acris crepitans*, AAABC01010, G5, S5

Habitat and distribution: Found in the mountains, Piedmont , and parts of the Coastal Plain of Georgia, northern cricket frogs may be observed in habitats with permanent bodies of shallow water which possess some vegetative cover. They often prefer marshy areas and relatively open, grassy margins of shallow water, but may also be found in or near small, slow-moving streams, and in ditches or mudflats.

Model: Applied 30 meter buffer to 1:24, 000 stream coverage. Kept habitats 20, 31, 72, and 80 within buffer. Kept habitats 11 (shallow freshwater only), 410, 411, 412, 414, 415, 424, 425, 431, 433, 434, 900, 930, 980, and 990 in all cases. Clipped by digitized range.

References: Barbour 1971, Conant and Collins 1998, Harrison 1970, Huheey and Stupka 1967, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Oak Toad, *Bufo quercicus*, AAABB01130, G5, S5

Habitat and distribution: Oak toads occur in Georgia south of the Fall Line, where they may be abundant in pinelands, occupying open-canopied, grassy areas of pine savannahs and flatwoods. They may also be found in maritime forests on many barrier islands. Suitable breeding sites for oak toads include ditches, borrow pits, and shallow cypress or flatwoods ponds.

Model: Habitats 11 (shallow freshwater only), 412, 420, 441, 512, 513, 620, 890, 900, and 990 within digitized range. Clipped by digitized range.

References: Ashton and Ashton 1988, Ashton and Franz 1979, Conant and Collins 1998, Delis et al. 1996, Gibbons and Semlitsch 1991, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Ocoee Salamander, *Desmognathus ocoee*, AAAAD03140, G5, S5

Habitat and distribution: Ocoee salamanders are inhabitants of forested areas in the Blue Ridge and some Piedmont foothills of Georgia. Requiring a habitat of mesic woodlands, they are may be observed near springs, seeps or rocky streams in hardwood or mixed forest. At higher elevations, they are frequently found well away from water on the forest floor.

Model: Kept habitats 414, 415, 424, and 433 in all cases. From flowaccumulation grid, created stream grid based on minimum values in different precipitation zones. Where annual precipitation is between 80 and 100 inches, minimum value for stream is 25. Where precipitation is between 60 and 80, minimum value for stream is 35. Where precipitation is < 60, minimum value for stream is 45. Used maximum value of 10, 000 in all cases. Used resultant grid as mask for habitats 410, 411, 413, 425, 431, 432, and 434. Clipped by digitized range.

References: Conant and Collins 1998, Hairston 1949, Hairston 1986, Martof et al. 1980, Mount 1975, Petranka 1998, Tilley 1973a, Tilley 1973b, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

One-toed Amphiuma, *Amphiuma pholeter*, AAAAB01020, G3, S1

Habitat and distribution: Confined chiefly to a limited range along the Gulf Coast of Florida and Alabama, one-toed amphiumas are known in Georgia only from the Ochlockonee River drainage in Thomas and Grady

counties. They are most frequently encountered in the floodplains of small streams. These eel-like, semi-aquatic salamanders are specialized in their habitat requirements, and need an environment of organic muck.

Model: Applied 30 meter buffer to 1:24, 000 stream coverage. Kept habitats 11 (shallow freshwater only) and 890 within buffer. Clipped by digitized range.

References: Conant and Collins 1998, Jensen 1999, Means 1992, Means 1996, Neill 1964, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Ornate Chorus Frog, *Pseudacris ornate*, AAABC05050, G5, S5

Habitat and distribution: Widespread in Georgia south of the Fall Line, ornate chorus frogs may be found in a variety of damp habitats such as pine flatwoods and savannas, or Carolina bays. They need a breeding environment of shallow, transient pools or ponds, often selecting places where there are abundant grasses and other emergent vegetation.

Model: Applied 30 meter buffer NWI freshwater wetlands. Kept habitats 20 and 31 within buffer. Kept habitats 11 (shallow freshwater only), 441, 512, 620, 890, 930, and 990 in all cases. Clipped by digitized range.

References: Ashton and Ashton 1988, Caldwell 1987, Conant and Collins 1998, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Pickerel Frog, *Rana palustris*, AAABH01160, G5, S4

Habitat and distribution: In Georgia, pickerel frogs occur chiefly north of the Fall Line, in shaded streams where water is cool and clear, or in other damp places in hardwood forest. In a few places on the Coastal Plain of southeast Georgia they may inhabit the relatively warm, turbid water of floodplain swamps.

Model: Applied 30 meter buffer to 1:24, 000 stream coverage. Kept habitats 31, 80, 422, and 440 within buffer. Kept habitats 410, 411, 412, 414, 415, 424, 425, 431, 433, 434, and 900 in all cases. Clipped by digitized range.

References: Barbour 1971, Conant and Collins 1998, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Schaaf and Smith 1970, Schaaf and Smith 1971, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Pig Frog, *Rana grylio*, AAABH01110, G5, S5

Habitat and distribution: Highly aquatic amphibians, pig frogs may be observed in ponds and lakes on the Coastal Plain and barrier islands. Additional habitat may include marshes, cypress bogs, and abandoned rice fields.

Model: Kept habitats 11 (shallow freshwater only), 890, 900, and 930. Kept habitats 20 and 31 where they intersect with NWI freshwater wetlands. Clipped by digitized range.

References: Altig and Lohoefener 1982, Ashton and Ashton 1988, Conant and Collins 1998, Delis et al. 1996, Gibbons and Semlitsch 1991, Lamb 1984, Martof et al. 1980, Mount 1975, Neill 1952, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Pigeon Mountain Salamander, *Plethodon petraeus*, AAAAD12310, G1, S1

Habitat and distribution: Endemic to Georgia, Pigeon Mountain salamanders are known to occur only on Pigeon Mountain in Walker County. Although limited in range, they are locally abundant, inhabiting rocky slopes in hardwood or mixed hardwood forest, where they are usually found within moist rock crevices. They are frequently seen around cave entrances, and have also been observed under logs and under leaf litter in the vicinity of rock outcrops.

Model: Habitats 410, 411, 414, 433, and 434 within mask of elevations between 225 m (738 feet) and 550 m (1804 feet). Clipped by digitized range.

References: Conant and Collins 1998, Jensen 1999, Jensen et al. 2002, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wynn et al. 1988

Pine Woods Treefrog, *Hyla femoralis*, AAABC02090, G5, S5

Habitat and distribution: Pine woods treefrogs in Georgia may be encountered south of the Fall Line in pine flatwoods, pine savannas, and pine-turkey oak forest.

Model: Habitats 11 (shallow freshwater only), 420, 422, 434, 440, 441, 512, 620, 890, 900, 930, and 990 within digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Delis et al. 1996, Gibbons and Semlitsch 1991, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Red Salamander, *Pseudotriton rubber*, AAAAD13020, G5, S5

Habitat and distribution: Relatively widespread in Georgia, red salamanders typically inhabit slow-moving springs or seepages in thick leaf litter or other appropriate cover. They are somewhat terrestrial, and nonbreeding adults may sometimes be found in forested areas adjacent to streams. Red salamanders are normally absent from large, swiftly flowing streams.

Model: Above fall line: from flowaccumulation grid, created stream grid based on minimum values in different precipitation zones. Where annual precipitation is between 80 and 100 inches, minimum value for stream is 25. Where precipitation is between 60 and 80, minimum value for stream is 35. Where precipitation is < 60, minimum value for stream is 45. Used maximum value of 10, 000 in all cases. Used resultant grid as mask for habitats 410, 411, 412, 413, 414, 415, 424, 425, 431, 432, 433, 434, 890, and 900. Below fall line: from flowaccumulation grid, kept pixels where values were between 100 and 10, 000. Used resultant grid as mask as for habitats 410, 411, 412, 413, 414, 415, 424, 425, 431, 432, 433, 434, 890, 900, and 990. Clipped by digitized range.

References: Bruce 1978, Conant and Collins 1998, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Martof 1975, Martof et al. 1980, Mount 1975, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Red-spotted/Central Newt, *Notophthalmus viridescens*, AAAAF01030, G5, S5

Habitat and distribution: These salamanders occur in a variety of habitats throughout Georgia. Adults may inhabit ponds, marshes, swamps, and other permanent or semipermanent bodies of water that lie within or adjacent to forested areas. These newts are notable for the presence in their life-cycle of a terrestrial eft phase; this phase typically moves from aquatic habitat into forested situations.

Model: Habitats 11 (shallow freshwater only), 410, 411, 412, 414, 415, 420, 422, 424, 425, 431, 433, 434, 440, 441, 620, 890, 900, 930, 980, and 990. Statewide range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Gates and Thompson 1982, Gibbons and Semlitsch 1991, Gill 1978, Healy 1975, Martof et al. 1980, Mount 1975, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

River Frog, *Rana heckscheri*, AAABH01120, G5, S5

Habitat and distribution: River frogs may be encountered south of the Fall line in many wetland habitats, including river swamps, bottomland hardwoods, shallow ponds or bayous, and other swampy places having a growth of titi, bay, or cypress.

Model: Kept habitats 11 (shallow freshwater only), 412, 890, 900, 980, and 990. Kept habitats 20 and 31 where they intersect with NWI freshwater wetlands. Clipped by digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Hansen 1957, Martof et al. 1980, Mount 1975, Sanders 1984, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Seal Salamander, *Desmognathus monticola*, AAAAD03060, G5, S5

Habitat and distribution: Most abundant in the Blue Ridge, seal salamanders typically inhabit areas in and around cold, well-aerated mountain streams, seepages or brooks. In the Piedmont, they may occur locally in small streams within cool, forested ravines.

Model: From flowaccumulation grid, created stream grid based on minimum values in different precipitation zones. Where annual precipitation is between 80 and 100 inches, minimum value for stream is 25. Where precipitation is between 60 and 80, minimum value for stream is 35. Where precipitation is < 60, minimum value for stream is 45. Used maximum value of 10, 000 in all cases. Used resultant grid as mask for habitats 410, 411, 412, 413, 414, 415, 424, 425, 431, 432, 433, and 434. Eliminated all single pixels of habitat. Clipped by digitized range.

References: Conant and Collins 1998, Hairston 1949, Hairston 1986, Martof et al. 1980, Mount 1975, Organ 1961, Petranka 1998, Petranka et al. 1994b, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Seepage Salamander, *Desmognathus aeneus*, AAAAD03010, G3G4, S3

Habitat and distribution: Seepage salamanders are residents of northern Georgia, occurring in habitats associated with moist, shaded deciduous or mixed forest. They are frequently found in the vicinity of springs, seepages or small streams.

Model: Kept habitata 410, 414, 415, 425, and 433 in all cases. Kept habitat 411 within mask of elevations > 900 (2952 feet), and habitat 900 within mask of elevations > 365 m (1197 feet). Clipped by digitized range.

References: Conant and Collins 1998, Hairston 1986, Harrison 1992, Jones 1982, Martof et al. 1980, Mount 1975, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Shovelnose Salamander, *Desmognathus marmoratus*, AAAAD10010, G4, S3

Habitat and distribution: Shovelnose salamanders are inhabitants of cool, well-oxygenated mountain streams. Shallow, rocky streams with loose gravel and moderately fast-flowing water provide favorable conditions. They are intolerant of siltation, and are restricted to the Blue Ridge in the northeastern corner of the state.

Model: From flowaccumulation grid, kept pixels where values were between 500 and 5000. Used resultant grid as mask for habitats 410, 411, 414, 424, 425, 431, 433, and 434. Clipped by digitized range.

References: Conant and Collins 1998, Martof 1962, Martof 1964, Martof et al. 1980, Petranka 1998, Pope and Hairston 1947, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Slimy Salamander complex, *Plethodon glutinosus complex*, AAAAD12070, G5, S5

Habitat and distribution: Slimy salamanders may be found under logs or in leaf litter in forested habitats throughout Georgia. They may be common in shaded hardwood forests, wooded floodplains, and on the slopes of shaded ravines, and may also occasionally inhabit pine woods in locations near hardwood bottomlands. Optimal habitat is moist and has a ground layer of humus and leaf litter. Many taxonomists separate slimy salamanders into a complex of individual species.

Model: Habitats 410, 411, 412, 414, 415, 420, 422, 424, 425, 431, 433, 434, 440, 441, 900, and 990 within digitized range.

References: Barbour 1971, Carr and Goin 1959, Conant and Collins 1998, Gibbons and Semlitsch 1991, Hairston 1993, Highton et al. 1989, Huheey and Stupka 1967, Jensen and Moulis 1999, Lacy 1997, Martof 1955, Martof et al. 1980, Mount 1975, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Southern Appalachian Salamander, *Plethodon teyahalee (oconaluftee)*, AAAAD12300, G3Q, S1

Habitat and distribution: Southern Appalachian salamanders are known to occur as far south as Rabun County, Georgia. These salamanders are typically encountered at high elevations in forested habitats, where they shelter under leaf litter, decaying logs or rocks. They are more plentiful in hardwood forest than in coniferous forest of pines or hemlock.

Model: Habitats 411, 414, 415, 424, 425, 431, and 433 within digitized range.

References: Conant and Collins 1998, Hairston 1993, Highton 1987, Highton et al. 1989, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Southern Chorus Frog, *Pseudacris nigrita*, AAABC05040, G5, S5

Habitat and distribution: Occurring in Georgia south of the Fall Line, southern chorus frogs are inhabitants of small gum and cypress ponds in flatwoods of slash or longleaf pine. They are typically encountered in grassy ground cover or in emergent vegetation along the water's edge.

Model: Kept habitats 11 (shallow freshwater only), 441, 620, 890, 930, 980, and 990. Kept habitats 20 and 31 where they intersect with NWI freshwater wetlands. Clipped by digitized range.

References: Ashton and Ashton 1988, Caldwell 1987, Conant and Collins 1998, Delis et al. 1996, Gibbons and Semlitsch 1991, Martof et al. 1980, Mount 1975, Schwartz 1957, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Southern Cricket Frog, *Acris gryllus*, AAABC01020, G5, S5

Habitat and distribution: Southern cricket frogs are found on the Coastal Plain and lower Piedmont, where they may be observed in most types of permanently aquatic habitats and in nearby areas having temporary accumulations of water. Southern cricket frogs thrive in densely vegetated places, and may often be found along the grassy margins of ponds, streams or ditches. They may also be found in forested areas, at the edges of water.

Model: Applied 30 meter buffer NWI freshwater wetlands. Kept habitats 11, 20, 22, 31, 72, 73, 80, 201, 202, 203, 420, 422, 434, 440, 441, and 620 within buffer. Kept habitats 412, 890, 900, 930, 980, and 990 in all cases. Clipped by digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Southern Dusky Salamander, *Desmognathus auriculatus*, AAAAD03020, G5, S5

Habitat and distribution: Confined to the Coastal Plain, southern dusky salamanders may be observed in habitats with mucky soil such as cypress swamps, springs, or bottomland hardwoods.

Model: Habitats 890, 900, and 990 within digitized range.

References: Conant and Collins 1998, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Lacy 1997, Martof et al. 1980, Means 1975, Means 1999, Mount 1975, Petranka 1998, Rossman 1959, , Wilson 1995

Southern Leopard Frog, *Rana sphenocephala*, AAABH01220, G5, S5

Habitat and distribution: Southern leopard frogs occur throughout Georgia in all types of freshwater environments, ranging from permanent and semi-permanent woodland ponds to potholes. In late summer and fall, southern leopard frogs may venture away from water into mesic woodlands.

Model: Applied 90 meter buffer to 1:24, 000 stream coverage, 90 meter buffer to NWI freshwater wetlands, and 90 meter buffer to habitat 11 (shallow freshwater only). Kept habitats 20, 22, 31, 33, 72, 73, 80, 201, 202, 203, 411, 422, 425, 434, 440, 441, and 620 within buffers. Kept habitats 7 (associated with freshwater), 11 (shallow freshwater only), 410, 412, 424, 433, 890, 900, 930, 980, and 990 in all cases. Statewide range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Delis et al. 1996, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Lacy 1997, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Southern Redback Salamander, *Plethodon serratus*, AAAAD12160, G5, S5

Habitat and distribution: Redback salamanders are inhabitants of mesic forests in Georgia, and may be found in roughly the northwestern quarter of the state. Optimal habitat possesses abundant leaf litter, rocks, and fallen logs to provide shelter.

Model: Habitats 410, 411, 412, 413, 414, 431, 433, and 434 within digitized range.

References: Camp 1986, Camp 1988, Conant and Collins 1998, Highton 1986, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Southern Toad, *Bufo terrestris*, AAABB01160, G5, S5

Habitat and distribution: The southern toad is found throughout the Coastal Plain of Georgia in and around wetlands and forested habitats.

Model: Applied 30 meter buffer to 1:24, 000 stream coverage and 120 meter buffer to NWI freshwater wetlands. Kept habitats 20, 22, 31, 72, 73, 80, 201, 202, and 203 within buffers. Kept habitats 11 (shallow freshwater only), 412, 420, 422, 434, 440, 441, 512, 620, 890, 900, 930, 980, and 990 in all cases. Clipped by digitized range.
References: Ashton and Ashton 1988, Blem 1979, Conant and Collins 1998, Delis et al. 1996, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Laerm and Hopkins 1997, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Southern Two-lined Salamander, *Eurycea cirrigera*, AAAAD05140, G5, S5

Model: Kept habitats 410, 414, 424, and 433, 890, 900, and 980 in all cases. Above fall line: kept pixels where values were > 45. Used resultant grid as mask for habitats 201, 202, 203, 411, 413, 422, 425, 431, 432, 434, and 440. Kept habitat 412 if within 30m of 1:24, 000 streams. Below fall line: Used rasterized 1:24, 000 streams as mask for habitats 201, 202, 203, 413, 420, 422, 432, 434, and 440. Kept habitat 412 if within 30m of 1:24, 000 streams. Clipped by digitized range.

References: Camp et al. 2000, Carr and Goin 1959, Conant and Collins 1998, Jacobs 1987, Jensen and Moulis 1999, Martof 1955, Martof et al. 1980, Mount 1975, Petranka 1998, Petzing and Phillips 1998b, Sever 1999, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Spotted Dusky Salamander, *Desmognathus conanti*, AAAAD03040, G5, S5

Habitat and distribution: Abundant in Georgia throughout the Piedmont and present in a few localities in the mountains, spotted dusky salamanders are especially abundant along the margins of small streams in locations with rocks, logs or mosses, and are also frequently encountered in bottomland hardwoods, swamps, springs and seepage areas.

Model: From flowaccumulation grid, created stream grid based on minimum values in different precipitation zones. Where annual precipitation is between 80 and 100 inches, minimum value for stream is 25. Where precipitation is between 60 and 80, minimum value for stream is 35. Where precipitation is < 60, minimum value for stream is 45. Used maximum value of 10, 000 in all cases. Used resultant grid as mask for habitats 410, 411, 412, 413, 414, 424, 425, 431, 432, 433, 434, and 900. Applied additional mask of elevations < 548 m (1900 feet). Eliminated all single pixels of habitat. Clipped by digitized range.

References: Barbour et al. 1969, Conant and Collins 1998, Martof 1955, Martof et al. 1980, Mount 1975, Orser and Shure 1972, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Spotted Salamander, *Ambystoma maculatum*, AAAAA01090, G5, S5

Habitat and distribution: Occurring in roughly the northern two-thirds of Georgia, spotted salamanders breed in late winter or early spring in temporary or ephemeral ponds within larger areas of hardwood or mixed forest. During most of the year, adults lead a fossorial existence in surrounding forests.

Model: Applied 90 meter buffer to mosaic of habitats 410, 411, 412, 420, 434, and 620. Kept habitats 900 and 980 within buffer. Applied 120 meter buffer to suitable pixels of habitats 900 and 980. Kept habitats 410, 411, 412, 413, 424, 425, 431, 432, 433 and 434 within this buffer. Clipped by digitized range.

References: Anderson 1967, Conant and Collins 1998, Douglas and Monroe 1981, Gates and Thompson 1981, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Petranka 1998, Semlitsch 1988, Shoop 1965, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Spring Peeper, *Pseudacris crucifer*, AAABC05090, G5, S5

Habitat and distribution: Widespread in the eastern U.S. and Canada, spring peepers occur throughout Georgia in many types of wooded situations. They particularly favor areas which possess shrubby secondary growth, and in which there are temporary ponds, ditches, or other semi-permanent water for breeding. After breeding, spring peepers move to damp, wooded places, where they become secretive and hard to find.

Model: Applied 120 meter buffer to mosaic of habitats 11 (freshwater only), 900, 930, 980, and 990. Kept habitats 31, 72, 73, 80, 201, 202, 203, 422, 425, 434, 440, 441, 620 within buffer. Kept habitats 11 (shallow freshwater only), 410, 411, 412, 414, 415, 420, 424, 431, 433, 900, 930, 980, and 990 in all cases. Statewide range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Spring Salamander, *Gyrinophilus porphyriticus*, AAAAD06020, G5, S4

Habitat and distribution: Spring salamanders may be found in Georgia in upland locations, usually near the edges of small, clear streams and springs. They require cool, moist surroundings in forested areas.

Model: From flowaccumulation grid, created stream grid based on minimum values in different precipitation zones. Where annual precipitation is between 80 and 100 inches, minimum value for stream is 25. Where precipitation is between 60 and 80, minimum value for stream is 35. Where precipitation is < 60, minimum value for stream is 45. Used maximum value of 10, 000 in all cases. Used resultant grid as mask for habitats

410, 411, 412, 414, 424, 425, 431, 433, and 434. Eliminated all single pixels of habitat. Clipped by digitized range.

References: Brandon 1967, Bruce 1972, Conant and Collins 1998, Martof et al. 1980, Mount 1975, Petranka 1998, Thompson 1982, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Squirrel Treefrog, *Hyla squirella*, AAABC02120, G5, S5

Habitat and distribution: Occurring throughout the Coastal Plain of Georgia (and expanding their range onto the Piedmont), squirrel treefrogs are most commonly seen in moist, open woods. Suitable habitats include pine savannas, mixed forest, or bottomland hardwoods. Squirrel treefrogs may also be encountered in residential areas, feeding by night on insects in well-lit places.

Model: Habitats 11 (shallow freshwater only), 20, 22, 24, 31, 72, 73, 201, 202, 203, 412, 420, 422, 434, 440, 441, 620, 890, 900, 930, and 990 within digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Striped Newt, *Notophthalmus perstriatus*, AAAAF01020, G2G3, S2

Habitat and distribution: Striped newts are found primarily on the lower Coastal Plain of Georgia. Adult are terrestrial, occupying forested environments in sandhill communities and longleaf pine forest. Striped newts require a breeding habitat of isolated, ephemeral ponds, particularly cypress, within suitable terrestrial habitat.

Model: Recoded habitats 512 and 620 to 1 and all else to 0; applied 3x3 moving window (FOCALMEAN using rectangle); kept areas where values were greater than .33; expanded these areas 3 pixels. Used resultant grid as mask for habitats 512, 620, and 890. Clipped by digitized range.

References: Bury et al. 1980, Christman and Means 1992, Conant and Collins 1998, Dodd 1993, Dodd and Cade 1998, Dodd and Laclaire 1995, Jensen 1999, Mecham 1967, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Tennessee Cave Salamander, *Gyrinophilus palleucus*, AAAAD06010, G2G3, S1

Habitat and distribution: Tennessee cave salamanders have been reported in Georgia from only two caves in Walker County. They are aquatic, and require limestone caves with permanent pools or streams.

Model: Created grid of likely limestone bedrock from geologic map of Georgia. Used as mask for habitats 410, 411, 413, 414, 423, 424, 432, 433, 434, 440, and 900. Clipped by digitized range. This overestimates habitat for this animal, but allows for its potential occurrence within karst features in a natural state throughout its range.

References: Brandon 1967, Buhlmann and Wynn 1996, Bury et al. 1980, Conant and Collins 1998, Cooper 1968, Mount 1975, Petranka 1998, Simmons 1975, Wilson 1995

Three-lined Salamander, *Eurycea guttolineata*, AAAAD05290, G5, S4S5

Habitat and distribution: Three-lined salamanders range throughout most of Georgia in low-lying areas. Suitable environments for them include floodplain forests, swamps, boggy streams, and some shaded seepage areas.

Model: Habitats 890, 900, and 980 within digitized range.

References: Carlin 1997, Conant and Collins 1998, Gordon 1953, Ireland 1979, Jensen and Moulis 1999, Lacy 1997, Martof 1955, Martof et al. 1980, Mount 1975, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Tiger Salamander, *Ambystoma tigrinum*, AAAAA01140, G5, S3

Habitat and distribution: Tiger Salamanders are relatively uncommon residents of Georgia south of the Fall Line, where they may breed in shallow, fishless ponds in pine savannahs and in sandy, longleaf pine flatwoods. Like other ambystomatids, terrestrial adults are highly fossorial during most of the year.

Model: Applied 90 meter buffer to mosaic of habitats 412, 420, 422, 434, 440, 441, and 620. Kept habitats 890, 900, 930, 980, and 990 within buffer. Applied 90 meter buffer to suitable pixels of habitats 890, 900, 930, 980, and 990. Kept habitats 412, 420, 422, 434, 440, 441, and 620 within this buffer. Clipped by digitized range.

References: Conant and Collins 1998, Gehlbach 1967a, Gibbons and Semlitsch 1991, Jensen 1994, Madison and Farrand 1998, Martof et al. 1980, Mount 1975, Neill 1957, Petranka 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Two-toed Amphiuma, *Amphiuma means*, AAAAB01010, G5, S5

Habitat and distribution: Found in the Coastal Plain of Georgia, two-toed amphiumas may be found in a variety of aquatic and swampy habitats such as cypress-tupelo swamps, wet meadows, and blackwater ponds.

Model: Kept habitats 11 (shallow freshwater only), 890, 900, 930, 980, and 990. Kept habitat 31 where it intersects with NWIs freshwater wetlands.

References: Carr and Goin 1959, Conant and Collins 1998, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Knepton 1954, Martof et al. 1980, Mount 1975, Petranka 1998, Salthe 1973, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Upland Chorus Frog, *Pseudacris feriarum*, AAABC05070, G5T5, S5

Habitat and distribution: Occurring from the upper Coastal Plain northward in Georgia, upland chorus frogs may be observed in many types of open and forested wetlands. Habitats include moist woodlands, river swamps, and open habitats such as wet meadows and boggy or marshy wetlands with shrubs and grasses.

Model: Kept habitats 410, 412, 434, 900, 930, 980, and 990. Kept habitats 20 and 31 where they intersect with NWI freshwater wetlands. Kept habitat 11 (shallow freshwater only) where it is part of a clump of habitat 11 < 100 ha. Clipped by digitized range.

References: Barbour 1971, Conant and Collins 1998, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Petzing and Phillips 1998c, Schwartz 1957, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Webster's Salamander, *Plethodon websteri*, AAAAD12210, G3, S1

Habitat and distribution: Occurring in the western part of the Georgia Piedmont and Ridge and Valley, Webster's salamanders inhabit moist deciduous forests, particularly on steep slopes. Typical habitat is often associated with the presence of red, white or black oaks.

Model: Habitats 410, 411, 412, 413, and 434 within digitized range.

References: Blaney and Relyea 1967, Conant and Collins 1998, Highton 1979, Highton 1986, Martof et al. 1980, Mount 1975, Petranka 1998, Semlitsch and West 1983, Wilson 1995

Wood Frog, *Rana sylvatica*, AAABH01200, G5, S3

Habitat and distribution: Wood frogs may be found from the Blue Ridge southwest to the Pine Mountain region of the Piedmont in Georgia. They breed during a short period in late winter, and require a source of standing water. Otherwise terrestrial in nature, wood frogs disperse into moist woods after breeding, where they are well-camouflaged on the leafy forest floor.

Model: Habitats 410, 411, 412, 414, 415, 424, 425, 431, 433, 434, 900, and 980 within digitized range. Clipped by digitized range.

References: Barbour 1971, Conant and Collins 1998, Hopey and Petranka 1994, Huheey and Stupka 1967, Martof 1970, Martof et al. 1980, Mount 1975, Petranka et al. 1994, Quinby 1954, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1949

Zigzag Salamander, *Plethodon dorsalis*, AAAAD12030, G4, S4

Habitat and distribution: Restricted in Georgia to the Cumberland Plateau region in the northwest corner of the state, zigzag salamanders live under leaf litter, logs, rocks, and bark primarily in hardwood and mixed forests. They require a moist habitat with abundant surface cover.

Model: Habitats 410, 411, 414, 433, and 434 within digitized range.

References: Barbour 1971, Conant and Collins 1998, Highton 1979, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Petranka 1998, Reinbold 1979, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Birds

Acadian Flycatcher, *Empidonax virescens*, ABPAE33020, G5, S5

Habitat and distribution: Acadian flycatchers breed statewide in Georgia. They are found in deciduous forests near streams, in bottomland hardwoods, and in other rich deciduous or mixed forest types. They generally prefer large forest tracts to small patches.

Model: Applied 90 meter buffer to 1:24, 000 stream coverage, kept habitats 410, 411, 412, 414, 424, 425, 431, 433, 434, 890, 990 within buffer. Kept habitat 900 in all cases. Applied mask of forested areas > 15 hectares (ha). Statewide range.

References: Aldrich and Coffin 1980, AOU 1983, Bent 1942, DeGraaf et al. 1991, Dickson 1978, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hespenheide 1971, Johnston and Odum 1956, Meyers and Odum 1991, Nicholson 1997, Noon et al. 1980, Robbins et al. 1989a, Sauer et al. 1997, Walkinshaw 1971, Wilcove 1988, Wilson and Cooper 1998

American Crow, *Corvus brachyrhynchos*, ABPAV10010, G5, S5

Habitat and distribution: American crows breed throughout Georgia, nesting in deciduous, coniferous, or mixed forest, and may be particularly abundant around forest edges. Other suitable habitats include farmlands, orchards, suburbs, parks, and woodlots. They are true habitat generalists.

Model: Habitats 7, 9, 18, 20, 22, 24, 31, 33, 34, 72, 73, 80, 83, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 511, 512, 513, 620, 890, 900, 920, 930, 980, 990. Statewide range.

References: AOU 1983, Bent 1946, DeGraaf et al. 1991, Dickson et al. 1980, Ehrlich et al. 1988, Goodwin 1976, Hamel 1992, Haney et al. 1986, Knight et al. 1987, Madge and Burn 1994, Nicholson 1997, Sauer et al. 1997, Wilcove 1988

American Goldfinch, *Corvus brachyrhynchos*, ABPBY06110, G5, S5

Habitat and distribution: American goldfinches breed in northern Georgia and much of the Coastal Plain. They may nest at the edges of woods or in shrubby places, marsh edges, overgrown fields, and orchards. Goldfinches are especially attracted to thistle.

Model: Habitats 20, 22, 31, 72, 73, 80, 201, 202, 203, 930, and 980 within digitized range.

References: AOU 1983, Bent 1968, Burleigh 1958, Clement 1993, Conner and Adkisson 1975, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Jackson 1988, Middleton 1993, Nicholson 1997, Nickell 1951, Sauer et al. 1997

American Kestrel, *Falco sparverius*, ABNKD06020, G5, S3

Habitat and distribution: American kestrels in Georgia prefer extensive open country with scattered trees for nesting. They forage over open areas such as pasture and woodland margins. Open longleaf pine provides a suitable natural forest habitat. They breed at scattered areas throughout the state.

Model: Habitats 80 and 620. Statewide range.

References: AOU 1983, Bent 1938, Bird 1988, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnsgard 1990, Lane and Fischer 1997, Nicholson 1997, Rohrbaugh and Yahner 1997, Sauer et al. 1997

American Oystercatcher, *Haematopus palliates*, ABNNC01010, G5, S2

Habitat and distribution: American oystercatchers are permanent residents in saline areas along the Georgia coast. They typically nest on open sand near barrier islands. Foraging habitat is intertidal sand or mud flats.

Model: Habitats 7, 9, 11 (shallow salt water only), and 920 within digitized range.

References: AOU 1983, Bent 1929, Corbat 1990, Ehrlich et al. 1988, Haney et al. 1986, Harris 1999a, Johnsgard 1981, Nol and Humphrey 1994, Tomkins 1954

American Redstart, *Setophaga ruticilla*, ABPBX06010, G5, S5

Habitat and distribution: In the upper Coastal Plain and Piedmont, American redstarts are generally found in bottomland hardwoods. In the mountains they may be associated with cove hardwoods or mixed mesophytic forest.

Model: Selected habitats 410, 411, 412, 414, 890, and 900. Kept contiguous clumps of habitat greater than 1 ha (11 pixels, approximate home range size). Applied mask of elevations < 1219 m (4000 feet). Clipped by digitized range.

References: AOU 1983, Bennett 1980, Bent 1953, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Nicholson 1997, Pashley and Barrow 1993, Sauer et al. 1997, Sherry and Holmes 1992, Sherry and Holmes 1997

American Robin, *Turdus migratorius*, ABPBJ20170, G5, S5

Habitat and distribution: American robins nest in most of Georgia. They may be found near the edges of most types of forest, and in diverse habitats of other kinds, especially those with short grass, shrubs or trees.

Model: Habitats 20, 22, 24, 31, 72, 73, 80, 201, 202, 203, 410, 411, 412, 413, 414, 415, 422, 424, 425, 431, 432, 433, 434, 440 within digitized range.

References: Aldrich and Coffin 1980, AOU 1983, Bent 1949, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Imhof 1976, Knupp et al. 1977, Nicholson 1997, Noon et al. 1980, Odum and Burleigh 1946, Pitts 1984, Sallabanks and James 1999, Sauer et al. 1997

American Woodcock, *Scolopax minor*, ABNNF19020, G5, S5

Habitat and distribution: American woodcocks breed locally in most of Georgia in a variety of wooded habitats. They prefer a mix of deciduous forest, particularly bottomland hardwood, with clearcuts, pasture, and shrubby areas.

Model: Applied 1 km moving window (FOCALSUM function using rectangle) to grid of suitable open habitats (20, 31, and 80) reclassed to value of 1. Kept areas where values were > 24. Applied 1 km moving window (FOCALSUM function using rectangle) to grid of suitable forested habitats (410, 412, 414, 415, 434, 900, 980) reclassed to value of 1. Kept areas where values were > 26. Mosaiced results of 2 FOCALSUM functions, and used as mask of all suitable habitats. Clipped by digitized range.

References: AOU 1983, Critcher and Quay 1953, DeGraaf et al. 1991, Ehrlich et al. 1988
Hamel 1992, Haney et al. 1986, Hudgins et al. 1985, Keppie and Whiting 1994, Pitelka 1943, Roboski and Causey 1981, Sauer et al. 1997, Straw et al. 1994

Anhinga, *Anhinga anhinga*, ABNFE01010, G5, S5

Habitat and distribution: Anhingas are found in Georgia south of the Fall Line. Nesting sites are in trees near the edges of open or semi-open water. Anhingas forage in freshwater habitats such as swamps, lakes and sluggish streams, but will also use brackish-water.

Model: Habitats 11 (shallow fresh water only), 890, 900, 930, 980, and 990 within digitized range.

References: AOU 1983, Bent 1922, DeGraaf et al. 1991, Dusi and Dusi 1987, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Odom 1976, Palmer 1962, Sauer et al. 1997, Spendelow and Patton 1988

Bachman's Sparrow, *Aimophila aestivalis*, ABPBX91050, G3, S3

Habitat and distribution: Bachman's sparrows are permanent residents in much of Georgia. They are most commonly encountered in mature, open pinewoods or recent clearcuts.

Model: Habitats 31, 422, and 620 within digitized range.

References: AOU 1983, Bent 1968, DeGraaf et al. 1991, Dunning 1993, Dunning and Watts 1990, Ehrlich et al. 1988, Gobris 1992, Haggerty 1986, Hamel 1992, Haney et al. 1986, Jackson 1988, Johnson and Landers 1982, Meanley 1988, Rising 1996, Sauer et al. 1997, Schneider 1999a, Stevenson and Anderson 1994

Bald Eagle, *Haliaeetus leucocephalus*, ABNKC10010, G4, S2

Habitat and distribution: Always around water, bald eagles nest in large living trees, often choosing the largest and sturdiest in the area. They forage over estuaries, reservoirs, large ponds, open marshes, and along shorelines – both freshwater and saltwater.

Model: Habitats 11 and 890. Statewide range, except areas of open ocean.

References: AOU 1983, Bent 1937, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnsgard 1990, Ozier 1999, Sauer et al. 1997, Stalmaster 1987, Stalmaster 1988

Barn Swallow, *Hirundo rustica*, ABPAU09030, G5, S5

Habitat and distribution: Barn swallows may be seen throughout Georgia in open habitats including clearcuts, farm lands, and rural or suburban areas. They prefer locations near water. They may nest on dams or under bridges at lakes and ponds, as well as in barns or sheds in open country.

Model: Habitats 11, 18, 20, 22, 31, 33, 34, 72, 73, 80, 83, 920, 930, and 980. Statewide range, except areas of open ocean.

References: AOU 1983, Bent 1942, Brown and Brown 1999, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Jackson and Burchfield 1975, Samuel 1971, Sauer et al. 1997, Speich et al. 1986, Turner 1989

Barred Owl, *Strix varia*, ABNSB12020, G5, S5

Habitat and distribution: Barred owls may be found throughout Georgia. They prefer mature forests, with swamps and bottomlands their most common habitat on the Piedmont and Coastal Plain. In the mountains, they may be found in uplands, hemlocks, coves, and along wooded streams.

Model: Habitats 201, 202, 203, 410, 411, 412, 414, 415, 420, 424, 425, 431, 433, 434, 890, 900, and 990. Statewide range.

References: Allen 1987, AOU 1983, Bent 1938, Burton 1973, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Heintzelman 1984, McGarigal and Fraser 1984, Nicholls and Warner 1972, Nicholson 1997, Sauer et al. 1997

Belted Kingfisher, *Ceryle alcyon*, ABNXD01020, G5, S5

Habitat and distribution: Belted kingfishers breed throughout Georgia, always in places near water. Fresh, brackish, and saltwater all may provide suitable habitat.

Model: Kept all rasterized 1:24, 000 streams, as well as habitats 7, 11 (shallow fresh and saltwater), 890, 920, and 930. Statewide range.

References: AOU 1983, Bent 1940, Burleigh 1958, Cornwell 1963, Davis 1982, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamas 1994, Hamel 1992, Haney et al. 1986, Nicholson 1997, Sauer et al. 1997

Black Skimmer, *Rynchops niger*, ABNNM14010, G5, S2

Habitat and distribution: Black skimmers breed in colonies along the Georgia coast on sandy beaches, interdune areas, or other open sandy places. They may also nest on mats of dead vegetation, or sand and shell berms, in salt marshes.

Model: Habitats 7, 9, 11 (saltwater), and 920 within digitized range.

References: AOU 1983, Bent 1921, Ehrlich et al. 1988, Gochfeld and Burger 1994, Gore 1987, Gore 1991, Haney et al. 1986, Sauer et al. 1997, Spendelow and Patton 1988, Stevenson and Anderson 1994

Black Vulture, *Coragyps atratus*, ABNKA01010, G5, S5

Habitat and distribution: Black vultures breed throughout Georgia at lower elevations. They may be seen foraging over many forested and non-forested habitats, frequently in agricultural areas near livestock, or around dumps.

Model: Habitats 7, 9, 18, 20, 22, 31, 33, 34, 72, 73, 80, 83, 201, 202, 203, 410, 411, 412, 413, 414, 420, 422, 431, 432, 433, 434, 440, 441, 512, 513, 620, 890, 900, 920, 930, 980, and 990 within mask of elevations < 548 m (1800 feet). Statewide range.

References: AOU 1983, Bent 1937, Buckley 1999, Coleman and Fraser 1989, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Imhof 1976, Jackson 1983, Nicholson 1997, Sauer et al. 1997

Black-and-white Warbler, *Mniotilta varia*, ABPBX05010, G5, S5

Habitat and distribution: Black-and-white warblers in Georgia usually breed in mature deciduous or mixed forest. On the Piedmont, they may favor bottomlands. In the mountains, they are frequently found in cove hardwoods. They generally range from the upper Coastal Plain northward.

Model: Habitats 410, 411, 412, 413, 414, 415, 431, 433, 434, 900. Applied mask of forested areas > 220 hectares (ha). Clipped by digitized range.

References: AOU 1983, Bent 1953, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Johnston and Odum 1956, Kendeigh and Fawver 1981, Kricher 1995, Nicholson 1997, Noon et al. 1980, Robbins et al. 1989a, Sauer et al. 1997, Wilcove 1988

Blackburnian Warbler, *Dendroica virens*, ABPBX03120, G5, S5

Habitat and distribution: Blackburnian warblers in Georgia breed in the Blue Ridge province at high elevations. They prefer mature mixed forest stands of hemlock, white pine and hardwoods. They are less common in pure hardwoods.

Model: Habitats 414, 415, 424, 425, 431, and 431 within mask of elevations > 838m (2750 feet). Clipped by digitized range.

References: AOU 1983, Bent 1953, Burleigh 1958, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Hubbard 1971, Morse 1994, Nicholson 1997, Sauer et al. 1997, Stupka 1963

Black-crowned Night-heron, *Nycticorax nycticorax*, ABNGA11010, G5, S3S4

Habitat and distribution: Black-crowned night-herons are permanent residents of parts of Georgia's lower Coastal Plain. They nest colonially in dense woods and thickets near lakes or bays. Mostly inactive by day, they forage in shallow water in freshwater or saltwater marshes, bays, lakes and ponds.

Model: Habitats 11 (shallow fresh and saltwater), 412, 420, 890, 900, 920, 930, 980, and 990 within digitized range.

References: AOU 1983, Beaver et al. 1980, Bent 1926, Burleigh 1958, Custer and Osborn 1977, Custer and Osborn 1978, Davis 1993, DeGraaf et al. 1991, Dusi and Dusi 1987, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Odom 1976, Palmer 1962, Sauer et al. 1997, Spendelow and Patton 1988, Teal 1965

Black-necked Stilt, *Himantopus mexicanus*, ABNND01010, G5, S1S2

Habitat and distribution: Black-necked stilts breed locally in coastal areas of Georgia. They nest along the shorelines of brackish or freshwater ponds, and in grassy marshes and wet meadows. Stilts forage in shallow water in these locations, and on mudflats or beaches.

Model: Habitats 7, 11 (shallow fresh and saltwater), 920, and 930 within digitized range.

References: AOU 1983, Bent 1927, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Haney et al. 1986, Johnsgard 1981, Robinson et al. 1999, Sauer et al. 1997, Stevenson and Anderson 1994, Tomkins 1950

Black-throated Blue Warbler, Dendroica fusca, ABPBX03050, G5, S4

Habitat and distribution: Black-throated blue warblers in Georgia breed in deciduous or mixed forests in the Blue Ridge region at high elevations. They show preferences for large blocks of forest and dense understories of mountain laurel or rhododendron.

Model: Habitats 411, 414, 415, 424, 425, 431, and 433. Applied masks of forested > 1000 ha. and elevations > 822m (2700 feet). Clipped by digitized range.

References: AOU 1983, Bent 1953, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holmes 1994, Holt 1974, Holway 1991, Hubbard 1971, Nicholson 1997, Robbins et al. 1989a, Sauer et al. 1997, Steele 1992, Wilcove 1988

Black-throated Green Warbler, *Dendroica caerulescens*, ABPBX03100, G5, S5

Habitat and distribution: Black-throated green warblers in Georgia breed in the Blue Ridge, Cumberland Plateau, uppermost Piedmont, and higher ridges of the Appalachian Valley. They prefer coniferous or mixed forests, particularly those with white pine or hemlock, and may be found less frequently in pure hardwoods.

Model: Habitats 411, 414, 415, 423, 424, 425, 431, 432, 433, and 434 within mask of elevations > 426 m (1400 feet). Clipped by digitized range.

References: AOU 1983, Bent 1953, Burleigh 1958, Collins 1983, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Morse 1993, Nicholson 1997, Sauer et al. 1997, Wilcove 1988

Blue Grosbeak, *Guiraca caerulea*, ABPBX63010, G5, S5

Habitat and distribution: Blue grosbeaks breed throughout Georgia at moderate and lower elevations. They like open country and brushy places such as clearcuts, abandoned fields, powerline rights-of-way, wood margins or agricultural areas.

Model: Habitats 20, 31, 73, 80, 83, 512, and 513 within mask of elevations < 762m (2500 feet). Statewide range.

References: AOU 1983, Bent 1968, Burleigh 1958, DeGraaf et al. 1991, Dickson 1980, Hamel 1992, Haney et al. 1986, Imhof 1976, Ingold 1993, Johnson and Landers 1982, Nicholson 1997, Sauer et al. 1997

Blue Jay, *Cyanocitta cristata*, ABPAV02020, G5, S5

Habitat and distribution: Nearly ubiquitous in Georgia, Blue jays are found in a wide variety of habitats including deciduous, mixed and coniferous forest. They may also be seen around farms, gardens, parks, and residential areas.

Model: Habitats 20, 22, 31, 72, 73, 80, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 513, 620, 890, 900, 980, and 990. Statewide range.

References: Aldrich and Coffin 1980, AOU 1983, Bent 1946, DeGraaf et al. 1991, Dickson et al. 1980, Ehrlich et al. 1988, Engels and Sexton 1994, Hamel 1992, Haney et al. 1986, Madge and Burn 1994, Meyers and Johnson 1978, Nicholson 1997, Sauer et al. 1997, Tarvin and Woolfenden 1999, Wilcove 1988

Blue-gray Gnatcatcher, *Polioptila caerulea*, ABPBJ08010, G5, S5

Habitat and distribution: Blue-gray gnatcatchers breed throughout much of Georgia at moderate and low elevations. They often nest in moist deciduous forests of bottomlands and swamps, but may also be found in sandhills, upland deciduous, mixed forest, and many pine stands.

Model: Habitats 31, 410, 411, 412, 413, 414, 420, 422, 431, 432, 433, 434, 440, 441, 512, 513, 620, 900, 980, and 990 within mask of elevations < 762m (2500 feet). Statewide range.

References: AOU 1983, Bent 1949, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Ellison 1992, Fehon 1955, Hamel 1992, Haney et al. 1986, Johnson and Landers 1982, Nicholson 1997, Pashley and Barrow 1993, Sauer et al. 1997

Blue-winged Warbler, *Vermivora pinus*, ABPBX01020, G5, S4

Habitat and distribution: Blue-winged warblers breed in the mountain areas and upper Piedmont of northern Georgia. Habitat includes overgrown fields, abandoned agricultural land, scrubby forest, and streamside thickets at moderate elevations.

Model: Habitats 20, 31, 80, 413, and 980 within digitized range.

References: AOU 1983, Askins 1994, Bent 1953, Confer and Knapp 1981, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Monroe 1937, Nicholson 1997, Sauer et al. 1997

Boat-tailed Grackle, *Quiscalus major*, ABPBXB6060, G5, S5

Habitat and distribution: Boat-tailed grackles are year-round residents of coastal Georgia and some inland locations. They are usually found near water, commonly in thickets near saltmarshes or estuaries. Other breeding habitat may include pastures, open woods, and residential areas.

Model: Habitats 7, 9, 20, 22, 24, 31, 72, 73, 80, 83, 201, 202, 203, 420, 513, 920, 930, 980, and 990 within digitized range.

References: AOU 1983, Bent 1958, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Jaramillo and Burke 1999, McIlhenny 1937, Post and Seals 1993, Post et al. 1996, Sauer et al. 1997, Stevenson and Anderson 1994

Broad-winged Hawk, *Buteo platypterus*, ABNKC19050, G5, S5

Habitat and distribution: Broad-winged hawks breed in Georgia mainly from the Fall Line northward, nesting and foraging in deciduous or mixed forest.

Model: Habitats 410, 411, 412, 413, 414, 415, 431, 432, 433, 434, 890, 900, and 990 within digitized range.

References: AOU 1983, Bent 1937, Burns 1911, Crocoll and Parker 1989, DeGraaf et al. 1991, Ehrlich et al. 1988, Goodrich et al. 1996, Hamel 1992, Haney et al. 1986, Johnsgard 1990, Matray 1974, Meyers and Johnson 1978, Nicholson 1997, Sauer et al. 1997

Brown Pelican, *Pelecanus occidentalis*, ABNFC01020, G4, S2

Habitat and distribution: Brown pelicans are local breeders in Georgia, where they nest in colonies on or near coastal islands. Nesting is generally in sandy areas with shrub thickets or patches of grass. Brown pelicans may be seen foraging along coastlines, inlets or bays, always near salt water.

Model: Habitats 7, 9, 11, and 920 within digitized range.

References: AOU 1983, Bent 1922, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Palmer 1962, Ruckdeschel et al. 1990, Spendelow and Patton 1988, Stevenson and Anderson 1994

Brown Thrasher, *Toxostoma rufum*, ABPBK06010, G5, S5

Habitat and distribution: Brown thrashers are permanent residents throughout much of Georgia, where they inhabit brushy places, usually in dry areas. Overgrown fields, woodland borders, clearcuts, thickets, brier patches, fencerows, open woods and residential areas may provide suitable thrasher habitat.

Model: Habitats 20, 31, 72, 73, 201, 202, 203, 411, 412, 413, 420, 423, 432, 434, 440, 441, 511, 512, 513, and 620. Statewide range.

References: AOU 1983, Askins 1994, Bent 1948, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Imhof 1976, Meyers and Johnson 1978, Nicholson 1997, Sauer et al. 1997

Brown-headed Cowbird, *Molothrus ater*, ABPBXB7030, G5, S5

Habitat and distribution: Brown-headed cowbirds breed throughout Georgia, parasitizing nests of other species near open areas. They often choose a fragmented habitat including agricultural areas, small blocks of forest or forest edges, residential areas, etc.

Model: Habitats 18, 20, 22, 31, 72, 73, 80, 83, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 512, 513, 620, 890, 900, 980, and 990. Statewide range.

References: AOU 1983, Bent 1958, DeGraaf et al. 1991, Dufty 1982, Ehrlich et al. 1988, Gates and Gysel 1978, Hamel 1992, Haney et al. 1986, Holt 1974, Jaramillo and Burke 1999, Lowther 1993, Mayfield 1965, Sauer et al. 1997

Brown-headed Nuthatch, *Sitta pusilla*, ABPAZ01040, G5, S5

Habitat and distribution: Brown-headed nuthatches are year-round residents throughout much of Georgia. They inhabit pine forests, especially those with mature trees. Brown-headed nuthatches are also seen in parks and residential areas with mature pines.

Model: Habitats 72, 73, 201, 202, 203, 422, 432, 434, 440, 441, and 620 within mask of elevations < 670m (2200 feet). Clipped by digitized range.

References: AOU 1983, Bent 1948, Burleigh 1958, DeGraaf et al. 1991, Dickson et al. 1980, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Jackson 1988, Johnston and Odum 1956, Meyers and Johnson 1978, Meyers and Odum 1991, Nicholson 1997, Norris 1958, O'Halloran and Conner 1987, Sauer et al. 1997, Withgott and Smith 1998

Canada Goose, *Branta canadensis*, ABNJB05030, G5, S4

Habitat and distribution: Mainly feral, nonmigratory birds in Georgia, Canada geese breed throughout most of the state. They may inhabit marshes, meadows, small islands and other open situations in and about fresh or brackish water. Flocks may sometimes be seen in urban parks with lakes or rivers.

Model: Habitats 7 (coastal beaches omitted), 11 (shallow freshwater only), 73, 80, and 930 within digitized range.

References: AOU 1983, Ehrlich et al. 1988, Haney et al. 1986, Robbins and Blom 1996, Sauer et al. 1997, Stevenson and Anderson 1994

Canada Warbler, *Wilsonia Canadensis*, ABPBX16030, G5, S4

Habitat and distribution: Canada warblers breed in the Georgia Blue Ridge province at high elevations. Suitable habitat includes ravines or cool slopes, with dense shrubbery such as mountain laurel or rhododendron. The forest canopy may be hemlock or hardwoods.

Model: Habitats 31, 424, 425, 431, and 433 within mask of elevations > 1158 m (3500 feet). Clipped by digitized range.

References: Bent 1953, Conway 1999, Curson et al. 1994, DeGraaf et al. 1991, Hamel 1992, Haney et al. 1986, Holt 1974, Hubbard 1971, Nicholson 1997, Robbins et al. 1989a, Sauer et al. 1997, Stupka 1963, Wilcove 1988

Carolina Chickadee, *Poecile carolinensis*, ABPAW01020, G5, S5

Habitat and distribution: Year-round residents throughout Georgia, Carolina chickadees may be found wherever trees are present, both in deep woods and in wooded residential areas. They like forests of all types, including mixed, coniferous and deciduous, and may also inhabit swampy areas. They are not found in much of the Okefenokee.

Model: Habitats 20, 31, 72, 73, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 620, 890, 900, 980, and 990. Statewide range, except much of the Okefenokee.

References: Aldrich and Coffin 1980, AOU 1983, Bent 1946, Brewer 1963, DeGraaf et al. 1991, Dickson et al. 1980, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Johnston and Odum 1956, Nicholson 1997, Sauer et al. 1997

Carolina Wren, *Thryothorus ludovicianus*, ABPBG06130, G5, S5

Habitat and distribution: Carolina wrens are year-round residents throughout Georgia, occupying a wide variety of habitats that provide at least some tree cover. They like brushy or tangled areas in the understory of forests, and are also common in residential areas, parks, and overgrown or brushy fields.

Model: Habitats 20, 22, 31, 72, 73, 80, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 513, 620, 890, 900, 980, and 990.

References: AOU 1983, Bent 1948, Burleigh 1958, DeGraaf et al. 1991, Dickson 1978, Ehrlich et al. 1988, Haggerty and Morton 1995, Hamel 1992, Haney et al. 1986, Meyers and Odum 1991, Nicholson 1997, Sauer et al. 1997, Strain and Mumme 1988, Wilcove 1988

Cattle Egret, *Bubulcus ibis*, ABNGA07010, G5, S5

Habitat and distribution: Not a native species, cattle egrets have become established in the Coastal Plain of Georgia and on coastal islands, where they nest in thickets or swamps. They may be seen foraging in pastures, grassy places, or mud flats, frequently well inland of tidal areas. Cattle egrets are often encountered in the vicinity of livestock. They are not found in much of the Okefenokee.

Model: Habitats 7, 11 (shallow fresh and saltwater), 73, 80, 83, 420, 513, 890, 900, 920, 930, 980, and 990 within digitized range.

References: AOU 1983, Bateman 1970, Custer and Osborn 1978, DeGraaf et al. 1991, Dusi and Dusi 1987, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Imhof 1976, Odom 1976, Sauer et al. 1997, Shanholtzer 1972, Stevenson and Anderson 1994, Telfair 1994, Werschkul 1977

Cedar Waxwing, *Bombycilla cedrorum*, ABPBN01020, G5, S4

Habitat and distribution: Cedar waxwings are relatively rare breeders in northern Georgia and in the upper Piedmont. They prefer open stands of coniferous forest, particularly hemlock and white pine, but also may be found in wooded residential areas or on the wooded fringes of agricultural areas.

Model: Habitats 22, 31, 72, 73, 201, 202, 203, 423, 424, 425, 431, and 433 within digitized range.

References: AOU 1983, Bent 1950, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Nicholson 1997, Sauer et al. 1997, Wilcove 1988, Witmer et al. 1997

Cerulean Warbler, *Dendroica cerulea*, ABPBX03240, G4, S3

Habitat and distribution: Cerulean warblers may breed at scattered locations in the Blue Ridge of Georgia. Very sensitive to forest fragmentation, they prefer large open stands of moist, mature hardwood forest. They are not found in coniferous woods.

Model: Habitats 410, 411, 413, 414, and 415 within mask of forested areas > 700 ha, and within stands > 75 years in age according to U.S. Forest Service CISC data. Clipped by digitized range.

References: AOU 1983, Bent 1953, DeGraaf et al. 1991, Ehrlich et al. 1988, Evans and Fischer 1997, Hamel 1992, Haney et al. 1986, Imhof 1976, Nicholson 1997, Robbins et al. 1989a, Robbins et al. 1989b, Sauer et al. 1997

Chestnut-sided Warbler, *Dendroica pensylvanica*, ABPBX03020, G5, S5

Habitat and distribution: Chestnut-sided warblers favor clearcuts, brushy thickets, open park-like deciduous forests, brier thickets, regenerating second growth hardwoods, edge habitats, and abandoned farmland reverting to forest. In Georgia they are found only at high elevations in the Blue Ridge.

Model: Habitats 20, 31, 411, 415, and 511 within mask of elevations > 838 m (2750 feet). Clipped by digitized range.

References: AOU 1983, Askins 1994, Bent 1953, Brooks 1947, Burleigh 1958, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Hubbard 1971, Kendeigh and Fawver 1981, Nicholson 1997, Odum and Burleigh 1946, Richardson and Brauning 1995, Sauer et al. 1997, Stupka 1963

Chimney Swift, *Chaetura pelagica*, ABNUA03010, G5, S5

Habitat and distribution: Chimney swifts breed throughout Georgia, and inhabit both open places and woodland. Swifts are largely dependent on the availability of suitable nest sites: chimneys, silos, wells, rafters, hollow trees, etc., and for this reason, they are often common around human habitation. They forage over either forested or open areas.

Model: Habitats 7, 11 (shallow fresh and saltwater), 20, 22, 24, 31, 33, 34, 72, 73, 80, 83, 201, 202, 203, 410, 411, 412, 414, 415, 424, 425, 431, 433, 620, 890, 900, and 930. Statewide range.

References: AOU 1983, Bent 1940, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Imhof 1976, Nicholson 1997, Sauer et al. 1997, Terres 1980

Chipping Sparrow, *Spizella passerina*, ABPBX94020, G5, S5

Habitat and distribution: Chipping sparrows breed throughout most of Georgia, with the exception of the lower Coastal Plain. They nest in areas having scattered trees and short grass: wooded residential areas, farmyards, golf courses, etc. They may also inhabit open coniferous and occasionally deciduous woods.

Model: Habitats 20, 22, 31, 72, 73, 80, 201, 202, 203, 411, 412, 413, 422, 431, 432, 434, 440, 441, 512, and 620 within digitized range.

References: AOU 1983, Bent 1968, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Imhof 1976, Middleton 1998, Nicholson 1997, Rising 1996, Sauer et al. 1997, Stevenson and Anderson 1994

Chuck-wills-widow, *Caprimulgus carolinensis*, ABNTA07010, G5, S4S5

Habitat and distribution: Chuck-will's widows breed throughout much of Georgia at moderate and lower elevations. They prefer dry or mesic mixed forest, but may also inhabit pine or oak woods. They may forage over adjacent fields or clearings.

Model: Habitats 9, 20, 31, 80, 410, 411, 412, 413, 420, 422, 432, 434, 440, 441, 512, 513, and 620 within mask of elevations < 518 m (1700 feet). Statewide range.

References: AOU 1983, Bent 1940, Cooper 1981, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Harper 1938, Imhof 1976, Nicholson 1997, Sauer et al. 1997, Straight and Cooper 2000

Clapper Rail, *Rallus longirostris*, ABNME05010, G5, S5

Habitat and distribution: Clapper rails are year-round residents of the coastal region of Georgia. They mostly inhabit salt marshes with Spartina grass. Areas near tidal creeks are ideal.

Model: Habitat 920 within digitized range.

References: Adams and Quay 1958, AOU 1983, Bent 1926, DeGraaf et al. 1991, Eddleman and Conway 1994, Eddleman and Conway 1998, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hon et al. 1977, Meanley 1985, Oney 1954, Sauer et al. 1997, Taylor 1998

Cliff Swallow, *Petrochelidon pyrrhonota*, ABPAU09010, G5, S3S4

Habitat and distribution: Cliff swallows in Georgia may nest under bridges or at dams on large lakes. Their distribution is strongly tied to large rivers. Foraging may take place over lakes, fields, cutover forests or other open areas near nest sites.

Model: Applied 1 km buffer to 1:100, 000 stream coverage, kept habitats 7, 11, 20, 31, 33, 34, 73, 80, 83, and 930 within buffer. Clipped by digitized range.

References: Alsop 1981, AOU 1983, Bent 1942, Brown and Brown 1995, Brown et al. 1992, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Samuel 1971, Sauer et al. 1997, Turner 1989

Common Barn-owl , *Tyto alba*, ABNSA01010, G5, S3S4

Habitat and distribution: Common barn-owls breed throughout most of Georgia, although they are usually absent from mountainous or heavily forested areas. They favor open country, especially pastures and fields. They most often nest in buildings; availability of nest sites is perhaps the primary limiting factor in their distribution.

Model: Kept classes 80 and 83, recoded to single value and expanded 1 pixel. Kept expanded clumps > 100 ha, using as mask for habitats 20, 31, 34, 80, and 83. Clipped by digitized range.

References: AOU 1983, Bent 1938, Burton 1973, Colvin 1985, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hegdal and Blaskiewicz 1984, Heintzelman 1984, Marti 1992, Nicholson 1997, Pough 1946

Common Grackle, *Quiscalus quiscula*, ABPBXB6070, G5, S5

Habitat and distribution: Common grackles are permanent residents throughout Georgia. They inhabit a wide variety of habitats, especially near residential or agricultural areas.

Model: Habitats 7, 9, 11 (shallow fresh water only), 18, 20, 22, 24, 72, 73, 80, 83, 201, 202, 203, 413, 420, 422, 423, 432, 434, 440, 441, 512, 513, 620, 890, 900, 930, 980, and 990. Statewide range, except coastal beaches and open ocean.

References: Aldrich and Coffin 1980, AOU 1983, Bent 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Erskine 1971, Fowler and Fowler 1985, Hamel 1992, Haney et al. 1986, Jaramillo and Burke 1999, Johnston 1990, Meyers and Johnson 1991, Nicholson 1997, Peer and Bollinger 1997, Sauer et al. 1997, Stevenson and Anderson 1994

Common Ground-dove, *Columbina passerina*, ABNPB06020, G5, S5

Habitat and distribution: Common ground-doves are permanent residents of Georgia south of the Fall Line. They nest in places with shrubs or small trees, in open habitats such as roadsides or fields, along forest edges, and in residential areas

Model: Habitats 9, 20, 22, 31, 72, 73, 80, 83, 201, 202, 203, 420, 422, 440, 441, 512, 513, and 620 within digitized range.

References: AOU 1983, Bent 1932, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Potter et al. 1980, Sauer et al. 1997, Stevenson and Anderson 1994, Terres 1980

Common Moorhen, *Gallinula chloropus*, ABNME13010, G5, S5

Habitat and distribution: Common moorhens are permanent residents of freshwater habitats in the Georgia Coastal Plain. In general, they may be found in ponds, marshes, streams, or any fresh water environment with emergent vegetation of cattails, bulrushes, reeds, or sedges.

Model: Habitats 11 (shallow fresh water only) and 930, within digitized range.

References: AOU 1983, DeGraaf et al. 1991, Ehrlich et al. 1988, Greij 1994, Hamel 1992, Haney et al. 1986, Helm et al. 1987, Matthews 1983, Sauer et al. 1997, Taylor 1998

Common Nighthawk, *Chordeiles minor*, ABNTA02020, G5, S5

Habitat and distribution: Common nighthawks breed throughout much of Georgia, where they inhabit open or bare areas. Along the coast, they are often encountered around sand dunes. Inland, they are primarily found around cities and towns, but may also be seen in clearcut areas, fields or very sparse forest.

Model: Habitats 9, 20, 22, 24, 31, 33, 34, 72, 73, 80, 83, 201, 202, 203, 420, 512, 513, and 620. Statewide range.

References: AOU 1983, Armstrong 1965, Bent 1940, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Larson 1970, Nicholson 1997, Poulin et al. 1996, Sauer et al. 1997

Common Raven, *Corvus corax*, ABPBX12010, G5, SU

Habitat and distribution: Rare this far south, common ravens are normally found in Georgia only at higher elevations of the Blue Ridge province, where they may nest in rocky and remote cliffs. They may be seen foraging over adjacent woods and fields, also at high elevations.

Model: Habitats 34, 411, 413, 414, 415, 423, 424, 425, 431, 432, 433, and 511 within mask of elevations > 1219 m (4000 feet). Clipped by digitized range.

References: AOU 1983, Bent 1946, Boarman and Heinrich 1999, DeGraaf et al. 1991, Ehrlich et al. 1988, Goodwin 1976, Hamel 1992, Haney et al. 1986, Hooper 1977, Hubbard 1971, Nicholson 1997, Sauer et al. 1997, Williams 1980

Common Yellowthroat, *Geothlypis trichas*, ABPBX12010, G5, S5

Habitat and distribution: Common yellowthroats breed throughout Georgia. Favored habitat is usually open country, including brushy places near wet or moist areas, shrubby brackish or freshwater marshes, old fields, swamp edges, etc.

Model: Habitats 9, 20, 31, 80, 420, 422, 440, 441, 512, 513, 620, 890, 900, 930, 980, and 990. Statewide range.

References: AOU 1983, Bent 1953, Burleigh 1958, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Guzy and Ritchison 1999, Hamel 1992, Haney et al. 1986, Holt 1974, James et al. 1993, Johnson and Landers 1982, Johnston and Odum 1956, Meyers and Johnson 1978, Meyers and Odum 1991, Nicholson 1997, Sauer et al. 1997

Cooper's Hawk, *Accipiter cooperii*, ABNKC12040, G5, S3S4

Habitat and distribution: Cooper's hawks breed throughout Georgia in a wide variety of wooded habitats. They are often spotted foraging over openings near forests, and in edge environments.

Model: Habitats 20, 31, 34, 72, 73, 201, 202, 203, 410, 411, 412, 413, 414, 415, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 620, 890, 900, and 990. Statewide range.

References: AOU 1983, Bent 1937, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnsgard 1990, Murphy et al. 1988, Nicholson 1997, Rosenfield and Bielefeldt 1993, Sauer et al. 1997, Snyder 1974

Dark-eyed junco, *Junco hyemalis*, ABPBXA5020, G5, S4?

Habitat and distribution: Dark-eyed juncos breed at higher elevations of the Blue Ridge of Georgia. They may nest in hardwood or mixed forest, in cool, moist conditions. They are often found near the edges of forests with grassy balds and in other nearby open areas.

Model: Habitats 31, 411, 414, 415, 424, 425, 431, 433, and 511 within mask of elevations > 990 m (3250 feet). Clipped by digitized range.

References: Andrle and Carroll 1988, AOU 1983, Bent 1968, Burleigh 1958, Byers et al. 1995, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hubbard 1971, Kendeigh and Fawver 1981, Nicholson 1997, Sauer et al. 1997, Wilcove 1988, Wolf 1987

Dickcissel, *Spiza americana*, ABPBX65010, G5, S3S4

Habitat and distribution: Generally considered a Midwestern or prairie species, Dickcissels are rare, occasional breeders in Georgia, primarily during invasion years. They inhabit open grassy areas such as pastures.

Model: Habitat 80, within digitized range.

References: AOU 1983, Bent 1968, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Fretwell 1986, Hamel 1992, Haney et al. 1986, Imhof 1976, McNair 1990, Nicholson 1997, Potter et al. 1980, Sauer et al. 1997

Downy Woodpecker, *Picoides pubescens*, ABNYF07030, G5, S5

Habitat and distribution: Downy woodpeckers breed throughout Georgia. They favor middle-aged to mature woodlands, although they are tolerant of earlier successional stages. Other habitats include residential areas, parks and orchards.

Model: Habitats 31, 72, 73, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 512, 513, 620, 890, 900, 980, and 990. Statewide range.

References: Aldrich and Coffin 1980, AOU 1983, Bent 1939, Conner et al. 1975, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnston and Odum 1956, Lawrence 1967, Meyers and Odum 1991, Nicholson 1997, Sauer et al. 1997, Shackelford and Conner 1997, Wilcove 1988, Winkler et al. 1995

Eastern Bluebird, *Sialia sialis*, ABPBJ15010, G5, S4S5

Habitat and distribution: Eastern bluebirds breed throughout Georgia. Birds of open country, they inhabit areas with little understory and sparse ground cover. Orchards, open fields, farmyards, roadsides, open residential areas, as well as open pine forests, may provide good bluebird habitat. Bluebirds are often abundant around residences with artificial nest boxes.

Model: Habitats 20, 22, 31, 72, 73, 80, 83, 422, 512, and 620 within mask of elevations < 1219 m (4000 feet). Statewide range.

References: Allen 1988, AOU 1983, Bent 1949, Conner and Adkisson 1975, DeGraaf et al. 1991, Ehrlich et al. 1988, Gowaty and Plissner 1998, Hamel 1992, Haney et al. 1986, Nicholson 1997, Sauer et al. 1997, Savareno 1991

Eastern Kingbird, *Tyrannus tyrannus*, G5, S5

Habitat and distribution: Eastern kingbirds breed statewide in Georgia. They are generally a bird of open country, favoring hedgerows, scattered trees, forest edge, recent clearcuts, and trees overhanging water.

Model: Habitats 11 (shallow fresh water only), 20, 31, 34, 72, 73, 80, 620, 890, 930, and 980. Statewide range.

References: AOU 1983, Bent 1942, DeGraaf et al. 1991, Dickson et al. 1980, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnston 1971, Meyers and Odum 1991, Murphy 1996, Nicholson 1997, Sauer et al. 1997

Eastern Meadowlark, *Sturnella magna*, ABPBXB2020, G5, S5

Habitat and distribution: Eastern meadowlarks are year-round residents in much of Georgia, except coastal areas. Meadowlarks are birds of open areas, occupying pastures and other grass-dominated habitats.

Model: Habitat 80 within digitized range.

References: AOU 1983, Bent 1958, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Jaramillo and Burke 1999, Lanyon 1995, Meyers and Johnson 1978, Meyers and Odum 1991, Nicholson 1997, Sauer et al. 1997, Stevenson and Anderson 1994, Wiens 1969

Eastern Phoebe, *Sayornis phoebe*, ABPAE35020, G5, S5

Habitat and distribution: The eastern phoebe breeds in Georgia from the upper Coastal Plain northward in wooded or partially wooded areas near streams, often preferring edges. Other habitats include farmyards, hedgerows and wooded residential areas.

Model: Habitats 7, 11 (shallow water only), 18, 22, 33, 34, 72, 73, 80, 201, 202, 203, 410, 411, 412, 414, 415, 424, 425, 431, 433, 890, 900, 930, and 980 within digitized range.

References: AOU 1983, Bent 1942, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnston 1971, McNair 1984, Nicholson 1997, Sauer et al. 1997, Weeks 1979, Weeks 1994

Eastern Screech-owl, *Otus asio*, ABNSB01030, G5, S5

Habitat and distribution: Eastern screech-owls breed throughout Georgia, nesting in a wide variety of habitats including deciduous, coniferous and mixed forest. They are frequently found in small woodlots or patches of forest, often near the edges of agricultural land, as well as in forested residential areas.

Model: Habitats 72, 73, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 512, 620, 890, 900, 980, and 990. Statewide range.

References: AOU 1983, Belthoff and Ritchison 1990, Belthoff et al. 1993, Bent 1938, Burton 1973, DeGraaf et al. 1991, Ehrlich et al. 1988, Gehlbach 1994, Gehlbach 1995, Hamel 1992, Haney et al. 1986, Heintzelman 1984, Pough 1946, Sauer et al. 1997, Sparks et al. 1994

Eastern Towhee, *Pipilo erythrophthalmus*, ABPBX74030, G5, S5

Habitat and distribution: Eastern towhees are year-round residents throughout Georgia, where they may be found in a variety of brushy or wooded habitats, including overgrown fields, thickets, forest edges, or the understory of open or cutover woodlands. They may also be found in residential areas.

Model: Habitats 20, 22, 31, 72, 73, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 431, 432, 434, 440, 441, 511, 512, 513, 620, 900, and 990 (no 990 in Okefenokee area). Statewide range.

References: AOU 1983, Bent 1968, Burleigh 1958, Conner and Adkisson 1975, DeGraaf et al. 1991, Ehrlich et al. 1988, Greenlaw 1996, Hagan 1993, Hamel 1992, Haney et al. 1986, Imhof 1976, Meyers and Odum 1991, Nicholson 1997, Rising 1996, Sauer et al. 1997

Eastern Wood-pewee, *Contopus virens*, ABPAE32060, G5, S5

Habitat and distribution: Eastern wood-pewees breed throughout Georgia, inhabiting open to medium-growth forests, primarily deciduous but also mixed and coniferous. They may also be found in parks, wooded suburbs, hedgerows or isolated clumps of trees.

Model: Habitats 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 512, 513, 620, 890, 900, and 990. Statewide range.

References: AOU 1983, Bent 1942, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hespenheide 1971, Holt 1974, Johnston 1971, Johnston and Odum 1956, McCarthy 1996, Meyers and Johnson 1978, Nicholson 1997, Noon et al. 1980, Pashley and Barrow 1993, Sauer et al. 1997

Eurasian collared-dove, *Streptopelia decaocto*, ABNPB02030, G5, SE

Habitat and distribution: Rapidly expanding their range, Eurasian collared-doves now breed throughout most of Georgia. These doves are typically associated with human populations in habitats such as suburbs, small towns, and agricultural areas where suitable food grains are present.

Model: Habitats 22, 24, 72, 80, and 83 within digitized range.

AOU 1983, Crawford 1995, Ehrlich et al. 1988, Hodges 1993, Horn and Flynn 2001, Smith 1987

European Starling, *Sturnus vulgaris*, ABPBT01010, G5, S5

Habitat and distribution: European starlings are found throughout Georgia. They may breed in either agricultural or urban locations.

Model: Habitats 22, 24, 72, 73, 80, and 83. Statewide range.

References: Aldrich and Coffin 1980, AOU 1983, Burleigh 1958, Cabe 1993, DeGraaf et al. 1991, Ehrlich et al. 1988, Feare 1984, Hamel 1992, Haney et al. 1986, Imhof 1976, Sauer et al. 1997, Terres 1980

Field Sparrow, *Spizella pusilla*, ABPBX94050, G5, S5

Habitat and distribution: Field sparrows are permanent residents throughout most of Georgia, breeding more commonly north of the Fall Line. They primarily inhabit old fields and other grassy areas with low shrubs, and are partial to briers, fencerows, forest edges, cut-over pine woods, etc.

Model: Habitats 20, 31, 80, and 512 within digitized range.

References: AOU 1983, Askins 1994, Bent 1968, Best 1977, Burleigh 1958, Carey et al. 1994, Conner and Adkisson 1975, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Imhof 1976, Nicholson 1997, Peterjohn and Rice 1991, Rising 1996, Sauer et al. 1997

Fish Crow, *Corvus ossifragus*, ABPAV10080, G5, S5

Habitat and distribution: A year-round Georgia resident, the fish crow is experiencing a range expansion northward into much of the Piedmont. It may be found in a wide variety of habitats including shores, marshes, shallow water, thickets, woodlands, fields, pastures and towns.

Model: Habitats 7, 9, 11, 18, 20, 22, 24, 31, 33, 72, 73, 80, 83, 201, 202, 203, 410, 412, 420, 422, 434, 440, 441, 513, 620, 890, 900, 920, 930, 980, and 990 within digitized range.

References: AOU 1983, Bent 1946, DeGraaf et al. 1991, Ehrlich et al. 1988, Goodwin 1976, Hamel 1992, Haney et al. 1986, Madge and Burn 1994, McNair 1987, Sauer et al. 1997

Glossy Ibis, *Plegadis falcinellus*, ABNGE02010, G5, S2S3

Habitat and distribution: Glossy ibises are very local summer residents of the Georgia coast and islands in coastal rivers. They nest in thickets of small trees and shrubs near water. Foraging is usually in shallow water in fresh or saltwater marshes and estuaries.

Model: Habitats 7, 11 (shallow fresh and saltwater), 420, 890, 920, 930, 980, and 990 within digitized range. Coastal beaches and open ocean omitted.

AOU 1983, Beaver et al. 1980, Bent 1926, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Odom 1976, Palmer 1962, Sauer et al. 1997, Spendelow and Patton 1988

Golden-winged Warbler, *Vermivora chrysoptera*, ABPBX01030, G4, S2

Habitat: Golden-winged warblers breed in the Blue Ridge province at higher elevations. They are usually found in clearcuts or old-field habitats with deciduous saplings; other potential habitats in north Georgia include power line rights-of way.

Model: Created new grid from habitats 20, 31, and 80. Expanded this grid 1 pixel around suitable pixels. Kept areas from expanded grid > 10 ha. Used this and elevations > 670m (2200 feet) as mask for suitable habitats. Clipped by digitized range.

References: AOU 1983, Askins 1994, Bent 1953, Brooks 1947, Confer 1992, Confer and Knapp 1981, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Ficken and Ficken 1968a, Ficken and Ficken 1968b, Hamel 1992, Haney et al. 1986, Holt 1974, Hubbard 1971, Nicholson 1997, Odum and Burleigh 1946, Sauer et al. 1997, Stupka 1963

Grasshopper Sparrow, *Ammodramus savannarum*, ABPBXA0020, G5, S4

Habitat and distribution: Grasshopper sparrows breed throughout much of Georgia north of the Fall Line, and in scattered pockets below, where they nest in larger open areas such as grassy fields or pastures.

Model: Habitats 80 and airports, where they are tracts > 10 ha, within digitized range.

References: AOU 1983, Bent 1968, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Herkert 1994, Johnston and Odum 1956, Meyers and Johnson 1978, Sauer et al. 1997, Vickery 1996, Young 1987

Gray Catbird, *Dumetella carolinensis*, ABPBK01010, G5, S5

Habitat and distribution: Gray catbirds breed throughout Georgia. They nest in thickets and other dense shrubby vegetation. Fencerows, abandoned farmland, residential areas, and pine plantations provide suitable habitat. The may also be present in dense underbrush in forested situations.

Model: Habitats 20, 31, 72, 73, 201, 202, 203, 410, 411, 412, 414, 415, 420, 424, 425, 431, 433, 434, 890, 900, 980, and 990. Statewide range.

References: Aldrich and Coffin 1980, AOU 1983, Burleigh 1958, Cimprich and Moore 1995, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Meyers and Johnson 1978, Meyers and Odum 1991, Nicholson 1997, Nickell 1965, Sauer et al. 1997

Gray Kingbird, *Tyrannus dominicensis*, ABPAE52070, G5, S2S3

Habitat and distribution: Gray kingbirds breed in some areas of the Georgia coast and on coastal islands. They nest near open areas such as along beaches or sand dunes of islands, in scattered trees, shrubs, or thickets. Gray kingbird habitat is usually within sight of saltwater.

Model: Habitats 7, 9, 11 (shallow fresh and saltwater), and 513 within digitized range.

References: AOU 1983, Ehrlich et al. 1988, Hamel 1992, Imhof 1976, National Geographic 1999, Stevenson and Anderson 1994, Terres 1980

Great Blue Heron, *Ardea herodias*, ABNGA04010, G5, S5

Habitat: Great blue herons are year-round residents in much of Georgia, where they nest in small groups of heronries in wooded areas, chiefly swamps or in isolated areas on islands. They forage in shallow water, in fresh or saltwater wetlands, and occasionally in fields and surf areas.

Model: Habitats 7, 11 (shallow fresh and saltwater), 73, 420, 513, 890, 900, 920, 930, 980, and 990 within digitized range.

References: AOU 1983, Bent 1926, Butler 1992, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Hancock and Elliott 1978, Haney et al. 1986, Odom 1976, Sauer et al. 1997, Spendelow and Patton 1988

Great Crested Flycatcher, *Myiarchus crinitus*, ABPAE43070, G5, S5

Habitat and distribution: Great-crested flycatchers breed statewide in Georgia. Inhabiting forest or forest edge, they may be found in deciduous, coniferous or mixed woodland. Other habitats include parks, wooded suburbs, and hedgerows with mature trees.

Model: Habitats 31, 72, 73, 201, 202, 203, 410, 411, 412, 413, 414, 420, 422, 423, 431, 432, 433, 434, 440, 441, 512, 620, 890, 900, 980, and 990. Statewide range.

References: AOU 1983, Bent 1942, DeGraaf et al. 1991, Dickson 1978, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnson and Landers 1982, Johnston 1971, Lanyon 1997, Meyers and Johnson 1978, Morrison 1988, Nicholson 1997, Pashley and Barrow 1993, Robbins et al. 1989a, Sauer et al. 1997, Stewart and Robbins 1958, Wilcove 1988

Great Egret, *Ardea alba*, ABNGA04040, G5, S4

Habitat and distribution: Great egrets are year-round residents of Georgia's coast and portions of the Coastal Plain where they nest in thickets of trees or shrubs on coastal islands and in tall trees along lakeshores. They forage in shallow water and on mudflats.

Model: Model: Habitats 7, 11 (shallow fresh and saltwater), 420, 890, 900, 920, 930, 980, and 990 within digitized range.

References: AOU 1983, Beaver et al. 1980, Bent 1926, Custer and Osborn 1978, DeGraaf et al. 1991, Dusi and Dusi 1987, Ehrlich et al. 1988, Hamel 1992, Hancock and Elliott 1978, Haney et al. 1986, Odom 1976, Sauer et al. 1997, Spendelow and Patton 1988, Teal 1965, Werschkul 1977

Great Horned Owl, *Bubo virginianus*, ABNSB05010, G5, S5

Habitat and distribution: Great horned owls breed throughout Georgia, generally in deciduous, mixed, or coniferous woods. They often choose fragmented landscapes, including pasture, croplands and fields as well as forest. They may be absent from heavily urban areas.

Model: Created grid of "edge" pixels between suitable open habitats (18, 20, 22, 31, 34, 72, 73, 80, 83, 201, 202, and 203) and suitable forested habitats (410, 411, 412, 413, 414, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 512, 513, 620, 890, 900, 980 and 990). Applied 1 km moving window (FOCALMEAN using rectangle), keeping areas where values were > 6. Used results of this as a mask for all suitable habitats. Statewide range.

References: AOU 1983, Baumgartner 1939, Bent 1938, Bosakowski et al. 1989, Burton 1973, DeGraaf et al. 1991, Ehrlich et al. 1988, Franks and Warnock 1969, Fuller 1979, Hamel 1992, Haney et al. 1986, Heintzelman 1984, Houston et al. 1998, James and Neal 1986, McGarigal and Fraser 1984, Sauer et al. 1997

Green Heron, *Butorides striatus*, ABNGA08010, G5, S5

Habitat and distribution: Green herons breed statewide in Georgia. They nest in wet woodlands, swamps and thickets. Green herons prefer fresh water, but they may also be found in brackish or saltwater.

Model: Kept all rasterized 1:24, 000 streams, as well as habitats 7, 890, 900, 920, 930, 980, and 990. Statewide range.

References: AOU 1983, Bent 1926, Davis and Kushlan 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Hancock and Elliott 1978, Haney et al. 1986, Kaiser and Reid 1987, Odom 1976, Palmer 1962, Sauer et al. 1997

Gull-billed Tern, *Sterna nilotica*, ABNNM08010, G5, S1

Habitat and distribution: Gull-billed terns are local summer residents and breeders across the coastal region of Georgia. They usually nest on sandy or shell beaches of coastal islands.

Model: Habitats 7 (associated with saltwater), 9, 11 (saltwater), and 920 within digitized range.

References: AOU 1983, Bent 1921, Burleigh 1958, Ehrlich et al. 1988, Erickson 1926, Everhart et al. 1980, Haney et al. 1986, Harris 1999d, Parnell et al. 1995, Spendelow and Patton 1988, Stevenson and Anderson 1994

Hairy Woodpecker, *Picoides villosus*, ABNYF07040, G5, S4

Habitat and distribution: Hairy woodpeckers breed throughout Georgia. They inhabit upland or lowland forests of many types, often selecting mature stands of deciduous forest, near edges. They may also be found in mature managed pine stands. They are generally more scarce near human habitation.

Model: Habitats 31, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 512, 620, 890, 900, 980, and 990 within digitized range.

References: AOU 1983, Bent 1939, Conner et al. 1975, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnston and Odum 1956, Kilham 1983, Nicholson 1997, Robbins et al. 1989a, Sauer et al. 1997, Shackelford and Conner 1997, Wilcove 1988, Winkler et al. 1995

Hooded Warbler, *Wilsonia citrina*, ABPBX16010, G5, S5
Habitat and distribution: Hooded warblers breed throughout Georgia primarily in fairly large tracts of moist, mature deciduous forests, especially bottomlands, and near streams or in ravines. Sometimes they are also found in mature pine forests.

Model: Habitats 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 900, and 990. Applied mask of forested areas > 15ha. Statewide range.

References: Aldrich and Coffin 1980, AOU 1983, Bent 1953, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Evans, Ogden, and Stutchbury 1994, Hamel 1992, Haney et al. 1986, Holt 1974, James et al. 1993, Johnston and Odum 1956, MacClintock et al. 1977, Meyers and Johnson 1978, Meyers and Odum 1991, Pashley and Barrow 1993, Robbins et al. 1989a, Sauer et al. 1997, Wilcove 1988

Horned Lark, *Eremophila alpestris*, ABPAT02010, G5, S3S4

Habitat and distribution: Horned larks have experienced a range expansion in Georgia, and are now found throughout much of the state. Formerly considered a prairie species, they are birds of open country. In Georgia they are most often seen around cultivated fields and pastures.

Model: Habitats 80 and 83 within digitized range.

References: AOU 1983, Beason 1995, Beason and Franks 1974, Bent 1942, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hurley and Franks 1976, Nicholson 1997, Sauer et al. 1997

House Finch, *Carpodacus mexicanus*, ABPBY04040, G5, S5

Habitat and distribution: House Finches are expanding their range in Georgia after being introduced from the Western U.S., and are now permanent residents throughout most of the state. They breed chiefly in urban and suburban areas, and sometimes in agricultural areas. These finches are frequently encountered around bird feeders.

Model: Habitats 20, 22, 24, 72, 73, 80, 83, 201, 202, and 203 within digitized range.

References: Andrle and Carroll 1988, AOU 1983, Clement 1993, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hill 1993, Sauer et al. 1997

House Sparrow, *Passer domesticus*, ABPBZ01010, G5, SE5

Habitat and distribution: Introduced from the Old World, house sparrows are permanent statewide residents in Georgia. Always found near humans, they may nest in cities or agricultural areas. They are absent from forest, including forested residential areas.

Model: Habitats 22, 24, 80, and 83. Statewide range.

References: AOU 1983, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Lowther and Cink 1992, Nicholson 1997, Sauer et al. 1997, Stevenson and Anderson 1994, Terres1980

House Wren, *Troglodytes aedon*, ABPBG09010, G5, S4

Habitat and distribution: House wrens in Georgia breed from just above the Fall Line northwards. During the breeding season, they occupy small blocks of forest with abundant shrubbery and openings. Suburban wooded residential areas are ideal.

Model: Habitats 22, 72, 73, 201, 202, and 203 within digitized range.

References: AOU 1983, Bent 1948, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnson 1998, Kendeigh 1941, Odum and Johnston 1951, Odum et al. 1993, Sauer et al. 1997

Indigo Bunting, *Passerina cyanea*, ABPBX64030, G5, S5

Habitat and distribution: Indigo buntings breed throughout most of Georgia, except for a large part of the Okefenokee Swamp. They prefer open places such as forest openings or clearcuts, power line rights-of-way, and pastures.

Model: Habitats 20, 31, 73, 80, 410, 411, 412, 413, 414, 415, 431, 434, 511, 512, 620, 890, and 900. Statewide range, except much of the Okefenokee.

References: AOU 1983, Askins 1994, Bent 1968, Burleigh 1958, Conner and Adkisson 1975, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Imhof 1976, Meyers and Johnson 1978, Nicholson 1997, Payne 1992, Sauer et al. 1997, Suarez et al. 1997, Wilcove 1988

Kentucky Warbler, *Oporornis formosus*, ABPBX11010, G5, S5

Habitat and distribution: Kentucky warblers breed throughout much of Georgia, except on the coast and lower Coastal Plain. They like any type of rich, moist hardwood forest at moderate elevations; habitat includes bottomlands and ravines with laurel and rhododendron.

Model: Habitats 410, 411, 412, 414, 431, 434, 890, and 900. Applied mask of forested areas > 18 ha. Clipped by digitized range.
References: AOU 1983, Bent 1953, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Gibbs and Faaborg 1990, Hamel 1992, Haney et al. 1986, James et al. 1993, Johnston and Odum 1956, McDonald 1998, Nicholson 1997, Noon et al. 1980, Robbins et al. 1989a, Sargent et al. 1997, Sauer et al. 1997, Wilcove 1988

Killdeer, *Charadrius vociferous*, ABNNB03090, G5, S5

Habitat and distribution: Killdeer are permanent residents of open areas throughout Georgia. Although often associated with water, they may also be found at some distance from it. Pastures, plowed fields, recent clearcuts, golf courses, airports, roadsides and large suburban lawns are all suitable habitats.

Model: Habitats 7, 9, 11 (shallow fresh and saltwater), 20, 22, 24, 31, 72, 73, 80, 83, 513, 920, and 930. Statewide range.

References: AOU 1983, Bent 1929, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnsgard 1981, Nicholson 1997, Sauer et al. 1997, Terres 1980

King Rail, *Rallus elegans*, ABNME05020, G4G5, S4S5

Habitat and distribution: Although common only in the Coastal Plain, King rails breed throughout much of Georgia. They favor a habitat of extensive freshwater or brackish marsh with abundant vegetation of sedges, bulrushes, and cattails.

Model: Habitat 930 within digitized range.

References: AOU 1983, Bent 1926, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Meanley 1969, Meanley 1992, Sauer et al. 1997, Taylor 1998

Laughing Gull, *Larus atricilla*, ABNNM03010, G5, S5

Habitat and distribution: Laughing gulls are local breeders along the coast of Georgia, where they may nest in dune areas, particularly those with some grass cover, sand spits, or other sandy areas.

Model: Habitats 7, 9, 11 (saltwater only), and 920 within digitized range.

References: AOU 1983, Bent 1921, Bongiorno 1970, Burger 1996, Ehrlich et al. 1988, Haney et al. 1986, Sauer et al. 1997, Spendelow and Patton 1988, Stevenson and Anderson 1994, Terres 1980

Least Bittern, *Ixobrychus exilis*, ABNGA02010, G5, S4

Habitat and distribution: Least bitterns breed commonly in Georgia along the coast and locally in much of the rest of the state. Breeding habitat is freshwater marshes with tall emergent vegetation.

Model: Habitat 930 within digitized range.

References: AOU 1983, Bent 1926, Brown and Dinsmore 1986, DeGraaf et al. 1991, Ehrlich et al. 1988, Gibbs et al. 1992, Hamel 1992, Hancock and Elliott 1978, Haney et al. 1986, Sauer et al. 1997, Weller 1961

Least Flycatcher, *Empidonax minimus*, ABPAE33070, G5, S3

Habitat and distribution: The least flycatcher breeds in the Blue Ridge province of Georgia, and even there it is extremely rare. It is usually found at higher elevations and may occur in a variety of forest types.

Model: Habitats 410, 411, 414, 415, 423, 424, 425, 431, 432, 433, and 980 within digitized range.

References: AOU 1983, Bent 1942, Briskie 1994, Davis 1959, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hespenheide 1971, Hubbard 1971, Johnston 1971, Nicholson 1997, Sauer et al. 1997

Least Tern, *Sterna antillarum*, ABNNM08100, G4, S3

Habitat and distribution: Least terns breed in coastal areas of Georgia where they nest in colonies, often on sandy beaches, or in other areas that are free of vegetation. Inland colonies may use flat roof tops for nesting.

Model: In coastal digitized range, habitats 7, 9, 11, and 920. In inland digitized range, habitats 11, 22, 24, 201, and 203.

References: AOU 1983, Atwood and Minsky 1983, Bent 1921, Burleigh 1958, Corbat 1990, DeGraaf et al. 1991, Ehrlich et al. 1988, Fisk 1978, Haney et al. 1986, Harris 1999c, Sauer et al. 1997, Savareno and Murphy 1995, Spendelow and Patton 1988, Thompson et al. 1997

Little Blue Heron, *Egretta caerulea*, ABNGA06040, G5, S3?

Habitat and distribution: Little blue herons are year-round residents in parts of the Coastal Plain of Georgia. They nest in heronries in swamps, forests, and thickets on coastal islands. Foraging habitats are shallow water and wetlands, preferably freshwater, but also salt.

Model: Habitats 7, 11 (shallow fresh and saltwater), 420, 890, 900, 920, 930, 980, and 990 within digitized range.
References: AOU 1983, Beaver et al. 1980, Bent 1926, Burleigh 1958, Custer and Osborn 1978, DeGraaf et al. 1991, Dusi and Dusi 1987, Ehrlich et al. 1988, Hamel 1992, Hancock and Elliott 1978, Haney et al. 1986, Odom 1976, Rodgers et al. 1995, Sauer et al. 1997, Spendelow and Patton 1988, Werschkul 1977

Loggerhead Shrike, *Lanius ludovicianus*, ABPBR01030, G5, S4

Habitat and distribution: Loggerhead shrikes are permanent residents throughout Georgia, except the Blue Ridge, parts of the upper Piedmont, and Okefenokee. Birds of open country, they may inhabit fields or pastures, particularly those with scattered trees for perching. Open longleaf pine also provides suitable habitat.

Model: Habitats 20, 80, 83, 513, and 620 within digitized range.

References: AOU 1983, Bent 1950, Bohall-Wood 1987, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Gawlik and Bildstein 1993, Hall et al. 1996, Hamel 1992, Haney et al. 1986, Sauer et al. 1997, Yosef 1996, Yosef and Grubb 1993

Louisiana Waterthrush, *Seiurus motacilla*, ABPBX10030, G5, S5

Habitat and distribution: Louisiana waterthrushes breed throughout Georgia, except the lower Coastal Plain. They are found in association with streams, particularly fast-flowing rocky streams or those with gravel bottoms. They favor deciduous forests, but may also breed near mud-bottomed streams in cypress swamps and bottomland forests.

Model: Applied 30 meter buffer to 1:24, 000 stream coverage, kept habitats 410, 411, 412, 414, 424, 425, 431, 433, 434, 890, 900 within buffer. Applied mask of forested areas (including clearcuts) > 350 ha. Clipped by digitized range.

References: AOU 1983, Bent 1953, Craig 1985, Curson et al. 1994, DeGraaf et al. 1991, Eaton 1958, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Nicholson 1997, Robbins et al. 1989a, Robinson 1995, Sauer et al. 1997, Wilcove 1988

Mallard, *Anas platyrhynchos*, ABNJB10060, G5, S5

Habitat and distribution: Believed to be feral birds in most of the South, mallards breed statewide in Georgia, except for a large part of the Okefenokee Swamp. They may be found in freshwater habitats such as marshes, lakes, or flooded bottomlands.

Model: Habitats 7 (only when associated with fresh water), 11 (fresh water only), 73, and 930. Statewide range, except much of the Okefenokee.

References: AOU 1983, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Nicholson 1997, Robbins and Blom 1996, Sauer et al. 1997, Stevenson and Anderson 1994

Marsh Wren, *Cistothorus palustris*, ABPBG10020, G5, S5

Habitat and distribution: Marsh wrens breed in coastal areas of Georgia, generally nesting in brackish or saltwater-tidewater marsh areas.

Model: Habitat 920 within digitized range.

References: AOU 1983, Bent 1948, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Kale 1965, Kroodsma and Verner 1997, Leonard and Picman 1987, Sauer et al. 1997

Mississippi Kite, *Ictinia mississippiensis*, ABNKC09010, G5, S3S4

Habitat and distribution: Mississippi kites breed in riverbottom forests of the Coastal Plain of Georgia and possibly in the lower Piedmont. They favor extensive hardwood stands for nesting, and forage in the forest as well as over marshes, clearings and cultivated fields. They may be found occasionally in well-forested urban areas of the Coastal Plain.

Model: Applied 1 km buffer to 1:100, 000 stream coverage, kept habitats 31, 80, 83, 201, 202, 203, 412, 890, 900, 930, and 990 within buffer. Clipped by digitized range.

References: AOU 1983, Barber et al. 1998, Bent 1937, Bolen and Flores 1994, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnsgard 1990, Kalla and Alsop 1983, Parker 1988, Parker 1999, Parker and Ogden 1979, Sauer et al. 1997

Mourning Dove, *Zenaida macroura*, ABNPB04040, G5, S5

Habitat and distribution: Mourning doves are permanent residents throughout Georgia, adaptable to a wide range of habitats. They may be found in open woods, often along the margins, in hedgerows, and in wooded residential areas.

Model: Habitats 20, 22, 31, 72, 73, 80, 83, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 431, 432, 434, 440, 441, 512, 513, 620, 900, and 990. Statewide range.

References: AOU 1983, Baskett et al. 1993, Bent 1932, DeGraaf et al. 1991, Dickson et al. 1980, Ehrlich et al. 1988, Grand and Mirarchi 1988, Hamel 1992, Haney et al. 1986, Mirarchi and Baskett 1994, Sauer et al. 1997, Sayre et al. 1980, Tomlinson et al. 1994

Northern Bobwhite, *Colinus virginianus*, ABNLC21020, G5, S5

Habitat and distribution: Northern bobwhite quail may be found in a variety of brushy habitats throughout much of Georgia. Suitable habitats include brushy pastures or fields, abandoned agricultural land, woodland margins, and open pine woods.

Model: Habitats 20, 31, 80, 83, 420, 422, 423, 432, 434, 440, 441, 512, and 620 within mask of elevations < 975 m (3200 feet). Applied mask of road density < 80 m per ha to eliminate urban areas. Statewide range, except barrier islands.

References: AOU 1983, Bent 1932, Brennan 1999, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnsgard 1973, Lee 1994, Meyers and Johnson 1978, Rosene 1969, Sauer et al. 1997

Northern Cardinal, *Cardinalis cardinalis*, ABPBX60010, G5, S5

Habitat and distribution: Northern cardinals breed throughout Georgia, where they are widespread in many wooded and shrubby habitats. They are abundant in wooded residential areas and along the edges of forests.

Model: Habitats 20, 22, 31, 72, 73, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 513, 620, 890, 900, 980, and 990. Statewide range.

References: Aldrich and Coffin 1980, AOU 1983, Beddal 1963, Bent 1968, Burleigh 1958, DeGraaf et al. 1991, Dickson 1978, Dow 1969, Ehrlich et al. 1988, Halkin and Linville 1999, Hamel 1992, Haney et al. 1986, Holt 1974, Johnston and Odum 1956, Meyers and Odum 1991, Nicholson 1997, Potter et al. 1980, Sauer et al. 1997, Stevenson and Anderson 1994

Northern Flicker, *Colaptes auratus*, ABNYF10020, G5, S5

Habitat and distribution: Northern flickers inhabit open woods, forest edge, and residential areas throughout Georgia. They seem to prefer hardwoods for breeding, but are also found in mixed woods and pines. They are most often found along forest edges.

Model: Created grid of "edge" pixels between open habitats (20, 22, 31, 34, 72, 73, 80, 83, 201, 202, 203, and 930) and all forested habitats (410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 513, 620, 890, 900, 980 and 990). Applied 1 km moving window (FOCALMEAN using rectangle), keeping areas where values were > 0. Used results of this as a mask for all suitable habitats. Statewide range.

References: Aldrich and Coffin 1980, AOU 1983, Bent 1939, Conner and Adkisson 1975, Conner et al. 1975, DeGraaf et al. 1991, Dickson et al. 1980, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Johnson and Landers 1982, Kilham 1983, Lawrence 1967, Moore 1995, Nicholson 1997, Royall and Bray 1980, Sauer et al. 1997, Shackelford and Conner 1997, Wilcove 1988, Winkler et al. 1999

Northern Mockingbird, *Mimus polyglottos*, ABPBK03010, G5, S5

Habitat and distribution: Northern mockingbirds breed throughout most of Georgia. Most common around towns, suburbs, and along roadsides, they may also be found in pastures or farm hedges, shrub patches, and woodland edges.

Model: Habitats 9, 20, 22, 24, 31, 34, 72, 73, 80, 83, 201, 202, 203, 512, 513, and 620. Statewide range.

References: Aldrich and Coffin 1980, AOU 1983, Burleigh 1958, DeGraaf et al. 1991, Derrickson and Breitwisch 1997, Dickson et al. 1980, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Meyers and Johnson 1978, Sauer et al. 1997

Northern Parula, *Parula americana*, ABPBX02010, G5, S5

Habitat and distribution: Northern parulas favor two different breeding habitat types in Georgia. On the Coastal Plain and Piedmont, they frequent swamps and mature bottomland hardwood. In mountain areas they are found in hemlock and mixed hemlock-deciduous forests, and occasionally pure hardwoods.

Model: Habitats 410, 411, 412, 414, 420, 424, 425, 431, 433, 434, 890, 900, and 990. Applied mask of forested areas > 30 ha. Statewide range.

References: AOU 1983, Bent 1953, Curson et al. 1994, DeGraaf et al. 1991, Dickson 1978, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, James et al. 1993, Johnson and Landers 1982, Moldenhauer and Regelski 1996, Nicholson 1997, Pashley and Barrow 1993, Robbins et al. 1989a, Sauer et al. 1997

Northern Rough-winged Swallow, *Stelgidopteryx serripennis*, ABPAU07010, G5, S5

Habitat and distribution: Northern rough-winged swallows may be seen throughout most of Georgia in open country and woodlands, particularly in locations near streams. They nest in vertical banks of ponds, lakes, rivers, quarries or other embankments, and their distribution depends on the availability of these nesting sites.

Model: Kept clumps of habitat 11 greater than 10 ha. Expanded resultant grid 1.2 km. Used this as mask for suitable habitats 11, 20, 22, 31, 33, 34, 72, 73, 80, 83, 201, 202, 203, 900, 930, and 980. Statewide range, except areas of open ocean.

References: AOU 1983, Bent 1942, DeGraaf et al. 1991, DeJong 1996, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Lunk 1962, Nicholson 1997, Sauer et al. 1997, Turner 1989

Orchard Oriole, *Icterus spurious*, ABPBXB9070, G5, S5

Habitat and distribution: Orchard orioles breed throughout Georgia in a variety of habitats. They may be found in clearcuts, agricultural areas, and sometimes around residential areas or parks.

Model: Habitats 20, 22, 31, 72, 73, 80, 83, 201, 202, 203, 512, and 513 within mask of elevations < 762 m (2500 feet). Statewide range.

References: AOU 1983, Bent 1958, Burleigh 1958, DeGraaf et al. 1991, Dickson et al. 1980, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Meyers and Odum 1991, Nicholson 1997, Orians 1985, Sauer et al. 1997, Scharf and Kren 1996

Osprey, *Pandion haliaetus*, ABNKC01010, G5, S3

Habitat and distribution: Ospreys breed throughout Georgia, although they are common only along the coast and in the Okefenokee Swamp; in the northern part of the state they are usually seen near reservoirs.

Model: Kept all rasterized 1:24, 000 streams, as well as clumps of habitat 11 greater than 10 ha. Within a mosaiced grid of these areas, expanded them 2 km. Used this as mask for suitable habitats 11, 920, and 930. Kept all 11, 920, and 930 in Okefenokee area. Clipped by digitized range.

References: AOU 1983, Bent 1937, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Henny 1988, Johnsgard 1990, Nicholson 1997, Poole 1989, Sauer et al. 1997

Ovenbird, *Seiurus aurocapillus*, ABPBX10010, G5, S5

Habitat and distribution: Ovenbirds breed in northern Georgia in extensive, mature, dry deciduous forests, usually in hilly areas. Occasionally they are found in mixed forest.

Model: Habitats 410, 411, 412, 413, 414, 415, 431, 433, and 434. Applied mask of forested areas > 6 ha. Clipped by digitized range.

References: AOU 1983, Bent 1953, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Gibbs and Faaborg 1990, Hamel 1992, Haney et al. 1986, Holt 1974, Nicholson 1997, Noon et al. 1980, Robbins et al. 1989a, Sauer et al. 1997, Smith and Shugart 1987, Sweeney and Dijak 1985, Van Horn and Donovan 1994, Wilcove 1988

Painted Bunting, *Passerina ciris*, ABPBX64060, G5, S3

Habitat and distribution: Painted buntings in Georgia breed along the coast and in some interior locations in the Coastal Plain. They are generally found in areas with brush or trees, weedy and shrubby areas, and in riparian thickets. Along the immediate Coast they may be common in residential areas.

Model: Digitized range into 2 areas: one along immediate coast and in the Savannah River valley, and one in rest of range. In coastal and Savannah River areas kept habitats 9, 20, 31, 420, 512, 513, and 980. In rest of range, kept habitats 420, 512, and 980 within 150 m of 1:100, 000 streams

References: AOU 1983, Bent 1968, Burleigh 1958, Cox 1996, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Lanyon and Thompson 1986, Lowther et al. 1999, Meyers et al. 1999, Sauer et al. 1997, Stevenson and Anderson 1994

Peregrine Falcon, *Falco peregrinus*, ABNKD06070, G4, S1

Habitat and distribution: Rare in Georgia, the Peregrine falcon was formerly known to nest in remote cliffs. Becoming nearly extinct by the 1970's, they have now been reintroduced and breed in downtown Atlanta and may occasionally be seen in other places.

Model: Habitat 24 within digitized range.

References: AOU 1983, Bent 1938, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnsgard 1990, Ratcliffe 1980, Williams 1999b

Pied-billed Grebe, *Podilymbus podiceps*, ABNCA02010, G5, S4S5

Habitat and distribution: Pied-billed grebes in Georgia breed at scattered localities in the Coastal Plain. Favored breeding habitat includes well-vegetated lakes, small ponds, sluggish streams, and marshes.

Model: Habitats 11 (shallow freshwater only) and 930 within digitized range.

References: AOU 1983, DeGraaf et al. 1991, Ehrlich et al. 1988, Gibbs and Melvin 1992, Hamel 1992, Haney et al. 1986, Muller and Storer 1999, Palmer 1962, Sauer et al. 1997

Pileated Woodpecker, *Dryocopus pileatus*, ABNYF12020, G5, S4

Habitat and distribution: Pileated woodpeckers breed throughout Georgia in mature coniferous, deciduous or mixed forest, from swampy areas to uplands. They require a large number of dead trees, and are more common on larger tracts of wooded land.

Model: From grid of all forested areas, expanded forest areas 1 pixel to cross roads, etc. From resultant grid, created mask of forested areas > 165 ha. Kept habitats 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 424, 425, 431, 432, 433, 434, 440, 441, 620, 890, 900, and 990 within mask. Statewide range.

References: AOU 1983, Bent 1939, Bull and Jackson 1995, Conner et al. 1975, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hoyt 1957, Nicholson 1997, Renken and Wiggers 1989, Renken and Wiggers 1993, Robbins et al. 1989a, Sauer et al. 1997, Shackelford and Conner 1997, Wilcove 1988, Winkler et al. 1995

Pine Warbler, *Dendroica pinus*, ABPBX03170, G5, S5

Habitat and distribution: Pine warblers reside year-round throughout most of Georgia. They prefer mid-aged to mature pine stands, but may also be found in mixed forest.

Model: Habitats 422, 423, 425, 431, 432, 434, 440, 441, and 620 within mask of elevations < 914 m (3000 feet). Statewide range.

References: AOU 1983, Bent 1953, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hardy 1991, Jackson 1988, Johnston and Odum 1956, Meyers and Johnson 1978, Meyers and Odum 1991, Rodewald et al. 1999, Sauer et al. 1997

Prairie Warbler, *Dendroica discolor*, ABPBX03190, G5, S5

Habitat and distribution: Prairie warblers breed throughout Georgia. Habitat includes open brushy, shrubby areas, sand dunes, and young pine plantations. They may also be found in mature pine stands.

Model: Habitats 20, 31, 440, 441, 512, and 620. Statewide range.

References: AOU 1983, Askins 1994, Bent 1953, Conner and Adkisson 1975, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Jackson 1988, James et al. 1993, Meyers and Johnson 1978, Meyers and Odum 1991, Nicholson 1997, Nolan 1978, Nolan et al. 1999, Sauer et al. 1997

Prothonotary Warbler, *Protonotaria citrea*, ABPBX07010, G5, S5

Habitat and distribution: Prothonotary warblers in Georgia breed commonly south of the fall line and locally in the Piedmont and Ridge & Valley. They prefer swamps and moist bottomland forests near standing water.

Model: Habitats 890 and 900 within digitized range.

References: AOU 1983, Bent 1953, Blem and Blem 1991, Curson et al. 1994, DeGraaf et al. 1991, Dickson 1978, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, James et al. 1993, Pashley and Barrow 1993, Petit 1989, Petit 1999, Reynolds 1997, Sauer et al. 1997, Walkinshaw 1979

Purple Gallinule, *Porphyrula martinica*, ABNME12010, G5, S4

Habitat and distribution: In Georgia Purple gallinules breed in freshwater habitats on the lower Coastal Plain. They may be found on the margins of lakes or ponds with emergent vegetation or in marshes with open water.

Model: Habitats 11 (shallow freshwater only) and 930 within digitized range.
References: AOU 1983, Bent 1926, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Helm 1994, Helm et al. 1987, Taylor 1998

Purple Martin, *Progne subis*, ABPAU01010, G5, S5

Habitat and distribution: Found throughout Georgia at moderate and lower elevations, purple martins may be seen in open fields and cut over areas, especially in places near water. They commonly nest in purple martin houses placed around farms, ponds, or residences.

Model: Habitats 7 (coastal beaches omitted), 11 (freshwater only), 20, 22, 31, 73, 80, 83, 930, and 980. Statewide range.

References: Allen and Nice 1952, AOU 1983, Bent 1942, Brown 1997, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Nicholson 1997, Robinson 1990, Sauer et al. 1997, Turner 1989

Red Crossbill, *Loxia curvirostra*, ABPBY05010, G5, SU

Habitat and distribution: Red crossbills are rare local breeders in Georgia in a few locations in the Blue Ridge, and on Pine Log Mountain in the upper Piedmont. In the Blue Ridge, they inhabit mature coniferous forests of montane species such as hemlock. At Pine Lob Mountain they are found in mature pines.

Model: Habitats 422, 424, 425, 433, and 440 within digitized range.

References: Adkisson 1996, AOU 1983, Ehrlich et al. 1988, Hamel 1992, Imhof 1976, National Geographic 1999, Nicholson 1997, Terres 1980

Red-bellied Woodpecker, *Melanerpes carolinus*, ABNYF04170, G5, S5

Habitat and distribution: Red-bellied woodpeckers breed throughout Georgia in deciduous, pine or mixed forest at moderate and low elevations. Other suitable habitat includes parks or residential areas with mature trees, pecan groves and small woodlots.

Model: Habitats 31, 72, 73, 201, 202, 203, 410, 411, 412, 413, 414, 420, 422, 431, 432, 434, 440, 441, 512, 620, 890, 900, 980, and 990 within mask of elevations > 914 m (3000 feet).

References: Aldrich and Coffin 1980, AOU 1983, Bent 1939, DeGraaf et al. 1991, Dickson 1978, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnson and Landers 1982, Meyers and Johnson 1978, Meyers and Odum 1991, Nicholson 1997, Reller 1972, Sauer et al. 1997, Shackelford et al. 2000, Winkler et al. 1995

Red-breasted Nuthatch, *Sitta canadensis*, ABPAZ01010, G5, S4

Habitat and distribution: Believed to be expanding its range southwards, the red-breasted nuthatch breeds in Georgia at high elevations in a few locations of the Blue Ridge province. Breeding habitat is mature montane forest, usually among evergreen species such as hemlocks or pines.

Model: Habitats 424, 425, 431, and 433 within digitized range.

References: Andrle and Carroll 1988, AOU 1983, DeGraaf et al. 1991, Ehrlich et al. 1988, Ghalambor and Martin 1999, Hamel 1992, Nicholson 1997, Oberle and Forsythe 1995, Oberle and Haney 1998, Renfrow 1996, Sauer et al. 1997

Red-cockaded Woodpecker, *Picoides borealis*, ABNYF07060, G3, S2

Habitat and distribution: Red-cockaded woodpeckers breed in small colonies in mature, open pine forests from the lower Piedmont of Georgia south through the Coastal Plain. Very sensitive to habitat fragmentation, they prefer large undisturbed stands of longleaf pine, although they may also be found in other types, too, including loblolly-shortleaf.

Model: Habitats 422 and 620 within digitized range.

References: AOU 1983, Baker 1981, Bent 1939, Conner and Rudolph 1991, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hooper et al. 1982, Jackson 1994, Jackson et al. 1979, Lennartz and Henry 1985, Ligon 1970, McFarlane 1992, Sauer et al. 1997, Shackelford and Conner 1997, Winkler et al. 1995

Red-eyed Vireo, *Vireo olivaceus*, ABPBW01240, G5, S5

Habitat and distribution: Red-eyed vireos breed throughout Georgia in deciduous or mixed forest, although they are not common in forests where conifers predominate. They may be found in both bottomlands and uplands.

Model: Habitats 410, 411, 412, 413, 414, 415, 420, 422, 431, 432, 433, 434, 900, and 990. Applied mask of forested areas > 2.5 ha. Statewide range, except much of the Okefenokee.

References: Aldrich and Coffin 1980, AOU 1983, Bent 1950, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Johnston and Odum 1956, Lawrence 1953, Meyers and Odum 1991, Nicholson 1997, Pashley and Barrow 1993, Robbins et al. 1989a, Sauer et al. 1997, Wilcove 1988, Williamson 1971

Red-headed Woodpecker, *Melanerpes erythrocephalus*, ABNYF04040, G5, S4

Habitat and distribution: Red-headed woodpeckers breed throughout Georgia in deciduous, coniferous, and mixed forests. They often are seen in open pine or oak woods. Other habitats include parks, golf courses, and residential areas.

Model: Habitats 31, 72, 73, 201, 202, 203, 410, 412, 420, 422, 434, 440, 441, 512, 620, 890, 900, and 990 within mask of elevations < 762 m (2500 feet). Statewide range.

References: AOU 1983, Bent 1939, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Kilham 1983, Nicholson 1997, Reller 1972, Sauer et al. 1997, Shackelford and Conner 1997, Winkler et al. 1995

Red-shouldered Hawk, *Buteo lineatus*, ABNKC19030, G5, S4

Habitat and distribution: The red-shouldered hawk breeds throughout Georgia at lower elevations. It is most common in and along the edges of wooded swamps, bottomlands, and moist, mature forests.

Model: Habitats 20, 31, 80, 201, 202, 203, 410, 412, 420, 890, 900, 930, and 990. Statewide range.

References: AOU 1983, Bent 1937, Crocoll 1994, Crocoll and Parker 1989, DeGraaf et al. 1991, Dijak et al. 1989, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Howell and Chapman 1997, Johnsgard 1990, Nicholson 1997, Preston et al. 1989, Sauer et al. 1997, Senchak 1991, Stewart 1949, Titus and Mosher 1981
Red-tailed Hawk, *Buteo jamaicensis*, ABNKC19110, G5, S4

Habitat and distribution: Red-tailed hawks breed throughout most of Georgia. They have a wide tolerance of habitat types, but nest most commonly in mature deciduous or mixed woodlands. Red-tailed hawks prefer to forage in open areas and along forest edges.
Model: Habitats 20, 22, 31, 33, 34, 72, 73, 80, 83, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 431, 432, 434, 440, 441, 512, 513, 620, 900, and 930. Statewide range, except much of the Okefenokee.
References: AOU 1983, Bent 1937, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Howell et al. 1978, Imhof 1976, Johnsgard 1990, Nicholson 1997, Peterson 1979, Preston and Beane 1993, Sauer et al. 1997, Titus and Mosher 1981

Red-winged Blackbird, *Agelaius phoeniceus*, ABPBXB0010, G5, S5

Habitat and distribution: Red-winged blackbirds are year-round residents throughout Georgia. They may nest in freshwater or saltwater marshes, wet thickets, borders of lakes or ponds, and in open places in swamps. They may also be seen in pastures, old fields, and other early successional habitats.

Model: Habitats 7 (coastal beaches omitted), 11 (shallow freshwater only), 20, 31, 73, 80, 83, 890, 920, 930, 980, and 990. Statewide range.

References: AOU 1983, Bent 1958, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Jaramillo and Burke 1999, Nero 1984, Nicholson 1997, Sauer et al. 1997, Skutch 1996, Stevenson and Anderson 1994, Yasukawa and Searcy 1995

Rock Dove, *Columba livia*, ABNPB01010, G5, SE5

Habitat and distribution: Introduced from Eurasia, rock doves are now found statewide in Georgia. They are not restricted to a particular breeding season, often nesting in midwinter. Rock doves are most frequently encountered in parks or other urban places, but may also be seen in agricultural areas.

Model: Habitats 24, 80, and 83. Statewide range.

References: AOU 1983, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnston 1992, Nicholson 1997, Sauer et al. 1997, Stevenson and Anderson 1994, Terres 1980

Rose-breasted Grosbeak, *Pheucticus ludovicianus*, ABPBX61030, G5, S4

Habitat and distribution: Rose-breasted grosbeaks breed in Georgia at higher elevations. They inhabit hardwood forest, including cove hardwoods and chestnut oak forests.

Model: Habitats 411, 414, 415, 424, 425, 431, 433, and 511. Applied masks of elevations > 838 m (2750 feet) and forested areas > 3 ha. Clipped by digitized range.

References: Andrle and Carroll 1988, AOU 1983, Bent 1968, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Hubbard 1971, Nicholson 1997, Robbins et al. 1989a, Sauer et al. 1997, Wilcove 1988

Royal Tern, *Sterna maxima*, ABNNM08030, G5, S5

Habitat and distribution: Royal terns are year-round residents of the Georgia coast and offshore coastal areas where they nest locally in colonies. Breeding locations are open sandy beaches, particularly isolated, sparsely vegetated sandbars free of predators. They forage over open water and salt marsh.

Model: Habitats 7, 9, 11, and 920 within digitized range.

References: AOU 1983, Bent 1921, Burleigh 1958, Ehrlich et al. 1988, Haney et al. 1986, Sauer et al. 1997, Spendelow and Patton 1988, Stevenson and Anderson 1994

Ruby-throated Hummingbird, *Archilochus colubris*, ABNUC45010, G5, S5

Habitat and distribution: Ruby-throated hummingbirds breed statewide in Georgia. They are most numerous in moist areas such as bottomland woods, but may also be found in upland forest, overgrown fields, clearcuts, and residential areas. They may be locally common where there are flowers such as honeysuckle or trumpetvine.

Model: Habitats 20, 31, 201, 202, 203, 410, 411, 412, 414, 415, 420, 422, 431, 434, 620, 900, 980, and 990. Statewide range.

References: AOU 1983, Bent 1940, DeGraaf et al. 1991, Dickson et al. 1980, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnsgard 1983, Nicholson 1997, Pitelka 1942, Robinson et al. 1996, Sauer et al. 1997, Wilcove 1988

Ruffed Grouse, *Bonasa umbellus*, ABNLC11010, G5, S4

Habitat and distribution: Ruffed grouse are year-round residents of the Blue Ridge province of Georgia. They may be found in a variety of forests in upland, hilly areas. In general, they prefer those with a heavy understory, such as mountain laurel or rhododendron. Stands of a relatively young age often provide excellent habitat.

Model: Habitats 20, 31, 410, 411, 412, 413, 414, 415, 423, 424, 425, 431, 432, 433, and 511 within mask of elevations > 500 m (1640 feet). Clipped by digitized range.

References: AOU 1983, Bent 1932, Conner and Adkisson 1975, DeGraaf et al. 1991, Ehrlich et al. 1988, Hale et al. 1982, Hamel 1992, Haney et al. 1986, Hewitt and Kirkpatrick 1997, Johnsgard 1973, Sauer et al. 1997, Thompson and Fritzell 1989, Wiggers et al. 1992, Wilcove 1988

Sandhill Crane, *Grus Canadensis*, ABNMK01010, G5, S1

Habitat and distribution: Sandhill cranes are permanent residents of Georgia only in the Okefenokee Swamp and a few nearby areas. Breeding habitat consists of open marshes or prairies surrounded by shrubs or forest.

Model: Habitats 11 (shallow fresh water only) and 930 within digitized range.

References: AOU 1983, Bennett 1989, Bent 1926, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Sauer et al. 1997, Tacha et al. 1992

Sandwich Tern, *Sterna sandvicensis*, ABNNM08050, G5, S4

Habitat and distribution: More common as summer visitors, Sandwich terns breed occasionally along the Georgia coast, often in the company of other species of terns. They nest on sandy beaches, small islands, dredges or flats, and may be found foraging in bays, estuaries, or on mudflats.

Model: Habitats 7, 9, and 11 (saltwater only) within digitized range.

References: AOU 1983, Bent 1921, Burleigh 1958, Ehrlich et al. 1988, Haney et al. 1986, Harrison 1987, Shealer 1999, Spendelow and Patton 1988, Stevenson and Anderson 1994, Terres 1980

Scarlet Tanager, *Piranga olivacea*, ABPBX45040, G5, S5

Habitat and distribution: Scarlet tanagers breed throughout much of Georgia generally north of the Fall Line. They prefer upland deciduous forest, but may also be found in bottomlands, mixed forest, and, in some places, heavily forested suburban areas.

Model: Habitats 410, 411, 412, 413, 414, 415, 431, 432, 433, 434, and 900. Applied mask of forested areas > 12 ha. Clipped by digitized range.

References: Aldrich and Coffin 1980, AOU 1983, Bent 1958, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Isler and Isler 1987, Mowbray 1999, Nicholson 1997, Robbins 1980, Robbins et al. 1989a, Roberts and Norment 1999, Sauer et al. 1997, Shy 1984, Wilcove 1988

Seaside Sparrow, *Ammodramus maritimus*, ABPBXA0060, G4, S3

Habitat and distribution: Seaside sparrows are year-round residents in coastal areas of Georgia, where they inhabit brackish or saltwater marshes.

Model: Habitat 920 within digitized range.

References: AOU 1983, Baker 1973, Bent 1968, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Post and Greenlaw 1994, Post et al. 1983, Pough 1946, Rising 1996, Robbins 1983, Stevenson and Anderson 1994

Sharp-shinned Hawk, *Accipiter striatus*, ABNKC12020, G5, S4

Habitat and distribution: Sharp-shinned hawks in Georgia breed above the Fall Line in forested areas, and are most numerous in mixed forest, although they also occupy hardwoods and coniferous woods.

Model: Habitats 20, 201, 202, 203, 410, 411, 412, 413, 414, 415, 423, 424, 425, 431, 432, 433, and 434 within digitized range.

References: AOU 1983, Bent 1937, Bildstein and Meyer 2000, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnsgard 1990, Meyer 1987, Palmer 1988, Sauer et al. 1997, Wiggers and Kritz 1991

Snowy Egret, *Egretta thula*, ABNGA06030, G5, S4

Habitat and distribution: Snowy egrets breed along the Georgia Coast and in some inland locations where they nest in shrub or tree thickets on islands or lake margins, and in swamps. They forage on mudflats and in the shallow waters of bays, lakes, and marshes.

Model: Habitats 7, 11 (shallow fresh and saltwater), 420, 890, 900, 920, 930, 980, and 990 within digitized range.

References: AOU 1983, Beaver et al. 1980, Bent 1926, Custer and Osborn 1978, DeGraaf et al. 1991, Dusi and Dusi 1987, Ehrlich et al. 1988, Hamel 1992, Hancock and Elliott 1978, Haney et al. 1986, Odom 1976, Parsons and Master 2000, Sauer et al. 1997, Smith 1995, Spendelow and Patton 1988, Teal 1965, Werschkul 1977

Solitary Vireo, *Vireo solitarius*, ABPBW01160, G5, S5

Habitat and distribution: Solitary vireos breed in northern Georgia in a variety of forested habitats. In the mountains, they are most often found in mixed hemlock and white pine forests, and in deciduous forests at higher elevations. They may be found in deciduous and mixed forests at some Piedmont locations south to near the Fall Line.

Model: Habitats 410, 411, 412, 413, 414, 415, 423, 424, 425, 431, 432, 433, 434, and 511 within digitized range.

References: AOU 1983, Bent 1950, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Hubbard 1971, James 1979, Nicholson 1997, Odum 1948, Sauer et al. 1997, Stupka 1963, Wilcove 1988

Song Sparrow, *Melospiza melodia*, ABPBXA3010, G5, S5

Habitat and distribution: Song sparrows breed throughout much of Georgia north of the Fall Line. They nest in a variety of shrubby habitats in open country, including farmyards, pastures, hedgerows, and clearcuts. Song sparrows may also be found in residential areas.

Model: Habitats 20, 22, 31, 72, 73, 80, 83, 201, 202, 203, and 980 within digitized range.

References: AOU 1983, Bent 1968, Burleigh 1958, DeGraaf 1989, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Nicholson 1997, Odum and Burleigh 1946, Rising 1996, Sauer et al. 1997

Summer Tanager, *Piranga rubra*, ABPBX45030, G5, S5

Habitat and distribution: Summer tanagers breed in most of Georgia at moderate and lower elevations. They most often inhabit relatively dry stands of hardwood or mixed forest. However, they may also be found in wooded residential areas, pine stands, or bottomland hardwoods. They are quite rare in most of the Okefenokee.

Model: Habitats 410, 411, 412, 413, 420, 422, 432, 434, 440, 441, 512, 513, and 900. Applied masks of elevations < 762 m (2500 feet) and forested areas > 40 ha. Statewide range, except much of the Okefenokee.

References: AOU 1983, Bent 1958, Burleigh 1958, DeGraaf et al. 1991, Dickson 1978, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Imhof 1976, Isler and Isler 1987, Nicholson 1997, Robbins et al. 1989a, Robinson 1996, Sauer et al. 1997, Shy 1984

Swainson's Warbler, *Limnothlypis swainsonii*, ABPBX09010, G4, S3

Habitat and distribution: Swainson's warblers breed throughout much of Georgia. On the Coastal Plain and Piedmont they may be found in moist bottomland hardwood stands, often in association with canebrakes. In the mountains they are usually found in ravines of hardwoods or mixed forest, in association with rhododendron or mountain laurel.

Model: Habitats 410, 414, 424, 425, 433, and 900. Applied mask of forested areas > 350 ha. Clipped by digitized range.

References: AOU 1983, Bent 1953, Brooks and Legg 1942, Brown and Dickson 1994, Curson et al. 1994, DeGraaf et al. 1991, Denton 1948, Eddleman et al. 1980, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Meanley 1966, Pashley and Barrow 1993, Sauer et al. 1997

Swallow-tailed Kite, *Elanoides forficatus*, ABNKC04010, G5, S2

Habitat and distribution: Swallow-tailed kites breed locally in Georgia in river swamps of the Coastal Plain. They nest in mature bottomland or swamp forests near open marsh, avoiding dry or upland habitats.

Model: Created new grid from habitats 11(freshwater only), 20, 31, 412, 441, 890, 900, 930, and 990. Kept tracts of suitable habitats > 530 ha. Used this as mask for suitable habitats. Clipped by digitized range.

References: AOU 1983, Bent 1937, Cely and Sorrow 1990, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Johnsgard 1990, Meyer 1995, Meyer and Collopy 1990, Sauer et al. 1997, Williams 1999a

Tree Swallow, *Tachycineta bicolor*, ABPAU03010, G5, S5

Habitat and distribution: Expanding their range southward, tree swallows currently breed in much of Georgia north of the Fall Line. They inhabit open areas near larger lakes or rivers.

Model: Applied 1.2 km buffer to 1:100, 000 stream coverage. Kept all clumps of habitat 11 greater than 40 ha. Mosaiced these two grids, and used as mask for suitable habitats 7, 11, 22, 80, 83, 930, and 980. Clipped by digitized range.

References: Andrle and Carroll 1988, AOU 1983, Bent 1942, DeGraaf et al. 1991, Duyck 1981, Ehrlich et al. 1988, Hamel 1992, Nicholson 1997, Robertson et al. 1992

Tricolored Heron, *Egretta tricolor*, ABNGA06050, G5, S4

Habitat and distribution: Tricolored herons are year-round residents near the Georgia coast. They may nest along lake shores or in thickets of small oaks, red maples, yuccas, bald-cypress and willows. Foraging habitat is shallow water and mud flats in saltwater or sometimes freshwater marshes.

Model: Habitats 7, 11 (shallow fresh and saltwater), 420, 513, 890, 900, 920, 930, 980, and 990 within digitized range.

References: AOU 1983, Bancroft et al. 1990, Beaver et al. 1980, Bent 1926, Burleigh 1958, Custer and Osborn 1978, Dusi and Dusi 1987, Ehrlich et al. 1988, Frederick 1997, Hamel 1992, Hancock and Elliott 1978, Haney et al. 1986, Odom 1976, Sauer et al. 1997, Spendelow and Patton 1988, Teal 1965, Werschkul 1977

Tufted Titmouse, *Baeolophus bicolor*, ABPAW01110, G5, S5

Habitat and distribution: Year-round residents throughout Georgia, tufted titmice may be found in many woodland habitats. They tend to prefer deciduous forest, but may also be found in mixed. Titmice occur in both uplands and bottomlands, and are also very common in wooded residential areas.

Model: Habitats 20, 31, 72, 73, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 433, 434, 440, 441, 512, 620, 890, 900, 980, and 990. Statewide range.

References: AOU 1983, Bent 1946, DeGraaf et al. 1991, Ehrlich et al. 1988, Grubb and Pravosudov 1994, Hamel 1992, Haney et al. 1986, Holt 1974, Johnston and Odum 1956, Laskey 1957, Pielou 1957, Sauer et al. 1997, Wilcove 1988

Turkey Vulture, *Cathartes aura*, ABNKA02010, G5, S5

Habitat and distribution: Turkey vultures breed throughout Georgia, usually nesting in a woodland, cliff or other remote area. They may be seen foraging just about everywhere, including both open and forested habitat.

References: AOU 1983, Bent 1937, Burleigh 1958, Coleman and Fraser 1989, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Jackson 1983, Kirk and Mossman 1998, Nicholson 1997, Sauer et al. 1997

Model: Habitats 7, 9, 18, 20, 22, 31, 33, 34, 72, 73, 80, 83, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 513, 620, 890, 900, 920, 930, 980, and 990. Statewide range.

Veery, *Catharus fuscescens*, ABPBJ18080, G5, S4

Habitat and distribution: Veeries breed in Georgia only at high elevations in the Blue Ridge, where they inhabit moist areas in deciduous, mixed, or coniferous forest. In this Southeast, veeries prefer mature forest with an understory of rhododendrons, ferns and shrubs.

Model: Habitats 411, 414, 415, 424, 425, 431, and 433 within mask of elevations > 1066 m (3500 feet). Clipped by digitized range.

References: AOU 1983, Bent 1949, Bertin 1977, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Hubbard 1971, Moskoff 1995, Nicholson 1997, Noon and Able 1978, Robbins et al. 1989, Sauer et al. 1997, Wilcove 1988

Virginia Rail, *Rallus limicola*, ABNME05030, G5, S3S4

Habitat and distribution: Virginia rails may breed at scattered locations in Georgia above the Fall Line. They inhabit freshwater marshes with emergent vegetation such as cattails or bulrushes. Virginia rails may forage over shallow water, moist soil or mudflats.

Model: Habitat 930 within digitized range.

References: AOU 1983, Bent 1926, Conway 1990, Conway 1995, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Sayre and Randle 1984, Taylor 1998

Whip-poor-will, *Caprimulgus vociferous*, ABNTA07070, G5, S5

Habitat and distribution: Whip-poor-wills are expanding their range southward in Georgia, onto much of the Coastal Plain. They usually inhabit hardwood or mixed forest, as well as some pine types.

Model: Habitats 20, 31, 410, 411, 412, 413, 414, 422, 423, 431, 432, 434, 440, and 900 within digitized range.

References: AOU 1983, Baker and Peake 1966, Bent 1940, Cooper 1981, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Imhof 1976, Nicholson 1997, Sauer et al. 1997

White Ibis, *Eudocimus albus*, ABNGE01010, G5, S4

Habitat and distribution: White ibises breed in Georgia from near the Fall Line southward. They nest in swamps, bottomlands, and wooded areas near water and along the coast. Foraging is in shallow water of bays, streams, ponds, swamps, and marshes.

Model: Habitats 7, 11 (shallow fresh and saltwater), 420, 890, 900, 920, 930, 980, and 990 within digitized range.

References: AOU 1983, Bent 1926, Bildstein et al. 1990, Custer and Osborn 1978, Dusi and Dusi 1987, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Kushlan and Bildstein 1992, Odom 1976, Sauer et al. 1997, Spendelow and Patton 1988, Teal 1965, Werschkul 1977

White-breasted Nuthatch, *Sitta carolinensis*, ABPAZ01020, G5, S4S5

Habitat and distribution: White-breasted nuthatches may be seen throughout much of Georgia, although they are rare in the southern part of the state. They are found in deciduous or mixed forest, particularly in mature stands. They prefer upland forests, but may also be found in bottomlands, parks and residential areas with mature trees. Birds on the Coastal Plain may be found in longleaf pine.

Model: Habitats 72, 201, 202, 203, 410, 411, 412, 413, 414, 415, 422, 424, 425, 431, 432, 433, 434, 620, 890, 900, and 990 within digitized range.

References: AOU 1983, Bent 1948, Butts 1931, DeGraaf et al. 1991, Dickson et al. 1980, Ehrlich et al. 1988, Engstrom 1996, Hamel 1992, Haney et al. 1986, Meyers and Johnson 1978, Nicholson 1997, Noon et al. 1980, Pravosudov and Grubb 1993, Robbins et al. 1989a, Sauer et al. 1997

White-eyed Vireo, *Vireo griseus*, ABPBW01020, G5, S5

Habitat and distribution: White-eyed vireos breed throughout most of Georgia at lower elevations. They prefer areas of thickets, brambles, undergrowth, old fields, fencerows, clearcuts, and willows. They may also be found along streamsides or swampy woods, and in association with live oak or Carolina bays.

Model: Habitats 20, 31, 420, 422, 440, 441, 512, 513, 620, 890, 900, 980, and 990 within mask of elevations < 700 m (2300 feet). Statewide range.

References: AOU 1983, Askins 1994, Bent 1950, Bradley 1980, Burleigh 1958, DeGraaf et al. 1991, Dickson 1978, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Hopp et al. 1995, Meyers and Odum 1991, Pashley and Barrow 1993, Sauer et al. 1997

Wild Turkey, *Meleagris gallopavo*, ABNLC14010, G5, S5

Habitat and distribution: Wild turkeys are year-round residents throughout Georgia where they inhabit a variety of wooded habitats. They may be found in hardwood or mixed forests, particularly those with oaks; they are less common in pine forests. Wild turkeys often select habitats where forest is interspersed with other types of land cover, especially openings.

Model: Habitats 20, 31, 80, 410, 411, 412, 413, 414, 415, 420, 422, 431, 432, 434, 440, 441, 512, 620, 900, and 990. Applied mask of road density < 80 m per ha to eliminate urban areas. Clipped by digitized range.

References: AOU 1983, Bent 1932, DeGraaf et al. 1991, Eaton 1992, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Kurzejeski and Lewis 1990, Powell 1967, Sauer et al. 1997, Shaffer and Gwynn 1967, Stoddard 1963, Wigley et al. 1986

Willet, *Catoptrophorus semipalmatus*, ABNNF02010, G5, S5

Habitat and distribution: Willets are permanent residents along the Georgia Coast. They most commonly breed in saltmarshes. Saltmarshes are also their preferred foraging habitat, but beaches are used, too.

Model: Habitats 7, 9, 11 (shallow saltwater only), and 920 within digitized range.

References: AOU 1983, Bent 1929, Burger and Shisler 1978, Burleigh 1958, DeGraaf et al. 1991, Ehrlich et al. 1988, Haney et al. 1986, Johnsgard 1981, Stevenson and Anderson 1994, Tomkins 1965

Willow Flycatcher, *Empidonax traillii*, ABPAE33040, G5, S3

Habitat and distribution: Willow flycatchers are rare in Georgia and breed sporadically in parts of the Piedmont and Blue Ridge. They may be found along streams or in open country near ponds or lakes; favoring willows and alders, they are almost always found near water.

Model: Habitats 900 and 980 within digitized range.

References: AOU 1983, Bent 1942, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Herndon 1958, McCabe 1991, Sauer et al. 1997

Wilson's Plover, *Charadrius wilsonia*, ABNNB03040, G5, S2

Habitat and distribution: Wilson's plovers are fairly common breeders along the Georgia Coast. They nest on sparsely vegetated beaches or dunes.

Model: Habitats 7 (coastal beaches only) and 9 within digitized range.

AOU 1983, Bent 1942, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Herndon 1958, McCabe 1991, Sauer et al. 1997

Winter Wren, *Troglodytes troglodytes*, ABPBG09050, G5, S2S3

Habitat and distribution: Preferring cool, dark forests, winter wrens breed in Georgia only at higher elevations of the Blue Ridge. Here they may be seen in association with northern hardwoods such as yellow birch and occasionally eastern hemlock.

Model: Habitats 414, 415, 424, and 433 within mask of elevations > 1066 m (3500 feet). Clipped by digitized range.

References: AOU 1983, Bent 1948, Burleigh 1935, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hubbard 1971, Nicholson 1997, Oberle and Haney 1998, Sauer et al. 1997, Sewell 1996, Wilcove 1988

Wood Duck, *Aix sponsa*, ABNJB09010, G5, S5

Habitat and distribution: Wood ducks are permanent residents throughout most of Georgia They favor quiet inland waters near woodlands, and may also be found on ponds, in marshes, and along streams. They may nest in holes in trees or in bird boxes.

Model: Habitats 11 (freshwater only), 890, 900, and 930. Statewide range.

References: Almand 1965, AOU 1983, Bellrose and Holm 1994, Bent 1923, Cottrell et al. 1990, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hepp and Bellrose 1995, Hepp and Hair 1977, Lowney and Hill 1989, Sauer et al. 1997

Wood Stork, *Mycteria americana*, ABNGF02010, G4, S2

Habitat and distribution: Wood storks breed in Georgia in a few localities along the Coast and on the Coastal Plain. They nest in swamps along standing open water, often selecting the top of a large cypress tree. Wood storks forage in shallow water, fresh or salt.

Model: Habitats 11 (shallow fresh and saltwater), 420, 890, 920, and 930 within digitized range.

References: AOU 1983, Bent 1926, Bratton 1988, Bryan and Coulter 1987, Coulter et al. 1999, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Harris 1999b, Pearson et al. 1992, Ruckdeschel and Shoop 1987, Sauer et al. 1997, Spendelow and Patton 1988

Wood Thrush, *Hylocichla mustelina*, ABPBJ19010, G5, S5

Habitat and distribution: Wood thrushes breed throughout Georgia, although they are somewhat rare in the extreme southern part of the state, and largely absent from the Okefenokee. Wood thrushes prefer rich

deciduous forests such as bottomland hardwoods, but may also be found in mixed forests with a deciduous understory, and in some wooded residential areas.

Model: Habitats 410, 412, 414, 422, 424, 425, 431, 433, 434, and 900. Applied mask of forested areas > 1 ha. Statewide range, except much of the Okefenokee.

References: Aldrich and Coffin 1980, AOU 1983, Bent 1949, Bertin 1977, Conroy and Krementz 1997, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, Hoover et al. 1995, Johnston and Odum 1956, Longcore and Jones 1969, Nicholson 1997, Robbins et al. 1989a, Roth 1987, Roth et al. 1996, Sauer et al. 1997, Weinberg and Roth 1998, Wilcove 1988

Worm-eating Warbler, *Helmitheros vermivorus*, ABPBX08010, G5, S5

Habitat and distribution: Worm-eating warblers breed in Georgia in mature deciduous and mixed forests, particularly those with a rich understory of rhododendron or mountain laurel. Forest types include oak-hickory, beech-maple and eastern hemlock.

Model: Habitats 410, 411, 412, 414, 424, 425, 431, 433, and 433. Applied mask of forested areas > 150 ha. Clipped by digitized range.

References: AOU 1983, Bent 1953, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Gale et al. 1997, Greenberg 1987, Hamel 1992, Haney et al. 1986, Hanners and Patton 1998, Nicholson 1997, Robbins et al. 1989a, Sauer et al. 1997, Wilcove 1988

Yellow Warbler, *Dendroica petechia*, ABPBX03010, G5, S4

Habitat and distribution: Yellow warblers prefer open scrubby vegetation, often along streams or other water bodies. Willow or alder thickets, clearcuts, and old fields, particularly in damp areas, represent the best habitats.

Model: Kept habitats 7, 11 (shallow fresh water only), and 980. Kept habitats 20, 31, and 80 where they intersect with National Wetlands Inventory (NWI) freshwater wetlands. Clipped by digitized range.

References: AOU 1983, Bent 1953, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Kendeigh and Fawver 1981, Lowther et al. 1999, Morse 1989, Nicholson 1997, Sauer et al. 1997

Yellow-billed Cuckoo, *Coccyzus americanus*, ABNRB02020, G5, S5

Habitat and distribution: Yellow-billed cuckoos breed throughout Georgia in habitats with thick, tangled vegetation such as moist deciduous forests, bottomland woods, and thickets. They avoid areas of pure conifers.

Model: Habitats 410, 411, 412, 413, 414, 420, 431, 434, 890, and 900 within mask of elevations < 1066 m (3500 feet). Statewide range, except much of the Okefenokee.

References: AOU 1983, Bent 1940, Brown and Koenen 1999, Burleigh 1958, DeGraaf et al. 1991, Dickson 1978, Dickson et al. 1980, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Hughes 1999, Imhof 1976, Johnson and Landers 1982, Nicholson 1997, Sauer et al. 1997, Terres 1980

Yellow-breasted Chat, *Icteria virens*, ABPBX24010, G5, S5

Habitat and distribution: Yellow-breasted chats breed at lower elevations throughout most of Georgia. They prefer overgrown fields, streamside thickets, brushy areas, and forest edges, often in dry areas or near briars. They become most common in harvested forests a few years after cutting.

Model: Habitats 20, 31, 80, 422, 440, 441, 513, and 620 within digitized range.

References: AOU 1983, Askins 1994, Bent 1953, Burleigh 1958, Conner and Adkisson 1975, Curson et al. 1994, DeGraaf et al. 1991, Dennis 1958, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, Holt 1974, James et al. 1993, Johnston and Odum 1956, Meyers and Johnson 1978, Nicholson 1997, Sauer et al. 1997, Thompson and Nolan 1958

Yellow-crowned Night-heron, *Nyctanassa violacea*, ABNGA13010, G5, S3S4

Habitat and distribution: Yellow-crowned night-herons breed in Georgia along the coast and throughout the Coastal Plain, most frequently in swamps and riverbottom forests. And sometimes also in coastal thickets or in woods along a lakeshore. They forage in freshwater swamps, streams, marshes and along lakeshores.

Model: Habitats 7 (coastal beaches omitted), 11 (shallow freshwater only), 412, 420, 890, 900, 920, 930, 980, and 990 within digitized range.

References: AOU 1983, Bent 1926, Custer and Osborn 1978, DeGraaf et al. 1991, Drennen et al. 1982, Ehrlich et al. 1988, Hamel 1992, Hancock and Elliott 1978, Haney et al. 1986, Odom 1976, Sauer et al. 1997, Spendelow and Patton 1988, Watts 1989, Watts 1995

Yellow-throated Vireo, *Vireo flavifrons*, ABPBW01170, G5, S4

Habitat and distribution: Yellow-throated vireos breed throughout Georgia at moderate or low elevations. They favor sites near the edges of mature, moist deciduous or mixed forest, and are often seen in bottomlands. They generally avoid pure coniferous forests.

Model: Created grid of "edge" pixels between open habitats 20, 31, 80, and 513 and all suitable forested habitats (410, 411, 412, 414, 420, 431, 432, 434, 890, 900, and 990). Applied 1 km moving window (FOCALMEAN using rectangle), keeping areas where values were > 0. Used results of this as a mask for suitable forested habitats. Statewide range.

References: AOU 1983, Bent 1950, DeGraaf et al. 1991, Dickson 1978, Ehrlich et al. 1988, Hamel 1992, Haney et al. 1986, James 1979, Pashley and Barrow 1993, Rodewald and James 1996, Sauer et al. 1997

Yellow-throated Warbler, *Dendroica dominica*, ABPBX03130, G5, S5

Habitat and distribution: Yellow-throated warblers breed throughout Georgia. They favor broadleaf evergreen or bottomland hardwood forests, especially those mixed with some pines or cypresses. They are often found in association with Spanish moss on the Coastal Plain, and in pines in the mountains.

Model: Habitats 420, 422, 423, 425, 431, 432, 434, 440, 441, 620, 890, 900, and 990. Statewide range.

References: AOU 1983, Bent 1953, Burleigh 1958, Curson et al. 1994, DeGraaf et al. 1991, Ehrlich et al. 1988, Hall 1996, Hamel 1992, Haney et al. 1986, Jackson 1988, James et al. 1993, Johnson and Landers 1982, Johnston and Odum 1956, Meyers and Odum 1991, Nicholson 1929, Sauer et al. 1997

Mammals

American Beaver, *Castor canadensis*, AMAFE01010, G5, S5

Habitat and distribution: American beavers are found throughout Georgia in a variety of aquatic habitats. They may occupy almost any stream, pond, swamp or lake with an adjacent supply of trees.

Model: Applied 30 meter buffer to 1:24, 000 stream coverage. Kept habitats 410, 411, 412, 414, 424, 431, 433, 434, 890, 900, 980, and 990 within buffer and mask of slope < 4%. Kept habitats 7 (associated with freshwater), 11 (shallow freshwater only), 930, and 980 in all cases. Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Hill 1982, Jenkins and Busher 1979, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Big Brown Bat, *Eptesicus fuscus*, AMACC04010, G5, S5

Habitat and distribution: Widely distributed throughout the United States, big brown bats occur statewide in Georgia where they may be seen foraging over rivers, in pastures, at forest edges, along city streets, and in a variety of mostly open habitats. They may roost in hollow trees, caves, tunnels, and in other manmade structures.

Model: Habitats 7, 9, 11 (except open ocean), 20, 22, 31, 33, 34, 72, 73, 80, 83, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 513, 620, 890, 900, 920, 930, 980, and 990. Statewide range.

References: Barbour and Davis 1969, Bat Conservation International 2001, Brown 1997, Burt and Grossenheider 1980, Golley 1962, Gore 1992b, Hall 1981, Humphrey 1982, Kurta and Baker 1990, Mills et al 1975, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Black Bear, *Ursus americanus*, AMAJB01010, G5, S4

Habitat and distribution: Historically occurring throughout the Southeast, black bear populations are currently restricted to forested habitats in remote and inaccessible terrain. They require large tracts of land, and persistant populations in Georgia may be found in heavily wooded terrain in the Blue Ridge, in remote swampland in the Okefenokee, and in floodplain forests of the Ocmulgee below Macon. Bears may disperse over great distances, and individuals are occasionally reported from almost all corners of the state.

Model: Habitats 31, 34, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 620, 890, 900, 980, and 990. Applied mask of road density < 30 m per ha. Clipped by digitized range.

References: Alt et al 1976, Brody and Pelton 1989, Brown 1997, Burt and Grossenheider 1980, Carlock et al. 1999, Clark et al. 1993, Cox et al. 1994, Garshelis 1978, Golley 1962, Hall 1981, Hamilton 1978, Hellegren and Vaughan 1990, Maehr 1992, Mykyatka and Pelton 1990, Pelton 1982, Rudis and Tansey 1995, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Black Rat, *Rattus rattus*, AMAFF21010, G5, SE

Habitat and distribution: Not native to North America, black rats are now found throughout the Southeast in and around garbage dumps, granaries, warehouses, and other environments associated with human presence. Agile climbers, they are at home in roofs and attics, but may also live in feral situations in urban forests.

Model: Habitats 22, 24, 72, 83, 201, 202, and 203. Statewide range.

References: Berger and Negus 1981, Brown 1997, Burt and Grossenheider 1980, Golley 1962, Hall 1981, Jackson 1982, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Bobcat, *Lynx rufus*, AMAJH03020, G5, S5

Habitat and distribution: Bobcats occur throughout Georgia in a variety of habitat types. They may be seen in practically any forest type, although they tend to prefer large tracts and may avoid humans.

Model: Expanded suitable habitat types 34, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 513, 620, 890, 900, 930, 980, and 990 1 pixel. Kept resultant clumps > 10 square km, using as mask for suitable habitats. Applied additional mask of road density < 80 m per ha. Statewide range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Hall and Newsom 1976, Lariviere and Walton 1997, Litvitaitis et al. 1986, Marshall and Jenkins 1966, McCord 1974, McCord and Cardoza 1982, Miller 1980, Miller and Speake 1978, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Brazilian Free-tailed Bat, *Tadarida brasiliensis*, AMACD01010, G5, S4

Habitat and distribution: Brazilian free-tailed bats are found in Georgia south of the Fall Line, where they may roost in caves, hollow trees, attics, storm sewers and other manmade structures. Foraging takes place over open areas.

Model: Habitats 11 (freshwater only), 22, 24, 72, 73, 80, 83, 201, 202, 203, and 930 within digitized range.

References: Bat Conservation International 2001, Belwood 1992c, Best et al. 1992, Brown 1997, Burt and Grossenheider 1980, Davis et al 1962, Golley 1962, Hall 1981, Humphrey 1982, LaVal 1973, Whitaker and Hamilton 1998, Wilkins 1989, Wilson and Ruff 1999

Common Gray Fox, *Urocyon cinereoargenteus*, AMAJA04010, G5, S5

Habitat and distribution: Occurring throughout the Southeastern U.S., gray foxes may be found in a variety of wooded or brushy habitats. They prefer locations with a diversity of woods and fields.

Model: Habitats 20, 31, 80, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 513, 620, 890, 900, 980, and 990 within digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Follman 1973, Fritzell and Haroldson 1982, Golley 1962, Hall 1981, Samuel and Nelson 1982, Trapp and Hallberg 1975, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999, Wood et al 1958, Yearsley and Samuel 1980

Common Raccoon, *Procyon lotor*, AMAJE02010, G5, S5
Habitat and distribution: Occurring throughout Georgia, these adaptable animals may be found in every ecological community having trees, but are most abundant in habitats where there is water: hardwood swamps, floodplain forests, and fresh- and saltwater marshes. Other habitats include mesic hardwood stands, farmlands, and suburban residential areas.

Model: Habitats 7, 9, 20, 22, 31, 73, 201, 202, 203, 410, 411, 412, 414, 415, 420, 422, 424, 425, 431, 433, 434, 440, 441, 511, 512, 513, 620, 890, 900, 920, 930, 980, and 990. Statewide range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Cunningham 1962, Golley 1962, Hall 1981, Hoffmann and Gottschang 1977, Kaufmann 1982, Lotze and Anderson 1979, Stuewer 1943, Urban 1970, Virginia Fish and Widlife Information Service 1998, Walker 1993, Whitaker and Hamilton 1998, Wilson and Ruff 1999
Cotton Mouse, *Peromyscus gossypinus*, AMAFF03080, G5, S5
Habitat and distribution: Outside the Blue Ridge and much of the Piedmont, cotton mice may be found in a variety of woodland and early successional habitats in Georgia. Although they prefer moist habitats, they may also be present in drier situations such as upland forests, clearcuts, old fields, palmetto thickets or pine flatwoods.

Model: Habitats 9, 20, 31, 72, 73, 201, 202, 203, 410, 411, 412, 413, 420, 422, 432, 434, 440, 441, 512, 513, 620, 890, 900, 930, 980, and 990 within digitized range.

References: Andrle 1981, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Gentry et al. 1971, Golley 1962, Hall 1981, Laerm and Boone 1995, Mitchell et al. 1995, Shadowden 1963, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999, Wolfe and Linzey 1977

Coyote, *Canis latrans*, AMAJA01010, G5, S4?

Habitat and distribution: Not native to the Southeast, coyotes have expanded their range and are now found statewide in Georgia. Although they prefer open woodlands, rangeland, and brushy or boulder-strewn areas, these extremely adaptable animals are able to survive almost anywhere.

Model: Habitats 20, 31, 34, 80, 83, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 513, 620, 900, and 990. Statewide range.

References: Bekoff 1977, Bekoff 1982, Bekoff and Wells, Brown 1997, Burt and Grossenheider 1980, Fisher 1975, Holzman et al. 1992, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999
Deer Mouse, *Peromyscus maniculatus*, AMAFF03040, G5, S5
Habitat and distribution: Deer mice are restricted to the Blue Ridge physiographic province of Georgia. They inhabit deciduous, coniferous or mixed forest in a variety of successional stages.

Model: Kept habitats 31, 73, 201, 202, 203, 411, 413, 423, 432, and 434 within mask of elevations > 600 m (1968 feet). Kept habitats 414, 415, 424, 425, 431, 433, and 511 in all cases. Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Ford et al. 1994, Golley 1962, Hall 1981, Menzel et al. 1999, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Eastern Chipmunk, *Tamias striatus*, AMAFB02230, G5, S5

Habitat and distribution: Found primarily in forested habitats, chipmunks occur north of a line running from extreme southwest Georgia to the lower Piedmont (in east Georgia). Although most often associated with deciduous forests, they are also familiar inhabitants of manmade environments such as golf courses, parks, suburbs, backyards and gardens.

Model: Habitats 31, 72, 73, 201, 202, 203, 410, 411, 412, 413, 414, 415, 422, 424, 425, 431, 433, 434, 440, and 511 within digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Golley 1962, Hall 1981, Snyder 1982, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Eastern Cottontail, *Sylvilagus floridanus*, AMAEB01040, G5, S5

Habitat and distribution: Highly adaptable, eastern cottontails occur statewide in Georgia, except for high elevations and the barrier islands, in open, brushy environments. They are often most abundant in disturbed or transitional habitats such as fallow weedy fields with briars, hedgerows, brushlands with grassy openings, and open forest edges.

Model: Kept habitats 20, 22, 31, 72, 73, 80, 201, 202, 203, 410, 411, 412, 413, 420, 422, 423, 425, 431, 432, 434, 440, 441, 512, and 620 within mask of elevations 1000 m (3280 feet). Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Chapman et al. 1980, Chapman et al. 1982, Cothran et al. 1991, Golley 1962, Hall 1981, Janes 1959, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Eastern Fox Squirrel, *Sciurus niger*, AMAFB07040, G5, S5

Habitat and distribution: Typically found in forests with a pine component, fox squirrels once ranged throughout much of Georgia, but are now limited to areas of the Coastal Plain and scattered populations in the Piedmont and Ridge and Valley. Fox squirrels often forage on the ground, and are more numerous in open forest.

Model: Kept habitats 73, 201, 202, and 203 on Coastal Plain. Kept habitats 420, 422, 432, 434, 440, 441, 512, and 620 in all cases. Clipped by digitized range.

References: Allen 1943, Bakken 1952, Baumgartner 1943, Besnday 1957, Brown 1997, Burt and Grossenheider 1980, Chesemore 1975, Cothran et al. 1991, Donohoe and Beal 1972, Dozier and Hall 1944, Flyger and Gates 1982, Golley 1962, Hall 1981, Koprowski 1994a, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Eastern Gray Squirrel, *Sciurus carolinensis*, AMAFB07010, G5, S5

Habitat and distribution: Common to abundant, gray squirrels may be found throughout Georgia. Primarily arboreal, they occupy forested habitats including mature hardwood forest with dense undergrowth, river bottoms, mixed forest, and dense or mature stands of oak and hickory. Gray squirrels also thrive in suburban and residential areas where there are trees.

Model: Habitats 22, 72, 73, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 620, and 900. Statewide range.

References: Besnday 1957, Brown 1997, Burt and Grossenheider 1980, Cordes and Barkalow 1973, Cothran et al. 1991, Doebel and McGinnes 1974, Flyger 1960, Flyger and Gates 1982, Golley 1962, Hall 1981, Hougart 1975, Koprowski 1994b, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Eastern Harvest Mouse, *Reithrodontomys humulis*, AMAFF02020, G5, S4

Habitat and distribution: Eastern harvest mice occur throughout Georgia in a variety of open habitats including old fields with broomsedges and other tall grasses, roadside ditches, and weedy areas with tangled briars or honeysuckle. They may also be found in marshy areas and in some pine stands.

Model: Kept habitats 20, 31, 80, 83, 422, 440, 441, 620, and 930 within mask of elevations < 500 m (1640 feet). Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, French 1980b, Golley 1962, Hall 1981, Howell 1954, King 1982, Stalling 1997, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Eastern Mole, *Scalopus aquaticus*, AMABB04010, G5, S5

Habitat and distribution: Eastern moles may be found throughout Georgia in a variety of forested and grassland habitats. Fossorial mammals, moles spend most of their lives an underground system of tunnels, and are more abundant in areas with moist, loamy or sandy soil. They may be scarce or absent from heavy clay, stony or gravelly soil, or soil that is too wet or too dry.

Model: Habitats 20, 22, 31, 72, 73, 80, 201, 202, 203, 410, 411, 412, 414, 415, 420, 422, 424, 425, 431, 433, 434, 440, 441, 512, 513, and 620. Statewide range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Davis 1942, Golley 1962, Hall 1981, Harvey 1976, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999, Yates and Pederson 1982, Yates and Schmidly 1978

Eastern Pipistrelle, *Pipistrellus subflavus*, AMACC03020, G5, S5

Habitat and distribution: Occurring throughout Georgia, eastern pipistrelles may be seen foraging at the edge of forested areas and in open pastures, often at sites near lakes or ponds. In cold climates, eastern pipistrelles hibernate in caves or mines, often returning to the same location year after year.

Model: Habitats 7, 11 (shallow freshwater only), 20, 22, 24, 31, 33, 34, 72, 73, 80, 83, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 620, 890, 900, 930, 980, and 990. Statewide range.

References: Bat Conservation International 2001, Best et al. 1992, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Fujita and Kunz 1984, Golley 1962, Hall 1981, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Eastern Red Bat, *Lasiurus borealis*, AMACC05010, G5, S5

Habitat and distribution: Common in the eastern United States, red bats occur throughout Georgia where they may be seen foraging over streams, small ponds, and forests. Red bats roost under loose bark or in the dense foliage of trees, often in edge habitats.

Model: Habitats 20, 31, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 424, 425, 431, 432, 433, 434, 440, 441, 620, 890, 900, and 990. Statewide range.

References: Barbour and Davis 1969, Bat Conservation International 2001, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Hart et al. 1993, Humphrey 1982, LaVal and LaVal 1979, Menzel et al. 1998, Shump and Shump 1982a, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Eastern Small-footed Myotis, *Myotis leibii*, AMACC01130, G3, S2?

Habitat and distribution: Eastern small-footed myotis bats may be found in the northern part of Georgia. Their habitat requirements are not well known, and they seem limited to deciduous and coniferous forests, where they may roost under rocks, in trees, or in the nooks and crannies of buildings.

Model: Habitats 34, 410, 411, 413, 414, 415, 424, 425, 431, 433, 434, and 900 within digitized range.

References: Bat Conservation International 2001, Brown 1997, Burt and Grossenheider 1980, Burt and Jennings 1997, Hall 1981, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Eastern Spotted Skunk, *Spilogale putorius*, AMAJF05010, G5, S4

Habitat and distribution: Possibly occurring statewide in Georgia (southeast Georgia is questionable), spotted skunks may be found on the Piedmont and Coastal Plain in habitats possessing good cover such as fallow fields, weedy pastures, fencerows, and brushy or sparsely wooded areas. In the mountains, they more often found in open forests with rocky outcrops, or along streams with a heavy rhododendron cover.

Model: Habitats 20, 31, 34, 80, 410, 411, 412, 414, 415, 420, 422, 424, 425, 431, 433, 434, 440, 441, 511, 512, 513, 620, 900, and 990 within digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Crabb 1948, Davis 1945, Golley 1962, Hall 1981, Howard and Marsh 1982, Kinlaw 1995, Reed and Kennedy 2000, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Eastern Woodrat, *Neotoma floridana*, AMAFF08010, G5, S3

Habitat and distribution: Occurring throughout most of the Southeast, Eastern woodrats may be found in forested habitats throughout Georgia, with the exception of the Piedmont. In the mountains, they prefer deciduous forests, particularly where the understory is dense, and often occur in areas with rock outcrops or caves. In the Coastal Plain of Georgia, woodrats may be abundant in lowland hardwood forests and swamps.

Model: Habitats 34, 410, 411, 412, 414, 415, 420, 424, 431, 433, 434, 890, 900, and 990 within digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Elliott 2001, Golley 1962, Hall 1981, Hay-Smith 1995, Schwartz and Odum 1957, Whitaker and Hamilton 1998, Wiley 1980, Wilson and Ruff 1999

Evening Bat, *Nycticeius humeralis*, AMACC06010, G5, S5

Habitat and distribution: Abundant throughout Georgia, evening bats may be seen foraging over clearings, farm ponds, in forest openings, and along watercourses. They typically form maternity colonies in hollow trees (frequently standing snags in beaver ponds), but also in sites such as culverts, attics and manmade structures. Relatively common throughout their summer range, evening bats are not often observed in winter.

Model: Habitats 7, 11 (shallow freshwater only), 20, 22, 24, 31, 34, 72, 73, 80, 83, 201, 202, 203, 410, 411, 412, 413, 414, 420, 422, 424, 425, 431, 432, 433, 434, 440, 441, 513, 620, 890, 900, and 990. Statewide range.

References: Bat Conservation International 2001, Brack 1984, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Watkins 1972, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Golden Mouse, *Ochrotomys nuttalli*, AMAFF04010, G5, S5

Habitat and distribution: Golden mice may be found throughout Georgia in forested habitats, including moist thickets, densely forested lowlands and floodplain forests. They may also be abundant in upland pine forest. In general, they prefer moist areas with a thick understory.

Model: Habitats 20, 31, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 424, 425, 431, 433, 434, 440, 441, 512, 620, 890, 900, and 990 within digitized range.

References: Breidling et al. 1983, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Ford et al. 1994, French 1980b, Gentry et al. 1971, Golley 1962, Hall 1981, King 1982, Linzey and Packard 1977, Mitchell et al. 1995, Russell and Russell 1999, Shadowden 1963, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Gray Myotis, *Myotis grisescens*, AMACC01040, G3, S1

Habitat and distribution: Present in regions underlying karst topography, gray myotis bats are known to occupy only two caves in Georgia. Extremely cave-dependent, these bats roost in caves year round, hibernating in the very few limestone caves which have the required conditions of stable humidity and winter temperatures. Foraging takes place over nearby riparian forests.

Model: Expanded habitats 410, 414, and 900 3 pixels. Kept habitats 7, 11, and 930 within this mask. Kept habitats 33, 34, 410, 414, and 900 in all cases. Clipped by digitized range.

References: Bat Conservation International 2001, Best et al. 1992, Brack 1984, Brown 1997, Burt and Grossenheider 1980, Decher and Choate 1995, Golley 1962, Gore 1992a, Hall 1981, Humphrey 1982, LaVal et al 1977, Ozier 1999b, Tuttle 1976a, Tuttle 1976b, Tuttle 1979, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Hairytail Mole, *Parascalops breweri*, AMABB03010, G5, S1

Habitat and distribution: Inhabitants of northern hardwood forests, hairytail moles are uncommon residents of Georgia, occurring only at high elevations of the Blue Ridge. In Georgia, they are known from only two sites in Rabun and Towns counties.

Model: Habitats 414, 415, 424, and 433 within digitized range.

References: Brown 1993, Hall 1981, Hallet 1971, Linzey and Linzey 1971, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Hispid Cotton Rat, *Sigmodon hispidus*, AMAFF07010, G5, S5

Habitat and distribution: Hispid cotton rats are found throughout Georgia in open and semi-open habitats with sufficient cover to provide security from predation. They may be abundant in old fields with broomsedges and other grasses, in marshes, and in thickets and other habitats with dense growth of honeysuckle or blackberries.

Model: Habitats 9, 20, 22, 31, 72, 80, 83, 201, 202, 203, 422, 440, 441, 512, 513, 620, 920, 930, and 980. Statewide range.

References: Andrle 1981, Atkeson and Johnson 1979, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Mitchell et al. 1995, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Hoary Bat, *Lasiurus cinereus*, AMACC05030, G5, S4

Habitat and distribution: Hoary bats are found throughout Georgia in a variety of wooded habitats including pine, hardwood or mixed forest stands. In addition, they frequently forage over open areas such as clearcuts or small ponds in wooded areas.

Model: Habitats 20, 31, 72, 73, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 513, 620, 890, 900, and 990. Statewide range.

References: Bat Conservation International 2001, Brown 1997, Burt and Grossenheider 1980, Golley 1962, Hall 1981, Hart et al. 1993, Shump and Shump 1982b, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Horse, *Equus caballus*, AMATA01010, G5, SE

Habitat and distribution: In Georgia, wild horses are encountered only on Cumberland Island, where there is a population resulting from one or more past releases. Observations indicate that these horses utilize multiple habitat types, all characterized by the presence of grass for grazing.

Model: Habitats 7, 18, 80, 420, 434, 441, and 513 within digitized range.

References: Ambrose et al. 1983, Brown 1997, Burt and Grossenheider 1980, Hall 1972, Hall 1981, Lenarz 1983, Ryden 1970, Slade and Godfrey 1982, Whitaker and Hamilton 1998, Wilson and Ruff 1999

House Mouse, *Mus musculus*, AMAFF22010, G5, SE

Habitat and distribution: Introduced from Europe and Asia, house mice are now ubiquitous throughout the United States. Although strongly associated with human habitats, they may also survive in the wild in fields, pastures, fencerows, weedy roadsides and sometimes even in wooded environments.

Model: Habitats 22, 24, 72, 73, 80, 83, 201, 202, and 203. Statewide range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Jackson 1982, Mitchell et al. 1995, Virginia Fish and Widdlife Information Service 199, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Indiana Bat, *Myotis sodalis*, AMACC01100, G2, SA

Habitat and distribution: Documented in Georgia in only two caves on the Cumberland Plateau, Indiana bats require hibernation caves with cool, stable temperatures and high relative humidity. Most of the known population winters in nine Midwestern caves. Indiana bats forage over riparian forest or water.

Model: Created grid of likely limestone bedrock from geologic map of Georgia. Used as mask for habitats 20, 31, 34, 410, 411, 413, 414, 424, 433, 434, and 900. Clipped by digitized range.

References: Barbour and Davis 1969, Bat Conservation International 2001, Brown 1997, Burt and Grossenheider 1980, Golley 1962, Hall 1981, Humphrey 1978, Humphrey 1982, Humphrey 1992, Humphrey et al 1977, LaVal et al 1977, Ozier 1999c, Thompson 1982, Virginia Fish and Widlife Information Service 1998, Wilson and Ruff 1999

Least Shrew, *Cryptotis parva*, AMABA04010, G5, S5

Habitat and distribution: Occurring throughout the Southeast, least shrews generally inhabit fields or other open grassy areas, but may also be found in marshes or wooded habitats such as saw palmetto hammocks or managed stands of mature loblolly or shortleaf pine.

Model: Habitats 20, 31, 80, 420, 422, 434, 440, 441, 513, 620, and 930. Statewide range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, French 1980b, Golley 1962, Hall 1981, Howell 1954, King 1982, Mitchell et al. 1995, Virginia Fish and Widlife Information Service 1998, Whitaker 1974, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Least Weasel, *Mustela nivalis*, AMAJF02020, G5, S1

Habitat and distribution: Least weasels reach the southern end of their range in far northern Georgia. They are normally associated with riparian areas, especially around agricultural or pasture areas.

Model: Habitats 80, 930, and 980 within digitized range.

References: Beer 1950, Brown 1997, Burt and Grossenheider 1980, Hall 1981, Jackson 1961, King 1975, Mumford 1969, Sheffield and King 1994, Svendsen 1982, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Little Brown Myotis, *Myotis lucifugus*, AMACC01010, G5, S3

Habitat and distribution: Little brown myotis may be found in north Georgia in forested areas, where they may roost in buildings or under the loose bark of trees, foraging by night over nearby water or clearings. They hibernate in caves or mines with cool, stable temperatures and high humidity.

Model: Created grid of likely limestone bedrock from geologic map of Georgia. Used as mask for habitats 7, 11, 20, 22, 31, 33, 34, 72, 73, 80, 83, 201, 202, 203, 410, 411, 413, 414, 422, 423, 424, 432, 433, 434, 900, 930, and 980. Clipped by digitized range.

References: Barbour and Davis 1969, Bat Conservation International 2001, Best et al. 1992, Brack 1984, Brown 1997, Burt and Grossenheider 1980, Fenton and Barclay 1980, Golley 1962, Hall 1981, Humphrey and Cope 1976, Humphrey 1982, Schowalter et al 1979, Schowalter et al 1979, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Longtail Shrew, *Sorex dispar*, AMABA01210, G4, S1

Habitat and distribution: Limited to mountainous regions of eastern North America, longtail shrews have a boreal habitat preference, occurring only in cool, moist forest. In Georgia, they may be found at high elevations of the Blue Ridge province in association with rocky habitats.

Model: Habitats 34, 411, and 415 within mask of elevations > 1066 m (3500 feet). Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Hall 1981, Kirkland 1981, Laerm et al. 1997, Pagels 1987, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Long-tailed Weasel, *Mustela frenata*, AMAJF02030, G5, S5

Habitat and distribution: Long-tailed weasels may be found in a wide variety of habitats throughout Georgia. Frequently found near water, they may occupy every type of terrestrial community from forested to open habitats.

Model: Expanded suitable habitat types 20, 31, 410, 411, 412, 413, 414, 415, 420, 422, 424, 425, 431, 433, 434, 440, 441, 512, 620, 890, 900, 930, 980, and 990 1 pixel. Kept resultant clumps > 12 ha, using as mask for suitable habitats. Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Sheffield and Thomas 1997, Svendsen 1982, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Marsh Rabbit, *Sylvilagus palustris*, AMAEB01030, G5, S5

Habitat and distribution: In Georgia occurring mostly below the Fall Line, marsh rabbits are residents of brackish and occasionally freshwater marshes, where they may nest in sedges at the water's edge. Seldom found far from standing water, marsh rabbits may also inhabit canebrakes, swamps, wet bottomlands and floodplains of rivers.

Model: Kept habitats 20, 31, and 80 where they intersect with NWI freshwater wetlands. Kept habitats 9, 513, 890, 900, 920, 930, 980, and 990 in all cases. Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Chapman and Wilner 1981, Chapman et al. 1982, Cothran et al. 1991, Forys 1995, Golley 1962, Hall 1981, Holler and Conaway 1979, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Marsh Rice Rat, *Oryzomys palustris*, AMAFF01010, G5, S5

Habitat and distribution: Marsh rice rats may be found throughout Georgia in wetland environments such as swamps, freshwater and saltwater marshes, and wet hammocks. Damp, grassy meadows, ditches, and the edges of lakes or streams also may provide suitable habitat for rice rats.

Model: Kept habitats 20, 31, and 80 where they intersect with NWI wetlands. Kept habitats 7, 9, 420, 890, 900, 920, 930, 980, and 990 in all cases. Clipped by digitized range.

References: Andrle 1981, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Mitchell et al. 1995, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999, Wolfe 1982

Masked Shrew, *Sorex cinereus*, AMABA01010, G5, S2S3

Habitat and distribution: In Georgia, masked shrews may be found in the Blue Ridge primarily in forested habitats. They prefer moist areas, and may be encountered in locations with a cover of leaf litter, mossy rocks and logs.

Model: Habitats 34, 414, 415, 424, 433, and 511 within mask of elevations > 450 m (1476 feet). Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Ford et al. 1994, Getz 1961, Hall 1981, Laerm et al. 1995a, Menzel et al. 1999, Moore 1949, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Meadow Jumping Mouse, *Zapus hudsonius*, AMAFH01010, G5, S3

Habitat and distribution: Meadow jumping mice inhabit wet meadows or fields in the Blue Ridge and Piedmont provinces of Georgia. Although perhaps most often seen in meadows, jumping mice may also be encountered in vegetation along creeks, at the edges of woods, and occasionally in woodlands having a lush carpet of grasses, sedges and herbs.

Model: Applied 30 m buffer to 1: 24, 000 stream coverage. Kept habitats 80, 411, and 412 within buffer. Kept habitats 410, 414, 900, and 930 in all cases. Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, French 1980b, Golley 1962, Hall 1981, Russell and Russell 1999, Virginia Fish and Widlife Information Service 1998, Whitaker 1972, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Meadow Vole, *Microtus pennsylvanicus*, AMAFF11010, G5, S3S4

Habitat and distribution: Generally found in the northeast Georgia mountains and upper Piedmont, meadow voles occur in a variety of grassland habitats such as wet meadows, upland fields, orchards, and openings in forests. They seem to prefer wet or moist areas.

Model: Kept habitats 20, 31, and 80 under moist conditions (where topographic relative moisture index > 30). Kept habitat 930 in all cases. Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Golley 1962, Hall 1981, Johnson and Johnson 1982, Van Vleck 1969, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Mink, *Mustela vison*, AMAJF02050, G5, S5

Habitat and distribution: Semi-aquatic mammals, mink may be found throughout Georgia in wetland habitats of all kinds. They may den in the banks of lakes, rivers, and other waterways, and may also inhabit swamps and freshwater, brackish or coastal salt marshes.

Model: Applied 30 m buffer to 1: 24, 000 stream coverage. Kept habitats 410, 414, 431, 433, and 990 within buffer. Kept habitats 7 (coastal beaches omitted), 11 (shallow fresh and saltwater; open ocean omitted), 890, 900, 920, 930, and 980 in all cases. Statewide range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Linscombe et al. 1982, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Muskrat, *Ondatra zibethicus*, AMAFF15010, G5, S5

Habitat and distribution: Found primarily above the Fall Line in Georgia (although well south of that in the Altamaha drainage), muskrats occupy aquatic habitats, including farm ponds, rivers, impoundments, and marshes.

Model: Habitats 7 (where associated with freshwater), 11 (shallow freshwater only), and 930 within digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Errington 1963, Golley 1962, Hall 1981, Lowery 1974, Palmisano 1972b, Perry 1982, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Willner et al. 1980, Wilson and Ruff 1999
New England (Appalachian) Cottontail, *Sylvilagus transitionalis (obscurus)*, AMAEB01050, G4, S1S2

Habitat and distribution: Rare in Georgia, Appalachian cottontails may be found in scattered locations, usually at high elevations of the Blue Ridge on mountain balds, in boreal forest habitats, and in 5 to 10 year old mountain clearcuts. Recent records for this species from the upper Piedmont (Stephens county) may indicate that it is more widely distributed than previously thought.

Model: Habitats 20, 31, 410, 411, 413, 414, 415, 431, 432, 434, and 511 within digitized range.

References: Blymyer 1976, Brown 1997, Bunch and Dye 1999, Burt and Grossenheider 1980, Chapman 1975, Chapman and Morgan 1973, Chapman and Stauffer 1981, Chapman et al. 1982, Dalke 1937, Golley 1962, Hall 1981, Ozier 1999e, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Nine-banded Armadillo, *Dasypus novemcinctus*, AMADA01010, G5, S4

Habitat and distribution: Expanding their range northwards in Georgia, nine-banded armadillos prefer locations with moist, loose textured soil, and are rare in sites with heavy clay or rocky soil, as well as in waterlogged areas. In the Georgia Piedmont, they are making extensive use of creek and river bottoms.

Model: Kept habitats 20, 31, 410, 412, 422, 434, 440, and 900 above Fall Line. Kept habitats 20, 31, 80, 83, 410, 412, 420, 422, 434, 440, 441, 512, 513, 620, 900, and 990 below Fall Line. Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Galbreath 1982, Golley 1962, Hall 1981, Humphrey 1974, Slaughter 1961, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Northern Myotis, *Myotis septentrionalis*, AMACC01150, G4, S3S4

Habitat and distribution: Occurring as far south as the Blue Ridge and Ridge and Valley in Georgia, northern myotis occupy primarily forested habitats, where they may be observed foraging at tree-top level along the forest edge, in clearings, and over ponds.

Model: Habitats 11, 20, 31, 34, 201, 202, 203, 410, 411, 413, 414, 415, 422, 423, 424, 425, 431, 432, 433, 434, 511, 900, and 930 within digitized range.

References: Bat Conservation International 2001, Best et al. 1992, Brown 1997, Burt and Grossenheider 1980, Fitch and Shump 1979, Golley 1962, Hall 1981, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Northern River Otter, *Lutra canadensis*, AMAJF08010, G5, S5

Habitat and distribution: Northern river otters are found throughout Georgia in a variety of fresh- and brackish-water habitats. They are most abundant in food-rich coastal areas such as estuaries, and the lower portions of streams or rivers.

Model: Habitats 7 (coastal beaches omitted), 11 (shallow freshwater only), 890, and 930. Statewide range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Lariviere and Walton 1998, Toweill and Tabor 1982, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson 1959, Wilson and Ruff 1999

Northern Short-tailed Shrew, *Blarina brevicauda*, AMABA03010, G5, S5

Habitat and distribution: Northern short-tailed shrews may be found in the Piedmont and Blue Ridge of Georgia in almost any forested habitat having a thick layer of leaf litter or other ground cover. Other potential habitats for these shrews include brushy areas, old fields and wooded residential areas.

Model: Habitats 20, 31, 80, 201, 202, 203, 410, 411, 412, 414, 415, 424, 425, 431, 433, 434, and 900 within digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Faust et al. 1971, Ford et al. 1994, French 1980b, Gentry et al. 1971, George et al. 1986, Getz 1961, Golley 1962, Hall 1981, Mitchell et al. 1995, Russell and Russell 1999, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Northern Yellow Bat, *Lasiurus intermedius*, AMACC05040, G4G5, S2S3
Habitat and distribution: Inhabiting the lower Coastal Plain of Georgia, northern yellow bats may be found in open pine-oak forests and live oak hammocks, near permanent water or open areas where they feed. These bats often roost in small colonies in trees or in clumps of Spanish Moss.

Model: Habitats 7, 9, 11 (shallow fresh and saltwater), 20, 31, 73, 80, 412, 413, 420, 432, 434, 441, 512, 513, 620, 890, 900, and 990 within digitized range.

References: Bat Conservation International 2001, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Hall 1981, Kern 1992, Virginia Fish and Widlife Information Service 1998, Webster et al. 1980, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Norway Rat, *Rattus norvegicus*, AMAFF21020, G5, SE

Habitat and distribution: Introduced from Europe, Norway rats have spread throughout North America. Highly adaptable to climate and environmental conditions, they may be found in a variety of urban and rural habitats, almost always in association with man.

Model: Habitats 22, 24, 72, 83, 201, 202, and 203. Statewide range.

References: Berger and Negus 1981, Brown 1997, Burt and Grossenheider 1980, Golley 1962, Hall 1981, Jackson 1982, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Nutria, *Myocastor coypus*, AMAFK01010, G5, SE

Habitat and distribution: Originally introduced from South America, nutria have escaped into the wild, and feral populations established in scattered localities in the Coastal Plain of Georgia and elsewhere in the Southeast. Adaptable to many aquatic environments, nutrias may be found in freshwater marshes, swamps, lakes and ponds where they nest in vegetation in shallow water.

Model: Habitats 11 (shallow freshwater only) and 930 within digitized range.

References: Adams 1956, Atwood 1950, Brown 1997, Burt and Grossenheider 1980, Chabreck et al 1981, Hall 1981, Harris and Webert 1962, Palmisano 1972b, Robicheaux 1978, Shirley et al 1981, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Willner 1982, Wilson and Ruff 1999, Woods et al. 1992

Oldfield Mouse, *Peromyscus polionotus*, AMAFF03060, G5, S5

Habitat and distribution: Found in much of the Georgia Piedmont and Coastal Plain, oldfield mice typically inhabit early successional stages of abandoned fields and other open, sandy habitats. They may also occupy grass-covered beach dunes.

Model: Habitats 7, 9, 20, 31, 80, 83, 420, 422, 440, 441, 512, 513, and 620 within digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Laerm and Boone 1995, Smith et al. 1973, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Pygmy Shrew, *Sorex hoyi*, AMABA01250, G5, S2

Habitat and distribution: Pygmy shrews are restricted to northern Georgia in relatively moist, cool forested locations having heavy leaf litter or an understory of rhododendron. They may also be found in nearby forest clearings.

Model: Habitats 31, 410, 411, 412, 413, 414, 415, 424, 425, 431, 432, 433, 434, and 511 within mask of elevations > 610 m (2000 feet). Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Ford et al. 1994, Hall 1981, Long 1974, Pagels 1987, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Rafinesque's Big-eared Bat, *Corynorhinus rafinesquii*, AMACC08020, G3G4, S3?

Habitat and distribution: Although geographically widespread in the Southeast, this bat is not common. Inhabiting mainly forested areas and riparian associations, big-eared bats may roost in hollow trees, under tree bark, or in buildings, culverts and other manmade structures. Suitable habitat includes mature forest of bottomland and upland hardwoods, although individuals are often captured foraging over young clearcuts.

Model: Habitats 31, 410, 411, 414, 415, 420, 424, 425, 431, 433, 434, 890, 900, and 990 within digitized range.

References: Bat Conservation International 2001, Belwood 1992a, Best et al. 1992, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Jones 1977, Ozier 1999a, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Red Fox, *Vulpes vulpes*, AMAJA03010, G5, S5

Habitat and distribution: Red foxes occur throughout Georgia in forested and open country. They use edge environments heavily, and may also inhabit suburban areas, parks or golf courses if daytime hiding places are present.

Model: Habitats 20, 31, 80, 410, 411, 412, 413, 414, 415, 420, 431, 432, 433, 434, 511, 512, and 900 within digitized range.

References: Ables 1969, Ables 1974, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Follman 1973, Golley 1962, Hall 1981, Harris 1977, Lariviere and Pasitschniak-Arts 1996, Samuel and Nelson 1982, Sunquist 1989, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Red Squirrel, *Tamiasciurus hudsonicus*, AMAFB08010, G5, S3

Habitat and distribution: Mainly associated with North American boreal forests, red squirrels inhabit coniferous, mixed, or northern hardwood forests at high elevations in the Blue Ridge of Georgia. Conifer seeds are a major component of the red squirrel’s diet, and suitable habitat is frequently associated with the presence of coniferous trees.

Model: Habitats 201, 202, 203, 415, 423, 424, 425, 431, 432, and 433 within mask of elevations > 550 m (1476 feet). Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Davis 1969, Flyger and Gates 1982, Golley 1962, Hall 1981, Komarek and Komarek, Odum 1949, Odum 1949, Smith 1965, Steele 1998, Virginia Fish and Widlife Information Service 1998, Wharton 1968, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Round-tailed Muskrat, *Neofiber alleni*, AMAFF14010, G3, S3

Habitat and distribution: Round-tailed muskrats occupy a range restricted to Florida and extreme south Georgia. They inhabit thick mats of vegetation in bogs and shallow freshwater marshes.

Model: Habitats 11 (shallow freshwater only) and 930 within digitized range.

References: Bergstrom et al. 2000, Birkenholz 1963, Birkenholz 1972, Brown 1997, Burt and Grossenheider 1980, Golley 1962, Hall 1981, Lefebvre 1992, Ozier 1999d, Perry 1982, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Seminole Bat, *Lasiurus seminolus*, AMACC0502, G5, S5

Habitat and distribution: Present throughout the Coastal Plain of Georgia, Seminole bats may be locally abundant in wooded habitats such as cypress stands and floodplain forests which border lakes or streams. They commonly roost in clumps of spanish moss, in dense foliage of trees, or under bark. Seminole bats forage over treetops, along waterways, and in clearings.

Model: Habitats 20, 31, 72, 80, 201, 202, 203, 412, 413, 420, 422, 432, 434, 440, 441, 512, 513, 620, 890, 900, 930, 980, and 990 within digitized range.

References: Bat Conservation International 2001, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Menzel et al. 1998, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilkins 1987, Wilson and Ruff 1999

Silver-haired Bat, *Lasionycteris noctivagans*, AMACC02010, G5, S5

Habitat and distribution: Occurring in Georgia north of the Fall Line, silver-haired bats inhabit forested areas and are often abundant in old-growth or mature forest, where they may roost in dense foliage, in hollow trees or under loose bark. They forage at tree-top level or over small ponds or streams. The winter habits of these bats are poorly known; they are believed to be migratory.

Model: Expanded suitable habitat types 410, 411, 412, 414, 415, 431, 433, 434, and 900 2 pixels. Kept habitat 11 (shallow freshwater only) within expanded area. Retained all other suitable pixels. Clipped by digitized range.

References: Bat Conservation International 2001, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Kunz 1982, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Smoky Shrew, *Sorex fumeus*, AMABA01180, G5, S3?

Habitat and distribution: Smoky shrews may be found in forested habitats in the Cumberland Plateau and Blue Ridge of Georgia. Fossorial mammals, they may be abundant in cool, moist forests in locations having thick layers of leaf litter for burrowing.

Model: Habitats 410, 412, 414, 415, 424, 431, 433, and 434 in Blue Ridge. Habitats 410, 412, 414, 424, 431, 433, and 434 within mask of elevations > 350 m (1148 feet) in Cumberland Plateau. Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Ford et al. 1994, Golley 1962, Hall 1981, Menzel et al. 1999, Owen 1984, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Southeastern Myotis, *Myotis austroriparius*, AMACC01030, G3G4, S3

Habitat and distribution: Southeastern myotis bats may be found in Georgia south of the Fall Line. Most frequently associated with caves, where they may form large maternity colonies, these bats may also roost in hollow trees, mine tunnels, culverts, and other manmade structures. They forage over water and in areas where longleaf pine and live oak are present.

Model: Habitats 7, 11 (except areas of open ocean), 33, 80, 412, 420, 513, 620, 890, 900, 920, 930, and 990 within digitized range.

References: Bat Conservation International 2001, Belwood 1992b, Brown 1997, Burt and Grossenheider 1980, Golley 1962, Hall 1981, Jones and Manning 1989, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Southeastern Pocket Gopher, *Geomys pinetis*, AMAFC02040, G5, S4

Habitat and distribution: Present in Georgia from the Fall Line south, southeastern pocket gophers inhabit deep, sandy soils that are often associated with long-leaf pine forest. They are most also in open pine-oak woodlands, pine flatwoods, and in weedy or grassy fields.

Model: Habitats 440, 441, 512, and 620 within digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Golley 1962, Hall 1981, Pembleton and Williams 1978, Whitaker and Hamilton 1998, Wilson and Ruff 1999
Southeastern Shrew, *Sorex longirostris*, AMABA01060, G5, S4
Habitat and distribution: Southeastern shrews are found throughout Georgia in many open and forested situations. They are perhaps most abundant in moist habitats with a dense ground cover of plants such as wooded swamps, marshes, and floodplain forest. They may also occur in upland forests, old fields, and loblolly pine plantations.

Model: Habitats 20, 31, 80, 410, 411, 412, 413, 414, 420, 422, 424, 425, 431, 432, 433, 434, 440, 441, 620, 890, 900, 930, 980, and 990 within mask of elevations < 760 m (2493 feet). Statewide range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, French 1980a, French 1980b, Gentry et al. 1971, Golley 1962, Hall 1981, King 1982, Mitchell et al. 1995, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Southern Bog Lemming, *Synaptomys cooperi*, AMAFF17010, G5, S1

Habitat and distribution: Southern bog lemmings have been reported from a single location in the Blue Ridge of Georgia. Bog lemming populations typically are variable, and they may be absent from apparently suitable situations. Damp meadows and bogs probably provide the best habitat. A key habitat feature may be the presence of grasses and sedges, major components of the bog lemming's diet.

Model: Habitats 80 and 930 within digitized range.

References: Brown 1993, Brown 1997, Lee et al. 1982, Linzey and Linzey 1971, Webster et al. 1985, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Southern Flying Squirrel, *Glaucomys volans*, AMAFB09010, G5, S5

Habitat and distribution: Woodland dwellers, flying squirrels in Georgia are primarily associated with hardwood forests, especially those with abundant oaks and hickories, but may also inhabit coniferous or mixed forest. Wooded urban parks and residential areas may also provide suitable habitat.

Model: Habitats 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 424, 425, 431, 432, 433, 434, 620, 900, and 990 within digitized range.

References: Bendel and Gates 1987, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Stone et al. 1997, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Southern Red-backed Vole, *Clethrionomys gapperi*, AMAFF09020, G5, S3S4

Habitat and distribution: Present in Georgia only at higher elevations of the Blue Ridge, southern red-backed voles inhabit mesic coniferous, mixed or deciduous forests. They prefer locations with abundant leaf litter, moss-covered rocks and cool, shady slopes. Other potential habitat for these voles includes rock slides, mountain balds, and rhododendron thickets.

Model: Habitats 34, 411, 414, 415, 424, 425, 431, 433, and 511 within mask of elevations > 670 m (2198 feet). Clipped by digitized range.

References: References: Brown 1997, Burt and Grossenheider 1980, Ford et al. 1994, Hall 1981, Menzel et al. 1999, Merritt 1981, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Southern Short-tailed Shrew, *Blarina carolinensis*, AMABA03020, G5, S5

Habitat and distribution: Southern short-tailed shrews may be found in Georgia outside of the Blue Ridge and upper Piedmont in a variety of mesic habitats, and may be abundant in well-drained hardwood sites. Although most common in wooded localities, they are considered a habitat generalist within mesic conditions.

Model: Habitats 20, 31, 72, 80, 201, 202, 203, 410, 411, 412, 420, 422, 434, 440, 441, 620, 900, 930, 980, and 990 within digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Hall 1981, King 1982, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Star-nosed Mole, *Condylura cristata*, AMABB05010, G5, S2?

Habitat and distribution: Occurring sporadically in Georgia, star-nosed moles inhabit moist fields, meadows, woods, marshy areas and other low, swampy places. Semi-aquatic mammals, they prefer damp, loose soils, and are generally absent from heavy clay and stony or gravelly soil.

Model: Applied 30 meter buffer to 1:24, 000 stream coverage. Kept habitats 31, 80, 410, 412, 414, 415, 424, 431, and 433 within buffer. Kept habitats 890, 900, 930, 980, and 990 in all cases. Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Laerm et al. 1997b, Peterson and Yates 1980, Rust 1966, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999, Yates and Pederson 1982

Striped Skunk, *Mephitis mephitis*, AMAJF06010, G5, S5

Habitat and distribution: Occurring statewide in Georgia, striped skunks may be found in a variety of habitats. Abundant in agricultural land or open areas, they may also be found in brushy or rocky places, at the edges of woodlots, and in fencerows. They are also common along forest-field edges, and in suburban and residential areas.

Model: Habitats 20, 31, 34, 80, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 513, 620, 890, 900, and 990. Statewide range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Godin 1982, Golley 1962, Hall 1981, Storm 1972, Verts 1967, Virginia Fish and Widlife Information Service 1998, Wade-Smith and Verts 1982, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Swamp Rabbit, *Sylvilagus aquaticus*, AMAEB01080, G5, S5

Habitat and distribution: Associated with river floodplains and other aquatic habitats, swamp rabbits occur in Georgia in swamps, marshes, and wet bottomlands. Although swamp rabbits occupy wet bottomlands and swamps, they need access to higher ground during flooding.

Model: Kept habitats 20, 31, and 80 where they intersect with NWI freshwater wetlands. Kept habitats 890, 900, 930, 980, and 990 in all cases. Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Chapman and Fledhammer 1981, Chapman et al. 1982, Golley 1962, Hall 1981, Lowe 1958, Terrell 1972, Toll et al 1960, Whitaker and Hamilton 1998, Wilson and Ruff 1999, Zollner et al. 2000

Virginia Opossum, *Didelphis virginiana*, AMAAA01010, G5, S5

Habitat and distribution: Virginia opossums are found statewide in Georgia and throughout most of the United States. Often selecting sites near water, opossums may be found in practically any habitat - even in heavily urban areas. They may show a preference for habitat diversity/edge effect.

Model: Habitats 9, 20, 22, 24, 31, 34, 72, 80, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 513, 620, 890, 900, 920, 930, 980, and 990. Statewide range.

References: Allen et al. 1985, Blumenthal and Kirkland 1976, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Gardner 1982, Golley 1962, Hall 1981, Lay 1942, Llewellyn and Dale 1964, McManus 1974, Verts 1963, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999, Wood and Odum 1964

Water Shrew, *Sorex palustris*, AMABA01150, G5, S1

Habitat and distribution: Chiefly mammals of northern latitudes, water shrews occur in Georgia only at higher elevations of the Blue Ridge, where they may be found in northern hardwoods or along the banks of cold, small streams.

Model: Applied 30 meter buffer to 1:24, 000 stream coverage. Kept habitats 411, 414, 415, 424, 431, and 433 within buffer. Clipped by digitized range.

References: Beneski and Stinson 1987, Brown 1997, Burt and Grossenheider 1980, Hall 1981, Laerm et al. 1995b, Pagels 1987, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

White-footed Mouse, *Peromyscus leucopus*, AMAFF03070, G5, S5

Habitat and distribution: Present in Georgia north of the Fall Line, white-footed mice are primarily dwellers of forest edges, brushy areas, and other habitats possessing a tree or shrub canopy. They may also be plentiful in hedgerows bordering agricultural areas. They are less common at high elevations.

Model: Habitats 20, 31, 80, 201, 202, 203, 410, 411, 412, 413, 422, 423, 431, 432, 434, 440, and 900 within digitized range.

References: Atkeson and Johnson 1979, Breidling et al. 1983, Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Ford et al. 1994, Golley 1962, Hall 1981, Lackey et al. 1985, Menzel et al. 1999, Mitchell et al. 1995, Russell and Russell 1999, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

White-tailed Deer, *Odocoileus virginianus*, AMALC02020, G5, S5

Habitat and distribution: Although white-tailed deer are currently widespread throughout Georgia, this was not true as recently as the 1950's. Deer thrive in various interspersed/forest edge habitats where they can find cover and ample forage. Deer are adaptable and very tolerant of human populations.

Model: Habitats 20, 22, 31, 73, 80, 83, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 513, 620, 890, 900, 930, 980, and 990. Applied mask of road density < 80 m per ha. Statewide range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Hall 1981, Hesselton and Hesselton 1982, Smith 1991, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Wild Pig, *Sus scrofa*, AMALA01010, G5, SE

Habitat and distribution: Not native to North America, pigs were first introduced to the Southeast by DeSoto in 1539, and current populations in Georgia may be a mixture of the descendents of these with European wild hogs subsequently introduced into the Appalachians. Favored habitat includes bottomlands with oak-hickory woodlands, mixed hardwood forest, live oak hammocks and the borders of swamps.

Model: Habitats 9, 410, 411, 414, 420, 424, 431, 433, 434, 513, 890, 900, 930, and 990 within mask of clumps of suitable habitat > 200 ha. Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, Golley 1962, Graves and Graves 1977, Hall 1981, Hanson and Karstad 1959, Kurz and Marchinton 1972, Sweeney 1970, Sweeney and Sweeney 1982, Whitaker and Hamilton 1998, Wilson and Ruff 1999, Wood and Brenneman 1980

Woodchuck, *Marmota monax*, AMAFB03010, G5, S3

Habitat and distribution: Recently expanding their range southwards in Georgia, woodchucks may be found in open habitats such as fencerows, thickets or brushy woodland edges, especially along fields, roads or streams. Kudzu patches in the Piedmont are also favored.

Model: Habitats 20 and 80 within digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Golley 1962, Hall 1981, Kwiecinski 1998, Lee and Funderburg 1982, Robinson and Lee 1980, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Woodland Jumping Mouse, *Napaeozapus insignis*, AMAFH02010, G5, S3

Habitat and distribution: Occurring chiefly in eastern Canada and in northern regions of the United States, woodland jumping mice may be found in montane habitats in the Appalachians as far south as the Blue Ridge of Georgia. Seldom occurring in open areas, they are mainly restricted to woodland habitats, often in riparian areas. They are most common in cool, damp forests with moss-covered rocks.

Model: Habitats 414, 415, 424, 425, 431, and 433 within mask of elevations > 700 m (2296 feet). Clipped by digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Ford et al. 1994, Hall 1981, Menzel et al. 1999, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Whitaker and Wrigley 1972, Wilson and Ruff 1999

Woodland Vole, *Microtus pinetorum*, AMAFF11150, G5, S5

Habitat and distribution: Fossorial mammals, woodland voles are found in most of Georgia in forested habitats characterized by a thick layer of leaf litter. They may also occasionally be found in dense grass, orchards, pinelands, and fallow fields bordering forested areas.

Model: Habitats 80, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 620, 900, and 990 within digitized range.

References: Brown 1997, Burt and Grossenheider 1980, Cothran et al. 1991, French 1980b, Golley 1962, Hall 1981, Johnson and Johnson 1982, King 1982, Menzel et al. 1999, Smolen 1981, Virginia Fish and Widlife Information Service 1998, Whitaker and Hamilton 1998, Wilson and Ruff 1999

Reptiles

Alabama Map Turtle, *Graptemys pulchra*, ARAAD05090, G4, S1

Habitat and distribution: Alabama map turtles have been reported from the Coosa drainage of northwest Georgia. Potential habitat includes rivers and larger streams that are associated with limestone bedrock.

Alabama map turtles appear to be absent from streams lacking an adequate supply of mussels, a required dietary component of adult females.

Model: Kept rasterized grid of 100, 000 streams. Clipped by digitized range.

Conant and Collins 1998, Ernst et al. 1994, Jensen 1999, Mount 1975, Santhoff and Wilson 1990, Shealy 1976, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Alligator Snapping Turtle, *Macroclemys temminckii*, ARAAB02010, G4G3, S3
Habitat and distribution: Alligator snapping turtles are uncommon inhabitants of Gulf drainage streams in southwestern Georgia. These large freshwater turtles typically occur in larger rivers and tributaries, lakes, and other bodies of water associated with river systems.

Model: Kept rasterized 1: 100, 000 streams, as well as habitats 7 (associated with freshwater) and 11 (freshwater only).

References: Conant and Collins 1998, Ernst et al. 1994, Ewert 1976, Harrel et al. 1996, Jensen 1999, Lane and Mitchell 1997, Lovich 1993, Mount 1975, Pritchard 1990, Sloan and Taylor 1987, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

American Alligator, *Alligator mississippiensis*, ARABA01010, G5, S4

Habitat and distribution: Residents of river swamps, lakes and bayous of the Atlantic and Gulf coasts, American alligators may be observed in Georgia south of the Fall Line in aquatic habitats. Shallow water in swamps, marsh-bordered lakes, and fresh or brackish marshes provide good habitat.

Model: Kept rasterized 1:100, 000 streams, as well habitats 7, 11 (shallow fresh and saltwater), 890, 920, and 930. Clipped by digitized range.

References: Alderton 1991, Bartlett and Bartlett 1999, Carr and Goin 1959, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Hunt and Ogden 1991, Joanen and McNease 1972, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tamarack 1993, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Banded Water Snake, *Nerodia fasciata*, ARADB22030, G5, S5

Habitat and distribution: Banded water snakes are common residents of Georgia south of the Fall Line, where they are occupants of diverse fresh and brackish water habitats. They prefer shallow, permanent water, and may be abundant in sinkholes, borrow pits, and swamps.

Model: Habitats 7 (associated with freshwater), 11 (shallow freshwater only), 31 (where it intersects with NWI freshwater wetlands), 890, 900, 930, 980, and 990 within digitized range.

References: Barbour 1971, Blaney and Blaney 1979, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Hebrard and Mushinsky 1978, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Schwaner and Mount 1976, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Barbour's Map Turtle, *Graptemys barbouri*, ARAAD05010, G2, S2

Habitat and distribution: Barbour's map turtles occur in Georgia in the Flint and Chattahoochee river systems, where they are often observed in association with limestone outcrops. These rare turtles are found exclusively in streams that contain a good supply of mollusks.

Model: Kept rasterized grid of 100, 000 streams. Clipped by digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Ernst et al. 1994, Jensen 1999, Jensen and Moulis 1999, Mount 1975, Sanderson 1974, Sanderson 1992, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Black/Eastern Kingsnake, *Lampropeltis getula*, ARADB19020, G5, S5

Habitat and distribution: Eastern kingsnakes occur throughout Georgia in a very wide variety of habitats. They may be encountered almost anywhere.

Model: Habitats 9, 20, 31, 33, 34, 80, 83, 201, 202, 203, 410, 411, 412, 413, 414, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 512, 513, 620, 890, 900, 980, and 990. Statewide range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jensen and Moulis 1999, Lacy 1997, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tamarack and Doherty 1993, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Black Racer, *Coluber constrictor*, ARADB07010, G5, S5

Habitat and distribution: Black racers occur throughout Georgia, and are extremely adaptable in their habitat tolerance2, occurring in most terrestrial environments - open pine woods, forest edges, brushy dunes, maritime forests, farmlands, bottomland hardwoods , etc..

Model: Habitats 20, 31, 80, 83, 410, 411, 412, 413, 414, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 512, 513, 620, 900, and 990. Statewide range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Petzing and Phillips 1998f, Plummer and Congdon 1994, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Black Swamp Snake, *Seminatrix pygaea*, ARADB31010, G5, S3

Habitat and distribution: Black swamp snakes are residents of the lower Coastal Plain of Georgia, typically in association with densely vegetated, aquatic habitats including cypress or gum swamps, and bogs. They need an environment of dense vegetative cover, and may be particularly numerous in areas where water hyacinths abound.

Model: Habitats 11 (shallow freshwater only), 31 (where it intersects with NWI freshwater wetlands), 890, and 930 within digitized range.

References: Conant and Collins 1998, Gibbons and Semlitsch 1991, Gibbons and West 2000, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Bog Turtle, *Clemmys muhlenbergii*, ARAAD02040, G3, S1

Habitat and distribution: Bog turtles have been reported from a few locations in the Blue Ridge of Georgia. Potential habitats include boggy seepages and streams, wet fields or pastures, marshy areas, and wetlands of willow and alder.

Model: Habitats 900, 930, and 980 within digitized range.

References: Bury 1979, Conant and Collins 1998, Ernst 1977, Ernst and Bury 1977, Ernst et al. 1994, Jensen 1999, Martof et al. 1980, Tryon 1990, Tryon and Herman 1991, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Box Turtle, *Terrapene carolina*, ARAAD08010, G5, S5

Habitat and distribution: Box turtles occur throughout Georgia in most types of forest communities. They may also be present in open, early-seral environments such as old fields or recently cut-over areas.

Model: Habitats 20, 31, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 512, 513, 620, 900, 980, and 990. Statewide range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Ernst et al. 1994, Gibbons and Semlitsch 1991, Hall et al. 1999, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Muegel and Claussen 1994, Stickel 1978, Stickel 1989, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Broadhead Skink, *Eumeces laticeps*, ARACH01080, G5, S5

Habitat and distribution: Broadhead skinks are found throughout Georgia in a variety of forested habitats. They prefer a moist environment with large, spreading trees such as live oak or water oak. Broadhead skinks are very arboreal, and may be observed in both living and dead trees.

Model: Habitats 72, 73, 201, 202, 203, 410, 411, 412, 420, 422, 434, 440, 441, 513, 620, 900, and 990 within digitized range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Jensen and Moulis 1999, Lacy 1997, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Brown Anole, *Anolis sagrei*, ARACF01060, G5, SE

Habitat and distribution: Previously introduced into Florida from the Caribbean region, brown anoles have expanded their range north, and have been observed in scattered localities near the Georgia coast and on the lower Coastal Plain. They have been most frequently noted in shrubbery at sites near major highways.

Model: Habitats 22, 24, 201, 202, and 203 within digitized range.

References: Ashton and Ashton 1988, Bartlett and Bartlett 1999, Campbell 1996, Conant and Collins 1998, Losos and Spiller 1999

Brown Snake, *Storeria dekayi*, ARADB34010, G5, S5

Habitat and distribution: Widespread in the eastern U.S., brown snakes occur throughout Georgia in habitats including hardwood and pine forest, as well as open areas such as orchards, fields and pastures. Brown snakes are notable for their ability to survive in urban environments including parks, golf courses, and most types of residential areas.

Model: Habitats 20, 22, 31, 72, 73, 80, 83, 201, 202, 203, 410, 411, 412, 413, 414, 420, 422, 424, 425, 431, 433, 434, 440, 441, 513, 620, 900, and 990. Statewide range.

References: Barbour 1971, Christman 1982, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Brown Water Snake, *Nerodia taxispilota*, ARADB22070, G5, S5

Habitat and distribution: Brown water snakes are relatively widespread in the Coastal Plain and much of the Piedmont in Georgia, occurring in slow-flowing rivers and streams, and sometimes in shallow waters of lakes and cypress swamps. These large snakes are arboreal, and may frequently be observed basking in trees or shrubs overhanging water.

Model: Applied 30 meter buffer to 1:24, 000 stream coverage. Kept habitats 31, 410, 411, 412, 413, 420, 422, 423, 432, 434, 440, 441, 512, 620, 890, 900, 980, and 990 within buffer. Also kept habitat 31 where it intersects with NWIs freshwater wetlands.
Kept habitats 7 (associated with freshwater), 11 (shallow freshwater only), 900, 930, and 980 in all cases. Clipped by digitized range.

References: Conant and Collins 1998, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jensen and Moulis 1999, Lacy 1997, Martof et al. 1980, Mills et al. 1995, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Canebrake/Timber Rattlesnake, *Crotalus horridus*, ARADE02040, G4, S4

Habitat and distribution: Timber and/or canebrake rattlesnakes are widespread in Georgia, occurring almost statewide. North of the Fall Line, they typically inhabit ridge tops with rocky places that provide winter shelter. In the Coastal Plain, they occupy very diverse habitats including swamps, river floodplains, pine woods, and habitats of the barrier islands.

Model: Habitats 34, 410, 411, 412, 413, 414, 415, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 511, 620, 900, and 990 within digitized range.

References: Barbour 1971, Brown 1993, Conant and Collins 1998, Galligan and Dunson 1979, Gibbons and Semlitsch 1991, Gibbons and West 2000, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Reinert 1984, Reinert and Zappalorti 1988, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Central Florida Crowned Snake, *Tantilla relicta*, ARADB35080, G5, S1
Habitat and distribution: Once thought to be endemic to Florida, central Florida crowned snakes are known in Georgia only from the Valdosta Limesink region, where they have been reported from a location in Lowndes County. Potential habitat in Georgia includes sandhills, hardwood and mixed forest, and longleaf pine woods, particularly those that are relatively dry. These small, secretive snakes require locations that have sandy soil and some type of surface cover.

Model: Habitats 413, 432, 434, 512, and 620 within digitized range.

References: Carr and Goin 1959, Conant and Collins 1998, Telford 1980b, Tennant 1997, Wilson 1995, Wright and Wright 1957

Chicken Turtle, *Deirochelys reticularia*, ARAAD03010, G5, S5

Habitat and distribution: Chicken turtles are found south of the Fall Line in Georgia, where they inhabit the still water of lakes, flooded ditches, borrow pits, and permanent or temporary ponds, especially in pine savannas. Chicken turtles are somewhat terrestrial, and may frequently be observed on land.

Model: Habitats 7 (associated with freshwater), 11 (freshwater only), 31 (where it intersects with NWI freshwater wetlands), 890, 900, 980, and 990 within digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Dundee and Rossman 1989, Ernst et al. 1994, Gibbons 1969, Gibbons and Semlitsch 1991, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Zug and Schwartz 1971

Coachwhip, *Masticophis flagellum*, ARADB21020, G5, S5

Habitat and distribution: Widespread in Georgia, coachwhips may be found in a variety of drier or open, grassy places. South of the Fall Line, they are typically associated with dry, sandy situations including areas of cut-over pines, pine flatwoods, maritime forest, and sandhills. In the Piedmont, they are usually found in drier forested or cutover areas.

Model: Habitats 9, 20, 31, 80, 411, 412, 413, 420, 422, 423, 432, 434, 440, 441, 512, 513, and 620 within digitized range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jensen and Moulis 1999, Lacy 1997, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Coal Skink, *Eumeces anthracinus*, ARACH01010, G5, S1

Habitat and distribution: Coal skinks are found in scattered locations in Georgia, where they occupy moist, forested habitats. They are most often associated with mixed pine-hardwood forest.

Model: Habitats 410, 411, 412, 414, 424, 425, 433, and 900 within digitized range.

References: Barbour 1971, Conant and Collins 1998, Martof et al. 1980, Means 1992, Mount 1975, Palmer and Braswell 1995, Walley 1998, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Common Map Turtle, *Graptemys geographica*, ARAAD05040, G5, S1

Habitat and distribution: On the periphery of their range, common map turtles are infrequently observed in Georgia, but have been reported from the northwestern corner of the state. Potential habitat includes shallow, silt-free water of rivers and larger tributaries.

Model: Kept rasterized grid of 100, 000 streams. Clipped by digitized range.

References: Barbour 1971, Conant and Collins 1998, Ernst et al. 1994, Fuselier and Edds 1994, Gordon and MacCulloch 1980, Jensen 1999, Martof et al. 1980, Mount 1975, Pluto and Bellis 1986, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Common Musk Turtle, *Sternotherus odoratus*, ARAAE02040, G5, S5

Habitat and distribution: Common musk turtles occur throughout Georgia, and may be plentiful in ponds, lakes, sloughs, and other still or sluggish water habitats. They require a soft substrate, in which they may hibernate, buried in mud. Although essentially aquatic, common musk turtles may occasionally be observed climbing or basking in the branches of trees overhanging water.

Model: Kept rasterized 1:100, 000 streams where slope < 4%. Kept habitats 7 (associated with freshwater) and 11 (freshwater only). Statewide range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Ernst 1986, Ernst et al. 1994, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Reynolds and Seidel 1982, Sutton and Christiansen 1999, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Copperhead, *Agkistrodon contortrix*, ARADE01010, G5, S5

Habitat and distribution: Although absent from the southeastern corner of the state, copperheads may be found nearly everywhere else in Georgia. They are adaptable in their habitat tolerance, and may be found in hardwoods and most types of pine forest, meadows and fields, and frequently in residential areas.

Model: Habitats 20, 31, 34, 80, 201, 202, 203, 410, 411, 412, 413, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 900, and 990 within digitized range.

References: Barbour 1971, Conant and Collins 1998, Gibbons and Semlitsch 1991, Gibbons and West 2000, Huheey and Stupka 1967, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Reinert 1984, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Coral Snake, *Micrurus fulvius*, ARADC02010, G5, S3

Habitat and distribution: Coral snakes occur in most of the Coastal Plain and parts of the Piedmont in Georgia. They may be abundant in flatwoods of longleaf or slash pine, pine-oak scrub, and maritime forest of live oak. Coral snakes are fossorial, and require an environment with loose, friable soil.

Model: Habitats 412, 413, 420, 432, 434, 441, 512, and 620 within digitized range.

References: Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jackson and Franz 1981, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Roze and Tilger 1983, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Corn Snake, *Elaphe guttata*, ARADB13020, G5, S5

Habitat and distribution: These colorful snakes are widespread in Georgia, and are encountered throughout the state in xeric habitats like mixed forest, pine flatwoods, or sandhill environments, and sometimes in bottomland or other mesic hardwoods. . They may also be abundant around abandoned farms and other places where small rodents thrive.

Model: Habitats 20, 31, 80, 83, 201, 202, 203, 410, 411, 412, 413, 420, 422, 431, 432, 434, 440, 441, 512, 513, 620, and 900. Statewide range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Huheey and Stupka 1967, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Cottonmouth, *Agkistrodon piscivorus*, ARADE01020, G5, S5

Habitat and distribution: Widespread in the southeastern U.S., cottonmouths may be found in almost any type of permanently aquatic habitat. They may be abundant in fresh and brackish water throughout the Coastal Plain, lower Piedmont, and western portions of the Ridge and Valley provinces of Georgia. Common habitats include cypress swamps, lakes, rivers, Carolina bays, and marshes.

Model: Kept habitats 7 (associated with freshwater), 11 (shallow freshwater only), 890, 900, 930, 980, and 990. Kept habitats 20 and 31 where they intersect with NWI freshwater wetlands. Clipped by digitized range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Diamondback Terrapin, *Malaclemys terrapin*, ARAAD06010, G4, S3

Habitat and distribution: Diamondback terrapins are residents of salt marsh and estuarine habitats of the Atlantic and Gulf Coasts. In Georgia, they may be encountered in shallow water of brackish and tidal saltmarshes, in estuaries, and nesting on beaches and coastal dunes.

Model: Habitats 7, 9, 11 (shallow saltwater only), and 920 within digitized range.

References: Ashton and Ashton 1988, Bishop 1983, Conant and Collins 1998, Ernst and Bury 1982, Ernst et al. 1994, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Eastern Diamondback Rattlesnake, *Crotalus adamanteus*, ARADE02010, G4, S4

Habitat and distribution: Eastern diamondbacks occur south of the Fall Line in Georgia, most typically in pine-dominated habitats of the lower Coastal Plain. Suitable situations include relatively dry pine flatwoods and sandhill habitats of longleaf pine and turkey oak. This species requires large areas of undisturbed habitat.

Model: Habitats 9, 412, 413, 420, 432, 434, 441, 512, 513, 620, and 900 within mask of road density < 80 m per ha to eliminate urban areas. Clipped by digitized range.

References: Berish 1998, Conant and Collins 1998, Gibbons and Semlitsch 1991, Gibbons and West 2000, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Eastern Garter Snake, *Thamnophis sirtalis*, ARADB36130, G5, S5

Habitat and distribution: True habitat generalists, garter snakes may be encountered throughout Georgia in most mesic habitats: hardwood and pine forests, on rocky hillsides, and in non-forested situations such as meadows and marshes. Garter snakes also occur in man-made environments such as roadside ditches, powerline rights-of-way, parks, golf courses and residential areas.

Model: Habitats 20, 22, 31, 72, 73, 80, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 424, 425, 431, 432, 433, 434, 440, 441, 511, 513, 620, 890, 900, 930, 980, and 990. Statewide range.

References: Barbour 1971, Carpenter 1952, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jensen and Moulis 1997, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant 1997, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Eastern Glass Lizard, *Ophisaurus ventralis*, ARACB02030, G5, S5

Habitat and distribution: Occupying the Coastal Plain and western portion of the Piedmont of Georgia, eastern glass lizards are residents of a variety of forested habitats including mesic and damp hardwoods, pine flatwoods, and maritime forest. They are quite adaptable, however, and may also be found in open habitats such as vacant lots, road shoulders, and fields.

Model: Habitats 7, 9, 20, 22, 31, 72, 73, 201, 202, 203, 410, 412, 420, 434, 441, 512, 513, and 620 within digitized range.

References: Ashton and Ashton 1988, Bartlett and Bartlett 1999, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Eastern Hognose Snake, *Heterodon platirhinos*, ARADB17020, G5, S5

Habitat and distribution: Eastern hognose snakes occupy sandy and dry habitats throughout Georgia. Typical conditions include pine woods, maritime forests of the barrier islands, and sandhill forests of turkey oak and longleaf pine.

Model: Habitats 20, 31, 410, 411, 412, 413, 414, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 512, and 620. Statewide range.

References: Barbour 1971, Conant and Collins 1998, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Petzing and Phillips 1998g, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Eastern Mud Turtle, *Kinosternon subrubrum*, ARAAE01050, G5, S5

Habitat and distribution: Although absent from the Blue Ridge of Georgia, eastern mud turtles are widespread elsewhere in the state. They prefer muddy-bottomed locations in slow-flowing or still water of beaver ponds, swamps and sluggish streams.

Model: Kept rasterized 1:100, 000 streams, as well habitats 11 (shallow freshwater only), 31 (where it intersects with NWI freshwater wetlands), 890, 900, 930, 980, and 990. Clipped by digitized range.

References: Ashton and Ashton 1988, Bennett 1972, Burke et al. 1994, Conant and Collins 1998, Dundee and Rossman 1989, Ernst et al. 1994, Gibbons and Semlitsch 1991, Iverson 1977b, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Fence Lizard, *Sceloporus undulates*, ARACF14130, G5, S5

Habitat and distribution: Fence lizards are abundant throughout Georgia, where they are typically associated with open-canopied, dry woodlands or rocky areas.

Model: Habitats 31, 34, 411, 412, 413, 420, 422, 423, 431, 432, 434, 440, 441, 512, 513, and 620. Statewide range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Lacy 1997, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Parker 1994, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Five-lined Skink, *Eumeces fasciatus*, ARACH01050, G5, S5

Habitat and distribution: Five-lined skinks occur throughout Georgia, where they may be most commonly encountered in mesic hardwood forest. They often prefer locations in valleys and along the banks of streams, and are also frequently observed around residential areas.

Model: Habitats 20, 31, 72, 201, 202, 203, 410, 411, 412, 413, 414, 415, 420, 422, 424, 425, 431, 432, 433, 434, 440, 441, 513, 620, 890, 900, and 990. Statewide range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Hecnar 1994, Huheey and Stupka 1967, Jensen and Moulis 1999, Lacy 1997, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Florida Cooter, *Pseudemys floridana*, ARAAD07030, G5, S5

Habitat and distribution: Florida cooters are found south of the Fall Line in Georgia in almost any freshwater habitat of still or slow-flowing water that has a soft, muddy bottom and aquatic vegetation. They may be abundant in such places as ponds, marshy areas, cypress swamps, oxbows, canals, and sluggish streams or rivers.

Model: Habitats 7 (associated with freshwater), 11 (shallow freshwater only), 890, and 930 within digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Dundee and Rossman 1989, Ernst et al. 1994, Gibbons and Semlitsch 1991, Kramer 1995, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Florida Green Water Snake, *Nerodia floridana*, ARADB22080, G5, S2

Habitat and distribution: Relatively uncommon residents of Georgia, Florida green water snakes have been occasionally observed in and around the Okefenokee Swamp, and at scattered locations in the Savannah and Flint River drainages. Potential habitat in Georgia includes freshwater marsh, wet prairies of the Okefenokee, and similar aquatic environments possessing shallow, quiet bodies of water.

Model: Habitats 7 (associated with freshwater), 11 (shallow freshwater only), and 930 within digitized range.

References: Carr and Goin 1959, Conant and Collins 1998, Gibbons and West 2000, Jensen and Moulis 1997, Mount 1975, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Florida Redbelly Turtle, *Pseudemys nelsoni*, ARAAD07040, G5, S2

Habitat and distribution: Otherwise endemic to Florida, Florida redbelly turtles have been reported in Georgia from the Okefenokee Swamp, Cumberland Island, and other locations in the extreme southeastern part of the state. These large freshwater turtles prefer an environment of profuse aquatic vegetation, and may be encountered in marshes or bogs, and in shallow water of slow-flowing streams, cypress swamps, ponds and flooded ditches.

Model: Habitats 7 (associated with freshwater), 11 (shallow freshwater only), and 930 within digitized range.

References: Ashton and Ashton 1988, Carr and Goin 1959, Conant and Collins 1998, Ernst et al. 1994, Kramer 1995, Shoop and Ruckdeschel 1986, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Florida Softshell, *Apalone ferox*, ARAAG01010, G5, S5

Habitat and distribution: Florida softshell turtles may be observed in Georgia in aquatic habitats well south of the Fall Line. They may be at home in ponds, lakes, canals, and sluggish rivers or streams, where they spend much time on the bottom, leaving the water only to bask and to lay eggs.

Model: Kept rasterized 1:100, 000 streams, as well habitats 11 (freshwater only), 890, 930, and 980. Clipped by digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Crenshaw and Hopkins 1955, Ernst et al. 1994, Martof et al. 1980, Mount 1975, Stevenson and Platt 1999, Webb 1973, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Florida Worm Lizard, *Rhineura floridana*, ARACA01010, G4, S1

Habitat and distribution: These secretive and infrequently observed reptiles burrow in soil in dry, sandy habitats, including upland hammocks and high pine. They have been reported from one location in Georgia, in Lanier County.

Model: Habitats 80, 434, 441, 512, and 620 within digitized range.

References: Ashton and Ashton 1988, Bartlett and Bartlett 1999, Conant and Collins 1998, Gans 1967, Wlson 1995

Glossy Crayfish Snake, *Regina rigida*, ARADB27030, G5, S4

Habitat and distribution: Glossy crayfish snakes have been reported from a variety of freshwater habitats south of the Fall Line in Georgia, where they typically occur in the shallow water of bogs, marshes, and slow-flowing streams. They may also thrive in low, damp situations around the edges of ponds and in cypress or gum swamps.

Model: Habitats 11 (shallow freshwater only), 31 (where it intersects with NWI freshwater wetlands), 890, 900, 930, 980, and 990 within digitized range.

References: Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Huheey 1959, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Gopher Tortoise, *Gopherus polyphemus*, ARAAF01030, G3, S3

Habitat and distribution: Gopher tortoises are relatively rare inhabitants of the Coastal Plain of Georgia. They are normally associated with dry sand ridge habitats of longleaf pine and turkey oak. This habitat closely parallels that of the indigo snake, gopher frog, and other unique occupants of sandhill communities.

Model: Recoded habitats 512 and 620 to 1 and all else to 0; applied 3x3 moving window (FOCALMEAN using rectangle); kept areas where values were greater than .33; used results of this as a mask for suitable habitats 20, 31, 413, 432, 441, 512, and 620. Clipped by digitized range.

References: Anderson and Herrington 1992, Ashton and Ashton 1988, Auffenberg and Franz 1978, Breininger et al. 1994, Conant and Collins 1998, Diemer 1992, Diemer and Speake 1983, Ernst et al. 1994, Jensen 1999, Landers and Garner 1981, Martof et al. 1980, McRae et al. 1981, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Green Anole, *Anolis carolinensis*, ARACF01010, G5, S5

Habitat and distribution: Arboreal lizards, green anoles are widespread in Georgia, in moist habitats possessing abundant trees and vegetation of shrubs and vines. They may also be seen in residential areas on fences and other manmade structures.

Model: Habitats 20, 22, 31, 72, 73, 201, 202, 203, 410, 411, 412, 413, 420, 422, 434, 440, 441, 512, 890, 900, 980, and 990 within digitized range.

References: Ashton and Ashton 1988, Bartlett and Bartlett 1999, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Jensen and Moulis 1999, Jenssen et al. 1998, Losos and Spiller 1999, Martof et al. 1980, Michaud and Echternacht 1995, Mount 1975, Palmer and Braswell 1995, Petzing and Phillips 1998d, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Ground Skink, *Scincella lateralis*, ARACH03010, G5, S5

Habitat and distribution: Occurring throughout Georgia, ground skinks occupy hardwood forests, most pines, and other forest types ranging from cypress-gum to maritime live oak.

Model: Habitats 9, 73, 201, 202, 203, 410, 411, 412, 413, 420, 422, 423, 432, 434, 440, 441, 512, 513, 620, 900, and 990. Statewide range.

References: Ashton and Ashton 1988, Barbour 1971, Brooks 1975, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Indigo Snake, *Drymarchon corais*, ARADB11010, G4, S3

Habitat and distribution: Indigo snakes are uncommon inhabitants of the Coastal Plain of Georgia. They are most often associated with dry sand ridge habitat having vegetation of longleaf pine and turkey oak. This sandhill habitat closely parallels that of the gopher tortoise, and indigo snakes frequently take refuge in gopher tortoise burrows.

Model: Recoded habitats 512 and 620 to 1 and all else to 0; applied 3x3 moving window (FOCALMEAN using rectangle); kept areas where values were greater than .33; used results of this as a mask for suitable habitats 412, 413, 432, 434, 441, 512, 620, 890, 900, and 990. Clipped by digitized range.

References: Behler et al. 1997, Conant and Collins 1998, Diemer and Speake 1981, Diemer and Speake 1983, Gibbons and West 2000, Jensen 1999, Lawler 1977, Moler 1992, Mount 1975, Speake and Mount 1973, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Island Glass Lizard, *Ophisaurus compressus*, ARACB02020, G3G4, S2

Habitat and distribution: Snakelike in appearance, island glass lizards are residents of the lower Coastal Plain and offshore islands of Georgia, where they occupy sandy, mainly xeric sites. Typical habitats include scrub pine regions and pine flatwoods.

Model: Habitats 9, 31, 420, 434, 441, 512, 513, and 620 within digitized range.

References: Ashton and Ashton 1988, Bartlett and Bartlett 1999, Conant and Collins 1998, Martof et al. 1980, Shoop and Ruckdeschel 1997, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Loggerhead, *Caretta caretta*, ARAAA01010, G3, S3

Habitat and distribution: These large sea turtles nest along the Georgia coast, and otherwise may be found in deep or shallow water of estuaries and the open water of the Atlantic. Loggerhead turtles in North America primarily nest on isolated beaches and coastal dunes of barrier islands, from North Carolina south to Florida.

Model: Habitats 7, 9, and 11 (saltwater only) within digitized range.

References: Ashton and Ashton 1988, Carr and Goin 1959, Conant and Collins 1998, Dodd 1992, Ernst et al. 1994, Martof et al. 1980, Mount 1975, Wilson 1995, Winn 1999

Mediterranean Gecko, *Hemidactylus turcicus*, ARACD03020, G5, SE

Habitat and distribution: Natives of Europe and Asia, Mediterranean geckos have becomes established in many states in the southern U.S., and in parts of Mexico and the Caribbean. They have been reported from a few widely scattered locations in Georgia. At home around human habitation, Mediterranean geckos may be observed in urban places and on buildings. They are nocturnal, and may sometimes be seen feeding on insects attracted to lights.

Model: Habitats 22, 24, 72, 201, 202, and 203 within digitized range.

References: Ashton and Ashton 1988, Bartlett and Bartlett 1999, Bechtel 1983, Conant and Collins 1998, Dundee and Rossman 1989, Mills 1990, Nelson and Carey 1993

Midland Water Snake, *Nerodia sipedon*, ARADB22060, G5, S5

Habitat and distribution: Midland water snakes are common inhabitants of a variety of aquatic environments north of the Fall Line and in southwest Georgia. Suitable habitat includes the flowing water of rivers and streams, and quiet, shallow waters of ponds, bogs, marshes and lakes.

Model: Kept rasterized 1:24, 000 streams, as well habitats 7 (associated with freshwater), 11 (shallow freshwater only), 900, 930, and 980. Clipped by digitized range.

References: Barbour 1971, Blaney and Blaney 1979, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and West 2000, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Schwaner and Mount 1976, Tiebout and Cary 1987, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Milk Snake, *Lampropeltis triangulum*, ARADB19050, G5, S4
Habitat and distribution: Occurring in the Cumberland Plateau, Ridge and Valley, and Blue Ridge of Georgia, milk snakes are most often observed in or near mountainous locations. Habitats in Georgia include ridges, hillsides, rocky pastures and hardwood forest.

Model: Habitats 22, 80, 201, 202, 203, 410, 411, 412, 413, 414, 415, 423, 424, 425, 431, 432, 433, 434, and 511 within digitized range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jensen and Moulis 1997, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williams 1994, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957
Mimic Glass Lizard, *Ophisaurus mimicus*, ARACB02040, G3, S2
Habitat and distribution: Mimic glass lizards are somewhat infrequently observed residents of flatwoods and other pine-dominated forests on the lower Coastal Plain of Georgia. They appear to prefer locations that have an open canopy of trees and ample ground cover of pine needles and other litter.

Model: Habitats 20, 31, 434, 441, 512, and 620 within digitized range.

References: Bartlett and Bartlett 1999, Conant and Collins 1998, Moler 1992, Palmer 1987, Palmer 1992, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Mole Kingsnake, *Lampropeltis calligaster*, ARADB19010, G5, S5

Habitat and distribution: Mole kingsnakes may be observed in Georgia north of the Fall Line and in some areas around the Fall Line. They typically inhabit upland, wooded situations including thickets, hardwood forest, and woods of Virginia pine and other upland pine species. They may also be found in open places such as fields and abandoned farmland.

Model: Habitats 20, 31, 80, 410, 411, 413, 422, 423, 432, 434, 440, and 512 within digitized range.

References: Conant and Collins 1998, Gibbons and West 2000, Martof et al. 1980, Means 1992, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Mole Skink, *Eumeces egregious*, ARACH01040, G4, S3

Habitat and disitribution: Associated with dry, sandy habitats of the Coastal Plain, mole skinks occupy areas dominated by longleaf pine and turkey oak, and scrub associations of sand pine and evergreen oak.

Model: Habitats 20, 31, 441, 512, 513, and 620 within digitized range.

References: Ashton and Ashton 1988, Bartlett and Bartlett 1999, Conant and Collins 1998, Greenberg et al. 1994, Mount 1963, Mount 1968, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Mud Snake, *Farancia abacura*, ARADB14010, G5, S5

Habitat and distribution: These primarily aquatic snakes are found in wetland habitats in Georgia south of the Fall Line, and to a lesser extent, in the Piedmont of Georgia. Mud snakes are most typically associated with swampy environments, and may be encountered in cypress swamps, river floodplains, and slow-flowing lowland streams.

Model: Habitats 7 (where associated with freshwater), 11 (shallow freshwater only), 31 (where it intersects with NWI freshwater wetlands), 890, 900, 930, 980, and 990 within digitized range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jensen and Moulis 1999, Lacy 1997, Martof et al. 1980, McDaniel and Karges 1983, Mount 1975, Neill 1964, Palmer and Braswell 1995, Petzing and Phillips 1998e, Semlitsch et al. 1988, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Painted Turtle, *Chrysemys picta*, ARAAD01010, G5, S5

Habitat and distribution: Painted turtles occur mostly north of the Fall Line in Georgia in freshwater habitats, including slow-moving streams and oxbows, lakes and ponds, and marshes, bogs, and flooded swamps.

Model: Kept rasterized 1:100, 000 streams where slope < 4%. Kept habitats 7 (associated with freshwater), 11 (freshwater only), 890, 900, 930, and 980. Clipped by digitized range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Ernst 1971, Ernst et al. 1994, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Pigmy Rattlesnake, *Sistrurus miliarius*, ARADE03020, G5, S5
Habitat and distribution: Pigmy rattlesnakes have a relatively wide range throughout the Coastal Plain and much of the Piedmont in Georgia, and may be encountered in diverse wet and dry forested habitats. They may be encountered in bottomland hardwood or mixed forest, pine flatwoods, swamps and wet savannas, as well as drier situations such as upland mixed forest and longleaf pine-scrub oak. They use sandy or friable soils for burrowing.

Model: Habitats 31, 410, 411, 412, 413, 420, 422, 432, 434, 440, 441, 512, 620, and 900 within digitized range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Palmer and Williamson 1971, Tennant and Bartlett 2000, Wainberg et al. 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Pine Snake, *Pituophis melanoleucus*, ARADB26010, G4, S3

Habitat and distribution: Pine snakes are found throughout much of Georgia, typically occupying xeric habitats characterized by sandy soil. South of the Fall Line, they may be encountered in pine flatwoods, and in dry, sandy forests of pine and scrub oak. From the Georgia Piedmont northward, pine snakes may be observed on ridges, and in dry, upland pine or mixed forest.

Model: Habitats 413, 422, 423, 432, 434, 440, 441, 512, and 620 within digitized range.

References: Barbour 1971, Burger and Zappalorti 1988, Conant and Collins 1998, Dundee and Rossman 1989, Franz 1992, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jensen and Moulis 1997, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Pine Woods Snake, *Rhadinaea flavilata*, ARADB28010, G4, S2

Habitat and distribution: These small, secretive snakes have been reported from the extreme southeastern Coastal Plain of Georgia. Pine woods snakes are most commonly associated with a habitat of damp pine flatwoods, but may also be observed in a few other moist, forested situations such as some mixed forests and maritime live oak. They require an environment with cover in the form of stumps or rotting logs.

Model: Habitats 420, 434, 441, and 620 within digitized range.

References: Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Malnate 1939, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Plainbelly Water Snake, *Nerodia erythrogaster*, ARADB22020, G5, S5

Habitat and distribution: Plainbelly water snakes occur in aquatic habitats in much of Georgia. They are frequently associated with river swamps and floodplains, slow-flowing streams, and lakes or ponds with swampy margins, but may also inhabit marshes, ditches, and other permanent bodies of water.

Model: Kept habitats 410, 411, 412, and 434 where they intersect with rasterized 1:24, 000 streams. Kept habitat 31 where it intersects with NWI freshwater wetlands. Kept habitats 7 (associated with freshwater), 11 (shallow freshwater only), 890, 900, 930, 980, and 990 in all cases.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Hebrard and Mushinsky 1978, Jensen and Moulis 1999, Lacy 1997, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Queen Snake, *Regina septemvittata*, ARADB27040, G5, S5

Habitat and distribution: These slender, aquatic snakes are relatively widespread in Georgia, and are typically associated with small, rocky streams with overhanging branches. Surrounding forest types may include hardwood or mixed forest. Queen snakes thrive in locations abounding in crayfish, which comprise the major component of their diet.

Model: Applied 90 meter buffer to 1:24, 000 stream coverage. Kept suitable habitats 410, 411, 413, 414, 424, 425, 432, 433, 434, and 900 within buffer. Clipped by digitized range.

References: Barbour 1971, Branson and Baker 1974, Conant and Collins 1998, Gibbons and Semlitsch 1991, Gibbons and West 2000, Lacy 1996, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Rainbow Snake, *Farancia erytrogramma*, ARADB14020, G5, S3

Habitat and distribution: Rainbow snakes are found in aquatic habitats on the Coastal Plain. They are most typically observed in and around rivers and large creeks, and occasionally in cypress ponds and Carolina bays.

Model: Habitats 7 (where associated with freshwater), 11 (shallow freshwater only), 31 (where it intersects with NWI freshwater wetlands), 890, 900, and 990 within digitized range.

References: Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Lacy 1997, Martof et al. 1980, Mitchell 1982, Mount 1975, Neill 1964, Palmer and Braswell 1995, Wilson 1995, Wright and Wright 1957

Red-bellied Snake, *Storeria occipitomaculata*, ARADB34030, G5, S5

Habitat and distribution: Occurring in all physiographic regions of Georgia, red-bellied snakes are inhabitants of moist, wooded areas that are characterized by abundant ground litter. Typical habitat includes hardwood and mixed forest, forests of loblolly, shortleaf or longleaf pine, and wooded residential areas.

Model: Habitats 20, 31, 201, 202, 203, 410, 411, 412, 413, 414, 415, 422, 424, 425, 431, 432, 433, 434, 440, 441, 511, 512, 620, 900, and 990. Statewide range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Linzey 1979, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Semlitsch and Moran 1984, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Ribbon Snake, *Thamnophis sauritus*, ARADB36120, G5, S5

Habitat and distribution: These slender, semi-aquatic snakes occur throughout Georgia in any type of wet situation. They may be particularly abundant along the coast and adjacent Coastal Plain near the edges of lakes, and in and around beaver ponds, marshes, bogs and swamps, and may also occur near flowing water along the edges of streams.

Model: Habitats 7 (associated with freshwater), 11 (shallow freshwater only), 31 (where it intersects with NWI freshwater wetlands), 890, 900, 930, 980, and 990. Statewide range.

References: Barbour 1971, Carpenter 1952, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant 1997, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Ringneck Snake, *Diadophis punctatus*, ARADB10010, G5, S5
Habitat and distribution: Ringneck snakes may be encountered throughout Georgia in forested habitats. They prefer mesic or moist forest types with friable soil for burrowing. Ringneck snakes require locations with abundant shelter of rotting logs, stumps, rocks and leaf litter. If these conditions are present, they may also be found in urban situations.

Model: Habitats 201, 202, 203, 410, 411, 412, 414, 415, 420, 422, 424, 425, 431, 433, 434, 440, 441, 900, and 990. Statewide range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

River Cooter, *Pseudemys concinna*, ARAAD07020, G5, S4S5

Habitat and distribution: Relatively widespread in Georgia, river cooters occupy several types of freshwater aquatic habitats. They typically prefer rivers and streams possessing moderate current, but may also be found in impoundments of these streams, and in other permanent bodies of water.

Model: Kept rasterized 1:100, 000 streams, as well habitats 7 (associated with freshwater), 11 (shallow freshwater only), and 890. Clipped by digitized range.

References: Ashton and Ashton 1988, Barbour 1971, Buhlmann and Vaughn 1991, Conant and Collins 1998, Dundee and Rossman 1989, Ernst et al. 1994, Gibbons and Semlitsch 1991, Mount 1975, Seidel and Dreslik 1996, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Rough Earth Snake, *Virginia striatula*, ARADB39010, G5, S4?

Habitat and distribution: Rough earth snakes are relatively widespread in Georgia south of the mountains. They are typically associated with mesic to dry forested environments, and are, in general, absent from aquatic and wetland habitats.

Model: Habitats 72, 201, 202, 203, 410, 411, 412, 413, 420, 422, 432, 434, 440, 441, and 620 within digitized range.

References: Carr and Goin 1959, Conant and Colllins 1998, Dundee and Rossman 1989, Gibbons and West 2000, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Powell et al. 1994, Tennant 1997, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Rough Green Snake, *Opheodrys aestivus*, ARADB23010, G5, S5

Habitat and distribution: Rough green snakes occur in a variety of habitats throughout Georgia. They are most typically encountered in dense vegetation around lakes and streams, where they may sometimes be observed climbing in trees or shrubs overhanging the water. Suitable habitat for rough green snakes includes cypress or gum swamps, floodplain forest, pine flatwoods, and pocosins of pond pine and sweet bay. They tend to avoid xeric conditions.

Model: Habitats 20, 31, 201, 202, 203, 410, 412, 420, 434, 890, 900, 980, and 990 within Georgia.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jensen and Moulis 1999, Lacy 1997, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Plummer 1981, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Scarlet Kingsnake, *Lampropeltis elapsoides*, ARADB19054, G5T5, S4

Habitat and distribution: The scarlet kingsnake may be encountered as far north as the Piedmont, most frequently in association with pine woods. Typical habitat includes forests of loblolly pine, longleaf pine woods, pine-scrub oak forest, and maritime forest of live oak.

Model: Habitats 413, 420, 422, 432, 434, 440, 441, and 512 within digitized range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jensen and Moulis 1997, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Tennant and Bartlett 2000, Williams 1994, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Scarlet Snake, *Cemophora coccinea*, ARADB03010, G5, S4S5

Habitat and distribution: Inhabiting all of Georgia except most of the Blue Ridge, scarlet snakes are typically found in dry pine forest of Virginia or shortleaf pine, as well as sandhill environments of longleaf pine and scrub oak. They may also be present in open habitats having sandy, friable soil.

Model: Habitats 31, 201, 202, 203, 413, 420, 422, 423, 432, 434, 440, 441, 512, 513, and 620 within digitized range.

References: Barbour 1971, Conant and Collins 1998, Gibbons and Semlitsch 1991, Gibbons and West 2000, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Palmer and Tregambo 1970, Tennant and Bartlett 2000, Williams 1985, Williams and Wilson 1967, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Six-lined Racerunner, *Cnemidophorus sexlineatus*, ARACJ02110, G5, S5

Habitat and distribution: Six-lined racerunners are found throughout Georgia in many types of dry, open environments such as fields, road cuts, rock outcrops, thicket margins and barren waste areas. In general, they favor habitats that are in the early seral stages of plant succession.

Model: Habitats 7, 9, 20, 31, 33, 34, 413, 420, 422, 423, 432, 434, 440, 441, 512, 513, and 620. Statewide range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Gibbons and Semlitsch 1991, Greenberg et al. 1994, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Trauth 1983, Trauth and McAllister 1996, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Slender Glass Lizard, *Ophisaurus attenuatus*, ARACB02010, G5, S3

Habitat and distribution: Snakelike in appearance, slender glass lizards are present throughout Georgia, where they inhabit grassy fields, brushy, cut-over woodlands and woodland margins. Suitable woodland environments include open forests of loblolly, Virginia, shortleaf or longleaf pine, as well as some xeric hardwoods.

Model: Habitats 20, 31, 80, 412, 413, 420, 422, 423, 432, 434, 440, 441, 512, and 620. Statewide range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Frick 1997, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Slider, *Trachemys scripta*, ARAAD09010, G5, S5

Habitat and distribution: Although absent from the Blue Ridge of Georgia, sliders are relatively widespread in aquatic environments elsewhere in the state. They are well-adapted to a habitat of quiet, or slow-flowing water, with a muddy bottom and profuse aquatic vegetation, and may be observed in ponds, sluggish streams, and a variety of wetland types, including floodplain forests, bogs, freshwater marshes, and cypress or gum swamps.

Model: Habitats 7 (associated with freshwater), 11 (freshwater only), 31 (where it intersects with NWI freshwater wetlands), 890, 900, 930, 980, and 990 within digitized range.

References: Barbour 1971, Bodie and Semlitsch 2000, Conant and Collins 1998, Ernst et al. 1994, Gibbons 1990, Gibbons and Semlitsch 1991, Mount 1975, Petranka 1998, Schubauer and Gibbons 1990, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Smooth Earth Snake, *Virginia valeriae*, ARADB39020, G5, S4?

Habitat and distribution: Widespread in Georgia, smooth earth snakes are most often observed along the edges of woods, and in open-canopied, mesic to dry forest. Associated forest types include hardwood, pine, and mixed pine-hardwoods. Smooth earth snakes are, in general, absent from aquatic and wetland habitats.

Model: Habitats 72, 201, 202, 203, 410, 411, 412, 413, 414, 420, 422, 432, 433, 434, 440, 441, and 620 within digitized range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and West 2000, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Powell et al. 1992, Tennant 1997, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Snapping Turtle, *Chelydra serpentina*, ARAAB01010, G5, S5

Habitat and distribution: Snapping turtles occur in all physiographic regions of Georgia, and may be abundant in most permanent freshwater habitat types. They thrive in swampy places, and in rivers and streams, ponds, lakes, marshes and bogs.

Model: Kept rasterized 1:24, 000 streams where slope < 4%. Kept habitats 7 (associated with freshwater), 11 (freshwater only), 31 (where it intersects with NWI freshwater wetlands), 890, 900, 930, 980, and 990. Statewide range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Ernst et al. 1994, Gibbons and Semlitsch 1991, Gibbons et al. 1988, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Pettit et al. 1995, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Southeastern Crowned Snake, *Tantilla coronata*, ARADB35020, G5, S4

Habitat and distribution: Occurring through the Piedmont and upper Coastal Plain of Georgia, Southeastern crowned snakes occur in a variety of wooded habitats. They generally prefer locations with relatively dry soil, and may be observed on dry, wooded hillsides or ridges, and in pine flatwoods and sandhills.

Model: Habitats 20, 31, 411, 412, 413, 422, 432, 434, 440, 441, 512, and 620 within digitized range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Semlitsch et al. 1981, Telford 1980a, Tennant 1997, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Southeastern Five-lined Skink, *Eumeces inexpectatus*, ARACH01070, G5, S5

Habitat and distribution: Typically associated with dry, well-drained habitats, southeastern five-lined skinks occur throughout Georgia, with the exception of the Blue Ridge and Cumberland Plateau. They may be abundant in pine clearings, on ridge tops, and in other well-drained situations, and may also be present in sandy habitats of the barrier islands.

Model: Habitats 7, 9, 20, 31, 33,34, 411, 412, 413, 420, 422, 423, 432, 434, 440, 441, 512, 513, and 620 within digitized range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Jensen and Moulis 1999, Lacy 1997, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Steiner 1986, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Southern Hognose Snake, *Heterodon simus*, ARADB17030, G2, S2

Habitat and distribution: Southern hognose snakes are uncommon inhabitants of xeric environments of the Coastal Plain of Georgia. In Georgia, these secretive, fossorial snakes are most often encountered in sandy, friable soil in scrub habitats of pine and turkey oak, in dry pine flatwoods, and in other xeric communities having suitable soil.

Model: Recoded habitats 512 and 620 to 1 and all else to 0; applied 3x3 moving window (FOCALMEAN using rectangle); kept areas where values were greater than .33; used results of this as a mask for suitable habitats 20, 31, 80, 412, 413, 420, 432, 434, 441, 512, and 620. Clipped by digitized range.

References: Conant and Collins 1998, Gibbons and Semlitsch 1991, Gibbons and West 2000, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Stevenson 1999, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Spiny Softshell, *Apalone spinifera*, ARAAG01030, G5, S5

Habitat and distribution: Although absent from the Blue Ridge of Georgia and from the area in and around the Okefenokee Swamp, spiny softshell turtles are present in a variety of aquatic habitats throughout the remainder of the state. They are primarily associated with sandy-bottomed locations in rivers and large creeks, but may also be observed in bayous, oxbows, lakes, and other permanent bodies of water.

Model: Kept rasterized 1:100, 000 streams. Kept clumps of habitats 7 (associated with freshwater) and 11 (freshwater only) greater than 10 ha. Clipped by digitized range.

References: Ashton and Ashton 1988, Barbour 1971, Conant and Collins 1998, Crenshaw and Hopkins 1955, Ernst et al. 1994, Gibbons and Semlitsch 1991, Huheey and Stupka 1967, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Vogt 1981, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Spotted Turtle, *Clemmys guttata*, ARAAD02010, G5, S3S4

Habitat and distribution: Spotted turtles are rather infrequently observed inhabitants of Georgia south of the Fall Line. Often associated with bottomland forest and swamps of cypress or gum, they also occupy open habitats such as marshes and bogs.

Model: Kept habitats 890, 900, 930, 980, and 990. Kept habitats 31 and 80 where they intersect with NWI freshwater wetlands. Clipped by digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Ernst et al. 1994, Gibbons and Semlitsch 1991, Jensen 1999, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Ward et al. 1976, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Striped Crayfish Snake, *Regina alleni*, ARADB27010, G5, S2

Habitat and distribution: Occupying a limited geographic range in peninsular Florida and extreme southern Georgia, striped crayfish snakes have been reported from locations in and around the Okefenokee Swamp. They most typically inhabit wet prairies and the shallow water of gum or cypress swamps, lakes, bogs and freshwater marshes.

Model: Habitats 11 (shallow freshwater only), 31 (where it intersects with NWI freshwater wetlands), 890, and 930 within digitized range.

References: Conant and Collins 1998, Gibbons and West 2000, Godley 1980, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Striped Mud Turtle, *Kinosternon baurii*, ARAAE01010, G5, S3

Habitat and distribution: Striped mud turtles are generally found south of the Fall Line in Georgia. Most often occurring in soft-bottomed bodies of water, they may thrive in sluggish streams or swamps and floodplain forest, and may also inhabit drainage canals, small ponds, flooded borrow pits, and other permanent and temporary sources of water.

Model: Habitats 7 (associated with freshwater), 11 (shallow freshwater only), 31 (where it intersects with NWI freshwater wetlands), 890, 900, 930, 980, and 990 within digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Dunson 1992, Ernst et al. 1994, Frick 1998, Gibbons and Semlitsch 1991, Jensen and Moulis 1999, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wilson et al. 1999, Wygoda 1979

Stripeneck/Loggerhead Musk Turtle, *Sternotherus minor*, ARAAE02030, G5, S5

Habitat and distribution: At home in many freshwater environments, loggerhead musk turtles are widespread in southern and western Georgia, where they may inhabit swamps, marshes, and slow-flowing rivers, streams and oxbows. They may also be observed in the clear, shallow creeks of the Ridge and Valley and Cumberland Plateau.

Model: Kept rasterized 1:100, 000 streams. Kept habitats 7 (associated with freshwater), 11 (freshwater only), 890, and 990. Clipped by digitized range.

References: Ashton and Ashton 1988, Conant and Collins 1998, Ernst et al. 1994, Huheey and Stupka 1967, Iverson 1977a, Iverson 1977c, Jensen and Moulis 1999, Martof et al. 1980, Mount 1975, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995

Worm Snake, *Carphophis amoenus*, ARADB02010, G5, S5

Habitat and distribution: These small, secretive snakes are north of the Fall Line in Georgia. Worm snakes are most abundant in mature, mesic hardwood forest, at sites having abundant humus and leaf litter. These fossorial snakes are secretive in nature, and are usually discovered under rocks, logs and debris on the forest floor.

Model: Habitats 31, 201, 202, 203, 410, 411, 412, 413, 414, 415, 422, 424, 425, 431, 432, 433, 434, 440, and 900 within digitized range.

References: Barbour 1971, Barbour et al. 1969, Conant and Collins 1998, Gibbons and Semlitsch 1991, Gibbons and West 2000, Huheey and Stupka 1967, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Russell and Hanlin 1999, Tennant and Bartlett 2000, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Yellow/Black/Gray Rat Snake, *Elaphe obsoleta*, ARADB13030, G5, S5

Habitat and distribution: Abundant throughout Georgia, rat snakes are encountered in most types of forested habitats, as well as early-successional and residential areas. Rat snakes may be particularly abundant in areas of intermixed forest and farmland, where cover and a food supply of small rodents are readily available.

Model: Habitats 20, 22, 31, 34, 72, 80, 83, 201, 202, 203, 410, 411, 412, 413, 414, 420, 422, 423, 424, 425, 431, 432, 433, 434, 440, 441, 512, 513, 620, 890, 900 and 990. Statewide range.

References: Barbour 1971, Conant and Collins 1998, Dundee and Rossman 1989, Gibbons and Semlitsch 1991, Gibbons and West 2000, Huheey and Stupka 1967, Jensen and Moulis 1999, Lacy 1997, Martof et al. 1980, Mount 1975, Palmer and Braswell 1995, Stickel et al. 1980, Whitehead and Charland 1985, Williamson and Moulis 1994a, Williamson and Moulis 1994b, Wilson 1995, Wright and Wright 1957

Appendix F – Sources Cited for Vertebrate Models

Amphibians and Reptiles

Alderton, D. 1991. Crocodiles and alligators of the world. Facts on File, New York.190 p.

Altig, R. and R. Lohoefener. 1982. Rana grylio. Catalogue of American Amphibians and Reptiles, p. 286.1-286.2.

Anderson, J.D. 1967. Ambystoma maculatum. Catalogue of American Amphibians and Reptiles, p. 51.1-51.2.

Anderson, J.D. 1967. Ambystoma opacum. Catalogue of American Amphibians and Reptiles, p. 46.1-46.2.

Anderson, O.F. and R.E. Herrington. 1992. Gopherus poluphemus. Herpetological Review 23:59.

Anderson, J.D. and G.K. Williamson. 1976. Terrestrial mode of reproduction in Ambystoma cingulatum. Herpetologica 32:214-221.

Ash, A.N. 1988. Disappearance of salamanders from clearcut plots. Journal of the Elisha Mitchell Scientific Society 104:116-122.

Ash, A.N. 1997. Disappearance and return of plethodontid salamanders to clearcut plots in the southern Blue Ridge mountains. Conservation Biology 11:983-989.

Ashton, R.E. 1992. Flatwoods salamander (Ambystoma cingulatum). Pages 39-43 in Rare and endangered biota of Florida: reptiles and amphibians (P. Moler, ed.). University Press of Florida, Gainesville.

Ashton, R.E., Jr. and P.S. Ashton. 1978. Movements and winter behavior of Eurycea bislineata (Amphibia, Urodela, Plethodontidae). Journal of Herpetology 12:295-298.

Ashton, R.E. and P.S. Ashton. 1988. Handbook of reptiles and amphibians of Florida. Windward Publishing, Inc, Miami.

Ashton, R.E. and P. Franz. 1979. Bufo quercicus. Catalogue of American Amphibians and Reptiles, pp. 222.1-222.2.

Auffenberg, W. and R. Franz. 1978. Gopherus polyphemus. Catalogue of American Amphibians and Reptiles, pp. 215.1-215.2.

Bailey, M.A. 1991. The dusky gopher frog in Alabama. Journal of the Alabama Academy of Science 62:28-34.

Barbour, R.W. 1958. Observations on the mountain chorus frog Pseudacris brachyphona in Kentucky. Am. Midl. Nat. 57:125-128.

Barbour, R.W. 1971. Amphibians and reptiles of Kentucky. University Press of Kentucky, Lexington. 334 p.

Barbour, R.W., J.W. Hardin, J.P. Schafer, and N.T. Harvey. 1969. Home range, movements, and activity of the dusky salamander, Desmognathus fuscus. Copeia 1969:293-297.

Barbour, R.W., M.J. Harvey, and J.W. Hardin. 1969. Home range, movements, and activity of the eastern worm snake, Carphophis amoenus amoenus. Ecology 50:470-476.

Bartlett, R.D. and P.P. Bartlett. 1999. Field guide to Florida reptiles and amphibians. Gulf Publishing Co, Houston, TX. 280 p.

Bechtel, E.R. 1983. Hemidactylus turcicus turcicus (geographic distribution). Herpetological Review 14:27-28.

Behler, J.L., B. Winn, and J.L. Behler. 1997. Snake fauna of St. Catherines Island, Georgia. Herpetological Review 28:162.

Bennett, D. 1972. Notes on the terrestrial wintering of mud turtles (Kinosternon subrubrum). Herpetologica 28:245-247.

Berish, J.E.D. 1998. Characterization of rattlesnake harvest in Florida. Journal of Herpetology 32:551-557.

Bishop, S.C. 1926. Notes on the habits and development of the mudpuppy, Necturus maculosus (Rafinesque). New York State Museum Bulletin 268:5 -60.

Bishop, J. 1983. Incidental capture of diamondback terrapins by crab pots. Estuaries 6:426-430.

Blaney, R.M. and P.K. Blaney. 1979. The Nerodia sipedon complex of water snakes in Mississippi and southeastern Louisiana. Herpetologica 35:350-359.

Blaney, R.M. and K. Relyea. 1967. The zigzag salamander, Plethodon dorsalis Cope, in southern Alabama. Herpetologica 23:246-247.

Blem, C.R. 1979. Bufo terrestris. Catalogue of American Amphibians and Reptiles, pp. 223.1-223.4.
Bodie, J.R. and R.D. Semlitsch. 2000. Spatial and temporal use of floodplain habitats by lentic and lotic species of aquatic turtles. Oecologica 122:138-146.
Brandon, R.A. 1967. Gyrinophilus palleucus. Catalogue of American Amphibians and Reptiles, pp. 32.1-32.2.
Brandon, R.A. 1967. Gyrinophilus porphyriticus. Catalogue of American Amphibians and Reptiles, pp. 33.1-33.3.
Brandon, R.A. 1967. Haideotriton and H. wallacei. Catalogue of American Amphibians and Reptiles, pp. 39.1-39.2.
Branson, B.A. and E.C. Baker. 1974. An ecological study of the queen snake, Regina septemvittata, in Kentucky. Tulane Studies in Zoology and Botany 18:153-171.
Breininger, D.R., P.A.Schmalzer, and C.R. Hinkle. 1994. Gopher tortoise (Gopherus polyphemus) densities in coastal shrub and slash pine flatwoods in Florida. Journal of Herpetology 28:60-65.
Brooks, G.R. 1975. Scincella lateralis. Catalogue of American Amphibians and Reptiles, pp. 169.1-169.4.
Brown, W.S. 1993. Biology, status, and management of the timber rattlesnake (Crotalus horridus): a guide for conservation. Herpetological Circular No. 22, Society for the Study of Amphibians and Reptiles.
Bruce, R.C. 1967. A study of the salamander genus Plethodon on the southeastern escarpment of the Blue Ridge Mountains. Journal of the Elisha Mitchell Scientific Society 82:74-82.
Bruce, R.C. 1968. The role of the Blue Ridge Embayment in the zoogeography of the green salamander, Aneides aeneus. Herpetologica 24:185-194.
Bruce, R.C. 1971. Life cycle and population structure of the salamander Stereochilus marginatus in North Carolina. Copeia 1971:234-236.
Bruce, R.C. 1972. Variation in the life cycle of the salamander Gyrinophilus porphyriticus. Herpetologica 28: 230-245.
Bruce, R.C. 1975. Reproductive biology of the mud salamander, Pseudotriton montanus, in western South Carolina. Copeia 1975:129-137.
Bruce, R.C. 1978. Reproductive biology of the salamander Pseudotriton ruber in the southern Blue Ridge Mountains. Copeia 1978:417-423.
Bruce, R.C. 1978. A comparison of the larval periods of Blue Ridge and Piedmont mud salamanders (Pseudotriton montanus). Herpetologica 34:325-332.
Buhlmann, K.A. and M.R. Vaughn. 1991. Ecology of the turtle Psuedemys concinna in the New River, West Virginia. Journal of Herpetology 25:72-78.
Buhlmann, K.A. and A.H. Wynn. 1996. Gyrinophilus palleucus (geographic distribution). Herpetological Review 27:147-148.
Burger, J. and R.T. Zappalorti. 1988. Habitat use in free-ranging pine snakes, Pituophis melanoleucus, in New Jersey pine barrens. Herpetologica 44:48-55.
Burke, V., J. Gibbons, and J. Greene. 1994. Prolonged forays by common mud turtles (Kinosternon subrubrum). Am. Midl. Nat. 131:190-195.
Bury, R.B. 1979. Review of the ecology and conservation of the bog turtle, Clemmys muhlenbergii. Spec. Sci. Report. Wildlife No. 219. Washington, D.C., U.S. Dept. Interior, Fish and Wildlife Service.
Bury, R.B., C.K. Dodd, Jr., and G.M. Fellers. 1980. Conservation of the amphibia of the United States: a review. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C., Resource Publication 134:1-34.
Caldwell, J.P. 1982. Hyla gratiosa. Catalogue of American Amphibians and Reptiles, pp. 298.1-298.2.
Caldwell, J.P. 1987. Demography and life history of two species of chorus frogs (Anura: Hylidae) in South Carolina. Copeia 1987:114-127.
Camp, C.D. 1986. Distribution and habitat of the southern red-back salamander, Plethodon serratus Grobman (Amphibia: Plethodontidae), in Georgia. Georgia Journal of Science 44:136-146.
Camp, C.D. 1988. Aspects of the life history of the southern red-back salamander, Plethodon serratus Grobman, in the southeastern United States. Am. Midl. Nat. 119:93-100.

Camp, C. and J.B. Jensen. 2000. Hemidactylium scutatum (geographic distribution). Herpetological Review 31:49.
Camp, C.D. and T.P. Lee. 1996. Intraspecific spacing and interaction within a population of Desmognathus quadramaculatus. Copeia 1996:78-84.
Camp, C.D. and D.G. Lovell. 1989. Fishing for spring lizards: a technique for collecting blackbelly salamanders. Herpetological Review 20:47.
Camp, C.D., J.L. Marshall, K.R. Landau, R.M. Austin, and S.G. Tilley. 2002. Sympatric occurrence of two species of the two-lined salamander (Eurycea bislineata) complex. Copeia 2000: 572-578.
Camp, C.D., S.G. Tilley, R.M Austin, and J.L. Marshall. 2002. A new species of black-bellied salamander (genus Desmognathus) from the Appalacian mountains of northern Georgia. Herpetologica. 58:471-484.
Campbell, T.S. 1996. Northern range expansion of the brown anole (Anolis sagrei) in Florida and Georgia. Herpetological Review 27:155-157.
Carlin, J.L. 1997. Genetic and morphological differences between Eurycea longicauda longicauda and E. guttolineata (Caudata: Plethodontidae). Herpetologica 53:206-217.
Carpenter, C.C. 1952. Comparative ecology of the common garter snake, the ribbon snake, and Butler's garter snake in mixed populations. Ecological Monographs 23:235-258.
Carr, A.F., Jr. 1939. Haideotriton wallacei, a new subterranean salamander from Georgia. Occasional Papers of the Boston Society of Natural History 8:333-336.
Carr, A. and C.J. Goin. 1959. Guide to the reptiles, amphibians, and freshwater fishes of Florida. Gainesville, Univ. of Florida Press.
Christman, S.P. 1982. Storeria dekayi. Catalogue of American Amphibians and Reptiles, pp. 306.1-306.4.
Christman, S.P. 1992. Many-lined salamander. Pages 58-61 in Rare and endangered biota of Florida: reptiles and amphibians (P. Moler, ed.). Gainesville, University Press of Florida.
Christman, S.P. and H.I. Kochman. 1975. The southern distribution of the many-lined salamander, Stereochilus marginatus. The Florida Scientist 38:139-141.
Christman, S.P. and D.B. Means. 1992. Striped newt (Notophthalmus perstriatus). Pages 62-65 in Rare and endangered biota of Florida: reptiles and amphibians (P. Moler, ed.). Gainesville, University Press of Florida.
Conant, R. and J.T. Collins. 1998. A field guide to the reptiles and amphibians: eastern and central North America. Houghton Mifflin, Boston. 616 p.
Cooper, J.E. 1968. The salamander Gyrinophilus palleucus in Georgia with notes on Alabama and Tennessee populations. Journal of the Alabama Academy of Science 39:182-185.
Corser, J.D. 2001. Decline of disjunct green salamander (Aneides aeneus) populations in the southern Appalachians. Biological Conservation 97:119-126.
Crenshaw, J.W. and M.N. Hopkins. 1955. The relationship of the softshelled turtles Trionyx ferox ferox and Trionyx ferox aspera. Copeia 1955:13-23.
Davic, R.D. and L.P. Orr. 1987. The relationship between rock density and salamander density in a mountain stream. Herpetologica 43:357-361.
Defauw, S.I. And P.J. English. 1994. Hemidactylium scutatum (geographic distribution). Herpetological Review 25:159.
Defauw, S.I. And P.J. English. 1994. Scaphiophus holbrookii holbrookii (geographic distribution). Herpetological Review 25:162.
Defauw, S.I. And A.A. Kinsey. 1994. Hyla gratiosa (geographic distribution). Herpetological Review 25:160.
Delis, P.R., H.R. Mushinsky, and E.D. McCoy. 1996. Decline of some west-central Florida anuran populations, in response to habitat degradation. Biodiversity and Conservation 5:1579-1595.
Diemer, J.E. 1992. Home range and movements of the tortoise Gopherus polyphemus in northern Florida. Journal of Herpetology 26:158-165.

Diemer, J.E. and D.W. Speake. 1981. The status of the eastern indigo snake in Georgia. Pp. 52-61 in R.R. Odom, J.W. Guthrie, eds. Proceedings of Nongame and Endangered Wildlife Symposium, August 13-14, 1981, Athens, GA.
Diemer, J.E. and D.W. Speake. 1983. The distribution of the eastern indigo snake, Drymarchon corais couperi, in Georgia. Journal of Herpetology 17:256-264.
Dodd, C.K. 1992. Pp. 128-134 in Rare and Endangered Biota of Florida, Volume 3, Amphibians and Reptiles (P. Moler, ed.). Gainesville, University Presses of Florida.
Dodd, C.K., Jr. 1993. Cost of living in an unpredictable environment: the ecology of striped newts Notophthalmus perstriatus during prolonged drought. Copeia 1993:605-614.
Dodd, C.K. and B.S. Cade. 1998. Movement patterns and the conservation of amphibians breeding in small, temporary wetlands. Conservation Biology 12:331-339.
Dodd, C.K., Jr. and L.V. LaClaire. 1995. Biogeography and the status of the striped newt (Notophthalmus perstriatus) in Georgia, U.S.A. Herpetological Natural History 3:37-46.
Douglas, M.E. and B.L. Monroe. 1981. A comparative study of topographical orientation in Ambystoma (Amphibia: Caudata). Copeia 1981:460-463.
Dundee, H.A. and D.A. Rossman. 1989. The amphibians and reptiles of Louisiana. Baton Rouge, Louisiana State University.
Dunson, W.A. Striped mud turtle. Pp. 105-110 in Rare and Endangered Biota of Florida, Volume 3, Amphibians and Reptiles, P. Moler, ed. University Presses of Florida, Gainesville, Florida.
Elliott, M.J. 2001. Green salamander surveys, Chattahoochee National Forest, Fall 2001. Unpublished report to U.S. Forest Service.
Ernst, C.H. 1971. Chrysemys picta. Catalogue of American Amphibians and Reptiles, pp. 106.1-106.4.
Ernst, C.H. 1971. Chrysemys picta. Catalogue of American Amphibians and Reptiles, pp. 106.1-106.4.
Ernst, C.H. 1977. Biological notes on the bog turtle, Clemmys muhlenbergii. Herpetologica 33:241-246.
Ernst, C.H. 1986. Ecology of the turtle, Sternotherus odoratus, in southeastern Pennsylvania. Journal of Herpetology 20:349-352.
Ernst, C.H. and R.B. Bury. 1977. Clemmys muhlenbergii. Catalogue of American Amphibians and Reptiles, pp. 204.1-204.2.
Ernst, C. and R. Bury. 1982. Malaclemys terrapin. Catalogue of American Amphibians and Reptiles, pp. 299.1-299.4.
Ernst, C.H., R.W. Barbour, and J.E. Lovich. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, DC. 578 p.
Ewert, M. 1976. Nest, nesting, and aerial basking of Macroclemys under natural conditions , and comparisons with Chelydra. Herpetologica 32:150-156.
Foard, T. and D.L. Auth. 1990. Food habits and gut parasites of the salamander, Stereochilus marginatus. Journal of Herpetology 24:428-431.
Folkerts, G.W. 1971. Notes on South Carolina salamanders. Journal of the Elisha Mitchell Scientific Society 87:206-208.
Franz, R. 1992. Florida pine snake. Pp. 254-258 in Rare and Endangered Biota of Florida, Volume 3, Amphibians and Reptiles (P. Moler, ed.). University Presses of Florida, Gainesville.
Franz, R. and C.J. Chantell. 1978. Limnaeoedus, L. ocularis. Catalogue of American Amphibians and Reptiles, pp. 209.1-209.2.
Frick, M.G. 1997. Ophisaurus attenuatus longicaudus (geographic distribution). Herpetological Review 28:97.
Frick, M.G. 1998. Kinosternon baurii (geographic distribution). Herpetological Review 29:50.
Funderburg, J.B. and D.S. Lee. 1967. Distribution of the lesser siren, Siren intermedia, in central Florida. Herpetologica 23:65.
Fuslelier, L. and D. Edds. 1994. Habitat partitioning among three sympatric species of map turtles, Genus Graptemys. Journal of Herpetology 28:154-158.

Galligan, J.H. and W.A. Dunson. 1979. Status of the timber rattlesnake (Crotalus horridus) populations in Pennsylvania. Biological Conservation 15:13-58.
Gans, C. 1967. Rhineura floridana. Catalogue of American Amphibians and Reptiles, pp. 43.1-43.2.
Gates, J.E. and E.C. Thompson. 1982. Small pool habitat selection by red-spotted newts in western Maryland. Journal of Herpetology 16:7-15.
Gehlbach, F.R. 1967. Ambystoma tigrinum. Catalogue of American Amphibians and Reptiles, pp. 52.1-52.4.
Gibbons, J.W. 1969. Ecology and population dynamics of the chicken turtle, Deirochelys reticularia. Copeia 1969:669-676.
Gibbons, J.W. 1990. Life history and ecology of the slider turtle., Smithsonian Institution Press, Washington, DC. 368 p.
Gibbons, J.W. and R.W. Semlitsch. 1991. Guide to the Reptiles and Amphibians of the Savannah River Site. University of Georgia Press, Athens, GA131 p.
Gibbons, J.W. and P.J. West (eds.). 2000. Snakes of Georgia and South Carolina. Savannah River Ecology Laboratory, Aiken, SC. 28 p.
Gibbons, J.W., S.S. Novak, and C.H. Ernst. 1988. Chelydra serpentina. Catalogue of American Amphibians and Reptiles, pp. 420.1-420.4.
Gill, D.E. 1978. The metapopulation ecology of the red-spotted newt, Notophthalmus viridescens (Rafinesque). Evolution 32:839-849.
Godley, J.S. 1980. Foraging ecology of the striped swamp snake, Regina alleni, in southern Florida. Ecological Monographs 50:411-436.
Gordon, R.E. 1950. The life history and ecology of the plethodontid salamander Aneides aeneus Cope. M.S. thesis, University of Georgia, Athens, Georgia.
Gordon, R.E. 1952. A contribution to the life history of the plethodontid salamander Aneides aeneus. Am. Midl. Nat. 74:666-701.
Gordon, R.E. 1953. A population of Holbrook's salamander, Eurycea longicauda guttolineata (Holbrook). Tulane Studies in Zoology 1:55-60.
Gordon, R.E. 1967. Aneides aeneus. Catalogue of American Amphibians and Reptiles, p. 30.1-30
Gordon, D. and R. MacCulloch. 1980. An investigation of the ecology of the map turtle, Graptemys geographica, in the northern part of its range. Can. J. Zool. 58:2210-2219.
Gosner, K.L. and I.H. Black. 1958. Notes on the life history of Brimley's chorus frog. Herpetologica 13:249-254.
Gosner, K.L. and I.H. Black. 1968. Catalogue of American Amphibians and Reptiles, pp. 67.1-67.2.
Green, N.B. and T.K. Pauley. 1987. Amphibians and reptiles in West Virginia. Univ. of Pittsburgh Press, Pittsburgh. 241 p.
Green, N.B., P. Brant, Jr., and B. Dowler. 1967. Eurycea lucifuga in West Virginia: its distribution, ecology, and life history. Proceedings of the West Virginia Academy of Science 39:297-304.
Greenberg, C.H., D.G. Neary, and L.D. Harris. 1994. Effect of high-intensity wildfire and silvicultural treatments on reptile communities in sand pine scrub. Conservation Biology 8:1047-1057.
Hairston, N.G. 1949. The local distribution and ecology of the plethodontid salamanders of the Southern Appalachians. Ecological Monographs 19:47-73.
Hairston, N.G. 1986. Species packing in Desmognathus salamanders: experimental demonstration of predation and competition. The American Naturalist 127:266-291.
Hairston, N.G. 1993. On the validity of the name teyahalee as applied to a member of the Plethodon glutinosus complex (Caudata: Plethodontidae): a new name. Brimleyana 18:65-69.
Hairston, N.G. and C.H. Pope. 1948. Geographic variation and speciation in Appalachian salamanders (Plethodon jordani group). Evolution 2:266-278.
Hall, R.J., P.F. Henry, and C.M. Bunck. 1999. Fifty-year trends in a box turtle population in Maryland. Biol. Conserv. 88:165-172.

Hanlin, H.G. and R.H. Mount. 1978. Reproduction and activity of the greater siren, Siren lacertina, in an Alabama Coastal Plain pond. Copeia 1978:358-360.
Hansen, K.L. 1957. Movements, area of activity, and growth of Rana heckscheri. Copeia 1957:274-277.
Harrel, J., C. Allen, and S. Hebert. 1996. Movements and habitat use of subadult alligator snapping turtles in Louisiana. Am. Midl. Nat. 135:60-67.
Harrison, J.R. 1970. The northern cricket frog, Acris crepitans Baird, in the lower Coastal Plain of South Carolina. Bull. South Carolina Academy of Sciences 32:39.
Harrison, J.R. 1992. Desmognathus aeneus. Catalogue of American Amphibians and Reptiles, p. 534.1-534.4.
Healy, W.R. 1975. Terrestrial activity and home range in efts of Notophthalmus viridescens. Am. Midl. Nat. 93:131-138.
Hebrard, J.J. and H.R. Mushinsky. 1978. Habitat use by five sympatric water snakes in a Louisiana swamp. Herpetologica 34:306-311.
Hecnar, S.J. 1994. Nest distribution, site selection, and breeding in the five-lined skink (Eumeces laticeps). Can. J. Zool. 72:1510-1516.
Herrington, B. 1997. Hemidactylium scutatum (geographic distribution). Herpetological Review 28:155.
Highton, R. 1973. Plethodon jordani. Catalogue of American Amphibians and Reptiles, pp. 130.1-130.3.
Highton, R. 1979. A new cryptic species of salamander of the genus Plethodon from the southeastern United States (Amphibia: Plethodontidae). Brimleyana 1:31-36.
Highton, R. 1986. Plethodon websteri. Catalogue of American Amphibians and Reptiles, pp. 384.1-384.2.
Highton, R. 1987. Plethodon teyahalee. Catalogue of American Amphibians and Reptiles, pp. 401.1-401.2.
Highton, R. and R.B. Peabody. 2000. Geographic protein variation and speciation in salamanders of the Plethodon jordani and Plethodon glutinosus complexes in the Southern Appalachian mountains with the description of four new species. Pages 31-94 in Bruce, R.C., R.G. Jaeger, and L.D. Houck, eds. The biology of Plethodontid salamanders. New York, Kluwer Academic. 485 p.
Highton, R., G.C. Maha, L.R. Maxson. 1989. Biochemical evolution in the slimy salamanders of the Plethodon glutinosus complex in the eastern United States. University of Illinois Biological Monographs 57:1-153.
Hoffman, R.C. 1980. Pseudacris brachyphona. Catalogue of American Amphibians and Reptiles, pp. 234.1-234.2.
Hoffman, R.L. 1983. Pseudacris brimleyi. Catalogue of American Amphibians and Reptiles, pp. 311.1-311.2.
Hoffman, R.L. 1988. Hyla femoralis. Catalogue of American Amphibians and Reptiles, pp. 436.1-436.3.
Hopey, M.E. and J.W. Petranka. 1994. Restriction of wood frogs to fish-free habitats: how important is adult choice? Copeia 1994:1023-1025.
Huheey, J.E. 1959. Distribution and variation in the glossy water snake, Natrix rigida. Copeia 1959:303-311.
Huheey, J.E. and A. Stupka. 1967. Amphibians and reptiles of the Great Smoky Mountains National Park. University of Tennessee Press, Knoxville, TN. 98 p.
Hunt, R.H. and J.J. Ogden. 1991. Selected aspects of the nesting ecology of American alligators in the Okefenokee Swamp. Journal of Herpetology 25:448-453.
Hutchison, U.H. 1966. Eurycea lucifuga. Catalogue of American Amphibians and Reptiles, pp. 24.1-24.2.
Ireland, P.H. 1979. Eurycea longicauda. Catalogue of American Amphibians and Reptiles, pp. 221.1-221.4.
Iverson, J. 1977. Geographic variation in the musk turtle, Sternotherus minor. Copeia 1977:502-517.
Iverson, J. !977. Kinosternon subrubrum. Catalogue of American Amphibians and Reptiles, pp. 193.1-193.4.
Iverson, J. 1977. Sternotherus minor. Catalogue of American Amphibians and Reptiles, pp. 195.1-195.2.
Jackson, D.R. and R. Franz. 1981. Ecology of the eastern coral snake (Micrurus fulvius) in northern peninsular Florida. Herpetologica 37:213-228.
Jacobs, J.F. 1987. A preliminary investigation of geographic variation and systematics of the two-lined salamander, Eurycea bislineata (Green). Herpetologica 43:423-446.
Jensen, J.B. 1994. Ambystoma tigrinum (geographic distribution). Herpetological Review 25:159.

Jensen, J.B. 1999. Alabama map turtle. Pp. 85-86 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. 1999. Alligator snapping turtle. Pp. 89-90 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. 1999. Barbour's map turtle. Pp. 81-82 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. 1999. Bog turtle. Pp. 71-72 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. 1999. Common map turtle. Pp. 83-84 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. 1999. Flatwoods salamander. Pp. 92-93 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. 1999. Georgia blind salamander. Pp. 100-101 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. 1999. Green salamander. Pp. 96-97 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. 1999. Hellbender. Pp. 98-99 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. 1999. Indigo snake. Pp. 75-76 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. 1999. One-toed amphiuma. Pp. 94-95 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. 1999. Pigeon mountain salamander. Pp. 104-105 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. 1999. Spotted turtle. Pp. 69-70 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. 1999. Striped newt. Pp. 102-103 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Social Circle, GA, Georgia Dept. of Natural Res., Wildlife Res. Div.
Jensen, J.B. and L.V. LaClaire. 1995. Rana capito (geographic distribution). Herpetological Review 26:106.
Jensen, J.B. and R.A. Moulis. 1997. Early rewards from the Georgia Herp Atlas. Herpetological Review 28:212-214.
Jensen, J.B. and R.A. Moulis. 1999. The Georgia Herp Atlas: year II county records. Herpetological Review 30:240-247.
Jensen, J.B., C.D. Camp, and J.L.. Marshall. 2002. Ecology and life history of the Pigeon Mountain salamander. Southeastern Naturalist 1: 3-16.
Jenssen, T.A., K.A. Hovde, and K.G. Taney. 1998. Size-related habitat use by nonbreeding Anolis carolinensis lizards. Copeia 1998:774-779.
Joanen, T. and L.L. McNease. 1972. A telemetric study of nesting female alligators on Rockefeller Refuge, Louisiana. Proceedings Annual Conference Southeastern Game and Fish Commissioners 25:106-116.
Jones, T.R. 1980. A reevaluation of the salamander Eurycea aquatica Rose and Bush (Amphibia: Plethodontidae). M.S. Thesis, Auburn University, Auburn, Alabama.
Jones, R.L. 1982. Distribution and ecology of the seepage salamander Desmognathus in Tennessee. Brimleyana 7:95-100.
Karlin, A.A. and D.B. Means. 1994. Genetic variation in the aquatic salamander genus Amphiuma. The American Midland Naturalist 132:1-9.
Kent, D.M., M.A. Langston, and D.W. Hanf. 1997. Observations of vertebrates associated with gopher tortoise burrows in Orange County, Florida. Fla. Scientist 60:197-201.
Knepton, J.C. 1954. A note on the burrowing habits of the salamander Amphiuma means. Copeia 1954:68.

Kolozsvary, M.B. and R.K. Swihart. 1999. Habitat fragmentation and the distribution of amphibians: patch and landscape correlates in farmland. Can. J. Zool. 77:1288-1299.
Kramer, M. 1995. Home range of the Florida red-bellied turtle in a Florida spring run. Copeia 1995:883-890.
Lacy, G.B. 1996. Regina septemvittata (geographic distribution). Herpetological Review 27:154-155.
Lacy, G.B. 1997. New county records of amphibians and reptiles from Georgia. Herpetological Review 28:163-164.
Laerm, J. and A.S. Hopkins. 1997. Status of possible disjunct populations of the southern toad, Bufo terrestris, in the Piedmont and Blue Ridge of Georgia. Herpetological Review 28:162-163.
Lamb, T. 1984. The influence of sex and breeding condition on microhabitat selection and diet in the pig frog Rana grylio. Am. Midl. Nat. 111:311-318.
Lamoureux, V.S. and D.M. Madison. 1999. Overwintering habitats of radio-implanted green frogs, Rana clamitans. J. of Herpetology 34:430-435.
Landers, J.L. and J.A. Garner. 1981. Status and distribution of the gopher tortoise in Georgia. Pp. 45-51 in R.R. Odom, J.W. Guthrie, eds., Proceedings of Nongame and Endangered Wildlife Symposium, August 13-14, 1981, Athens, GA.
Lane, J.J. and W.A. Mitchell. 1997. Species profile: Alligator snapping turtle (Macroclemys temminckii) on military installations in the southeast United States. Technical Report SERDP-97-9, U.S. Army Corps of Engineers, Vicksburg, MS.
Lawler, H.E. 1977. The status of Drymarchon corais couperi, the eastern indigo snake, in the southeastern United States. Herpetological Review 8:76-79.
Linzey, D.W. 1979. The snakes of Alabama. Strode Publishers, Huntsville. 136 p.
Losos, J.B. and D.A. Spiller. 1999. Differential colonization success and asymmetrical interactions between two lizard species. Ecology 80:252-258.
Lovich, J. 1993. Macroclemys temminckii. Catalogue of American Amphibians and Reptiles, pp. 562.1-562.4.
Madison, D.M. 1969. Homing behaviour of the red-cheeked salamander, Plethodon jordani. Anim. Behav. 17:25-31.
Madison, D.M. and L. Farrand. 1998. Habitat use during breeding and emigration in radio-implanted tiger salamanders, Ambystoma tigrinum. Copeia 1998:402-410.
Malnate, E. 1939. A study of the yellow-lipped snake, Rhadinaea flavilata. Zoologica 24:359-366.
Martof, B.S. 1953. Home range and movements of the green frog, Rana clamitans. Ecology 34:529-543.
Martof, B.S. 1955. Observations on the life history and ecology of the amphibians of the Athens area, Georgia. Copeia 1955:166-170.
Martof, B.S. 1962. Some aspects of the life history and ecology of the salamander Leurognathus. The American Midland Naturalist 67:1-35.
Martof, B.S. 1964. Leurognathus and Leurognathus marmoratus. Catalogue of American Amphibians and Reptiles, pp. 3.1-3.2.
Martof, B.S. 1968. Ambystoma cingulatum. Catalogue of American Amphibians and Reptiles, p. 57.1-2.
Martof, B.S. 1970. Rana sylvatica. Catalogue of American Amphibians and Reptiles, pp. 86.1-86.4.
Martof, B.S. 1972. Pseudobranchus, P. striatus. Catalogue of American Amphibians and Reptiles, pp. 118.1-118.4.
Martof, B.S. 1973. Siren intermedia. Catalogue of American Amphibians and Reptiles, pp. 127.1-127.3.
Martof, B.S. 1973. Siren lacertina. Catalogue of American Amphibians and Reptiles, pp. 128.1-128.2.
Martof, B.S. 1975. Pseudotriton montanus. Catalogue of American Amphibians and Reptiles, pp. 166.1-166.2.
Martof, B.S. 1975. Pseudotriton ruber. Catalogue of American Amphibians and Reptiles, pp. 167.1-167.3.
Martof, B.S., W.M. Palmer, J.R. Bailey, and J.R. Harrison III. 1980. Amphibians and Reptiles of the Carolinas and Virginia. University of North Carolina Press, Chapel Hill, NC. 264 p.
McDaniel, V.R. and J.P. Karges. 1983. Farancia abacura. Catalogue of American Amphibians and Reptiles, pp. 314.1-314.2.

McRae, W.A., J.L. Landers, and J.A. Garner. 1981. Movement patterns and home range of the gopher tortoise. Am. Midl. Nat. 106:165-179.
Means, D.B. 1975. Competitive exclusion along a habitat gradient between two species of salamanders (Desmognathus) in western Florida. Journal of Biogeography 2:253-263.
Means, D.B. 1992. Coal skink. Pp. 219-222 in Rare and Endangered Biota of Florida, Volume 3, Amphibians and Reptiles, P. Moler, ed. University Presses of Florida, Gainesville.
Means, D.B. 1992. Mole kingsnake. Pp. 227-231 in Rare and Endangered Biota of Florida, Volume 3, Amphibians and Reptiles (P. Moler, ed.). Gainesville, University Presses of Florida.
Means, D.B. 1992. Georgia blind salamander. Pp. 49-53 in Rare and Endangered Biota of Florida, Volume 3, Amphibians and Reptiles, P. Moler, ed. University Presses of Florida, Gainesville.
Means, D.B. 1992. One-toed amphiuma. Pp. 34-38 in Rare and Endangered Biota of Florida, Volume 3, Amphibians and Reptiles (P. Moler, ed.). University Presses of Florida, Gainesville.
Means, D.B. 1992. Four-toed salamander. Pp. 54-57 in Rare and Endangered Biota of Florida, Volume 3, Amphibians and Reptiles (P. Moler, ed.). University Presses of Florida, Gainesville.
Means, D.B. 1993. Desmognathus apalachicolae. Catalogue of American Amphibians and Reptiles, pp. 556.1-556.2.
Means, D.B. 1996. Amphiuma pholeter. Catalogue of American Amphibians and Reptiles, pp. 622.1-622.2.
Means, D.B. and A.A. Karlin. 1989. A new species of Desmognathus from the eastern gulf coastal plain. Herpetologica 45:37-46.
Means, D.B., J.G. Palis, and M. Buggatt. 1996. Effects of slash pine silviculture on a Florida population of flatwoods salamander (Ambystoma cingulatum). Conservation Biology 10:426-437.
Mecham, J.S. 1967. Notophthalmus perstriatus. Catalogue of American Amphibians and Reptiles, pp. 38.1-38.2.
Meffe, G.K. and A.L. Sheldon. 1987. Habitat use by dwarf waterdogs (Necturus punctatus) in South Carolina streams, with life history notes. Herpetologica 43:490-496.
Michaud, E.J. and A.C. Echternacht. 1995. Geographic variation in the life history of the lizard Anolis carolinensis and support for the pelvic constraint model. Journal of Herpetology 29:86-97.
Mills, T. 1990. Hemidactylus turcicus (geographic distribution). Herpetological Review 21:40.
Mills, M.S., C.J. Hudson, and H.J. Berna. 1995. Spatial ecology and movements of the brown water snake (Nerodia taxispilota). Herpetologica 51:412-423.
Mitchell, J.C. 1982. Farancia erytrogramma. Catalogue of American Amphibians and Reptiles, pp. 292.1-292.2.
Mittleman, M.A. 1967. Manculus and M. quadridigitatus. Catalogue of American Amphibians and Reptiles, pp. 44.1-44.2.
Moler, P.E. Mimic glass lizard. Pp. 247-250 in Rare and Endangered Biota of Florida, Volume 3, Amphibians and Reptiles (P. Moler, ed.). University Presses of Florida, Gainesville.
Moler, P.E. 1992. Eastern indigo snake. Pp. 181-186 in Rare and Endangered Biota of Florida, Volume 3, Amphibians and Reptiles (P. Moler, ed.). University Presses of Florida, Gainesville.
Moler, P.E. and J. Kezer. 1993. Karyology and systematics of the salamander genus Pseudobranchus (Sirenidae). Copeia 1993:39-47.
Mount, R.H. 1963. The natural history of the red-tailed skink Eumeces egregius. Am. Midl. Nat. 70:356-385.
Mount, R.H. 1968. Eumeces egregius. Catalogue of American Amphibians and Reptiles, pp. 73.1-73.2.
Mount, R.H. 1975. The Reptiles and Amphibians of Alabama. Auburn Printing, Auburn, AL. 345 p.
Muegel, L.A. and D.L. Claussen. 1994. Effects of slope on voluntary locomotor performance in the turtle, Terrapene carolina carolina. Journal of Herpetology 28:6-11.
Neill, W.T. 1948. A new subspecies of treefrog from Georgia and South Carolina. Herpetologica 4:175-179.
Neill, W.T. 1948. Hibernation of amphibians and reptiles in Richmond county, Georgia. Herpetologica 4:107-114.
Neill, W.T. 1952. New records of Rana virgatipes and Rana grylio in Georgia and South Carolina. Copeia 1952:194-195.

Neill, W.T. 1957. Distributional notes on Georgia amphibians, and some corrections. Copeia 1957:43-47.
Neill, W.T. 1963. Hemidactylium scutatum. Catalogue of American Amphibians and Reptiles, p. 2.1-2.2.
Neill, W.T. 1963. Notes on the Alabama waterdog, Necturus alabamensis Viosca. Herpetologica 19:166-174.
Neill, W.T. 1964. A new species of salamander, genus Amphiuma, from Florida. Herpetologica 20:62-66.
Neill, W.T. 1964. Taxonomy, natural history, and zoogeography of the rainbow snake, Farancia erytrogramma. Am. Midl. Nat. 71:257-295.
Nelson, D.H. and S.D. Carey. 1993. Range extension of the Meditteranean gecko (Hemidactylus turcicus) along the Northeastern Gulf Coast of the United States. Northeast Gulf Science 13:53-58.
Organ, J.A. 1961. Studies of the local distribution, life history, and population dynamics of the salamander genus Desmognathus in Virginia. Ecological Monographs 31:189-220.
Orser, P.N. and D.J. Shure. 1972. Effects of urbanization on the salamander Desmognathus fuscus fuscus. Ecology 53:1148-1154.
Palis, J.G. 1996. Flatwoods salamander (Ambystoma cingulatum). Element stewardship abstract. Natural Areas Journal 16:49-54.
Palis, J.G. and R.A. Fischer. 1997. Species profile: gopher frog (Rana capito spp.) on military installations in the southeastern United States. Technical Report SERDP-97-5, U.S. Army Corps of Engineers, Vicksburg, MS.
Palmer, W.M. and A.L. Braswell. 1995. Reptiles of North Carolina. Univ. of North Carolina Press, Chapel Hill. 412 p.
Palmer, W.M. and G. Tregambo. 1970. Notes on the scarlet snake Cemophora coccinea copei in North Carolina. Herpetologica 26:300-303.
Palmer, W.M. and G.M. Williamson. 1971. Observations on the natural history of the carolina pygmy rattlesnake, Sistrurus miliarus. Journal of the Elisha Mitchell Scientific Society 87:20-25.
Parker, W.S. 1994. Demography of the fence lizard, Sceloporus undulatus, in Northern Mississippi. Copeia 1994:136-152.
Peck, S.B. and B.L. Richardson. 1976. Feeding ecology of the salamander Eurycea lucifuga in the entrance, twilight zone, and dark zone of caves. Annales de Speleologie 31:175-182.
Petranka, J.W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.
Petranka, J.W., M.E. Hopey, B.J. Jennings, S.D. Baird, and S.J. Boone. 1994. Breeding habitat segregation of wood frogs and american toads: the role of interspecific tadpole predation and adult choice. Copeia 1994:691-697.
Petranka, J.W., M.P. Brannon, M.E. Hopey, and C.K. Smith. 1994. Effects of timber harvesting on low elevation populations of southern Appalachian salamanders. Forest Ecology and Management 67:135-147.
Pettit, K.E., C.A. Bishop, and R.J. Brooks. 1995. Home range and movements of the common snapping turtle, Chelydra serpentina serpentina, in a coastal wetland of Hamilton Harbour, Lake Ontario, Canada. Can. Field-Nat. 109:192-200.
Petzing, J.E. and C.A. Phillips. 1998. Ambystoma opacum (geographic distribuition). Herpetological Review 29:105.
Petzing, J.E. and C.A. Phillips. 1998. Eurycea cirrigera (geographic distribution). Herpetological Review 29:106.
Petzing, J.E. and C.A. Phillips. 1998. Pseudacris triseriata (geographic distribution). Herpetological Review 29:108.
Petzing, J.E. and C.A. Phillips. 1998. Anolis carolinensis (geographic distribution). Herpetological Review 29:110.
Petzing, J.E. and C.A. Phillips. 1998. Farancia abacura (geographic distribution). Herpetological Review 29:112.

Petzing, J.E. and C.A. Phillips. 1998. Coluber constrictor (geographic distribution). Herpetological Review 29:175.
Petzing, J.E. and C.A. Phillips. 1998. Heterodon platirhinos (geographic distribution). Herpetological Review 29:177.
Pfingsten, R.A. and A.M. White. 1989. Necturus maculosus. In: Salamanders of Ohio, R.A. Pfingsten and F.L. Downs, eds. Ohio Biological Survey Bulletin, New Series 7(2):72-77.
Plummer, M.V. 1981. Habitat utilization, diet, and movements of a temperate, arboreal snake (Opheodrys aestivus). Journal of Herpetology 15:425-432.
Plummer, M.V. and J.D. Congdon. 1994. Radiotelemetric study of activity and movements of racers (Coluber constrictor) associated with a Carolina bay in South Carolina. Copeia 1994:20-26.
Pluto, T. and E. Bellis. 1986. Habitat utilization by the turtle, Graptemys geographica, along a river. Journal of Herpetology 20:22-31.
Pope, C.H. and N.G. Hairston. 1947. The distribution of Leurognathus, a Southern Appalachian genus of salamanders. Fieldana Zoology 31:155-162.
Powders, V.N. and R. Cate. 1980. Food of the dwarf salamander, Eurycea quadridigitata in Georgia. Journal of Herpetology 14:82-83.
Powell, R., J.T. Collins, and L.D. Fish. 1992. Virginia valeriae. Catalogue of American Amphibians and Reptiles, pp. 552.1-552.6.
Powell, R., J.T. Collins, and L.D. Fish. 1994. Virginia striatula. Catalogue of American Amphibians and Reptiles, pp. 599.1-599.6.
Pritchard, P. 1990. The alligator snapping turtle: biology and conservation. Milwaukee Public Mus. Publ, Milwaukee, WI. 104 p.
Pylka, J.W. and R.D. Warren. 1958. A population of Haideotriton in Florida. Copeia 1958:334-336.
Quinby, J.A. 1954. Rana sylvatica Le Conte in South Carolina. Herpetologica 10:87-88.
Rabb, G.B. 1966. Stereochilus and S. marginatus. Catalogue of American Amphibians and Reptiles, pp. 25.1-25.2.
Raymond, C.R. and C.M. Hardy. 1991. Effects of a clearcut on a population of mole salamander, Ambystoma talpoideum, in an adjacent unaltered forest. J. of Herpetology 25:509-513.
Reigle, N.J., Jr. 1967. The occurrence of Necturus in the deeper waters of Green Bay. Herpetologica 23:232-233.
Reinbold, S.C. 1979. Habitat comparisons of two sympatric salamander species of the genus Plethodon (Amphibia, Caudata, Plethodontidae). Journal of Herpetology 13:504-506.
Reinert, H.K. 1984. Habitat separation between sympatric snake populations. Ecology 65:478-486.
Reinert, H.K. and R.T. Zappalorti. 1988. Timber rattlesnakes of the pine barrens: their movement patterns and habitat preference. Copeia 1988:1057-1059.
Reynolds, S.L. and M.E. Seidel. 1982. Sternotherus odorartus. Catalogue of American Amphibians and Reptiles, pp. 287.1.-287.4.
Ritke, M.E., J.G. Babb, and M.K. Ritke. 1991. Breeding-site specificity in the gray treefrog (Hyla chrysoscelis). Journal of Herpetology 25:123-125.
Rose, E.L. and F.M. Bush. 1963. A new species of Eurycea (Amphibia: Caudata) from the southeastern United States. Tulane Studies in Zoology 10:121-128.
Roze, J.A. and G.M. Tilger. 1983. Micrurus fulvius. Catalogue of American Amphibians and Reptiles, pp. 316.1-316.4.
Russell, K.R. and H.G. Hanlin. 1999. Aspects of the ecology of worm snakes (Carphophis amoenus) associated with small isolated wetlands in South Carolina. Journal of Herpetology 33:339-344.
Salthe, S.N. 1973. Amphiuma means. Catalogue of American Amphibians and Reptiles, pp. 148.1-148.2.
Sanders, A.E. 1984. Rana heckscheri. Catalogue of American Amphibians and Reptiles, pp. 348.1-348.2.
Sanderson, R. 1974. Sexual dimorphism in the Barbour's map turtle, Malaclemys barbouri. Master's thesis, Univ. of South Florida.

Sanderson, R. 1992. Barbour's map turtle. Pp. 196-199 in Rare and Endangered Biota of Florida, Volume 3, Amphibians and Reptiles, P. Moler, ed. University Presses of Florida, Gainesville, Florida.
Santhoff, S. and L. Wilson. 1990. Graptemys pulchra (geographic distribution). Herpetological Review 21:39.
Schaaf, R.T. and P.W. Smith. 1970. Geographic variation in the pickerel frog. Herpetologica 26:240-254.
Schaaf, R.T. and P.W. Smith. 1971. Rana palustris. Catalogue of American Amphibians and Reptiles, pp. 117.1-117.3.
Schubauer, J.P., J.W. Gibbons, and J.R. Spotila. 1990. Pages 223-232 in J.W. Gibbons, ed. Life history and ecology of the slider turtle Smithsonian Institution Press, Washington, DC.
Schwaner, T.D. and R.H. Mount. 1978. Systematic and ecological relationships of the water snakes Natrix sipedon and Natrix faasciata in Alabama and the Florida panhandle. Occasional Publications of the Museum of Natural History, University of Kansas 45:1-44.
Schwartz, A. 1957. Chorus frogs (Pseudacris nigrita LeConte) in South Carolina. Amer. Mus. Novitates 1838:1-12.
Schwartz, A. 1974. Eleutherodactylus planirostris. Catalogue of American Amphibians and Reptiles, pp. 154.1-154.4.
Seidel, M.E. and M.J. Dreslik. 1996. Pseudemys concinna. Catalogue of American Amphibians and Reptiles, pp. 626.1-626.12.
Semlitsch, R.D. 1981. Terrestrial activity and summer home range of the mole salamander (Ambystoma talpoideum). Canadian Journal of Zoology 59:315-322.
Semlitsch, R.D. 1983. Terrestrial movements of an eastern tiger salamander, Ambystoma tigrinum. Herpetological Review 14:112-113.
Semlitsch, R.D. 1988. Allotopic distribution of two salamanders: effects of density, food, and pond drying. Ecology 68:994-1002.
Semlitsch, R.D. and G.B. Moran. 1984. Ecology of the redbelly snake using mesic habitats in South Carolina. Am. Midl. Nat. 111:33-40.
Semlitsch, R.D. and C.A. West. 1983. Aspects of the life history and ecology of Webster's salamander, Plethodon websteri. Copeia 1983:339-346.
Semlitsch, R.D., K.L. Brown, and J.P. Caldwell. 1981. Habitat utilization, seasonal activity, and population size structure of the Southeastern crowned snake Tantilla coronata. Herpetologica 37:40-46.
Semlitsch, R.D., J.H.K. Pechman, and J.W. Gibbons. 1988. Annual emergence of juvenile mud snakes (Farancia abacura) at aquatic habitats. Copeia 1988:243-245.
Sever, D.M. 1999. Eurycea cirrigera. Catalogue of American Amphibians and Reptiles, pp. 684.1-684.6.
Sever, D.M. 1999. Eurycea wilderae. Catalogue of American Amphibians and Reptiles, pp. 685.1-685.4.
Shealy, R. 1976. The natural history of the Alabama map turtle, Graptemys pulchra, in Alabama. Bull. Fla. State Mus. Biol. Sci. 21:47-111.
Shoop, C.R. 1964. Ambystoma talpoideum. Catalogue of American Amphibians and Reptiles, p. 8.1-8.2.
Shoop, C.R. 1965. Orientation of Ambystoma maculatum in movements to and from breeding pools. Science 149:558-59.
Shoop, C.R. and C. Ruckdeschl. 1986. New herpetological records for Cumberland Island, Georgia. Herpetological Review 17:51.
Shoop, C.R. and C. Ruckdeschel. 1997. Ophisaurus compressus (geographic distribution). Herpetological Review 28:157.
Simmons, D. 1975. The evolutionary ecology of Gyrinophilus palleucus. Unpublished master's thesis, University of Florida, Gainesville.
Sloan, K. and D. Taylor. 1987. Habitats and movements of adult alligator snapping turtles in northeastern Louisiana. Proc. Annual Conference of Southeastern Fish and Wildlife Agencies 41:343-348.
Smith, P.W. 1966. Hyla avivoca. Catalogue of American Amphibians and Reptiles, pp. 28.1-28.2.
Snyder, D.H. 1991. The green salamander (Aneides aeneus) in Tennessee and Kentucky, with comments on the Carolinas' Blue Ridge population. Journal of the Tennessee Academy of Science 66:165-169.

Speake, D.W. and R.H. Mount. 1973. Some possible ecological effects of rattlesnake roundups in the southeastern Coastal Plain. Proceedings Annual Conference Southeastern Game and Fish Commissioners 27:267-277.
Steiner, T.M. 1986. Eumeces inexpectatus. Catalogue of American Amphibians and Reptiles, pp. 385.1-385.2.
Stevenson, H.M. 1967. Additional specimens of Amphiuma pholeter from Florida. Herpetologica 23:134.
Stevenson, D.J. 1999. Heterodon simus (geographic distribution). Herpetological Review 30:54.
Stevenson, D.J. and B.J. Platt. 1999. Apalone ferox (geographic distribution). Herpetological Review 30:51.
Stewart, M.M. 1983. Rana clamitans. Catalogue of American Amphibians and Reptiles, pp. 337.1-337.4.
Stickel, C.F. 1978. Changes in a box turtle population during three decades. Copeia 1978:221-225.
Stickel, L.F. 1989. Home range behavior among box turtles of a bottomland forest in Maryland. Journal of Herpetology 23:40-44.
Stickel, L.F., W.H. Stickel, and F.C. Schmid. 1980. Ecology of a Maryland population of black rat snakes. Am. Midl. Nat. 103:1-14.
Sutton, K. and J. Christiansen. 1999. J. Iowa Acad. Of Sci. 106:63-65.
Tamarack, J.L. 1993. Alligator mississippiensis (diet). Herpetological Review 24:57.
Tamarack, J.L. and B. Doherty. 1993. Lampropeltis getulus (predation fatality). Herpetological Review 24:62.
Telford, S.R. 1980. Tantilla coronata. Catalogue of American Amphibians and Reptiles, pp. 308.1-308.2.
Telford, S.R. 1980. Tantilla relicta. Catalogue of American Amphibians and Reptiles, pp. 257.1-257.2.
Tennant, A. 1997. A field guide to snakes of Florida. Gulf Publishing Co., Houston. 257 p.
Tennant, A. and R.D. Bartlett. 2000. Snakes of North America: eastern and central regions. Gulf Publishing Co., Houston. 588 p.
Thompson, E.F. 1982. A guide to the amphibians, reptiles, and mammals of South Carolina. University of South Carolina, Columbia. 150 p.
Tiebout, H.M. and J.R. Cary. 1987. Dynamic spatial ecology of the water snake, Nerodia sipedon. Copeia 1987:1-18.
Tilley, S.G. 1973. Life histories and natural selection in populations of the salamander Desmognathus ochrophaeus. Ecology 54:3-17.
Tilley, S.G. 1973. Desmognathus ochrophaeus. Catalogue of American Amphibians and Reptiles, pp. 129.1-129.4.
Trauth, S.E. 1983. Nesting habitat and reproductive characteristics of the lizard Cnemidophorus sexlineatus. Am. Midl. Nat. 109:289-299.
Trauth, S.E. and C.T. McAllister. 1996. Cnemidophorus sexlineatus. Catalogue of American Amphibians and Reptiles, pp. 628.1-628.12.
Tryon, B.W. 1990. Bog turtles (Clemmys muhlenbergii) in the south: a question of survival. Bull. Chicago Herpetological Soc. 25:57-66.
Tryon, B.W. and D.W. Herman. 1991. Status, conservation, and management of the bog turtle, Clemmys muhlenbergii, in the southeastern United States. Pp. 36-53 in Beaman, K.R., et al. Proceedings of the first international symposium on turtles and tortoises: conservation and captive husbandry. Chapman Univ, Orange, CA.
Vogt, R.C. 1981. Natural history of amphibians and reptiles of Wisconsin. Milwaukee Public Museum, Milwaukee, WI. 205 p.
Wainberg, R., C. Camp, and J.B. Jensen. 2000. Sistrurus miliarus miliarus (geographic distribution). Herpetological Review 31:57.
Walley, H.D. 1998. Eumeces anthracinus. Catalogue of American Amphibians and Reptiles, pp. 658.1-658.6.
Ward, F.P., C.J. Hohmann, J.F. Ulrich, and S.E. Hill. 1976. Seasonal microhabitat selections of spotted turtles (Clemmys guttata) in Maryland elucidated by radioisotope tracking. Herpetologica 32:60-64.
Webb, R.G. 1973. Trionyx ferox. Catalogue of American Amphibians and Reptiles, pp. 138.1-138.3.
Whitehead, P.J. and M.B. Charland. 1985. Habitat selection in an Ontario population of the snake, Elaphe obsoleta. Journal of Herpetology 19:12-19.

Williams, P.K. 1973. Seasonal movements and population dynamics of four sympatric mole salamanders, genus Ambystoma. Ph.D. thesis, Indiana University, Bloomington.
Williams, A.A. 1980. Fluctuations in a population of the cave salamander. National Speleological Society Bulletin 42:49-52.
Williams, K.L. 1985. Cemophora coccinea. Catalogue of American Amphibians and Reptiles, pp. 374.1-374.4.
Williams, K.L. 1994. Lampropeltis triangulum. Catalogue of American Amphibians and Reptiles, pp. 594.1-594.10.
Williams, K.L. and L.D. Wilson. 1967. A review of the colubrid snake genus Cemophora Cope. Tulane Stud. Zool. 13:103-124.
Williamson, G.K. and R.L. Moulis. 1994a. Distribution of amphibians and reptiles in Georgia, vol. 2 (locality data). Savannah Science Museum, Inc., Savannah, GA. 712 p.
Williamson, G.K. and R.L. Moulis. 1994b. Distribution of amphibians and reptiles in Georgia, vol. 1 (maps). Savannah GA, Savannah Science Museum, Inc.
Wilson, L.A. 1995. Land Manager's Guide to the Amphibians and Reptiles of the South. The Nature Conservancy, Chapel Hill, NC. 360 p.
Wilson, D., H. Mushinsky, and E. McCoy. Nesting behavior of the striped mud turtle, Kinosternon baurii. Copeia 1999:958-968.
Winn, B. 1999. Pp. 65-66 in Protected animals of Georgia (J.C. Ozier, et al., eds.). Georgia Dept. of Natural Res., Wildlife Res. Div., Social Circle, GA
Winn, B., J.B. Jensen, and S. Johnson. 1999. Eleutherodactylus planirostris (geographic distribution). Herpetological Review 30:49.
Wood, J.T. 1955. The nesting of the four-toed salamander, Hemidactylium scutatum (Schlegel), in Virginia. The American Midland Naturalist 53:381-389.
Wright, A.H. and A.A. Wright. 1949. Handbook of frogs and toads of the United States and Canada. Comstock Publishing Associates, Ithaca, NY. 640 p.
Wright, A.H. and A.A. Wright. 1957. Handbook of snakes of the United States and Canada. Comstock Publishing Associates, Ithaca, NY. 1105 p.
Wygoda, M. 1979. Terrestrial activity of striped mud turtles in west-central Florida. Journal of Herpetology 13:469-480.
Wynn, A.H., R. Highton, and J.F. Jacobs. 1988. A new species of rock-crevice dwelling Plethodon from Pigeon Mountain, Georgia. Herpetologica 44:135-143.
Zug, G.R. and A. Schwartz. 1971. Deirochelys and D. reticularia. Catalogue of American Amphibians and Reptiles, pp. 107.1-107.3.

Birds

Adams, D.A. and T.L. Quay. 1958. Ecology of the clapper rail in southeastern North Carolina. J. Wildl. Manage. 22:149-156.
Adkisson, C.S. 1996. Red crossbill (Loxia curvirostra). In A. Poole and F. Gill, eds., The Birds of North America, No. 256. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Aldrich, J.W. and R.W. Coffin. 1980. Breeding bird populations from forest to suburbia after thirty-seven years. Am. Birds 34:3-7.
Alisaukas, R.T., T.W. Arnold. 1994. American coot. Pages 127-143 in Migratory shore and upland game bird management in North America (T.S. Tacha and C.E. Braun, eds.). Allen Press, Lawrence, KS.
Allen, O.S. 1979. An analysis of range extensions of certain species of birds in the Athens (Clarke Co.), Georgia area. M.S. thesis, Univ. Georgia, Athens.
Allen, A.W. 1987. Habitat suitability index models: barred owl. USFWS Biol. Rep. 82(10.143).

Allen, D.H. 1988. Home range and habitat use of eastern bluebirds on the Savannah River Plant, South Carolina. M.S. thesis, Clemson Univ., Clemson, SC.
Allen, R.W. and M.M. Nice. 1952. A study of the breeding biology of the purple martin. Am. Midl. Nat. 47:606-665.
Almand, D.J. 1965. A contribution to the management requirements of the wood duck (Aix sponsa) in the Piedmont of Georgia. M.S. thesis, Univ. Georgia, Athens.
Alsop, F.J. III. 1981. The cliff swalllow in Tennessee. Migrant 52:1-11.
Andrle, R.F. and J.R. Carroll. 1988. The atlas of breeding birds of New York State. Cornell Univ, Ithaca, NY. 551 p.
American Ornithologists' Union. 1983. Check-list of North American birds, 6th ed. Allen Press, Lawrence, KS. 877 pp.
Armstrong, J.J. 1965. Breeding home range in the nighthawk and other birds; its evolution and ecological significance. Ecology 46:619-29.
Askins, R.A. 1994. Open corridors in a heavily forested landscape: impact on shrubland and forest-interior species. Wildl. Soc. Bulletin 22:339-347.
Atwood, J.L. and D.E. Minsky. 1983. Least tern foraging ecology at three major California breeding colonies. West. Birds 14:57-71.
Baker, J.L. 1973. Preliminary studies of the dusky seaside sparrow on the St. Johns National Wildlife Refuge. Proc. Ann. Conf. Southeastern Assoc. Game and Fish Commissioners 27:207-214.
Baker, W.W. 1981. The distribution, status and future of the red-cockaded woodpecker in Georgia. Pp. 82-87 in Proceeding of the nongame and endangered wildlife symposium (R.R. Odum and J.W. Guthrie, eds.). Georgia Dep. Nat. Resour., Game Fish Div., Tech. Bull. WL-5.
Baker, W.W. and R.H. Peake. 1966. Whip-poor-will populations in the lower Piedmont of Georgia. Oriole 31:15-19.
Bancroft, G.T., S.D. Jewell, and A.M. Strong. Foraging and nesting ecology of herons in the lower Everglades relative to water conditions. South Florida Water Management District, West Palm Beach.
Barber, J.D., E.D. Wiggers, and R.B. Barber. 1998. Nest-site characterization and reproductive success of Mississippi kites in the Mississippi River floodplains. J. Wildl. Manage. 62: 1373-1378.
Baskett, T.S., M.W. Sayre, R.E. Tomlinson and R.E. Mirarchi, eds. 1993. Ecology and management of the mourning dove. Stackpole Books, Harrisburg, PA. 567 p.
Bateman, D.L. 1970. Movement-behvaior in three species of colonial nesting wading birds: a radiotelemetric study. Ph.D. diss., Auburn Univ., Auburn, AL.
Baumgartner, F.M. 1939. Territory and population in the great horned owl. Auk 56:274-282.
Beason, R.C. 1995. Horned lark (Eremophila alpestris). In A. Poole and F. Gill, eds., The Birds of North America, No. 195. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Beason, R.C. and E.C. Franks. 1974. Breeding behavior of the horned larks of western North America. Auk 91:65-74.
Beaver, D.L., R.G. Osborn and T.W. Custer. 1980. Nest-site and colony characteristics of wading birds in selected Atlantic coast colonies. Wilson Bull. 92:200-220.
Beddal, B.G. 1963. Range expansion of the cardinal and other birds in the northeastern states. Wilson Bull. 75:140-56.
Bellrose, F.C. 1980. Ducks, geese, and swans of North America. Harrisburg, PA, Stackpole.
Bellrose, F.C. and D.J. Holm. 1994. Ecology and management of the wood duck. Stackpole Books, Harrisburg, PA. 588 p.
Belthoff, J.R. and G. Ritchison. 1990. Nest-site selection by Eastern screech-owls in central Kentucky. Condor 92:982-990.
Belthoff, J.R., E.J. Sparks, and G. Ritchison. 1993. Home ranges of adult and juvenile eastern screech-owls: size, seasonal variation and extent of overlap. J. Raptor Res. 27:8-15.

Bennett, S.E. 1980. Interspecific competition and the niche of the American Redstart, Setophaga ruticilla, in wintering and breeding communities. Pages 319-336 in A. Keast and E.S. Morton, eds., Migrant birds in the Neotropics: ecology, behavior, distribution, and conservation. Smithson. Inst. Press, Washington, D.C.
Bennett, A.J. 1989. Movements and home range of Florida sandhill cranes. J. Wildl. Manage. 53:830-836.
Bent, A.C. 1919. Life histories of North American diving birds. U.S. National Museum Bulletin No. 107.
Bent, A.C. 1921. Life histories of North American gulls and terns. U.S. National Museum Bulletin 113.
Bent, A.C. 1922. Life histories of North American petrels and pelicans. U.S. National Museum Bulletin No. 121.
Bent, A.C. 1923. Life histories of North American wild fowl, vol. 1. U.S. National Museum Bulletin No. 126.
Bent, A.C. 1926. Life histories of North American marsh birds. U.S. National Museum Bulletin No. 135.
Bent, A.C. 1927. Life histories of North American shorebirds, part 1. U.S. National Museum Bulletin 142.
Bent, A.C. 1929. Life histories of North American shorebirds, part 2. U.S. National Museum Bulletin 146.
Bent, A.C. 1932. Life histories of North American gallinaceous birds. U.S. Naional Museum Bulletin No. 162.
Bent, A.C. 1937. Life histories of North American birds of prey, part 1. U.S. National Museum Bulletin No. 167.
Bent, A.C. 1938. Life histories of North American birds of prey, part 2. U.S. National Museum Bulletin No. 170.
Bent, A.C. 1939. Life histories of North American woodpeckers. U.S. National Museum Bulletin No. 174.
Bent, A.C. 1940. Life histories of North American cuckoos, goatsuckers, hummingbirds, and their allies. U.S. National Museum Bulletin No. 176.
Bent, A.C. 1942. Life histories of North American flycatchers, larks, swallows, and their allies. U.S. National Museum Bulletin No. 179.
Bent, A.C. 1946. Life histories of North American jays, crows, and titmice. U.S. National Museum Bulletin No. 191
Bent, A.C. 1948. Life histories of North American nuthatches, wrens, thrashers, and their allies. U.S. National Museum Bulletin No. 195.
Bent, A.C. 1949. Life histories of North American thrushes, kinglets, and their allies. U.S. National Museum Bulletin No. 196.
Bent, A.C. 1950. Life histories of North American wagtails, shrikes, vireos, and their allies. U.S. National Museum Bulletin No. 197.
Bent, A.C. 1953. Life histories of American wood warblers. U.S. National Museum Bulletin No. 203.
Bent, A.C. 1958. Life histories of North American blackbirds, orioles, tanagers, and their allies. U.S. National Museum Bulletin No. 211.
Bent, A.C. 1968. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies; order Passeriformes: family Fringillidae. Dover Publications, New York.
Bertin, R.I. 1977. Breeding habitats of the wood thrush and veery. Condor 79:303-311.
Best, L.B. 1977. Terriotory quality and mating success in the Field Sparrow (Spizella pusilla). Condor 79:192-204.
Bildstein, K.L. and K. Meyer. 2000. Sharp-shinned hawk (Accipiter striatus). In A. Poole and F. Gill, eds., The Birds of North America, No. 482. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Bildstein, K.L., W. Post, P. Frederick and J.W. Johnston. 1990. Freshwater wetlands, rainfall, and the breeding ecology of white ibises in coastal South Carolina. Wilson Bull. 102:84-98.
Bird, R.D. 1988. American kestrel. Pages 253-290 in Handbook of North American birds, vol. 5 (R.S. Palmer, ed.). Yale Univ. Press, New Haven, CT.
Blem, C.R. and L.B. Blem. 1991. Nest box selection by prothonotary warblers. J. Field Ornithology 62(3): 299-307.

Boarman, W.I. And B. Heinrich. 1999. Common raven (Corvus corax). In A. Poole and F. Gill, eds., The Birds of North America, No. 476. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Bohall-Wood, P. 1987. Abundance, habitat use, and perch use of loggerhead shrikes in north-central Florida. Wilson Bull. 99:82-86.
Bolen, E.C. and D. Flores. 1994. Mississippi kite: portrait of a southern hawk. University of Texas Press, Austin. 115 p.
Bongiorno, S.F. 1970. Nest-site selection by adult laughing gulls (Larus atricilla). Anim. Behav. 18:434-444.
Bosakowski, T., R. Speiser and D.G. Smith. 1989. Nesting ecology of forest-dwelling great horned owls in the eastern deciduous forest biome. Can. Field-Nat. 103:65-69.
Bradley, R.A. 1980. Vocal and territorial behavior in the White-eyed Vireo. Wilson Bull. 92:302-311.
Bratton, S.P. 1988. Wood stork use of fresh and salt water habitats on Cumberland Island National Seashore. U.S. National Park Service CPSU Technical Report No. 30.
Brennan, L.A. 1999. Northern bobwhite. In A. Poole, P. Stettenheim, and F. Gill, eds., The Birds of North America, No. 397. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Brewer, R. 1963. Ecological and reproductive relationships of black-capped and Carolina chickadees. Auk 80:9-47.
Briskie, J.V. 1994. Least flycatcher (Empidonax minimus). In A. Poole and F. Gill, eds., The Birds of North America, No. 99. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Brooks, M. 1947. Breeding habitats of certain wood warblers in the unglaciated southern Appalachian region. Auk 64:291-294.
Brooks, M. and W.C. Legg. 1942. Swainson's Warbler in Nicholas County, West Virginia. Auk 59:76-86.
Brown, C.R. 1997. Purple martin (Progne subis). In A. Poole and F. Gill, eds., The Birds of North America, No. 287. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Brown, C.R. and M.B Brown. 1995. Cliff swallow (Hirundo pyrrhonota). In A. Poole and F. Gill, eds., The Birds of North America, No. 149. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Brown, C.R. and M.B. Brown. 1999. Barn swallow (Hirundo rustica). In A. Poole and F. Gill, eds., The Birds of North America, No. 452. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Brown, R.E. and J.G. Dickson. 1994. Swainson's warbler (Limnothlypis swainsonii). In A. Poole and F. Gill, eds., The Birds of North America, No. 215. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Brown, M. and J.J. Dinsmore. 1986. Implications of marsh size and isolation for marsh bird management. J. Wildl. Manage. 50:392-397.
Brown, B. and M. Koenen. 1999. Yellow-billed cuckoo (Coccyzus Americanus). In Wings of the Americas Species Information and Management Abstracts. The Nature Conservancy. Version 11/19/99
Brown, C.R., M.B. Brown and A.R. Ives. 1992. Nest placement relative to food and its influence on the evolution of avian coloniality. Am. Nat. 139: 205-207.
Brown, C.R., M.B. Brown and A.R. Ives. 1992. Nest placement relative to food and its influence on the evolution of avian coloniality. Am. Nat. 139:205-217.
Bryan, A.L. and M.C. Coulter. 1987. Foraging flight characteristics of wood storks in east-central Georgia, U.S.A. Colon. Waterbirds 10:157-161.
Buckley, N.J. 1999. Black vulture (Coragyps atratus). In A. Poole and F. Gill, eds., The Birds of North America, No. 411. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.

Bull, E.L. and J.A. Jackson. 1995. Pileated woodpecker (Dryocopus pileatus). In A. Poole and F, Gill, eds., The Birds of North America, No. 148. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Burger, J. 1996. Laughing gull (Larus atricilla). In A. Poole and F. Gill, eds., The Birds of North America, No. 225. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Burger, J. and J. Shisler. 1978. Nest-site selection of willets in a New Jersey salt marsh. Wilson Bull. 90:599-607.
Burleigh, T.D. 1935. Two new birds from the southern Appalachians. Proc. Biol. Soc. Wash. 48:61-62.
Burleigh, T.D. 1958. Georgia birds. Univ. of Oklahoma Press, Norman, OK. 746 pp.
Burns, F.L. 1911. A monograph of the broad-winged hawk (Buteo platypterus). Wilson Bull. 23:139-320.
Burton, J.A. (ed.). 1973. Owls of the world. Peter Lowe, Wert, The Netherlands. 216 p.
Butler, R.W. 1992. Great blue heron (Ardea herodias). In A. Poole and F. Gill, eds., The Birds of North America, No. 25. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Butts, W.K. 1931. A study of the chickadee and white-breasted nuthatch by means of marked individuals. Part III: the white-breasted nuthatch (Sitta carolinensis cookei). Bird-Banding 2:59-76.
Byers, C., U. Olsson, and J. Curson. 1995. Buntings and sparrows: a guide to the buntings and North American sparrows. Pica Press, Sussex, UK. 334 p.
Cabe, P.R. 1993. European starling (Sturnus vulgaris). In A. Poole and F. Gill, eds., The Birds of North America, No. 48. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Carey, M., D.E. Burhans, and D.A. Nelson. 1994. Field sparrow (Spizella pusilla). In A. Poole and F. Gill, eds., The Birds of North America, No. 103. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Philadelphia.
Cely, J.E. and J.A. Sorrow. 1990. The American swallow-tailed kite in South Carolina. Nongame and Heritage Trust Fund publ. No. 1. South Carolina Wildl. And Mar. Resour. Dept., Columbia, SC.
Cimprich, D.A. and F.R. Moore. 1995. Gray catbird. In A. Poole and F. Gill, eds., The Birds of North America, No. 167. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Clement, P. 1993. Finches and sparrows: an identification guide. Princeton University Press, Princeton, NJ. 500 p.
Coleman, J.S. and J.D. Fraser. 1989. Habitat use and home ranges of black and turkey vultures. J. Wildl. Manage. 53:782-792.
Collins, S.L. 1983. Geographic variation in habitat structure of the black-throated green warbler (Dendroica virens). Auk 100:382-389.
Colvin, B.A. 1985. Common barn owl population decline in Ohio and the relationship to agricultural trends. J. Field Ornithol. 56:224-235.
Confer, J.L. 1992. Golden-winged-warbler (Vermivora chrysoptera). In A. Poole and F. Gill, eds., The Birds of North America, No. 20. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Confer, J.L. and K. Knapp. 1981. Golden-winged Warblers and Blue-winged Warblers: the relative success of a habitat specialist and a generalist. Auk 98:108-114.
Conner, R.N. and C.S. Adkisson. 1975. Effects of clearcutting on the diversity of breeding birds. J. Forestry 73:781-785.
Conner, R.N. and D.C. Rudolph. 1991. Forest habitat loss, fragmentation, and red-cockaded woodpecker populations. Wilson Bull. 103: 446-457.
Conner, R.N., R.G. Cooper, H.S. Crawford and H.S. Mosby. 1975. Woodpecker nesting habitat in cut and uncut woodlands in Virginia. J. Wildl. Manage. 3-9:144-150.

Conroy, M.J. and D.G. Krementz. 1997. Effects of forest management on population parameters and habitat use of wood thrushes. Final Report, Work Order #22, Coop Agreement #14-16-0009-1551, Georgia Cooperative Fish and Wildlife Research Unit, Athens, GA.

Conway, C.J. 1990. Seasonal changes in movements and habitat use by three sympatric species of rails. M.S., Univ. of Wyoming, Laramie.

Conway, C.J. 1995. Virginia rail (Rallus limicola). In A. Poole and F. Gill, eds., The Birds of North America, No. 173. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.

Conway, C.J. 1999. Canada warbler (Wilsonia canadensis). In A. Poole and F. Gill, eds., The Birds of North America, No. 421. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.

Cooper, R.J. 1981. Relative abundance of Georgia caprimulgids based on call-counts. Wilson Bull. 93: 363-371.

Corbat, C.A. 1990. Nesting ecology of selected beach-nesting birds in Georgia. Ph.D. diss., Univ. of Georgia, Athens.

Cornwell, G.W. 1963. Observations of the breeding biology and behavior of a nesting population of belted kingfishers. Condor 65:426-431.

Cottrell, S.D., H.H. Prince, and P.I. Padding. 1990. Nest success, duckling survival, and brood habitat selection of wood ducks in a Tennessee riverine system. Pp. 191-197 in Proc. 1988 N. Am. Wood duck Symposium (L.H. Fredrickson et al., eds.). St. Louis, MO.

Coulter, M.C., J.A. Rodgers, J.C. Ogden, and F.C. Depkin. 1999. Wood stork (Mycteria americana). In A. Poole and F. Gill, eds., The Birds of North America, No. 409. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.

Cox, J. 1996. Painted bunting. Pages 644-651 R.E. Ashton, ed., Rare and endangered biota of Florida, revised edition. Univ. Press of Florida, Gainesville.

Craig, R.J. 1985. Comparative habitat use by Louisiana and northern Waterthrushes. Wilson. Bull. 97:347-355.

Critcher, T.S. and T.L. Quay. 1953. The American woodcock in North Carolina. Chat 17:62-68.

Crocoll, S.T. 1994. Red-shouldered hawk (Buteo lineatus). In A. Poole and F. Gill, eds., The Birds of north America, No. 107. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.

Crocoll, S.T. and J.W. Parker. 1989. The breeding biology of broad-winged and red-shouldered hawks in western New York. J. Raptor Res. 23:125-139.

Curson, J., D. Quinn and D. Beadle. 1994. Warblers of the americas: an identification guide. Houghton Mifflin Co., New York. 252 p.

Custer, T.W. and R.G. Osborn. 1977. Wading birds as biological indicators: 1975 colony survey. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Wildl. No. 206. Washington, DC.

Custer, T.W. and R.B. Osborn. 1978. Feeding habitat use by colonially breeding herons, egrets, and ibises in North Carolina. Auk 95:733-743.

Davis, D.E. 1959. Observations on territorial behavior of least flycatchers. Wilson Bull. 71:73-85.

Davis, W.J. 1982. Territory size in Megaceryle alcyon along a stream habitat. Auk 99:353-362.

Davis, W.E. 1993. Black-crowned night-heron (Nycticorax nycticorax). In A. Poole and F. Gill, eds., The Birds of North America, No. 74. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.

Davis, Jr., W.E. and J.A. Kushlan. 1994. Green heron (Butorides virescens). In A. Poole and F. Gill, eds., The Birds of North America, No. 129. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.

DeGraaf, R.M. 1989. Territory sizes of song sparrows, Melospiza melodia, in rural and suburban habitats. Can. Field-Nat. 103:43-47.

DeGraaf, R.M., V.E. Scott, R.H. Hamre, L. Ernst, S.H. Anderson. 1991. Forest and rangeland birds of the United States. U.S. Dept. Agric. For. Serv., Agriculture Handbook 688. 625 pp.
DeJong, M.J. 1996. Northern rough-winged swallow (Stelgidopteryx serripennis). In A. Poole and F. Gill, eds., The Birds of North America, No. 234). The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washiington, DC.
Dennis, J.V. 1958. Some aspects of the breeding biology of the yellow-breasted chat. Bird Banding 29:169-183.
Denton, J.F. 1948. First record of Swainson's Warbler in the Georgia mountains in summer. Oriole 13:24-25.
Derrickson, K.C. and R. Breitwisch. 1992. Northern mockingbird (Mimus polyglottus). In A. Poole, P. Stettenheim, and F. Gill, eds., The Birds of North America, No. 7. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Dickson, J.G. 1978. Forest bird communities of the bottomland hardwoods. Pp. 66-73 in Management of southern forests for nongame birds (R.M. DeGraff, tech. Coord.). U.S. For. Serv. Gen. Tech. Rep. SE-14.
Dickson, J.G., R.N. Conner and J.H. Williamson. 1980. Relative abundance of breeding birds in forest stands in the southeast. South J. Appl. For. 4:174-179.
Dijak, W.D., B. Tannenbaum and M.A. Parker. 1990. Nest-site characteristics affecting success and reuse of res-shouldered hawk nests. Wilson Bull. 102:480-486.
Dow, D.D. 1969. Home range and habitat of the cardinal in peripheral and central populations. Can. J. Zool. 47:103-114.
Drennen, D.J., L.J. Hunt and T. King. 1982. Nest characteristics of a yellow-crowned night heron (Nyctanassa violacea) colony. J. Ala. Acad. Sci. 53:5-9.
Dufty, A.M. 1982. Movements and activities of radio-tracked brown-headed cowbirds. Auk 99:315-327.
Dunning, J.B. 1993. Bachman's sparrow (Aimophila aestivalis). In A. Poole and F. Gill, eds., The Birds of North America, No. 38. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Dunning, J.B. and B.D. Watts. 1990. Regional differences in habitat occupancy by Bachman's sparrow. Auk 107:463-472.
Dusi, J.L. and R.T. Dusi. 1987. A thirty-four-year summary of the status of heron colony sites in the Coastal Plain of Alabama, USA. Colon. Waterbirds 10:27-37.
Duyck, B.E. 1981. Range expansion of nesting tree swallows. Chat 45:98-100.
Eaton, S.W. 1958. A life history of the Louisiana waterthrush. Wilson Bull. 70:210-235.
Eaton, S.W. 1992. Wild turkey (Meleagris gallopavo). In A. Poole and F. Gill, eds., The Birds of North America, No. 22. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Eddleman, W.R. and C.J. Conway. 1994. Clapper rail. Pages 167-179 in T.S. Tacha and C.E. Braun, eds., Migratory shore and upland game bird management in North America. Allen Press, Lawrence, KS.
Eddleman, W.R. and C.J. Conway. 1998. Clapper rail (Rallus longirostris). In A. Poole and F. Gill, eds., The Birds of North America, No. 340. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Eddleman, W.R., K.E. Evans, and W.H. Elder. 1980. Habitat characteristics and management of Swainson's Warbler in southern Illinois. Wildlife Soc. Bull. 8:228-233.
Ehrlich, P.R., D.S. Dobkin and D. Wheye. 1988. The birder's handbook. Simon & Schuster, New York. 785 p.
Ellison, W.G. 1992. Blue-gray gnatcatcher (Polioptila caerulea). In A. Poole, P. Stettenheim, and F. Gill, eds., The Birds of North America, No. 23. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Engels, T.M. and C.W. Sexton. 1994. Negative correlation of blue jays and golden-cheeked warblers near an urbanizing area. Conser. Biol. 8:286-290.

Engstrom, R.T. 1996. White-breasted nuthatch. Pp. 595-601 in R.E. Ashton, ed., Rare and endangered biota of Florida, revised edition. Univ. Press of Florida, Gainesville.
Erickson, W.J. 1926. Gull-billed terns breeding on the coast of Georgia. Auk 43:533-534.
Erskine, A.J. 1971. Some new perspectives on the breeding ecology of common grackles. Wilson Bull. 83:352-370.
Esler, D. 1989. An assessment of American coot herbivory of hydrilla. J. Wildl. Manage. 53:1147-1149.
Evans, D.E. and R.A. Fischer. 1997. Species profile: Cerulean warbler (Dendroica cerulea) on military installations in the southeastern United States. Technical Report SERDP-97-12, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
Evans Ogden, L.J. and B.J. Stutchbury. 1994. Hooded warbler (Wilsonia citrina). In A. Poole and F. Gill, eds., The Birds of North America, No. 110. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Everhart, S.H., J.F. Parnell, R.F. Soots, Jr., and P.D. Doerr. 1980. Pp. 1-39 in Natural and dredged material nesting habitats of gull-billed terns, common terns, and black skimmers in North Carolina. Raleigh, NC, UNC-Sea Grant Publ. No. 79-05.
Feare, C.J. 1984. The starling. Oxford Univ. Press, Oxford. 315 p.
Fehon, J.H. 1955. Life-history of the blue-gray gnatcatcher (Polioptila caerula caerula). Ph.D. diss., Florida State Univ., Tallahassee.
Ficken, M.S. 1962. Agonistic behavior and territory in the American redstart. Auk 79:607-632.
Ficken, M.S. and R.W. Ficken. 1968. Ecology of Blue-winged Warblers, Golden-winged Warblers and some other Vermivora. Am. Mid. Nat. 79:311-319.
Ficken, M.S. and R.W. Ficken. 1968. Territorial relationships of Blue-winged Warblers, Golden-winged Warblers and their hybrids. Wilson Bull. 80:442-451.
Fisk, E.J. 1978. Roof-nesting terns, skimmers, and plovers in Florida. Fla. Field Nat. 6:1-8.
Fowler, L.J. and D.K. Fowler. 1985. Breeding birds and vegetation along the Duck River in middle Tennessee. J. Tenn. Acad. Sci. 60: 48-50.
Franks, E.C. and J.E. Warnock. 1969. Great horned owl nesting in a populated area. Wilson Bull. 81:332-333.
Frederick, P.C. 1997. Tricolored heron (Egretta tricolor). In A. Poole and F. Gill, eds., The Birds of North America, No. 306. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Fretwell, S.D. 1986. Distribution and abundance of the dickcissel. Pages 211-242 in R.F. Johnson, ed., Current ornithology, vol. 4. Plenum Press, New York.
Fuller, M.R. 1979. Spatiotemporal ecology of four sympatric raptor species. Ph.D. diss., Univ. of Minnesota, St. Paul.
Gale, G.A., L.A. Hanners, and S.R. Patton. 1997. Reproductive success of worm-eating warblers in a forest landscape. Conservation Bio. 11:246-250.
Galli, A.E., C.F. Leck and R.T.T. Forman. 1976. Avian distribution patterns in forest islands of different sizes in central New Jersey. Auk 93:356-364.
Gates, J.E. and L.W. Gysel. 1978. Avian nest dispersion and fledging success in field-forest ecotones. Ecology 59:871-883.
Gawlik, D.E. and K.L. Bildstein. 1990. Reproductive success and nesting habitat of loggerhead shrikes in north-central South Carolina. Wilson Bull. 102:37-48.
Gawlik, D.E. and K.L. Bildstein. 1993. Seasonal habitat use and abundance of loggerhead shrikes in South Carolina. J. Wildl. Manage. 57:352-357.
Gehlbach, F.R. 1994. The eastern screech-owl: life history, ecology, and behavior in suburbia and the countryside. Texas A&M Univ. Press, College Station. 302 p.
Gehlbach, F.R. 1995. Eastern screech-owl (Otus asio). In A. Poole and F. Gill, eds., The Birds of North America No. 9. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.

Ghalambor, C.K. and T.E. Martin. 1999. Red-breasted nuthatch (Sitta canadensis). In A. Poole and F. Gill, eds., The Birds of North America, No. 459. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Gibbs, J.P. and J. Faaborg. 1990. Estimating the viability of Ovenbird and Kentucky Warbler populations in forest fragments. Conserv. Biol. 4:193-196.
Gibbs, J.P. and S.M. Melvin. 1992. Pied-billed grebe, Podilymbus podiceps. Pages 31-49 in K.J. Schneider and D.M. Pence, editors. Migratory nongame birds of management concern in the northeast. U.S. Fish and Wildlife Service, Newton Corner, MA.
Gibbs, J.P., F.A. Reid, and S.M. Melvin. 1992. Least bittern (Ixobrychus exilis). In A. Poole and F. Gill, eds., The Birds of North America, No. 17. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Gobris, N.M. 1992. Habitat occupancy during the breeding season by Bachman's sparrow at Piedmont National Wildlife Refuge in central Georgia. M.S. thesis, Univ. Georgia, Athens.
Gochfeld, M. and J. Burger. 1994. Black skimmer (Rynchops niger). In A. Poole and F. Gill, eds., The Birds of North America, No. 108. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Gooders, J. and T. Boyer. 1986. Ducks of North America. Facts on File Publications, New York. 176 p.
Goodrich, L.J., S.C. Crocoll, and S.E. Senner. 1996. Broad-winged hawk (Buteo platypterus). In A. Poole and F. Gill, eds., The Birds of North America, No. 218. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, D.C.
Goodwin, D. 1976. Crows of the world. Ithaca, NY, Cornell Univ. Press. 299 p.
Gore, J.A. 1987. Black skimmers on roofs in northwestern Florida. Fla. Field Nat. 15:77-79.
Gore, J.A. 1991. Distribution and abundance of nesting least terns and black skimmers in northwest Florida. Florida Field Nat. 19:65-72.
Gowaty, P.A. and J.H. Plissner. 1998. Eastern bluebird (Sialia sialis). In A. Poole and F. Gill, eds., The Birds of North America, No. 381. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Grand, J.B. and R.E. Mirarchi. 1988. Habitat use by recently fledged mourning doves in east-central Alabama. J. Wildl. Manage. 52:153-157.
Greenberg, R. 1987. Seasonal foraging specialization in the Worm-eating Warbler. Condor 89:158-168.
Greenlaw, J.S. 1996. Eastern towhee (Pipilo erythrophthalmus). In A. Poole and F. Gill, eds., The Birds of North America, No. 262. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Greij, E.D. 1994. Common moorhen. Pages 145-157 in T.S. Tacha and C.E. Braun, eds., Migratory shore and upland game bird management in North America. Allen Press, Lawrence, KS.
Grubb, T.C. and V.V. Pravosudov. 1994. Tufted titmouse (Parus bicolor). In A. Poole and F. Gill, eds., The Birds of North America, No. 86. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Guzy, M.J. and G. Ritchison. 1999. Common yellowthroat (Geothlypis trichas). In A. Poole and F. Gill, eds., The Birds of North America, No. 448. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Hagan, J.M. 1993. Decline of the rufous-sided towhee in the eastern United States. Auk 110:863-874.
Hagan, J.M. III. 1993. Decline of the rufous-sided towhee in the eastern United States. Auk 110:863-874.
Haggerty, T.M. 1986. Reproductive ecology of Bachman's sparrow in central Arkansas. Ph.D. diss., Univ. Arkansas, Fayetteville.
Haggerty, T.M. and E.S. Morton. 1995. Carolina wren (Thryothorus ludovicianus). In A. Poole and F. Gill, eds., The Birds of North America, No. 188. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Hain, W., Jr. 1927. Florida red-shouldered hawk. Oologist 44:141-142.

Hale, P.E., A.S. Johnson, and J.L. Landers. 1982. Characteristics of ruffed grouse drumming sites in Georgia. J. Wildl. Manage. 46:115-123.
Halkin, S.L. and S.U. Linville. 1999. Northern cardinal (Cardinalis cardinalis). In A. Poole and F. Gill, eds., The Birds of North America, No. 440. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Hall, G.A. 1996. Yellow-throated warbler (Dendroica dominica). In A. Poole and F. Gill, eds., The Birds of North America, No. 223. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Hall, S.P., H.E. LeGrand, Jr., and R.A. Fischer. 1996. Species profile: loggerhead shrike (Lanius ludovicianus) on military installations in the southeastern United States. Technical Report SERDP-97-8, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
Hamas, M.J. 1994. Belted kingfisher (Ceryle alcyon). In A. Poole and F. Gill, eds., The Birds of North America, No. 84. The Academy of Natural Sciences, Philadelphia and The American ornithologists' Union, Washington, DC.
Hamel, P.B. 1992. Land manager's guide to the birds of the south. The Nature Conservancy, Chapel Hill, NC. 367 p.
Hamel, P.B., H.E. LeGrand, M.R. Lennartz and S.A. Gauthreaux. 1982. Bird-habitat relationships on southeastern forest lands. U.S. Dept. Agric. For. Serv., Gen. Tech. Rep. SE-22. Southeast. For. Exp. Stn., Asheville, N.C. 417 pp.
Hancock, J. and H. Elliott. 1978. The herons of the world. Harper & Row, New York. 304 p.
Haney, J.C., P. Brisse, D.R. Jacobson, M.W. Oberle and J.M. Paget. 1986. Annotated check-list of Georgia birds. Occasional Publication No. 10. Georgia Ornithological Society, Atlanta.
Hanners, L.E. and S.R. Patton. 1998. Worm-eating warbler (Helmitheros vermivorus). In A. Poole and F. Gill, eds., The Birds of North America, No. 367. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, D.C.
Harding, K.C. 1931. Nesting habits of the Black-throated Blue Warbler. Auk 48:512-522.
Hardy, C.L. 1991. A comparison of bird communities in loblolly vs. white pine plantations on the Oak Ridge National Env. Research Park. M.S. thesis, Univ. Tennessee, Knoxville.
Harper, F. 1938. The chuck-will's-widow in the Okefinokee region. Oriole 3:9-14.
Harris, M.J. 1999. American oystercatcher. Pages 48-49 in J. Ozier, et al., eds., The protected animals of Georgia. GA Dept. of Nat. Res., Wildlife Res. Division, Social Circle, GA.
Harris, M.J. 1999. Wood stork. Pages 52-53 J. Ozier, et al., eds., in Protected animals of Georgia. GA Dept. of Nat. Res., Wildlife Res. Division, Social Circle, GA.
Harris, M.J. 1999. Least tern. Pages 56-57 in J. Ozier, et al., eds., The protected animals of Georgia. GA Dept. of Nat. Res., Wildlife Res. Division, Social Circle, GA.
Harris, M.J. 1999. Gull-billed tern. Pages 58-59 in J. Ozier, et al., eds., The protected animals of Georgia. GA Dept. of Nat. Res., Wildlife Res. Division, Social Circle, GA.
Harrison, P. 1987. A field guide to the seabirds of the world. The Stephen Greene Press, Lexington, MA. 317 p.
Hatch, J.J. 1995. Changing populations of double-crested cormorants. Colon. Waterbirds 18:8-24.
Hatch, J.J. and D.V. Weseloh. 1999. Double-crested cormorant (Phalacrocorax auritus). In A. Poole and F. Gill, eds., The Birds of North America, No. 441. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Hegdal, P.L. and R.W. Blaskiewicz. 1984. Evaluation of the potential hazard to barn owls of talon (brodifacoum bait) used to control rats and house mice. Environ. Toxicol. Chem. 3:167-179.
Heintzelman, D.S. 1984. Guide to North American owl-watching. Winchester Press, Piscataway, NJ. 193 p.
Helm, R.N. 1994. Purple gallinule. Pages 159-165 in T.S. Tacha and C.E. Braun, eds. Magratory shore and upland game bird management in North America. Allen Press, Lawrence, KS.
Helm, R.N., D.N. Pashley, and P.J. Zwank. 1987. Notes on the nesting of the common moorhen and purple gallinule in southwest Louisiana. J. Field Ornithology 58:55-61.

Henny, C.J. 1988. Osprey. Pp. 73-101 in R.S. Palmer, ed., Handbook of North American birds, vol. 4. Yale Univ. Press, New Haven, CT.
Hepp, G.R. and F.C. Bellrose. 1995. Wood duck (Aix sponsa). In A. Poole and F. Gill, eds., The Birds of North America, No. 169. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Hepp, G.R. and J.D. Hair. 1977. Wood duck brood mobility and utilizationof beaver pond habitats. Proc. Annu. Conf. Southeast Assoc. Fish Wildl. Agencies 31:216-225.
Herkert, J.R. 1994. The effects of habitat fragmentation on midwestern grassland bird communities. J. Ecol. Appl. 4:461-471.
Herndon, L.R. 1958. Traill's flycatcher breeding in Tennessee. Migrant 29:37-42.
Hespenheide, H.A. 1971. Flycatcher habitat selection in the eastern deciduous forest. Auk 88:61-74.
Hewitt, D.G. and R.L. Kirkpatrick. 1997. Daily activity patterns of ruffed grouse in SW Virginia. J. Field Ornithology 68:413-420.
Hill, G.E. 1993. House finch (Carpodacus mexicanus). In A. Poole and F. Gill, eds., The Birds of North America, No. 45. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Holmes, R.T. 1994. Black-throated blue warbler (Dendroica caerulescens). In A. Poole and F. Gill, eds., The Birds of North America, No. 87. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Holt, J.P. 1974. Bird populations in the hemlock sere on the Highlands Plateau, North Carolina, 1946 to 1972. Wilson Bull. 86:397-406.
Holway, D.A. 1991. Nest site selection and the importance of nest concealment in the Black-throated Blue Warbler. Condor 93:575-581.
Hon, T., R.R. Odom, and D.P. Belcher. 1977. Results of Georgia's clapper rail banding program. Proc. Ann. Conf. Southeast. Assoc. Fish. Wildl. Agen. 31:72-76.
Hooper, R.G. 1977. Nesting habitat of common ravens in Virginia. Wilson Bull. 89:233-242.
Hooper, R.G., L.J. Niles, R.F. Harlow, and G.W. Wood. 1982. Home ranges of red-cockaded woodpeckers in coastal South Carolina. Auk 99: 675-682.
Hoover, J.P., M.C. Brittingham and L.J. Goodrich. 1995. Effects of forest patch size on nesting success of wood thrushes. Auk 112:146-155.
Hoover, J.P., M.C. Brittingham, and L.J. Goodrich. 1995. Effects of forest patch size on nesting success of wood thrushes. Auk 112:146-155.
Hopp, S.L., A. Kirby, and C.A. Boone. 1995. White-eyed vireo (Vireo griseus). In A. Poole and F. Gill, eds., The Birds of North America, No. 168. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Horn, E. and J.F. Flynn. 2001. Eurasian collared-dove. http://www.gos.org/sightings/ecdo.html, Georgia Ornithological Society, Atlanta, GA.
Houston, C.S., D.G. Smith and C. Rohner. 1998. Great Horned Owl (Bubo virginianus). In A. Poole and F. Gill, eds., The Birds of North America, No. 372. The Birds of North America, Inc., Philadelphia.
Howell, D.L. and B.R. Chapman. 1997. Home range and habitat use of red-shouldered hawks in Georgia. Wilson Bull. 109:131-144.
Howell, J., B. Smith, J.B. Holt, Jr. and D.R. Osborne. 1978. Habitat structure and producivity in red-tailed hawks. Bird Banding 49:162-171.
Hoyt, S.F. 1957. The ecology of the pileated woodpecker. Ecology 38:246-256.
Hubbard, J.P. 1971. The avifauna of the southern Appalachians: past and present. Pages 197-232 in The distributional history of the biota of the southern Appalachians, pt. 3: vertebrates. Virginia Polytechnic Inst. And State Univ., Blacksburg.
Hudgins, J.E., G.L. Storm, and J.S. Wakely. 1985. Local movements and diurnal-habitat selection by male American woodcock in Pennsylvania. J. Wildl. Manage. 49:614-619.

Hughes, J.M. 1999. Yellow-billed cuckoo (Coccyzus americanus). In A. Poole and F. Gill, eds., The Birds of North America, No. 418. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Hurley, R.J. and E.C. Franks. 1976. Changes in the breeding ranges of two grassland birds. Auk 93:108-115.
Imhof, T.A. 1976. Alabama birds. University of Alabama Press, University, AL. 591 p.
Ingold, J.L. 1993. Blue grosbeak (Guiraca caerulea). In A. Poole and F. Gill, eds.,The Birds of North America, No. 79. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Isler, M.L. and P.R. Isler. 1987. The tanagers: natural history, distribution, and identification. Smithsonian Institution Press, Washington, DC. 404 p.
Jackson, J.A. 1983. Nesting phenology, nest site selection, and reproductive success of black and turkey vultures. Pages 245-270 in S.R. Wilbur and J.A. Jackson, eds., Vulture bioogy and management. Univ. of Calif. Press, Berkeley.
Jackson, J.A. 1988. The southeastern pine forest ecosystem and its birds: past, present, and future. Bird Conservation 3:119-159.
Jackson, J.A. 1994. Red-cockaded woodpecker (Picoides borealis). In A. Poole and F. Gill, eds., The Birds of North America, No. 85. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Jackson, J.A. and P.G. Burchfield. 1975. Nest-site selection of barn swallows in east-central Mississippi. Am. Midl. Nat. 94:503-509.
Jackson, J.A. and B.J.S. Jackson. 1995. The double-crested cormorant in the south-central United States: habitat and population changes of a feathered pariah. Colon. Waterbirds 18:118-130.
Jackson, J.A., W.W. Baker, V. Carter, T. Cherry and M.L. Hopkins. 1979. Recovery plan for the red-cockaded woodpecker. U.S. Fish Wildl. Serv., Atlanta, GA.
James, R.D. 1979. The comparative foraging behavior of Yellow-throated and Solitary Vireos: the effect of habitat and synpatry. Pp. 137-163 in J.G. Dickson et al., eds., The role of insectivorous birds in forest ecosystems. Academic Press, New York.
James. D.A. and J.C. Neal. 1986. Arkansas birds: their distribution and abundance. Univ. of Arkansas Press, Fayetteville. 402 p.
James, F.C., D.A. Wiedenfeld, and C.E. McCulloch. 1993. Trends in breeding populations of warblers:declines in the southern highlands and increases in the lowlands. Pages 43-56 in J.M. Hagan III and D.W. Johnston, eds., Ecology and conservation of neotropical migrant landbirds. Smithsonian Inst. Press, Washington, DC.
Jaramillo, A. and P. Burke. 1999. New world blackbirds: the icterids. Princeton University Press, Princeton, NJ. 431 p.
Johnsgard, P.A. 1973. Grouse and quails of North America. University of Nebraska, Lincoln. 553 p.
Johnsgard, P.A. 1981. The plovers, sandpipers, and snipes of the world. Univ. of Nebraska Press, Lincoln. 493p.
Johnsgard, P.A. 1983. The hummingbirds of North America. Smithsonian Inst. Press, Washington, DC. 278 p.
Johnsgard, P.A. 1990. Hawks, eagles and falcons of North America. Smithsonian Institution press, Washington, DC. 403 p.
Johnson, L.S. 1998. House wren (Troglodytes aedon). In A. Poole and F. Gill, eds., The Birds of North America, No. 380. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Johnson, A.S. and J.L. Landers. 1982. Habitat relationships of summer resident birds in slash pine flatwoods. J. Wildl. Manage. 46:416-428.
Johnston, D.W. 1971. Niche relationships among some deciduous forest flycatchers. Auk 88:796-804.
Johnston, D.W. 1990. Three years of observations of a breeding colony of common grackles. Raven 61:66-68.

Johnston, R.F. 1992. Rock dove (Columba livia). In A. Poole, P. Stettenheim, and F. Gill, eds., The Birds of North America, No. 13. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Johnston, D.W. and E.P. Odum. 1956. Breeding bird populations in relation to plant succession on the Piedmont of Georgia. Ecology 37:50-62.
Kaiser, M.S. and F.A. Reid. 1987. A comparison of green-backed heron nesting in two freshwater ecosystems. Colon. Waterbirds 10:78-83.
Kale, H.W. 1965. Ecology and bioenergetics of the long-billed marsh wren in Georgia. Publ. Nuttal Ornithol. Club no. 5.
Kalla, P.I. And F.J. Alsop III. 1983. The distribution, habitat preference and status of the Mississippi kite in Tennessee. Am. Birds 37:146-149.
Kendeigh, S.C. 1941. Territorial and mating behavior of the house wren. Illinois Biol. Monogr. 18:1-356.
Kendeigh, S.C. and B. Fawver. 1981. Breeding bird populations in the Great Smoky Mountains, Tennessee and North Carolina. Wilson Bull. 75:418-27.
Kennamer, R.A., W.F. Harvey IV and G.R. Hepp. 1988. Notes on hooded merganser nests in the coastal plain of South Carolina. Wilson Bull. 100:686-688.
Keppie, D.M. and R.M. Whiting. 1994. American woodcock (Scolopax minor). In A. Poole and F. Gill, eds., The Birds of North America, No. 100. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Kilham, L. 1983. Life history studies of woodpeckers of eastern North America. Publ. Nuttall Ornithol. Club no. 20.
Kirk, D.A. and M.J. Mossman. 1998. Turkey vulture (Cathartes aura). In A. Poole and F. Gill, eds., The Birds of North America, No. 339. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Kitchen, D.W. and G.S. Hunt. 1969. Brood habitat of the hooded merganser. J. Wildl. Manage. 33:605-609.
Knight, R.C., D.J. Grout, and S.A. Temple. 1987. Nest-defense behavior of the American crow in urban and rural areas. Condor 89:175-177.
Knupp, D.M., R.B. Owen, Jr., and J.B. Dimond. 1977. Reproductive biology of the American robin in northern Maine. Auk 94:80-85.
Kricher, J. 1995. Black-and-white warbler (Mniotilta varia). In A. Poole and F. Gill, eds., The Birds of North America, No. 158. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Kroodsma, D.E. and J. Verner. 1997. Marsh wren (Cistothorus palustris). In A. Poole and F. Gill, eds., The Birds of North America, No. 308. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Kurzejeski, E.W. and J.B. Lewis. 1990. Home ranges, movements, and habitat use of wild turkey hens in northern Missouri. Proc. Natl. Wild Turkey Symp. 6:67-71.
Lane, J.J. and R.A. Fischer. 1997. Species profile: southeastern American kestrel (Falco sparverius paulus) on military installations in the southeastern United States. U.S. Army Corps of Engineers Technical Report SERDP-97-4.
Lanyon, W.E. 1995. Western meadowlark (Sturnella magna). In A. Poole and F. Gill, eds., The Birds of North America, No. 160. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Lanyon, W.E. 1997. Great-crested flycatcher (Myiarchus crinitus). In A. Poole and F. Gill, eds., The Birds of North America,No. 300. The Academy of Natural Sciences, Philadelphia and The American ornithologists' Union, Washingon, DC.
Lanyon, S.M. and C.F. Thompson. 1986. Site fidelity and habitat quality as determinants of settlement pattern in male painted buntings. Condor 88:206-210.
Larson, E.R. 1970. A nesting study of the common nighthawk. Kentucky Warbler 46:3-6.

Laskey, A.R. 1957. Some tufted titmouse life history. Bird Banding 28:135-145.
Lawrence, L. de K. 1953. Nesting life and behaviour of the red-eyed vireo. Can. Field-Natur. 67:47-77.
Lawrence, L. 1967. A comparative life history study of four species of woodpeckers. Ornithol. Monogr. No. 5. Lawrence, KS, Allen Press.
Lee, J.M. 1994. Habitat ecology of northern bobwhite habitat at Copiah Co. Wildlife Management Area. M.S. thesis, Mississippi State University, Starkville.
Lennartz, M.R. and V.C. Henry. 1985. Endangered species recovery plan. Red-cockaded woodpecker (Picoides borealis). U.S. Fish Wildl. Serv., Atlanta, GA.
Leonard, M.L. and J. Picman. 1987. Nesting mortality and habitat selection by marsh wrens. Auk 104:491-495.
Ligon, J.D. 1970. Behavior and breeding biology of the red-cockaded woodpecker. Auk 87:255-278.
Longcore, J.R. and R.E. Jones. 1969. Reproductive success of the wood thrush in a Delaware woodlot. Wilson Bull. 81:396-406.
Lowney, M.S. and E.P. Hill. 1989. Wood duck nest sites in bottomland hardwood forests of Mississippi. J. Wildl. Manage. 53:378-382.
Lowther, P.E. 1993. Brown-headed cowbird (Molothrus ater). In A. Poole and F. Gill, eds., The Birds of North America, No. 47. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Lowther, P.E. and C.L. Cink. 1992. House sparrow (Passer domesticus). In A. Poole, P. Stettenheim, and F. Gill, eds., The Birds of North America, No. 12. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Lowther, P.E., S.M. Lanyon, and C.W. Thompson. 1999. Painted bunting (Passerina ciris). In A. Poole and F. Gill, eds., The Birds of North America, No. 398. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Lowther, F.C. C. Celada, N.K. Klein, C.C. Rimmer, and D.A. Rimmer. 1999. Yellow warbler (Dendroica petechia). In A. Poole and F. Gill, eds., The Birds of North America, No. 454. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Lunk, W.A. 1962. The rough-winged swallow: a study based on its breeding biology in Michigan. Bull. Nuttal Ornithol. Club no. 4
MacClintock, L., R.F. Whitcomb, and R.L. Whitcomb. 1977. Evidence for the value of corridors and minimization of isolation in preservation of biotic diversity. Am. Birds 31:6-16.
Madge, S. and H. Burn. 1994. Crows and jays: a guide to the crows, jays, and magpies of the world. Houghton and Mifflin, New York. 191 p.
Marti, C.D. 1992. Barn owl (Tyto alba). In A. Poole, P. Stettenheim and F. Gill, eds., The Birds of North America, No. 1. The Academy of Natural Sciences, Philadelphia and The American Ornithologistss' Union, Washington, DC.
Matray, P.F. 1974. Broad-winged hawk nesting and ecology. Auk 91:307-324.
Matthews, W.C. 1983. Home range, movements, and habitat selection of nesting gallinules in a Louisiana freshwater marsh. M.S. thesis, Louisiana State University, Baton Rouge.
Mayfield, H.F. 1965. The brown-headed cowbird, with old and new hosts. Living Bird 4:13-28.
McCabe, R.A. 1991. The little green bird: ecology of the willow flycatcher. Rusting Rock Press, Milwaukee, WI. 171 p.
McCarthy, J.P. 1996. Eastern wood-pewee (Contopus virens). In A. Poole and F. Gill, eds., The Birds of North America, No. 245. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
McDonald, M.V. 1998. Kentucky warbler (Oporornis formosus). In A. Poole and F. Gill, eds., The Birds of North America, No. 324. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
McFarlane, R.W. 1992. A stillness in the pines: the ecology of the red-cockaded woodpecker. W.W. Norton, New York. 270 p.

McGarigal, K. and J.D. Fraser. 1984. The effect of forest stand age on owl distribution in southwestern Virginia. J. Wildl. Manage. 48: 1393-1398.
McIlhenny, E.A. 1937. Life history of the boat-tailed grackle in Louisiana. Auk 54:274-295.
McNair, D.B. 1984. Nest placement of the Eastern phoebe under bridges in south-central North Carolina. Oriole 49:1-6.
McNair, D.B. 1987. Status and distribution of the fish crow in the Carolinas and Georgia. Oriole 52:28-45.
McNair, D.B. 1990. Review of proven, reliable, and possible breeding records of the dickcissel in Georgia and the Carolinas. Oriole 55: 1-18.
Meanley, B. 1966. Some observations on habits of the Swainson's warbler. Living Bird 5:151-165.
Meanley, B. 1985. The marsh hen: a natural history of the clapper rail of the Atlantic Coast salt marsh. Tidewater Publishers, Centreville, MD. 123 p.
Meanley, B. 1988. Notes on the Bachman's sparrow in the Croatan National Forest. Chat 52:2-3.
Meanley, B. 1992. King rail (Rallus elegans). In A. Poole, P. Stettenheim, and F. Gill, eds., The Birds of North America, No. 3. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, D.C.
Meyer, K.D. 1987. Sexual size dimorphism and the behavioral ecology of breeding and wintering sharp-shinned hawks. Ph.D. diss, Univ. of North Carolina, Chapel Hill.
Meyer, K.D. 1995. Swallow-tailed kite (Elanoides forficatus). In A. Poole and F. Gill, eds., The Birds of North America. The Academy of natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, D.C.
Meyer, K.D. and M.W. Collopy. 1990. Status, distribution, and habitat requirements of the American swallow-tailed kite (Elanoides forficatus forficatus) in Florida. Final report, Florida Game and Fresh Water Fish Comm., Tallahassee, FL.
Meyers, J.M. and A.S. Johnson. 1978. Bird communities associated with succession and management of loblolly-shortleaf pine forests. Pages 50-65 in R.M. DeGraff, coordinator, Proceedings of the workshop: management of southern forests for nongame birds. U.S. Dept. Agric., For. Serv. Gen. Tech. Report SE-14, Asheville, NC.
Meyers, J.M. and E.P. Odum. 1991. Breeding bird populations of the Okefenokee Swamp in Georgia: baseline for assessing future avifaunal changes. J. Field Ornithol. 62:53-68.
Meyers, J.M., E.G. Springborn, and L.K. Duncan. 1999. Unpublished data.
Middleton, A.L.A. 1993. American goldfinch (Carduelis tristis). In A. Poole and F. Gill, eds., The Birds of North America, No. 79. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Middleton, A.L.A. 1998. Chipping sparrow (Spizella passerina). In A. Poole and F. Gill, eds., The Birds of North America, No. 334. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Moldenhauer, R.R. and D.J. Regelski. 1996. Northern parula (Parula maericana). In A. Poole and F. Gill, eds., The Birds of North America, No. 215. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Monroe, B.L. 1937. A blue-winged warbler nest near Nashville. Migrant 8:38-39.
Moore, W.S. 1995. Northern flicker (Colaptes auratus). In A. Poole and F. Gill, eds., The Birds of North America, No. 166. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Morgan, K.A. and J.E. Gates. 1982. Bird population patterns in forest edge and strip vegetation at Remington Farms, Maryland. J. Wildl. Manage. 46:933-944.
Morrison, K. 1988. How to be ahost to a great crested flycatcher. Fla. Nat. 61:6-7.
Morse, D.H. 1973. The foraging of small populations of Yellow Warblers and American Redstarts. Ecology 54:346-355.
Morse, D.H. 1989. American warblers. Harvard Univ. Press, Cambridge, MA. 406 p.

Morse, D.H. 1993. Black-throated green warbler (Dendroica virens). In A. Poole and F. Gill, eds., The Birds of North America, No. 55. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Morse, D.H. 1994. Blackburnian warbler (Dendroica fusca). In A. Poole and F. Gill, eds., The Birds of North America, No. 102. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Morse, T.E., J.L. Jakabosky and V.P. McCrow. 1969. Some aspects of the breeding biology of the hooded merganser. J. Wildl. Manage. 33:596-604.
Mowbray, T.B. 1999. Scarlet tanager (Piranga olivacea). In A. Poole and F. Gill, eds., The Birds of North America, No. 479. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Muller, M.J. and R.W. Storer. 1999. Pied-billed grebe (Podilymbus podiceps). In A. Poole and F. Gill, eds., The Birds of North America, No. 410. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Murphy, M.T. 1996. Eastern kingbird (Tyrannus tyrannus). In A. Poole and F. Gill, eds., The Birds of North America, No. 253. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Murphy, R.K., M.W. Gratson and R.N. Rosenfield. 1988. Activity and habitat use by a breeding male Cooper's hawk in a suburban area. J. Raptor Res. 22:97-100.
Murray, N. and D. Stauffer. 1995. Nongame bird use of habitat in central Appalachian riparian forests. J. Wildl. Manage. 59:78-88.
National Geographic. 1999. Field guide to the birds of North America. National Geographic Society, Washington, DC. 480 p.
Nero, R.W. 1984. Redwings. Smithsonian Inst. Press, Washington, DC. 160 p.
Nicholls, T.H. and D.W. Warner. 1972. Barred owl habitat use as determined by radiotelemetry. J. Wildl. Manage. 36:213-224.
Nicholson, D.J. 1929. Nesting of the Yellow-throated Warbler. Wilson Bull. 41:45-46.
Nicholson, C.P. 1997. Atlas of the breeding birds of Tennessee. Univ. of Tennessee Press, Knoxville. 426 p.
Nickell, W. 1951. Studies of habitats, territory, and nests of the eastern goldfinch. Auk 68:447-470.
Nickell, W.P. 1965. Habitats, territory and nesting of the catbird. Am. Midl. Nat. 73:433-478.
Nol, E. and R.C. Humphrey. 1994. American oystercatcher A. Poole and F. Gill, eds.,(Haematopus palliatus). In The Birds of North America, No. 82. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Nolan, V., Jr. 1978. The ecolofy and behavior of the Prairie Warbler Dendroica discolor. Ornithol. Monogr. No. 26.
Nolan, V., E.D. Ketterson, and C.A. Buerkle. 1999. Prairie warbler (Dendroica discolor). In A. Poole and F. Gill, eds., The Birds of North America, No. 455. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Noon, B.R. and K.P. Able. 1978. A comparison of avian community structure in the northern and southern Appalachian mountains. Pages 98-117 in R.M. DeGraff, Coordinator. Management of southern forests for nongame birds. USDA For. Serv., Gen. Tech. Rept. SE-14, Asheville, NC.
Noon, B.R., D.K. Dawson, D.B. Inkley, C.S. Robbins, and S.H. Anderson. 1980. Consistency in habitat preference of forest bird species. Trans. N. Am. Wildl. Nat. Resour. Conf. 45:226-244.
Norris, R.A. 1958. Comparative biosystematics and life history of the nuthatches Sitta pygmaea and Sitta pusilla. Univ. Calif. Publ. Zool. 56:119-300.
Oberle, M.W. and D.M. Forsythe. 1995. Possible breeding of the red-breasted nuthatch and golden-crowned kinglet in Georgia and South Carolina. Oriole 60:52-55.
Oberle, M.W. and J.C. Haney. 1998. Possible breeding range extensions of northern forest birds in northeast Georgia. Oriole 63:35-44.

Odom, R.R. 1970. Nest box production and brood survival of wood ducks on the Piedmont National Wildlife Refuge. Proc. Southeast. Assoc. of Game and Fish Comm. 24:108-117.
Odom, R.R. 1976. Heronry survey of the Georgia coast. Oriole 41:19-35.
Odum, E.P. 1948. Nesting of the mountain vireo at Athens, Georgia, conclusive evidence of a southward invasion. Oriole 13:17-20.
Odum, E.P. and T.D. Burleigh. 1946. Southward invasion in Georgia. Auk 63:388-401.
Odum, E.P. and D.W. Johnston. 1951. The house wren breeding in Georgia: an analysis of a range extension. Auk 68:356-367.
Odum, E.P., O.S. Allen III and H.R. Pulliam. 1993. Southward extension of breeding ranges of passerine birds in the Georgia Piedmont in relation to the reversed latitudinal gradient. Georgia J. Sci. 51:131-140.
O'Halloran, K.A. and R.N. Conner. 1987. Habitat use by brownheaded nuthatches. Bull. Tex. Ornithol. Soc. 20:7-13.
Oney, J. 1954. Clapper rail survey and investigation study. Final Rept., Fed. Aid proj. W-9-R. Georgia Game and Fish Comm., Atlanta.
Orians, G.H. 1985. Blackbirds of the Americas. Univ. of Washington Press, Seattle. 163 p.
Ozier, J.C. 1999. Bald eagle. Pages 50-51 in J.C. Ozier, et al., eds., Protected animals of Georgia., GA Dept. of Nat. Res., Wildlife Res. Div., Social Circle, GA.
Palmer, R.S. 1962. Handbook of North American birds. Vol. 1: loons through flamingoes. Yale Univ. Press, New Haven, CT.
Palmer, R.S. 1988. Sharp-shinned hawk. Pages 304-319 in R.S. Palmer, ed., Handbook of North American birds, vol. 4. Yale Univ. Press, New Haven, CT.
Parker, J.W. 1988. Mississippi kite. Pages 166-186 in R.S. Palmer, ed., Handbook of North American birds, vol. 4. Yale Univ. Press, New Haven, CT.
Parker, J.W. 1999. Mississippi kite (Ictinia mississippiensis). In A. Poole and F. Gill, eds., The Birds of North America, No. 402. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Parker, J.W. and J.C. Ogden. 1979. The recent history and status of the Mississippi kite. Am. Birds 33:119-129.
Parnell, J.F., R.M. Erwin, and K.C. Molina. 1995. Gull-billed tern (Sterna nilotica). In A. Poole and F. Gill, eds., The Birds of North America, No. 140. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Parsons, K.C. and T.L. Master. 2000. Snowy egret (Egretta thula). In A. Poole and F. Gill, eds., The Birds of North America, No. 489. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Pashley, D.N. and W.C. Barrow. 1993. Effects of land use practices on neotropical migratory birds in bottomland hardwood forests. Pages 315-320 in D.M. Finch and P.W. Stangel, eds., Status and management of neotropical migratory birds. U.S. Forest Service Gen. Tech. Rept. RM-229, Fort Collins, CO.
Payne, R.B. 1992. Indigo bunting (Passerina cyanea). In A. Poole and F. Gill, eds., The Birds of North America, No. 4. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Pearson, S.M., J.M. Walsh, and J. Pickering. 1992. Wood stork use of wetland habitats around Cumberland Island, Georgia. Colon. Waterbirds 15:33-42.
Peer, B.D. and E.K. Bollinger. 1997. Common grackle (Quiscalus quiscula). In A. Poole and F. Gill, eds., The Birds of North America, No. 271. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Peterjohn , B.G. and D.L. Rice. 1991. The Ohio breeding bird atlas. Ohio Dep. Nat. Resources, Columbus.
Peterson, L. 1979. Ecology of great horned owls and red-tailed hawks in southeastern Wisconsin. Wisc. Dep. Nat. Resourc. Tech. Bull. No. 111.

Petit, L.J. 1989. Breeding biology of Prothonotary Warblers in riverine habitat in Tennessee. Wilson Bull. 101:51-61.
Petit, L.J. 1999. Prothonotary warbler (Protonotaria citrea). In A. Poole and F. Gill, eds., The Birds of North America, No. 408. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Pielou, W.P. 1957. A life-history study of the tufted titmouse, Parus bicolor Linnaeus. Ph.D. diss., Michigan State Univ., East Lansing.
Pitelka, F.A. 1942. Territoriality and related problems in North American hummingbirds. Condor 44:189-204.
Pitelka, F.A. 1943. Territoriality, display and certain ecological relations of the American woodcock. Wilson Bull. 55:88-114.
Pitts, T.D. 1984. Description of American robin territories in Tennessee. Migrant 55:1-6.
Poole, A.F. 1989. Ospreys, a natural and unnatural history. Cambridge, Cambridge Univ. Press.
Post, W. and J.S. Greenlaw. 1994. Seaside sparrow (Ammodramus maritimus). In A. Poole and F. Gill, eds., The Birds of North America, No. 127. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Post, W. and C.A. Seals. 1993. Nesting associations of least bitterns and boat-tailed grackles. Condor 95:139-144.
Post, W., J.S. Greenlaw, T.L. Merriam and L.A. Wood. 1983. Comparative ecology of northern and southern populations of the seaside sparrow. Pages 123-136 in T.L. Quay, J.B. Funderburg, Jr., D.S. Lee, E.F. Potter, and C.S. Robbins, eds., The seaside sparrow, its biology and management. Occas. Pap. North Carolina Biol. Surv., Raleigh, NC.
Post, W., J.P. Poston, and G.T. Bancroft. 1996. Boat-tailed grackle (Quiscalus major). In A. Poole and F. Gill, eds., The Birds of North America, No. 207. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Potter, E.F., J.F. Parnell, and R.P. Teulings. 1980. Birds of the Carolinas. University of North Carolina Press, Chapel Hill. 408 p.
Poulin, R.G., S.D. Grindal, and R.M. Brigham. 1996. Common nighthawk (Chordeiles minor). In A. Poole and F. Gill, eds., The Birds of North America, No. 213. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Powell, J.A. 1967. Management of the Florida turkey and the eastern turkey in Georgia and Alabama. Pages 409-451 in O. Hewitt, ed., The wild turkey and its management. The Wildlife Society, Washington, DC.
Pravosudov, V.V. and T.C. Grubb. 1993. White-breasted nuthatch (Sitta canadensis). In A. Poole and F. Gill, eds., The Birds of North America, No. 54. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Preston, C.R. and R.D. Beane. 1993. Red-tailed hawk (Buteo jamaicensis). In A. Poole and F. Gill, eds., The Birds of North America, No. 52. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Preston, C.R., C.S. Harger and H.E. Harger. 1989. Habitat use and nest-site selection by red-shouldered hawks in Arkansas. Southwest. Naturalist 34:72-78.
Ratcliffe, D. 1980. The perigrine falcon. Buteo Books, Vermillion, SD. 416 p.
Reller, A.W. 1972. Aspects of behavioral ecology of red-headed and red-bellied woodpeckers. Amer. Midl. Nat. 88:270-290.
Rendell, W.B. and R.J. Robertson. 1991. Competition for cavities among great crested flycatchers, Myiarchus crinitus, northern flickers, Colaptes auratus, and tree swallows, Tachycineta bicolor. Can. Field-Nat. 105:113-114.
Renfrow, F. 1996. Red-breasted nuthatches nesting at the Red River Gorge: a first state record for Kentucky. Kentucky Warbler 72:62-64.

Renken, R.B. and E.P. Wiggers. 1989. Forest characteristics related to pileated woodpecker territory size in Missouri. Condor 91:642-652.
Renken, R.B. and E.P. Wiggers. 1993. Habitat characteristics related to pileated woodpecker densities in Missouri. Wilson Bull. 105:77-83.
Reynolds, K.D. 1997. Accumulation of DDT and mercury in diets and selected tissues of Prothonotary warblers (Protonotaria citrea) as related to foraging dynamics on a spatially heterogeneous contaminated site in Alabama. M.S. thesis, Clemson Univ., Clemson, SC.
Richardson, M.E. and D.W. Brauning. 1995. Chestnut-sided warbler (Dendroica pensylvanica). In A. Poole and F. Gill, eds., The Birds of North America, No. 190. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Rising, J.D. 1996. A guide to the identification and natural history of the sparrows of the United States and Canada. Academic Press, San Diego. 365 p.
Rising, J.D. and N.J. Flood. 1998. Baltimore oriole (Icterus galbula). In A. Poole and F. Gill, eds., The Birds of North America, No. 384. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Robbins, C.S. 1979. Effects of forest fragmentation on breeding bird populations. Pages 198-213 in R.M. DeGraff and K.E. Evans, eds., Management of north central and northeastern forests for nongame birds. U.S. Forest Service, Gen. Tech. Rept. NC-51.
Robbins, C.S. 1980. Effect of forest fragmentation on breeding bird populations in the piedmont of the mid-Atlantic region. Atlantic Nat. 33:31-36.
Robbins, C.S. 1983. Distribution and migration of seaside sparrows. Pages 31-40 in T.L. Quay, J.B. Funderburg, Jr., D.S. Lee, E.F. Potter, and C.S. Robbins, eds., The seaside sparrow, its biology and management. Occas. Pap. North Carolina Biol. Surv., Raleigh, NC.
Robbins, C.S. and E.A.T. Blom. 1996. Atlas of the breeding birds of Maryland and the District of Columbia. Univ. of Pittsburgh Press, Pittsburgh. 479 p.
Robbins, C.S., D.K. Dawson, and B.A. Dowell. 1989. Habitat requirements of breeding birds of the middle Atlantic states. Wildl. Monogr. 103.
Robbins, C.S., J.W. Fitzpatrick, and P.B. Hamel. 1989. A warbler in trouble: Dendroica cerulea. Pages 549-562 in J.M. Hagan III and D.W. Johnston, eds., Ecology and conservation of neotropical migrant landbirds. Smithsonian Inst. Press, Washington, DC.
Roberts, C. and C.J. Norment. 1999. Effects of plot size and habitat characteristics on breeding success of scarlet tanagers. Auk 116:73-82.
Robertson, R.J., B.J. Stutchbury, and R.R. Cohen. 1992. Tree swallow (Tachycineta bicolor). In A. Poole and F. Gill, eds., The Birds of North America, No. 11. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Robinson, J.C. 1990. An annotated checklist of the birds of Tennessee. Univ. of Tennessee Press, Knoxville. 274 p.
Robinson, W.D. 1995. Louisiana waterthrush (Seiurus motacilla). In A. Poole and F. Gill, eds., The Birds of North America, No. 151. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, D.C.
Robinson, W.D. 1996. Summer tanager (Piranga rubra). In A. Poole and F. Gill, eds., The Birds of North America, No. 248. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Robinson, T.R., R.R. Sargent, and M.B. Sargent. 1996. Ruby-throated hummingbird (Archilochus colubris). In A. Poole and F. Gill, eds., The Birds of North America, No. 204. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Robinson, J.A., J.M. Reed, J.P. Skorupa, and L.W. Oring. 1999. Black-necked stilt (Himantopus mexicanus). In A. Poole and F. Gill, eds., The Birds of North America, No. 449. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.

Roboski, J.C. and M.K. Causey. 1981. Incidence, habitat use, and chronology of woodcock nesting in Alabama. J. Wildl. Manage. 45:793-797.
Rodewald, P.G. and R.D. James. 1996. Yellow-throated vireo (Vireo flavifrons). In A. Poole and F. Gill, eds., The Birds of North America, No. 247. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Rodewald, P.G., J.H. Withgott, and K.G. Smith. 1999. Pine warbler (Dendroica pinus). In A. Poole and F. Gill, eds., The Birds of North America, No. 438. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Rodgers, J.A., Jr. and H.T. Smith. 1995. Little blue heron (Egretta caerulea). In A. Poole and F. Gill, eds., The Birds of North America, No. 145. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Rohrbaugh, R.W. and R.H. Yahner. 1997. Effects of microhabitat and macrohabitat on nest-box use and nesting success of American kestrels. Wilson Bull. 109:410-423.
Rosene, W. 1969. The bobwhite quail: its life and management. Rutgers Univ. Press, New Brunswick, NJ. 418 p.
Rosenfield, R.N. and J. Bielefeldt. 1993. Cooper's Hawk (Accipiter cooperi). In A. Poole and F. Gill, eds., The Birds of North America, No. 75. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Roth, R.R. 1987. Assessment of habitat quality for wood thrush in a residential area. Pages 139-149 in L.W. Adams and D.L. Leedy, eds., Integrating man and nature in the metropolitan environment. National Inst. Urban Wildl., Columbia, MD.
Roth, R.R., M.S. Johnson, and T.J. Underwood. 1996. Wood thrush (Hylolicha mustelina). In A. Poole and F. Gill, eds., The Birds of North America, No. 246. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Royall, W.C. and D.E. Bray. 1980 A study of radio-equipped flickers. North American Bird Bander 5:47-50.
Ruckdeschel, C. and C.R. Shoop. 1987. Aspects of wood stork nesting ecology on Cumberland Island, Georgia. Oriole 52:21-27.
Ruckdeschel, C., C.R. Shoop, and B. Winn. 1990. Brown pelican nesting in Georgia. Oriole 55:65-68.
Sallabanks, R. and F.C. James. 1999. American robin (Turdus migratorius). In A. Poole and F. Gill, eds., The Birds of North America, No. 462. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Samuel, D.E. 1971. The breeding biology of barn and cliff swallows in West Virginia. Wilson Bull. 83:284-301.
Sargent, R.A., J.C. Kilgo, B.R. Chapman and K.V. Miller. 1997. Nesting success of Kentucky and hooded warblers in a forested landscape. Wilson Bull. 109:233-238.
Sauer, J.R., J.E. Hines, G. Gough, I. Thomas, and B.G. Petterjohn. 1997. The North American Breeding Bird Survey Results and Analysis. Version 96.4. Patuxent Wildlife Research Center, Laurel, MD.
Savareno, A.J. 1991. Seasonal home ranges of the habitat use by eastern bluebirds. M.S. thesis, Clemson Univ., Clemson, SC.
Savareno, L.A. and T.M. Murphy. 1995. A review of nesting sites used by least terns in South Carolina. Chat 59:41-46.
Sayre, M.W. and W.D. Randle. 1984. Comparison of habitat use by migrant soras and Virginia rails. J. Wildl. Manage. 48:599-605.
Sayre, M.W., T.S. Baskett, and K.C. Sadler. 1980. Radio-telemetry studies of the mourning dove in Missouri. Missouri Terrestrial Ser. 9. Missouri Dept. Conserv., Jefferson City.
Scharf, W.C. and J. Kren. 1996. Orchard oriole (Icterus spurius). In A. Poole and F. Gill, eds., The Birds of North America, No. 255. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.

Schneider, T.M. 1999. Bachman's sparrow. Pages 32-33 in J.C. Ozier, et al., eds., Protected animals of Georgia. Georgia Dept. of Natural Res., Wildlife Res. Div., Social Circle, GA.
Schneider, T.M. 1999. Wilson's plover. Pages 38-39 in J.C. Ozier, et al., eds., Protected animals of Georgia. Georgia Dept. of Natural Res., Wildlife Res. Div., Social Circle, GA.
Senchak, S.S. 1991. Home ranges and habitat selection of red-shouldered hawks in central Maryland: evaluating telemetry triangulation errors. M.S. thesis, Virginia Polytechnic Institute and State Univ., Blacksburg, VA.
Sewell, J. 1996. From the field. Oriole 61: 85-92.
Shackelford, C.E. and R.N. Conner. 1997. Woodpecker abundance and habitat use in three forest types in eastern Texas. Wilson Bull. 109:614-629.
Shackleford, C.E., R.E. Brown, and R.N. Conner. 2000. Red-bellied woodpecker (Melanerpes carolinus). In A. Poole and F. Gill, eds., The Birds of North America, No. 500. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Shaffer, C.H. and J.V. Gwynn. 1967. Management of the eastern Turkey in oak-pine and pine forests of Virginia and the Southeast. Pages 303-342 in O. Hewitt, ed., The wild turkey and its management. The Wildlife Soc., Washington, DC.
Shanholtzer, G.F. 1972. Range expansion dynamics of the cattle egret. PhD. diss., Univ. Georgia, Athens.
Shealer, D. 1999. Sandwich tern (Sterna sandvicensis). In A. Poole and F. Gill, eds., The Birds of North America, No. 405. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Sherry, T.W. and R.T. Holmes. 1992. Population fluctuations in a long-distance neotropical migrant: demographic evidence for the importance of breeding season events in the American redstart. Pages 431-442 in J.M. Hagan III and D.W. Johnston, eds., Ecology and conservation of neotropical migrant landbirds. Smithsonian Inst. Press, Washington, D.C.
Sherry, T.W. and R.T. Holmes. 1997. American redstart (Setophaga ruticilla). In A. Poole and F. Gill, eds., The Birds of North America, No. 277. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Shy, E. 1984. Habitat shift and geographical variation in North American tanagers (Thraupinae: Piranga). Oecologica 63:281-285.
Skutch, A.F. 1996. Orioles, blackbirds, and their kin. The University of Arizona Press, Tucson. 291 p.
Smith, J.P. 1995. Foraging flights and habitat use of nesting wading birds (Ciconiiformes) at Lake Okeechobee, Florida. Colon. Waterbirds 18: 139-158.
Smith, T.M. and H.H. Shugart. 1987. Territory size variation in the Ovenbird: the role of habitat structure. Ecology 68:695-704.
Snyder, N.F.R. 1974. Can the Cooper's hawk survive? Natl. Geogr. 145:432-442.
Sparks, E.J., J.R. Belthoff and G. Ritchison. 1994. Habitat use by Eastern screech-owls in central Kentucky. J. Field Ornithol. 65:83-95.
Speich, J.M., H.L. Jones, and E.M. Benedict. 1986. Review of the natural nesting of the barn swallow in North America. Am. Midl. Nat. 115:248-254.
Spendelow, J.A. and S.R. Patton. 1988. National atlas of coastal waterbird colonies in the contiguous United States: 1976-1982. U.S. Fish Wildl. Serv. Biol. Rep. No. 88(5).
Stalmaster, M.V. 1987. The bald eagle. University Books, New York. 227 p.
Stalmaster, M.V. 1988. Bald eagle. Pages 187-237 in R.S. Palmer, ed., Handbook of North American birds, vol. 4. Yale Univ. Press, New Haven, CT.
Steele, B.B. 1992. Habitat selection by breeding Black-Throated Blue Warblers (Dendroica caerulescens) at two spatial scales. Ornis Scand. 23:33-42.
Stevenson, H.M. and B.H. Anderson. 1994. The birdlife of Florida. University of Florida Press, Gainesville. 892 p.
Stewart, R.E. 1949. Ecology of a nesting red-shouldered hawk population. Wilson Bull. 61:26-35.

Stewart, R.E. and C.S. Robbins. 1958. Birds of Maryland and the District of Columbia. Fish and Wildlife Serv., N. Am. Fauna No. 62.
Stinner, D.H. 1983. Colonial wading birds and nutrient cycling in the Okefenokee Swamp ecosystem. Ph.D. diss., Univ. Georgia, Athens.
Stoddard, H.L. 1963. Maintenance and increase of the eastern wild turkey on private lands of the coastal plain of the deep southeast. Tall Timbers Res. Stn. Bull. 3:1-49.
Straight, C.A. and R.J. Cooper. 2000. Chuck-will's-widow (Caprimulgus carolinensis). In A. Poole and F. Gill, eds., The Birds of North America, No. 499. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Strain, J.G. and R.L. Mumme. 1988. Effects of food supplementation, song playback, and temperature on vocal territorial behavior of Carolina wrens. Auk 105:11-16.
Straw, J.A., D.G. Krementz, M.W. Olinde, and G.F. Sepik. 1994. American woodcock. Pages 97-114 in T.C. Tacha and C.E. Braun, eds., Migratory Shore and Upland Game Bird Management in North America. Allen Press, Lawrence, KS.
Stupka, A. 1963. Notes on the birds of Great Smoky Mountains National Park. Univ. Tennessee Press, Knoxville. 242 p.
Suarez, A.V., K.S. Pfennig, and S.K. Robinson. 1997. Nesting success of a disturbance-dependent songbird on different kinds of edges. Conservation Biology 11:928-935.
Sweeney, J.M. and W.D. Dijak. 1985. Ovenbird habitat capability model for an oak-hickory forest. Proc. Annu. Conf. Southeast. Assoc. Fish Wildl. Agencies 39:430-438.
Tacha, T.C., S.A. Nesbitt, P.A. Vohs. 1992. Sandhill crane (Grus canadensis). In A. Poole, P. Stettenheim, and F. Gill, eds., The Birds of North America, No. 31. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Tarvin, K.A. and G.E. Woolfenden. 1999. Blue jay (Cyanocitta cristata). In A. Poole and F. Gill, eds., The Birds of North America, No. 469. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Taylor, B. 1998. Rails: A guide to the rails, crakes, gallinules and coots of the world. Yale University Press, New Haven, CT. 600 p.
Teal, J.M. 1965. Nesting success of egrets and herons in Georgia. Wilson Bull. 77:257-263.
Telfair, R.C. III. 1994. Cattle egret (Bubulcus ibis). In A. Poole and F. Gill, eds., The Birds of North America, No. 113. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Terres, J.K. 1980. The Audubon society encyclopedia of American birds. Alfred A. Knopf, New York.
Thompson, F.R. and E.K. Fritzell. 1989. Habitat use, home range, and survival of territorial male ruffed grouse. J. Wildl. Manage. 53:15-21.
Thompson, C.F. and V. Nolan. 1973. Population biology of the yellow-breasted chat in southern Indiana. Ecol. Monogr. 43:145-171.
Thompson, B.C., J.A. Jackson, J. Burger, L.A. Hill, E.M. Kirsch, and J.L. Atwood. 1997. Least tern (Sterna antillarum). In A. Poole and F. Gill, eds., The Birds of North America, No. 290. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Titus, K. and J.A. Mosher. 1981. Nest-site habitat selected by woodland hawks in the central Appalachians. Auk 98:270-281.
Tomkins, I.R. 1944. Wilson's plover in its summer home. Auk 61:259-269.
Tomkins, I.R. 1950. A Georgia breeding record of the black-necked stilt. Oriole 15:30-31.
Tomkins, I.R. 1954. Life history notes on the American oyster-catcher. Oriole 19:37-45.
Tomkins, I.R. 1965. The willets of Georgia and South Carolina. Wilson Bull. 77:151-167.
Tomlinson, R.E., D.D. Dolton, R.R. George, and R.E. Mirarchie. 1994. Mourning dove. Pages 5-26 in T.C. Tacha and C.E. Braun, eds., Migratory Shore and Upland Game Bird Management in North America. Allen Press, Lawrence, KS.

Truslow, F.K. 1958. Limpkin, the crying bird that haunts Florida swamps. Natl. Geog. 115:114-121.
Turner, A. 1989. A handbook to the swallows and martins of the world. Christopher Helm, London. 257 p.
Van Horn, M.A. And T.M. Donovan. 1994. Ovenbird (Seiurus aurocapillus). In A. Poole and F. Gill, eds., The Birds of North America, No. 88. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Vickery, P.D. 1996. Grasshopper sparrow (Ammodramus savannarum). In A. Poole and F. Gill, eds., The Birds of North America, No. 239. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Vickery, P.D., M.L. Hunter, and S.M. Melvin. 1994. Effects of habitat are on the distribution of grassland birds in Maine. Conservation Biology 8:1087-1097.
Villard, M.A., G. Merriam and B.A. Maurer. 1995. Dynamics of neotropical migratory birds in a fragmented temperate forest. Ecology 76:27-40.
Walkinshaw, L.H. 1941. The prothonotary warbler, a comparison of nesting conditions in Tennessee and Michigan. Wilson Bull. 53:3-21.
Walkinshaw, L.H. 1971. Studies of the Acadian flycatcher in Michigan. Bird-Banding 37:227-257.
Walkinshaw, L.H. 1979. Prothonotary warbler. Pages 156-160 in L. Griscom and A. Sprunt, Jr., eds., The warblers of America. Doubleday and Co., Garden City, NJ.
Watts, B.D. 1989. Nest-site characteristics of Yellow-crowned Night-herons in Virginia. Condor 91: 979-983.
Watts, B.D. 1995. Yellow-crowned night-heron (Nyctanassa violacea). In A. Poole and F. Gill, eds., The Birds of North America, No. 161. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Weeks, H.P., Jr. 1979. Nesting ecology of the eastern phoebe in southern Indiana. Wilson Bull. 91:441-454.
Weeks, H.E. 1994. Eastern phoebe (Sayornis phoebe). In A. Poole and F. Gill, eds., The Birds of North America, No. 94. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Weinberg, H.J. 1994. Impact of forest size and landscape urbanization on a neotropical migrant, the wood thrush. M.S. Thesis, Univ. of Delaware, Newark.
Weinberg, H.J. and R.R. Roth. Forest area and habitat quality for nesting wood thrushes. Auk 115:879-889.
Weller, M.W. 1961. Breeding biology of the least bittern. Wilson Bull. 73:11-35.
Wenny, D.G., R.L. Clawson, J. Faaborg, and S.L. Sheriff. 1993. Population density, habitat selection and minimum area requirements of three forest-interior warblers in central Missouri. Condor 95:968-979.
Werschkul, D.F. 1977. Changes in a southeastern heronry. Oriole 42:5-10.
Whitcomb, B.L., R.F. Whitcomb, and D. Bystrak. 1977. Long-term turnover and effects of selective logging on the avifauna of forest fragments. Am. Birds 31:17-23.
Wicker, a.M. and K.M. Endres. 1995. Relationship between waterfowl amd American coot abundance with submerged macrophytic vegetation in Currituck Sound, NC. Estuaries 18:428-431.
Wiens, J.A. 1969. An approach to the study of ecological relationships among grassland birds. Ornithol. Monogr. No. 8. Allen Press, Lawrence, KS.
Wiggers, E.D. and K.J. Kritz. 1991. Comparison of nesting habitat of coexisting sharp-shinned and Cooper's hawks. Wilson Bull. 100:256-271.
Wiggers, E.P., M.K. Laubhan, and D.A. Hamilton. 1992. Forest structure associated with ruffed grouse abundance. Forest Ecology and Management 49:211-218.
Wigley, T.B., J.M. Sweeney, M.E. Garner and M.A. Melchiores. 1986. Wild turkey home range in the Ouachita Mountains. J. Wildl. Manage. 50:540-544.
Wilcove, D.S. 1988. Changes in the avifauna of the Great Smoky Mountains: 1947-1983. Wilson Bull. 100: 256-271.
Williams, M.D. 1980. Notes on the breeding biology and behavior of the ravens of Peregrine Ridge, Great Smoky Mountains National Park, Tennessee. Migrant 51:77-80.

Williams, E.J. 1999. Swallow-tailed kite. Pages 44-45 in J.C. Ozier, et al., eds., Protected animals of Georgia. Georgia Dept. of Natural Res., Wildlife Res. Div., Social Circle, GA.
Williams, E.J. 1999. Peregrine falcon. Pages 46-47 in J.C. Ozier, et al., eds., Protected animals of Georgia. Georgia Dept. of Natural Res., Wildlife Res. Div., Social Circle, GA.
Williamson, P. 1971. Feeding ecology of the Red-eyed Vireo (Vireo olivaceous) and associated foliage-gleaning birds. Ecol. Monogr. 41:129-152.
Wilson, R.R. and R.J. Cooper. 1998. Breeding biology of Acadian flycatchers in a bottomland hardwood forest. Wilson Bull. 110: 226-232.
Winkler, H., D.A. Christie and D. Nurney. 1995. Woodpeckers: a guide to the woodpeckers, piculets and wrynecks of the world. Pica Press, East Sussex, U.K. 406 p.
Withgott, J.H. and K.G. Smith. 1998. Brown-headed nuthatch (Sitta pusilla). In A. Poole and F. Gill, eds., The Birds of North America, No. 349. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Witmer, M.C., D.J. Mountjoy, and L. Elliot. 1997. Cedar waxwing (Bombycilla cedrorum). In A. Poole and F. Gill, eds., The Birds of North America, No. 309. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Wolf, L. 1987. Host-parasite interactions of brown-headed cowbirds and dark-eyed juncos in Virginia. Wilson Bull. 99:338-350.
Yasukawa, K. and W.A. Searcy. 1995. Red-winged blackbird (Agelaius phoeniceus). In A. Poole and F. Gill, eds., The Birds of North America, No. 184. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Yosef, R. 1996. Loggerhead shrike (Lanius ludovicianus). In A. Poole and F. Gill, eds., The Birds of North America, No. 231. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, DC.
Yosef, R. and T.C. Grubb. 1993. Effect of vegetation height on hunting behavior and diet of loggerhead shrikes. Condor 95:127-131.
Young, D.P., Jr. 1987. Observations of grasshopper sparrows in Clarke County, Georgia. Oriole 52:49-50.

Mammals

Ables, E.D. 1969. Activity studies of red foxes in southern Wisconsin. J. Wildl. Manage. 33:145-153.
Ables, E.D. 1974. Ecology of the red fox in North America. Pages 148-163 in M.W. Fox, ed., The Wild Canids. Van Reinhold Co., New York. 508 p.
Adams, W.H., Jr. 1956. The nutria in coastal Louisiana. Proc. Louisiana Acad. Sci. 19:28-41.
Allen, D.L. 1943. Michigan fox squirrel management. Michigan Dept. Conserv., Game Div. Publ. 100. 404 p.
Allen, C.H., R.L. Marchinton, and W.M. Lentz. 1985. Movement, habitat use, and denning of opossums in the Georgia Piedmont. Am. Midl. Nat. 113:408-412.
Alt, G.L., et al. 1976. Home range and activity patterns of black bears in northeastern Pennsylvania. Trans. Northeast. Sect. Wildl. Soc. 33:45-56.
Ambrose, J., S. Bratton, K. Davison, L. Fitch, M. Goigel, F. Golley, J. McMurtry, W. Querin, and D. Simon. 1983. An analysis of feral horse population structure on Cumberland Island. CPSU-Technical Report 1. NPS Cooperative Unit, Univ. of Georgia. 12 p.
Andrle, J.B. 1981. Habitat use and relative abundance of the small mammals of a South Carolina barrier island. Brimleyana 5:129-134.
Atkeson, T.D. and A.S. Johnson. 1979. Succession of small mammals on pine plantations in the Georgia Piedmont. Am. Midl. Nat. 101:385-392.
Atwood, E.L. 1960. Life history studies of nutria, or coypu, in coastal Louisiana. J. Wildl. Manage. 14:249-265.

Bakken, A.A. 1952. Interrelationships of Sciurus carolinensis (Gmelin) and Sciurus niger (Linnaeus) in mixed populations. Ph.D. diss., Univ. Wisconsin, Madison. 188 p.
Barbour, R.W. and W.H. Davis. 1969. Bats of America. Univ. Kentucky Press, Lexington. 286 p.
Bat Conservation International. 2001. Http://www.batcon.org/, Bat Conservation International, Inc., Austin, TX.
Baumgartner, L.L. 1943. Fox squirrels in Ohio. J. Wildl. Manage. 7:193-202.
Beeman, L.E. and M.R. Pelton. 1976. Homing of black bears in the Great Smoky Mountains National Park. Pages 87-95 in Pelton et al., Bears: their biology and management. 3rd Int. Conf. Bear Res. And Manage. IUCN Publ. New Series no. 40.
Beer, J.R. 1950. Least weasel in Wisconsin. J. Mammal. 31:146-149.
Bekoff, M. 1977. Canis latrans. Mammalian Species No. 79. Am. Soc. Mammal., New York.
Bekoff, M. 1978. Coyotes: biology, behavior and management. Academic Press. New York. 384 p.
Bekoff, M. 1982. Coyote. Pages 447-459 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Bekoff, M. and M.C. Wells. 1980. Social ecology and behavior of coyotes. Sci. Am. No. 242:130-148.
Belwood, J.J. 1992. Southeastern big-eared bat. Pages 287-293 in S.R. Humphrey, ed., Rare and endangered biota of Florida, Vol. I: Mammals. Univ. of Florida Press, Gainesville.
Belwood, J.J. 1992. Southeastern brown bat. Pages 335-342 in S.R. Humphrey, ed., Rare and endangered biota of Florida, Vol. I: Mammals. Univ. of Florida Press, Gainesville.
Belwood, J.J. 1992. Brazilian free-tailed bat. Pages 357-368 in S.R. Humphrey, ed., Rare and endangered biota of Florida, Vol. I: Mammals. Univ. of Florida Press, Gainesville.
Bendel, P.R. and J.E. Gates. 1987. Home range and microhabitat partitioning of the Southern flying squirrel Glaucomys volans. Journal of Mammalogy 68:243-255
Beneski, J.T. and D.W. Stinson. 1987. Sorex Palustris. Mammalian Species No. 296. Am. Soc. Mammal., New York.
Berger, P.J. and N.C. Negus. 1981. Population dynamics of Rattus rattus and R. norvegicus in a riparian habitat. Journal of Mammalogy 63:151-154.
Bergstrom, B.J., T. Farley, H.L. Hill, Jr., and T. Hon. 2000. Ecology and conservation of a frontier population of the round-tailed muskrat (Neofiber alleni). Pages 74-82 in B.R. Chapman and J. Laerm, eds., Fourth colloquium on conservation of mammals in the Southeastern United States. Occasional Papers of the North Carolina State Museum of Natural Sciences, No. 12.
Besnady, C.D. 1057. Bushytail business. Wisconsin Conserv. Bull. 22:17-19.
Best, T.L. and J.B. Jennings. 1997. Myotis leibii. Mammalian Species No. 547. Am. Soc. Mammal., New York.
Best, T.L., S.D. Carey, K.G. Caesar, and T.H. Henry. 1992. Distribution and abundance of bats in the Coastal Plain caves of southern Alabama. NSS Bulletin 54:61-65.
Birkenholz, D.E. 1962. A study of the life history and ecology of the round-tailed muskrat (Neofiber alleni True) in north-central Florida. Ecol. Monogr. 33:255-280.
Birkenholz, D.E. 1972. Neofiber alleni. Mammalian Species No. 15. Am. Soc. Mammal., New York.
Blumenthal, E.M. and G.L. Kirkland, Jr. 1976. The biology of the opossum, Didelphis virginiana, in Southcentral Pennsylvania. Proc. Pennsylvania Acad. Sci. 50:81-85.
Blymyer, M.J. 1976. A new elevation record for the New England cottontail (Sylvilagus transitionalis) in Virginia. Chesapeake Sci. 17:197-207.
Brack, V. 1984. The foraging ecology of some bats in Indiana. Proceedings Indiana Academy of Sci. 94:231-237.
Breidling, F.E., F.P. Day, and R.K. Rose. 1983. An evaluation of small rodents in four Dismal Swamp plant communities. Virginia J. of Sci. 34:14-28.
Brody, A.J. and M.R. Pelton. 1989. Effects of roads on black bear movement in western North Carolina. Wildlife Soc. Bull. 17:5-10.
Brown, L.N. 1993. Presence of the southern bog lemming (Synaptomys cooperi) and hairy-tailed mole (Parasclops breweri) in Georgia. Georgia J. of Sci. 51:112.

Brown, L.N. 1997. A guide to the mammals of the southeastern United States. Univ. of Tennessee Press, Knoxville. 236 p.
Bunch, M.S. and A.S. Dye. 1999. Bat, woodrat and New England cottontail survey and technical guidance. Unpublished report, South Carolina Department of Natural Resources.
Burt, W.H. and R.P. Grossenheider. 1980. A field guide to the mammals of North America north of Mexico. Houghton Mifflin, Boston. 289 p.
Burt, J.L. and J.B. Jennings. 1997. Myotis leibii. Mammalian Species No. 547. Am. Soc. Mammal., New York.
Cameron, G.N. and Pencer, S.R. 1981. Sigmodon hispidus. Mammalian Species No. 158. Am. Soc. Mammal., New York.
Carlock, D., J. Ezell, G. Balckcom, W. Abler, P. Dupree, and D. Forster. 1999. Black bear management plan for Georgia. Georiga Department of Nat. Res., Wildl. Res. Div., Social Circle, GA. 24 p.
Chabreck, R.H., et al. 1981. Foods and feeding habits of nutria in brackish marsh in Louisiana. Pages 531-543 in J.A. Chapman and D. Pursley, eds., Worldwide furbearer conference procedings, Vol. 1. Worldwide Furbearer Conf., Inc., Frostburg, MD.
Chapman, J.A. 1975. Sylvilagus transitionalis. Mammalian Species No. 55. Am. Soc. Mammal., New York.
Chapman, J.A. and G.A. Feldhammer. 1981. Sylvilagus aquaticus. Mammalian Species No. 151. Am. Soc. Mammal., New York.
Chapman, J.A. and R.P. Morgan. 1973. Systematic status of the cottontail complex in western Maryland and nearby West Virginia. Wildl. Monogr. 36:1-54.
Chapman, J.A. and J.R. Stauffer. 1981. The status and distribution of the New England cottontail. Pages 973-983 in K. Meyers and D.D. MacInnes, eds., Proc. of the world Lagomorph conference, Univ. Guelph, Ontario.
Chapman, J.A. and G.R. Wilner. 1981. Sylvilagus palustris. Mammalian Species No. 153. Am. Soc. Mammal., New York.
Chapman, J.A. et al. 1982. Cottontails. Pages 83-123 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Chapman, J.A., J.G. Hockman and M.M. Ojeda.. 1980. Sylvilagus floridanus. Mammalian Species No. 136. Am. Soc. Mammal., New York.
Chesemore, D.L. 1975. Ecology of fox and gray squirrels (Sciurus niger and Sciurus carolinensis) in Oklahoma. Ph.D. diss. Oklahoma State Univ., Stillwater. 370 p.
Clark, J.D., J.E. Dunn, and K.G. Smith. 1993. A multivariate method of female black bear habitat use for a geographic system. J. Wildl. Manage. 57:519-526.
Cordes, C.L. and F.S. Barkalow, Jr. 1973. Home range and dispersal in a North Carolina gray squirrel population. Proc. Annual Conf. Southeastern Assoc. Fish Game Comm. 26:124-135.
Cothran, E.G., M.H. Smith, J.D. Woldd, and J.B. Gentry. 1991. Mammals of the Savannah River Site. National Environmental Research Park Program, Aiken, SC.
Cox, J., R. Kautz, M. MacLaughlin, and T. Gilbert. 1994. Closing the gaps in Florida's wildlife habitat conservation system. Florida Game and Freshwater Fish Commission, Tallahassee, FL.
Crabb, W.D. 1948. The ecology and management of the prairie spotted skunk in Iowa. Ecol. Monogr. 18:201-232.
Cunningham, E.R. 1962. A study of the eastern raccoon Procyon lotor (L.) on the Atomic Energy Commission Savannah River Plant. M.S. thesis. Univ. Georgia. 55 p.
Dalke, P.D. 1937. A preliminary report of the New England cottontail studies. Trans. North Am. Wildl. Conf. 2:542-548.
Davis, W.B. 1942. The moles of Texas. Am. Midl. Nat. 27:380-386.
Davis, W.B. 1945. Texas skunks. Texas Game and Fish 3:8-11, 25-26.
Davis, D.E. 1953. The characteristics of rat populations. Q. Rev. Bio. 28:373-401.
Davis, D.E. 1953. Analysis of home range from recapture data. J. Mammal. 34:352-358.

Davis, D.W. 1969. The behavior and population dynamics of the red squirrel, Tamiasciurus hudsonicus, in Saskatchewan. Ph.D. diss. Univ. of Arkansas, Fayetteville. 222 p.
Davis, R.B., et al. 1962. Mexican free-tailed bats in Texas. Ecol. Monogr. No. 32:311-346.
Decher, J. and J.R. Choate. 1995. Myotis griescens. Mammalin Species No. 510. Am. Soc. Mammal., New York.
Doebel, J.H., and B.S. McGinnes. 1974. Home range and activity of a gray squirrel population. J. Wildl. Manage. 38:860-867.
Dolan, P.G. and D.C. Carter. 1977. Glaucomys volans. Mammalian Species No. 78. Am. Soc. Mammal, New York.
Donohoe, R.W. and R.O. Beal. 1972. Squirrel behavior as determined by radiotelemetry. Ohio Dept. Nat. Res. Fish Wildl. Rep. 2. 20 p.
Dozier, H.L. and H.E. Hall. 1944. Observations on the Bryant fox squirrel. Maryland Conserv. 21:2-7.
Ecke, D.H. 1954. An invasion of Norway rats in southwest Georgia. J. Mammal. 35:521-525.
Elliott, M.J. 2001. Green salamander surveys, Chattahoochee National Forest, Fall 2001. Unpublished report to U.S. Forest Service.
Errington, P.L. 1963. The decline of a muskrat population. J. Wildlife Manage. 27:1-8.
Faust, B.F., M.H. Smith, and W.B. Wray. 1971. Distances moved by small mammals as an apparent function of grid size. Acta Theriologica 16:161-177.
Fenton, M.B. and R.M. Barclay. 1980. Myotis Lucifugus. Mmmalian Species No. 142. Am. Soc. Mammal., New York.
Fisher, J. 1975. The plains dog moves east. Nat. Wildl. 13:14-16.
Fitch, J.H. and K.A. Shump. 1979. Myotis keenii. Mammalian Species No. 121. Am.Soc. Mammal., New York.
Fitch, H.S., et al. 1952. The armadillo in the southeastern United States. J. Mammal. 33:21-37.
Flyger, V. 1960. Movements and home range of the gray squirrel, Sciurus carolinensis, in two Maryland woodlots. Ecology 41:365-369.
Flyger, V. and J.E. Gates. 1982. Fox and gray squirrels. Pages 209-229 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Flyter, V. and J.E. Gates. 1982. Pine squirrels. Pages 230-238 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Follman, E.H. 1973. Comparative ecology and behavior of red and gray foxes. Ph.D. diss. Southern Illinois Univ, Carbondale.
Ford, W.M., J. Laerm, D.C. Weinand, and K.G. Barker. 1994. Abundance and distribution of shrews and other small mammals in the Chattahoochee National Forest of Georgia. Proc. Ann. Conf. SE Fish and Wildl. Agencies 48:310-320.
Forys, E. 1995. Metapopulations of marsh rabbits: a population viability analysis for the Lower Keys marsh rabbit. Unpublished paper. University of Florida, Gainesville.
French, T.W. 1980. Sorex Longirostris. Mammalian Species No. 143. Am. Soc. Mammal., New York.
French, T.W. 1980. Natural history of the southeastern shrew, Sorex longirostris. Am. Midl. Nat. 104:13-31.
Fritzell, E.K. and K.J. Haroldson. 1982. Urocyon cinereoargenteus. Mammalian Species No. 189. Am. Soc. Mammal., New York.
Fujita, M.S. and T.H. Kunz. 1984. Pipistrellus subflavus. Mammalian Species No. 228. Am. Soc. Mammal., New York.
Fuller, T.K. 1978. Variable home-range sizes of female gray foxes. J. Mammal. 59:446-449.
Galbreath, G.J. 1982. Armadillo. Pp. 71-79 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Gardner, A.L. 1982. Virginia Oppossum. Pp 3-36 in J.A. Chapman and G.A. Feldhamer, eds., in Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Garshelis, D.L. 1978. Movement, ecology and activity behavior of black bears in the Great Smoky Mountains National Park. M.S. thesis. Univ. Tennessee, Knoxville.

Garshelis, D.L. and M.R. Pelton. 1980. Activity of black bears in the Great Smoky Mountains National Park. J. Mammal. 61:8-19.
Gentry, J.B., F.B. Golley, and M.H. Smith. 1971. Yearly fluctuations in small mammal populations in a southeastern United States hardwood forest. Acta Theriologica 15:179-190.
George S.B., J.R. Choate, and Genoways. 1986. Blarina brevicauda. Mammalian Species No. 261. Am. Soc. Mammal., New York.
Getz, L.L. 1961. Factors influencing the local distribution of shrews. Am. Midl. Nat. 65:67-88.
Gipson, P.S., and J.A. Sealander. 1972. Home range and activity of the coyote (Canis latrans frustror) in Arkansas. Proc. Annu. Conf. Southeast. Assoc. Fish and Game Comm. 26:82-95.
Godin, A.J. 1982. Striped and hooded skunks. Pp. 674-687 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Golley, F.B. 1962. Mammals of Georgia: a study of their distribution and functional role in the ecosystem. University of Georgia Press, Athens, GA.
Gore, J.A. 1992. Gray bat. Pages 63-70 in S.R. Humphrey, ed., Rare and endangered biota of Florida, Vol. I: Mammals. Univ. of Florida Press, Gainesville.
Gore, J.A. 1992. Big brown bat. Pages 343-348 in S.R. Humphrey, ed., Rare and endangered biota of Florida, Vol. I: Mammals. Univ. of Florida Press, Gainesville.
Graves, H.B. and K.L. Graves. 1977. Some observations of biobehavioral adaptations of swine. Pages 102-110 in G.W. Wood, ed., Research and management of wild hog populations: procedings of a symposium. Belle W. Baruch For. Sci. Inst., Clemson Univ., S.C.
Grizzell, R.A., Jr. 1955. A study of the southern woodchuck, Marmota monax monax. Am. Midl. Nat. 53:257-293.
Hall, R. 1972. Wild horse biology and alternatives for management, Pryor Mountain wild horse range. Bur. Land Manage., Billings Dist. 67 p.
Hall, H.T. and J.D. Newsome. 1976. Summer home ranges and movements of bobcats in bottomland hardwoods of southern Louisiana. Proc. Annu. Conf. Southeast Assoc. Fish Wildl. Agencies 30:427-436.
Hallet, J.G. 1978. Parasclops breweri. Mammalian Species No. 98. Am. Soc. Mammal., New York.
Hamilton, R.J. 1978. Ecology of the black bear in southeastern North Carolina. M.S. Thesis. Univ. Georgia, Athens.
Hanson, R.P. and L. Karstad. 1959. Feral swine in the southeastern United States. J. Wildl. Manage. 23:64-74.
Harris, S. 1977. Distribution, habitat utilization and age structure of a suburban fox (V. vulpes) population. Mammal. Rev. 7:25-29.
Harris, V.T. and F. Webert. 1962. Nutria feeding activity and its effect on marsh vegetation in southwestern Louisiana. Spec. Sci. Rep. Wildl. 64:1-53.
Hart, J.A., G.L. Kirkland, and S.C. Grossman. 1993. Relative abundance and habitat use by tree bats, Lasiurus spp., in southcentral Pennsylvania. Can. Field-Nat. 107:208-212.
Harvey, M.J. 1976. Home range, movements and diel activity of the eastern mole, Scalopus aquaticus. Am. Midl. Nat. 95:436-445.
Hayes, J.P. and R.G. Harrison. 1992. Variation in mitochondrial DNA and the biogeographic history of woodrats (Neotoma) of the Eastern United States. Syst. Biol. 41:331-344.
Hay-Smith, L. 1995. Neotoma floridana floridana: Natural history, ecology, and movements in north-central Florida. Bull. of the Fla. Mus. of Nat. History. 38:211-244.
Hellegren, E.C. and M.R. Vaughan. 1990. Range dynamics of black bears in Great Dismal Swamp, Virginia-North Carolina. Proc. Annual Conf. Southeast. Assoc. Fish and Wildl. Agencies 44:268-278.
Hesselton, W.T. and R.M. Hesselton. 1982. Pages 878-901 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Hill, E. P. 1982. Beaver. Pages 256-281 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.

Hoffmann, C.O., and J.L. Gottschang. 1977. Numbers, distribution and movements of a raccoon population in a suburban residential community. J. Mammal. 58:623-636.
Holler, N.R. and C.H. Conaway. 1979. Reproduction of the marsh rabbit (Sylvilagus palustris) in south Florida. J. Mammal. 60:769-777.
Holzman, S., M.J. Conroy, and J. Pickering. 1992. Home range, movements, and habitat use of coyotes in southcentral Georgia. Journal of Wildl. Manage. 56:139-146.
Hougart, B. 1975. Activity patterns of radio-tracked gray squirrels. M.S. Thesis. Univ. Maryland, College Park.
Howard, W.E. and R.E. Marsh. 1982. Spotted and hog-nosed skunks. Pages 664-673 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Howell, J.C. 1954. Populations and home ranges of small mammals on an overgrown field. Journal of Mammalogy 35:177-186.
Humphrey, S.R. 1974. Zoogeography of the nine-banded armadillo (Dasypus novemcinctus) in the United States. BioScience 24:457-462.
Humphrey, S.R. 1978. Status, winter habitat, and management of the endangered Indiana bat, Myotis sodalis. Florida Sci 41:65-76.
Humphrey, S.R. Bats. Pages 52-70 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Humphrey, S.R. 1992. Indiana bat. Pages 54-62 in S.R. Humphrey, ed., Rare and endangered biota of Florida, Vol. I: Mammals. Univ. of Florida Press, Gainesville.
Humphrey, S. R. and J.B. Cope. 1976. Population ecology of the little brown bat, Myotis lucifugus, in Indiana and north-central Kentucky. Am. Soc. Mamm. Spec. Publ. 4:1-81.
Humphrey, S.R. et al. 1977. Summer habitat and ecology of the endangered Indiana bat, Myotis sodalis. J. Mammal. 58:334-346.
Jackson, H.H.T. 1961. Mammals of Wisconsin. Univ. Wisconsin Press, Madison. 504 p.
Jackson, W.B. 1982. Norway Rat and Allies. Pages 1077-1098 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Janes, D.W. 1959. Home range and movements of the eastern cottontail in Kansas. Univ. Kansas Publ., Mus. Nat. Hist. 10:553-572.
Jenkins, J.H. 1971. The status and management of the bobcat and cougar in the southeastern states. Pages 87-91 in S.E. Jorgensen and L.D. Mech, eds., Proc. of the symposium on native cats of North America. U.S. Fish and Wildl. Serv., Twin Cities, MN.
Jenkins, S.H. and P.E. Busher. 1979. Castor canadensis. Mammalian Species No. 120. Am. Soc. Mammal., New York.
Johnson, M.L. and S. Johnson. 1982. Voles. Pages 326-354 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Jones, C. 1977. Plecotus rafinesquii. Mammalian Species No. 69. Am.Soc. Mammal., New York.
Jones, C. and R.W. Maning. 1989. Myotis austroriparius. Mammalisn Species No. 332. Am. Soc. Mammal., New York.
Kaufmann, J.H. 1982. Raccoon and allies. Pages 567-585 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Kern, W.H. 1992. Northern yellow bat. Pages 349-356 in Rare and endangered biota of Florida, Vol. I: Mammals (S.R. Humphrey, ed.). Gainesville, Univ. of Florida Press.
Kight, J. 1962. An ecological study of the bobcat (Lynx rufus Schreber) in west-central South Carolina. M.S. thesis, Univ. Georgia, Athens.
King, C.M. 1975. The home range of the weasel (Mustela nivalis) in an English woodland. J. Animal Ecol. 44:639-668.
King, K.J. 1982. The effects of prescribed burning and thinning in natural Piedmont loblolly-shortleaf pine stands on small mammal populations. M.S. thesis, Univ. Georgia, Athens.

Kinlaw, A. 1995. Spilogale putorius. Mammalian Species No. 511. Am. Soc. Mammal., New York.
Kirkland, G.L., Jr. 1981. Sorex dispar and Sorex gaspensis. Mammalian Species No. 155. Am. Soc. Mammal., New York.
Komarek, E.V., and Komarek, R. 1938. Mammals of the Great Smoky Mountains. Bull. Chicago Acad. Sci. 3:137-162.
Koprowski, J.L. 1994. Sciurus niger. Mammalian Species No. 479. Am. Soc. Mammal., New York.
Koprowski, J.L. 1994. Sciurus carolinensis. Mammalian Species No. 480. Am. Soc. Mammal., New York.
Kunz, T.H. 1982. Lasionycteris noctivigans. Mammalisn Species No. 172. Am. Soc. Mammal., New York.
Kurta, A. and R.H. Baker. 1990. Eptesicus fuscus. Mammalisn Species No. 356. Am. Soc. Mammal., New York.
Kurz, J.C. and R.L. Marchinton. 1972. Radiotelemetry studies of feral hogs in South Carolina. J. Wild. Manage. 36:1240-1248.
Kwiecinski, G.C. 1998. Marmota monax. Mammalian Species No. 591. Am. Soc. Mammal., New York.
Lackey, J.L., D.G. Huckaby and B.G. Ormiston. 1985. Peromyscus leucopus. Mammalian Species No. 247. Am. Soc. Mammal., New York.
Laerm, J. 1992. Georgia's rarest mammal. Georgia Wildlife 2:46-53.
Laerm, J., G. Livingston, C. Spencer, and B. Stuart. 1997. Condylura cristata in the Blue Ridge province of western South Carolina. Brimleyana 24:46-49.
Laerm, J. and J.L. Boone. 1995. Corrections of records of occurrence of Peromyscus polionotus and P. gossypinus in the Blue Ridge province of Georgia. Brimleyana 22:9-14.
Laerm, J., E. Brown, M.A. Menzel, A. Wotjalik, W.M. Ford, and M. Strayer. 1995. The masked shrew, Sorex cinereus, and red-backed vole, Clethrionomys gapperi, in the Blue Ridge province of South Carolina. Brimleyana 22:15-21.
Laerm, J., C.H. Wharton, and W.M. Ford. 1995. First record of the water shrew, Sorex palustris, in Georgia, with comments on its distribution and status in the southern Appalachians. Brimleyana 22:47-51.
Laerm, J., C.H. Wharton, and W.M. Ford. 1997. The rock shrew, Sorex dispar, in Georgia, with comments on its conservation status in the southern Appalachians. Brimleyana 24:1-5.
Lariviere, S. and M. Pasitschniak-Arts. 1996. Vulpes vulpes. Mammalian Species No. 537. Am. Soc. Mammal., New York.
Lariviere, S. and L.R. Walton. 1997. Lynx rufus. Mammalian Species No. 563. Am. Soc. Mammal., New York.
Lariviere, S. and L.R. Walton. 1998. Lontra canadensis. Mammalian Species No. 587. Am. Soc. Mammal., New York.
Lauhachinda, V. 1978. Life h istory of the river otter in Alabama with emphasis on food habits. Ph.D. diss. Auburn Univ., Auburn, AL.
LaVal, R.K., et al. 1977. Foraging behavior and nocturnal activity patterns of Missouri bats, with emphasis on the endangered species, Myotis grisescens and Myotis sodalis. J. Mammal. 58:592-599.
LaVal, R.K. 1973. Observations on the biology of Tadarida brasiliensis cynocephala in southeastern Louisiana. Am. Midl. Nat. 89:112-120.
LaVal, R.K. and M.K. Laval. 1979. Notes on reproduction, behavior and abundance of the red bat, Lasiurus borealis. J. Mammal. 60:209-212.
Lay, D.W. 1942. Ecology of the oppossum in eastern Texas. J. Mammal. 23:147-159.
Layne, J.N. and D. Glover. 1977. Home range of the armadillo in Florida. J. Mammal. 58:411-413.
Lee, D.S., J.B. Funderburg, and M.K. Clark. 1982. A distributional survey of North Carolina mammals. North Carolina Biological Survey, Raleigh.
Lenarz, M. 1983. Population size, movements, habitat preferences, and diet of the feral horses of Cumberland Island National Seashore. CPSU-Technical Report 3. NPS Cooperative Unit, Univ. of Georgia, Athens.
Linscombe, G., N. Kinler and R.J. Aulerich. 1982. Mink. Pages 629-643 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.

Linzey, A.V. and D.W. Linzey. 1971. Mammals of the Great Smoky Mountains National Park. University of Tennessee Press, Knoxville.
Linzey, D.W. and R.L. Packard. 1977. Ochrotomys nuttali. Mammalian Species No. 75. Am. Soc. Mammal., New York.
Litvaitis, J. A., J. A. Sherburne, and J. A. Bissonette. 1986. Bobcat habitat use and home range size in relation to prey density. J. Wildl. Manage. 50:110-117.
Llewellyn, L.M. and F.H. Dale. 1964. Notes on the ecology of the oppossum in Maryland. J. Mammal. 45:113-122.
Long, C.A. 1974. Microsorex hoyi and Microsorex thompsoni. Mammalian Species No. 33. Am.Soc. Mammal., New York.
Lord, R.D. 1961. A population study of the gray fox. Am. Midl. Nat. 66:87-109.
Lotze, J. and S. Anderson. 1979. Procyon lotor. Mammalian Species No. 119. Am. Soc. Mammal., New York.
Lowe, C.E. 1958. Ecology of the swamp rabbit in Georgia. J. Mammal. 39:116-127.
Lowery, G.H., Jr. 1974. The mammals of Louisiana and its adjacent waters. Louisiana State Univ. Press. Baton Rouge. 565 p.
Marshall, A.D., and J.H. Jenkins. 1966. Movements and home ranges of bobcats as determined by radio-tracking in the upper coastal plain of west-central South Carolina. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 20:206-214.
Mcbee, K. and R.J. Baker. 1982. Dasypus novemcinctus. Mammalian Species No. 162. Am. Soc. Mammal., New York.
McCord, C.M. 1974. Selection of winter habitat by bobcats (Lynx rufus) on the Quabbin Reservation, Massachusetts. J. Mammal. 55:428-437.
McCord, C.M. and J.E. Cardoza. 1982. Bobcat and lynx. Pages 728-766 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
McDaniel, J.C. 1963. Otter population study. Proc. Southeast. Assoc. Fish Game Comm. 17:163-168.
McManus, J.J. 1974. Didelphis virginiana. Mammalian Species No. 40. Am. Soc. Mammal., New York.
Menzel, M.A., J.C. Carter, B.R. Chapman, and J. Laerm. 1998. Quantitative comparison of tree roosts used by red bats (Lasiurus borealis) and Seminole bats (L. seminolus). Canadian J. of Zool. 76:630-634.
Menzel, M.A., W.M. Ford, J. Laerm, and D. Krishon. 1999. Forest to wildlife opening: habitat gradient analysis among small mammals in the southern Appalachians. Forest Ecol. and Manage. 114:227-232.
Menzel, M.A., B.R. Chapman, W.M. Ford, J.M. Menzel, and J. Laerm. 2000. A review of the distribution and roosting ecology of bats in Georgia. Georgia J. of Sci. 58:143-178.
Merritt, J.F. 1981 Clethrionomys gapperi. Mammalian Species No. 146. Am. Soc. Mammal., New York.
Miller, H.A. 1961. Page 1 in K. Halls and R..H. Ripley, eds., Deer browse plants of southern forests. Southern and Southeastern For. Exp. Stns., U.S. Forest Service.
Miller, S.D. 1980. The ecology of the bobcat in southern Alabama. Ph.D. Diss. Auburn Univ., Auburn, AL.
Miller, S.D. and D.W. Speake. 1978. Prey utilization by bobcats on quail plantations in south Alabama. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 32:100-111.
Miller, S.D. and D.W. Speake. 1978. Status of the bobcat: an endangered species? Pages 145-153 in R. Odom and L. Landers, eds., Proc. Rare and Endangered Wildl. Symp., Athens, GA.
Mills, R.S. et al. 1975. Population dynamics of the big brown bat (Eptesicus fuscus) in southwestern Ohio. J. Mammal. 56:591-604.
Mitchell, M.S., K.S. Karriker, E.J. Jones, and R.A. Lancia. 1995. Small mammal communities associated with pine plantation management of pocosins. Journal Wildl. Manage. 59:875-881.
Moore, J.C. 1949. Notes on the shrew, sorex cinereus, in the southern Appalachians. Ecology 30:234-237.
Mowbray, E.E., J.A.Chapman and J.R. Goldsberry. 1976. Preliminary observations on otter distribution and habitat preferences in Maryland with descriptions of other field sign. Northeast Fish Wildl. Conf. 33:125-131.
Mumford, R.E. 1969. Distribution of mammals of Indiana. Indiana Acad. Sci., Indianapolis. 114 p.

Mykatka, J.M. and M.R. Pelton. 1990. Management strategies for Florida black bears based on home range habitat composition. International Conf. Bear Res. and Manage. 8:161-167.
Odum, E.P. 1949. Small mammals of the Highlands (North Carolina) Plateau. J. Mammal. 30:179-192.
Owen, J.G. 1984. Sorex fumeus. Mammalisn Species No. 215. Am. Soc. Mammal., New York.
Ozier, J.C. 1999. Rafinesque's big-eared bat. Pages 11-12 in J.C. Ozier, et al., eds., Protected animals of Georgia. Georgia Dept. of Natural Res., Wildlife Res. Div., Social Circle, GA.
Ozier, J.C. 1999. Gray bat. Pages 21-22 in J.C. Ozier, et al., eds., Protected animals of Georgia. Georgia Dept. of Natural Res., Wildlife Res. Div., Social Circle, GA.
Ozier, J.C. 1999. Indiana bat. Pages 23-24 in J.C. Ozier, et al., eds., Protected animals of Georgia. Georgia Dept. of Natural Res., Wildlife Res. Div., Social Circle, GA.
Ozier, J.C. 1999. Round-tailed muskrat. Pages 25-26 in J.C. Ozier, et al., eds., Protected animals of Georgia. Georgia Dept. of Natural Res., Wildlife Res. Div., Social Circle, GA.
Ozier, J.C. 1999. Appalachian cottontail. Pages 27-28 in J.C. Ozier, et al., eds., Protected animals of Georgia. Georgia Dept. of Natural Res., Wildlife Res. Div., Social Circle, GA.
Pagels, J.F. 1987. The pygmy shrew, rock shrew and water shrew: Virginia's rarest shrews. Virginia J. of Sci. 38:364-368.
Palmisano, A.W., Jr. 1972. The distribution and abundance of muskrats (Ondatra zibethicus) in relation to vegetative types in Louisiana coastal marshes. Proc. Southeast. Assoc. Game and Fish Comm. 26:160-177.
Palmisano. A.W. 1972. Habitat preference of waterfowl and fur animals in the northern gulf coast marshes. Proc. Coastal Marsh and Estuary Manage. Symp. 2:163-190.
Pelton, M.R. 1982. Black Bear. Pages 504-514 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Pembleton, E.F. and S.L. Williams. 1978. Geomys pinetis. Mammalian Species No. 86. Am. Soc. Mammal., New York.
Perry, H.R., Jr. 1982. Muskrats. Pages 282-325 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Peterson, K.E. and T.L. Yates. 1980. Condylura cristata. Mammalian Species No. 129. Am.Soc. Mammal., New York.
Poole, E.L. 1940. A life history sketch of the Allegheny woodrat. J. Mammal. 21:249-270.
Reed, A.W. and M.L. Kennedy. 2000. Conservation status of the Eastern spotted skunk Spilogale putorius in the Appalachian mountains of Tennessee. Am. Midl. Nat. 144:133-138.
Reich, L.M. 1981. Microtus pennsylvanicus. Mammalian Species No. 159. Am. Soc. Mammal., New York.
Rust, C.C. 1966. Notes on the star-nosed mole (Condylura cristata). J. Mammal. 47:538.
Robicheaux, B.L. 1978. Ecological implications of variably spaced ditches on nutria in a brackish marsh, Rockefeller Refuge, Louisiana. M.S. thesis. Louisiana Tech. Univ., Ruston, LA.
Robinson, S.S. and D. S. Lee. 1980. Recent range expansion of the woodchuck, Marmota monax, on the Southeast. Brimleyana 3:43-48.
Rudis, V.A. and J.B. Tansey. 1995. Regional assessment of remote forests and black bear habitat from forest resource surveys. J. Wildl. Manage. 59:170-180.
Russell, C.R. and I.M. Russell. 1999. Microhabitat selection by small mammals in a southern Appalachian fen in the USA. Wetlands Ecology and Management 7:219-224.
Ryden, H. 1970. America's last wild horses. Dutton, New York. 311 p.p.
Slaughter, B.H. 1961. The significance of Dasypus bellus in Pleistocene local faunas. Texas J. Sci. 13:311-315.
Samuel, D.E. and B.B. Nelson. 1982. Foxes. Pages 475-490 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Schowalter, D.B. et al. 1979. Life history characteristics of little brown bats (Myotis lucifigus). Alberta. Can. Field. Nat. 93:243-251.

Schwartz, A. and E.P. Odum. 1957. The woodrars of the eastern United States. J. Mammal. 38:197-206.
Schwartz, C.W., E.R. Schwartz. 1981. The Wild mammals of Missouri (2nd Ed.). Univ. of Missouri Press and Missouri Conserv. Dept., Columbia, MO. 356 p.
Shadowen, H. E. 1963. A live trap study of small mammals in Louisiana. Journal Mammal. 44:103-108.
Sheffield, S.R. and C.M. King. 1994. Mustela nivalis. Mammalian Species No. 454. Am. Soc. Mammal., New York.
Sheffield, S.R. and H.H. Thomas. 1997. Mustela frenata. Mammalian Species No. 570. Am. Soc. Mammal., New York.
Shirley, M.G., et al., 1981. Foods of nutria in fresh marshes of southeastern Louisiana. Pages 517-530 in J.A. Chapman and D. Pursley, eds., Worldwide furbearer conference procedings, Vol. 1. Worldwide Furbearer Conf., Inc., Frostburg, MD.
Shump, K.A. and A.U. Shump. 1982. Lasiurus borealis. Mammalian Species No. 183. Am. Soc. Mammal., New York.
Shump, K.A. and A.U. Shump. 1982. Lasiurus cinereus. Mammalian Species No. 185. Am. Soc. Mammal., New York.
Slade, L.M. and E.B. Godfrey. 1982. Wild horses. Pages 1089-1098 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Smith, C.C. 1965. Interspecific competition in the genus of tree squirrels, Tamiasciurus. Ph.D. diss. Univ. Washington, Seattle.
Smith, W.P. 1991. Odocoileus virginianus. Mammalian Species No. 388. Am. Soc. Mammal., New York.
Smith, M. H., B. J. Boize, and J. B. Gentry. 1973. Validity of the center of activity concept. Journal of Mammology 54:747-749.
Smolen, M.J. 1981. Microtus pinetorum. Mammalian Species No. 147. Am. Soc. Mammal., New York
Snyder, D.P. 1982. Tamias striatus. Mammalian Species No. 168. Am. Soc. Mammal., New York.
Stalling, D.T. 1997. Reithrodontomys humulis. Mammalian Species No. 565. Am. Soc. Mammal., New York.
Steele, M.A. 1998. Tamiasciurus hudsonicus. Mammalian Species No. 586. Am. Soc. Mammal., New York.
Stone, K.A., G.A. Heidt, P.J. Caster, and M.L. Kennedy. 1997. Using geographic information systems to determine home range of the southern flying squirrel. Am. Midl. Nat. 137:106-111.
Storm, G.L. 1965. Movements and activities of foxes as determined by radio tracking. J. Wildl. Manage. 29:1-12.
Storm, G.L. 1972. Daytime retreats and movements of skunks on farmlands in Illinois. J. Wildl. Manage. 36:31-45.
Stuewer, F.W. 1943. Raccoons: their habits and management in Michigan. Ecol. Monogr. 13:203-257.
Sunquist, M.E. 1989. Comparison of spatial and temporal activity of red foxes and gray foxes in north central Florida. Florida Field Nat. 17:11-18.
Svendsen, G.E. 1982. Weasels. Pages 613-628 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Sweeney, J.M. 1970. Preliminary investigations of a feral hog (Sus scrofa) population on the Savannah River Plant, South Carolina. M.S. thesis. Univ. Georgia, Athens.
Sweeney, J.M. and J.R. Sweeney. 1982. Feral Hog. Pages 1099-1113 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Terrell, T.L. 1972. The swamp rabbit (Sylvilagus aquaticus) in Indiana. Am. Midl. Nat. 87:283-295.
Thompson, C.E. 1982. Myotis sodalis. Mammalian Species No. 163. Am.Soc. Mammal., New York.
Toll, J.E., et al. 1960. Home range, reproduction, and foods of the swamp rabbit in Missouri. Am. Midl. Nat. 63:398-412.
Toweill, D.E. and J.E. Tabor. 1982. River Otter. Pp. 688-703 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Trapp, G.R. and D.L. Hallberg. 1975. Ecology of the gray fox (Urocyon cinereoargenteus): a review. Pages 164-178 in M.W. Fox, ed.,The Wild Canids. Van Reinhold Co., New York, 508 p.

Trent, T.T. and O.S. Rongstad. 1974. Home range and survival of cottontail rabbits in southwestern Wisconsin. J. Wildl. Manage. 38:459-472.
Tuttle, M.D. 1976. Population ecology of the gray bat (Myotis grisescens): factors influencing growth and survival of the newly volant young. Ecology 57:587-595.
Tuttle, M.D. 1976. Population ecology of the gray bat (Myotis gresescens): philopatry, timing and patterns of movement, weight loss during migration, and seasonal adaptive strategies. Univ. Kansas Mus. Nat. Hist. Occas. Pap. 54:1-38.
Tuttle, M.D. 1979. Status, causes of decline, and management of endangered gray bats. J. Wildl. Manage. 43:1-17.
Urban, D. 1970. Raccoon populations, movement patterns, and predation on a managed waterfowl marsh. J. Wildl. Manage. 34:372-382.
Van Vleck, D. B. 1969. Standardization of Microtus home range calculation. J. Mammal. 50:69-80.
Verts, B.J. 1963. Movements and populations of oppossums in a cultivated area. J. Wildl. Manage. 27:127-129.
Verts, B.J. 1967. The biology of the striped skunk. Univ. Illinois Press, Urbana. 218 p.
Virginia Fish and Wildlife Information Service. 1998.http://151.199.74.222/scripts/oicgi.exe/inet_xlate, Virginia Department of Game and Inland Fisheries, Richmond, VA.
Wade-Smith, J. and B.J. Verts. 1982. Mephitis mephitis. Mammalian Species No. 173. Am. Soc. Mammal., New York.
Walker, R. S. 1993. Habitat use, movement, and density of the raccoon (Procyon lotor) in a wetland/sandhill mosaic of north-central Florida. University of Florida, Gainesville.
Watkins, L.C. 1972. Nycticeius humeralis. Mammalian Species No. 23. Am. Soc. Mammal., New York.
Webster, W.D., J.K. Jones, and R.J. Baker. 1980. Lasiurus intermedius. Mammalian Species No. 132. Am. Soc. Mammal., New York.
Webster, W.D., J.F. Parnell, and W.C. Biggs. Mammals of the Carolinas, Virginia, and Maryland. University of North Carolina Press, Chapel Hill. 255 p.
Wharton, C.H. 1968. Distribution of the red squirrel in Georgia. J. Mammal. 49:153-155.
Whitaker, J.O. 1972. Zapus hudsonius. Mammalian Species No. 11. Am. Soc. Mammal., New York.
Whitaker, J.O. 1974. Cryptotis parva. Mammalisn Species No. 43. Am Soc. Mammal., New York.
Whitaker, J.O. and W.J. Hamilton. 1998. Mammals of the eastern United States. Comstock Pub. Assoc., Ithaca, NY. 583 p.
Whitaker, J.O. and R.E. Wrigley. 1972. Napaeozapus insignis. Mammalian Species No. 14. Am. Soc. Mammal., New York.
Wiley, R.W. 1980. Neotoma floridana. Mammalian Species No. 139. Am. Soc. Mammal., New York
Wilkins, K.T. 1987. Lasiurus seminolus. Mammalian Species No. 280. Am. Soc. Mammal., New York.
Wilkins, K.T. 1989. Tadarida brasiliensis. Mammalian Species No. 331. Am. Soc. Mammal., New York.
Willner, G.R. 1982. Nutria. Pages 1059-1076 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Willner, G.R., G.A. Feldhammer, E.E. Zucker, and J.A. Chapman. 1980. Ondatra zibethicus. Mammalian Species No. 141. Am.Soc. Mammal., New York.
Wilson, K.A. 1959. The otter in North Carolina. Proc. Southeast Assoc. Fish Game Comm. 13:267-277.
Wilson, D.E. and S. Ruff. 1999. The Smithsonian book of North American mammals. Washington, DC, Smithsonian Inst. Press. 750 p.
Wolfe. J.L. 1982. Oryzomys palustris. Mammalian Species No. 176. Am. Soc. Mammal., New York.
Wolfe, J.L. and A.V. Linzey. 1977. Peromyscus gossypinus. Mammalian Species No. 70. Am. Soc. Mammal., New York.
Wood, G.W. and T.E. Lynn, Jr. 1977. Wild hogs in southern forests. Southern J. Appl. For. 1:12-17.

Wood, G.W. and R.E. Brenneman. 1977. Research and management of feral hogs on Hobcaw Barony. Pages 23-35 in G.W. Wood, ed., Research and management of wild hog populations: procedings of a symposium. Belle W. Baruch For. Sci. Inst., Clemson, SC.
Wood, G.W. and R.E. Brenneman. 1980. Feral hog movements and habitat utilization in coastal South Carolina. J. Wildl. Manage. 42:420-427.
Wood, J. E. and E.P. Odum. 1964. A nine-year history of furbearer populations on the AEC Savannah River Plant area. J. Mammal. 45:540-551.
Wood, J.E., D.E. Davis and E.V. Komarek. 1958. The distribution of fox populations in relation to vegetation in Southern Georgia. Ecology 39:160-162.
Woods, C.A., C. Contreras, G. Willner-Chapman, and H.P. Whidden. 1992. Myocastor coypus. Mammalian Species No. 398. Am. Soc. Mammal., New York.
Yates, T.L. and R.J. Pedersen. 1982. Moles. Pages 37-51 in J.A. Chapman and G.A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore.
Yates, T.L. and Schmidly, D.J. 1978. Scalopus aquaticus. Mammalian Species No. 105. Am. Soc. Mammal., New York.
Yearsley, E.F. and D.E. Samuel. 1980. Use of reclaimed surface mines by foxes in West Virginia. J. Wildl. Manage. 44:729-734.
Zarn, M. 1977. Wild and free-roaming horses: status of present knowledge. U.S. Dept. Inter., Bur. Land Manage., and U.S.D.A. Forest Service, Tech. Note 294. Denver Serv. Center, Denver, CO. 72p.
Zollner, P.A., W.P. Smith, and L.A. Brannon. 2000. Home range use by swamp rabbits (Sylvilagus aquaticus) in a frequently inundated bottomland forest. Am. Midl. Nat. 143:64-69.

Appendix G – Vertebrate Distribution Maps