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A GAP ANALYSIS OF SOUTH CAROLINA

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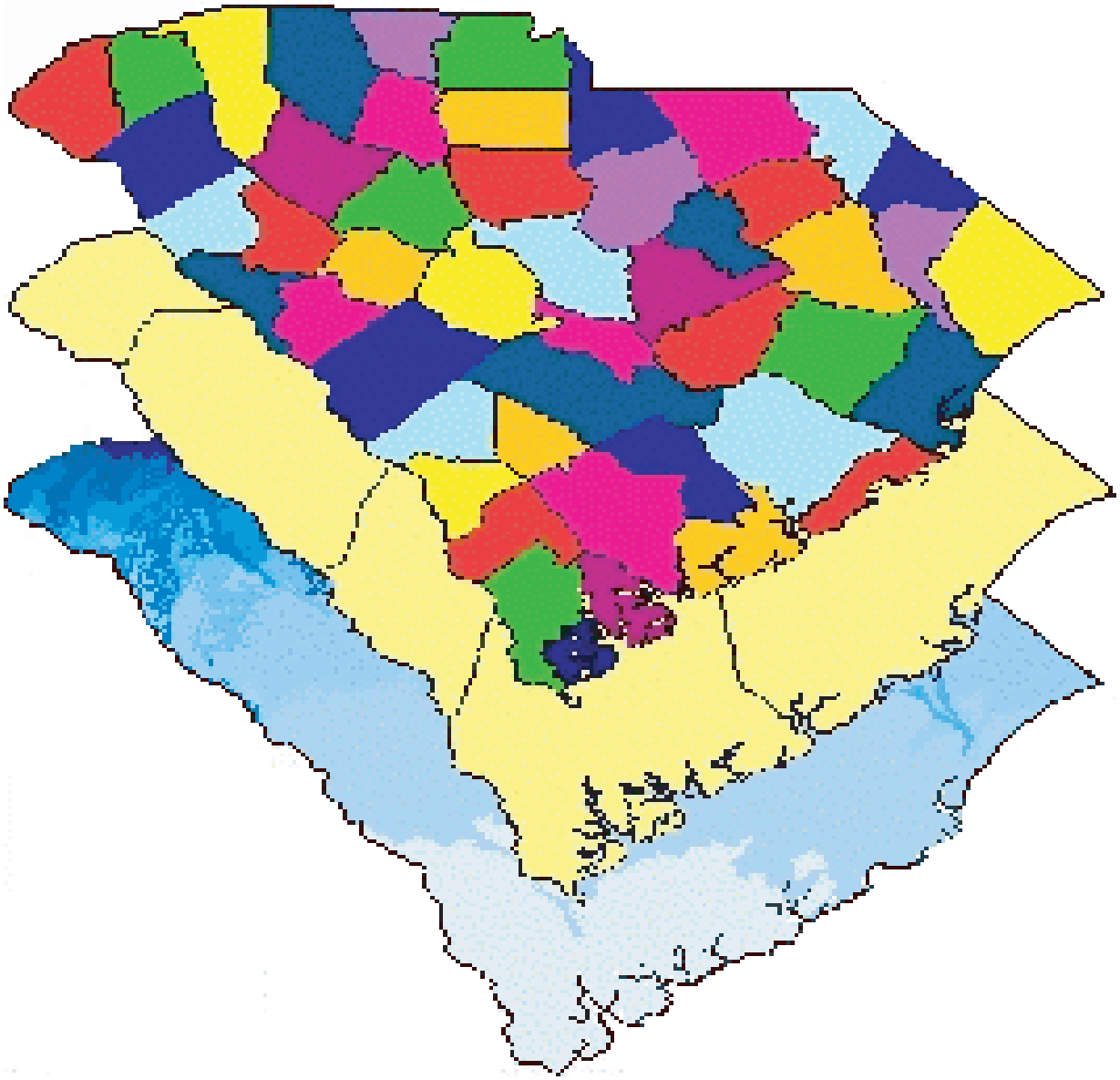
2001 Final Report



A GEOGRAPHIC APPROACH TO PLANNING FOR BIOLOGICAL DIVERSITY

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

THE SOUTH CAROLINA GAP ANALYSIS PROJECT

FINAL REPORT

2001

Dr. Elise Vernon Schmidt, Coordinator
Dr. David Otis, Principal Investigator
Cindy Aulbach, Botanical Services
Dr. Frank Tian, GIS Analyst
James D. Scurry, GIS Manager
Yvette Alger, Vegetation Ecologist
Dr. Francois G. F. Smith, Remote Sensor
Daniel Fairey, Protected Lands
Dr. David Gordon, Wildlife Biologist

Submitted by:
Dr. Elise Vernon Schmidt, Coordinator
Dr. Craig Allen, Principal Investigator

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Clemson University
Clemson, South Carolina 29236

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Biological Resources Discipline
Gap Analysis Program

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DEDICATION

We dedicate this report to the naturalists, both professional and amateur, who have dedicated their lives to the study of the natural diversity of the state and who have shared that knowledge with others.

EXECUTIVE SUMMARY

The SC-GAP project began in 1996 as an effort of the South Carolina Cooperative Fish and Wildlife Research Unit. Partners in the project from the beginning included the South Carolina Department of Natural Resources and the US Fish and Wildlife Services Coastal Ecosystems Project. The objectives of the project were to 1) map the vegetation of South Carolina in as much detail as possible with the goal being the production of a land cover map easily cross-walked to the TNC alliance level, which is dominant species, 2) produce a database of vertebrate ranges and habitat affinities for use in predicting vertebrate distributions within the state, 3) produce a database of protected lands within the state including both public and private agencies with associated ownership data and to classify them by protection status, 4) analyse the relative protection of the state's biodiversity through a gap analysis, 5) build partners during the development and implementation stages of the SC-GAP projects and 6) provide scientific data on the state of South Carolina's biodiversity to the managers and decision-makers of the state of South Carolina.

The SC-GAP land cover maps the state's natural and man-made vegetation types to two classifications, a general 27-class habitat map that was used in modeling vertebrate distributions. We also produced a more detailed 54-class map in accordance with the National GAP guidelines of mapping to the alliance level where possible. The initial data used in developing the map was remotely-sensed satellite data that was pre-classified to 28 classes. We used data from detailed soil surveys, National Wetlands Inventory surveys, and elevation maps to improve this classification and develop our 54-class land cover. This was aggregated into the habitat map for use in producing vertebrate distributions. The accuracy of the map was determined through a combination of aerial photography and ground assessment points that were compared with the general land cover. Overall map accuracy of the general land cover, Anderson Level II and Anderson Level I classifications were 33%, 50% and 71%, respectively.

The vertebrate database was developed through consultation with current literature, with acknowledged state experts and with general taxonomic guides. This produced a database with ranges and habitat affinities for a total of 455 vertebrate species that regularly occur in South Carolina. After the database was completed, experts were again consulted to assist in resolving conflicts in the data and quality checking the database. A total of 65 amphibians, 73 reptiles, 249 birds and 68 mammals were included in the final database and predictive modeling. Modeling took place by attributing each species to the counties where it is known to occur and to the habitat types it uses within those counties. These occurrence maps were overlain to produce coverages of overall species richness and richness for each taxonomic group. The accuracy of the predicted vertebrate distributions was assessed by comparing a list of species that SC-GAP predicts would be present at a site to a list of species known to occur at a site. We used species lists from five areas within the state to check our accuracy. The accuracy ranged from 57% to 85% depending on the site. For the largest site with the longest period of study the accuracy was 85%.

The third database component of the project was the production of a database on land ownership within the state. This was accomplished through a partnership with the US Fish and Wildlife Service who assisted in mapping stewardship lands for the eight coastal counties. If all GAP status lands (1 through 4) are considered, there is a total of 6580 acres of publicly and privately owned land within the state, comprising about 8.1% of the total. If the lands of highest protection, GAP status 1 and 2, only are counted, this amounts to 1801 acres or about 2% of South Carolina. Clearly there is a need for more activity in land protection within the state.

The GAP analysis phase of the project indicates the need for further action to protect our natural habitats and our rural landscapes. While many of our forests receive at least some level of protection, very little of our scrub/shrub, grassland or cultivated land is protected according to GAP status. The very large majority of our vertebrate species are protected on less than 10% of their habitat. For some species of concern, we have reached or surpassed our conservation goals, especially for those with specific habitat needs. For species such as bats, however, where habitat requirements are less well defined, more work needs to be done in ensuring their ongoing protection.

The outreach portion of the project has been very successful through partnerships developed during the accomplishment of our goals. These partnerships will continue through activities such as finer scale mapping of state natural land covers, through scientific studies of invertebrate diversity and better habitat modeling and through ongoing land cover and change detection projects. For the end-users of all kinds within the state, a close-out reception for the SC-GAP project was held in December 2001 and was well attended and well received. Posters of GAP products were displayed, and information was disseminated about future directions. Requests are already coming for the data and to have a chance to see the displays from the meeting. There are many committed and excellent land managers, planners, agency personnel and conservation groups that are interested in the data, and it is our hope that they will take it, use it, and make it better.

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We acknowledge contributions to this report by Chris Cogan, Patrick Crist, Blair Csuti, Tom Edwards, Michael Jennings, and J. Michael Scott; as well as the previous GAP projects.

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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 reflects the complexity of the project it describes. A glossary of terms is provided to aid the reader's 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 Program 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 animal species), for South Carolina. 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 biotic elements (plant communities and native animal species) 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 and selected other taxa 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.
3) document the representation of natural vegetation communities 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 or regional level but maintain consistency with national standards. Within the state, participation by a wide 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, animal habitat characterization, and biodiversity conservation assessment 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 predicted distribution of 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 unrepresented or underrepresented in existing management areas. It functions as a preliminary step to the more detailed studies needed to establish actual boundaries for planning and management of biological resources on the ground. These data and results are then made available to the public so that institutions as well as individual landowners and managers 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 established Natural Heritage Programs in all 50 states. 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 quickly and cheaply assess the other 85-90% of species. GAP is not designed to identify and aid protection of elements that are rare or of very restricted distribution; rather it is designed to help "keep common species common" by identifying risk far in advance of actual population decline. These concepts are further developed below.

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 and Nicholls 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 land cover types mapped in GAP serve directly as a coarse filter, the goal being to assure adequate representation of all native vegetation community types in biodiversity management areas. Landscapes with great vegetation diversity often are those with high edaphic variety or topographic relief. When elevational 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.

More detailed analyses were not part of this project, but are areas of research that GAP as a national program is pursuing. For example, a second filter could combine 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 movement of wide-ranging animals and the migration of species in response to climate change.

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 respective sections:

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 communities before they 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 Description of South Carolina

South Carolina (Figure 1) is located in the southeastern United States, one of the biologically richest areas of North America. It is comprised of three or four physiographic provinces: the mountains of the Blue Ridge Province, the rolling hills of the Piedmont, the Sandhills (sometimes included with the Coastal Plain) and the coastal plain (Figure 2, note that light green depicts shore habitat used in vertebrate modeling, yellow indicates the coastal plain which includes the shore region, orange depicts the piedmont, and brown represents the mountains or Blue Ridge Province). Precambrian granite and gneiss make up the base rock of the Blue Ridge mountain region with a thick series of late Precambrian sedimentary rocks on top. The Blue Ridge Province experiences some of the highest rainfall on the east coast and possesses some spectacular valleys and coves. The flora is very rich and diverse in this area, especially in the mountain coves.

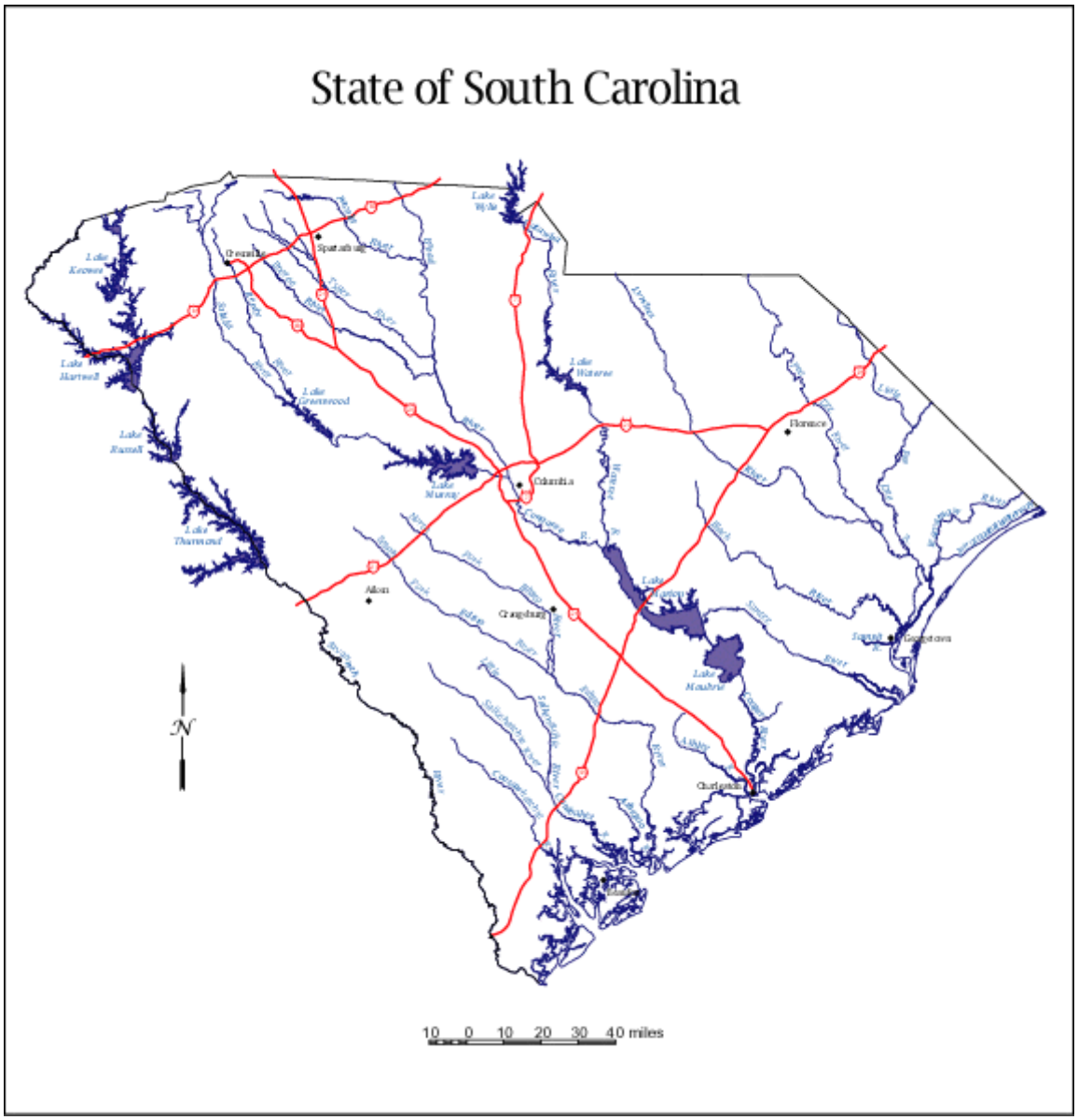


Figure 1. A general map of South Carolina.

Originally, the forests that dominated the mountain region were in the oak-chestnut association until chestnut trees were decimated by the chestnut blight in the early 1900s. Generally the forests are mixed mesophytic forests consisting mainly of oak types. The rich cove forests and seepage communities provide habitat for a diversity of plants, including many rare species. The mountains are separated from the Piedmont by the Brevard Zone or fault.

The Piedmont region extends from the foothills of the mountains to the fall line near the center of the state. The fall line represents a transition from the igneous and metamorphic rocks of the Piedmont to the unconsolidated segments of the coastal plain. A significant formation of the Piedmont is the slate belt that comprises about 20 percent of the

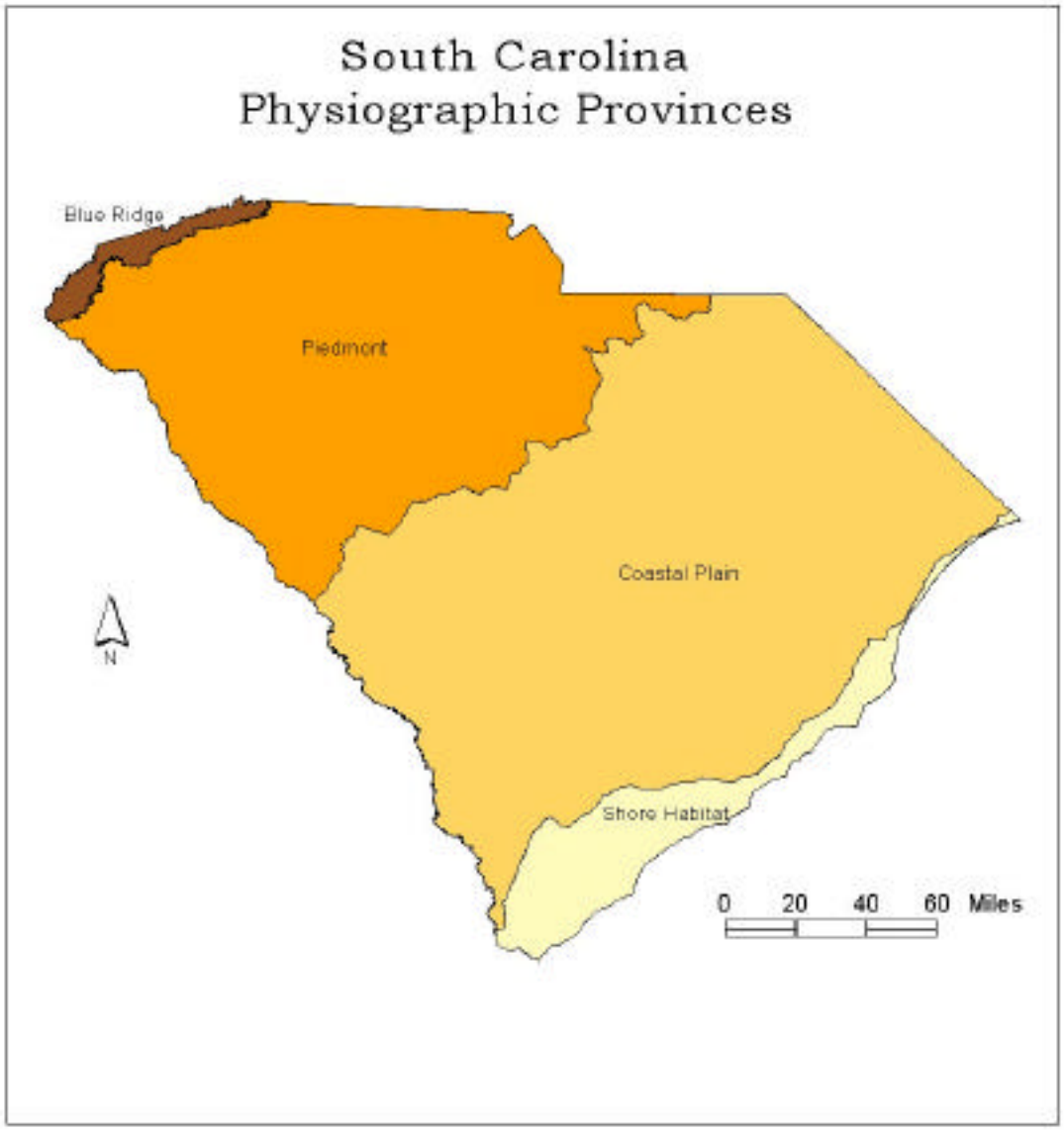


Figure 2. Physiographic regions of South Carolina.

province and, because of its susceptibility to erosion, forms slightly lower areas with wide valleys. The Piedmont region has been highly altered by agricultural practices that contributed to erosion and depletion of the formerly rich soils of the region. The topography of the Piedmont consists of rolling hills with fairly steep river valleys. Forests are often oak-hickory associations with a high diversity of plant life along the rivers.

The Sandhills are often included as part of the coastal plain and form a drier, more hilly portion of the state with an often unique vegetation including xeric pine/oak forests and richly vegetated seeps. Variation in vegetation types, from xeric to very mesic is influenced by soil drainage, topography, and the action of fire. Longleaf pine and turkey oak can be found on drier uplands with a variety of oaks and hickories found on the

slopes of the sandhills. Mesic communities are also found in the sandhills in areas of poor drainage; these include seepage communities and Atlantic white cedar swamps. The topography is sculpted by streams passing from the harder bedrock of the Piedmont through the soft sands of the coastal plain resulting in hills and valleys with occasional waterfalls, bluffs and shoals.

The Coastal Plain extends from the fall line to the coast and was formed by sediments laid down by the sea. Ancient seashores experienced periods of shifting for considerable distances across the coastal plain due to tilting or warping of the landscape and fluctuations of sea level. The coastal plain is very flat with wandering rivers and streams. The action of waves and formation of sandbars is responsible for very interesting formations of ancient ridges and low-lying areas in the coastal areas of the state. Dominant tree species are often coniferous with hardwoods dominating only in the maritime forests and river bottoms. Extensive riverine swamps are separated by uplands with more xeric forests, pine flatwoods, Carolina Bays and isolated freshwater wetlands.

Carolina Bays are a formation unique to the southeastern US and range in occurrence from Delaware to Florida but are concentrated in the Carolinas and Georgia. They are elliptical depressions oriented in a northwest to southeast direction with a raised sand ridge on the southeastern edge. There are varying hydrologic characteristics, ranging from permanently- to seasonally-flooded. Typical vegetation includes black gum, sweet gum, magnolia, bald cypress and maple. Shrubs such as sumac, buttonbush, gallberry and red bay also occur along with other plants such as water lilies, sedges and various grasses. Carolina Bays provide significant wildlife habitat as well as water quality and erosion control.

South Carolina has a mild, humid climate ranging from highest temperatures in the center of the state to cooler temperatures in the mountains and along the coast. Higher rainfall averages can be found in the mountains with the lowest averages in the upper Coastal Plain and Sandhills.

Tropical storms or hurricanes occur in the state at a frequency of about one every two years, often doing little damage and bringing much needed rains. The greatest effect from hurricanes is on the outer coast, and they generally lose power and strength as they move inland. High rainfall and storm surge cause damage as do the high winds often associated with hurricanes. In addition to wind damage and destruction, saltwater incursion also kills trees in coastal forests. The high winds associated with Hurricane Hugo in 1989 impacted extensive coastal forests and felled trees inland in areas such as the Congaree Swamp as it moved up the center of the state. Hurricane Floyd in 1999 was accompanied by high rainfall and flooding events; much of the damage was to property in the northeastern portion of the state.

The first Europeans to arrive in South Carolina were Spanish and French explorers who arrived in the 16th century. The land at that time was inhabitated by many small tribes of Native Americans, including Cherokees and Catawbas. It wasn't until 1670 that a permanent European settlement was established near Charleston. Other European settlers

arrived and began growing crops such as rice and indigo. Large numbers of African slaves were brought into the colony to work on plantations. Cotton became a major crop in the upcountry after the invention of the cotton gin.

On May 23, 1788, South Carolina became the eighth state to enter the union. However, by the early 1800s, South Carolinians were dissatisfied with the federal government and by 1860 became the first of the southern states to secede from the Union. General Sherman marched through South Carolina burning plantations and most of the city of Columbia. As with many southern states, the Reconstruction period that followed was a time of economic, social and political upheaval. The economy suffered from low cotton prices and the demise of the plantation system.

By the beginning of the 20th Century, economic recovery was beginning with the development of a textile industry and the arrival of other manufacturers. Tourism has developed as a major industry, centered around the state's beaches and mountains. Hurricane Hugo struck the coast in 1989 and caused tremendous damage to homes, businesses and natural areas. Most areas have recovered from the damage but remnants of the hurricane's damage persist in many formerly intact forests.

South Carolina grows more peaches than any other state except California; it ranks fifth in overall tobacco production. Other top agricultural commodities include nursery and greenhouse products, watermelons, peanuts, broilers and turkeys, and cattle and calves. The only commercial tea plantation in America is 20 miles south of Charleston on Wadmalaw Island.

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 spatial 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 et al.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. There may be considerable variation in the floristics of subcanopy vegetation layers (community association) that are not resolved when mapping at the level of dominant canopy vegetation types (alliance), and there is a need to address this part of the diversity of nature. As information accumulates from field studies on patterns of variation in understory layers, it can be attributed to the mapped units of alliances.

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:

- an ability to distinguish areas of different actual dominant vegetation;
- a utility for modeling animal species habitats;
- a suitability for use within and among biogeographic regions;
- 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);
- a framework that can interface with classification systems used by other organizations and nations to the greatest extent possible; and
- a capability to fit, both categorically and spatially, with classifications of other themes such as agricultural and built environments.

For GAP, the system that fits best is referred to as the National Vegetation Classification System (NVCS) (FGDC 1997). 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).

The classification of vegetation from remotely sensed data for SC-GAP proceeded in two steps, the production of an initial classified image using 28 general classes and the refinement of that classification using ancillary data to provide a 54-class map that consists of aggregated alliances. The initial classification scheme for SC-GAP was based on the Land Manager's Guide for Birds (Hamel 1992) and the Land Manager's Guide for Reptiles and Amphibians (Wilson, 1995) (see Table 1). It was felt that this level of detail would be readily achieved and would provide the basis for further refinement of the map using ancillary data. This simplified classification scheme was used because it was not possible to produce the initial version of the map at the originally intended level for several reasons. The original methodology called for mapping to the TNC alliance level classification scheme. This includes classifications such as Sand Live Oak Forest Alliance, the description of which includes a context of beach shores and a scrub/shrub comprised of certain species. Soil is also an important part of the classification. These types of classes are difficult to determine from simply evaluating spectral characteristics. In other words, these classes are environmental or habitat descriptions that are not necessarily discernible by simple statistical categorizing of image brightness values.

The general vertebrate habitat land cover provides the basis for producing predicted vertebrate distributions, and taxonomic experts used the 28 classes of this version to produce the habitat association database. The vertebrate habitat map can easily be crosswalked to an Anderson Level III classification (Anderson et al. 1976) as well as further refined for our final land cover map.

The classification for the final land cover consists of 54 classes. Although the classification is crosswalked to the NVCS, it doesn't fit in a neatly hierarchical sense. In attempting to create a land cover that reflects vegetational patterns on the ground and that will be appropriate for a variety of users with a range of botanical knowledge, we simplified the classification from a potential of 231 alliances to a more useable set of habitat descriptions. A detailed description of the 54 map classes with a crosswalk to TNC/UNESCO classification is provided in Appendix 1. Some alliances may appear more than once in association with a map class due to the nature of our classification.

Table 1. Original land cover classes with working description

Class Name	Class Description
1 - fresh water	ponds, rivers, any inland water
2 - marine water	salt or estuarine water
3 – marsh	high and low marsh, non-forested wetland
4 - bays and pocosins	Carolina bays, also called pocosins, wetland ovular depressions
5 - stream margins	30 meter buffer around rivers and streams
6 - swamps/bottomland	Cypress tupelo swamps
7 – bottomland hardwood	river floodplain hardwoods, wet depressions
8 - wet soil	areas of bare wet soil, little or no canopy, sand bars and dredge spoil
9 - wet scrub/shrub thicket	short bushy vegetation, transitional, over wet soil
10 - dry scrub/shrub thicket	short bushy vegetation, transitional, over dry soil
11 - sandy bare/friable soil	sand, beaches, sandhill exposed soil
12 - open canopy, recently cleared forest	transitional areas, mainly bare soil and pioneering grassy vegetation, fallen trees
13 - rock outcrops	caves, bare exposed rocks
14 - aquatic vegetation	algae, macrophytes, seagrass, not marsh
15 - upland pine/closed canopy forest	mainly pine plantations, tight canopies, very little soil or scrub vegetation shows through
16 - upland pine forest/deciduous understory	pine with mainly scrub oak understory, canopy is more spread out but is still fairly close

17 - upland pine forest/grass understory	pine with natural grasses underneath, canopy is very spread out
18 - upland deciduous forest	deciduous arboreal vegetation in dry soil
19 - mesic deciduous forest	deciduous arboreal vegetation in wet soil, not in flood plain or bottomland depression
20 - upland mixed forest	forest which is mixed with evergreen and deciduous so that each 30 meter squared area is relatively evenly mixed
21 - mesic mixed forest	mixed forests in marginal bottomland floodplain areas
22 - grasslands/pasture	native grasses, fallow fields, pastureland
23 - cultivated land	agriculture, lawns, golf courses
24 - urban development - high intensity	industrial development, central business district, large highways
25 - urban development - low intensity	residential development
26 - ecotone boundary/edge shadows	boundary between cultivated and natural classes, based mainly on shadows from native vegetation on to cultivated land
27 - mesic evergreen	evergreen in wet areas, not bottomland floodplain, maritime evergreen
28 – maritime forest	Live oak, palmetto forests

Methods

Mapping Standards and Data Sources

For SC-GAP we maintained the original 30 x 30 meter pixel resolution of the TM data throughout the classification process. All scenes were rectified with less than 1 pixel error. A target accuracy of 80% was set for classification of major vegetation and land cover types.

The TM imagery (see Figure 3) was acquired from the Multi-Resolution Land Characteristics Consortium (MRLC). This consortium established a partnership with USGS Earth Resources Observation Systems (EROS) Data Center. The MRLC offers imagery, which is distributed by EROS Data Center, at a drastically reduced price to its members. The purpose of MRLC is to generate land cover data of the entire United States based on standardized satellite image classification procedures and protocols. One means to do this is to facilitate mapping by offering inexpensive imagery to mapping agencies. The list of scenes available for South Carolina was found on the MRLC homepage (http://www.epa.gov/mrlc). The scenes acquired for this project are as follows:

Table 2. Thematic Mapper imagery acquired for production of the SC-GAP land cover.

path/row	date recorded
15/36	10-18-91
16/36	3-1-92
17/36	3-24-92
18/36	10-28-93
15/37	10-18-91
16/37	11-26-91
17/37	12-19-91
16/38	3-1-92

Aerial videography was not obtained for use in developing the land cover. NAPP color photographs were used to assist in the initial classification of the imagery.

It should be noted that the land cover map produced by these methods is limited to the time that the imagery was taken. Thus our product reflects land cover in the state as it existed in 1991 through 1993. The most obvious time-related errors will be those in transitional classes such as clearcuts, scrub/shrub, closed canopy pine (mainly pine plantations), urban and other classes impacted by development/land use decisions.

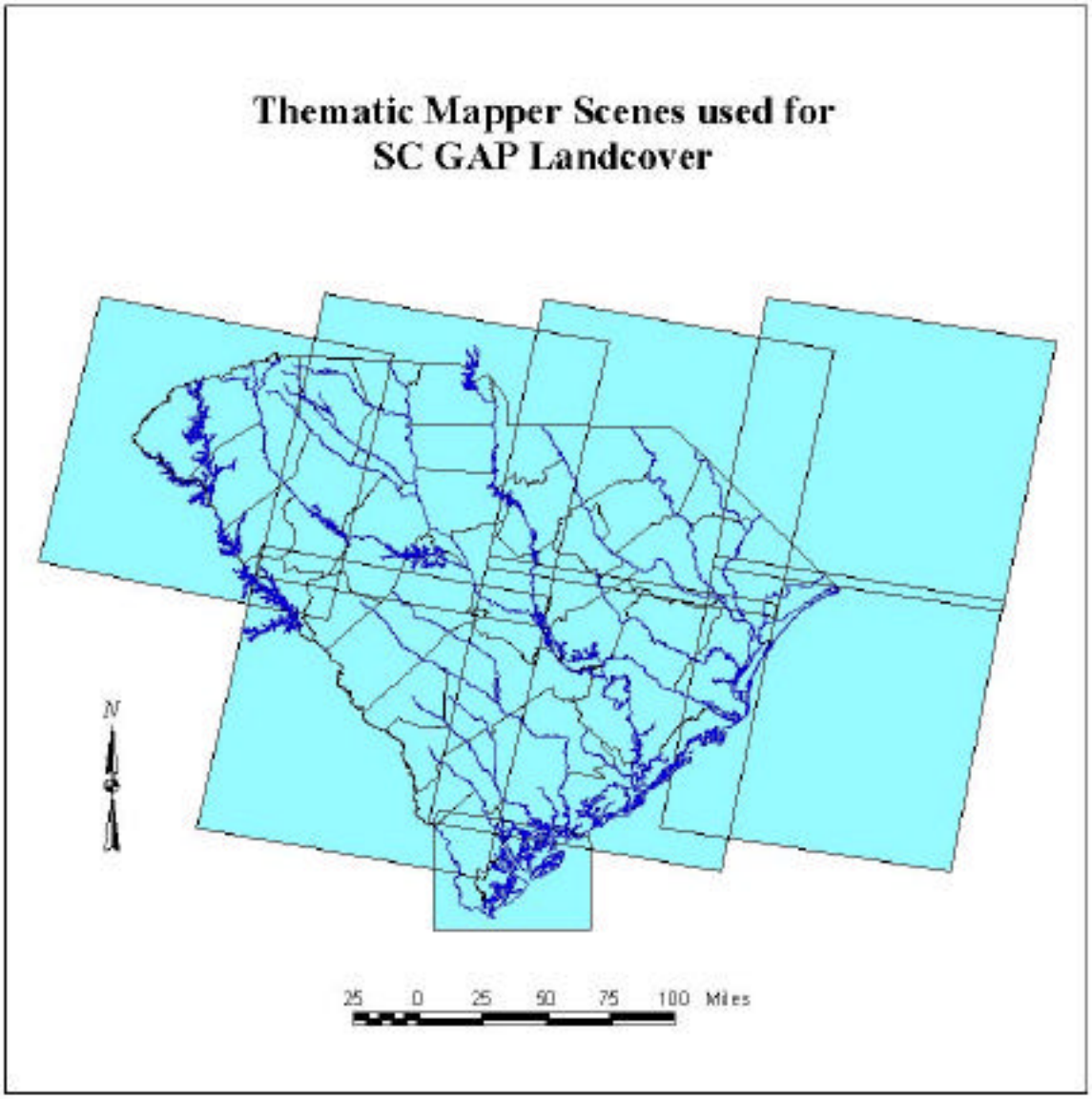


Figure 3. Layout of TM scenes used in SC-GAP land cover mapping.

Imagery and Ancillary Data

The imagery was imported into the image processing software format from its native binary format. The software used in this project was Earth Resources Data Analysis Systems (ERDAS) Imagine 8.2 and 8.3. The imagery was loaded into the Import tool as a band sequential file. The rows and columns were determined for each image by viewing the header information. This is listed in the .dda file and can be accessed using Data View option in the Import tool. It is necessary to know the number of bands while importing. MRLC data consists of six bands because the thermal infrared was not distributed to the state given the applications for which the data is used.

The MRLC imagery came already rectified but unfortunately it was not rectified to UTM zone 17. In order to correct this problem it was necessary to re-rectify the data. This was done by first displaying the image so that the rectification attributes could be displayed as well. This can be done in Imagine 8.2 by selecting Image Info. In this tool the map information and projection information are displayed. These attributes were deleted and replaced with new values. Under map info, 30 x 30 meter pixel size was selected, and UTM was selected for the projection.

The file was originally projected in UTM zone 18, and South Carolina is completely in zone 17, but the image is consistent within itself. The problem is that coordinate values are incorrect. This means a full rectification is not necessary, because it is simply projected to the wrong zone. This can be corrected without collecting GCPs (Ground Control Points). The scene was instead resampled, UTM zone 17 was selected as the projection, and Clark 1886 was selected as the spheroid. The scene then had to be refined by setting coordinates over a known point on the scenes. This was done in Imagine by using Set Drop Point. Once the point was selected, in this case a road intersection, the same point was selected from a reference layer. This layer was created by rectifying a Digital Line Graph (DLG) roads layer using a statewide set of GPS road intersection data. The drop point corresponded to one of the GPS road intersections. The coordinates of the GPS point were typed into the drop point dialog box and thus the imagery was calibrated spatially with this dataset.

The first step in sub-setting the image data was acquiring the 11-digit hydrologic unit boundary data from South Carolina Department of Health and Environmental Control. Hydrologic units are small watershed areas based on the digitizing of ridges in the landscape interpreted from 1:24,000 and 1:62,500 USGS topographic maps. The topographic maps of South Carolina used to delineate these watersheds were based on aerial photography flown from the 1930's through the 1950's. The work on the hydrologic unit dataset for South Carolina was done by Claude Lowry Jr. at the USDA Natural Resources Conservation Service, USDA, in Columbia S.C. The work was begun in 1966. The maps were then published at the National Cartographic Office of the USDA in Ft. Worth, Texas in September 1981. Elevation-based drainage was the only criterion for watershed boundary delineation. Each watershed boundary makes up a hydrologic unit and there are a total of 280 of these 11-digit watersheds. There are several levels of hydrologic units categorized in this way. They are distinguished by the level of watershed they delineate. The layer used in this project was an 11-digit layer. This refers to the

hydrologic unit code (HUC). This number is hierarchical and tells the scale of the watershed by how many digits the code contains. Presently there are eight-digit (more general units) and fourteen-digit (more specific units) layers available as well. The 11-digit layer was selected because 280 units was an appropriate number of units for sufficient subdivision of the TM data. Figure 4 shows the boundaries of the 11-digit HUCs and their parent 8-digit units that have been grouped by color. More units would have caused the classification to take too long, and fewer units would mean that there was not the level of stratification necessary to accurately classify the many classes of features.

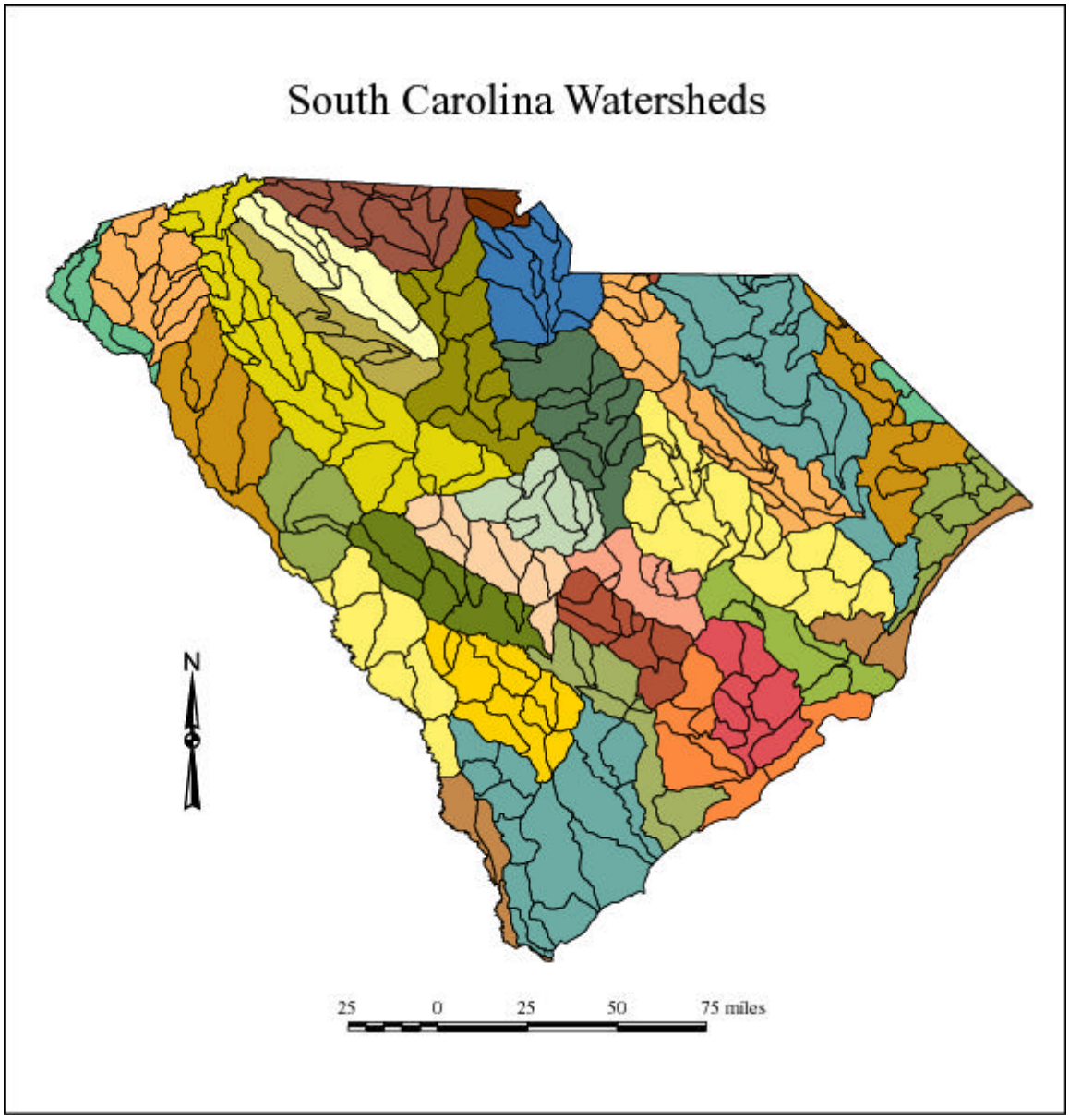


Figure 4. 11-digit HUCs used to subset TM imagery for South Carolina. Color groupings represent the parent 8-digit HUCs.

The hydrologic units were utilized as boundaries for subsetting the imagery. Generally, the smaller the target classification area, the fewer the number of potential classes. This is thought to make the classification more accurate. For example, a classification completed for an area of one square mile is likely to be more accurate than a classification of a 50 square mile area using the same classification scheme. This is because it is not as inaccurate to interpolate over a small area than a large area from samples used to label the classes. Also, if a photo-interpretation error is made during labeling, the error only affects that area within the unit being classified. Breaking the imagery up into physically homogeneous areas, or physiographic regions, is standard practice in large area classification (Jensen 1996) and is called 'brute-force' classification (Yuill 1997).

Each image was subset by the hydrologic units until the state was covered by 280 subset TM images. This was done in Imagine 8.2 by creating AOIs (Areas of Interest) from the hydrologic boundaries. Then these were used in the Subset tool. During the subset process the image was displayed with the AOI displayed over it. Then the Inquire Box was also displayed, and Fit to AOI option was selected. At this point it is necessary to extend the box past the AOI slightly. The box is used to chop the image off beyond the borders of this box. If it is not used then the resulting subset image has zero values to the extent of the original image. If the box is not extended, then it is possible for slivers to be produced in the data when the classified units are eventually mosaicked. Unfortunately this was not realized until after the project was in the mosaicking stage. Slivers of no value do not occur every time the units are subset, but often enough to be a problem. Another problem is that hydrologic units sometimes extend beyond their primary scene's boundaries. In these cases, the unit boundaries are only partially "filled with data" and thus a significant hole is left during the mosaicking process. This was subsequently realized and dealt with by finding the areas that were left empty of data, screen-digitizing AOIs around them, and subsetting them from the image scenes. In other words, the hydrologic units were simply broken into parts whereby each part would be contained within a scene, i.e. not crossing scene boundaries. Then these new subsets were mosaicked back "into" the statewide dataset. This is done so that parts of two different images do not have to be classified together since they have different ranges of reflectance values. This only requires analysis of one image at a time.

During the subset process, it is necessary to select the bands to be used in the analysis. It is not necessary to use all six bands of the MRLC TM imagery for classification. In fact, too much spectral information can create confusion in pixel values, thus leading to a "salt and pepper" look as well as hard-drive space depletion. Each band is the same file size, therefore, if two bands are deleted the image requires one-third less storage space. Bands two, three, four, and five were selected for this project. These bands are standard for general vegetation classification. Band one, which corresponds to the visual blue wavelengths, is often too influenced by atmospheric scattering to be very helpful in vegetative studies. Band six is a middle infrared band that is not necessary when middle infrared (MIR) band five is used since they have a similar spectral curve. Vegetation reflects a similar amount of band five-wavelength energy as band six wavelengths so that only one band was used. When looking at the chlorophyll-producing vegetation spectral

curve, it is evident that the other four bands must be used. The contrast of red and near-infrared is the greatest, so these two bands must be used. A principal components analysis indicates which bands give the greatest contrast in pixel values in an image, and thus helps to select the bands that provide the most information when used together. This analysis was done by Florida Gap (see FL-GAP report) as well as other studies. It is usually the case that bands 2,3,4, and 5 are the four most important bands for vegetation classification using Landsat TM imagery.

The subset process produced 280 images that were then clustered using the Iterative Self-Organizing Data Analysis Technique (ISODATA) clustering algorithm. ISODATA performs an entire statistical classification of the pixel values repeatedly with the number of times to be defined by the user. It uses a minimum spectral distance method to determine which pixels form a cluster. The number of clusters is determined by the user. The first iteration of the ISODATA process creates arbitrary clusters that are accumulated in the later iterations (ERDAS Field Guide, 1997).

In Imagine 8.2, the defaults were used. Maximum iterations remained six, and the convergence threshold was maintained at 0.950. The number of classes was set to fifty. Fifty classes were chosen because this would give the most labeling options (before diminishing returns) by breaking up the data statistically to such a point that the interpreter would have more freedom in naming features. This means more detail is possible in the classification because the features are broken into classes of relatively few pixels. Also, each image covers a small area, so although this requires more work from the interpreter, it also means there is more reliance on the knowledge of the interpreter. This is ideal if the interpreter has botanical knowledge. Otherwise the interpreter is forced to rely on a fairly general classification scheme as was used in this study.

Digital National Wetlands Inventory (NWI) wetlands information is available for most of the state. The National Wetlands Inventory began in 1954 as a national inventory of wetland habitat, primarily related to the presence of valuable waterfowl habitat. The classification had several shortcomings and was revised in 1974 when further surveys were initiated. The classification is widely used and applicable to all types of wetlands (Cowardin et al. 1979). The purpose of the revision was to make the data useful to all kinds of resource managers and provide a uniform classification. The South Carolina NWI dataset is complete for all regions of the state except for the Upper Santee drainage and the Upper Savannah drainage in the Piedmont and most of the Blue Ridge Province. These data are developed through joint funding agreements between the SC DNR and the U.S. Fish and Wildlife Service, National Wetlands Inventory (NWI). They are delineated from 1:40,000-scale NAPP color infrared photography and correspond to the USFWS Cowardin classification system for wetlands and deepwater habitats of the United States. The wetlands habitats are mapped to a one-acre minimum map unit but smaller units often are identified. The upland categories are delineated simultaneously using the Anderson, Level II system developed by the U.S. Geological Survey with a ten-acre minimum resolution. Polygons were dissolved for each county to derive 32 classes (see Appendix 2) of land use and were converted to raster format.

Statewide soil information was also available in digital format. Soils data are derived from existing county surveys available from the Natural Resources Conservation Service (formerly the Soil Conservation Service). Under a DNR contract, the map sheets are zoom-transferred (ZTS) to topographic quadrangle base maps and redrafted to stable base mylar to remove the distortion from the non-rectified photographic base on which they are delineated. The NRCS reviews the draft product to correct any ZTS problems, and the data are digitized. After digitization, the data are quality reviewed to ensure edge-matching and attributing compliance and linked to the STATSGO tabular attribute files that characterize each soil type for a series of composition, productivity, and suitability variables. The resolution of the data is 5 acres, and spatial accuracy conforms to USGS mapping standards. Polygons were dissolved for each county according to 24 soil type classes (see Appendix 3) and converted to raster format.

Classification of Imagery

The clusters generated from the ISODATA algorithm applied to the 1991-1993 TM images were labeled by interpreting National Aerial Photography Program (NAPP) aerial photography. A 1994 statewide coverage of NAPP air photos exists for South Carolina. This photography is in the form of hard-copy color-infrared positive transparencies. The infrared spectral information of the film enables the interpreter to easily distinguish between deciduous and evergreen vegetative features. Identification of alliances or species of vegetation requires extensive botanical knowledge and experience. Also, water features were easily detected using this source.

Each watershed image subset had a fifty-cluster layer displayed over it in order to determine where in the image each cluster of values was located. There were some problems in the clustering, however. For example, often water pixels were extensively confused with pine plantation pixels. This problem can be remedied using ancillary data such as soil classification. When this problem occurred at this stage, the clusters with near equal overlap were assigned to the pine plantation class because the water could be later determined from other data. There were other problems with trying to classify according to the classification scheme used, but all of these classes could also be distinguished from others by using ancillary datasets.

Once the clusters are labeled it is necessary to organize the clusters in terms of the classification scheme. This was done by recoding the clusters with numbers that correspond to classes in the scheme. When recoding, a dialog box appears asking what each cluster should be named. Each cluster was placed in the class that best defines it according to the labels given to each. The result is 280 classified hydrologic units that are ready to be mosaicked. The names and colors selected for each class are stored in a 'working' hydrologic unit classification that was eventually copied to a final recoded watershed unit. It is necessary that all the classifications are consistent so that the mosaic works.

An independent and experienced photo-interpreter checked the accuracy of the initial classification based on a subjective visual analysis of the data using NAPP photographs and a knowledge of South Carolina vegetation patterns. Through this approach, obvious

illogical errors were caught and remedied immediately. For example, in this project an entire bottomland swamp area, the Congaree National Monument, was mis-labeled as upland deciduous by the interpreter. This area was easily subset and recoded to bottomland swamp. These errors may not necessarily be resolved by ancillary data, but tend to be straightforward to fix. An error matrix was developed for this assessment to help the interpreter decide what classes were the least accurate and thus needed either simple recoding changes, cluster-busting, or more fundamental changes using a decision rule applied to ancillary data. The error matrix helped to make decisions to correct the initial classification (see Table 3).

The true test of how accurately each subset classification works is how well the subsets mosaic. When the classifications are mosaicked together, it is easy to tell which subsets are misclassified because they do not fit in the same pattern with the other units but rather look like a patchwork layer. Some of this patchiness can be resolved by applying ancillary information; but some units must be re-classified, or cluster-busted. In Imagine there is a mosaic tool, but it contains histogram and contrast matching algorithms that should not be used. Last Overlay is the only appropriate mosaic algorithm to use in this tool given that classified data is being mosaicked. Sometimes Imagine cannot handle such large numbers of input files for mosaicking. This depends on system constraints. In this project, several parts of the state were mosaicked in an initial run. The results of this process were subsequently mosaicked together to produce a statewide dataset.

The resulting mosaicked statewide dataset was analyzed for errors that this new smaller scale made possible to detect. At this point, some of the noticeable errors were fixed using the AOI screen digitizing technique, where a boundary is digitized around the problem area so that it can be subset, recoded, and mosaicked back into the statewide dataset.

Table 3. SC-GAP vegetation mapping quality assurance spot-checking results by watershed

Unit	Class Name	QA/QC Comments
1	9.dry scrub/shrub	**frequent** conflict w/23.urban & 24.low urban
1	15.pine/decid under	**moderate** conflict with 19.mixed
1	17.upland decid	**frequent** conflict w/14.pine/clocan&15.pine/decid under&19.mixed
1	22.cultivated	**moderate** conflict w/23.urban & 24.low urban
2	17.upland decid	**moderate** conflict w/18.mesic decid
2	22.cultivated	**moderate** conflict w/23.urban & 24.low urban
4	9.dry scrub/shrub	**mod**erate conflict w/young16.pine/grass under
4	14.pine/clo can	**rare** conflict w/18.mesic decid (& shadows)
4	17.upland decid	**rare** conflict w/18.mesic decid
4	22.cultivated	**rare** conflict w/23.urban & 24.low urban
5	22.cultivated	**frequent** conflict w/1.water & 24.low urban
6	1.water	**frequent** conflict w/17.upland decid (shadows)
6	15.pine/decid under	**frequent** conflict w/young 14.pine/clo can & 17.upland decid
6	22.cultivated	slight conflict w/12.rock outcrop & 17.upland decid
7	17.upland decid	**moderate** conflict w/11.clearcut & 20.mesic mixed
8	9.dry scrub/shrub	**frequent** conflict w/17.upland decid
8	14.pine/clo can	**frequent** conflict w/1.water & 20.mesic mixed
8	17.upland decid	**moderat**e conflict w/18.mesic decid & 19.mixed
8	22.cultivated	**moderate** conflict w/23.urban
9	9.dry scrub/shrub	**frequent** conflict w/11.clearcut & 17.upland decid
9	17.upland decid	**moderate** conflict w/18.mesic decid & 19.mixed
9	22.cultivated	slight conflict w/23.urban
10	9.dry scrub/shrub	**frequent** conflict w/17.upland decid
10	14.pine/clo can	**frequent** conflict w/1.water&15/pine/decidund&16.pine/grassund
10	17.upland decid	**moderate** conflict w/19.mixed
10	22.cultivated	**moderate** conflict w/24.low urban
11	9.dry scrub/shrub	**frequent** conflict w/17.upland decid
11	17.upland decid	**moderate** conflict w/15.young pine/decid under & 18.mesic decid
11	22.cultivated	**moderate** conflict w/9.dry s/s & 23.urban & 24.low urban
11	24.low urban	slight conflict w/class-edge transition pixels
14	17.upland decid	**frequent** conflict w/18.mesic decid&19.mixed&20.mesic mixed

Identification of land cover types from remotely-sensed data is only accurate to a certain degree because it bases the classification totally on spectral reflectance of features on the surfaced of the earth. This is an accurate approach if the classification scheme is general. However, to map to the level required for the final product, it was necessary to use datasets that could further refine the unsupervised classification. In the development of the initial land cover, vegetation types on soils ranging from moist to very wet were purposely underestimated with the plan of using soil and wetlands information to improve the classification of mesic and wetland types. These were the four primary sources of ancillary data for the classification of South Carolina vegetation:

1. NWI: We used all five types of wetlands (Marine, Estuarine, Riverine, Lacustrine, and Palustrine) to varying degrees. Lacustrine aquatic beds and riverine aquatic beds were used to discriminate aquatic vegetation only. The marine unconsolidated shore class was used to develop a shore category only. Estuarine and palustrine classes were extensively used to improve wetlands and shore classification. See appendices for specific rules (see Appendix 4) and for NWI classes used in the rules (Appendix 5). NWI classes such as estuarine vs fresh marsh and salt marsh, fresh and salt water were used to improve our coastal map classification as well as helping to discriminate salt flat/salt shrub habitat; the sparse vegetation of salt flat/salt shrub is difficult to distinguish from satellite imagery. Palustrine forested and scrub/shrub classes were grouped into deciduous and evergreen forested wetland types and deciduous and evergreen scrub/shrub wetlands. These were used to improve classification of swamp, forested bottomland, wet scrub shrub and pocosin land cover types. Some NWI urban classes were helpful in mapping maritime forests associated with resort residential areas and golf courses, and NWI upland forest types assisted in the discrimination of natural evergreen forests from planted pine. Few final SC map classes were derived solely from NWI classification; most decisions were based on the initial general classification plus a wetlands or soil or both wetland and soil classification. Final map classes derived solely from NWI ancillary data include beaches, salt flat/salt shrub, salt vs fresh water, mud flats and spoil impoundments in the coastal plain and fresh water in the mountains. See Appendix 1 for a description of how each class was derived from ancillary data.

2. Soils: These formed a significant source of data for the mapping procedure, especially in refining mesic forest and shrub types from original classes and in developing a more accurate bottomland classification. Efforts to map a seepage shrub class based on soil slope and drainage proved unsatisfactory as did efforts to use soil complexes in our mapping effort. Alfisols (circum-neutral soils) were of limited assistance in the coastal plain, they are usually wet soils but didn't have consistently unique forest types. In the Piedmont, alfisols were used to model four new map classes, basic dry and basic mesic deciduous forests, and basic dry and basic mesic mixed forests. After the analysis, it was discovered that there was essentially no dry basic deciduous forest modeled (about 81 pixels). In the Piedmont, where it was difficult to discern narrow riparian habitat from satellite data, soils were very valuable in producing our Piedmont bottomland, narrow stream valley forests and floodplain forests. Additionally, soil types were used to produce a rocky shoals class (of very limited extent), rock outcrops, and to include water where not originally classified. Soil classes were also used with TRMI modeling (see

next section) in the mountains. In the coastal plain, specific soils were recognized as supporting maritime forests and were thus used to assist in mapping this particular land cover type.

3: Topographic Relative Moisture Index (TRMI) and other elevational data: A different set of ancillary data was undertaken for modeling in the Blue Ridge Province. We used digital elevation models (see Figure 5) to develop measures of slope, aspect, relative slope position, elevation and slope configuration. Using methods outlined in Halpin (1999) the above-mentioned variables were incorporated into an index referred to as TRMI. TRMI ranks each pixel according to its relative moisture. Values range from 0 – 60 with lower values indicating drier sites and higher values indicating more mesic sites (Parker 1982). TRMI, relative slope position, slope, slope configuration, elevation and soils were used as separate variables to model mountain communities. Predictive land cover distribution models were built based on patterns observed in ground-truthing points and published literature. Soils and TRMI were used to distinguish dry vs. mesic mixed and deciduous forest. Elevation, relative slope position and soils were used to model ridgetop/upper slope evergreen woodlands. Comparison of mapped landcover with ground-truthing data revealed that the original 29-class map often mapped steep upper-slopes as cultivated land or grassland/pasture, when in fact these areas were covered with dry deciduous forest. Decision rules were created to correct this problem by changing agricultural map classes on steep slopes (slope > 30 degrees) with upland forest soils to dry deciduous forest.

NWI wetlands data were not available for the entire region so were not used in modeling the Blue Ridge Province of South Carolina. This modeling process was also iterative, as described above. Shadows were a slight problem in the mountains. It was determined that they were generally found on north facing slopes that were probably mesic in nature. We made the assumption based on knowledge of the area that they consisted primarily of deciduous forests so if the slope was greater than about 3%, we converted the shadows to mesic deciduous forests. In a few cases, soil rules mistakenly converted new reservoirs to an inappropriate land cover. This occurred where the soil data pre-dated the creation of a lake. These were fixed by digitizing an AOI and manually converting the land cover back to water. There was interest in using geological information to classify cove forests, however, the digital geological data were too coarse and would have inconsistently mapped cove forests. We therefore used slope configuration, relative slope position and soil to produce our Deciduous Rich/Acidic Cove Forest. See Appendix 4 for rules incorporating TRMI values.

4. Ecoregion Delineation (see Figure 2): Ecoregion delineation was performed using elevation for mountains, soil types for sandhills/Piedmont fall line and NWI wetland information for salt water/fresh water. Elevation is generally accepted to be a good way to delineate the Blue Ridge mountain province. Although the Brevard Belt is considered to be the geologic boundary for the Blue Ridge, we decided that because montane vegetation continues southward we would use topography to define the mountain boundary. In developing the boundary we followed the edge of the Blue Ridge escarpment, south of which the elevation marked drops off into the piedmont. This line

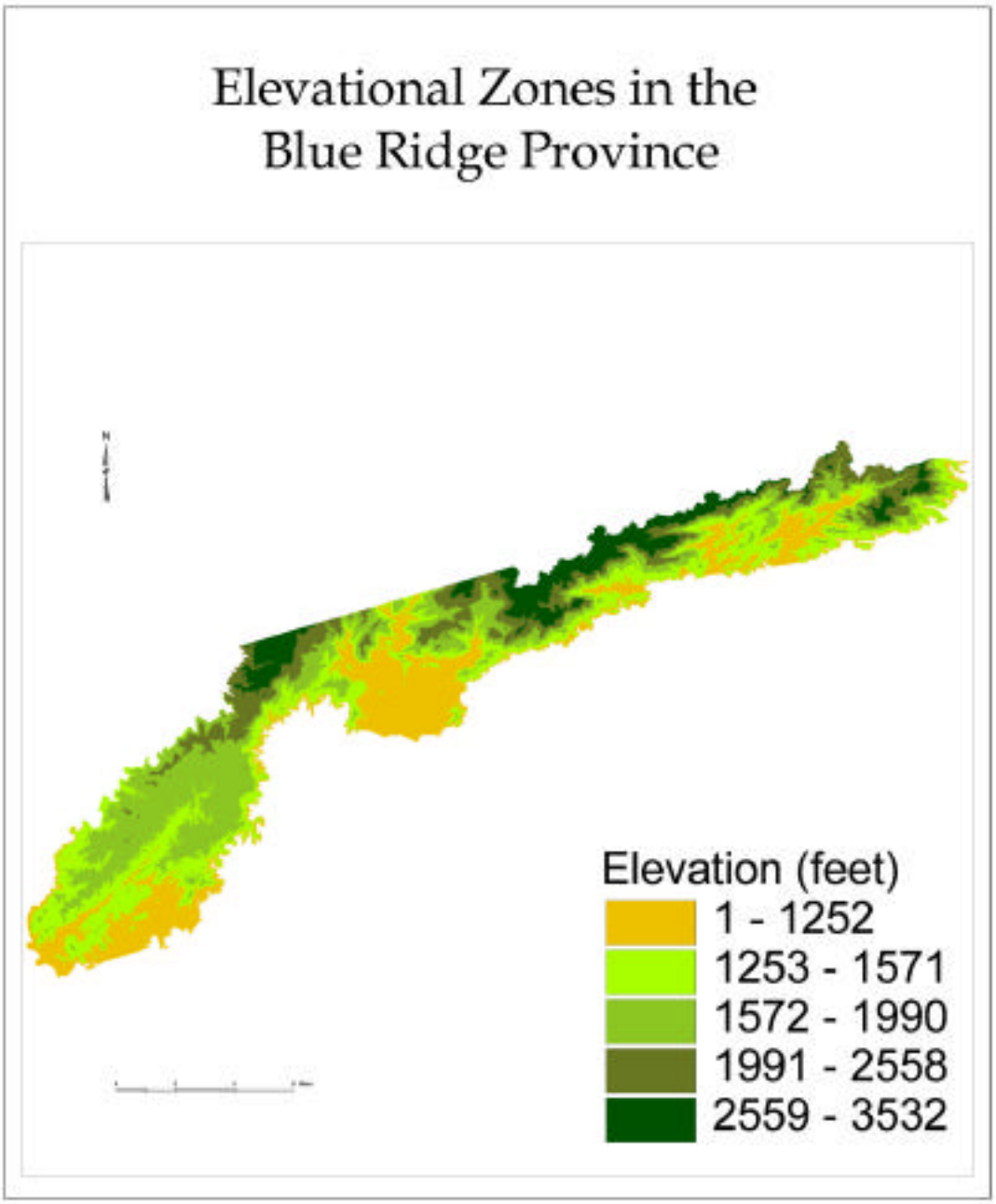


Figure 5. Elevation data used in modeling the Blue Ridge Province montane vegetation.

began with an elevation of 1000 feet at the western edge of the state and rose to 1200 feet at the eastern edge of Greenville county. We manually adjusted the boundary line to include specific regions generally accepted to be montane, such as the Keowee-Toxaway gorge and affiliated parks. Disjunct topographic ridge such as piedmont monadnocks occurring south of the escarpment were excluded from the mountain province. The sandhills region lies at the upper extent of the coastal plain and forms the boundary with the Piedmont. The soils undergo a fairly noticeable change from sandhills to Piedmont and were used to develop the Piedmont boundary. In some cases where they extended up a riparian corridor or traversed a heavily urbanized area, the boundary was simplified. For shore habitat, we used NWI as our primary source to discriminate between estuarine and palustrine land cover types but a boundary consisting of US17 was used to delineate habitat used by vertebrates that are strongly tied to marine waters and beaches.

Modeling of the Detailed Land Cover

Once the initial classification of the imagery was complete and the ancillary data prepared, we were ready to model the final, detailed map. This resulted in a 54-class detailed land cover. Because we improved many of the general classes used in the habitat map, we then merged the final 54 classes back into the more general 28-class habitat map for use in modeling. The initial land cover was, therefore, only used to produce a background on which to model the final two products. As we discuss the land covers that were produced by SC-GAP, we will refer to them as the initial map (classified from the TM imagery), the detailed map (54 classes produced with ancillary data) and the habitat map (the 28 class land cover used in the vertebrate modeling and all gap analyses).

The modeling of the vegetation using ancillary data was a highly iterative process. We used expert botanical knowledge, existing vegetation maps, and NAPP color aerial photographs in addition to digital data on soils and wetlands. Initially, four soil wetness classes were developed that were merged from detailed county soil digital data (see Appendix 5). Subsequently classes delineating circum-neutral soils, seep producing soils, water, complex soil types, and eventually specific regional soils were added. Figure 6 is an example of the map derived from generalized soil classes for Georgetown County. Classes from the National Wetlands Inventory were also merged and used to improve classification of both wetland and upland land cover types. We began by simply using soil wetness categories to convert upland deciduous forest to mesic deciduous and similar cases.

We also did a general conversion of many forest types to forested wetlands using both soil and NWI Palustrine Forested (PFO) classes; this provided a set of general 'swamp' forest types. Figure 7 shows the distribution of wetlands and uplands derived from our generalized NWI classes for Georgetown County. Although it proved impossible to distinguish the composition of the different 'swamp' classes derived from original map classes such as upland deciduous or mesic mixed, we maintained them as separate map classes to indicate their origin. This led to a series of land cover types with anomalous

names that reflected the original name such as swamp/upland pine deciduous oak understory or swamp/deciduous forest. For the gap analysis, these were eventually merged into a general bottomland forest type comprised of primarily deciduous classes, and others were incorporated into the wet evergreen map class. It is our hope that maintaining the origin of these bottomland types (for example Swamp/Bottomland Type 14 was originally land cover type 14 on very wet soil) may enable someone to eventually refine this classification.

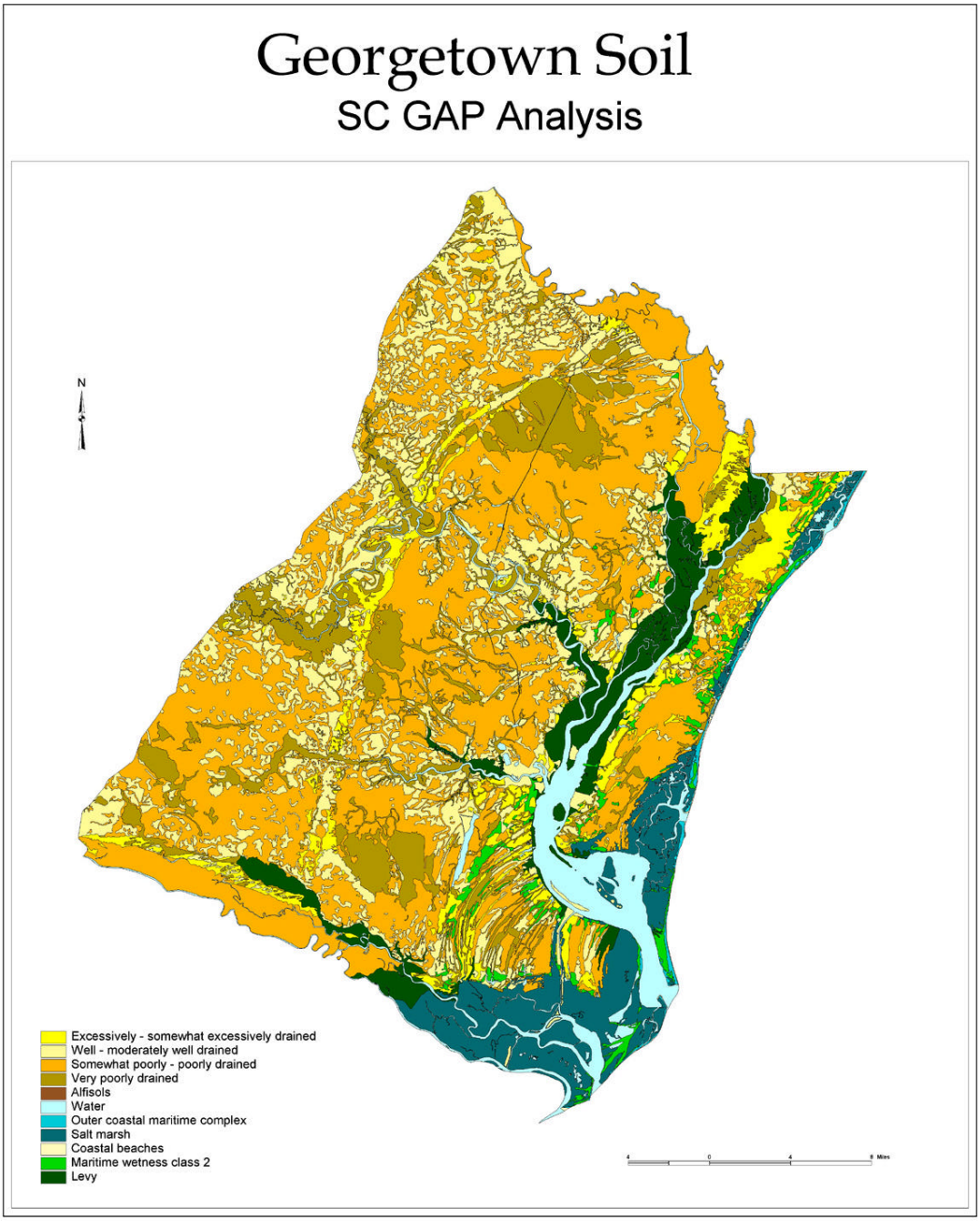


Figure 6. Depiction of general soil classification used in modeling detailed land cover. This map is for Georgetown County, one of eight coastal counties.

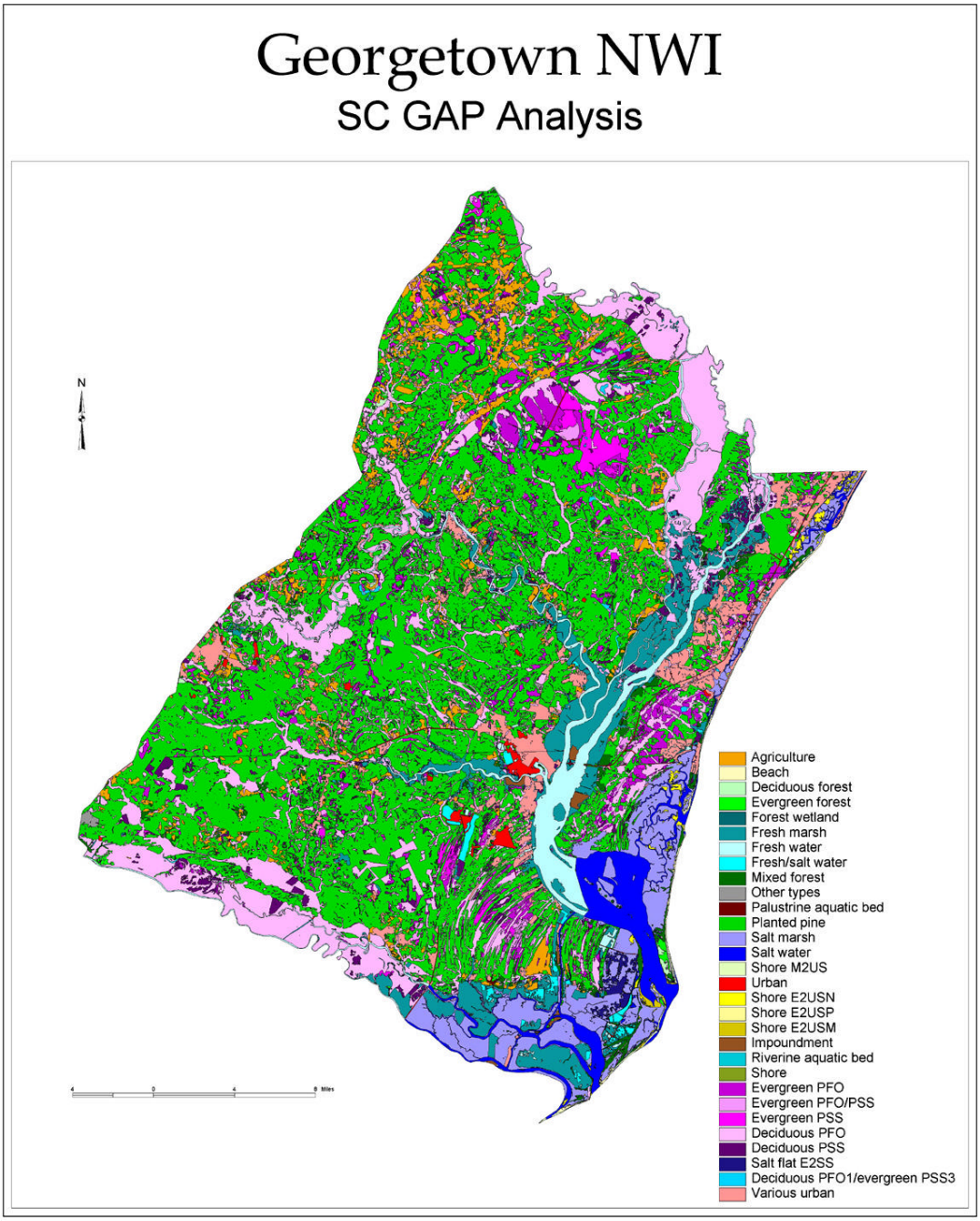


Figure 7. General NWI classes used in modeling detailed land cover. This example is from Georgetown County, one of the coastal counties.

We used both sets of ancillary data to remove common errors such as mistaking water for planted pine, mistaking clearcuts for cultivated land and to improve the classification of salt and fresh water, as well as the classification of marshes. We would examine the land cover for patterns and accuracy after each iteration of applying the decision rules and then would change the rules accordingly. We used botanical knowledge of the state, NAPP color infrared photos and site visits to assess the results of each modeling iteration. In addition to checking our accuracy, this process helped us to understand the relationship of NWI and soil types to actual land cover and to add new rules and change the priorities. Eventually we ended up with the set of rules found in Appendix 4 arranged by priority of application. Some areas of the Piedmont and mountains were missing NWI information; for these areas in the Piedmont, soil data alone were used in the modeling. In the mountains, soils were used in conjunction with TRMI.

During the development of the land cover we made site visits to problem areas, consulted color aerial NAPP photos, consulted with public land managers, and used available smaller area maps to improve our modeling procedure. As we reached the end, we did a cross-tabulation of original land cover, NWI wetland type, soil type and resulting classification to analyze problems and potential changes to the rules. This resulted in a few changes to the decision rules and an understanding of some common mis-classifications that are understandable and relatively minor.

When we began the classification of TM data into our original 28-class map, we made the effort to delineate some potentially useful classes such as ecotone boundary and stream margins. Additionally, a dataset of Carolina Bays had been developed by the SCDNR Heritage Trust program (Bennett and Nelson 1991), this was digitized into the land cover. The Ecotone Boundary class was mapped when the classifier could discriminate shadows falling from forested habitat onto cleared land, either cultivated or pasture. At the end, however, it was clear that this class was unevenly discriminated and of little extent. This made it inappropriate to use in a statewide map.

The Stream Margin class was produced by buffering classified pixels identified as water for a width of 30 meters (one pixel) and re-classifying this as 'stream margin.' This proved to be un-useable because the buffer was placed around all pixels identified as fresh water and thus we had a Stream Margin around small bodies of water such as farm ponds as well as very large lakes. In addition, original habitat type was lost, so there was no indication whether the stream margin consisted of cleared land, deciduous forest, evergreen woodland, or any other class. It was decided to remove this class as well, and return to the original classification and attempt to buffer streams at a later date.

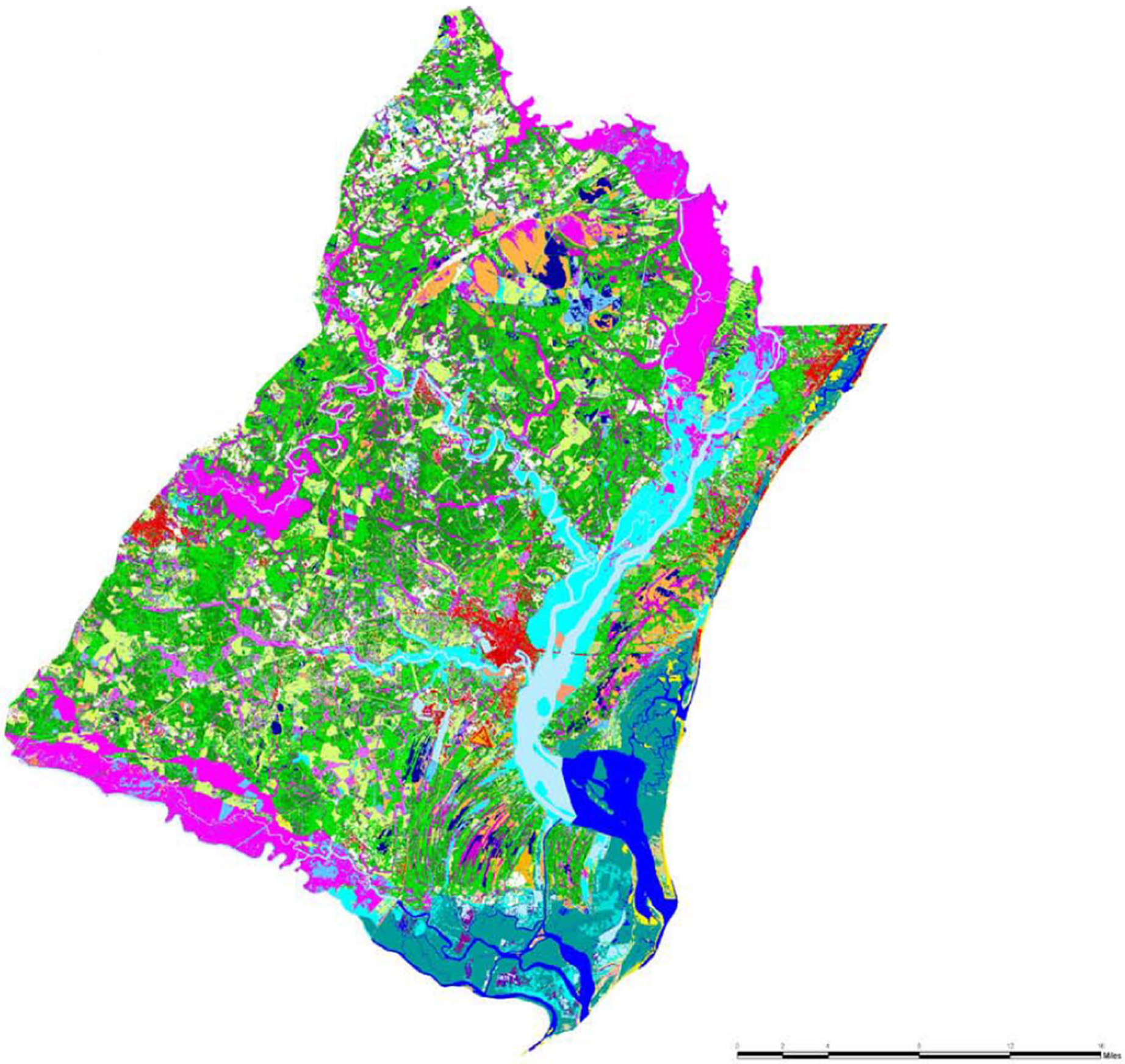
The Carolina Bays were hand-digitized onto the land cover using center points from the report (SCDNR 1999) and the original TM data to recognize the characteristic oval shape. These clusters were then labeled as 'Carolina Bay.' Unfortunately, the accompanying report had little vegetation information attached to each bay, and the land cover now lacked any information as to the diversity of land cover types within the bay. It was determined to return to the original classification for these areas as well and retain the Carolina Bay data as a separate coverage.

Maritime forest was delineated in an early version of the map in an incorrect manner; this was also remedied in the following manner. It was necessary to replace the pixels that were changed to maritime forest, Carolina Bays and stream margin with an earlier classification that had the original land cover types. To do this, an earlier version of the land cover was mosaicked with the latest version for the subset of pixels that were incorrectly changed. This earlier version was the modified according to the decision rules. To re-classify ecotone boundary pixels, a nearest neighbor analysis was used since the class Ecotone Boundary was described in the intial classification. The maritime class in the vertebrate habitat map was derived from the detailed 54-class land cover.

The vegetation modeling was carried out on a county level using the four ancillary datasets. This resulted in a set of 46 land cover maps for all counties that were subsequently mosaicked together (see Figure 8 for an example county land cover). This process resulted in a number of slivers that were removed using a nearest neighbor analysis. Map units seem to match well across county boundaries and so little correction was required for this.

Georgetown Land Cover

SC GAP Analysis



- Aquatic vegetation
- Beach
- Closed canopy evergreen forest/woodland
- Coastal upland mixed forest
- Cultivated land
- Dry deciduous forest/woodland
- Dry mixed forest/woodland
- Dry scrub/shrub thicket
- Estuarine salt flat/salt shrub thicket
- Fresh water
- Fresh water marsh/emergent wetland
- Grassland/pasture
- Intertidal beach
- Low density residential
- Marine water
- Maritime shrub complex
- Mesic deciduous forest/woodland
- Mesic mixed forest/woodland
- Mud/sand flat
- Needle-leaved evergreen mixed forest/woodland
- Open canopy/recently cleared forest
- Pine woodland
- Pocosin
- Salt and brackish marsh
- Sandy bare soil
- Spoil deposit/impoundment
- Swamp/bottomland hardwood forest
- Swamp/bottomland type 14
- Swamp/bottomland type 15
- Swamp/bottomland type 16
- Swamp/bottomland type 17
- Swamp/bottomland type 18
- Swamp/bottomland type 19
- Urban development
- Urban residential
- Wet evergreen
- Wet maritime forest
- Wet pinewoods
- Wet scrub/shrub thicket
- Wet soil

Figure 8. A detailed land cover of Georgetown County.

As the map was finalized and visually checked, it became apparent that certain AOIs had been classified differently in the original clustering and identification than the surrounding AOIs. This resulted in areas of markedly different composition that matched HUC boundaries. In one case, the urban map class was greatly overestimated, whereas the surrounding HUCs were predominantly cultivated land; in another, closed canopy pine predominated in an area of mixed forested classes. Another case involved an overestimation of mixed forest. We attempted to correct some of these errors with decision rules that would work statewide to correct similar errors. For example, we removed urban classes in the land cover by using NWI polygons that were mapped as cultivated land; this greatly improved the one misclassified AOI. In most cases, since these problems were errors resulting from the original classification of TM imagery, there was little we could do, and we decided not to reclassify to remove these errors. We feel that these errors indicate a trend for a particular AOI that was overemphasized but is not completely wrong. For example, an AOI that covers a large part of the mountain region is classified as 'Closed-canopy Evergreen' with little other forest or woodland classes, and the boundary of the AOI is visually obvious. However, a comparison with other data sources indicated that this particular area is dominated by evergreen forests. Although it is clear that we underestimated hardwoods in that particular area, we feel the error was within reason and reflected the nature of the particular area. In general, the AOI-related errors may emphasize real patterns that differ with surrounding habitat. The problem is that distinct boundaries were produced rather than a soft edge as would naturally occur between different land cover types in transition. The errors do not, however, necessarily misrepresent the predominant cover type.

We used NWI salt and fresh marsh to differentiate between these two types and also to convert original land cover types to salt or fresh marsh. When NWI indicated impoundment, we were unable to convert fresh to salt marsh and vice versa. This led to a mixed pixel effect where fresh marsh shows up in salt marsh and salt marsh within fresh. Rather than digitize changes to the surrounding marsh type, we left the mixed pixels to indicate human alteration of the landscape. Nearly all impoundments within the area of salt water are brackish in nature.

After the land cover modeling was complete, a final round of hand-digitizing was used to fix significant errors in well-known areas of the coastal plain. Due to mosaicking county coverages, mismatch of soil polygons with land cover types, and mismatch of NWI and soils, some pixels were not modeled, such as salt and fresh marsh. These were adjusted by hand where appropriate and where the omission was obvious. Sometimes pixels were missing – these were replaced by nearest neighbor analysis.

Special Feature Mapping

In order to map maritime forests, we depended greatly on soil type and on distribution in the coastal area. Several types of soils were distinguished: 7MF soils were originally designated as the barrier island soils and 51MF were the outer coastal, but non-barrier island soils. The 7MF soils are complexes and no wetness class was assigned because they are a usually a mix of excessively well drained soils and very poorly drained soils occurring on the old dune ridges and swales of barrier islands.

However, even with the 7MF soil decision rules, we determined that maritime forests were still underrepresented. We found other soils that were definitely/strongly outer coastal soils that typically support maritime forests, and we developed classes 7MF1 and 7MF3 to reflect the wetness classes of these soils. The designation of 7MF was maintained because it was the code for maritime soils. These were then used to map the four classes of maritime land cover types. Please refer to the decision rules and class descriptions (see Appendices 1 and 4) for more information.

But, it still didn't help with the outer coastal forests that were quite maritime in nature, formerly called Inland Maritime Forests by the TNC Southeast Regional Classification (precursor to the TNC Global Classification). They were referred to as "inland maritime forests" because they didn't occur on barrier islands. This concept was based on North Carolina coastal forests. Our work in SC showed that in the lower coastal areas, the "inland maritime forest" concept applies to forests well inland from the direct influence of salt spray. They occur as far inland as US Highway 17. Therefore, to avoid the issue of inland versus barrier island "maritime," we named this forest type "Coastal Upland Mixed Forest." Soils east of US 17 that support mostly evergreen forests of a maritime nature were classified as 51MF. Since these soils aren't complexes, wetness classes could be appended and utilized in the decision rules.

Results

The SC-GAP land cover consists of two versions, a general 27-class land cover (see Table 4 and Figure 9) based on vertebrate habitat affinities and a detailed land cover consisting of 54 classes (see Figure 10). Appendix 5 contains a crosswalk from classes in the general land cover to the derived detailed classes. The general difference between the two land covers is a more detailed treatment of wetlands, coastal habitat and maritime forests. For example, there are 15 wetland map types in the detailed map, including marsh and swamp/bottomland, as compared with 6 in the general map. There are 4 kinds of maritime forests in the detailed vs. 1 in the general map and 6 coastal habitats such as intertidal beach, salt flat/salt shrub, vs 2 (marine water and beach) in the general land cover. In the detailed 54-class map, we felt that we were taking remotely sensed mapping as far as it could go and this was only possible due to the availability of excellent ancillary data. While the accuracy assessment doesn't address the accuracy of the detailed land cover, it gives a general idea of the usefulness of the data.

In meeting with land managers and botanists within South Carolina, we find that the map has been perceived as being very useful in describing patterns of vegetation within certain areas. Known patches of wet evergreen, for example, have been mapped on our land cover and can be found in relation to surrounding areas. The purpose for the gap analysis process is to provide large area maps on which to base decisions for these areas and to provide a basis for further mapping efforts. We have come to realize the importance of our land cover and our ancillary data sets for visualizing patterns on the landscape. These patterns indicate areas for potential future studies and fieldwork.

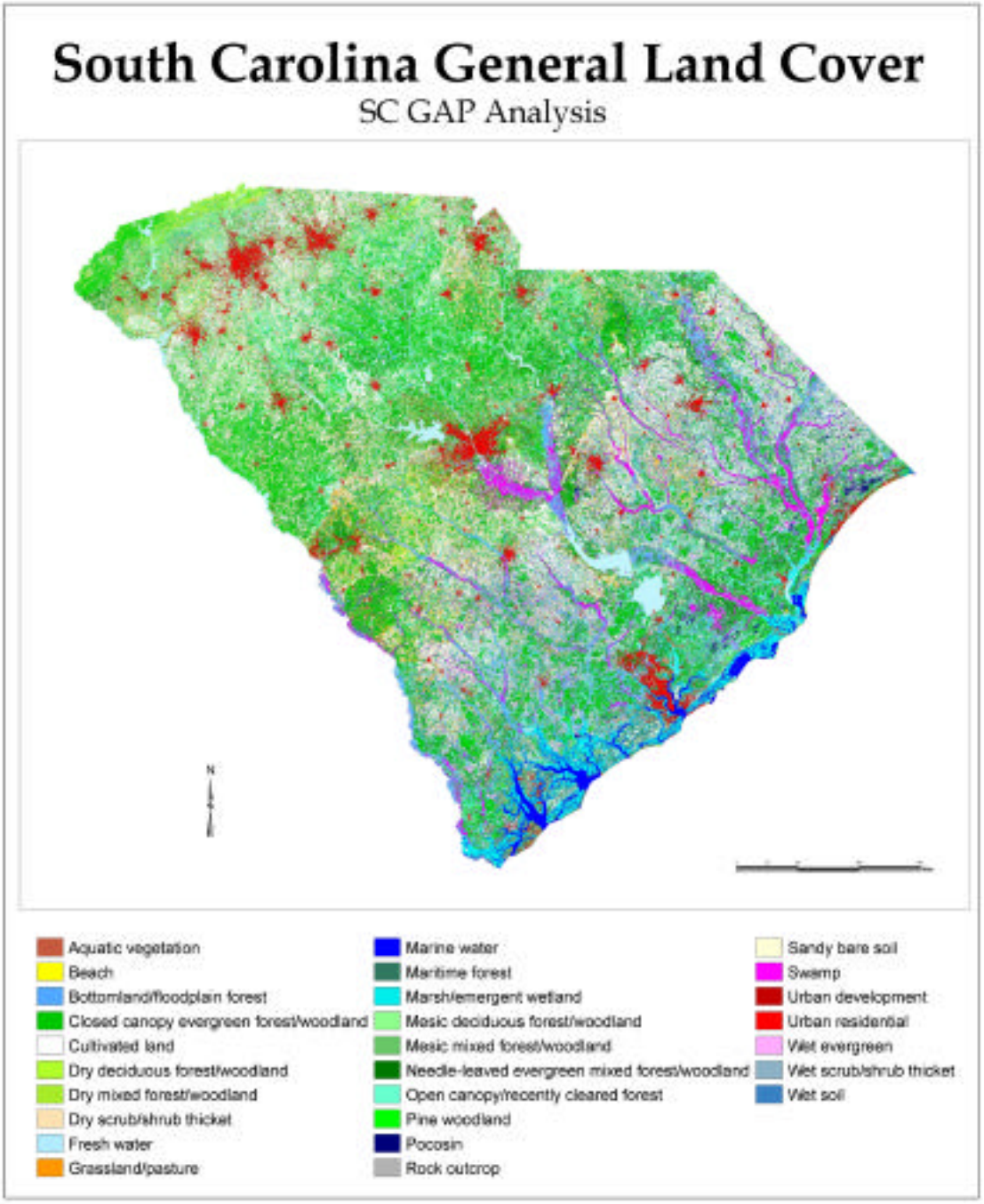


Figure 9. The 27-class general land cover used for modeling vertebrate species.

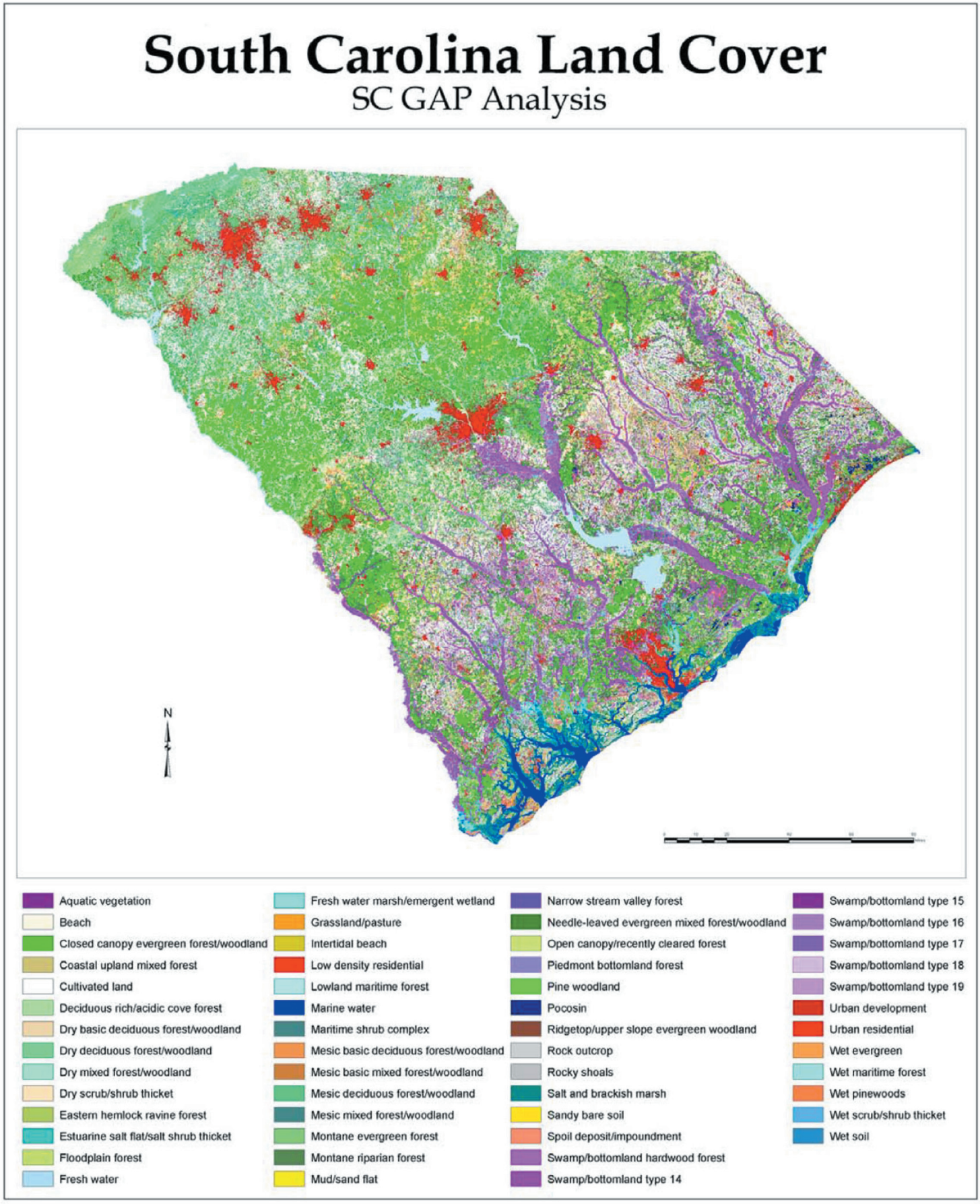


Figure 10. The detailed land cover consisting of 54 classes.

Table 4. The land cover types mapped, their area in square kilometers (multiply by 100 for hectares or 270 for acres), and the percent of the state's total area represented by the mapped type.

Mapped Type	Total Area	Percent of State
Fresh Water	2361	2.9
Marine Water	1032	1.3
Marsh	2073	2.6
Pocosin	365	0
Swamp	3075	3.8
Bottomland	8185	10.1
Wet Soil	225	0.3
Wet Scrub/Shrub	2387	3.0
Dry Scrub/Shrub	5273	6.5
Sandy Bare Soil	63	0
Recently Cleared	5960	7.4
Rock Outcrop	16	0
Aquatic Vegetation	34	0
Closed Canopy Evergreen	10928	13.5
Evergreen Mixed	7937	9.8
Pine Woodland	713	1.0
Dry Deciduous	695	1.0
Mesic Deciduous	7909	9.8
Dry Mixed	291	0.3
Mesic Mixed	892	1.1
Grassland/Pasture	2197	2.7
Cultivated Land	12310	15.2
Urban Development	1308	1.6
Urban Residential	2446	3.0
Wet Evergreen	1455	1.8
Maritime Forest	655	0.8
Beach	30	0

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 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 where products are made available to others, 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.

Methods

The accuracy assessment will inform users of the land cover map's suitability for their particular purpose. The goal of accuracy assessment was to assess thematic accuracy of the South Carolina 27-class vertebrate land cover map. Accuracy assessment is a major undertaking, requiring large sample sizes of reference data against which to compare classified map categories. South Carolina Gap accuracy assessment methodology was designed so that sample size could be maximized, while minimizing cost and time. Utilization of remote sensing imagery, such as 1994 NAPP photography, 1994 digital ortho photo quarter-quadrangles (DOQQ's), and 2000 aerial videography, allowed for more efficient classification of sites where feasible. Additionally, sample size was increased by incorporating a separate dataset of ground-truthed vegetation survey points contributed by Leslie Parris, as a part of her Master's thesis work on fire ant invasion

patterns. The methodologies employed for both sets of data, ant survey work and gap survey work, are presented separately below.

Ant Habitat Survey Dataset

Statewide ant habitat sampling in South Carolina was stratified by four physiogeographic regions: mountain, piedmont, sandhills, and coastal plain (Barry 1980 and SC-GAP) (see Figure 2). The regions were delineated on the ground by topographic features and state, county and national forest boundaries. The SC-GAP sandhills coverage was used for verifying the delineation of the sandhills region. The Nature Conservancy's North American Ecoregion Classification Map (ABI 2001) was used to verify the mountain, piedmont, and coastal plains regions delineation.

In addition to region, ant habitat sampling was further stratified by land cover type. SC-GAP provided the original spectrally-derived 29-class land cover map in raster format. Using this land cover, all vegetative land cover classes and an urban land cover class were selected for ant habitat sampling. Not all land cover classes were represented in each region.

Vegetative land covers included: freshwater and saltwater marsh (MARSH), Carolina bay (BAY), swamp/bottomland hardwood forest (SWPBHW), cleared forest (CLEAR), upland pine forest (UPLDPN), pine woodland (LLPINE), upland (UPLDDEC) and mesic (MESDEC) deciduous forest, upland (UPLDMX) and mesic (MESMX) mixed forest, grassland (GRASS), cultivated land (CULT), beach (BEACH) and maritime forest (MARIT).

Statewide ant habitat sampling was conducted at 364 locations with sampling of 16 distinct land cover types (see Table 5). During the summer of 1999, sampling was completed in the mountain region from May to August. Nine distinct land cover types were sampled in the mountain region with an average of 10 replicates per land cover type, totaling 86 sampling locations. Piedmont region ant habitat sampling was completed during the late summer and early fall of 1999. Sampling was conducted from August to October at 89 locations. Ten land covers were sampled in the piedmont region, with approximately ten replicates of each land cover type. During the summer of 2000, sampling was completed in the coastal plains region from May to August at 111 locations. Eleven land cover types, with ten replicates of each, were sampled in the coastal plains. Sandhills region was completed in the late summer and fall of 2000. Eight distinct land cover types were sampled, and the number of replicates of each land cover ranged from 8 to 11, totaling 78 sampling locations. Variation in the number of replicates sampled is attributed to the availability of each land cover type and accessibility to the land cover.

SC GAP's original land cover, roads coverage and public-property boundary coverage were used in the site-selection process. Land cover grid and road coverage were overlayed and used to determine the quantity and accessibility of the different habitat types.

Table 5. Number of ant habitat sampling replicates in the mountain, piedmont, coastal plains and sandhills regions of South Carolina, partitioned by land cover class, 1999-2000. (RECAREA = recreation area, MARSH = freshwater and saltwater marsh, BAY = Carolina bay, SWPBHW = swamp/bottomland hardwood forest, BEACH = beach, CLEAR = cleared forest, UPLDPN = upland pine forest, LLPINE = pine woodland, UPLDDEC = upland deciduous forest, MESDEC = mesic deciduous forest, UPLDMX = upland mixed forest, MESMX = mesic mixed forest, GRASS = grassland/pasture, CULT = cultivated land, MARIT = maritime forest.)

	Region			
Land cover class	Mountain	Piedmont	Coastal plains	Sandhills
RECAREA	9	10	10	10
MARSH	0	0	11	0
BAY	0	0	0	8
SWPBHW	0	10	10	10
BEACH	0	0	10	0
CLEAR	5	10	10	11
UPLDPN	8	10	10	10
LLPINE	0	0	11	0
UPLDDEC	10	10	0	10
MESDEC	10	9	10	0
UPLDMX	27	10	0	0
MESMX	10	9	0	0
GRASS	3	10	10	11
CULT	4	1	10	8
MARIT	0	0	9	0
Total	86	89	111	78

Once available land covers were identified in each of the four regions, ant habitat sampling sites were selected with the aid of the coverages and a systematic evaluation of land cover types on the ground. Potential ant habitat sampling locations were identified on the SC-GAP land cover map, based on land cover class, and then visited by vehicle to evaluate sampling suitability. Potential sampling sites were surveyed at a distance of 50m from the road, to determine if the land cover was contiguous at least 30m in all directions. Habitat patches, of a single contiguous land cover type, $\geq$60m x 80m, qualified as suitable and were then selected for ant habitat sampling.

Ants were sampled on public lands managed by the U.S. Fish and Wildlife Service, U.S. Forest Service, U. S. National Park Service, South Carolina Department of Parks, Recreation and Tourism, South Carolina Department Natural Resources, Duke Power, Baruch Marine Institute, Fort Jackson Military Reserve, and private land owners, such as Nemours Foundation. The distance driven between sampling locations was standardized based the size of the property. Sampling locations were separated by one

mile within relatively small tracts of land (≤# ha), such as state parks and heritage preserves, and by two miles within larger tracts of land, including national forests and national wildlife refuges.

Data collected at each sampling site included fire ant presence/absence, fire ant index of abundance, region, county, date, temperature, estimated maximum vegetation height, aspect and degree of slope, road type, percent canopy cover, dominant canopy species, percent understory cover, dominant understory species, location description, property ownership, transect orientation and land cover type corresponding to the SC-GAPer land cover class descriptions. These data were used as part of the accuracy assessment of the general land cover. A Trimble Geoexplorer II GPS unit (Trimble, Sunnyvale, CA) was used to collect geographic positions on roadsides corresponding to each transect location. The data were downloaded, differentially corrected, and exported with Pathfinder 2.1 software (Trimble, Sunnyvale, CA).

At each site, GPS coordinates were recorded roadside at the beginning of the transect. Vegetation survey data was documented for a 30x30m area at a distance of 50m along the transect. To adjust for the spatial discrepancy between GPS location and vegetation survey location, GPS points were subsequently offset by a distance of 50m along the orientation of the transect. Once the final 27-class vertebrate land cover map had been completed, the offset GPS points were overlaid onto the vertebrate map, and the classified land cover at each survey point was recorded. Only 299 of the total 364 ant survey points were utilized for SC-GAP accuracy assessment. Excluded points were those that lacked transect orientation and/or land cover interpretation. The 29-class land cover map used by the ant survey differed slightly from the final SC Gap 27-class land cover map. The ant survey project leader, who had visited most sites in the field, crosswalked reference sample points from the old to new classification. For most land cover classes, the crosswalk simply involved a change in numeric land cover code. However, four land cover classes required some reinterpretation: pocosins, beaches, swamps, and bottomlands. The original map lumped all forms of Carolina bay vegetation including marshes, pocosins, and swamps into a single class. Beaches were originally included in the sandy bare soil class. Swamps and bottomlands were grouped into a single class in the original map. To reclassify survey points falling into one of the above-mentioned reference classes, field notes and digital photographs were reviewed and in some cases NAPP photography was examined.

Gap Survey Dataset

Aerial videography has been employed as a standard methodology by a number of GAP projects to aid in discernment of reference land cover classes. Although videography requires an initial investment in equipment and training of interpreters, it can significantly reduce the time and cost of reference data collection (Gap Analysis Program 2000). For SC-GAP land cover accuracy assessment, the US Fish and Wildlife Service provided necessary equipment for interpretation of videography. In the fall of 2000, SC-GAP, in conjunction with the GA-GAP, hired Dana Slaymaker to fly aerial video transects across both states. Transects were set up so that each physiographic province would be covered (see Figure 11).

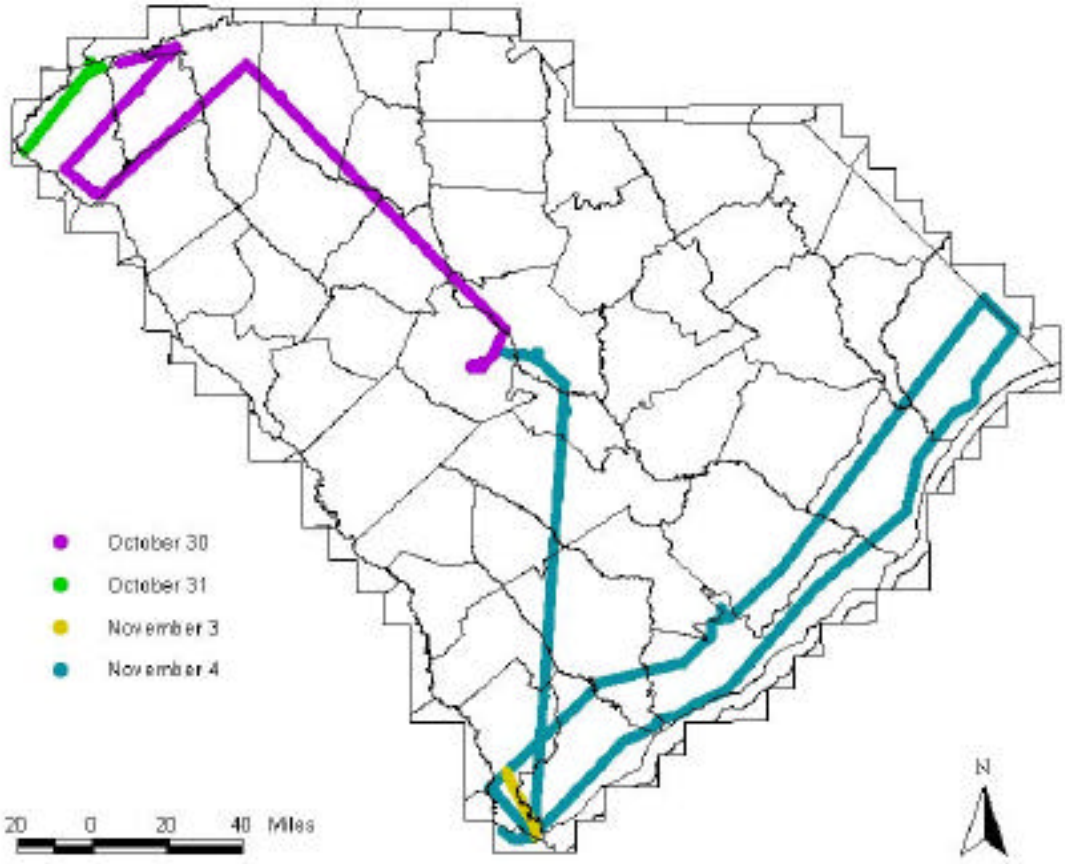


Figure 11. Flightlines used to obtain aerial videography for accuracy assessment of SC-GAPland cover

During the course of aerial videography flights, two digital video cameras -- one set to 12x zoom and the other to wide-angle -- recorded land cover on the ground below. A global positioning system (GPS) recorded the airplane's coordinates and matched each set of coordinates with a time-code. Positional accuracy of coordinates were improved from +/- 70 meters to +/- 5 meters by adjusting for variability in elevation above ground and tip/tilt of the plane using a gyroscope and laser imaging of the topography.

The data produced by aerial videography flights were a series of wide and zoom angle digital videotapes, each with time-codes recorded in the audio tracks. Time-codes were matched to ground coordinates so that video frames could be aligned with the correct positions on the ground.

During the course of aerial video interpretation, the interpreter played back the wide and zoom images through digital video recorders onto a pair of monitors. Clips of video crossing sample polygons were saved onto a PC using MotoDV Version 1.4 software (Digital Origin, Inc., Mountain View, CA, 1999). Individual frames were extracted from the video clips using VisFrameX1_1.exe software supplied by Dana Slaymaker. For each interpreted videography sample site, the movie clip usually along with one or more representative video frames were archived on CD-ROM.

The sample units chosen for assessment were contiguous groups of like-classified pixels. Clusters, not pixels, were chosen as the sample unit because typically adjacent pixels are not classified independently of one another. Clusters of pixels were converted into polygons, so that each polygon represents a sample unit.

The goal was to classify all points to the level of the 54-class detailed map where possible. Although we did not collect sufficient samples to adequately present the accuracy assessment results at the 54-class level, it is hoped that the more detailed reference data will be of use to investigators in the future.

In order to ensure adequate sample sizes for all classes, including rare types, sampling was stratified by vertebrate land cover class. The necessary sample size was arrived at using the equations below:

$$n = \frac{Np(1-p)}{Ns^2 + p(1-p)}$$

where N is the total number of polygons.

As the number of map polygons (N) becomes large, the finite population correction factor is close to 1, so the previous equation becomes:

$$n = \frac{p(1-p)}{s^2}$$

Using this last sample size formula with a conservative presumed accuracy of 50% (p=0.5) results in a required sample size of no more than 40 samples per land cover type

to meet the National GAP criterion of a standard error of 8% (Crist and Deitner 2000). Due to time constraints, we used a slightly lower required sample size of 30 polygons per class. As stated above, incorporation of the ant survey data increased sample sizes, but some classes still had less than 30 samples. Sample sizes, relative acreages, and standard errors of each class are provided in the results.

To minimize the influence of spatial accuracy on thematic accuracy, polygon edges were avoided by leaving a one-pixel buffer of like-classified pixels around each sampled polygon. Clusters of dimension three-by-three pixels or larger were selected, and polygon boundaries were drawn inside of the one-pixel buffer. This was accomplished by using the ArcView 3.2 neighborhood analysis program to create a grid of "variety" values based on the 58-class detailed land cover. The neighborhood was defined as a 3x3 pixel area; a value was assigned to each pixel in the land cover, based on the number of differently classified pixels within the neighborhood surrounding the pixel. For example, a pixel of marsh surrounded on all sides by other marsh pixels would be given a variety of one. A pixel of marsh surrounded by five pixels of marsh and three pixels of fresh water would be given a value of two. Pixels with a value of one are those that are surrounded on all sides by like-classified pixels within a minimum of a 3x3 pixel area. Once the variety grid had been created, it was converted to a polygon coverage and was used to clip the land cover into polygons. The resultant polygons varied in size from one to many pixels, but each polygon was surrounded on all sides by a one-pixel buffer area. These polygons are hereafter referred to as being of dimensions 3x3 pixels or larger, because the total size of the pixel cluster was larger than 3x3. This approach did not provide for a sufficient number of sample sites in certain classes. For these classes, polygons smaller than 3x3 pixels in dimension were accepted, and the one-pixel buffer was not added. The relative allocation of sampling to small and large polygons is shown along with the accuracy for each map class in Table 6.

National GAP recognizes that in order to maximize efficiency, it is often helpful to subset the entire set of polygons so that the entire state is not considered the sample universe (Crist et al. 2000). In South Carolina, we subset polygons by intersection with roads and/or videography flight paths. For map classes having >30 polygons along the flight path, an initial set of approximately five video training points was randomly chosen from the population of polygons intersecting with both roads and flight paths. These training sites were visited on the ground in order to familiarize the interpreter with the representation of different land cover types on aerial videography. Training sites were included in the accuracy assessment. Once training sites had been selected, additional accuracy assessment points were randomly chosen from the population of polygons intersecting with the videography flight path. For those classes with fewer than 30 polygons along the flight path, such as rock outcrops, aquatic vegetation, and beaches, additional sample sites were randomly chosen from the entire population of polygons for accuracy assessment using other methods.

Table 6. The relative amount and accuracy of small vs. large polygons used in the accuracy assessment

	Small Polygons			Large Polygons		
Mapped Class	*n*	Accuracy	Standard error	*n*	Accuracy	Standard error
1	0			33	84.85%	6.24%
2	17	47.06%	12.11%	13	84.62%	10.01%
3	0			30	90.00%	5.48%
4	15	0.00%	0.00%	13	15.38%	10.01%
6	0			17	70.59%	11.05%
7	20	60.00%	10.95%	8	37.50%	17.12%
8	20	15.00%	7.98%	10	50.00%	15.81%
9	23	4.35%	4.25%	5	0.00%	0.00%
10	3	0.00%	0.00%	24	20.83%	8.29%
11	28	10.71%	5.85%	1	0.00%	0.00%
12	0			24	37.50%	9.88%
13	20	5.00%	4.87%	11	18.18%	11.63%
14	26	3.85%	3.77%	3	0.00%	0.00%
15	1	0.00%	0.00%	29	58.62%	9.15%
16	0			11	0.00%	0.00%
17	21	14.29%	7.64%	2	50.00%	35.36%
18	17	17.65%	9.25%	0		
19	0			14	14.29%	9.35%
20	25	24.00%	8.54%	0		
21	31	6.45%	4.41%	0		
22	23	13.04%	7.02%	3	0.00%	0.00%
23	0			31	64.52%	8.59%
24	9	11.11%	10.48%	19	42.11%	11.33%
25	12	33.33%	13.61%	17	64.71%	11.59%
27	6	16.67%	15.21%	19	42.11%	11.33%
28	0			31	74.19%	7.86%
29	12	41.67%	14.23%	13	84.62%	10.01%
Overall Unweighted Accuracy:	329	17.33%	2.09%	381	53.81%	2.55%

Video Interpretation

Once samples had been chosen, video training and interpretation began. The interpreter attempted to classify each polygon to the level of the 54-class detailed map. Where unable to classify at this level, sites were classified to either the vertebrate map level or Anderson Level II. Appendix 6 provides a crosswalk among the map class levels.

Individual canopy species can often be distinguished by interpretation of aerial videography (see VA-GAP for an example of training methodology). However, species recognition requires some initial training. At the beginning of the accuracy assessment process in South Carolina, the interpreter visited a selection of accuracy assessment points in the field and also viewed their corresponding aerial video imagery. An attempt was made to learn the recognition of diagnostic canopy species for each map class (Slaymaker et al 1996). After training, the interpreter used aerial video to classify only those sites where he/she felt comfortable identifying the dominant or diagnostic species. One class for which aerial videography was heavily utilized was maritime forests, where live oaks, juniper, and palmetto trees stand out on the video. For many classes, even with some training, the interpreter did not feel comfortable classifying sites based on aerial videography. These sites were then visited in the field where possible; where field visits were not possible, the sites were excluded from the accuracy assessment sample points.

Sites were classified using one or more of three methods – 1994 DOQQ/NAPP, 2000 aerial videography, or field visit. Regardless of which interpretation method was utilized, there were some general guidelines for interpretation:

- When dealing with mixed polygons, interpretation was based on the dominant land cover. If no clear dominant was observed, the polygon was thrown out.
- If the polygon could not be interpreted based on DOQQ/NAPP imagery, and a field visit or aerial videography revealed that the polygon had been altered from a prior land cover, an attempt was made to classify the site as it had been at the time of the satellite imagery. For example, often a portion of a site would be clearcut, but the rest of the site would remain in its original condition. These sites were classified according to their original condition rather than their current status. Where it was impossible or questionable to interpret the prior condition of an altered site, the polygon was not interpreted.
- Sites that could not be interpreted for one of the above-mentioned reasons or for other reasons, were not included in the accuracy assessment.
- To ensure consistency in interpretation, a key to the detail map classes was created. For certain detailed map classes, species overlap was such that interpretation was limited to the habitat level. Affected classes were basic versus non-basic forest types, which could not usually be distinguished either on the ground or through remotely sensed imagery. Swamp/bottomland classes, which were separated in the habitat map but collapsed in the detail map, were always classified at the habitat level.
- Notes were made describing general characteristics of each polygon, including descriptions of secondary land cover classes present within the polygon.

For each site, the interpreter overlaid the sample polygon onto the appropriate 1994 DOQQ in ArcView, and also examined the corresponding 1994 color infra-red NAPP photo. If possible, the interpreter classified the land cover based on this imagery. The centroid of the interpreted polygon was recorded as the accuracy assessment point. Map classes such as urban residential, urban development, water, sandy bare soil, spoil deposits/impoundments, beaches, pine plantations, cultivated land, and other sparsely vegetated or non-natural classes could usually be interpreted from DOQQ/NAPP imagery.

If unable to classify the site without more detailed imagery, aerial videography was utilized for sites where it was available. The interpreter viewed both the wide angle and zoom imagery for the clip of video intersecting the polygon, and saved this clip as a movie (.mov file) using MotoDV Version 1.4 software (Digital Origin, Inc., Mountain View, CA, 1999). Individual frames within the movie clip were extracted using Mosaiker software supplied by Dana Slaymaker (VisFrameX1_1.exesoftware). If the interpreter was able to classify the land cover based on the video, the GPS coordinates of the most representative video frame were recorded as the sample point. For each interpreted videography sample site, the movie clip and sometimes also one or more representative frames were archived on CD-ROM.

If the interpreter was unable to classify a site using aerial videography or DOQQ/NAPP imagery, a field visit was attempted. When surveying sites in the field, the interpreter navigated to a pre-selected waypoint within the dominant land cover of the polygon. To avoid property access issues, waypoints were typically placed along roadsides. At the waypoint, the surveyor noted dominant and/or diagnostic species; recorded general site characteristics; took a digital photo showing overall stand structure; and assigned the appropriate land cover class at either the detail or vertebrate map level. To prevent field surveys from straying outside of the polygon or being biased by small-patch inclusions of non-dominant land cover types, the surveyor brought a hardcopy image of the DOQQ with the site's boundaries overlaid. The area covered by the field survey was greater than the minimum mapping unit (MMU = 1 pixel = 30x30 meters). Sites that could not be feasibly reached in the field were left uninterpreted.

Overall, a total of 710 points were classified to the detailed or vertebrate map class. Of these, 371 points were interpreted using DOQQ/NAPP imagery; 215 points were interpreted using videography; and 124 points were interpreted by field survey. An additional 48 points were interpreted to the appropriate Anderson Level I class.

A total of 1009 samples were photo-interpreted or ground truthed at either the 54-class detailed map level or the 27-class vertebrate map level, including 299 ant survey samples and 710 gap survey samples. An additional 48 gap survey samples were classified according to Anderson Level II (Anderson et al., 1976). Samples that had been classified at the 54-class detailed map level were crosswalked to the appropriate land cover class in the 27-class vertebrate map without deleting the original detailed classification label (see crosswalk table, Appendix 6).

Results

Results of the vertebrate map accuracy assessment are presented in the form of an error matrix or contingency (see Table 7), in which classified data are compared to ground truthed or photo-interpreted reference data (see Table 8 for Anderson Level II). Within the table, rows represent the classified data, columns refer to the reference data, and entries along the major diagonal represent correct classifications. Two different measures of accuracy can be calculated from an error matrix. The first, user's accuracy, deals with errors of commission, and estimates the probability that a sample from a particular classified land cover type actually represents that land cover type on the ground. User's accuracy is calculated by dividing the number of correctly classified samples of land cover X by the total number of samples classified as land cover X (row total). Producer's accuracy deals with errors of omission, and estimates the probability that a sample from a ground truthed or photo-interpreted land cover type was correctly mapped as that land cover type. Producer's accuracy is calculated by dividing the number of correctly classified samples of land cover X by the total number of reference samples of land cover X (column total) (Story and Congalton, 1986). The accuracy measure of most interest to potential map users is the user's accuracy. Per class user's and producer's accuracy measures are provided in Table 7. User's accuracies ranged from 87.2% for marshes to 3% for wet shrublands; producer's accuracies ranged from 100% for pocosins and rock outcrops to 8% for needle-leaved evergreen mixed woodlands. Sample sizes for producer's accuracies were more variable than those of user's accuracies because collection of reference samples was stratified by classified land cover classes, not reference land cover classes. Weighted overall accuracy was calculated by weighting the accuracy of each land cover class by the relative acreage of that land cover class in the map and summing the weighted per class accuracies (see Table 7).

The overall weighted accuracy for the 27-class vertebrate map is 33.4%. Although this is a low accuracy, the individual class accuracies reveal that for certain classes the map is a reliable tool. Following is a discussion of factors affecting the accuracy of map classification and assessment of map accuracy.

Possible Sources of Error

The temporally dynamic nature of land cover makes accuracy assessment difficult unless conducted at or near the time of image acquisition. In the SC Gap map, certain highly dynamic classes such as aquatic vegetation, wet/dry shrublands, wet soil, open canopy/recently cleared forest, grassland/pasture, cultivated land, urban residential, and urban development had low to moderate accuracy. Aquatic vegetation coverage varies from year to year in part due to management of impounded wetlands. Crop rotation results in conversion of land between cultivation and grassland/pasture. Wet and dry shrublands are generally transitional in nature, and are therefore often confused with several other classes. Tidal variations in water level affect the visibility of mud/sand flats.

Fresh and salt/brackish water classes had high to moderate accuracies, but were often confused with one another and with marshes. Often the line between fresh and brackish varies from year to year depending on water flow along tidal rivers and management of impounded wetlands. It is difficult to discern the correct boundary between fresh and

Table 7. Error matrix for the 27 class habitat land cover, total accuracy is 33.42% and error is 1.48%.

Mapped Vert Class	1	2	3	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28	29	Row Total	User's Acc	Std Error	Wtd Acc
Water 1	28	3	2		1								1													0		35	80.00%	6.76%	0.0234
Salt Water 2	3	19	9		0																					0	1	32	59.38%	8.68%	0.0076
Marsh 3			34		1			2													1					1		39	87.18%	5.35%	0.0224
Pocosin 4			0	2	0	4		1			2			9		1									8	1		28	7.14%	4.87%	0.0003
Swamp 6			2		17	10											1	2								0		32	53.13%	8.82%	0.0202
Bottomland 7			0		3	18					3			2			1	10		1		1		2		5		46	39.13%	7.20%	0.0396
Wet Soil 8	1	3	3		0	2	8		1	1	1			3				1		1		1	1	2		0	1	30	26.67%	8.07%	0.0007
Wet Sc/Sh 9			0		5	6		1	2	1				1				2		1		5	1	5		2	1	33	3.03%	2.98%	0.0009
Dry Sc/Sh 10			2		0	2	1	1	5	1	4			4	1		1		4		2	7		1	1	2		39	12.82%	5.35%	0.0084
Sandy soil 11			0		0		1	1		3	2			2				1		1	1	9	2	6	1	0		30	10.00%	5.48%	0.0001
Clearcut 12			0		0			1		1	13			6	2	9	1			1	4	1			1	0		40	32.50%	7.41%	0.0240
Rock 13	9		0		0	1				1		3	2	3	2		1	4	2	2	1					0		31	9.68%	5.31%	0.0000
Aq veg 14	4	2	15		0		1	2	2				1									1				1		29	3.45%	3.39%	0.0000
Upl pine 15			0		0	3					16			31	3	1	7	13	20	11	1					0		106	29.25%	4.42%	0.0395
Pine/dec16			0		0	2					7			12	2	2	1	2	2	1		1	2	1		2	1	38	5.26%	3.62%	0.0052
Pine wood17			0		0	1					1			7	2	5		1	1		1	4		1		5		29	17.24%	7.01%	0.0015
Dry dec 18			0		0	1				1				4	3		7	5	4	2	1	1		1		0		30	23.33%	7.72%	0.0020
Wet dec 19			0		0	1					5			7			9	9	9	7	3	1		2		0		53	16.98%	5.16%	0.0166
Dry mix 20			0		0	1			1					5	6	2	2		7	1				2		0		27	25.93%	8.43%	0.0009
Wet mix 21			0		0	1			1					12	2		3	4		3	2	1		4		0		33	9.09%	5.00%	0.0010
Grass 22			1		0				2		1			1		1		1			6	13	2	2		1		31	19.35%	7.10%	0.0053
Cult 23			1		0				1	1	2								1		22	35	1			0		64	54.69%	6.22%	0.0833
Urban 24		1	0		0				1					4	1		1	2				2	9	9		0		30	30.00%	8.37%	0.0049
Urb/res 25			0		0			1	1						1		1				1	5	4	15		2	1	32	46.88%	8.82%	0.0142
Wet eve 27			0		0	4			1		2			2		5									9	5		28	32.14%	8.83%	0.0058
Maritime 28			0		0	1								2		1								4		25		33	75.76%	7.46%	0.0061
Beach 29		1	1		0		1		1												2	1		1		1	22	31	70.97%	8.15%	0.0003
Column Total	45	29	70	2	27	58	12	10	19	10	59	3	4	117	25	27	36	57	50	32	48	89	22	58	20	53	27	1009			
Producer's Accuracy	62.22%	65.52%	48.57%	100.00%	62.96%	31.03%	66.67%	10.00%	26.32%	30.00%	22.03%	100.00%	25.00%	26.50%	8.00%	18.52%	19.44%	15.79%	14.00%	9.38%	12.50%	39.33%	40.91%	25.86%	45.00%	47.17%	81.48%				
Standard Error	7.23%	8.83%	5.97%	0.00%	9.29%	6.07%	13.61%	9.49%	10.10%	14.49%	5.40%	0.00%	21.65%	4.08%	5.43%	7.48%	6.60%	4.83%	4.91%	5.15%	4.77%	5.18%	10.48%	5.75%	11.12%	6.86%	7.48%				

Table 8. Anderson Level II codes and percent cover of each mapped type.

Code	Label	%Total Acreage
1	Bare Exposed Rock	0.02%
2	Beaches	0.04%
3	Cropland and Pasture	17.95%
4	Deciduous Forest	10.65%
5	Evergreen Forest	21.78%
6	Forested Wetland	19.14%
7	Mixed Forest	12.09%
8	Nonforested Wetland	2.84%
9	Non-residential Urban	1.62%
10	Residential Urban	3.03%
11	Sandy areas other than beaches	0.08%
12	Shrub and Brush Rangeland	6.52%
13	Water	4.24%

brackish water without measuring the salinity on the ground, because often the vegetation in adjacent marshes may not be reflective of current salinity levels. The mapping of fresh and salt/brackish water was based entirely on 1989-1994 NWI data. Although this time period overlaps with that of image acquisition (1991-1993), accuracy may have been improved by basing the map on salinity measurements taken along tidal rivers concurrently with TM image acquisition. However, such a task was not feasible for our project. Future mapping efforts should take into account the temporal variability of potential map classes; final mapped classes should be those that generally change at a slower rate than the rate of map creation/assessment.

Another factor influencing accuracy assessment is polygon size. Where feasible, the gap survey selected samples from the population of polygons greater than or equal to three-by-three pixels in dimension. Polygons were clipped so that each had a one pixel buffer of like-classified pixels on all sides. The buffer was intended to minimize the influence of edge effects and spatial accuracy on the assessment of thematic accuracy. In classes where the number of polygons of dimensions 3x3 or larger was insufficient, smaller polygons were considered as potential samples. For land cover classes where the sample sizes of large (3x3 pixels or greater) and small (less than 3x3 pixels) polygons were similar, the accuracy of smaller polygons was approximately half the accuracy of the larger polygons (see Table 6). The overall accuracy of all sampled small polygons was 17.3%, compared to an overall accuracy of 53.8% for large polygons. Several land cover classes including salt/brackish water, pocosins, wet soil, wet/dry shrublands, sandy bare soil, rock outcrops, aquatic vegetation, pine woodlands, dry deciduous forests, mesic/dry mixed forests, grassland/pasture, urban residential, and beaches were sampled heavily from small polygons and had accuracies of less than 50% (see Table 6).

Edge effects are caused by a variety of factors, including spatial offsetting among data layers used in map creation; conversion from polygon to raster coverages; and the attribution of categorical labels to environmental gradients. These edge effects were most pronounced in smaller polygons.

Often, polygons were composed of patches of differing land cover classes. The two sources of accuracy assessment data, the ant survey and the gap survey, dealt with mixed polygons in differing manners. The ant survey, conducted at an early phase of map creation, did not have the final map polygons to assess. Therefore, interpreters were unable to choose the dominant land cover type and focus ground truthing within patches of dominant land cover. The gap survey was conducted following completion of the final land cover map, and each polygon was photo-interpreted to determine the dominant land cover. Where the dominant land cover could not be discerned from photo-interpretation, the surveyer navigated in the field to a predetermined waypoint within the dominant spectral signature of the polygon to assess the land cover. Where a dominant class could not be reliably interpreted, the sample was excluded from analyses. Although the gap survey's methodology of designating a dominant land cover provided for a more comprehensive survey of the polygon as a whole, even this methodology is not without bias. The designation of a dominant land cover will be affected by the differences in viewpoint between the mapper and interpreter. For example, areas with clusters of dense pine trees, interspersed with cleared treeless areas may be classified by the

interpreter as two different land cover types – pine forest and grassland/pasture. However, the mapper may view this same polygon as a pine woodland with a grassy understory. Another example would be a polygon dominated by forest, but also including small areas of rock outcrop. To the interpreter, the dominant land cover would be forest. However, the mapper may pick up more on the rock outcrop and label the polygon as such. These types of errors will lead to confusion of spatially associated land cover types, such as marsh and water, bottomlands and adjacent mesic deciduous forest, and pond pine woodlands and pocosins. Some of these mixed polygon issues have been dealt with in the SC-GAP Vertebrate Class Descriptions (see Appendix 5), wherein spatially associated land cover classes are described as complexes.

Spectrally similar classes such as urban residential and urban development, are prone to low accuracy. Zhu et al. (2000) recognize that it is very difficult to unambiguously separate high intensity residential areas from industrial areas using TM imagery or NAPP photography. In the South Carolina Gap project, aerial videography was very helpful in distinguishing between these two land cover classes for the accuracy assessment. However, the TM data used in modeling of land cover is of much lower resolution than aerial videography and was often unable to accurately distinguish these types. Likewise, the spectral similarity of aquatic vegetion to marshes and water affect the map accuracy and photo-interpretation of accuracy assessment points. Aerial videography, where available, did provide better resolution imagery, but submerged aquatic vegetation was often underestimated.

Overlap among map class definitions led to lowered accuracies for certain classes. For instance, physiognomic categories such as grassland, shrubland, woodland, and forest require the interpreter to judge the relative percentages of different strata. The cut-off between categories, even when clearly defined in class descriptions, can often be interpreted differently among observers. Examples of classes which can and are often confused include evergreen and mixed forests, deciduous and mixed forests, mesic and dry forests, mesic forests and temporarily flooded bottomlands, bottomlands and swamps, and pocosins and wet evergreen woodlands. To determine the extent of intepreter variability in map class assessment, the gap survey sample points were compared to those of the ant survey. For classes where the two datasets had comparable sample sizes, the per class accuracy was often quite different between datasets. For example, the ant survey data showed an accuracy of 33% (n=15) for the swamp class, while the gap survey data gave an accuracy of 71% (n=17) for the same class. Dry deciduous forests had accuracies of 31% (n=13) and 18% (n=17) according to the ant and gap surveys, respectively. The earlier ant survey work was based on very sparse map class definitions, while the later gap survey had more detailed class descriptions to aid in discriminating map classes. As maps become more detailed, the amount of overlap between classes increases. In order to minimize interpreter bias, specific descriptions of map classes should be drawn up, and ideally, more than one observer should visit sample sites.

Often, confused land cover classes are ecologically very similar. For example, the open canopy afforded by a woodland and a sparsely wooded shrubland may offer comparable habitat to vertebrate species. In these cases, it may be useful for the map user to merge

classes. Accuracy assessments themselves often include this type of "fuzzy" accuracy assessment, wherein confusion between ecologically similar classes is considered less problematic than confusion between ecologically dissimilar classes (Gopal and Woodcock, 1994). The disadvantage of fuzzy accuracy assessment is that the author presumes to know the significance of interclass confusions to all readers. Rather than making inferences regarding the significance of particular class confusions to the reader, we suggest that map users take it upon themselves to merge those classes that they deem to be ecologically similar for the purposes of their specific studies. By merging ecologically similar classes, the accuracy of the map can be greatly improved without losing necessary detail.

As indicated in the methods section, for several classes the minimal recommended sample size could not be achieved in the time allotted. The standard errors of per class accuracies, while generally at or below the recommended maximum of 8%, are sometimes greater than recommended (Crist et al., 2000). Classes with standard errors greater than 8% require additional sampling to precisely measure class accuracy.

Anderson Level I and II Classification

To facilitate comparison among maps created in other states, the 27-class vertebrate land cover map was collapsed into a standardized Anderson classification system with fewer land cover classes (Anderson et al., 1976). When classes were merged into an Anderson Level II classification, the overall weighted accuracy increased from 33.4% to 51.4% (see Table 9). At this classification level, the different upland forested classes, which cumulatively account for 44.5% of the state's total area, are still segregated. When these classes are merged in the Anderson Level I classification, the overall weighted accuracy increases to 71.9% and the accuracy of the forest class becomes 85.6% (see Table 10). By merging grassland/pasture and cultivated land into a single class, the resultant class accuracy becomes 80.0%. The resultant accuracies are comparable to results achieved by Gap projects in other states.

Table 9. Anderson Level II error matrix. Estimated user's accuracies and standard errors are presented in the last two columns, and producer's accuracies with standard errors are in the last two rows. Overall weighted accuracy is 51.40%, with a standard error of 1.57%. See codes in Table 8.

	Reference Data														
Land Cover	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**Row Total**	**P_U%**
1	**3**		1	5	3	1	6				1		11	31	**9.68**
2		**22**	3				1	2		1		1	1	31	**70.97**
3			**76**	1	5		2	2	3	2	1	3		95	**80.00**
4			6	**30**	16	2	25			3	1			83	**36.14**
5			11	22	**89**	6	45			1	1			175	**50.86**
6		1	6	16	27	**88**	15	2	1	7	1	3		167	**52.69**
7		1	4	12	43	5	**51**		2	11		2		131	**38.93**
8		1	2	1	4	5	2	**45**	1	2	1	1	4	69	**65.22**
9			2	3	4		1		**9**	9		1	1	30	**30.00**
10		1	6	1		1	3		4	**15**		1		32	**46.88**
11			10	1	4	2	1	1	2	6	**3**			30	**10.00**
12			9	1	8	4	7	3		1	1	**5**		39	**12.82**
13		1	1			3	1	27				2	**61**	96	**63.54**
Column Total	3	27	137	93	203	117	160	82	22	58	10	19	78	**1009**	
P_A %	**100.00**	**81.4**	**55.47**	**32.26**	**43.84**	**75.21**	**31.88**	**54.88**	**40.91**	**25.86**	**30.00**	**26.32**	**78.21**		

Table 10. Anderson Level I error matrix.

	Reference Data										
Classified Data	Ag	Barren Land	Forest	Range land	Urban or Built-up	Water	Wetland	Row Total	User's Accuracy	Standard Error	%Total
Agri-culture	**76**	1	8	3	5		2	95	80.00%	4.10%	17.95 %
Barren Land	14	**29**	21	1	9	12	6	92	31.52%	4.84%	0.14%
Forest	21	3	**333**	2	17		13	389	85.60%	1.78%	44.52 %
Range Land	9	1	16	**5**	1		7	39	12.82%	5.35%	6.52%
Urban or Built-up Land	8	1	12	2	**37**	1	1	62	59.68%	6.23%	4.65%
Water	1	1	1	2		**61**	30	96	63.54%	4.91%	4.24%
Wetland	8	4	65	4	11	4	**140**	236	59.32%	3.20%	21.98 %
Column Total	137	40	456	19	80	78	199	**1009**			
Producer's Accuracy	55.47 %	72.50 %	73.03 %	26.32 %	46.25%	78.21 %	70.35%				
Standard Error	4.25%	7.06%	2.08%	10.10 %	5.57%	4.67%	3.24%				

Overall Weighted Accuracy and Standard Error:	**71.86%**	1.42%

Limitations and Discussion

The SC-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 land cover provides significant information about vegetational patterns on the ground and the relationship of land cover types to one another. The accuracy of the mapped classes varies by class, and the user should consult specific class accuracy for those they are interested in. In a general sense, while different forest types were confused with one another, forests were consistently mapped with high accuracy. Bottomlands and swamps, when grouped together, were fairly accurate. Grouping cultivated land and pastureland provided a good accuracy for that class. The maritime forest class is a class of good accuracy, both because of the detailed soil information used and because of the ease of discerning it on the aerial photography.

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 that are suitable, at best, for approximating distribution at the regional level or counties for example. The purpose of the GAP vertebrate species maps is to provide more precise information about the current predicted distribution of individual native species according to actual habitat characteristics within their general ranges and to allow calculation of predicted area of distributions and associations to specific habitat characteristics.

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 (heterogeneous 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) will likely reveal the limitations of this process to incorporate differences in habitat quality (e.g., understory condition) or necessary microhabitat features such as standing dead trees.

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 wide 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. Perhaps most importantly, as a first effort in developing such detailed distributions, they should be viewed as testable hypotheses to be confirmed or refuted in the field. We encourage biologists and naturalists to conduct such tests and report their findings in the appropriate literature and to the Gap Analysis Program such that new data may improve future iterations.

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.

Methods

Mapping Standards and Data Sources

The SC-GAP project used scientific literature and expert opinion to develop a list of vertebrate species in South Carolina and model their potential spatial distribution. An initial list of 592 species (397 birds, 134 reptiles and amphibians, and 61 mammals) was created using Thompson 1982, Post and Gauthreaux 1989, Martof et al. 1980, and Golly 1966. The only criterion used in creating the list was the species' presence in South Carolina based on the conclusions of these four bibliographic sources. Various experts evaluated each species for inclusion in the South Carolina database.

Several rules were developed for inclusion/exclusion in the final SC-GAP Species List.

1) Include species that breed, winter, or migrate through South Carolina.
2) Exclude species considered as escapees and accidentals, and species not easily tied to the vegetation layer, including pelagic birds.
3) Expert opinion could include or exclude species from the final list. Questionable species, i.e. species occurring irregularly, were compared with other sources to determine inclusion or exclusion. All questionable species were given to experts to determine inclusion or exclusion from the final list.

Following these criteria, the list of vertebrate species was reduced to 488.

The minimum mapping unit (MMU) for the vertebrate mapping is the 30 x 30 meter pixel used in the development of the land cover. For the final product, each vertebrate distribution was aggregated up to a 90 x 90 meter pixel MMU to meet National GAP standards. All other modeling was based on 30 x 30 meter pixels. A thematic accuracy of 80% was established as our goal for mapping vertebrate species.

Mapping Range Extent

In order to model the species distributions, the general extent of each species was required. This information provided the spatial control on each species' potential distribution as predicted by its habitat affiliation. The range extent was mapped for each species using counties as the basis of its general occurrence. It was determined to use counties because of the familiarity of most taxonomic specialists with similar distributional studies. Many of them have collected species for local and regional museums and participated in county-based surveys. Additionally, most of South Carolina's counties follow physiographic features to some extent; for example, many of

the county boundaries follow major rivers, and some physiographic provinces are generally recognized by their counties. The range extent was refined for physiographic regions using the same criteria used in land cover mapping (see chapter 2) with the addition of a 'shore' category specifically for those birds and reptiles, shorebirds and marine turtles that are tied to coastal beach, scrub/shrub and marine habitats.

Species range maps were created using range descriptions and maps from several publications. Reptiles and amphibian species ranges followed those identified by Wilson (1991), Conant and Collins (1991), Petranka (1998), and Ernst and Barbour (1989). Birds and mammals were derived from Hamel (1992) and Whitaker and Hamilton (1998), respectively. Additional range information was provided by Martof et al. (1980), Thompson (1982), Post and Gauthreaux (1989), and Golly (1966).

Range maps included in these source documents generally did not contain information regarding county-specific distributions. As a result, county associations were determined by integrating range maps and county boundaries. General species range maps and county boundary maps were scanned and saved as TIFF files and imported into WordPerfect8. These maps were rescaled, coregistered and compared graphically to identify which counties were included in each species' range map. A data form, which included a state map with county boundaries for inputting the species ranges by county, was developed in MS Access. Species presence was coded P for Permanent Residence, S for Summer Residence, W for Winter Residence, M for Migrant, or left blank for absent. Accidental range extensions for species occurring regularly within the state were not included in the county range database. Species whose only occurrence was accidental according to Hamel (for example Northern Saw-whet Owl) were included. It was eventually determined to not include migratory species because of the difficulty in defining habitat – many migratory species tend to be more generalist in their habitat affinities while in migration. We included a number of introduced species such as the house sparrow, European starling, Norway rat, black rat, and house mouse.

A prototype data entry project was conducted to enable the GAP team to analyze the procedure for entering range data to ensure timely and efficient completion of this part of the vertebrate layer, as well as to ensure relative ease in transferring data into the GIS. Several species were selected which addressed a multitude of potential data entry problems or possibilities. Microsoft Access was used to create a relational database with a form for data entry. Pull-down lists for county names and physiographic regions were included to eliminate potential mistakes in data input.

Museum data from the Clemson University Museum as well as data from the S.C. Natural Heritage Database were imported into the Access database. In addition, data from the Charleston Museum was digitized with assistance from students of the College of Charleston, Conservation Biology class (Dr. Arch McCallum, Professor). Neither of these data sources was used to develop species range maps. In general, we tried to avoid reliance on museum data to build the range maps for several reasons. First, the collections were largely comprised of data that was greater than 20 years old, and there has been considerable landscape change since then. Second, museum collections often

are concentrated in the immediate area of the institution; this would lead to an overestimation of vertebrate diversity in a few geographical areas. Third, many collections are specialized and focus on specific taxa while minimizing distributional data for other species. For example, the Natural Heritage database was created primarily for tracking species of concern and thus consists predominantly of records for a small percentage of the vertebrate diversity in the State. All of the museum data, however, was used informally as a quality review control to assess the accuracy of the range maps generated by the SC-GAP project.

The range database was imported into ArcView where a graphical county range map was generated for each species, based on presence within the county. For avian species, permanent, summer, and winter ranges were delineated. A layout template was developed which allowed for simultaneous review of the range map and the habitat matrix for each species. All layouts were developed to allow for easy photocopying for distribution to our experts (see Appendix 7).

Wildlife habitat relationships

Essential to modeling the vertebrate species distribution patterns was the development of a habitat affinities database. These data provided information regarding each species use of specific vegetative communities or habitats that was linked to the spatial land cover data. The habitat information used by the SC-GAP project was compiled using the scientific literature, field guides, and the Florida GAP database. Based on these records, a habitat matrix was created for each species using the 28 habitat classes from the initial vegetation map. This matrix was reviewed by our experts prior to implementation of the modeling.

During the development of the land cover, it became clear that two land cover classes were inadequately mapped. The ecotone boundary classification was derived from shadows cast from forested areas onto agricultural or cleared fields. While this is a valuable habitat class, it was inconsistently mapped due to the difficulty of discriminating shadows where varying sun angles and habitat boundary orientation confuse the landscape. Further, other habitat affinities were considered adequate surrogates to model species that were identified as using this ecotonal habitat.

Stream margins were also mapped during the initial effort but were removed because the process of mapping eliminated specific vegetation types found along the streams. Also, ponds, lakes, streams and rivers were designated as water in the land cover classification with no differentiation between features based on their structure or function. As a result, streams could not be isolated in the database for development of a riparian classification. Again, see the Land Cover chapter for further description of the land cover development process. Ecotones and stream margins were dropped from the final land cover of vertebrate habitat classes. Although these two classes were not used, the information is maintained in the database for those species using these habitats. A beach class was added to the vertebrate habitat land cover before the final modeling based on recommendations of the reviewers. A total of 27 classes were used for the development of final vertebrate models.

Data review process

Experts were given two opportunities to review the vertebrate database. First, maps for each species were distributed to state experts for review of both range extent and habitat affinity. Experts relied on personal knowledge, research on species distribution and consultation with personal records for assessment of the accuracy of the data. Comments from all reviewers were compiled and distributed to each of the experts. At this point, the database was updated and an interface with the Oracle database was developed for transactional editing and quality review by SC GAP staff.

Second, a joint meeting of taxonomic experts was held for each group – birds, mammals, reptiles and amphibians. The range extent and habitat affinity data were displayed on a computer projector and evaluated by meeting participants. The SC GAP coordinator and vertebrate species technical staff were present to answer any questions regarding the classification and composition of land cover types. Species distributions and habitat affinities were discussed until there was general consensus, and the data were modified accordingly. Some of the 488 species were removed from the list because they are migratory or, if present during the summer, are not known to breed, have been extirpated, or are introduced/domestic animals. After final review and debate, the list that was used to develop vertebrate species models contained 455 species of birds, mammals, reptiles, and amphibians (see Appendix 8 for a list).

As species were entered into the final database, information was also recorded as to their distribution by physiographic region to incorporate into the final modeling procedures. Of the 455 species occurring in South Carolina, 210 were of statewide distribution, 65 were found in coastal plain and shore habitats, 1 species was confined to the piedmont, and 29 were found only in the mountains. The remaining 150 had idiosyncratic distributions. See the land cover methodology for development of physiographic regions.

Distribution Modeling

Three primary vertebrate modeling products were generated for the SC GAP project. The first was a predicted distribution map for each of the 455 species identified by the experts as relevant to biodiversity studies in South Carolina. These models combined habitat affinities and land cover data to create distribution maps that highlighted areas whose vegetation was capable of supporting individual vertebrate species. In the development of the habitat database, each vertebrate species was only coded as to presence or absence for particular habitats and county occurrence. No attempt was made to indicate suitability or preference for habitat by vertebrate species. Experts considered whether the habitat in question was necessary for maintenance of the species within the state; if so, that habitat was included in the database.

In order to implement the models, species were grouped into categories based on statewide or physiographic distribution. An Arc/Info script was developed to attribute each species to the appropriate counties and habitat. This resulted in a map with 30 x 30 meter pixel resolution attributing each species to a predicted habitat within its

documented range (see Figure 12 for an example of a predicted distribution map by habitat type). At this point, information was retained as to particular habitat types. Predicted habitat maps for all species were subsequently resampled to produce binary presence/absence maps to comply with National GAP standards (see Figure 12). Graphic files were produced from the presence/absence maps and saved in Joint Photographic Expert Group (JPEG) format. After the models were generated, all binary maps were re-sampled to a 90 x 90 meter pixel resolution for delivery of the final product because of the volume of data generated at the higher resolution.

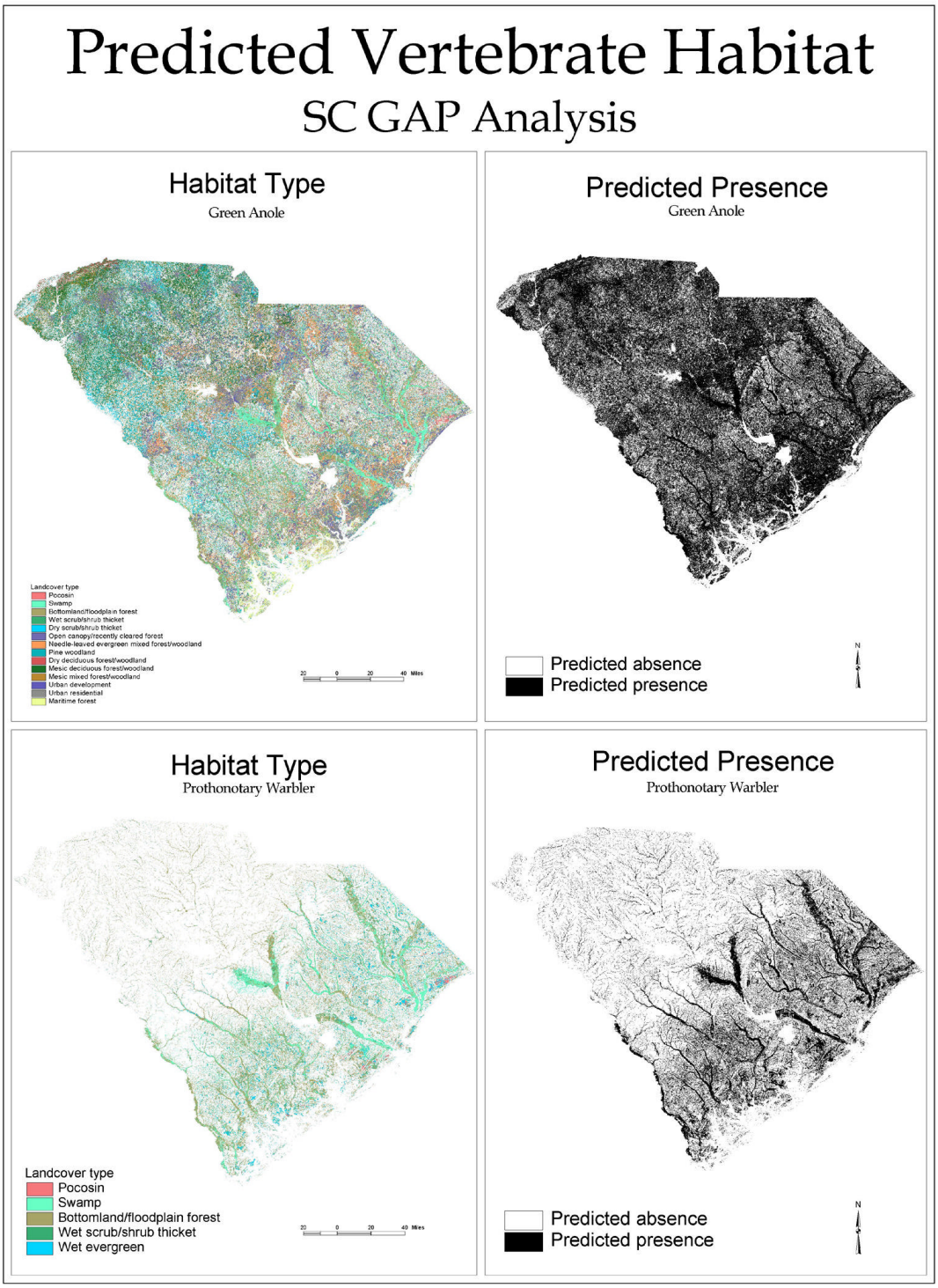


Figure 12. Predicted distribution for two species illustrating a distribution including habitat information and the binary presence/absence map used in the richness modeling process

No ancillary data were used directly to model the vertebrate distributions. NWI wetland, soil and elevation information was used in the development of the land cover data, and its influence on species distributions is reflected in the relationship between the land cover types and habitat affinities. However, use of general habitat affinities resulted in the overestimation of potential distributions for several species that are limited by proximity to other significant natural resources or topographic features. Therefore, in order to refine several of the vertebrate distribution models, we attempted to map riparian species (those species, primarily birds and amphibians, that are always found within 300 meters of water bodies) using a buffer for distance from water on the land cover. This was unsatisfactory in the coastal plain because much of the water in the area is under tree canopy and so was not mapped in the land cover. This process worked better in the piedmont, where water is more clearly visible, but still missed some bottomland forests where water flows at least part of the year and was therefore not used.

Statewide NWI data is not available for all of South Carolina, and an exploratory attempt at using NWI freshwater classes to improve distributions in the coastal plain alone was also unsatisfactory. It resulted in clearly different predictions for statewide species between the coastal plain and the piedmont. Distributions were realistic in the coastal plain where freshwater buffers limited predicted distributions but were overestimated in the piedmont where distribution was not limited. A combination of buffering freshwater using NWI data in the coast and buffering mapped freshwater plus bottomland forests in the piedmont and mountains might provide a more accurate predicted distribution for riparian species but was not attempted due to time constraints.

The second vertebrate species product was a general distribution database corresponding to the U.S. Environmental Protection Agency's EMAP hexagon structure. In order to attribute the EMAP hexagon coverage, the national hexagon database was overlain with the species distribution data by county, and each hexagon was populated based on the presence or absence of each species within any county overlapping a hexagon. If any pixels indicated presence within a hexagon, this resulted in the entire hexagon being attributed for that species. This will result in an overestimation of range extent for many of the species.

The third vertebrate product was a hyper-distribution. Development of a hyper-distribution was carried out based on the hexagon presence/absence database. This will allow users to query individual hexagons to determine whether a particular species is predicted to be found in the area or to get a list of species for each hexagon. The resolution is in 30 x 30 meter pixels, so an individual pixel could be queried but since the data is built based on the hexagon distribution that provides the finest scale of resolution.

Results

There were several land cover or habitat types found in South Carolina that affect species distributions both positively and negatively. Due to the spatial and spectral resolution of Landsat Thematic Mapper data, many of these could not be adequately identified. For

example, rock outcrops provide significant habitat for many species but are not consistently mapped at the scale of the SC-GAP land cover. Golf courses were also often mentioned as habitat, especially for some reptiles and amphibians and many species were associated with the sand rims or other particular aspects of Carolina Bays. Although these habitats were not specifically mapped, they were noted in the habitat affinity database for future identification as satellite-based sensors achieve higher resolution. Conversely, some special habitats that were delineated with NWI include mud flats, beaches, salt flat/salt shrub.

Mammals
Bats were particularly difficult because of very specific habitat requirements such as caves for nesting colonies, bridges, or occurrence near buildings. Red wolf is bred in captivity and was not included. Mountain lions or cougars are sighted from time to time but are probably escapees from captivity, these were also not included.

Birds
Bald Eagles were problematic, our habitat database included land cover types in which they would nest. We did not limit distribution to areas surrounding large bodies of water, a requirement for bald eagle nesting. Farm ponds are important habitat for many species, especially migratory and wintering waterfowl. While these are apparent as small bodies of water in a matrix of cultivated land, they were not identified as such. The Cliff Swallow is limited to land cover types associated with bridges and therefore was difficult to map. Presence of the Saw Whet Owl in South Carolina is very speculative.

Amphibians
As indicated in the methodology, it was difficult to map amphibians with close ties to water because of the lack of statewide NWI for buffering water bodies. Many amphibians are not able to coexist with fish, a problem that might be addressed with an aquatic gap project for the state. The gray treefrog (*Hyla versicolor*) and Cope's gray treefrog (*H. chrysoscelis*) are poorly understood and sometimes included as the same by many projects. Also slimy salamanders, of which SC-GAP included four species, have recently undergone a taxonomic split (see species list, Appendix 8). Many amphibians have spotty distributions that are not adequately understood or represented by the mapping process. These are indicated in the database and provide a source of future projects. Borrow pits are often important larval habitat for many amphibians but weren't mapped.

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. (In the case of our data, where numbers of animal species are mapped for the same grid cells.) These are color-coded or shaded in intensity from the highest numbers of co-occurrence (richness) to the lowest. 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 best conservation opportunities. They may occur in already protected areas or may represent mostly already protected species or those not

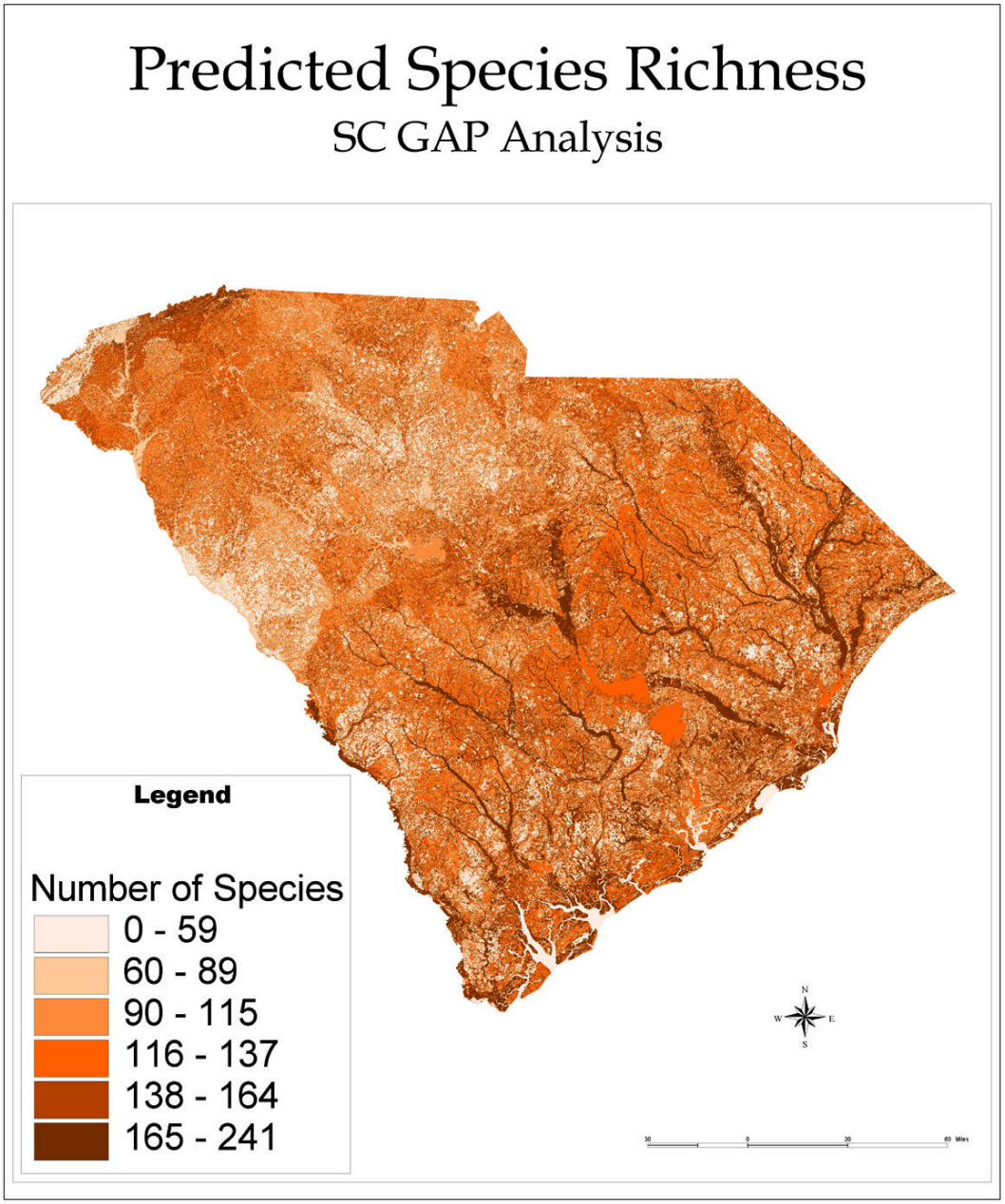


Figure 13. Overall species richness

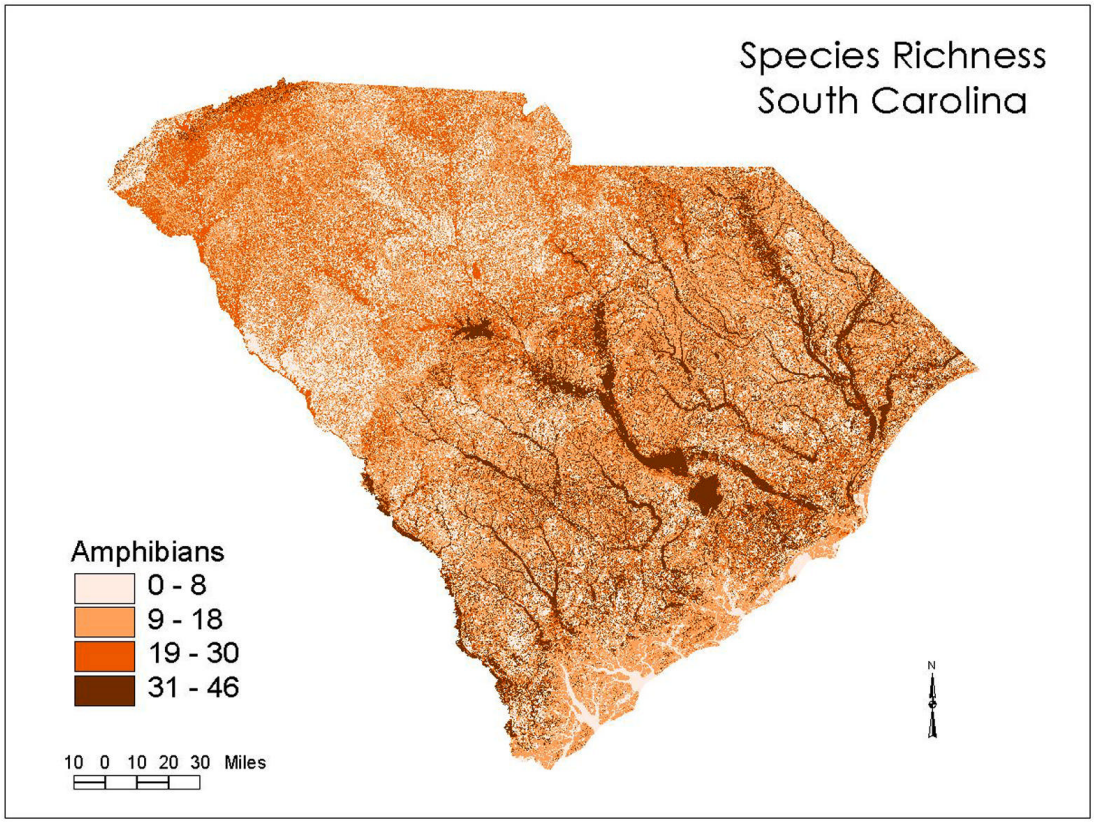


Figure 14. Species richness of amphibians

at risk. Still, they are often a useful starting point to examine conservation opportunities in combination with other analyses described in this report's Introduction and in the Analysis section. We also feel they may be useful for other rewarding applications such as identifying places of interest for wildlife observation and study. Richness is depicted for all mapped taxa (see Figure 13), and by taxonomic groups (see Figures 14-17).

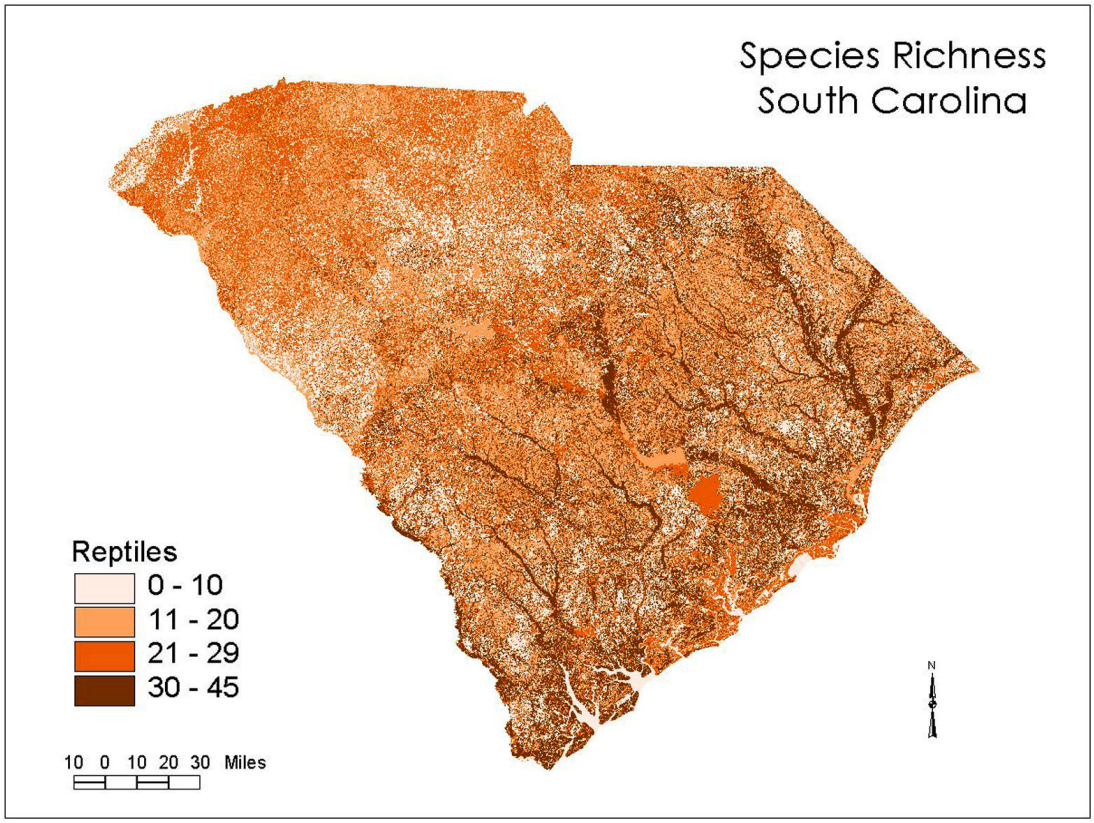


Figure 15. Species richness of reptiles

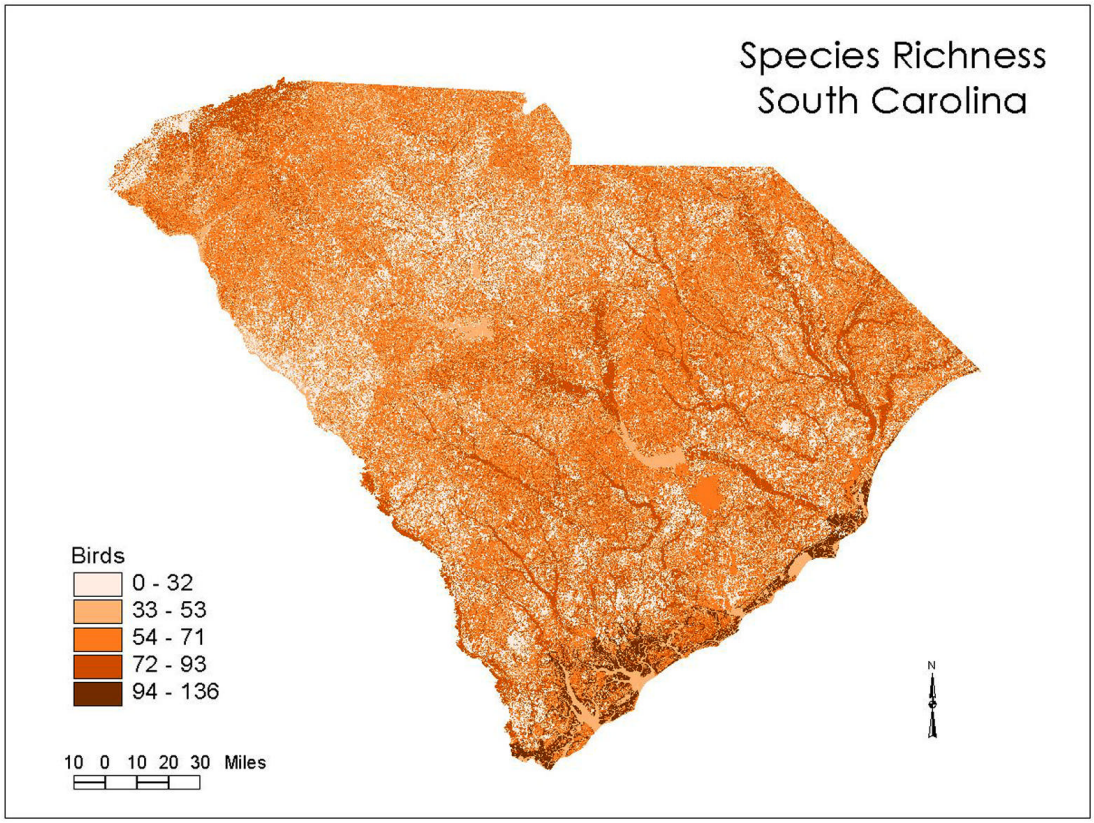


Figure 16. Species richness of birds

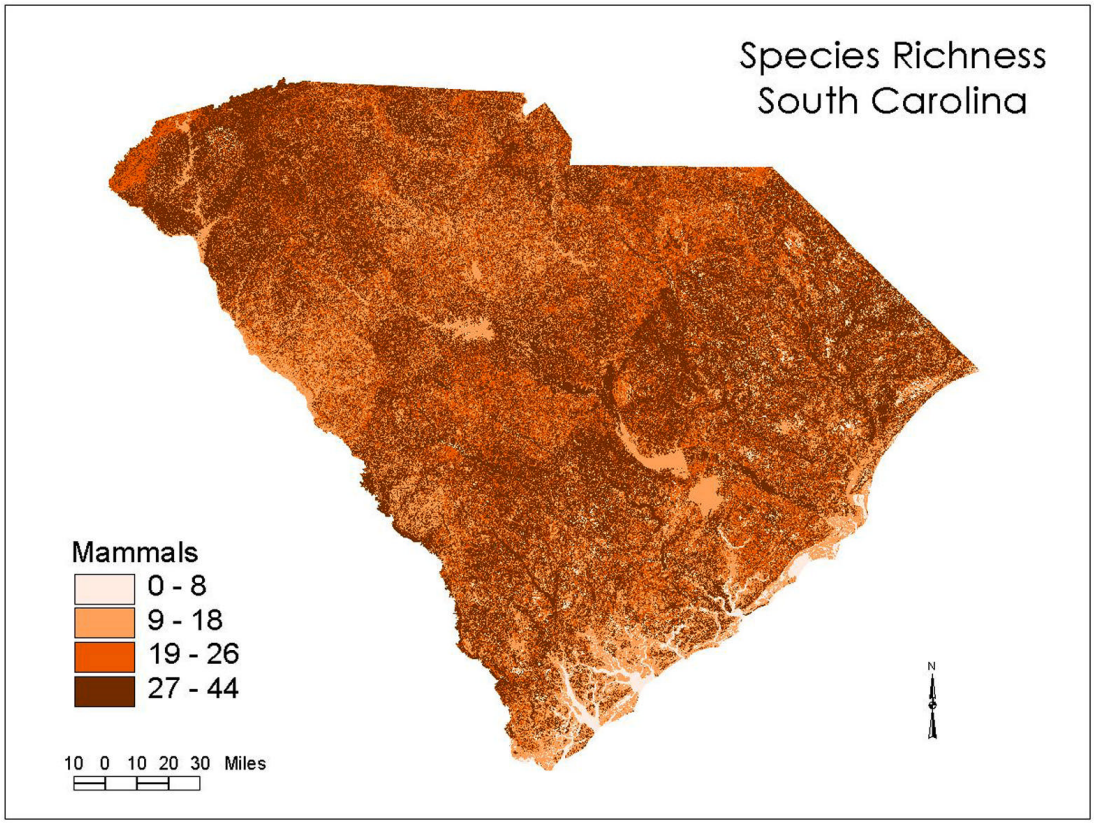


Figure 17. Species richness of mammals

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. It is, however, necessary to provide some measure of confidence in the results of the gap analysis for species collectively, if not individually or by taxonomic group (comparison to stewardship and management status), and to allow users to judge the suitability of the distribution maps for their own uses. We, therefore, 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. This reflects not only an improvement over the modeling process, but also the opportunity to map true changes in species distributions over time. However, we feel that assessing the accuracy of the current maps provides useful information about their reliability to potential users.

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. There is a conscious effort in the GAP process, however, to err on the side of commission: in other words, to attribute species as possibly present when they are not. There are two primary reasons for doing so: first, few species have systematic, unbiased known ranges and we believe science is best served by identifying a greater potential for sampling and investigation than a conservative approach that may miss such opportunities; second, in conducting the analysis of conservation representation (see the Analysis section), we believe it most appropriate to identify a species that may need additional conservation attention that is then refuted by further investigation rather than identifying a species as sufficiently protected that is discovered not to be by its subsequent loss. The methods for validating and assessing the accuracy of the vertebrate distribution maps are presented below along with the results.

Methods

To test the accuracy of the vertebrate species predictions, we used a subset of the state consisting of public lands that have either been intensively studied for biodiversity assessment or that, because of public use, have well-developed species lists (see Table 11). These areas were distributed throughout the state and covered the three physiographic regions present in the state (see Figure 18). Species lists are generally lists of species accumulated through time and a combination of fieldwork, individual sightings and research. Surveys, as we define them, include areas for which systematic surveys, either visual or trapping, have been undertaken. Scientific research involves intensive study of a particular area, habitat or taxon. A list of contact information for each area may be obtained upon request from the authors. The numbers of years for each area varies from less than ten to 50.

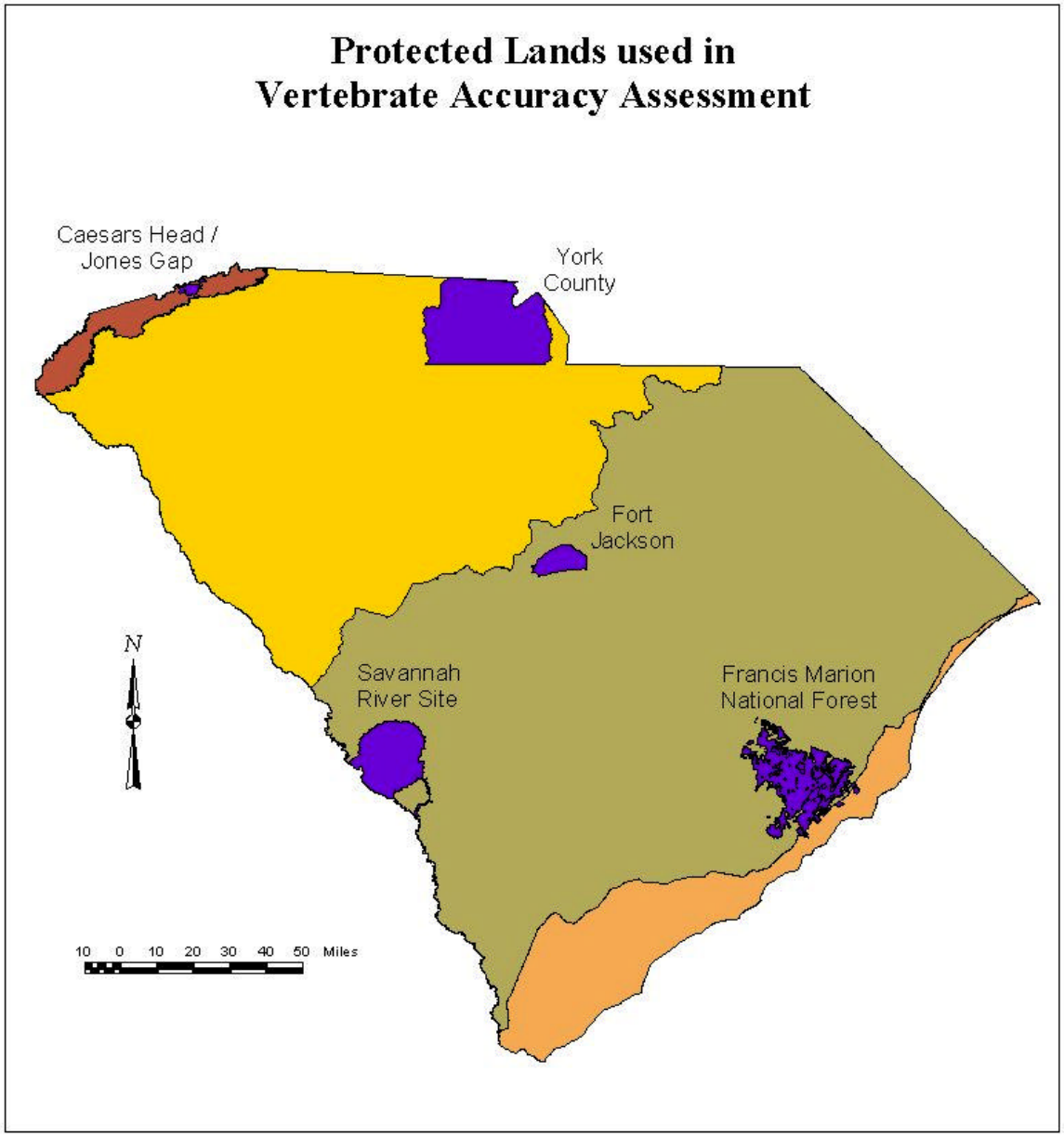


Figure 18. Sites used in the accuracy assessment of predicted vertebrate distributions

The species lists are compared with predicted distributions for each area, based on county of occurrence and available habitat, from SC-GAP to provide an assessment of errors of omission and commission. Species that are accidentals or escapees were not included; these include nine warbler species from the Mt. Bridge Wilderness Area that do not regularly visit South Carolina. Other accidentals that were documented in species lists included the Northern Goshawk (*Accipiter gentilis*) and Golden Eagle (*Aquila chrysaetos*) in Mt. Bridge Wilderness Area. The Cougar (*Felis concolor*) was documented in three of the study sites but is considered to be an escapee and was not part of the SC-GAP species list. We determined to include the four new species of slimy salamander in the SC-GAP database while recognizing that most species lists and records would just record slimy salamander. During the accuracy assessment, if a species of slimy salamander was recorded by a site, it counted as a single match for one or many species of predicted slimy salamander species. The gray treefrog also counted as one if both species were recorded under gray treefrog. Sites recorded Bewick's wren, a species that has not been seen in the state in the past ten years or so; this was not included in the SC-GAP database and so was counted as an omission.

Omission error (percentage of species present on a site that were not predicted), commission error (percentage of species predicted but not present on a site), and overall accuracy (%) were calculated for each taxonomic class, as well as all classes, within each test site.

Table 11. Areas with species lists or surveys that were used to assess the accuracy of the predicted distribution of vertebrate species in South Carolina.

Property Name	Animals surveyed	Data Source
York County ($1{,}103\ km^2$)	All taxa	Species lists, surveys, museum records
Francis Marion National Forest ($1017\ km^2$)	All taxa	Species lists, surveys and scientific studies
Savannah River Site ($803\ km^2$)	All taxa	Species lists, surveys and scientific studies
Ft Jackson Army Base ($212\ km^2$)	All taxa	Species lists and surveys
Mt Bridge Wilderness Area ($43.7\ km^2$)	All taxa	Species lists and surveys

Results

The overall accuracy of the predicted vertebrate distributions ranged from 57% at Ft. Jackson to 85.5% at the Savannah River Site (see Table 12). Two of the larger sites with the most extensive study, Savannah River Site and Francis Marion National Forest, had the highest accuracy. Total omission errors ranged from 4.9 at Ft. Jackson to 11.3 at Francis Marion NF. Total commission errors ranged from 9.5 at the Savannah River Site to 66.8 at Ft. Jackson. While sample sizes are too small to make any statistical comparisons, some general statements can be made. Commission errors were much higher overall than omission errors, except at Francis Marion National Forest and Savannah River Site. At Savannah River Site, commission errors were still higher but not by a large amount. For amphibians, reptiles and mammals, omission error was highest at the Francis Marion National Forest except in the birds. There was no clear pattern by taxon for omission errors, and birds had a higher commission error at four of the five sites. Mt. Bridge Wilderness Area had a very high commission error for reptiles. There was also no real pattern in differences of accuracy except that mammals and reptiles were generally better predicted than birds and amphibians.

The highest accuracy was achieved at SRS, a site of intermediate area but with a history of long-term (50 years) surveys and scholarly work through the Savannah River Ecology Lab. Through the work of on-site scientists, contractors, government personnel and visiting scientists, thousands of scientific papers on the flora and fauna of the site have been published. Francis Marion National Forest, by virtue of being near a major population center, a museum, and a university, has also been the site of numerous scientific studies. York County is in the piedmont, an area of the state that is relatively unknown; we feel our data point strongly to the need for more study in this particular area.

Table 12. Results of SC-GAP vertebrate accuracy assessment for areas where species lists were available. Sites are listed in order of decreasing size.

Managed Area And taxa	List Count	GAP Count	Omission Error Count	Omission Error Percent	Commission Error Count	Commission Error Percent	Overall Accuracy (%)
York County Museum Survey							
Amphibians	16	25	2	12.5	7	28.0	64.0
Reptiles	27	42	3	7.0	12	28.5	64.3
Mammals	32	43	1	2.0	10	23.3	74.4
Birds	102	175	12	6.9	61	58.2	58.3
Total	176	286	19	6.6	90	31.5	61.5
Francis Marion National Forest							
Amphibians	43	53	8	15.1	2	3.8	81.1
Reptiles	57	66	8	12.1	1	1.5	86.4
Mammals	43	61	16	26.2	2	3.3	70.4
Birds	167	206	4	1.9	36	17.5	81.1
Total	310	386	35	11.3	41	13.2	80.3
Savannah River Site							
Amphibians	40	44	1	2.3	3	6.8	90.9
Reptiles	60	64	1	1.6	3	4.7	93.8
Mammals	50	52	2	3.8	0	0.0	96.2
Birds	156	198	14	7.0	28	14.1	78.8
Total	306	358	18	5.0	34	9.5	85.5
Fort Jackson							
Amphibians	25	45	1	2.2	19	42.2	55.5
Reptiles	33	53	7	13.2	13	24.5	62.3
Mammals	26	46	2	4.3	18	39.1	56.5
Birds	103	184	6	3.2	75	40.7	56.0
Total	187	328	16	4.9	125	66.8	57.0
Mt. Bridge Wilderness Area							
Amphibians	22	32	2	6.3	8	25.0	68.8
Reptiles	16	38	1	2.6	22	57.9	42.1
Mammals	39	59	1	1.7	19	32.2	66.1
Birds	122	166	22	13.3	22	13.3	73.5
Total	199	295	26	8.8	71	24.1	67.5

Limitations and Discussion

In general, SC-GAP met our goal of 80% accuracy at two sites and fell below at three additional sites. The fact that our data had the highest accuracy at the two most-studied, long-term sites leads us to feel that we achieved our goal of predicting vertebrate distributions with good accuracy. As with many GAP products, errors of commission were sometimes high; we hope this leads to more study throughout the state to further develop our knowledge of the state's vertebrate species and their distribution.

These data are intended for use at a landscape scale or above. As was clear from our data analysis, we predicted vertebrate species much better in large areas than in small. We also predict the potential for a species to occur in a certain area but cannot say for certain that they will be there. We hope our data provides many opportunities to investigate species habitat relationships and to better understand the distribution of our state species. This is particularly true in areas such as the piedmont, which has been poorly studied, and in the mountains where many species occur at the edges of their ranges. It would also be our recommendation to study those species that occur in lands used by humans such as cultivated lands and urban/suburban backyards. This is conceivably very significant habitat and is well worth including in our network of 'conservation' lands.

CHAPTER 4
LAND STEWARDSHIP

Introduction

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 management 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 also is not unlikely 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 homogeneous 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 status.

The characteristics used to determine 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 Standard

Due to the variable nature of the existing source data, it was not possible to map stewardship data to an established accuracy standard. Many of the spatial property files were extracted from field maps, plat and tax maps and Digital Line Graph (DLG) where the input data scale ranged from 1:250,000 to 1:4,800. Where multiple boundaries existed, higher resolution data were used in this database. Coordinate geometry (COGO) functions of the resident GIS were used to input legal description boundary definitions

where available. In addition, all property features were compared to various road, hydrography and other data layers to ensure that property boundaries conformed to various natural and cultural features. Data entered from multiple map sources were manually edgematched to ensure cartographic integrity across quadrangle or other map boundaries.

Attribute values, record formats and naming conventions conformed to national GAP management status and ownership protocols. Various input screens were developed in Oracle to provide pulldown menu choices to ensure spelling and case sensitivity consistency.

Methods

Dates of Inventory
The primary inventory of public lands in S.C. for GAP began in February 1997 and ran through March 1999. Updates and corrections continue to be made as received from agencies.

Method of Collection/Items Collected
A survey of agencies was begun with a letter of request to agency heads initiated on February 26th, 1997. The letter included a brief description of the GAP project and a short form listing items of information needed and designation of a contact person knowledgeable of the agencies' land property.

A simple data entry form was developed to record information about each property and provide a paper trail to information collected. A Microsoft Access / Oracle interface and data entry forms were set up so that attribute data for each property could be recorded. A unique number was assigned to each property record that could be tied to a map of property boundaries.

The survey proceeded by making contact and follow-ups with each assigned agency person or property manager and collecting property information and boundary maps, usually consisting of plats, tax maps, or boundary maps drawn on topographic or other base maps. The property was assigned a number, and attribute data was entered into the Access database system. The boundary map with an attached entry form and/or assigned number was delivered to the SC DNR NRIMA Section for digitizing. A GAP management status code and selected metadata descriptors were added to the database after the property record information was collected.

Existing Sources of Data
At the start of the project, some public lands data existed. Each of these databases was evaluated for relevance to SC-GAP. The S.C. General Services Office currently is developing a tabular inventory of state-owned lands based on county assessor office records. This inventory was not used because it would not be complete within the SC-GAP project period and because past experience of working with these records indicated they were incomplete and outdated. Similarly, the U.S. General Services Administration

has regularly published an inventory of U.S. civilian and military real property in each state. The last inventory was published in September 1997. This inventory is based on questionnaires to federal agencies, and although it is known to contain some errors, it was useful as a check on data collected from federal agencies or as a source when no local contact for a federal agency could be obtained.

Four major databases had been developed over the past decade that provided a framework for the GAP project. The SCDNR Land Resources Division completed a tabular inventory of state and federal lands in S.C. in 1986. This inventory contained a variety of attributes such as owner, manager, and acreage for each property. As a result, this tabular database was used as the base for the GAP managed lands inventory with the addition of management status and other attributes. The Land Division also had completed a digital spatial inventory of DNR-owned lands. Property boundaries for DNR lands were cartographically transferred from plats and field maps to 1:100,000-scale topographic base maps and digitized into the Arc/Info geographic information system. These data provided the initial spatial data for the land stewardship database. Individual polygon/parcel boundaries were replaced with more accurate data as they became available.

The second primary data source was the Digital Line Graph (DLG) data developed by the Water Resources Division (WRD) of the SCDNR. Between 1989 and 1995, the WRD worked with the U.S. Geological Survey through Joint Funding Agreements (JFAs) to develop boundary, hydrography, hypsography, and transportation layers for the 566 1:24,000-scale topographic maps for South Carolina. The boundary layer of the DLGs included state and national park, refuge and forest properties, wildlife management areas, reservations and other public-owned lands. Because the DLGs had better spatial resolution and accuracy, these data were used to replace the Land Resources Division data where appropriate. Parcel identification numbers were assigned to link the higher resolution spatial data to the tabular inventory database.

The third major contributor in the effort to produce a protected lands layer was the U.S. Fish and Wildlife Service's (USFWS) Coastal Ecosystem Program. As a part of this program, the Charleston Ecological Services office maintains a tabular and digital map inventory of public and private conservation lands in the eight coastal counties of the state. This inventory is based on county deeds, plats, tax maps, conservation easement agreements and other documents available from the local land records office. The results of this inventory, particularly the private lands data, were incorporated into the overall protected lands layer for the Gap Analysis.

The fourth database consisted of the forest tract inventory data from the U.S. Forest Service for the Francis Marion and Sumter National Forest units in South Carolina. These data are comprised of polygonal vector-based property boundaries including outholdings and special use areas. Special use areas included natural and recreational areas, botanical and zoological reserves, wildlife areas, scenic river corridors and roadless management areas.

Scope and Rationale of Inventory

The SC-GAP Managed Lands team discussed the scope of the inventory of public and private lands prior and during the data collection phase. Group members discussed the managed lands inventory with representatives from the Southeast including Florida, North Carolina and Tennessee. All these representatives emphasized the need to collect the larger parcels for a GIS analysis that are consistent with the large, generally-defined polygons of other data layers such as vertebrate species ranges. Others in the SC group pointed out that some of the smaller properties might be important from a special species habitat or from an ecological representative point. Also considered was the time frame for the project to reasonably collect the data needed. Another factor was the original National GAP standard of using 1:100,000 scale base map and the minimum mapping unit of 100 hectares. The SC GAP group considered this to be too gross a scale for the parcels of the Southeast.

It was decided to use a two-tiered approach to collecting managed lands. First, all land 100 acres or larger would be automatically included in the inventory and classified into one of the four standard management classes. In addition, all other public lands of any size would be included that were designated or considered to be largely natural in nature or were protected or managed for plant or animal wildlife. Private or institutional land holdings protecting biodiversity would be brought in from the U.S. FWS-Coastal Ecosystem Program's conservation lands inventory or other sources.

The SCDNR-NRIMA Section integrated the three existing source data files into a statewide land stewardship database of property boundaries and associated attributes. For each property parcel, the highest resolution spatial data was retained in the database. Similarly, information updates were requested from property owners and spatial and tabular attributes were modified. Coordinate Geometry (COGO) functions were used to input survey coordinates from property plats into the GIS. Other modifications were obtained from tax maps, site plans or other base maps.

Assignment of GAP Classes/Other Contacts

The managed lands committee of the SC GAP decided to use the four basic classes of the National GAP program, but to modify the definition of the classes slightly to fit the conditions in South Carolina. The managed lands committee met with the property manager of the S.C. Heritage Trust Program and the wildlife manager of the SC DNR Wildlife & Freshwater Fisheries Division and consulted with GAP coordinators in adjoining states about the definition of the GAP classes in South Carolina (see Table 13).

An initial assignment of GAP classes was made for each property based on basic knowledge of the type of property and its assigned use. General guidance was provided by Heritage Trust, Wildlife Lakes and Fish Hatchery managers of the SC DNR and by Parks managers of the SC PRT Department. Specific assistance was obtained by contacting the individual property manager of selected properties (in addition to the assigned agency contact). Generally, the majority use of the property was considered in making a decision about what GAP management status class to assign the property.

Properties that had a variety of uses, were largely developed, had no program mandate or no other assurance of remaining unchanged were placed in the unprotected class 4.

Table 13. Management Status Categorization; bold characters indicate where SC-GAP differed from the handbook.

Status 1: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to **restore and/or** maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management. **This classification may include hunting activities if hunting is not actively managed for.**

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 that may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance. **This status includes lands that may be managed for hunting.**

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 (e.g., logging) or localized intense type (e.g., mining). It also confers protection to federally listed endangered and threatened species throughout the area.

Status 4: There are no known public or private institutional mandates or legally recognized easements or deed restrictions held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types. The area generally allows conversion to unnatural land cover throughout

Stewardship Mapping

The 1:24,000 scale coverage incorporated in the South Carolina Gap Analysis Project was created using the Arc/Info geographic information system software. As indicated previously, source data from the U.S. Fish and Wildlife Service, the U.S. Forest Service and the S.C. Dept. of Natural Resources were the initial components of this data set. Each of these data was constructed using the Arc/Info GIS and was easily transferred between agencies. All features in each data set were inspected for resolution, positional accuracy and quality. Redundant or antiquated data were eliminated from the spatial data set. The remaining features were combined with the Arc/Info GIS to create a single statewide data set (Figure 19).

Once all databases were integrated, additional stewardship properties were incorporated into the database. Additions and modifications to existing properties were submitted to the DNR based on the stewardship questionnaire and inventory form mailed to all state and federal agencies and land management organizations in the state. Revised property boundaries were returned on a variety of media including topographic maps, survey plats and legal descriptions, tax maps and digital survey data. Several methods including on-screen and tablet-based digitizing and Coordinate Geometry (COGO) were used to input additional property boundaries and to edit existing properties.

Use of the COGO module in Arc/Info was the most accurate method of data input because it operated on survey data and legal descriptions of the property. An AML (Arc Macro Language program) that contained bearing and traverse information was generated, which allowed for a high accuracy of property location, or georeferencing. In many cases survey source maps were not available from the property manager. As a result, on-screen manual digitizing was used to input the data. This process required the use of ancillary data sources, such as Digital Raster Graphics (DRGs), Digital Line Graphs (DLGs) and Digital Orthophoto Quarter-Quadrangles (DOQQs), that aid in determining the correct location of a property. It is standard practice to reference roads, utility or hydrography data maps when creating properties using the on-screen digitizing method. Property boundary conflicts between the data sources were resolved by manual editing techniques.

Each property in the spatial data file was assigned a unique identification number that was used to link the spatial feature to the tabular inventory information stored in the Oracle relational database management system. The database attributes included property name, owner, manager/contact, address, contact phone number, GAP class agency code, GAP management status, surveyed acreage and other relevant stewardship information.

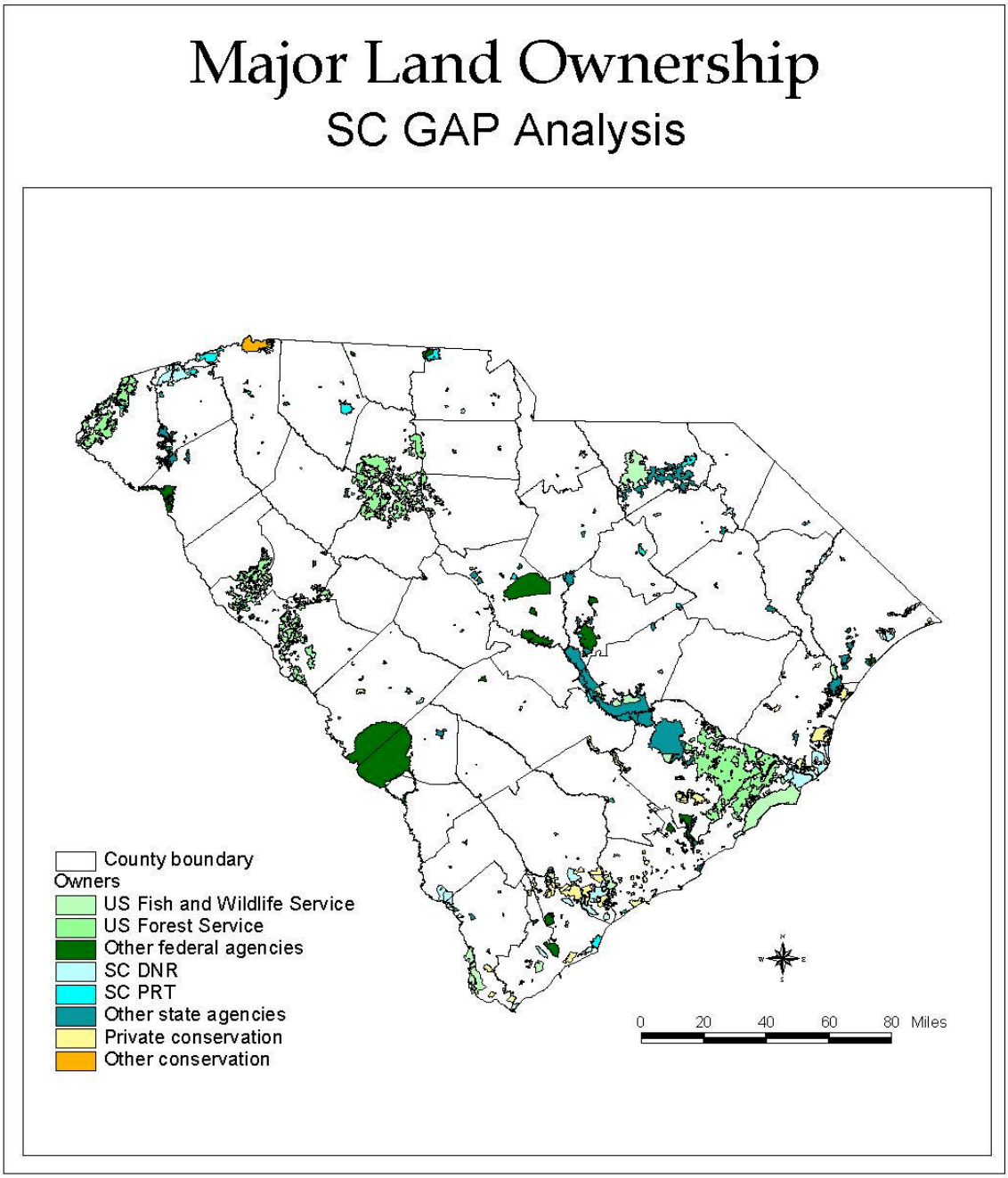


Figure 19. Major land ownership in South Carolina

Results

The following table (see Table 14) presents summary statistics of area representation of stewardship and management categories in the state. We begin by comparing representation of various stewardship categories in management status categories. Table 14 provides information on the proportional make-up of management status categories by stewardship and vice-versa, so that land stewards can see to what degree their lands generally contribute to biodiversity maintenance. Appendix 9 identifies all management areas identified by SC-GAP as management status 1 or 2 along with the manager and source of the information used to categorize the area. Analyses of representation (see page_) were based on these identified places, therefore places not identified here (or changes in management plans that would influence the assigned status) will affect the analyses.

Table 14. This table indicates the area in square kilometers (km sq) (multiply by 100 for hectares and by 247 for acres) for the following measurements: 1) area of the land stewardship category in each management status and total for the state, 2) the steward's percent of total area in each management category and of the state area, and 3) total area of each stewardship category in the state and its percent of state area.

Land Owner	Gap Status 1	Gap Status 2	Gap Status 3	Gap Status 4	Total Area
USFWS	454 0.6	0	0	0	454 0.6
USFS	131 0.2	14 0.02	2472 3.1	0	2617 3.2
Other Federal	90 0.1	0	1065 1.3	372 0.5	1437 1.9
SCDNR	332 0.4	372 0.5	3 0	0	704 0.9
SCPRT	0	98 0.1	167 0.2	0	265 0.3
Other State	0 0	82 0.1	414 0.5	338 0.4	834 1.0
Private Conservation	149 0.2	0 0	14 0.02	0 0	163 0.2
Other	1 0	78 0.1	27 0.03	0 0	106 0.13
Total	1157 1.4	644 0.8	4162 5.2	710 0.9	6580 8.1

Limitations and Discussion

This map is a compilation of ownership maps provided by a variety of sources that are individually responsible for their accuracy. It was created solely for the purpose of conducting the analyses described in this report and is not suitable for locating boundaries on the ground or determining precise area measurements of individual tracts. The information is as complete as possible with the exception of some small tracts and many private parcels, especially those under the management of local land trusts.

CHAPTER 5
ANALYSIS BASED ON STEWARDSHIP AND MANAGEMENT STATUS

Introduction

This chapter describes the method and results of the gap analysis as used by the Gap Analysis Program. As described in the general introduction to this report, the primary objective of GAP is to provide information on the distribution and status of several elements of biological diversity. 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, p. 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 element in biodiversity management areas 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:

- historic loss or gain in distribution,
- nature of the spatial distribution,
- immediate versus long term risk, and
- degree of local adaptation among populations of the biotic elements that are worthy of individual conservation consideration.
- Such analyses are beyond the scope of this project, but we encourage their application coupled with field confirmation of the mapped distributions.

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, for details). 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.

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 of the above organizations as described in the introduction. 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.

Methods

The gap analysis is accomplished by first producing: maps of land cover (see Figures 8, 9, and 10), predicted distributions for selected animal species (see Figure 12), and land stewardship and management status (see Figure 18). 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.

Results

The data are provided in a format that allows users to carry out inquiries about the representation of each element in different land stewardship and management categories as appropriate to their own management objectives. This forms the basis of Gap's mission to provide land owners and managers with the information necessary to conduct informed policy development, planning, and management for biodiversity maintenance.

As a coarse indicator of the status of the elements, we provide a breakdown along five levels of representation (0-<1%, 1-<10%, 10-<20%, and 20-<50%; >=50%). The <1% level indicates those elements with essentially none of their distribution in a protected status while levels of 10%, 20%, and 50% have been recommended in the literature as necessary amounts of conservation (Noss and Cooperrider 1994; Noss 1991; Odum and Odum 1972; Specht et al. 1974; Ride 1975; Miller 1994).

Land Cover Analysis

A summary of the analysis according to the thresholds described above is shown in Table 15 below. This table provides the area in square kilometers (multiply by 100 for hectares, 247 for acres) of each types' mapped distribution by management status and land steward for status 1 and 2 lands, and the percent of the types' total distribution in each category. For example, bottomland/floodplain forest comprises a total of 8185 km^2 of the state's area. Of that, 2.23% occurs on GAP status 1 or 2 lands and 5.35% on GAP status 3.

Table 15. Vertebrate habitat classes and their relative protection in GAP status 1 and 2 lands.

Land Cover	# Vert. Spp.	Total Area	Area Protected	% Protected
Fresh Water	168	2361	67	2.83
Marine Water	51	1032	150	14.54
Marsh	179	2073	428	20.64
Pocosin	160	365	26	7.13
Swamp	208	3075	225	7.32
Bottomland	212	8185	183	2.23
Wet Soil	47	225	13	5.77
Wet Scrub/Shrub	69	2387	44	1.84
Dry Scrub/Shrub	96	5273	27	0.51
Sandy Bare Soil	92	63	1	1.59
Recently Cleared	76	5960	45	0.76
Rock Outcrop	33	16	1	6.25
Aquatic Vegetation	72	34	11	32.35
Closed Canopy	56	10928		
Evergreen			196	1.80
Evergreen Mixed	185	7937	140	1.76
Pine Woodland	188	713	21	2.94
Dry Deciduous	180	695	99	14.24
Mesic Deciduous	195	7909	130	1.65
Dry Mixed	165	291	7	2.41
Mesic Mixed	212	892	8	0.89
Grassland/Pasture	159	2197	8	0.37
Cultivated Land	144	12310	16	0.13
Urban Development	37	1308	1	0.08
Urban Residential	150	2446	0	0.00
Wet Evergreen	56	1455	44	3.03
Maritime Forest	136	655	39	5.95
Beach	56	30	6	20.00

As explained above, we provide results according to thresholds of representation advocated in the literature to conserve biodiversity. The values in the table will allow users to set any desirable threshold to identify elements requiring more protection according to their criteria. The following summaries highlight potential gaps and conservation needs; Appendix 9 provides figures of stewardship representation for all land cover types by land steward and management status.

Land Cover with 0-<1% representation in GAP status 1 and 2: This group included dry scrub/shrub thicket and open canopy/recently cleared forest. The single forest type with this low level of protection was the mesic deciduous forest/woodland. The low level of protection afforded the grassland, pasture, dry scrub/shrub group is consistent with low

levels of protection afforded grasslands and shrub habitats throughout the United States (cite). It is disturbing that mesic deciduous woodland is also poorly protected in that it forms a significant component of vertebrate habitat within the state, containing the fourth highest level of diversity.

Land Cover with 1-<10% representation in GAP status 1 and 2: 19, 28. These land cover types include fresh water, barren habitats including wet soil, sandy bare soil, and rock outcrops. Bottomland/wetland habitat such as pocosins, swamps, bottomlands, and wet evergreen are also in this category. Mesic deciduous woodland is also poorly protected. Four map classes including evergreen are included here: closed canopy pine, evergreen mixed forest, pine woodland, and dry mixed forest/woodland. Maritime forest is also poorly protected by GAP status 1 and 2 lands.

Land Cover with l0%-<20% representation in GAP status 1 and 2: This includes only two land cover types, dry deciduous forest and marine water.

Land Cover with 20% -<50% representation in GAP status 1 and 2: Land cover types with this level of protection include beach habitat, marsh, and aquatic emergent vegetation. These are all low diversity vertebrate habitats.

Land Cover with at least 50% representation in GAP status 1 and 2: There are no land cover types with greater than 50% protection according to GAP status 1 and 2.

Although it has long been generally recognized that swamps and bottomland hardwoods, along with mesic deciduous hardwoods provide significant habitat and corridors for wildlife, the level of protection does not reflect the significance of this habitat. Deciduous forests in general and bottomlands, specifically, have been a target for land protection within the state prior to GAP. There is significant protection for some of the deciduous forests, especially in the mountains, through many efforts including significant recent acquisitions.

It has been recently recognized that several species of concern within the state utilize the grassland, pastures and successional land that is disappearing to urbanization and to pine plantations. A recent working group for Partners in Flight recognized within the Atlantic Coastal Plain that grasslands/savannas/pastures, and early successional shrub-shrub habitat are among the significant habitat planning units (South Atlantic Coastal Plain Working Group Executive Summary, 2000). Additionally they recognized urban/suburban backyard habitats. All of these habitats have been low priority for acquisition and protection, it is hoped that will change.

Limitations and Discussion for Land Cover Analysis

Assessing the conservation status of natural land cover is limited by several confounding factors:

GAP has typically found the accuracy of the mapped distributions of natural communities at the floristic (e.g., alliance) level to be substantially lower and more variable than that of animal distributions;

any aggregation of biotic units (e.g., above species) is a surrogate for species or lower levels of biotic organization and will underrepresent conservation need (Pressey and Logan 1995); and

for the most part we cannot distinguish the degree of natural condition or value of the mapped units due to management manipulation, exotic invasion, or spatial configuration. Considering an aggregation of species such as we have mapped to be sufficiently represented in existing conservation areas cannot be determined solely by the percentage of the community represented because the aggregation has unmapped variation in species composition that we could not measure. Until individual plant species distributions can be mapped, it is not possible to assure that the full range of vegetation biodiversity is represented, and surrogates must be used.

The mapping of successional habitats is very difficult and tends to have a low accuracy. Because our TM imagery dates were in the early 1990s and our accuracy assessment took place nearly nine years later, we have a poor idea of the accuracy and condition of those lands. Urban change is also taking place at a fast rate within the state, in some cases land is converted to impervious surfaces at a rate 3 to 5 times that of population growth.

Predicted Animal Species Distributions Analysis

A summary table is not provided due to the large number of species analyzed, but some generalizations and examples of species results by the various thresholds are provided below. The accompanying database provides this information for further analysis. An analysis of some species of concern is included in Table 16. For a full analysis of vertebrate species protection, see Appendix 10.

Table 16. Some South Carolina species of concern and their percent distribution in the different protection categories. SP = Species, TH = total habitat, GAP = GAP Status, PA = total protected habitat, PP = percent total protected, FA = federal protected habitat, FP = percent federal protected, SA = state protected habitat, SP = percent state protected, OA = other protected habitat, OP = percent other protected. Area is in km^2.

ITIS CODE	AREA	STATUS	STATUS AREA	STATUS PCT	FWS AREA	FS AREA	OF AREA	DNR AREA	PRT AREA	OS AREA	PC AREA	OC AREA
Flatwoods Salamander												
173596	1068	1	34	3.18	24	4	0	6	0	0	0	0
173596	1068	2	12	1.12	0	0	0	5	0	3	4	0
173596	1068	3	122	11.42	0	86	10	0	0	0	26	0
173596	1068	4	900	84.27	0	0	0	0	0	315	0	0
Bog Turtle												
173773	52	1	4	7.69	0	0	0	0	0	0	0	4
173773	52	2	0	0.00	0	0	0	0	0	0	0	0
173773	52	3	0	0.00	0	0	0	0	0	0	0	0
173773	52	4	48	92.31	0	0	0	0	0	0	0	0
Gopher Tortoise												
173858	375	1	0	0.00	0	0	0	0	0	0	0	0
173858	375	2	9	2.40	0	0	0	9	0	0	0	0
173858	375	3	1	0.27	0	0	0	0	0	0	1	0
173858	375	4	365	97.33	0	0	0	0	0	1	0	0

Wood Stork

174897	1740	1	261	15.00	154	0	0	99	0	0	8	0
174897	1740	2	161	9.25	0	0	0	127	0	0	34	0
174897	1740	3	165	9.48	0	3	0	0	15	4	143	0
174897	1740	4	1153	66.26	0	0	19	0	0	8	6	0

Bald Eagle

175420	26583	1	925	3.48	525	50	56	229	0	0	59	6
175420	26583	2	336	1.26	0	0	0	192	26	61	57	0
175420	26583	3	1812	6.82	0	805	439	0	69	133	365	1
175420	26583	4	23510	88.44	0	0	106	1	0	719	14	0

Piping Plover

176507	1766	1	266	15.06	158	0	0	100	0	0	8	0
176507	1766	2	150	8.49	0	0	0	114	0	0	36	0
176507	1766	3	161	9.12	0	2	0	0	16	3	140	0
176507	1766	4	1189	67.33	0	0	20	0	0	10	8	0

Least Tern

176923	2805	1	404	14.40	281	0	0	114	0	0	9	0
176923	2805	2	164	5.85	0	0	0	126	0	0	38	0
176923	2805	3	176	6.27	0	3	0	0	18	4	151	0
176923	2805	4	2061	73.48	0	0	31	0	0	13	9	0
176926	2807	1	411	14.64	284	0	0	118	0	0	9	0

Red-cockaded Woodpecker

178257	8744	1	154	1.76	106	9	0	38	0	0	1	0
178257	8744	2	45	0.51	0	0	0	21	4	6	14	0
178257	8744	3	777	8.89	0	312	258	0	26	100	81	0
178257	8744	4	7768	88.84	0	0	7	0	0	53	0	0

Southeastern Myotis

179993	30358	1	498	1.64	214	55	56	125	0	0	48	0
179993	30358	2	170	0.56	0	0	0	51	36	61	22	0
179993	30358	3	1831	6.03	0	994	480	0	67	161	129	0
179993	30358	4	27859	91.77	0	0	74	0	0	700	0	0

Rafinesque's Big-eared Bat

555664	32562	1	417	1.28	108	57	55	114	0	0	51	32
555664	32562	2	201	0.62	0	5	0	89	36	59	12	0
555664	32562	3	1219	3.74	0	517	383	0	43	104	171	1
555664	32562	4	30725	94.36	0	0	79	1	0	224	6	0

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).

The land cover used in the vertebrate modeling was a 27-class habitat map, the accuracy at an Anderson Level II is about 51%, Anderson level I was about 71%. The classes that were of lowest accuracy included pocosins, aquatic vegetation other than marsh, and some of the transitional classes such as clearcut and grassland/pasture. When forest types are merged, they are accurate; sub-classes such as upland deciduous or mesic mixed should be used with caution. However, the patterns of mixed forest types, or forest types and clearcut, seem to be very representational of the landscape of South Carolina and can be used in field studies and in general planning activities.

The vertebrate predicted distributions are overall quite accurate and can be used with some confidence in areas of the size of a county or portion of a county. These predicted distributions, however, cannot be used to assess relative abundance or predict a species or individual occurrence at a particular site. The user should pay special attention to species with low confidence such as bats.

The stewardship mapping is accurate for the time of the data collection and within the accuracy standards described in the methods. Again, this analysis is intended for broad-scale analyses to determine patterns of the landscape and overall distribution of species diversity in relation to landscape features and land ownership.

CHAPTER 6
CONCLUSIONS AND MANAGEMENT IMPLICATIONS

The South Carolina GAP Project has been a success in its effort to map state biodiversity, to predict distributions of vertebrate species, and to document the stewardship of these elements through land protection efforts. But in addition to this, connections were made through teamwork and cooperative projects. It is hoped that the combination of scientific information with the enhanced communication made possible through our common history with SC-GAP will facilitate future conservation activities in the state.

The South Carolina land cover represents a significant step as part of an ongoing set of projects in the state concerning land use change. Urban change detection and projections of future growth are projects that the SCDNR and the Strom Thurmond Institute at Clemson University have been involved in. The critical step in any urban change project is to understand what habitat is being lost, and this can be accomplished through the use of the SC-GAP land cover. Urban growth and its accompanying sprawl are impacting some of the least protected areas of the state, our grassland and shrublands.

The process of deriving a land cover and the accuracy assessment process have led us to understand the difficulty of mapping from remotely sensed information the complex landscape that exists in the southeast. Pocosins and wet evergreen woodlands are examples of land cover types that are subtly different in characteristics such as percent canopy cover. Pine flatwoods are a highly endangered and necessary part of the landscape; these were also difficult to map because of the variation in percent canopy cover. Our beaches, coastlines and outer coastal areas are a complex of different soil types and their accompanying vegetation. Old sand dunes produce ridges of upland soil separated by wetland depressions, each supporting unique vegetation. These land cover types will benefit from finer-scale mapping efforts and more intense ground level assessment.

Another challenge was posed by the conversion of land cover classes from one transitional state to another. Planted pine (our closed canopy evergreen), scrub/shrub thickets, recently cleared land and cultivated land may all be present on the same parcel of land at different times as a result of planting and harvest of pine plantations. This transition is temporal and may be assessed through examining land covers produced at different time intervals. The SCDNR proposes mapping the land cover of South Carolina at approximately five-year intervals, beginning before the 2001 SC-GAP project and continuing five years after. Analysis of the pine plantation landscape using the potential transitional classes listed above will greatly assist in mapping this significant part of the South Carolina landscape.

We benefited greatly from the association with and assistance from various taxonomic experts within South Carolina. It is clear they are well able to predict the distribution and habitat affinities of the 455 species that occur within the state. Some species clearly require further study of both habitat use and distribution. Additionally, many features of the landscape are not mapped in this project and are significant components of species habitats. These include things such as borrow pits, ecotonal areas, urban roosting sites for bats and chimney swallows, and environmentally friendly golf courses. GAP projects explicitly do not deal with abundances, and this information is essential to understanding the biodiversity of the state. A comprehensive monitoring and inventory program for the state that includes all species, rare or common, specialists or generalists, is essential in documenting critical habitat.

South Carolina has protected just over 8% of its habitat. This protection is not distributed evenly throughout habitat types or physiographic regions. Some of the best-protected habitats are not rich in terrestrial vertebrates, these include salt water, marsh and aquatic vegetation. However, this does provide some promise for the analysis of aquatic species in the future. Cultivated and pasture lands, backyard habitats and transitional vegetation types are some of the least well protected. These are often privately owned, and the state would benefit hugely from an emphasis on farmland conservation and protection programs as well as those addressing backyard habitat. Many species such as the painted bunting, which has become a species of special concern in the state, are closely tied to these habitats that are disappearing under spreading urbanization.

The good news is that swamps and bottomlands, while not well protected, enjoy a higher level of protection than many other habitat types. These are shown by our analysis to be significant habitats for a large diversity of animals and should certainly continue to be targets for protection.

Two of the pine classes and our mixed mesic forest are significant vertebrate habitats and do not occur frequently on protected lands. In many cases these may be associated with timbering activities. A program of education and cooperation with landowners for these habitats could result in significant habitat protection such as that seen with the Safe Harbor program for Red-cockaded woodpeckers. Private landowners and corporations bear the responsibility for a very large portion of the diversity of South Carolina. They can act as partners in protecting both habitat and species diversity. Educational and outreach programs should be developed and disseminated throughout the state to assist this group in maintaining the natural beauty and diversity of South Carolina.

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/gap

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.

GIS products including state specific coverages and data will be available through the SCDNR GIS clearinghouse at http://www.dnr.state.sc.us/water/nrima/gisdata/

Minimum GIS Required for Data Use
To use the data available from the clearinghouse, user must have ArcView with Spatial Analyst, ArcInfo or a compatible ESRI subsystem. The data will be available using ArcIMS software which can then be viewed using basic internet capabilities beginning in October 2002.

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 10, 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.

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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 1993b)

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., in press)

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, vegetational 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., in press)

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

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)
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)
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
EDC EROS Data Center
ECOMAP The National Hierarchical Framework of Ecological Units mapping project of the USDA Forest Service
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
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
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

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
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)
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)
SCICOLL Scientific Collections Permit Database
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

USFS US Forest Service
USFWS US Fish & Wildlife Service
UTM Universal Transverse Mercator
UVM University of Vermont
WHRM Wildlife/habitat relationship model
WISCLAND Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data

APPENDICES

Appendix 1. A detailed description of South Carolina GAP Land Cover classes and a listing of appropriate TNC alliances within each class. A description is provided for the more general habitat map and the detailed land cover

Map Class 1 – Fresh Water

Fresh water includes ponds, lakes, rivers, streams, flooded borrow pits and beaver ponds. It may also include rocky shoals and wet sand/mud flats, where patches are too small to map separately.

The aerial extent of this class was expanded using NWI class fresh water and soil class water; in quadrangles where neither of these ancillary data sources are available, fresh water pixels may be underestimated.

Map Class 2 – Marine water

Marine water includes salt and brackish water along the coast in the Atlantic Ocean and in estuaries.

In the eight coastal counties, NWI class salt water was used to change water pixels to marine water. NWI data were available for all coastal counties.

Map Class 3 – Fresh Water Marsh/Emergent Wetland

This class includes all freshwater wetlands dominated by herbaceous vegetation. It encompasses several of Nelson's natural communities to include Depression Meadow, Tidal Freshwater Marsh, Upland Bog, and Hillside Herb Bog (Nelson, 1986). The GAP concept of interdune ponds is that of a fresh water marsh; however, Nelson's description of interdune ponds is of water-filled ponds supporting aquatic vegetation, which should be found mapped as map class 12, aquatic vegetation.

Decision rules, especially utilizing NWI, were critical in distinguishing fresh water marshes from salt marshes.

Several ecological complexes and compositional groups are found in this freshwater marsh and emergent wetland class. These include the Depression Meadow Compositional Group, Coastal Island Pond Compositional Group and the Tidal Freshwater Complex.

Depression Meadow Compositional Group

This group includes flatwoods depression meadows and limestone sinkhole ponds, inner coastal plain high ponds, and coastal island ponds. If they're large

enough to be mapped separately, they are found as class 3. Otherwise, they're inclusions within other coastal plain map classes, especially 13, 15, 25 and 44.

V.A.5.N.k.18 *Panicum hemitomon* Seasonally Flooded Temperate Herbaceous Alliance
V.A.5.N.k.28 *Spartina bakeri* Seasonally Flooded Herbaceous Alliance
V.A.5.N.k.65 *Carex striata* Seasonally Flooded Herbaceous Alliance
V.B.2.N.h.3 *Woodwardia virginica* Seasonally Flooded Herbaceous Alliance
V.B.2.N.h.100 *Polygonum spp.* (section *Persicaria*) Seasonally Flooded Herbaceous Alliance

Coastal Island Pond Compositional Group

Many of the barrier island and marsh island ponds will be found as inclusions within the Coastal Upland Mixed Forest, Class 44 or Lowland Maritime Forest, Class 26. If they're large enough to be mapped separately, they should be mapped as Class 3. The Coastal Island Pond Compositional Group includes the following alliances:

V.A.5.N.k.31 *Typha domingensis* Seasonally Flooded Temperate Herbaceous Alliance
V.A.5.N.k.28 *Spartina bakeri* Seasonally Flooded Herbaceous Alliance
V.A.5.N.k.5 *Carex hyalinolepis* Seasonally Flooded Herbaceous Alliance
V.B.2.N.h.100 *Polygonum spp.* (section Persicaria) Seasonally Flooded Herbaceous Alliance

Tidal Freshwater Ecological Complex

This complex is found in major estuaries and rivers that are under tidal influence but are fresh water. It includes most of the rice field vegetation where dikes have been broken and natural hydrology has been restored. Where tidal freshwater marshes can be distinguished, they are referred to as the Tidal Freshwater Marsh Compositional Group since all the alliances are named for herbaceous perennials. Where Tidal Freshwater Forests can be distinguished, they are separated out as the Tidal Freshwater Forest Compositional Group; however, if they are distinguishable at the mapping level, they will be mapped as Class 5, Swamps/Bottomland Hardwoods. Tidal Freshwater Shrublands will be found mapped as Class 7, Wet Scrub/Shrub Thickets where they're large enough to be distinguished. Where tidal forests and/or tidal shrublands are present but cannot be mapped separately from marshes, they are considered to be inclusions in the Tidal Freshwater Ecological Complex.

Tidal Freshwater Marsh Compositional Group
Tidal Freshwater Marsh
V.A.5.N.n.10 *Spartina cynosuroides* Tidal Herbaceous Alliance
V.A.5.N.n.2 *Typha (angustifolia, domingensis)* Tidal Herbaceous Alliance
V.A.5.N.n.14 *Zizania aquatica* Tidal Herbaceous Alliance
V.A.5.N.n.15 *Zizaniopsis miliacea* Tidal Herbaceous Alliance

Tidal Freshwater Forest Compositional Group

Freshwater Tidal Bald Cypress - Tupelo Swamp
Tidal swamp forests usually found mapped as Class 5, Swamps/Bottomland Hardwoods. These are inclusions in Freshwater Marsh where they're too small to map separately.

I.B.2.N.h.2 *Nyssa biflora-(Nyssa aquatica, Taxodium distichum)* Tidal Forest Alliance

II.B.2.N.f.2 *Taxodium distichum* Tidal Woodland Alliance

Tidal Freshwater Shrubland Compositional Group
Tidal River Edge Shrub Wetland – tidally flooded shrublands, occurring in association with freshwater tidal marshes and tidally flooded forests. Where large enough, will be mapped at wet scrub/shrub, class 7, but they are usually found as fringes along tidal creeks and are an inclusion within class 3, freshwater marsh.

III.A.2.N.l.1 *Myrica cerifera-Rosa palustris* Tidal Shrubland Alliance

III.B.2.N.h.2 *Alnus (incana, serrulata)* Tidal Shrubland Alliance

The following alliances are attributed to the freshwater marsh/emergent wetland class.

I.B.2.N.h.2 *Nyssa biflora-(Nyssa aquatica, Taxodium distichum)* Tidal Forest Alliance
Tidal swamps occurring as inclusions within tidal freshwater marsh where they're too small to map separately.

I.B.2.N.f.2 *Taxodium distichum* Tidal Woodland Alliance
Tidal swamps occurring as inclusions within tidal freshwater marsh where they're too small to map separately.

II.B.2.N.c.4 *Taxodium ascendens* Seasonally Flooded Woodland Alliance
Coastal plain pond-cypress woodlands and savannas in relatively flat basins, especially Carolina Bays, remnants of bays, or isolated ponds within a flatwoods matrix.

III.A.2.N.l.1 *Myrica cerifera-Rosa palustris* Tidal Shrubland Alliance
Tidal shrublands occurring as inclusions within tidal freshwater marsh where they're too small to map separately.

III.B.2.N.h.2 *Alnus (incana, serrulata)* Tidal Shrubland Alliance
Tidal shrublands occurring as inclusions within tidal freshwater marsh where they're too small to map separately.

V.A.5.N.j.2 *Andropogon glomeratus* Temporarily Flooded Herbaceous AllianceOccurs in disturbed wetland sites, such as old fields; should map as fresh water marsh (3).

V.A.5.N.j.4 *Carex torta* Temporarily Flooded Herbaceous AllianceAlluvial wetlands on sand, gravel, and rock bars in the mountains. Probably mapped as rock outcrop (11), wet soil (6), or fresh water marsh (3).

V.A.5.N.k.3 *Aristida palustris* - *Andropogon* (*callipes, glaucopsis*) – *Rhynchospora* spp. Seasonally Flooded Herbaceous Alliance
Occurs in relatively shallow to deep seasonally flooded portions of coastal plain ponds and lakes of the coastal plain, including limesink ponds.

V.A.5.N.k.5 *Carex hyalinolepis* Seasonally Flooded Herbaceous Alliance
Seasonally flooded depressional wetlands, occurring in the coastal plain.

V.A.5.N.k.9 *Dichanthelium* (*erectifolium, wrightianum*) - *Rhynchospora filifolia* Seasonally Flooded Herbaceous Alliance
Coastal plain ponds, including some limestone sinkhole ponds.

V.A.5.N.k.14 *Juncus effusus* Seasonally Flooded Herbaceous Alliance
Widely variable in terms of geographic location.

V.A.5.N.k.16 *Leptochloa fascicularis* var. *maritima* Seasonally Flooded Herbaceous Alliance
Brackish, non-tidal wetland; often occurring as interdune wetland; also occurring in waterfowl impoundments.

V.A.5.N.k.18 *Panicum hemitomon* Seasonally Flooded Temperate Herbaceous Alliance
Occurs in ponds, lakes, depression meadows, flatwoods ponds, interdune swales, etc.

V.A.5.N.k.22 *Rhynchospora* (*careyana, inundata*) Seasonally Flooded Herbaceous Alliance
Coastal plain upland depressions.

V.A.5.N.k.23 *Rhynchospora* spp. - *Panicum* (*rigidulum, verrucosum*) – *Rhexia virginica* Seasonally Flooded Herbaceous Alliance
Occurs on seasonally flooded pond shores and lakeshores in the coastal plain.

V.A.5.N.k.25 *Scirpus cyperinus* Seasonally Flooded Herbaceous Alliance
Occurs in seasonally flooded marshes or emergent zones of upland depression ponds.

V.A.5.N.k.28 *Spartina bakeri* Seasonally Flooded Herbaceous Alliance
Interdune ponds; most are too small to be mapped. In SC, known only from the South Atlantic coastal plain ecoregion, these circular depressions are found on marsh islands.

V.A.5.N.k.29 *Spartina patens* Seasonally Flooded Herbaceous Alliance
Maritime Wet Grasslands, interdune ponds.

V.A.5.N.k.31 *Typha domingensis* Seasonally Flooded Temperate Herbaceous Alliance
Occurs in interdune ponds, and other coastal non-tidal wetlands.

V.A.5.N.k.34 *Zizaniopsis miliacea* Seasonally Flooded Temperate Herbaceous Alliance
Occurs in a variety of situations, from rocky beds of slow-moving rivers to stagnant coastal plain waters.

V.A.5.N.k.65 *Carex striata* Seasonally Flooded Herbaceous Alliance
Coastal plain depression meadow.

V.A.5.N.l.1 *Eleocharis* (*elongata, equisetoides*) – *Rhynchospora tracyi* Semipermanently Flooded Herbaceous Alliance
Deeper coastal plain depressional wetlands, including limestone sinks and interdune ponds.

V.A.5.N.l.4 *Phragmites australis* Semipermanently Flooded Herbaceous Alliance
Occurs in depressions, spoil impoundments and along rivers.

V.A.5.N.l.9 *Typha* (*angustifolia, latifolia*) - (*Scirpus* spp.) Semipermanently Flooded Herbaceous Alliance
Most commonly occurs along lake margins and in shallow basins, and occasionally in river backwaters. Also occurs in borrow pits and rice field impoundments.

V.A.5.N.m.17 *Rhynchospora oligantha – Sarracenia* spp. - (*Aristida beyrichiana, Ctenium aromaticum*) Saturated Herbaceous Alliance
Coastal plain herbaceous bog.

V.A.5.N.m.5 *Carex crinita – Osmunda* spp. / *Sphagnum* spp. Saturated Herbaceous Alliance
Fens, often small enough that surrounding trees cast shade and otherwise affect the microenvironment.

V.A.5.N.n.10 *Spartina cynosuroides* Tidal Herbaceous Alliance
Narrow stands along tidal creeks and sloughs or on levees of oligohaline tidal marshes. Should map as fresh water marsh (3) and as salt and brackish marshes (32).

V.A.5.N.n.14 *Zizania aquatica* Tidal Herbaceous Alliance
Tidal freshwater marsh.

V.A.5.N.n.15 *Zizaniopsis miliacea* Tidal Herbaceous Alliance
Tidal freshwater marsh.

V.A.5.N.n.2 *Typha* (*angustifolia, domingensis*) Tidal Herbaceous Alliance
Tidal freshwater to brackish marsh.

V.A.5.N.n.3 *Cladium mariscus* ssp. *jamaicense* Tidal Temperate Herbaceous AllianceTidal brackish marsh.

V.A.5.N.n.7 *Phragmites australis* Tidal Herbaceous Alliance
Tidal marsh occurring in fresh to brackish salinities.

V.B.2.N.d.2 *Justicia americana* Temporarily Flooded Herbaceous Alliance
Occurs on rocky river shoals in the piedmont. Should map as rocky shoals (50), fresh water marsh (3), or fresh water (1). It may also map as urban development (22) due to the presence of rocks.

V.B.2.N.e.1 *Pontederia cordata – Peltandra virginica* Semipermanently Flooded Herbaceous Alliance
Very wet or partially submerged forb vegetation of rivershores and lakeshores, and sometimes of artificial ponds, lakes, and impoundments.

V.B.2.N.f.12 *Senecio tomentosus – Croton willdenowii* Saturated Herbaceous Alliance
Granitic flatrock community occurring on thin soils over granitic rocks. Where they are large enough to map, these sites should map as rock outcrop (11) or fresh water marsh (3).

V.B.2.N.f.14 *Talinum teretifolium – Portulaca smallii* Saturated Herbaceous Alliance
Granitic flatrock community. Where they are large enough to map, these sites should map as rock outcrop (11) or fresh water marsh (3).

V.B.2.N.f.15 *Vittaria appalachiana – Heuchera parviflora* Saturated Herbaceous Alliance
Herbaceous vegetation on rock substrates associated with waterfalls; soils are shallow and constantly saturated. Where they are large enough to map, these sites should map as rock outcrop (11) or fresh water marsh (3).

V.B.2.N.f.7 *Diphylleia cymosa – Saxifraga micranthidifolia* Saturated Herbaceous Alliance
Moderate- to high-elevation forested (shaded) seeps in the mountains. Occurrences are typically very small, but can be extensive (to more than a hectare in size).

V.B.2.N.f.9 *Impatiens* (*capensis, pallida*) – *Monarda didyma* Saturated Herbaceous Alliance
High elevation, open small seeps in the mountains. Marshy – seepy areas dominated by forbs instead of graminoids may, if large enough, show as wet soil, not as marsh.

V.B.2.N.h.100 *Polygonum* spp. (Section *Persicaria*) Seasonally Flooded Herbaceous Alliance
Occurs in wet depressions, lakes, and ponds.

V.B.2.N.h.3 *Woodwardia virginica* Seasonally Flooded Herbaceous Alliance
Occurs in seasonally flooded wetland depressions in the coastal plain.

V.D.2.N.g.1 *Eragrostis hypnoides - Lipocarpha micrantha – Micranthemum umbrosum* Seasonally Flooded Herbaceous Alliance
Occurs on seasonally flooded riverbanks and other sandy shores in the coastal plain. Where large enough to map, should class as fresh water marsh (3) or wet soil (6).

V.D.2.N.h.1 *Amphianthus pusillus – Isoetes* spp. Seasonally Flooded Herbaceous Alliance
Occurs in seasonally flooded pools on granitic flatrocks. May be an inclusion within rock outcrop (11).

V.D.2.N.i.1 *Diamorpha smallii* Saturated Herbaceous Alliance
Occurs in ephemeral pools on large granite outcrops in the piedmont. May be an inclusion within rock outcrop (11).

VI.A.1.N.b.1 *Sphagnum cuspidatum* Seasonally Flooded Nonvascular Alliance
Occurs in coastal plain depressions.

Map Class 4 – Pocosin

This class includes all freshwater wetlands dominated by evergreen shrubs in the coastal plain. It encompasses two of Nelson's natural communities to include Pocosin and Swale Pocosin (Nelson, 1986). It doesn't include Nelson's Streamhead Pocosin which should be found under wet evergreen, class 25, due to the tree canopy. It also excludes Nelson's Seepage Pocosin which also has a tree canopy. However, where the canopy is open enough that it's undetected in the mapping process, the occurrences of Seepage Pocosins in the fall-line sandhills are likely too small to be mapped separately from xeric sandhill scrub forests. Also, although they support evergreen wetland shrub species, the soils on which seepage pocosins are found are not mapped by NRCS as wetland soils so they cannot be identified by decision rules. Pocosins naturally grade into class 25, wet evergreen. Many pocosins support scattered trees; where the tree density is great enough, they'll be mapped as wet evergreen.

Decision rules using NWI and soil information helped greatly in delineating this class. Pocosins occur on saturated soils of GAP soil wetness class 3 or 4 and NWI palustrine evergreen scrub/shrub with or without a forested component.

Pocosins are found in the fall-line sandhills and in the coastal plain. In the coastal plain, they're often found in Carolina Bays within a mosaic of various bay communities. The Carolina Bay Pocosin Ecological Complex takes into account this mosaic of evergreen wetland communities where they're too small to be mapped separately.

Carolina Bay Pocosin Ecological Complex – many Carolina Bays are comprised of a mosaic of pocosins and wet evergreen forests, especially in the Northeastern coastal plain. Where they cannot be distinguished, this complex should be used. Where the occurrences are large enough, bay forests and pond pine woodlands are mapped as class 25, wet evergreen forests.

- Low Pocosin
  - III.C.2.N.e.1 *Zenobia pulverulenta-Lyonia lucida-Ilex (coriacea, glabra)* Saturated Shrubland Alliance
- High Pocosin
  - III.A.2.N.j.2 *Lyonia lucida-Ilex glabra* Saturated Wooded Shrubland Alliance
  - III.C.2.N.f.1 *Zenobia pulverulenta-Cyrilla racemiflora-Lyonia lucida* Wooded Shrubland
- Pond Pine Woodland – see class 25, wet evergreen
  - II.A.4.N.f.9 *Pinus serotina* Saturated Woodland Alliance
- Bay Forest – see class 25, wet evergreen
  - I.A.4.N.g.2 *Gordonia lasianthus* Saturated Forest Alliance
  - I.A.4.N.g.3 *Magnolia virginiana - Persea palustris* Saturated Forest Alliance

The following alliances are attributed to the pocosin class:

III.A.2.N.i.2 *Arundinaria gigantea* Saturated Shrubland Alliance

III.A.2.N.i.3 *Cyrilla racemiflora – Ilex coriacea - (Cliftonia monophylla)* Saturated Shrubland Alliance
Coastal plain and sandhill evergreen shrublands (pocosins) occurring in poorly drained flats, along lake or pond shores, and on hillside seeps.

III.A.2.N.j.1 *Arundinaria gigantea* Saturated Wooded Shrubland Alliance
Occurs on saturated peaty soils; pond pine and pocosin shrubs are present along with the cane.

III.A.2.N.j.2 *Lyonia lucida – Ilex glabra* Saturated Wooded Shrubland Alliance
High pocosins on saturated mineral or organic soils. May also be found mapped as class 25, wet evergreen, depending on the amount of *Pinus serotina* in the overstory.

III.B.2.N.e.7 *Vaccinium formosum – Vaccinium fuscatum* Seasonally Flooded Shrubland Alliance
Depressional wetlands in the coastal plain and lower piedmont. This should map as pocosin (4) or wet scrub/shrub (8) in the coastal plain and as wet scrub/shrub (8) in the piedmont.

III.C.2.N.e.1 *Zenobia pulverulenta* - *Lyonia lucida* - *Ilex* (*coriacea, glabra*) Saturated Shrubland Alliance
Low pocosins of coastal plain peat domes.

III.C.2.N.f.1 *Zenobia pulverulenta – Cyrilla racemiflora* Saturated Wooded Shrubland Alliance
High pocosins of the coastal plain.

Map Class 5 – Swamp/Bottomland Hardwood

This class is comprised of deep swamps supporting cypress and tupelo and bottomland hardwood forests of varying hydrologic regimes. Overall, these two primary types of deciduous forested wetlands were indistinguishable in the mapping process, even with NWI and soils data. They are separated conceptually into the Swamp Forest Ecological Complex and the Bottomland Hardwood Forest Ecological Complex.

Several natural plant communities as described by Nelson (1986) are included in this concept including Bald Cypress – Tupelo Gum Swamp, Bottomland Hardwoods, Marl Forest, Non-Alluvial Swamp Forest, Piedmont Seepage Forest, Pond Cypress Pond, Small Stream Forest, Swamp Tupelo Pond, Tidal Bald Cypress – Tupelo Gum Swamp, and Upland Depression Swamp Forest. Although Marl Forest is considered by Nelson to be a terrestrial community, it is included in our swamp/bottomland hardwood class. Marl Forests are found on temporarily flooded, poorly to very poorly drained alfisols in the coastal plain of South Carolina and they support bottomland hardwood plant species.

We were unable to reliably distinguish forested isolated freshwater ponds from riverine systems; therefore, alliances representing both types of wetlands are listed below.

Soils and NWI were used to refine the classification of swamps and bottomland hardwoods. Many of the deeper swamp forests were originally placed in this class in the original vegetation map; however, many of the bottomland hardwood forests in particular were originally classified as various upland forest classes. Using GAP soil wetness classes 3, 4 and 6 (in the coastal plain) and NWI deciduous palustrine forested wetlands, either combined or separately, swamps and bottomland hardwood forests were distinguished from upland forests.

Because many of the bottomland hardwood forests were derived from 6 different upland forest classes, they were reclassified as six separate new classes with a reference to the original class from which they were derived. Although alliances couldn't be assigned to

a particular new class with certainty, there were some general correlations. For example, swamp type 15 very often supports laurel oak-dominated bottomlands whereas swamp type 18 often supports more deeply flooded swamp forests dominated by water tupelo. These new classes have been lumped into the swamp/bottomland hardwood class but we have retained the ability to separate them out again in the hope that it will be useful in future studies. Some of the differences are due to differences in originally assigning class values to the original 280 hydrologic units.

Swamp Forest Ecological Complex

This complex supports the deeper seasonally to semipermanently flooded swamps that are often characterized by the dominance of cypress and/or tupelo. It includes the following TNC alliances:

I.B.2.N.e.21 *Taxodium ascendens* Seasonally Flooded Forest Alliance
Occurs along streams in the Pee Dee River System or in depressions and ponds throughout the coastal plain.

I.B.2.N.e.22 *Taxodium distichum* - *Nyssa* (*aquatica*, *biflora*, *ogeche*) Seasonally Flooded Forest Alliance
Occurs in floodplains throughout the coastal plain.

I.B.2.N.e.8 *Nyssa* (*aquatica*, *biflora*, *ogeche*) Floodplain Seasonally Flooded Forest Alliance
Occurs in floodplains, sloughs, and backswamps throughout the coastal plain.

I.B.2.N.e.9 *Nyssa* (*aquatica*, *biflora*, *ogeche*) Pond Seasonally Flooded Forest Alliance
Swamps occurring as isolated ponds within an upland matrix in the coastal plain, especially within pine flatwoods.

I.B.2.N.f.2 *Nyssa aquatica* - (*Taxodium distichum*) Semipermanently Flooded Forest Alliance
Occurs in backwater sloughs, low wet flats, swales and backswamps, and along blackwater streams throughout the coastal plain.

I.B.2.N.f.3 *Taxodium distichum* Semipermanently Flooded Forest Alliance
Occurs throughout the coastal plain.

I.B.2.N.h.2 *Nyssa biflora* - (*Nyssa aquatica*, *Taxodium distichum*) Tidal Forest Alliance
Tidally flooded forests occurring along rivers in the coastal plain. Should be mapped as swamp/bottomland hardwoods (5) or as an inclusion in tidal freshwater marsh (3).

I.B.2.N.f.2 *Taxodium distichum* Tidal Woodland Alliance

II.B.2.N.c.4 *Taxodium ascendens* Seasonally Flooded Woodland Alliance
Coastal plain pond-cypress woodlands and savannas in relatively flat basins, especially Carolina Bays, remnants of bays, or isolated ponds within a flatwoods matrix.

Bottomland Hardwood Forest Ecological Complex

This complex includes river bottoms and low-lying floodplains where cypress and tupelo are usually not dominants. This complex encompasses the concept of map classes 33 through 38 and is discussed further under those classes. Floodplain and levee forests of class 28 may be found as inclusions within this complex but are listed and described under class 28.

I.B.2.N.d.11 *Fraxinus pennsylvanica* - *Ulmus americana* - *Celtis* (*occidentalis*, *laevigata*) Temporarily Flooded Forest Alliance
Occurs on base-rich alluvial sites throughout the state. This alliance is mapped as class 5 in the Coastal plain and sandhills, and as piedmont bottomland (45) in the piedmont and mountains.

I.B.2.N.d.12 *Liquidambar styraciflua* - (*Liriodendron tulipifera*, *Acer rubrum*) Temporarily Flooded Forest Alliance
Bottomland community of moderately wet floodplains in piedmont and coastal plain. In the coastal plain and sandhills, this alliance is mapped as class 5; in the piedmont it should be found mapped as 43, narrow stream valley forest or as 45, piedmont bottomland forest.

I.B.2.N.d.16 *Quercus* (*michauxii*, *pagoda*, *shumardii*) - *Liquidambar styraciflua* Temporarily Flooded Forest Alliance
Occurs primarily in brownwater situations (but also sometimes in blackwater) in the piedmont and coastal plain. This alliance is probably mapped as swamp/bottomland hardwood forest (5) in the coastal plain and sandhills and as floodplain (28), piedmont bottomland (45) or narrow stream valley forest (43) in the piedmont and mountains.

I.B.2.N.d.17 *Quercus* (*phellos*, *nigra*, *laurifolia*) Temporarily Flooded Forest Alliance
Occurs along blackwater rivers in the coastal plain. Should be mapped as swamp/bottomland (5). Swamp forests dominated by *Q. laurifolia* were most often found mapped as class 33, swamp type 15.

I.B.2.N.d.4 *Acer saccharinum* Temporarily Flooded Forest Alliance
Floodplain forest of major rivers. This alliance is probably mapped as floodplain forest (28) or bottomland hardwood (5) in the coastal plain and sandhills, and as floodplain forest (28), narrow stream valley forest (43), or piedmont bottomlands (45) in the piedmont and mountains.

I.B.2.N.d.9 *Fagus grandifolia* Temporarily Flooded Forest Alliance
Occurs along small streams in the piedmont and possibly other parts of the state. This alliance could potentially be mapped as floodplain forest (28), bottomland hardwood (5), piedmont bottomland (45), or narrow stream valley forest (43).

I.B.2.N.e.1 *Acer rubrum* - *Fraxinus pennsylvanica* Seasonally Flooded Forest Alliance
Occurs in floodplains of rivers and perennial streams. This alliance could potentially be mapped as swamp/bottomland hardwood forest (5), narrow stream valley forest (43), or piedmont bottomland (45).

I.B.2.N.e.11 *Planera aquatica* Seasonally Flooded Forest Alliance
Occurs along coastal plain rivers and backswamps.

I.B.2.N.e.12 *Quercus laurifolia* Seasonally Flooded Forest Alliance
Seasonally flooded, mostly blackwater forests occurring in the coastal plain. Swamp forests dominated by *Q. laurifolia* were most often found mapped as class 33, swamp type 15.

I.B.2.N.e.13 *Quercus lyrata* - (*Carya aquatica*) Seasonally Flooded Forest Alliance
Occurs in floodplains, sloughs, and depressions throughout the coastal plain.

I.B.2.N.e.15 *Quercus phellos* Seasonally Flooded Forest Alliance
Occurs primarily in upland depressions in the piedmont and inner coastal plain. Should map as piedmont bottomland (45) or swamp/bottomland (5).

I.B.2.N.e.19 *Salix nigra* Seasonally Flooded Forest Alliance
Occurs in coastal plain floodplains or non-riverine swamps, usually following disturbance. This alliance will probably be mapped as either floodplain forest (28) or swamp/bottomland hardwood forest (5).

I.B.2.N.e.20 *Sapium sebiferum* Seasonally Flooded Forest Alliance
Occurs in seasonally flooded forests and isolated ponds throughout the coastal plain, especially the outer coastal plain.

I.B.2.N.e.6 *Liquidambar styraciflua* - (*Acer rubrum*) Seasonally Flooded Forest Alliance
Occurs in seasonally flooded depressions (not floodplains) throughout the coastal plain.

I.B.2.N.g.2 *Acer rubrum* - *Nyssa sylvatica* Saturated Forest Alliance
Occurs in seepage areas on hillsides, streamheads, floodplains, and other poorly drained depressions. No known examples, but could be mapped as swamp/bottomland hardwood (5), narrow stream valley forest (43), piedmont

bottomland (45), or floodplain forest (28). It's likely that this is a piedmont community in South Carolina.

I.B.2.N.g.4 *Liquidambar styraciflua* Saturated Forest Alliance
Occurs in seepage areas with peaty soils throughout the coastal plain.

I.B.2.N.g.5 *Nyssa biflora* - *Acer rubrum* - (*Liriodendron tulipifera*) Saturated Forest Alliance
Occurs on extensive peat flats in the coastal plain, in seepage-fed edges of floodplains or on slopes wet by nearly constant seepage. Also occurs on seepage-fed edges of small streams in the piedmont. In general, this alliance is probably mapped as swamp/bottomland hardwood (5) or piedmont bottomland (45)

I.B.2.N.g.6 *Quercus laurifolia* - *Nyssa biflora* Saturated Forest Alliance
Occurs in the coastal plain on poorly drained interstream flats or on upland flats with saturated soils. Bottomland forests dominated by *Q. laurifolia* were most often found mapped as class 33, swamp type 15

I.B.2.N.g.7 *Quercus michauxii* - *Quercus pagoda* Saturated Forest Alliance
Occurs on non-riverine flats. In general, this alliance should be mapped as swamp/bottomland hardwood (5) in the coastal plain or piedmont bottomland (45) in the piedmont.

III.A.2.N.g.1 *Arundinaria gigantea* Temporarily Flooded Shrubland Alliance
Rare community occurring on streamside flats or bottomlands. Probably only occurs as small-patch inclusions within floodplain forests (28), piedmont bottomlands (45), swamp/bottomland (5), and narrow stream valley forests (43).

Map Class 6 – Wet Soil

Map Class 7 – Wet Scrub / Shrub Thicket

This class includes shrublands that are saturated or temporarily, seasonally, or semipermanently flooded. In the coastal plain, these shrublands, as classified here, are dominated by deciduous shrubs; whereas, in the piedmont, they can support both deciduous and evergreen shrubs. Shrublands dominated by evergreen shrubs in the coastal plain are placed in map class 4, pocosins. Many of these shrublands are a result of disturbance, particularly clearing, and may be found mapped as class 10, open canopy/recently cleared forest.

Soils that were in wetness class 3, 4 or 6, were used to refine the wet scrub/shrub class. The NWI deciduous scrub/shrub wetland class was also used to distinguish this class. There is some overlap between our wet scrub/shrub thicket class and open canopy, recently cleared forests, map class 10.

Nelson (1986) doesn't treat any communities that would fall under our concept of wet scrub/shrub thickets. The following are TNC alliances that are included in this class:

III.A.2.N.g.2 *Ligustrum sinense* Temporarily Flooded Shrubland Alliance
Wetland bottomlands heavily infested with Ligustrum. May also occur as an inclusion within floodplain forest (28), piedmont bottomland (45), narrow stream valley forest (43), and swamp/bottomland hardwood (5).

III.B.2.N.d.5 *Salix caroliniana* Temporarily Flooded Shrubland Alliance
Shrub thickets occurring on riverbanks, sand bars, and other wet sites. Occurs mostly in the coastal plain, rarely in the piedmont and mountains. This alliance will probably be mapped as a narrow band inclusion within floodplain forest (28), swamp/bottomland hardwood forest (5), narrow stream valley forest (43), or piedmont bottomland (45).

III.B.2.N.d.7 *Salix nigra* Temporarily Flooded Shrubland Alliance
Shrub thickets along rivers or lakeshores of the piedmont and coastal plain. This alliance will probably be mapped as a narrow band inclusion within floodplain forest (28), swamp/bottomland hardwood forest (5), narrow stream valley forest (43), or piedmont bottomland (45).

III.B.2.N.e.8 *Vitis rotundifolia - Ampelopsis arborea - Campsis radicans* Seasonally Flooded Vine-Shrubland Alliance
This alliance includes wetland vegetation that commonly develops following disturbance in coastal plain bottomlands. This alliance is also present as a small-patch inclusion within the swamps/bottomland hardwood forests (5) and floodplain forests (28).

III.A.2.N.h.100 *Cyrilla racemiflora* Seasonally Flooded Shrubland Alliance
Seasonally flooded coastal plain ponds, often occurring in matrix of pine flatwoods. May also be found mapped as pocosin, class 4, if the occurrence is large enough.

III.A.2.N.i.100 *Myrica cerifera* Saturated Shrubland Alliance
Wetland dune swales, flats, and interdune swales, usually situated between dune grasslands and maritime forest.

III.A.2.N.l.1 *Myrica cerifera – Rosa palustris* Tidal Shrubland Alliance
Tidally flooded shrublands, occurring in association with freshwater tidal marshes and tidally flooded forests. Occurrences can exceed 50 acres in size, according to TNC. Should fall under wet scrub/shrub (7), or could be small-patch inclusion within fresh water marsh (3).

III.A.4.N.d.2 *Hypericum fasciculatum* Seasonally Flooded Shrubland Alliance

Shrubby wet prairies and depressional wetlands of the coastal plain; possibly also in old borrow pits. Classified as wet scrub/shrub (7) or as an inclusion within pine flatwoods.

III.B.2.N.e.5 *Decodon verticillatus* Seasonally Flooded Shrubland Alliance
Occurs in coastal plain depression ponds, floodplain pools, waterfowl impoundments, and lakeshores. It is mapped as wet scrub/shrub (7) or it could be a small-patch inclusion within freshwater marsh (3).

III.B.2.N.e.7 *Vaccinium formosum – Vaccinium fuscatum* Seasonally Flooded Shrubland Alliance
Depressional wetlands in the coastal plain and lower piedmont. It should map as pocosin (4) or wet scrub/shrub (7) in the coastal plain and as wet scrub/shrub (7) in the piedmont.

III.B.2.N.f.1 *Cephalanthus occidentalis* Semipermanently Flooded Shrubland Alliance
Occurring in shallow water depressions, oxbow ponds, sinkhole ponds, and backwater sloughs of stream and river floodplains. This alliance is probably either mapped as wet scrub/shrub (7) or as a small-patch inclusion within swamp/bottomland hardwood (5), piedmont bottomland (45), narrow stream valley forest (43), or floodplain forest (28).

III.B.2.N.g.1 *Alnus serrulata* Saturated Shrubland Alliance
Non-alluvial, palustrine vegetation of the piedmont.

III.B.2.N.h.2 *Alnus (incana, serrulata)* Tidal Shrubland Alliance
Occurs along the tidal freshwater reaches of rivers. May occur as a fringing shrubland, zonal between wild rice tidal marshes and tidal cypress-gum forests. Less commonly, it occupies large patches in freshwater marshes. Probably occurs either as a small-patch inclusion within fresh water marsh (3) or as wet scrub/shrub (7).

Map Class 8 – Dry Scrub / Shrub Thicket

Dry scrub/shrub thickets often characterize recently cleared or other disturbed areas in uplands. Since they occur on moderately well drained to excessively drained soils, soil decision rules were used to distinguish dry scrub/shrub thickets from wet scrub/shrub thickets.

The only dry scrub/shrub thicket communities that were recognized by Nelson (1996) were the maritime shrub thickets, placed in map class 27, and the salt shrub thickets, placed in map class 30. There are few alliances recognized at this time by TNC in this map class.

Dry scrub/shrub thickets can include the following TNC alliances:

III.A.2.N.a.1 *Ligustrum sinense* Shrubland Alliance
Upland areas infested with *Ligustrum.*

III.A.2.N.b.5 *Rhododendron maximum* Shrubland Alliance
Evergreen shrublands restricted to the Blue Ridge province.

III.A.4.N.a.5 *Ceratiola ericoides* Shrubland Alliance
Xeric shrublands occurring on deep sands. Occurs in sandhills and the outer coastal plain as small-patches within turkey oak barrens and dry sandhill scrub. Most occurrences are probably too small to map.

III.B.2.N.a.11 *Pueraria montana* Vine-Shrubland Alliance
Kudzu vine-shrubland occupying a variety of disturbed sites throughout the state.

IV.A.1.N.a.3 *Chrysoma pauciflosculosa* Dwarf-Shrubland Alliance
Evergreen shrublands of fall line sandhills. They're probably inclusions in dry sandhill scrub forests as most occurrences are small.

Map Class 9 – Sandy Bare Soil

Map Class 10 – Open Canopy/Recently Cleared Forest

Map Class 11 – Rock Outcrop

Caves, crevices, rocky outcrops. Includes granitic flatrocks of the piedmont and granitic domes of the mountains. Rock outcrops were often either too small to map or were confused with urban land cover types by the mapper, so the rock outcrop class is underestimated on the Gap map.

In the Blue Ridge sections of Greenville, Pickens, and Oconee counties, GAP soil class 18, rock, was used to map rock outcrops.

Nelson (1986) classifies rock outcrops as Granitic Domes and Granitic Flatrocks. TNC alliances found on rock outcrops include:

V.A.5.N.e.4 *Carex biltmoreana* Herbaceous Alliance
Occurs on steeply sloping outcrops of felsic to mafic rock in the mountains.

V.A.5.N.j.4 *Carex torta* Temporarily Flooded Herbaceous Alliance
Alluvial wetlands on sand, gravel, and rock bars in the mountains.

V.A.5.N.m.100 *Scirpus cespitosus* Saturated Herbaceous Alliance
Restricted to saturated or ponded areas at the base of sheer, north-facing granitic dome cliffs.

V.B.2.N.b.10 *Saxifraga michauxii* Herbaceous Alliance
Occurs on acidic rocky summits in the mountains.

V.B.2.N.b.11 *Selaginella* (*tortipila, rupestris*) Herbaceous Alliance
Granitic dome community, occurring on smooth rock substrates or rock with few crevices or fractures in the mountains and piedmont.

V.B.2.N.f.12 *Senecio tomentosus – Croton willdenowii* Saturated Herbaceous Alliance
Granitic flatrock community occurring on thin soils over granitic rocks.

V.B.2.N.f.14 *Talinum teretifolium – Portulaca smallii* Saturated Herbaceous Alliance
Granitic flatrock community.

V.B.2.N.f.15 *Vittaria appalachiana – Heuchera parviflora* Saturated Herbaceous Alliance
Herbaceous vegetation on rock substrates associated with waterfalls; soils are shallow and constantly saturated.

V.D.2.N.h.1 *Amphianthus pusillus – Isoetes* spp. Seasonally Flooded Herbaceous Alliance
Occurs in seasonally flooded pools on granitic flatrocks.

V.D.2.N.i.1 *Diamorpha smallii* Saturated Herbaceous Alliance
Occurs in ephemeral pools on large granite outcrops in the piedmont.

VI.B.1.N.b.3 *Umbilicaria mammulata* Nonvascular Alliance
Occurs on relatively moist, shaded rock outcrops.

VII.A.1.N.a.1 *Asplenium montanum* Sparsely Vegetated Alliance
Occurs on near-vertical cliffs.

VII.A.1.N.a.2 *Asplenium ruta-muraria – Pellaea atropurpurea* Sparsely Vegetated Alliance
Occurs on limestone and dolomite outcrops, usually shaded by trees rooted in adjacent forest.

Map Class 12 – Aquatic Vegetation

Vegetation of semi-permanent or temporary lakes, ponds or pools. Abandoned rice fields supporting emergent vegetation are mapped as class 3, fresh water marsh.

In fresh water areas, NWI lacustrine, riverine, or palustrine aquatic plant beds can be used to define this class.

The following list of alliances are those attributed to South Carolina by TNC. However, the knowledge of aquatic plant distribution hasn't kept up with the dissemination of that knowledge and several other alliances are known to occur in the state but have not yet been submitted to TNC for inclusion. These include alliances dominated by *Najas* spp., *Brasenia schreberi, Potamogeton* spp., *Pistia, Eichhornia,* and *Ceratophyllum*.

V.B.2.N.e.100 *Ludwigia peploides* Semipermanently Flooded Herbaceous Alliance
Floating or stranded mats occurring in shallow water of flats in slow-moving streams, shallow lakes, natural and artificial impoundments.

V.B.2.N.e.2 *Ludwigia uruguayensis* Semipermanently Flooded Herbaceous Alliance
Floating or stranded mats, often covering large numbers of acres in lakes and reservoirs. This alliance is probably referring to *Ludwigia hexapetala.*

V.C.1.N.b.3 *Halodule beaudettei* Permanently Flooded - Tidal Herbaceous Alliance
Estuarine seagrass bed attributed by TNC to South Carolina. Should map as aquatic vegetation (13).

V.C.2.N.a.2 *Brasenia schreberi* Permanently Flooded Herbaceous Alliance

V.C.2.N.a.100 *Nelumbo lutea* Permanently Flooded Temperate Herbaceous Alliance
Occurs in artificial impoundments, natural oxbow lakes and ponds.

V.C.2.N.a.101 *Orontium aquaticum – (Scirpus subterminalis)* Permanently Flooded Herbaceous Alliance
Aquatic vegetation of acidic, oligotrophic waters of the coastal plain. Usually found in blackwater sandhills streams.

V.C.2.N.a.102 *Nymphaea odorata* - *Nuphar* spp. Permanently Flooded Temperate Herbaceous Alliance
Occurs in a variety of water bodies.

V.C.2.N.a.103 *Myriophyllum heterophyllum* Permanently Flooded Herbaceous Alliance

V.C.2.N.a.11 *Nymphoides aquatica* Permanently Flooded Herbaceous Alliance
Occurs in the aquatic zones of coastal plain ponds.

V.C.2.N.a.12 *Podostemon ceratophyllum* Permanently Flooded Herbaceous Alliance
Occurs on shoals in rocky streambeds and riverbeds.

V.C.2.N.a.14. *Potamogeton* spp. - *Ceratophyllum* spp. - *Elodea* spp. Permanently Flooded Herbaceous Alliance

V.C.2.N.a.5 *Hydrilla verticillata* Permanently Flooded Herbaceous Alliance
Occurs in natural and man-made lakes.

V.C.2.N.b.4 *Ruppia maritima* Permanently Flooded - Tidal Temperate Herbaceous Alliance
Tidal brackish seagrass beds. Occurs in managed impoundments in the outer coastal plain.

Map Class 13 – Closed Canopy Evergreen Forest

This class includes closed canopy sites dominated by pines, cedars, hemlocks, and evergreen oaks. Most forests dominated by evergreen oaks were moved to other classes using decision rules. Mixed forests will map out here if the density of pine is great enough. This class can occur on any soil wetness class ranging from dry to wet and it occurs throughout the state. Most pine plantations are found in this class.

This class was overestimated in the original vegetation map. NWI and soil decision rules were used to remove maritime forests, wet evergreen forests and bottomlands from this class and assign them to their appropriate mapping classes.

Decision rules that were useful to identify coastal upland forests and lowland maritime forests involved using upland NWI classes that excluded planted pines and a specific set of coastal and maritime soils. If the GAP soil class was class 3 or 4, wetland soils, and NWI was palustrine evergreen forest, then the land cover class was changed to 25, wet evergreen forest. For GAP soil classes of 3 or 4 and NWI palustrine evergreen scrub/shrub, then the land cover class was changed to pocosin in the coastal plain. The combination of GAP wetland soil classes and NWI upland evergreen forest, excluding planted pines was used to define wet pinewoods, class 31. Bottomland forest types were moved from this class by utilizing wetland soils either with NWI palustrine forested wetlands or other non-planted pine classes.

Nelson (1986) has no natural communities that would be included in this land cover class. See also Class 53, Montane Evergreen Forest, for evergreen forest alliances restricted to the mountains. The following TNC alliances are found in this class:

I.A.8.C.x.4 *Pinus echinata* Planted Forest Alliance
Planted shortleaf pine forests in the piedmont.

I.A.8.C.x.5 *Pinus elliottii* Planted Forest Alliance
Planted slash pine forests primarily in the coastal plain but also found in the piedmont.

I.A.8.C.x.6 *Pinus palustris* Planted Forest Alliance
Planted longleaf pine forests in the coastal plain.

I.A.8.C.x.9 *Pinus taeda* Planted Forest Alliance
Planted loblolly pine forests. This is the most common alliance in this land cover class.

I.A.8.N.b.14 *Pinus strobus* Forest Alliance
Only occurs in the piedmont and mountains.

I.A.8.N.b.15 *Pinus taeda* - *Pinus echinata* Forest Alliance
Successional forests.

I.A.8.N.b.16 *Pinus taeda* Forest Alliance
Very common succession forest type.

I.A.8.N.b.9 *Pinus palustris* - (*Pinus elliottii*) Forest Alliance
Coastal plain successional forests on disturbed sites.

I.A.8.N.c.2 *Juniperus virginiana* Forest Alliance
Successional forests occurring on old fields, successional cleared land, and other disturbed areas, especially on calcareous bedrock.

I.A.8.N.c.9 *Tsuga caroliniana* Forest Alliance
Occurs in the mountains and upper piedmont, mostly on cliffs, rocky slopes, and ridges, less commonly on more gentle slopes and flat areas in valleys. Occupies higher and drier sites than Tsuga canadensis.

Map Class 14 – Needle-leaved Evergreen Mixed Woodland

Upland pine stands with a relatively open canopy and an understory of deciduous scrub oaks. Typical evergreen overstory components are longleaf pine, Virginia pine, loblolly pine, and shortleaf pine. This class includes the Piedmont, Sandhills, and Coastal Plain Scrub Complexes. Small inclusions of pond pine seeps, longleaf pine seeps, seepage shrub slopes, small depression pocosins, streamhead pocosins, depression meadows, or hillside herb bogs may occur within this map class. Mixed forests also map out here, or these woodlands may be found mapped as dry mixed forests or as dry deciduous forests. Where the canopy is very sparse, these woodlands may be mapped as dry scrub/shrub (8), open canopy/recently cleared forest (10), grassland/pasture (20), or cultivated land (21).

This class occurs on soil wetness class 1. Because of the relatively low density of pines, most of these woodlands are found mapped as dry deciduous forests (16) or dry mixed forests (18), especially in the fall-line sandhills.

In the sandhills and coastal plain, these woodlands typically occupy the deepest, driest sands, especially on ridge tops. However, they occur in a mosaic of other sandhills communities that may be inclusions in this mapping unit. This mosaic of communities is referred to as the Sandhill Scrub Ecological Complex as described below.

Natural communities defined by Nelson (1986) that typify this class are Pine – Scrub Oak Woodland and Xeric Sandhill Scrub. These are the classic sandhill scrub communities occurring on the driest, deepest sands in the fall-line sandhills and coastal plain. Small

mapping inclusions in this class would include Nelson's Bay Forest, Hillside Herb Bog, Pond Pine Woodland, Seepage Pocosin, Swale Pocosin, Streamhead Pocosin, and Upland Pine – Wiregrass Woodland.

II.A.4.N.a.1 *Pinus palustris / Quercus* spp. Woodland Alliance
Xeric to dry woodlands of the sandhills and coastal plain. This alliance should fall under this needle-leaved evergreen mixed woodland class (14), but may instead be mapped as closed canopy evergreen forest (13) if the canopy is relatively closed or as a variety of open canopy classes (8, 10, 20, 21) if the canopy is too sparse.

II.C.3.N.a.11 *Pinus echinata - Quercus (alba, falcata, stellata, velutina)* Woodland Alliance
Xeric to dry woodlands of the piedmont. This alliance may be mapped as closed canopy evergreen forest (13) if the canopy is dominated by pines or as dry mixed forest (18). It may be mapped as dry deciduous forest (16) if pines are relatively few in number.

Sandhill Scrub Ecological Complex

II.A.4.N.a.1 *Pinus palustris / Quercus* spp. Woodland Alliance
Southeastern Coastal Plain Xeric Sandhill Scrub
Southeastern Coastal Plain Subxeric Pine – Scrub Oak Sandhill
Inclusions:
Atlantic Coastal Plain Mesic Longleaf Pine Forest/Upland Pine – Wiregrass Woodland
II.A.4.N.a.22 *Pinus palustris* Woodland Alliance
Southeastern Coastal Plain Turkey Oak Barrens
II.B.2.N.a.17 *Quercus laevis* Woodland Alliance
Pond Pine Seep
II.A.4.N.f.9 *Pinus serotina* Saturated Woodland Alliance
Longleaf Pine Seep/Seepage Pocosin
II.A.4.N.f.6 *Pinus palustris - Pinus (elliottii, serotina)* Saturated Woodland Alliance
Swale Pocosin/ Small Depression Pocosin
III.A.2.N.j.020 *Lyonia lucida - Ilex glabra* Saturated Wooded Shrubland Alliance
Streamhead Pocosin/Bay Forest/ Coastal Plain Hillside Herbaceous Seepage Bog
I.A.4.N.g.2 *Gordonia lasianthus* Saturated Forest Alliance
II.A.4.N.f.9 *Pinus serotina* Saturated Woodland Alliance

<u>Map Class 15 – Pine Woodland</u>

This class consists of upland pine woodlands with a grassy understory. Flatwoods with longleaf pine and/or slash pine are included in this class. Examples of small wetland inclusions within this map class are pine savannas, depression meadows, tupelo or pond cypress pond forests, wet

pine flatwoods, pond pine woodlands, pocosins, and pitcher plant flats. Small changes in soil and/or elevation result in a mosaic of these communities in coastal plain interstream flats and in more mesic sandhills areas. Where the canopy is very sparse, pine woodlands may be mapped as dry scrub/shrub (8), open canopy/recently cleared forest (10), grassland/pasture (20), or cultivated land (21).

Pine woodlands are distinguished from wet pine flatwoods (wet pinewoods, class 31) by the predominance of upland plant species and by the absence of pond pine.

Pine woodlands occur on soils in wetness classes 1 and 2. This class was originally overestimated on the first vegetation map. Most decision rules dealing with this class were written to remove erroneously assigned forests from this class.

Nelson's (1986) concept of pine woodlands includes Upland Pine – Wiregrass Woodlands and Pine Flatwoods. TNC alliances that encompass the pine woodlands concept include:

II.A.4.N.a.19 *Pinus elliottii* Woodland Alliance
Upland woodlands occurring on barrier islands and other near-coastal areas.

II.A.4.N.a.22 *Pinus palustris* Woodland Alliance
Mesic to dry-mesic upland woodlands and savannas, occurring in the coastal plain, sandhills, and possibly also piedmont.

II.A.4.N.a.28 *Pinus taeda* Woodland Alliance
Coastal plain woodlands often occurring in maritime situations.

TNC alliances that are associated with pine woodlands in the landscape include:

II.A.4.N.f.9 *Pinus serotina* Saturated Woodland Alliance
II.A.4.N.f.6 *Pinus palustris - Pinus (elliottii, serotina)* Saturated Woodland Alliance
III.A.2.N.j.020 *Lyonia lucida - Ilex glabra* Saturated Wooded Shrubland Alliance
II.A.4.N.a.1 *Pinus palustris/Quercus* spp. Woodland Alliance
II.B.2.N.c.4 *Taxodium ascendens* Seasonally Flooded Woodland Alliance
V.A.5.N.k.18 *Panicum hemitomon* Seasonally Flooded Temperate Herbaceous Alliance
V.A.5.N.k.28 *Spartina bakeri* Seasonally Flooded Herbaceous Alliance
V.A.5.N.k.65 *Carex striata* Seasonally Flooded Herbaceous Alliance
V.B.2.N.h.3 *Woodwardia virginica* Seasonally Flooded Herbaceous Alliance
V.B.2.N.h.100 *Polygonum spp.* (section Persicaria) Seasonally Flooded Herbaceous Alliance

<u>Map Class 16 – Dry Deciduous Forest / Woodland</u>

This class includes oak-hickory xeric upland forests and woodlands. Pine - scrub oak woodlands may also map here where pines are at very low density. Dry woodlands with a very open canopy may be mapped as dry scrub/shrub (8), open canopy/recently cleared

(10), grassland/pasture (20), or cultivated land (21).

This class occurs on soil wetness class 1 and is distinguished from mesic deciduous forests/woodlands by soil wetness.

Nelson (1986) described several natural plant communities that would be included in this class. These include Chestnut Oak Forest, Pine – Oak Heath, and Oak – Hickory Forest

I.B.2.N.a.22 *Liquidambar styraciflua* Forest Alliance
Probably will map out as both 17 and 18, depending on soils.

I.B.2.N.a.27 *Quercus alba* - (*Quercus rubra*, *Carya* spp.) Forest Alliance
Described as dry-mesic forest, sometimes occurring on calcareous substrate.

I.B.2.N.a.29 *Quercus alba* - *Quercus* (*falcata*, *stellata*) Forest Alliance
Described as dry or dry-mesic deciduous forests, often occupying transitional zones between mesic and xeric communities.

I.B.2.N.a.31 *Quercus falcata* Forest Alliance
Described as dry deciduous forests.

I.B.2.N.a.36 *Quercus prinus* - (*Quercus coccinea*, *Quercus velutina*) Forest Alliance
Xeric oak forest occurring on extreme sites, such as monadnocks in the piedmont or ridgetops in the mountains.

I.B.2.N.a.37 *Quercus prinus* - *Quercus* (*alba*, *falcata*, *rubra*, *velutina*) Forest Alliance
Dry-mesic to mesic forests occurring on moderately sheltered low ridges, flats, and valleys at low elevations in the mountains and on upper to middle dry-mesic slopes in the piedmont. May also include forests overlying calcareous bedrock.

I.B.2.N.a.38 *Quercus prinus* - *Quercus rubra* Forest Alliance
Dry-mesic oak forests of the mountains and upper piedmont.

I.B.2.N.a.41 *Quercus stellata* - *Quercus marilandica* Forest Alliance
Dry oak forest, sometimes occurring on calcareous substrates. This forest type is found at the Rock Hill Blackjack Heritage Preserve. This could also be mapped under class 46, dry basic deciduous forest.

II.B.2.N.a.17 *Quercus laevis* Woodland Alliance
Turkey oak barrens occurring on sandy ridges or high dunes in the sandhills and coastal plain. This alliance may also be found mapped as dry scrub/shrub (8).

II.B.2.N.a.23 *Quercus prinus* - *Quercus marilandica* Woodland Alliance
Woodlands occurring on south- to west-facing slopes in the piedmont.

Map Class 17 – Mesic Deciduous Forest

Southern mixed hardwood forests and mesic mixed hardwoods forests with a diversity of deciduous hardwood trees. Where the canopy is very sparse, deciduous woodlands may be mapped as dry scrub/shrub (8), open canopy, recently cleared (10), grassland/pasture (20), or cultivated land (21).

This class occurs on soil wetness class 2 and is distinguished from dry deciduous forests/woodlands by soil decision rules.

Nelson (1986) would place Mesic Mixed Hardwood Forest, Southern Mixed Hardwood Forest, Beech-Magnolia Hammock and Oak-Hickory Forest in this class. Beech-Magnolia is included in the Gap class 29, Mesic Mixed Forest due to the presence of the evergreen *Magnolia grandiflora*. If *Magnolia* is underrepresented, then it would be mapped in this class. Oak-Hickory Forests would be found in both dry deciduous forest and mesic deciduous forest depending on the soils.

I.B.2.N.a.16 *Fagus grandifolia* - *Quercus alba* Forest Alliance
Dry-mesic to mesic forests occurring on mesic slopes and small stream bottoms in the coastal plain and adjacent physiographic provinces. Occurrences may be too narrow to map separately.

I.B.2.N.a.100 *Quercus velutina* - *Quercus alba* - (*Quercus coccinea*) Forest Alliance
Dry-mesic forests that occur in the piedmont and mountains only.

I.B.2.N.a.101 *Quercus muehlenbergii* - (*Acer saccharum*) Forest Alliance
Basic forest which may be found in the mountains. Coastal plain occurrences contain *Acer barbatum*, instead of *Acer saccharum*. Gap doesn't map basic forests separately in the CP. Therefore, coastal plain occurrences of this alliance will be mapped under class 17, mesic deciduous forests while piedmont and mountain occurrences will be mapped as class 47, mesic basic deciduous forest.

I.B.2.N.a.103 *Quercus alba* Montane Forest Alliance

I.B.2.N.a.108 *Quercus rubra* Montane Forest Alliance

I.B.2.N.a.11 *Carya glabra – Tilia americana var. caroliniana – Celtis laevigata* Forest Alliance
Mesic Shell Midden Forest. Shell midden EO's documented by NHP are evergreen types. This alliance is most likely found as an inclusion within coastal upland mixed forests, class 44.

I.B.2.N.a.15 *Fagus grandifolia* - *Acer saccharum* - (*Liriodendron tulipifera*) Forest Alliance

Rich, mesic forests occurring throughout the state.

I.B.2.N.a.2 *Acer barbatum* - *Fraxinus americana* - *Juglans nigra* Forest Alliance
Mesic calcareous forests. Gap doesn't map basic forests separately in the coastal plain. Therefore, coastal plain occurrences will be mapped under mesic deciduous class 17, while piedmont occurrences will be mapped as mesic basic deciduous, class 47. In the coastal plain, this alliance is most likely found as an inclusion within coastal upland mixed forests, class 44.

I.B.2.N.a.22 *Liquidambar styraciflua* Forest Alliance

I.B.2.N.a.24 *Liriodendron tulipifera* Forest Alliance

I.B.2.N.a.26 *Quercus alba* - (*Quercus nigra*) Forest Alliance
Mesic and dry-mesic forests of the coastal plain.

I.B.2.N.a.27 *Quercus alba* - (*Quercus rubra*, *Carya* spp.) Forest Alliance
Described as dry-mesic forest, sometimes occurring on calcareous substrate.

I.B.2.N.a.35 *Quercus nigra* Forest Alliance
Described as upland mesic or dry-mesic stand, sometimes with 10-60% or more Pinus taeda in canopy.

I.B.2.N.a.37 *Quercus prinus* - *Quercus* (*alba*, *falcata*, *rubra*, *velutina*) Forest Alliance
Dry-mesic to mesic forests occurring on moderately sheltered low ridges, flats, and valleys at low elevations in the mountains and on upper to middle dry-mesic slopes in the piedmont. May also include forests overlying calcareous bedrock.

I.B.2.N.a.38 *Quercus prinus* - *Quercus rubra* Forest Alliance
Dry-mesic oak forests of the mountains and upper piedmont.

Map Class 18 – Dry Mixed Forest / Woodland

These are xeric mixed evergreen and deciduous forests and woodlands. They are distinguished from Dry Deciduous Forest, class 16, by having a mixed canopy of evergreen and deciduous trees. This class is underestimated on the land cover map, as many mixed forests have been mapped as upland evergreen forests (13 and 14. Dry mixed woodlands with very open canopies may be mapped as dry scrub/shrub (8), open canopy/recently cleared forest (10), grassland/pasture (20), or cultivated land (21).

This class occurs on soil wetness class 1 and is distinguished from mesic mixed forests/woodlands by soil wetness decision rules.

Nelson (1986) doesn’t separate mixed evergreen/deciduous forests of this type. The following TNC alliances may be found in this class:

I.C.2.N.a.5 *Quercus hemisphaerica* - *Carya glabra* Forest Alliance
Dry-mesic to sub-xeric sandy forests occurring in the coastal plain.

I.C.3.N.a.14 *Pinus echinata* - *Quercus* (*alba*, *falcata*, *stellata*, *velutina*) Forest Alliance
Dry-mesic forests occurring primarily on dry hilltops, upper slopes, and ridges on acidic soils throughout the state.

I.C.3.N.a.15 *Pinus echinata – Quercus (coccinea, falcata, prinus)* Forest Alliance
Dry mixed pine-oak forests of the low mountains and upper piedmont.

I.C.3.N.a.16 *Pinus echinata* - *Quercus stellata* - *Quercus marilandica* Forest Alliance
Dry and xeric mixed forest occurring in the piedmont, often on monadnocks, and sandhills.

I.C.3.N.a.22 *Pinus strobus* - *Quercus* (*coccinea*, *prinus*) Forest Alliance
Dry mixed forests occurring in the mountains.

I.C.3.N.a.28 *Pinus virginiana* - *Quercus* (*coccinea*, *prinus*) Forest Alliance
Xeric mixed forests of the mountains and piedmont.

II.C.3.N.a.11 *Pinus echinata* - *Quercus* (*alba*, *falcata*, *stellata*, *velutina*) Woodland Alliance
Xeric woodlands occurring on edaphically extreme sites.

Map Class 19 – Mesic Mixed Forest/Woodland

Mesic mixed evergreen and deciduous forests and woodlands. This class is underestimated on the land cover map, as many mixed forests have been mapped as closed canopy evergreen forests (13) or as mesic deciduous forests (17). Mesic mixed woodlands with very sparse canopies may be mapped as dry scrub/shrub (8), open canopy/recently cleared forest (10), grassland/pasture (20), or cultivated land (21).

This class occurs on soil wetness class 2 and is distinguished from dry mixed forests/woodlands by soil wetness.

Nelson (1986) doesn't separate mixed evergreen/deciduous forests of this type. The following TNC alliances may be found in this class:

I.B.2.N.a.35 *Quercus nigra* Forest Alliance
Described as upland mesic or dry-mesic stand, sometimes with 10-60% or more Pinus taeda in canopy.

I.C.2.N.a.2 *Fagus grandifolia* - *Magnolia grandiflora* Forest Alliance

Mesic to dry-mesic forest, occurring throughout the coastal plain. These forests often occur between bottomland and upland forests along streams and rivers. They're often too narrow to be found mapped separately.

I.C.2.N.a.8 *Quercus virginiana* - *Quercus pagoda* Forest Alliance
Wet-mesic forests of the outer coastal plain.

I.C.3.N.a.21 *Pinus strobus* - *Quercus* (*alba*, *rubra*, *velutina*) Forest Alliance
Dry-mesic to mesic mixed forests occurring in the mountains.

I.C.3.N.a.23 *Pinus taeda* - (*Liquidambar styraciflua*, *Liriodendron tulipifera*) Forest Alliance
Occurs on successional sites in the piedmont and coastal plain.

I.C.3.N.a.24 *Pinus taeda* - *Quercus* (*alba*, *falcata*, *stellata*) Forest Alliance
Mesic mixed forests of the piedmont and coastal plain.

I.C.3.N.a.26 *Pinus taeda* - *Quercus nigra* Forest Alliance
Dry to dry-mesic mixed forests of the coastal plain, often occurring as maritime forests.

Map Class 20 – Grassland/Pasture

Old fields, meadows, wet meadows, grassy fields, livestock pastures. This also includes low-density rural – low density housing with cleared land, trees, outbuildings, etc. Woodlands with very sparse canopies may be mapped as this class.

Because this class is not considered to be natural vegetation, few TNC alliances have been described that include grasslands and pastures as they occur in South Carolina.

V.A.5.N.c.3 *Andropogon virginicus* Herbaceous Alliance
V.A.5.N.c.8 *Festuca (arundinacea, pratensis)* Herbaceous Alliance
V.A.5.N.e.6 *Cynodon dactylon* Herbaceous Alliance

Map Class 21 – Cultivated Land

Agricultural fields, lawns, golf courses. This also includes low-density rural – low density housing with cleared land, trees, outbuildings, etc. Woodlands with very sparse canopies may be mapped as this class.

Map Class 22 – Urban Development

Industrial, CBD, cities, etc. Rocky shoals, rock outcrops, and bare sand are sometimes mapped as this class, where reflectance confounded the mapper. This class also shows up in agricultural areas, especially in areas of open bare sand.

Map Class 23 – Residential Urban

High intensity residential development associated with cities. Rocky shoals, rock outcrops, and bare sand are sometimes labeled as this class, where reflectance confounded the mapper.

Map Class 24 – Density Residential

Residential with interspersed patches of forest and urban.

Map Class 25 – Wet Evergreen

Wet evergreen includes pond pine woodlands, bay forests, wet longleaf/pond pine flatwoods, blackwater streamside forests, and Atlantic white cedar swamps.

Blackwater streamside forests are found in the fall-line sandhills and in blackwater systems of the coastal plain. They're often referred to as evergreen streamside forests or streamside pocosins but fall within the pond pine woodland definition. White cedar swamps, pond pine woodlands/streamhead-streamside pocosin, and bay forests occur in a mosaic in the saturated areas along blackwater streams and rivers. The complex of communities that comprise the wetlands of blackwater streams has been referred to as the Sandhills Palustrine Ecological Complex.

Pond pine woodlands and wet flatwoods often occur in a mosaic on interstream flats in the coastal plain in association with various swamp/bottomland communities. Wet flatwoods are those that usually support a mixture of longleaf pines and pond pines with evergreen shrubs dominating in the understory/shrub layer. Flatwoods without a pond pine component are placed in the Wet Pinewoods class (31).

Soils and NWI are crucial to mapping wet evergreen. Wet evergreen occurs on soil classes 3 and 4 in association with NWI palustrine forested evergreen wetlands. All upland forest classes from the original vegetation map that met the soil and NWI criteria were changed to wet evergreen.

This class encompasses Nelson's (1986) concepts of Streamhead Pocosin, Swale Pocosin, Bay Forest, Atlantic White Cedar Swamp and Pond Pine Woodland

I.A.4.N.g.2 *Gordonia lasianthus* Saturated Forest Alliance
Loblolly bay forest, found on saturated soils along blackwater streams and in peat-based Carolina bays.

I.A.4.N.g.3 *Magnolia virginiana* - *Persea palustris* Saturated Forest Alliance
Sweet bay-red bay forests.

I.A.8.N.g.2 *Chamaecyparis thyoides* Saturated Forest Alliance

Occurs on saturated soils along blackwater streams in the sandhills and coastal plain. In South Carolina, these forests are rarely found associated with Carolina Bays.

II.A.4.N.f.2 *Pinus elliottii* Saturated Temperate Woodland Alliance
Coastal plain wet flatwoods; restricted to southern South Carolina.

III.A.2.N.j.2 *Lyonia lucida – Ilex glabra* Saturated Wooded Shrubland Alliance
High pocosins on saturated mineral or organic soils. This alliance is mapped as pocosin (4) or wet evergreen depending on the tree canopy present.

II.A.4.N.f.6 *Pinus palustris* - *Pinus* (*elliottii*, *serotina*) Saturated Woodland Alliance
Wet pine flatwoods of the coastal plain and sandhills.

II.A.4.N.f.9 *Pinus serotina* Saturated Woodland Alliance
Pond pine woodland or pocosin, occurring in Carolina bays throughout the coastal plain and on saturated soils along blackwater streams in the sandhills and coastal plain.

Map Class 26 – Lowland Maritime Forest

Wet to wet-mesic evergreen forests of the outer coastal plain; characterized by the presence of live oak and palmetto. This forest type is referred to as hydric hammocks in Florida and is now ascribed to South Carolina. With additional research, it's likely that more alliances will be described for South Carolina similar to those attributed to the Gulf Coast.

These forests occur on inland maritime soils with wetness class 3 where the vegetation is characterized by NWI as upland evergreen forests, upland mixed forests or evergreen palustrine forested wetland. They also occur on outer maritime soils where NWI characterizes the forests as evergreen palustrine wetlands.

These forests fall under the general community of Maritime Forest (Nelson, 1986). The following alliance is the only TNC alliance documented at this time in South Carolina>

I.A.4.N.e.1 *Quercus virginiana* Temporarily Flooded Forest Alliance
Wetland maritime forests occurring in the southeast coastal plain of South Carolina.

Map Class 27 – Maritime Shrub Complex

This complex consists of evergreen shrubs occupying dunes and dune swales along the coast. Occurrences are usually linear and are found between the beaches and the upland forests. Because they're usually quite narrow, they are most often found as inclusions within the coastal upland mixed forest (44).

Scrub/shrub and open, non-beach areas on the original vegetation map (classes 6, 7, 8,

20, 21) combined with NWI upland evergreen forest and palustrine evergreen forests and shrublands occurring on outer maritime soils were reclassified to the maritime shrub complex.

This complex includes John Nelson's 1986 Maritime Grassland and Maritime Shrub Thicket natural communities.

Maritime dune systems are comprised of grasslands and shrublands on dunes and in interdune swales. Where they cannot be reliably distinguished, they should be classified as the Maritime Dune Complex which consists of the Maritime Shrubland Ecological Complex and the Maritime Grassland Ecological Complex as described below.

Maritime Shrubland Ecological Complex

This complex consists of all communities called Maritime Dune Shrub Thickets.

III.A.2.N.c.32 *Quercus virginiana-Ilex vomitoria-(Myrica cerifera)* Shrubland Alliance
Upland maritime dune shrubland.
III.A.2.N.i.100 *Myrica cerifera* Saturated Shrubland Alliance

Maritime Grassland Ecological Complex

This complex consists of herbaceous dune and swale vegetation. These are inclusions within the Maritime Shrub Complex but are often too small or narrow to map separately. They are primarily included in the beach class (40).

V.A.5.N.a.9 *Uniola paniculata* Temperate Herbaceous Alliance – Maritime Grassland
V.A.5.N.c.12 *Muhlenbergia filipes* Herbaceous Alliance – Maritime Wet Grassland
V.A.5.N.j.2 *Andropogon glomeratus* Temporarily Flooded Herbaceous Alliance – Maritime Grassland
VII.C.2.N.a.2 *Cakile edentula* Sparse Vegetation Alliance – Maritime Grassland

Map Class 28 – Floodplain Forest

Floodplain forests are temporarily flooded communities occurring on levees and in floodplains throughout the state. In piedmont occurrences of this class, the community composition may be similar to that of narrow stream valley forests (class 43). Where they are too narrow to map separately, adjacent communities such as seasonally to semipermanently flooded bottomlands will be included in this map class.

Soils were the primary feature distinguishing these forests. These soils include Buncombe, Congaree, Chewacla, Shellbluff, Riverview, Toccoa and mixed alluvial land.

The soils are classified by NRCS as being well drained, non-wetland soils, although the forests are comprised of wetland vegetation.

Decision rules were used to identify this map class. All upland forests on the original vegetation map that occurred on soil class 5, levee soils, were placed in floodplain forest. Where NWI was available, planted pines were excluded by a decision rule.

Nelson (1986) refers to these forests as Levee, which is essentially the concept utilized here. The following TNC alliances may be found in this class:

I.B.2.N.d.13 *Platanus occidentalis* - (*Fraxinus pennsylvanica*, *Celtis laevigata*, *Acer saccharinum*) Temporarily Flooded Forest Alliance
Occurs on fronts, terraces, and levees of medium to large rivers in the coastal plain and lower piedmont.

I.B.2.N.d.15 *Populus deltoides* Temporarily Flooded Forest Alliance
Riverfront floodplain forest occurring throughout the state.

I.B.2.N.d.21 *Salix caroliniana* Temporarily Flooded Forest Alliance
Occurs on riverfronts and lakeshores in the coastal plain.

I.B.2.N.d.22 *Salix nigra* Temporarily Flooded Forest Alliance
Occurs along rivers and streams throughout the state.

I.B.2.N.d.3 *Acer negundo* Temporarily Flooded Forest Alliance
Early successional forests along large river floodplains and sandbars.

I.B.2.N.d.5 *Betula nigra* - (*Platanus occidentalis*) Temporarily Flooded Forest Alliance
Occurs on riverfronts, especially on levees, throughout the state.

I.A.8.N.e.2 *Pinus taeda* Temporarily Flooded Forest Alliance
Occurs on higher ridges in floodplains.

I.C.3.N.b.2 *Pinus glabra* - *Quercus* (*laurifolia*, *michauxii*, *nigra*) Temporarily Flooded Forest Alliance
Occurs on natural levees and floodplains of coastal plain streams. This class should be mapped as floodplain forest (30) or wet pine - mixed hardwood forest (35).

III.A.2.N.g.1 *Arundinaria gigantea* Temporarily Flooded Shrubland Alliance
Rare community occurring on streamside flats or bottomlands. Occurs as small-patch inclusions within floodplain forests (28), piedmont bottomlands (45), swamp/bottomland (5), and narrow stream valley forests (43).

III.A.2.N.g.2 *Ligustrum sinense* Temporarily Flooded Shrubland Alliance

Wetland bottomlands heavily infested with Ligustrum. Probably occurs as inclusion within floodplain forest (28) and other bottomlands. May also occur as wet scrub/shrub (7) if large enough.

III.B.2.N.d.5 *Salix caroliniana* Temporarily Flooded Shrubland Alliance
Shrub thickets occurring on riverbanks, sand bars, and other wet sites. Occurs mostly in the coastal plain, rarely in the piedmont and mountains. This alliance is probably an inclusion within floodplain forest.

III.B.2.N.d.7 *Salix nigra* Temporarily Flooded Shrubland Alliance
Shrub thickets along rivers or lakeshores of the piedmont and coastal plain. This alliance is probably an inclusion within floodplain forest.

III.B.2.N.e.8 *Vitis rotundifolia – Ampelopsis arborea – Campsis radicans* Seasonally Flooded Vine-Shrubland Alliance
Wetland vegetation that develops following disturbance in the coastal plain. This alliance is probably present as a small-patch inclusion within forested wetlands.

Map Class 29 – Wet Maritime Forest

This class consists of wet-mesic to wet areas characterized by *Sabal palmetto, Quercus virginiana* and/or *Q. laurifolia*. It includes floodplain forests and sloughs and may be restricted to the South Atlantic coastal plain of South Carolina. This class encompasses the concept of hydric hammock as it is applied in Florida and South Georgia.

Wet maritime forests were derived from upland forests on the original Gap map by using a specific set of very poorly drained coastal soils combined with NWI evergreen forests. They were also derived by using NWI estuarine forested wetlands.

I.A.4.N.e.1 *Quercus virginiana* Temporarily Flooded Forest Alliance
Floodplain or levee forests in the outer coastal plain.

I.A.4.N.g.4 *Sabal palmetto* - *Quercus virginiana* Saturated Forest Alliance
Palmetto sloughs, hydric hammocks.

1.C.2.N.d.3 *Sabal palmetto – Quercus laurifolia – Quercus virginiana – Magnolia virginiana – Ulmus americana* Saturated Forest Alliance
Hydric hammocks, more diverse than the *Sabal palmetto – Quercus virginiana* Saturated Forest Alliance.

II.A.2.N.c.3 *Sabal palmetto* Saturated Woodland Alliance
Wet woodlands often occurring in old maritime dune swales and flats. It also includes marsh edge *Sabal palmetto* communities with marsh grass understories.

Map Class 30 – Estuarine Salt Flat/Salt Shrub Thicket

Salt flats and salt shrub thickets tend to occur in a matrix and are not differentiable at the Gap mapping level. Often patches of salt marsh will also occur as inclusions within this class. In some areas salt flats and/or salt shrub thickets map out as sandy bare soil.

On NAPP photos, they appear as bright, reflective sandy areas (salt flats) or grayish green areas within salt marshes (salt shrub thickets). NWI and soils provided excellent tools to distinguish this class. If the land cover class was salt marsh and NWI classified it as a sandy area, it was placed in estuarine salt flat/salt shrub thicket. NWI alone can be used if it's classified as emergent intertidal scrub-shrub or as estuarine irregularly flooded unconsolidated sediments. For occurrences along the margins of marsh and barrier islands, if the land cover class was wet or dry scrub/shrub, NWI was palustrine deciduous scrub-shrub and soils were outer maritime, then it was reclassified as estuarine salt flat/salt shrub thicket.

Nelson (1986) uses the same classification for these natural communities: Salt Flat and Salt Shrub Thicket. The following TNC alliances are found in this class:

III.A.4.N.e.100 *Tamarix* spp. Tidal Shrubland Alliance
Thickets in upper tidal zones of salt or brackish marshes.

III.B.2.N.h.1 *Baccharis halimifolia – Iva frutescens* Tidal Shrubland Alliance
Maritime shrub community, growing in association with salt marshes. Where occurrences are too small to map, they will be found as inclusions within salt and brackish marshes (32).

III.B.2.N.h.4 *Borrichia frutescens* Tidal Shrubland Alliance
Occupies upper marsh edges and flats; patch size ranges from narrow bands to flats in excess of 500 ha. Where patches were large enough, they were mapped usually as salt flat/salt shrub thicket (30)or less commonly as wet scrub/shrub (7). Narrow linear patches were not differentiated from adjacent upland or salt marsh (32).

IV.A.2.N.c.5 *Sarcocornia perennis* - (*Distichlis spicata, Spartina alternifolia*) Tidal Dwarf-Shrubland Alliance
Tidally flooded hypersaline flats or very shallow depressions. They are mapped as salt flat/salt shrub thicket (30) where large enough, or as surrounding salt marsh (32) where too small to map.

VII.C.2.N.d.3 *Sesuvium* spp. – *Atriplex* spp. – *Suaeda* spp. Tidal Sparsely Vegetated Alliance
Occurs on the backside of the ends of barrier islands. Tends to appear as scattered mound-like clumps of vegetation in a wet sand flat. May be found mapped as mud/sand flat (39).

<u>Map Class 31 – Wet Pinewoods</u>

The concept of this coastal wetland class was originally based on lowland pine - oak forests and spruce pine - mixed hardwood forests. However, wet-mesic to wet longleaf flatwoods without a pond pine component are also found mapped here. Planted pines on wet soils may also map out here.

Decision rules are necessary to delineate this class. From the original vegetation map, all areas in the outer coastal plain originally mapped as upland forest types that are classified as NWI forested wetlands on alfisols were placed in wet pinewoods.

These forests correspond to Nelson's (1986) Spruce Pine – Mixed Hardwood Swamp, Pine Flatwoods, in part, Pine Savannah, and Pond Cypress Savannah. TNC alliances included in this class are:

I.C.2.N.d.2 *Quercus virginiana* - *Quercus nigra* Saturated Forest Alliance
Occurs on low moist to wet flats in the coastal plain.

I.C.3.N.b.2 *Pinus glabra* - *Quercus* (*laurifolia*, *michauxii*, *nigra*) Temporarily Flooded Forest Alliance
Occurs on natural levees and floodplains of coastal plain streams and rivers. Covers broad flats in Charleston, Dorchester and Colleton Counties in particular.

I.C.3.N.b.4 *Pinus taeda* - *Liquidambar styraciflua* - *Nyssa biflora* Temporarily Flooded Forest Alliance
Mixed forests on slightly elevated ridges within coastal plain floodplains.

I.C.3.N.b.5 *Pinus taeda* - *Liriodendron tulipifera* Temporarily Flooded Forest Alliance
Occurs in floodplains of the piedmont and coastal plain following disturbance.

I.C.3.N.b.8 *Pinus taeda* - *Quercus* (*phellos*, *nigra*, *laurifolia*) Temporarily Flooded Forest Alliance
Mixed forests of blackwater coastal plain rivers.

I.C.3.N.d.5 *Pinus taeda* - *Liquidambar styraciflua* - *Acer rubrum* Saturated Forest Alliance
Successional forests occurring on coastal plain nonriverine flats.

II.A.4.N.f.6 *Pinus palustris – Pinus (elliottii, serotina)* Saturated Woodland Alliance
Several associations in this alliance are considered the classic longleaf pine grass-sedge savanna. Due to the very low density of trees, these savannas may be mapped as freshwater marshes. However, NWI decision rules should have placed most pine savannas in class 31, wet pine woods.

II.C.3.N.c.1 *Pinus elliottii* - *Taxodium ascendens* Saturated Woodland Alliance
Coastal plain wet flatwoods and cypress strands.

Map Class 32 – Salt and Brackish Marsh

This class includes all salt and brackish marshes. They often have small patch inclusions of salt shrub thickets, salt flats, mud and sand flats, and shell midden woodlands.

NWI class salt marsh was used to define salt and brackish marshes and to separate them from freshwater marshes.

This class corresponds to Nelson's (1996) Salt Marsh class.

Salt Marsh Complex

The Salt Marsh Ecological Complex is comprised of two or more of the following alliances where salt marshes, brackish marshes and salt flats cannot be mapped separately and/or where shrublands dominated by *Baccharis*, *Borrichia* or *Iva* cannot be distinguished from salt or brackish marshes. Small occurrences of Shell Midden Woodland within a large matrix of marsh may not be mapped from satellite imagery because of their size. Therefore, this alliance is included in the salt marsh complex.

Emergent Herbaceous Estuarine Wetlands

Salt Marsh

V.A.5.N.n.1 *Spartina alterniflora* Tidal Herbaceous Alliance

Other Tidal and Brackish Marshes

V.A.5.N.n.3 *Cladium mariscus* ssp. *jamaicense* Tidal Herbaceous Alliance

V.A.5.N.n.5 *Juncus roemerianus* Tidal Herbaceous Alliance

V.A.5.N.n.7 *Phragmites australis* Tidal Herbaceous Alliance

V.A.5.N.n.9 *Spartina bakeri – (Spartina patens)* Tidal Herbaceous Alliance

V.A.5.N.n.10 *Spartina cynosuroides* Tidal Herbaceous Alliance

V.A.5.N.n.11 *Spartina patens-(Distichlis spicata)* Tidal Herbaceous Alliance

Salt Flats – these are inclusions in salt marshes, see class 30

IV.A.2.N.c.5 *Sarcocornia perennis - (Distichlis spicata, Spartina alterniflora)* Tidal Dwarf Shrubland Alliance

VII.C.2.N.d.3 *Sesuvium spp.-Atriplex spp.-Suaeda spp.* Tidal Sparsely Vegetated Alliance

Barrier Island/Marsh Shrublands

Salt Shrub Thickets – these are inclusions in salt marshes, see class 30, estuarine salt flat/salt shrub thicket

III.B.2.N.h.1 *Baccharis halimifolia-Iva frutescens* Tidal Shrubland Alliance

III.B.2.N.h.4 *Borrichia frutescens* Tidal Shrubland Alliance

Marsh shrublands – transition from salt marsh to marsh islands

III.A.2.N.l.1 *Myrica cerifera – Rosa palustris* Tidal Shrubland Alliance

Woodlands

Shell Midden Woodland – these are inclusions in salt marshes

II.A.2.N.a.3 *Quercus virginiana-Juniperus virginiana-(Sabal palmetto)* Woodland Alliance

Map Classes 33-38 – Swamp/Bottomland Types 14-19

These classes have been merged with map class 5, Swamp/Bottomland Hardwood Forest. They represent a diversity of bottomland and swamp communities that range from temporarily flooded to seasonally flooded to saturated. The original vegetation map erred on the upland side of wetness values. Therefore, to derive these swamp classes, forests originally classified as vegetation classes 14 through 19 that occur on soils of wetness classes 3 or 4 were reclassified as these map classes.

We have been unable to definitively assign specific alliances to each of these swamp/bottomland types. However, there are some generalizations that have become apparent. For example, the swamp/bottomland type 18 often supports more deeply flooded swamp forests dominated by water tupelo. Also, swamp/bottomland type 15 very often supports laurel oak-dominated bottomlands. This is because since laurel oaks are tardily deciduous, they often provide an evergreen infrared signature, thus originally this map class was classified as an upland evergreen forest/woodland class. Swamp/bottomland type 15 is sometimes strongly correlated with wet evergreen (25), especially in the Francis Marion Forest and Georgetown County. In this case, merging this class with swamp/bottomland hardwood results in a misleading map. We were unable to resolve this problem.

These new classes have been lumped into the swamp/bottomland hardwood class but we have retained the ability to separate them out again in the hope that it will be useful in future studies. Some of the differences are due to differences in originally assigning class values to the original 280 hydrologic units and are AOI problems and some of the differences are indeed real.

Bottomland Hardwood Forest Ecological Complex

This complex includes river bottoms and low-lying floodplains where cypress and tupelo are usually not dominants. This complex encompasses the concept of map classes 33 through 38 and is discussed further under those classes. Floodplain and levee forests of class 28 may be found as inclusions within this complex but are listed and described under class 28. The following TNC alliances have been assigned to this complex and are attributed to map classes 33 through 38.

I.B.2.N.d.11 *Fraxinus pennsylvanica* - *Ulmus americana* - *Celtis* (*occidentalis*, *laevigata*) Temporarily Flooded Forest Alliance
Occurs on base-rich alluvial sites throughout the state.

I.B.2.N.d.12 *Liquidambar styraciflua* - (*Liriodendron tulipifera*, *Acer rubrum*) Temporarily Flooded Forest Alliance
Bottomland community of moderately wet floodplains in piedmont and coastal plain.

I.B.2.N.d.16 *Quercus* (*michauxii*, *pagoda*, *shumardii*) - *Liquidambar styraciflua* Temporarily Flooded Forest Alliance
Occurs primarily in brownwater situations (but also sometimes in blackwater) in the piedmont and coastal plain.

I.B.2.N.d.17 *Quercus* (*phellos*, *nigra*, *laurifolia*) Temporarily Flooded Forest Alliance
Occurs along blackwater rivers in the coastal plain. Swamp forests dominated by *Q. laurifolia* were most often found mapped as class 33, swamp type 15.

I.B.2.N.d.4 *Acer saccharinum* Temporarily Flooded Forest Alliance
Floodplain forest of major rivers.

I.B.2.N.e.1 *Acer rubrum* - *Fraxinus pennsylvanica* Seasonally Flooded Forest Alliance
Occurs in floodplains of rivers and perennial streams.

I.B.2.N.e.11 *Planera aquatica* Seasonally Flooded Forest Alliance
Occurs along coastal plain rivers and backswamps.

I.B.2.N.e.12 *Quercus laurifolia* Seasonally Flooded Forest Alliance
Seasonally flooded, mostly blackwater forests occurring in the coastal plain. Swamp forests dominated by *Q. laurifolia* were most often found mapped as class 33, swamp type 15.

I.B.2.N.e.13 *Quercus lyrata* - (*Carya aquatica*) Seasonally Flooded Forest Alliance
Occurs in floodplains, sloughs, and depressions throughout the coastal plain.

I.B.2.N.e.15 *Quercus phellos* Seasonally Flooded Forest Alliance
Occurs primarily in upland depressions in the inner coastal plain.

I.B.2.N.e.19 *Salix nigra* Seasonally Flooded Forest Alliance
Occurs in coastal plain floodplains or non-riverine swamps, usually following disturbance.

I.B.2.N.e.20 *Sapium sebiferum* Seasonally Flooded Forest Alliance
Occurs in seasonally flooded forests and isolated ponds throughout the coastal plain, especially the outer coastal plain.

I.B.2.N.e.6 *Liquidambar styraciflua* - (*Acer rubrum*) Seasonally Flooded Forest Alliance
Occurs in seasonally flooded depressions (not floodplains) throughout the coastal plain.

I.B.2.N.g.4 *Liquidambar styraciflua* Saturated Forest Alliance
Occurs in seepage areas with peaty soils throughout the coastal plain.

I.B.2.N.g.5 *Nyssa biflora* - *Acer rubrum* - (*Liriodendron tulipifera*) Saturated Forest Alliance
Occurs on extensive peat flats in the coastal plain, in seepage-fed edges of floodplains or on slopes wet by nearly constant seepage.

I.B.2.N.g.6 *Quercus laurifolia* - *Nyssa biflora* Saturated Forest Alliance
Occurs in the coastal plain on poorly drained interstream flats or on upland flats with saturated soils. Bottomland forests dominated by *Q. laurifolia* were most often found mapped as class 33, swamp type 15

I.B.2.N.g.7 *Quercus michauxii* - *Quercus pagoda* Saturated Forest Alliance
Occurs on non-riverine flats.

Map Class 39 – Mud/Sand Flat

These are open, unvegetated to sparsely vegetated flats of sand or mud within estuarine systems. They are usually infrequently or irregularly flooded by salt water.

These are mapped by using NWI in conjunction with salt marshes. Mud and sand flats are mapped by NWI as E2USM or E2USN.

Nelson (1986) refers to these areas as Intertidal Mud/Sand Flats. They are usually without vegetation; however, inclusions of the following TNC alliances may be found in association with mud/sand flats. These alliances are attributed to class 30, estuarine salt flat/salt shrub thicket.

IV.A.2.N.c.5 *Sarcocornia perennis* - *(Distichlis spicata, Spartina alterniflora)* Tidal Dwarf Shrubland Alliance

VII.C.2.N.d.3 *Sesuvium* spp.-*Atriplex* spp.-*Suaeda* spp. Tidal Sparsely Vegetated Alliance

Map Class 40 – Beach

Derived entirely from NWI and soils, this class includes marine beaches along the coast that are above intertidal beaches (42) and are rarely to irregularly flooded.

GAP/NWI class beach (2) was used to define beaches. Areas on soils labeled coastal beaches were reclassified as beach.

This class includes Nelson's Maritime Grassland (1986). Because soil wetness cannot be readily determined, this alliance includes dry grasslands as well as wetland swales.

Maritime Grassland Ecological Complex
This complex consists of herbaceous dune and swale vegetation. These dune grasslands are often too small or narrow to map separately and are usually found as inclusions within the Maritime Shrub Complex.

V.A.5.N.a.9 *Uniola paniculata* Temperate Herbaceous Alliance
V.A.5.N.c.12 *Muhlenbergia filipes* Herbaceous Alliance – Maritime Wet Grassland
V.A.5.N.j.2 *Andropogon glomeratus* Temporarily Flooded Herbaceous Alliance –
VII.C.2.N.a.2. *Cakile edentula* Sparse Vegetation Alliance

Map Class 41 – Spoil Deposit/Impoundment

Spoil deposits and spoil impoundments are found primarily along the Intracoastal Waterway in the outer coastal plain. Where spoil deposits are new or impounded, they typically have either bare soil or herbaceous vegetation. Older, unimpounded spoil deposits usually support evergreen forests and will be found mapped as coastal upland mixed forests, class 44.

NWI was used to determine this class – the modifiers 's' for spoil and 'sh' for spoil impoundment determined this class.

The only TNC alliance specifically attributed to spoil areas is the following:

V.A.5.N.a. *Phragmites australis* Herbaceous Vegetation

Map Class 42 – Intertidal Beach

This class was primarily identified in Charleston County as low and regularly flooded beaches.

NWI class Marine, unconsolidated shores was used to define this class. Nelson (1986) also refers to this class as Intertidal Beach. It is a non-vegetated community.

Map Class 43 – Narrow Stream Valley Forest

Narrow stream valley forests are temporarily flooded forests bordering small first and second order streams in the piedmont. The vegetation of these forests may be similar to that of floodplain forests (28). Where they are too small to map separately, seasonally to semipermanently flooded bottomlands may be included in this class.

Forests in this class are defined as occurring on specific soils to include Worsham, local alluvial land and mixed or mixed wet alluvial land. Worsham soils are in soil wetness class 3 and they are typically found at the headwaters of small streams. However, downstream from the Worsham soils, the drainageway typically supports soils referred to

as alluvial land which have a soil wetness class of 2. Therefore, these soils were used to define this class to provide complete mapping of these small streams.

This class is included in Nelson's (1986) Bottomland Hardwoods.

I.B.2.N.d.11 *Fraxinus pennsylvanica* - *Ulmus americana* - *Celtis* (*occidentalis*, *laevigata*) Temporarily Flooded Forest Alliance
Occurs on base-rich alluvial sites throughout the state.

I.B.2.N.d.12 *Liquidambar styraciflua* - (*Liriodendron tulipifera*, *Acer rubrum*) Temporarily Flooded Forest Alliance
Bottomland community of moderately wet floodplains in piedmont and coastal plain.

I.B.2.N.d.14 *Platanus occidentalis* - (*Liquidambar styraciflua*, *Liriodendron tulipifera*) Temporarily Flooded Forest Alliance
Occurs on rocky streambeds and alluvial deposits on relatively high-gradient rivers in the upper piedmont and mountains.

I.B.2.N.d.16 *Quercus* (*michauxii*, *pagoda*, *shumardii*) - *Liquidambar styraciflua* Temporarily Flooded Forest Alliance
Occurs primarily in brownwater situations (but also sometimes in blackwater) in the piedmont and coastal plain.

I.B.2.N.d.22 *Salix nigra* Temporarily Flooded Forest Alliance
Occurs along rivers and streams throughout the state.

I.B.2.N.d.9 *Fagus grandifolia* Temporarily Flooded Forest Alliance
Occurs along small streams in the piedmont and possibly other parts of the state.

I.B.2.N.g.2 *Acer rubrum* - *Nyssa sylvatica* Saturated Forest Alliance
Occurs in seepage areas on hillsides, streamheads, floodplains, and other poorly drained depressions

I.B.2.N.g.5 *Nyssa biflora* - *Acer rubrum* - (*Liriodendron tulipifera*) Saturated Forest Alliance
Occurs on seepage-fed edges of small streams in the piedmont. Also occurs in the coastal plain.

I.C.3.N.b.5 *Pinus taeda* - *Liriodendron tulipifera* Temporarily Flooded Forest Alliance
Occurs in floodplains of the piedmont and coastal plain following disturbance.

III.A.2.N.g.1 *Arundinaria gigantea* Temporarily Flooded Shrubland Alliance
Rare community occurring on streamside flats or bottomlands.

III.A.2.N.g.2 *Ligustrum sinense* Temporarily Flooded Shrubland Alliance
Wetland bottomlands heavily infested with Ligustrum.

III.B.2.N.d.2 *Alnus serrulata* Temporarily Flooded Shrubland Alliance
Shrub thickets along rivers and streams on rocky shoals, gravel, and bars in the mountains.

III.B.2.N.d.7 *Salix nigra* Temporarily Flooded Shrubland Alliance
Shrub thickets along rivers or lakeshores of the piedmont and coastal plain.

III.B.2.N.f.1 *Cephalanthus occidentalis* Semipermanently Flooded Shrubland Alliance
Occurring in shallow water depressions, oxbow ponds, sinkhole ponds, and backwater sloughs of stream and river floodplains.

Map Class 44 – Coastal Upland Mixed Forest

This class consists of upland coastal and maritime forests with *Quercus virginiana, Pinus* spp. *Ilex vomitoria, Myrica cerifera* and *Sabal palmetto.* It includes upland forests of barrier islands as well as those forests considered to be inland maritime forests. Adjacent to and within maritime forests are small patch and narrow linear maritime communities which often cannot be distinguished at the Gap mapping level. Examples of these communities include: dune grasslands, dune shrublands, interdune ponds, palmetto sloughs, tidal shrublands, shell midden woodlands, and calcareous coastal fringe forests.

Most coastal upland forests were originally classified as closed canopy evergreen forests due to the presence of evergreen oaks and pines. NWI and soils were used extensively to refine the classification. Outer coastal soils known to support maritime forests, such as Newhan, Crevasse, and Fripp, and other coastal soils of soil wetness classes 1 and 2 were utilized in conjunction with NWI. NWI upland evergreen, upland mixed, and residential resort forests on the aforementioned soils work well to define maritime forests.

Nelson (1986) refers all coastal evergreen forests to the natural community, Maritime Forest.

Maritime Forest Ecological Complex
This complex includes all three of the forest alliances as well as the woodland alliance listed below. Generally, on barrier and marsh islands, the *Quercus virginiana-(Sabal palmetto)* Forest Alliance has spatial dominance. Embedded within these live oak forests, interdune ponds occur that are below our mapping level as well as palmetto-dominated sloughs that may be too narrow for mapping. Normally, the maritime forests are bordered by tidal shrublands that also are too narrow to map. In the case of marsh islands, the tidal shrublands completely encircle the islands. The *Carya-Tilia-Celtis* Forest Alliance usually occurs as small patches within maritime forests. The *Quercus virginiana- Juniperus virginiana -(Sabal palmetto)* Woodland Alliance may also be found on the margins of marsh islands or separately within the salt marsh where they may

not be distinguishable from the surrounding marsh at our mapping level. On barrier islands, the transition from maritime forest to the live-oak dominated dune shrub thicket may not be distinguished so it is also included here. Therefore, this complex can include:

Palmetto Sloughs – see wet maritime forest, class 29
I.A.4.N.g.4 *Sabal palmetto-Quercus virginiana* Saturated Forest Alliance
Calcareous Coastal Fringe Forest
I.B.2.N.a.11 *Carya glabra-Tilia americana var. caroliniana-Celtis laevigata* Forest Alliance
Shell Midden Woodlands
II.A.2.N.a.3 *Quercus virginiana- Juniperus virginiana -(Sabal palmetto)* Woodland Alliance
Maritime Dune Shrub Thicket – see maritime shrub complex, class 27
III.A.2.N.c.32 *Quercus virginiana-Ilex vomitoria-(Myrica cerifera)* Shrubland Alliance
Salt Shrub Thicket – see estuarine salt flat/salt shrub thicket, class 30
III.B.2.N.h.1 *Baccharis halimifolia-Iva frutescens* Tidal Shrubland Alliance
III.B.2.N.h.4 *Borrichia frutescens* Tidal Shrubland Alliance
Interdune Pond – see freshwater marsh/emergent wetland, class 3
V.A.5.N.k.29 *Typha domingensis* Seasonally Flooded Temperate Herbaceous Alliance
V.A.5.N.k.28 *Spartina bakeri* Seasonally Flooded Herbaceous Alliance
In SC, known only from the South Atlantic coastal plain ecoregion, these circular depressions are found on marsh islands, not barrier islands.
V.A.5.N.k.5 *Carex hyalinolepis* Seasonally Flooded Herbaceous Alliance
V.B.2.N.h.100 *Polygonum spp*. (section Persicaria) Seasonally Flooded Herbaceous Alliance

The following TNC alliances are attributed to the Coastal Upland Mixed Forest class:

I.A.4.N.a.2 *Quercus hemisphaerica* Forest Alliance
Dry-mesic to mesic forests of the coastal plain.

I.A.4.N.a.4 *Quercus virginiana* - (*Sabal palmetto*) Forest Alliance
Maritime forest and xeric marsh hammock.

I.C.2.N.a.8 *Quercus virginiana* - *Quercus pagoda* Forest Alliance
Wet-mesic forests of the outer coastal plain.

I.C.3.N.a.26 *Pinus taeda* - *Quercus nigra* Forest Alliance
Dry to dry-mesic mixed forests of the coastal plain.

II.A.2.N.a.2 *Sabal palmetto* Temperate Woodland Alliance

II.A.2.N.a.3 *Quercus virginiana- Juniperus virginiana -(Sabal palmetto)* Woodland Alliance
Shell midden woodlands.

II.A.4.N.a.19 *Pinus elliottii* Woodland Alliance
Upland woodlands occurring on barrier islands and other near-coastal areas.

II.A.4.N.a.28 *Pinus taeda* Woodland Alliance
Coastal plain woodlands often occurring in maritime situations.

Map Class 45 – Piedmont Bottomland Forest

These are seasonally to semipermanently flooded bottomland forests of the piedmont, which occur on poorly drained soils along streams and rivers. The vegetation of this class is similar to that of swamp/bottomland hardwood forests (5). Where they are too small or narrow to map separately, temporarily flooded forests may be included in this class.

Piedmont bottomland forests were defined as those occurring in the piedmont physiographic province on soil wetness classes 3 or 4. They were also determined by using the NWI palustrine forested wetland class.

Nelson (1986) includes this class in a general Bottomland Hardwood class. The following TNC alliances may be represented in piedmont bottomland forests:

I.B.2.N.d.11 *Fraxinus pennsylvanica* - *Ulmus americana* - *Celtis* (*occidentalis*, *laevigata*) Temporarily Flooded Forest Alliance
Occurs on base-rich alluvial sites throughout the state.

I.B.2.N.d.12 *Liquidambar styraciflua* - (*Liriodendron tulipifera*, *Acer rubrum*) Temporarily Flooded Forest Alliance
Bottomland community of moderately wet floodplains in the piedmont and coastal plain..

I.B.2.N.d.13 *Platanus occidentalis* - (*Fraxinus pennsylvanica*, *Celtis laevigata*, *Acer saccharinum*) Temporarily Flooded Forest Alliance
Occurs on fronts, terraces, and levees of medium to large rivers in the CP and lower piedmont.

I.B.2.N.d.14 *Platanus occidentalis* - (*Liquidambar styraciflua*, *Liriodendron tulipifera*) Temporarily Flooded Forest Alliance
Occurs on rocky streambeds and alluvial deposits on relatively high-gradient rivers in the upper piedmont and mountains.

I.B.2.N.d.15 *Populus deltoides* Temporarily Flooded Forest Alliance
Riverfront floodplain forest occurring throughout the state.

I.B.2.N.d.16 *Quercus* (*michauxii*, *pagoda*, *shumardii*) - *Liquidambar styraciflua* Temporarily Flooded Forest Alliance
Occurs primarily in brownwater situations (but also sometimes in blackwater) in the piedmont and coastal plain.

I.B.2.N.d.22 *Salix nigra* Temporarily Flooded Forest Alliance
Occurs along rivers and streams throughout the state.

I.B.2.N.d.3 *Acer negundo* Temporarily Flooded Forest Alliance
Early successional forests along large river floodplains and sandbars.

I.B.2.N.d.4 *Acer saccharinum* Temporarily Flooded Forest Alliance
Floodplain forest of major rivers.

I.B.2.N.d.5 *Betula nigra* - (*Platanus occidentalis*) Temporarily Flooded Forest Alliance
Occurs on riverfronts, especially on levees, throughout the state. Corresponds to Forest Svc stand type #72.

I.B.2.N.d.9 *Fagus grandifolia* Temporarily Flooded Forest Alliance
Occurs along small streams in the piedmont and possibly other parts of the state..

I.B.2.N.e.1 *Acer rubrum* - *Fraxinus pennsylvanica* Seasonally Flooded Forest Alliance
Occurs in floodplains of rivers and perennial streams.

I.B.2.N.e.15 *Quercus phellos* Seasonally Flooded Forest Alliance
Occurs primarily in upland depressions (not floodplains) throughout the coastal plain and piedmont.

I.B.2.N.g.2 *Acer rubrum* - *Nyssa sylvatica* Saturated Forest Alliance
Occurs in seepage areas on hillsides, streamheads, floodplains, and other poorly drained depressions.

I.B.2.N.g.5 *Nyssa biflora* - *Acer rubrum* - (*Liriodendron tulipifera*) Saturated Forest Alliance
Occurs on extensive peat flats in the coastal plain, in seepage-fed edges of floodplains or on slopes wet by nearly constant seepage. Also occurs on seepage-fed edges of small streams in the piedmont.

I.B.2.N.g.7 *Quercus michauxii* - *Quercus pagoda* Saturated Forest Alliance
Occurs on non-riverine flats.

I.C.3.N.b.5 *Pinus taeda* - *Liriodendron tulipifera* Temporarily Flooded Forest Alliance

Occurs in floodplains of the piedmont and coastal plain following disturbance.

III.A.2.N.g.1 *Arundinaria gigantea* Temporarily Flooded Shrubland Alliance
Rare community occurring on streamside flats or bottomlands.

III.A.2.N.g.2 *Ligustrum sinense* Temporarily Flooded Shrubland Alliance
Wetland bottomlands heavily infested with Ligustrum. This alliance will probably be mapped as a small inclusion within bottomlands or it may also occur as wet scrub/shrub (7) if patch is large enough.

III.B.2.N.d.2 *Alnus serrulata* Temporarily Flooded Shrubland Alliance
Shrub thickets along rivers and streams on rocky shoals, gravel, and bars in the mountains. Probably this alliance will usually just show up as a narrow band inclusion within adjacent forest types or it may show up as rocky shoals (50), when situated on a rocky shoal.

III.B.2.N.d.7 *Salix nigra* Temporarily Flooded Shrubland Alliance
Shrub thickets along rivers or lakeshores of the piedmont and coastal plain. This alliance will probably be mapped as a narrow band inclusion within swamp/bottomland hardwood (5), piedmont bottomland (45), narrow stream valley forest (43), or floodplain forest (28).

III.B.2.N.f.1 *Cephalanthus occidentalis* Semipermanently Flooded Shrubland Alliance
Occurring in shallow water depressions, oxbow ponds, sinkhole ponds, and backwater sloughs of stream and river floodplains. This alliance is found mapped as wet scrub/shrub (7) or as a small-patch inclusion within swamp/bottomland hardwood (5), piedmont bottomland (45), narrow stream valley forest (43), or floodplain forest (28).

Map Class 46 – Dry Basic Deciduous Forest

Xeric forests or woodlands overlying basic or circumneutral soil. Soils were used to distinguish this class from classes 17, 18, and 47. Disturbed deciduous sites overlying basic soils will be mapped as class 46, but may not contain typical basic forest species. Woodlands with very sparse canopies may be mapped as dry scrub/shrub (8), open canopy/recently cleared forest (10), grassland/pasture (20), or cultivated land (21).

Deciduous forests were placed in this class if they occurred on alfisols with a soil wetness class of 1. The original vegetation map occasionally erroneously placed deciduous and mixed upland forests in class 5, swamps and bottomland hardwoods. A combination of NWI deciduous upland forest class on alfisols with soil wetness class 1 corrected this error.

This class is equivalent to Nelson's (1986) Montmorillonite Forest. The following TNC alliance comprises this class:

I.B.2.N.a.27 *Quercus alba* - (*Quercus rubra*, *Carya* spp.) Forest Alliance
Described as dry-mesic forest, sometimes occurring on calcareous substrate.

I.B.2.N.a.37 *Quercus prinus* - *Quercus* (*alba*, *falcata*, *rubra*, *velutina*) Forest Alliance
Dry-mesic to mesic forests occurring on moderately sheltered low ridges, flats, and valleys at low elevations in the mountains and on upper to middle dry-mesic slopes in the piedmont. May also include forests overlying calcareous bedrock.

I.B.2.N.a.41 *Quercus stellata* - *Quercus marilandica* Forest Alliance
Dry oak forest, sometimes occurring on calcareous substrates.

Map Class 47 – Mesic Basic Deciduous Forest

Mesic forests or woodlands overlying basic or circumneutral soil. Soils were used to distinguish this class from classes 16, 17, and 46. Disturbed deciduous sites overlying basic soils will be mapped as class 47 but may not contain typical basic forest species. Woodlands with very sparse canopies may be mapped as dry scrub/shrub (8), open canopy/recently cleared forest (10), grassland/pasture (20), or cultivated land (21).

Deciduous forests were placed in this class if they occurred on alfisols with a soil wetness class of 2. The original vegetation map occasionally erroneously placed deciduous and mixed upland forests in class 5, swamps and bottomland hardwoods. A combination of NWI deciduous upland forest class on alfisols with soil wetness class 2 corrected this error.

This class is equivalent to Nelson's Basic Forest (1986) which he attributes to the piedmont, especially in association with diabase dikes. The concept here is also of piedmont forests. Mesic basic deciduous forests in the coastal plain weren't able to be distinguished by soil rules because the alfisols of the coastal plain fall into wetness class 3.

I.B.2.N.a.16 *Fagus grandifolia* - *Quercus alba* Forest Alliance
Dry-mesic to mesic forests with *Quercus alba* and *Fagus grandifolia* that typically occur on mesic slopes and small stream bottoms.

I.B.2.N.a.101 *Quercus muehlenbergii* - (*Acer saccharum*) Forest Alliance
Basic forest which may be found in the mountains.

I.B.2.N.a.2 *Acer barbatum* - *Fraxinus americana* - *Juglans nigra* Forest Alliance
Mesic calcareous forests. Gap doesn't map basic forests separately in the coastal plain. Therefore, coastal plain occurrences of this alliance will be mapped under mesic deciduous class 18, while piedmont occurrences will be mapped as 47.

I.B.2.N.a.27 *Quercus alba* - (*Quercus rubra*, *Carya* spp.) Forest Alliance

Described as dry-mesic forest, sometimes occurring on calcareous substrate.

I.B.2.N.a.37 *Quercus prinus* - *Quercus* (*alba*, *falcata*, *rubra*, *velutina*) Forest Alliance
Dry-mesic to mesic forests occurring on moderately sheltered low ridges, flats, and valleys at low elevations in the mountains and on upper to middle dry-mesic slopes in the piedmont. May also include forests overlying calcareous bedrock.

II.B.2.N.a.25 *Quercus stellata* - *Quercus marilandica* Woodland Alliance
Post oak - blackjack oak barrens occurring on montmorillonitic clays or limestone-derived soils in the piedmont and coastal plain.

Map Class 48 – Mesic Basic Mixed Forest/Woodland

Mesic forests or woodlands with mixed evergreen and deciduous canopy species, overlying basic or circumneutral soil. These forests are often mapped as evergreen forests or woodlands, classes 13 and 14. Soils were used to distinguish this class from classes 18, 19, and 20. Disturbed mixed sites overlying basic soils will be mapped as class 48, but may not contain typical basic forest species. Woodlands with very sparse canopies may be mapped as dry scrub/shrub (8), open canopy/recently cleared forest (10), grassland/pasture (20), or cultivated land (21).

I.C.3.N.a.3 *Juniperus virginiana – Quercus (stellata, velutina, marilandica)* Forest Alliance
Mixed dry-mesic forests of the piedmont and possibly elsewhere in the state.

Map Class 49 – Ridgetop/Upper Slope Evergreen Woodland

Ridgetops and upper slopes dominated by *Pinus rigida, P. pungens, P. virginiana*, and/or *Tsuga caroliniana.* Oaks, especially *Quercus prinus* and *Q. coccinea* are typically also present and may be co-dominant with the evergreen species. The canopy ranges from open woodlands to closed canopy forests. Sites on shallow rocky soils often have open, stunted canopies. Typical shrubs include *Vaccinium pallidum, Kalmia latifolia*, and *V. stamineum*.

Digital elevation models and soils were used to devise decision rules to map this class. This class is defined as occurring on ridgetops above 2000 feet in elevation where the soils were classed as type 1 or 2.

I.A.8.N.b.5 *Pinus echinata* Forest Alliance

I.A.8.N.b.17 *Pinus virginiana* Forest Alliance

I.A.8.N.c.9 *Tsuga caroliniana* Forest Alliance

I.C.3.N.a.15 *Pinus echinata – Quercus (coccinea, falcata, prinus)* Forest Alliance

II.A.4.N.a.23 *Pinus pungens – (Pinus rigida)* Woodland Alliance
Woodlands occurring in the mountains on xeric ridges and exposed, steep side-slopes.

Map Class 50 – Rocky Shoals

These are regularly flooded rocky shoals in streams and rivers in the mountains and piedmont.

Rocky shoals were initially underestimated for several reasons. If the water levels were high, they mapped as water. If water levels were low, they often mapped as urban development, class 22 due to the similarities of rock and concrete to the mapper. If mapped as urban development, rocky shoals could be identified in those areas where the original vegetation map indicated urban and the soil class was water.

Nelson (1986) described this class as Shoal and Stream Bar. His definition includes sandy shoals in the coastal plain whereas the GAP concept is strictly of rocky shoals. Nelson's sandy shoals will be found mapped as fresh water marsh (3) or wet soil (6). The following TNC alliances typify this land cover class:

III.B.2.N.d.2 *Alnus serrulata* Temporarily Flooded Shrubland Alliance
This alliance includes shrub thickets dominated by *Alnus serrulata* along rivers and streams on rocky shoals and gravel and bars.

V.A.5.N.j.4 *Carex torta* Temporarily Flooded Herbaceous Alliance
Alluvial wetlands on sand, gravel, and rock bars in the mountains.

V.B.2.N.d.2 *Justicia americana* Temporarily Flooded Herbaceous Alliance
Occurs on rocky river shoals in the mountains and piedmont. *Hymenocallis coronaria* is found in association with this alliance in piedmont streams and rivers.

V.C.2.N.a.12 *Podostemum ceratophyllum* Permanently Flooded Herbaceous Alliance
Occurs on shoals in rocky streambeds and riverbeds.

Map Class 51 – Montane Riparian Forest

Temporarily flooded to saturated forests along streams and rivers in the mountains. This class includes several forest types including bogs, seeps, bottomlands, and floodplains. Riparian shrublands, which are typically too narrow to map separately, have been listed as inclusions within this class. Typical canopy species within the forests include: *Acer rubrum, Platanus occidentalis, Liquidambar styraciflua, Betula lenta, B. nigra, Liriodendron tulipifera, Tsuga canadensis, Pinus strobus*, and *Magnolia fraseri*.

This class was created exclusively by using soil decision rules. If the land cover class in the original vegetation map was an upland forest type to include evergreen, mixed and deciduous forests, and the soil type was wetness class 3, 4, 5, or 11, then it was placed in

montane riparian forest.

This class falls within the Small Steam Forest natural community of Nelson (1986). The following TNC alliances should be found in this class:

I.A.8.N.e.3 *Tsuga canadensis – (Pinus strobus)* Temporarily Flooded Forest Alliance
Occurs on floodplains and terraces in the mountains.

I.B.2.N.d.14 *Platanus occidentalis* - (*Liquidambar styraciflua*, *Liriodendron tulipifera*) Temporarily Flooded Forest Alliance
Occurs on rocky streambeds and alluvial deposits on relatively high-gradient rivers in the upper piedmont and mountains. Should be found mapped as narrow stream valley forest (43) or floodplain forest (28) in the piedmont and as montane riparian forest (69) in the mountains.

I.B.2.N.e.19 *Salix nigra* Seasonally Flooded Forest Alliance
Occurs along rivers and streams throughout the state. This alliance will also be mapped as floodplain forest (28) and narrow stream valley (43).

I.B.2.N.d.5 *Betula nigra* - (*Platanus occidentalis*) Temporarily Flooded Forest Alliance
Occurs on riverfronts, especially on levees, throughout the state. This alliance is also mapped as floodplain forest (28), narrow stream valley forest (43), and piedmont bottomland (45).

I.C.3.N.d.7 *Tsuga canadensis – Acer rubrum* Saturated Forest Alliance
Hemlock - hardwood forests occurring on poorly drained bottomlands in the mountains.

III.A.2.N.g.1 *Arundinaria gigantea* Temporarily Flooded Shrubland Alliance
Rare community occurring on streamside flats or bottomlands in the mountains and piedmont. When patches are large enough to distinguish, this alliance they should be mapped as wet shrub/scrub (7). It probably occurs mostly as small-patch inclusions within floodplain forests (28), narrow stream valley forests (43), or montane riparian forests (51).

III.B.2.N.d.2 *Alnus serrulata* Temporarily Flooded Shrubland Alliance
Shrub thickets along rivers and streams on rocky shoals, gravel, and bars in the mountains. When patches are large enough to distinguish, this alliance is mapped as wet shrub/scrub (7). This alliance likely occurs as a narrow band inclusion within montane riparian forest (51). Alternatively, this alliance may also be found on rocky shoals (50).

<u>Map Class 52 – Deciduous Rich/Acidic Cove Forest</u>

These are mesic deciduous forests occurring in protected coves and ravines. In rich cove communities, the canopy is usually a diverse mix of mesic hardwoods such as *Liriodendron tulipifera, Tilia americana var. heterophylla, T. americana var. caroliniana, Aesculus flava, Magnolia fraseri, and Halesia carolina.* The shrub layer is dominated by non-ericaceous species such as *Lindera benzoin, Hydrangea arborescens, and Calycanthus floridus var. glaucus.* The herbaceous layer is typically very lush and diverse. Acidic coves typically have lower species richness and a shrub layer dominated by ericaceous species, especially Rhododendron maximum.

Digital elevation models and soils were used to define this class. Deciduous forests occurring on concave valley bottoms where the soils were class 1 or 2, were mapped as cove forests.

Nelson (1986) places these forests in Cove Forest. The following TNC alliance typifies rich coves:

I.B.2.N.a.23 *Liriodendron tulipifera - Tilia americana var. heterophylla - Aesculus flava - Acer saccharum* Forest Alliance
Rich cove forests, occurring in the mountains only.

The following TNC alliance typifies deciduous acidic coves:

I.B.2.N.a.24 *Liriodendron tulipifera* Forest Alliance

<u>Map Class 53 – Montane Evergreen Forest</u>

These are closed canopy, evergreen-dominated forests, including planted pine stands. Canopy dominants include: *Pinus strobus, Pinus virginiana, Pinus echinata, Pinus taeda*.

This class is restricted to the mountains and is derived entirely by decision rules. All areas located within the mountain province, originally classified as land cover classes 13, Closed Canopy Evergreen Forest, or 14, Needle-leaved Evergreen Mixed Forest/Woodland, were placed in Montane Evergreen Forest.

Nelson (1986) has no natural communities that would be included in this land cover class.

I.A.8.C.x.8 *Pinus strobus* Planted Forest Alliance
Planted white pine forests in the mountains.

I.A.8.C.x.10 *Pinus virginiana* Planted Forest Alliance
Planted Virginia pine forests, possibly in the mountains.

I.A.8.N.b.14 *Pinus strobus* Forest Alliance
Only occurs in the piedmont and mountains.

I.A.8.N.b.5 *Pinus echinata* Forest Alliance
Dry, evergreen forests occurring in the mountains and piedmont. Soils are acidic and are derived from sandstone, chert, or granitic rock. These communities are situated on ravines, ridges, and steep, often S- to W-facing slopes below 2400 ft.

I.A.8.N.b.17 *Pinus virginiana* Forest Alliance
Occurs on lower slopes and ridges in the Southern Blue Ridge, often in association with *Pinus rigida*. Also occurs in the piedmont.

I.A.8.N.c.2 *Juniperus virginiana* Forest Alliance
Successional forests occurring on old fields, successional cleared land, and other disturbed areas, especially on calcareous bedrock.

I.A.8.N.c.9 *Tsuga caroliniana* Forest Alliance
Occurs in the mountains and upper piedmont, mostly on cliffs, rocky slopes, and ridges, less commonly on more gentle slopes and flat areas in valleys. Occupies higher and drier sites than Tsuga canadensis.

Map Class 54 – Eastern Hemlock Ravine Forest

These are evergreen to mixed forests that occur on protected lower slopes in mountain coves and ravines. The canopy is dominated or co-dominated by Tsuga canadensis, often mixed with Pinus strobus and mesic hardwoods such *as Liriodendron tulipifera, Magnolia fraseri, Acer rubrum, Fagus grandifolia, Quercus rubra, Betula lenta,* and *Tilia americana var. heterophylla.* The understory is characterized by dense thickets of *Rhododendron maximum,* sometimes mixed with *Ilex opaca, Kalmia latifolia, Leucothoe fontanesiana, Clethra acuminata, Hydrangea arborescens,* and/or *Hamamelis virginiana.*

Digital elevation models and soils were used to define this class. Evergreen or mixed forests occurring in valley bottoms on soil class 1 or 2 were mapped as hemlock ravines.

This class corresponds to Nelson's (1986) Hemlock Forest. The following TNC alliances are considered to be typical of this class:

I.A.8.N.b.13 *Pinus strobus - Tsuga canadensis* Forest Alliance
Occurs on alluvial terraces and steep, protected gorge slopes in the mountains.

I.A.8.N.c.8 *Tsuga canadensis* Forest Alliance
Occurs in mountains on valley flats, narrow ravines, and north- to east-facing slopes from 1800-3500 ft.

I.C.3.N.a.33 *Tsuga canadensis - Liriodendron tulipifera* Forest Alliance
Acidic cove forests or mesic successional forests occurring in the mountains.

Appendix 2. NWI classes used in land cover development.

1. Agriculture
2. Beach
3. Deciduous forest
4. Evergreen forest
5. Forested wetland – not included in category 25, 26, 28
6. Fresh marsh
7. Fresh water
8. Fresh/salt water
9. LAB
10. Mixed forest
11. Other
12. PAB
13. Planted pine
14. Salt marsh
15. Salt water
16. Shore-M2US
17. SS Wetland – not included in category 27, 29
18. Urban
19. Shore – E2USN
20. Shore – E2USP
21. Shore – E2USM\
22. Impoundment
23. RAB
24. Shore – E2US
25. Evergreen PFO
26. Evergreen PFO/PSS
27. Evergreen PSS
28. Deciduous PFO
29. Deciduous PSS
30. Salt flat E2SS*
31. PFO1/SS3B*- include in inclusive evergreen PFO
32. Combined U11, U12, and U17h

*** any combination within this class**

Appendix 3. Soil types used in land cover development

1. excessively and somewhat excessively drained
2. well and moderately-well drained
3. somewhat poorly and poorly drained
4. very poorly drained
5. levee or temporarily flooded soils
6. alfisols
7. complexes
8. water
9. no drainage
10. seep-producing soils – NOT USED
11. piedmont and mountain special soils, Worsham, Local Alluvial, Elbert wetness 1 or 2
12. no code
13. no code
14. no code
15. Rutledge and Paxville soils in Dillon and Marlboro counties
16. piedmont soils – same as 6a – class 1 alfisols
17. piedmont soils – same as 6b – class 2 alfisols
18. rock outcrops – Greenville, Oconee, Pickens
19. 7MF
20. 7MF1
21. 7MF3
22. 4SM
23. CO – Coastal Beaches
24. 51MF1
25. 51MF2
26. 51MF3
27. 51MF4

Appendix 4. Final rules for land cover modeling

Priority Rules

1. If NWI class E2USN or E2USM, put in veg class 39, mud/sand flat

2. If NWI contains the modifiers hs or sh, put in veg class 41, spoil deposit/impoundment

3. If NWI class beach, put in veg class 40, beach

4. If NWI class M2US, put in veg class 42, intertidal beach

5. If NWI class E2USP or E2SS*, put in veg class 30, estuarine salt flat/salt shrub thicket

6. If NWI class fresh water, or fresh/salt water, specifically palustrine or lacustrine unconsolidated bottom, put in veg class 1, fresh water

7. If NWI class fresh/salt water, specifically marine and estuarine unconsolidated bottom, put in veg class 2, marine water

8. If veg class 13, 14, 15, 21, or 22 and NWI class fresh marsh, put in veg class 3, fresh water marsh/emergent wetland

9. If veg classes 33 or 34 and NWI class PFO1/PSS3B, put in veg class 4, pocosin

10. If NWI class salt marsh, and soil type 22, put in veg class 32, salt and brackish marsh

Statewide Rules

11. If veg class 26 (from original gapmo 17) and NWI class deciduous PSS, put in veg class 7

12. If veg class 26 (from original gapmo17) and NWI class deciduous PFO put in veg class 5, swamp/bottomland hardwood forest

13. If veg class 26 (from original gapmo 17) and NWI U42 or U43 and soil type 3, 4, or 6, put in veg class 31, wet pinewoods

14. If veg class 26 (from original gapmo 17), put in veg class 13, closed canopy evergreen forest/woodland

15. If veg class 1 and NWI class LAB, RAB or PAB, put in veg class 12, aquatic vegetation.

16. If veg class 3 and NWI class agriculture, put in veg class 21, cultivated land

17. If veg class 8 and NWI class planted pine, put in veg class 10, open canopy/recently cleared forest

18. If veg class 20 or 21 and NWI class planted pine, put in veg class 10/open canopy, recently cleared forest

19. If veg class 3 and NWI class planted pine, put in veg class 10, open canopy/recently cleared forest

20. If veg class 7 and NWI class planted pine, put in veg class 10, open canopy/recently cleared forest

21. If veg class 16 and soil type 2, put in veg class 17, mesic deciduous forest/woodland

22. If veg class 17 and soil type 1, put in veg class 16, dry deciduous forest/woodland

23. If veg class 18 and soil type 2, put in veg class 19, mesic mixed forest/woodland

24. If veg class 19 and soil type 1, put in veg class 18, dry mixed forest/woodland

25. If veg class 5 and NWI class deciduous PSS, put in veg class 7, wet scrub/shrub thicket

26. If veg class 8 and soil type 3, 4, 5, 6, 11, 21, 22, 26 or 27, put in veg class 7, wet scrub/shrub thicket

27. If veg class 7 and soil type 1, 2, 20, 24 or 25, put in veg class 8, dry scrub/shrub thicket

28. If veg class 22 and NWI class agriculture, put in veg class 21, cultivated land

29. If veg class 13 or 14 and soil type 3 or 4 and NWI class deciduous PSS, put in veg class 7, wet scrub/shrub thicket

30. If veg class 13 through 19 and NWI class 'not planted pine' and soil type 5 with soil wetness class of 1 or 2, put in veg class 28, floodplain forest

31. For counties without NWI: If veg class 14 through 19 and soil type 5 with soil wetness class of 1 or 2, put in veg class 28, floodplain forest.

Coastal Plain and Sandhills

32. If veg class 22 and soil type 3, 4 or 6 and NWI forested wetland classes (5, 25, 26, 28), put in veg class 5, swamp/bottomland hardwood forest

33. If veg class 13, 14, or 15 and NWI class evergreen PSS and soil type 3 or 4, put in veg class 4, pocosin

34. If veg class 13, 14, or 15 and NWI class evergreen PFO and soil type 3 or 4, put in veg class 25, wet evergreen

35. If veg class 13, 14, or 15 and NWI class evergreen PFO/PSS and soil type 3 or 4, put in veg class 4, pocosin

36. If veg class 13 or14 and NWI class deciduous PFO, and soil type <u>not</u> 20, 21, 22, 23, 25, 26, or 27, put in veg class 33, swamp/bottomland type 14

37. If veg class 15 and NWI class deciduous PFO, and soil type not 20, 21, 22 23, 25, 26, 27, put in veg class 34, swamp/bottomland type 15

38. If veg class 13, 14, or 15 and NWI U42 and soil type 3, 4, or 6, put in veg class 31 wet pinewoods

39. If veg class 13 or 14 and soil type 3, 4, or 6 and NWI class deciduous forest, forested wetland, mixed forest, or SS wetland, put in veg class 33, swamp/bottomland type 14

40. If veg class 15 and soil type 3, 4, or 6 and NWI class deciduous forest, forested wetland, mixed forest, or SS wetland, put in veg class 34, swamp/bottomland type 15

41. If veg class 16, 17, 25 or 44 and NWI class fresh marsh, put in veg class 3, freshwater marsh/emergent wetland

42. If veg class 16 and NWI class deciduous PFO, and soil type not 20, 21, 22, 23, 25, 26, 27, put in veg class 35, swamp/bottomland type 16

43. If veg class 16 and NWI class evergreen PFO or evergreen PFO/PSS, and soil type 3 or 4, put in veg class 25, wet evergreen.

44. If veg class 16 and soil type 3, 4 or 6, put in veg class 35, swamp/bottomland type 16

45. If veg class 17 and NWI class deciduous PFO, and soil type not 20, 21, 22, 23, 25, 26, or 27, put in veg class 36, swamp/bottomland type 17

46. If veg class 17 and NWI class evergreen PFO or evergreen PFO/PSS, and soil type 3 or 4, put in veg class 25, wet evergreen.

47. If veg class 17 and soil type 3, 4 or 6, put in veg class 36, swamp/bottomland type 17

48. If veg class 18 and NWI class deciduous PFO, and soil type not 20, 21, 22, 23, 25, 26, or 27 put in veg class 37, swamp/bottomland type 18

49. If veg class 18 and NWI class evergreen PFO or evergreen PFO/PSS, and soil type 3 or 4, put in veg class 25, wet evergreen

50. If veg class 18 and soil type 3, 4 or 6, put in veg class 37, swamp/bottomland type 18

51. If veg class 19 and NWI class deciduous PFO, and soil type not 20, 21, 22, 23, 25, 26, or 27, put in veg class 38, swamp/bottomland type 19

52. If veg class 19 and NWI class evergreen PFO or evergreen PFO/PSS, and soil type 3 or 4, put in veg class 25, wet evergreen.

53. If veg class 19 and soil type 3, 4 or 6, put in veg class 38, swamp/bottomland type 19

54. If veg class 20 or 21 and NWI class deciduous PFO, deciduous PFO/PSS, deciduous PSS, forested wetland, or SS wetland, put in veg class 10, open canopy/recently cleared forest.

55. If veg class 20 or 21 and NWI class evergreen PFO, evergreen PFO/PSS, or evergreen PSS and soil type not 20, 21, 22, 23, 25, 26, or 27, put in veg class 10, open canopy/recently cleared forest

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56. If veg class 3 and NWI class planted pine, put in veg class 13, closed canopy evergreen

57. If veg class 5 and NWI class fresh marsh, put in veg class 3, fresh water marsh/emergent wetland

58. If veg class 7 and NWI class fresh marsh, put in veg class 3, fresh water marsh/emergent wetland

59. If veg class 8 and NWI class fresh marsh, put in veg class 3, fresh water marsh/emergent wetland

60. If veg class 6, 7, 8, 20 or 21, and NWI U42, or NWI class evergreen PFO, evergreen PFO/PSS or evergreen PSS and soil type 20 or21, put in veg class 27, maritime shrub complex

61. If veg class 7 or 8 and NWI class deciduous PSS and soil type 20 or 21, put in veg class 30, estuarine salt flat/salt shrub thicket

62. If veg class 20 and NWI class fresh marsh, put in veg class 3, fresh water marsh/emergent wetland

63. If veg class 21 and NWI class fresh marsh, put in veg class 3, fresh water marsh/emergent wetland

64. If veg class 6, 7, 14, 15, 16, 17, 18, 19, 25, 33 through 38 and NWI class fresh marsh, put in veg class 3, fresh water marsh/emergent wetland

65. If veg class 3 or 13 and NWI class salt marsh put in veg class 32, salt and brackish marsh

66. If veg class 5 and NWI class salt marsh, put in veg class 32, salt and brackish marsh

67. If veg class 6, 7, or 8 and NWI class salt marsh, put in veg class 32, salt and brackish marsh

68. If veg class 20 and NWI class salt marsh, put in veg class 32, salt and brackish marsh.

69. If veg class 14 through 19, 21, 25, or 33 through 38, and NWI class salt marsh, put in veg class 32, salt and brackish marsh

70. If veg class 3, 5, 13 through 19 or 25 and NWI class U11, U12, or U17 and soil type 25 or 26, put in veg class 44, coastal upland mixed forest

71. If veg class 3, 5, 13 through 19 or 25 and NWI U42, U43 U11, U12, or U17 and soil type 20 put in veg class 44, coastal upland mixed forest. Only east of US17

72. If veg class 5, 13 through 19 or 25 and NWI U11, U12, U17, U42, or U43 and soil type 21, put in veg class 26, lowland maritime forest

73. If veg class 13, 14 or 15 and NWI class deciduous PFO, deciduous PFO/PSS, or deciduous PSS and soil type 20, 21, 25, 26, or 27, put in veg class 35, swamp/bottomland type 16

74. If veg class 16 through 19 and NWI class deciduous PFO, deciduous PFO/PSS, or deciduous PSS and soil type 20, 21, 25, 26, or 27, put in veg class 36, swamp/bottomland type 17

75. If veg class 3, 5, 13 through 19 and NWI class evergreen PFO, evergreen PFO/PSS, evergreen PSS, or PFO1/SS3B* and soil type 20 or 21 put in veg class 26, lowland maritime forest

76. If veg class 3, 5, 13 through 19 and NWI class evergreen PFO, evergreen PFO/PSS, evergreen PSS, or PFO1/SS3B* and soil type 26, put in veg class 26, lowland maritime forest

77. If veg class 3, 5, 13, 14, 15, or 25 and NWI U11, U12, U17, U42, or U43, and soil type 22, put in class 44, coastal upland mixed forest

78. If veg class 5, 6, 7, 16 through 19 and soil type 22, put in veg class 32, salt and brackish marsh

79. If veg class 3, 13 through 19 and NWI U42, or U43, and soil type 25, put in veg class 44, coastal upland mixed forest

80. If veg class 3, 13 through 19 and NWI U42, or U43, and soil type 26, put in veg class 26, lowland maritime forest

81. If veg class 3, 13 through 19 and NWI U42, U43, evergreen PFO, evergreen PFO/PSS, evergreen PSS, or PFO1/SS3B* and soil type 27, put in veg class 29, wet maritime forest

82. Special Georgetown county rule: If veg class 13 through 19 and NWI U11, U42, U43, or unknown and soil name Levy, put in veg class 44, coastal upland mixed forest

83. If veg class 3, 6, 9, 20 or 21 and soil type 23, put in veg class 40, beach

84. If veg class 7 or 8 and soil type 23, put in veg class 27, maritime shrub complex

85. If veg class 13 through 19 and soil type 23, put in veg class 44, coastal upland mixed forest

86. If veg class 3 and soil type 22, put in veg class 32, salt and brackish marsh

87. If veg class 22 and soil type 22, put in veg class 32, salt and brackish marsh

88. If veg class 22 and NWI class salt marsh, put in veg class 32, salt and brackish marsh

89. If veg class 13 through 19 or 25 and NWI class E2FO*, put in veg class 29, wet maritime forest

90. If veg class 3 and NWI E2FO*, put in veg class 32, salt and brackish marsh

91. If veg class 13, 14, 15, or 25 and soil type 22, put in veg class 36, salt and brackish marsh

92. If veg class 3, 13 through 19, or 25 and NWI U11, U12, U17, or U76 and soil type 27, put in veg class 44, coastal upland mixed forest

93. If veg class 3, 13, 14, or 15 and NWI U11, U12, U17, or U76 and soil type 8, put in veg class 44, coastal upland mixed forest

Piedmont

94. If veg class 22 and soil type 8, put in veg class 50, rocky shoals

95. If any veg class and soil type 8, put in veg class 1, water

96. If veg class 4 or 25 put in veg class 13, closed canopy evergreen forest/woodland

97. If soil type 18, put in veg class 11, rock outcrop

98. If veg class 14, 15, 16, 17, 18, or 19 and soil type 11 put in veg class 43, narrow stream valley forest

99. If veg class 14 and NWI class deciduous PFO, put in veg class 45, piedmont bottomland forest

100. If veg class 14 and soil type 3 or 4, put in veg class 45, piedmont bottomland forest

101. If veg class 15 and NWI class deciduous PFO, put in veg class 45, piedmont bottomland forest

102. If veg class 15 and soil type 3 or 4, put in veg class 45, piedmont bottomland forest

103. If veg class 16 and NWI class deciduous PFO, put in veg class 45, piedmont bottomland forest

104. If veg class 16 and soil type 3 or 4, put in veg class 45, piedmont bottomland forest

105. If veg class 17 and NWI class deciduous PFO, put in veg class 45, piedmont bottomland forest

106. If veg class 17 and soil type 3 or 4, put in veg class 45, piedmont bottomland forest

107. If veg class 18 and NWI class deciduous PFO, put in veg class 45, piedmont bottomland forest

108. If veg class 18 and soil type 3 or 4, put in veg class 45, piedmont bottomland forest

109. If veg class 19 and NWI class deciduous PFO, put in veg class 45, piedmont bottomland forest

110. If veg class 19 and soil type 3 or 4, put in veg class 45, piedmont bottomland forest

111. If veg class 22 and soil type 3 or 4, and NWI class forested wetland, put in veg class 45, piedmont bottomland forest

112. If veg class 16 or 17 and soil type 16, put in veg class 46, dry basic deciduous forest/woodland

113. If veg class 16 or 17 and soil type 17, put in veg class 47, mesic basic deciduous forest/woodland

114. If veg class 18 or 19 and soil type 16, put in veg class dry basic mixed forest/woodland (there were no pixels of this class in the final map, therefore no number)

115. If veg class 18 or 19 and soil type 17, put in veg class 48, mesic basic mixed forest/woodland

116. If veg class 5 and soil type 1 or 2 and NWI class planted pine, put in veg class 13, closed canopy evergreen forest/woodland

117. If veg class 5 and soil type 1 and NWI class deciduous forest, put in veg class 16, dry deciduous forest/woodland

118. If veg class 5 and soil type 2 and NWI class deciduous forest, put in veg class 17, mesic deciduous forest/woodland

119. If veg class 5 and soil type 16 and NWI class deciduous forest, put in veg class 46, dry basic deciduous forest/woodland

120. If veg class 5 and soil type 17 and NWI class deciduous forest, put in veg class 47, mesic basic deciduous forest/woodland

121. If veg class 5 and soil type 1 and NWI class mixed forest, put in veg class 18, dry mixed forest/woodland

122. If veg class 5 and soil type 2 and NWI class mixed forest, put in veg class 19, mesic mixed forest/woodland

123. If veg class 5 and soil type 16 and NWI class mixed forest, put in veg class dry basic mixed forest

124. If veg class 5 and soil type 17 and NWI class mixed forest, put in veg class 48, mesic basic mixed forest/woodland

125. If veg class 5 and soil type 1, 2, 16, or 17 and NWI class agriculture, put in veg class 21 cultivated land

126. If veg class 5 and soil type 1, 2, 16 or 17 and NWI class planted pine, put in veg class 13, closed canopy evergreen forest/woodland

127. If veg class 5, change to veg class 45, piedmont bottomland forest

Mountains

Module 1 (highest priority – should override any other conflicting modules in Mountain Rules)

128. If soil type 18 and any veg class, put in veg class 11, rock outcrop

129. If soil type 8 and any veg class, put in veg class 1, fresh water

Module 2 – RSP_Config (should override modules 3-6 in Mountain Rules)

130. If RSP_reclass2 = 20 *(valley bottom)* and Config = 10 *(concave)* and soil type 1 or 2 and veg class 16 or 17, put in veg class 52, deciduous rich/acidic cove forest.

131. If veg class 13, 14, 18, or 19 and RSP_reclass2 = 20 and soil type 1 or 2, put in veg class 54, eastern hemlock ravine forest

Module 3 - Slope (should override modules 4-6 in Mountain Rules)

132. If slope_reclass < 10 *(slope >3 degrees)* and soil <> water and veg class 1, put in veg class 17, mesic deciduous forest/woodland

133. If (slope_reclass = 0 *(slope >30 degrees)*) and veg class 20 or 21 and soil type 1 or 2, put in veg class 16, dry deciduous forest/woodland

Module 4 – Elev_top (should override modules 5 and 6 in Mountain Rules)

134. If (elevation > 2000 ft and Top = 1 *(ridgetop)*) and veg class 20 or 21 and soil type 1 or 2, put in veg class 16, dry deciduous forest/woodland

135. If top = 1 and elevation > 2000 ft and veg class 13, 14, 18, or 19 and soil type 1 or 2, put in veg class 49, ridgetop/upper slope evergreen woodland

Module 5 – TRMI (should override module 6)

136. If veg class 16 and soil type 1 or 2 and TRMI>=25, put in veg class 17, mesic deciduous forest/woodland

137. If veg class 17 and soil type 1 or 2 and TRMI<25, put in veg class 16, dry deciduous forest/woodland

138. If veg class 18 and soil type 1 or 2 and TRMI>=25, put in veg class 19, mesic mixed forest/woodland

139. If veg class 19 and soil type 1 or 2 and TRMI<25, put in veg class 18, dry mixed forest/woodland

Module 6 (should not override any other modules)

140. If veg class 13, 14, 15, 16, 17, 18, or 19 and soil type 3, 4, 5, or 11 put in veg class 51, montane riparian forest

141. If veg class 13 or 14, put in veg class 53, montane evergreen forest

142. If veg class 28, put in veg class 51, montane riparian forest

Piedmont soil rules:

1. If Worsham, Elbert, Mixed alluvial, or Local alluvial soil and soil wetness class 3, put in soil type 3

2. If Mixed alluvial or Local alluvial soil and it is modified by the word 'wet' and crosses soil types 2 and 3, put in soil type 3

3. If Worsham, Elbert, Mixed alluvial, or Local alluvial soil and soil wetness class 2 or 2/3, put in soil type 11

4. If alfisol and soil wetness class 1, put in soil class 16 (6a), put in dry basic forest types

5. If alfisol and soil wetness class 2, put in soil class 17 (6b), put in mesic basic forest types

6. If levee soil types have wetness class 1 or 2, put in soil type 5

7. If levee soil types have mixed wetness classes, i.e. 2/3, put in soil type 11

8. If levee soil types are wetness class 3, put in soil type 3

Appendix 5. A Crosswalk of the detailed land cover classes to the final vertebrate habitat land cover

Number	Animal Habitat Class	Detailed Class
1	Fresh Water	Fresh Water
2	Marine Water	Marine Water
3	Marsh/Emergent Wetland	Fresh Water Marsh/Emergent Wetland Salt and Brackish Marsh
4	Pocosin	Pocosin
5	Not used	
6	Swamp	Swamp/Bottomland Hardwood Forest
7	Bottomland/Floodplain Forest	Floodplain Forest; Swamp/Bottomland Type 14; Swamp/Bottomland Type 15; Swamp/Bottomland Type 16; Swamp/Bottomland Type17; Swamp/Bottomland Type 18; Swamp/Bottomland Type 19; Narrow Stream Valley Forest; Piedmont Bottomland Forest; Montane Riparian Forest
8	Wet Soil	Wet Soil; Mud/Sand Flat; Spoil Deposit/ Impoundment
9	Wet Scrub/Shrub Thicket	Wet Scrub/Shrub Thicket; Estuarine Salt Flat/Salt Shrub Thicket
10	Dry Scrub/Shrub Thicket	Dry Scrub/Shrub Thicket; Maritime Shrub Complex
11	Sandy Bare Soil	Sandy Bare Soil
12	Open Canopy/Recently Cleared Forest	Open Canopy/Recently Cleared Forest
13	Rock Outcrop	Rock Outcrop; Rocky Shoals
14	Aquatic Vegetation	Aquatic Vegetation
15	Closed Canopy Evergreen Forest/Woodland	Closed Canopy Evergreen Forest/Woodland; Ridgetop/Upper Slope Evergreen Woodland; Montane Evergreen Forest; Eastern Hemlock Ravine Forest
16	Needle-leaved Evergreen Mixed Forest/Woodland	Needle-leaved Evergreen Mixed Forest/Woodland;
17	Pine Woodland	Pine Woodland

18	Dry Deciduous Forest/Woodland	Dry Deciduous Forest/Woodland; Dry Basic Deciduous Forest/ Woodland
19	Mesic Deciduous Forest/Woodland	Mesic Deciduous Forest/Woodland; Mesic Basic Deciduous Forest/ Woodland; Deciduous Rich/Acidic Cove Forest
20	Dry Mixed Forest/Woodland	Dry Mixed Forest/Woodland
21	Mesic Mixed Forest/Woodland	Mesic Mixed Forest/Woodland; Mesic Basic Mixed Forest/ Woodland
22	Grassland/Pasture	Grassland/Pasture
23	Cultivated Land	Cultivated Land
24	Urban Development	Urban Development
25	Urban Residential	Urban Residential; Low Density Residential
26	Not used	
27	Wet Evergreen	Wet Evergreen; Wet Pinewoods
28	Maritime Forest	Lowland Maritime Forest; Wet Maritime Forest; Coastal Upland Mixed Forest
29	Beach	Beach; Intertidal Beach

Appendix 6. A crosswalk of the detailed land cover to other land covers used in modeling vertebrates or accuracy assessment

Anderson Level I	Anderson Level II	Vertebrate Class Label	Detail Map Class Label
Water	Water	Fresh water	Fresh water
Water	Water	Marine water	Marine water
Wetland	Nonforested Wetland	Marsh/emergent wetland	Freshwater Marsh/Emergent Wetland
Wetland	Nonforested Wetland	Marsh/emergent wetland	Salt and Brackish Marsh
Wetland	Forested Wetland	Pocosin	Pocosin
Wetland	Forested Wetland	Swamp	Swamp/Bottomland Hardwood Forest
Wetland	Forested Wetland	Bottomland/floodplain forest	Floodplain Forest
Wetland	Forested Wetland	Bottomland/floodplain forest	Montane Riparian Forest
Wetland	Forested Wetland	Bottomland/floodplain forest	Narrow Stream Valley Forest
Wetland	Forested Wetland	Bottomland/floodplain forest	Piedmont Bottomland Forest
Wetland	Forested Wetland	Bottomland/floodplain forest	Swamp/Bottomland Type 14
Wetland	Forested Wetland	Bottomland/floodplain forest	Swamp/Bottomland Type 15
Wetland	Forested Wetland	Bottomland/floodplain forest	Swamp/Bottomland Type 16
Wetland	Forested Wetland	Bottomland/floodplain forest	Swamp/Bottomland Type 17
Wetland	Forested Wetland	Bottomland/floodplain forest	Swamp/Bottomland Type 18
Wetland	Forested Wetland	Bottomland/floodplain forest	Swamp/Bottomland Type 19
Wetland	Nonforested Wetland	Wet soil	Mud/Sand Flat
Wetland	Nonforested Wetland	Wet soil	Spoil Deposit/Impoundment
Wetland	Nonforested Wetland	Wet soil	Wet soil
Wetland	Forested Wetland	Wet scrub/shrub thicket	Estuarine Salt Flat/Salt Shrub Thicket
Wetland	Forested Wetland	Wet scrub/shrub thicket	Wet Scrub/Shrub Thicket

Rangeland	Shrub and Brush Rangeland	Dry scrub/shrub thicket	Dry Scrub/Shrub Thicket
Rangeland	Shrub and Brush Rangeland	Dry scrub/shrub thicket	Maritime Shrub Complex
Barren Land	Sandy areas other than beaches	Sandy bare soil	Sandy Bare Soil
Forest	Evergreen Forest	Open canopy/recently cleared forest	Open Canopy, Recently Cleared Forest
Barren Land	Bare Exposed Rock	Rock outcrop	Rock Outcrop
Barren Land	Bare Exposed Rock	Rock outcrop	Rocky Shoal
Water	Water	Aquatic vegetation	Aquatic Vegetation
Forest	Evergreen Forest	Closed canopy evergreen forest/woodland	Closed Canopy Evergreen Forest
Forest	Evergreen Forest	Closed canopy evergreen forest/woodland	Eastern Hemlock Ravine Forest
Forest	Evergreen Forest	Closed canopy evergreen forest/woodland	Montane Evergreen Forest
Forest	Evergreen Forest	Closed canopy evergreen forest/woodland	Ridgetop/Upper Slope Evergreen Woodland
Forest	Mixed Forest	Needle-leaved evergreen mixed forest/woodland	Needle-leaved Evergreen Mixed Woodland
Forest	Evergreen Forest	Pine woodland	Pine Woodland
Forest	Deciduous Forest	Dry deciduous forest/woodland	Dry Basic Deciduous Forest
Forest	Deciduous Forest	Dry deciduous forest/woodland	Dry Deciduous Forest/Woodland
Forest	Deciduous Forest	Mesic deciduous forest/woodland	Deciduous Rich/Acidic Cove Forest
Forest	Deciduous Forest	Mesic deciduous forest/woodland	Mesic Basic Deciduous Forest
Forest	Deciduous Forest	Mesic deciduous forest/woodland	Mesic Deciduous Forest/Woodland
Forest	Mixed Forest	Dry mixed forest/woodland	Dry Mixed Forest/Woodland
Forest	Mixed Forest	Mesic mixed forest/woodland	Mesic Basic Mixed Forest
Forest	Mixed Forest	Mesic mixed forest/woodland	Mesic Mixed Forest/Woodland
Agriculture	Cropland and Pasture	Grassland/pasture	Grasslands/Pasture
Agriculture	Cropland and Pasture	Cultivated land	Cultivated Land

Urban or Built-up Land	Non-residential Urban	Urban development	Urban Development
Urban or Built-up Land	Residential Urban	Urban residential	Low Density Residential
Urban or Built-up Land	Residential Urban	Urban residential	Residential Urban
Wetland	Forested Wetland	Wet evergreen	Wet Evergreen
Wetland	Forested Wetland	Wet evergreen	Wet Pinewoods
Forest	Mixed Forest	Maritime forest	Coastal Upland Mixed Forest
Forest	Mixed Forest	Maritime forest	Lowland Maritime Forest
Forest	Mixed Forest	Maritime forest	Wet Maritime Forest
Barren Land	Beaches	Beach	Beach
Barren Land	Beaches	Beach	Intertidal Beach

Appendix 7. State taxonomic experts

Name	Affiliation	Taxonomic Group	Task
Steve Bennett	SCDNR	Herptiles	Both
John Cely	SCDNR	Birds	Both
Sid Gauthreaux	Clemson University	Birds	Both
Richard Montinucci	Clemson University	Herptiles	Both
John Fauth	College of Charleston	Herptiles	Both
Julian Harrison	College of Charleston	Herptiles	Both
Lex Glover	SCDNR	Birds	Both
Wally Dawson	University of South Carolina	Mammals	Both
Mary Bunch	SCDNR	Mammals	Both
Susan Loeb	US Forest Service	Mammals	Both
Ed Pivorun	Clemson University	Mammals	Both
Arch McCallum	College of Charleston	All taxa	Range
Tom Murphy	SCDNR	Birds	Range

Appendix 8. List of species used in vertebrate modeling for SC-GAP including species name, scientific name and ITIS Code

lesser siren	Siren intermedia	173736
greater siren	Siren lacertina	173735
eastern newt	Notophthalmus viridescens	173615
two-toed amphiuma	Amphiuma means	173609
green salamander	Aneides aeneus	173699
flatwoods salamander	Ambystoma cingulatum	173596
Mabee's salamander	Ambystoma mabeei	173600
spotted salamander	Ambystoma maculatum	173590
marbled salamander	Ambystoma opacum	173591
mole salamander	Ambystoma talpoideum	173604
tiger salamander	Ambystoma tigrinum	173592
seepage salamander	Desmognathus aeneus	173636
southern dusky salamander	Desmognathus auriculatus	173637
dusky salamander	Desmognathus fuscus	173633
seal salamander	Desmognathus monticola	173640
mountain dusky salamander	Desmognathus ochrophaeus	173641
blackbelly salamander	Desmognathus quadramaculatus	173642
southern two-lined salamander	Eurycea cirrigera	550246
three-lined salamander	Eurycea longicauda	173687
dwarf salamander	Eurycea quadridigitata	173695
spring salamander	Gyrinophilus porphyriticus	173715
four-toed salamander	Hemidactylium scutatum	173678
shovelnose salamander	Leurognathus marmoratus	173723
Atlantic coast slimy salamander	Plethodon chlorobryonis	208282
white-spotted slimy salamander	Plethodon cylindraceus	208283
Jordan's salamander	Plethodon jordani	173660
South Carolina slimy salamander	Plethodon variolatus	208295
webster's salamander	Plethodon websteri	173673
southern Appalachian salamander	Plethodon teyahalee	208294
mud salamander	Pseudotriton montanus	173682
red salamander	Pseudotriton ruber	173680
many-lined salamander	Stereochilus marginatus	173647
dwarf waterdog	Necturus punctatus	173625
dwarf siren	Pseudobranchus striatus	173738
eastern spadefoot	Scaphiopus holbrooki	173426
American toad	Bufo americanus	173473
Woodhouse's toad	Bufo woodhousii	173476
oak toad	Bufo quercicus	173479
southern toad	Bufo terrestris	173475

southern cricket frog	Acris gryllus	173518
northern cricket frog	Acris crepitans	173520
pine barrens treefrog	Hyla andersonii	173509
bird-voiced treefrog	Hyla avivoca	173511
gray treefrog	Hyla versicolor	173503
Cope's gray treefrog	Hyla chrysoscelis	173502
green treefrog	Hyla cinerea	173505
pine woods treefrog	Hyla femoralis	173499
barking treefrog	Hyla gratiosa	173508
squirrel treefrog	Hyla squirella	173504
spring peeper	Pseudacris crucifer	207303
southern chorus frog	Pseudacris nigrita	173530
little grass frog	Pseudacris ocularis	207286
Brimley's chorus frog	Pseudacris brimleyi	173524
upland chorus frog	Pseudacris triseriata	173525
ornate chorus frog	Pseudacris ornata	173531
gopher frog	Rana capito	207016
bullfrog	Rana catesbeiana	173441
green frog	Rana clamitans	173438
pig frog	Rana grylio	173442
southern leopard frog	Rana sphenocephala	173436
carpenter frog	Rana virgatipes	173437
river frog	Rana heckscheri	173453
pickerel frog	Rana palustris	173435
wood frog	Rana sylvatica	173440
eastern narrowmouth toad	Gastrophryne carolinensis	173467
common musk turtle	Sternotherus odoratus	173758
eastern mud turtle	Kinosternon subrubrum	173763
loggerhead	Caretta caretta	173830
green turtle	Chelonia mydas	173833
hawksbill	Eretmochelys imbricata	173836
Atlantic ridley	Lepidochelys kempii	551770
snapping turtle	Chelydra serpentina	173752
leatherback	Dermochelys coriacea	173843
painted turtle	Chrysemys picta	173783
spotted turtle	Clemmys guttata	173771
bog turtle	Clemmys muhlenbergii	173773
chicken turtle	Deirochelys reticularia	173786
diamondback terrapin	Malaclemys terrapin	173780
river cooter	Pseudemys concinna	173805
Florida cooter	Pseudemys floridana	173809
eastern box turtle	Terrapene carolina	173776
yellowbelly slider	Trachemys scripta	173819
striped mud turtle	Kinosternon baurii	173765
gopher tortoise	Gopherus polyphemus	173858

Florida softshell	Apalone ferox	208675
spiny softshell	Apalone spinifera	208680
American alligator	Alligator mississippiensis	551771
slender glass lizard	Ophisaurus attenuatus	174106
island glass lizard	Ophisaurus compressus	174109
eastern glass lizard	Ophisaurus ventralis	174110
mimic glass lizard	Ophisaurus mimicus	209006
green anole	Anolis carolinensis	173885
Texas horned lizard	Phrynosoma cornutum	173938
fence lizard	Sceloporus undulatus	173865
coal skink	Eumeces anthracinus	173962
five-lined skink	Eumeces fasciatus	173959
southeastern five-lined skink	Eumeces inexpectatus	173960
broadhead skink	Eumeces laticeps	173961
ground skink	Scincella lateralis	174008
six-lined racerunner	Cnemidophorus sexlineatus	174014
worm snake	Carphophis amoenus	174161
scarlet snake	Cemophora coccinea	174195
black racer	Coluber constrictor	174169
ringneck snake	Diadophis punctatus	174158
corn snake	Elaphe guttata	174175
rat snake	Elaphe obsoleta	174177
mud snake	Farancia abacura	174164
rainbow snake	Farancia erytrogramma	174166
eastern hognose snake	Heterodon platirhinos	563935
southern hognose snake	Heterodon simus	174156
mole kingsnake	Lampropeltis calligaster	174185
eastern kingsnake	Lampropeltis getula	209247
scarlet kingsnake (milk)	Lampropeltis triangulum	174187
coachwhip	Masticophis flagellum	174238
redbelly water snake	Nerodia erythrogaster	174244
banded water snake	Nerodia fasciata	174248
brown water snake	Nerodia taxispilota	174255
northern water snake	Nerodia sipedon	174251
Florida green water snake	Nerodia floridana	209382
rough green snake	Opheodrys aestivus	174172
pine snake	Pituophis melanoleucus	174263
glossy crayfish snake	Regina rigida	174123
queen snake	Regina septemvittata	174125
pine woods snake	Rhadinaea flavilata	174265
black swamp snake	Seminatrix pygaea	174273
brown snake	Storeria dekayi	174129
redbelly snake	Storeria occipitomaculata	174131
southeastern crowned snake	Tantilla coronata	174280
eastern ribbon snake	Thamnophis sauritus	174134

eastern garter snake	Thamnophis sirtalis	174136
rough earth snake	Virginia striatula	174150
smooth earth snake	Virginia valeriae	174151
eastern coral snake	Micrurus fulvius	174354
copperhead	Agkistrodon contortrix	174296
cottonmouth	Agkistrodon piscivorus	174299
eastern diamondback rattlesnake	Crotalus adamanteus	174309
timber rattlesnake	Crotalus horridus	174306
pygmy rattlesnake	Sistrurus miliarius	174302
American black duck	Anas rubripes	175068
acadian flycatacher	Empidonax virescens	178339
American avocet	Recurvirostra americana	176721
american bittern	Botaurus lentiginosus	174856
American coot	Fulica americana	176292
American crow	Corvus brachyrhynchos	179731
American goldfinch	Carduelis tristis	179236
American kestrel	Falco sparverius	175622
American oystercatcher	Haematopus palliatus	176472
American redstart	Setophaga ruticilla	178979
American robin	Turdus migratorius	179759
American wigeon	Anas americana	175094
American woodcock	Scolopax minor	176580
anhinga	Anhinga anhinga	174755
American swallow-tailed kite	Elanoides forficatus	175289
bachman's sparrow	Aimophila aestivalis	179386
bald eagle	Haliaeetus leucocephalus	175420
barn swallow	Hirundo rustica	178448
black-and-white warbler	Mniotilta varia	178844
black-bellied plover	Pluvialis squatarola	176567
black-crowned night-heron	Nycticorax nycticorax	174832
barred owl	Strix varia	177921
belted kingfisher	Ceryle alcyon	178119
blue-gray gnatcatcher	Polioptila caerulea	179853
brown-headed cowbird	Molothrus ater	179112
brown-headed nuthatch	Sitta pusilla	178785
blackburnian warbler	Dendroica fusca	178904
blue grosbeak	Guiraca caerulea	179145
blue jay	Cyanocitta cristata	179680
black scoter	Melanitta nigra	175171
black skimmer	Rynchops niger	554447
black vulture	Coragyps atratus	175272
barn owl	Tyto alba	177851
black-necked stilt	Himantopus mexicanus	176726
bonaparte's gull	Larus philadelphia	176839
brant	Branta bernicla	175011

brewer's blackbird	Euphagus cyanocephalus	179094
brown creeper	Certhia americana	178803
brown pelican	Pelecanus occidentalis	174685
brown thrasher	Toxostoma rufum	178627
black-throated blue warbler	Dendroica caerulescens	178888
boat-tailed grackle	Quiscalus major	179108
black-throated green warbler	Dendroica virens	178898
bufflehead	Bucephala albeola	175145
broad-winged hawk	Buteo platypterus	175365
blue-winged teal	Anas discors	175086
blue-winged warbler	Vermivora pinus	178853
Carolina chickadee	Parus carolinensis	178709
cattle egret	Bubulcus ibis	174803
Canada goose	Branta canadensis	174999
canvasback	Aythya valisineria	175129
Carolina wren	Thryothorus ludovicianus	178581
caspian tern	Sterna caspia	176924
Canada warbler	Wilsonia canadensis	178977
cedar waxwing	Bombycilla cedrorum	178532
chipping sparrow	Spizella passerina	179435
chimney swift	Chaetura pelagica	178001
clapper rail	Rallus longirostris	176209
cliff swallow	Hirundo pyrrhonota	178453
common ground-dove	Columbina passerina	177152
common goldeneye	Bucephala clangula	175141
common grackle	Quiscalus quiscula	179104
cooper's hawk	Accipiter cooperii	175309
common loon	Gavia immer	174469
common merganser	Mergus merganser	175185
common moorhen	Gallinula chloropus	176284
common nighthawk	Chordeiles minor	177979
common raven	Corvus corax	179725
common snipe	Gallinago gallinago	176700
common tern	Sterna hirundo	176888
common yellowthroat	Geothlypis trichas	178944
chestnut-sided warbler	Dendroica pensylvanica	178911
chuck-will's-widow	Caprimulgus carolinensis	177960
double-crested cormorant	Phalacrocorax auritus	174717
dark-eyed junco	Junco hyemalis	179410
dickcissel	Spiza americana	179165
downy woodpecker	Picoides pubescens	178259
dunlin	Calidris alpina	176661
eastern bluebird	Sialia sialis	179801
eastern kingbird	Tyrannus tyrannus	178279
eastern meadowlark	Sturnella magna	179034

eastern phoebe	Sayornis phoebe	178329
eastern screech-owl	Otus asio	177856
eastern towhee	Pipilo erythrophthalmus	179276
eastern wood-pewee	Contopus virens	178359
European starling	Sturnus vulgaris	179637
evening grosbeak	Coccothraustes vespertinus	179173
fish crow	Corvus ossifragus	179737
field sparrow	Spizella pusilla	179443
fox sparrow	Passerella iliaca	179464
Forster's tern	Sterna forsteri	176887
gadwall	Anas strepera	175073
great black-backed gull	Larus marinus	176815
great blue heron	Ardea herodias	174773
gull-billed tern	Sterna nilotica	176926
great crested flycatcher	Myiarchus crinitus	178309
golden-crowned kinglet	Regulus satrapa	179865
great horned owl	Bubo virginianus	177884
glossy ibis	Plegadis falcinellus	174924
gray catbird	Dumetella carolinensis	178625
great egret	Casmerodius albus	174810
green heron	Butorides virescens	174793
greater scaup	Aythya marila	175130
grasshopper sparrow	Ammodramus savannarum	179333
greater yellowlegs	Tringa melanoleuca	176619
green-winged teal	Anas crecca	175081
hairy woodpecker	Picoides villosus	178262
herring gull	Larus argentatus	176824
Henslow's sparrow	Ammodramus henslowii	179340
hermit thrush	Catharus guttatus	179779
house finch	Carpodacus mexicanus	179191
horned grebe	Podiceps auritus	174482
horned lark	Eremophila alpestris	554256
hooded merganser	Lophodytes cucullatus	175183
house sparrow	Passer domesticus	179628
hooded warbler	Wilsonia citrina	178972
house wren	Troglodytes aedon	178541
indigo bunting	Passerina cyanea	179150
kentucky warbler	Oporornis formosus	178937
killdeer	Charadrius vociferus	176520
king rail	Rallus elegans	176207
laughing gull	Larus atricilla	176837
lapland longspur	Calcarius lapponicus	179526
long-billed curlew	Numenius americanus	176593
long-billed dowitcher	Limnodromus scolopaceus	176679
little blue heron	Egretta caerulea	174827

le conte's sparrow	Ammodramus leconteii	179345
least bittern	Ixobrychus exilis	174846
least sandpiper	Calidris minutilla	176656
lesser scaup	Aythya affinis	175134
least tern	Sterna antillarum	176923
lesser yellowlegs	Tringa flavipes	176620
lincoln's sparrow	Melospiza lincolnii	179484
loggerhead shrike	Lanius ludovicianus	178515
louisiana waterthrush	Seiurus motacilla	178935
marbled godwit	Limosa fedoa	176686
mallard	Anas platyrhynchos	175063
marsh wren	Cistothorus palustris	178608
merlin	Falco columbarius	175613
Mississippi kite	Ictinia mississippiensis	554268
mourning dove	Zenaida macroura	177125
mottled duck	Anas fulvigula	175070
northern bobwhite	Colinus virginianus	175863
northern cardinal	Cardinalis cardinalis	179124
northern flicker	Colaptes auratus	178154
northern harrier	Circus cyaneus	175430
northern mockingbird	Mimus polyglottos	178620
baltimore oriole	Icterus galbula	179083
northern parula	Parula americana	178868
northern pintail	Anas acuta	175074
northern rough-winged swallow	Stelgidopteryx serripennis	178443
northern shoveler	Anas clypeata	175096
northern saw-whet owl	Aegolius acadicus	177942
orange-crowned warbler	Vermivora celata	178856
oldsquaw	Clangula hyemalis	175147
orchard oriole	Icterus spurius	179064
osprey	Pandion haliaetus	175590
ovenbird	Seiurus aurocapillus	178927
painted bunting	Passerina ciris	179156
palm warbler	Dendroica palmarum	178921
pied-billed grebe	Podilymbus podiceps	174505
peregrine falcon	Falco peregrinus	175604
Piping plover	Charadrius melodus	176507
pine siskin	Carduelis pinus	179233
pine warbler	Dendroica pinus	178914
pileated woodpecker	Dryocopus pileatus	178166
Prairie warbler	Dendroica discolor	178918
prothonotary warbler	Protonotaria citrea	178846
Purple finch	Carpodacus purpureus	179186
Purple gallinule	Porphyrula martinica	176280
Purple martin	Progne subis	178464

Purple sandpiper	Calidris maritima	176646
ring-billed gull	Larus delawarensis	176830
red-breasted merganser	Mergus serrator	175187
red-breasted nuthatch	Sitta canadensis	178784
red-bellied woodpecker	Melanerpes carolinus	178195
ruby-crowned kinglet	Regulus calendula	179870
red-cockaded woodpecker	Picoides borealis	178257
red crossbill	Loxia curvirostra	179259
redhead	Aythya americana	175125
red knot	Calidris canutus	176642
red-eyed vireo	Vireo olivaceus	179021
red-headed woodpecker	Melanerpes erythrocephalus	178186
ring-necked duck	Aythya collaris	175128
rock dove	Columba livia	177071
royal tern	Sterna maxima	176922
red-shouldered hawk	Buteo lineatus	175359
red-tailed hawk	Buteo jamaicensis	175350
ruby-throated hummingbird	Archilochus colubris	178032
rusty blackbird	Euphagus carolinus	179091
ruddy duck	Oxyura jamaicensis	175175
Ruffed grouse	Bonasa umbellus	175790
Ruddy turnstone	Arenaria interpres	176571
red-winged blackbird	Agelaius phoeniceus	179045
sanderling	Calidris alba	176669
sandwich tern	Sterna sandvicensis	176927
savannah sparrow	Passerculus sandwichensis	179314
short-billed dowitcher	Limnodromus griseus	176675
scarlet tanager	Piranga olivacea	179883
short-eared owl	Asio flammeus	177935
semipalmated plover	Charadrius semipalmatus	176506
seaside sparrow	Ammodramus maritimus	179346
sedge wren	Cistothorus platensis	178605
Snow bunting	Plectrophenax nivalis	179532
snowy egret	Egretta thula	174813
Snow goose	Chen caerulescens	175038
sora	Porzana carolina	176242
song sparrow	Melospiza melodia	179492
Sooty tern	Sterna fuscata	176894
blue-headed vireo	Vireo solitarius	179010
spotted sandpiper	Actitis macularia	176612
Sharp-shinned hawk	Accipiter striatus	175304
surf scoter	Melanitta perspicillata	175170
summer tanager	Piranga rubra	179888
swamp sparrow	Melospiza georgiana	179488
Swainson's warbler	Limnothlypis swainsonii	178848

tree swallow	Tachycineta bicolor	178431
tricolored heron	Egretta tricolor	174826
tundra swan	Cygnus columbianus	174987
Tufted titmouse	Parus bicolor	178738
turkey vulture	Cathartes aura	175265
vesper sparrow	Pooecetes gramineus	179366
virginia rail	Rallus limicola	176221
Water pipit	Anthus spinoletta	178489
White-breasted nuthatch	Sitta carolinensis	178775
White-crowned sparrow	Zonotrichia leucophrys	179455
White-eyed vireo	Vireo griseus	178991
Worm-eating warbler	Helmitheros vermivorus	178850
White ibis	Eudocimus albus	174930
whimbrel	Numenius phaeopus	176599
willet	Catoptrophorus semipalmatus	176638
Wilson's plover	Charadrius wilsonia	176517
wild turkey	Meleagris gallopavo	176136
winter wren	Troglodytes troglodytes	178547
Wood duck	Aix sponsa	175122
Wood stork	Mycteria americana	174897
Wood thrush	Hylocichla mustelina	179777
whip-poor-will	Caprimulgus vociferus	177961
White-throated sparrow	Zonotrichia albicollis	179462
White-winged scoter	Melanitta fusca	175163
Yellow-breasted chat	Icteria virens	178964
Yellow-billed cuckoo	Coccyzus americanus	177831
Yellow-bellied sapsucker	Sphyrapicus varius	178202
Yellow-crowned night-heron	Nyctanassa violacea	174842
Yellow rail	Coturnicops noveboracensis	176259
Yellow-rumped warbler	Dendroica coronata	178891
Yellow-throated vireo	Vireo flavifrons	179009
Yellow-throated warbler	Dendroica dominica	178905
Yellow warbler	Dendroica petechia	178878
virginia opossum	Didelphis virginiana	179921
masked shrew	Sorex cinereus	179929
southeastern shrew	Sorex longirostris	179936
smoky shrew	Sorex fumeus	179943
pygmy shrew	Sorex hoyi	179946
northern short-tailed shrew	Blarina brevicauda	179967
Carolina short-tailed shrew	Blarina carolinensis	179968
least shrew	Cryptotis parva	179971
hairy-tailed mole	Parascalops breweri	179977
eastern mole	Scalopus aquaticus	179979
star-nosed mole	Condylura cristata	179964
little brown myotis	Myotis lucifugus	179988

southeastern myotis	Myotis austroriparius	179993
eastern small-footed myotis	Myotis leibii	179999
northern long-eared myotis	Myotis septentrionalis	180000
Silver-haired bat	Lasionycteris noctivagans	180014
eastern pipistrelle	Pipistrellus subflavus	180025
big brown bat	Eptesicus fuscus	180008
eastern red bat	Lasiurus borealis	180016
Seminole bat	Lasiurus seminolus	180020
Hoary bat	Lasiurus cinereus	180017
northern yellow bat	Lasiurus intermedius	180019
evening bat	Nycticeius humeralis	180022
Rafinesque's big-eared bat	Corynorhinus rafinesquii	555664
Brazilian free-tailed bat	Tadarida brasiliensis	180088
nine-banded armadillo	Dasypus novemcinctus	180103
marsh rabbit	Sylvilagus palustris	180120
eastern cottontail	Sylvilagus floridanus	180124
new england cottontail	Sylvilagus transitionalis	180127
swamp rabbit	Sylvilagus aquaticus	180121
eastern chipmunk	Tamias striatus	180207
woodchuck	Marmota monax	180137
eastern gray squirrel	Sciurus carolinensis	180175
eastern fox squirrel	Sciurus niger	180172
red squirrel	Tamiasciurus hudsonicus	180166
southern flying squirrel	Glaucomys volans	180170
American beaver	Castor canadensis	180212
Marsh rice rat	Oryzomys palustris	180336
eastern harvest mouse	Reithrodontomys humulis	180342
deer mouse	Peromyscus maniculatus	180276
oldfield mouse	Peromyscus polionotus	180290
white-footed mouse	Peromyscus leucopus	180278
Cotton mouse	Peromyscus gossypinus	180279
golden mouse	Ochrotomys nuttalli	180379
Hispid cotton rat	Sigmodon hispidus	180349
eastern woodrat	Neotoma floridana	180372
southern red-backed vole	Clethrionomys gapperi	180294
meadow vole	Microtus pennsylvanicus	180297
woodland vole	Microtus pinetorum	180314
muskrat	Ondatra zibethicus	180318
black rat	Rattus rattus	180362
norway rat	Rattus norvegicus	180363
House mouse	Mus musculus	180366
meadow jumping mouse	Zapus hudsonius	180386
woodland jumping mouse	Napaeozapus insignis	180390
coyote	Canis latrans	180599
red fox	Vulpes vulpes	180604

common gray fox	Urocyon cinereoargenteus	180609
black bear	Ursus americanus	180544
common raccoon	Procyon lotor	180575
long-tailed weasel	Mustela frenata	180556
mink	Mustela vison	180553
eastern spotted skunk	Spilogale putorius	180570
striped skunk	Mephitis mephitis	180562
northern river otter	Lutra canadensis	180572
bobcat	Lynx rufus	180582
feral pig	Sus scrofa	180722
white-tailed deer	Odocoileus virginianus	180699

Appendix 9. Vertebrate habitat land cover types by protection type and manager. FWS Area = Fish and Wildlife Service owned property, FS Area = Forest Service owned property, OF Area = Other federally-owned property, DNR Area = SC Department of Natural Resources owned property, PRT = SC Parks, Recreation and Tourism owned property, OS = Other state owned property, PC = Protected Conservation property and OC = Other conservation property.

COVER TYPE	AREA	STATUS	STATUS AREA	STATUS PCT	FWS AREA	FS AREA	OF AREA	DNR AREA	PRT AREA	OS AREA	PC AREA	OC AREA
1	2361	1	59	2.58	48	0	0	7	0	0	0	4
1	2361	2	4	0.25	0	0	0	3	1	0	0	0
1	2361	3	56	2.41	0	21	14	0	5	7	9	0
1	2361	4	2242	94.96	0	0	54	0	0	511	0	0
2	1032	1	135	13.28	123	0	0	12	0	0	0	0
2	1032	2	12	1.26	0	0	0	11	0	0	1	0
2	1032	3	13	1.36	0	0	0	0	2	0	11	0
2	1032	4	872	84.50	0	0	4	0	0	2	1	0
3	2073	1	275	13.31	172	0	0	95	0	0	8	0
3	2073	2	151	7.33	0	0	0	116	0	2	33	0
3	2073	3	203	9.94	0	8	0	0	15	4	176	0
3	2073	4	1444	69.66	0	0	26	0	0	23	6	0
4	365	1	20	6.03	0	3	0	17	0	0	0	0
4	365	2	2	1.10	0	0	0	0	0	0	2	0
4	365	3	43	12.33	0	35	4	0	0	0	4	0
4	365	4	300	82.19	0	0	0	0	0	0	0	0
6	3075	1	165	5.43	45	19	42	33	0	0	26	0
6	3075	2	56	1.89	0	0	0	5	8	43	0	0
6	3075	3	200	6.60	0	90	81	0	3	7	19	0
6	3075	4	2654	86.31	0	0	1	0	0	38	0	0
7	8185	1	130	1.62	28	27	13	42	0	0	19	1
7	8185	2	48	0.61	0	0	0	25	7	8	8	0
7	8185	3	435	5.35	0	264	88	0	10	20	53	0
7	8185	4	7572	92.51	0	0	3	0	0	91	0	0
8	225	1	9	4.44	7	0	0	2	0	0	0	0
8	225	2	2	1.33	0	0	0	0	0	0	2	0
8	225	3	5	2.67	0	1	0	0	0	0	4	0

8	225	4	209	92.89	0	0	4	0	0	6	0	0
9	2387	1	33	1.42	11	6	3	12	0	0	1	0
9	2387	2	9	0.42	0	0	0	6	0	2	1	0
9	2387	3	94	4.06	0	63	9	0	0	2	20	0
9	2387	4	2251	94.30	0	0	4	0	0	14	0	0
10	5273	1	13	0.30	3	1	0	6	0	0	1	2
10	5273	2	10	0.21	0	0	0	7	3	0	0	0
10	5273	3	209	3.98	0	101	78	0	9	9	12	0
10	5273	4	5041	95.60	0	0	7	0	0	10	0	0
11	63	1	0	1.59	0	0	0	0	0	0	0	0
11	63	2	0	0.00	0	0	0	0	0	0	0	0
11	63	3	0	3.17	0	0	0	0	0	0	0	0
11	63	4	63	100.00	0	0	1	0	0	3	0	0
12	5960	1	25	0.42	10	2	0	13	0	0	0	0
12	5960	2	19	0.34	0	0	0	10	0	6	3	0
12	5960	3	310	5.22	0	241	13	0	4	36	16	0
12	5960	4	5606	94.06	0	0	1	0	0	23	0	0
13	16	1	0	0.00	0	0	0	0	0	0	0	0
13	16	2	0	6.25	0	0	0	0	0	0	0	0
13	16	3	0	0.00	0	0	0	0	0	0	0	0
13	16	4	16	100.00	0	0	0	0	0	0	0	0
14	34	1	0	0.00	0	0	0	0	0	0	0	0
14	34	2	11	32.35	0	0	0	11	0	0	0	0
14	34	3	3	8.82	0	0	0	0	0	0	3	0
14	34	4	20	58.82	0	0	0	0	0	1	0	0
15	10928	1	119	1.12	50	37	0	21	0	0	2	9
15	10928	2	72	0.68	0	5	0	47	11	3	6	0
15	10928	3	1268	11.63	0	731	382	0	33	73	49	0
15	10928	4	9469	86.65	0	0	10	0	0	21	0	0
16	7937	1	107	1.37	87	2	0	17	0	0	1	0
16	7937	2	30	0.39	0	0	0	13	3	4	10	0
16	7937	3	722	9.12	0	371	214	0	22	79	36	0
16	7937	4	7078	89.18	0	0	7	0	0	43	0	0
17	713	1	14	2.10	11	1	0	2	0	0	0	0
17	713	2	5	0.84	0	0	0	2	0	2	1	0

17	713	3	101	14.45	0	48	17	0	2	21	13	0
17	713	4	593	83.17	0	0	0	0	0	6	0	0
18	695	1	52	7.77	8	8	0	7	0	0	1	28
18	695	2	44	6.47	0	2	0	29	13	0	0	0
18	695	3	58	8.63	0	28	21	0	4	4	1	0
18	695	4	541	77.84	0	0	0	0	0	1	0	0
19	7909	1	58	0.75	4	12	0	13	0	0	2	27
19	7909	2	69	0.90	0	5	0	32	30	2	0	0
19	7909	3	366	4.68	0	241	60	0	25	36	4	0
19	7909	4	7416	93.77	0	0	6	0	0	16	0	0
20	291	1	2	0.69	0	0	0	2	0	0	0	0
20	291	2	5	1.72	0	0	0	3	2	0	0	0
20	291	3	9	3.44	0	1	6	0	2	0	0	0
20	291	4	275	94.50	0	0	0	0	0	0	0	0
21	892	1	1	0.22	0	0	0	1	0	0	0	0
21	892	2	5	0.67	0	0	0	2	3	0	0	0
21	892	3	32	3.81	0	6	16	0	3	7	0	0
21	892	4	854	95.74	0	0	0	0	0	0	0	0
22	2197	1	6	0.32	4	0	0	2	0	0	0	0
22	2197	2	1	0.05	0	0	0	1	0	0	0	0
22	2197	3	48	2.23	0	2	37	0	0	5	4	0
22	2197	4	2142	97.50	0	0	2	0	0	6	0	0
23	12310	1	10	0.09	4	0	0	3	0	0	0	3
23	12310	2	4	0.04	0	0	0	4	0	0	0	0
23	12310	3	102	0.85	0	11	40	0	2	21	28	0
23	12310	4	12194	99.06	0	0	25	0	0	43	1	0
24	1308	1	0	0.08	0	0	0	0	0	0	0	0
24	1308	2	0	0.00	0	0	0	0	0	0	0	0
24	1308	3	30	2.45	0	3	25	0	0	1	1	0
24	1308	4	1278	97.71	0	0	23	0	0	13	0	0
25	2446	1	0	0.00	0	0	0	0	0	0	0	0
25	2446	2	0	0.00	0	0	0	0	0	0	0	0
25	2446	3	17	0.82	0	1	14	0	1	1	0	0
25	2446	4	2429	99.30	0	0	14	0	0	16	0	0
27	1455	1	32	2.27	8	6	0	18	0	0	0	0

27	1455	2	9	0.76	0	0	0	5	2	0	2	0
27	1455	3	98	6.87	0	53	5	0	4	5	31	0
27	1455	4	1316	90.45	0	0	0	0	0	5	0	0
28	655	1	22	3.51	7	0	0	14	0	0	1	0
28	655	2	15	2.44	0	0	0	14	0	0	1	0
28	655	3	49	7.79	0	0	0	0	6	0	43	0
28	655	4	569	86.87	0	0	8	0	0	3	4	0
29	30	1	4	16.67	2	0	0	2	0	0	0	0
29	30	2	1	3.33	0	0	0	1	0	0	0	0
29	30	3	0	3.33	0	0	0	0	0	0	0	0
29	30	4	25	83.33	0	0	0	0	0	0	0	0

Appendix 10. Vertebrate species protection status by land owner and protection type. FWS Area = Fish and Wildlife Service owned property, FS Area = Forest Service owned property, OF Area = Other federally-owned property, DNR Area = SC Department of Natural Resources owned property, PRT = SC Parks, Recreation and Tourism owned property, OS = Other state owned property, PC = Protected Conservation property and OC = Other conservation property.

ITIS CODE	AREA	STATUS	STATUS AREA	STATUS PCT	FWS AREA	FS AREA	OF AREA	DNR AREA	PRT AREA	OS AREA	PC AREA	OC AREA
173426	63482	1	834	1.31	317	120	60	204	0	0	58	75
173426	63482	2	407	0.64	0	13	0	206	85	70	33	0
173426	63482	3	3656	5.76	0	1925	1013	0	128	292	297	1
173426	63482	4	58585	92.29	0	0	142	2	0	821	7	0
173441	49663	1	935	1.88	419	76	56	257	0	0	62	65
173441	49663	2	467	0.94	0	8	0	263	70	67	59	0
173441	49663	3	2424	4.88	0	1129	578	0	104	216	396	1
173441	49663	4	45837	92.30	0	0	150	2	0	799	13	0
173503	39383	1	443	1.12	137	60	56	104	0	0	49	37
173503	39383	2	201	0.51	0	6	0	76	52	57	10	0
173503	39383	3	1275	3.24	0	638	355	0	53	107	122	0
173503	39383	4	37464	95.13	0	0	110	1	0	724	2	0
173509	3856	1	104	2.70	98	0	4	2	0	0	0	0
173509	3856	2	1	0.03	0	0	0	1	0	0	0	0
173509	3856	3	277	7.18	0	87	90	0	16	83	1	0
173509	3856	4	3474	90.09	0	0	1	0	0	2	0	0
173615	25182	1	540	2.14	154	73	56	143	0	0	52	62
173615	25182	2	281	1.12	0	8	0	131	68	60	14	0
173615	25182	3	1375	5.46	0	737	311	0	65	107	154	1
173615	25182	4	22986	91.28	0	0	76	0	0	673	5	0
173752	27101	1	729	2.69	305	63	56	214	0	0	58	33
173752	27101	2	364	1.34	0	6	0	201	52	60	45	0
173752	27101	3	1405	5.18	0	668	304	0	65	90	277	1
173752	27101	4	24603	90.78	0	0	94	0	0	691	7	0
173776	49870	1	457	0.92	162	57	13	132	0	0	29	64
173776	49870	2	255	0.51	0	7	0	137	66	21	24	0
173776	49870	3	2223	4.46	0	1114	603	0	92	210	203	1
173776	49870	4	46935	94.11	0	0	78	1	0	240	7	0

173858	375	1	0	0.00	0	0	0	0	0	0	0	0
173858	375	2	9	2.40	0	0	0	9	0	0	0	0
173858	375	3	1	0.27	0	0	0	0	0	0	1	0
173858	375	4	365	97.33	0	0	0	0	0	1	0	0
173885	47810	1	664	1.39	219	85	59	184	0	0	56	61
173885	47810	2	332	0.69	0	7	0	150	73	72	30	0
173885	47810	3	2703	5.65	0	1497	648	0	97	232	228	1
173885	47810	4	44111	92.26	0	0	80	1	0	280	6	0
173961	22495	1	476	2.12	106	72	55	134	0	0	51	58
173961	22495	2	257	1.14	0	7	0	113	64	60	13	0
173961	22495	3	1301	5.78	0	714	291	0	57	99	140	0
173961	22495	4	20461	90.96	0	0	21	0	0	159	5	0
174106	16476	1	150	0.91	107	5	0	32	0	0	3	3
174106	16476	2	54	0.33	0	0	0	27	9	6	12	0
174106	16476	3	1102	6.69	0	526	355	0	38	116	67	0
174106	16476	4	15170	92.07	0	0	19	0	0	70	0	0
174134	36100	1	736	2.04	324	57	59	228	0	0	59	9
174134	36100	2	318	0.88	0	1	0	190	20	60	47	0
174134	36100	3	1279	3.54	0	501	294	0	47	71	365	1
174134	36100	4	33767	93.54	0	0	140	2	0	750	13	0
174158	36462	1	608	1.67	206	78	56	157	0	0	53	58
174158	36462	2	303	0.83	0	7	0	136	71	64	25	0
174158	36462	3	2166	5.94	0	1111	565	0	88	192	209	1
174158	36462	4	33385	91.56	0	0	46	1	0	229	5	0
174172	26196	1	420	1.60	113	59	58	134	0	0	51	5
174172	26196	2	165	0.63	0	0	0	65	25	60	15	0
174172	26196	3	1253	4.78	0	614	350	0	40	75	173	1
174172	26196	4	24358	92.98	0	0	43	0	0	188	5	0
174185	49004	1	338	0.69	146	35	3	83	0	0	9	62
174185	49004	2	215	0.44	0	7	0	113	59	18	18	0
174185	49004	3	2096	4.28	0	1118	532	0	80	227	139	0
174185	49004	4	46355	94.59	0	0	72	1	0	182	2	0
174187	19736	1	269	1.36	139	31	13	65	0	0	21	0
174187	19736	2	87	0.44	0	0	0	41	11	15	20	0
174187	19736	3	1358	6.88	0	694	386	0	38	131	109	0

174187	19736	4	18022	91.32	0	0	14	0	0	148	0	0
174280	22666	1	214	0.94	119	12	0	48	0	0	4	31
174280	22666	2	108	0.48	0	2	0	66	20	7	13	0
174280	22666	3	1059	4.67	0	464	302	0	41	129	123	0
174280	22666	4	21285	93.91	0	0	44	1	0	102	6	0
174306	40598	1	648	1.60	213	83	59	176	0	0	56	61
174306	40598	2	319	0.79	0	7	0	145	75	66	26	0
174306	40598	3	2400	5.91	0	1255	637	0	95	197	215	1
174306	40598	4	37231	91.71	0	0	43	1	0	233	6	0
174309	10822	1	250	2.31	78	48	0	88	0	0	36	0
174309	10822	2	133	1.23	0	0	0	57	1	58	17	0
174309	10822	3	724	6.69	0	544	0	0	14	1	164	1
174309	10822	4	9715	89.77	0	0	18	0	0	87	5	0
174773	7759	1	516	6.65	275	20	43	142	0	0	36	0
174773	7759	2	220	2.84	0	0	0	127	10	46	37	0
174773	7759	3	473	6.10	0	122	96	0	25	20	210	0
174773	7759	4	6550	84.42	0	0	87	0	0	583	8	0
174793	7740	1	512	6.61	272	20	43	138	0	0	35	4
174793	7740	2	219	2.83	0	0	0	127	10	46	36	0
174793	7740	3	471	6.09	0	121	96	0	25	19	210	0
174793	7740	4	6538	84.47	0	0	86	0	0	580	7	0
174810	7759	1	516	6.65	275	20	43	142	0	0	36	0
174810	7759	2	220	2.84	0	0	0	127	10	46	37	0
174810	7759	3	473	6.10	0	122	96	0	25	20	210	0
174810	7759	4	6550	84.42	0	0	87	0	0	583	8	0
174846	4374	1	332	7.59	220	0	0	103	0	0	9	0
174846	4374	2	158	3.61	0	0	0	120	1	3	34	0
174846	4374	3	260	5.94	0	29	14	0	20	12	185	0
174846	4374	4	3624	82.85	0	0	80	0	0	534	6	0
175068	28016	1	647	2.31	299	47	56	181	0	0	55	9
175068	28016	2	272	0.97	0	1	0	156	18	55	42	0
175068	28016	3	1009	3.60	0	396	226	0	37	61	288	1
175068	28016	4	26088	93.12	0	0	111	1	0	708	8	0
175073	17682	1	477	2.70	349	0	0	119	0	0	9	0
175073	17682	2	175	0.99	0	0	0	136	1	3	35	0

175073	17682	3	379	2.14	0	38	56	0	25	33	227	0
175073	17682	4	16651	94.17	0	0	110	1	0	581	9	0
175086	5405	1	470	8.70	345	0	0	116	0	0	9	0
175086	5405	2	171	3.16	0	0	0	132	1	3	35	0
175086	5405	3	276	5.11	0	29	15	0	22	12	198	0
175086	5405	4	4488	83.03	0	0	84	0	0	537	8	0
175096	5405	1	470	8.70	345	0	0	116	0	0	9	0
175096	5405	2	171	3.16	0	0	0	132	1	3	35	0
175096	5405	3	276	5.11	0	29	15	0	22	12	198	0
175096	5405	4	4488	83.03	0	0	84	0	0	537	8	0
175122	15742	1	636	4.04	294	47	56	178	0	0	55	6
175122	15742	2	279	1.77	0	1	0	163	18	55	42	0
175122	15742	3	908	5.77	0	384	185	0	35	40	263	1
175122	15742	4	13919	88.42	0	0	85	0	0	666	7	0
175134	5405	1	470	8.70	345	0	0	116	0	0	9	0
175134	5405	2	171	3.16	0	0	0	132	1	3	35	0
175134	5405	3	276	5.11	0	29	15	0	22	12	198	0
175134	5405	4	4488	83.03	0	0	84	0	0	537	8	0
175145	5405	1	470	8.70	345	0	0	116	0	0	9	0
175145	5405	2	171	3.16	0	0	0	132	1	3	35	0
175145	5405	3	276	5.11	0	29	15	0	22	12	198	0
175145	5405	4	4488	83.03	0	0	84	0	0	537	8	0
175175	4374	1	332	7.59	220	0	0	103	0	0	9	0
175175	4374	2	158	3.61	0	0	0	120	1	3	34	0
175175	4374	3	260	5.94	0	29	14	0	20	12	185	0
175175	4374	4	3624	82.85	0	0	80	0	0	534	6	0
175187	5405	1	470	8.70	345	0	0	116	0	0	9	0
175187	5405	2	171	3.16	0	0	0	132	1	3	35	0
175187	5405	3	276	5.11	0	29	15	0	22	12	198	0
175187	5405	4	4488	83.03	0	0	84	0	0	537	8	0
175304	35343	1	580	1.64	189	76	55	146	0	0	53	61
175304	35343	2	289	0.82	0	7	0	122	74	63	23	0
175304	35343	3	2199	6.22	0	1187	590	0	86	190	146	0
175304	35343	4	32275	91.32	0	0	28	0	0	209	1	0
175359	12527	1	321	2.56	74	50	55	95	0	0	46	1

175359	12527	2	117	0.93	0	0	0	34	20	53	10	0
175359	12527	3	720	5.75	0	396	192	0	18	36	78	0
175359	12527	4	11369	90.76	0	0	5	0	0	131	0	0
175590	8476	1	639	7.54	390	20	43	150	0	0	36	0
175590	8476	2	230	2.71	0	0	0	138	10	46	36	0
175590	8476	3	479	5.65	0	119	96	0	26	20	218	0
175590	8476	4	7128	84.10	0	0	86	0	0	576	8	0
175613	16624	1	294	1.77	183	0	0	103	0	0	8	0
175613	16624	2	159	0.96	0	0	0	123	0	2	34	0
175613	16624	3	356	2.14	0	19	79	0	19	30	209	0
175613	16624	4	15815	95.13	0	0	55	1	0	77	8	0
175863	20492	1	50	0.24	24	3	0	15	0	0	2	6
175863	20492	2	23	0.11	0	0	0	15	4	3	1	0
175863	20492	3	465	2.27	0	162	174	0	15	56	58	0
175863	20492	4	19954	97.37	0	0	36	0	0	66	1	0
176221	2073	1	275	13.27	172	0	0	95	0	0	8	0
176221	2073	2	151	7.28	0	0	0	116	0	2	33	0
176221	2073	3	201	9.70	0	8	0	0	15	4	174	0
176221	2073	4	1446	69.75	0	0	25	0	0	23	6	0
176242	2074	1	275	13.26	172	0	0	95	0	0	8	0
176242	2074	2	152	7.33	0	0	0	117	0	2	33	0
176242	2074	3	202	9.74	0	8	0	0	15	4	175	0
176242	2074	4	1445	69.67	0	0	25	0	0	23	6	0
176520	27661	1	397	1.44	250	3	0	127	0	0	10	7
176520	27661	2	192	0.69	0	0	0	139	3	9	41	0
176520	27661	3	758	2.74	0	288	123	0	30	76	241	0
176520	27661	4	26314	95.13	0	0	131	1	0	634	9	0
176656	19150	1	362	1.89	239	0	0	114	0	0	9	0
176656	19150	2	168	0.88	0	0	0	127	1	3	37	0
176656	19150	3	421	2.20	0	42	93	0	24	38	224	0
176656	19150	4	18199	95.03	0	0	114	1	0	595	9	0
176700	19094	1	357	1.87	237	0	0	111	0	0	9	0
176700	19094	2	178	0.93	0	0	0	138	1	3	36	0
176700	19094	3	423	2.22	0	41	93	0	24	38	227	0
176700	19094	4	18136	94.98	0	0	112	1	0	592	8	0

176830	19079	1	483	2.53	352	0	0	122	0	0	9	0
176830	19079	2	179	0.94	0	0	0	138	2	3	36	0
176830	19079	3	415	2.18	0	43	82	0	26	35	229	0
176830	19079	4	18002	94.36	0	0	136	1	0	598	10	0
176839	5719	1	485	8.48	354	0	0	122	0	0	9	0
176839	5719	2	176	3.08	0	0	0	134	1	3	38	0
176839	5719	3	287	5.02	0	32	16	0	24	12	203	0
176839	5719	4	4771	83.42	0	0	90	0	0	548	9	0
177071	16067	1	11	0.07	5	0	0	3	0	0	0	3
177071	16067	2	5	0.03	0	0	0	4	1	0	0	0
177071	16067	3	156	0.97	0	17	81	0	4	24	30	0
177071	16067	4	15895	98.93	0	0	63	1	0	73	1	0
177851	17235	1	316	1.83	189	0	0	114	0	0	10	3
177851	17235	2	174	1.01	0	0	0	136	0	3	35	0
177851	17235	3	409	2.37	0	23	79	0	25	31	251	0
177851	17235	4	16336	94.78	0	0	62	1	0	76	12	0
177921	23165	1	475	2.05	102	74	55	134	0	0	52	58
177921	23165	2	264	1.14	0	7	0	118	68	58	13	0
177921	23165	3	1265	5.46	0	686	280	0	61	83	154	1
177921	23165	4	21161	91.35	0	0	21	0	0	157	5	0
177979	32909	1	184	0.56	120	5	0	48	0	0	5	6
177979	32909	2	72	0.22	0	0	0	43	8	8	13	0
177979	32909	3	1300	3.95	0	542	431	0	46	141	140	0
177979	32909	4	31353	95.27	0	0	92	1	0	146	6	0
178119	15742	1	636	4.04	294	47	56	178	0	0	55	6
178119	15742	2	279	1.77	0	1	0	163	18	55	42	0
178119	15742	3	908	5.77	0	384	185	0	35	40	263	1
178119	15742	4	13919	88.42	0	0	85	0	0	666	7	0
178186	47245	1	714	1.51	254	111	56	170	0	0	56	67
178186	47245	2	384	0.81	0	12	0	187	81	72	32	0
178186	47245	3	3580	7.58	0	2027	902	0	121	290	239	1
178186	47245	4	42567	90.10	0	0	41	1	0	246	5	0
178257	8744	1	154	1.76	106	9	0	38	0	0	1	0
178257	8744	2	45	0.51	0	0	0	21	4	6	14	0
178257	8744	3	777	8.89	0	312	258	0	26	100	81	0

178257	8744	4	7768	88.84	0	0	7	0	0	53	0	0
178259	56785	1	787	1.39	267	123	56	214	0	0	57	70
178259	56785	2	413	0.73	0	13	0	201	88	74	37	0
178259	56785	3	3956	6.97	0	2218	1006	0	136	307	288	1
178259	56785	4	51629	90.92	0	0	64	1	0	278	6	0
178309	46940	1	636	1.35	207	82	56	176	0	0	54	61
178309	46940	2	311	0.66	0	7	0	139	73	65	27	0
178309	46940	3	2266	4.83	0	1155	573	0	90	209	238	1
178309	46940	4	43727	93.16	0	0	70	2	0	267	7	0
178443	19330	1	81	0.42	58	1	0	13	0	0	1	8
178443	19330	2	15	0.08	0	0	0	10	3	1	1	0
178443	19330	3	232	1.20	0	37	108	0	9	35	43	0
178443	19330	4	19002	98.30	0	0	98	1	0	577	1	0
178489	14729	1	27	0.18	16	0	0	8	0	0	0	3
178489	14729	2	8	0.05	0	0	0	6	0	0	2	0
178489	14729	3	160	1.09	0	15	79	0	3	26	37	0
178489	14729	4	14534	98.68	0	0	32	0	0	55	2	0
178547	30205	1	491	1.63	110	76	59	161	0	0	53	32
178547	30205	2	239	0.79	0	5	0	100	57	61	16	0
178547	30205	3	1547	5.12	0	856	345	0	65	90	190	1
178547	30205	4	27928	92.46	0	0	32	1	0	180	6	0
178620	29493	1	62	0.21	24	4	0	26	0	0	2	6
178620	29493	2	38	0.13	0	0	0	23	5	6	4	0
178620	29493	3	726	2.46	0	360	211	0	18	74	63	0
178620	29493	4	28667	97.20	0	0	75	1	0	113	1	0
178625	29288	1	122	0.42	38	12	3	65	0	0	4	0
178625	29288	2	64	0.22	0	0	0	41	4	10	9	0
178625	29288	3	819	2.80	0	436	161	0	24	72	126	0
178625	29288	4	28283	96.57	0	0	62	1	0	112	6	0
178738	34630	1	622	1.80	202	81	56	172	0	0	53	58
178738	34630	2	305	0.88	0	7	0	135	72	64	27	0
178738	34630	3	2162	6.24	0	1144	532	0	88	188	209	1
178738	34630	4	31541	91.08	0	0	44	1	0	224	5	0
178785	13741	1	162	1.18	107	10	0	43	0	0	2	0
178785	13741	2	60	0.44	0	0	0	27	11	7	15	0

178785	13741	3	993	7.23	0	484	275	0	36	116	82	0
178785	13741	4	12526	91.16	0	0	24	0	0	72	0	0
178846	15429	1	384	2.49	94	61	59	123	0	0	47	0
178846	15429	2	131	0.85	0	0	0	41	19	56	15	0
178846	15429	3	878	5.69	0	503	189	0	19	37	129	1
178846	15429	4	14036	90.97	0	0	9	0	0	148	0	0
178848	15081	1	403	2.67	87	64	55	120	0	0	48	29
178848	15081	2	172	1.14	0	5	0	66	32	56	13	0
178848	15081	3	859	5.70	0	427	234	0	25	60	112	1
178848	15081	4	13647	90.49	0	0	6	0	0	144	0	0
178856	28357	1	401	1.41	102	59	59	131	0	0	50	0
178856	28357	2	167	0.59	0	0	0	60	33	60	14	0
178856	28357	3	1390	4.90	0	751	338	0	56	86	158	1
178856	28357	4	26399	93.10	0	0	32	0	0	173	5	0
178868	22071	1	464	2.10	95	71	55	133	0	0	52	58
178868	22071	2	256	1.16	0	7	0	113	67	57	12	0
178868	22071	3	1209	5.48	0	667	279	0	58	78	127	0
178868	22071	4	20142	91.26	0	0	20	0	0	153	5	0
178914	14396	1	184	1.28	114	10	0	57	0	0	3	0
178914	14396	2	76	0.53	0	0	0	41	11	8	16	0
178914	14396	3	1045	7.26	0	485	275	0	43	117	125	0
178914	14396	4	13091	90.93	0	0	32	1	0	75	5	0
178921	22684	1	322	1.42	190	1	0	120	0	0	11	0
178921	22684	2	182	0.80	0	0	0	142	2	3	35	0
178921	22684	3	571	2.52	0	105	134	0	35	36	261	0
178921	22684	4	21609	95.26	0	0	82	1	0	97	13	0
178937	23802	1	473	1.99	98	77	58	131	0	0	51	58
178937	23802	2	250	1.05	0	7	0	105	67	59	12	0
178937	23802	3	1257	5.28	0	731	289	0	52	80	105	0
178937	23802	4	21822	91.68	0	0	16	0	0	163	1	0
178972	23802	1	473	1.99	98	77	58	131	0	0	51	58
178972	23802	2	250	1.05	0	7	0	105	67	59	12	0
178972	23802	3	1257	5.28	0	731	289	0	52	80	105	0
178972	23802	4	21822	91.68	0	0	16	0	0	163	1	0
178991	30560	1	446	1.46	118	66	59	152	0	0	51	0

178991	30560	2	181	0.59	0	0	0	66	37	61	17	0
178991	30560	3	1537	5.03	0	815	372	0	62	96	191	1
178991	30560	4	28396	92.92	0	0	33	0	0	180	5	0
179021	30013	1	573	1.91	182	74	55	151	0	0	53	58
179021	30013	2	288	0.96	0	7	0	127	70	61	23	0
179021	30013	3	1938	6.46	0	1039	494	0	80	160	164	1
179021	30013	4	27214	90.67	0	0	28	0	0	196	5	0
179064	15375	1	29	0.19	12	0	0	16	0	0	1	0
179064	15375	2	20	0.13	0	0	0	18	0	1	1	0
179064	15375	3	172	1.12	0	11	56	0	10	22	73	0
179064	15375	4	15154	98.56	0	0	48	1	0	63	5	0
179083	14408	1	353	2.45	82	55	55	84	0	0	47	30
179083	14408	2	152	1.05	0	2	0	60	30	52	8	0
179083	14408	3	721	5.00	0	385	207	0	19	34	76	0
179083	14408	4	13182	91.49	0	0	19	0	0	147	0	0
179094	14461	1	13	0.09	9	0	0	4	0	0	0	0
179094	14461	2	5	0.03	0	0	0	5	0	0	0	0
179094	14461	3	149	1.03	0	10	78	0	2	26	33	0
179094	14461	4	14294	98.85	0	0	28	0	0	50	1	0
179112	74294	1	1083	1.46	452	123	59	308	0	0	68	73
179112	74294	2	572	0.77	0	13	0	324	87	78	70	0
179112	74294	3	4316	5.81	0	2251	1090	0	152	335	487	1
179112	74294	4	68323	91.96	0	0	121	3	0	360	14	1
179150	44342	1	665	1.50	218	85	59	186	0	0	56	61
179150	44342	2	336	0.76	0	7	0	153	75	72	29	0
179150	44342	3	2660	6.00	0	1493	613	0	98	229	226	1
179150	44342	4	40681	91.74	0	0	42	1	0	250	6	0
179191	21339	1	28	0.13	9	1	0	10	0	0	2	6
179191	21339	2	16	0.07	0	0	0	11	5	0	0	0
179191	21339	3	366	1.72	0	117	160	0	13	33	43	0
179191	21339	4	20929	98.08	0	0	71	1	0	83	1	0
179276	38502	1	378	0.98	109	73	3	114	0	0	11	68
179276	38502	2	272	0.71	0	12	0	157	67	19	17	0
179276	38502	3	2584	6.71	0	1502	625	0	96	194	167	0
179276	38502	4	35268	91.60	0	0	55	1	0	114	5	0

179366	14506	1	17	0.12	9	0	0	5	0	0	0	3
179366	14506	2	5	0.03	0	0	0	5	0	0	0	0
179366	14506	3	152	1.05	0	14	78	0	2	26	32	0
179366	14506	4	14332	98.80	0	0	28	0	0	49	1	0
179386	28694	1	261	0.91	180	9	0	67	0	0	5	0
179386	28694	2	118	0.41	0	0	0	68	11	16	23	0
179386	28694	3	2387	8.32	0	1241	694	0	68	222	162	0
179386	28694	4	25928	90.36	0	0	31	0	0	107	5	0
179443	26448	1	75	0.28	34	5	0	28	0	0	2	6
179443	26448	2	43	0.16	0	0	0	25	5	8	5	0
179443	26448	3	776	2.93	0	403	187	0	19	93	74	0
179443	26448	4	25554	96.62	0	0	38	1	0	90	1	0
179488	16095	1	630	3.91	258	56	58	201	0	0	56	1
179488	16095	2	273	1.70	0	0	0	154	17	57	45	0
179488	16095	3	990	6.15	0	462	185	0	31	36	275	1
179488	16095	4	14202	88.24	0	0	34	0	0	168	7	0
179526	14522	1	14	0.10	9	0	0	5	0	0	0	0
179526	14522	2	5	0.03	0	0	0	5	0	0	0	0
179526	14522	3	151	1.04	0	11	78	0	3	26	33	0
179526	14522	4	14352	98.83	0	0	29	0	0	53	1	0
179637	18264	1	19	0.10	10	0	0	6	0	0	0	3
179637	18264	2	7	0.04	0	0	0	6	1	0	0	0
179637	18264	3	206	1.13	0	19	119	0	4	29	35	0
179637	18264	4	18032	98.73	0	0	66	1	0	79	1	0
179737	33473	1	659	1.97	284	51	55	213	0	0	56	0
179737	33473	2	294	0.88	0	0	0	170	17	58	49	0
179737	33473	3	1250	3.73	0	460	311	0	44	85	349	1
179737	33473	4	31270	93.42	0	0	110	1	0	250	14	0
179759	55093	1	667	1.21	221	84	56	191	0	0	54	61
179759	55093	2	334	0.61	0	7	0	151	74	71	31	0
179759	55093	3	2627	4.77	0	1398	624	0	95	251	258	1
179759	55093	4	51465	93.41	0	0	74	2	0	297	7	0
179801	41629	1	359	0.86	155	42	13	93	0	0	23	33
179801	41629	2	172	0.41	0	2	0	92	32	22	24	0
179801	41629	3	1859	4.47	0	978	473	0	54	199	155	0

179801	41629	4	39239	94.26	0	0	57	1	0	233	2	0
179870	53215	1	795	1.49	268	127	59	213	0	0	58	70
179870	53215	2	402	0.76	0	13	0	196	88	70	35	0
179870	53215	3	3746	7.04	0	2043	1003	0	133	273	293	1
179870	53215	4	48272	90.71	0	0	66	1	0	269	6	0
179936	45883	1	649	1.41	215	85	59	174	0	0	55	61
179936	45883	2	321	0.70	0	7	0	140	75	71	28	0
179936	45883	3	2658	5.79	0	1494	651	0	92	233	188	0
179936	45883	4	42255	92.09	0	0	36	0	0	253	1	0
179979	50102	1	386	0.77	155	38	3	117	0	0	11	62
179979	50102	2	237	0.47	0	7	0	128	61	20	21	0
179979	50102	3	2194	4.38	0	1155	537	0	88	228	186	0
179979	50102	4	47285	94.38	0	0	82	1	0	190	6	0
179993	30358	1	498	1.64	214	55	56	125	0	0	48	0
179993	30358	2	170	0.56	0	0	0	51	36	61	22	0
179993	30358	3	1831	6.03	0	994	480	0	67	161	129	0
179993	30358	4	27859	91.77	0	0	74	0	0	700	0	0
180016	49004	1	565	1.15	174	72	56	145	0	0	53	65
180016	49004	2	295	0.60	0	8	0	136	69	66	16	0
180016	49004	3	1844	3.76	0	961	439	0	74	172	197	1
180016	49004	4	46300	94.48	0	0	144	1	0	774	6	0
180020	56611	1	375	0.66	249	18	4	96	0	0	8	0
180020	56611	2	165	0.29	0	0	0	87	29	23	26	0
180020	56611	3	3031	5.35	0	1551	851	0	102	298	229	0
180020	56611	4	53040	93.69	0	0	137	2	0	709	6	0
180022	34929	1	499	1.43	221	50	56	122	0	0	50	0
180022	34929	2	196	0.56	0	0	0	83	26	61	26	0
180022	34929	3	2603	7.45	0	1304	825	0	76	193	204	1
180022	34929	4	31631	90.56	0	0	70	1	0	227	5	0
180124	69432	1	596	0.86	227	100	17	148	0	0	31	73
180124	69432	2	341	0.49	0	13	0	187	78	31	32	0
180124	69432	3	3844	5.54	0	2121	1028	0	126	323	245	1
180124	69432	4	64651	93.11	0	0	109	2	0	308	2	0
180175	46430	1	579	1.25	198	72	55	139	0	0	54	61
180175	46430	2	296	0.64	0	7	0	134	70	63	22	0

180175	46430	3	2154	4.64	0	1070	588	0	87	205	203	1
180175	46430	4	43401	93.48	0	0	92	1	0	275	7	0
180318	7517	1	503	6.69	265	20	43	136	0	0	35	4
180318	7517	2	216	2.87	0	0	0	126	10	46	34	0
180318	7517	3	464	6.17	0	119	96	0	25	19	205	0
180318	7517	4	6334	84.26	0	0	81	0	0	573	6	0
180349	44804	1	684	1.53	351	37	45	205	0	0	40	6
180349	44804	2	301	0.67	0	0	0	168	19	61	53	0
180349	44804	3	2079	4.64	0	976	515	0	64	191	333	0
180349	44804	4	41740	93.16	0	0	93	2	0	230	8	0
180366	18264	1	19	0.10	10	0	0	6	0	0	0	3
180366	18264	2	7	0.04	0	0	0	6	1	0	0	0
180366	18264	3	206	1.13	0	19	119	0	4	29	35	0
180366	18264	4	18032	98.73	0	0	66	1	0	79	1	0
180556	64680	1	962	1.49	401	85	59	287	0	0	66	64
180556	64680	2	498	0.77	0	7	0	276	76	75	64	0
180556	64680	3	3073	4.75	0	1521	733	0	118	263	437	1
180556	64680	4	60147	92.99	0	0	134	2	0	353	14	0
180575	66413	1	1006	1.51	416	92	59	309	0	0	66	64
180575	66413	2	525	0.79	0	7	0	295	79	76	68	0
180575	66413	3	3186	4.80	0	1577	738	0	123	269	477	2
180575	66413	4	61696	92.90	0	0	139	2	0	366	15	0
180604	37509	1	191	0.51	47	26	0	50	0	0	6	62
180604	37509	2	163	0.43	0	7	0	89	50	11	6	0
180604	37509	3	1226	3.27	0	673	285	0	51	136	81	0
180604	37509	4	35929	95.79	0	0	60	1	0	124	1	0
180722	59362	1	1017	1.71	433	116	56	277	0	0	65	70
180722	59362	2	548	0.92	0	13	0	317	83	70	65	0
180722	59362	3	3736	6.29	0	1863	974	0	139	291	467	2
180722	59362	4	54061	91.07	0	0	93	2	0	302	13	1
209247	60754	1	924	1.52	389	79	55	273	0	0	64	64
209247	60754	2	481	0.79	0	7	0	266	73	73	62	0
209247	60754	3	2934	4.83	0	1452	693	0	114	259	415	1
209247	60754	4	56415	92.86	0	0	108	2	0	329	13	0
173435	30376	1	356	1.17	55	23	56	127	0	0	30	65

173435	30376	2	225	0.74	0	8	0	85	54	56	22	0
173435	30376	3	1269	4.18	0	518	519	0	51	75	106	0
173435	30376	4	28526	93.91	0	0	82	0	0	50	0	0
173436	51205	1	919	1.79	416	76	56	245	0	0	61	65
173436	51205	2	452	0.88	0	8	0	250	70	66	58	0
173436	51205	3	2422	4.73	0	1131	615	0	98	220	357	1
173436	51205	4	47412	92.59	0	0	144	2	0	802	8	0
173440	991	1	145	14.63	0	52	0	21	0	0	3	69
173440	991	2	129	13.02	0	12	0	81	36	0	0	0
173440	991	3	233	23.51	0	219	0	0	12	0	2	0
173440	991	4	484	48.84	0	0	0	0	0	0	0	0
173467	69091	1	1100	1.59	488	116	56	300	0	0	65	75
173467	69091	2	559	0.81	0	13	0	316	85	76	69	0
173467	69091	3	4069	5.89	0	2109	1017	0	147	331	464	1
173467	69091	4	63363	91.71	0	0	166	3	0	852	14	1
173475	59330	1	1136	1.91	501	118	60	312	0	0	68	77
173475	59330	2	549	0.93	0	13	0	326	61	79	70	0
173475	59330	3	3255	5.49	0	1245	1070	0	128	312	499	1
173475	59330	4	54390	91.67	0	0	112	3	0	856	14	1
173479	27528	1	500	1.82	232	48	56	115	0	0	49	0
173479	27528	2	160	0.58	0	0	0	64	15	59	22	0
173479	27528	3	1405	5.10	0	550	468	0	44	137	205	1
173479	27528	4	25463	92.50	0	0	45	1	0	727	6	0
173504	19824	1	707	3.57	328	50	56	215	0	0	58	0
173504	19824	2	302	1.52	0	0	0	180	15	59	48	0
173504	19824	3	1182	5.96	0	405	333	0	44	69	330	1
173504	19824	4	17633	88.95	0	0	79	1	0	708	12	0
173508	22085	1	506	2.29	229	54	56	119	0	0	48	0
173508	22085	2	152	0.69	0	0	0	48	22	59	23	0
173508	22085	3	1599	7.24	0	839	452	0	40	129	139	0
173508	22085	4	19828	89.78	0	0	12	0	0	691	0	0
173511	1618	1	26	1.61	25	0	0	1	0	0	0	0
173511	1618	2	20	1.24	0	0	0	19	1	0	0	0
173511	1618	3	156	9.64	0	0	151	0	1	1	3	0
173511	1618	4	1416	87.52	0	0	0	0	0	2	0	0

173520	20585	1	296	1.44	135	23	14	43	0	0	19	62
173520	20585	2	174	0.85	0	8	0	100	58	4	4	0
173520	20585	3	1168	5.67	0	509	422	0	65	157	15	0
173520	20585	4	18947	92.04	0	0	64	0	0	155	0	0
173525	30671	1	281	0.92	45	63	56	36	0	0	44	37
173525	30671	2	131	0.43	0	6	0	70	51	3	1	0
173525	30671	3	1236	4.03	0	675	359	0	49	107	46	0
173525	30671	4	29023	94.63	0	0	91	1	0	496	1	0
173531	29258	1	516	1.76	239	51	56	122	0	0	48	0
173531	29258	2	162	0.55	0	0	0	63	17	59	23	0
173531	29258	3	1476	5.04	0	590	527	0	39	145	175	0
173531	29258	4	27104	92.64	0	0	38	1	0	733	2	0
173590	36698	1	901	2.46	407	76	56	240	0	0	60	62
173590	36698	2	445	1.21	0	8	0	244	69	66	58	0
173590	36698	3	2266	6.17	0	1117	536	0	95	193	324	1
173590	36698	4	33086	90.16	0	0	115	1	0	752	7	0
173596	1068	1	34	3.18	24	4	0	6	0	0	0	0
173596	1068	2	12	1.12	0	0	0	5	0	3	4	0
173596	1068	3	122	11.42	0	86	10	0	0	0	26	0
173596	1068	4	900	84.27	0	0	0	0	0	315	0	0
173604	19275	1	358	1.86	149	55	56	40	0	0	49	9
173604	19275	2	126	0.65	0	0	0	69	12	28	17	0
173604	19275	3	1013	5.26	0	433	280	0	26	66	207	1
173604	19275	4	17778	92.23	0	0	50	1	0	692	6	0
173625	11541	1	349	3.02	122	44	56	81	0	0	46	0
173625	11541	2	119	1.03	0	0	0	43	14	53	9	0
173625	11541	3	600	5.20	0	288	182	0	14	29	87	0
173625	11541	4	10473	90.75	0	0	5	0	0	640	0	0
173636	443	1	9	2.03	0	9	0	0	0	0	0	0
173636	443	2	4	0.90	0	4	0	0	0	0	0	0
173636	443	3	42	9.48	0	36	0	0	2	4	0	0
173636	443	4	388	87.58	0	0	0	0	0	0	0	0
173640	555	1	94	16.94	0	17	0	15	0	0	2	60
173640	555	2	96	17.30	0	7	0	58	31	0	0	0
173640	555	3	60	10.81	0	53	0	0	7	0	0	0

173640	555	4	305	54.95	0	0	0	0	0	0	0	0
173642	555	1	94	16.94	0	17	0	15	0	0	2	60
173642	555	2	96	17.30	0	7	0	58	31	0	0	0
173642	555	3	60	10.81	0	53	0	0	7	0	0	0
173642	555	4	305	54.95	0	0	0	0	0	0	0	0
173660	531	1	90	16.95	0	16	0	16	0	0	2	56
173660	531	2	101	19.02	0	6	0	62	33	0	0	0
173660	531	3	61	11.49	0	52	0	0	9	0	0	0
173660	531	4	279	52.54	0	0	0	0	0	0	0	0
173678	13853	1	222	1.60	99	22	13	28	0	0	3	57
173678	13853	2	129	0.93	0	7	0	65	54	3	0	0
173678	13853	3	791	5.71	0	491	122	0	50	126	2	0
173678	13853	4	12711	91.76	0	0	8	0	0	13	0	0
173682	31450	1	568	1.81	226	67	56	136	0	0	50	33
173682	31450	2	234	0.74	0	6	0	87	55	63	23	0
173682	31450	3	1976	6.28	0	1078	498	0	74	183	143	0
173682	31450	4	28672	91.17	0	0	75	0	0	709	1	0
173715	10130	1	105	1.04	0	20	0	22	0	0	3	60
173715	10130	2	121	1.19	0	7	0	62	49	3	0	0
173715	10130	3	538	5.31	0	437	14	0	36	49	2	0
173715	10130	4	9366	92.46	0	0	60	0	0	10	0	0
173735	14031	1	663	4.73	307	49	56	196	0	0	55	0
173735	14031	2	281	2.00	0	0	0	162	15	58	46	0
173735	14031	3	949	6.76	0	379	204	0	31	55	279	1
173735	14031	4	12138	86.51	0	0	31	0	0	671	7	0
173758	27101	1	729	2.69	305	63	56	214	0	0	58	33
173758	27101	2	364	1.34	0	6	0	201	52	60	45	0
173758	27101	3	1405	5.18	0	668	304	0	65	90	277	1
173758	27101	4	24603	90.78	0	0	94	0	0	691	7	0
173771	13933	1	351	2.52	112	48	0	108	0	0	49	34
173771	13933	2	146	1.05	0	0	0	34	49	53	10	0
173771	13933	3	635	4.56	0	341	173	0	13	14	94	0
173771	13933	4	12801	91.88	0	0	6	0	0	652	0	0
173780	3322	1	426	12.82	288	0	0	128	0	0	10	0
173780	3322	2	178	5.36	0	0	0	139	0	0	39	0

173780	3322	3	220	6.62	0	3	0	0	24	4	189	0
173780	3322	4	2498	75.20	0	0	33	0	0	11	14	0
173786	12059	1	567	4.70	280	49	0	183	0	0	55	0
173786	12059	2	266	2.21	0	0	0	162	1	58	45	0
173786	12059	3	793	6.58	0	382	104	0	22	6	278	1
173786	12059	4	10433	86.52	0	0	29	0	0	594	7	0
173805	15742	1	636	4.04	294	47	56	178	0	0	55	6
173805	15742	2	279	1.77	0	1	0	163	18	55	42	0
173805	15742	3	908	5.77	0	384	185	0	35	40	263	1
173805	15742	4	13919	88.42	0	0	85	0	0	666	7	0
173819	23790	1	755	3.17	308	53	56	217	0	0	59	62
173819	23790	2	329	1.38	0	0	0	166	62	56	45	0
173819	23790	3	1311	5.51	0	636	284	0	58	59	273	1
173819	23790	4	21395	89.93	0	0	92	0	0	686	7	0
173833	2666	1	393	14.74	274	0	0	110	0	0	9	0
173833	2666	2	161	6.04	0	0	0	126	0	0	35	0
173833	2666	3	180	6.75	0	4	0	0	17	4	155	0
173833	2666	4	1932	72.47	0	0	25	0	0	9	8	0
173843	2584	1	390	15.09	272	0	0	109	0	0	9	0
173843	2584	2	159	6.15	0	0	0	124	0	0	35	0
173843	2584	3	169	6.54	0	2	0	0	17	4	146	0
173843	2584	4	1866	72.21	0	0	24	0	0	9	8	0
173865	25426	1	278	1.09	136	22	0	83	0	0	6	31
173865	25426	2	147	0.58	0	2	0	85	26	14	20	0
173865	25426	3	1591	6.26	0	848	372	0	58	159	154	0
173865	25426	4	23410	92.07	0	0	41	1	0	110	5	0
173938	856	1	29	3.39	10	0	0	18	0	0	1	0
173938	856	2	16	1.87	0	0	0	15	0	0	1	0
173938	856	3	50	5.84	0	1	0	0	7	0	42	0
173938	856	4	761	88.90	0	0	15	0	0	2	5	0
173959	35394	1	423	1.20	158	54	13	113	0	0	27	58
173959	35394	2	246	0.70	0	7	0	130	59	25	25	0
173959	35394	3	2112	5.97	0	1203	448	0	81	210	169	1
173959	35394	4	32613	92.14	0	0	44	1	0	203	5	0
174008	46295	1	718	1.55	250	113	56	177	0	0	55	67

174008	46295	2	372	0.80	0	13	0	179	82	67	31	0
174008	46295	3	3387	7.32	0	1826	947	0	119	261	233	1
174008	46295	4	41818	90.33	0	0	56	1	0	246	5	0
174109	2865	1	294	10.26	161	0	0	123	0	0	10	0
174109	2865	2	191	6.67	0	0	0	145	0	0	46	0
174109	2865	3	265	9.25	0	14	0	0	23	6	222	0
174109	2865	4	2115	73.82	0	0	35	0	0	11	12	0
174123	6753	1	522	7.73	266	23	43	154	0	0	36	0
174123	6753	2	230	3.41	0	0	0	137	10	47	36	0
174123	6753	3	484	7.17	0	136	99	0	22	15	212	0
174123	6753	4	5517	81.70	0	0	27	0	0	574	6	0
174129	37430	1	305	0.81	130	28	0	81	0	0	7	59
174129	37430	2	188	0.50	0	7	0	101	53	11	16	0
174129	37430	3	1596	4.26	0	751	455	0	70	182	138	0
174129	37430	4	35341	94.42	0	0	90	1	0	152	6	0
174136	48171	1	794	1.65	387	46	43	206	0	0	45	67
174136	48171	2	427	0.89	0	8	0	247	69	56	47	0
174136	48171	3	2109	4.38	0	886	588	0	105	187	342	1
174136	48171	4	44841	93.09	0	0	156	2	0	717	13	0
174150	30167	1	538	1.78	186	56	56	132	0	0	51	57
174150	30167	2	196	0.65	0	0	0	51	64	58	23	0
174150	30167	3	1882	6.24	0	1024	515	0	63	146	134	0
174150	30167	4	27551	91.33	0	0	34	0	0	211	0	0
174161	43288	1	392	0.91	150	52	13	91	0	0	25	61
174161	43288	2	218	0.50	0	7	0	112	59	19	21	0
174161	43288	3	1906	4.40	0	976	514	0	73	200	143	0
174161	43288	4	40772	94.19	0	0	62	1	0	225	2	0
174164	14042	1	579	4.12	281	48	0	195	0	0	55	0
174164	14042	2	275	1.96	0	0	0	160	15	56	44	0
174164	14042	3	847	6.03	0	332	206	0	23	15	270	1
174164	14042	4	12341	87.89	0	0	31	0	0	666	7	0
174175	62334	1	669	1.07	230	82	59	177	0	0	57	64
174175	62334	2	342	0.55	0	7	0	160	75	72	28	0
174175	62334	3	2825	4.53	0	1478	728	0	103	257	258	1
174175	62334	4	58498	93.85	0	0	110	2	0	333	7	0

174195	38289	1	292	0.76	127	26	0	69	0	0	8	62
174195	38289	2	192	0.50	0	7	0	107	54	10	14	0
174195	38289	3	1656	4.33	0	806	455	0	78	176	141	0
174195	38289	4	36149	94.41	0	0	73	1	0	144	6	0
174244	15425	1	644	4.18	280	49	56	198	0	0	55	6
174244	15425	2	282	1.83	0	0	0	161	21	56	44	0
174244	15425	3	920	5.96	0	405	204	0	27	16	267	1
174244	15425	4	13579	88.03	0	0	31	0	0	666	7	0
174263	19740	1	247	1.25	115	25	0	46	0	0	5	56
174263	19740	2	161	0.82	0	7	0	82	50	9	13	0
174263	19740	3	1316	6.67	0	693	357	0	58	149	59	0
174263	19740	4	18016	91.27	0	0	17	0	0	74	0	0
174265	4160	1	50	1.20	17	3	0	28	0	0	2	0
174265	4160	2	36	0.87	0	0	0	21	0	6	9	0
174265	4160	3	472	11.35	0	272	94	0	10	1	95	0
174265	4160	4	3602	86.59	0	0	14	0	0	41	5	0
174296	34379	1	704	2.05	325	55	13	218	0	0	35	58
174296	34379	2	393	1.14	0	7	0	243	63	22	58	0
174296	34379	3	2115	6.15	0	1011	484	0	97	184	338	1
174296	34379	4	31167	90.66	0	0	70	1	0	210	12	0
174299	15879	1	689	4.34	315	49	56	212	0	0	57	0
174299	15879	2	297	1.87	0	0	0	177	15	58	47	0
174299	15879	3	1026	6.46	0	383	220	0	41	58	323	1
174299	15879	4	13867	87.33	0	0	40	1	0	675	12	0
174354	14187	1	156	1.10	109	5	0	39	0	0	3	0
174354	14187	2	56	0.39	0	0	0	35	2	6	13	0
174354	14187	3	1068	7.53	0	497	325	0	34	107	105	0
174354	14187	4	12907	90.98	0	0	25	0	0	62	5	0
174469	3395	1	197	5.80	173	0	0	20	0	0	0	4
174469	3395	2	18	0.53	0	0	0	15	1	0	2	0
174469	3395	3	72	2.12	0	21	15	0	7	7	22	0
174469	3395	4	3108	91.55	0	0	60	0	0	514	1	0
174685	2612	1	394	15.08	274	0	0	111	0	0	9	0
174685	2612	2	160	6.13	0	0	0	125	0	0	35	0
174685	2612	3	171	6.55	0	2	0	0	18	4	147	0

174685	2612	4	1887	72.24	0	0	24	0	0	9	8	0
174755	4476	1	222	4.96	93	19	43	40	0	0	27	0
174755	4476	2	62	1.39	0	0	0	8	9	44	1	0
174755	4476	3	232	5.18	0	93	94	0	6	10	29	0
174755	4476	4	3960	88.47	0	0	2	0	0	549	0	0
174803	17040	1	546	3.20	283	23	43	161	0	0	36	0
174803	17040	2	225	1.32	0	0	0	130	10	47	38	0
174803	17040	3	621	3.64	0	143	176	0	25	31	246	0
174803	17040	4	15648	91.83	0	0	56	1	0	622	8	0
174813	1702	1	261	15.33	153	0	0	100	0	0	8	0
174813	1702	2	159	9.34	0	0	0	125	0	0	34	0
174813	1702	3	162	9.52	0	2	0	0	15	4	141	0
174813	1702	4	1120	65.80	0	0	20	0	0	8	6	0
174827	6580	1	501	7.61	265	20	43	137	0	0	36	0
174827	6580	2	226	3.43	0	0	0	137	9	46	34	0
174827	6580	3	442	6.72	0	102	95	0	22	15	208	0
174827	6580	4	5411	82.23	0	0	27	0	0	574	6	0
174842	13836	1	659	4.76	303	48	56	197	0	0	55	0
174842	13836	2	266	1.92	0	0	0	149	15	56	46	0
174842	13836	3	851	6.15	0	332	187	0	31	34	266	1
174842	13836	4	12060	87.16	0	0	33	0	0	668	8	0
174856	3978	1	348	8.75	232	1	0	106	0	0	9	0
174856	3978	2	162	4.07	0	0	0	122	0	5	35	0
174856	3978	3	337	8.47	0	59	31	0	21	28	198	0
174856	3978	4	3131	78.71	0	0	26	0	0	540	6	0
174924	1674	1	259	15.47	152	0	0	99	0	0	8	0
174924	1674	2	147	8.78	0	0	0	113	0	0	34	0
174924	1674	3	160	9.56	0	2	0	0	15	4	139	0
174924	1674	4	1108	66.19	0	0	19	0	0	8	6	0
174999	17779	1	486	2.73	350	1	0	118	0	0	10	7
174999	17779	2	177	1.00	0	0	0	136	2	3	36	0
174999	17779	3	382	2.15	0	41	56	0	25	33	227	0
174999	17779	4	16734	94.12	0	0	111	1	0	581	9	0
175038	2977	1	398	13.37	276	0	0	113	0	0	9	0
175038	2977	2	163	5.48	0	0	0	128	0	0	35	0

175038	2977	3	199	6.68	0	3	0	0	18	4	174	0
175038	2977	4	2217	74.47	0	0	32	1	0	11	9	0
175081	16746	1	347	2.07	225	1	0	105	0	0	9	7
175081	16746	2	164	0.98	0	0	0	125	2	3	34	0
175081	16746	3	367	2.19	0	41	56	0	23	33	214	0
175081	16746	4	15868	94.76	0	0	106	1	0	578	7	0
175125	3589	1	441	12.29	318	0	0	114	0	0	9	0
175125	3589	2	169	4.71	0	0	0	131	0	3	35	0
175125	3589	3	230	6.41	0	12	0	0	18	4	196	0
175125	3589	4	2749	76.60	0	0	30	0	0	276	8	0
175128	2362	1	59	2.50	48	0	0	7	0	0	0	4
175128	2362	2	4	0.17	0	0	0	3	1	0	0	0
175128	2362	3	56	2.37	0	21	14	0	5	6	10	0
175128	2362	4	2243	94.96	0	0	55	0	0	511	0	0
175163	967	1	134	13.86	122	0	0	12	0	0	0	0
175163	967	2	13	1.34	0	0	0	12	0	0	1	0
175163	967	3	13	1.34	0	0	0	0	2	0	11	0
175163	967	4	807	83.45	0	0	4	0	0	0	1	0
175171	1009	1	137	13.58	124	0	0	13	0	0	0	0
175171	1009	2	13	1.29	0	0	0	12	0	0	1	0
175171	1009	3	14	1.39	0	0	0	0	2	0	12	0
175171	1009	4	845	83.75	0	0	4	0	0	2	1	0
175183	16739	1	774	4.62	419	47	56	191	0	0	55	6
175183	16739	2	281	1.68	0	1	0	163	18	55	44	0
175183	16739	3	920	5.50	0	384	186	0	37	40	272	1
175183	16739	4	14764	88.20	0	0	90	0	0	668	9	0
175185	4210	1	335	7.96	220	0	0	102	0	0	9	4
175185	4210	2	158	3.75	0	0	0	120	1	3	34	0
175185	4210	3	257	6.10	0	29	12	0	20	11	185	0
175185	4210	4	3460	82.19	0	0	79	0	0	507	6	0
175265	32284	1	571	1.77	190	75	55	142	0	0	51	58
175265	32284	2	282	0.87	0	7	0	118	71	63	23	0
175265	32284	3	2040	6.32	0	1090	549	0	77	186	138	0
175265	32284	4	29391	91.04	0	0	23	0	0	206	1	0
175289	8057	1	482	5.98	247	44	0	148	0	0	43	0

175289	8057	2	239	2.97	0	0	0	148	0	49	42	0
175289	8057	3	590	7.32	0	300	10	0	18	4	257	1
175289	8057	4	6746	83.73	0	0	30	0	0	306	7	0
175309	38080	1	584	1.53	197	73	55	143	0	0	55	61
175309	38080	2	301	0.79	0	7	0	136	73	63	22	0
175309	38080	3	2225	5.84	0	1155	600	0	93	190	186	1
175309	38080	4	34970	91.83	0	0	51	1	0	228	5	0
175420	26583	1	925	3.48	525	50	56	229	0	0	59	6
175420	26583	2	336	1.26	0	0	0	192	26	61	57	0
175420	26583	3	1812	6.82	0	805	439	0	69	133	365	1
175420	26583	4	23510	88.44	0	0	106	1	0	719	14	0
175430	16580	1	293	1.77	181	0	0	100	0	0	9	3
175430	16580	2	157	0.95	0	0	0	122	0	2	33	0
175430	16580	3	358	2.16	0	22	79	0	18	31	208	0
175430	16580	4	15772	95.13	0	0	53	1	0	73	7	0
175604	1839	1	274	14.90	161	0	0	105	0	0	8	0
175604	1839	2	151	8.21	0	0	0	115	0	0	36	0
175604	1839	3	166	9.03	0	2	0	0	16	4	144	0
175604	1839	4	1248	67.86	0	0	21	0	0	11	8	0
175790	593	1	95	16.02	0	17	0	17	0	0	3	58
175790	593	2	105	17.71	0	7	0	63	35	0	0	0
175790	593	3	75	12.65	0	66	0	0	9	0	0	0
175790	593	4	318	53.63	0	0	0	0	0	0	0	0
176136	50825	1	610	1.20	212	74	55	154	0	0	54	61
176136	50825	2	318	0.63	0	7	0	145	71	69	26	0
176136	50825	3	2461	4.84	0	1307	599	0	90	243	221	1
176136	50825	4	47436	93.33	0	0	59	1	0	275	7	0
176280	2877	1	325	11.30	217	0	0	99	0	0	9	0
176280	2877	2	167	5.80	0	0	0	131	0	2	34	0
176280	2877	3	228	7.92	0	12	10	0	16	4	186	0
176280	2877	4	2157	74.97	0	0	25	0	0	504	6	0
176284	4471	1	335	7.49	220	0	0	102	0	0	9	4
176284	4471	2	170	3.80	0	0	0	132	1	3	34	0
176284	4471	3	264	5.90	0	29	15	0	20	11	189	0
176284	4471	4	3702	82.80	0	0	80	0	0	536	6	0

176506	1767	1	267	15.11	158	0	0	101	0	0	8	0
176506	1767	2	149	8.43	0	0	0	113	0	0	36	0
176506	1767	3	160	9.05	0	2	0	0	16	3	139	0
176506	1767	4	1191	67.40	0	0	20	0	0	10	8	0
176517	1767	1	267	15.11	158	0	0	101	0	0	8	0
176517	1767	2	149	8.43	0	0	0	113	0	0	36	0
176517	1767	3	160	9.05	0	2	0	0	16	3	139	0
176517	1767	4	1191	67.40	0	0	20	0	0	10	8	0
176571	1767	1	267	15.11	158	0	0	101	0	0	8	0
176571	1767	2	149	8.43	0	0	0	113	0	0	36	0
176571	1767	3	160	9.05	0	2	0	0	16	3	139	0
176571	1767	4	1191	67.40	0	0	20	0	0	10	8	0
176580	49167	1	868	1.77	317	87	59	281	0	0	63	61
176580	49167	2	465	0.95	0	7	0	261	71	71	55	0
176580	49167	3	2182	4.44	0	1096	404	0	88	175	417	2
176580	49167	4	45652	92.85	0	0	81	2	0	275	13	0
176599	1767	1	267	15.11	158	0	0	101	0	0	8	0
176599	1767	2	149	8.43	0	0	0	113	0	0	36	0
176599	1767	3	160	9.05	0	2	0	0	16	3	139	0
176599	1767	4	1191	67.40	0	0	20	0	0	10	8	0
176620	2257	1	278	12.32	163	0	0	107	0	0	8	0
176620	2257	2	154	6.82	0	0	0	118	0	0	36	0
176620	2257	3	194	8.60	0	3	0	0	17	4	170	0
176620	2257	4	1631	72.26	0	0	30	1	0	13	9	0
176642	1767	1	267	15.11	158	0	0	101	0	0	8	0
176642	1767	2	149	8.43	0	0	0	113	0	0	36	0
176642	1767	3	160	9.05	0	2	0	0	16	3	139	0
176642	1767	4	1191	67.40	0	0	20	0	0	10	8	0
176669	1767	1	267	15.11	158	0	0	101	0	0	8	0
176669	1767	2	149	8.43	0	0	0	113	0	0	36	0
176669	1767	3	160	9.05	0	2	0	0	16	3	139	0
176669	1767	4	1191	67.40	0	0	20	0	0	10	8	0
176679	1767	1	267	15.11	158	0	0	101	0	0	8	0
176679	1767	2	149	8.43	0	0	0	113	0	0	36	0
176679	1767	3	160	9.05	0	2	0	0	16	3	139	0

176679	1767	4	1191	67.40	0	0	20	0	0	10	8	0
176726	1767	1	267	15.11	158	0	0	101	0	0	8	0
176726	1767	2	149	8.43	0	0	0	113	0	0	36	0
176726	1767	3	160	9.05	0	2	0	0	16	3	139	0
176726	1767	4	1191	67.40	0	0	20	0	0	10	8	0
176824	3213	1	413	12.85	285	0	0	119	0	0	9	0
176824	3213	2	168	5.23	0	0	0	130	0	0	38	0
176824	3213	3	206	6.41	0	4	0	0	19	4	179	0
176824	3213	4	2426	75.51	0	0	41	1	0	16	10	0
176887	2735	1	404	14.77	281	0	0	114	0	0	9	0
176887	2735	2	162	5.92	0	0	0	125	0	0	37	0
176887	2735	3	175	6.40	0	2	0	0	18	4	151	0
176887	2735	4	1994	72.91	0	0	25	0	0	11	9	0
176894	1133	1	149	13.15	131	0	0	18	0	0	0	0
176894	1133	2	18	1.59	0	0	0	14	0	0	4	0
176894	1133	3	19	1.68	0	0	0	0	3	0	16	0
176894	1133	4	947	83.58	0	0	5	0	0	3	3	0
176923	2805	1	404	14.40	281	0	0	114	0	0	9	0
176923	2805	2	164	5.85	0	0	0	126	0	0	38	0
176923	2805	3	176	6.27	0	3	0	0	18	4	151	0
176923	2805	4	2061	73.48	0	0	31	0	0	13	9	0
176926	2807	1	411	14.64	284	0	0	118	0	0	9	0
176926	2807	2	166	5.91	0	0	0	128	0	0	38	0
176926	2807	3	179	6.38	0	2	0	0	18	4	155	0
176926	2807	4	2051	73.07	0	0	25	0	0	12	9	0
177125	34175	1	221	0.65	128	12	0	70	0	0	5	6
177125	34175	2	95	0.28	0	0	0	54	16	9	16	0
177125	34175	3	1410	4.13	0	600	432	0	55	152	171	0
177125	34175	4	32449	94.95	0	0	68	1	0	135	6	0
177152	17664	1	69	0.39	31	2	0	34	0	0	2	0
177152	17664	2	44	0.25	0	0	0	32	0	7	5	0
177152	17664	3	473	2.68	0	174	129	0	14	52	104	0
177152	17664	4	17078	96.68	0	0	53	1	0	85	6	0
177856	44099	1	711	1.61	245	113	56	175	0	0	55	67
177856	44099	2	369	0.84	0	12	0	178	82	67	30	0

177856	44099	3	3336	7.56	0	1824	909	0	118	256	228	1
177856	44099	4	39683	89.99	0	0	53	1	0	239	5	0
177942	6991	1	186	2.66	130	37	0	9	0	0	1	9
177942	6991	2	41	0.59	0	4	0	24	12	1	0	0
177942	6991	3	789	11.29	0	626	4	0	34	123	2	0
177942	6991	4	5975	85.47	0	0	3	0	0	4	0	0
177960	30320	1	307	1.01	132	28	0	79	0	0	9	59
177960	30320	2	213	0.70	0	7	0	115	57	17	17	0
177960	30320	3	1872	6.17	0	1038	428	0	82	197	127	0
177960	30320	4	27928	92.11	0	0	34	0	0	106	5	0
178001	29534	1	319	1.08	84	47	55	82	0	0	46	5
178001	29534	2	115	0.39	0	0	0	37	17	53	8	0
178001	29534	3	849	2.87	0	374	289	0	19	58	109	0
178001	29534	4	28251	95.66	0	0	70	1	0	209	1	0
178154	29035	1	276	0.95	126	27	0	61	0	0	6	56
178154	29035	2	187	0.64	0	7	0	95	54	15	16	0
178154	29035	3	1681	5.79	0	941	402	0	67	194	77	0
178154	29035	4	26891	92.62	0	0	34	0	0	115	0	0
178195	45557	1	744	1.63	253	119	56	194	0	0	55	67
178195	45557	2	380	0.83	0	12	0	183	84	68	33	0
178195	45557	3	3438	7.55	0	1878	915	0	122	262	260	1
178195	45557	4	40995	89.99	0	0	54	1	0	245	6	0
178262	32185	1	621	1.93	201	81	56	172	0	0	53	58
178262	32185	2	305	0.95	0	7	0	135	72	64	27	0
178262	32185	3	2141	6.65	0	1142	517	0	87	186	208	1
178262	32185	4	29118	90.47	0	0	29	1	0	208	5	0
178329	28885	1	520	1.80	119	79	55	157	0	0	52	58
178329	28885	2	277	0.96	0	7	0	123	69	61	17	0
178329	28885	3	1484	5.14	0	774	355	0	66	111	177	1
178329	28885	4	26604	92.10	0	0	39	1	0	187	5	0
178339	32509	1	564	1.73	186	78	59	160	0	0	52	29
178339	32509	2	248	0.76	0	5	0	95	59	63	26	0
178339	32509	3	2026	6.23	0	1129	487	0	74	163	172	1
178339	32509	4	29671	91.27	0	0	24	0	0	210	1	0
178448	16868	1	78	0.46	58	1	0	12	0	0	0	7

178448	16868	2	12	0.07	0	0	0	9	2	1	0	0
178448	16868	3	211	1.25	0	35	93	0	8	33	42	0
178448	16868	4	16567	98.22	0	0	83	1	0	561	1	0
178453	4676	1	0	0.00	0	0	0	0	0	0	0	0
178453	4676	2	1	0.02	0	0	0	1	0	0	0	0
178453	4676	3	16	0.34	0	5	1	0	0	10	0	0
178453	4676	4	4659	99.64	0	0	2	0	0	11	0	0
178515	17665	1	32	0.18	20	1	0	8	0	0	0	3
178515	17665	2	12	0.07	0	0	0	8	1	2	1	0
178515	17665	3	277	1.57	0	64	111	0	6	49	47	0
178515	17665	4	17344	98.18	0	0	43	1	0	72	1	0
178541	9914	1	23	0.23	9	1	0	9	0	0	1	3
178541	9914	2	12	0.12	0	0	0	8	4	0	0	0
178541	9914	3	278	2.80	0	104	131	0	11	15	17	0
178541	9914	4	9601	96.84	0	0	24	0	0	32	0	0
178581	61369	1	829	1.35	283	129	59	229	0	0	59	70
178581	61369	2	425	0.69	0	13	0	208	89	76	39	0
178581	61369	3	4104	6.69	0	2285	1053	0	138	314	313	1
178581	61369	4	56011	91.27	0	0	70	2	0	299	6	0
178608	2014	1	275	13.65	172	0	0	95	0	0	8	0
178608	2014	2	151	7.50	0	0	0	116	0	2	33	0
178608	2014	3	200	9.93	0	8	0	0	15	3	174	0
178608	2014	4	1388	68.92	0	0	25	0	0	20	6	0
178627	40641	1	613	1.51	202	77	55	163	0	0	55	61
178627	40641	2	308	0.76	0	7	0	138	74	64	25	0
178627	40641	3	2321	5.71	0	1192	643	0	94	196	195	1
178627	40641	4	37399	92.02	0	0	53	1	0	235	5	0
178775	43443	1	688	1.58	237	113	56	161	0	0	54	67
178775	43443	2	353	0.81	0	12	0	164	82	66	29	0
178775	43443	3	3284	7.56	0	1823	909	0	111	256	185	0
178775	43443	4	39118	90.04	0	0	45	1	0	236	1	0
178803	34630	1	622	1.80	202	81	56	172	0	0	53	58
178803	34630	2	305	0.88	0	7	0	135	72	64	27	0
178803	34630	3	2162	6.24	0	1144	532	0	88	188	209	1
178803	34630	4	31541	91.08	0	0	44	1	0	224	5	0

178850	22584	1	470	2.08	95	77	55	135	0	0	50	58
178850	22584	2	244	1.08	0	7	0	101	66	57	13	0
178850	22584	3	1248	5.53	0	718	279	0	52	83	115	1
178850	22584	4	20622	91.31	0	0	13	0	0	154	0	0
178888	525	1	89	16.95	0	16	0	16	0	0	2	55
178888	525	2	101	19.24	0	6	0	62	33	0	0	0
178888	525	3	60	11.43	0	52	0	0	8	0	0	0
178888	525	4	275	52.38	0	0	0	0	0	0	0	0
178891	42289	1	674	1.59	217	89	59	192	0	0	56	61
178891	42289	2	328	0.78	0	7	0	148	77	67	29	0
178891	42289	3	2469	5.84	0	1308	620	0	99	199	242	1
178891	42289	4	38818	91.79	0	0	55	1	0	248	6	0
178904	525	1	89	16.95	0	16	0	16	0	0	2	55
178904	525	2	101	19.24	0	6	0	62	33	0	0	0
178904	525	3	60	11.43	0	52	0	0	8	0	0	0
178904	525	4	275	52.38	0	0	0	0	0	0	0	0
178918	42414	1	461	1.09	185	76	0	123	0	0	9	68
178918	42414	2	286	0.67	0	12	0	155	72	20	27	0
178918	42414	3	3243	7.65	0	1861	821	0	114	277	170	0
178918	42414	4	38424	90.59	0	0	36	1	0	129	0	0
178944	27449	1	784	2.86	337	66	59	253	0	0	60	9
178944	27449	2	334	1.22	0	1	0	190	28	63	52	0
178944	27449	3	1547	5.64	0	694	317	0	63	86	385	2
178944	27449	4	24784	90.29	0	0	107	1	0	706	12	0
178977	479	1	86	17.95	0	16	0	13	0	0	2	55
178977	479	2	90	18.79	0	6	0	56	28	0	0	0
178977	479	3	57	11.90	0	52	0	0	5	0	0	0
178977	479	4	246	51.36	0	0	0	0	0	0	0	0
179009	29357	1	549	1.87	175	74	55	136	0	0	51	58
179009	29357	2	270	0.92	0	7	0	112	70	60	21	0
179009	29357	3	1886	6.42	0	1039	494	0	73	159	121	0
179009	29357	4	26652	90.79	0	0	19	0	0	192	0	0
179034	14506	1	17	0.12	9	0	0	5	0	0	0	3
179034	14506	2	5	0.03	0	0	0	5	0	0	0	0
179034	14506	3	152	1.05	0	14	78	0	2	26	32	0

179034	14506	4	14332	98.80	0	0	28	0	0	49	1	0
179091	36646	1	428	1.17	92	69	55	131	0	0	49	32
179091	36646	2	207	0.56	0	5	0	77	54	57	14	0
179091	36646	3	1314	3.59	0	704	313	0	51	102	143	1
179091	36646	4	34697	94.68	0	0	53	1	0	212	2	0
179124	54598	1	686	1.26	222	89	59	195	0	0	57	64
179124	54598	2	332	0.61	0	7	0	152	77	67	29	0
179124	54598	3	2575	4.72	0	1320	661	0	101	221	271	1
179124	54598	4	51005	93.42	0	0	82	2	0	291	7	0
179156	12785	1	38	0.30	16	0	0	20	0	0	2	0
179156	12785	2	23	0.18	0	0	0	21	0	1	1	0
179156	12785	3	250	1.96	0	14	125	0	11	16	84	0
179156	12785	4	12474	97.57	0	0	54	1	0	61	6	0
179173	32517	1	564	1.73	186	75	55	139	0	0	51	58
179173	32517	2	278	0.85	0	7	0	115	70	63	23	0
179173	32517	3	2010	6.18	0	1089	527	0	77	182	135	0
179173	32517	4	29665	91.23	0	0	35	0	0	215	1	0
179233	42289	1	674	1.59	217	89	59	192	0	0	56	61
179233	42289	2	328	0.78	0	7	0	148	77	67	29	0
179233	42289	3	2469	5.84	0	1308	620	0	99	199	242	1
179233	42289	4	38818	91.79	0	0	55	1	0	248	6	0
179314	16673	1	298	1.79	183	0	0	103	0	0	9	3
179314	16673	2	160	0.96	0	0	0	124	0	2	34	0
179314	16673	3	362	2.17	0	23	80	0	19	31	209	0
179314	16673	4	15853	95.08	0	0	55	1	0	77	8	0
179345	6642	1	45	0.68	26	3	0	16	0	0	0	0
179345	6642	2	26	0.39	0	0	0	13	0	8	5	0
179345	6642	3	373	5.62	0	207	67	0	6	60	33	0
179345	6642	4	6198	93.32	0	0	3	0	0	35	0	0
179410	47272	1	327	0.69	142	29	0	85	0	0	9	62
179410	47272	2	221	0.47	0	7	0	121	58	17	18	0
179410	47272	3	2048	4.33	0	1054	522	0	86	225	161	0
179410	47272	4	44676	94.51	0	0	76	1	0	171	6	0
179455	22224	1	34	0.15	13	1	0	12	0	0	2	6
179455	22224	2	17	0.08	0	0	0	13	4	0	0	0

179455	22224	3	384	1.73	0	116	172	0	13	37	46	0
179455	22224	4	21789	98.04	0	0	50	1	0	75	1	0
179462	42289	1	674	1.59	217	89	59	192	0	0	56	61
179462	42289	2	328	0.78	0	7	0	148	77	67	29	0
179462	42289	3	2469	5.84	0	1308	620	0	99	199	242	1
179462	42289	4	38818	91.79	0	0	55	1	0	248	6	0
179484	5166	1	324	6.27	194	7	3	110	0	0	10	0
179484	5166	2	167	3.23	0	0	0	125	0	6	36	0
179484	5166	3	402	7.78	0	120	26	0	19	28	209	0
179484	5166	4	4273	82.71	0	0	30	0	0	44	7	0
179492	34590	1	404	1.17	201	20	3	133	0	0	14	33
179492	34590	2	253	0.73	0	5	0	169	35	8	36	0
179492	34590	3	1054	3.05	0	429	242	0	56	80	247	0
179492	34590	4	32879	95.05	0	0	86	1	0	129	8	0
179532	42	1	5	11.90	2	0	0	3	0	0	0	0
179532	42	2	1	2.38	0	0	0	1	0	0	0	0
179532	42	3	0	0.00	0	0	0	0	0	0	0	0
179532	42	4	36	85.71	0	0	1	0	0	0	0	0
179680	34630	1	622	1.80	202	81	56	172	0	0	53	58
179680	34630	2	305	0.88	0	7	0	135	72	64	27	0
179680	34630	3	2162	6.24	0	1144	532	0	88	188	209	1
179680	34630	4	31541	91.08	0	0	44	1	0	224	5	0
179777	31803	1	549	1.73	175	74	55	136	0	0	51	58
179777	31803	2	272	0.86	0	7	0	113	70	60	22	0
179777	31803	3	1908	6.00	0	1040	510	0	75	161	122	0
179777	31803	4	29074	91.42	0	0	34	0	0	208	0	0
179853	22071	1	464	2.10	95	71	55	133	0	0	52	58
179853	22071	2	256	1.16	0	7	0	113	67	57	12	0
179853	22071	3	1209	5.48	0	667	279	0	58	78	127	0
179853	22071	4	20142	91.26	0	0	20	0	0	153	5	0
179888	34630	1	622	1.80	202	81	56	172	0	0	53	58
179888	34630	2	305	0.88	0	7	0	135	72	64	27	0
179888	34630	3	2162	6.24	0	1144	532	0	88	188	209	1
179888	34630	4	31541	91.08	0	0	44	1	0	224	5	0
179929	323	1	46	14.24	0	9	0	9	0	0	1	27

179929	323	2	56	17.34	0	4	0	33	19	0	0	0
179929	323	3	40	12.38	0	34	0	0	6	0	0	0
179929	323	4	181	56.04	0	0	0	0	0	0	0	0
179946	559	1	92	16.46	0	17	0	16	0	0	2	57
179946	559	2	105	18.78	0	7	0	64	34	0	0	0
179946	559	3	66	11.81	0	57	0	0	9	0	0	0
179946	559	4	296	52.95	0	0	0	0	0	0	0	0
179967	820	1	104	12.68	0	45	0	15	0	0	3	41
179967	820	2	88	10.73	0	10	0	54	24	0	0	0
179967	820	3	229	27.93	0	219	0	0	9	0	1	0
179967	820	4	399	48.66	0	0	0	0	0	0	0	0
179968	46188	1	326	0.71	79	54	16	116	0	0	26	35
179968	46188	2	188	0.41	0	5	0	94	48	24	17	0
179968	46188	3	1761	3.81	0	1014	368	0	60	161	158	0
179968	46188	4	43913	95.07	0	0	53	1	0	213	2	0
179988	80	1	7	8.75	0	1	0	0	0	0	0	6
179988	80	2	2	2.50	0	1	0	1	0	0	0	0
179988	80	3	4	5.00	0	4	0	0	0	0	0	0
179988	80	4	67	83.75	0	0	0	0	0	0	0	0
179999	950	1	144	15.16	0	53	0	21	0	0	3	67
179999	950	2	128	13.47	0	12	0	81	35	0	0	0
179999	950	3	235	24.74	0	223	0	0	10	0	2	0
179999	950	4	443	46.63	0	0	0	0	0	0	0	0
180008	58511	1	745	1.27	334	101	56	155	0	0	53	46
180008	58511	2	312	0.53	0	11	0	148	62	68	23	0
180008	58511	3	2981	5.09	0	1659	778	0	94	233	216	1
180008	58511	4	54473	93.10	0	0	152	2	0	795	3	0
180017	40534	1	631	1.56	244	74	56	143	0	0	52	62
180017	40534	2	303	0.75	0	8	0	129	72	69	25	0
180017	40534	3	2335	5.76	0	1316	551	0	87	224	157	0
180017	40534	4	37265	91.94	0	0	93	1	0	754	1	0
180019	21943	1	336	1.53	131	51	0	105	0	0	49	0
180019	21943	2	161	0.73	0	0	0	74	1	65	21	0
180019	21943	3	1236	5.63	0	727	248	0	23	10	227	1
180019	21943	4	20210	92.10	0	0	39	1	0	641	6	0

180103	4107	1	23	0.56	12	0	0	11	0	0	0	0
180103	4107	2	18	0.44	0	0	0	8	3	0	7	0
180103	4107	3	299	7.28	0	0	259	0	2	0	38	0
180103	4107	4	3767	91.72	0	0	6	0	0	10	0	0
180121	274	1	1	0.36	0	1	0	0	0	0	0	0
180121	274	2	1	0.36	0	0	0	1	0	0	0	0
180121	274	3	15	5.47	0	13	0	0	0	2	0	0
180121	274	4	257	93.80	0	0	0	0	0	0	0	0
180137	3641	1	12	0.33	0	0	0	5	0	0	1	6
180137	3641	2	7	0.19	0	0	0	2	5	0	0	0
180137	3641	3	37	1.02	0	17	0	0	2	18	0	0
180137	3641	4	3585	98.46	0	0	4	0	0	8	0	0
180170	33172	1	589	1.78	194	75	55	154	0	0	53	58
180170	33172	2	295	0.89	0	7	0	130	70	64	24	0
180170	33172	3	2062	6.22	0	1090	527	0	84	182	178	1
180170	33172	4	30226	91.12	0	0	43	0	0	219	5	0
180172	14935	1	210	1.41	119	12	0	47	0	0	4	28
180172	14935	2	104	0.70	0	2	0	63	19	7	13	0
180172	14935	3	1020	6.83	0	455	313	0	40	113	99	0
180172	14935	4	13601	91.07	0	0	33	0	0	77	5	0
180212	39950	1	1039	2.60	540	74	56	246	0	0	61	62
180212	39950	2	456	1.14	0	8	0	252	66	70	60	0
180212	39950	3	2488	6.23	0	1314	513	0	97	220	343	1
180212	39950	4	35967	90.03	0	0	107	1	0	759	9	0
180278	31516	1	220	0.70	40	22	13	75	0	0	10	60
180278	31516	2	146	0.46	0	7	0	71	58	9	1	0
180278	31516	3	857	2.72	0	415	259	0	51	127	5	0
180278	31516	4	30293	96.12	0	0	27	0	0	128	0	0
180290	12243	1	14	0.11	0	1	0	13	0	0	0	0
180290	12243	2	26	0.21	0	0	0	20	2	0	4	0
180290	12243	3	733	5.99	0	322	354	0	14	21	22	0
180290	12243	4	11470	93.69	0	0	4	0	0	31	0	0
180297	5286	1	140	2.65	131	0	0	6	0	0	0	3
180297	5286	2	41	0.78	0	0	0	41	0	0	0	0
180297	5286	3	59	1.12	0	9	0	0	2	12	36	0

180297	5286	4	5046	95.46	0	0	9	1	0	22	7	0
180314	46363	1	401	0.86	149	54	13	95	0	0	26	64
180314	46363	2	228	0.49	0	7	0	118	63	19	21	0
180314	46363	3	2066	4.46	0	1074	555	0	82	204	151	0
180314	46363	4	43668	94.19	0	0	67	1	0	229	2	0
180336	12499	1	567	4.54	282	30	46	168	0	0	37	4
180336	12499	2	244	1.95	0	0	0	145	12	49	38	0
180336	12499	3	661	5.29	0	221	148	0	26	27	239	0
180336	12499	4	11027	88.22	0	0	88	0	0	596	7	0
180362	29592	1	161	0.54	38	28	13	53	0	0	21	8
180362	29592	2	66	0.22	0	0	0	37	12	9	8	0
180362	29592	3	808	2.73	0	383	250	0	24	54	97	0
180362	29592	4	28557	96.50	0	0	76	1	0	178	2	0
180379	50488	1	723	1.43	256	117	59	164	0	0	57	70
180379	50488	2	373	0.74	0	13	0	178	85	68	29	0
180379	50488	3	3577	7.08	0	1953	1015	0	121	270	218	0
180379	50488	4	45815	90.74	0	0	44	1	0	250	1	0
180386	8214	1	88	1.07	80	0	0	5	0	0	0	3
180386	8214	2	14	0.17	0	0	0	7	6	1	0	0
180386	8214	3	274	3.34	0	176	3	0	16	79	0	0
180386	8214	4	7838	95.42	0	0	3	0	0	10	0	0
180544	15680	1	286	1.82	24	22	59	116	0	0	8	57
180544	15680	2	199	1.27	0	7	0	62	49	57	24	0
180544	15680	3	816	5.20	0	459	249	0	21	45	42	0
180544	15680	4	14379	91.70	0	0	10	0	0	28	0	0
180562	49462	1	437	0.88	113	64	55	119	0	0	51	35
180562	49462	2	228	0.46	0	5	0	92	53	64	14	0
180562	49462	3	1841	3.72	0	1004	459	0	62	161	155	0
180562	49462	4	46956	94.93	0	0	89	1	0	270	2	0
180582	74373	1	1085	1.46	452	123	59	310	0	0	68	73
180582	74373	2	574	0.77	0	13	0	325	88	78	70	0
180582	74373	3	4318	5.81	0	2252	1091	0	152	335	487	1
180582	74373	4	68396	91.96	0	0	123	3	0	364	14	1
180609	46318	1	489	1.06	120	73	55	125	0	0	52	64
180609	46318	2	269	0.58	0	7	0	119	65	64	14	0

180609	46318	3	1847	3.99	0	1026	440	0	64	163	154	0
180609	46318	4	43713	94.38	0	0	49	1	0	238	2	0
207016	10216	1	363	3.55	192	26	43	74	0	0	28	0
207016	10216	2	94	0.92	0	0	0	24	10	50	10	0
207016	10216	3	865	8.47	0	386	266	0	26	104	83	0
207016	10216	4	8894	87.06	0	0	9	0	0	597	0	0
207303	55705	1	1013	1.82	443	89	60	291	0	0	64	66
207303	55705	2	490	0.88	0	8	0	276	73	70	63	0
207303	55705	3	2672	4.80	0	1250	630	0	110	228	452	2
207303	55705	4	51530	92.51	0	0	157	2	0	824	14	0
208282	32847	1	592	1.80	223	112	56	150	0	0	51	0
208282	32847	2	163	0.50	0	12	0	31	19	67	34	0
208282	32847	3	2775	8.45	0	1394	908	0	73	260	139	1
208282	32847	4	29317	89.25	0	0	35	1	0	242	5	0
208294	2821	1	93	3.30	0	17	0	17	0	0	3	56
208294	2821	2	104	3.69	0	6	0	62	33	3	0	0
208294	2821	3	121	4.29	0	60	1	0	16	44	0	0
208294	2821	4	2503	88.73	0	0	6	0	0	2	0	0
208675	4287	1	316	7.37	203	28	0	57	0	0	28	0
208675	4287	2	119	2.78	0	0	0	118	0	0	1	0
208675	4287	3	228	5.32	0	42	9	0	17	0	159	1
208675	4287	4	3624	84.53	0	0	21	0	0	11	7	0
209382	2304	1	257	11.15	192	3	0	54	0	0	8	0
209382	2304	2	101	4.38	0	0	0	101	0	0	0	0
209382	2304	3	217	9.42	0	46	10	0	16	0	145	0
209382	2304	4	1729	75.04	0	0	25	0	0	267	6	0
551770	2612	1	394	15.08	274	0	0	111	0	0	9	0
551770	2612	2	160	6.13	0	0	0	125	0	0	35	0
551770	2612	3	171	6.55	0	2	0	0	18	4	147	0
551770	2612	4	1887	72.24	0	0	24	0	0	9	8	0
554256	14569	1	18	0.12	9	0	0	6	0	0	0	3
554256	14569	2	5	0.03	0	0	0	5	0	0	0	0
554256	14569	3	156	1.07	0	15	79	0	3	26	33	0
554256	14569	4	14390	98.77	0	0	29	0	0	53	1	0
554268	13316	1	569	4.27	247	44	55	169	0	0	54	0

554268	13316	2	254	1.91	0	0	0	145	13	54	42	0
554268	13316	3	786	5.90	0	293	184	0	28	31	249	1
554268	13316	4	11707	87.92	0	0	44	0	0	163	7	0
555664	32562	1	417	1.28	108	57	55	114	0	0	51	32
555664	32562	2	201	0.62	0	5	0	89	36	59	12	0
555664	32562	3	1219	3.74	0	517	383	0	43	104	171	1
555664	32562	4	30725	94.36	0	0	79	1	0	224	6	0
173437	14080	1	659	4.68	306	49	56	193	0	0	55	0
173437	14080	2	279	1.98	0	0	0	162	14	58	45	0
173437	14080	3	923	6.56	0	382	173	0	32	56	279	1
173437	14080	4	12219	86.78	0	0	31	0	0	671	7	0
173438	37354	1	925	2.48	415	76	56	254	0	0	62	62
173438	37354	2	462	1.24	0	8	0	259	69	67	59	0
173438	37354	3	2318	6.21	0	1118	536	0	102	194	367	1
173438	37354	4	33649	90.08	0	0	124	1	0	755	12	0
173442	7538	1	448	5.94	240	48	0	105	0	0	55	0
173442	7538	2	225	2.98	0	0	0	160	0	21	44	0
173442	7538	3	723	9.59	0	330	103	0	19	6	264	1
173442	7538	4	6142	81.48	0	0	28	0	0	348	7	0
173453	11233	1	349	3.11	122	44	56	81	0	0	46	0
173453	11233	2	107	0.95	0	0	0	31	14	53	9	0
173453	11233	3	593	5.28	0	286	183	0	14	28	82	0
173453	11233	4	10184	90.66	0	0	5	0	0	639	0	0
173473	11557	1	111	0.96	0	23	0	20	0	0	3	65
173473	11557	2	131	1.13	0	8	0	66	53	4	0	0
173473	11557	3	449	3.89	0	338	16	0	36	59	0	0
173473	11557	4	10866	94.02	0	0	62	0	0	15	0	0
173476	31627	1	275	0.87	117	23	14	45	0	0	11	65
173476	31627	2	145	0.46	0	8	0	69	59	4	5	0
173476	31627	3	1326	4.19	0	519	528	0	69	203	7	0
173476	31627	4	29881	94.48	0	0	80	0	0	186	0	0
173499	23922	1	541	2.26	239	53	56	143	0	0	50	0
173499	23922	2	194	0.81	0	0	0	83	17	66	28	0
173499	23922	3	1595	6.67	0	740	446	0	47	162	199	1
173499	23922	4	21592	90.26	0	0	22	1	0	716	5	0

173502	37956	1	686	1.81	254	82	59	174	0	0	55	62
173502	37956	2	325	0.86	0	8	0	151	72	67	27	0
173502	37956	3	2223	5.86	0	1176	551	0	90	192	213	1
173502	37956	4	34722	91.48	0	0	102	1	0	746	6	0
173505	30911	1	740	2.39	337	56	59	230	0	0	58	0
173505	30911	2	315	1.02	0	0	0	189	15	61	50	0
173505	30911	3	1321	4.27	0	495	326	0	45	75	379	1
173505	30911	4	28535	92.31	0	0	85	2	0	746	14	0
173518	30011	1	852	2.84	455	52	56	231	0	0	58	0
173518	30011	2	345	1.15	0	0	0	199	19	64	63	0
173518	30011	3	2219	7.39	0	667	904	0	78	197	372	1
173518	30011	4	26595	88.62	0	0	49	1	0	742	7	0
173524	10394	1	332	3.19	107	44	56	79	0	0	46	0
173524	10394	2	116	1.12	0	0	0	42	13	53	8	0
173524	10394	3	526	5.06	0	288	134	0	8	10	86	0
173524	10394	4	9420	90.63	0	0	5	0	0	639	0	0
173530	10209	1	227	2.22	97	26	0	76	0	0	28	0
173530	10209	2	105	1.03	0	0	0	35	10	50	10	0
173530	10209	3	721	7.06	0	387	206	0	14	24	90	0
173530	10209	4	9156	89.69	0	0	9	0	0	601	0	0
173591	33089	1	650	1.96	242	76	56	161	0	0	53	62
173591	33089	2	302	0.91	0	8	0	133	72	64	25	0
173591	33089	3	2099	6.34	0	1109	526	0	88	188	187	1
173591	33089	4	30038	90.78	0	0	84	1	0	714	5	0
173592	21611	1	460	2.13	217	19	56	120	0	0	48	0
173592	21611	2	140	0.65	0	0	0	41	17	59	23	0
173592	21611	3	1429	6.61	0	686	442	0	40	128	133	0
173592	21611	4	19582	90.61	0	0	65	0	0	690	0	0
173600	10656	1	329	3.09	135	49	0	99	0	0	46	0
173600	10656	2	115	1.08	0	0	0	34	14	55	12	0
173600	10656	3	557	5.23	0	374	19	0	14	50	100	0
173600	10656	4	9655	90.61	0	0	4	0	0	619	0	0
173609	16831	1	672	3.99	312	49	56	200	0	0	55	0
173609	16831	2	282	1.68	0	0	0	163	15	58	46	0
173609	16831	3	1020	6.06	0	383	258	0	34	60	284	1

173609	16831	4	14857	88.27	0	0	33	0	0	676	7	0
173633	18525	1	238	1.28	105	23	14	30	0	0	4	62
173633	18525	2	138	0.74	0	8	0	67	54	4	5	0
173633	18525	3	961	5.19	0	511	253	0	56	137	4	0
173633	18525	4	17188	92.78	0	0	64	0	0	23	0	0
173637	13118	1	389	2.97	135	49	56	102	0	0	47	0
173637	13118	2	116	0.88	0	0	0	34	15	55	12	0
173637	13118	3	766	5.84	0	374	220	0	18	53	101	0
173637	13118	4	11847	90.31	0	0	6	0	0	646	0	0
173641	2383	1	97	4.07	0	17	0	17	0	0	3	60
173641	2383	2	105	4.41	0	7	0	62	33	3	0	0
173641	2383	3	112	4.70	0	60	0	0	17	35	0	0
173641	2383	4	2069	86.82	0	0	1	0	0	2	0	0
173647	11165	1	385	3.45	135	49	56	99	0	0	46	0
173647	11165	2	125	1.12	0	0	0	45	14	55	11	0
173647	11165	3	592	5.30	0	371	53	0	15	49	104	0
173647	11165	4	10063	90.13	0	0	5	0	0	647	0	0
173673	717	1	1	0.14	0	1	0	0	0	0	0	0
173673	717	2	0	0.00	0	0	0	0	0	0	0	0
173673	717	3	62	8.65	0	62	0	0	0	0	0	0
173673	717	4	654	91.21	0	0	0	0	0	1	0	0
173680	23700	1	302	1.27	109	23	56	36	0	0	16	62
173680	23700	2	187	0.79	0	8	0	101	69	4	5	0
173680	23700	3	1323	5.58	0	510	546	0	71	163	33	0
173680	23700	4	21888	92.35	0	0	66	0	0	179	0	0
173687	22231	1	475	2.14	135	68	56	104	0	0	50	62
173687	22231	2	232	1.04	0	8	0	97	62	56	9	0
173687	22231	3	1127	5.07	0	644	267	0	50	77	89	0
173687	22231	4	20397	91.75	0	0	66	0	0	659	0	0
173695	19116	1	493	2.58	221	52	56	117	0	0	47	0
173695	19116	2	161	0.84	0	1	0	61	16	60	23	0
173695	19116	3	1318	6.89	0	585	418	0	37	138	140	0
173695	19116	4	17144	89.68	0	0	67	0	0	689	0	0
173699	270	1	44	16.30	0	9	0	7	0	0	1	27
173699	270	2	49	18.15	0	4	0	29	16	0	0	0

173699	270	3	34	12.59	0	32	0	0	2	0	0	0
173699	270	4	143	52.96	0	0	0	0	0	0	0	0
173723	341	1	49	14.37	0	9	0	8	0	0	1	31
173723	341	2	53	15.54	0	5	0	30	18	0	0	0
173723	341	3	37	10.85	0	33	0	0	4	0	0	0
173723	341	4	202	59.24	0	0	0	0	0	0	0	0
173736	14751	1	664	4.50	307	49	56	197	0	0	55	0
173736	14751	2	281	1.90	0	0	0	162	15	58	46	0
173736	14751	3	957	6.49	0	385	204	0	33	55	279	1
173736	14751	4	12849	87.11	0	0	31	0	0	671	7	0
173738	4217	1	311	7.37	202	31	0	58	0	0	20	0
173738	4217	2	114	2.70	0	0	0	113	0	0	1	0
173738	4217	3	238	5.64	0	54	0	0	18	0	165	1
173738	4217	4	3554	84.28	0	0	21	0	0	57	7	0
173763	33058	1	678	2.05	305	51	56	202	0	0	55	9
173763	33058	2	292	0.88	0	1	0	170	20	56	45	0
173763	33058	3	1129	3.42	0	435	284	0	39	69	301	1
173763	33058	4	30959	93.65	0	0	128	1	0	733	8	0
173765	4643	1	131	2.82	70	0	0	53	0	0	8	0
173765	4643	2	86	1.85	0	0	0	85	0	1	0	0
173765	4643	3	363	7.82	0	0	206	0	16	1	140	0
173765	4643	4	4063	87.51	0	0	22	0	0	5	0	0
173773	52	1	4	7.69	0	0	0	0	0	0	0	4
173773	52	2	0	0.00	0	0	0	0	0	0	0	0
173773	52	3	0	0.00	0	0	0	0	0	0	0	0
173773	52	4	48	92.31	0	0	0	0	0	0	0	0
173783	9813	1	65	0.66	4	12	0	15	0	0	2	32
173783	9813	2	75	0.76	0	5	0	33	34	3	0	0
173783	9813	3	426	4.34	0	247	91	0	34	52	2	0
173783	9813	4	9247	94.23	0	0	60	0	0	81	0	0
173809	13703	1	648	4.73	295	48	56	194	0	0	55	0
173809	13703	2	275	2.01	0	0	0	160	15	56	44	0
173809	13703	3	849	6.20	0	330	188	0	30	34	266	1
173809	13703	4	11931	87.07	0	0	30	0	0	665	7	0
173830	2611	1	393	15.05	274	0	0	110	0	0	9	0

173830	2611	2	161	6.17	0	0	0	125	0	0	36	0
173830	2611	3	171	6.55	0	2	0	0	18	4	147	0
173830	2611	4	1886	72.23	0	0	24	0	0	9	8	0
173836	2695	1	397	14.73	276	0	0	112	0	0	9	0
173836	2695	2	163	6.05	0	0	0	127	0	0	36	0
173836	2695	3	182	6.75	0	4	0	0	18	4	156	0
173836	2695	4	1953	72.47	0	0	25	0	0	9	8	0
173960	22477	1	248	1.10	128	16	0	67	0	0	6	31
173960	22477	2	141	0.63	0	2	0	81	27	14	17	0
173960	22477	3	1507	6.70	0	799	369	0	56	160	123	0
173960	22477	4	20581	91.56	0	0	29	0	0	93	5	0
173962	580	1	1	0.17	0	0	0	1	0	0	0	0
173962	580	2	37	6.38	0	0	0	33	1	3	0	0
173962	580	3	29	5.00	0	0	0	0	6	23	0	0
173962	580	4	513	88.45	0	0	0	0	0	0	0	0
174014	21585	1	246	1.14	128	16	0	65	0	0	6	31
174014	21585	2	135	0.63	0	2	0	79	24	13	17	0
174014	21585	3	1473	6.82	0	793	352	0	53	153	122	0
174014	21585	4	19731	91.41	0	0	28	0	0	92	5	0
174110	21737	1	91	0.42	29	5	0	53	0	0	4	0
174110	21737	2	88	0.40	0	0	0	55	4	9	20	0
174110	21737	3	1227	5.64	0	347	630	0	31	41	178	0
174110	21737	4	20331	93.53	0	0	61	1	0	126	6	0
174125	6068	1	106	1.75	14	2	56	17	0	0	11	6
174125	6068	2	20	0.33	0	1	0	3	16	0	0	0
174125	6068	3	319	5.26	0	89	175	0	15	35	5	0
174125	6068	4	5623	92.67	0	0	55	0	0	148	0	0
174131	35098	1	259	0.74	121	25	0	49	0	0	5	59
174131	35098	2	167	0.48	0	7	0	86	51	10	13	0
174131	35098	3	1466	4.18	0	711	425	0	62	179	89	0
174131	35098	4	33206	94.61	0	0	58	1	0	134	1	0
174151	25046	1	274	1.09	124	25	0	62	0	0	7	56
174151	25046	2	183	0.73	0	7	0	99	53	10	14	0
174151	25046	3	1456	5.81	0	706	415	0	71	159	105	0
174151	25046	4	23133	92.36	0	0	64	0	0	108	5	0

174156	13230	1	171	1.29	123	4	0	41	0	0	3	0
174156	13230	2	55	0.42	0	0	0	34	2	6	13	0
174156	13230	3	897	6.78	0	273	378	0	32	103	111	0
174156	13230	4	12107	91.51	0	0	39	0	0	81	5	0
174166	13703	1	648	4.73	295	48	56	194	0	0	55	0
174166	13703	2	275	2.01	0	0	0	160	15	56	44	0
174166	13703	3	849	6.20	0	330	188	0	30	34	266	1
174166	13703	4	11931	87.07	0	0	30	0	0	665	7	0
174169	73741	1	841	1.14	288	129	59	233	0	0	59	73
174169	73741	2	430	0.58	0	13	0	212	89	77	39	0
174169	73741	3	4212	5.71	0	2298	1095	0	140	336	342	1
174169	73741	4	68258	92.56	0	0	98	2	0	346	7	1
174177	56712	1	662	1.17	219	83	59	180	0	0	57	64
174177	56712	2	325	0.57	0	7	0	149	76	67	26	0
174177	56712	3	2561	4.52	0	1273	720	0	99	222	246	1
174177	56712	4	53164	93.74	0	0	108	2	0	310	7	0
174238	36467	1	295	0.81	178	51	0	62	0	0	4	0
174238	36467	2	103	0.28	0	7	0	64	4	9	19	0
174238	36467	3	2393	6.56	0	1150	787	0	67	199	190	0
174238	36467	4	33676	92.35	0	0	65	1	0	132	6	0
174248	13858	1	596	4.30	300	48	0	193	0	0	55	0
174248	13858	2	276	1.99	0	0	0	162	14	56	44	0
174248	13858	3	832	6.00	0	349	144	0	29	40	269	1
174248	13858	4	12154	87.70	0	0	30	0	0	671	7	0
174251	9743	1	67	0.69	0	14	0	18	0	0	2	33
174251	9743	2	83	0.85	0	6	0	36	38	3	0	0
174251	9743	3	447	4.59	0	319	51	0	32	43	2	0
174251	9743	4	9146	93.87	0	0	59	0	0	9	0	0
174255	11581	1	349	3.01	122	44	56	81	0	0	46	0
174255	11581	2	107	0.92	0	0	0	31	14	53	9	0
174255	11581	3	602	5.20	0	294	182	0	14	29	83	0
174255	11581	4	10523	90.86	0	0	5	0	0	638	0	0
174273	6945	1	522	7.52	266	23	43	154	0	0	36	0
174273	6945	2	230	3.31	0	0	0	137	10	47	36	0
174273	6945	3	484	6.97	0	136	99	0	22	15	212	0

174273	6945	4	5709	82.20	0	0	27	0	0	575	6	0
174302	24224	1	504	2.08	192	60	59	142	0	0	50	1
174302	24224	2	182	0.75	0	0	0	70	24	63	25	0
174302	24224	3	1701	7.02	0	882	433	0	51	142	192	1
174302	24224	4	21837	90.15	0	0	26	0	0	198	5	0
174482	3395	1	197	5.80	173	0	0	20	0	0	0	4
174482	3395	2	18	0.53	0	0	0	15	1	0	2	0
174482	3395	3	72	2.12	0	21	15	0	7	7	22	0
174482	3395	4	3108	91.55	0	0	60	0	0	514	1	0
174505	3253	1	328	10.08	217	0	0	102	0	0	9	0
174505	3253	2	156	4.80	0	0	0	119	0	3	34	0
174505	3253	3	227	6.98	0	11	11	0	17	4	184	0
174505	3253	4	2542	78.14	0	0	26	0	0	506	6	0
174717	4511	1	470	10.42	345	0	0	116	0	0	9	0
174717	4511	2	169	3.75	0	0	0	131	0	3	35	0
174717	4511	3	250	5.54	0	12	14	0	20	7	197	0
174717	4511	4	3622	80.29	0	0	31	0	0	537	8	0
174826	2616	1	304	11.62	194	0	0	102	0	0	8	0
174826	2616	2	156	5.96	0	0	0	119	0	3	34	0
174826	2616	3	215	8.22	0	11	0	0	16	4	184	0
174826	2616	4	1941	74.20	0	0	26	0	0	273	6	0
174832	6546	1	500	7.64	265	20	43	136	0	0	36	0
174832	6546	2	214	3.27	0	0	0	125	9	46	34	0
174832	6546	3	438	6.69	0	102	95	0	22	15	204	0
174832	6546	4	5394	82.40	0	0	27	0	0	572	6	0
174897	1740	1	261	15.00	154	0	0	99	0	0	8	0
174897	1740	2	161	9.25	0	0	0	127	0	0	34	0
174897	1740	3	165	9.48	0	3	0	0	15	4	143	0
174897	1740	4	1153	66.26	0	0	19	0	0	8	6	0
174930	6618	1	518	7.83	261	23	43	155	0	0	36	0
174930	6618	2	230	3.48	0	0	0	137	10	47	36	0
174930	6618	3	478	7.22	0	137	100	0	19	10	212	0
174930	6618	4	5392	81.47	0	0	29	0	0	578	6	0
174987	9996	1	336	3.36	224	0	0	103	0	0	9	0
174987	9996	2	160	1.60	0	0	0	123	0	3	34	0

174987	9996	3	300	3.00	0	15	37	0	19	17	212	0
174987	9996	4	9200	92.04	0	0	41	1	0	528	8	0
175011	995	1	139	13.97	124	0	0	15	0	0	0	0
175011	995	2	15	1.51	0	0	0	13	0	0	2	0
175011	995	3	14	1.41	0	0	0	0	2	0	12	0
175011	995	4	827	83.12	0	0	4	0	0	1	2	0
175063	29448	1	808	2.74	424	51	56	212	0	0	56	9
175063	29448	2	302	1.03	0	1	0	180	19	56	46	0
175063	29448	3	1076	3.65	0	431	232	0	40	63	309	1
175063	29448	4	27262	92.58	0	0	116	1	0	713	10	0
175070	1564	1	167	10.68	148	0	0	19	0	0	0	0
175070	1564	2	16	1.02	0	0	0	14	0	0	2	0
175070	1564	3	28	1.79	0	4	0	0	2	0	22	0
175070	1564	4	1353	86.51	0	0	5	0	0	258	1	0
175074	5973	1	446	7.47	320	0	0	117	0	0	9	0
175074	5973	2	172	2.88	0	0	0	134	0	3	35	0
175074	5973	3	263	4.40	0	15	0	0	18	4	226	0
175074	5973	4	5092	85.25	0	0	44	1	0	291	9	0
175094	16746	1	347	2.07	225	1	0	105	0	0	9	7
175094	16746	2	164	0.98	0	0	0	125	2	3	34	0
175094	16746	3	367	2.19	0	41	56	0	23	33	214	0
175094	16746	4	15868	94.76	0	0	106	1	0	578	7	0
175129	5469	1	473	8.65	345	0	0	115	0	0	9	4
175129	5469	2	172	3.14	0	0	0	132	1	3	36	0
175129	5469	3	277	5.06	0	30	15	0	23	11	198	0
175129	5469	4	4547	83.14	0	0	85	0	0	538	8	0
175130	3802	1	442	11.63	318	0	0	115	0	0	9	0
175130	3802	2	169	4.45	0	0	0	131	0	3	35	0
175130	3802	3	233	6.13	0	12	0	0	18	6	197	0
175130	3802	4	2958	77.80	0	0	31	0	0	276	8	0
175141	1790	1	59	3.30	48	0	0	7	0	0	0	4
175141	1790	2	4	0.22	0	0	0	3	1	0	0	0
175141	1790	3	47	2.63	0	16	11	0	4	6	10	0
175141	1790	4	1680	93.85	0	0	1	0	0	486	0	0
175147	967	1	135	13.96	122	0	0	13	0	0	0	0

175147	967	2	12	1.24	0	0	0	11	0	0	1	0
175147	967	3	13	1.34	0	0	0	0	2	0	11	0
175147	967	4	807	83.45	0	0	4	0	0	0	1	0
175170	1040	1	142	13.65	125	0	0	17	0	0	0	0
175170	1040	2	15	1.44	0	0	0	13	0	0	2	0
175170	1040	3	17	1.63	0	0	0	0	2	0	15	0
175170	1040	4	866	83.27	0	0	4	0	0	1	1	0
175272	43211	1	696	1.61	242	113	56	164	0	0	54	67
175272	43211	2	356	0.82	0	13	0	166	82	66	29	0
175272	43211	3	3316	7.67	0	1824	932	0	111	260	189	0
175272	43211	4	38843	89.89	0	0	33	1	0	227	1	0
175350	38870	1	302	0.78	132	27	0	72	0	0	9	62
175350	38870	2	199	0.51	0	7	0	110	57	11	14	0
175350	38870	3	1717	4.42	0	812	494	0	80	187	144	0
175350	38870	4	36652	94.29	0	0	60	1	0	132	6	0
175365	17358	1	283	1.63	39	22	55	94	0	0	16	57
175365	17358	2	178	1.03	0	7	0	67	65	38	1	0
175365	17358	3	730	4.21	0	324	275	0	48	76	7	0
175365	17358	4	16167	93.14	0	0	8	0	0	116	0	0
175622	15220	1	32	0.21	20	1	0	8	0	0	0	3
175622	15220	2	12	0.08	0	0	0	8	1	2	1	0
175622	15220	3	256	1.68	0	62	96	0	5	47	46	0
175622	15220	4	14920	98.03	0	0	28	0	0	56	1	0
176207	2109	1	275	13.04	172	0	0	95	0	0	8	0
176207	2109	2	163	7.73	0	0	0	128	0	2	33	0
176207	2109	3	206	9.77	0	8	0	0	15	4	179	0
176207	2109	4	1465	69.46	0	0	25	0	0	25	6	0
176209	1601	1	251	15.68	149	0	0	94	0	0	8	0
176209	1601	2	144	8.99	0	0	0	111	0	0	33	0
176209	1601	3	155	9.68	0	2	0	0	15	3	135	0
176209	1601	4	1051	65.65	0	0	19	0	0	8	6	0
176259	11866	1	287	2.42	181	0	0	98	0	0	8	0
176259	11866	2	155	1.31	0	0	0	120	0	2	33	0
176259	11866	3	335	2.82	0	13	77	0	17	20	208	0
176259	11866	4	11089	93.45	0	0	51	1	0	61	7	0

176292	4471	1	335	7.49	220	0	0	102	0	0	9	4
176292	4471	2	170	3.80	0	0	0	132	1	3	34	0
176292	4471	3	264	5.90	0	29	15	0	20	11	189	0
176292	4471	4	3702	82.80	0	0	80	0	0	536	6	0
176472	2734	1	402	14.70	280	0	0	113	0	0	9	0
176472	2734	2	163	5.96	0	0	0	125	0	0	38	0
176472	2734	3	175	6.40	0	2	0	0	18	4	151	0
176472	2734	4	1994	72.93	0	0	25	0	0	11	9	0
176507	1766	1	266	15.06	158	0	0	100	0	0	8	0
176507	1766	2	150	8.49	0	0	0	114	0	0	36	0
176507	1766	3	161	9.12	0	2	0	0	16	3	140	0
176507	1766	4	1189	67.33	0	0	20	0	0	10	8	0
176567	1766	1	266	15.06	158	0	0	100	0	0	8	0
176567	1766	2	150	8.49	0	0	0	114	0	0	36	0
176567	1766	3	161	9.12	0	2	0	0	16	3	140	0
176567	1766	4	1189	67.33	0	0	20	0	0	10	8	0
176593	1766	1	266	15.06	158	0	0	100	0	0	8	0
176593	1766	2	150	8.49	0	0	0	114	0	0	36	0
176593	1766	3	161	9.12	0	2	0	0	16	3	140	0
176593	1766	4	1189	67.33	0	0	20	0	0	10	8	0
176612	4752	1	351	7.39	230	0	0	108	0	0	9	4
176612	4752	2	163	3.43	0	0	0	122	1	3	37	0
176612	4752	3	272	5.72	0	32	16	0	22	11	191	0
176612	4752	4	3966	83.46	0	0	86	0	0	545	8	0
176619	2254	1	277	12.29	163	0	0	106	0	0	8	0
176619	2254	2	155	6.88	0	0	0	118	0	0	37	0
176619	2254	3	194	8.61	0	3	0	0	17	4	170	0
176619	2254	4	1628	72.23	0	0	30	1	0	13	9	0
176638	1838	1	273	14.85	161	0	0	104	0	0	8	0
176638	1838	2	153	8.32	0	0	0	116	0	0	37	0
176638	1838	3	166	9.03	0	2	0	0	16	4	144	0
176638	1838	4	1246	67.79	0	0	20	0	0	11	8	0
176646	42	1	5	11.90	2	0	0	3	0	0	0	0
176646	42	2	1	2.38	0	0	0	1	0	0	0	0
176646	42	3	0	0.00	0	0	0	0	0	0	0	0

176646	42	4	36	85.71	0	0	1	0	0	0	0	0
176661	1766	1	266	15.06	158	0	0	100	0	0	8	0
176661	1766	2	150	8.49	0	0	0	114	0	0	36	0
176661	1766	3	161	9.12	0	2	0	0	16	3	140	0
176661	1766	4	1189	67.33	0	0	20	0	0	10	8	0
176675	1766	1	266	15.06	158	0	0	100	0	0	8	0
176675	1766	2	150	8.49	0	0	0	114	0	0	36	0
176675	1766	3	161	9.12	0	2	0	0	16	3	140	0
176675	1766	4	1189	67.33	0	0	20	0	0	10	8	0
176686	1766	1	266	15.06	158	0	0	100	0	0	8	0
176686	1766	2	150	8.49	0	0	0	114	0	0	36	0
176686	1766	3	161	9.12	0	2	0	0	16	3	140	0
176686	1766	4	1189	67.33	0	0	20	0	0	10	8	0
176721	1796	1	268	14.92	159	0	0	101	0	0	8	0
176721	1796	2	150	8.35	0	0	0	114	0	0	36	0
176721	1796	3	165	9.19	0	2	0	0	15	4	144	0
176721	1796	4	1213	67.54	0	0	19	0	0	11	7	0
176815	3140	1	405	12.90	282	0	0	114	0	0	9	0
176815	3140	2	166	5.29	0	0	0	128	0	0	38	0
176815	3140	3	200	6.37	0	4	0	0	18	4	174	0
176815	3140	4	2369	75.45	0	0	41	1	0	15	10	0
176837	3099	1	354	11.42	265	0	0	89	0	0	0	0
176837	3099	2	169	5.45	0	0	0	129	0	2	38	0
176837	3099	3	185	5.97	0	5	0	0	2	4	174	0
176837	3099	4	2391	77.15	0	0	7	1	0	23	10	0
176888	2734	1	402	14.70	280	0	0	113	0	0	9	0
176888	2734	2	163	5.96	0	0	0	125	0	0	38	0
176888	2734	3	175	6.40	0	2	0	0	18	4	151	0
176888	2734	4	1994	72.93	0	0	25	0	0	11	9	0
176922	2806	1	410	14.61	284	0	0	117	0	0	9	0
176922	2806	2	166	5.92	0	0	0	128	0	0	38	0
176922	2806	3	181	6.45	0	3	0	0	18	4	156	0
176922	2806	4	2049	73.02	0	0	25	0	0	12	9	0
176924	2734	1	402	14.70	280	0	0	113	0	0	9	0
176924	2734	2	163	5.96	0	0	0	125	0	0	38	0

176924	2734	3	175	6.40	0	2	0	0	18	4	151	0
176924	2734	4	1994	72.93	0	0	25	0	0	11	9	0
176927	2734	1	402	14.70	280	0	0	113	0	0	9	0
176927	2734	2	163	5.96	0	0	0	125	0	0	38	0
176927	2734	3	175	6.40	0	2	0	0	18	4	151	0
176927	2734	4	1994	72.93	0	0	25	0	0	11	9	0
177831	23802	1	473	1.99	98	77	58	131	0	0	51	58
177831	23802	2	250	1.05	0	7	0	105	67	59	12	0
177831	23802	3	1257	5.28	0	731	289	0	52	80	105	0
177831	23802	4	21822	91.68	0	0	16	0	0	163	1	0
177884	18320	1	56	0.31	28	1	0	22	0	0	2	3
177884	18320	2	29	0.16	0	0	0	22	1	3	3	0
177884	18320	3	328	1.79	0	65	111	0	13	49	90	0
177884	18320	4	17907	97.75	0	0	52	1	0	75	6	0
177935	1725	1	259	15.01	152	0	0	99	0	0	8	0
177935	1725	2	147	8.52	0	0	0	113	0	0	34	0
177935	1725	3	160	9.28	0	2	0	0	16	3	139	0
177935	1725	4	1159	67.19	0	0	20	0	0	8	7	0
177961	8851	1	85	0.96	12	12	0	30	0	0	4	27
177961	8851	2	92	1.04	0	5	0	51	32	3	1	0
177961	8851	3	426	4.81	0	242	65	0	35	37	47	0
177961	8851	4	8248	93.19	0	0	15	0	0	19	4	0
178032	28361	1	534	1.88	115	84	59	165	0	0	53	58
178032	28361	2	278	0.98	0	7	0	125	69	61	16	0
178032	28361	3	1428	5.04	0	787	309	0	64	87	180	1
178032	28361	4	26121	92.10	0	0	40	1	0	188	5	0
178166	34630	1	622	1.80	202	81	56	172	0	0	53	58
178166	34630	2	305	0.88	0	7	0	135	72	64	27	0
178166	34630	3	2162	6.24	0	1144	532	0	88	188	209	1
178166	34630	4	31541	91.08	0	0	44	1	0	224	5	0
178202	40587	1	649	1.60	212	83	56	186	0	0	54	58
178202	40587	2	326	0.80	0	7	0	145	73	70	31	0
178202	40587	3	2471	6.09	0	1384	545	0	92	224	225	1
178202	40587	4	37141	91.51	0	0	46	1	0	247	5	0
178279	27104	1	98	0.36	41	5	0	42	0	0	4	6

178279	27104	2	60	0.22	0	0	0	40	5	9	6	0
178279	27104	3	826	3.05	0	403	187	0	26	93	117	0
178279	27104	4	26120	96.37	0	0	47	1	0	93	6	0
178359	20540	1	523	2.55	285	25	0	143	0	0	14	56
178359	20540	2	321	1.56	0	7	0	202	53	12	47	0
178359	20540	3	1507	7.34	0	705	337	0	77	156	232	0
178359	20540	4	18189	88.55	0	0	41	0	0	92	7	0
178431	6947	1	346	4.98	209	6	0	122	0	0	9	0
178431	6947	2	170	2.45	0	0	0	130	0	4	36	0
178431	6947	3	349	5.02	0	78	0	0	17	4	250	0
178431	6947	4	6082	87.55	0	0	51	1	0	303	8	0
178464	16951	1	18	0.11	10	0	0	5	0	0	0	3
178464	16951	2	7	0.04	0	0	0	6	1	0	0	0
178464	16951	3	173	1.02	0	16	94	0	3	27	33	0
178464	16951	4	16753	98.83	0	0	42	0	0	65	1	0
178532	49400	1	714	1.45	248	115	56	174	0	0	54	67
178532	49400	2	373	0.76	0	12	0	174	82	72	33	0
178532	49400	3	3594	7.28	0	2063	922	0	116	292	201	0
178532	49400	4	44719	90.52	0	0	47	1	0	260	1	0
178605	12642	1	346	2.74	202	8	3	119	0	0	11	3
178605	12642	2	182	1.44	0	0	0	134	4	7	37	0
178605	12642	3	663	5.24	0	223	143	0	29	42	226	0
178605	12642	4	11451	90.58	0	0	40	0	0	61	7	0
178709	50829	1	762	1.50	257	121	56	201	0	0	57	70
178709	50829	2	391	0.77	0	13	0	190	87	68	33	0
178709	50829	3	3647	7.18	0	1978	993	0	132	271	272	1
178709	50829	4	46029	90.56	0	0	62	1	0	255	6	0
178784	24667	1	283	1.15	158	48	0	64	0	0	4	9
178784	24667	2	134	0.54	0	5	0	75	22	11	21	0
178784	24667	3	2269	9.20	0	1219	657	0	70	190	133	0
178784	24667	4	21981	89.11	0	0	34	1	0	92	0	0
178844	22071	1	464	2.10	95	71	55	133	0	0	52	58
178844	22071	2	256	1.16	0	7	0	113	67	57	12	0
178844	22071	3	1209	5.48	0	667	279	0	58	78	127	0
178844	22071	4	20142	91.26	0	0	20	0	0	153	5	0

178853	346	1	51	14.74	0	8	0	10	0	0	2	31
178853	346	2	57	16.47	0	2	0	35	20	0	0	0
178853	346	3	41	11.85	0	34	0	0	7	0	0	0
178853	346	4	197	56.94	0	0	0	0	0	0	0	0
178878	6	1	0	0.00	0	0	0	0	0	0	0	0
178878	6	2	0	0.00	0	0	0	0	0	0	0	0
178878	6	3	0	0.00	0	0	0	0	0	0	0	0
178878	6	4	6	100.00	0	0	0	0	0	0	0	0
178898	7084	1	222	3.13	22	75	0	30	0	0	38	57
178898	7084	2	166	2.34	0	7	0	81	33	26	19	0
178898	7084	3	843	11.90	0	668	0	0	20	35	119	1
178898	7084	4	5853	82.62	0	0	5	0	0	50	0	0
178905	31471	1	606	1.93	190	80	56	169	0	0	53	58
178905	31471	2	298	0.95	0	7	0	132	72	62	25	0
178905	31471	3	2038	6.48	0	1093	500	0	84	165	195	1
178905	31471	4	28529	90.65	0	0	29	1	0	201	5	0
178911	593	1	96	16.19	0	17	0	17	0	0	3	59
178911	593	2	105	17.71	0	7	0	63	35	0	0	0
178911	593	3	75	12.65	0	65	0	0	10	0	0	0
178911	593	4	317	53.46	0	0	0	0	0	0	0	0
178927	8924	1	163	1.83	95	11	0	27	0	0	2	28
178927	8924	2	80	0.90	0	2	0	45	19	4	10	0
178927	8924	3	797	8.93	0	402	243	0	29	86	37	0
178927	8924	4	7884	88.35	0	0	7	0	0	44	0	0
178935	6520	1	120	1.84	21	2	55	30	0	0	11	1
178935	6520	2	23	0.35	0	0	0	2	16	5	0	0
178935	6520	3	284	4.36	0	71	169	0	12	27	5	0
178935	6520	4	6093	93.45	0	0	1	0	0	97	0	0
178964	31545	1	546	1.73	197	67	59	166	0	0	52	5
178964	31545	2	192	0.61	0	0	0	78	27	61	26	0
178964	31545	3	1923	6.10	0	984	521	0	59	132	226	1
178964	31545	4	28884	91.56	0	0	35	1	0	212	6	0
178979	14971	1	266	1.78	76	13	55	86	0	0	7	29
178979	14971	2	167	1.12	0	5	0	55	45	55	7	0
178979	14971	3	549	3.67	0	245	166	0	37	65	36	0

178979	14971	4	13989	93.44	0	0	9	0	0	96	0	0
179010	43111	1	744	1.73	253	119	56	194	0	0	55	67
179010	43111	2	379	0.88	0	12	0	183	83	68	33	0
179010	43111	3	3416	7.92	0	1876	899	0	121	260	259	1
179010	43111	4	38572	89.47	0	0	39	1	0	228	6	0
179045	34505	1	685	1.99	276	63	59	225	0	0	57	5
179045	34505	2	294	0.85	0	0	0	166	21	59	48	0
179045	34505	3	1265	3.67	0	532	284	0	39	69	339	2
179045	34505	4	32261	93.50	0	0	77	2	0	238	8	0
179104	61011	1	742	1.22	262	116	56	182	0	0	56	70
179104	61011	2	384	0.63	0	13	0	189	84	67	31	0
179104	61011	3	3578	5.86	0	1860	1014	0	125	289	289	1
179104	61011	4	56307	92.29	0	0	106	2	0	307	7	0
179108	5443	1	314	5.77	188	0	0	116	0	0	10	0
179108	5443	2	174	3.20	0	0	0	134	0	3	37	0
179108	5443	3	302	5.55	0	17	0	0	24	4	257	0
179108	5443	4	4653	85.49	0	0	81	1	0	60	13	0
179145	31862	1	292	0.92	130	28	0	68	0	0	7	59
179145	31862	2	198	0.62	0	7	0	102	57	16	16	0
179145	31862	3	1872	5.88	0	1040	466	0	76	202	88	0
179145	31862	4	29500	92.59	0	0	27	0	0	109	0	0
179165	16430	1	17	0.10	9	0	0	5	0	0	0	3
179165	16430	2	6	0.04	0	0	0	6	0	0	0	0
179165	16430	3	166	1.01	0	12	93	0	3	24	34	0
179165	16430	4	16241	98.85	0	0	42	0	0	63	1	0
179186	50829	1	762	1.50	257	121	56	201	0	0	57	70
179186	50829	2	391	0.77	0	13	0	190	87	68	33	0
179186	50829	3	3647	7.18	0	1978	993	0	132	271	272	1
179186	50829	4	46029	90.56	0	0	62	1	0	255	6	0
179236	54682	1	636	1.16	211	83	59	164	0	0	55	64
179236	54682	2	307	0.56	0	7	0	134	75	66	25	0
179236	54682	3	2474	4.52	0	1268	694	0	91	220	201	0
179236	54682	4	51265	93.75	0	0	75	1	0	289	2	0
179259	3947	1	5	0.13	0	0	0	5	0	0	0	0
179259	3947	2	14	0.35	0	0	0	6	7	1	0	0

179259	3947	3	340	8.61	0	169	121	0	15	29	6	0
179259	3947	4	3588	90.90	0	0	3	0	0	9	0	0
179333	3089	1	8	0.26	4	0	0	4	0	0	0	0
179333	3089	2	6	0.19	0	0	0	3	3	0	0	0
179333	3089	3	83	2.69	0	9	54	0	4	12	4	0
179333	3089	4	2992	96.86	0	0	3	0	0	7	0	0
179340	8303	1	45	0.54	26	3	0	16	0	0	0	0
179340	8303	2	26	0.31	0	0	0	13	0	8	5	0
179340	8303	3	456	5.49	0	289	67	0	7	60	33	0
179340	8303	4	7776	93.65	0	0	3	0	0	36	0	0
179346	1601	1	251	15.68	149	0	0	94	0	0	8	0
179346	1601	2	144	8.99	0	0	0	111	0	0	33	0
179346	1601	3	155	9.68	0	2	0	0	15	3	135	0
179346	1601	4	1051	65.65	0	0	19	0	0	8	6	0
179435	26590	1	199	0.75	116	12	0	36	0	0	3	32
179435	26590	2	94	0.35	0	2	0	54	20	6	12	0
179435	26590	3	1074	4.04	0	466	354	0	35	135	84	0
179435	26590	4	25223	94.86	0	0	51	1	0	117	1	0
179464	28623	1	184	0.64	118	11	3	42	0	0	4	6
179464	28623	2	63	0.22	0	0	0	33	8	9	13	0
179464	28623	3	1241	4.34	0	597	361	0	37	135	111	0
179464	28623	4	27135	94.80	0	0	45	1	0	117	1	0
179628	18264	1	19	0.10	10	0	0	6	0	0	0	3
179628	18264	2	7	0.04	0	0	0	6	1	0	0	0
179628	18264	3	206	1.13	0	19	119	0	4	29	35	0
179628	18264	4	18032	98.73	0	0	66	1	0	79	1	0
179725	570	1	96	16.84	0	17	0	17	0	0	3	59
179725	570	2	105	18.42	0	7	0	63	35	0	0	0
179725	570	3	64	11.23	0	55	0	0	9	0	0	0
179725	570	4	305	53.51	0	0	0	0	0	0	0	0
179731	57167	1	944	1.65	394	84	56	286	0	0	63	61
179731	57167	2	486	0.85	0	7	0	268	74	73	64	0
179731	57167	3	2833	4.96	0	1406	625	0	111	255	434	2
179731	57167	4	52904	92.54	0	0	100	2	0	320	13	0
179779	39843	1	672	1.69	216	89	59	191	0	0	56	61

179779	39843	2	327	0.82	0	7	0	148	76	67	29	0
179779	39843	3	2450	6.15	0	1307	605	0	97	198	242	1
179779	39843	4	36394	91.34	0	0	41	1	0	232	6	0
179865	33172	1	589	1.78	194	75	55	154	0	0	53	58
179865	33172	2	295	0.89	0	7	0	130	70	64	24	0
179865	33172	3	2062	6.22	0	1090	527	0	84	182	178	1
179865	33172	4	30226	91.12	0	0	43	0	0	219	5	0
179883	6862	1	104	1.52	0	21	0	23	0	0	3	57
179883	6862	2	126	1.84	0	7	0	66	50	3	0	0
179883	6862	3	299	4.36	0	215	12	0	34	38	0	0
179883	6862	4	6333	92.29	0	0	5	0	0	7	0	0
179921	75850	1	1117	1.47	460	129	59	328	0	0	68	73
179921	75850	2	595	0.78	0	13	0	341	90	79	72	0
179921	75850	3	4423	5.83	0	2306	1096	0	156	341	522	2
179921	75850	4	69715	91.91	0	0	123	3	0	371	14	1
179943	961	1	142	14.78	0	52	0	22	0	0	3	65
179943	961	2	134	13.94	0	12	0	84	38	0	0	0
179943	961	3	234	24.35	0	218	0	0	14	0	2	0
179943	961	4	451	46.93	0	0	0	0	0	0	0	0
179964	11092	1	551	4.97	279	46	0	165	0	0	55	6
179964	11092	2	255	2.30	0	1	0	153	4	55	42	0
179964	11092	3	748	6.74	0	303	151	0	25	11	257	1
179964	11092	4	9538	85.99	0	0	30	0	0	559	7	0
179971	42479	1	499	1.17	305	14	3	157	0	0	14	6
179971	42479	2	252	0.59	0	0	0	168	15	18	51	0
179971	42479	3	1872	4.41	0	858	450	0	65	190	309	0
179971	42479	4	39856	93.83	0	0	91	2	0	187	8	0
179977	540	1	94	17.41	0	17	0	15	0	0	3	59
179977	540	2	98	18.15	0	7	0	60	31	0	0	0
179977	540	3	62	11.48	0	55	0	0	7	0	0	0
179977	540	4	286	52.96	0	0	0	0	0	0	0	0
180000	973	1	144	14.80	0	53	0	21	0	0	3	67
180000	973	2	133	13.67	0	12	0	85	36	0	0	0
180000	973	3	237	24.36	0	223	0	0	12	0	2	0
180000	973	4	459	47.17	0	0	0	0	0	0	0	0

180014	32834	1	534	1.63	215	62	56	117	0	0	50	34
180014	32834	2	227	0.69	0	6	0	85	55	61	20	0
180014	32834	3	1849	5.63	0	997	491	0	73	162	126	0
180014	32834	4	30224	92.05	0	0	89	0	0	718	1	0
180025	23390	1	301	1.29	160	25	0	50	0	0	5	61
180025	23390	2	163	0.70	0	7	0	83	50	10	13	0
180025	23390	3	1369	5.85	0	716	369	0	63	154	67	0
180025	23390	4	21557	92.16	0	0	108	0	0	609	0	0
180088	3863	1	4	0.10	2	0	0	2	0	0	0	0
180088	3863	2	1	0.03	0	0	0	1	0	0	0	0
180088	3863	3	93	2.41	0	6	78	0	1	2	6	0
180088	3863	4	3765	97.46	0	0	38	0	0	29	0	0
180120	18432	1	527	2.86	256	27	45	161	0	0	38	0
180120	18432	2	258	1.40	0	0	0	160	9	51	38	0
180120	18432	3	782	4.24	0	205	185	0	31	51	309	1
180120	18432	4	16865	91.50	0	0	66	1	0	126	12	0
180127	1041	1	148	14.22	0	53	0	23	0	0	4	68
180127	1041	2	138	13.26	0	12	0	86	40	0	0	0
180127	1041	3	250	24.02	0	233	0	0	15	0	2	0
180127	1041	4	505	48.51	0	0	0	0	0	0	0	0
180166	937	1	141	15.05	0	52	0	21	0	0	3	65
180166	937	2	129	13.77	0	12	0	82	35	0	0	0
180166	937	3	232	24.76	0	218	0	0	12	0	2	0
180166	937	4	435	46.42	0	0	0	0	0	0	0	0
180207	13462	1	163	1.21	0	57	0	33	0	0	5	68
180207	13462	2	170	1.26	0	12	0	91	63	4	0	0
180207	13462	3	857	6.37	0	619	115	0	54	67	2	0
180207	13462	4	12272	91.16	0	0	11	0	0	19	0	0
180276	945	1	141	14.92	0	52	0	21	0	0	3	65
180276	945	2	131	13.86	0	12	0	82	37	0	0	0
180276	945	3	232	24.55	0	218	0	0	12	0	2	0
180276	945	4	441	46.67	0	0	0	0	0	0	0	0
180279	37336	1	790	2.12	376	77	59	220	0	0	58	0
180279	37336	2	392	1.05	0	7	0	243	19	67	56	0
180279	37336	3	2418	6.48	0	1185	615	0	75	199	343	1

180279	37336	4	33736	90.36	0	0	61	1	0	251	8	0
180294	967	1	142	14.68	0	52	0	22	0	0	3	65
180294	967	2	136	14.06	0	12	0	85	39	0	0	0
180294	967	3	234	24.20	0	218	0	0	14	0	2	0
180294	967	4	455	47.05	0	0	0	0	0	0	0	0
180342	22217	1	332	1.49	186	5	0	125	0	0	10	6
180342	22217	2	174	0.78	0	0	0	130	5	3	36	0
180342	22217	3	615	2.77	0	158	163	0	28	41	225	0
180342	22217	4	21096	94.95	0	0	61	1	0	84	8	0
180363	16067	1	11	0.07	5	0	0	3	0	0	0	3
180363	16067	2	5	0.03	0	0	0	4	1	0	0	0
180363	16067	3	156	0.97	0	17	81	0	4	24	30	0
180363	16067	4	15895	98.93	0	0	63	1	0	73	1	0
180372	20083	1	422	2.10	77	71	59	105	0	0	52	58
180372	20083	2	237	1.18	0	7	0	111	41	64	14	0
180372	20083	3	1092	5.44	0	602	299	0	29	46	116	0
180372	20083	4	18332	91.28	0	0	26	0	0	192	0	0
180390	961	1	142	14.78	0	52	0	22	0	0	3	65
180390	961	2	134	13.94	0	12	0	84	38	0	0	0
180390	961	3	234	24.35	0	218	0	0	14	0	2	0
180390	961	4	451	46.93	0	0	0	0	0	0	0	0
180553	42032	1	779	1.85	355	85	56	207	0	0	58	18
180553	42032	2	356	0.85	0	6	0	208	33	60	49	0
180553	42032	3	2368	5.63	0	1139	663	0	75	147	343	1
180553	42032	4	38529	91.67	0	0	124	2	0	736	8	0
180570	80	1	5	6.25	0	0	0	3	0	0	0	2
180570	80	2	12	15.00	0	0	0	7	5	0	0	0
180570	80	3	8	10.00	0	4	0	0	4	0	0	0
180570	80	4	55	68.75	0	0	0	0	0	0	0	0
180572	9748	1	510	5.23	270	20	43	138	0	0	35	4
180572	9748	2	229	2.35	0	0	0	139	10	46	34	0
180572	9748	3	519	5.32	0	122	134	0	25	24	214	0
180572	9748	4	8490	87.09	0	0	84	0	0	582	6	0
180599	65733	1	559	0.85	215	93	13	135	0	0	30	73
180599	65733	2	330	0.50	0	13	0	181	77	28	31	0

180599	65733	3	3713	5.65	0	2053	994	0	124	319	223	0
180599	65733	4	61131	93.00	0	0	81	2	0	280	2	0
180699	74330	1	1083	1.46	452	123	59	308	0	0	68	73
180699	74330	2	584	0.79	0	13	0	336	87	78	70	0
180699	74330	3	4319	5.81	0	2251	1090	0	152	335	490	1
180699	74330	4	68344	91.95	0	0	121	3	0	362	14	1
207286	27764	1	698	2.51	303	57	59	222	0	0	57	0
207286	27764	2	307	1.11	0	0	0	184	6	64	53	0
207286	27764	3	1492	5.37	0	645	391	0	38	48	369	1
207286	27764	4	25267	91.01	0	0	67	1	0	765	9	0
208283	18769	1	278	1.48	156	5	13	32	0	0	5	67
208283	18769	2	161	0.86	0	0	0	93	64	4	0	0
208283	18769	3	1130	6.02	0	676	179	0	73	199	3	0
208283	18769	4	17200	91.64	0	0	12	0	0	18	0	0
208295	8606	1	86	1.00	23	32	0	16	0	0	15	0
208295	8606	2	81	0.94	0	0	0	81	0	0	0	0
208295	8606	3	889	10.33	0	694	9	0	15	2	168	1
208295	8606	4	7550	87.73	0	0	32	0	0	78	5	0
208680	12661	1	470	3.71	249	28	14	145	0	0	28	6
208680	12661	2	222	1.75	0	1	0	158	9	12	42	0
208680	12661	3	705	5.57	0	294	104	0	31	32	243	1
208680	12661	4	11264	88.97	0	0	83	0	0	627	7	0
209006	3102	1	42	1.35	9	3	0	28	0	0	2	0
209006	3102	2	43	1.39	0	0	0	28	0	6	9	0
209006	3102	3	360	11.61	0	257	0	0	10	1	92	0
209006	3102	4	2657	85.65	0	0	15	0	0	31	5	0
550246	22397	1	459	2.05	197	54	0	115	0	0	31	62
550246	22397	2	173	0.77	0	0	0	42	52	57	22	0
550246	22397	3	1417	6.33	0	816	368	0	32	92	109	0
550246	22397	4	20348	90.85	0	0	15	0	0	598	0	0
551771	14795	1	771	5.21	404	48	56	208	0	0	55	0
551771	14795	2	289	1.95	0	0	0	172	15	56	46	0
551771	14795	3	847	5.72	0	337	188	0	27	15	279	1
551771	14795	4	12888	87.11	0	0	35	0	0	667	9	0
554447	2734	1	402	14.70	280	0	0	113	0	0	9	0

554447	2734	2	163	5.96	0	0	0	125	0	0	38	0
554447	2734	3	175	6.40	0	2	0	0	18	4	151	0
554447	2734	4	1994	72.93	0	0	25	0	0	11	9	0
563935	24080	1	346	1.44	148	39	13	92	0	0	24	30
563935	24080	2	162	0.67	0	2	0	91	30	17	22	0
563935	24080	3	1497	6.22	0	728	419	0	54	142	154	0
563935	24080	4	22075	91.67	0	0	39	0	0	173	5	0

Appendix 11. All management areas identified by SC-GAP as management status 1 or 2 along with the manager and source of the information used to categorize the area

Manager	Name	Acres	Status	Source
CU	Clemson Experimental Forest-Causey	798.94	2	1
CU	Clemson Experimental Forest-Liberty 1	135.45	2	1
CU	Clemson Experimental Forest-Liberty 2	225.56	2	1
CU	Clemson Experimental Forest-Liberty 3	207.14	2	1
NAS	Francis Beidler Forest	11019.62	1	2
NPS	Congaree Swamp National Monument	22200.00	1	3
SCDNR	Aiken Gopher Tortoise Heritage Preserve	1394.90	1	4
SCDNR	Ashmore Heritage Preserve	1039.52	1	4
SCDNR	Bald Rock Heritage Preserve	163.02	1	4
SCDNR	Bay Point Shoal Heritage Preserve	1.00	1	4
SCDNR	Bear Branch Heritage Preserve	172.25	1	4
SCDNR	Belvue Springs Heritage Preserve	28.41	1	4
SCDNR	Bennett's Bay Heritage Preserve	679.83	1	4
SCDNR	Bird Key-Stono Heritage Preserve	20.00	1	4
SCDNR	Bird Mountain Tract	43.70	1	4
SCDNR	Blackwell Bunched Arrowhead Heritage Preserve	15.80	1	4
SCDNR	Brasstown Creek Heritage Preserve	461.30	1	4
SCDNR	Bunched Arrowhead Heritage Preserve	158.66	1	4
SCDNR	Buzzard Roost Heritage Preserve	501.00	1	4
SCDNR	Buzzard's Island Heritage Preserve	0.74	1	4
SCDNR	Capers Island Heritage Preserve	1203.00	1	4
SCDNR	Cartwheel Bay Heritage Preserve	568.00	1	4
SCDNR	Cathedral Bay Heritage Preserve	58.00	1	4
SCDNR	Chandler Heritage Preserve	252.68	1	4
SCDNR	Chestnut Ridge Heritage Preserve	1669.23	1	4
SCDNR	Clear Creek Heritage Preserve	18.83	1	4
SCDNR	Congaree Bluffs Heritage Preserve	201.07	1	4
SCDNR	Congaree Creek Heritage Preserve	627.00	1	4
SCDNR	Crab Bank Heritage Preserve	22.00	1	4
SCDNR	Craig Pond Tract	264.49	1	4
SCDNR	Crosby Oxypolis Heritage Preserve	32.00	1	4
SCDNR	Crowfield Plantation	11.78	1	4
SCDNR	Daw's Island Heritage Preserve	1866.00	1	4
SCDNR	Deveaux Bank Heritage Preserve	15.00	1	4
SCDNR	Dungannon Plantation Heritage Preserve	643.13	1	4
SCDNR	Eastatoe Creek Heritage Preserve	373.55	1	4
SCDNR	Fort Frederick Heritage Preserve	3.04	1	4
SCDNR	Fort Lamar Heritage Preserve	14.00	1	4
SCDNR	Forty Acre Rock Heritage Preserve	1540.87	1	4
SCDNR	Glassy Mountain Heritage Preserve	64.88	1	4

SCDNR	Gopher Branch Heritage Preserve	10.09	1	4
SCDNR	Great Pee Dee River Heritage Preserve	2725.00	1	4
SCDNR	Green's Shell Enclosure Heritage Preserve	3.00	1	4
SCDNR	Henderson Heritage Preserve	417.07	1	4
SCDNR	Janet Harrison Highpond Heritage Preserve	30.00	1	4
SCDNR	Joiner Bank Heritage Preserve	1.00	1	4
SCDNR	Laurel Fork Heritage Preserve	1000.00	1	4
SCDNR	Lewis Ocean Bay Heritage Preserve	9392.63	1	4
SCDNR	Little Pee Dee River Heritage Preserve	10025.47	1	4
SCDNR	Little Pee Dee State Park Bay Heritage Preserve	301.00	1	4
SCDNR	Long Branch Bay Heritage Preserve	50.90	1	4
SCDNR	Longleaf Pine Heritage Preserve	842.75	1	4
SCDNR	Lynchburg Savanna Heritage Preserve	290.82	1	4
SCDNR	Nipper Creek Heritage Preserve	90.00	1	4
SCDNR	North Santee Bar Heritage Preserve	1.00	1	4
SCDNR	Old Island Heritage Preserve	400.00	1	4
SCDNR	Otter Island	2094.12	1	4
SCDNR	Pacolet River Heritage Preserve	277.57	1	4
SCDNR	Peter's Creek Heritage Preserve	160.51	1	4
SCDNR	Rock Hill Blackjacks Heritage Preserve	289.78	1	4
SCDNR	Savage Bay Heritage Preserve	110.33	1	4
SCDNR	Savannah River Bluffs Heritage Preserve	83.84	1	4
SCDNR	Segars-McKinnon Heritage Preserve	795.20	1	4
SCDNR	Shealy's Pond Heritage Preserve	62.00	1	4
SCDNR	Snee Farm Heritage Preserve	12.00	1	4
SCDNR	St. Helena Sound Heritage Preserve	10302.00	1	4
SCDNR	Stevens Creek Heritage Preserve	433.77	1	4
SCDNR	Stoney Creek Battery Heritage Preserve	0.50	1	4
SCDNR	Tillman Sand Ridge Heritage Preserve	963.06	1	4
SCDNR	Tom Yawkey Wildlife Center Heritage Preserve	18085.50	1	4
SCDNR	Victoria Bluff Heritage Preserve	1111.00	1	4
SCDNR	Waccamaw River Heritage Preserve	5346.65	1	4
SCDNR	Watson-Cooper Heritage Preserve	1707.41	1	4
SCDNR	Woods Bay State Park Heritage Preserve	470.00	1	4
SCDNR	Angelus Tract	52.89	2	5
SCDNR	Bagwell Property/Wildlife Habitat	85.65	2	5
SCDNR	Bear Island Wildlife Management Area	12031.83	2	5
SCDNR	Cohen Campbell Fish Hatchery/Styx Compound	297.98	2	5
SCDNR	Crossroads Tract	358.91	2	5
SCDNR	Donnelley Wildlife Management Area	331.84	2	5
SCDNR	Draper Tract/Wildlife Management Area	806.40	2	5

SCDNR	Gray Court Wildlife Management Area	61.00	2	5
SCDNR	Hitchcock Woods	1934.03	2	5
SCDNR	James Ross Wildlife Preserve	304.61	2	5
SCDNR	James W. Webb Wildlife Center	5863.00	2	5
SCDNR	Jocassee Gorges	31903.28	2	5
SCDNR	Lake George Warren	1159.00	2	5
SCDNR	Lake John D. Long/Wildlife Lake	216.20	2	5
SCDNR	Mason Wildlife Preserve	1994.74	2	5
SCDNR	McBee Wildlife Management Area	778.27	2	5
SCDNR	McConnells Tract/Wildlife Management (Turkey Creek)	249.15	2	5
SCDNR	Palachucola Wildlife Management Area	7104.11	2	5
SCDNR	Samworth Wildlife Management Area	1586.26	2	5
SCDNR	Santee Coastal Reserve	23499.00	2	5
SCDNR	Santee Delta Wildlife Management Area	1791.50	2	5
SCDNR	Trask Natural Area	84.00	2	5
SCDNR	Turtle Island Waterfowl Management Area	1667.00	2	5
SCDNR	Victoria Bluff Natural Area	156.92	2	5
SCDNR	Waddell Mariculture Center	144.00	2	5
SCPRT	Aiken State Natural Area	1067.00	2	6
SCPRT	Croft State Natural Area	7053.76	2	6
SCPRT	Keowee-Toxaway State Natural Area	1000.00	2	6
SCPRT	Lee State Natural Area	2839.00	2	6
SCPRT	Mountain Bridge Wilderness Area (Caesars Head & Jones Gap)	10813.00	2	6
SCPRT	Woods Bay State Natural Area	1541.00	2	6
SCDOT	Black River Mitigation Site	1711.51	2	7
SCDOT	Bucksport & Oliver Mitigation Site	8029.00	2	7
SCDOT	Huspah Creek Mitigation Site	370.29	2	7
SCDOT	Sandy Island Mitigation Site	9164.74	2	7
SCDOT	Vacant-Wetlands Mitigation (Rd. S-114)	10.60	2	7
TNC	Bailey Island Preserve	417.10	1	8
TNC	Bamberg County Cobane	58.49	1	8
TNC	Black River Swamp	1311.39	1	8
TNC	Campbell and Lockhart Tracts (Blue Wall Preserve)	137.00	1	8
TNC	Cliffs At Glassy Preserve	602.00	1	8
TNC	Greenville Watershed	19000.00	1	8
TNC	Johns Island Maritime Forest	96.63	1	8
TNC	Landrum Watershed	585.00	1	8
TNC	Peachtree Rock Preserve	305.00	1	8
TNC	Penell Tract (Blue Wall Preserve)	452.00	1	8
TNC	Red Bluff Marsh	2198.79	1	8
TNC	Tryon Watershed	640.00	1	8
USFWS	ACE Basin NWR Combahee Unit	326.00	1	9
USFWS	ACE Basin NWR Combahee Unit	988.00	1	9

USFWS	ACE Basin NWR Combahee Unit	6677.22	1	9
USFWS	ACE National Wildlife Refuge-Bonnie	1421.00	1	9
USFWS	ACE National Wildlife Refuge-Combahee	1819.00	1	9
USFWS	ACE National Wildlife Refuge-Grove	1955.00	1	9
USFWS	ACE National Wildlife Refuge-Jehossee	4500.00	1	9
USFWS	Cape Romain National Wildlife Refuge	34044.94	1	9
USFWS	Carolina Sandhills National Wildlife Refuge	45348.43	1	9
USFWS	Pickney Island National Wildlife Refuge	4052.70	1	9
USFWS	Santee National Wildlife Refuge	4413.28	1	9
USFWS	Savannah National Wildlife Refuge	14334.47	1	9
USFWS	Tybee NWR	129.57	1	9
USFWS	Waccamaw National Wildlife Refuge	134.00	1	9
USFS	FMNF Botanical and Zoological Area		1	10
USFS	FMNF Roadless Area		1	10
USFS	FMNF Wilderness Area		1	10
USFS	SNF Andrew Pickens Ranger District Botanical and Zoological Area		1	10
USFS	SNF Andrew Pickens Ranger District Roadless Area		1	10
USFS	SNF Andrew Pickens Ranger District Wilderness Area		1	10
USFS	SNF Enoree Ranger District Botanical and Zoological Area		1	10
USFS	SNF Long Cane Ranger District Botanical and Zoological Area		1	10
USFS	SNF Wild and Scenic Corridor along the Chattooga River		2	10

1. CU - Clemson University, Contact Person, Stassen Thompson, (864) 656-1287
2. NAS – National Audubon Society, Contact Person, Norman Brunswick, (843) 462-2150
3. NPS – National Park Service, National GAP Handbook
4. SCDNR – South Carolina Department of Natural Resources, Heritage Trust Fund Act, South Carolina Statutes, Contact Johnny Stowe, (803) 734-4037
5. SCDNR- Wildlife Management Areas, Contact Tim Ivey, (803) 734-4116
6. SCPRT – South Carolina Parks, Recreation and Tourism, State Parks, A New Vision for the 21st Century, SCPRT, 1998.
7. SCDOT – South Carolina Department of Transportation, Contact Person, Blanche Sproul, (803) 737-1395
8. TNC – The Nature Conservancy, South Carolina Chapter, (803) 254-9049
9. USFWS – U.S. Fish and Wildlife Service, David Gordon, (843) 727-4707
   USFS – U.S. Forest Service Strategic Plan, 2000

Appendix 12. List of example GAP applications

Businesses and Non-government Organizations:
The following are some examples of applications of GAP data by the private sector:

- The Wyoming Natural Heritage Program (a private non-government organization) transformed the endangered and sensitive species database into a spatially referenced digital geographic information system using the GAP digital base map and other GAP spatial data.
- Hughes Corp. is experimenting with the Utah and Nevada GAP digital base maps, simulating images to aid the development of new space-based remote sensing devices.
- The Nature Conservancy used the Wyoming GAP data to develop a map of ecoregions of Wyoming.
- Weyerhaeuser Corp. is using the Arkansas GAP data in managing their lands in Arkansas.
- IBM Corp. is funding a project at the University of California-Santa Barbara that, in part, uses GAP data in the development of visualization software.
- NM-GAP vegetation data is being used for an environmental assessment of a proposed spaceport, a state/private venture.

County and City Planning:
Some other examples of the use of GAP by local governments are:

- CA-GAP biological data were combined with the Southern California Association of Governments (SCAG) land ownership data to show which ownerships and jurisdictions were needed for joint conservation planning and management of a particular natural community or species, maximizing efficiency and minimizing the potential for yet another conservation crisis.
- In California, county and city planners of several jurisdictions, wildlife agencies, developers of the 4S Ranch property, and the state Natural Communities Conservation Planning program used the GAP regional data, as well as more detailed information, to conserve 1,640 acres of habitat within a 2,900-acre planned development.
- Day-to-day county planning operations in Piute, Grande, and Washington counties, Utah.
- County planners in Piute County, Utah, used GAP data to optimize the siting of a proposed sawmill for aspen with respect to the distribution of aspen stands.
- Missoula County, Montana, used the GAP land cover map of the area as a base map for its comprehensive long-range plan.
- Snohomish County, Washington, used the GAP land cover map in meeting state requirements for a growth management plan.
- The City of Bainbridge Island, Washington, used GAP data to assist them in development of a watershed planning project.

State Uses:
The following are some examples of uses of GAP data by state agencies.

- The GAP database of species habitats was used by the Tennessee Wildlife Resources Agency (TWRA) to update its book "Species in Need of Management."
- Images of land cover derived from GAP TM data are used by TWRA for locating particular habitat types. Information on the locations of these habitat types is provided by TWRA to the public for a wide variety of public service functions, from education to cooperative resource management.
- Early GAP data developed by TWRA were used to help identify an extremely important area of the state with high biodiversity that was subsequently purchased by the state for conservation.
- Preliminary findings from GAP were used by TWRA to develop three resource management initiatives.
- The Tennessee GAP project, which is being carried out primarily by TWRA, is the foundation of a multi-agency, long-term biodiversity program for Tennessee.
- GAP data have been used by the Tennessee Forestry Stewardship Program to help develop a district program for nine conservation planning districts, outlining Best Management Practices (BMPs) for biological conservation on private lands.
- GAP data are being used extensively by TWRA in the preparation of project proposals to the North American Waterfowl Conservation Program. These proposals require that biodiversity issues are addressed in specific detail. The use of GAP data on occurrence of land cover types and terrestrial vertebrates has made this possible.
- The Wyoming Department of Fish and Game used GAP data to assist them in transforming the Wildlife Observation System database into a spatially referenced geographic information system.
- The Utah Division of Wildlife Resources and the Bear River Water Conservancy District used the Utah GAP land cover map in a resource management assessment for mitigating conflicts between a proposed groundwater withdrawal project and the maintenance of an elk calving area in the Uinta Mountains.
- The Utah Division of Wildlife Resources, the Rocky Mountain Elk Foundation, and Sheik Safari International used the Utah GAP land cover map to identify critical elk habitat. The environmental profile of these areas was then used to identify other similar areas for elk habitat enhancement.
- The Utah Division of Wildlife Resources used the Utah GAP land cover map for a rapid ecological assessment of the Echo Henefer Wildlife Management Area.
- The Washington Department of Fish and Wildlife used GAP data to develop a breeding bird atlas and an atlas of mammals of Washington State.
- The Washington Department of Fish and Wildlife uses GAP data to operate an integrated landscape management program.
- The Washington Department of Fish and Wildlife uses GAP data from Eastern Washington to assist with an innovative program that brings the forest products industry, state agency biologists, non-government organizations, and tribal biologists together in the field to jointly determine the appropriate management practices for any particular site of concern (Timber, Fish & Wildlife Program).
- The Idaho Department of Fish and Game used GAP data to evaluate the impact from expanded military training activities on public lands in Southern Idaho.
- The Idaho Department of Fish and Game uses GAP data for regional planning efforts on a regular basis.

Statewide Planning:
Biodiversity planning programs or projects are now under way in Arizona, California, Colorado, Maine, Missouri, Nevada, Oregon, and Tennessee. It is likely that similar efforts will develop in other states. These activities were the subject of the State Biodiversity Programs meeting discussed on page _ in this report. In some cases, these efforts grew out of the state GAP project, however, in most cases, the GAP data are being used to meet a previously defined need. In all cases, GAP data are central to their development and operations. The goals of each of these programs or projects are presented briefly below.

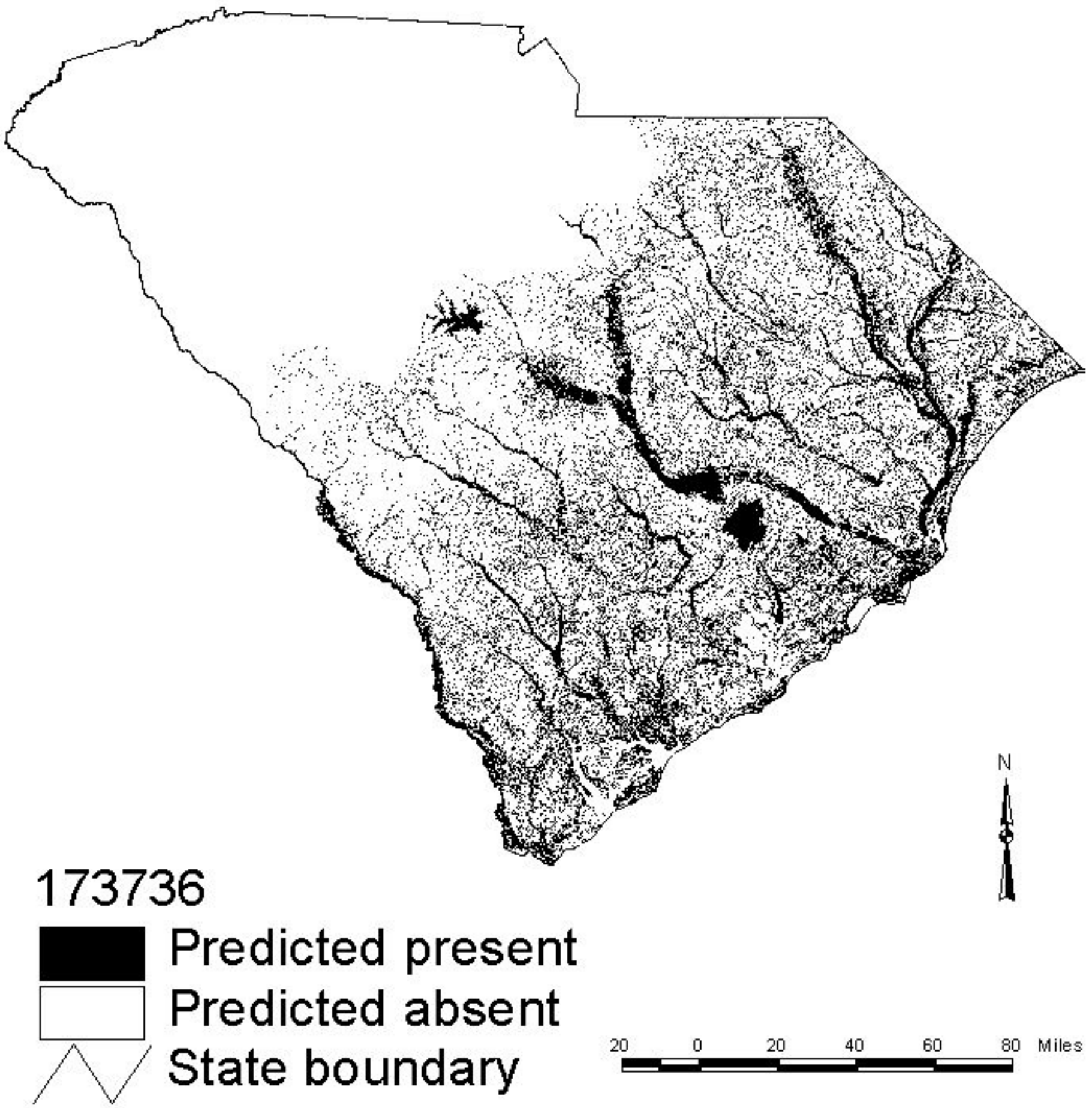
Federal Agency Applications:
Some examples of applications of GAP data by federal agencies follow:

- GAP data are being supplied to all military installations in the Great Basin ecoregion for integrated management of the natural resources. These installations constitute a very large amount of land area. Much of it is of high value for native species.
- The Ouachita National Forest used the Arkansas GAP data to help them develop an ecosystem management plan.
- The Wyoming GAP data were used by NASA to calibrate a model that predicts vegetation types based on climate and soil variables.
- The potential contributions to biodiversity conservation of four different options proposed for new wilderness designation in Idaho were quantified by the Idaho Cooperative Fish and Wildlife Research Unit in cooperation with the Park Studies Unit.
- The potential contributions to biodiversity conservation of four different options proposed for new national park designation in Idaho were quantified by the Idaho Cooperative Park Studies Unit.
- The U.S. Forest Service in Booneville, Arkansas, used the Arkansas GAP data land cover maps in a 3-dimensional presentation to provide the public with a visual representation of the region and to enhance the public's involvement with the National Forest planning process.
- The U.S. Fish and Wildlife Service regularly uses the GAP data for Southern California for habitat evaluation and management.
- The U.S. Forest Service, Bureau of Land Management, and National Park Service are using the GAP data for a wide variety of natural resource management operations in Utah. For example, the entire Utah GAP database is directly linked with existing National Park Service databases for use by National Parks.
- The Bureau of Land Management uses the Wyoming GAP data for managing the Buffalo Resource Area.
- The U.S. Forest Service used the Utah GAP data to help assist them in evaluating human-induced impacts to forested lands surrounding ski resorts in central Utah.
- The U.S. Fish and Wildlife Service in Delaware used GAP data to help identify potential habitat for the federally endangered Delmarva fox squirrel. These maps were displayed and served as a catalyst for bringing together people with a stake in the issue.

- The U.S. Fish and Wildlife Service used the Indiana GAP data as part of a biological assessment for the base closure of the Jefferson Proving Grounds and its conversion to a National Wildlife Refuge. This 58,000-acre installation has restricted human access due to unexploded ordinance and contains some of the highest-quality natural habitat in Indiana.
- The U.S. Fish and Wildlife Service in Louisiana used GAP data to avoid conflict over the designation of critical habitat of the federally endangered Louisiana black bear.
- The NOAA Coastal Marine Sanctuary in Washington State uses GAP data for an educational display.
- In Washington and New Mexico, digital land cover maps have been distributed to all National Forests.
- The U.S. Natural Resources Conservation Service (NRCS) in New Mexico is using a GAP clustered imagery as a base for their land cover mapping activities.
- The Department of Defense is funding the development of an electronic environmental information system for the Mojave ecoregion, which would use GAP data as a foundation or base layer of information. The system will link 29 DoD installations to a common source of environmental information.

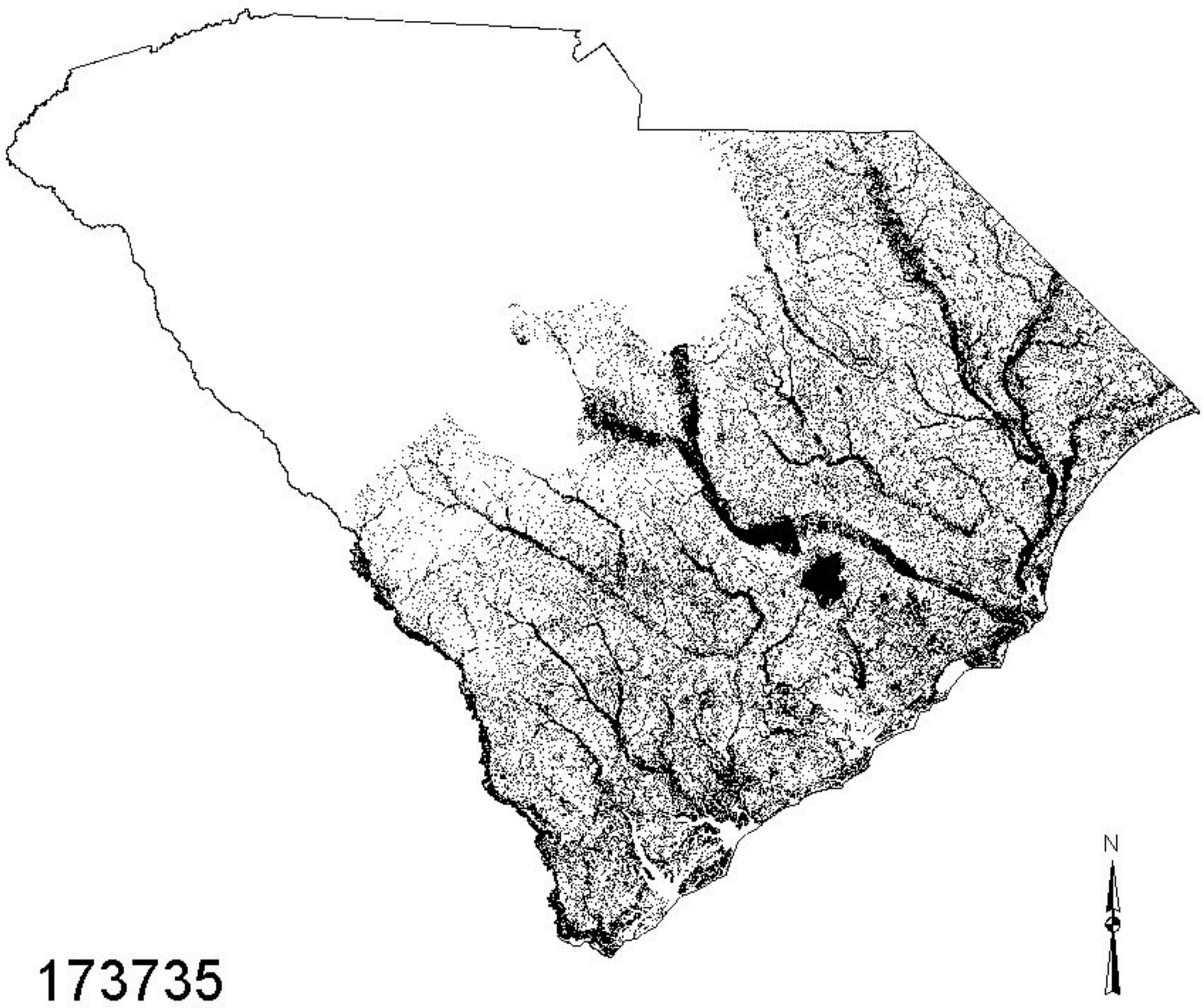
Lesser Siren

(Siren intermedia)



Greater Siren

(Siren lacertina)



173735

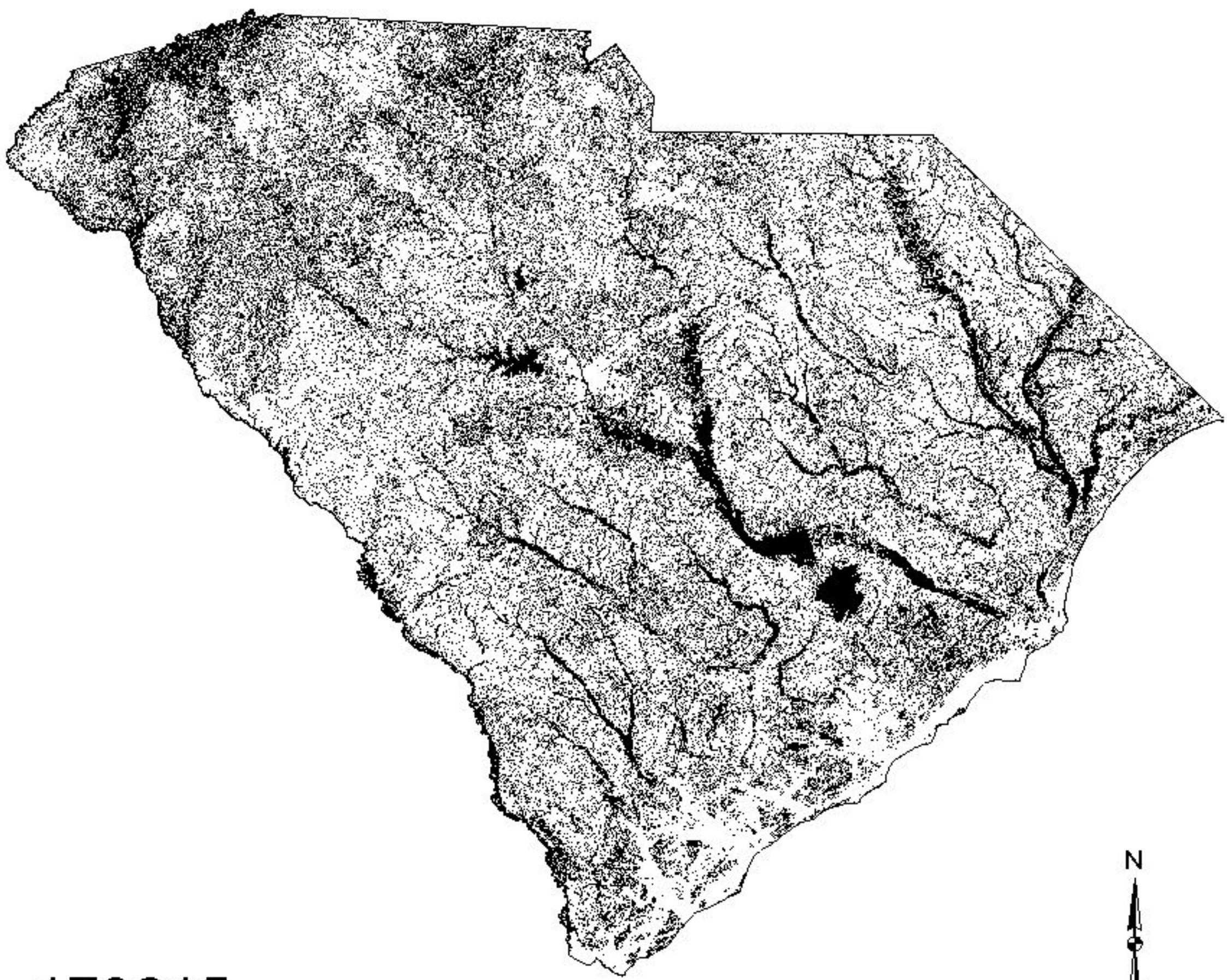
Predicted present

Predicted absent

State boundary

Eastern Newt

(Notophthalmus viridescens)



173615

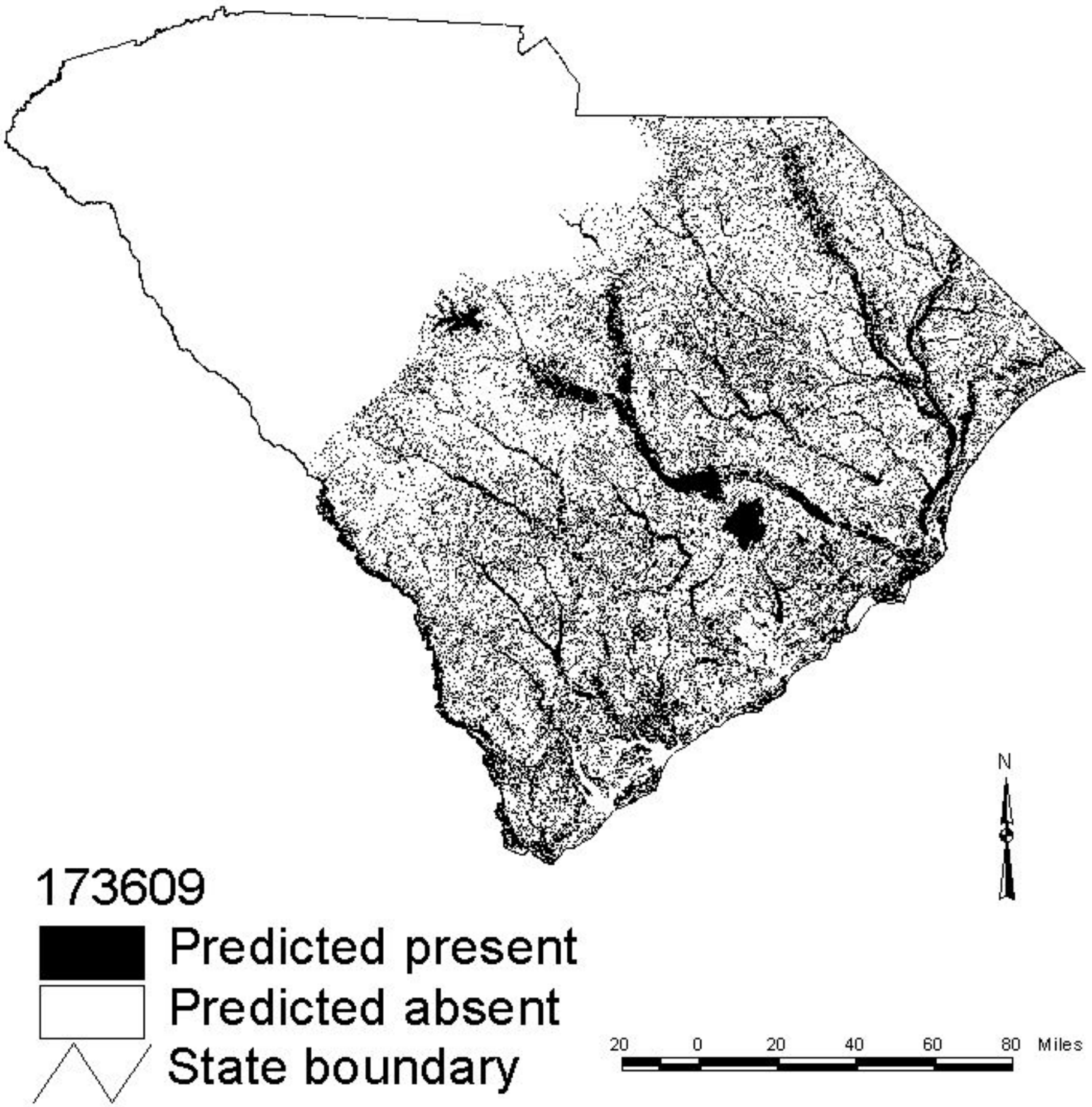
Predicted present

Predicted absent

State boundary

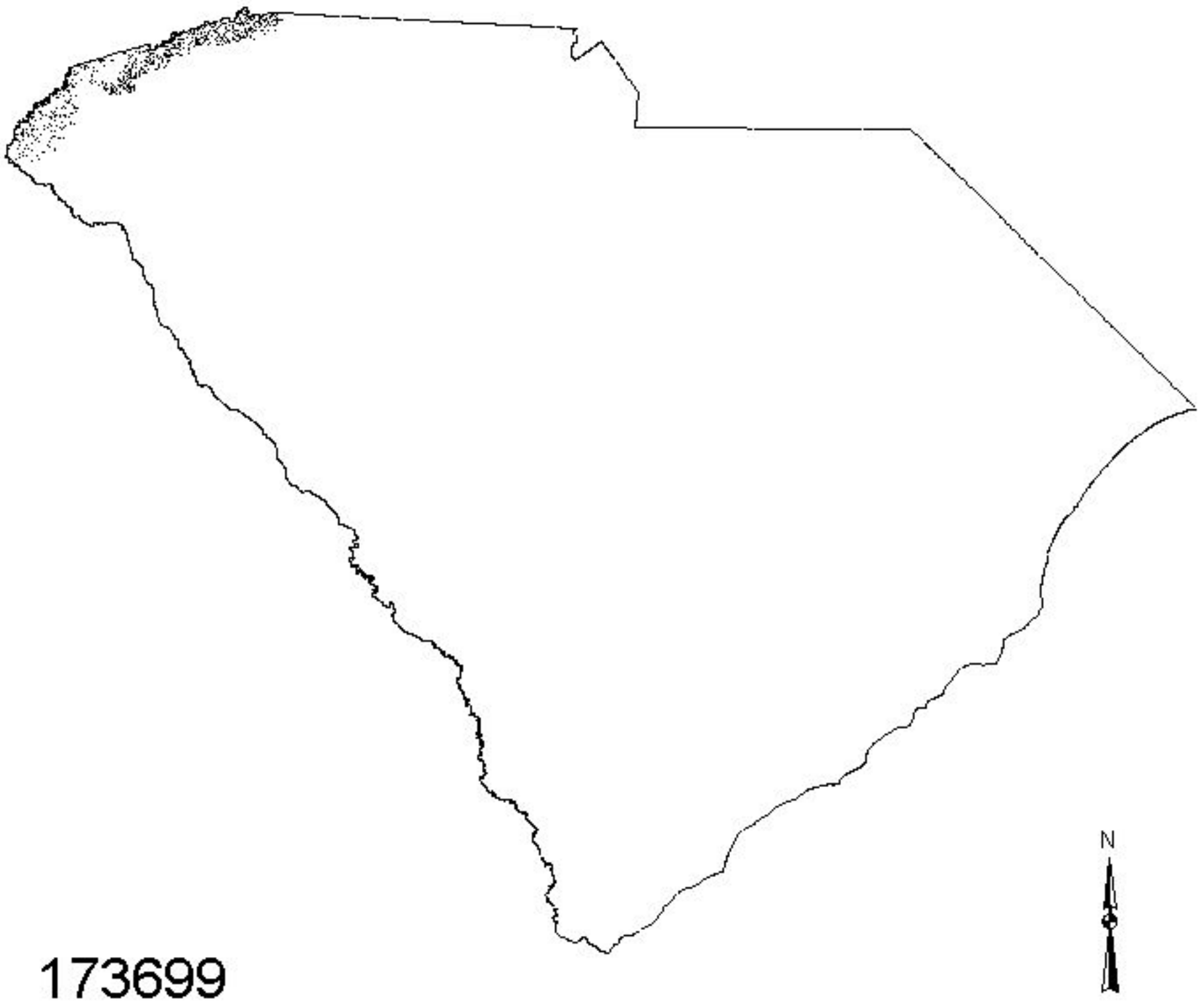
Two-toed Amphiuma

(Amphiuma means)



Green Salamander

(Aneides aeneus)



173699

Predicted present

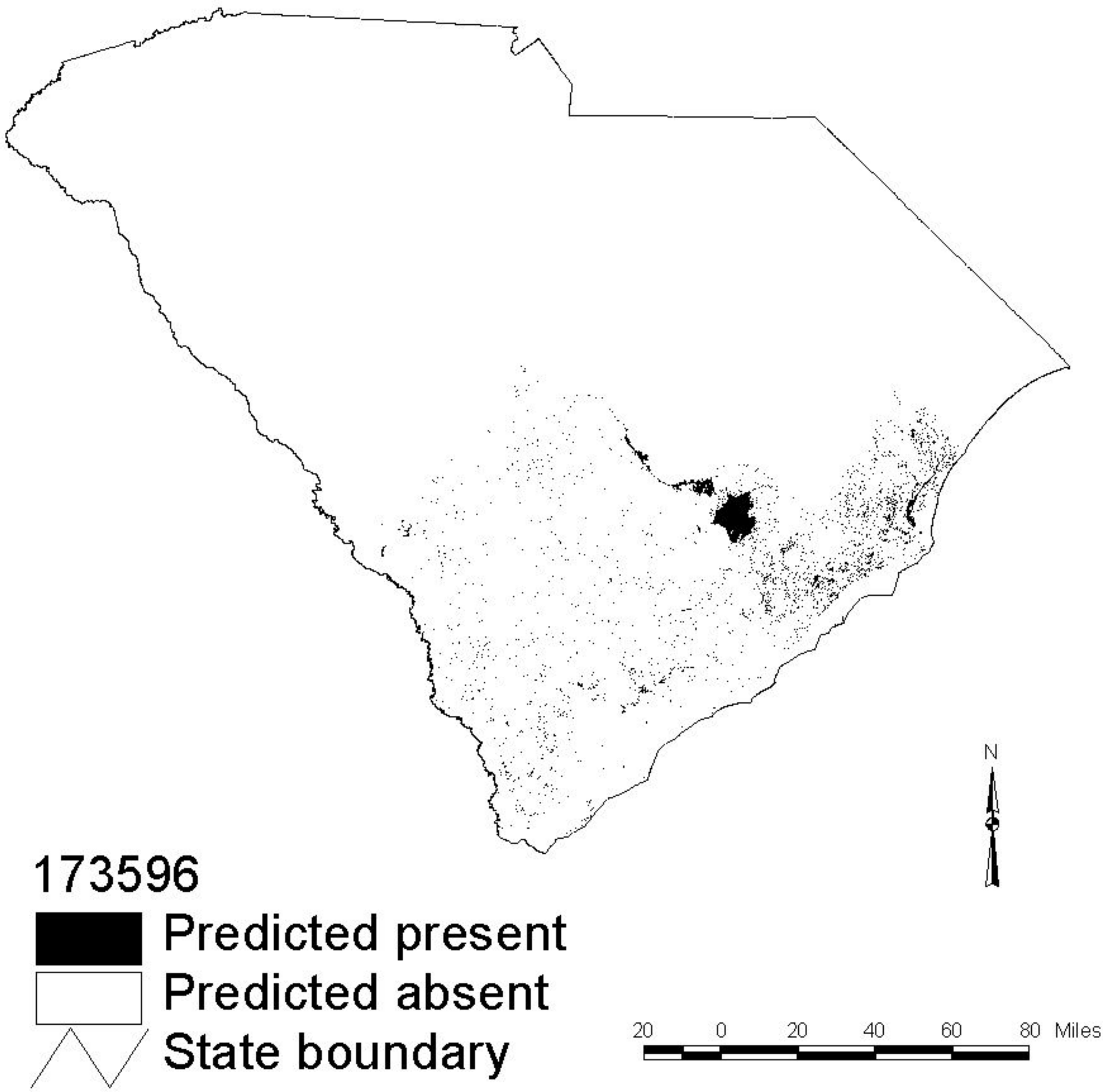
Predicted absent

State boundary

20 0 20 40 60 80 Miles

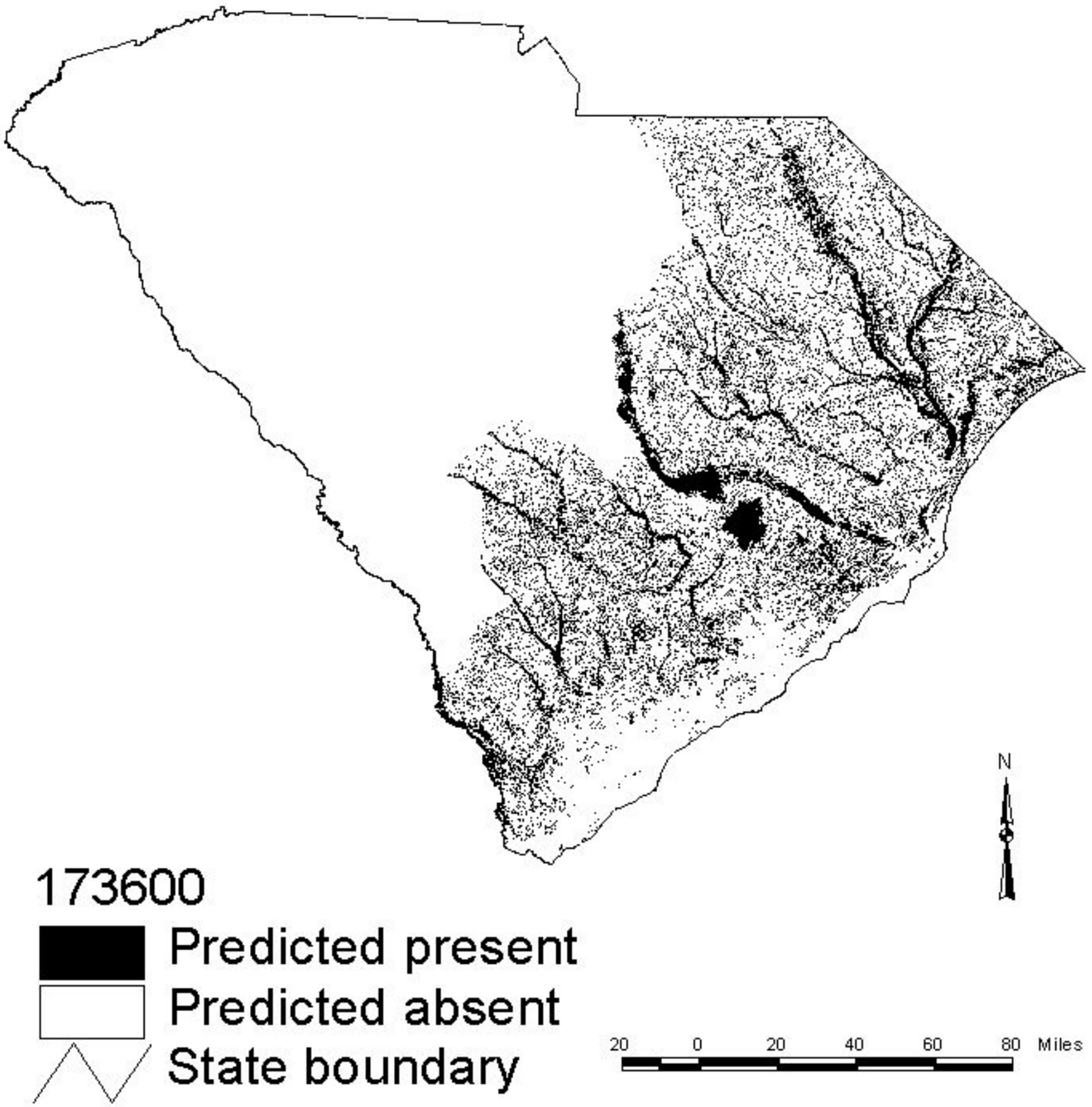
Flatwoods Salamander

(Ambystoma cingulatum)



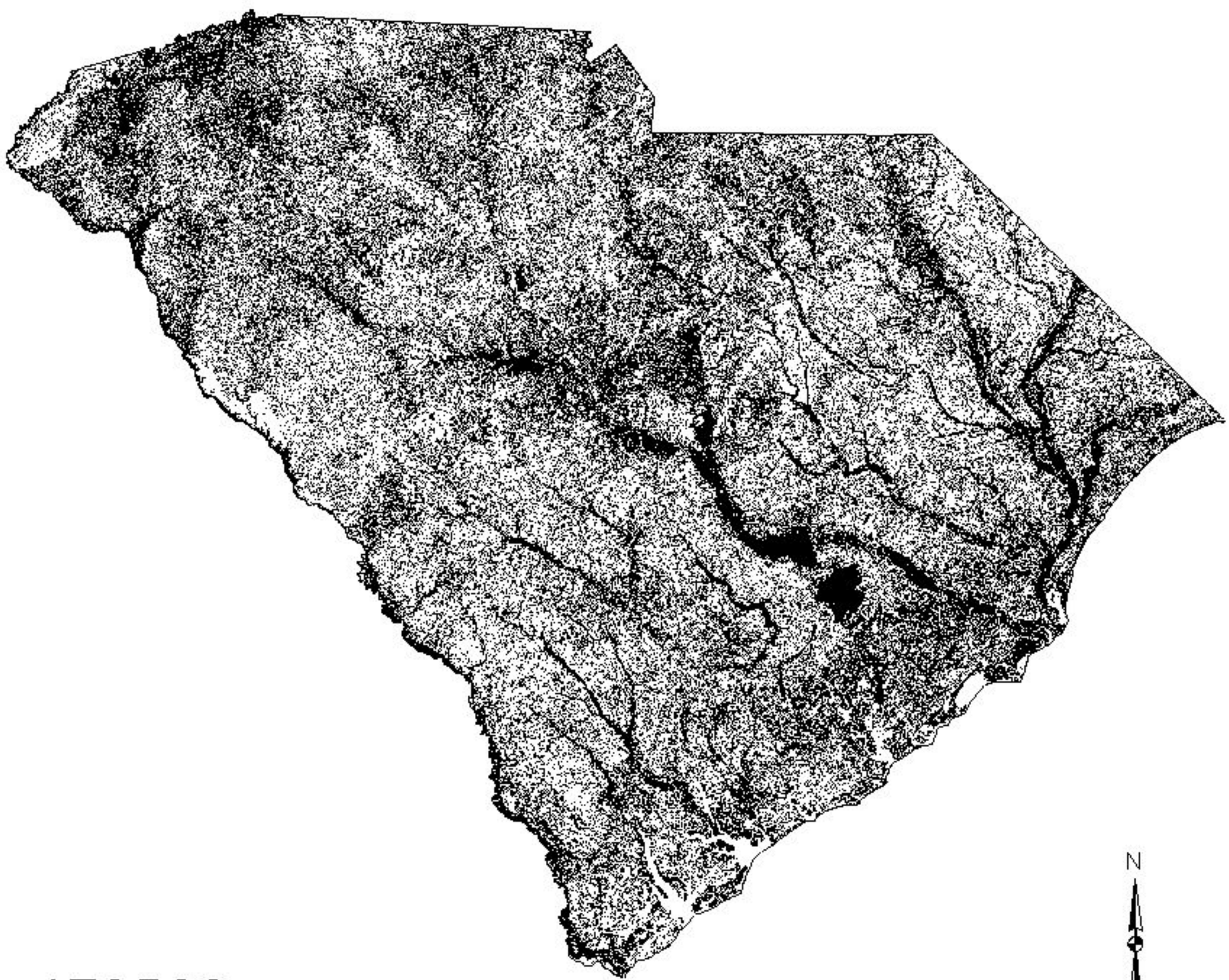
Mabee's Salamander

(Ambystoma mabeei)



Spotted Salamander

(Ambystoma maculatum)



173590

Predicted present

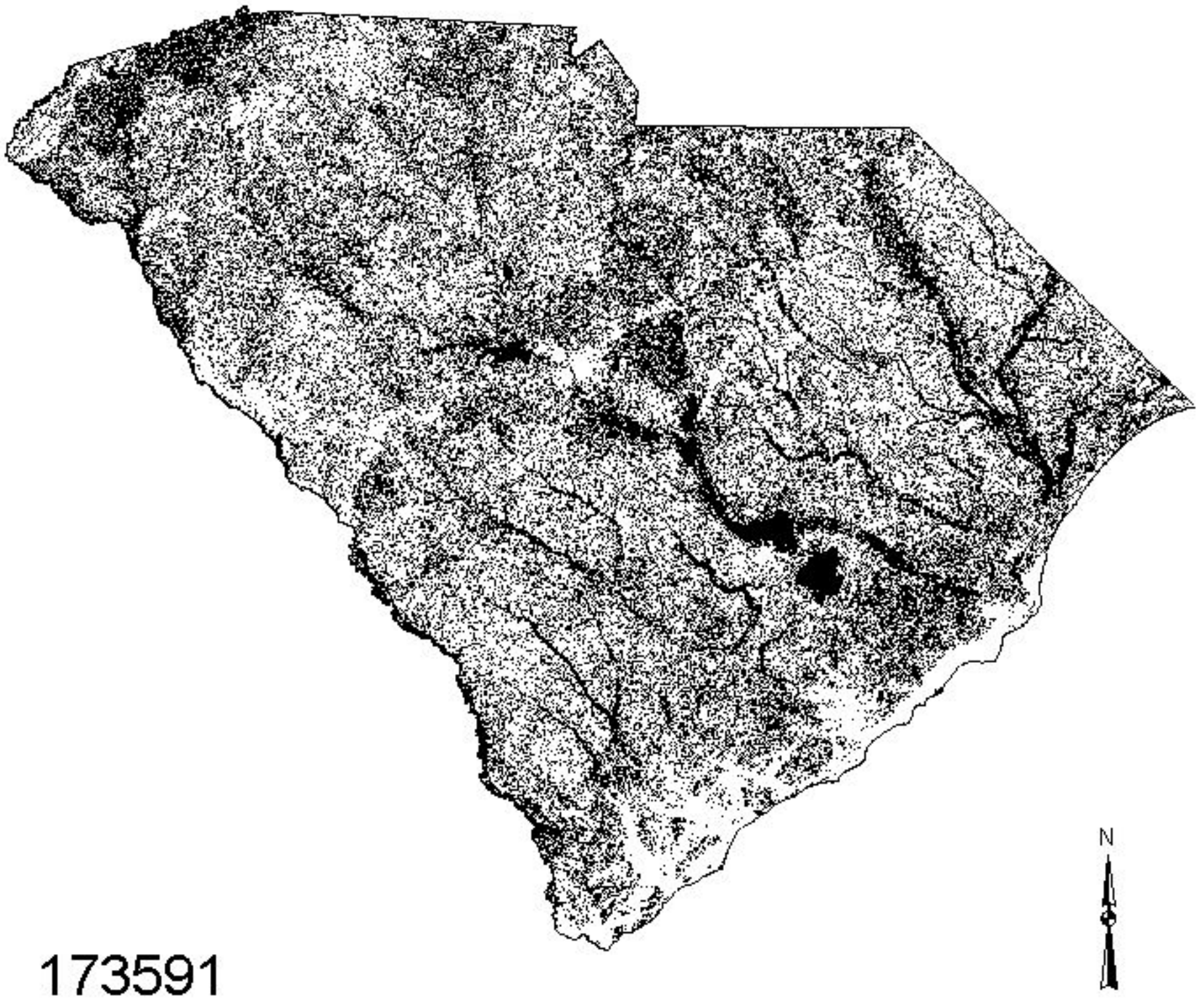
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Marbled Salamander

(Ambystoma opacum)



173591

Predicted present

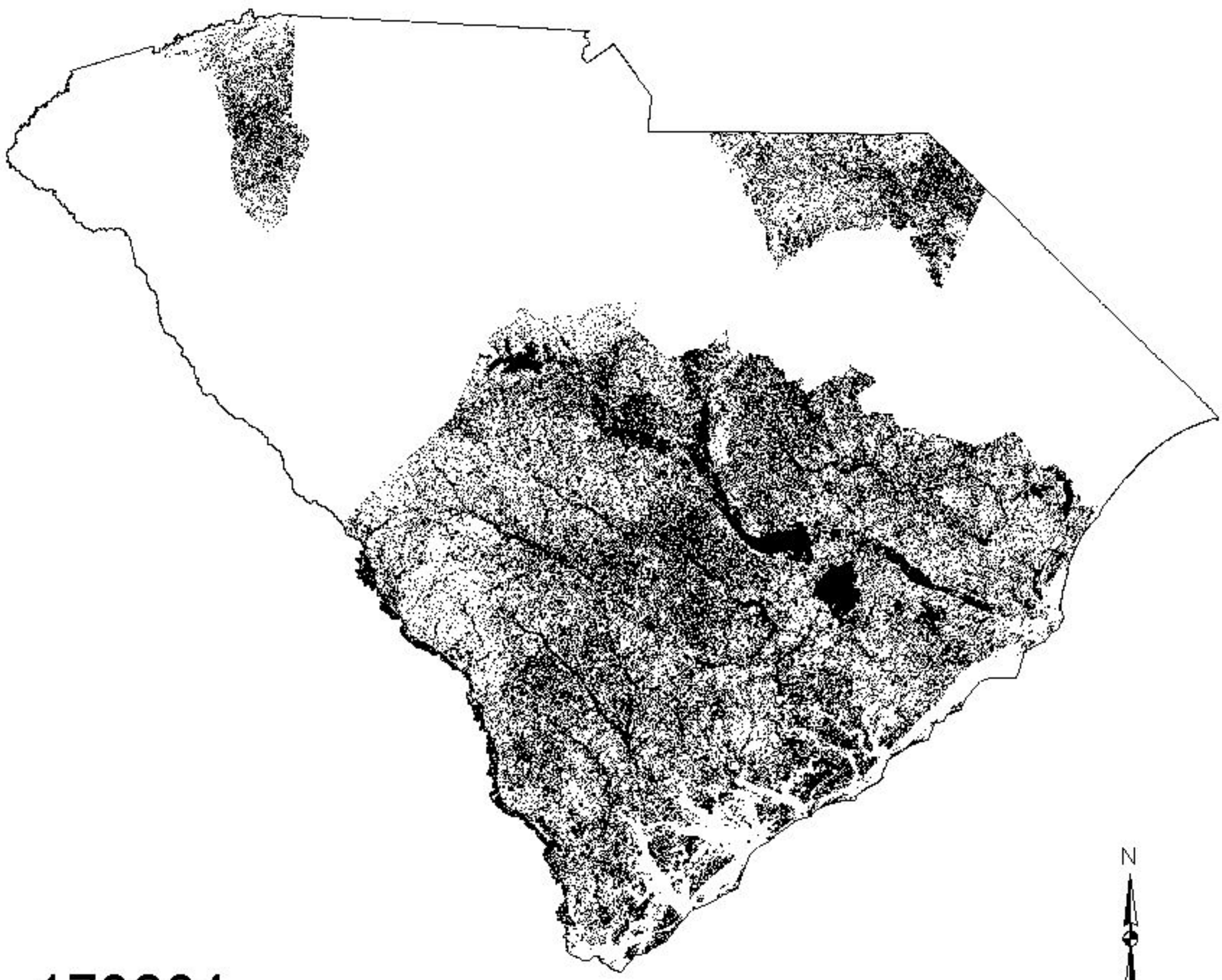
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Mole Salamander

(Ambystoma talpoideum)



173604

Predicted present

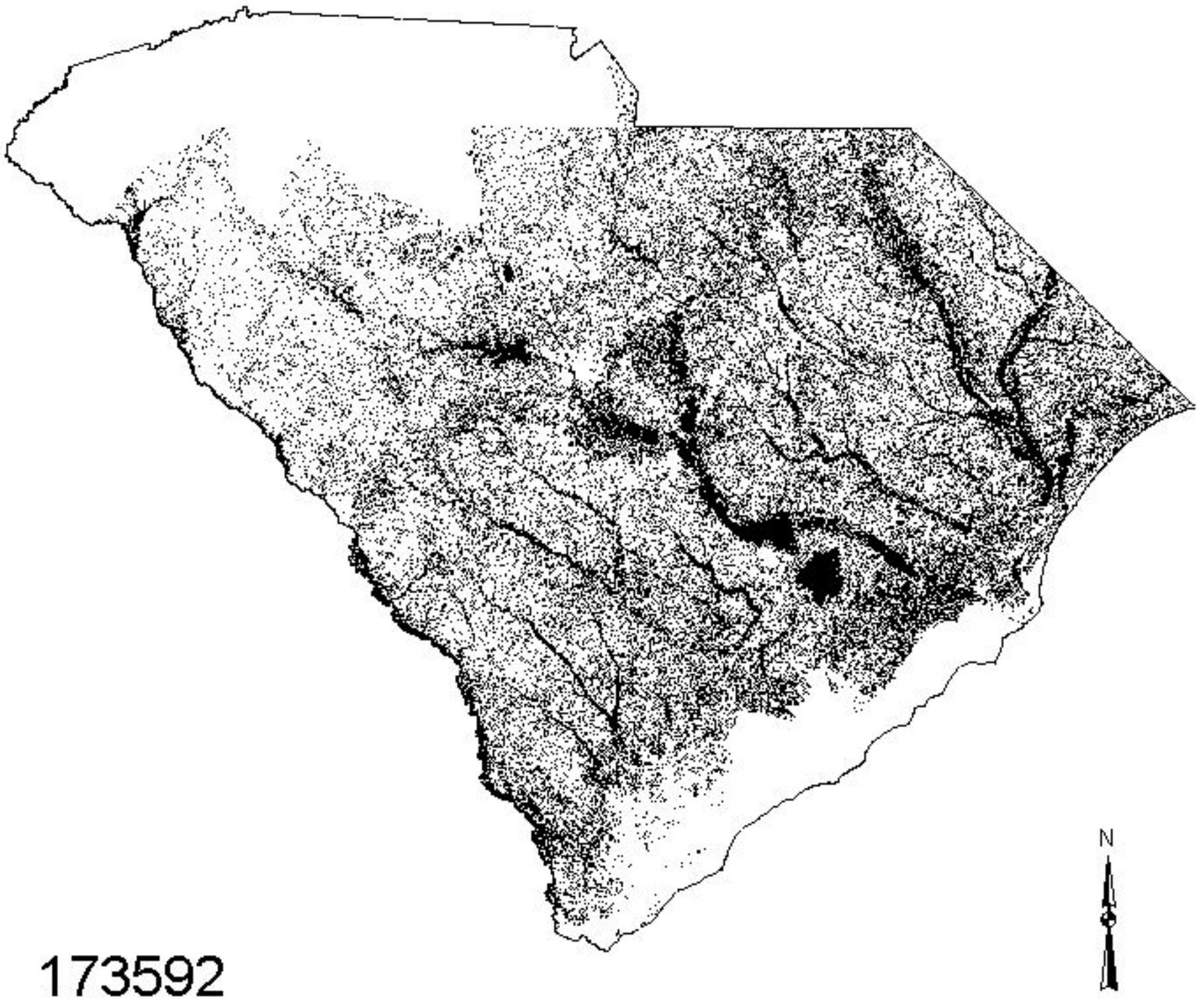
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Tiger Salamander

(Ambystoma tigrinum)



173592

Predicted present

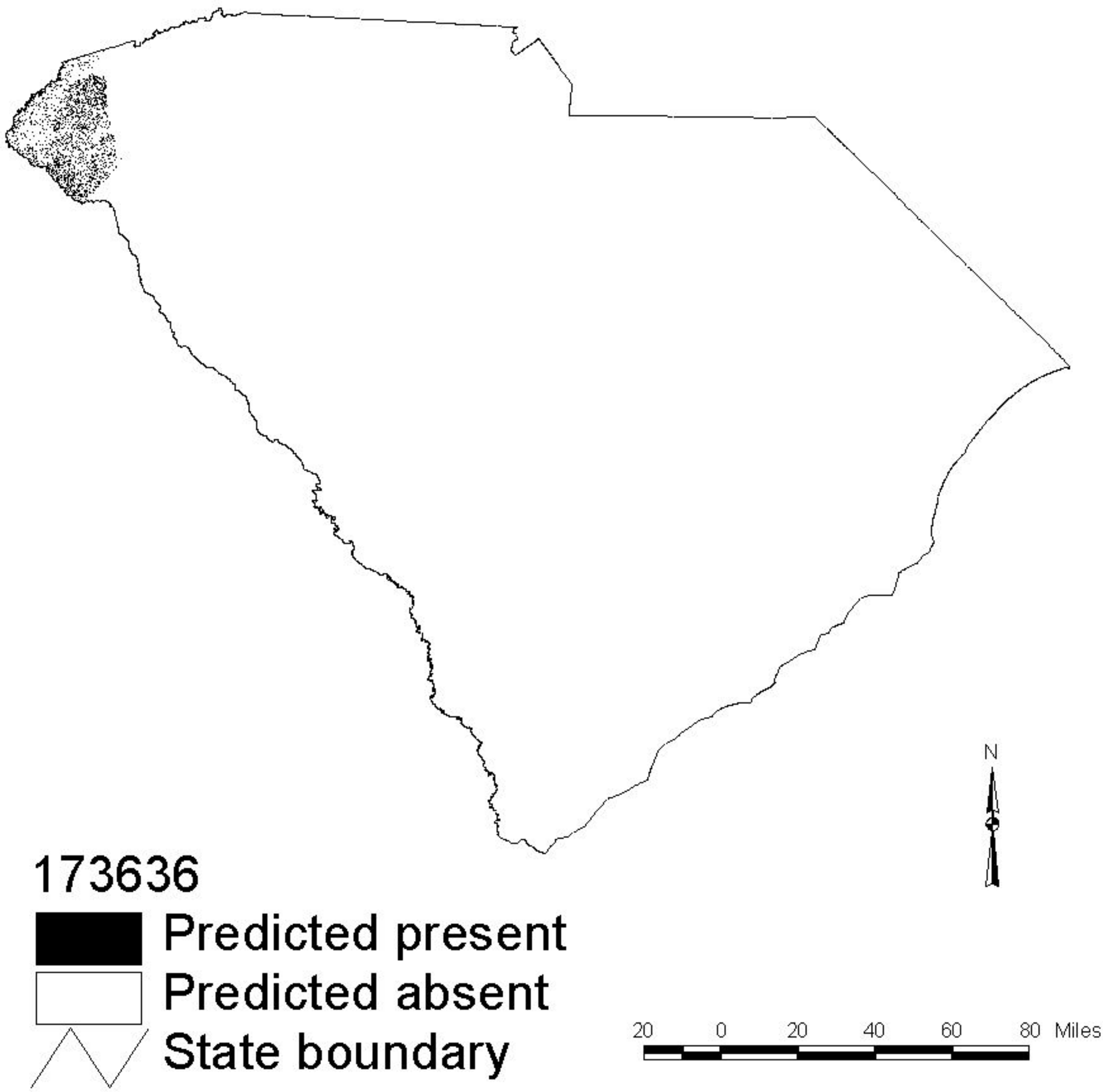
Predicted absent

State boundary

20 0 20 40 60 80 Miles

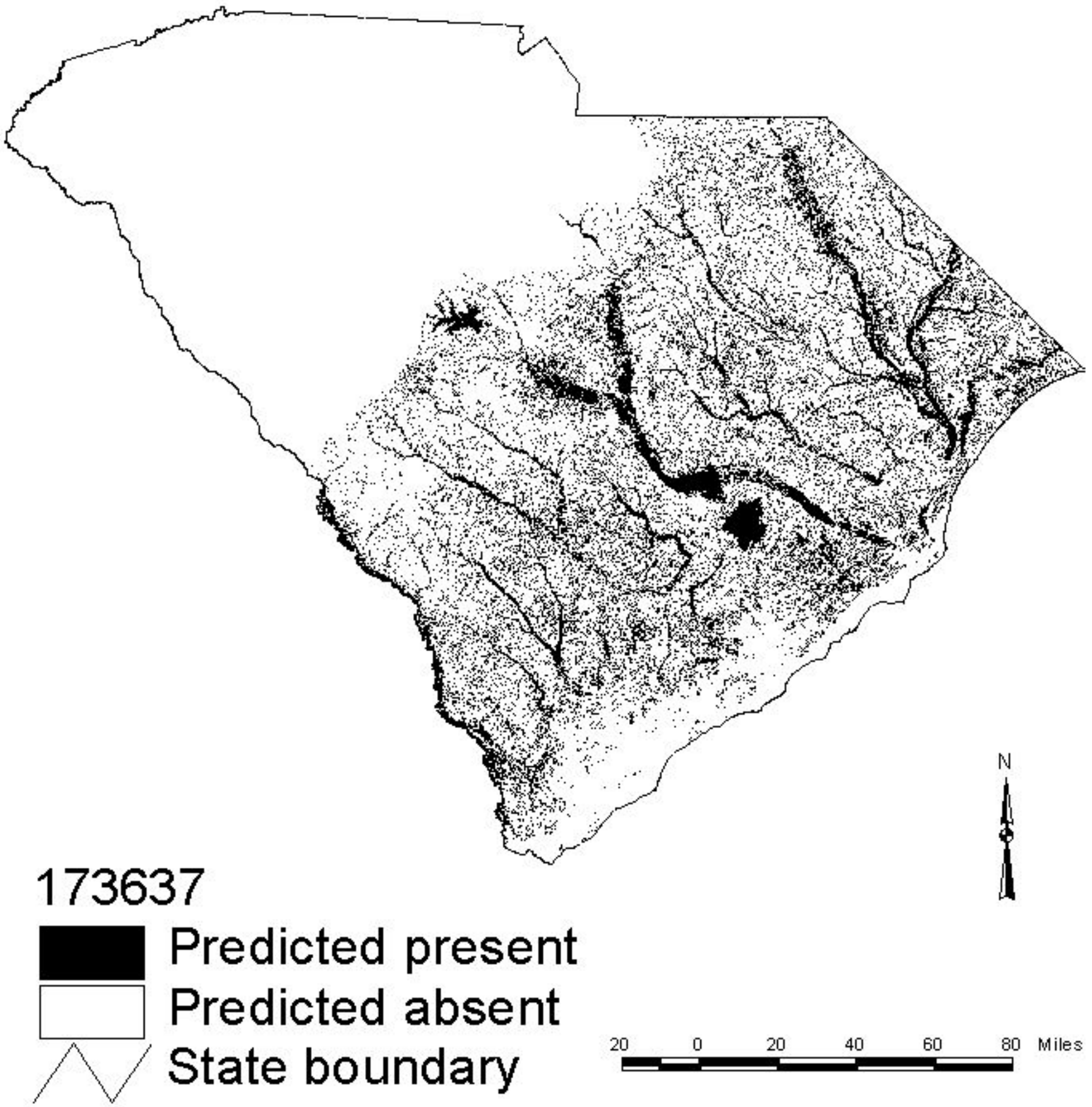
Seepage Salamander

(Desmognathus aeneus)



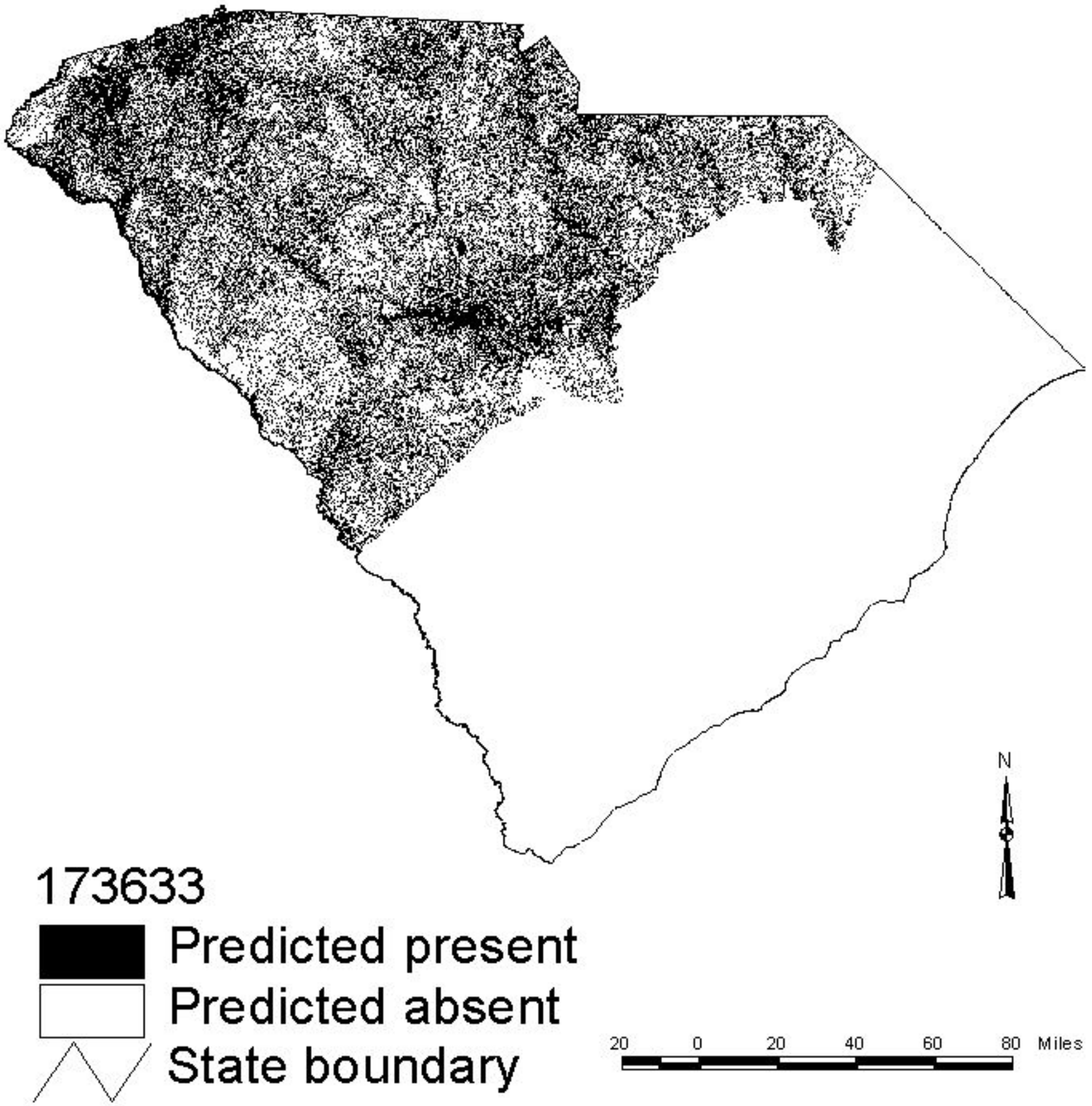
Southern Dusky Salamander

(Desmognathus auriculatus)



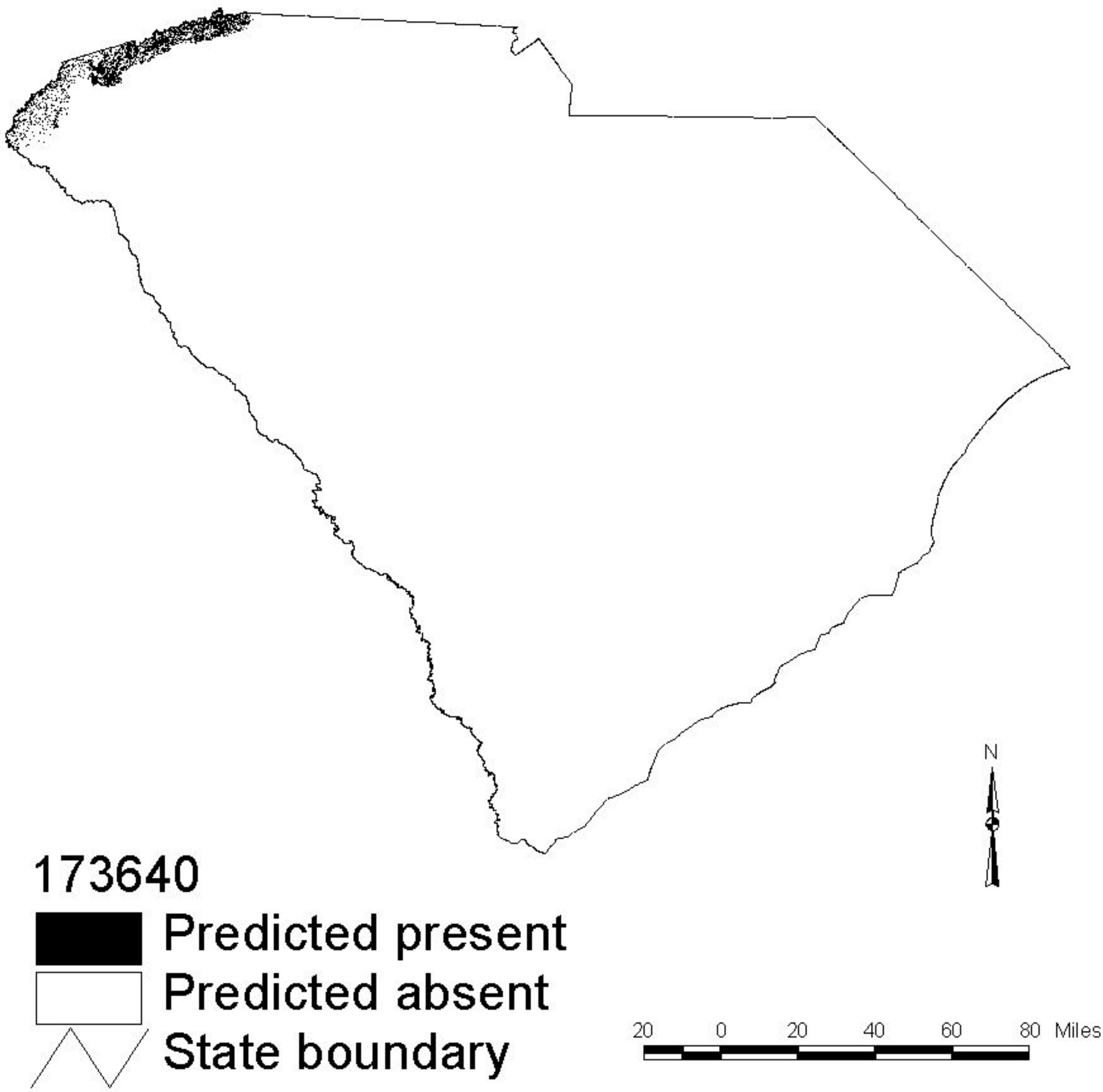
Dusky Salamander

(Desmognathus fuscus)



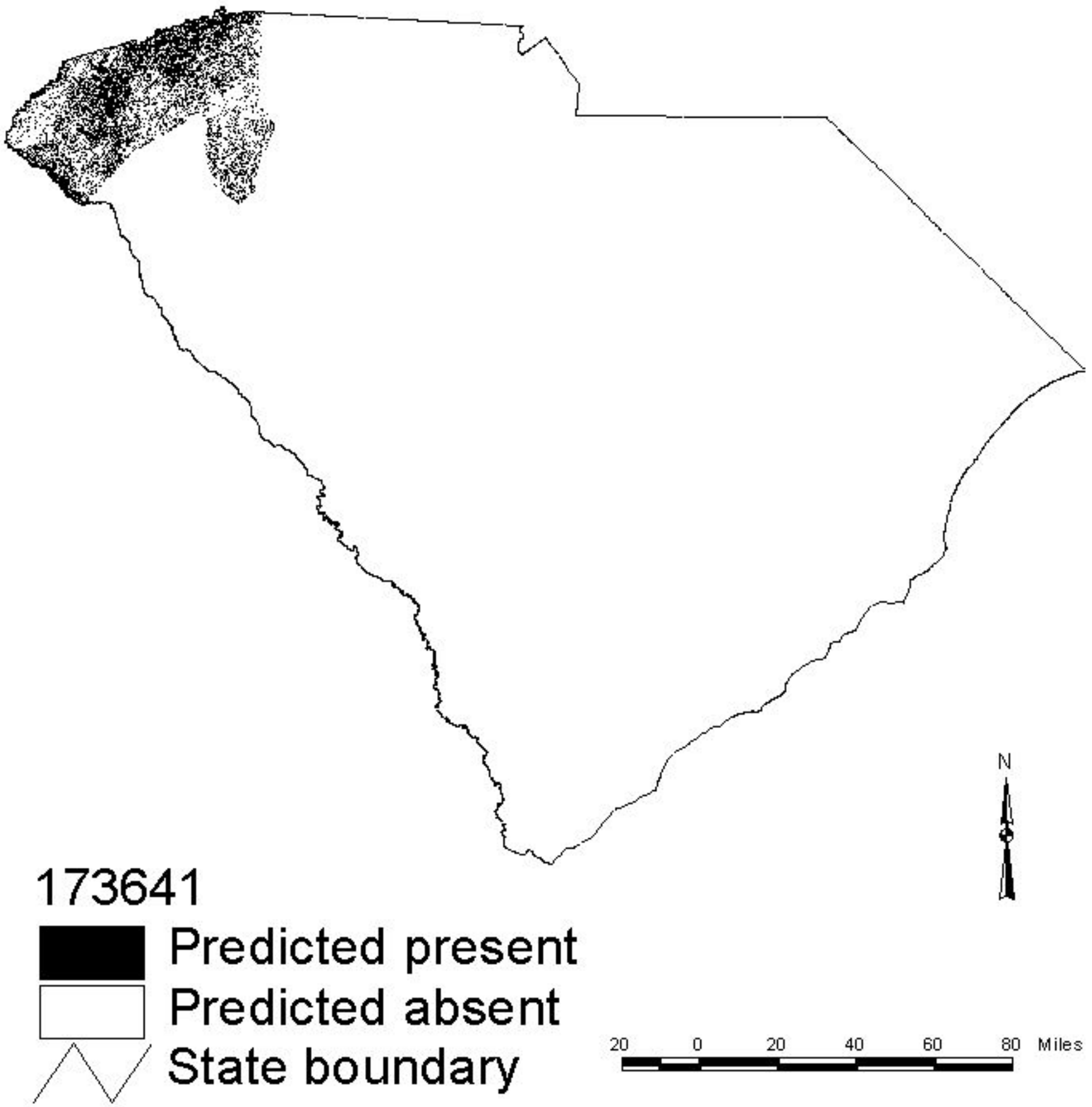
Seal Salamander

(Desmognathus monticola)



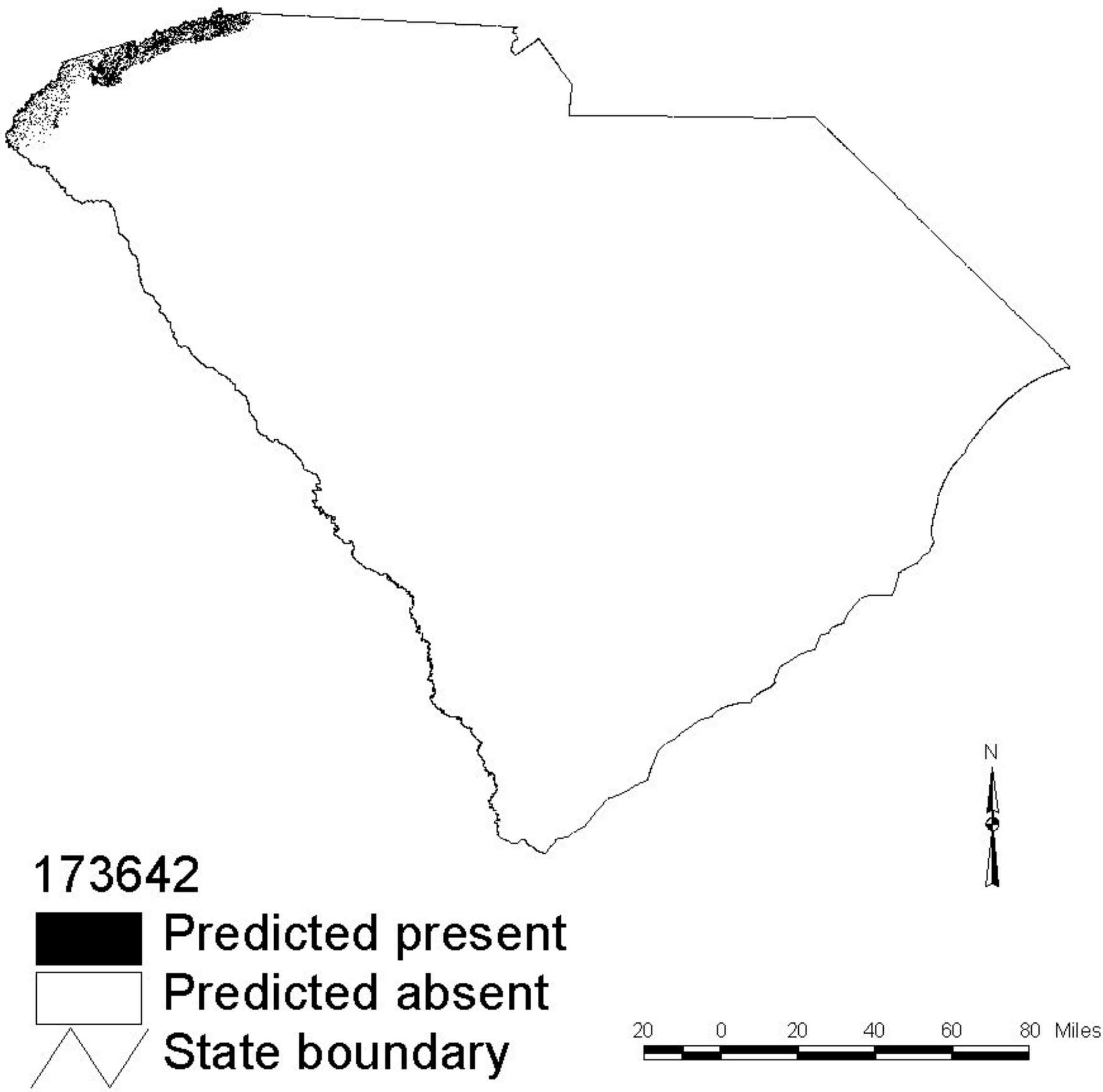
Mountain Dusky Salamander

(Desmognathus ochrophaeus)



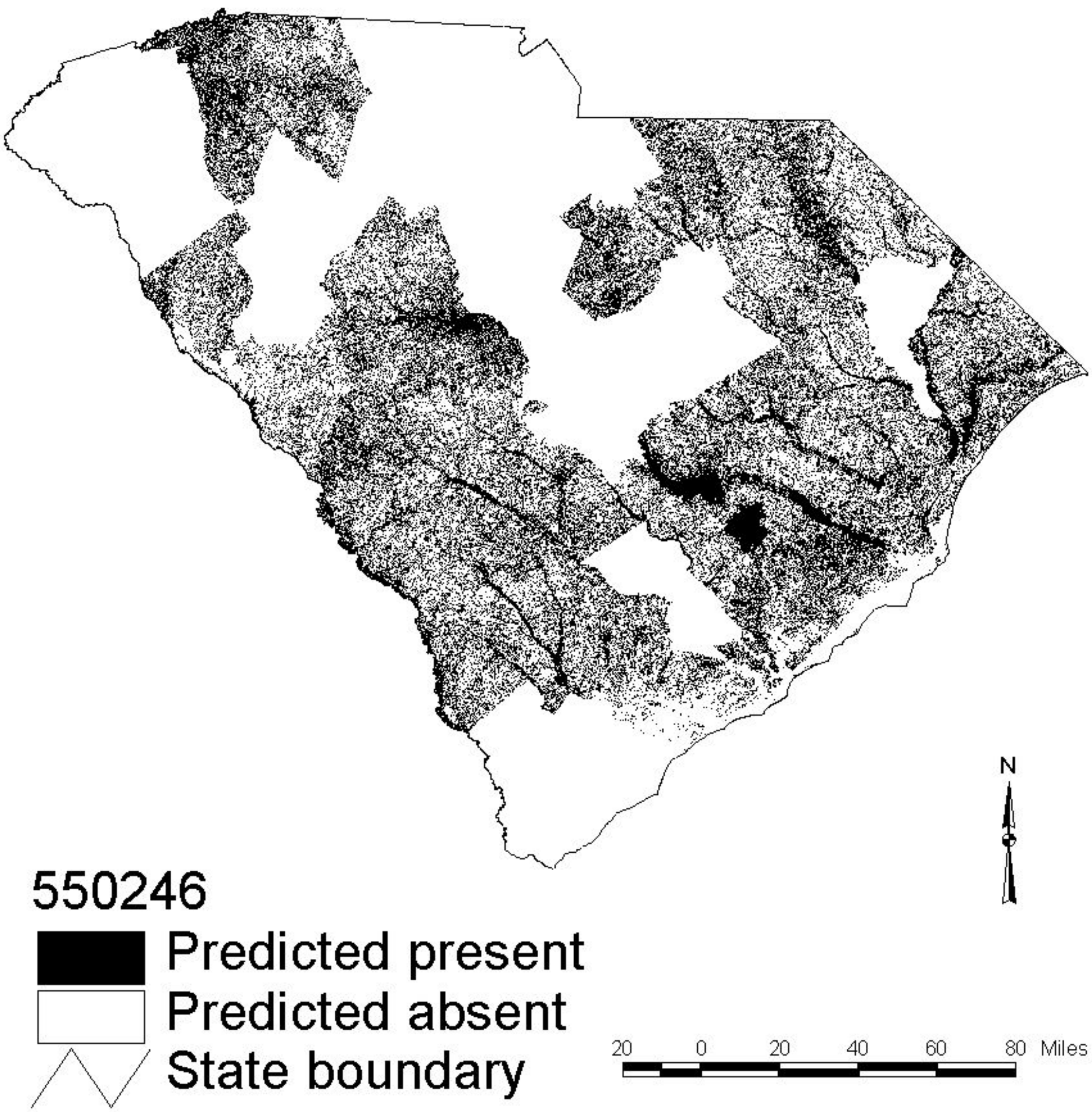
Seal Salamander

(Desmognathus monticola)



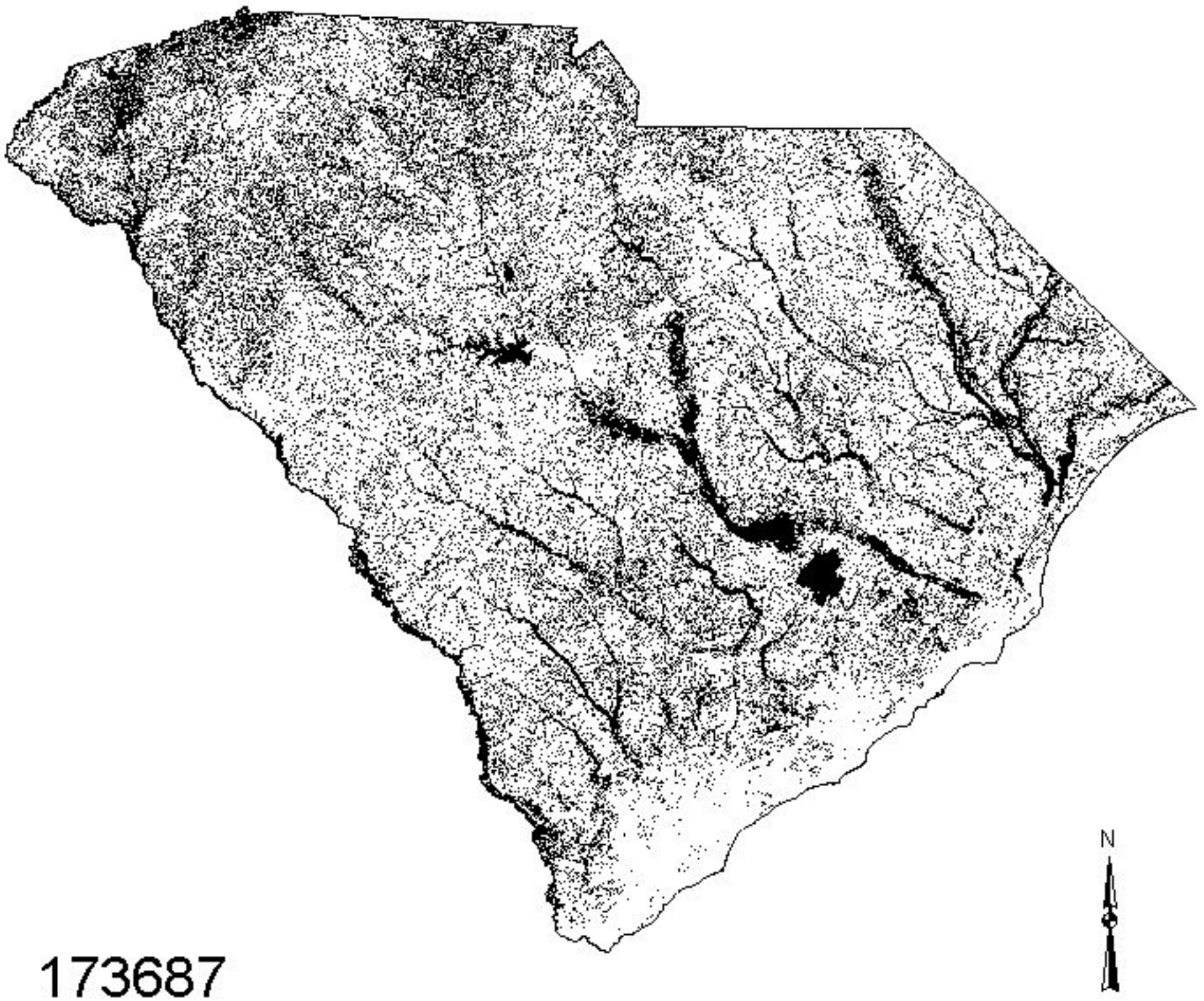
Southern Two-lined Salamander

(Eurycea cirrigera)



Three-lined Salamander

(Eurycea longicauda)



173687

Predicted present

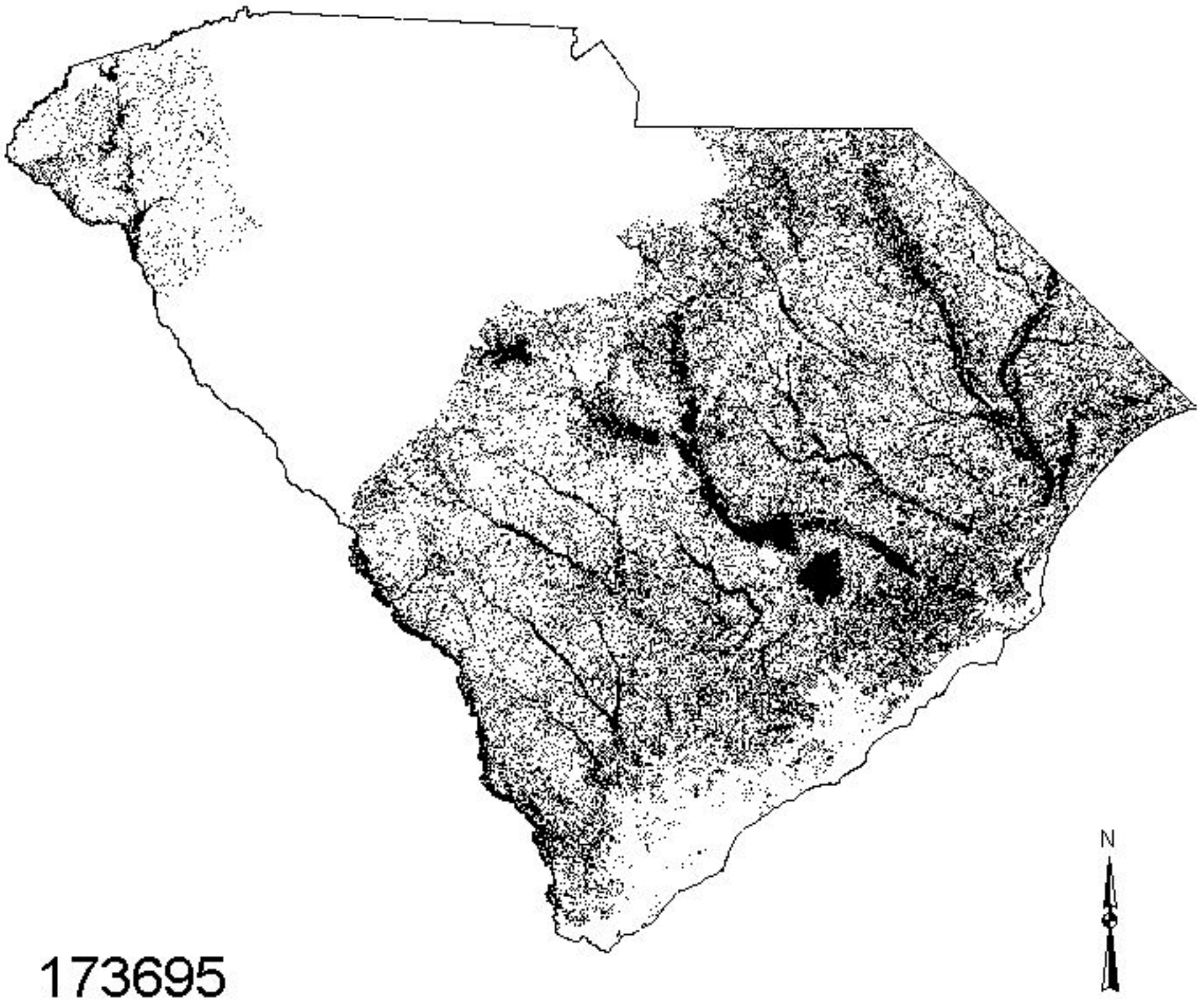
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Dwarf Salamander

(Eurycea quadridigitata)



173695

Predicted present

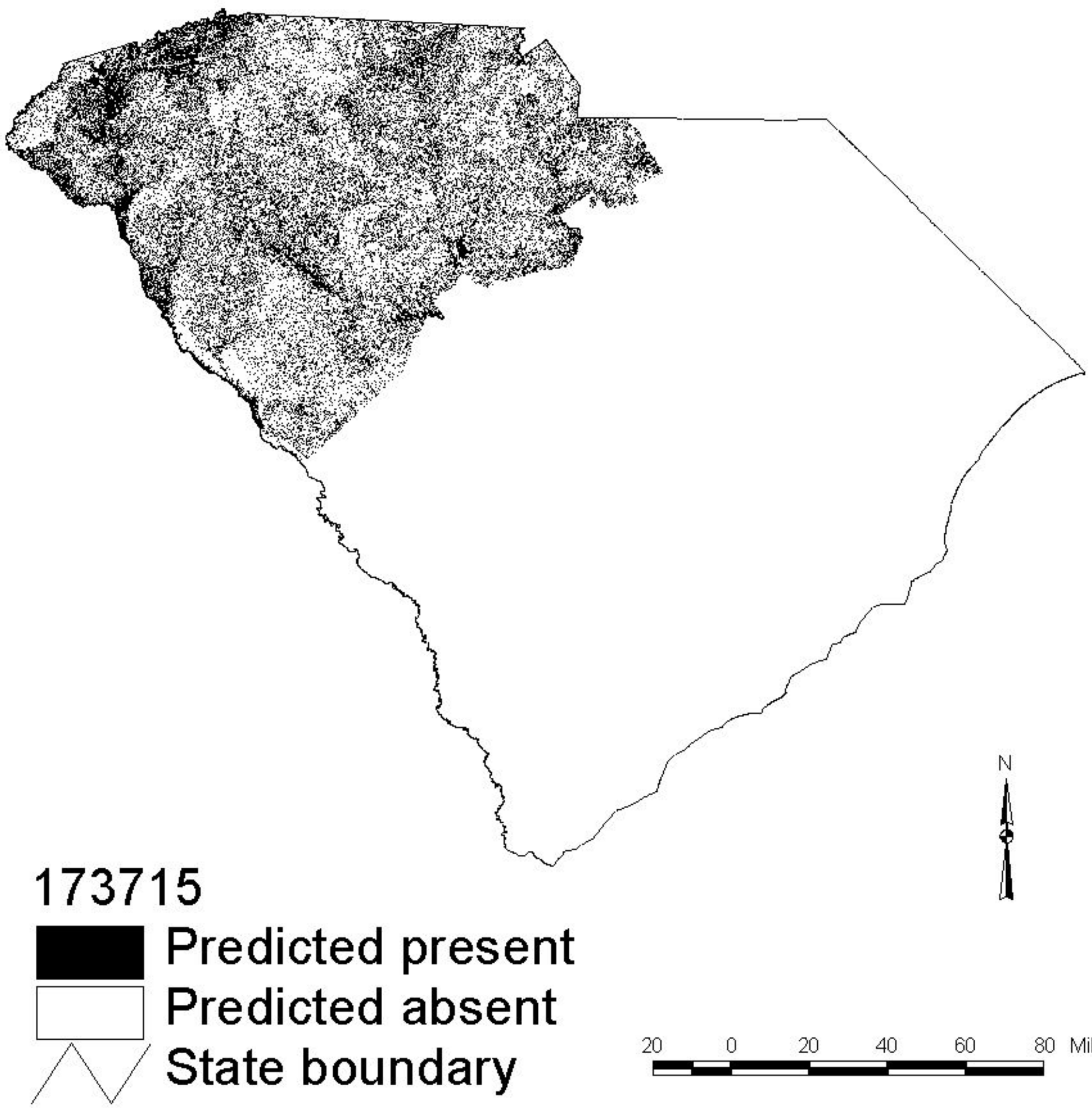
Predicted absent

State boundary

20 0 20 40 60 80 Miles

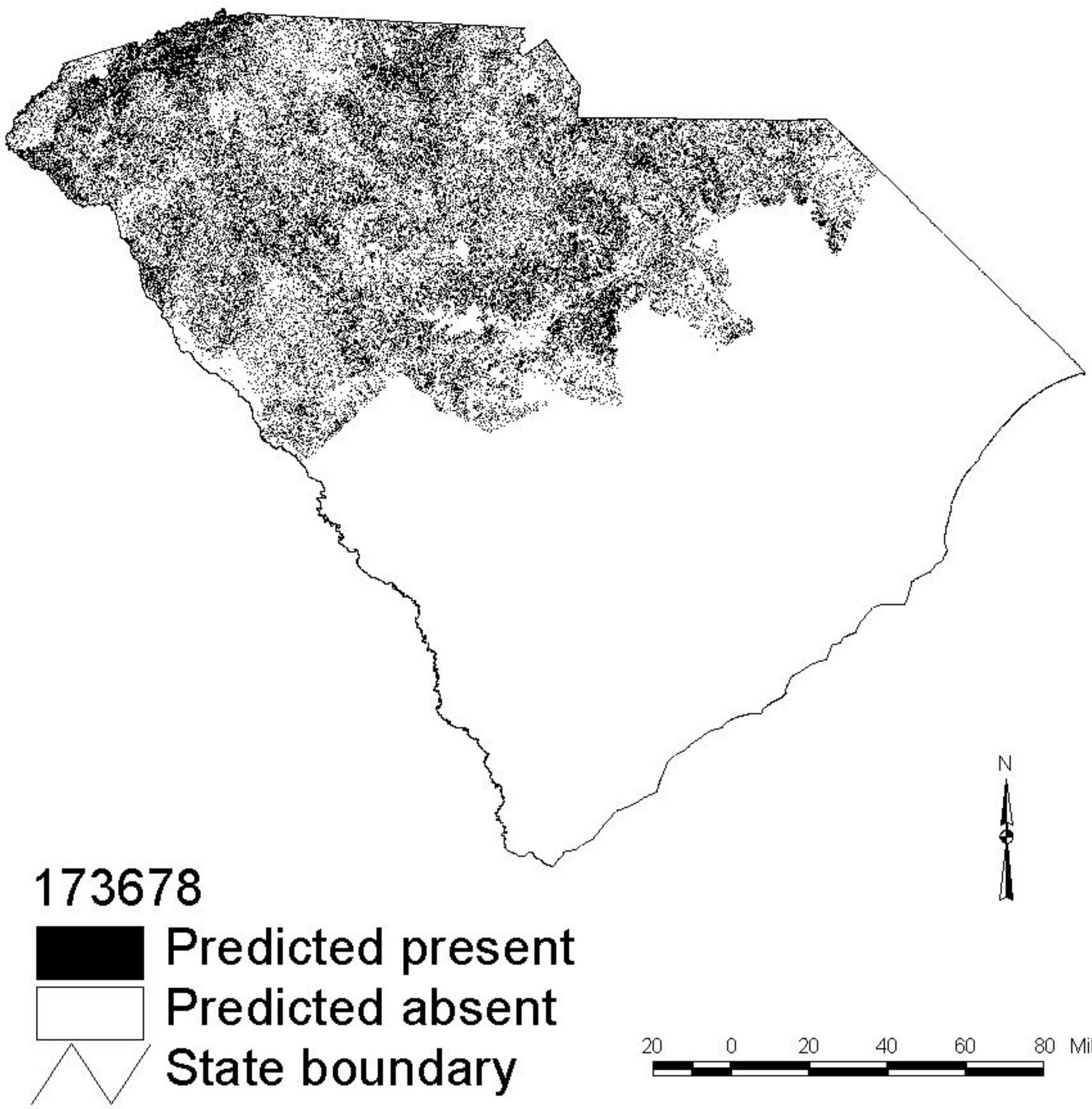
Spring Salamander

(Gyrinophilus porphyriticus)



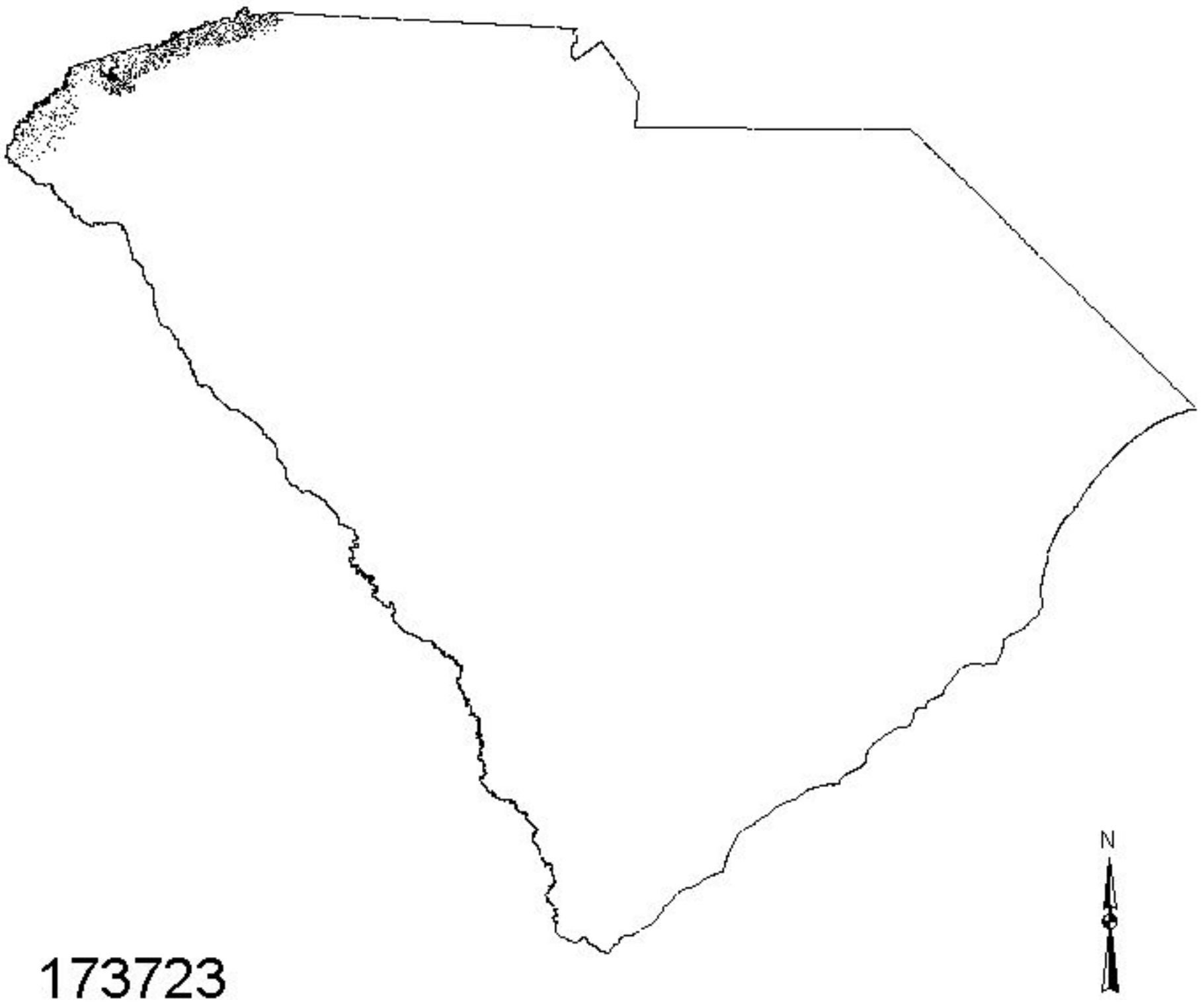
Four-toed Salamander

(Hemidactylium scutatum)



Shovelnose Salamander

(Leurognathus marmoratus)



173723

Predicted present

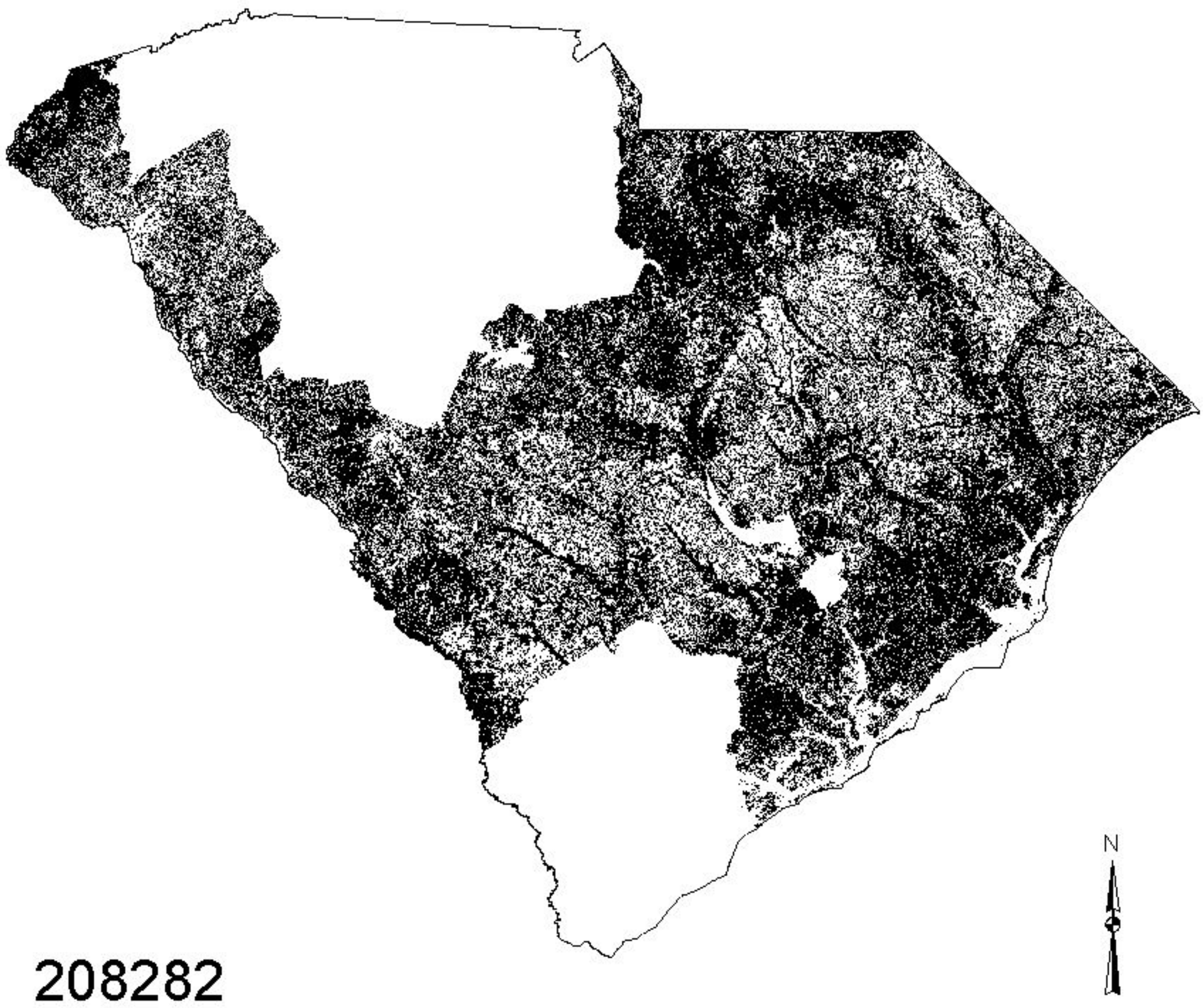
Predicted absent

State boundary

20 0 20 40 60 80 Miles

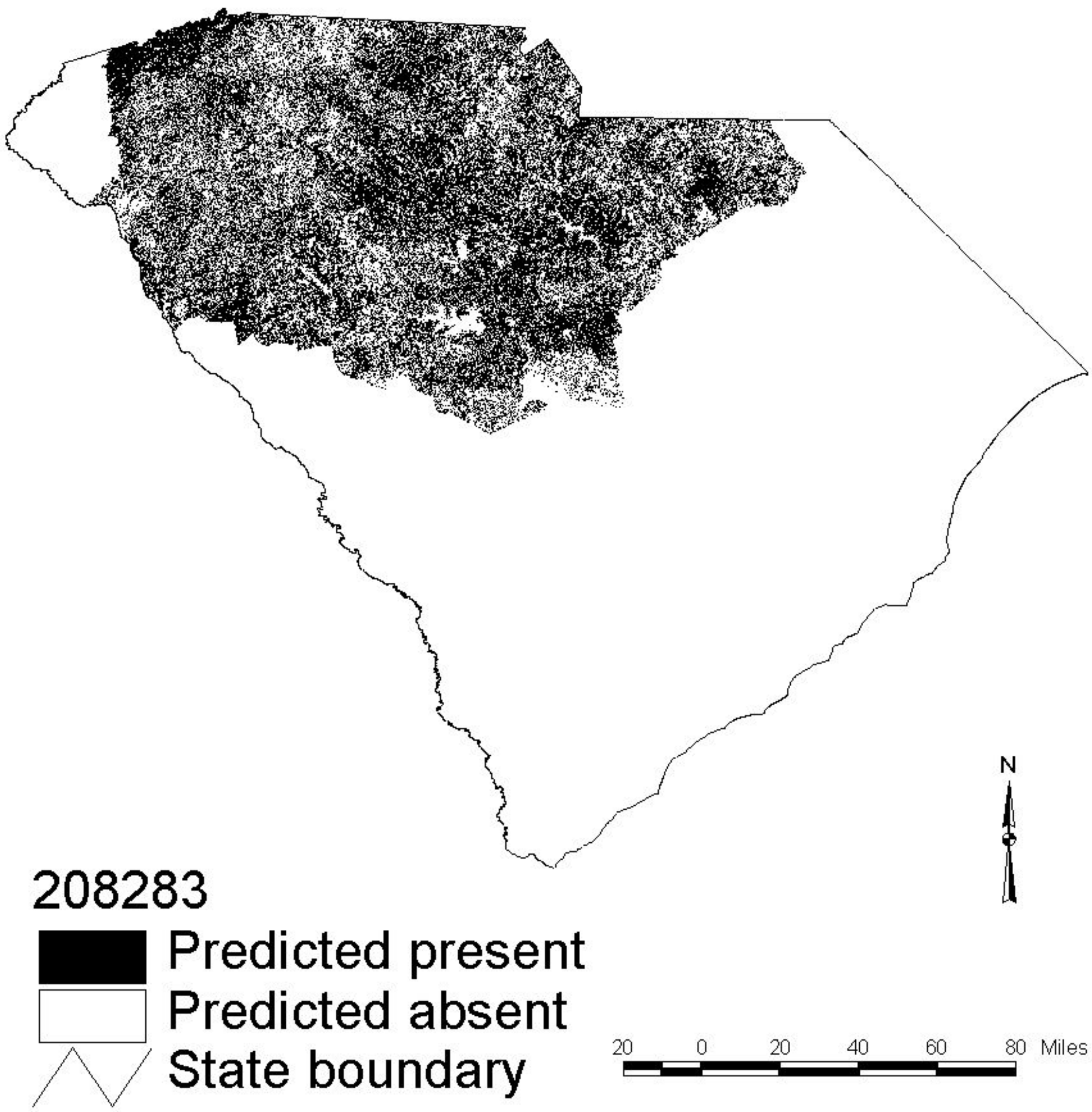
Atlantic Coast Slimy Salamander

(Plethodon chlorobryonis)



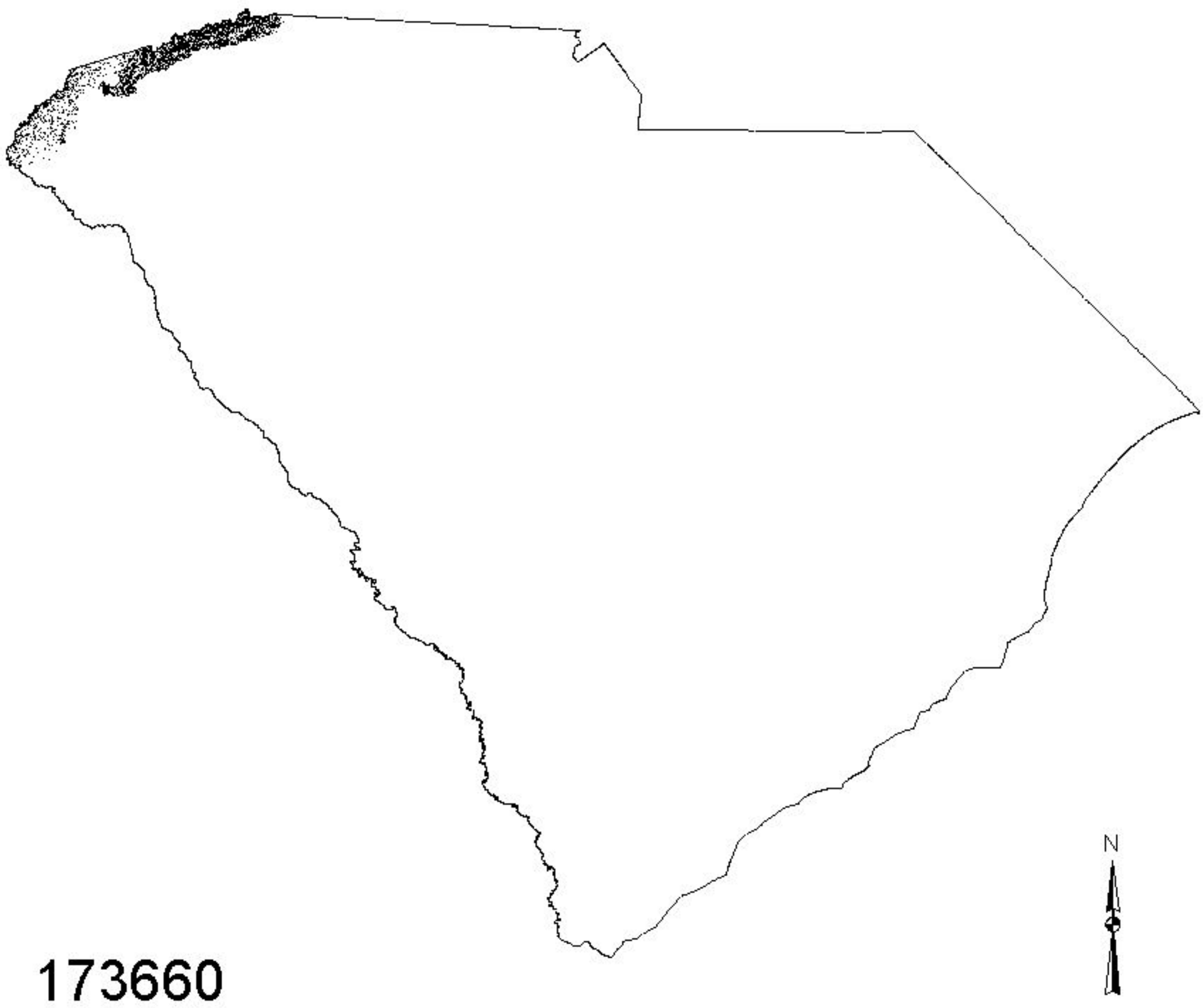
White-spotted Slimy Salamander

(Plethodon cylindraceus)



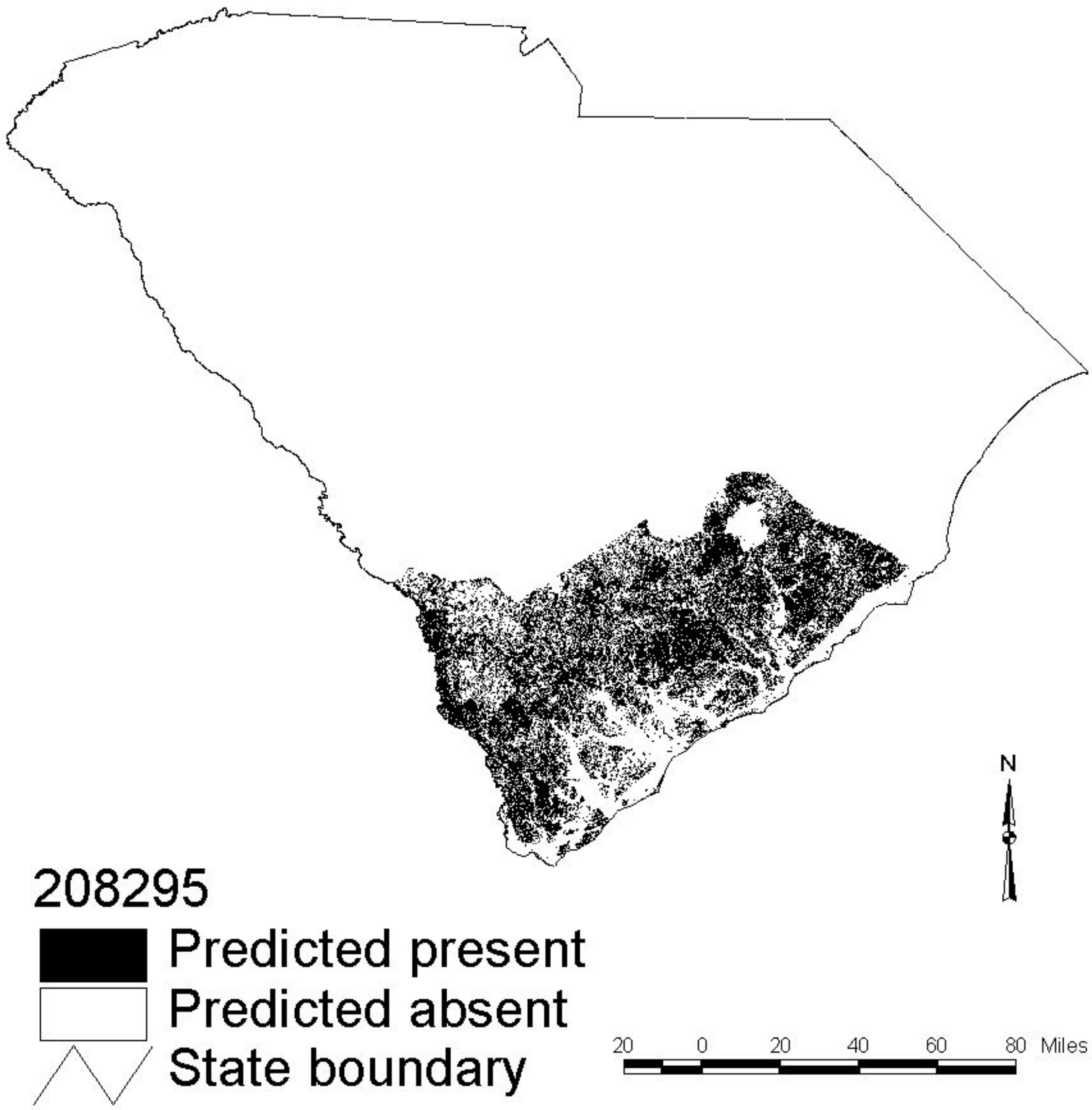
Jordan's Salamander

(Plethodon jordani)



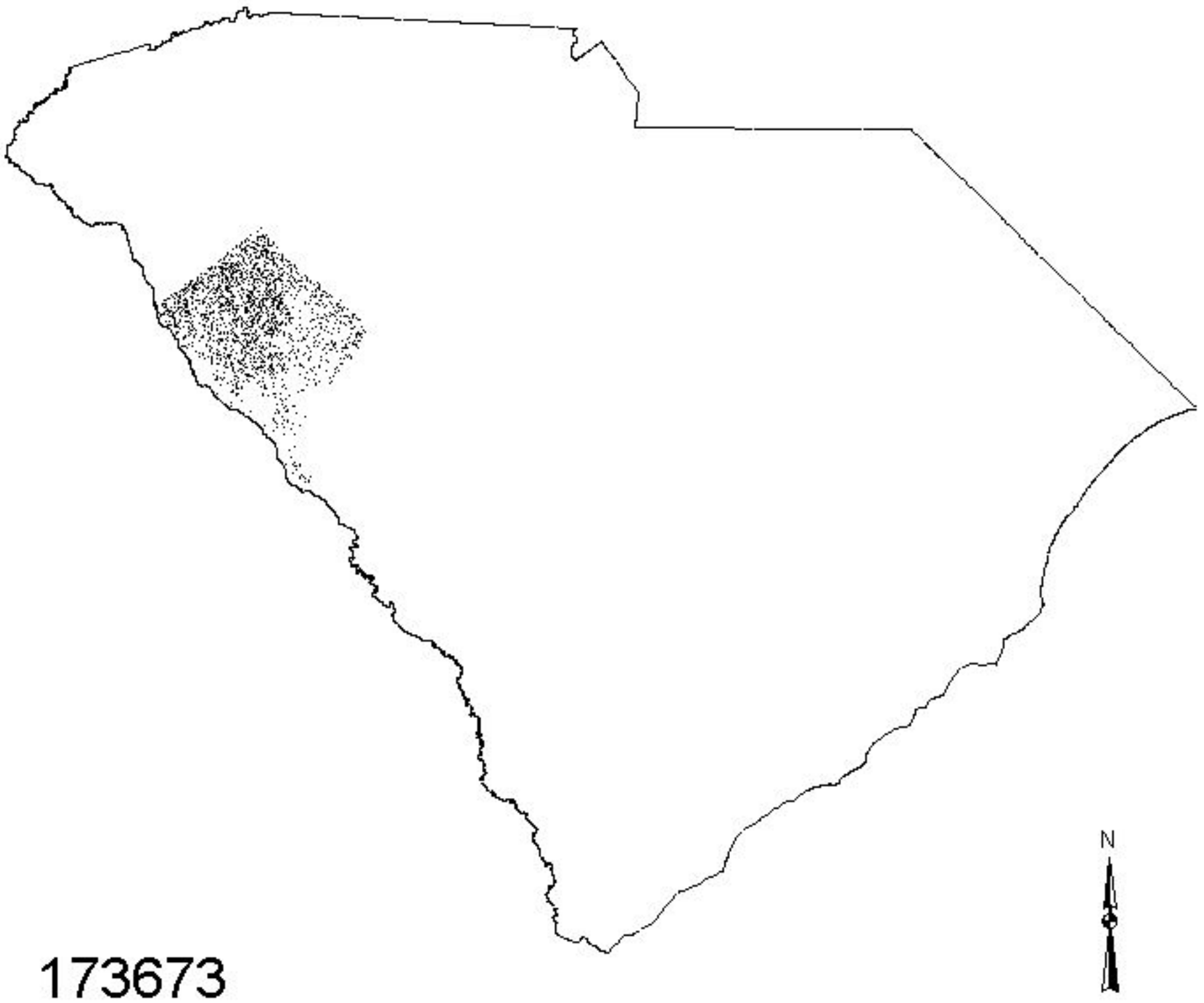
South Carolina Slimy Salamander

(Plethodon variolatus)



Webster's Salamander

(Plethodon websteri)



173673

Predicted present

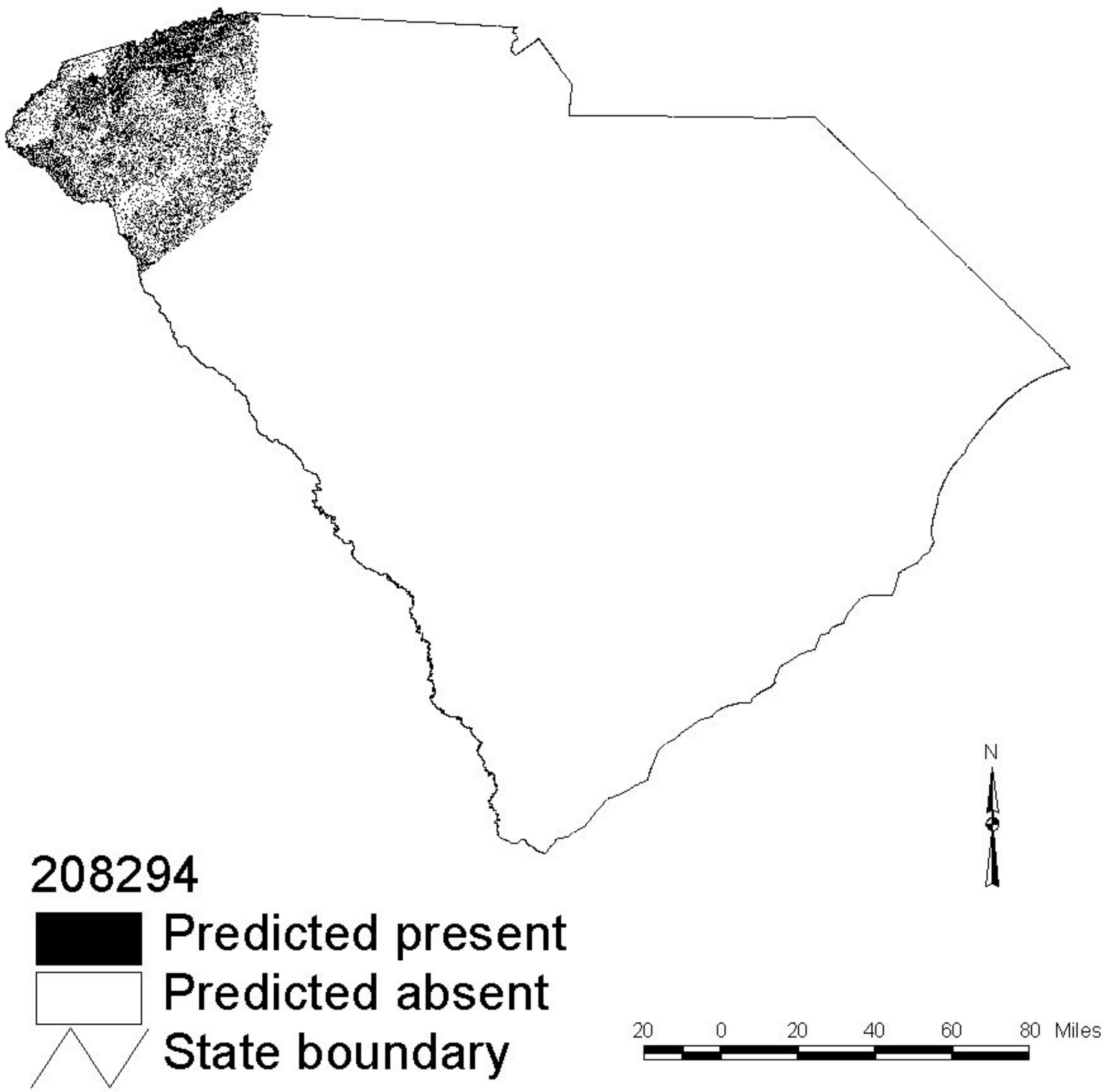
Predicted absent

State boundary

20 0 20 40 60 80 Miles

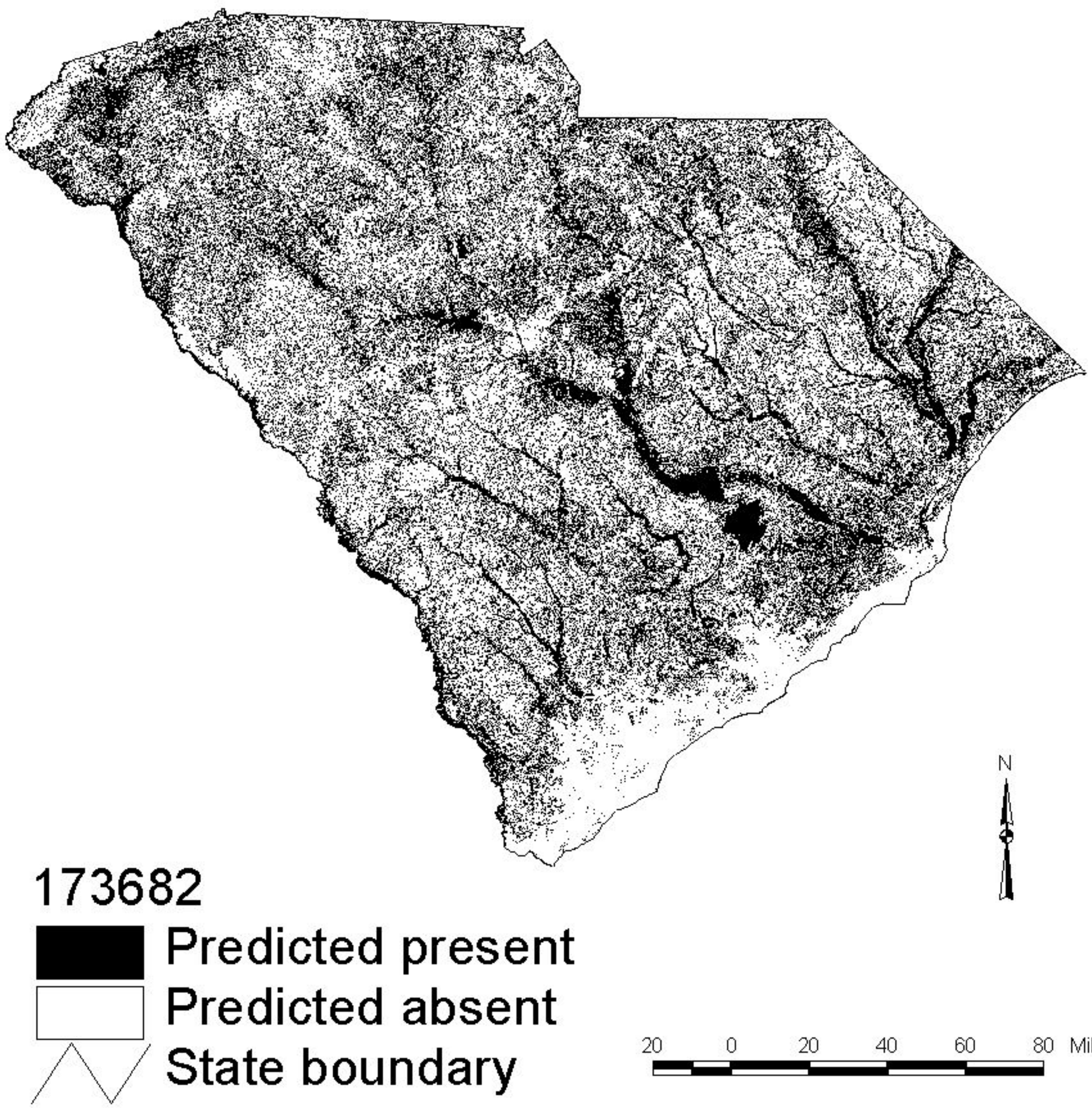
Southern Appalachian Salamander

(Plethodon teyahalee)



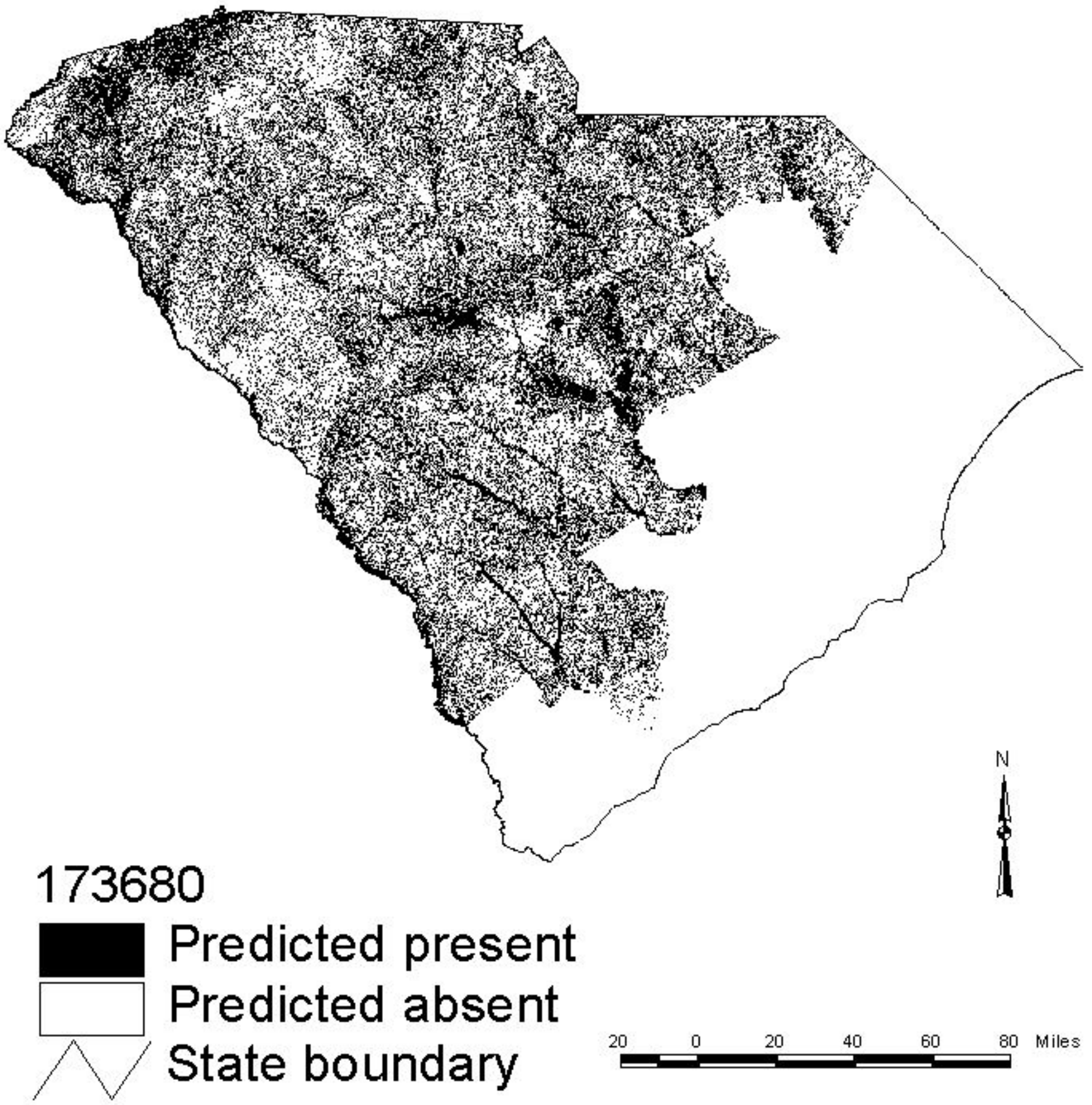
Mud Salamander

(Pseudotriton montanus)



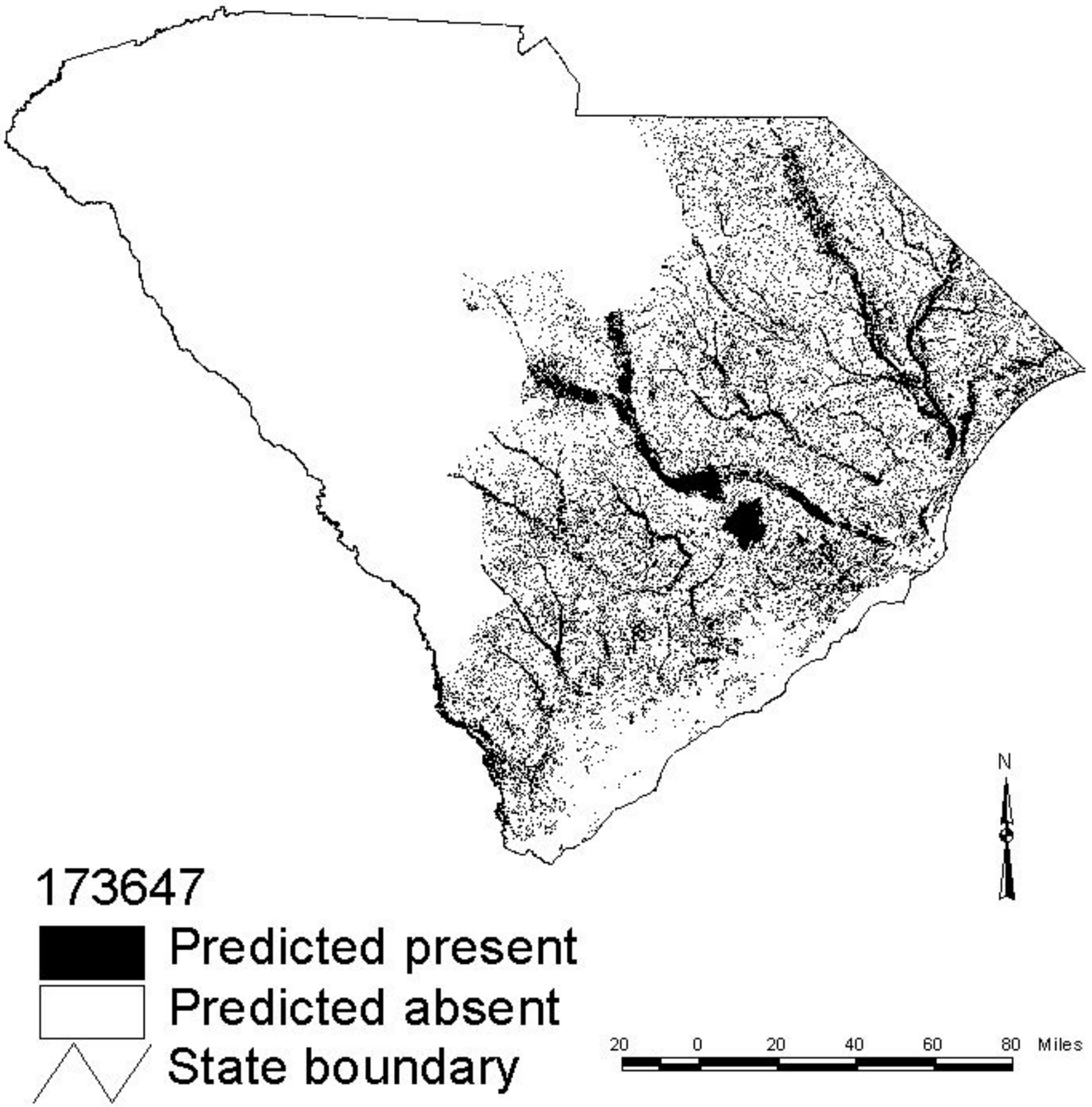
Red Salamander

(Pseudotriton ruber)



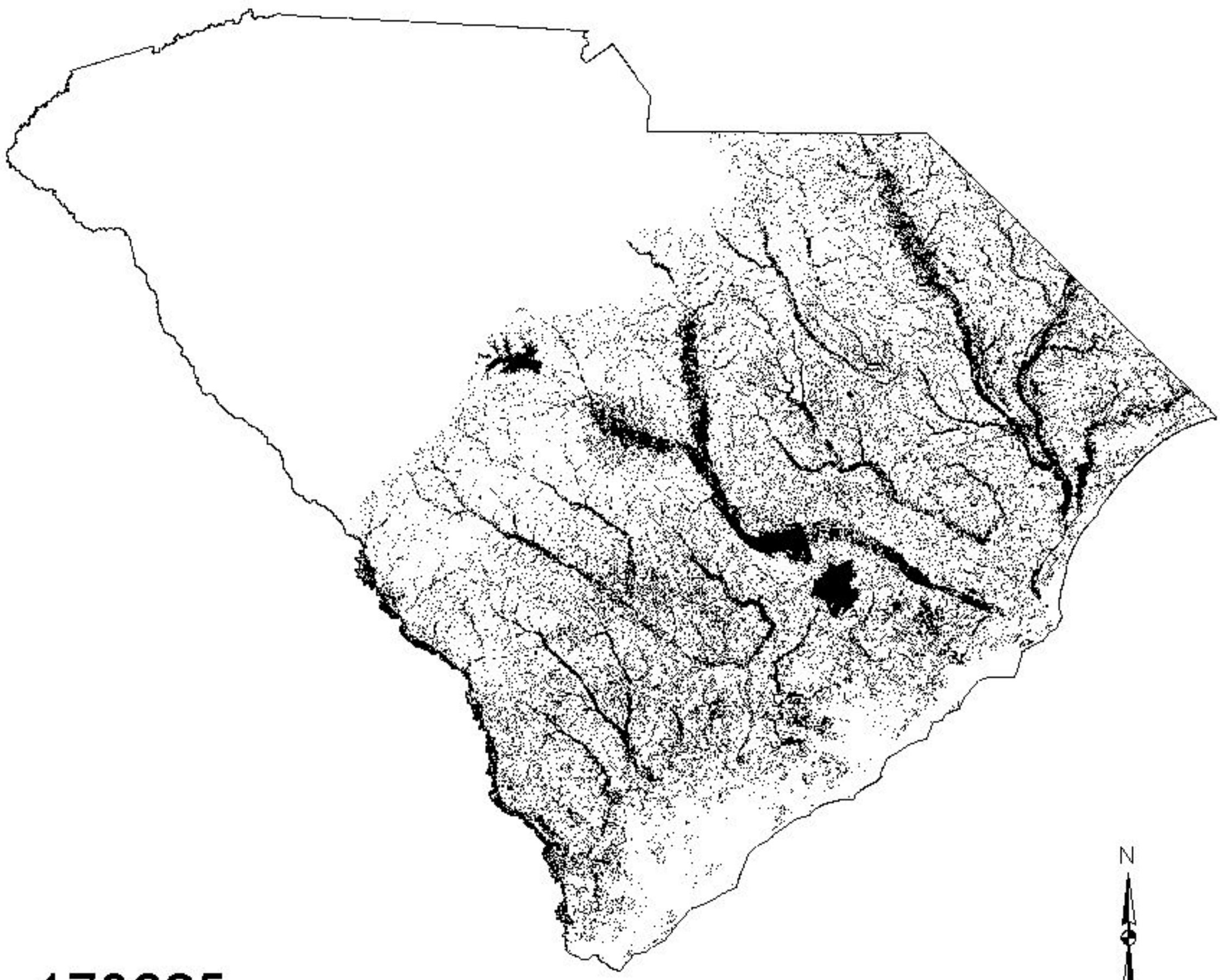
Many-lined Salamander

(Stereochilus marginatus)



Dwarf Waterdog

(Necturus punctatus)



173625

Predicted present

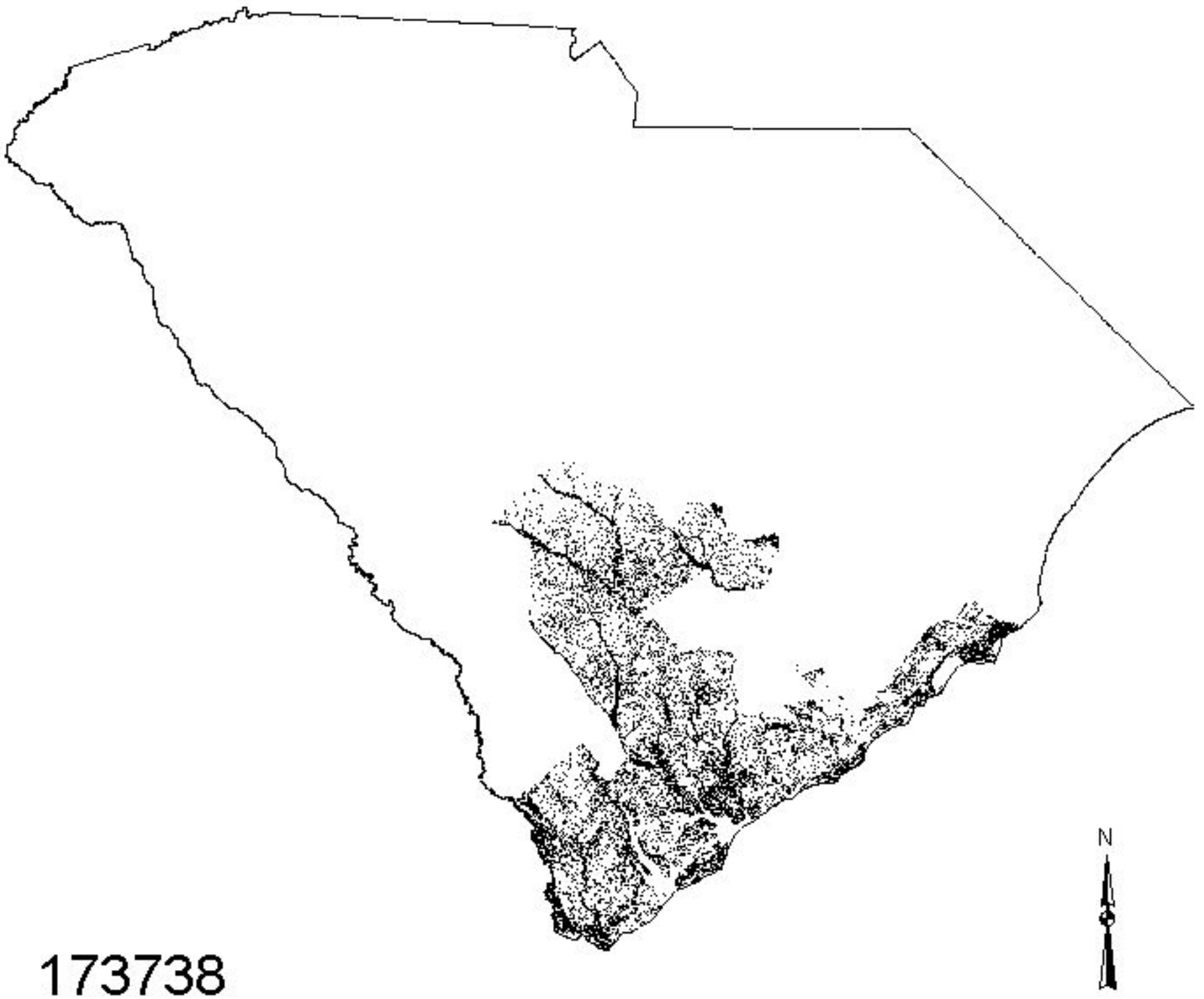
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Dwarf Siren

(Pseudobranchus striatus)



173738

Predicted present

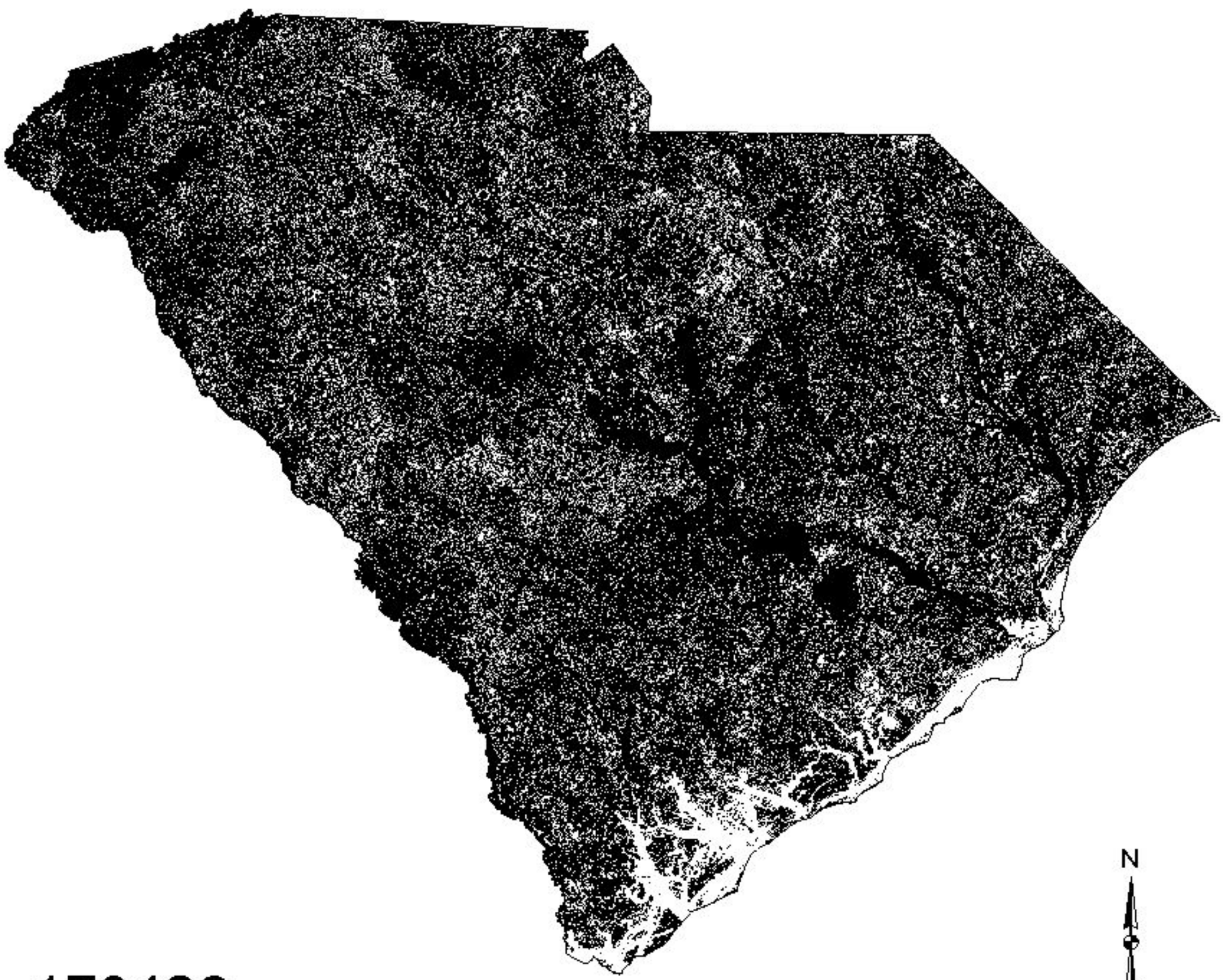
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Eastern Spadefoot

(Scaphiopus holbrooki)



173426

Predicted present

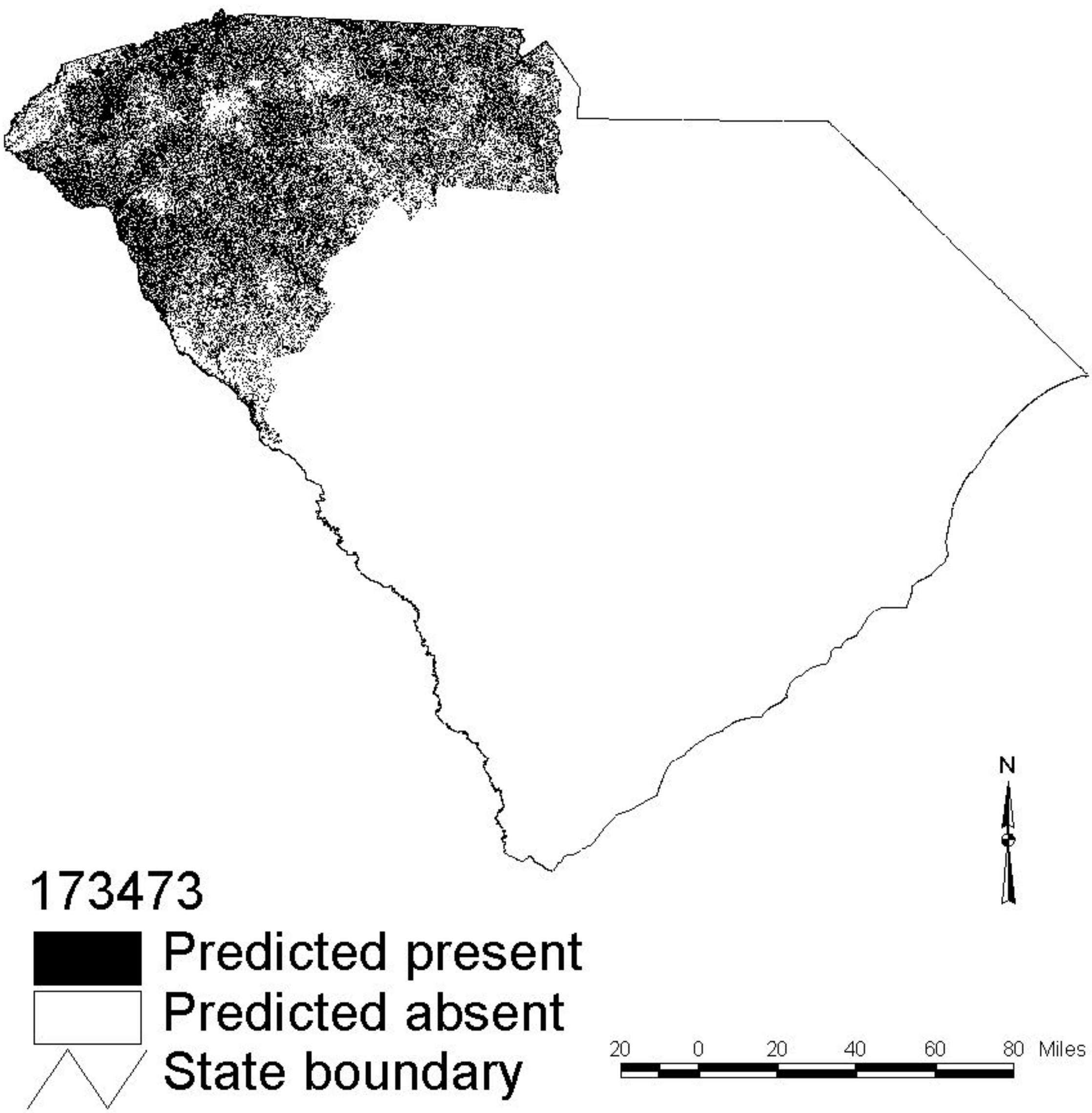
Predicted absent

State boundary

20 0 20 40 60 80 Miles

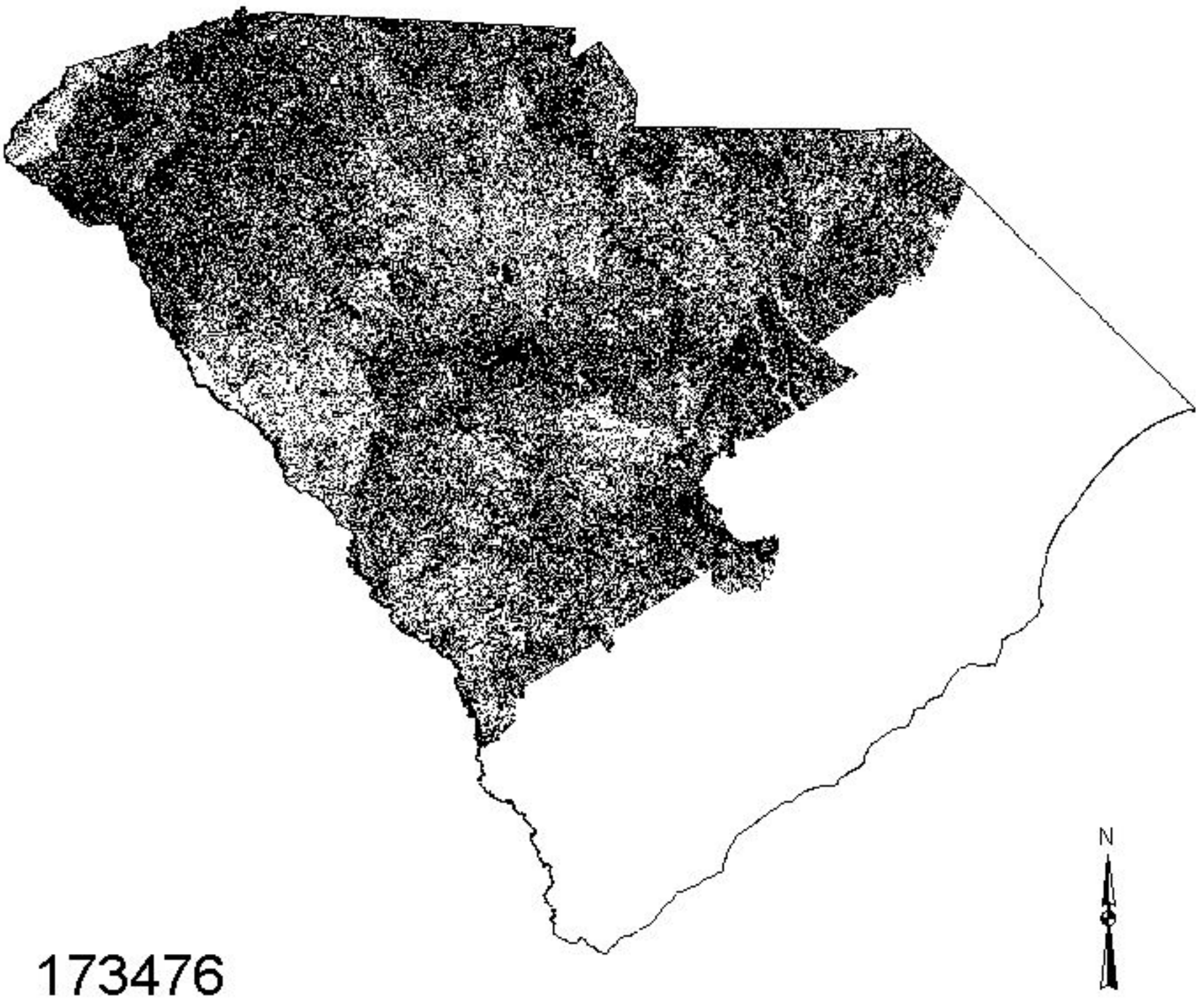
American Toad

(Bufo americanus)



Woodhouse's Toad

(Bufo woodhousii)



173476

Predicted present

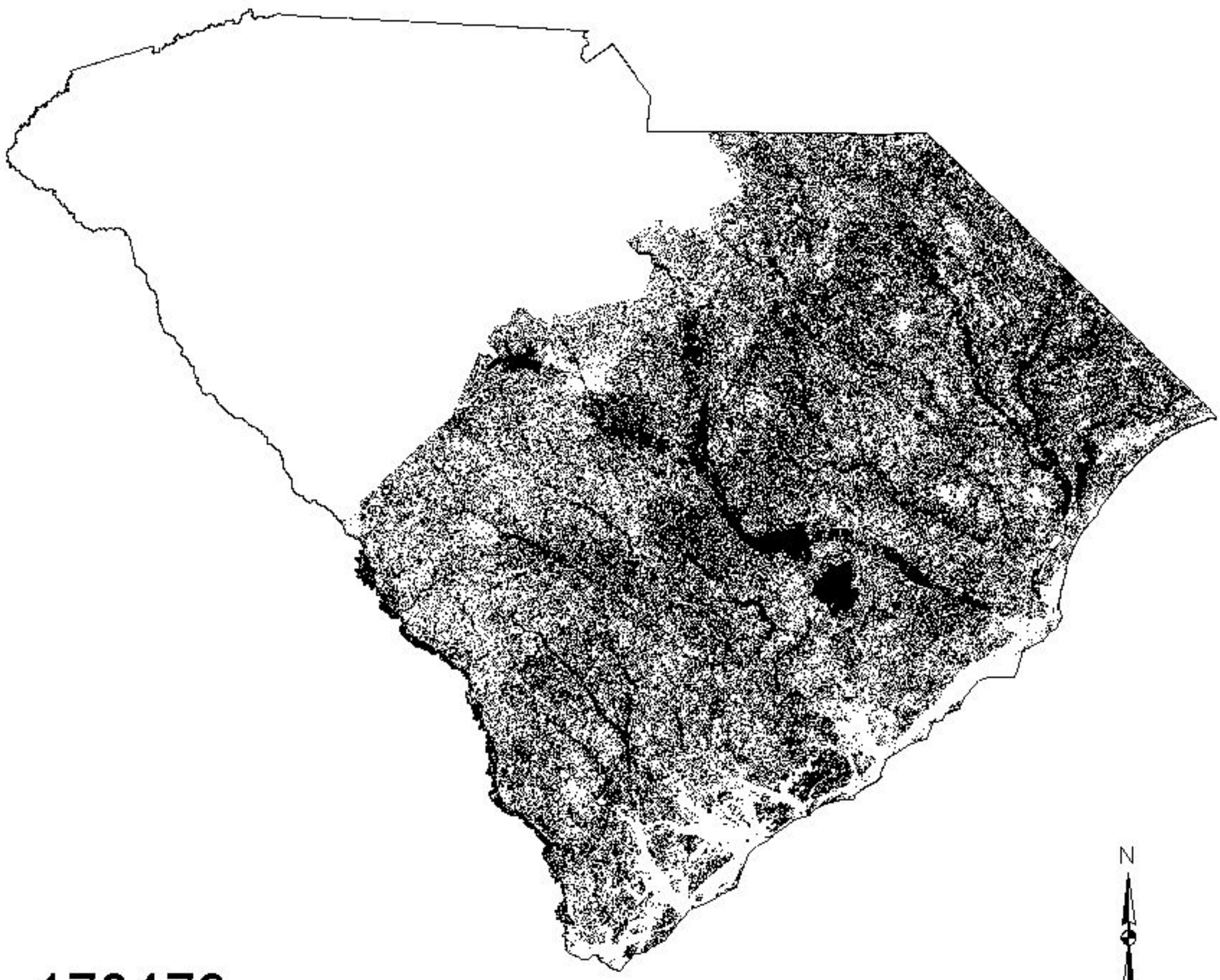
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Oak Toad

(Bufo quercicus)



173479

Predicted present

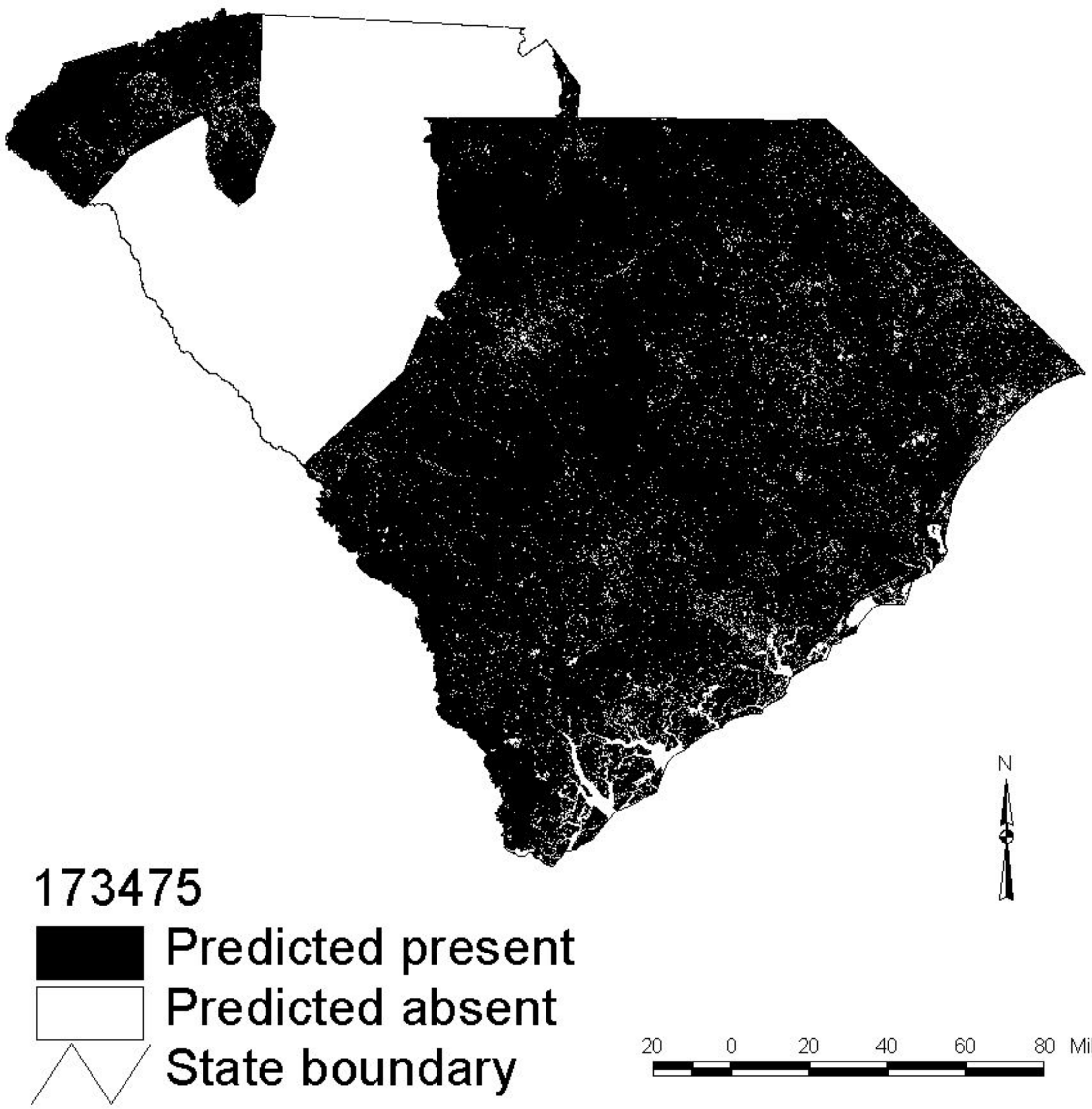
Predicted absent

State boundary

20 0 20 40 60 80 Miles

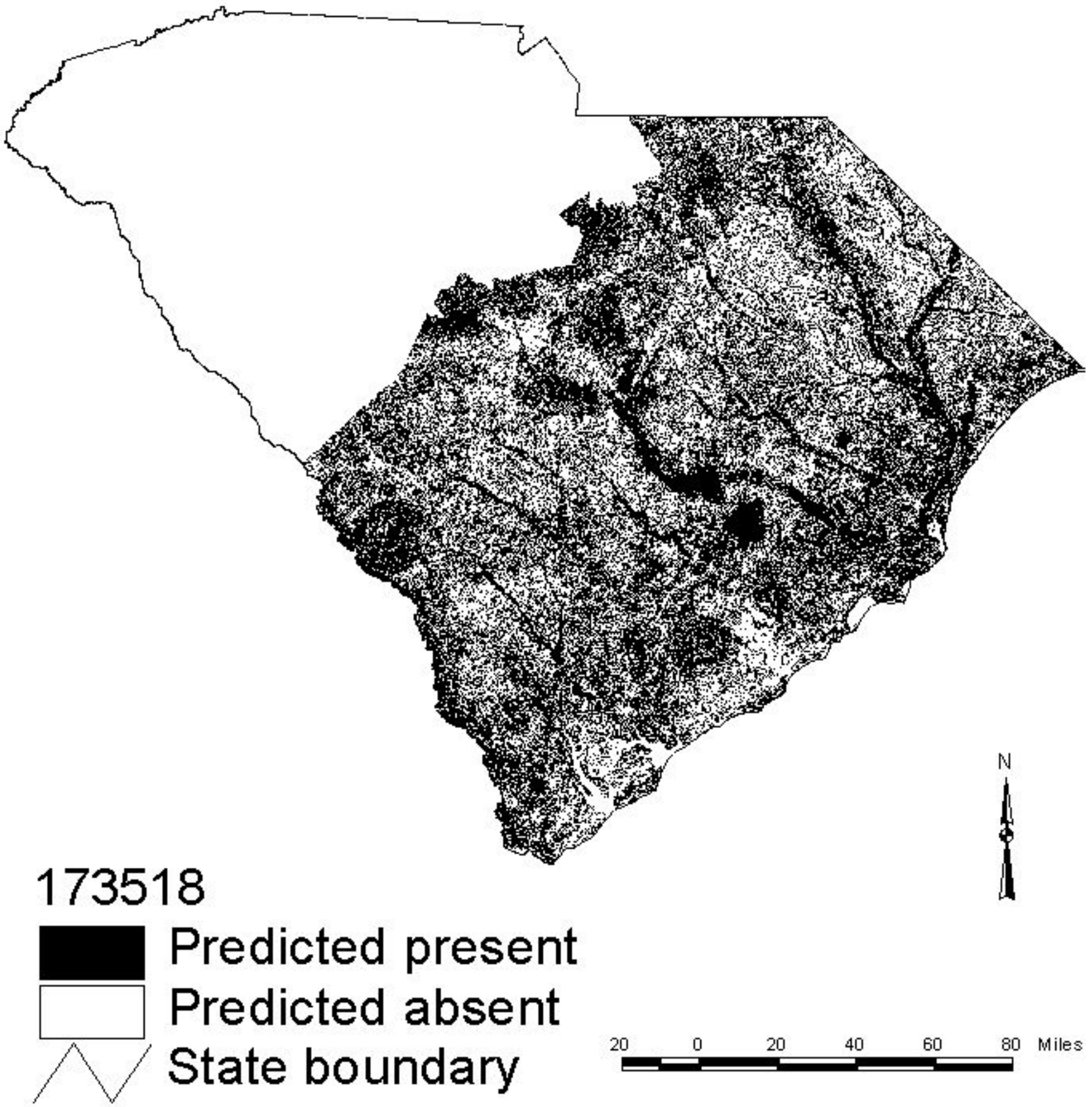
Southern Toad

(Bufo terrestris)



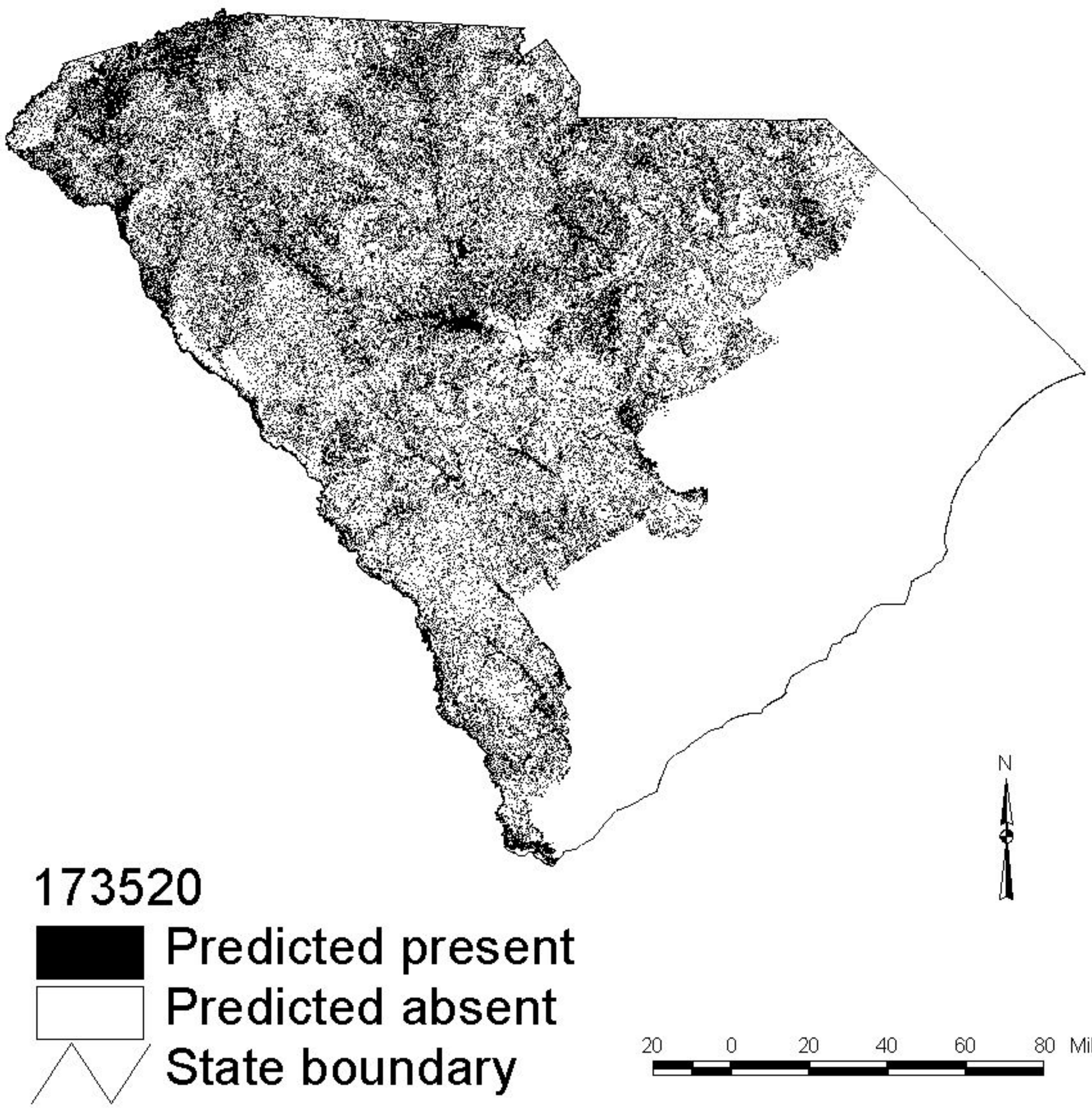
Southern Cricket Frog

(Acris gryllus)



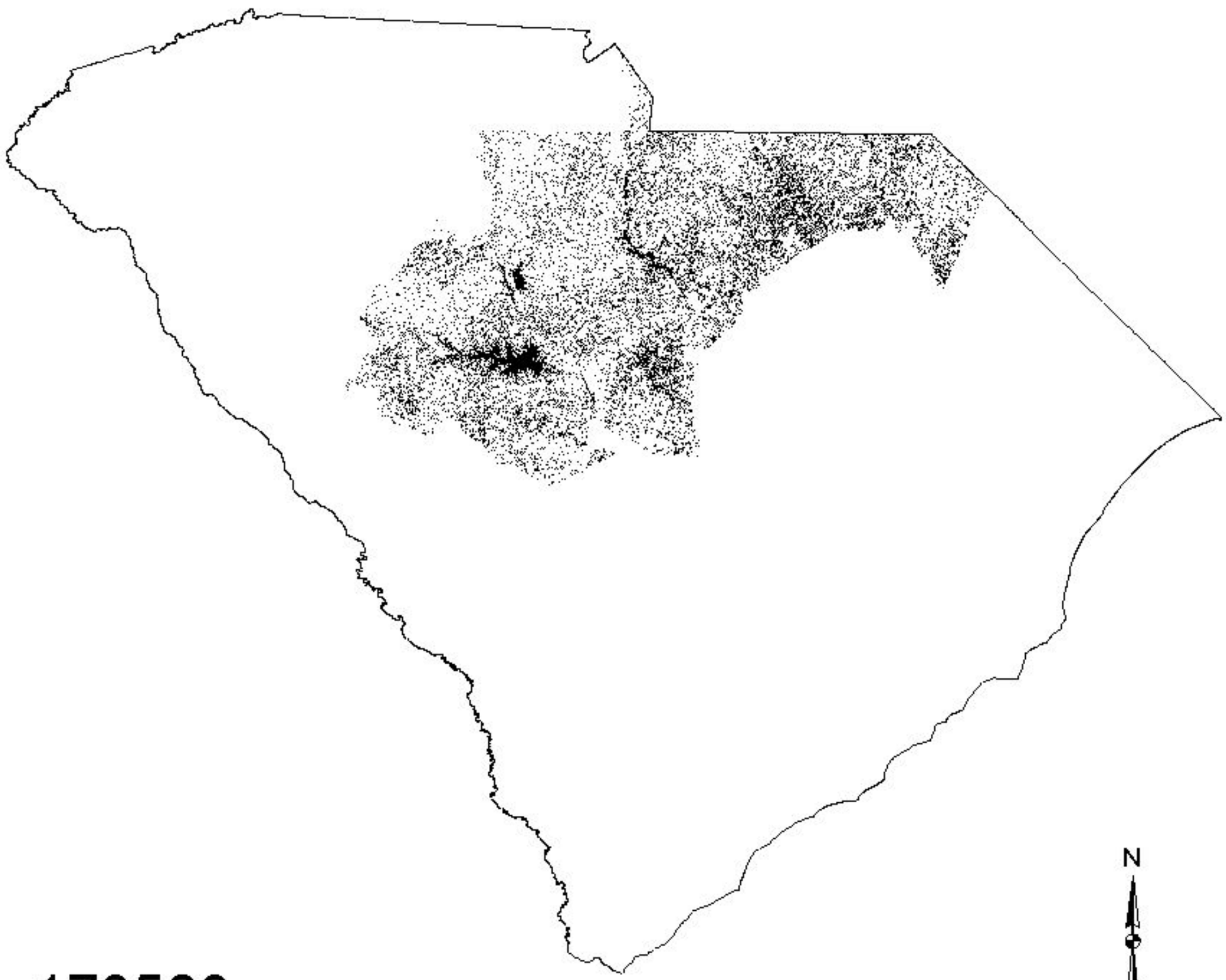
Northern Cricket Frog

(Acris crepitans)



Pine Barrens Treefrog

(Hyla andersonii)



173509

Predicted present

Predicted absent

State boundary

Bird-voiced Treefrog

(Hyla avivoca)

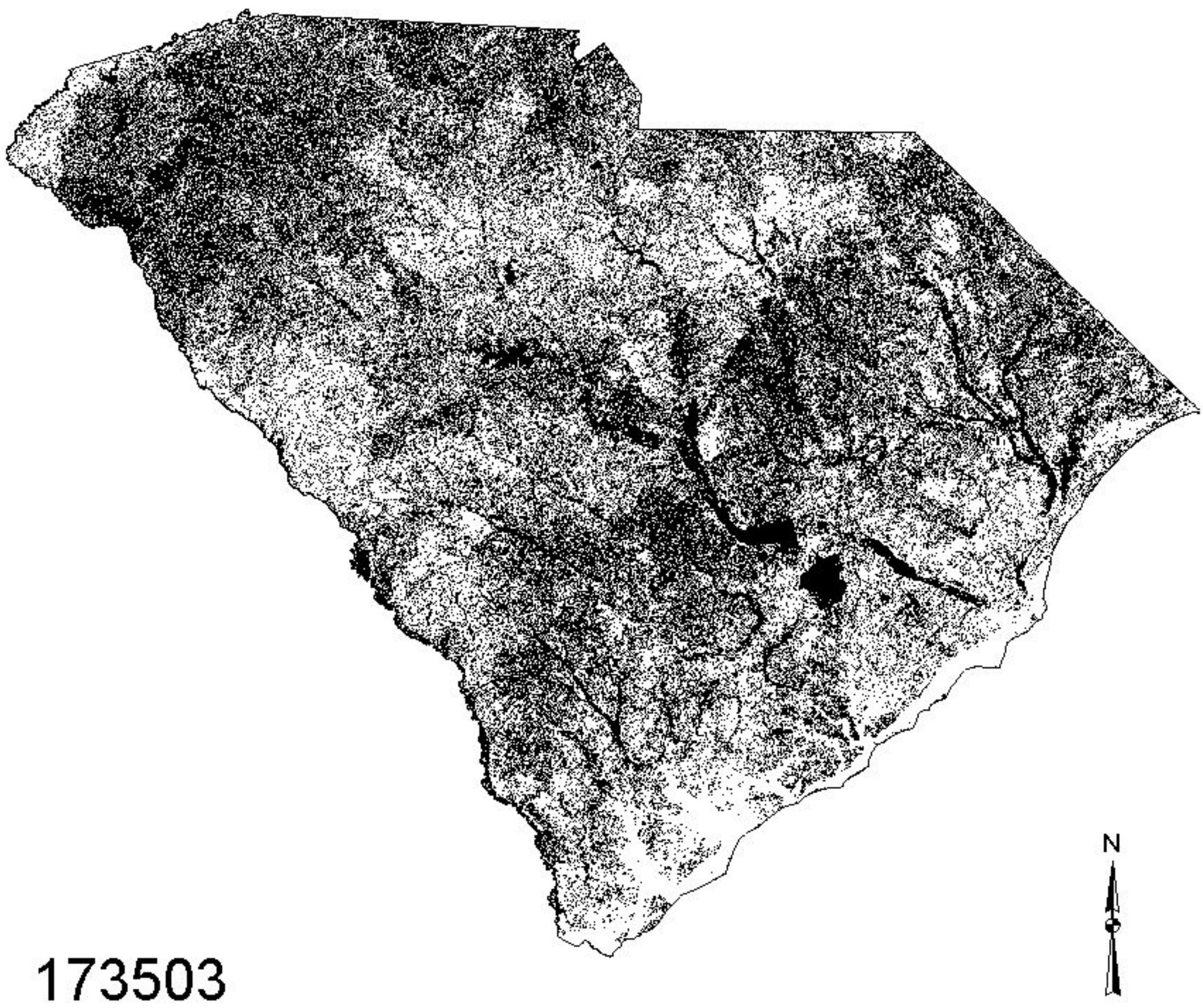
173511

Predicted present

Predicted absent

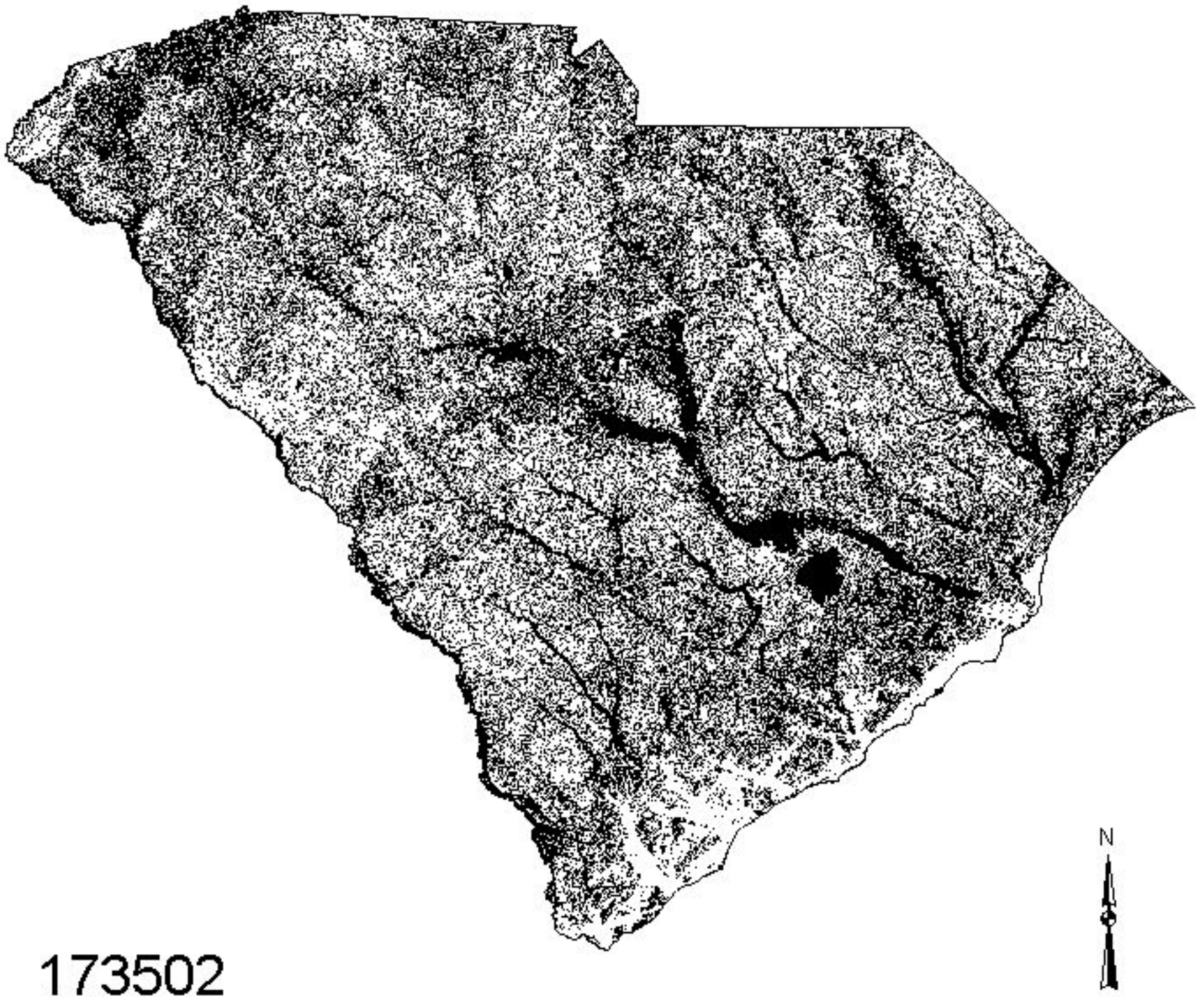
State boundary

Gray Treefrog
(Hyla versicolor)



Cope's Gray Treefrog

(Hyla chrysoscelis)



173502

Predicted present

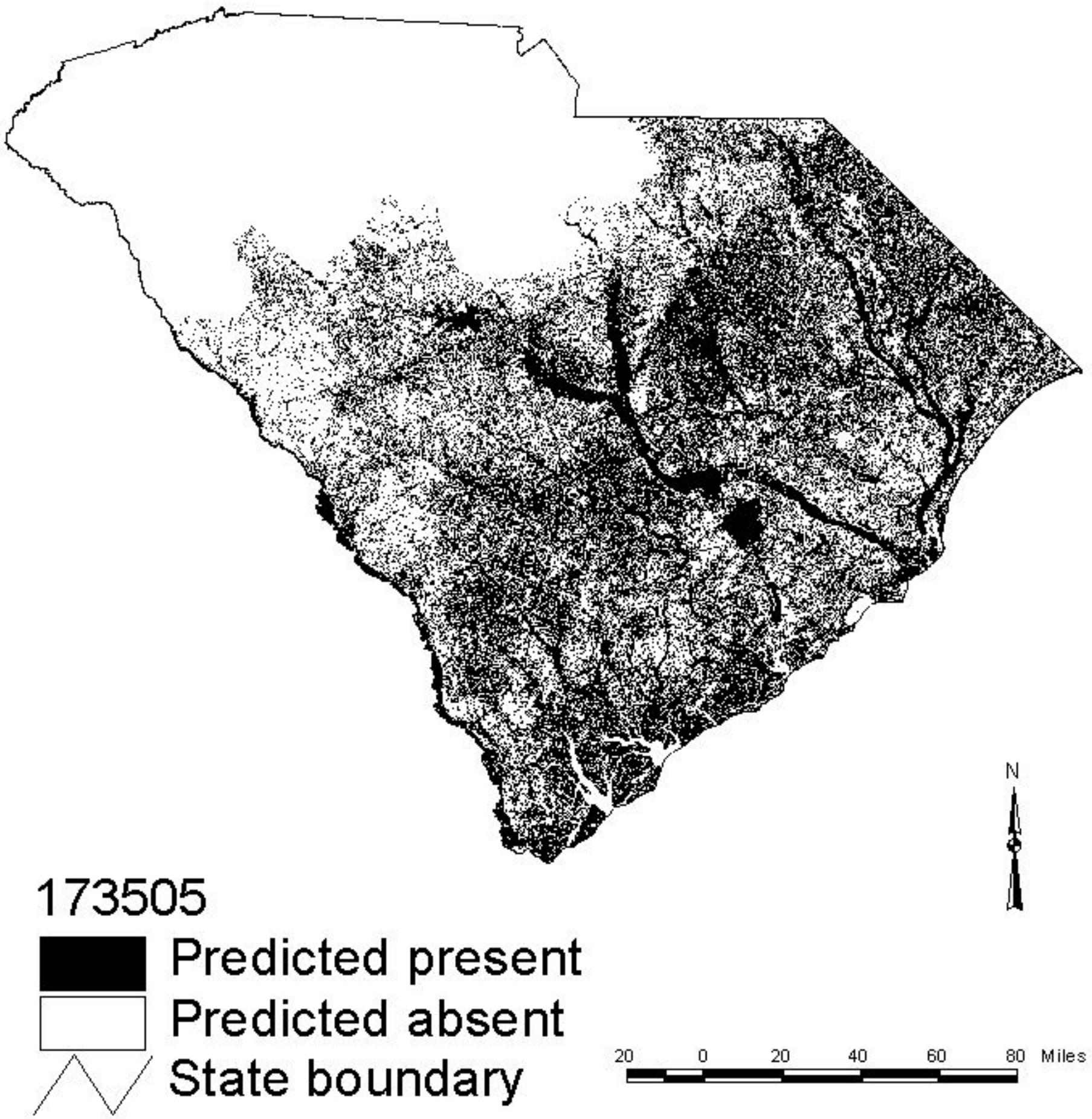
Predicted absent

State boundary

20 0 20 40 60 80 Miles

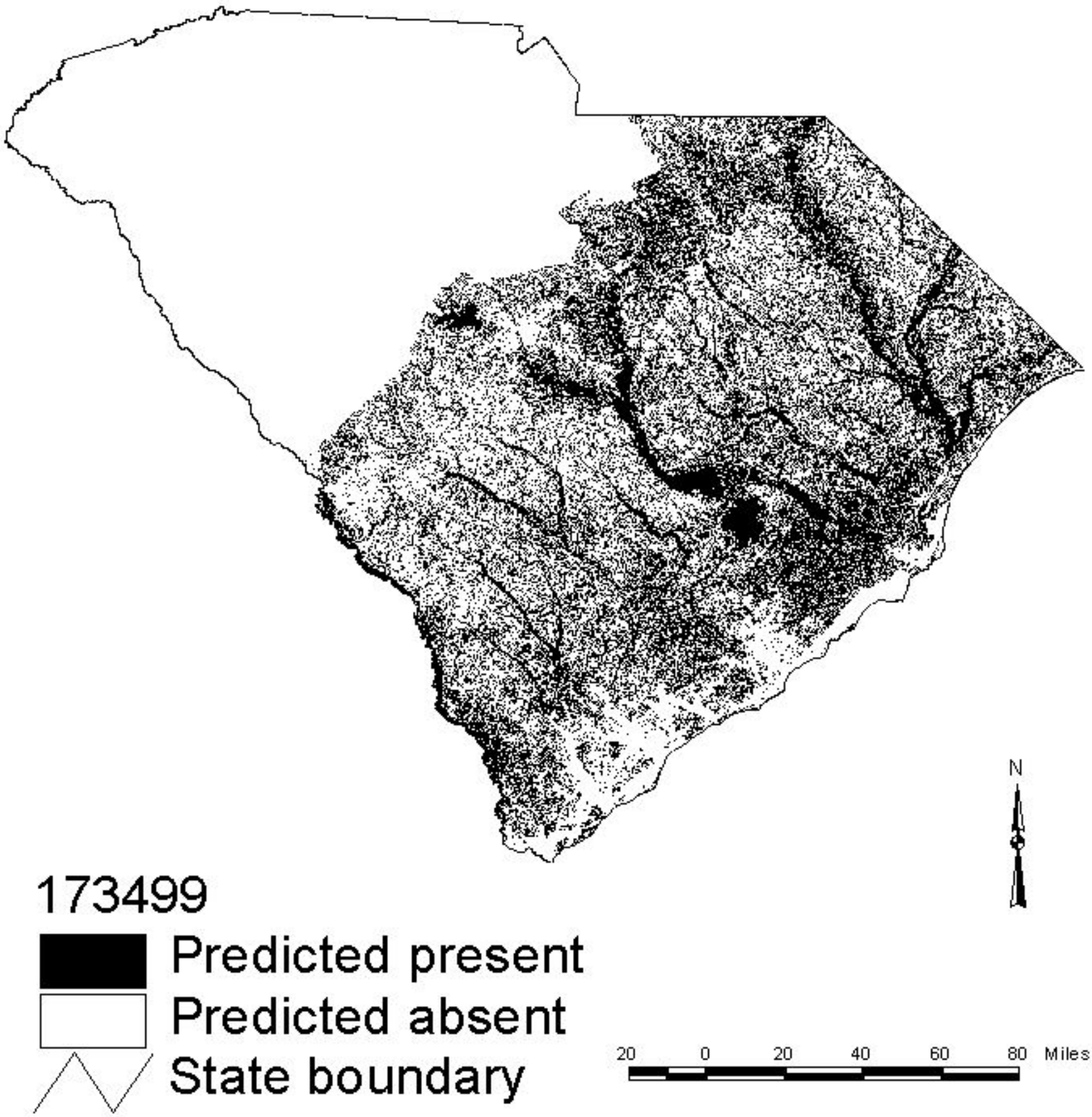
Green Treefrog

(Hyla cinerea)



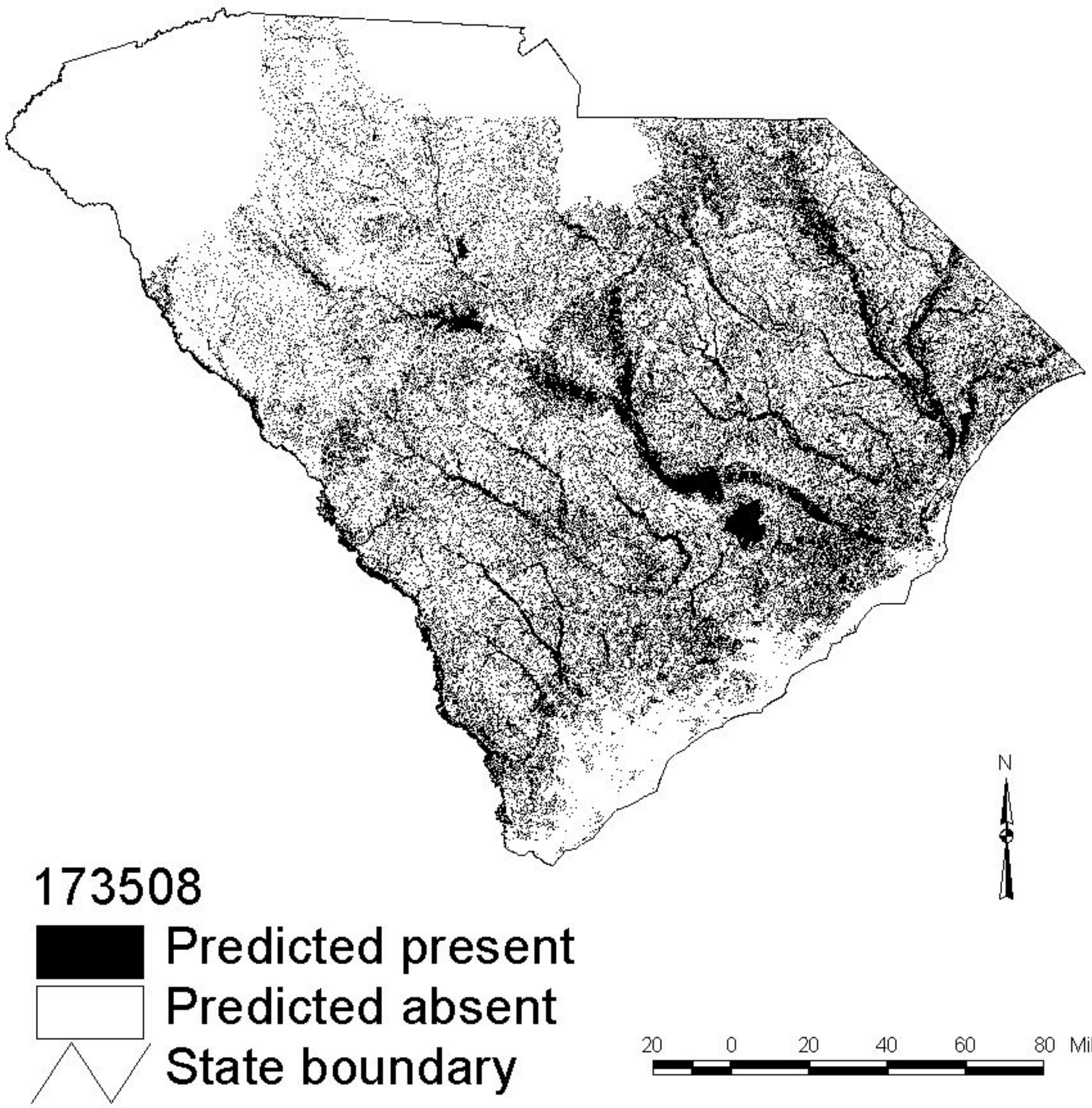
Pine Woods Treefrog

(Hyla femoralis)



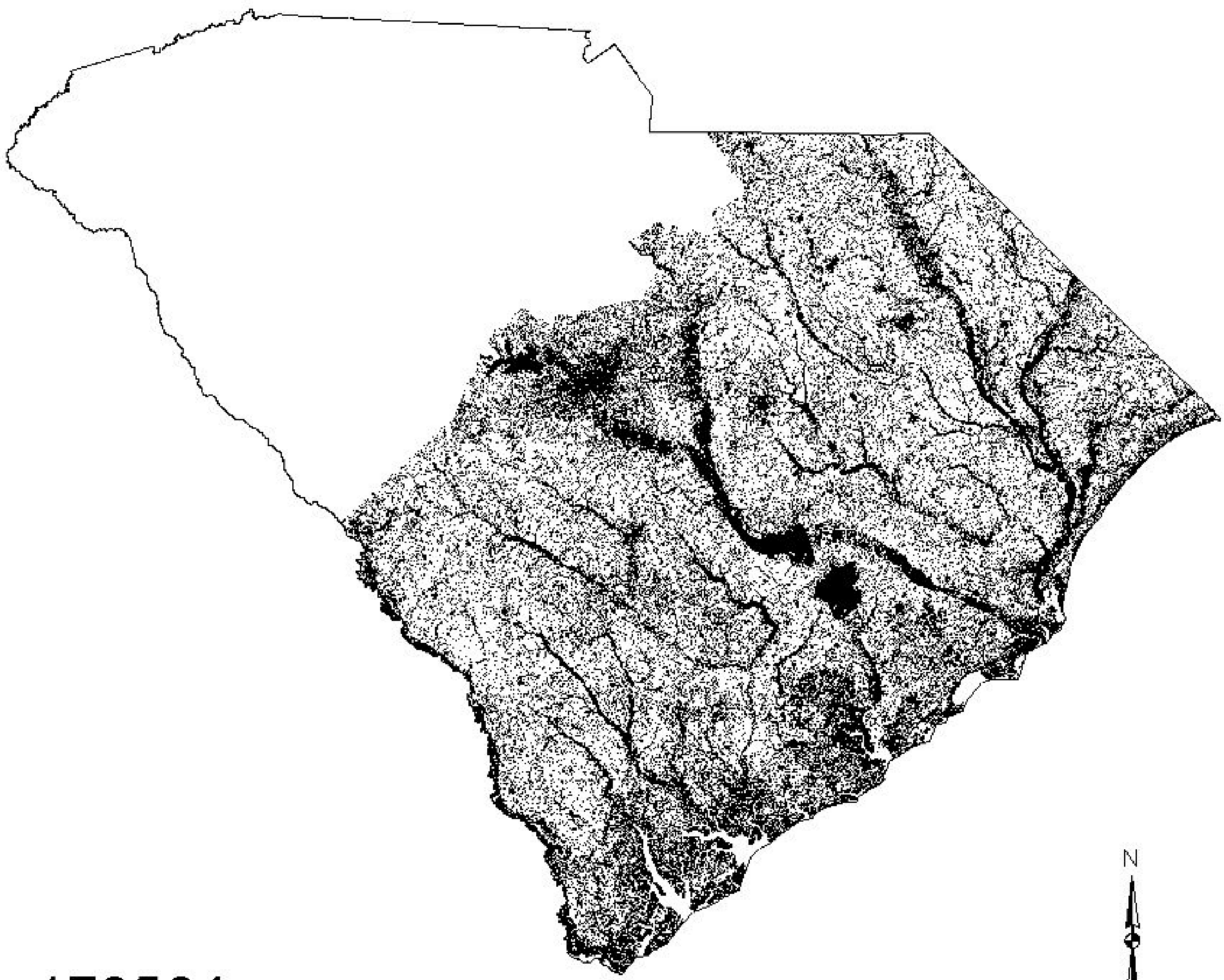
Barking Treefrog

(Hyla gratiosa)



Squirrel Treefrog

(Hyla squirella)



173504

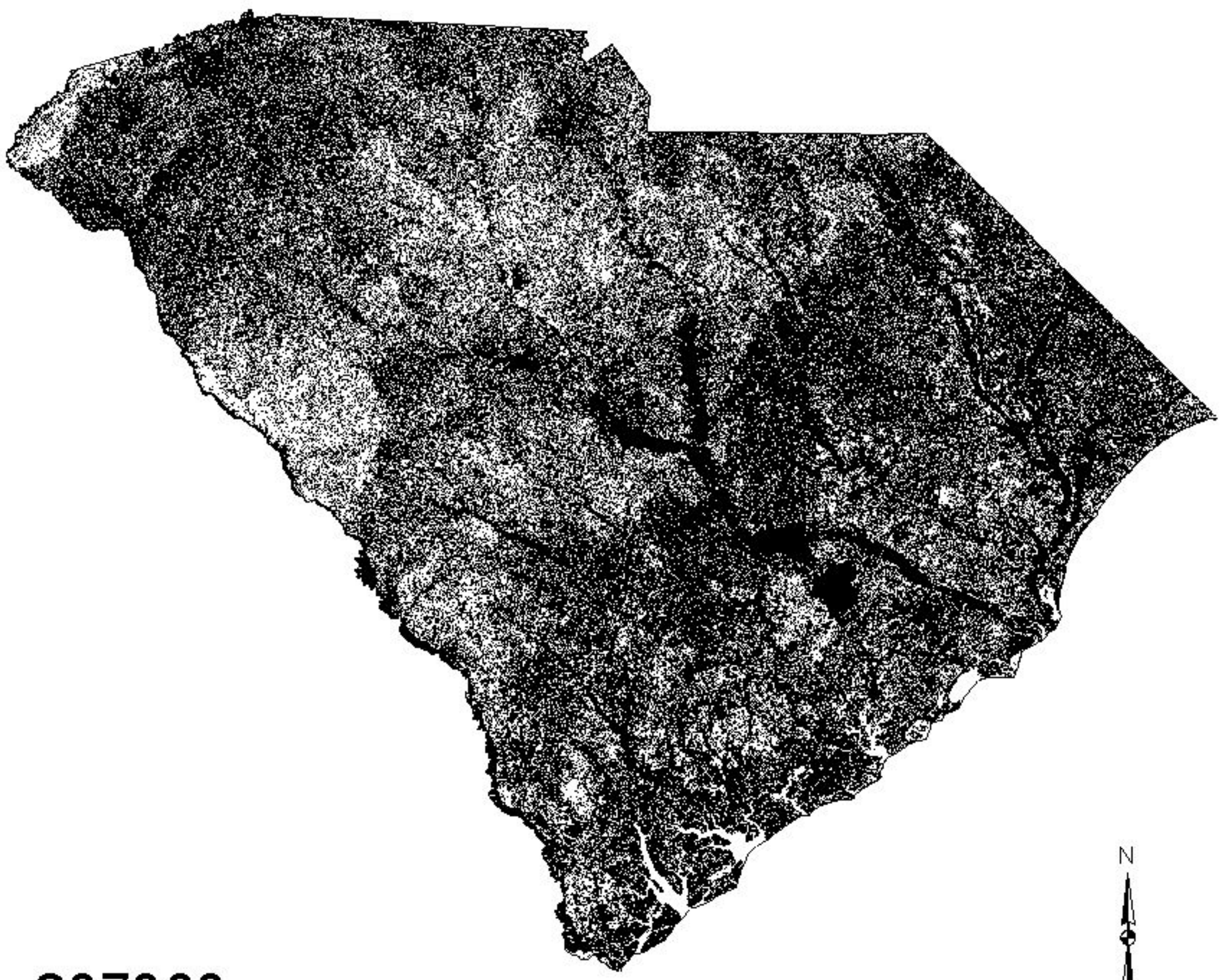
Predicted present

Predicted absent

State boundary

Spring Peeper

(Pseudacris crucifer)



207303

Predicted present

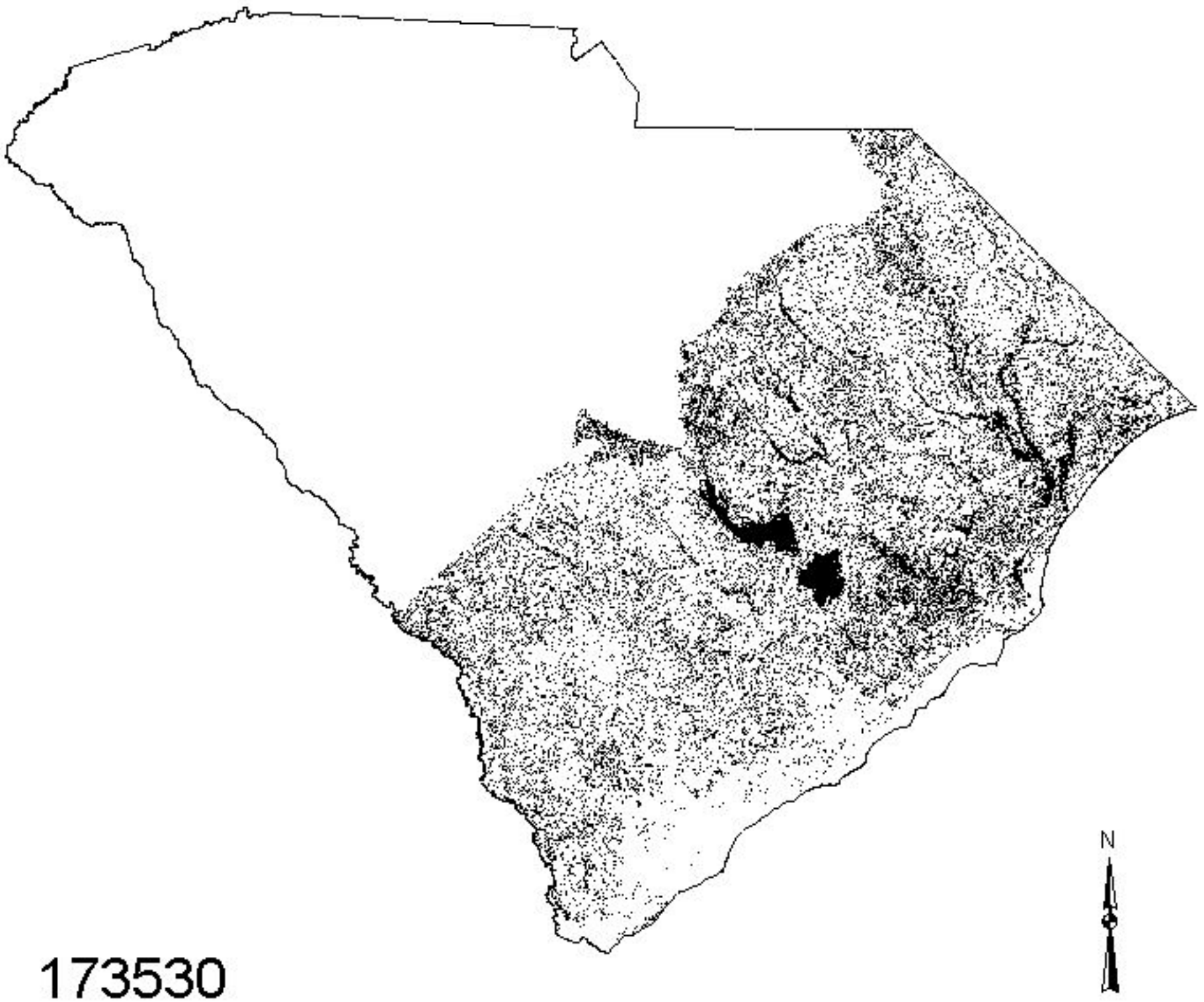
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Southern Chorus Frog

(Pseudacris nigrita)



173530

Predicted present

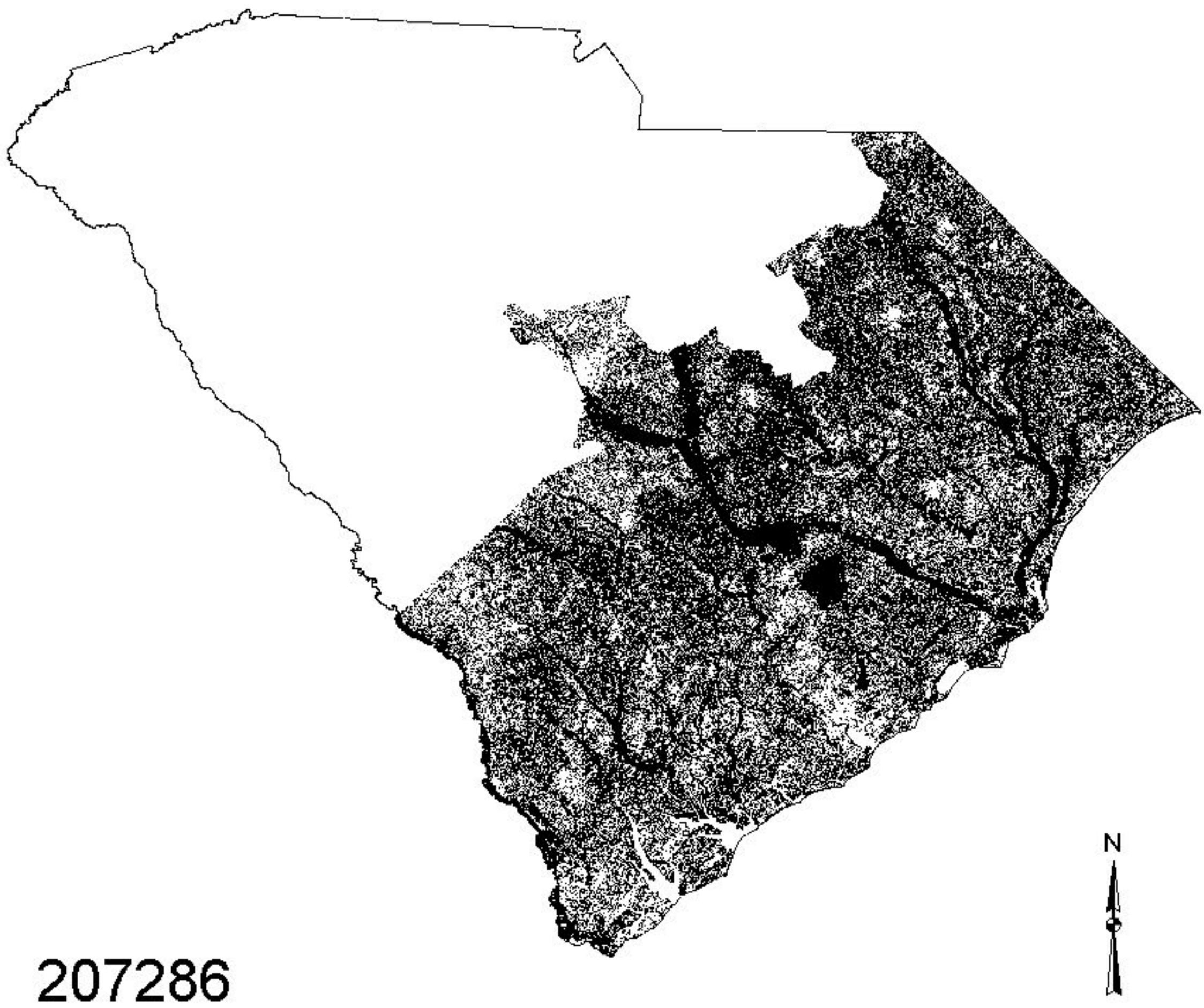
Predicted absent

State boundary

20 0 20 40 60 80 Miles

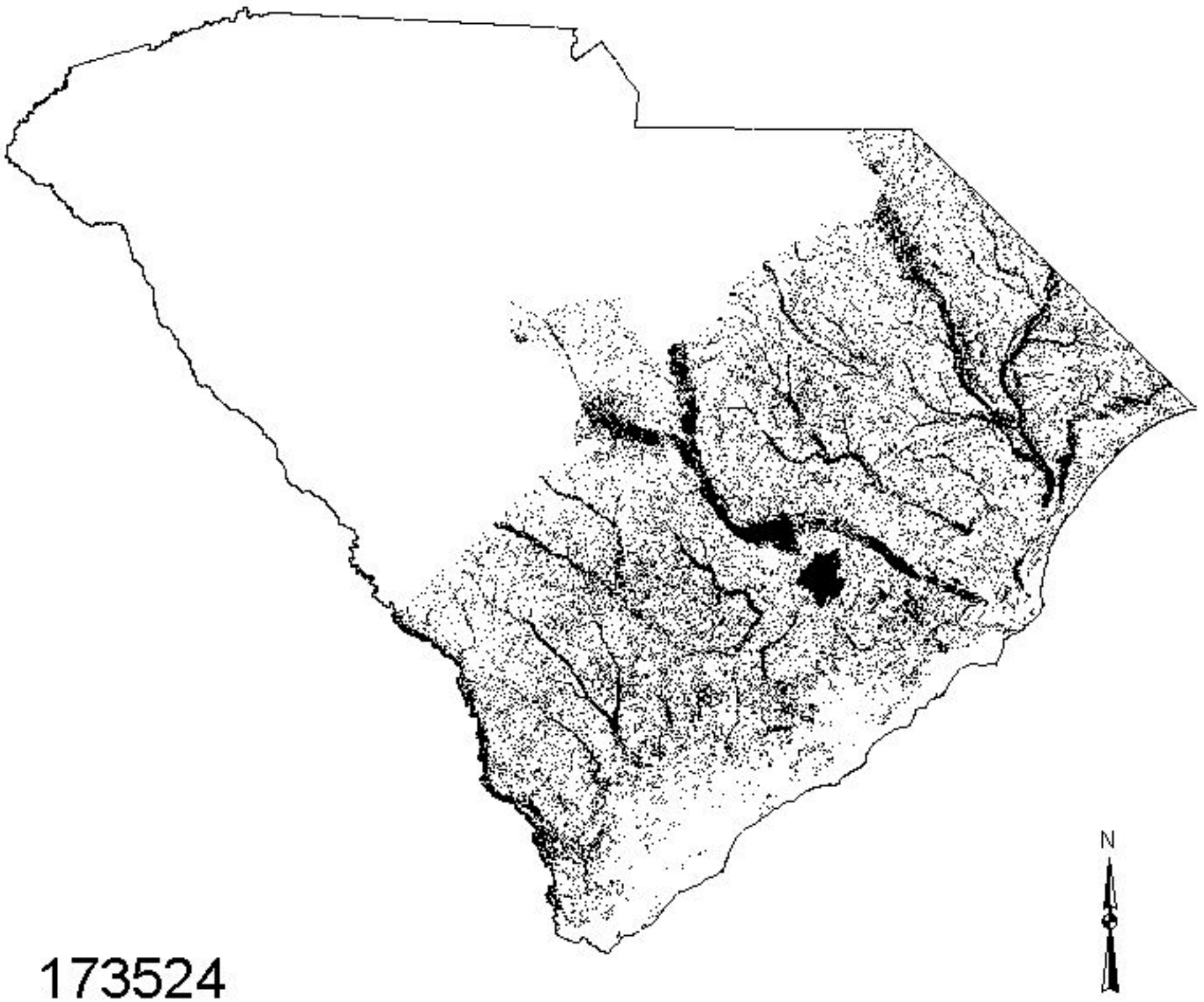
Little Grass Frog

(Pseudacris ocularis)



Brimley's Chorus Frog

(Pseudacris brimleyi)



173524

Predicted present

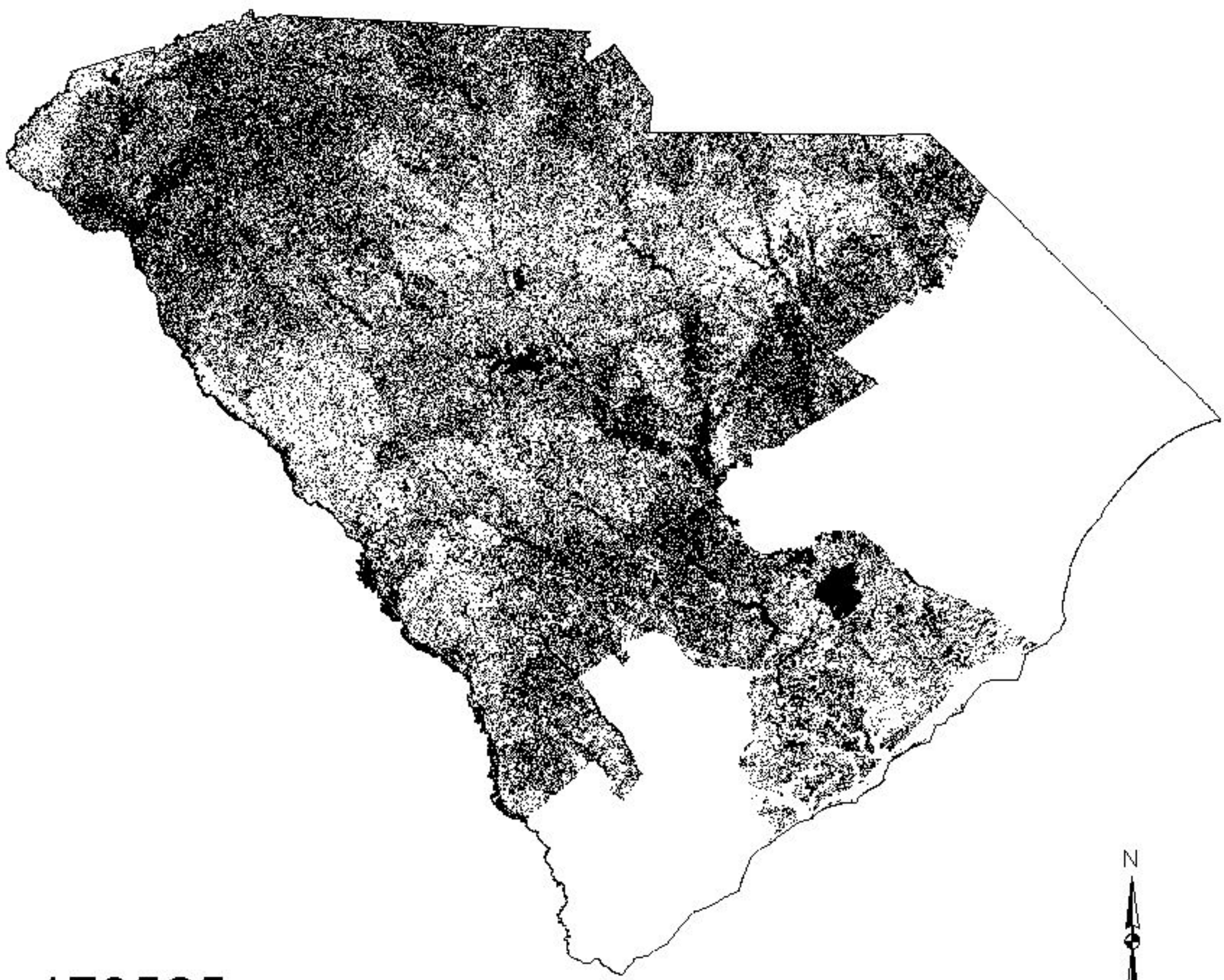
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Upland Chorus Frog

(Pseudacris triseriata)



173525

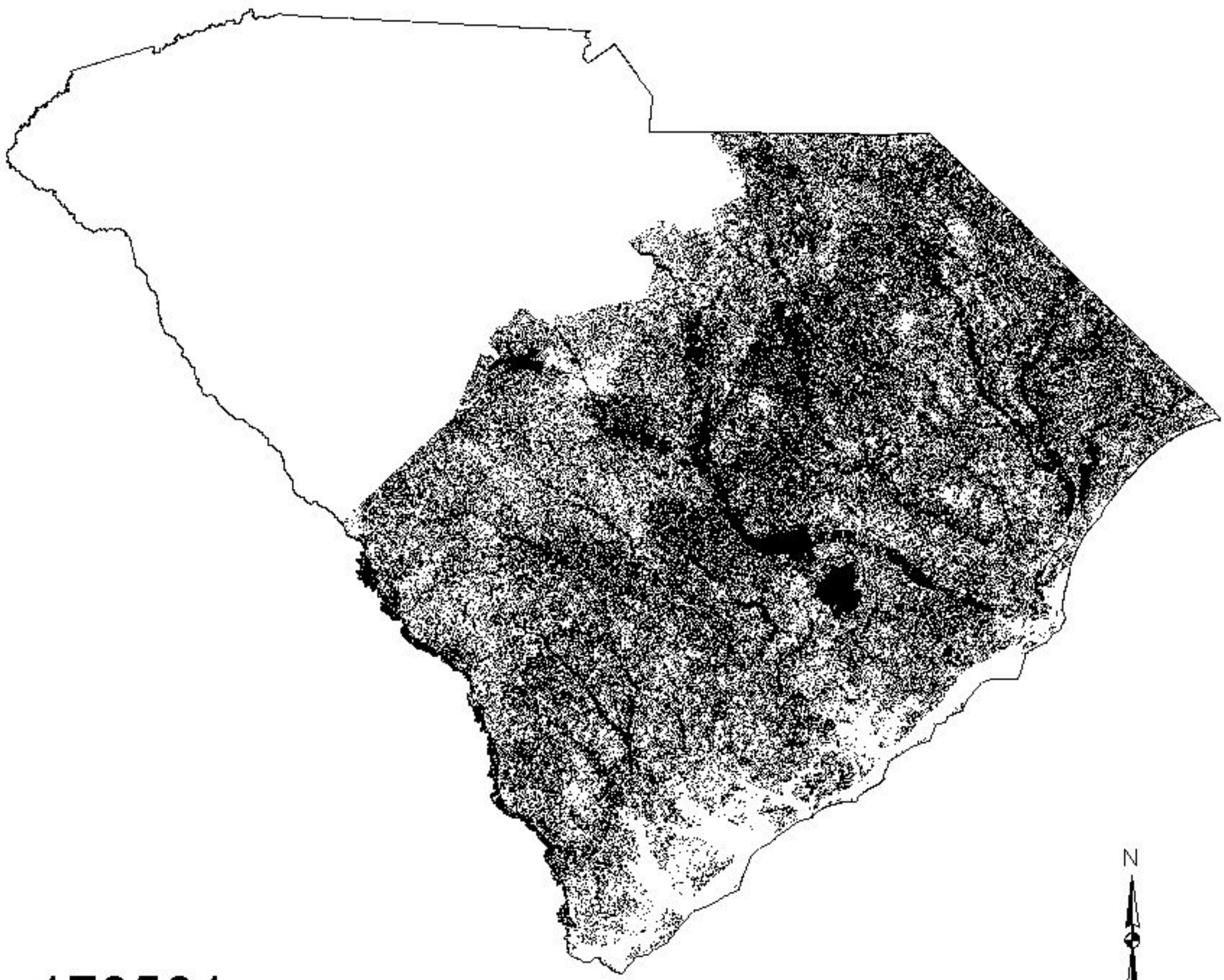
Predicted present

Predicted absent

State boundary

Ornate Chorus Frog

(Pseudacris ornata)



173531

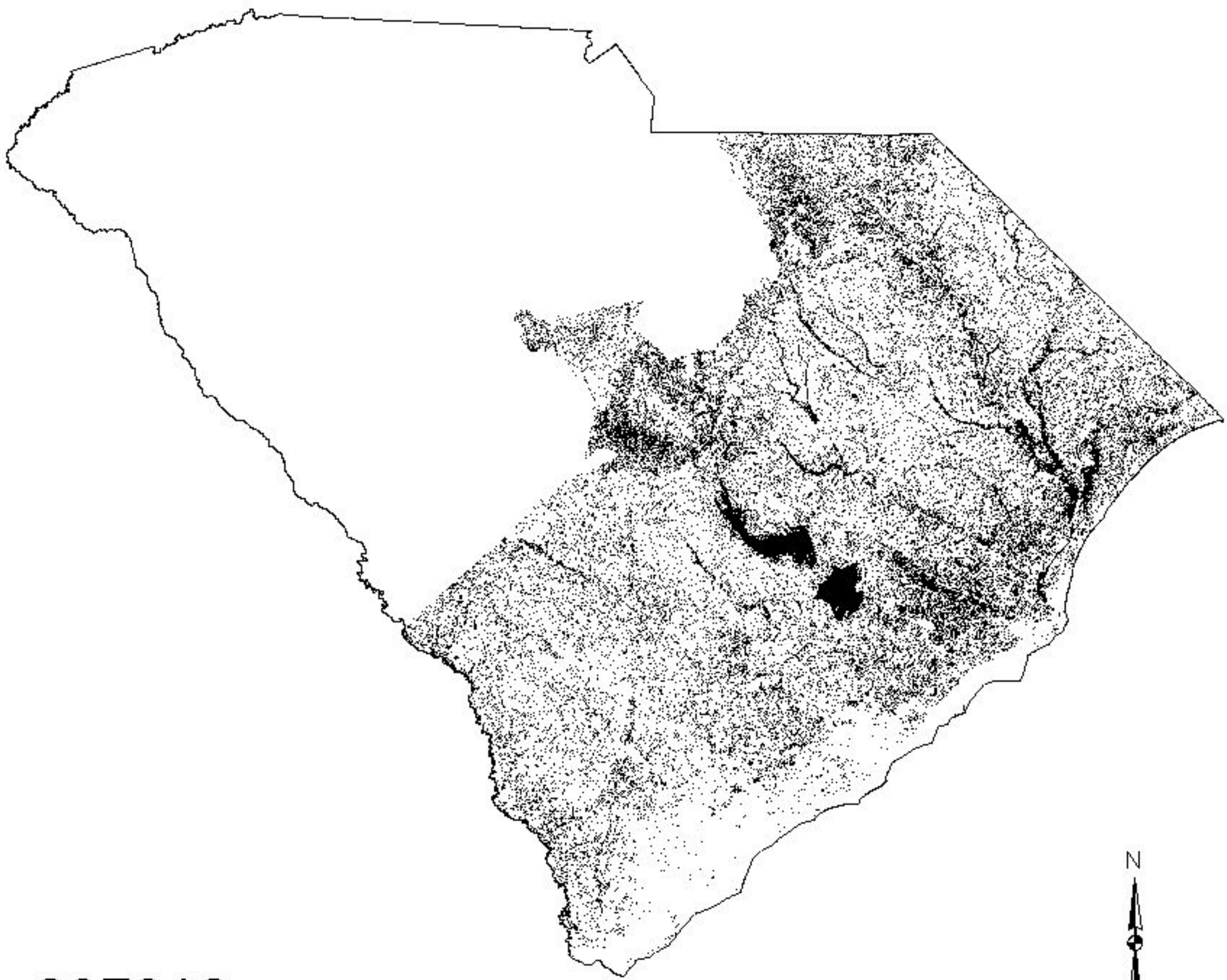
Predicted present

Predicted absent

State boundary

Gopher Frog

(Rana capito)



207016

Predicted present

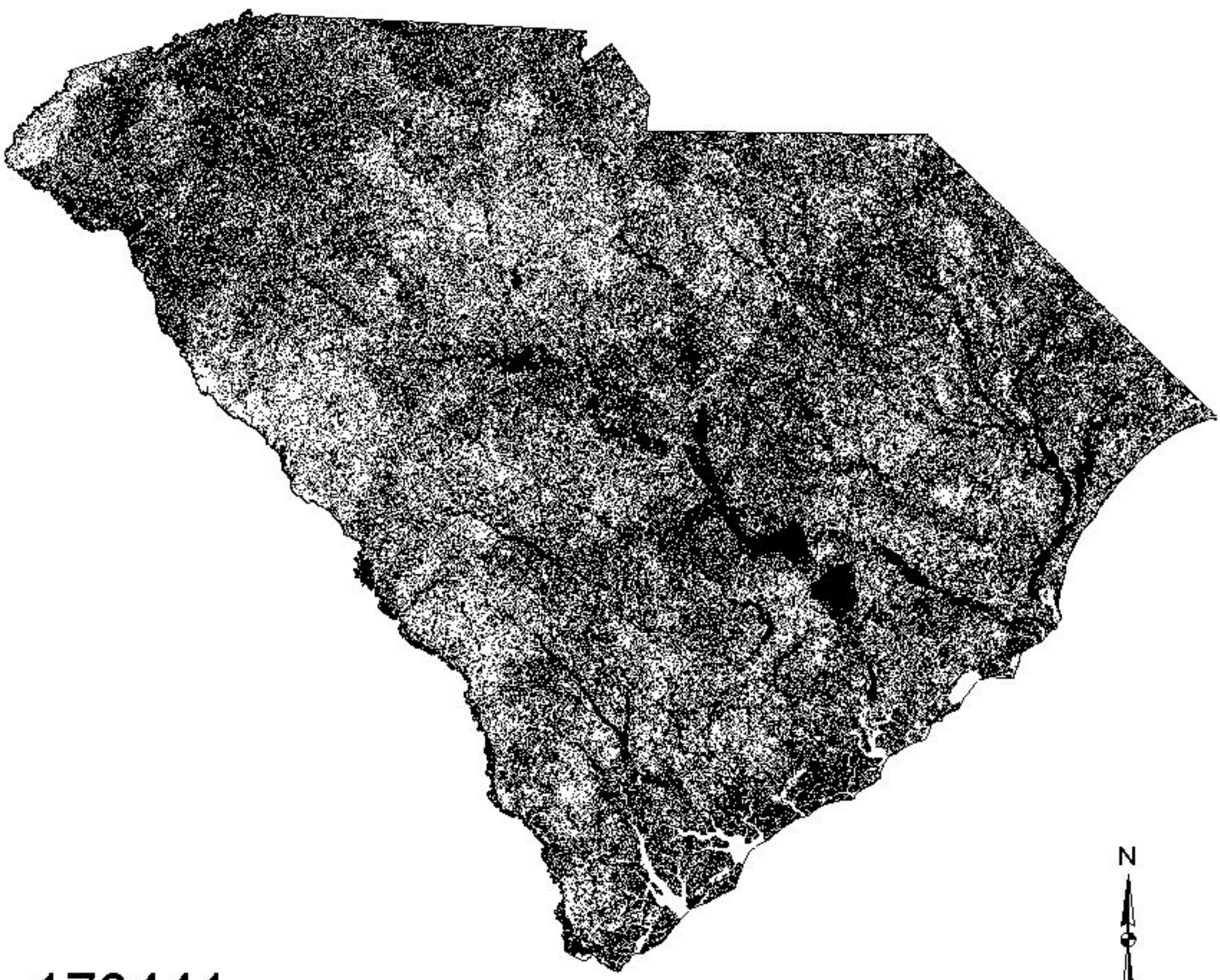
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Bullfrog

(Rana catesbeiana)



173441

Predicted present

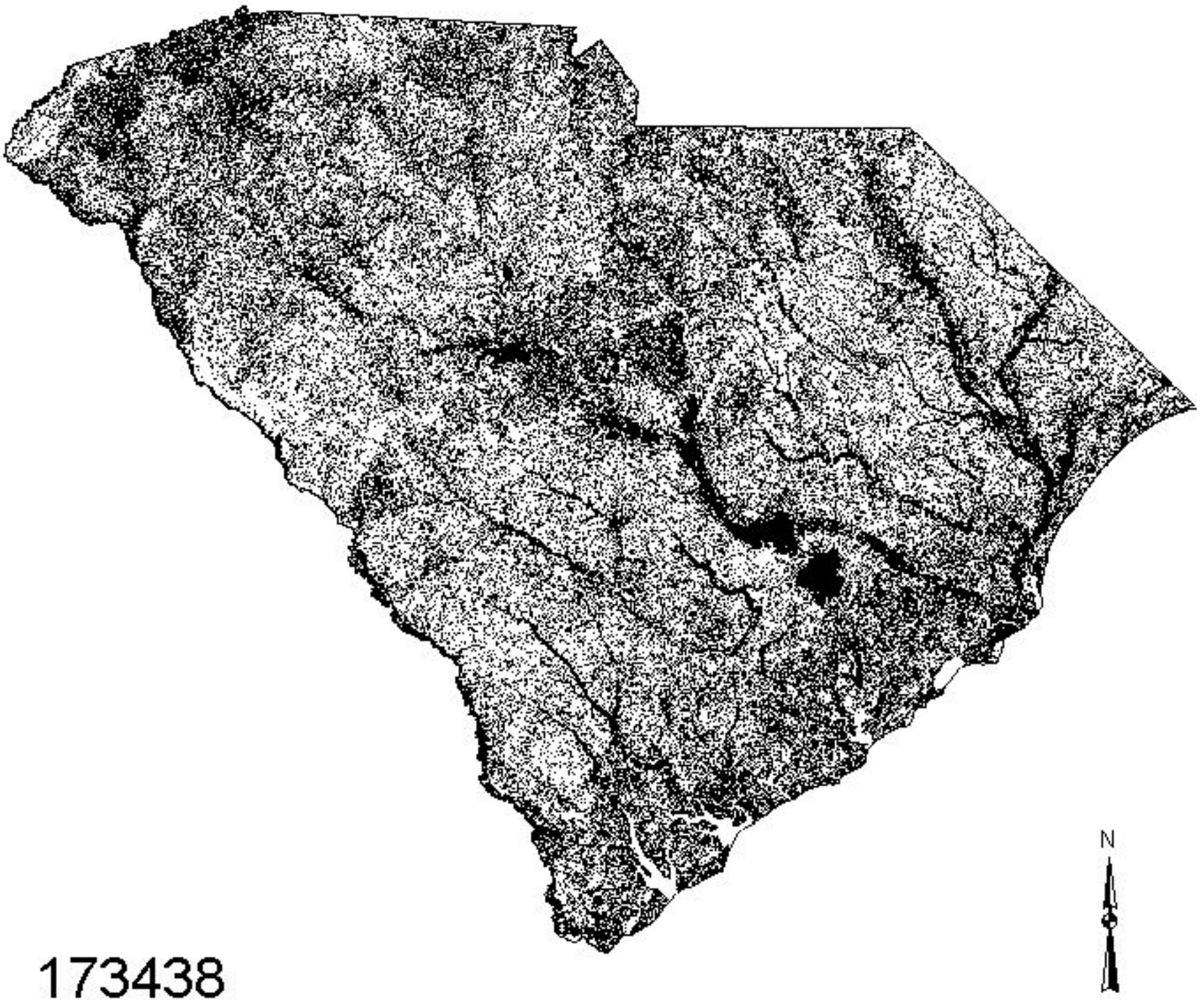
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Green Frog

(Rana clamitans)



173438

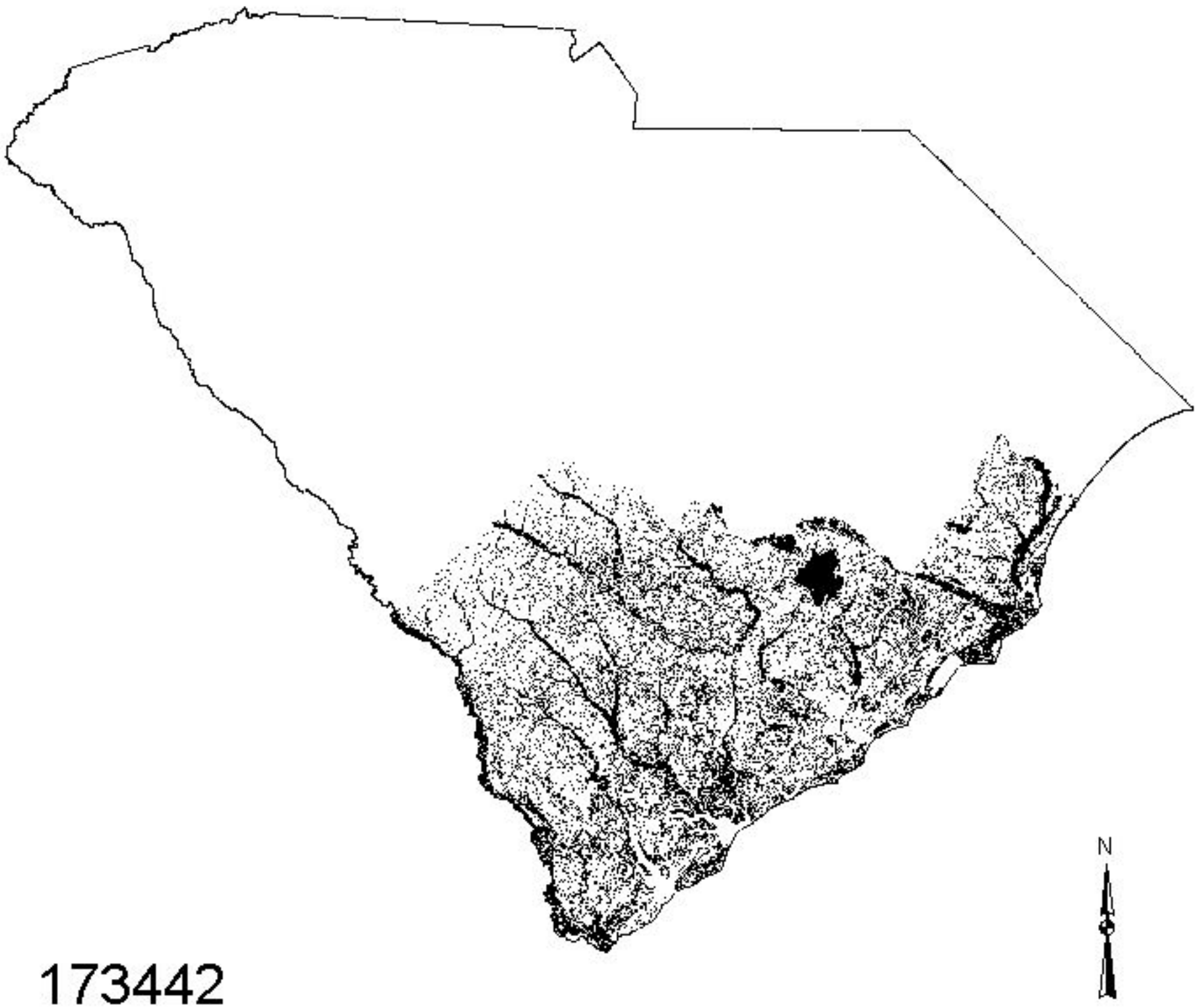
Predicted present

Predicted absent

State boundary

Pig Frog

(Rana grylio)



173442

Predicted present

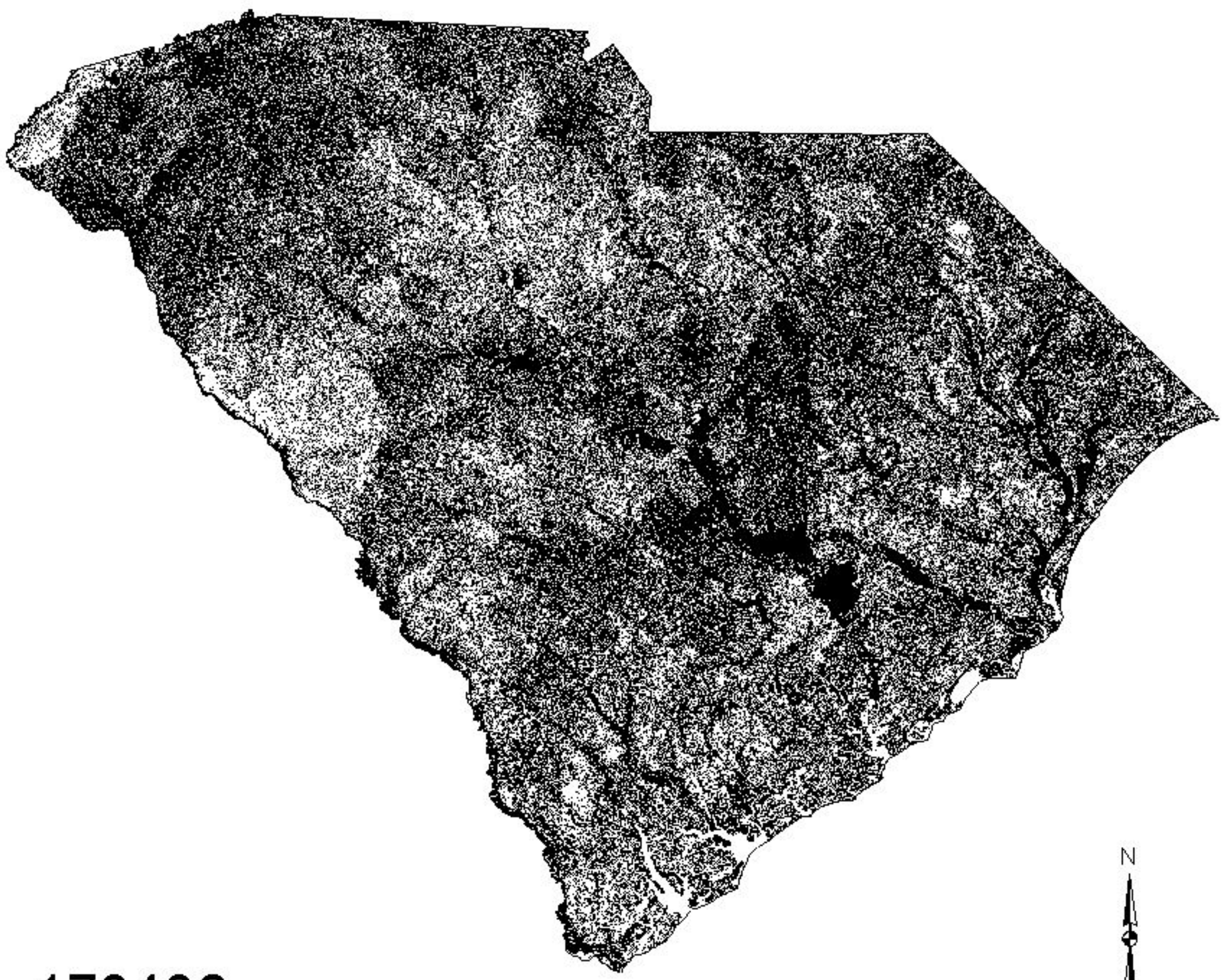
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Southern Leopard Frog

(Rana sphenocephala)



173436

Predicted present

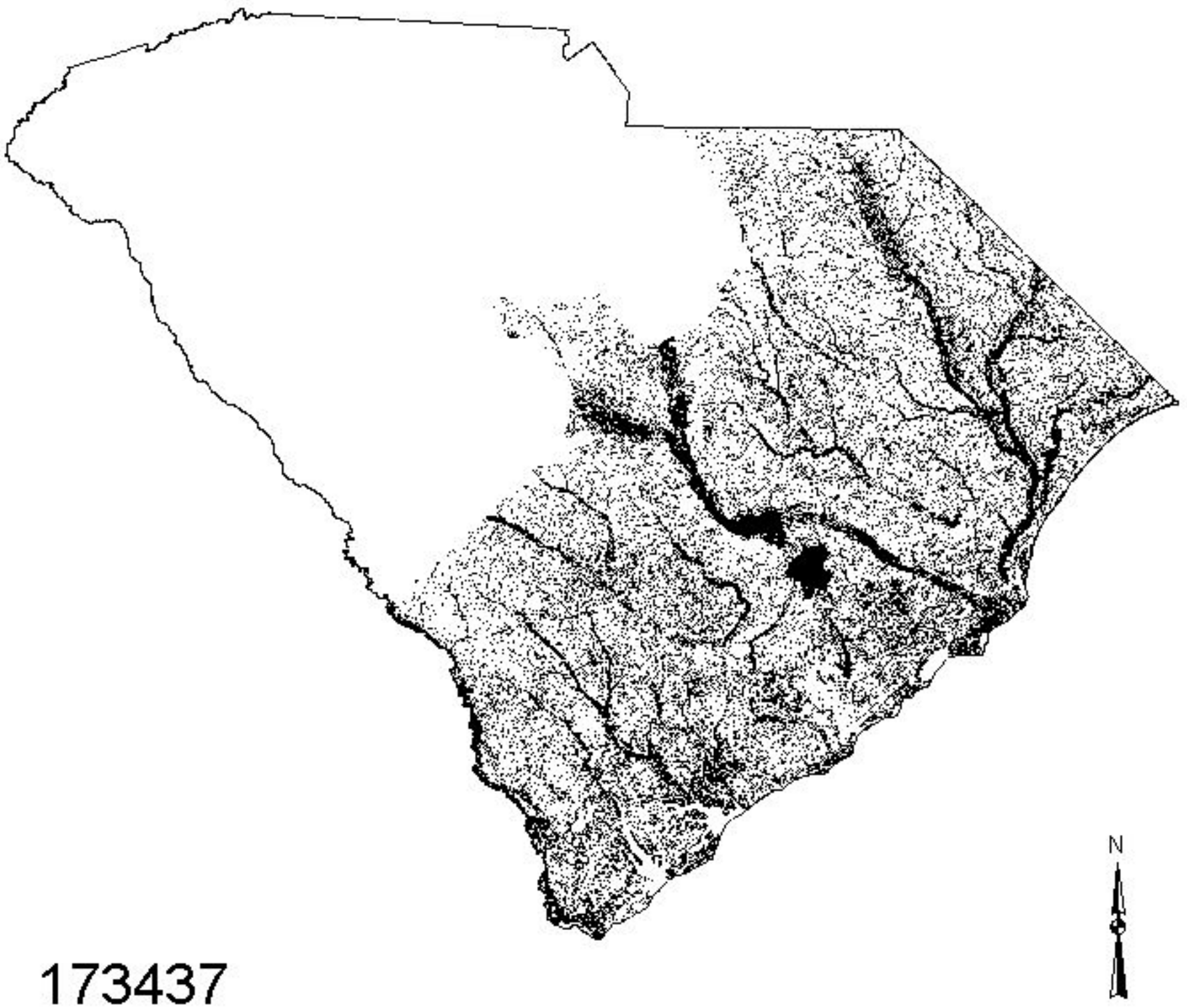
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Carpenter Frog

(Rana virgatipes)



173437

Predicted present

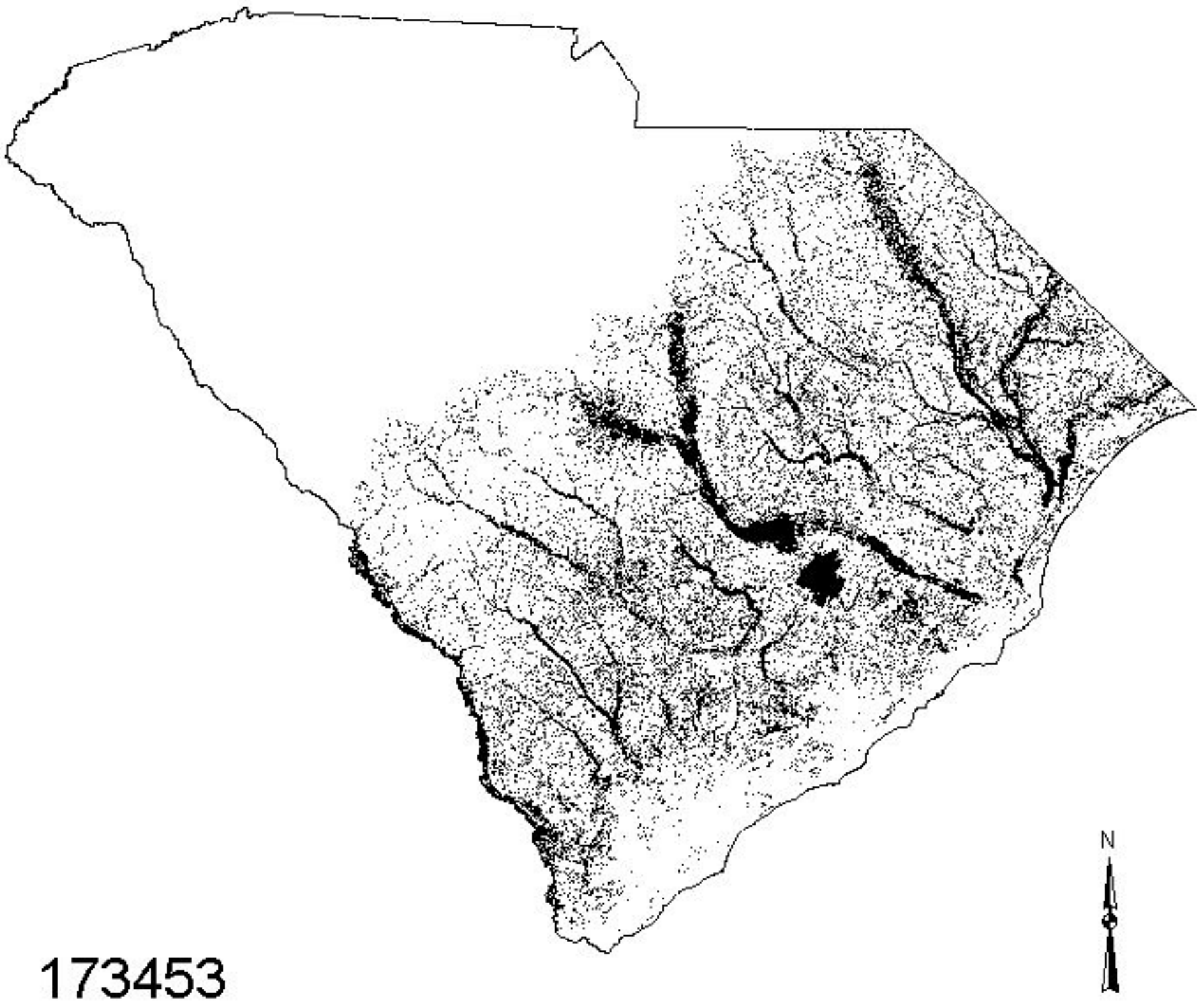
Predicted absent

State boundary

20 0 20 40 60 80 Miles

River Frog

(Rana heckscheri)



173453

Predicted present

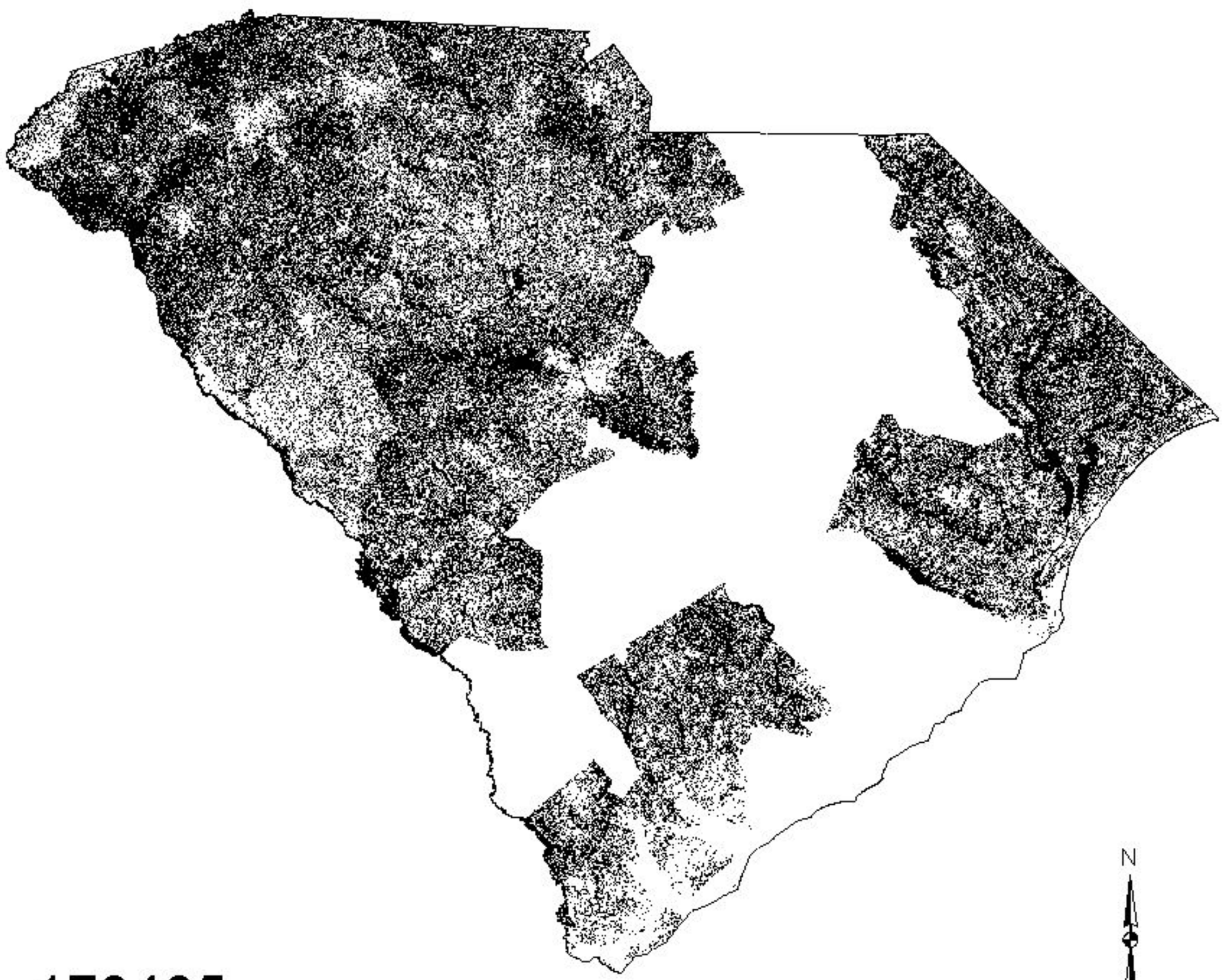
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Pickerel Frog

(Rana palustris)



173435

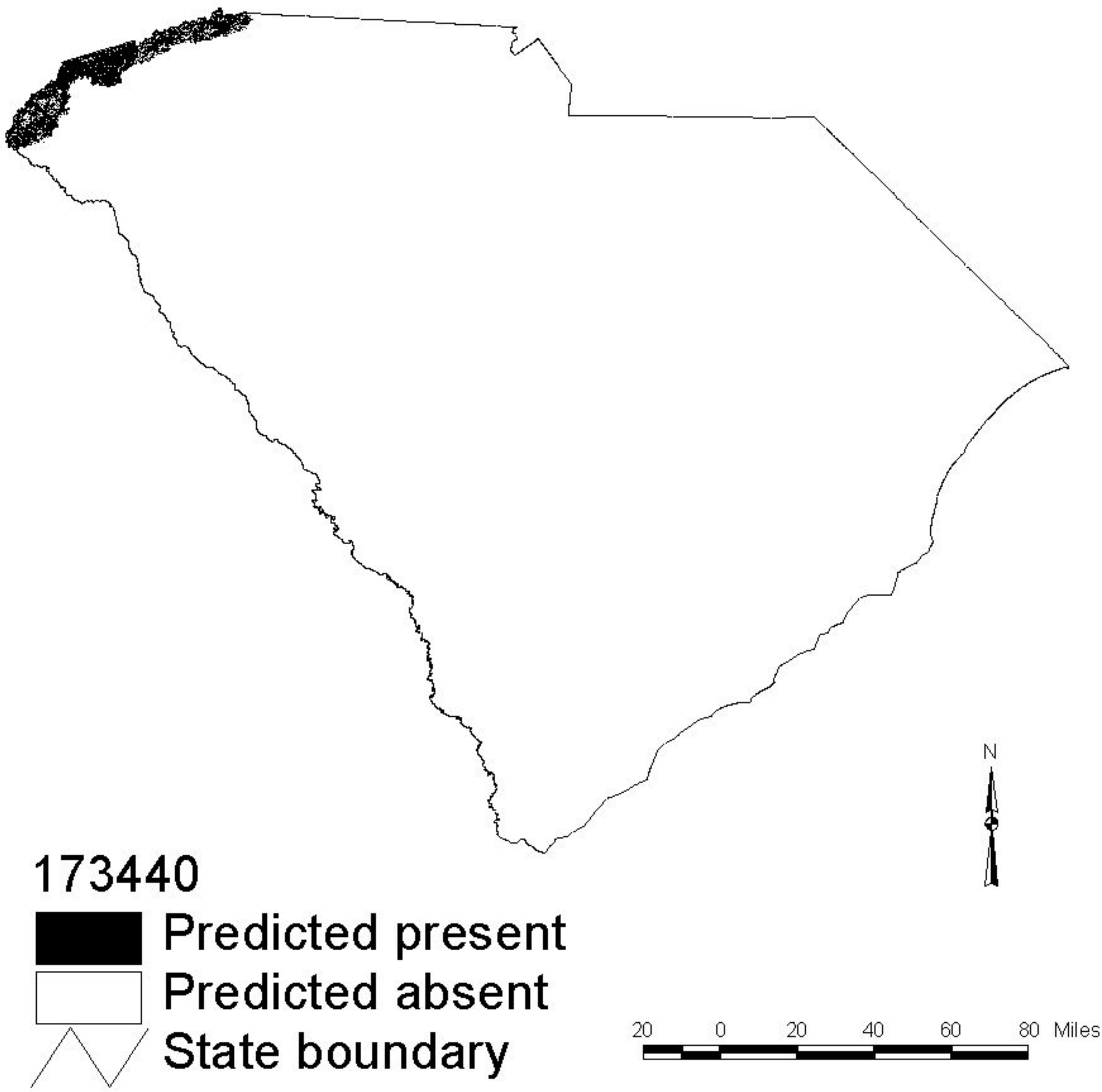
Predicted present

Predicted absent

State boundary

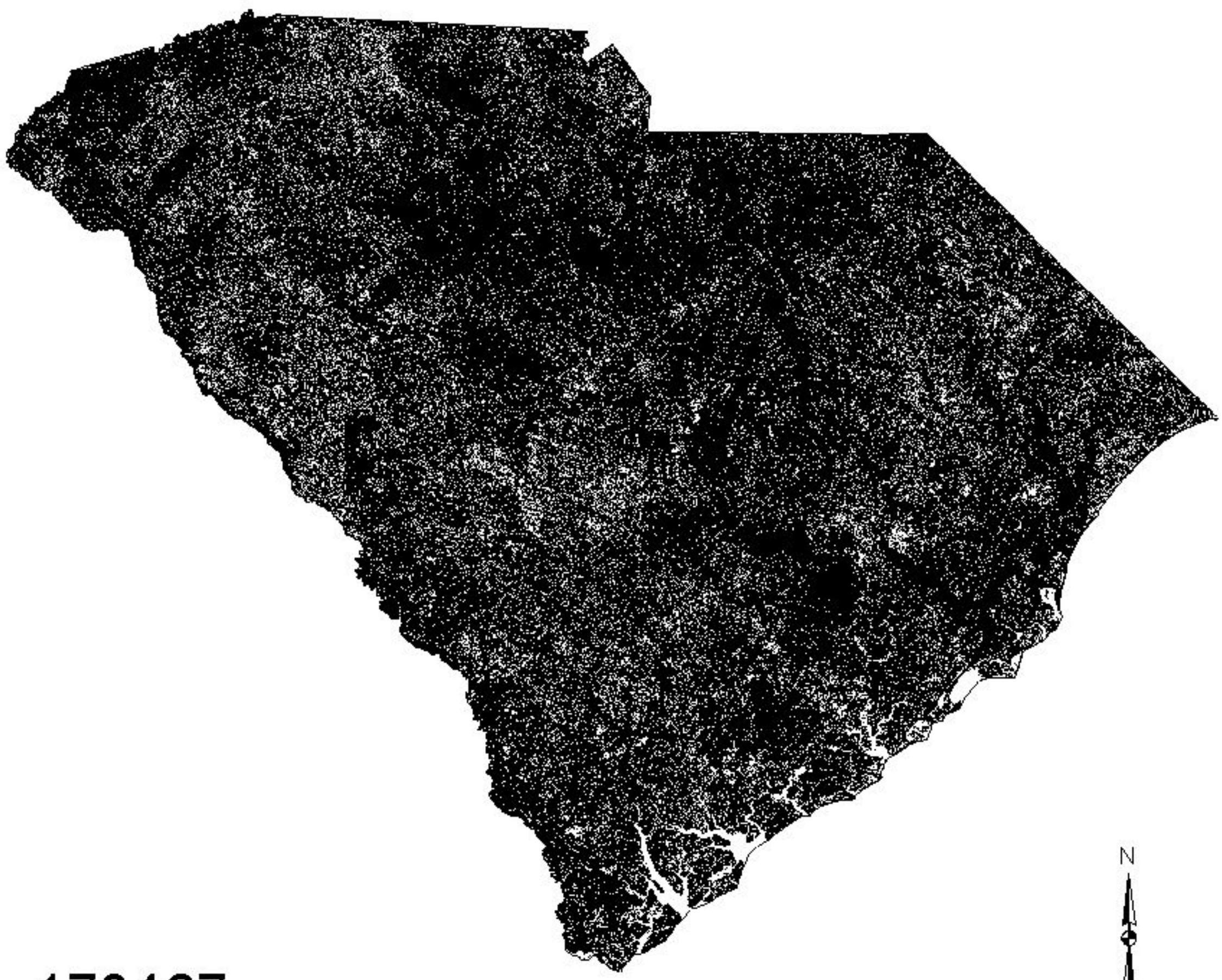
Wood Frog

(Rana sylvatica)



Eastern Narrowmouth Toad

(Gastrophryne carolinensis)



173467

Predicted present

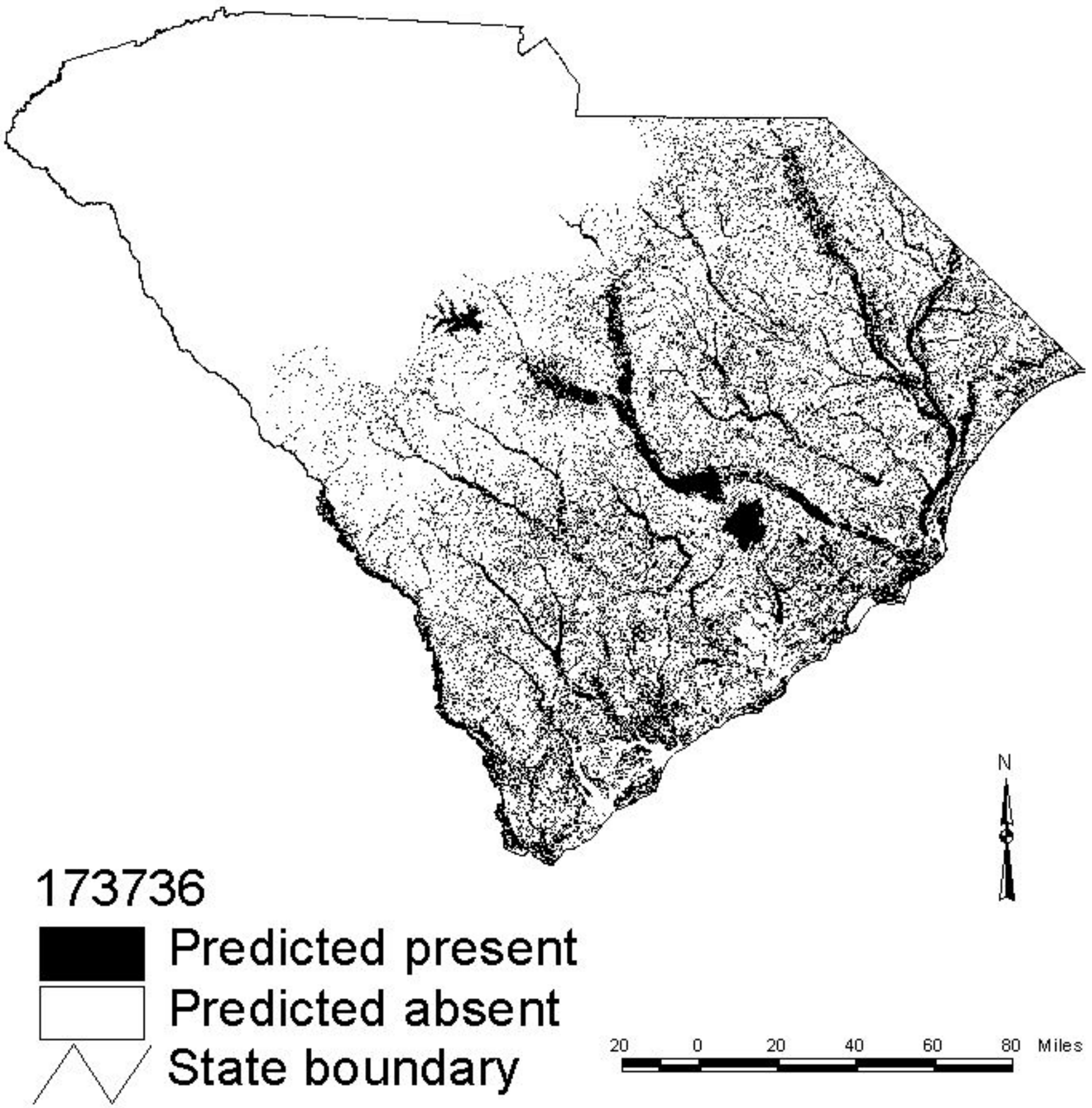
Predicted absent

State boundary

20 0 20 40 60 80 Miles

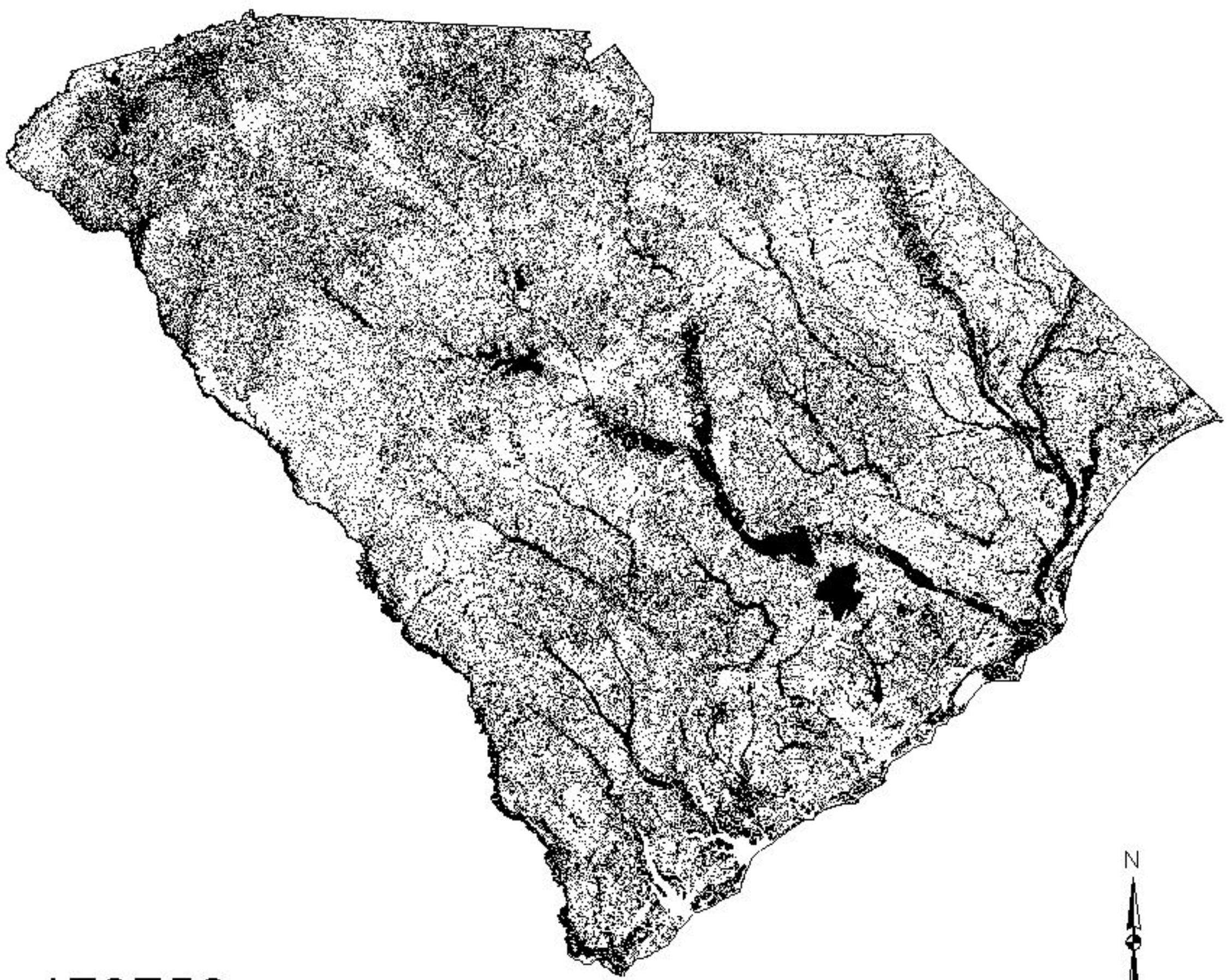
Lesser Siren

(Siren intermedia)



Common Musk Turtle

(Sternotherus odoratus)



173758

Predicted present

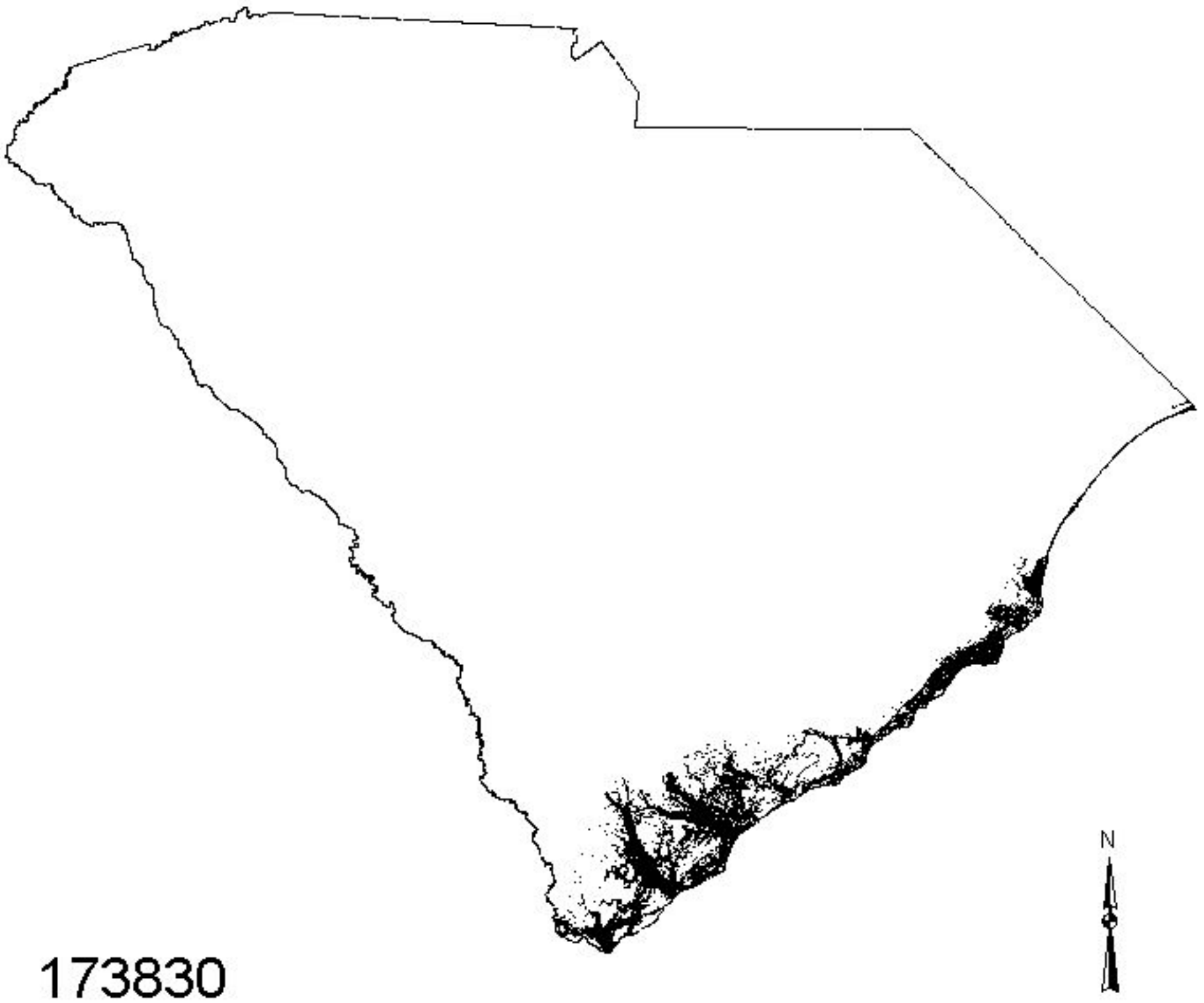
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Loggerhead

(Caretta caretta)



173830

Predicted present

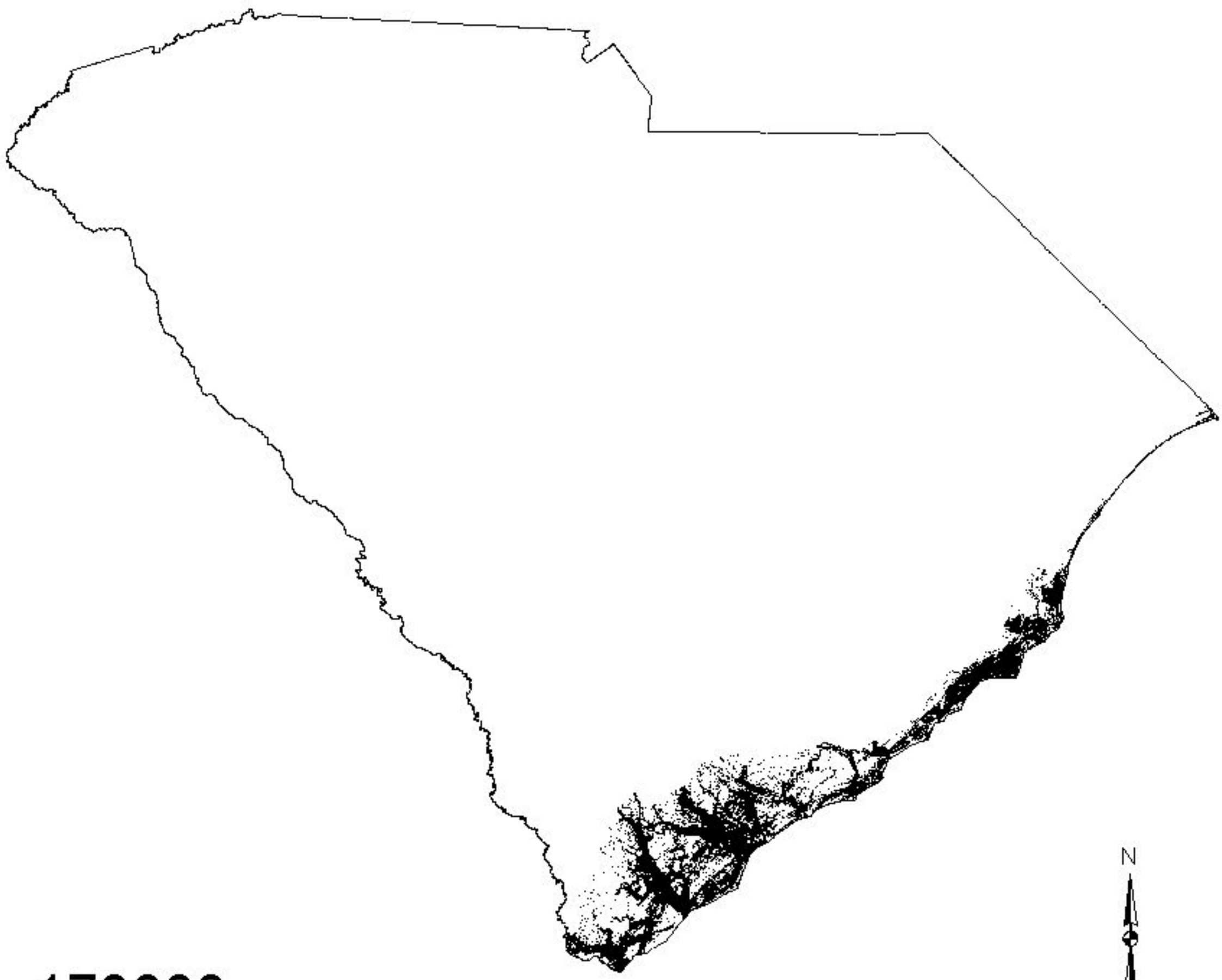
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Green Turtle

(Chelonia mydas)



173833

Predicted present

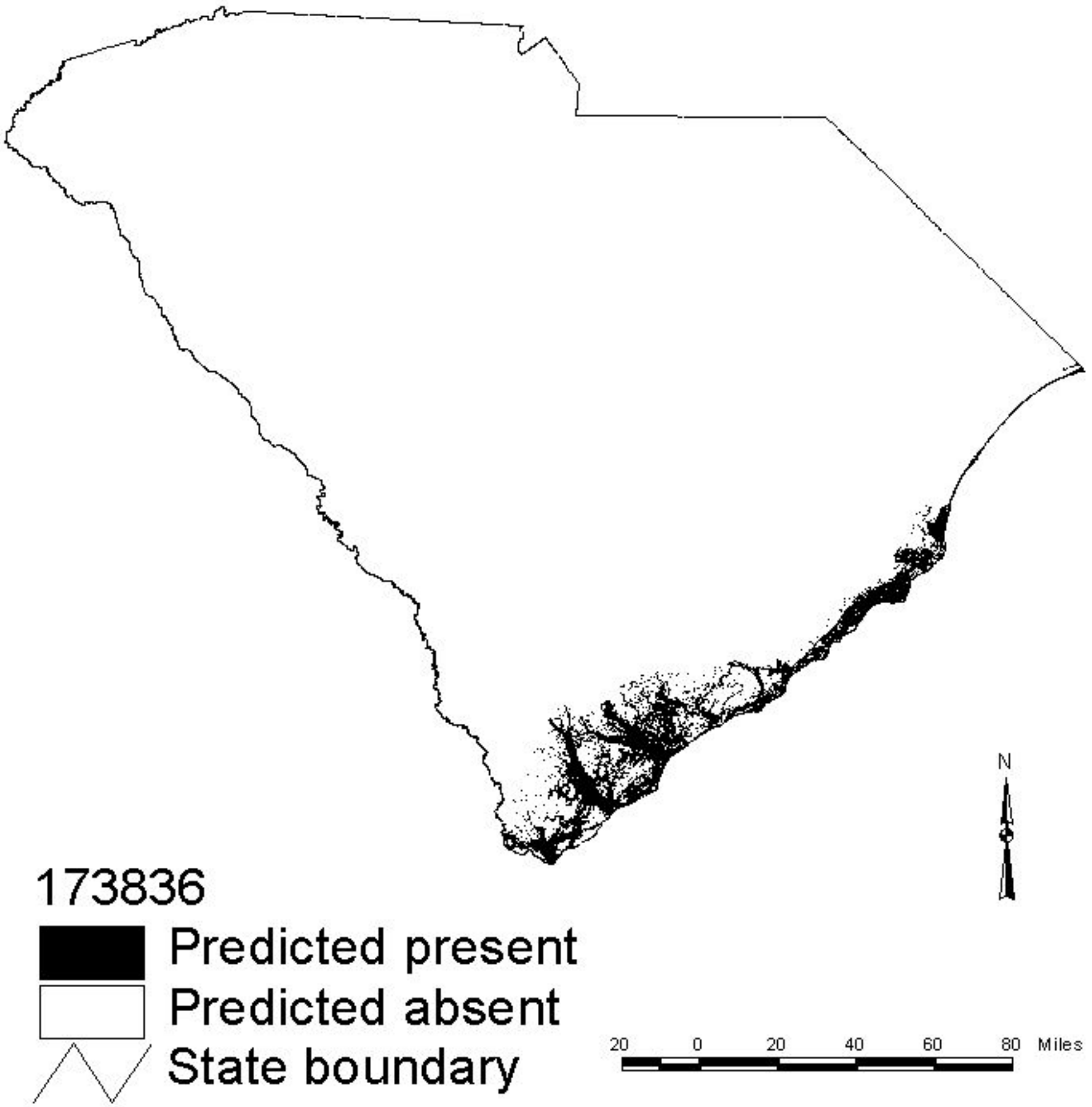
Predicted absent

State boundary

20 0 20 40 60 80 Miles

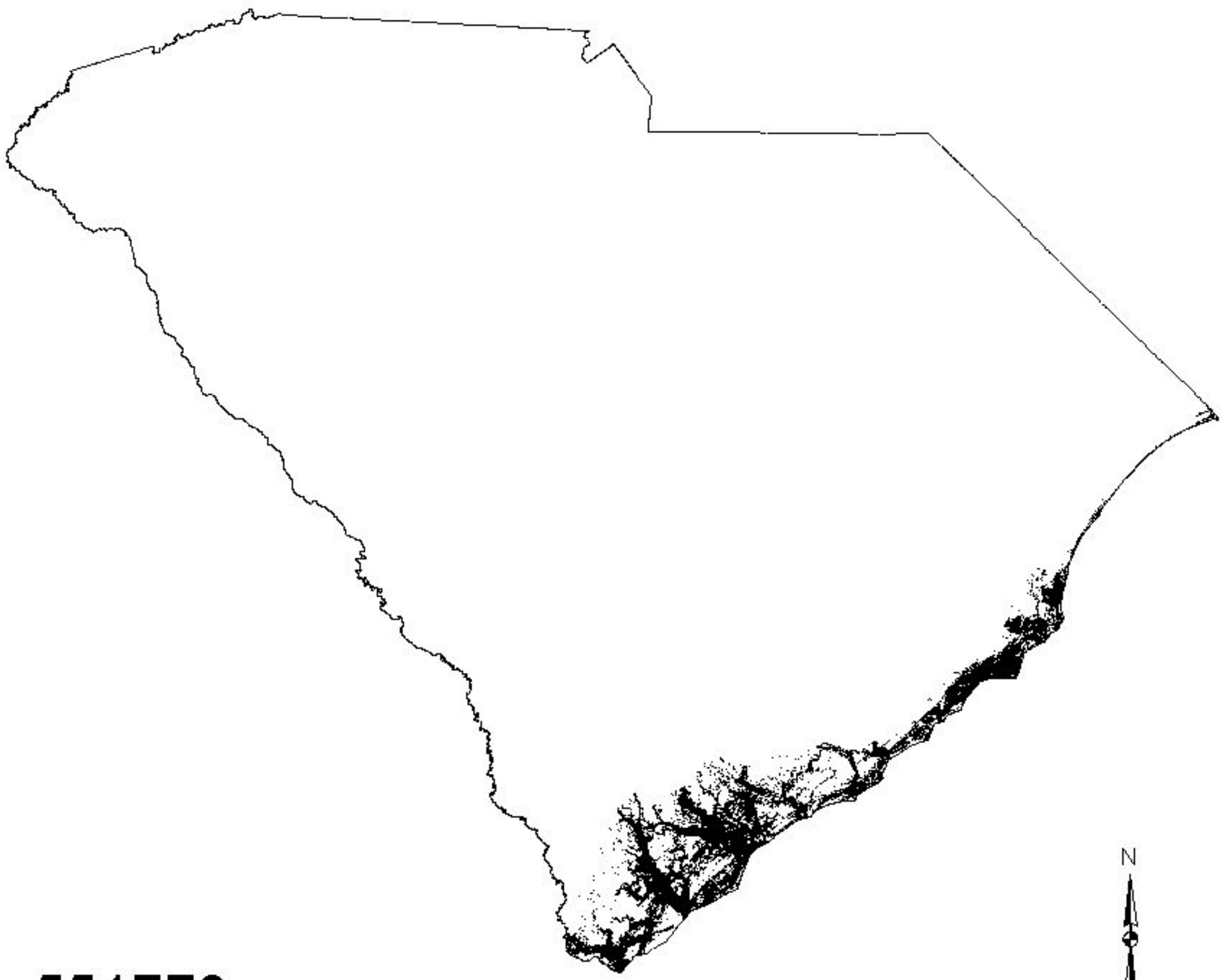
Hawksbill

(Eretmochelys imbricata)



Atlantic Ridley

(Lepidochelys kempii)



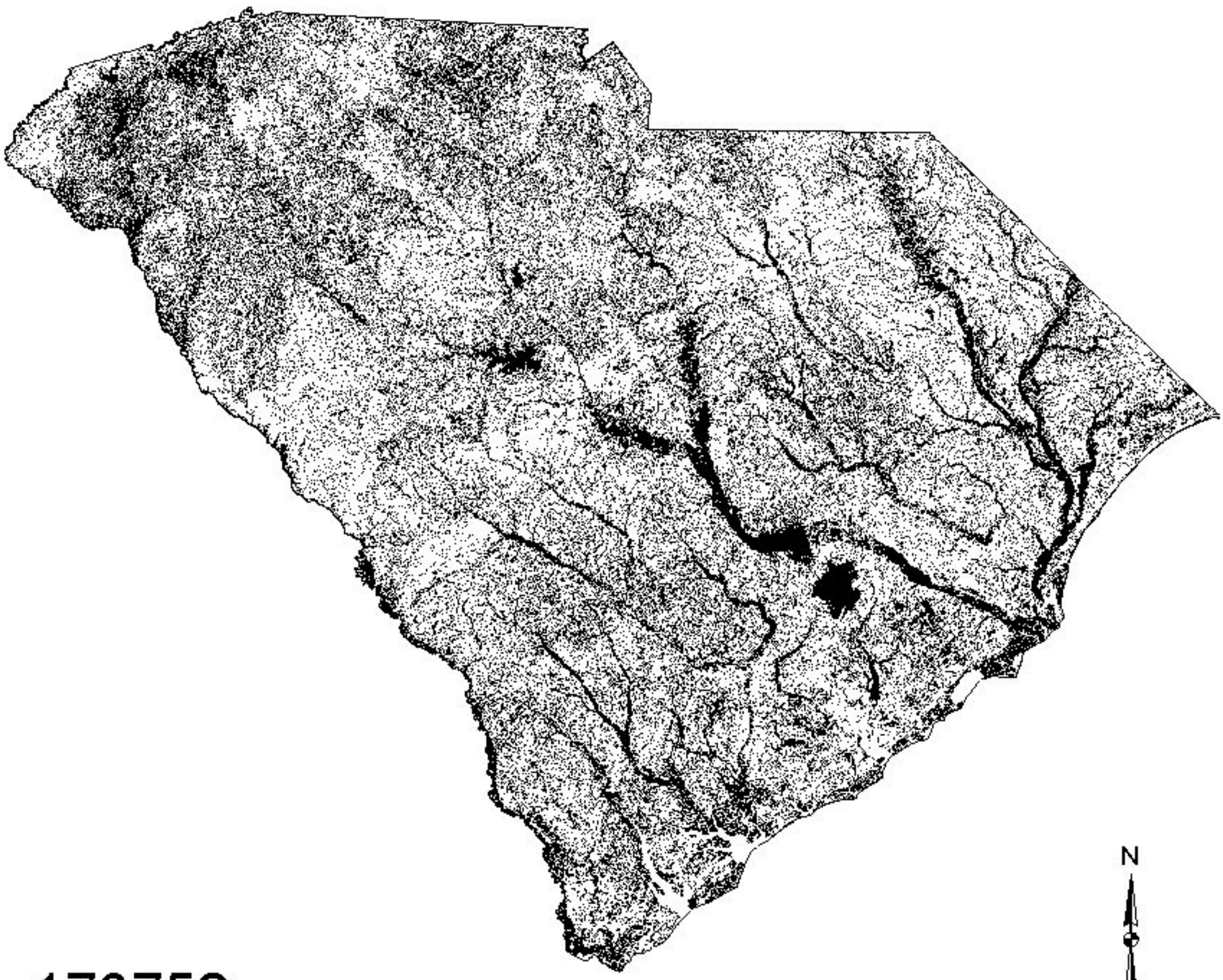
551770

Predicted present

Predicted absent

State boundary

Snapping Turtle
(Chelydra serpentina)



173752

Predicted present

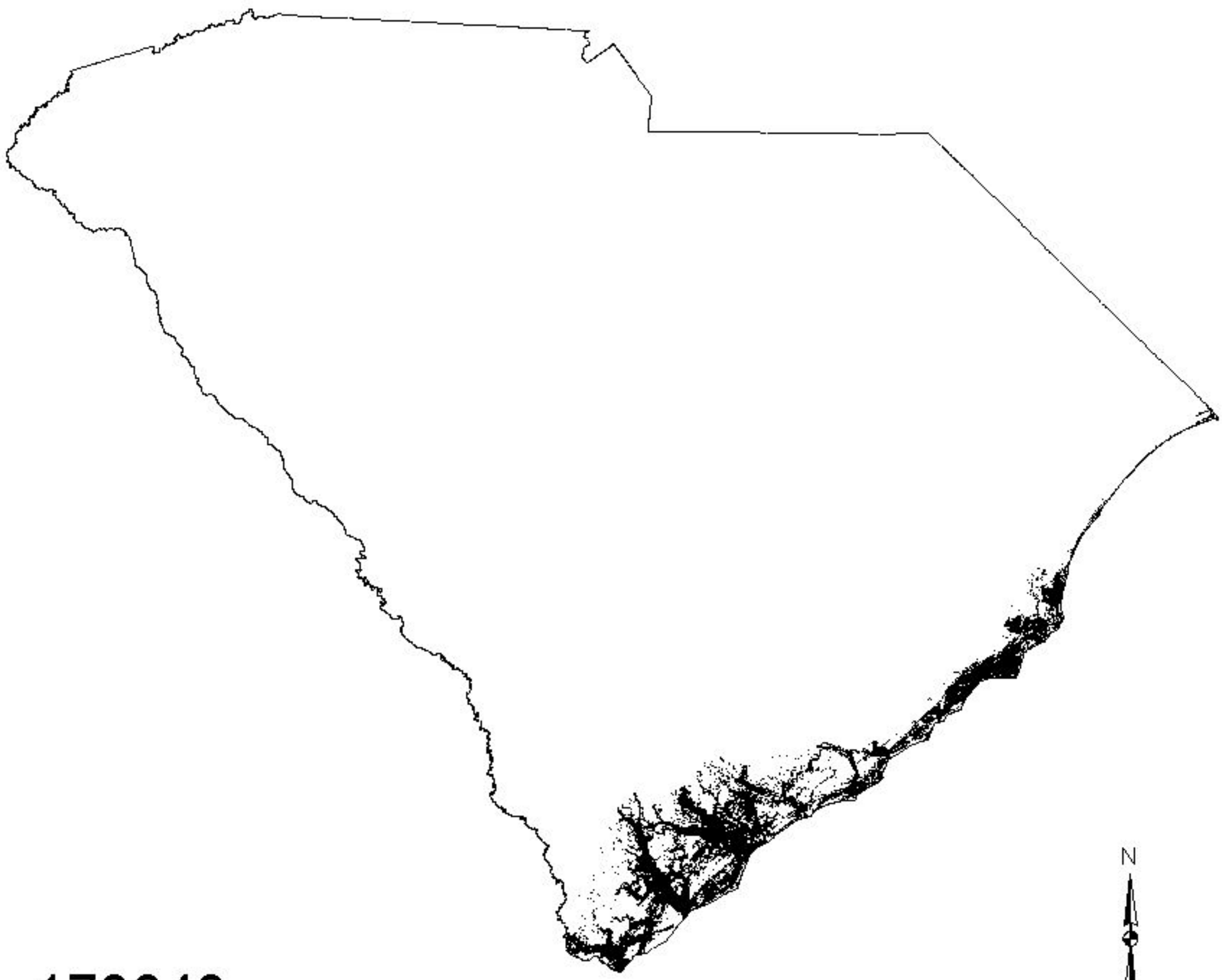
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Leatherback

(Dermochelys coriacea)



173843

Predicted present

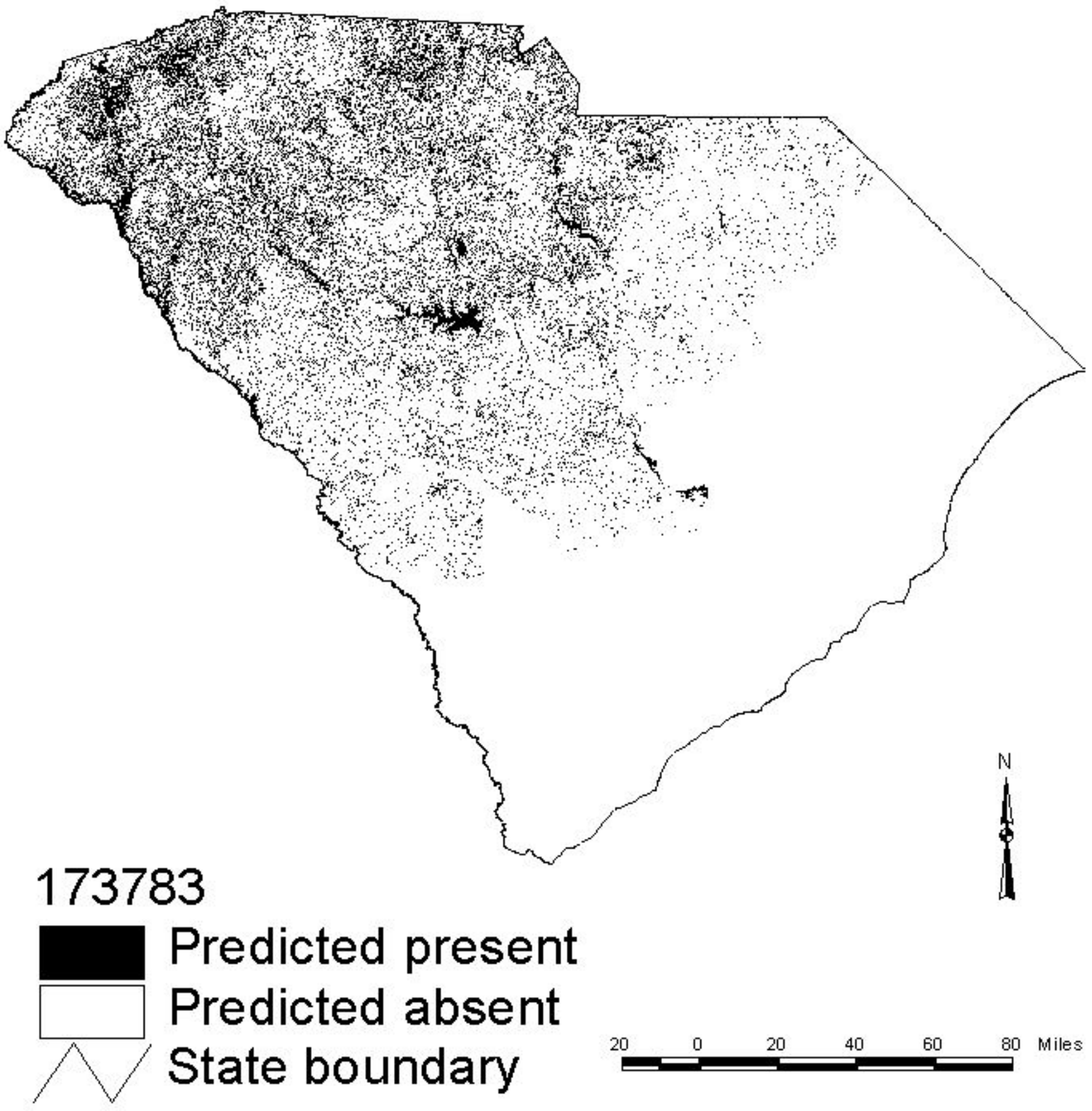
Predicted absent

State boundary

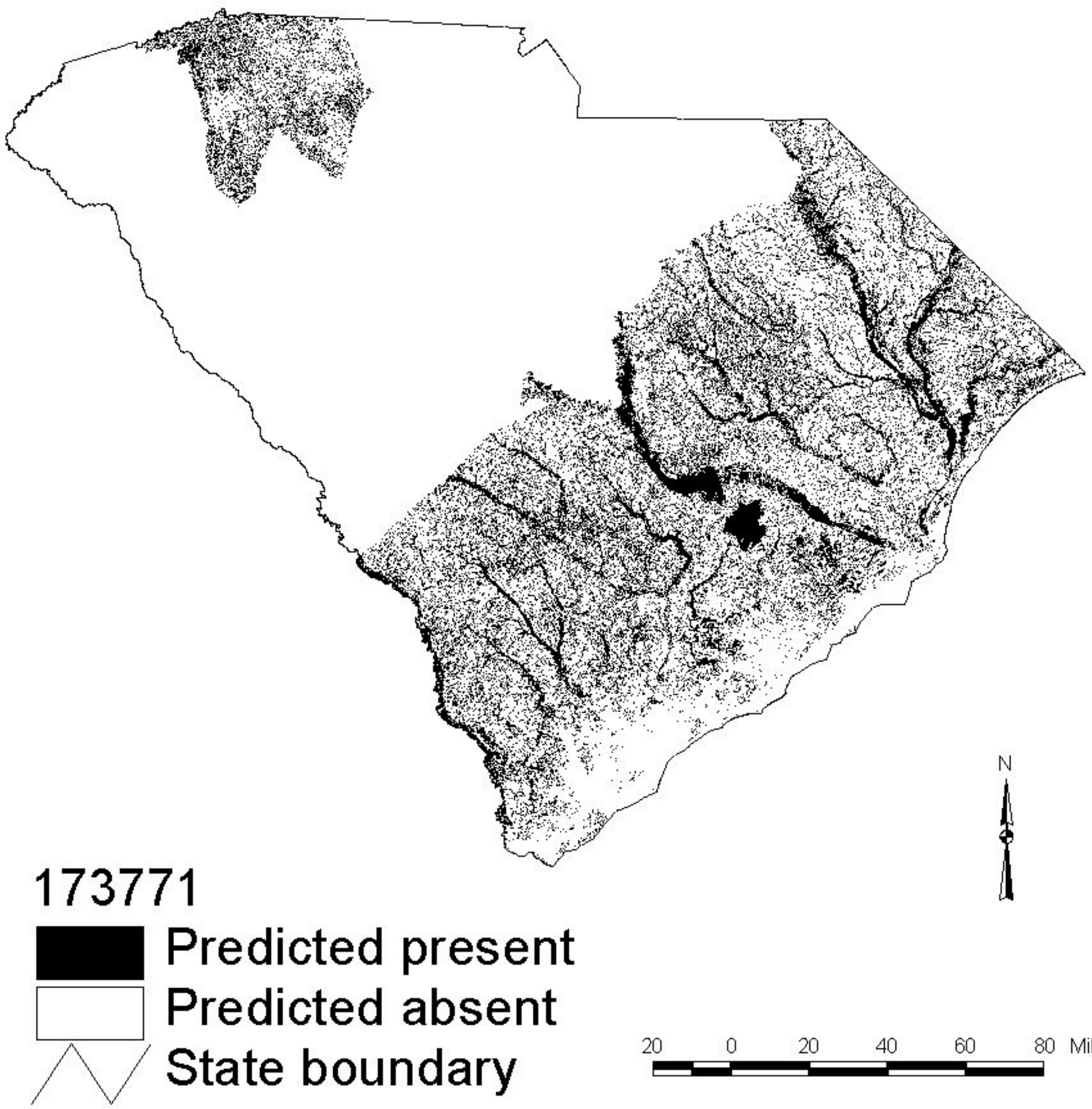
20 0 20 40 60 80 Miles

Painted Turtle

(Chrysemys picta)

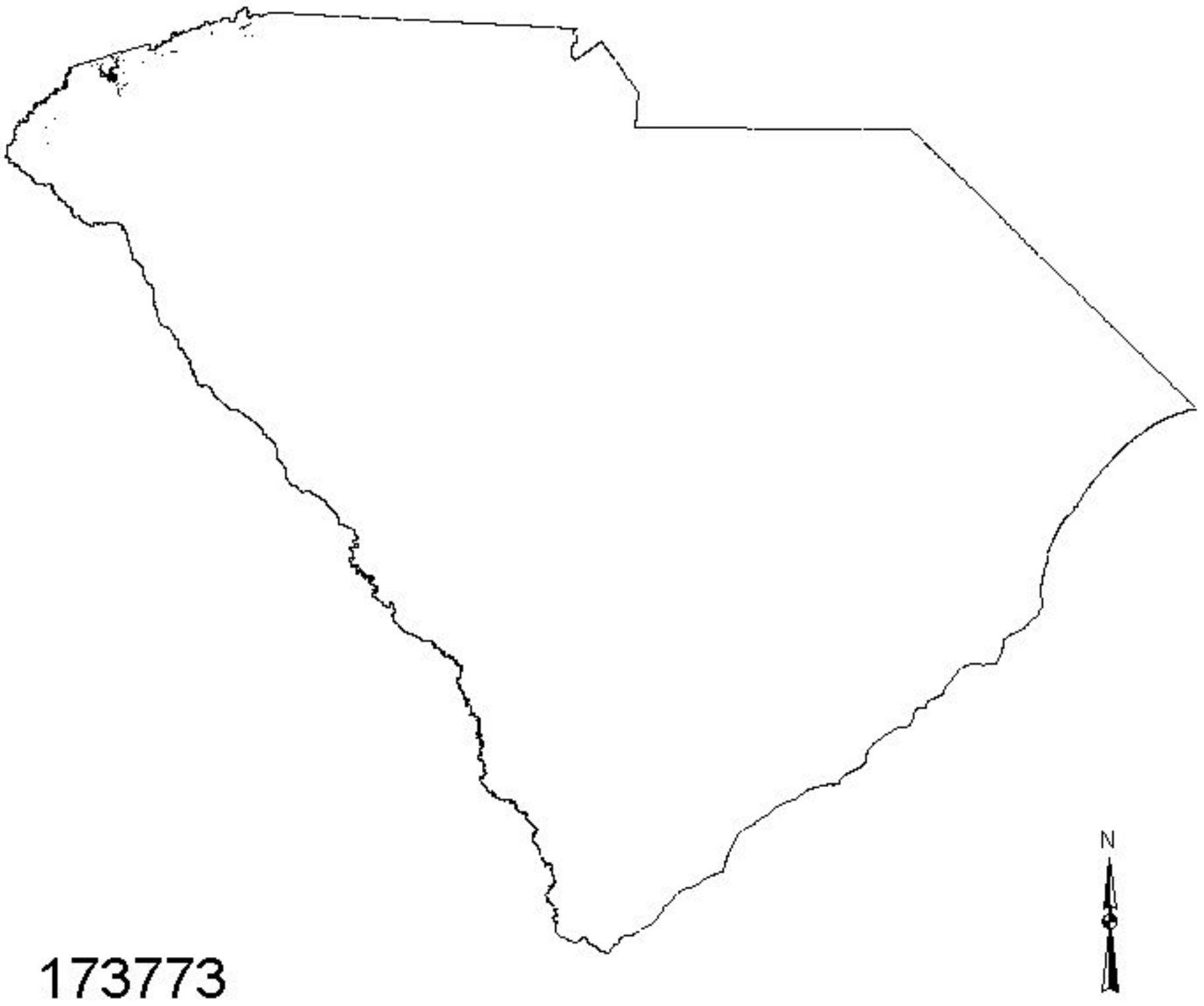


Spotted Turtle
(Clemmys guttata)



Bog Turtle

(Clemmys muhlenbergii)



173773

Predicted present

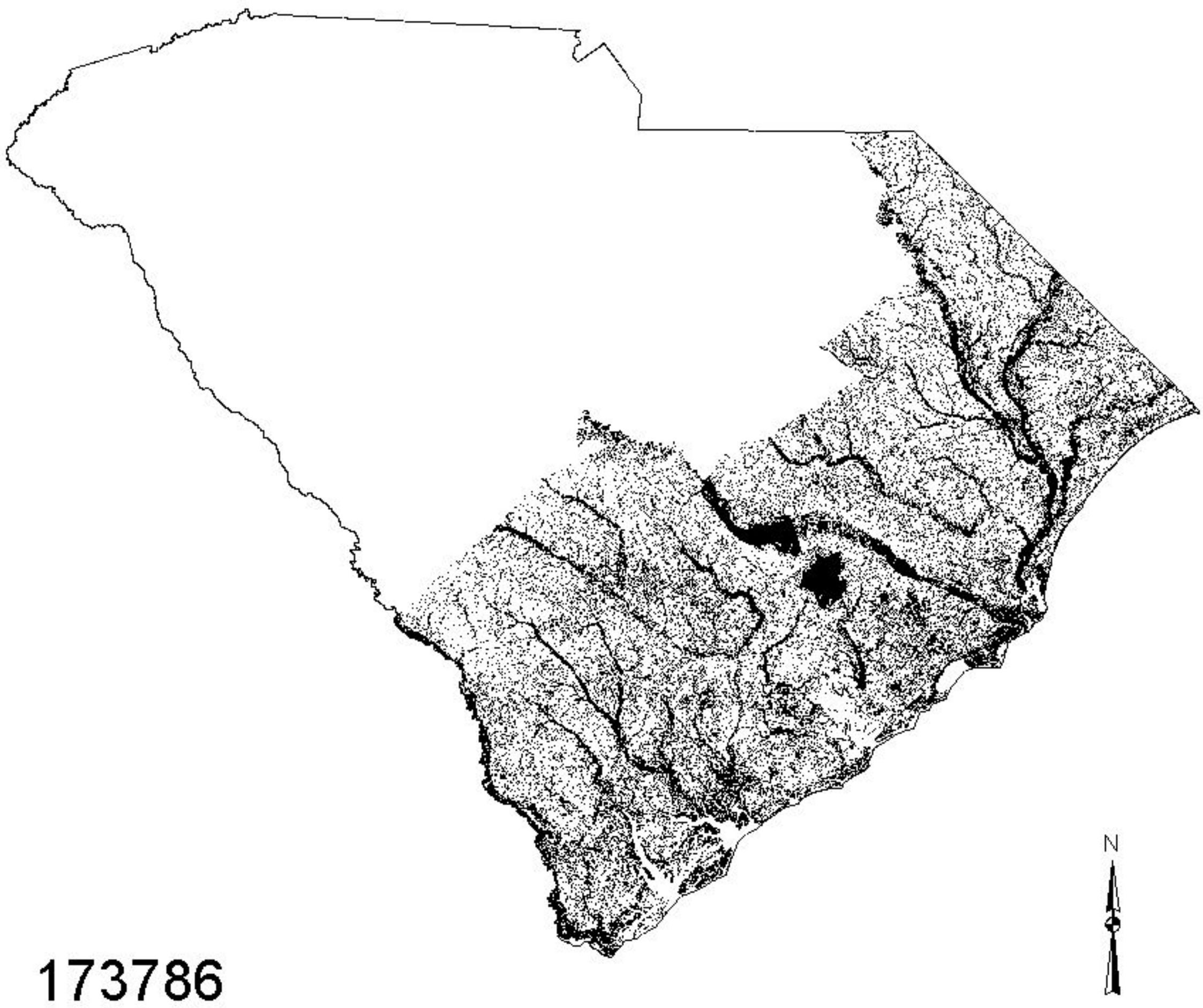
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Chicken Turtle

(Deirochelys reticularia)



173786

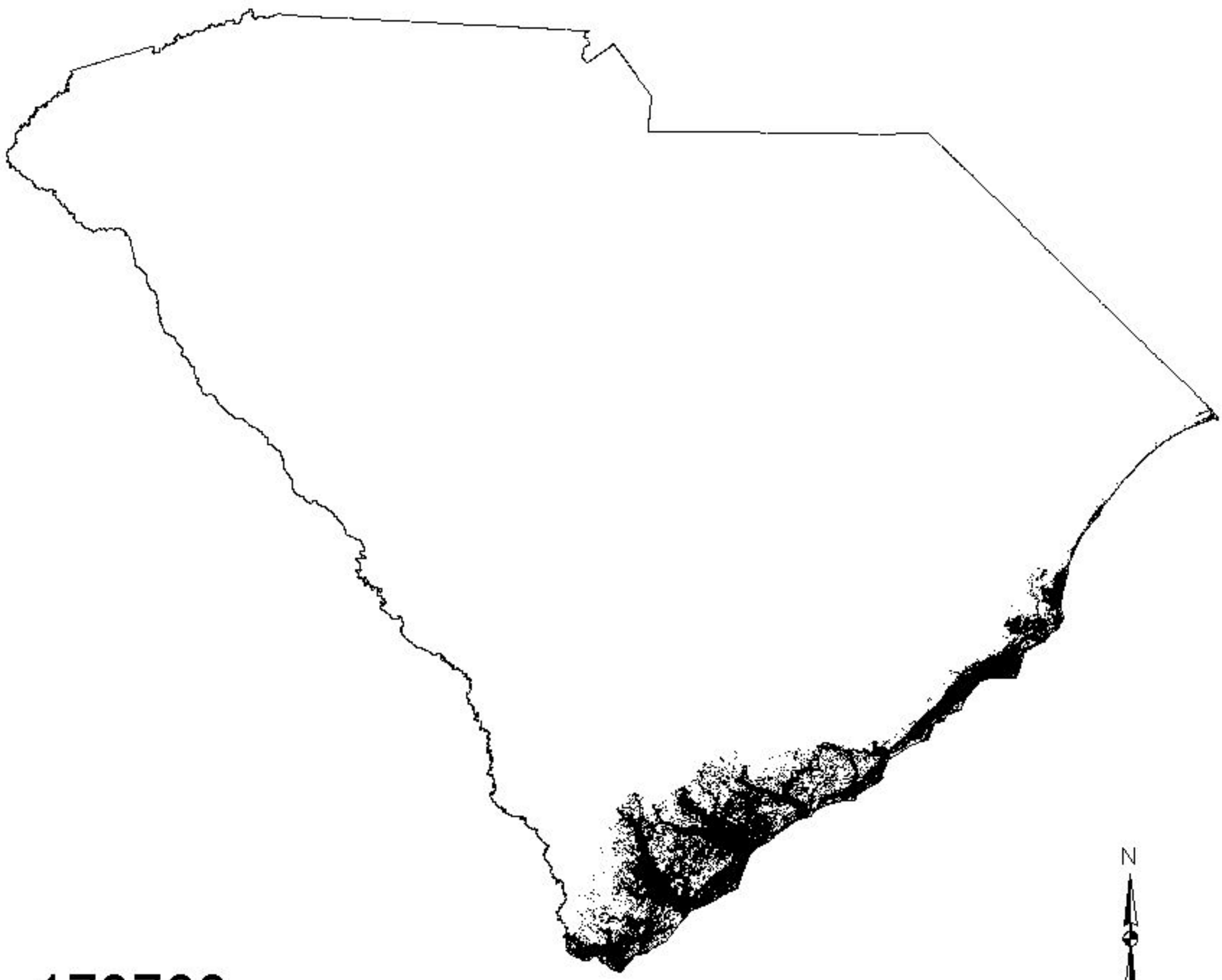
Predicted present

Predicted absent

State boundary

Diamondback Terrapin

(Malaclemys terrapin)



173780

Predicted present

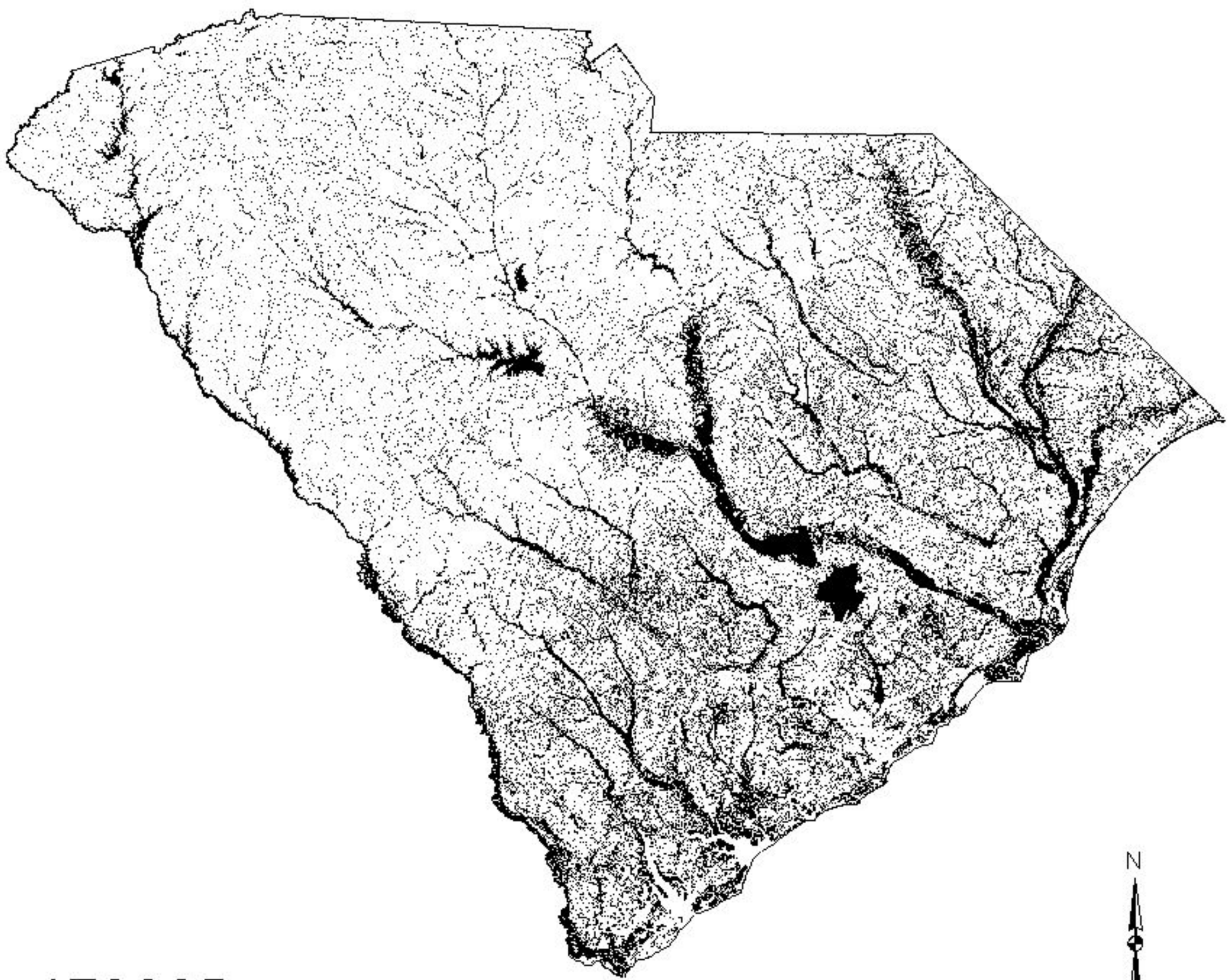
Predicted absent

State boundary

20 0 20 40 60 80 Miles

River Cooter

(Pseudemys concinna)



173805

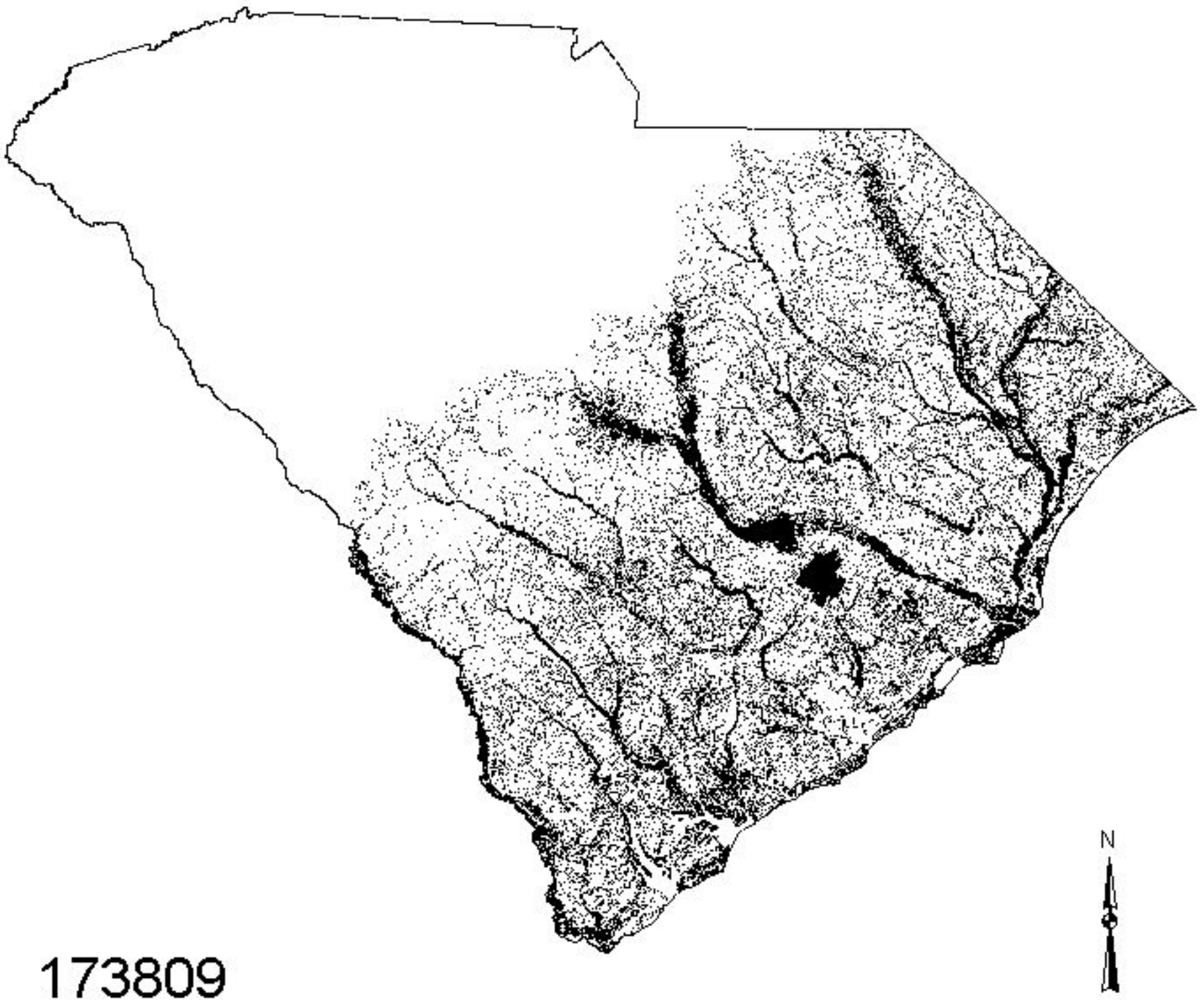
Predicted present

Predicted absent

State boundary

Florida Cooter

(Pseudemys floridana)



173809

Predicted present

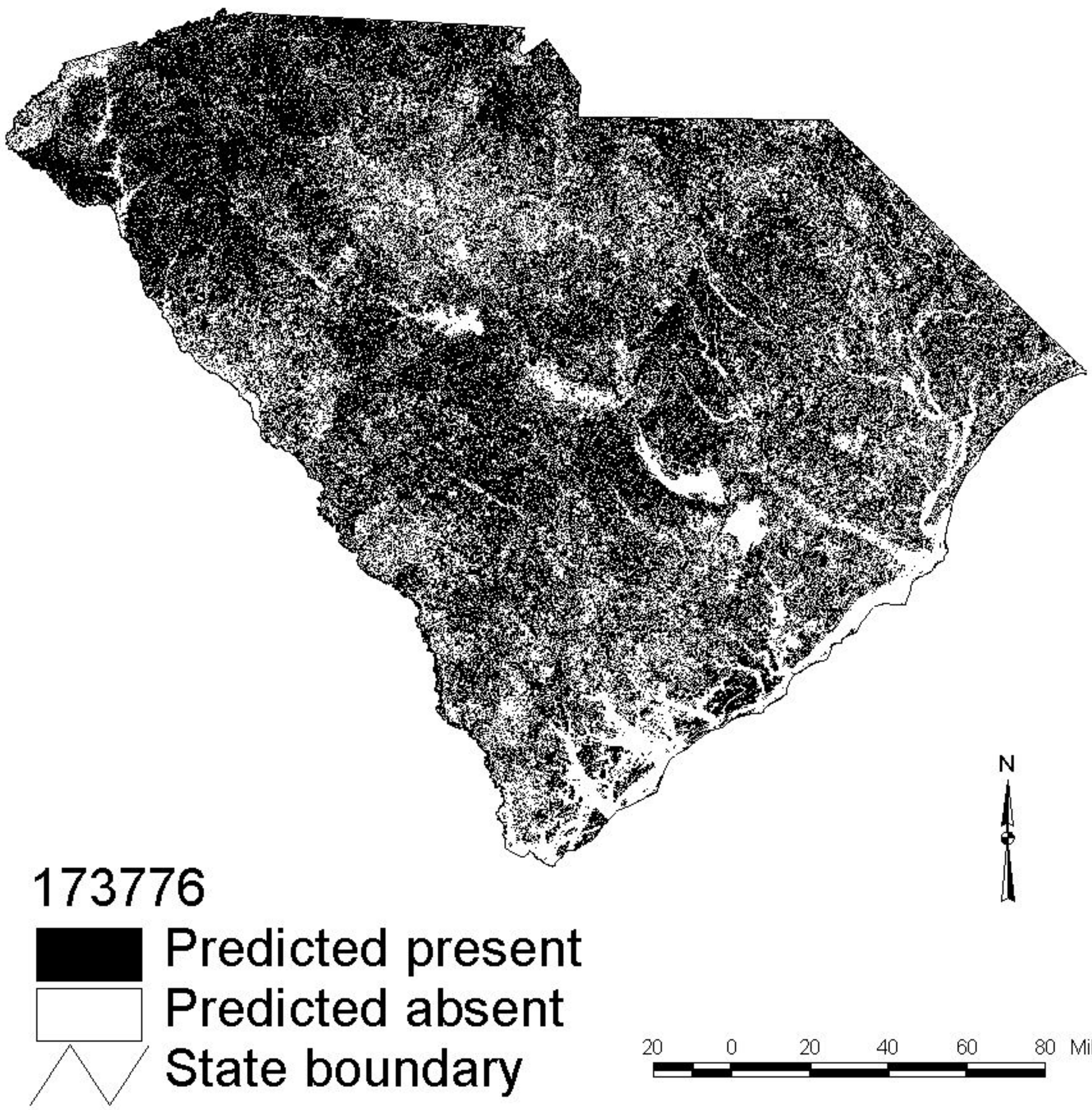
Predicted absent

State boundary

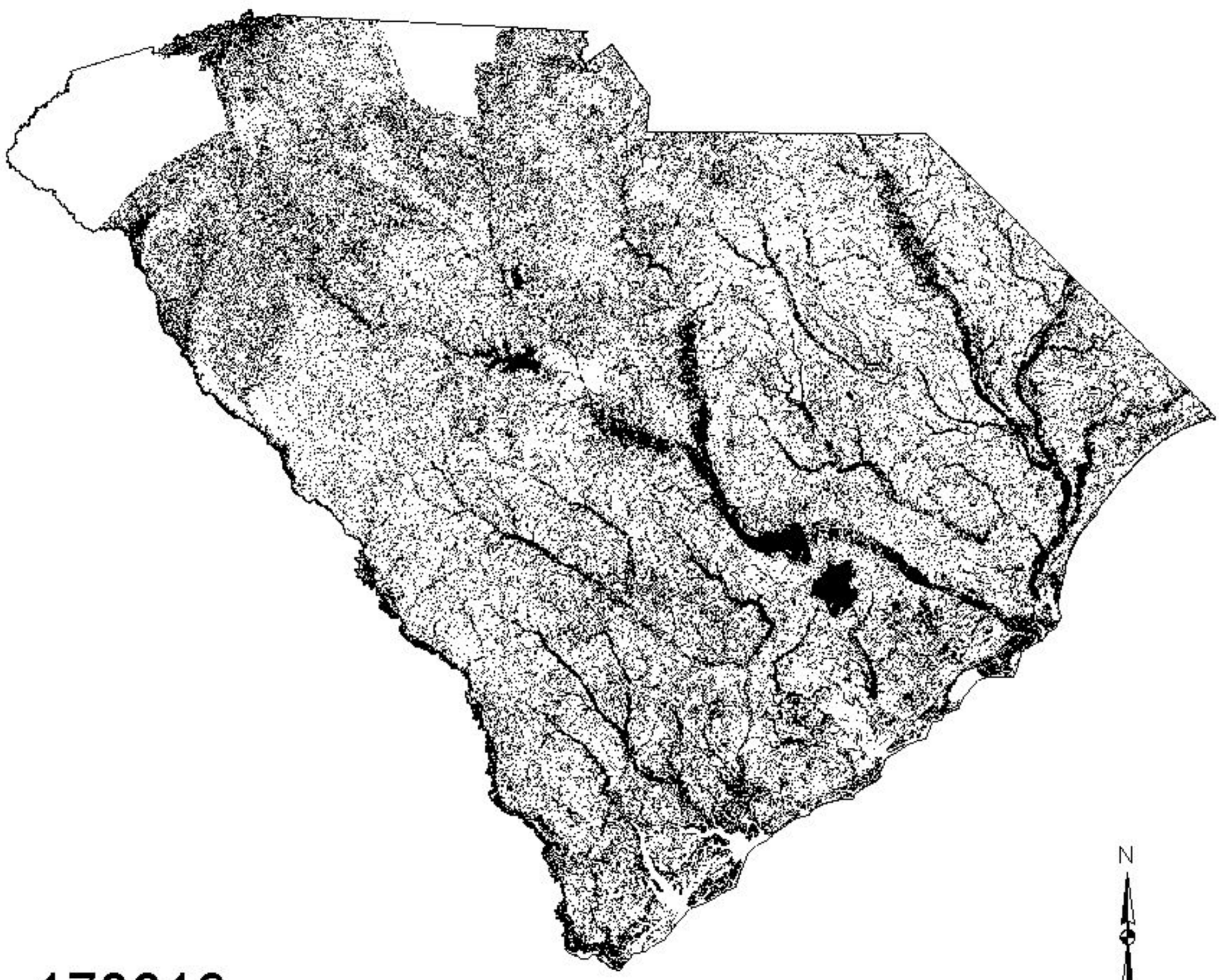
20 0 20 40 60 80 Miles

Eastern Box Turtle

(Terrapene carolina)



Yellowbelly Slider
(Trachemys scripta)



173819

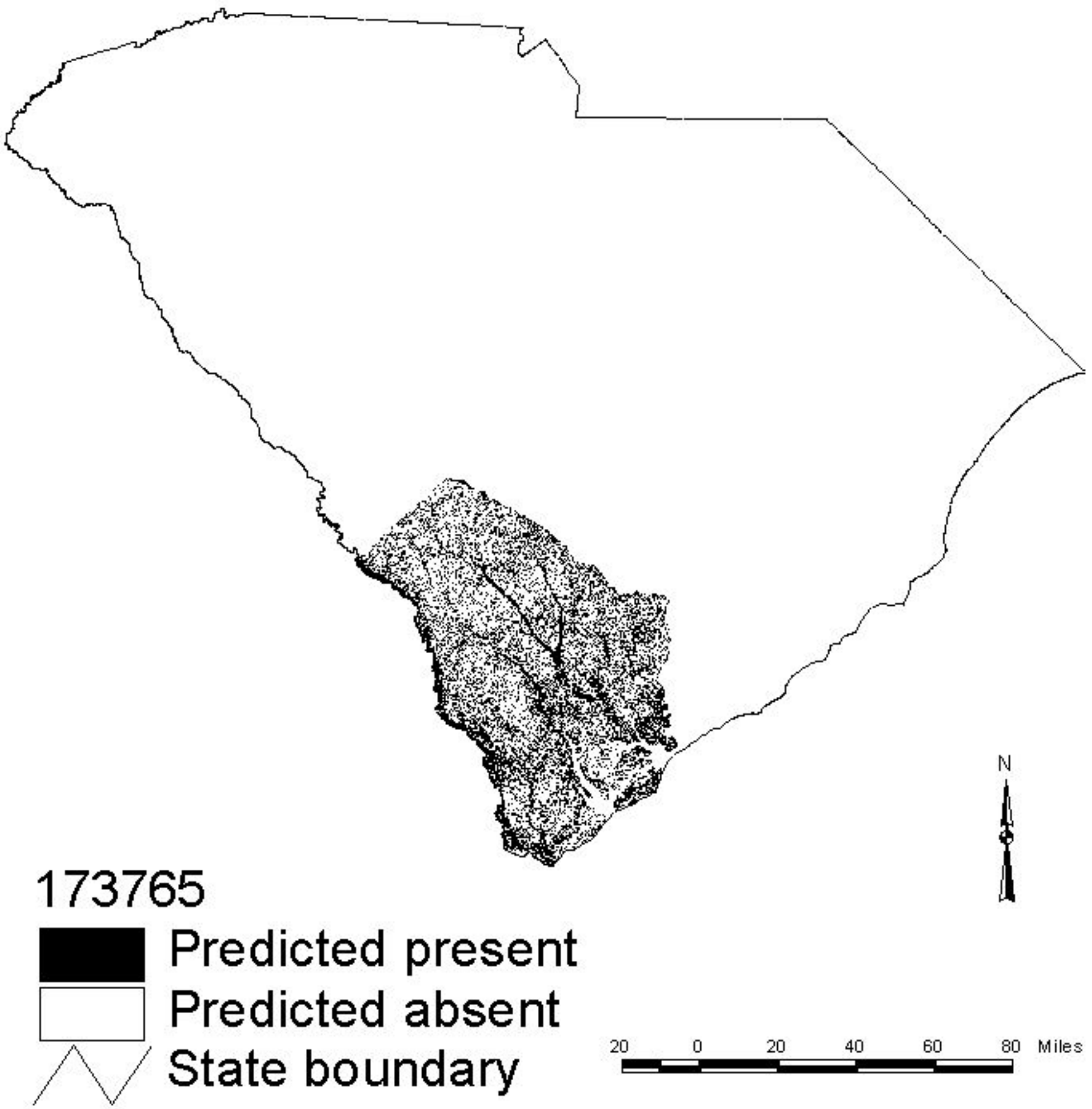
Predicted present

Predicted absent

State boundary

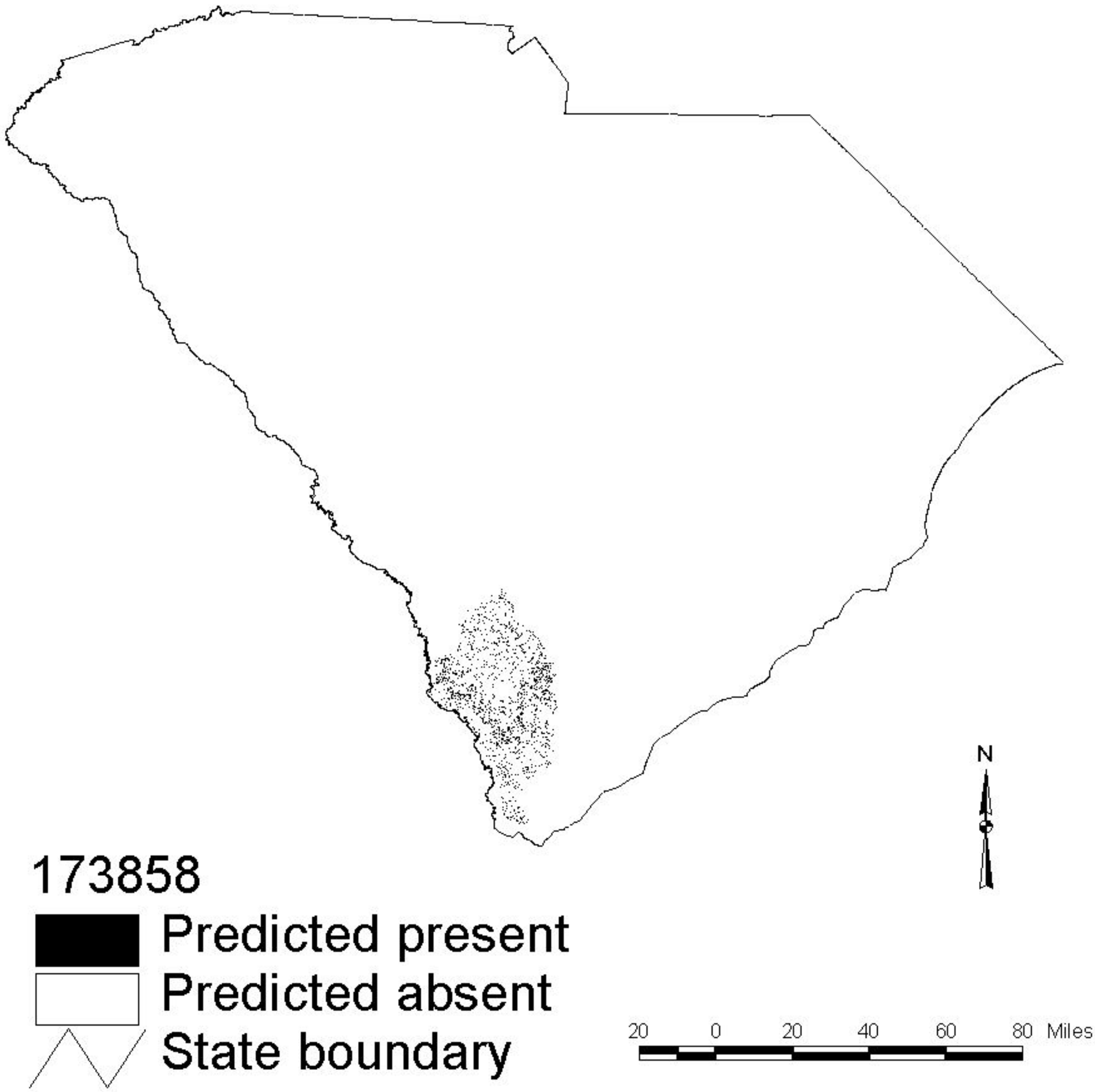
Striped Mud Turtle

(Kinosternon baurii)



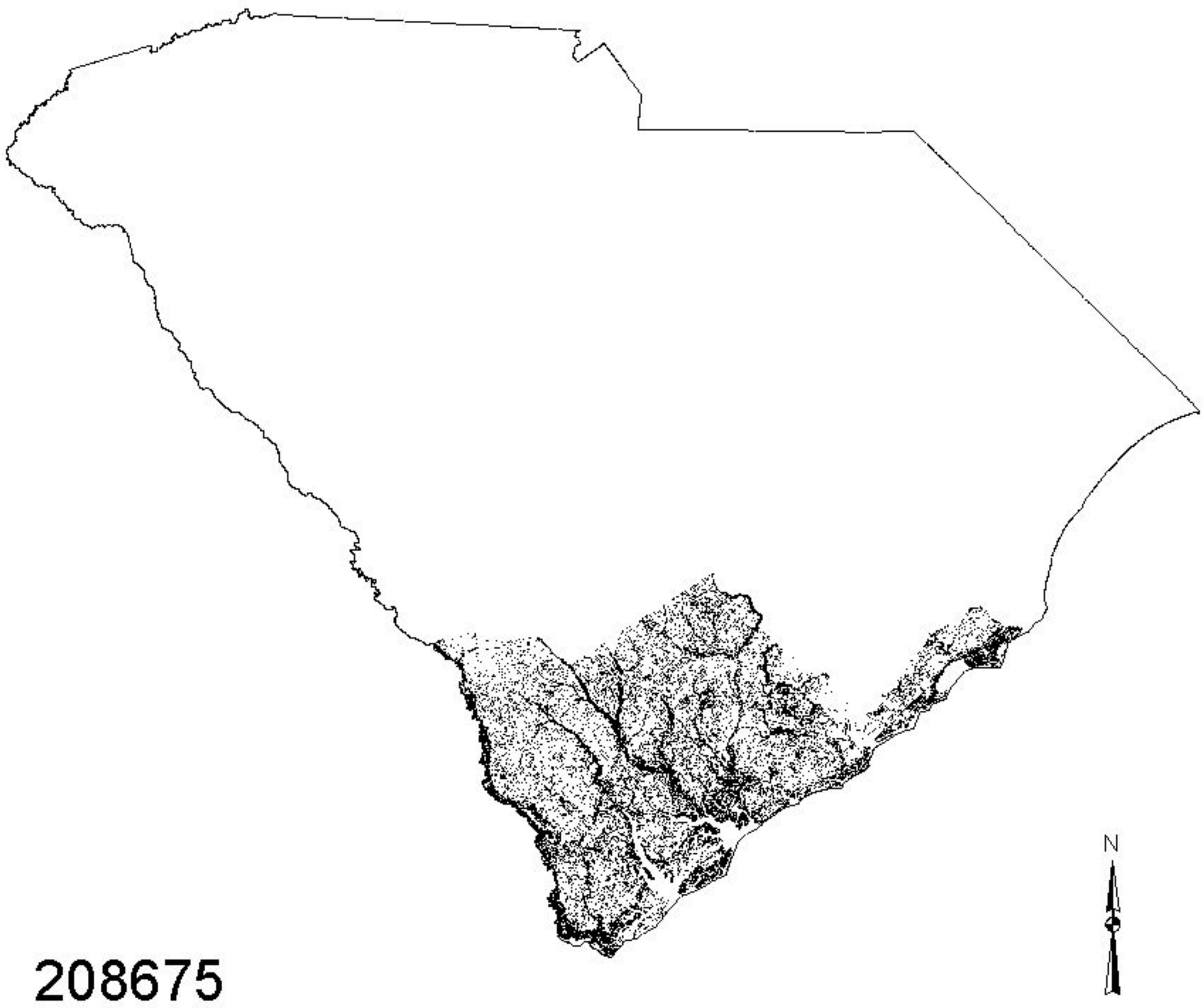
Gopher Tortoise

(Gopherus polyphemus)



Florida Softshell

(Apalone ferox)



208675

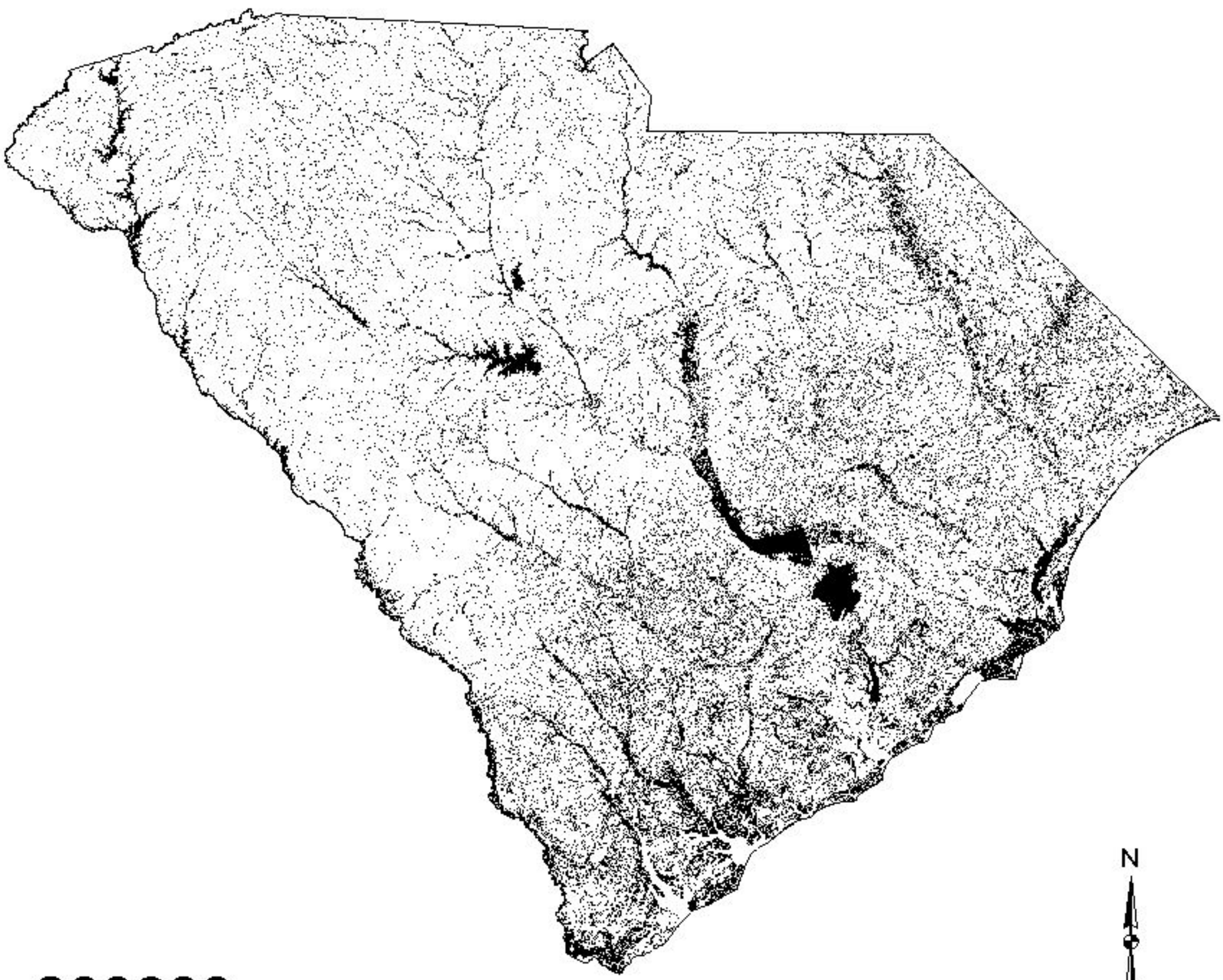
Predicted present

Predicted absent

State boundary

Spiny Softshell

(Apalone spinifera)



208680

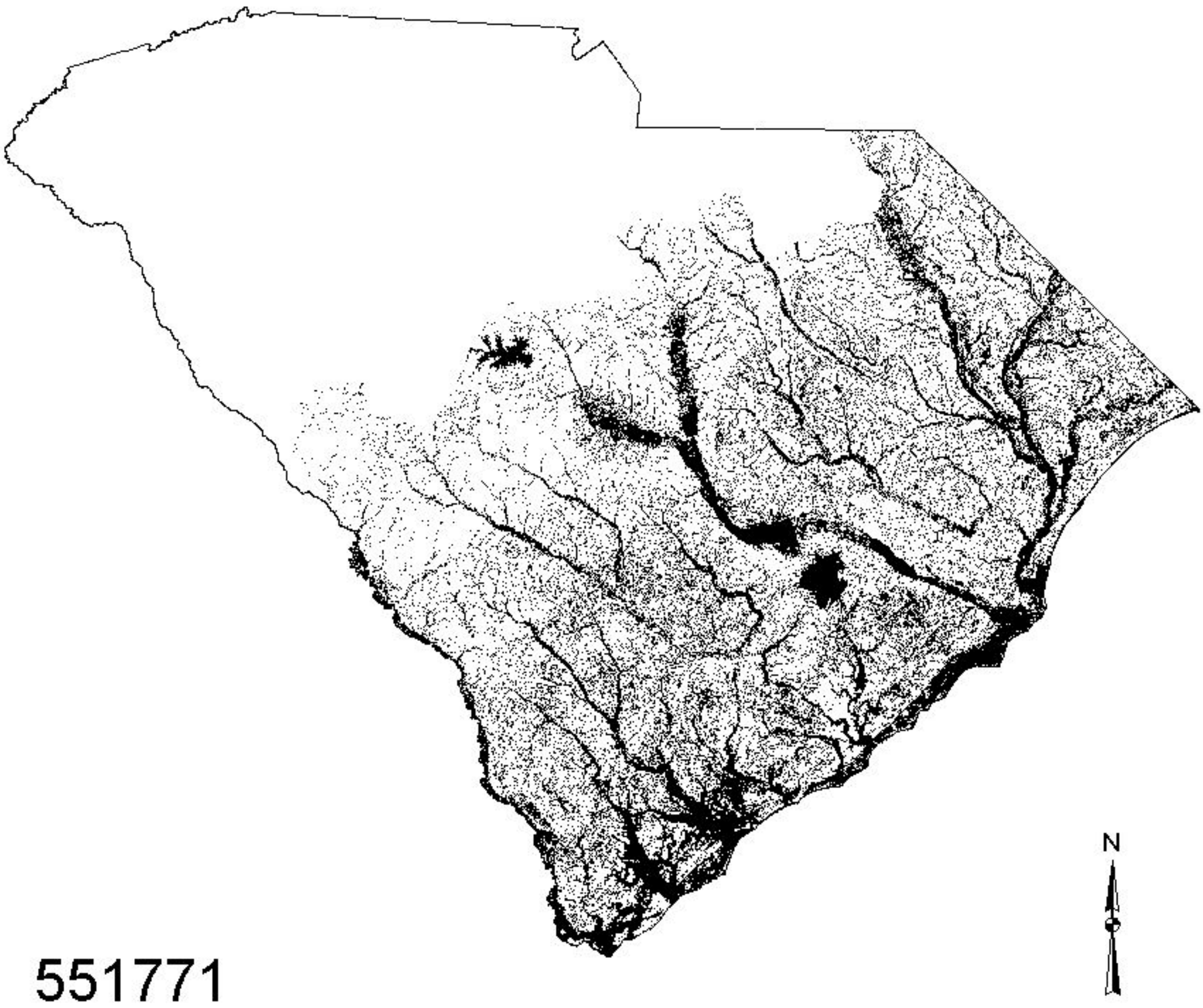
Predicted present

Predicted absent

State boundary

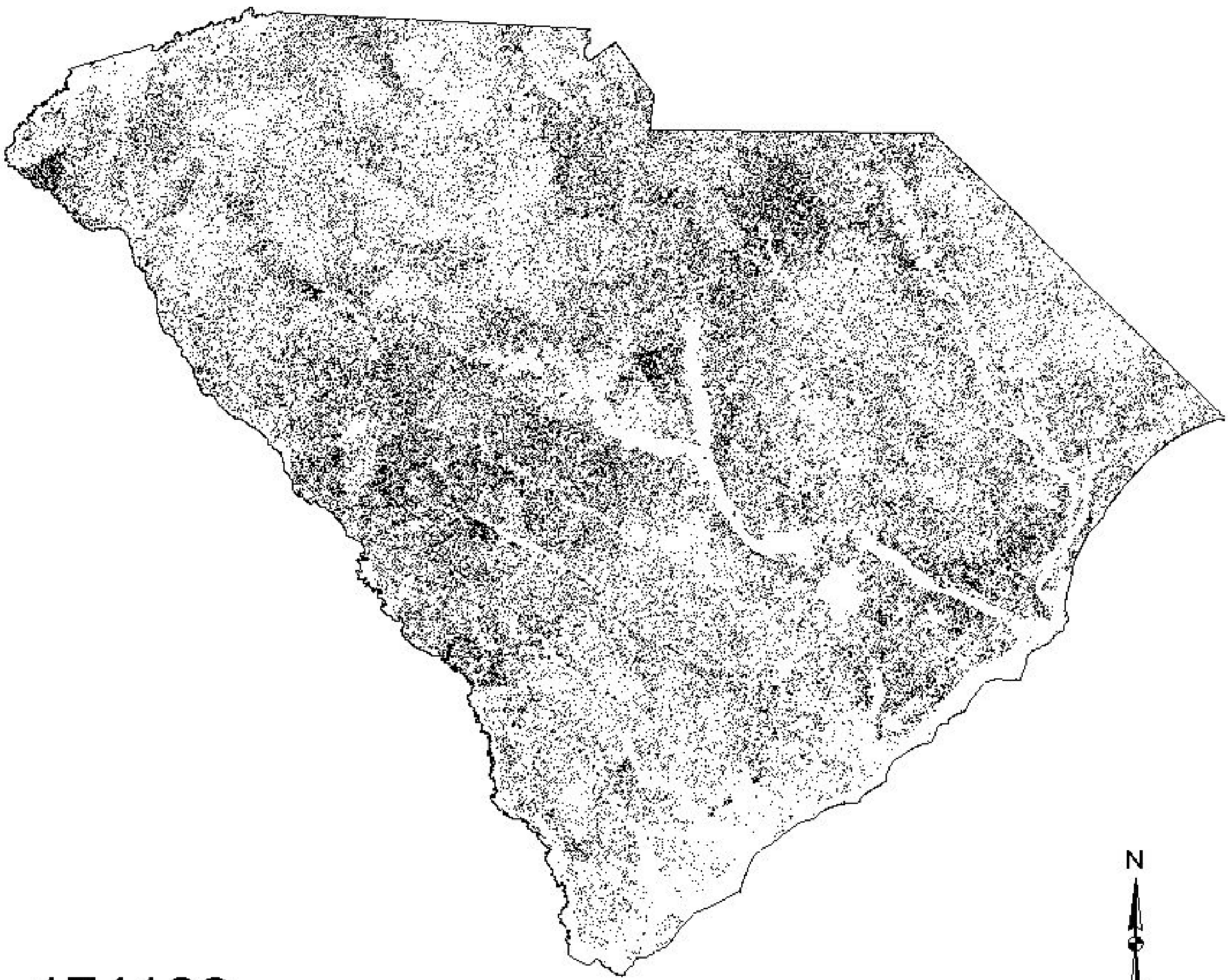
American Alligator

(Alligator mississippiensis)



Slender Glass Lizard

(Ophisaurus attenuatus)



174106

Predicted present

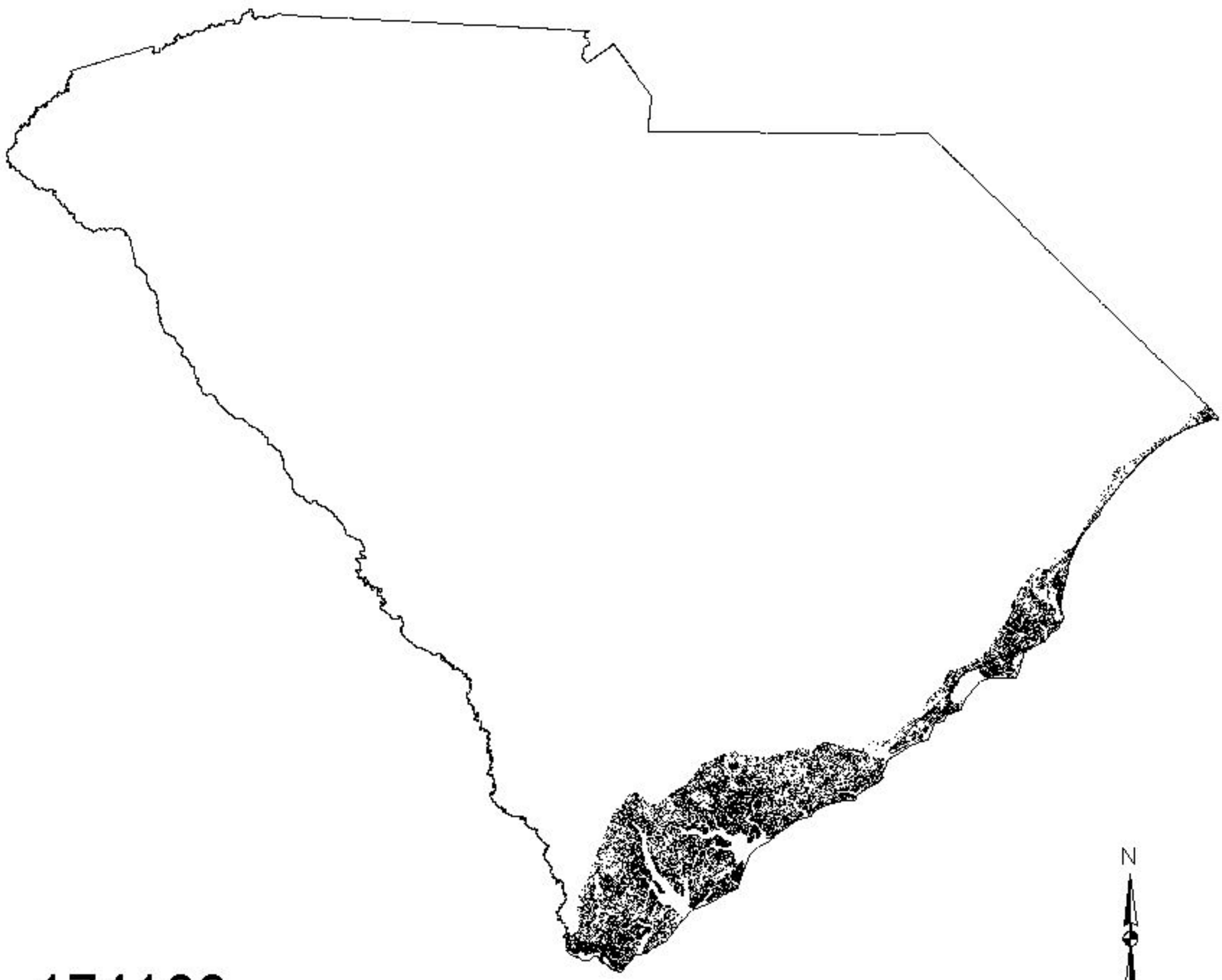
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Island Glass Lizard

(Ophisaurus compressus)



174109

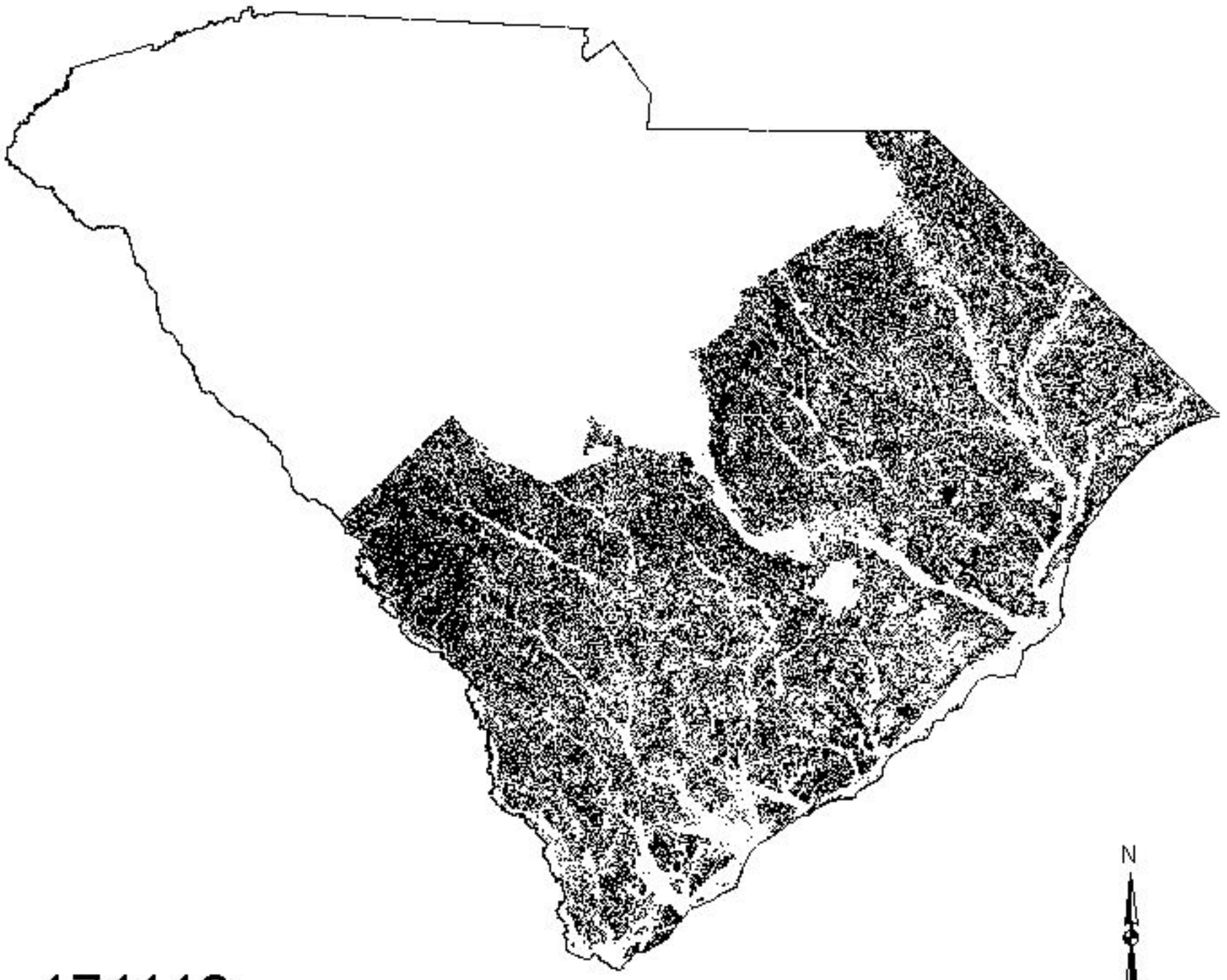
Predicted present

Predicted absent

State boundary

Eastern Glass Lizard

(Ophisaurus ventralis)



174110

Predicted present

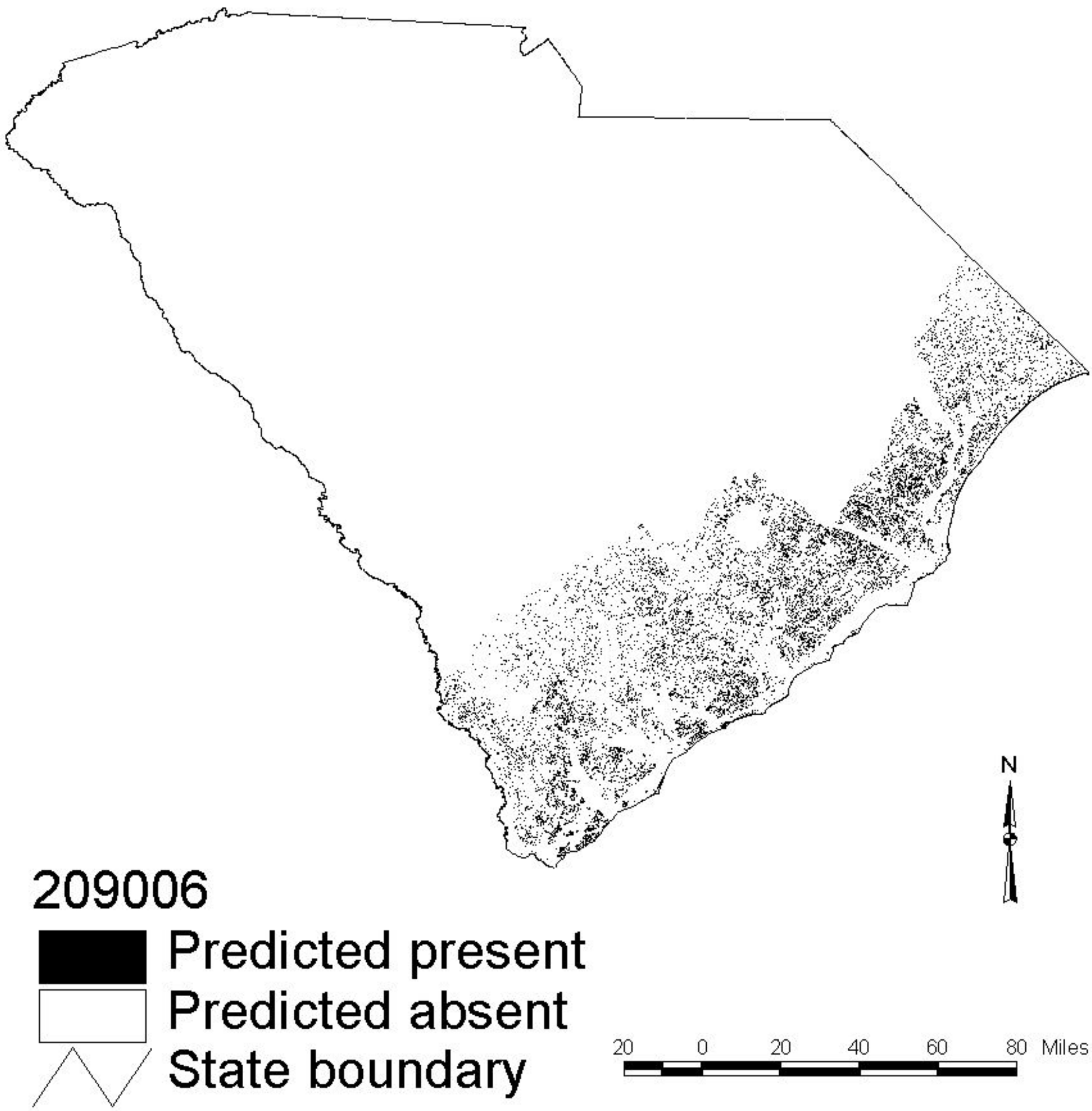
Predicted absent

State boundary

20 0 20 40 60 80 Miles

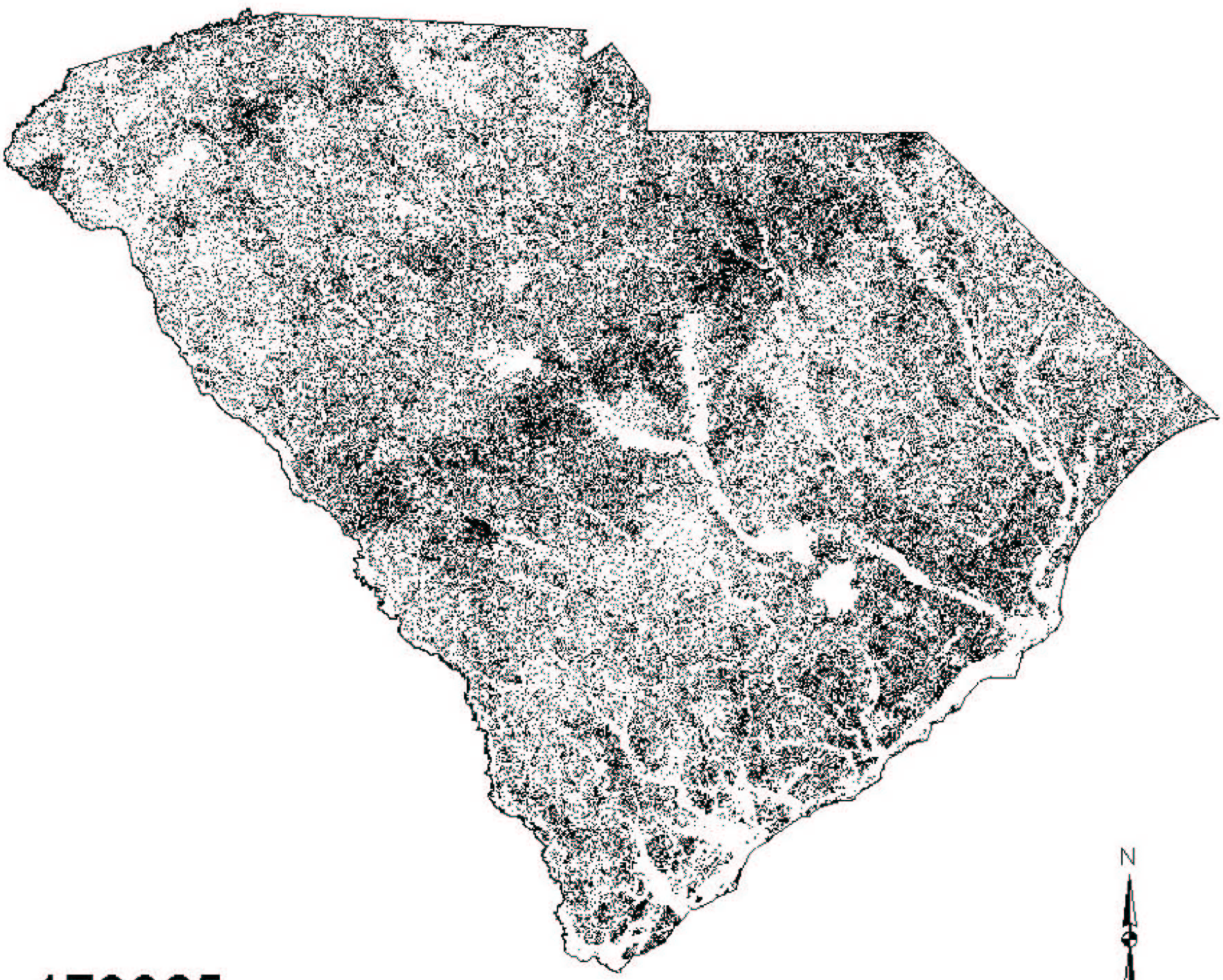
Mimic Glass Lizard

(Ophisaurus mimicus)



Fence Lizard

(Sceloporus undulatus)



173865

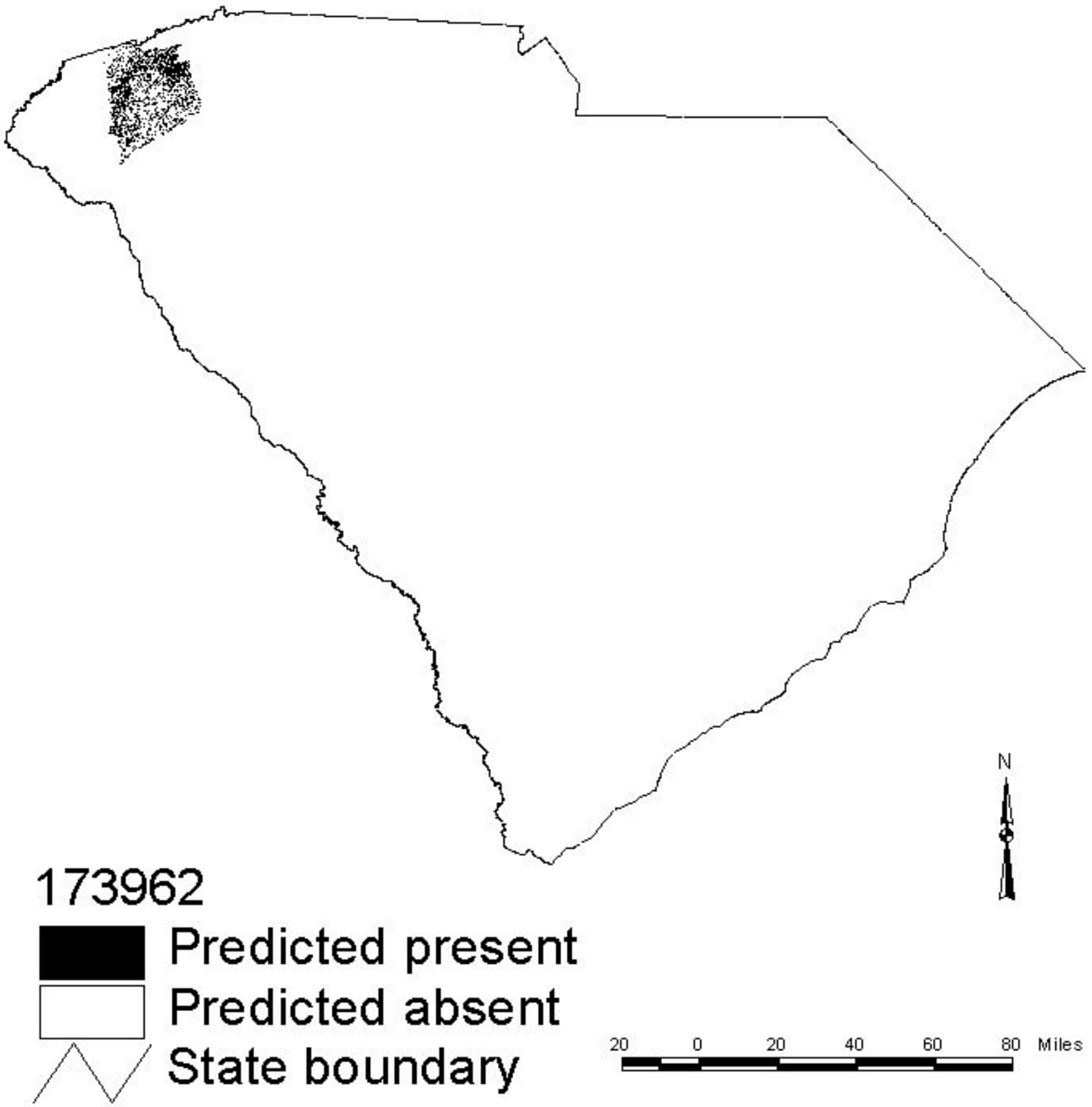
Predicted present

Predicted absent

State boundary

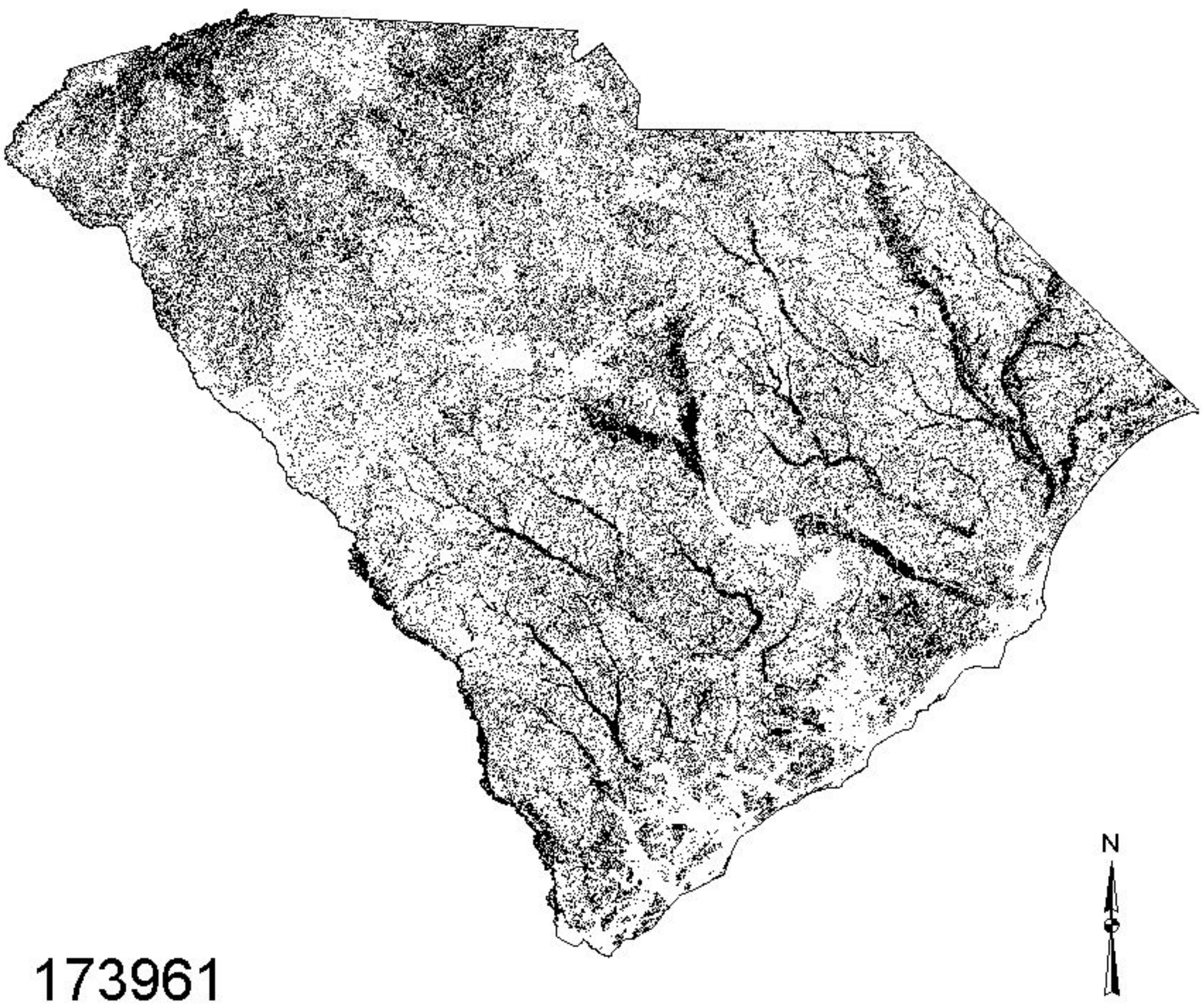
Coal Skink

(Eumeces anthracinus)

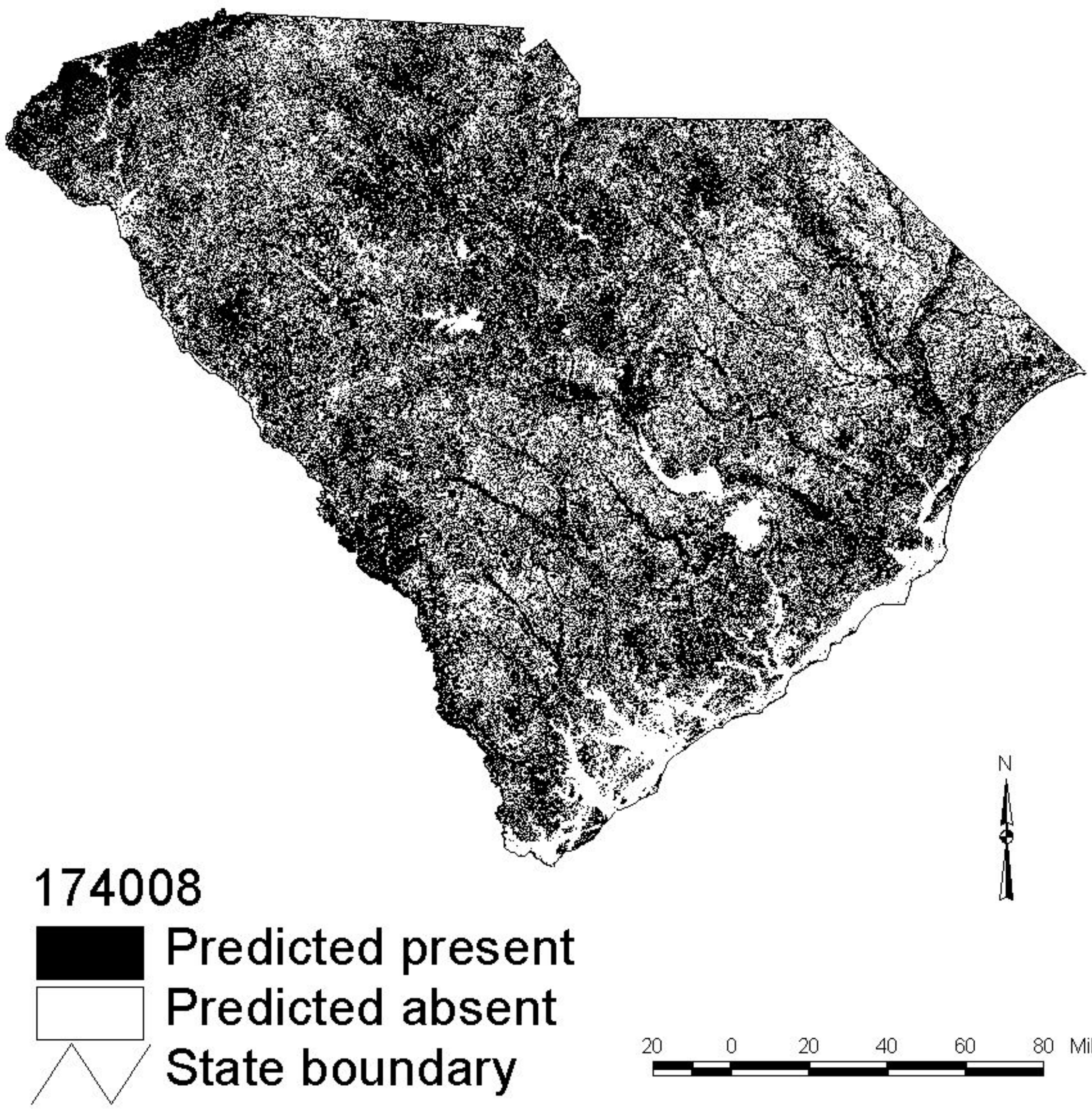


Broadhead Skink

(Eumeces laticeps)

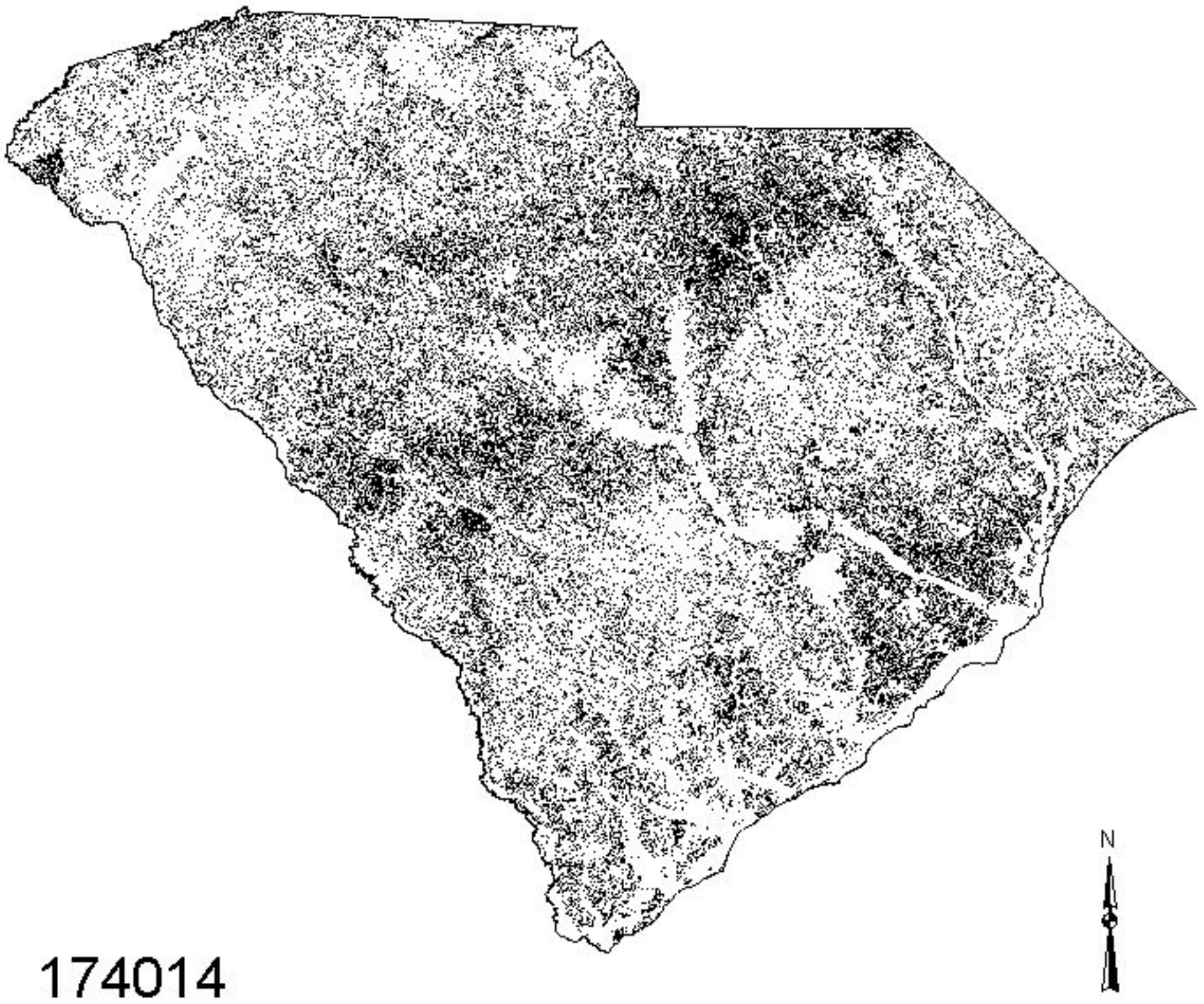


Ground Skink
(Scincella lateralis)



Six-lined Racerunner

(Cnemidophorus sexlineatus)



174014

Predicted present

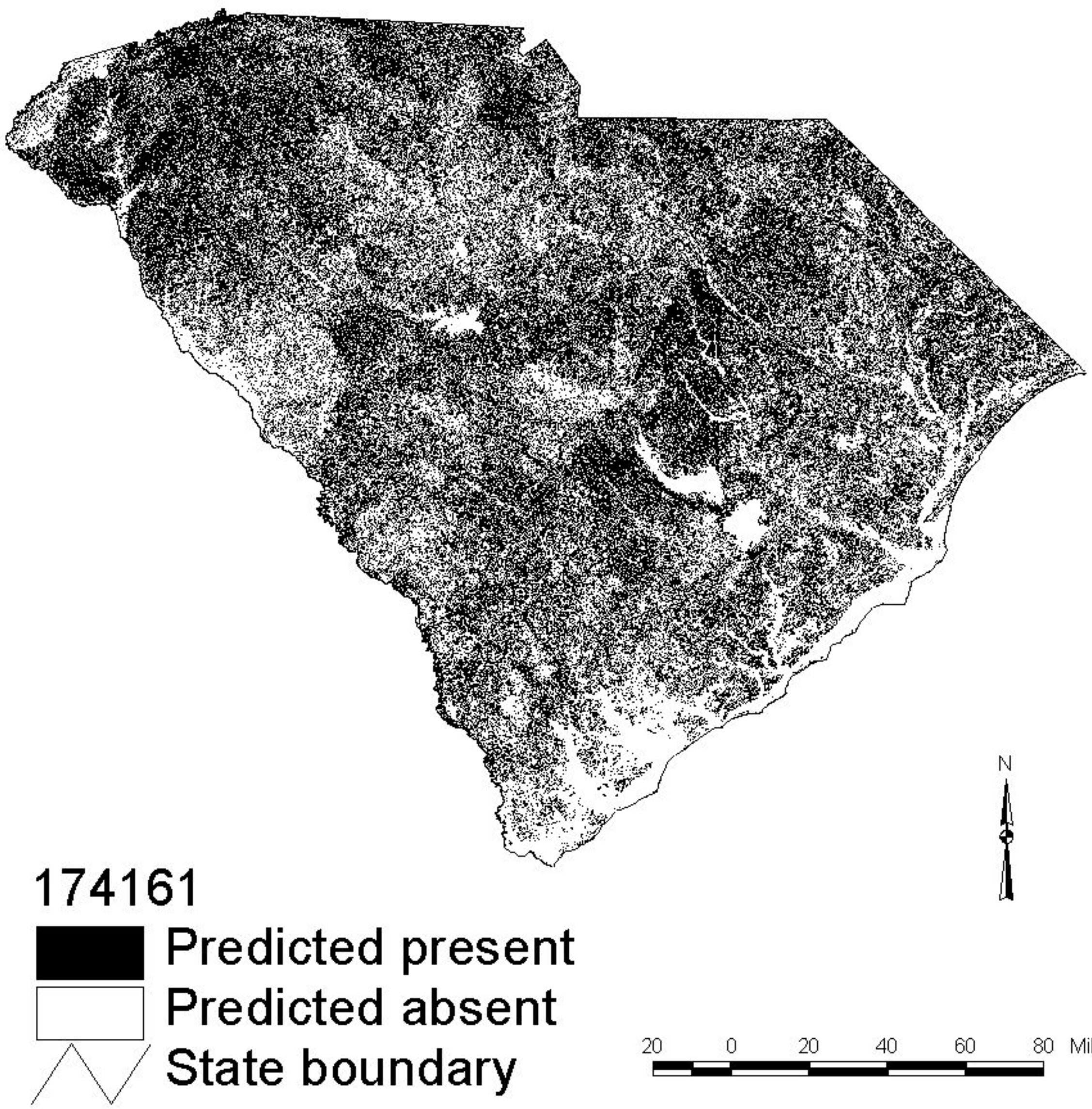
Predicted absent

State boundary

20 0 20 40 60 80 Miles

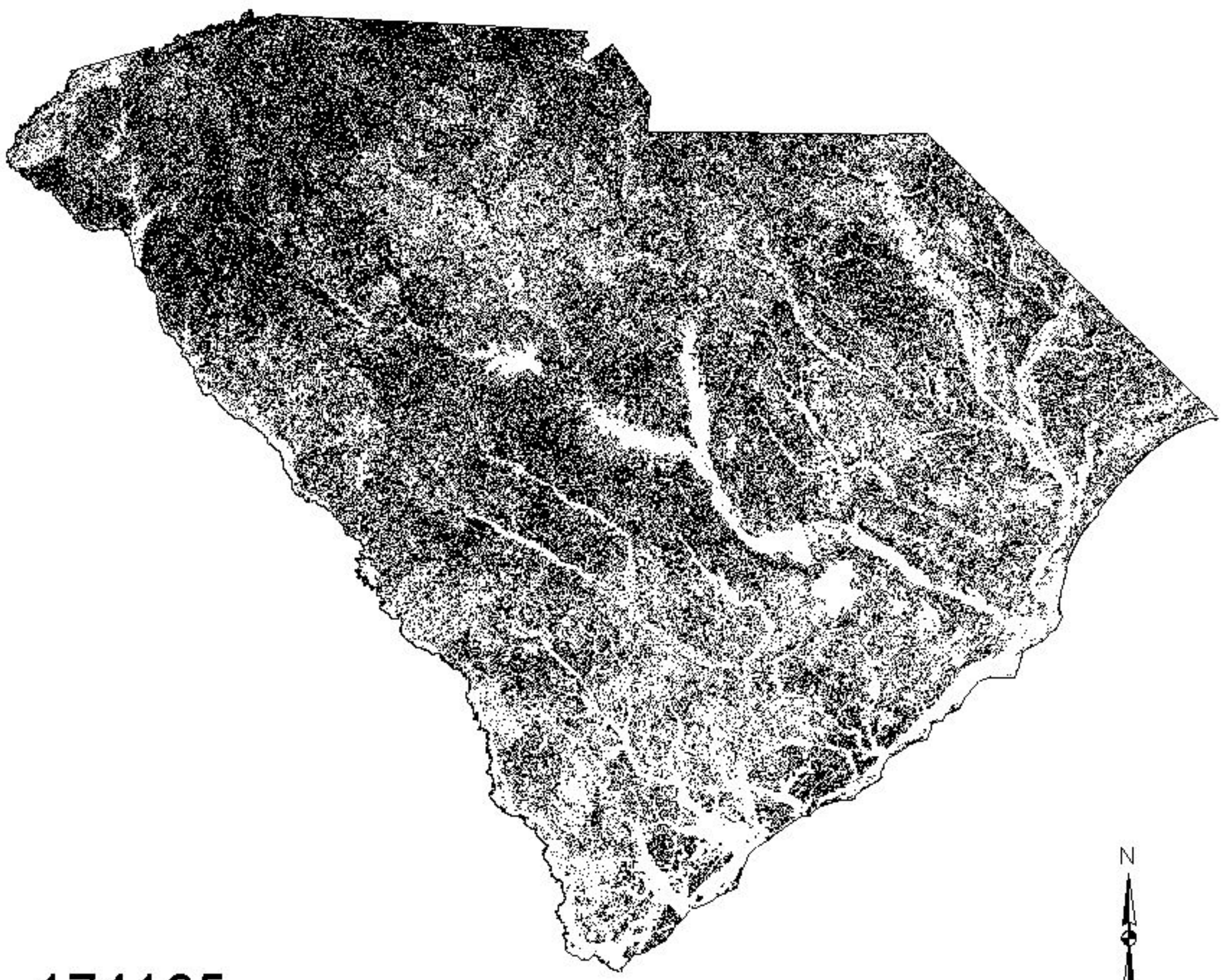
Worm Snake

(Carphophis amoenus)



Scarlet Snake

(Cemophora coccinea)



174195

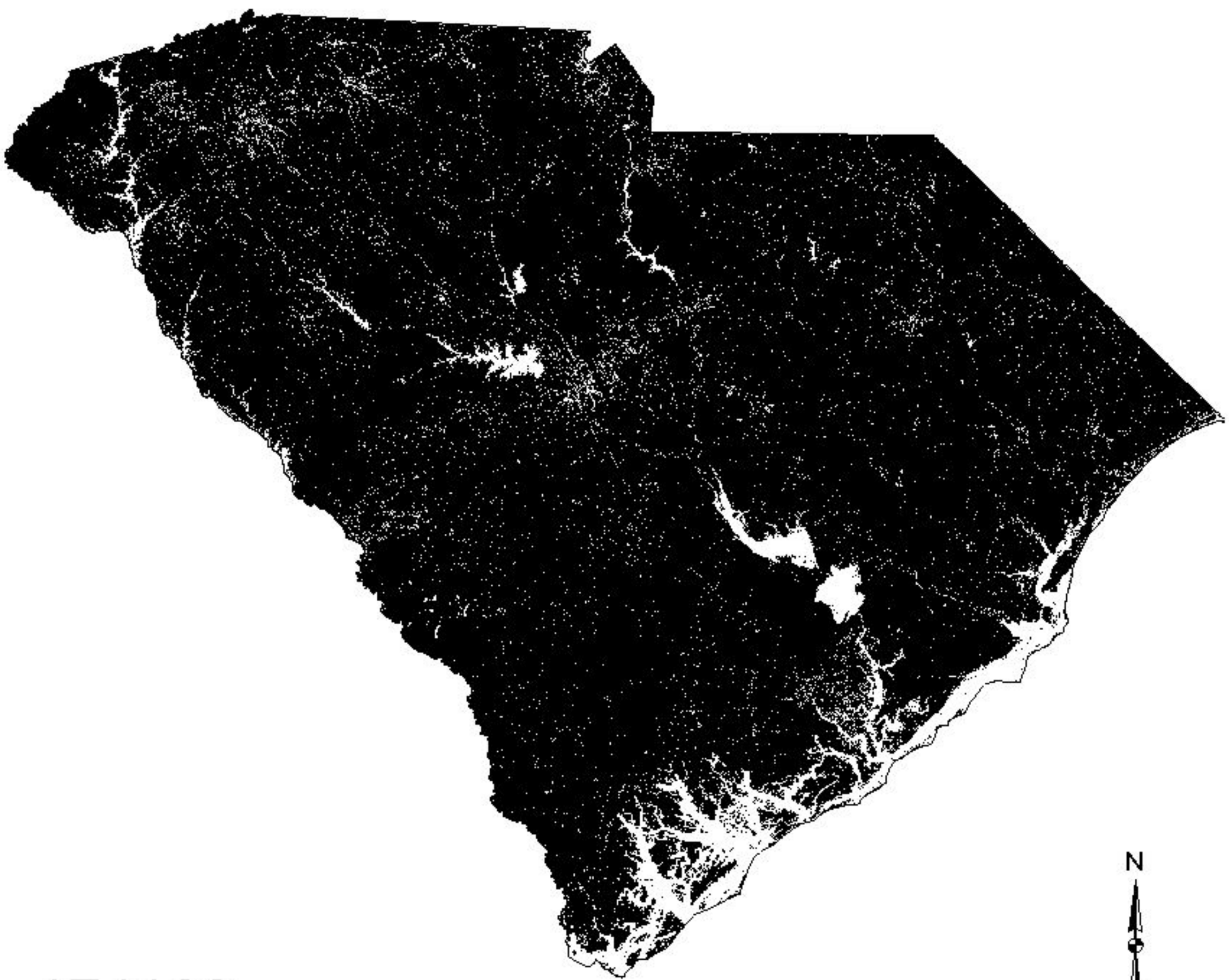
Predicted present

Predicted absent

State boundary

Black Racer

(Coluber constrictor)



174169

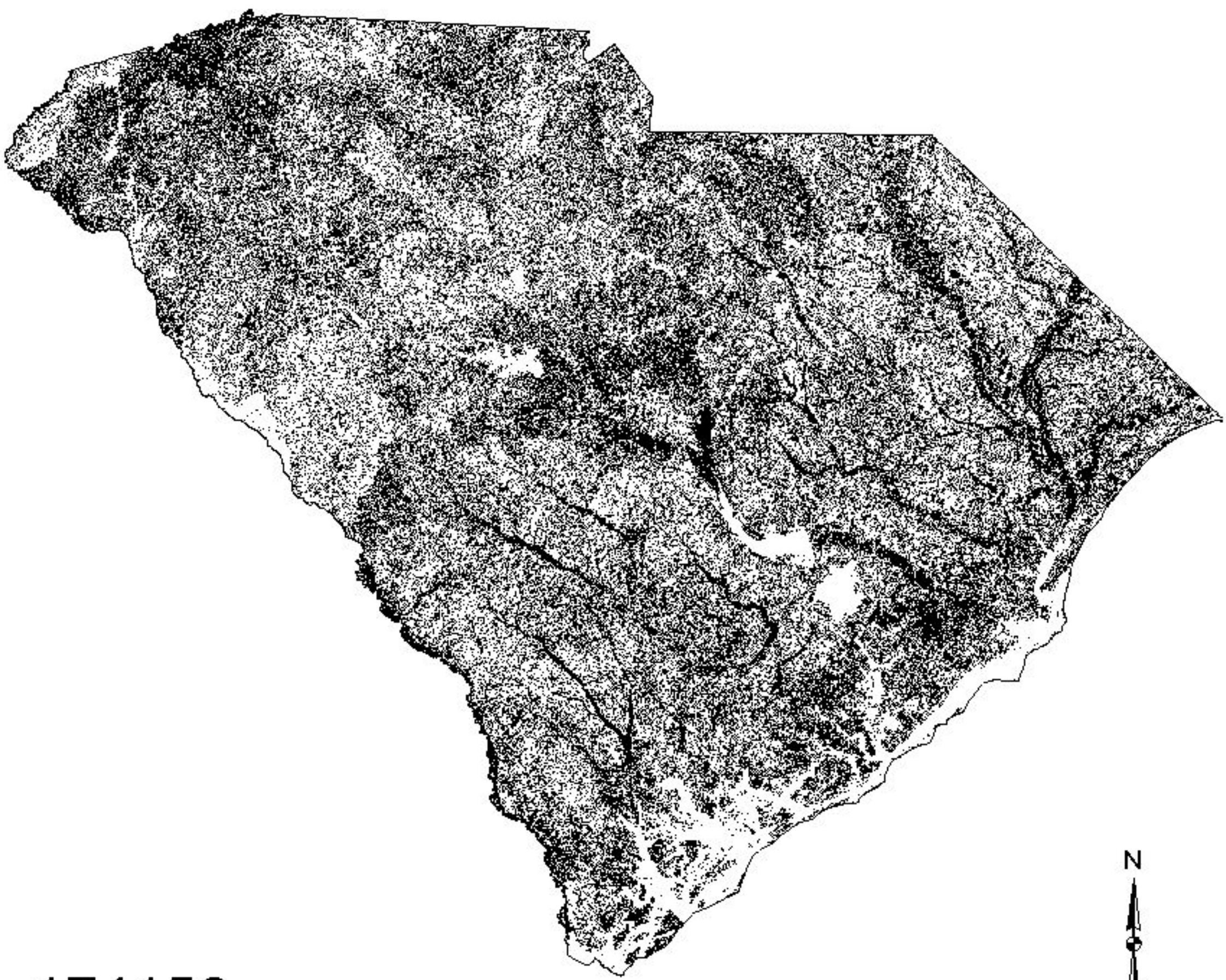
Predicted present

Predicted absent

State boundary

Ringneck Snake

(Diadophis punctatus)



174158

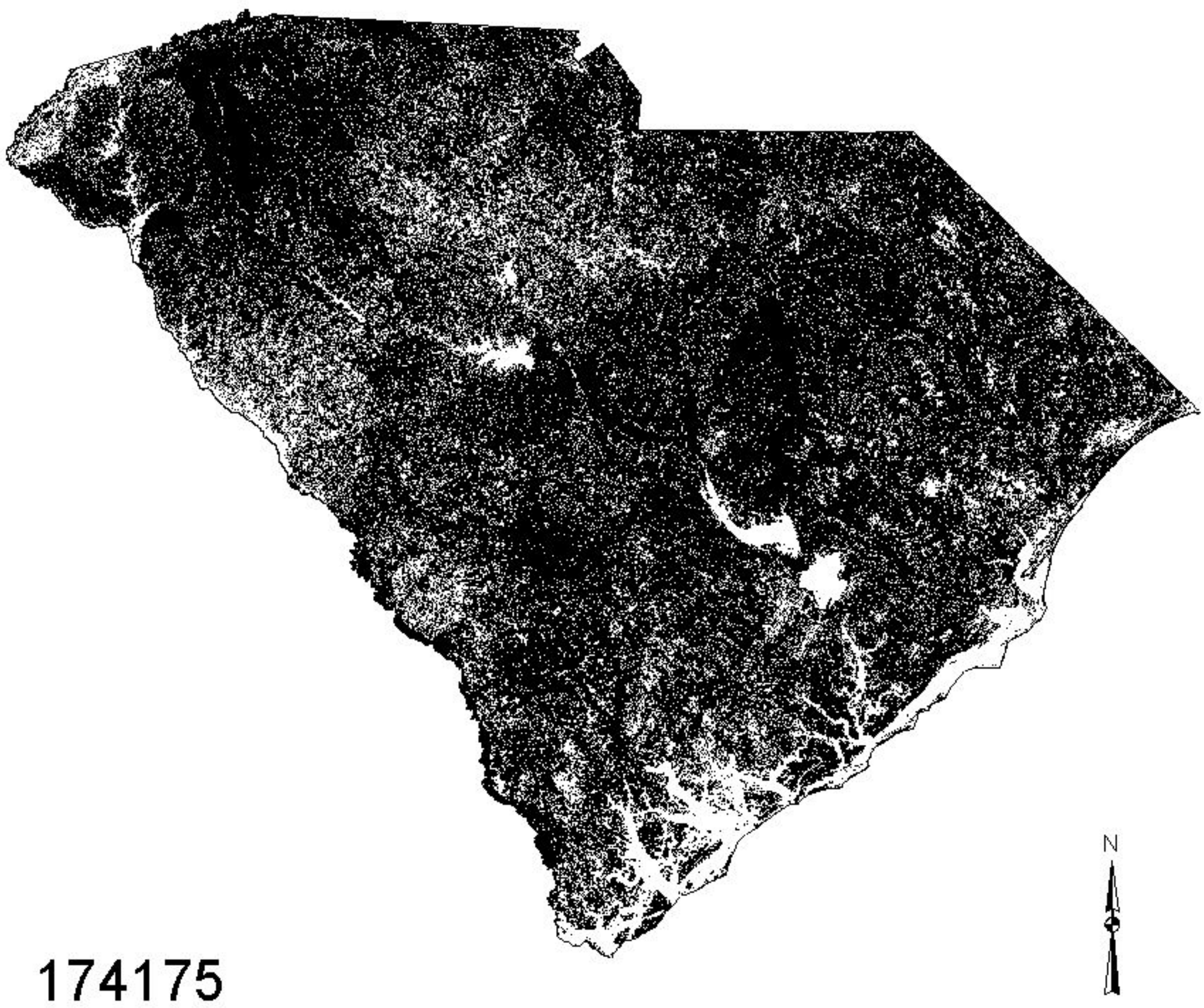
Predicted present

Predicted absent

State boundary

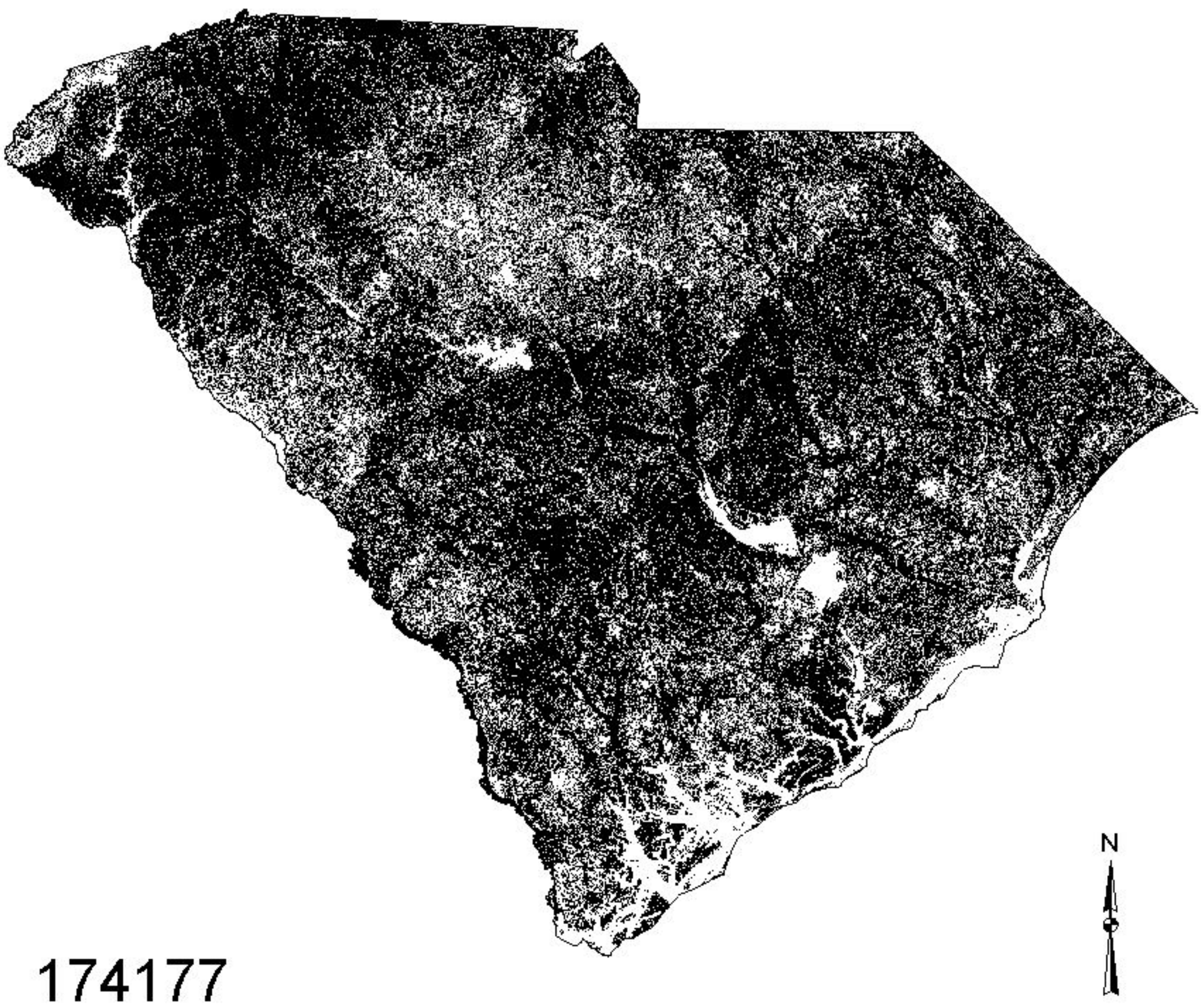
Corn Snake

(Elaphe guttata)



Rat Snake

(Elaphe obsoleta)



174177

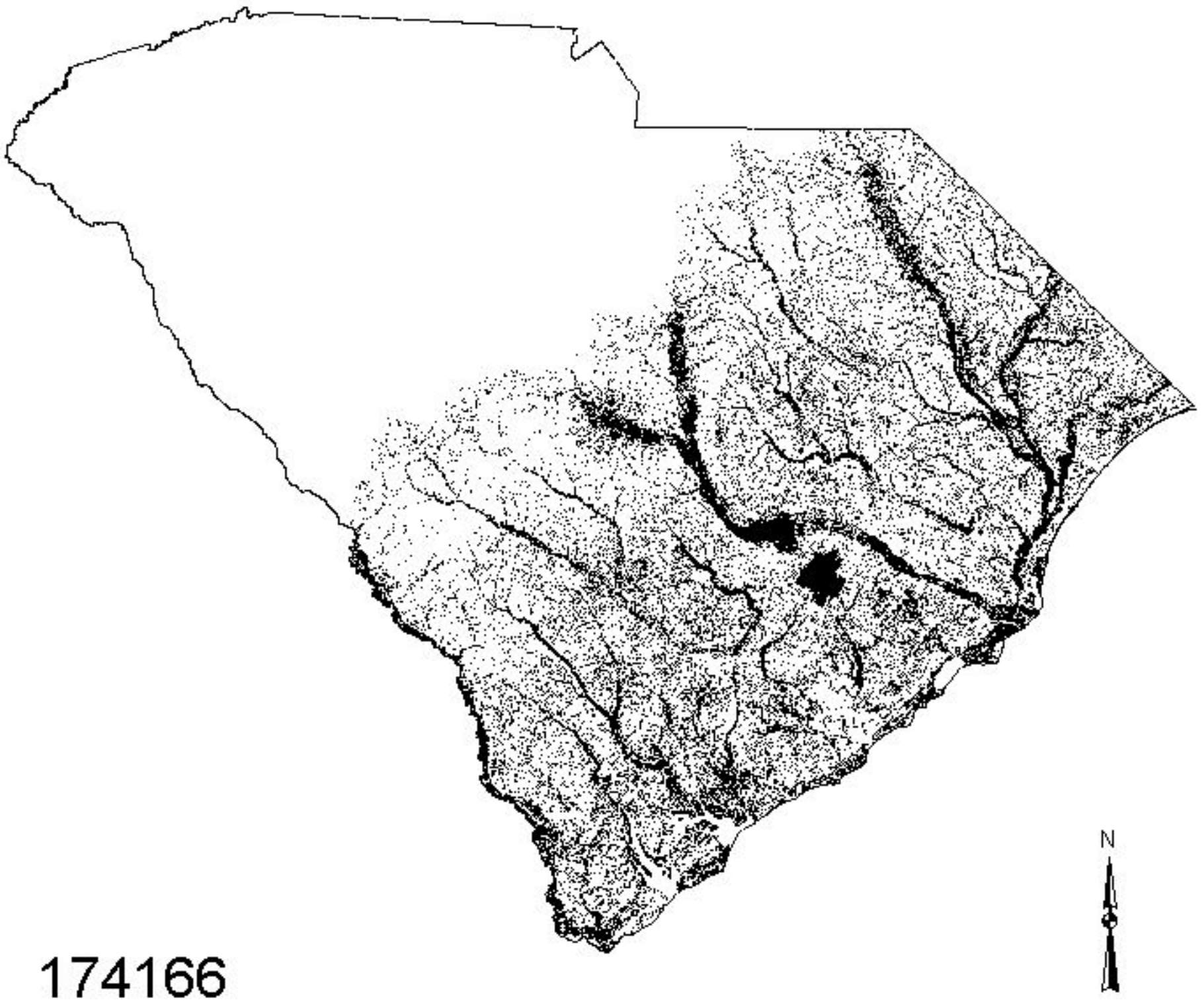
Predicted present

Predicted absent

State boundary

Rainbow Snake

(Farancia erytrogramma)

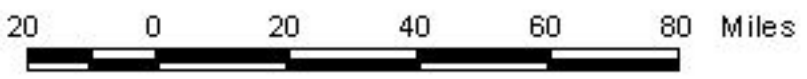


174166

Predicted present

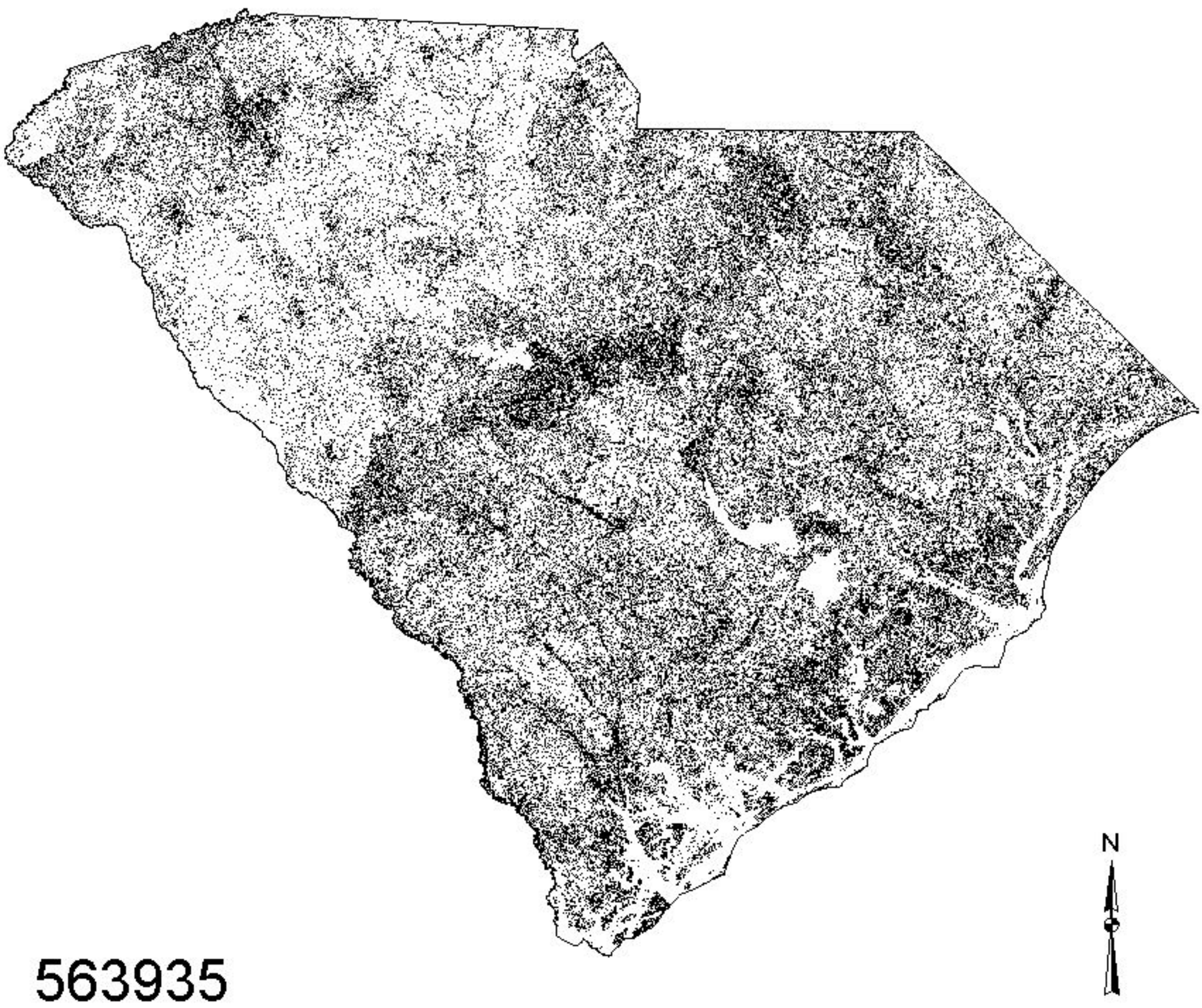
Predicted absent

State boundary



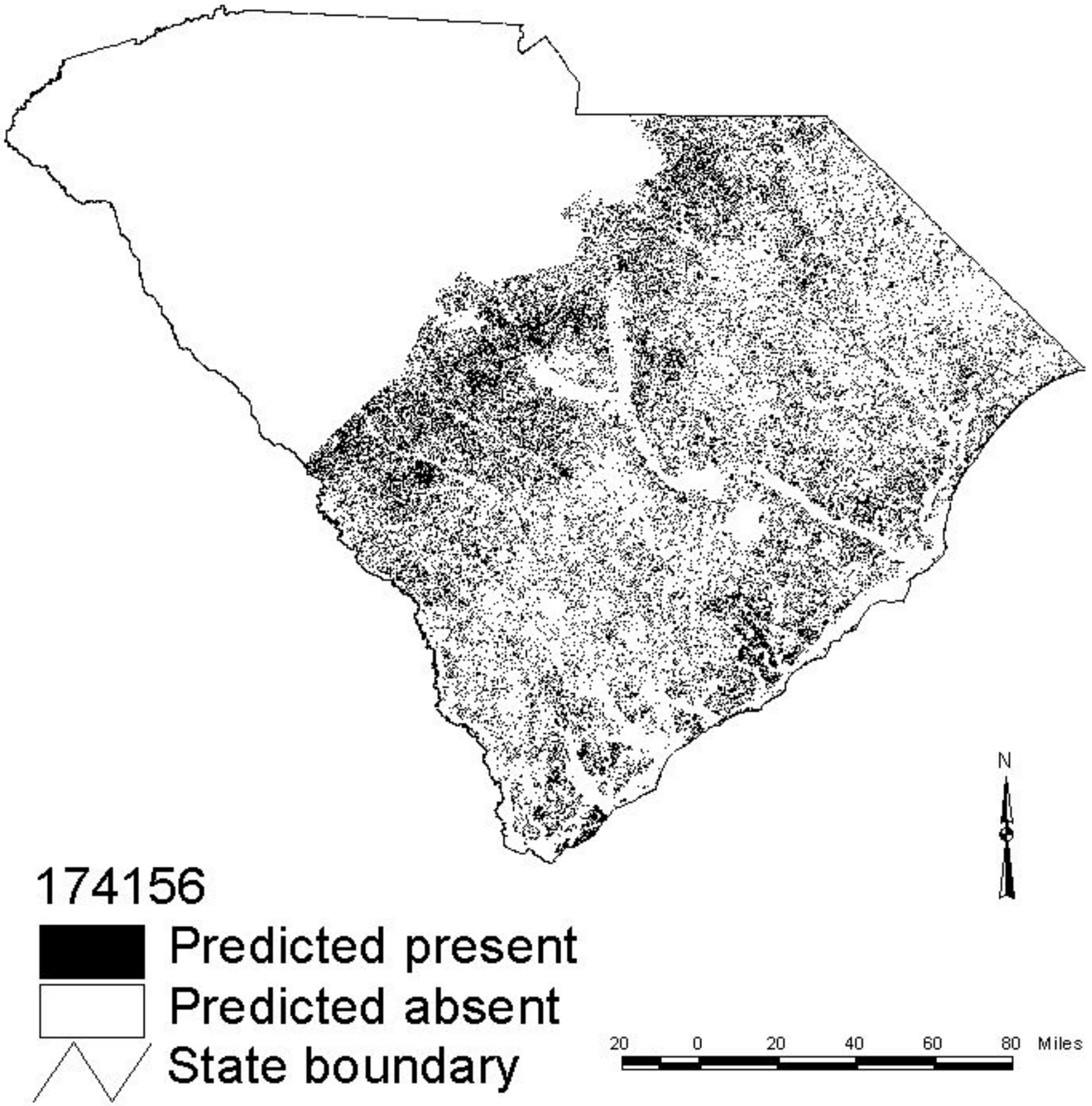
Eastern Hognose Snake

(Heterodon platirhinos)



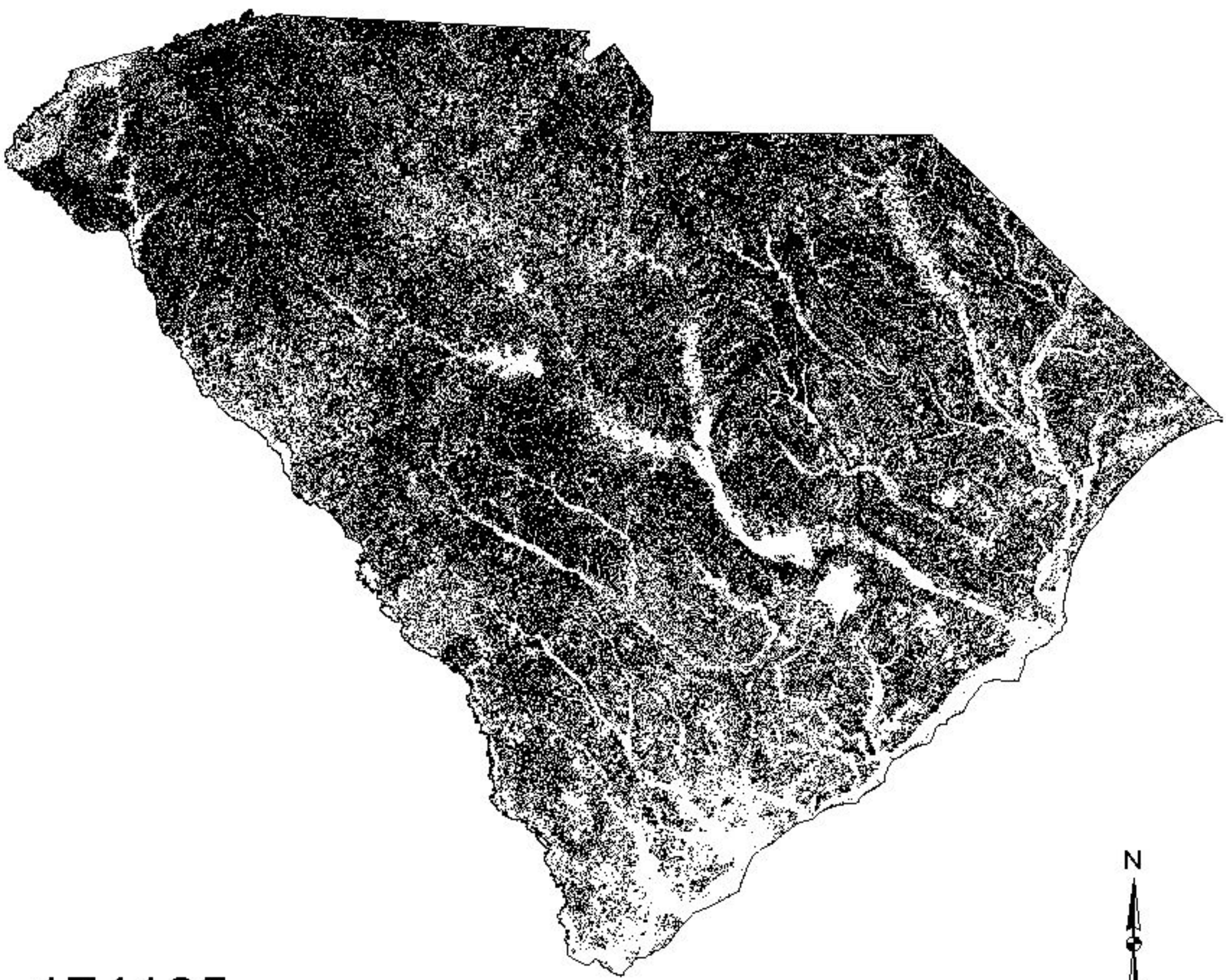
Southern Hognose Snake

(Heterodon simus)



Mole Kingsnake

(Lampropeltis calligaster)



174185

Predicted present

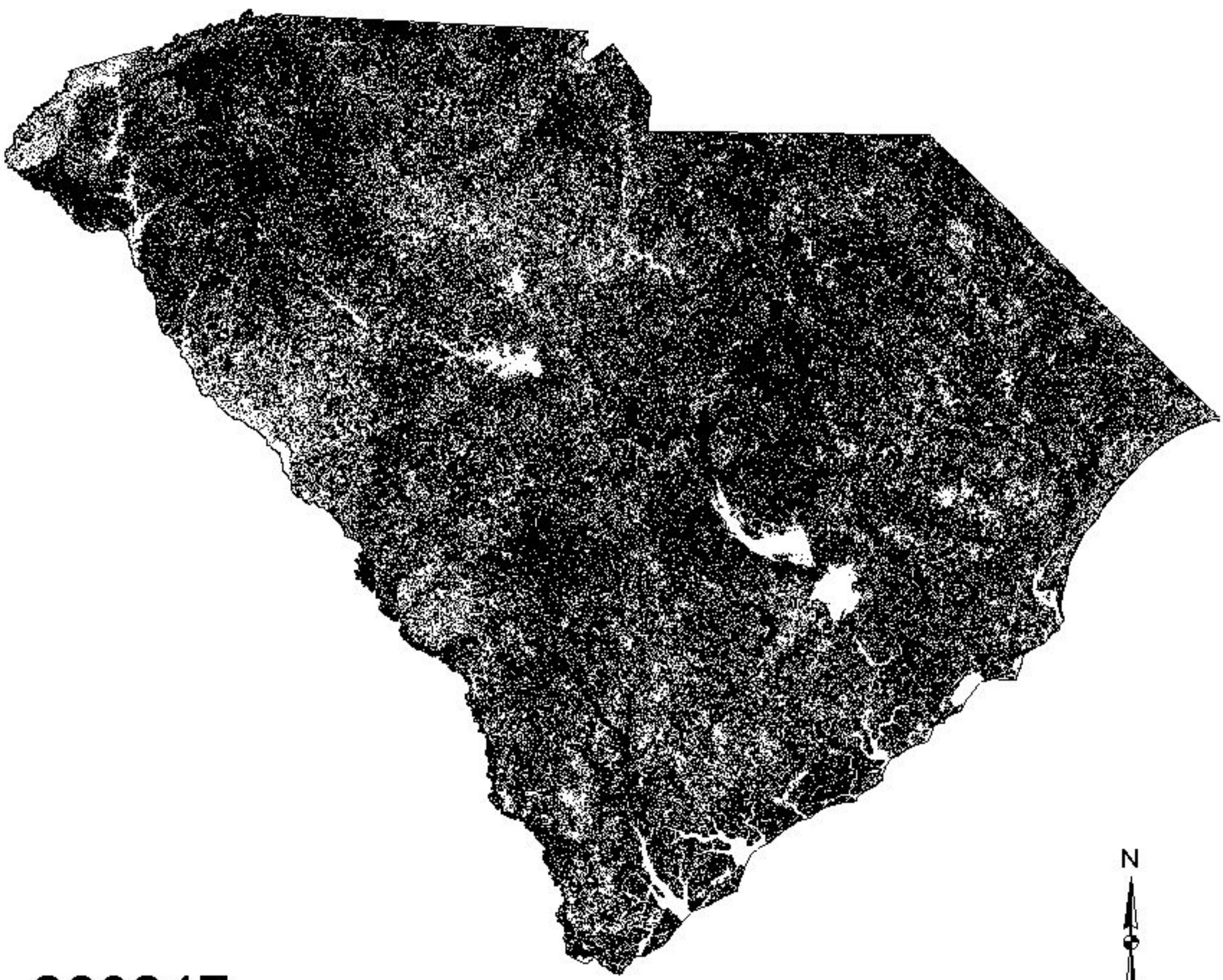
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Eastern Kingsnake

(Lampropeltis getula)



209247

Predicted present

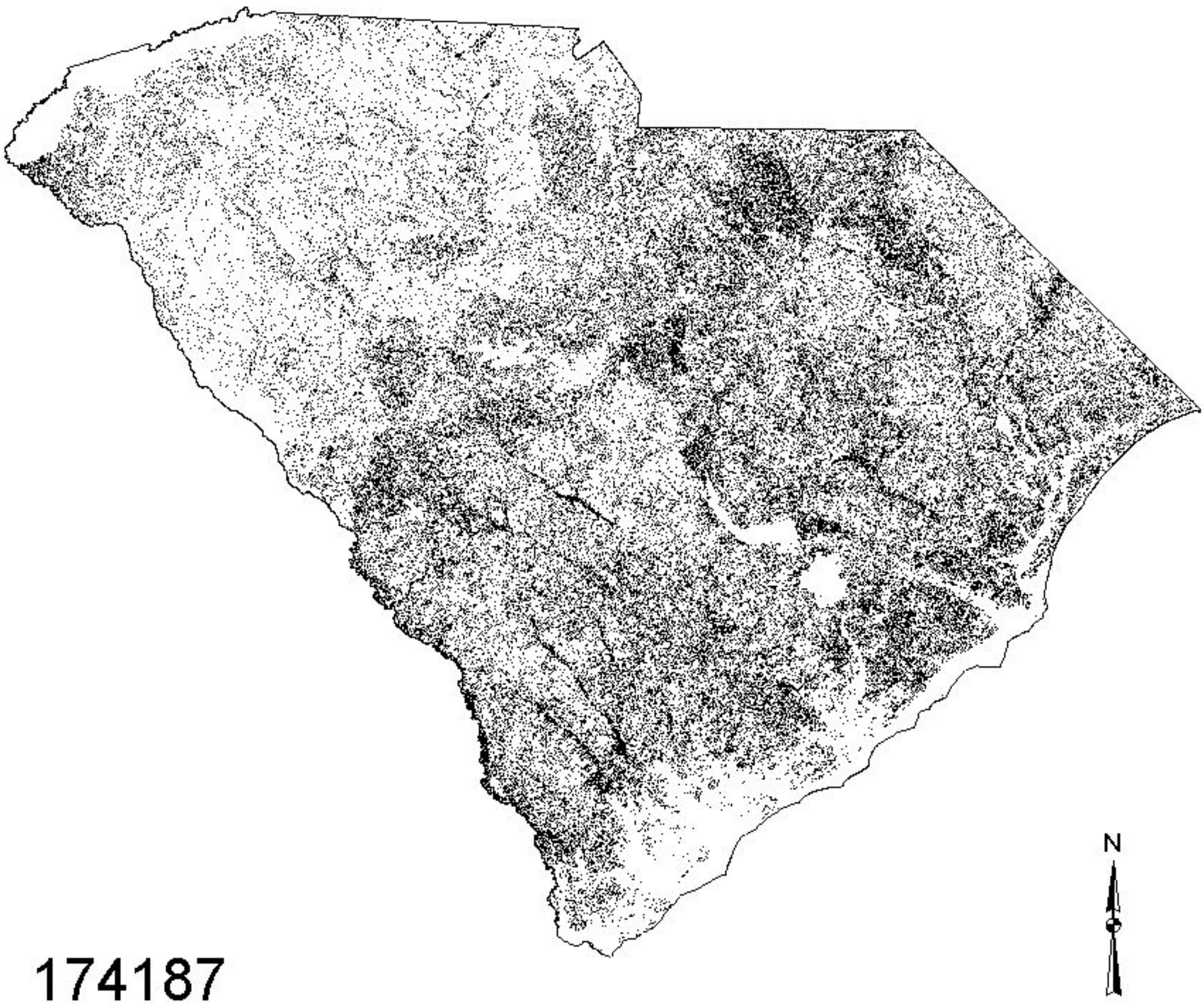
Predicted absent

State boundary

20 0 20 40 60 80 Miles

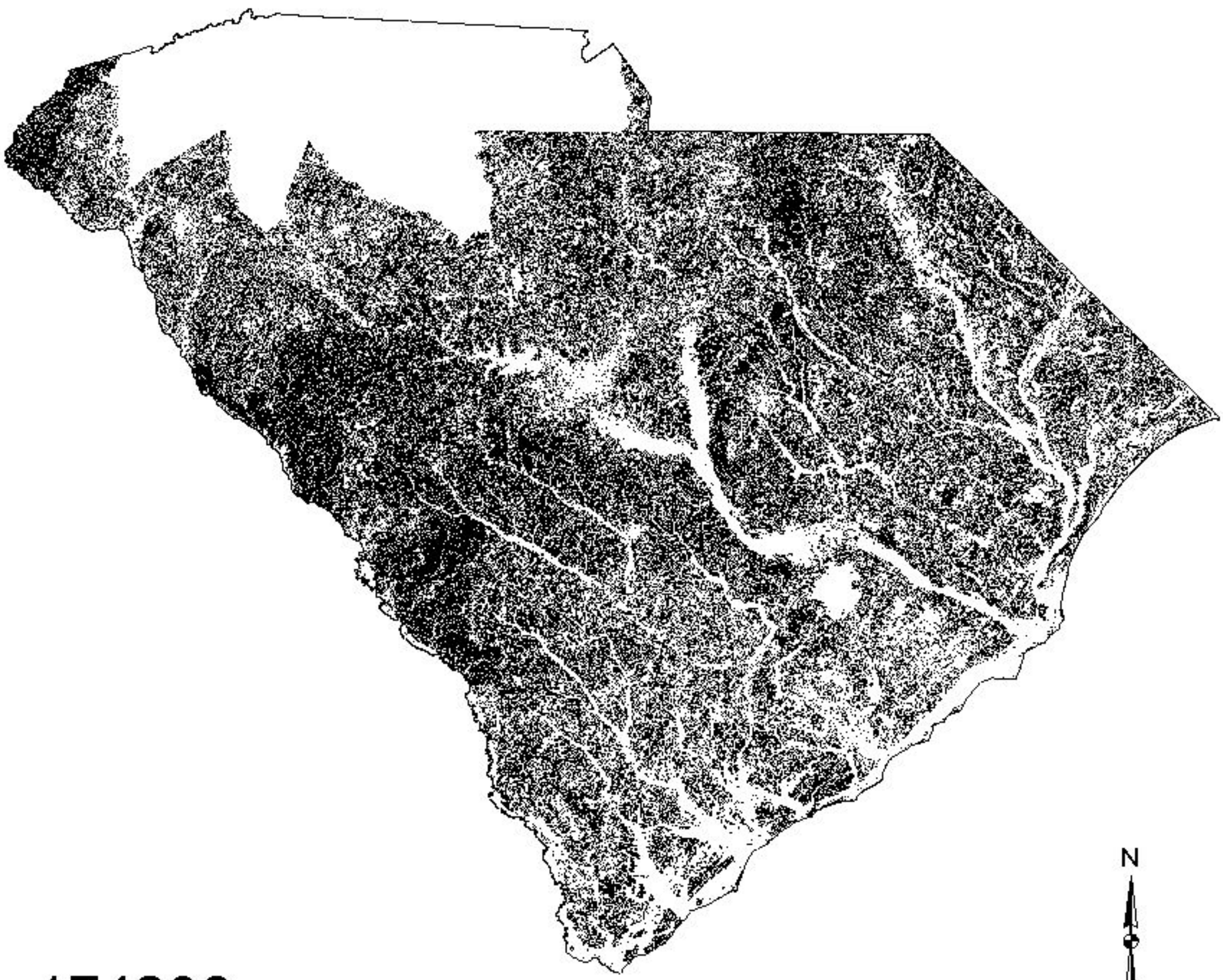
Scarlet Kingsnake (milk)

(Lampropeltis triangulum)



Coachwhip

(Masticophis flagellum)



174238

Predicted present

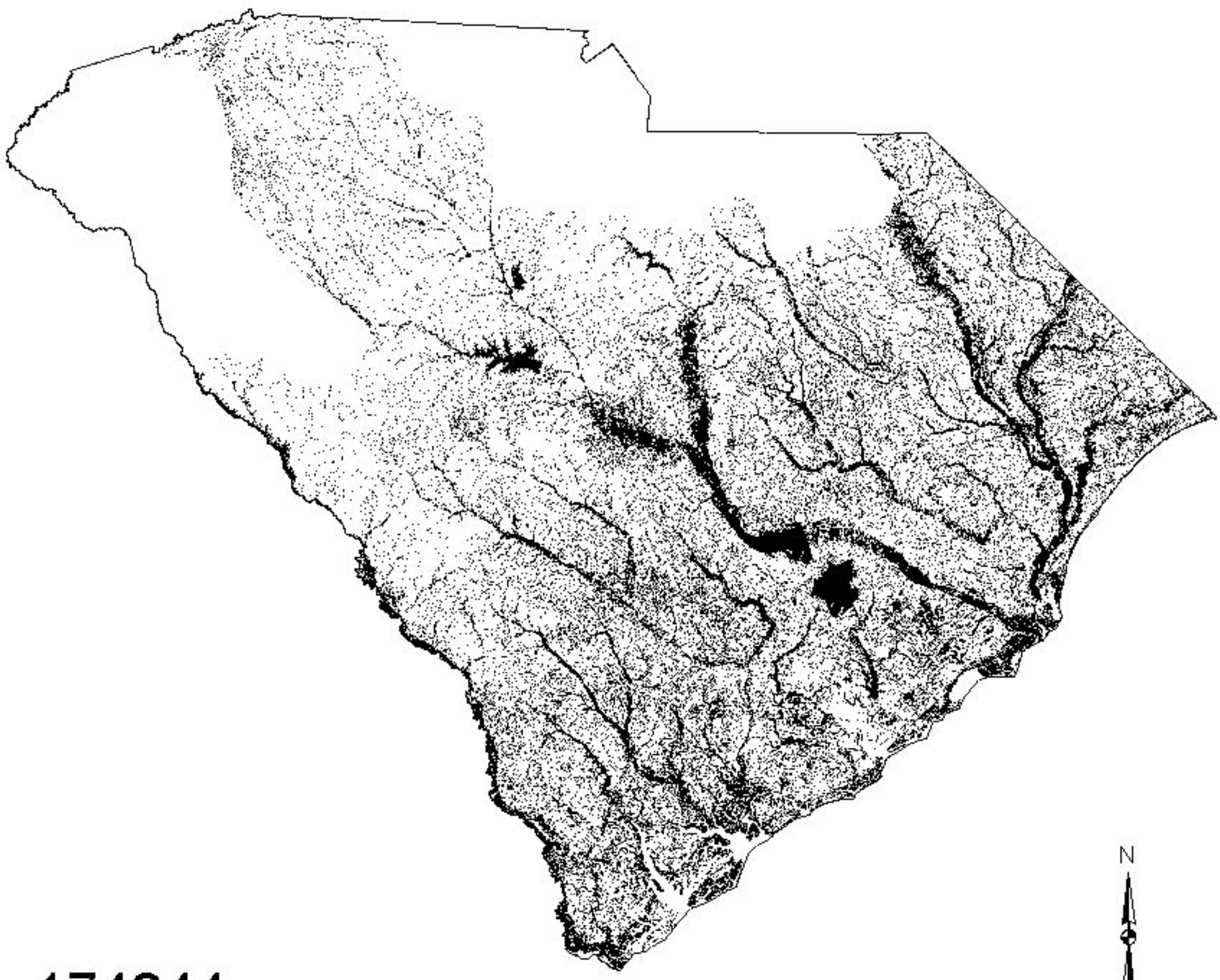
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Redbelly Water Snake

(Nerodia erythrogaster)



174244

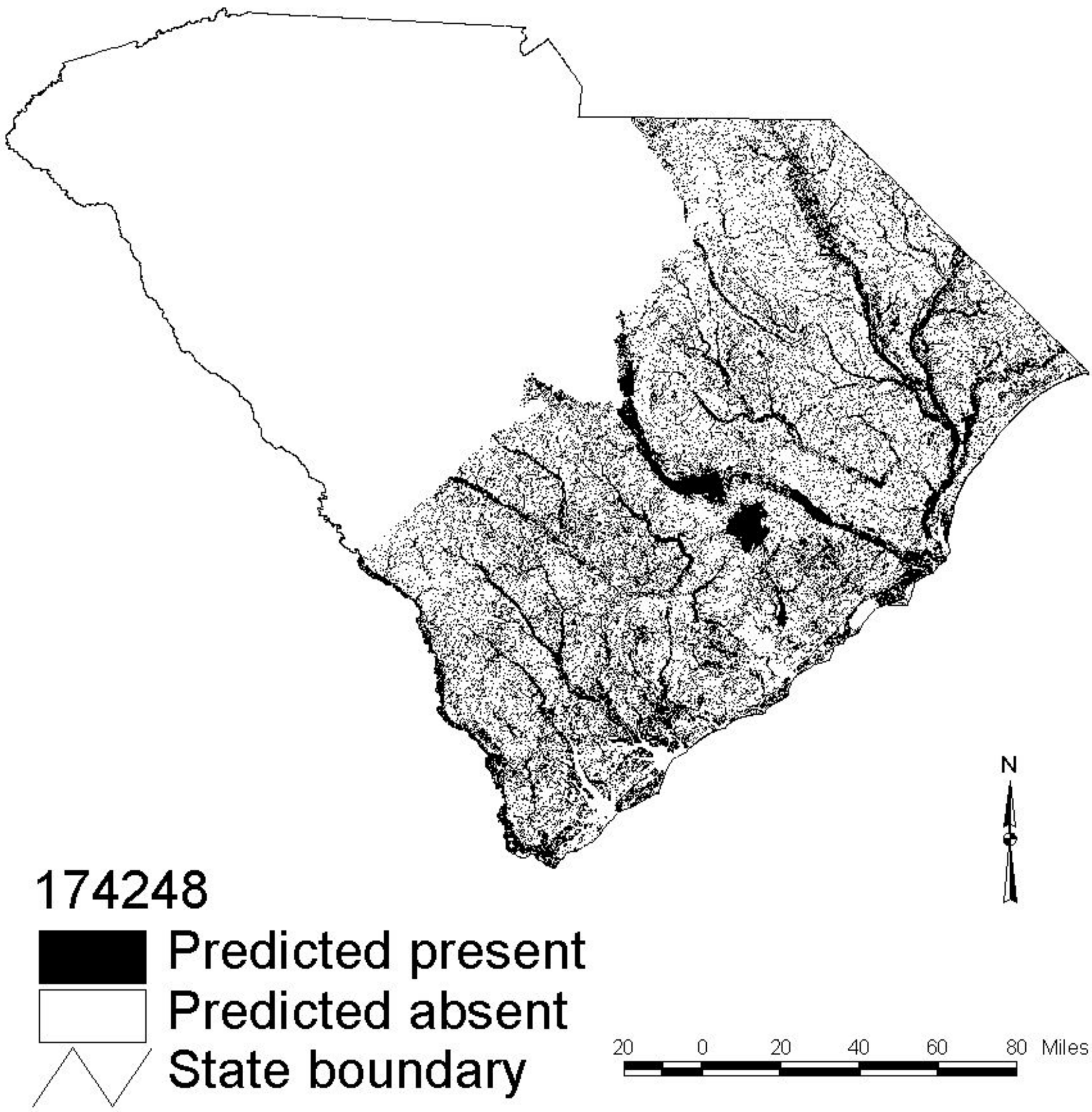
Predicted present

Predicted absent

State boundary

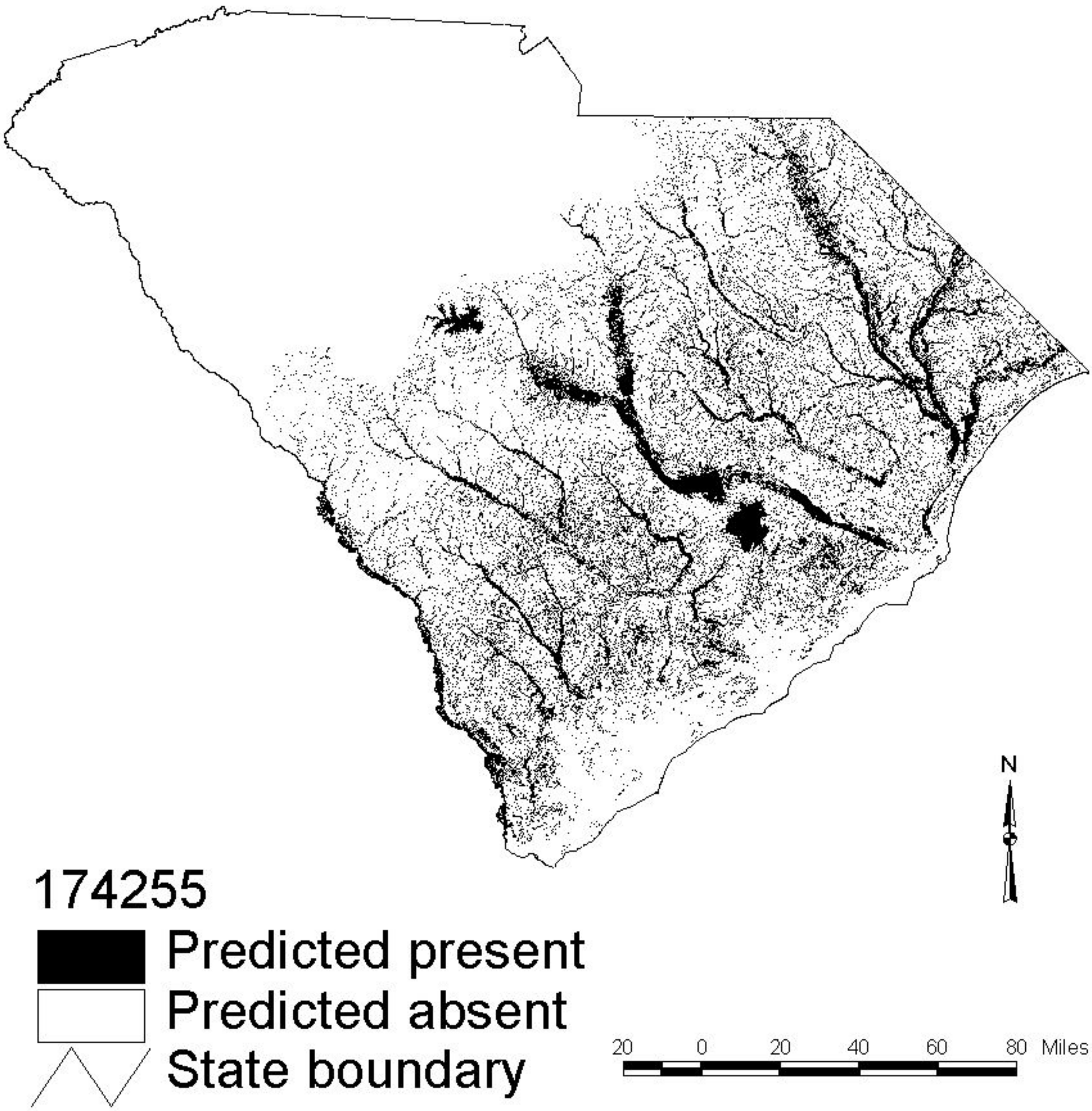
Banded Water Snake

(Nerodia fasciata)



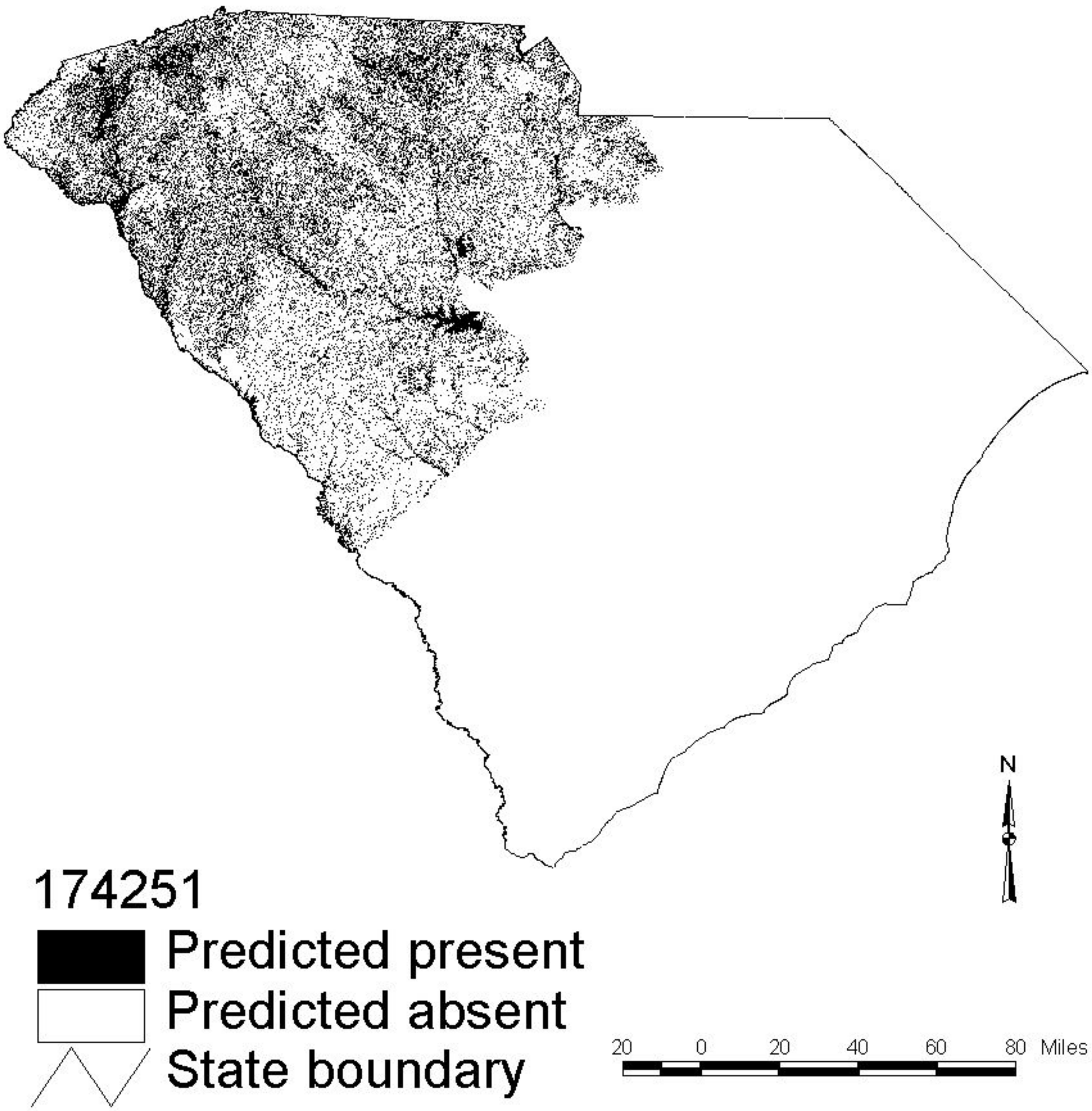
Brown Water Snake

(Nerodia taxispilota)



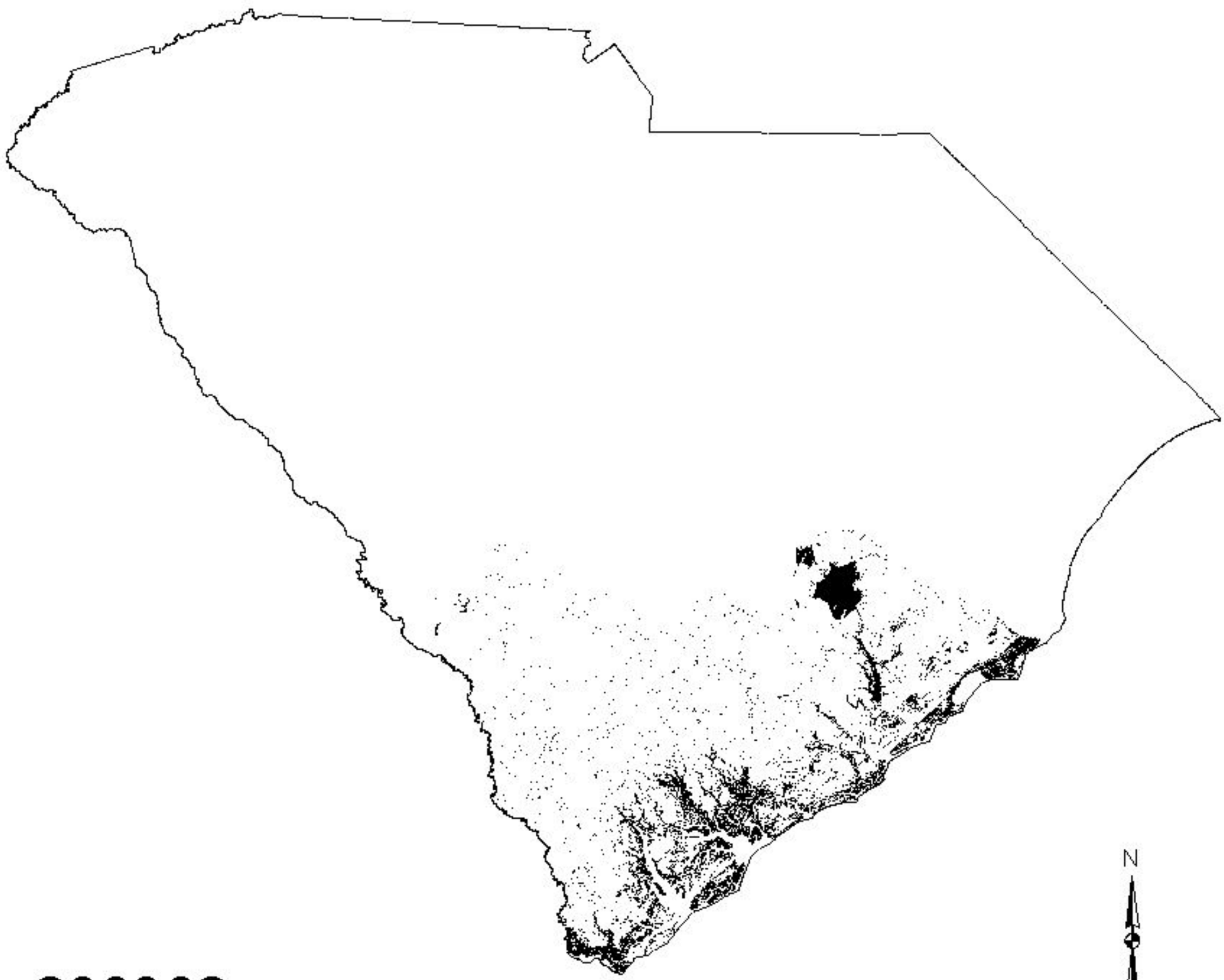
Northern Water Snake

(Nerodia sipedon)



Florida Green Water Snake

(Nerodia floridana)



209382

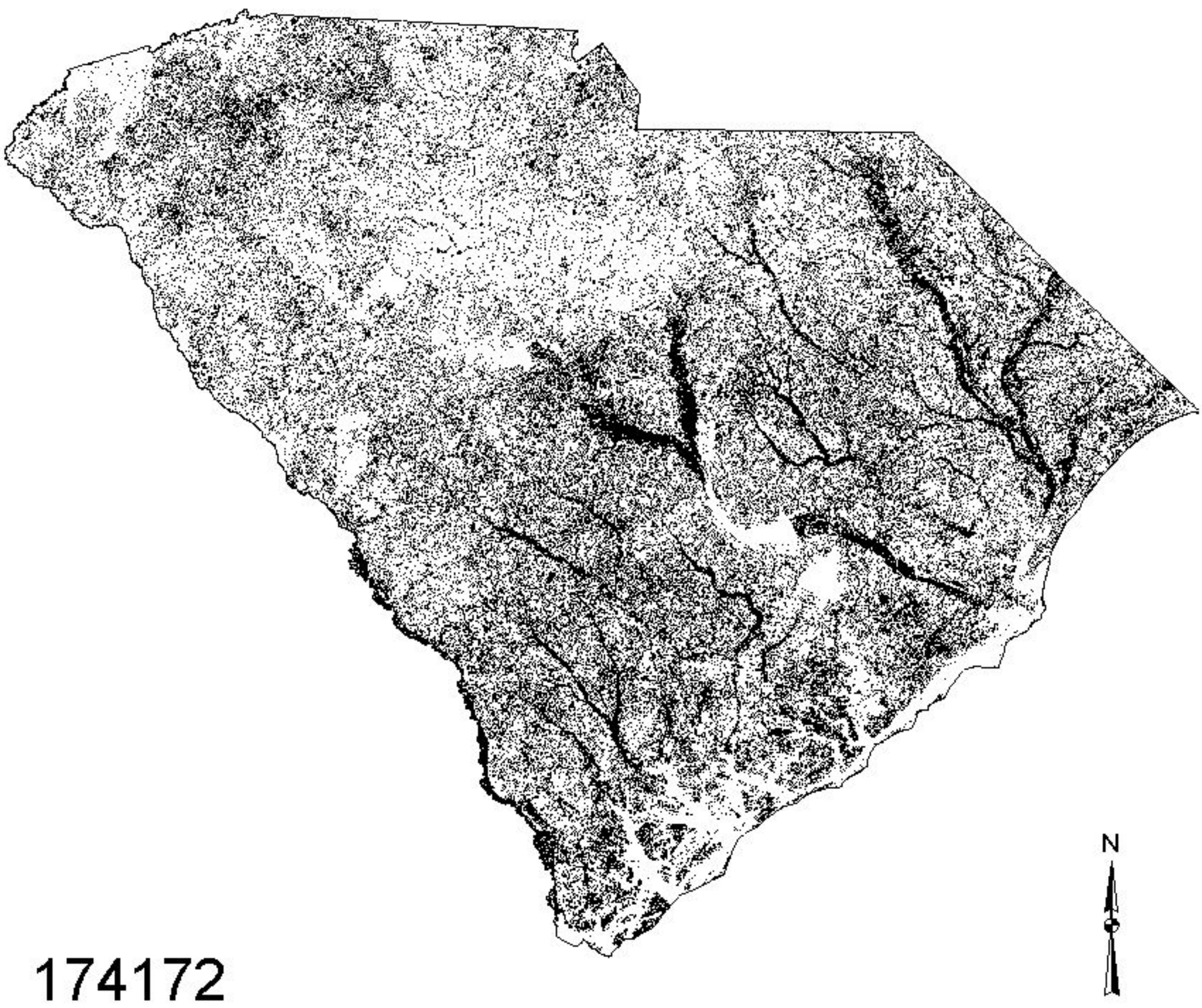
Predicted present

Predicted absent

State boundary

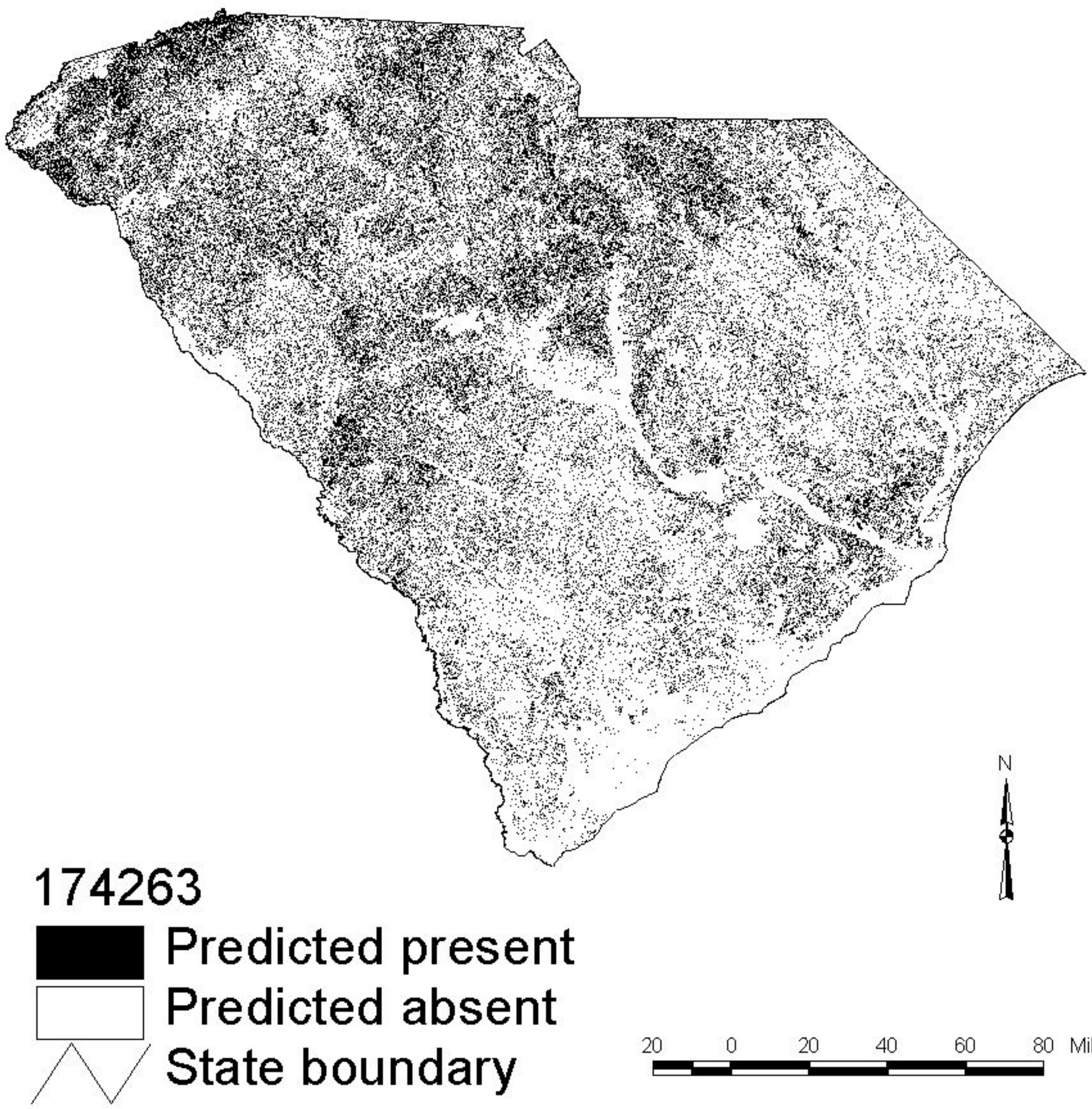
Rough Green Snake

(Opheodrys aestivus)



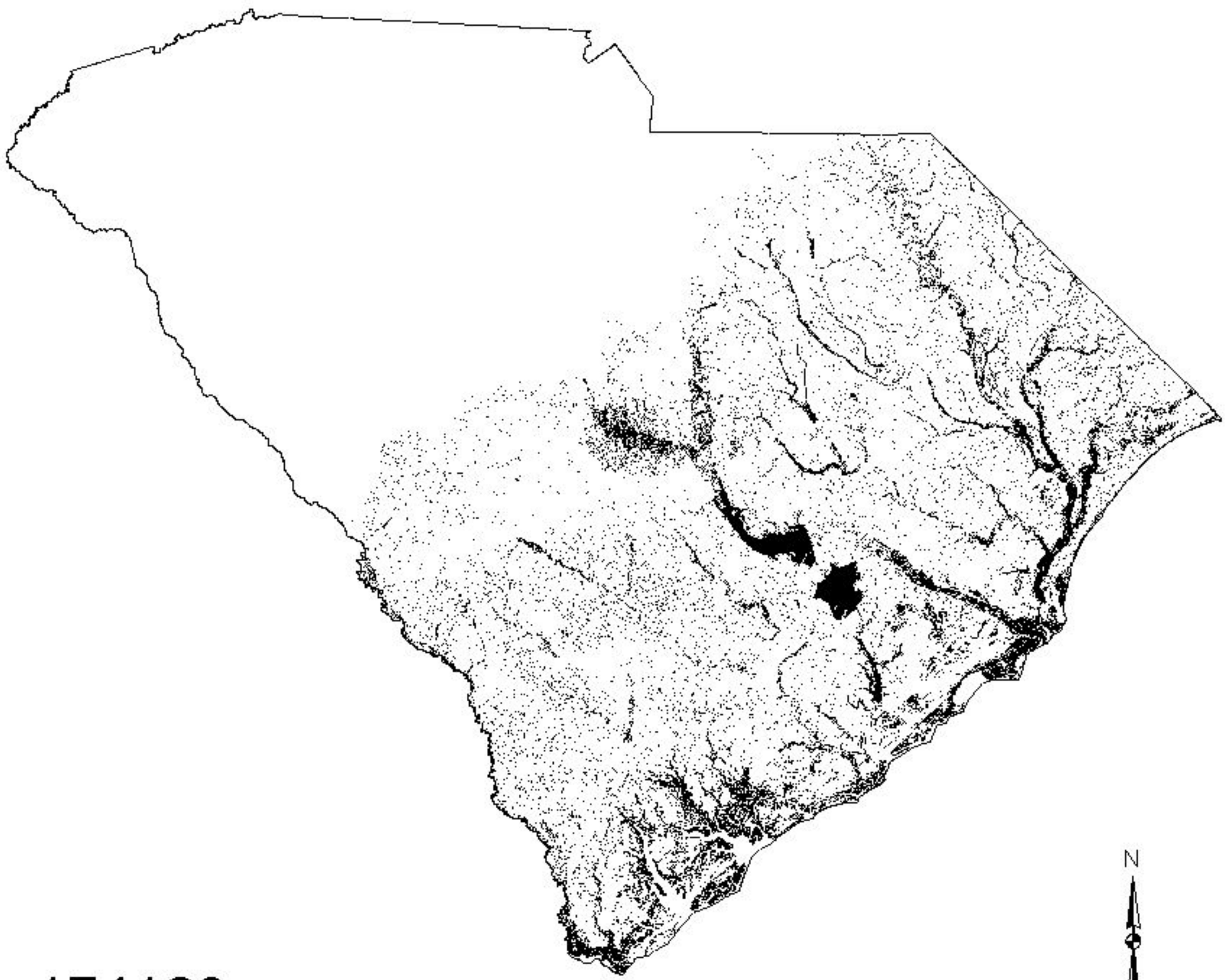
Pine Snake

(Pituophis melanoleucus)



Glossy Crayfish Snake

(Regina rigida)



174123

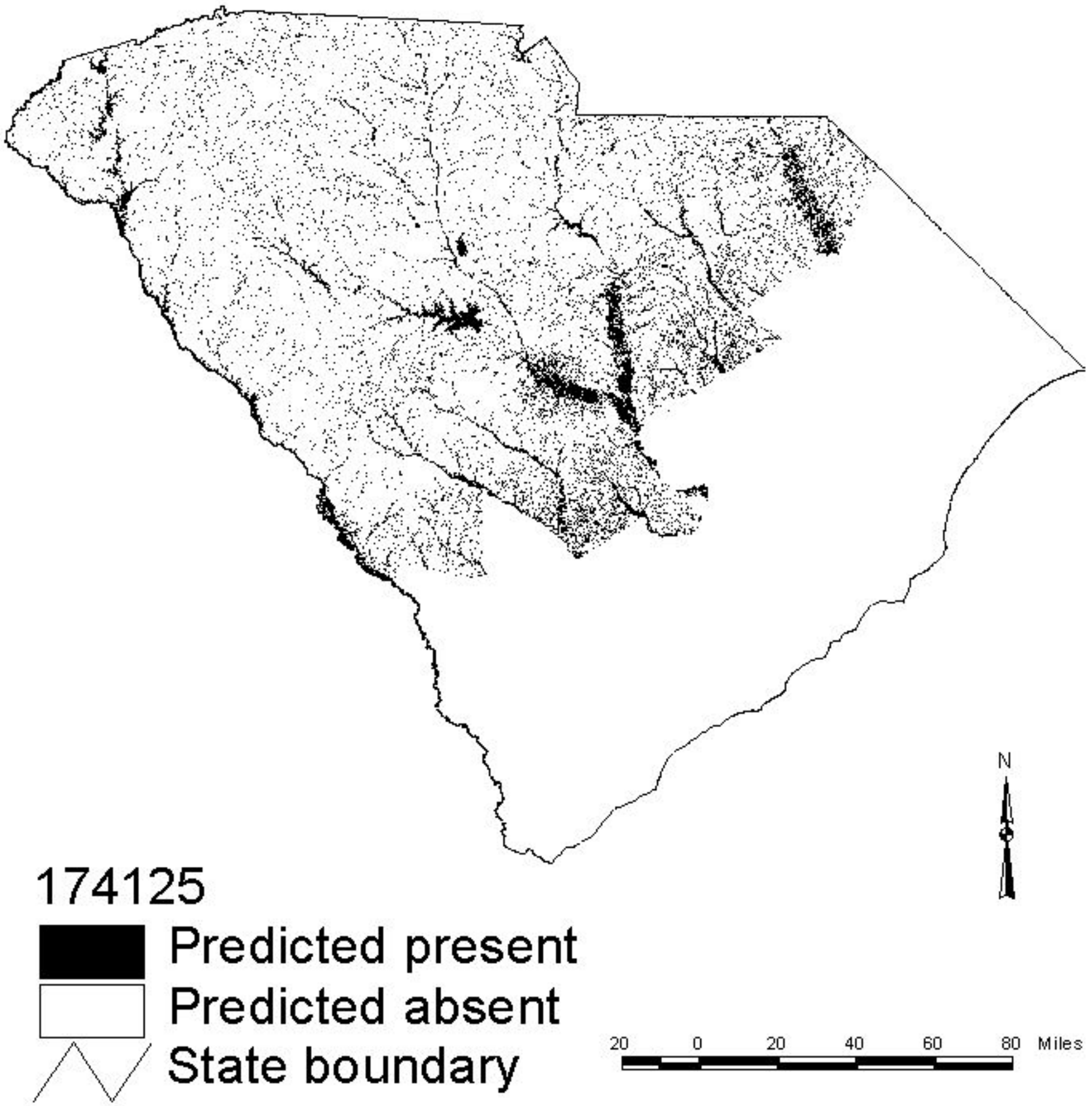
Predicted present

Predicted absent

State boundary

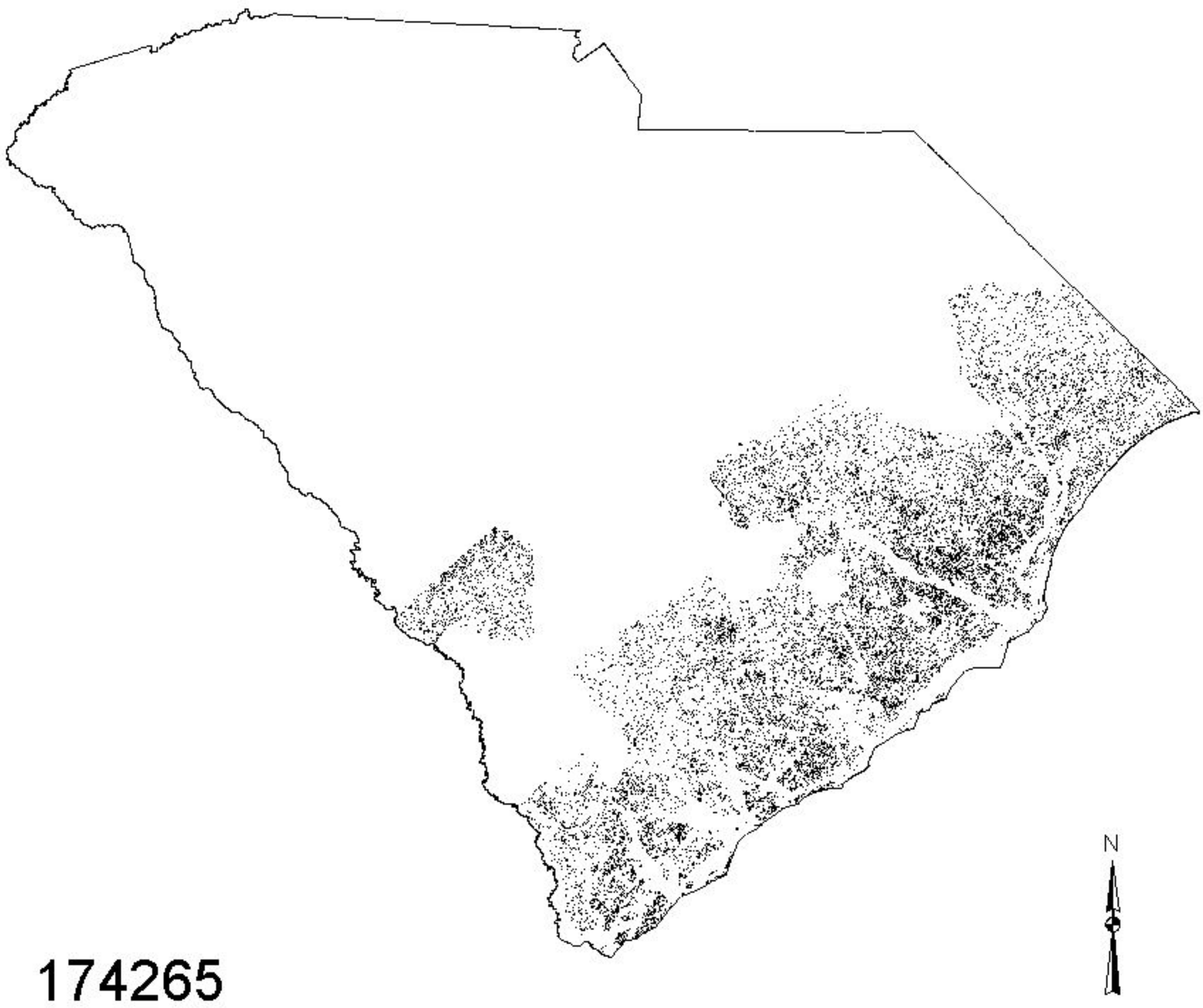
Queen Snake

(Regina septemvittata)



Pine Woods Snake

(Rhadinaea flavilata)



174265

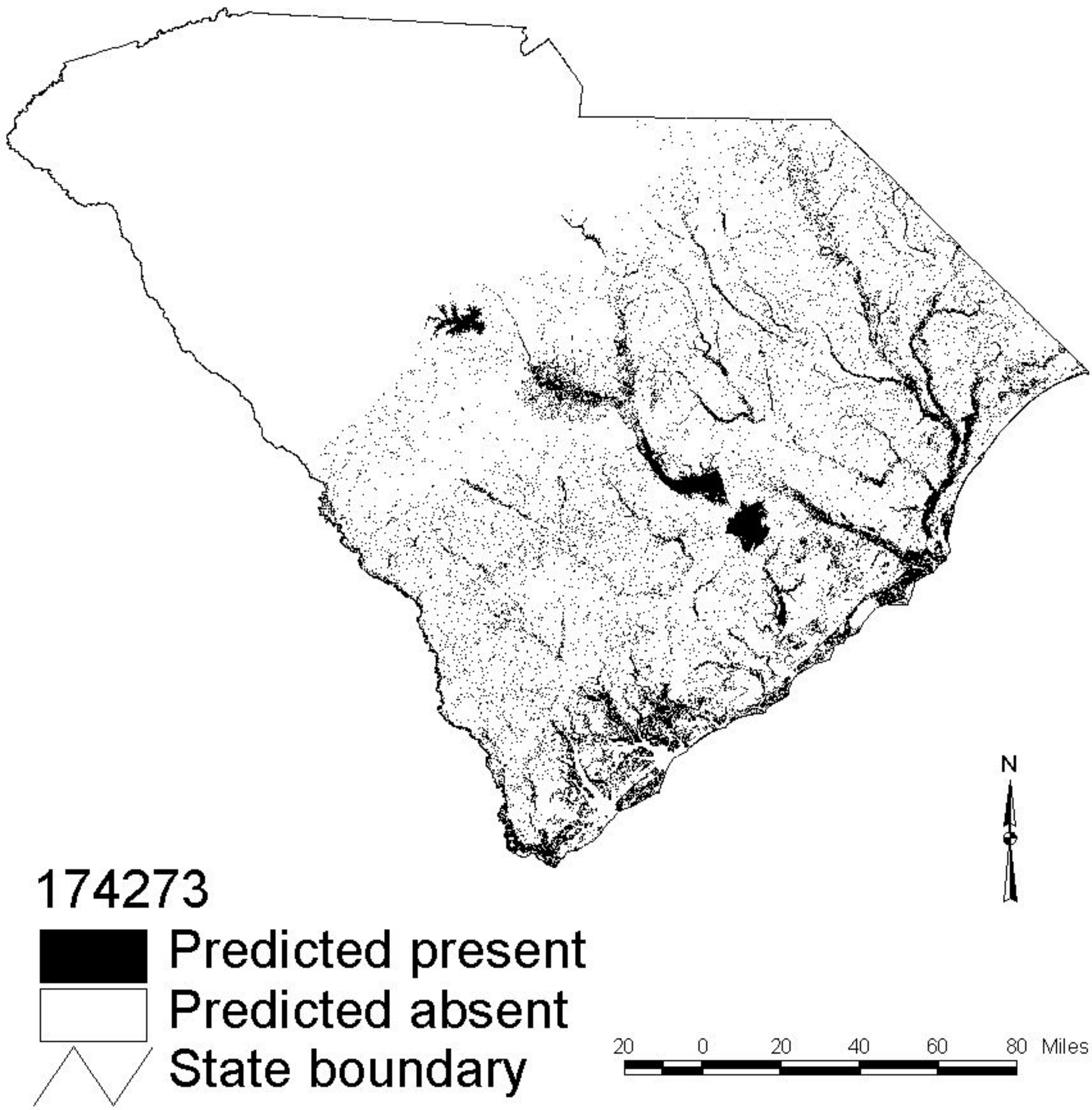
Predicted present

Predicted absent

State boundary

Black Swamp Snake

(Seminatrix pygaea)



Brown Snake

(Storeria dekayi)

174129

Predicted present

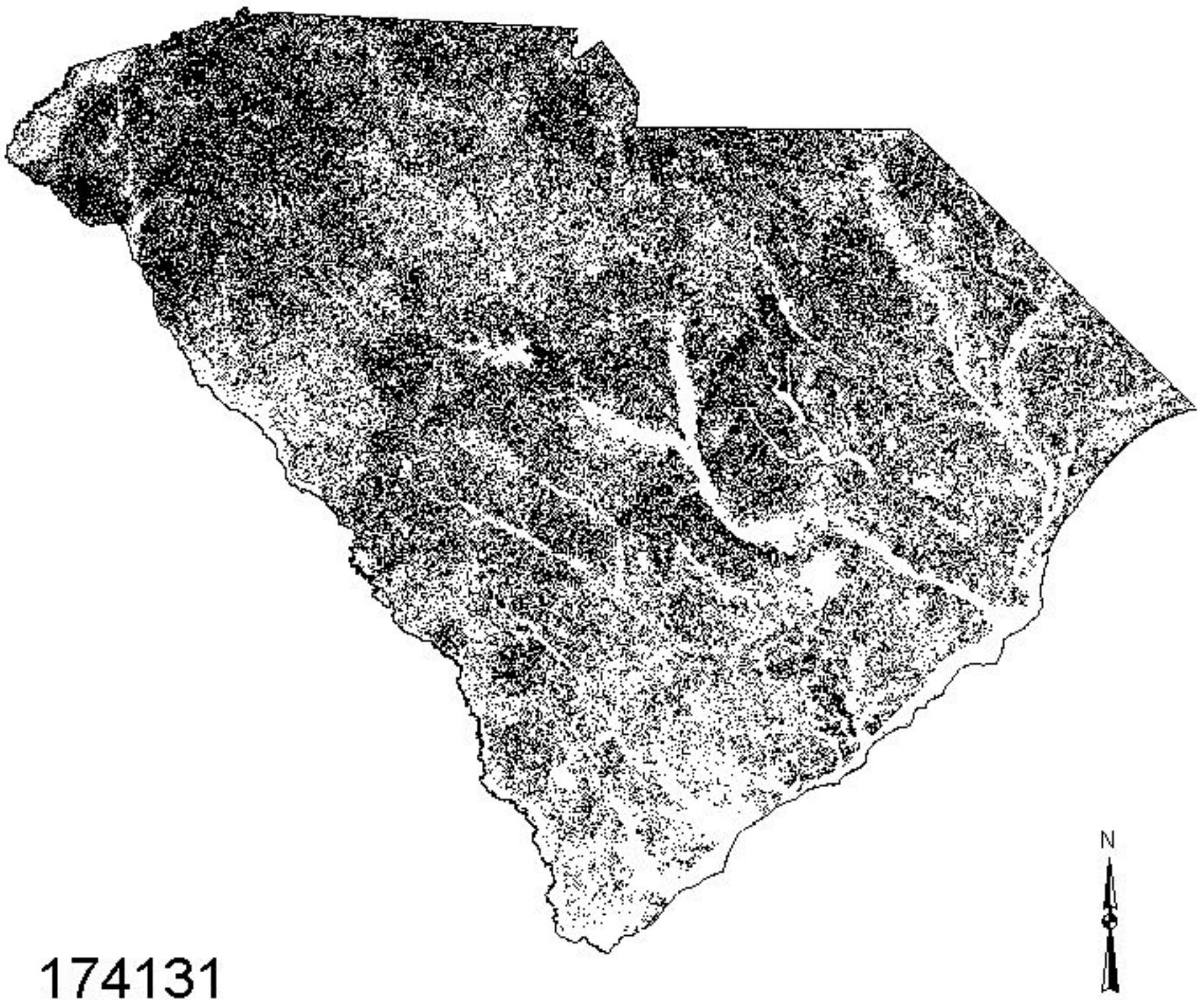
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Redbelly Snake

(Storeria occipitomaculata)



174131

Predicted present

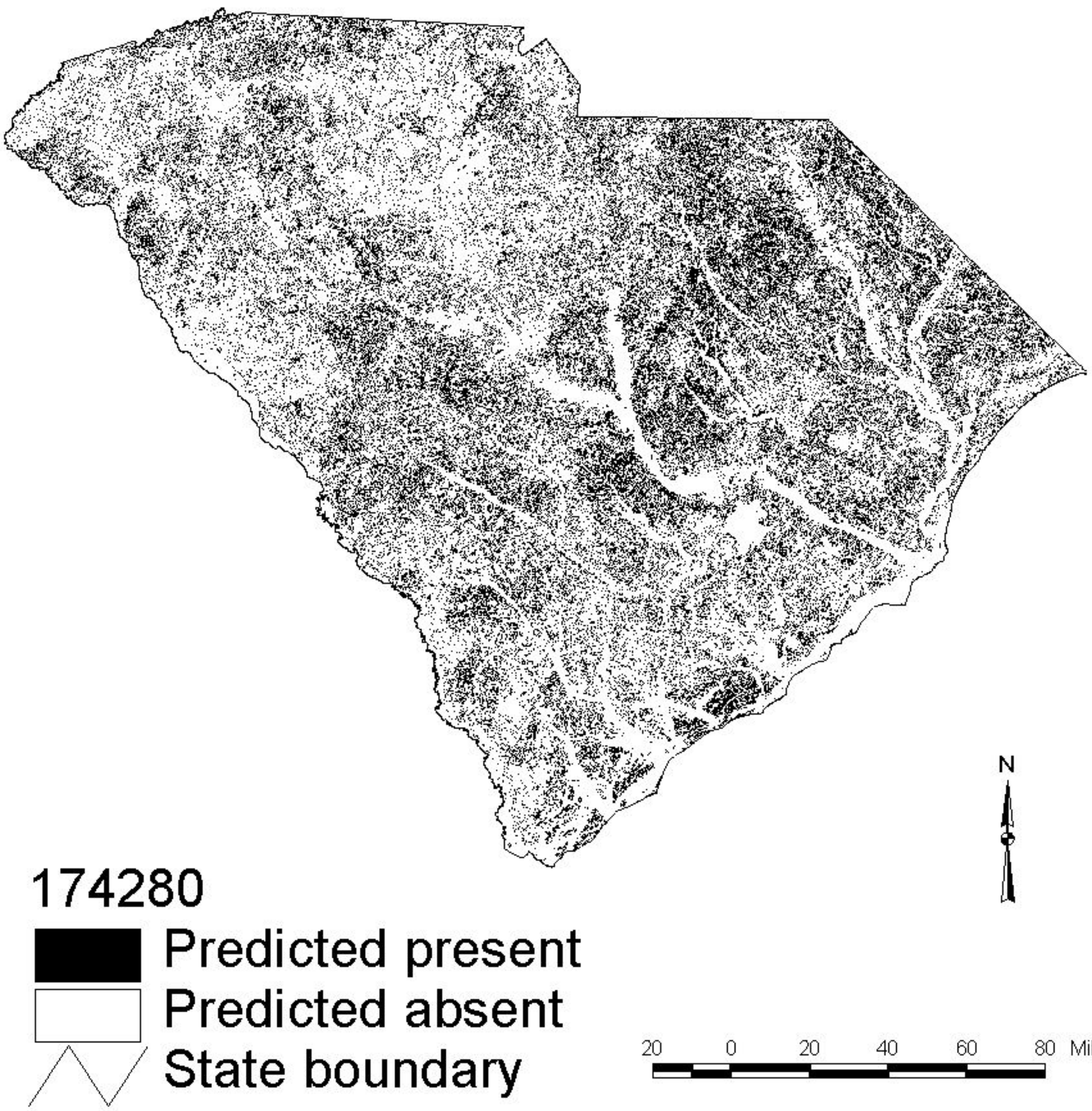
Predicted absent

State boundary

20 0 20 40 60 80 Miles

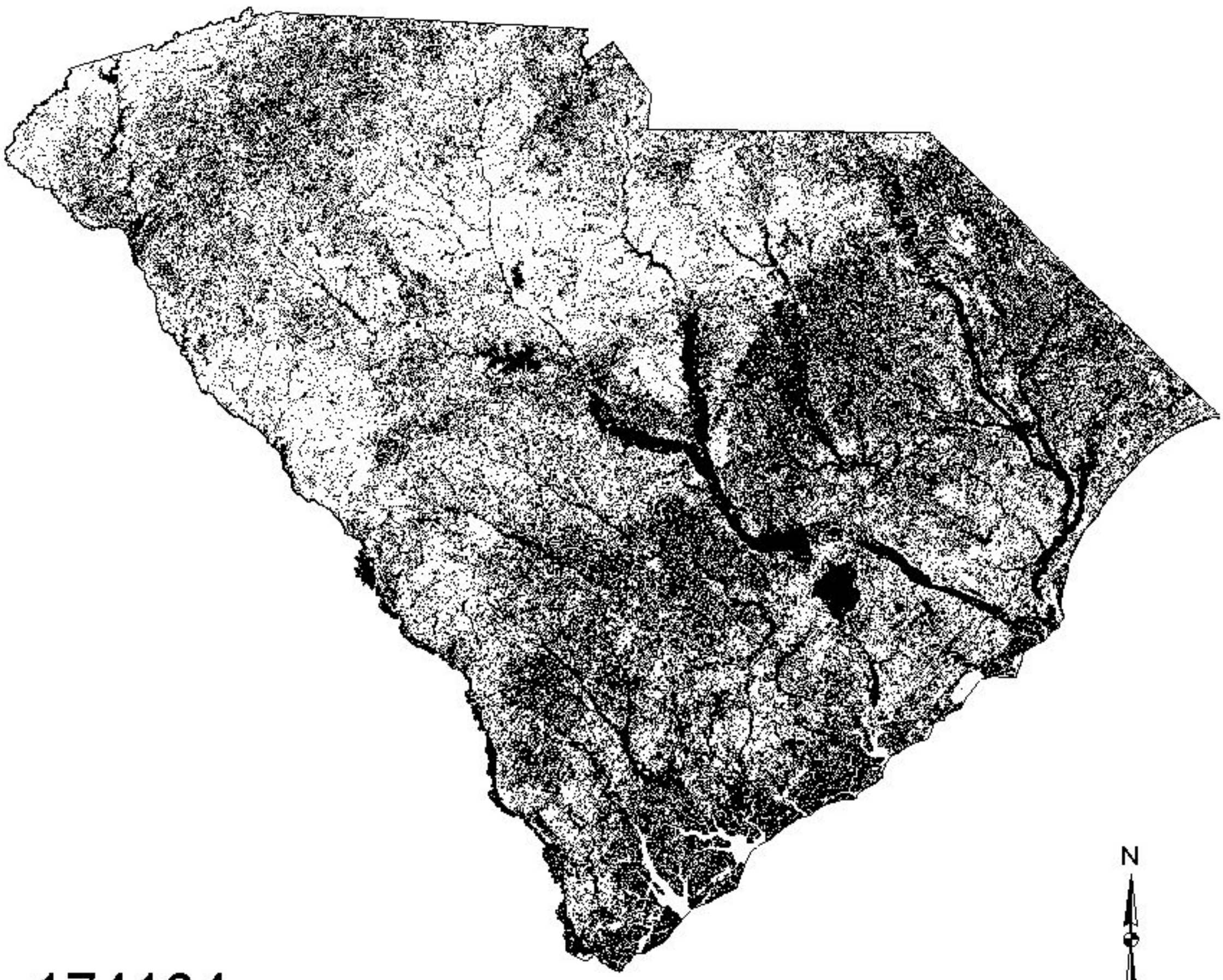
Southeastern Crowned Snake

(Tantilla coronata)



Eastern Ribbon Snake

(Thamnophis sauritus)



174134

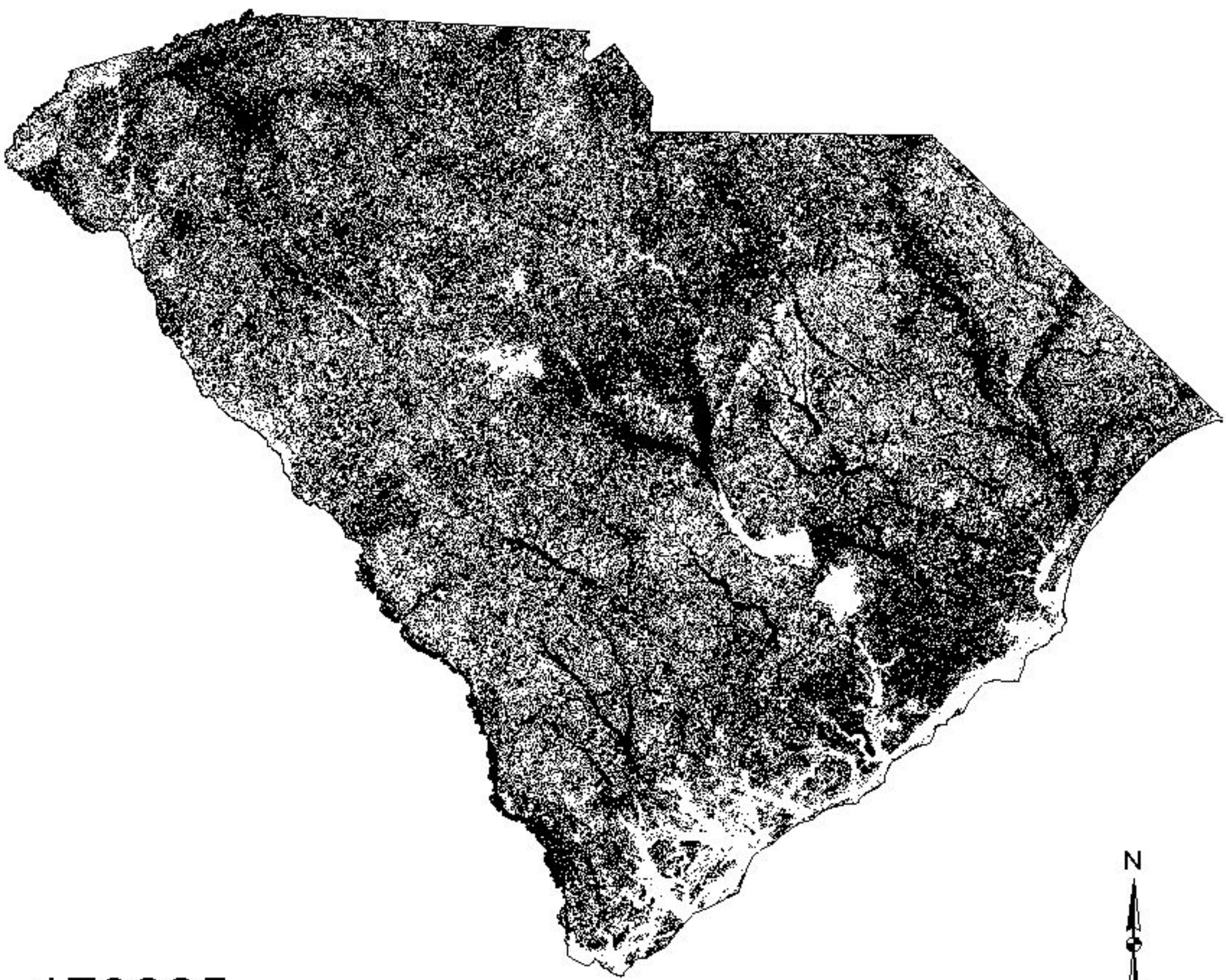
Predicted present

Predicted absent

State boundary

Green Anole

(Anolis carolinensis)



173885

Predicted present

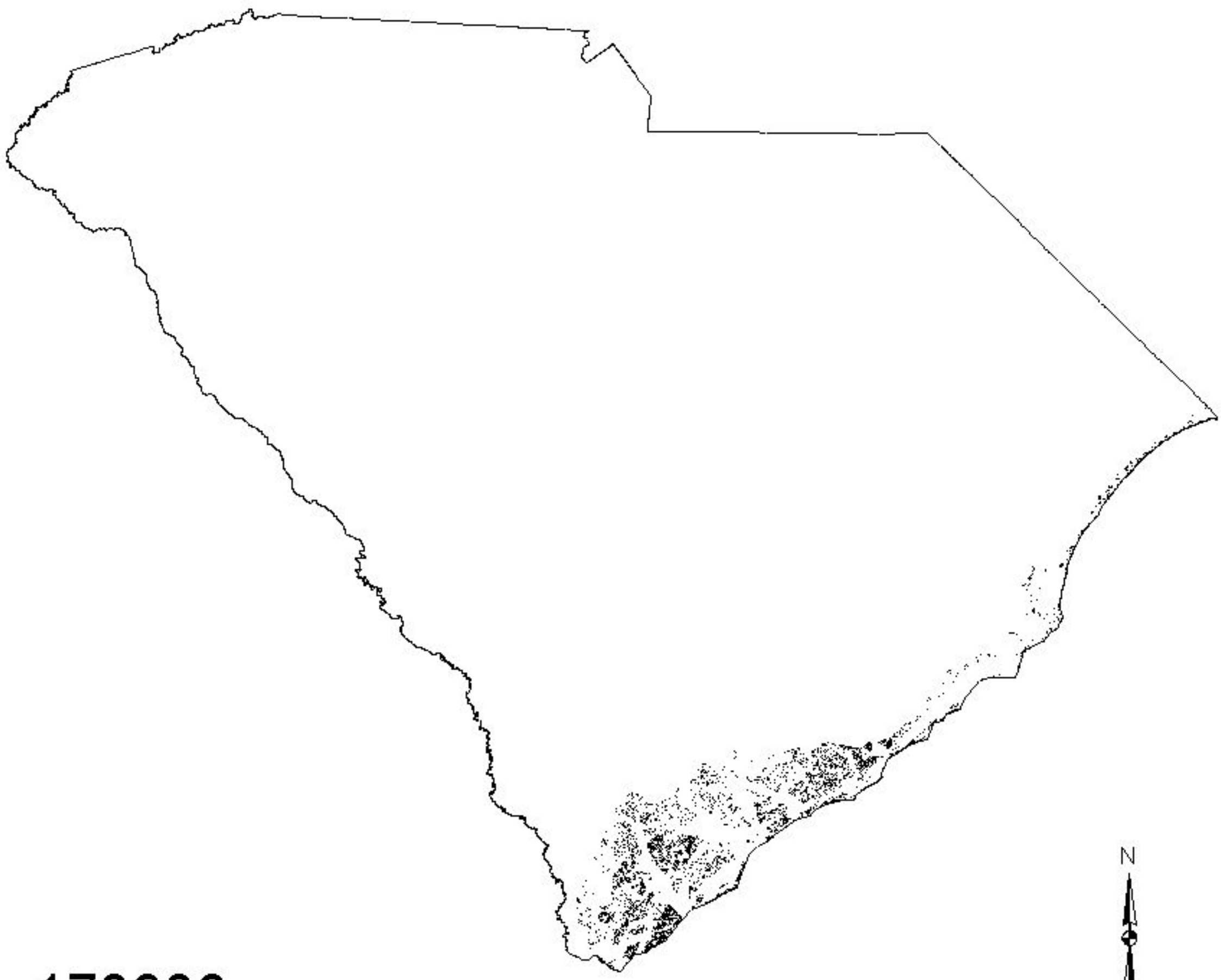
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Texas Horned Lizard

(Phrynosoma cornutum)



173938

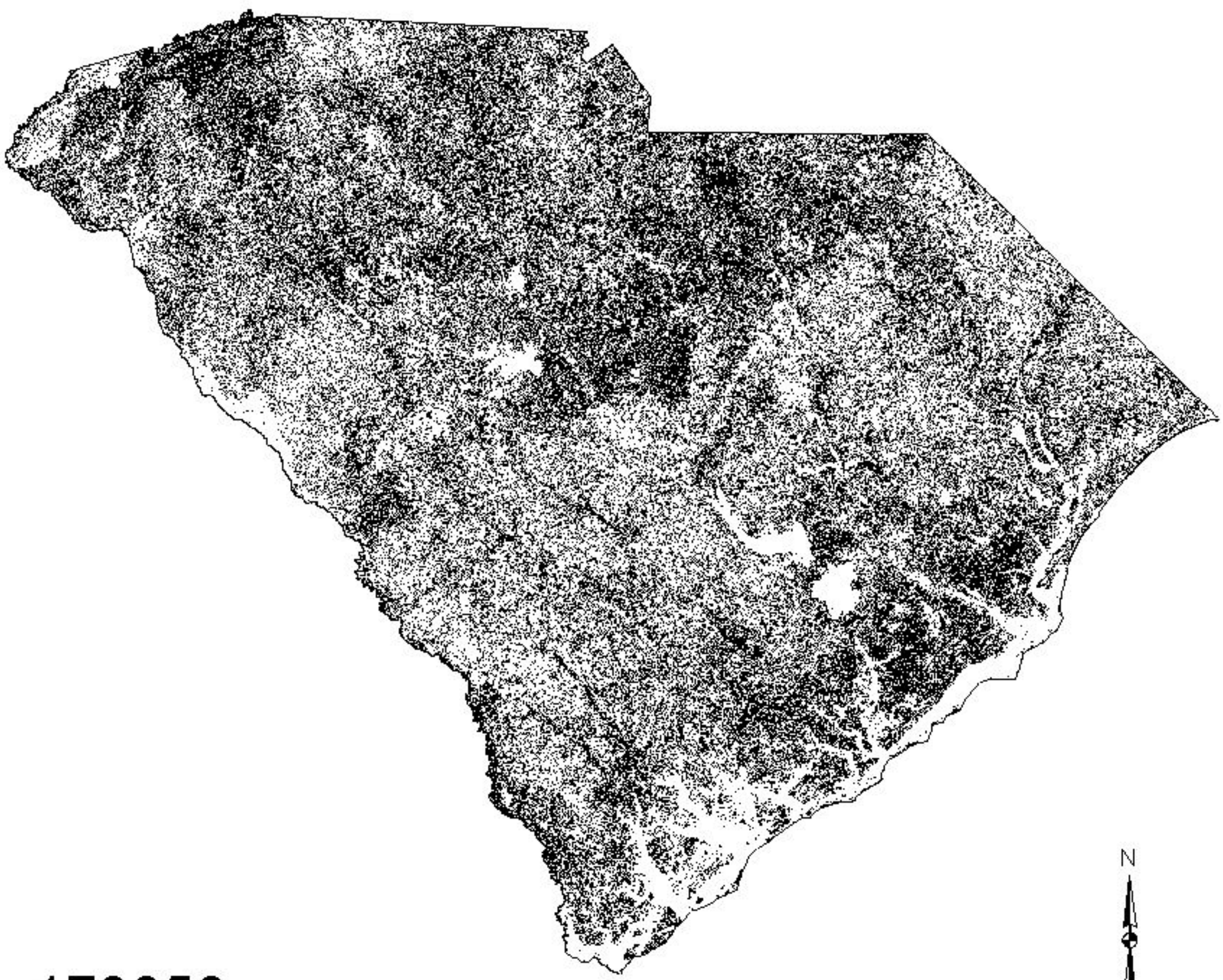
Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Five-lined Skink
(Eumeces fasciatus)



173959

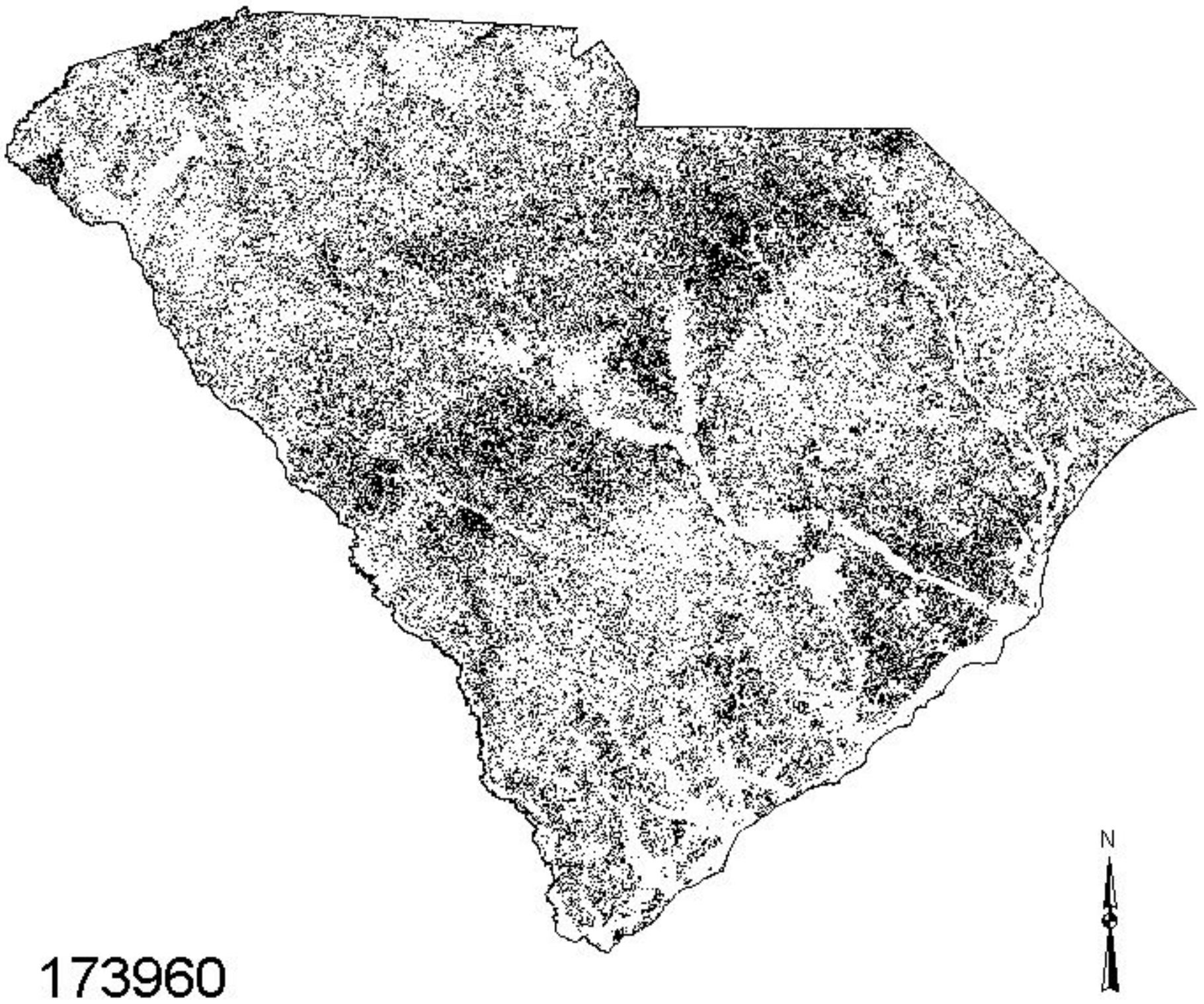
Predicted present

Predicted absent

State boundary

Southeastern Five-lined Skink

(Eumeces inexpectatus)



173960

Predicted present

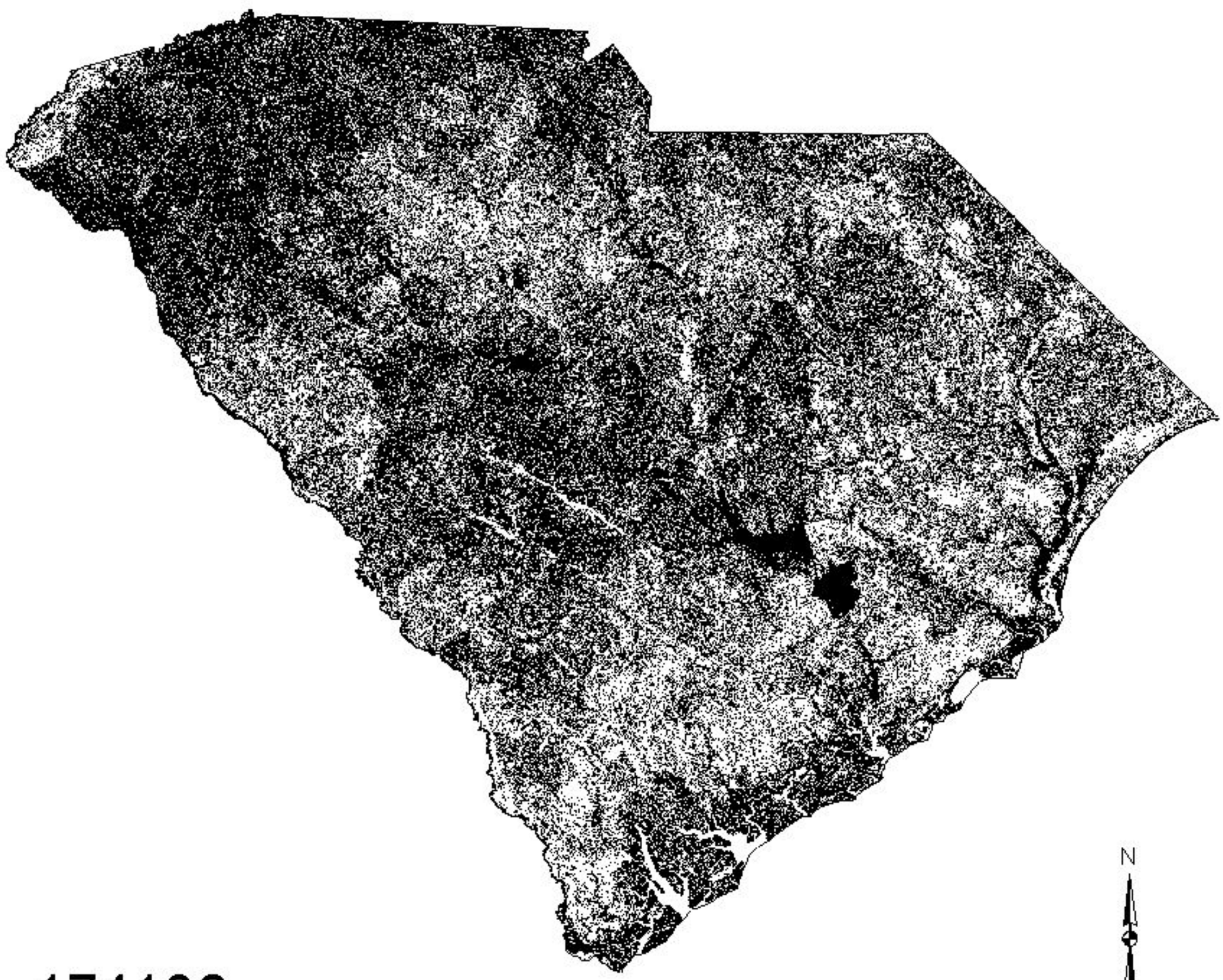
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Eastern Garter Snake

(Thamnophis sirtalis)



174136

Predicted present

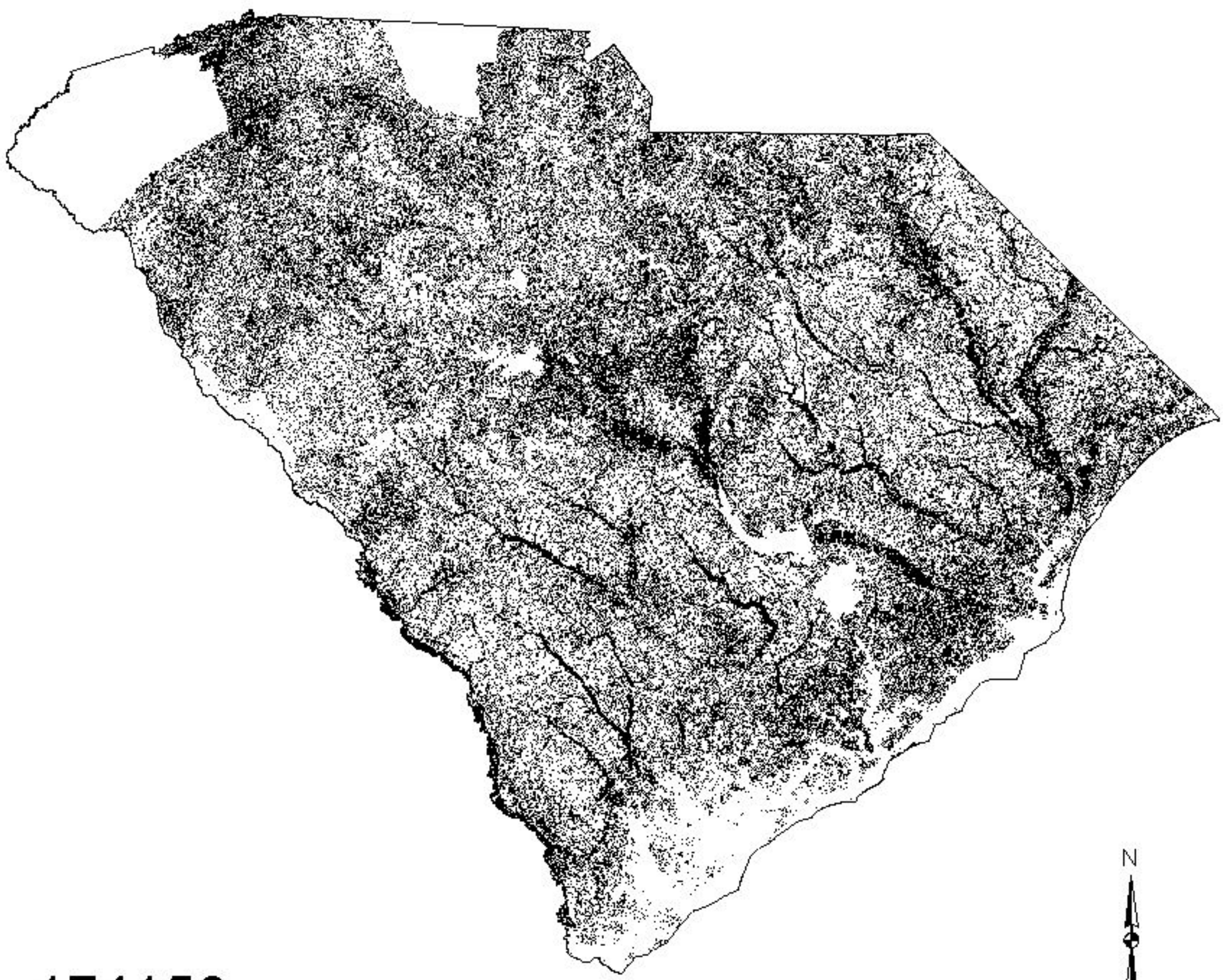
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Rough Earth Snake

(Virginia striatula)



174150

Predicted present

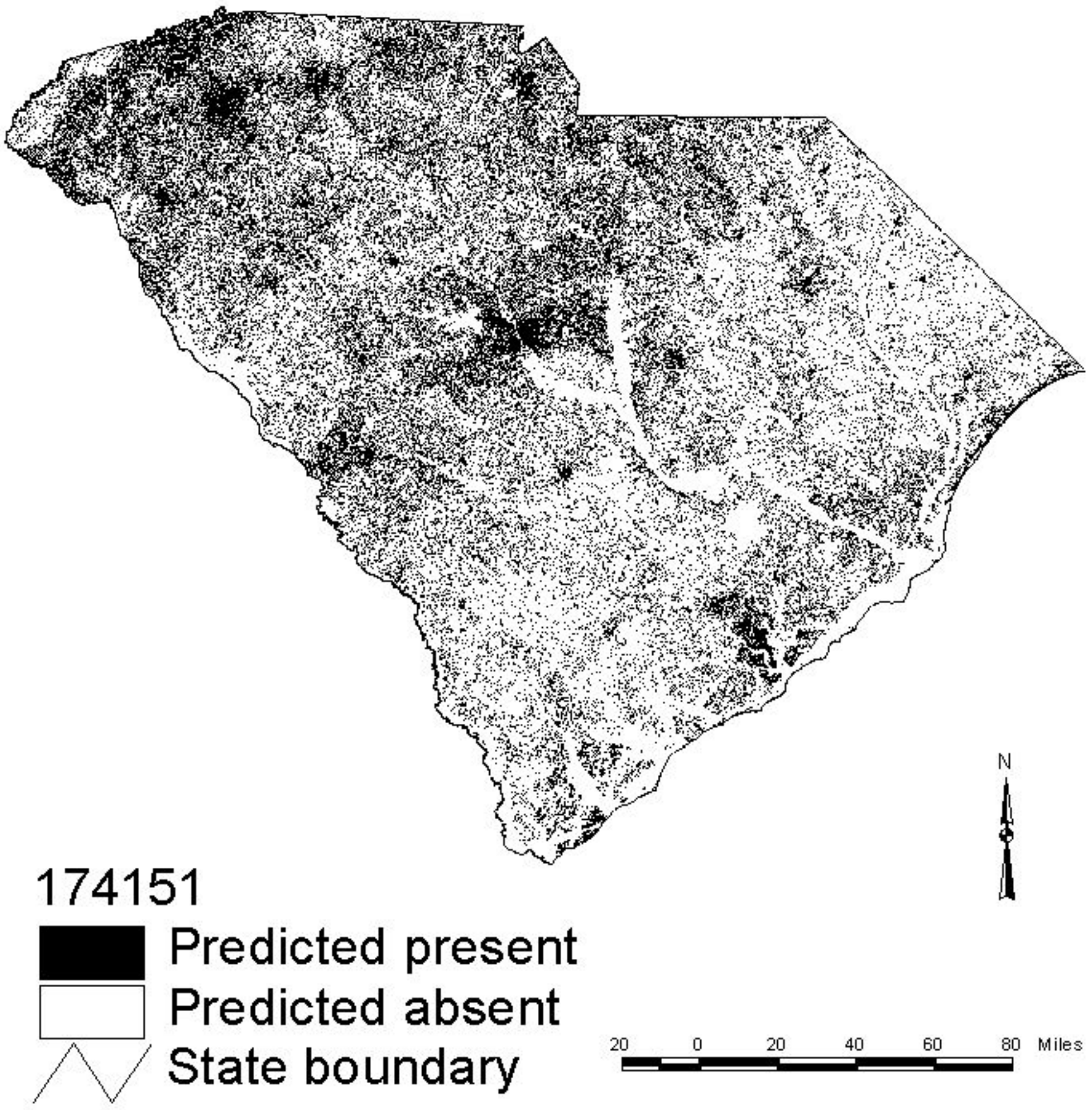
Predicted absent

State boundary

20 0 20 40 60 80 Miles

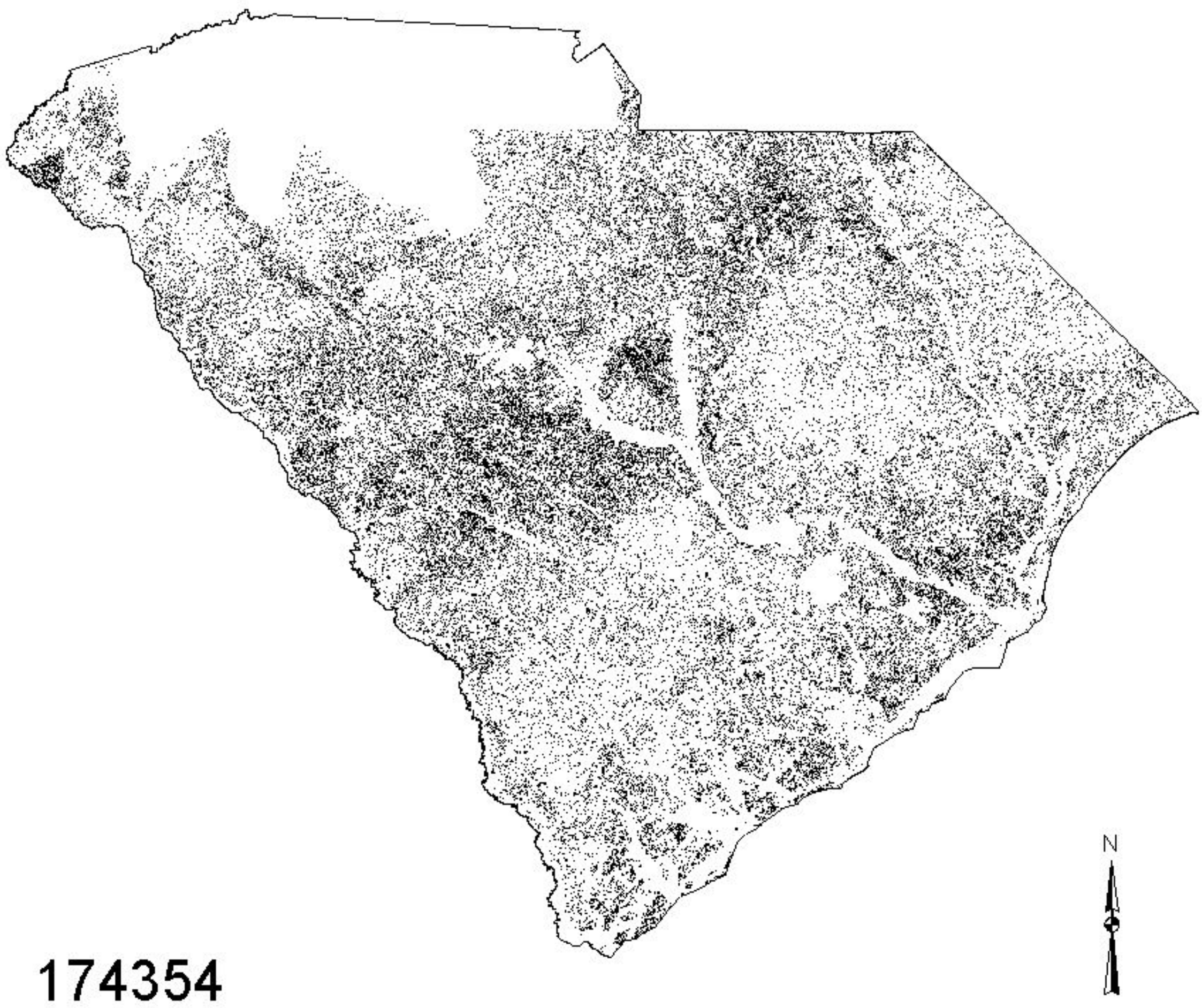
Smooth Earth Snake

(Virginia valeriae)

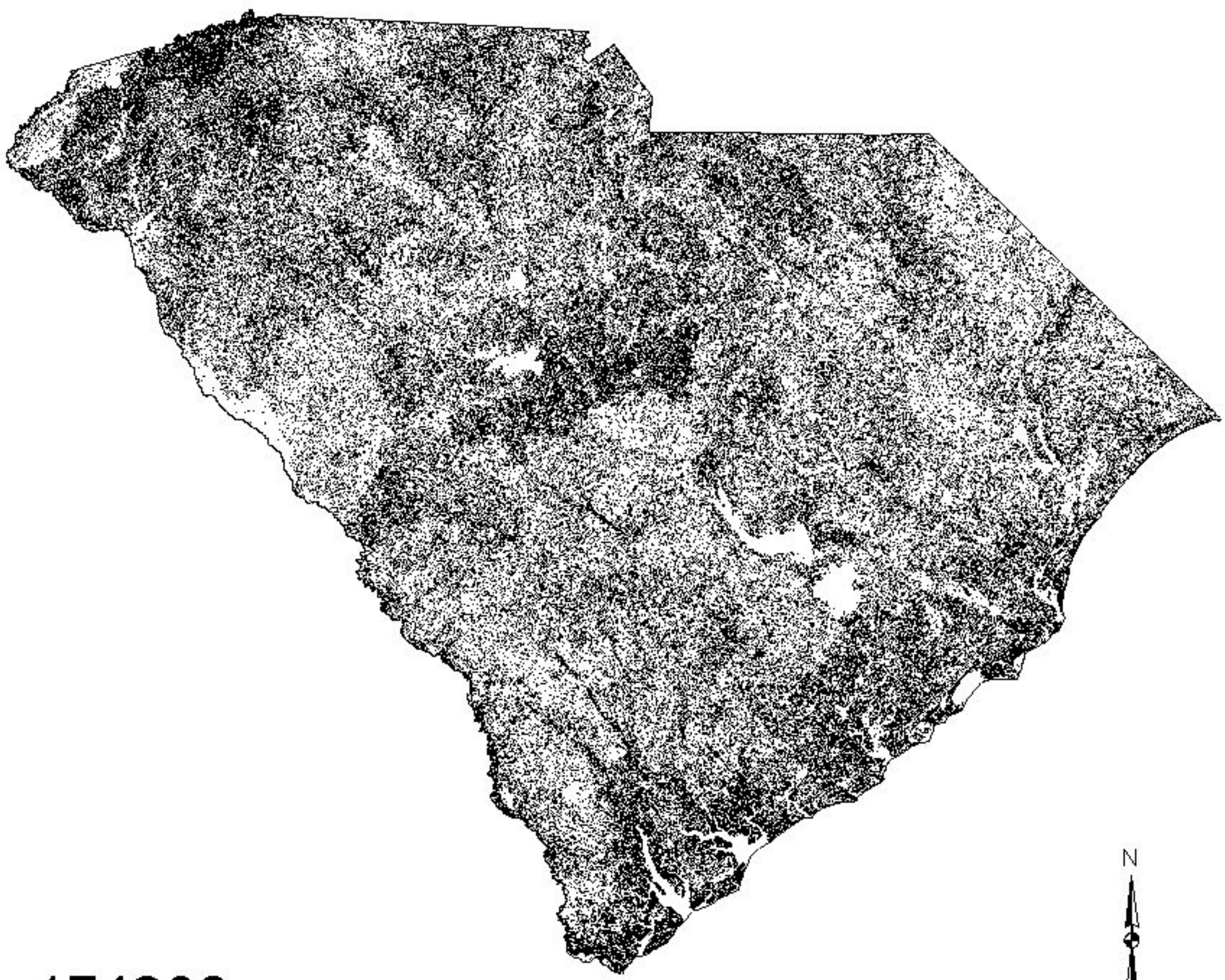


Eastern Coral Snake

(Micrurus fulvius)



Copperhead
(Agkistrodon contortrix)



174296

Predicted present

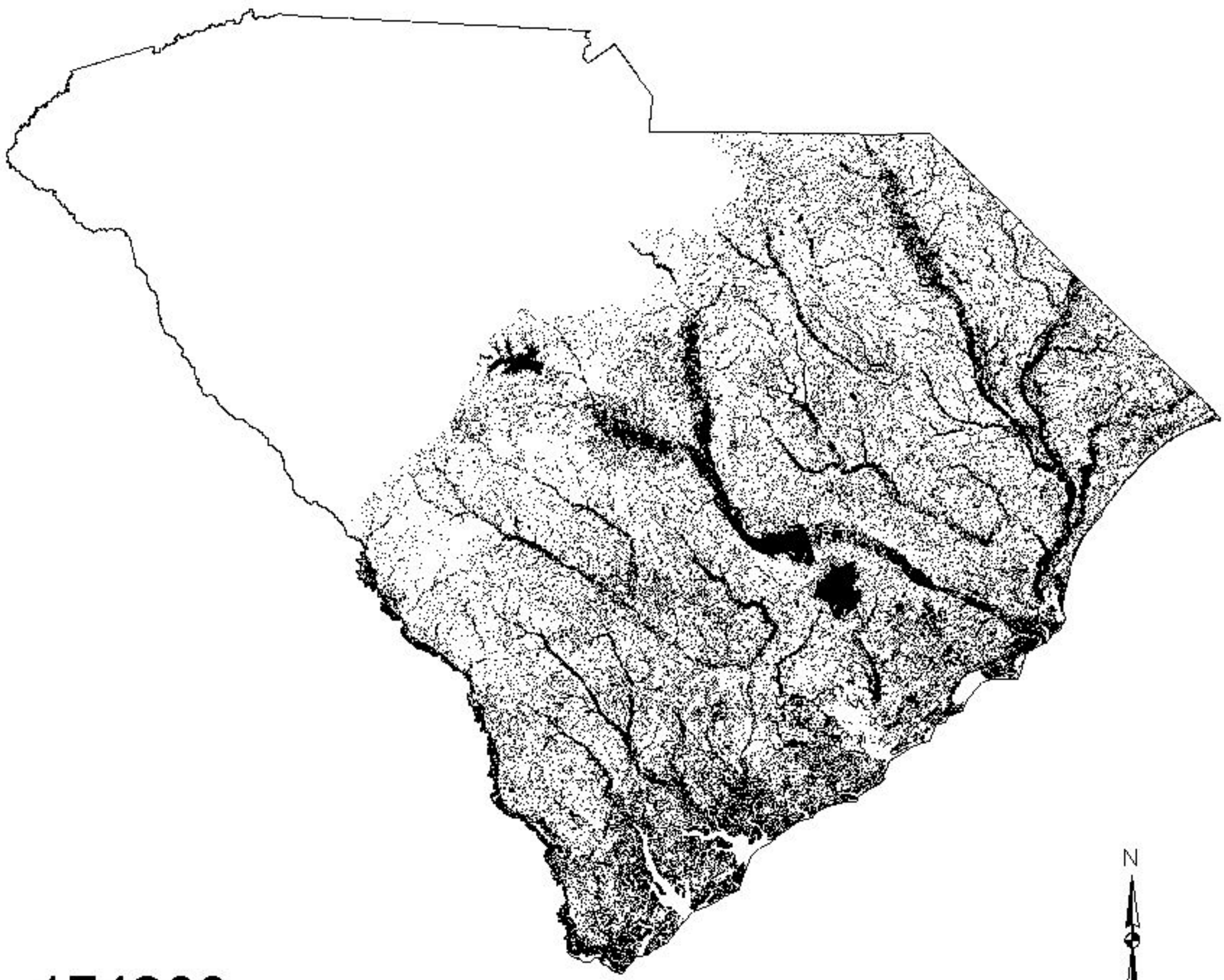
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Cottonmouth

(Agkistrodon piscivorus)



174299

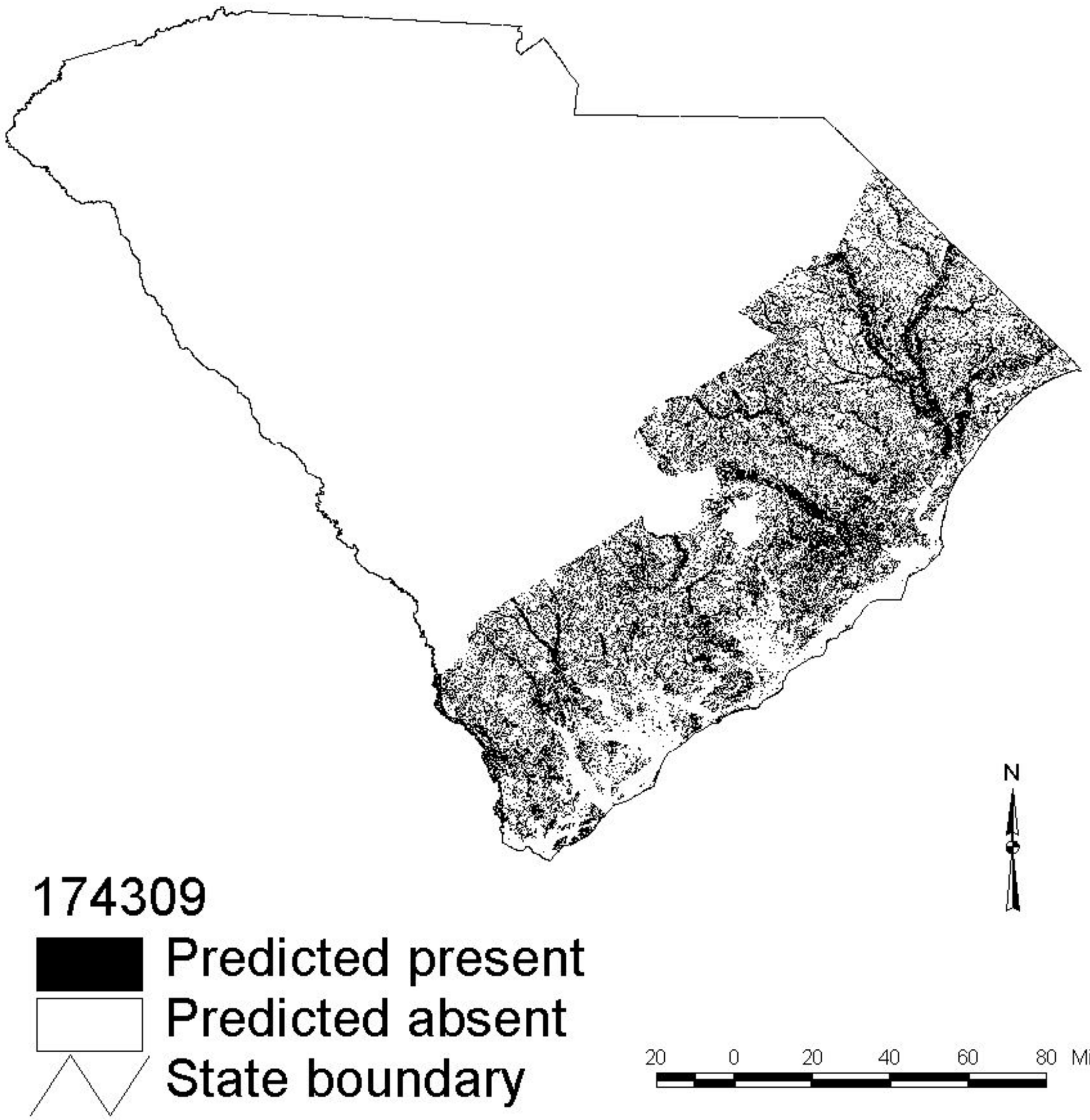
Predicted present

Predicted absent

State boundary

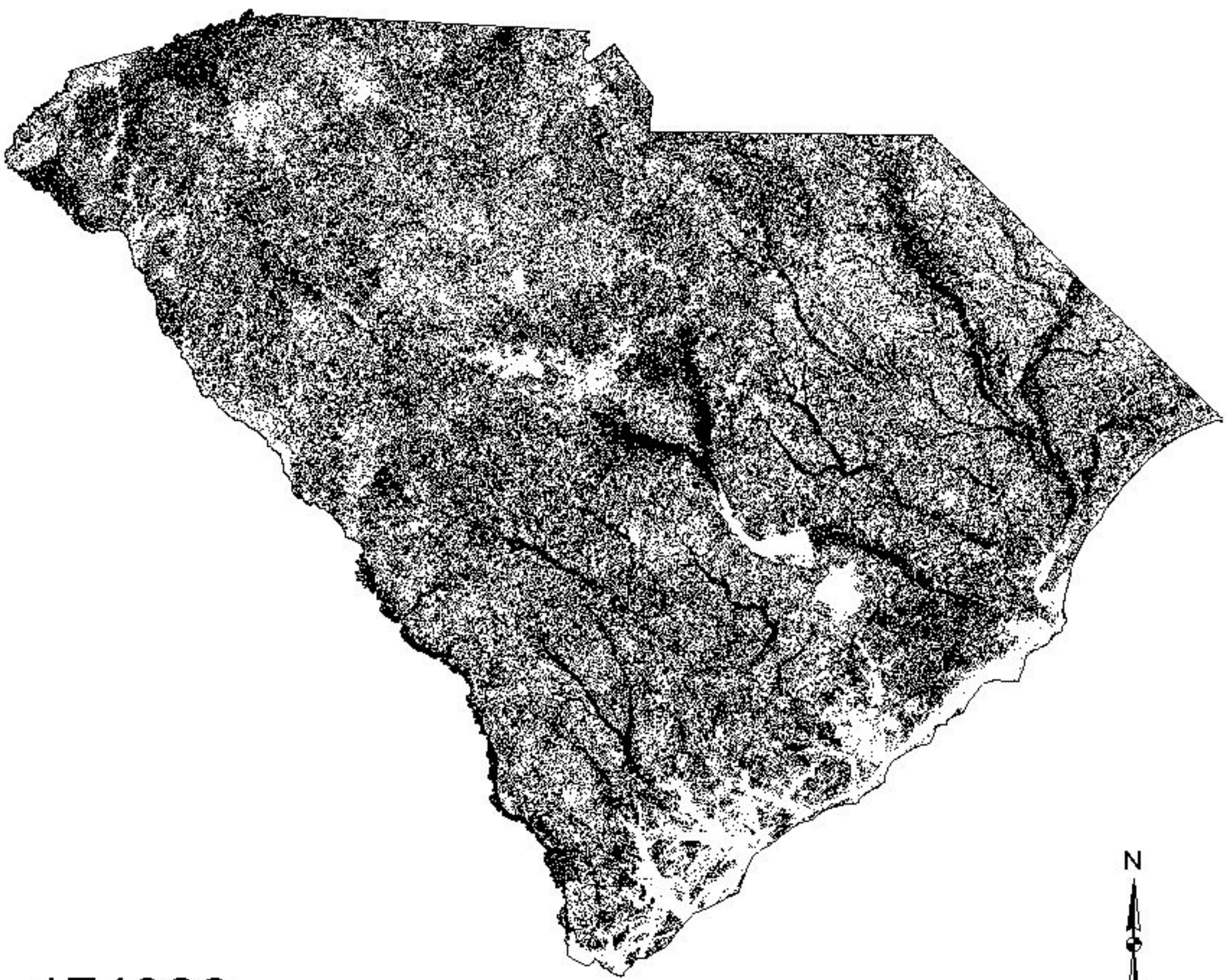
Eastern Diamondback Rattlesnake

(Crotalus adamanteus)



Timber Rattlesnake

(Crotalus horridus)



174306

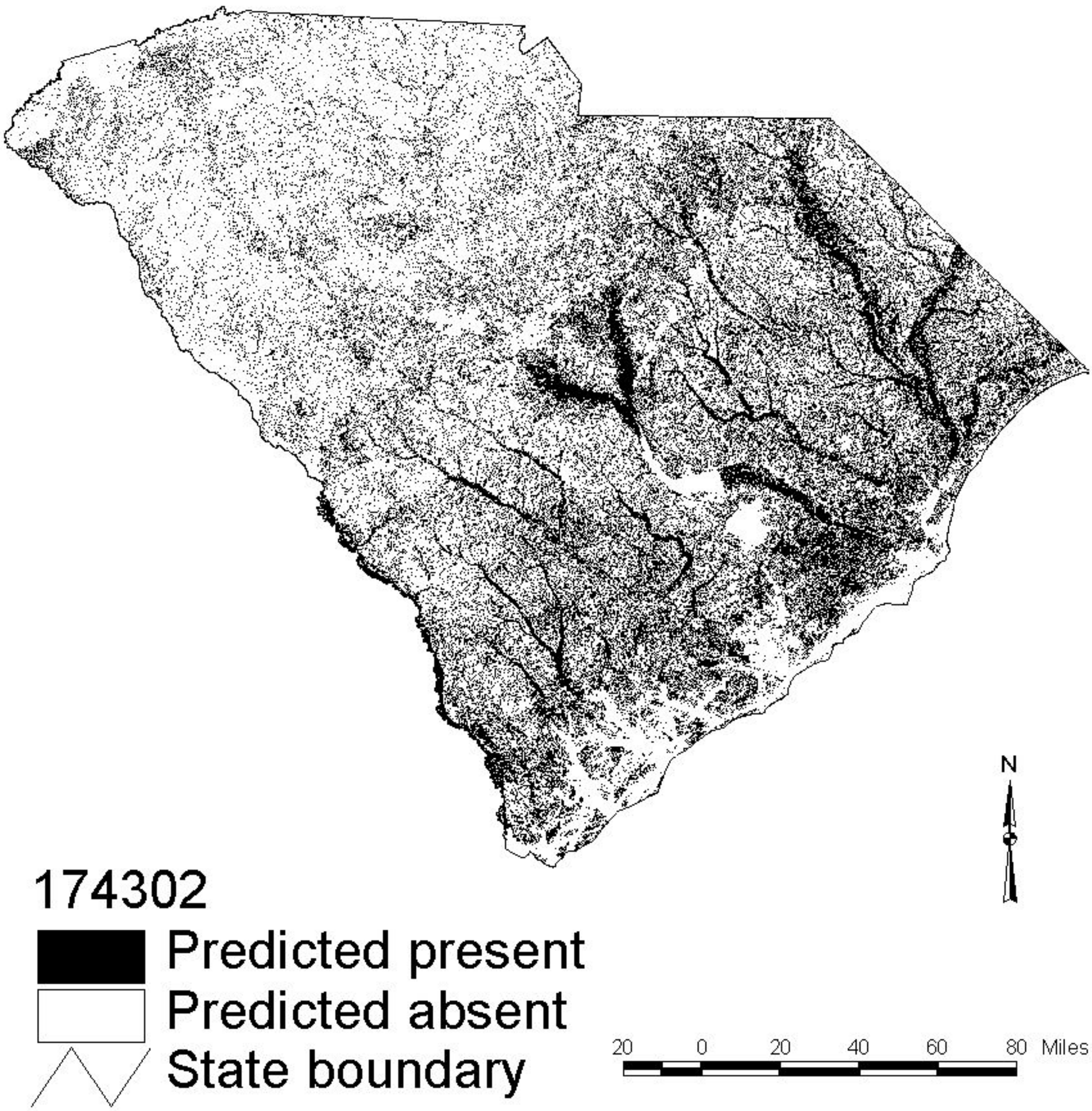
Predicted present

Predicted absent

State boundary

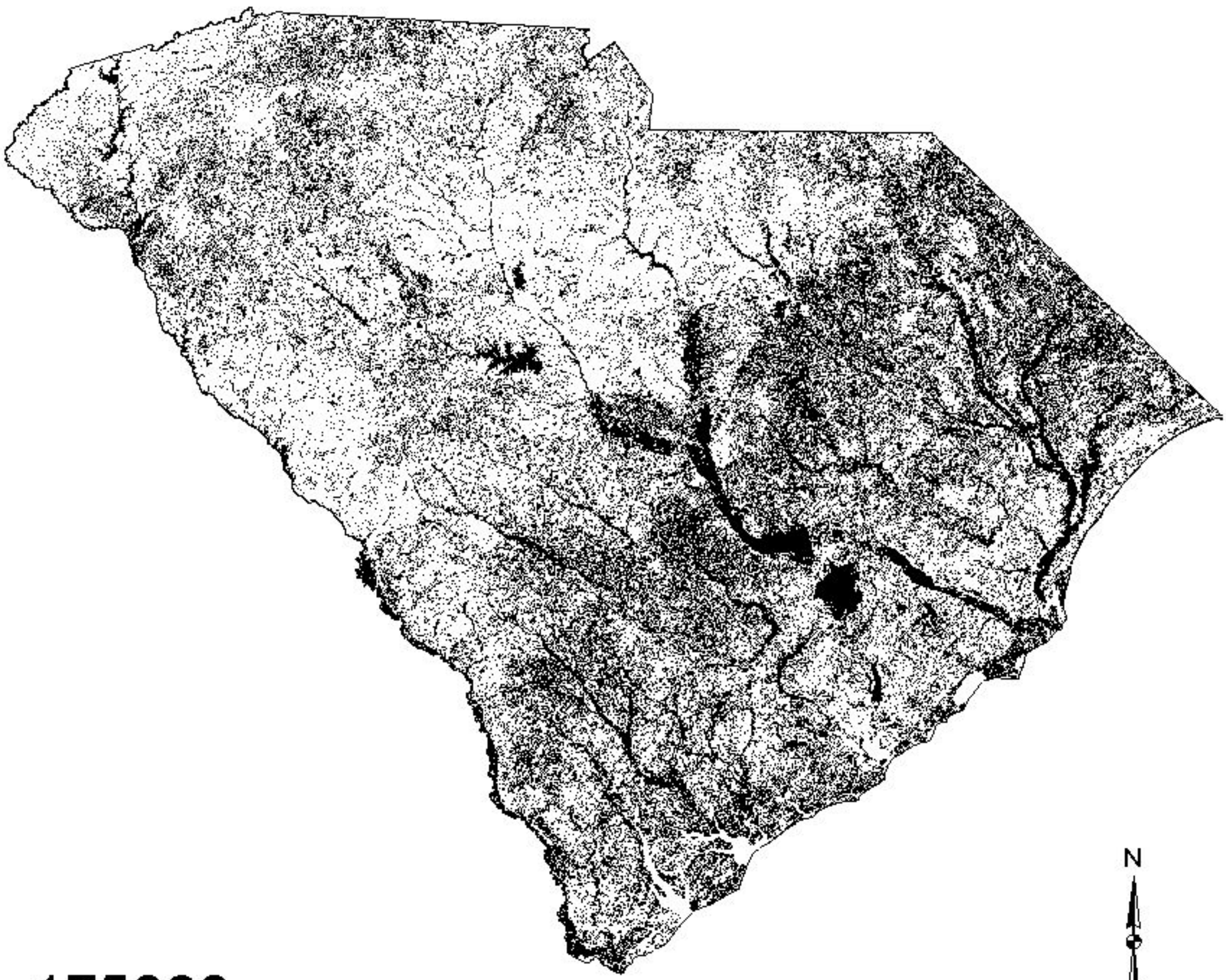
20 0 20 40 60 80 Miles

Pygmy Rattlesnake
(Sistrurus miliarius)



American Black Duck

(Anas rubripes)



175068

Predicted present

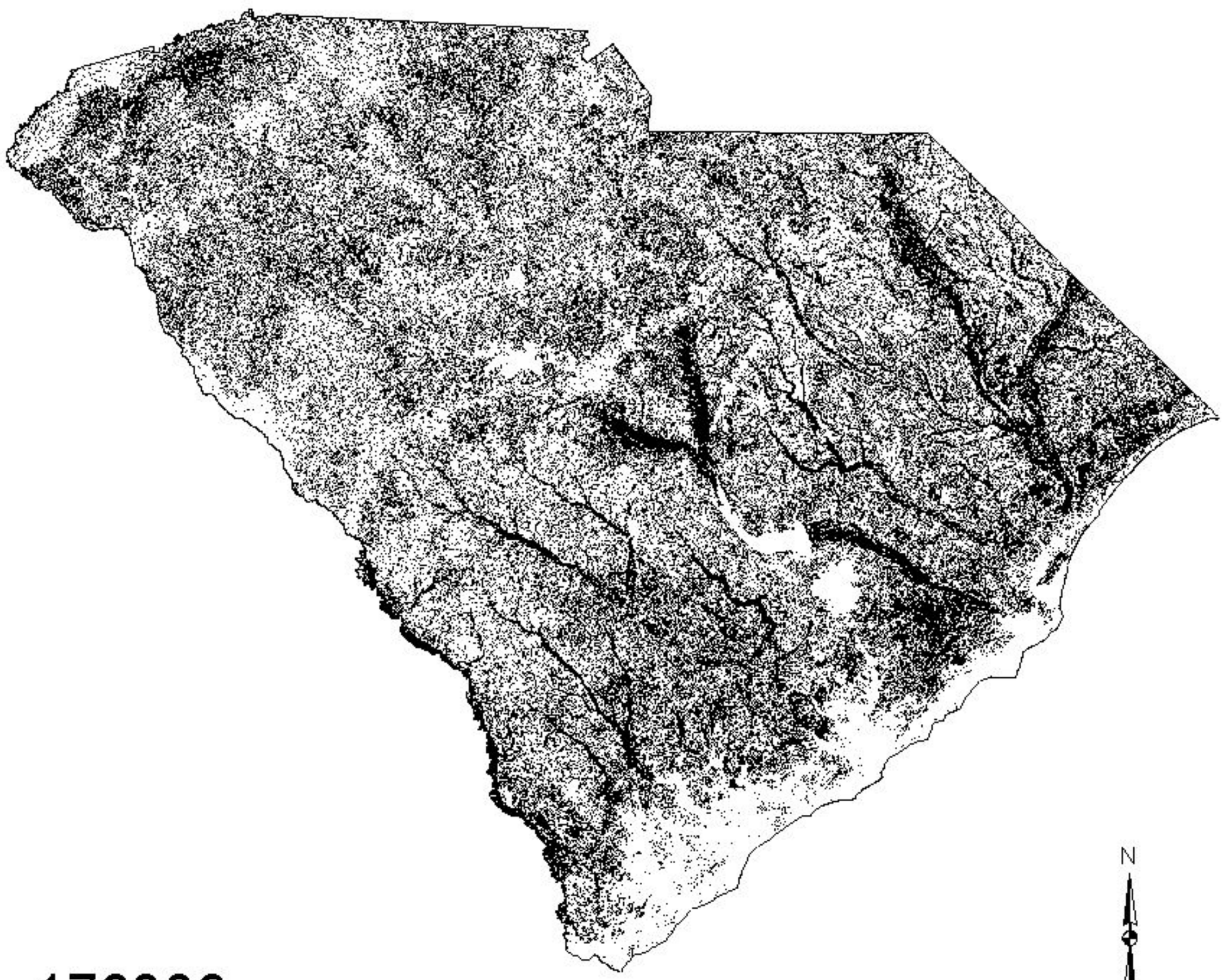
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Acadian Flycatcher

(Empidonax virescens)



178339

Predicted present

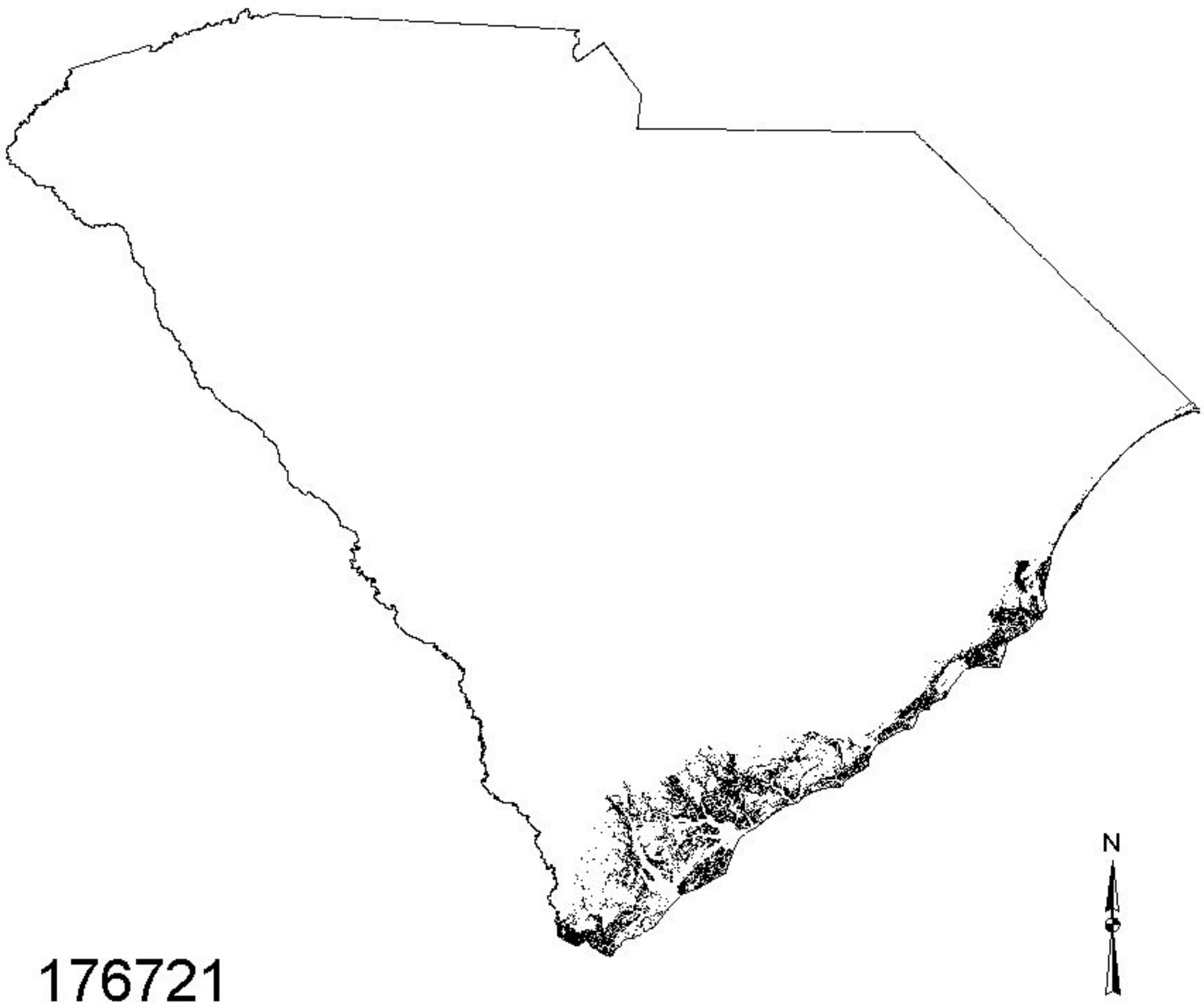
Predicted absent

State boundary

20 0 20 40 60 80 Miles

American Avocet

(Recurvirostra americana)



176721

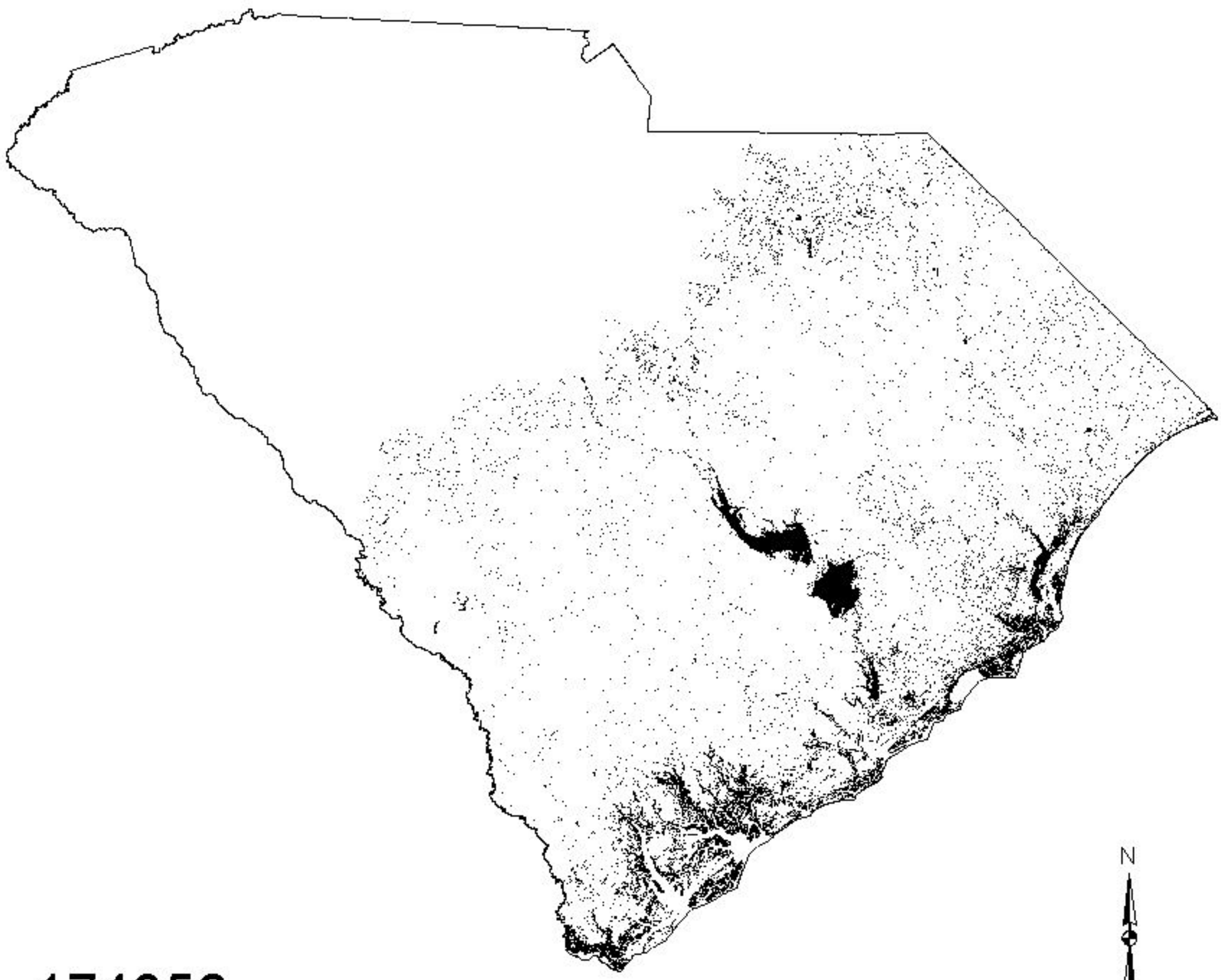
Predicted present

Predicted absent

State boundary

American Bittern

(Botaurus lentiginosus)



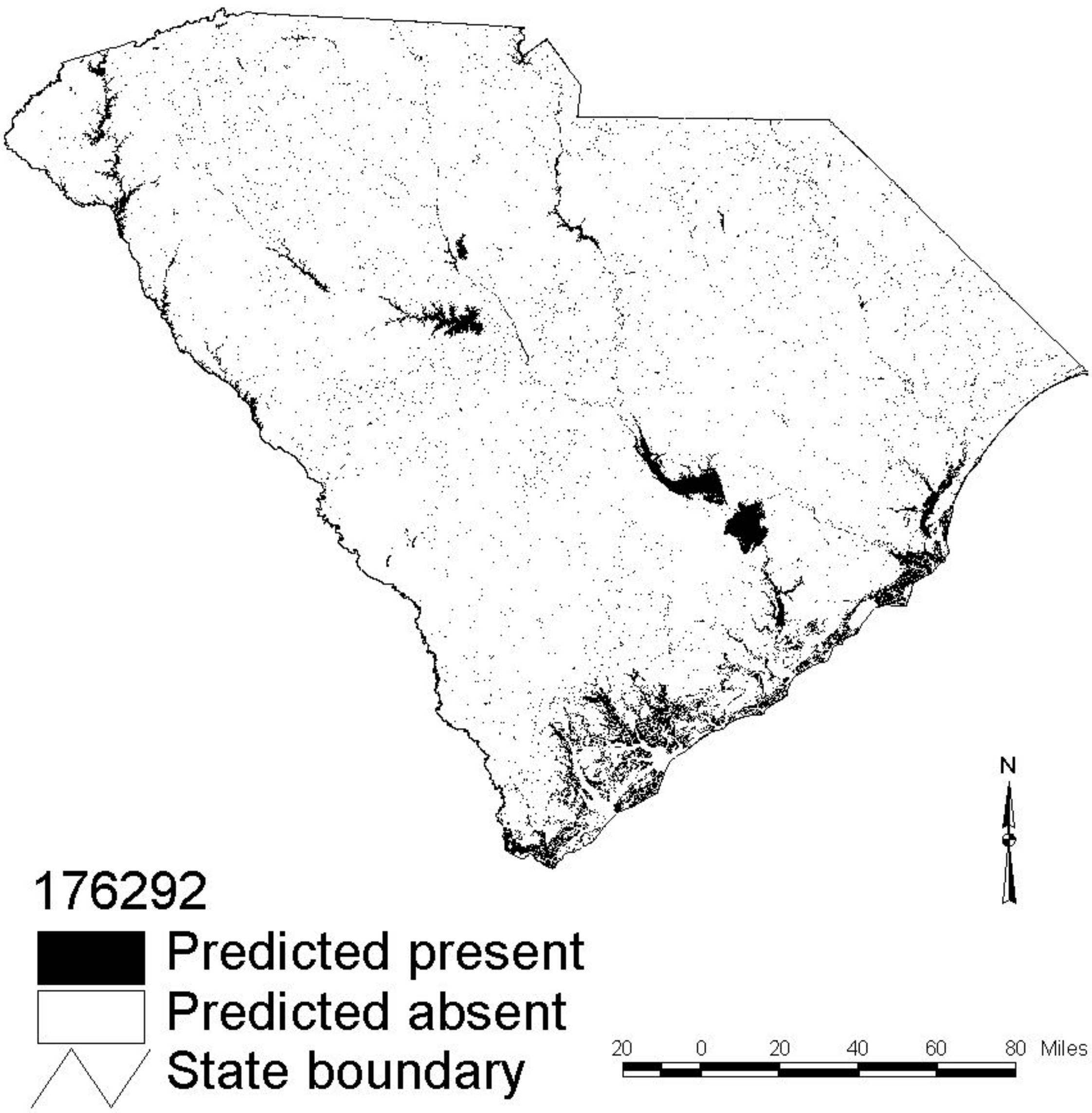
174856

Predicted present

Predicted absent

State boundary

American Coot
(Fulica americana)



176292

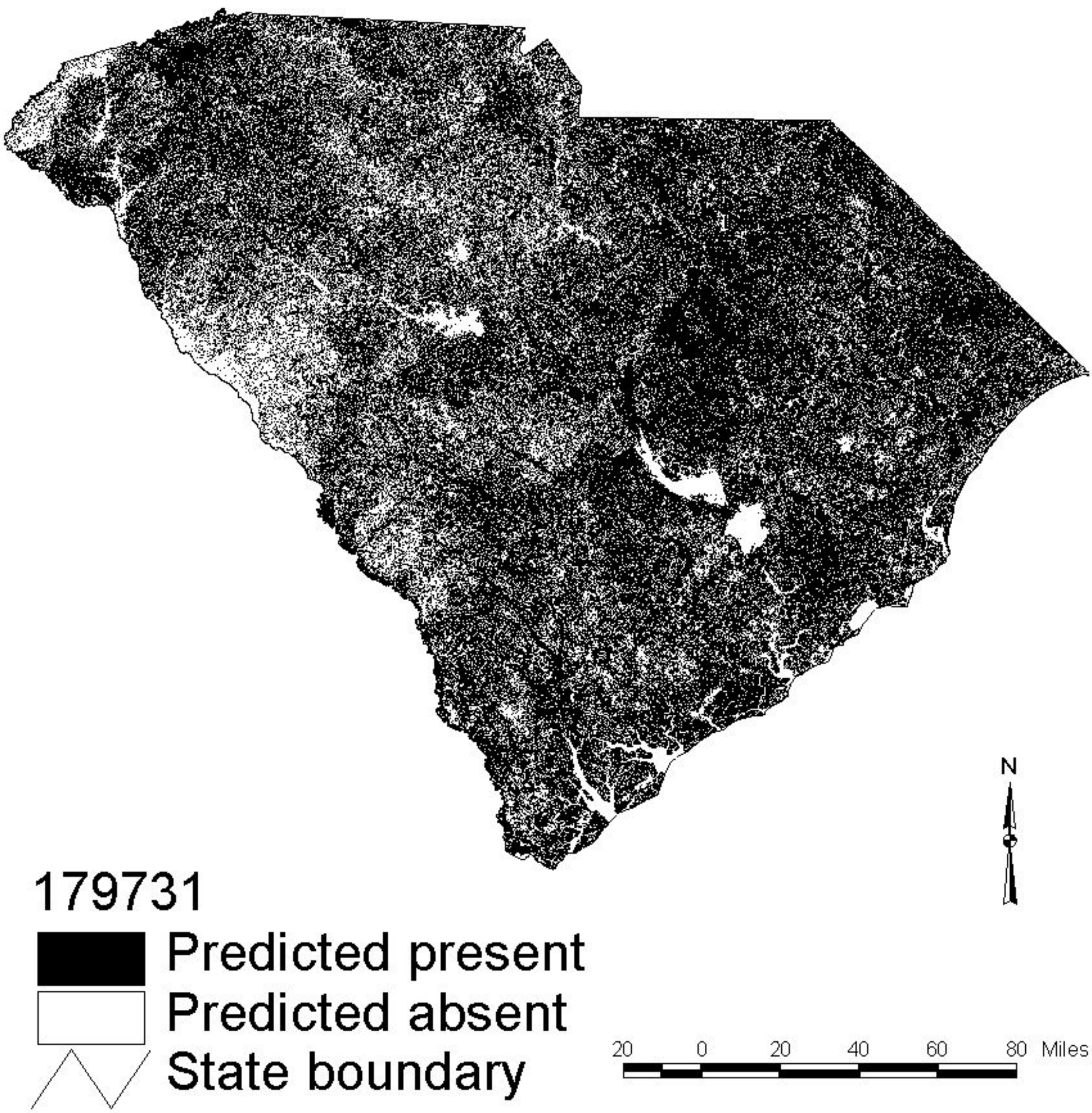
Predicted present

Predicted absent

State boundary

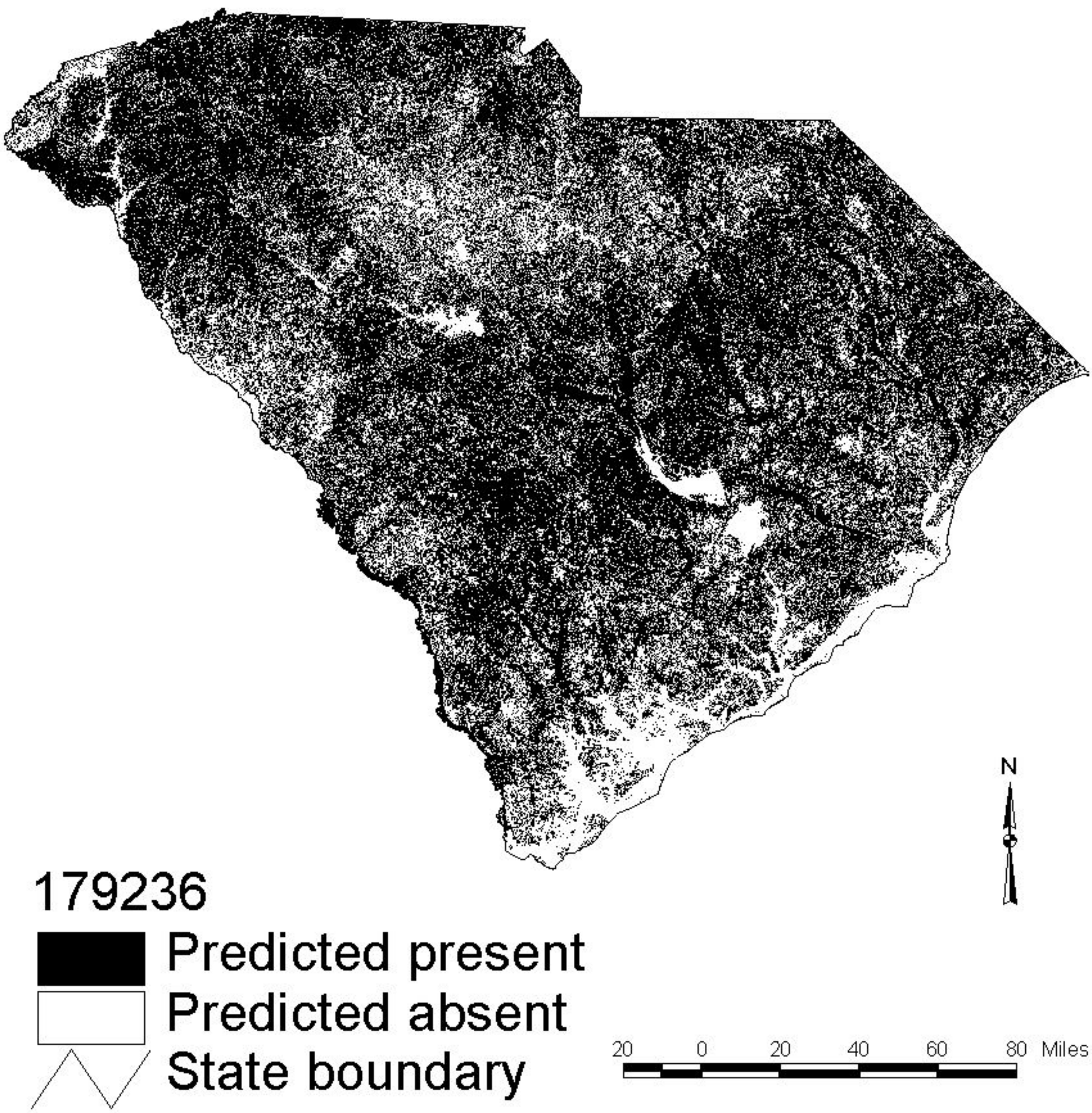
American Crow

(Corvus brachyrhynchos)



American Goldfinch

(Carduelis tristis)



American Kestrel

(Falco sparverius)

175622

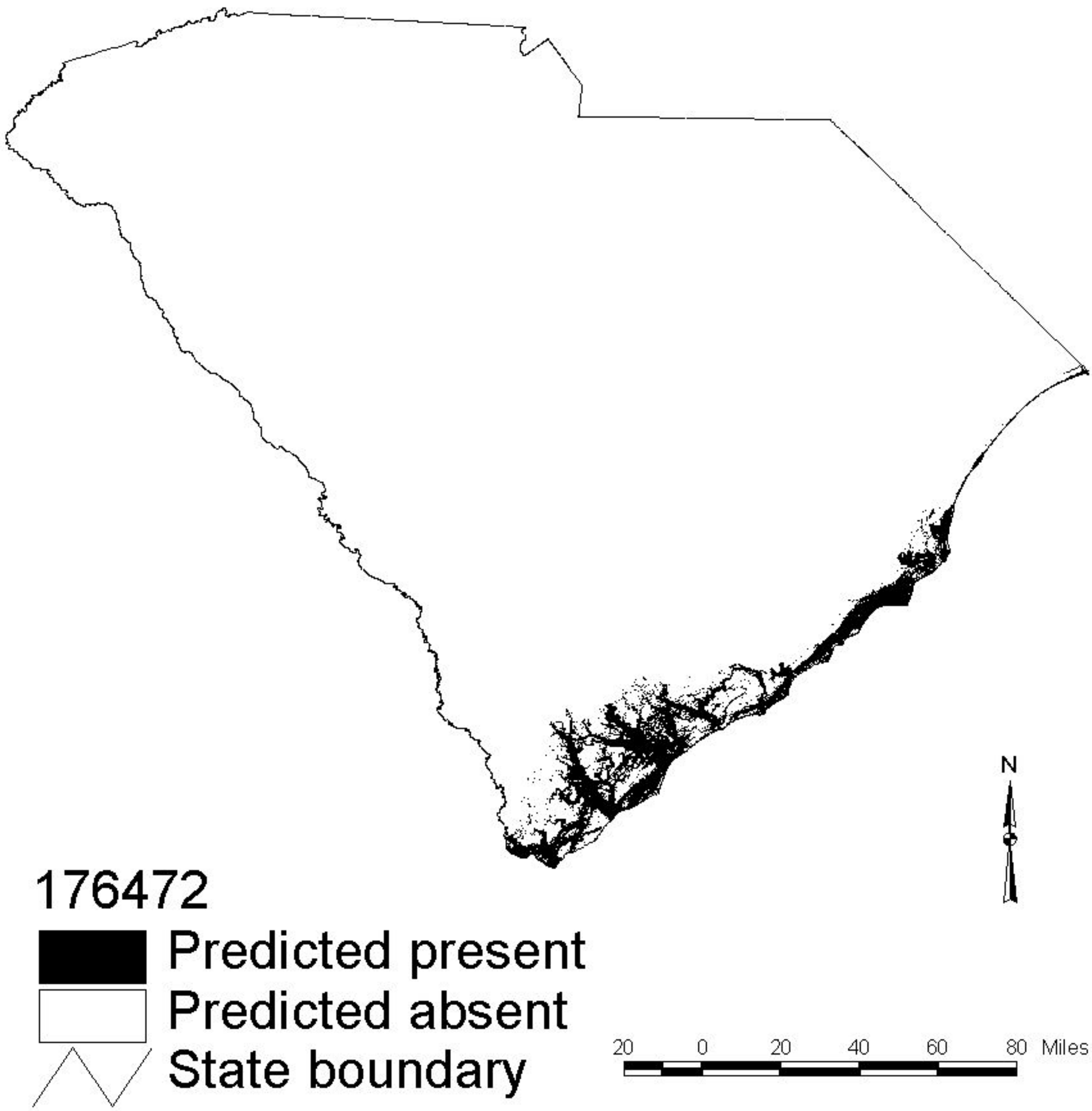
Predicted present

Predicted absent

State boundary

American Oystercatcher

(Haematopus palliatus)



176472

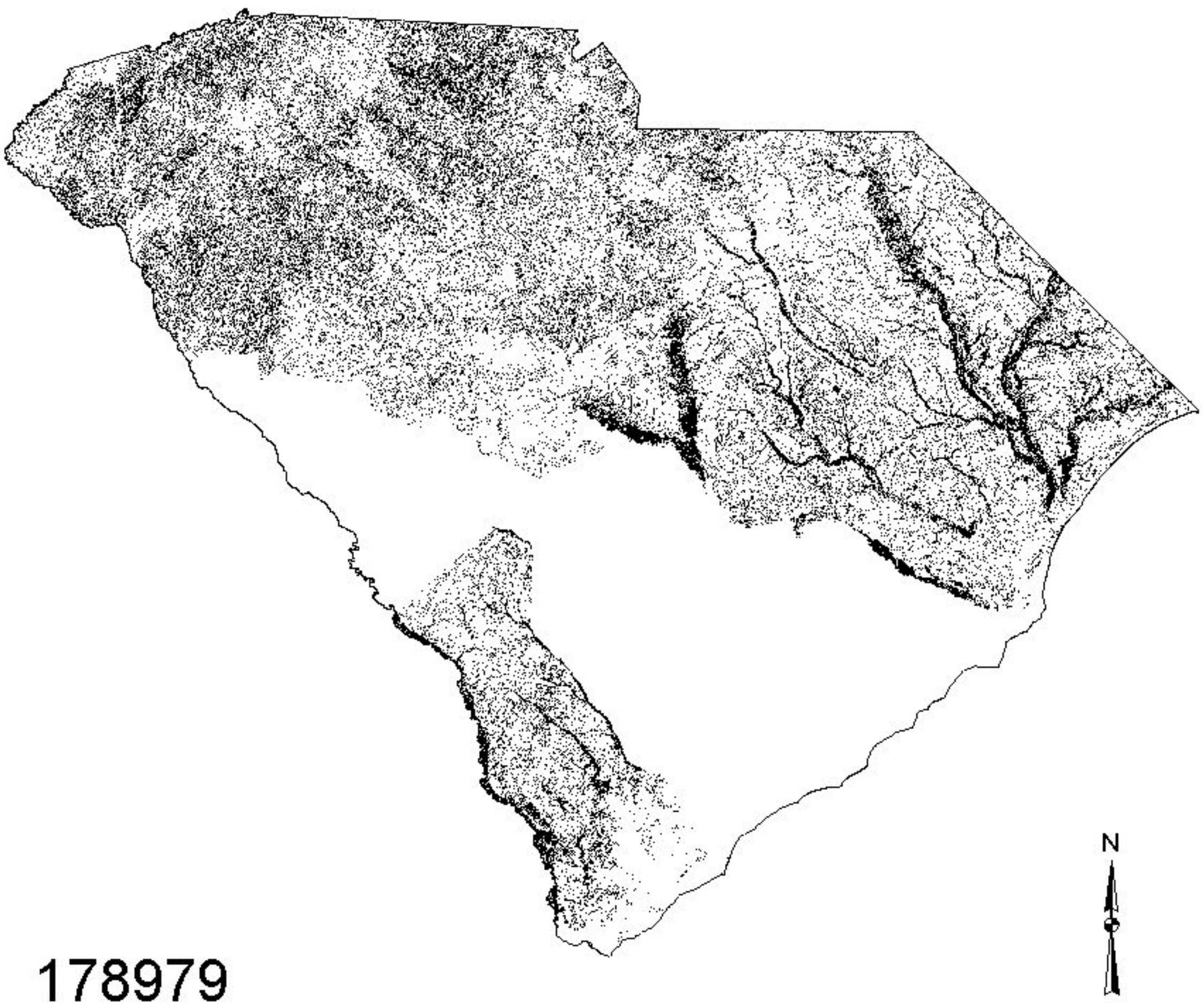
Predicted present

Predicted absent

State boundary

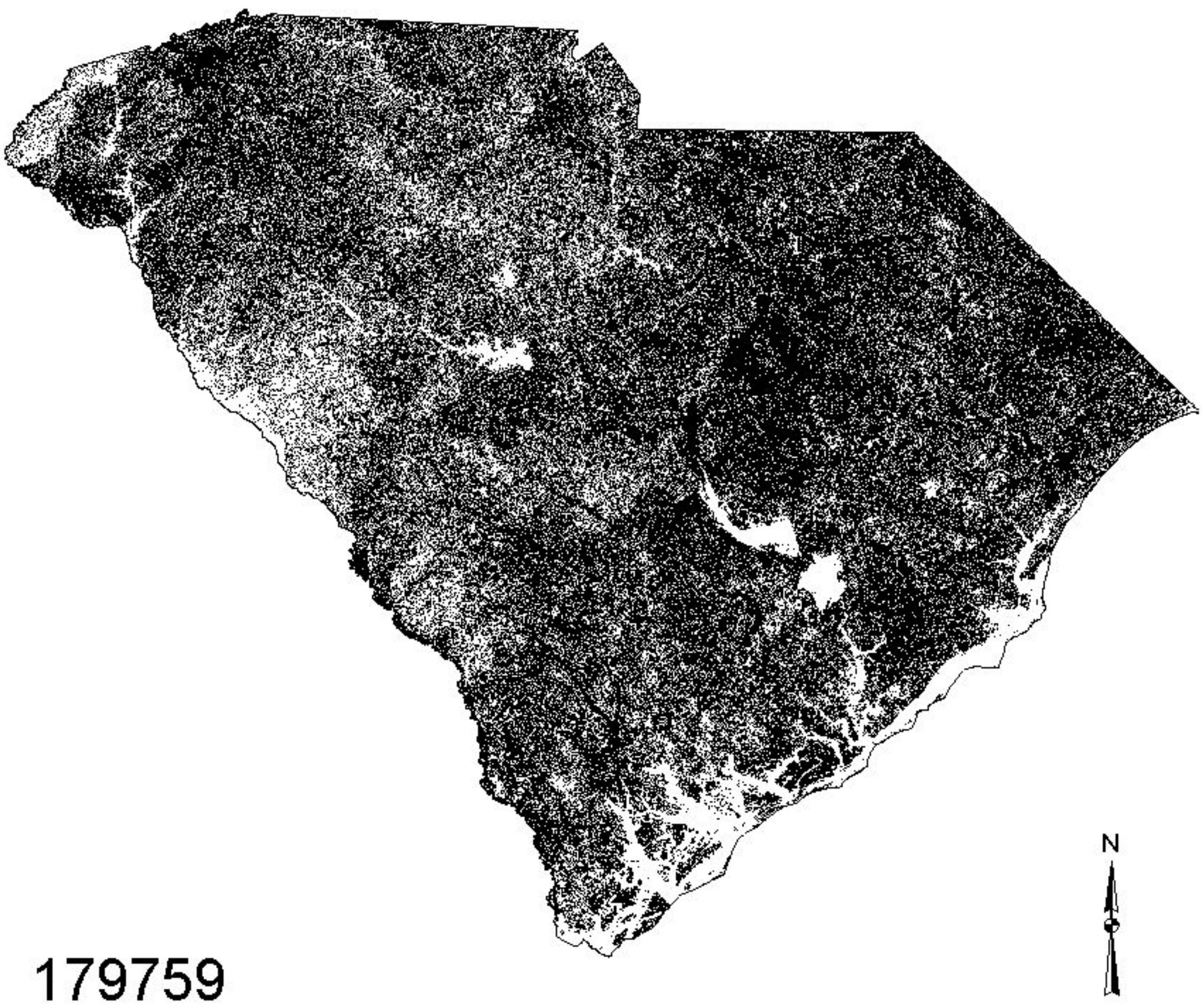
American Redstart

(Setophaga ruticilla)



American Robin

(Turdus migratorius)



179759

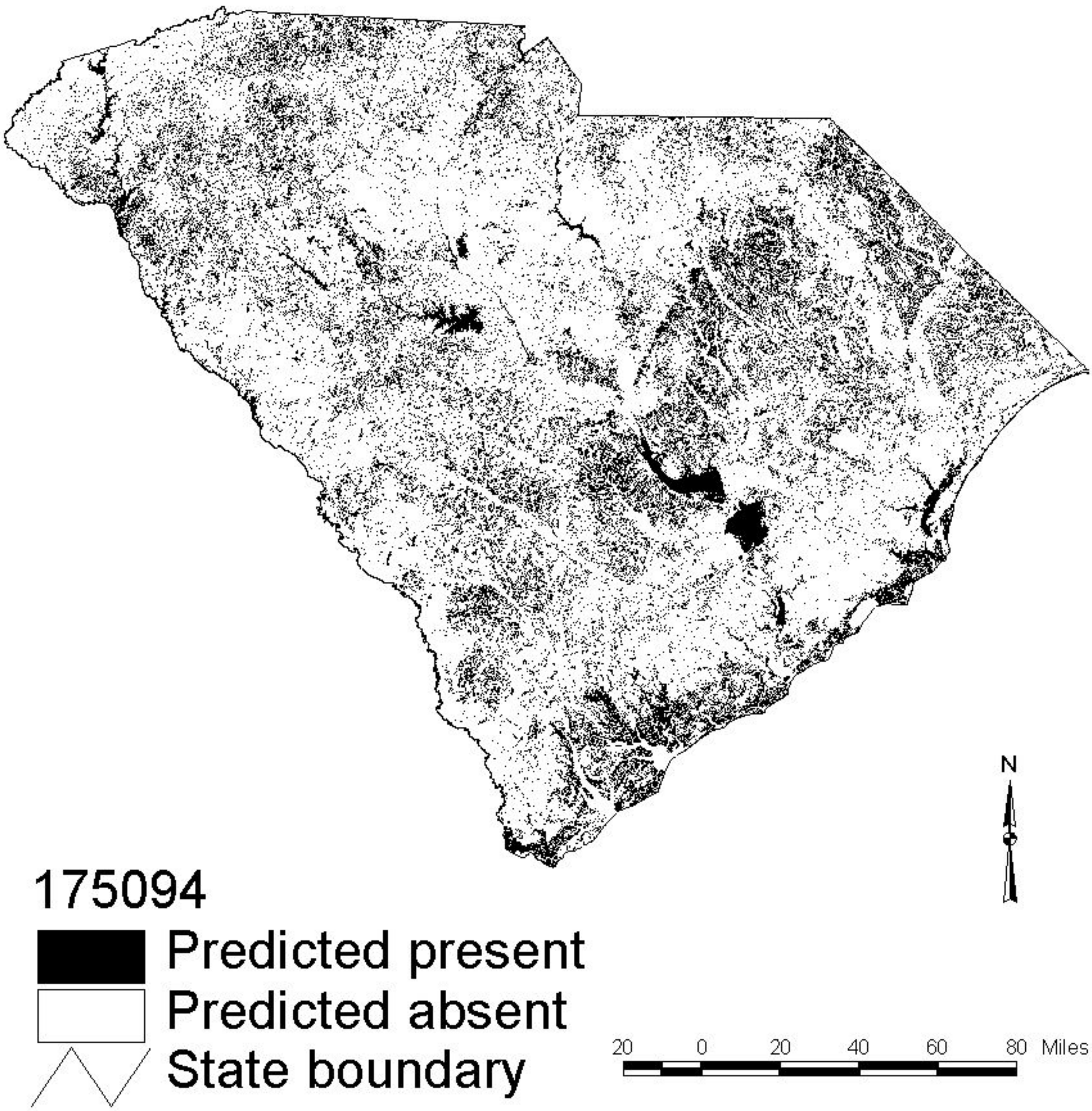
Predicted present

Predicted absent

State boundary

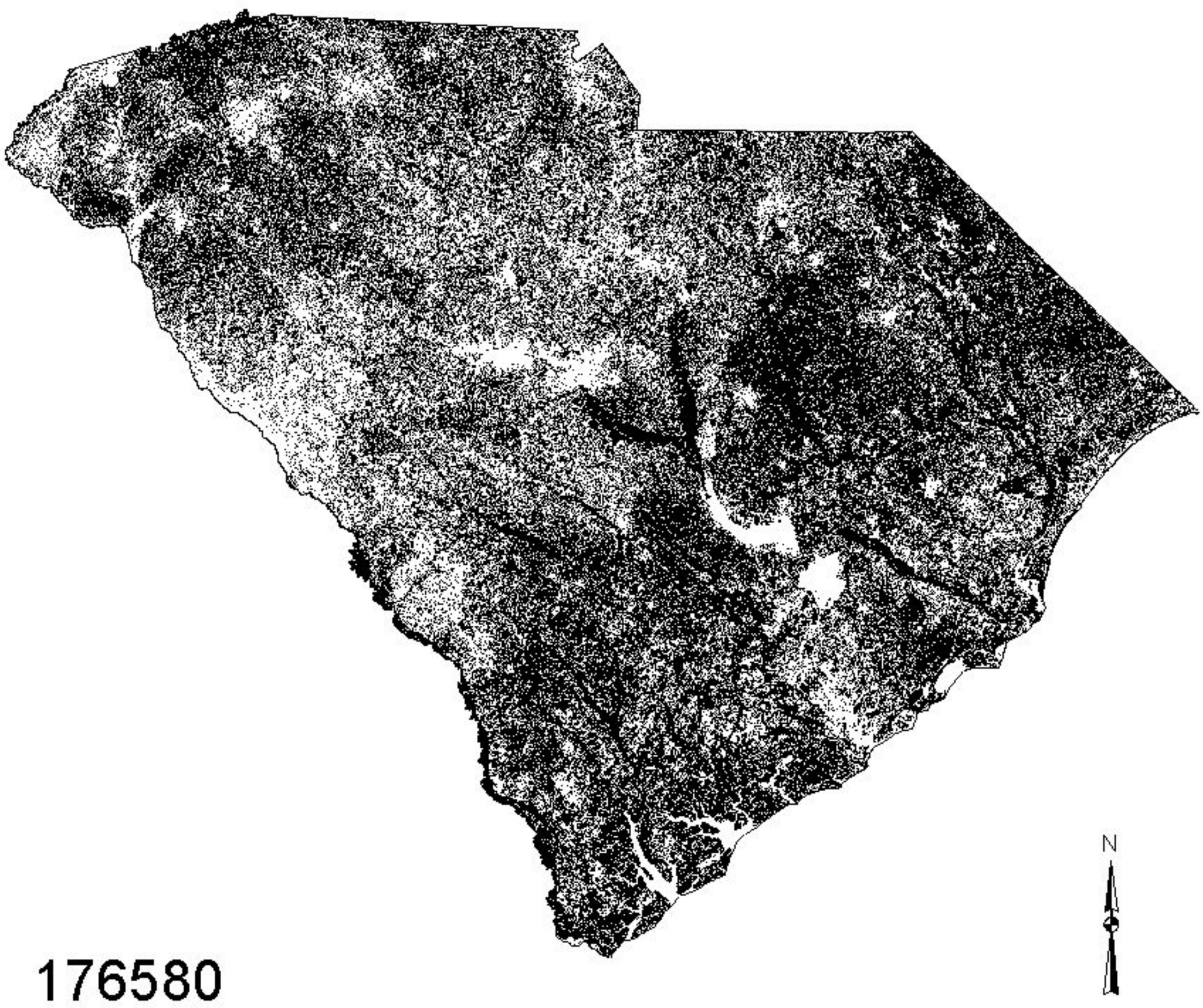
American Wigeon

(Anas americana)



American Woodcock

(Scolopax minor)



176580

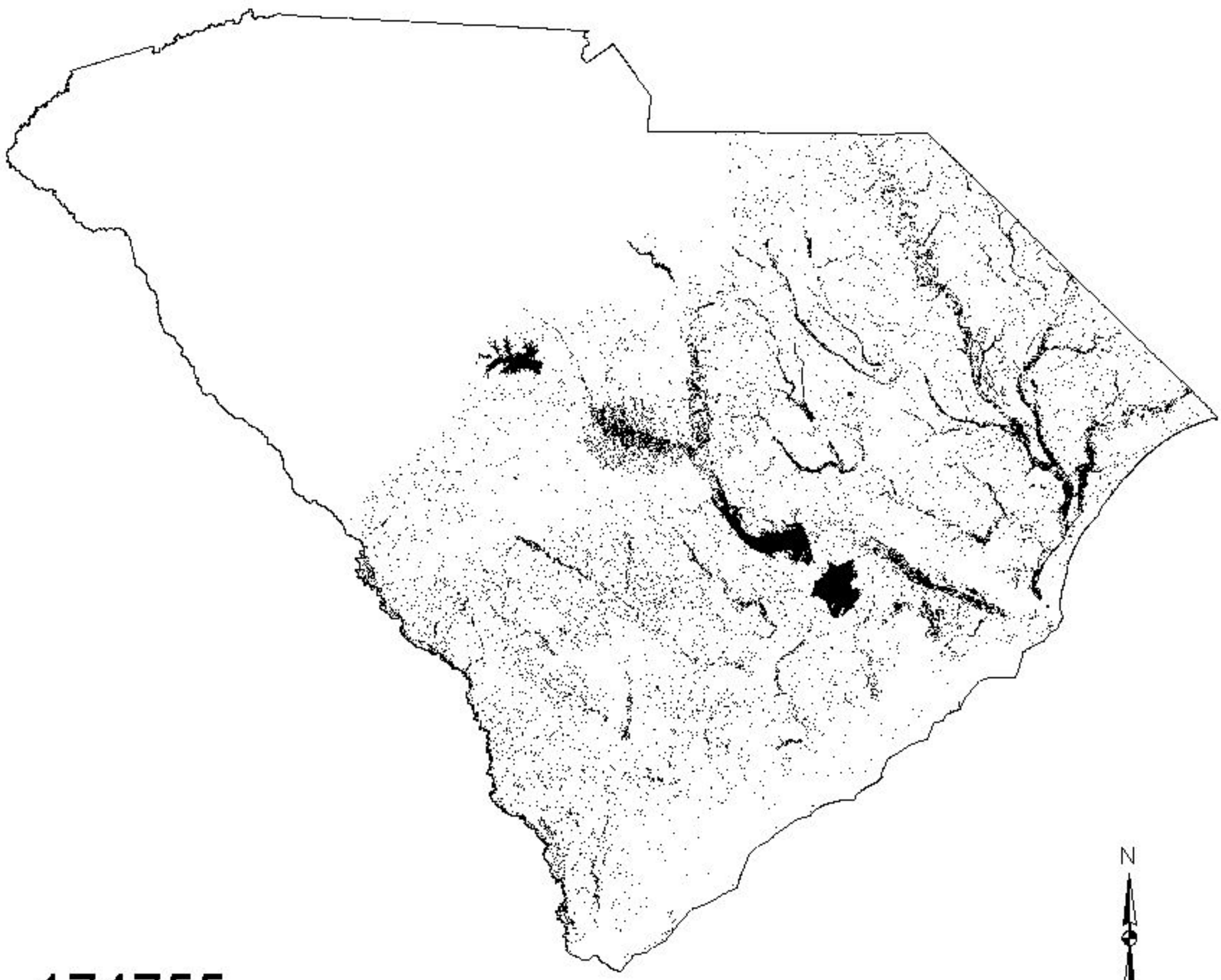
Predicted present

Predicted absent

State boundary

Anhinga

(Anhinga anhinga)



174755

Predicted present

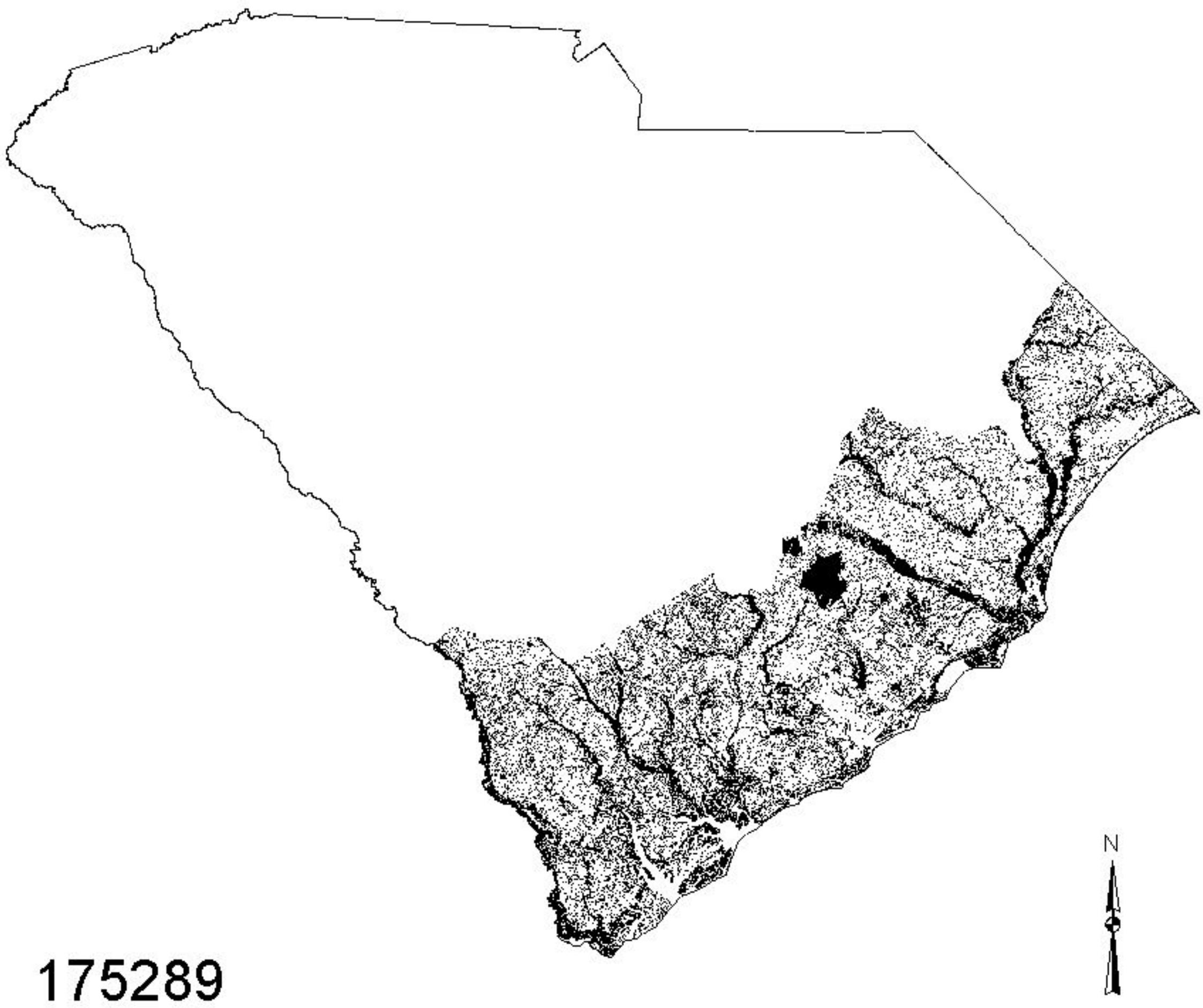
Predicted absent

State boundary

20 0 20 40 60 80 Miles

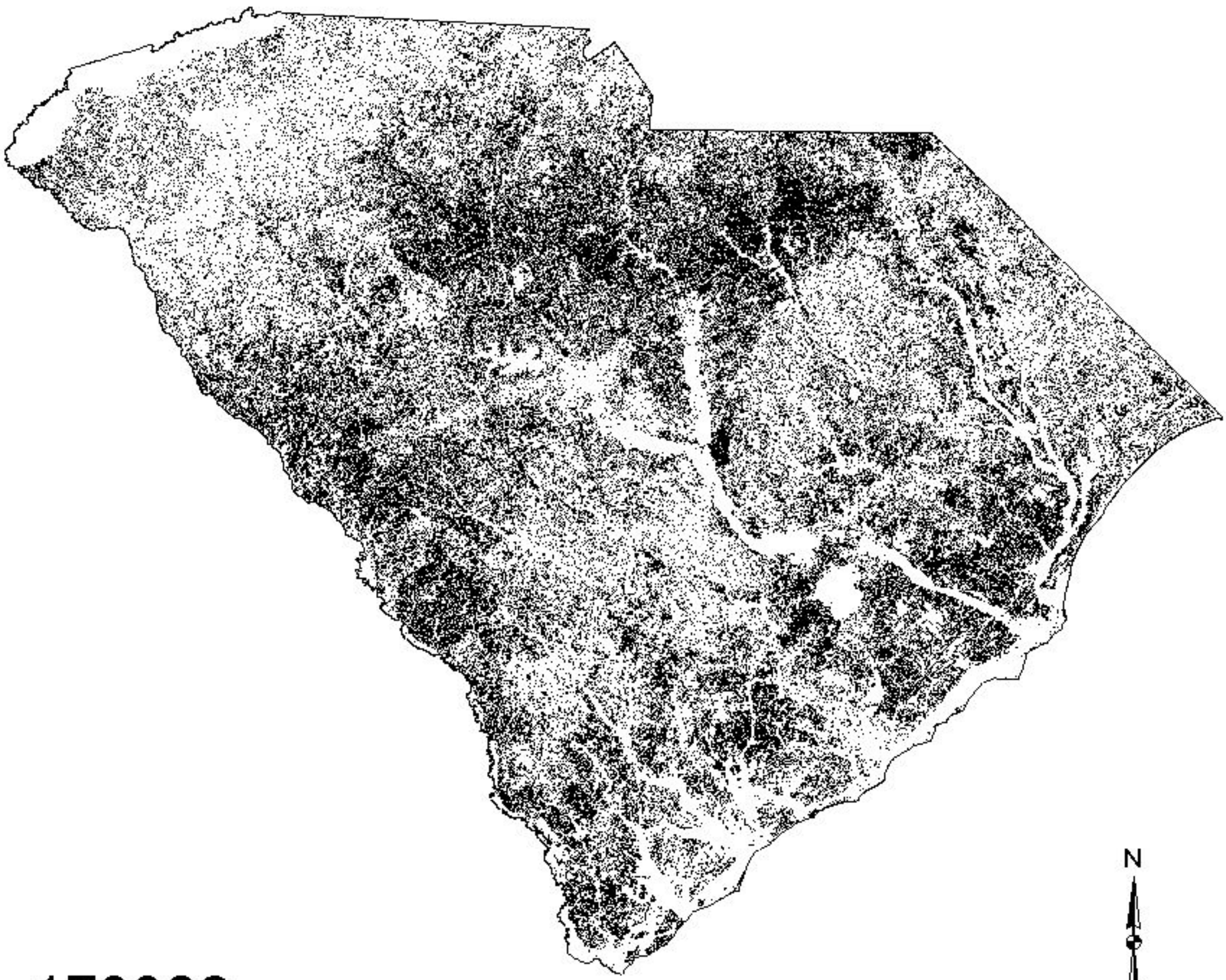
American Swallow-tailed Kite

(Elanoides forficatus)



Bachman's Sparrow

(Aimophila aestivalis)



179386

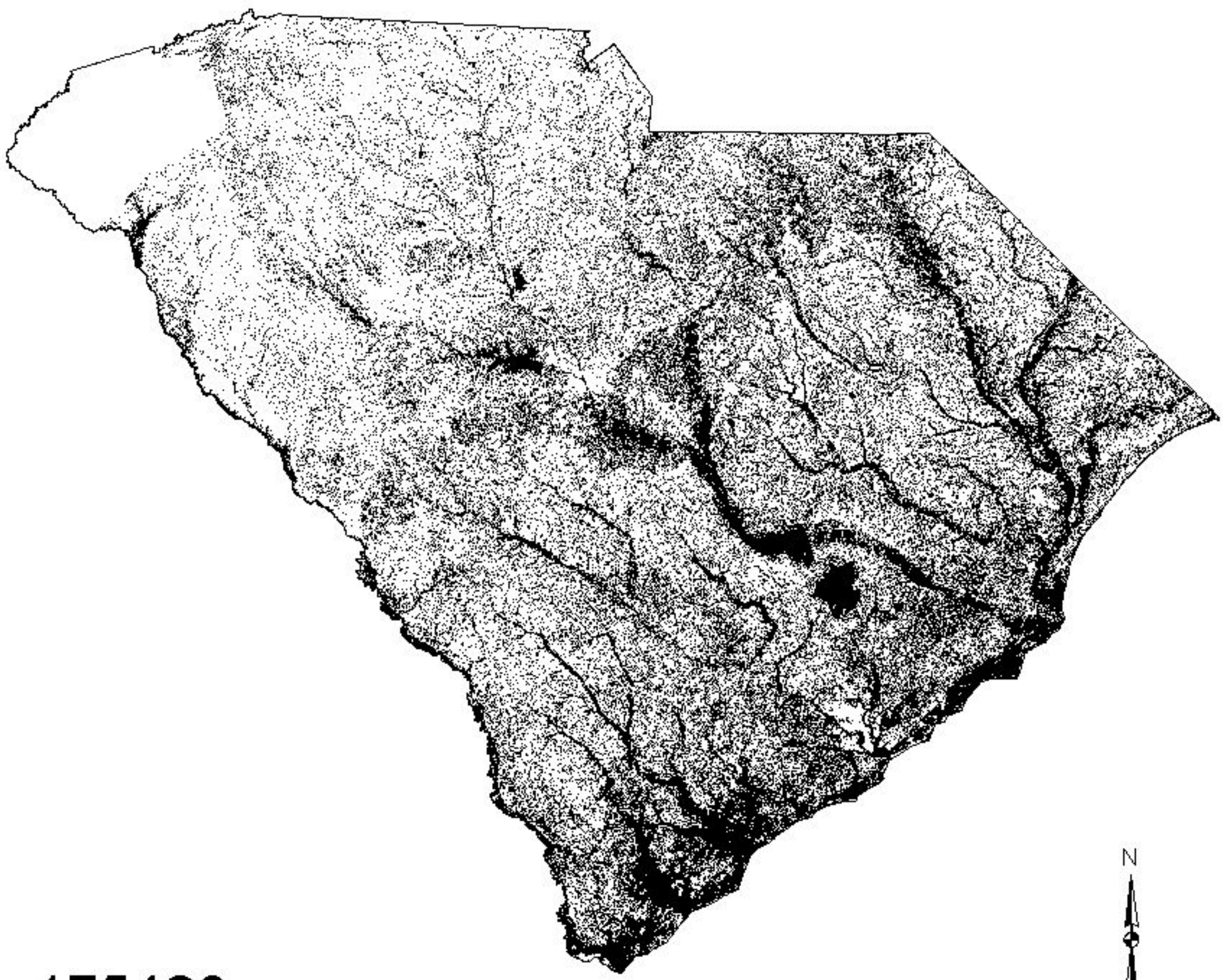
Predicted present

Predicted absent

State boundary

Bald Eagle

(Haliaeetus leucocephalus)



175420

Predicted present

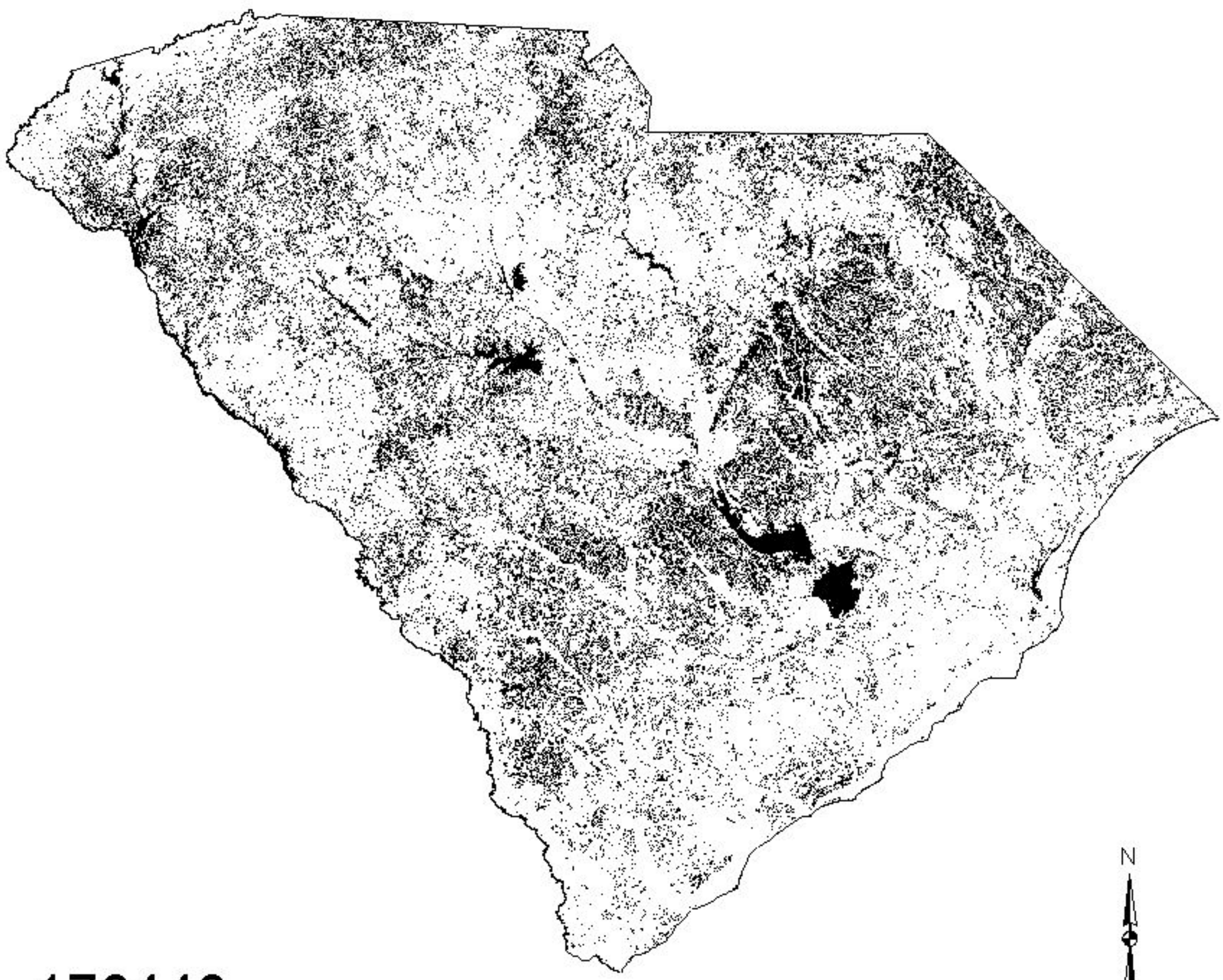
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Barn Swallow

(Hirundo rustica)



178448

Predicted present

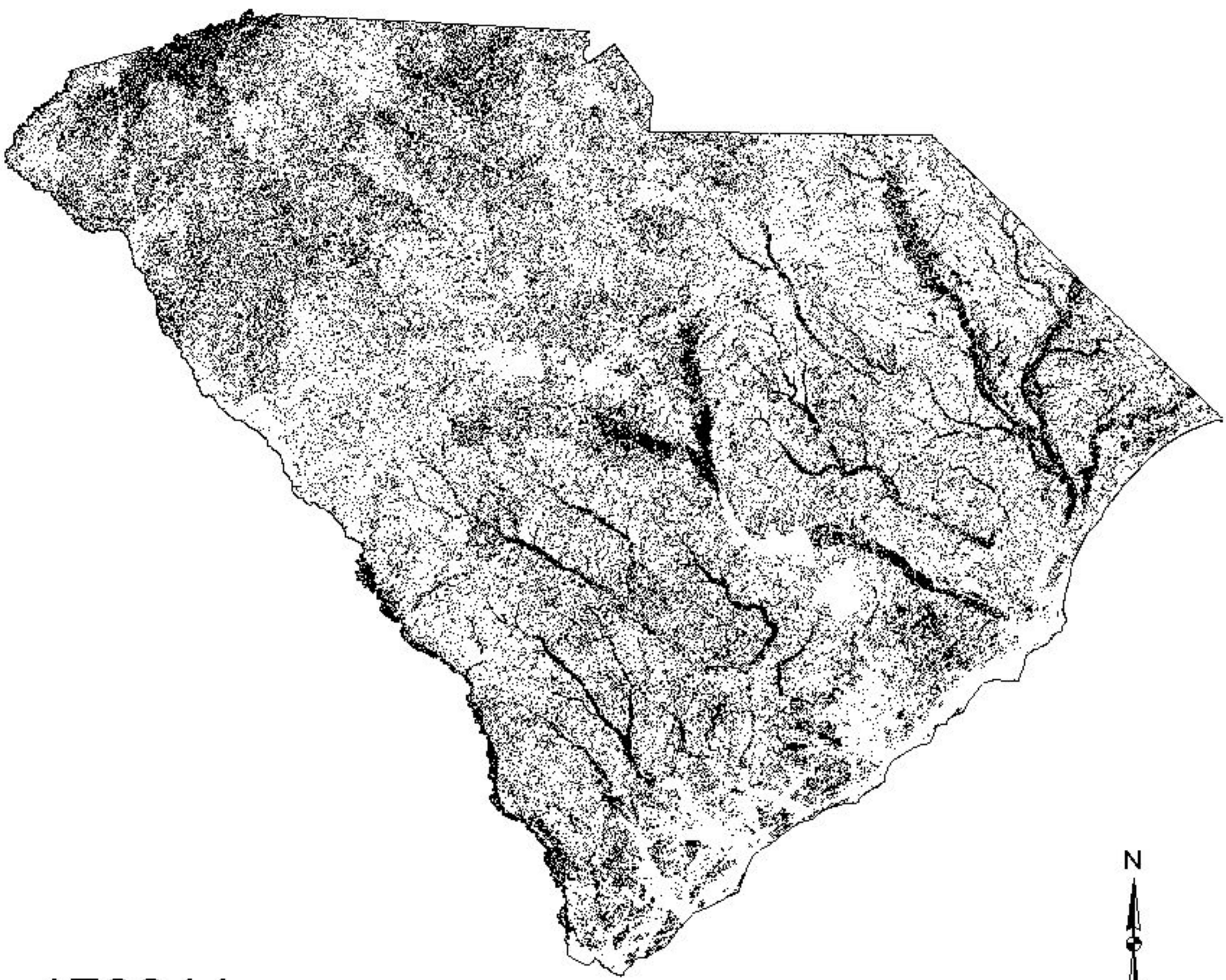
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Black-and-white Warbler

(Mniotilta varia)



178844

Predicted present

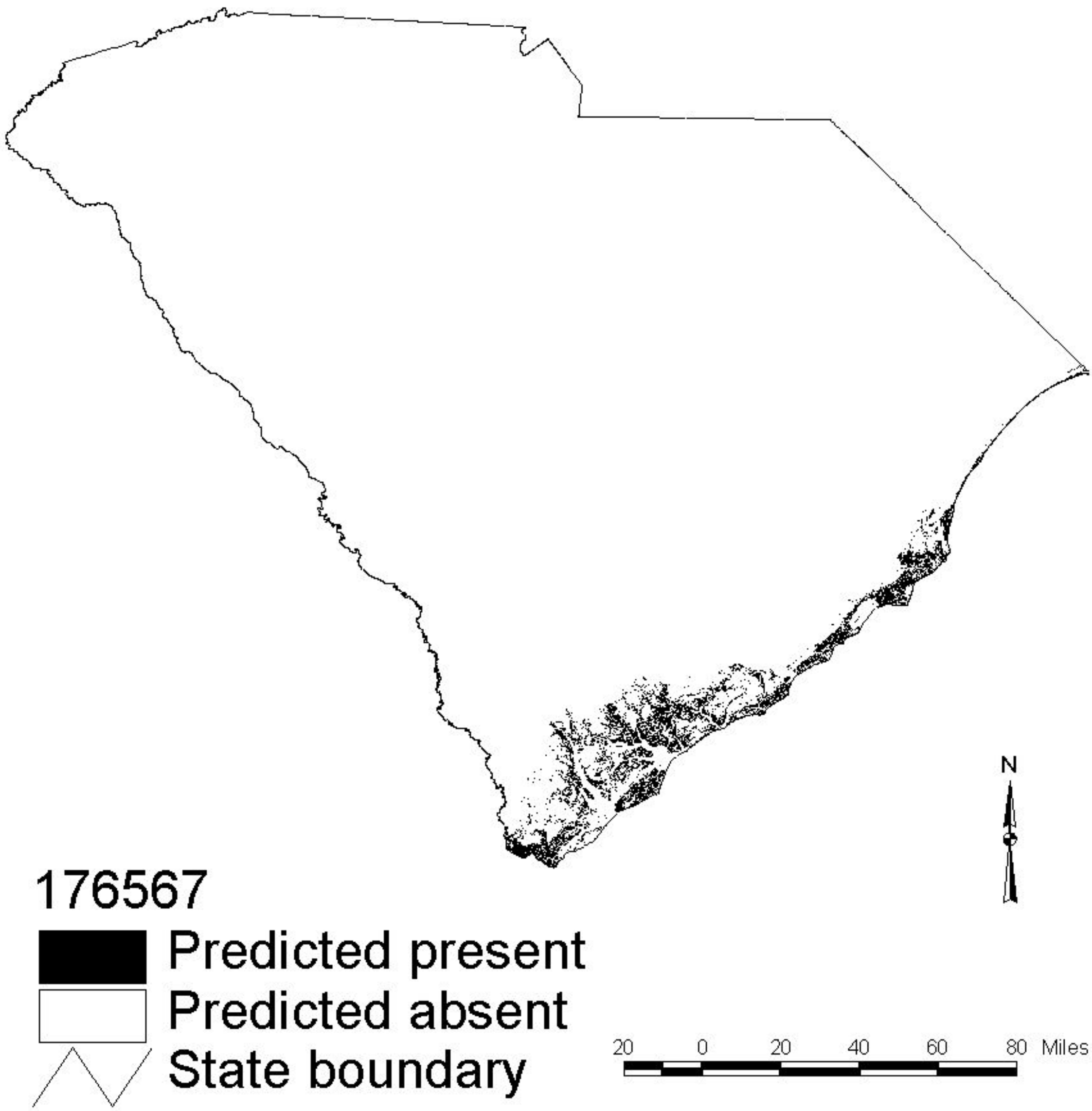
Predicted absent

State boundary

20 0 20 40 60 80 Miles

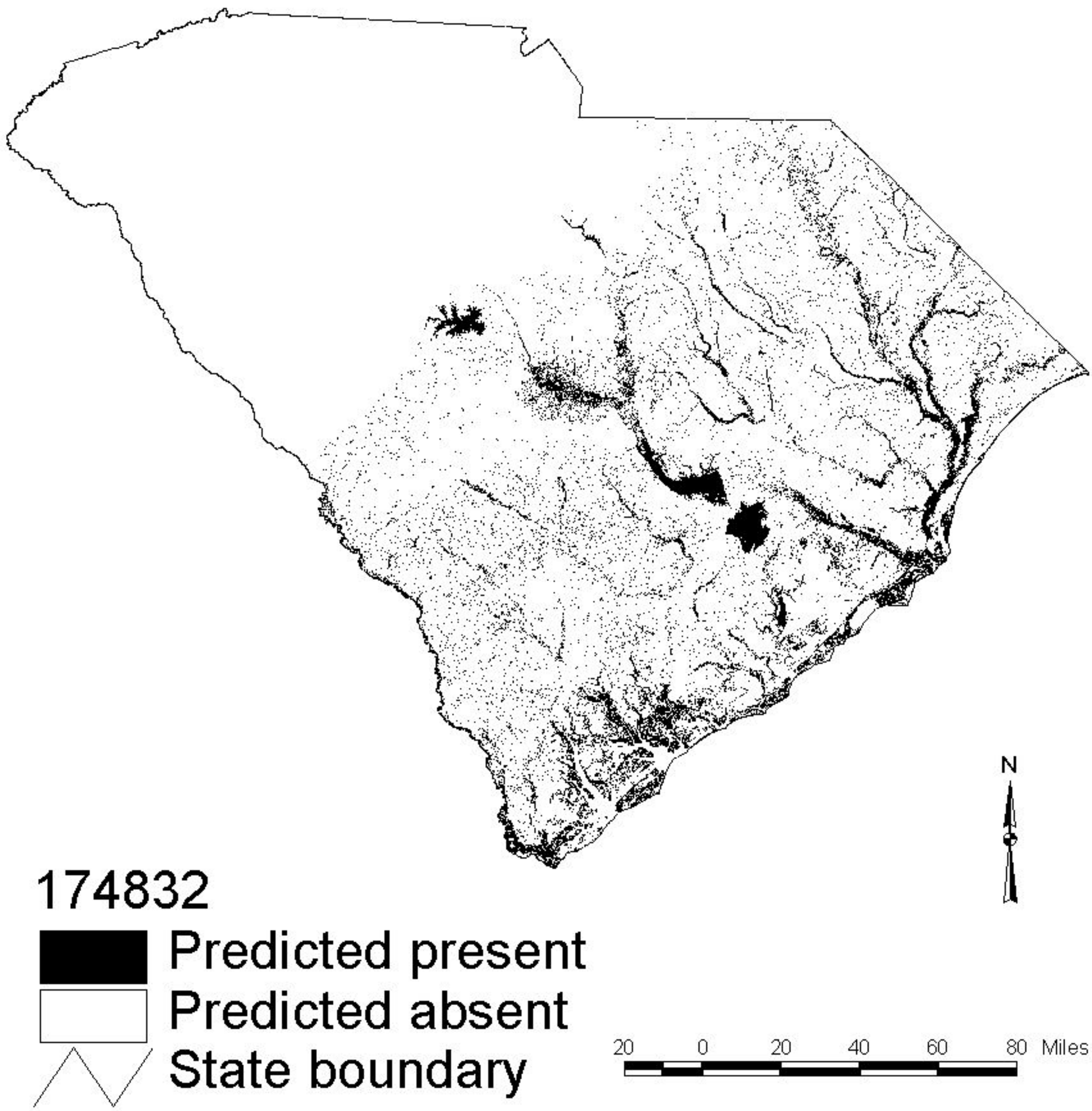
Black-bellied Plover

(Pluvialis squatarola)



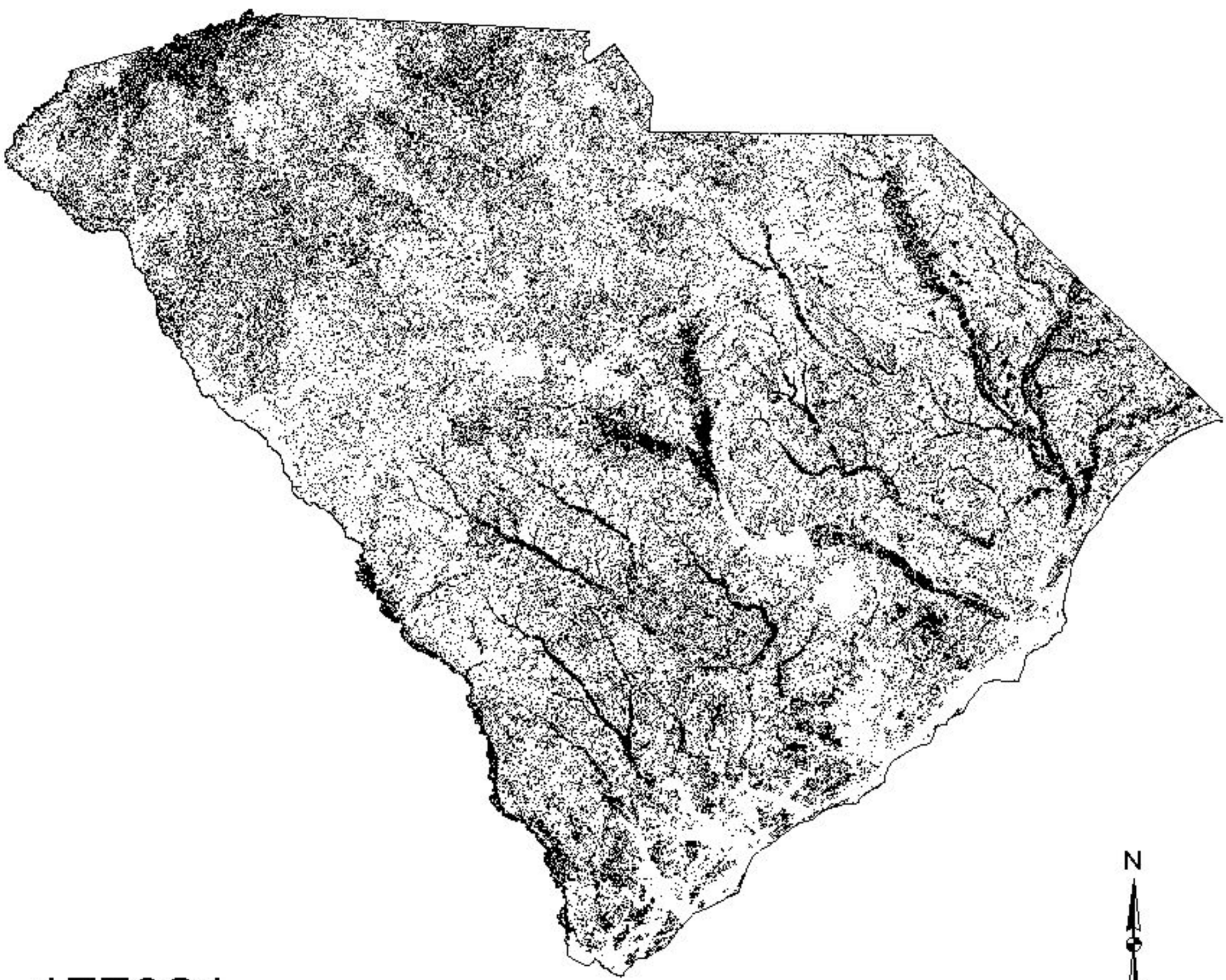
Black-crowned Night-heron

(Nycticorax nycticorax)



Barred Owl

(Strix varia)



177921

Predicted present

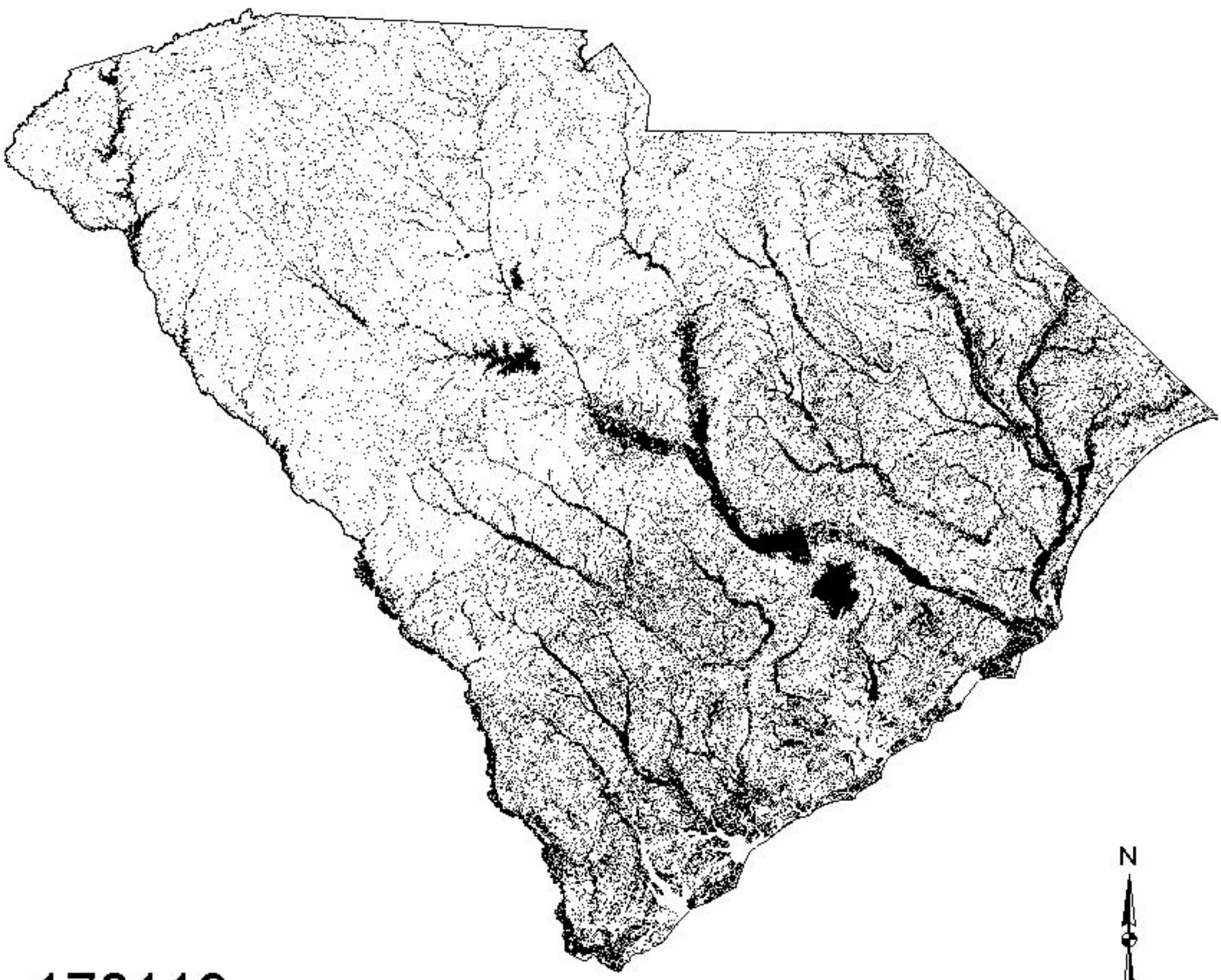
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Belted Kingfisher

(Ceryle alcyon)



178119

Predicted present

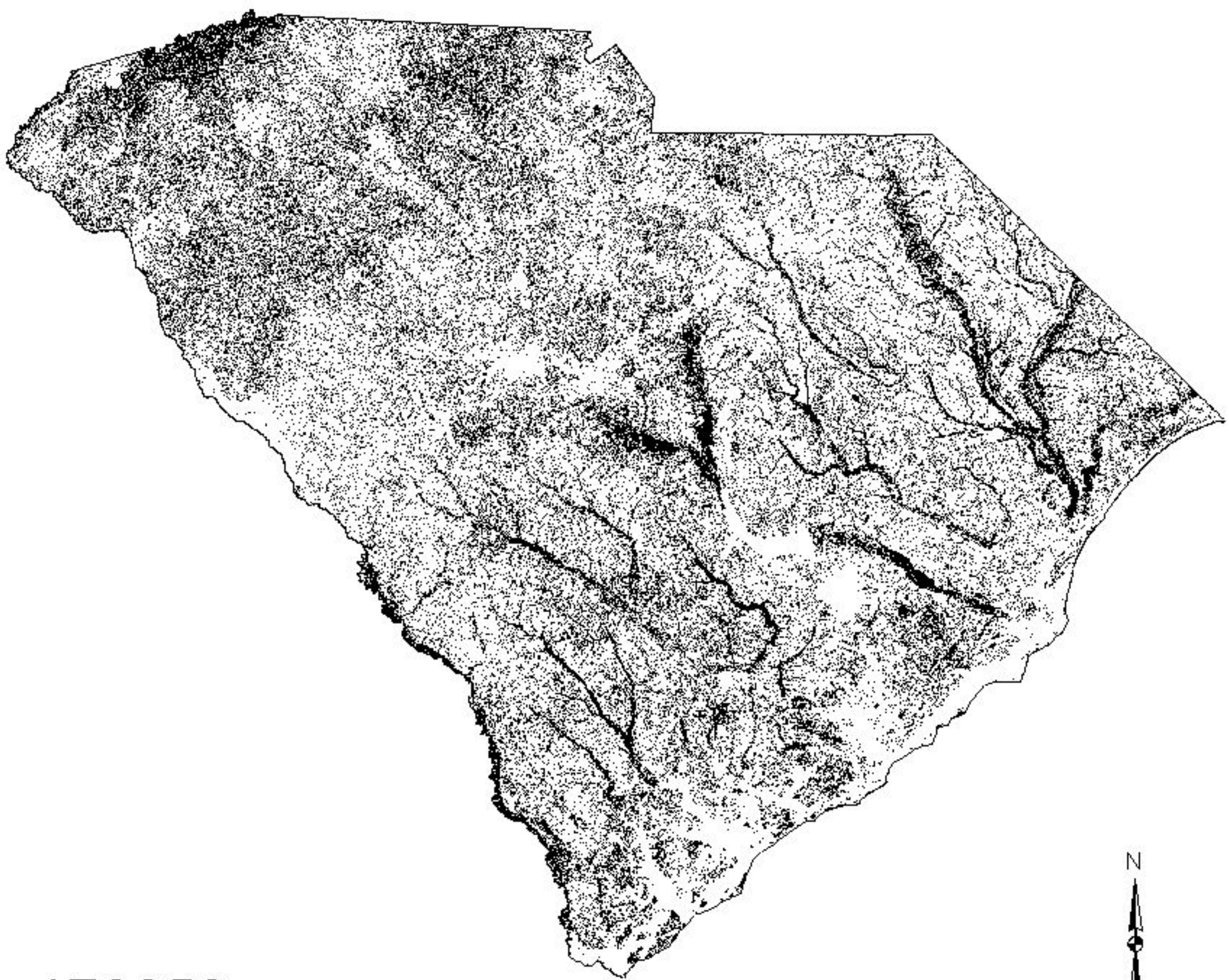
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Blue-gray Gnatcatcher

(Polioptila caerulea)



179853

Predicted present

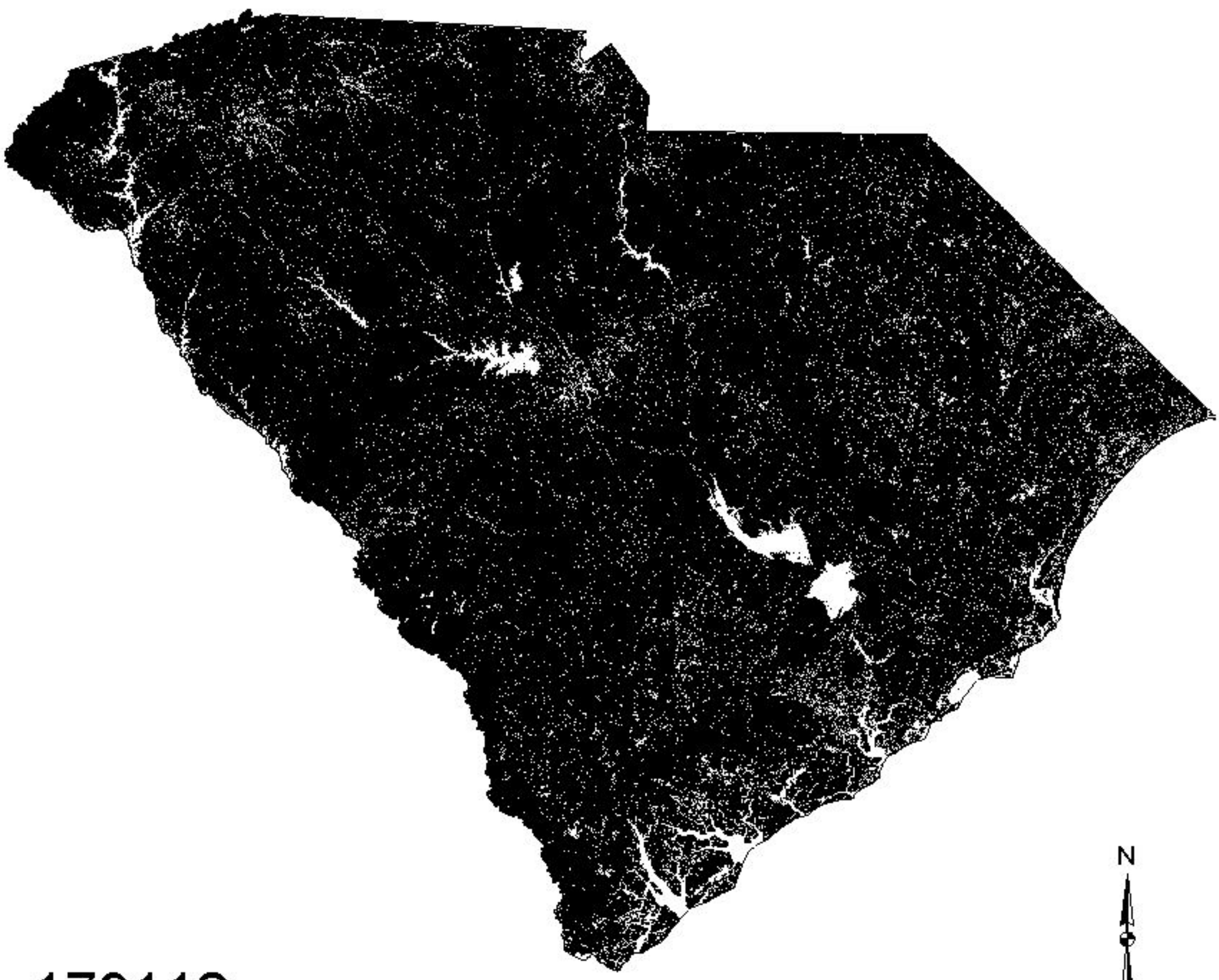
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Brown-headed Cowbird

(Molothrus ater)



179112

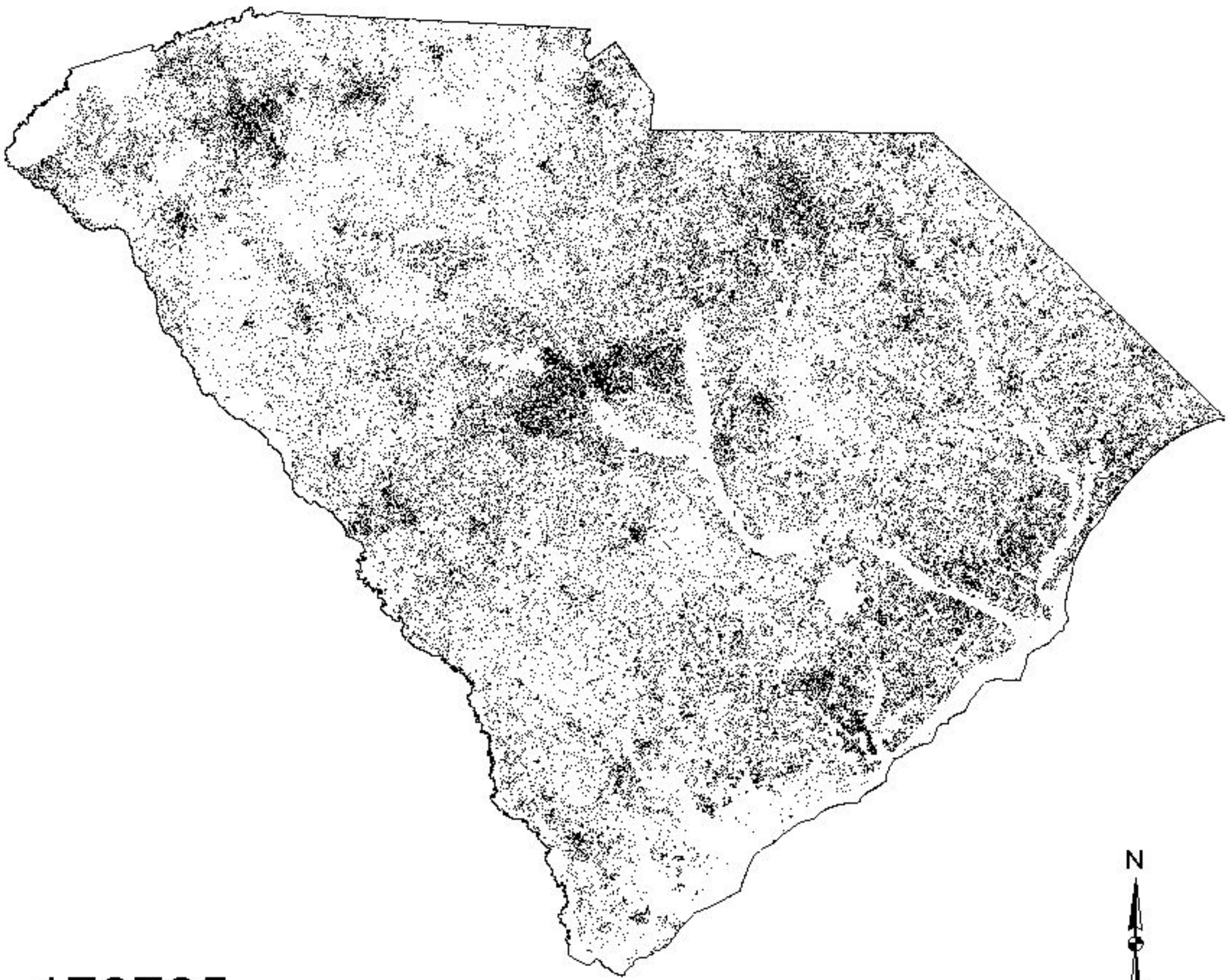
Predicted present

Predicted absent

State boundary

Brown-headed Nuthatch

(Sitta pusilla)



178785

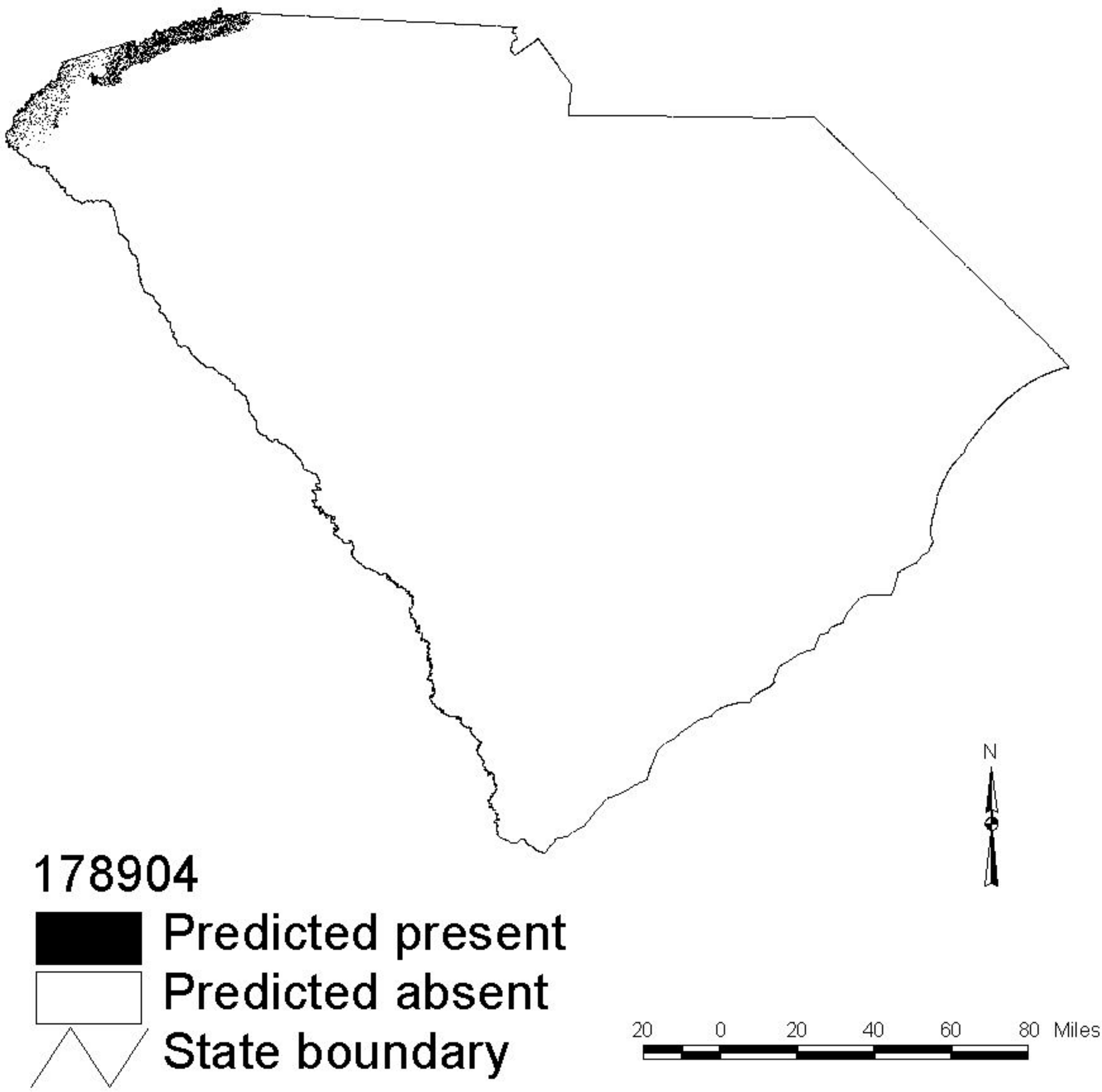
Predicted present

Predicted absent

State boundary

Blackburnian Warbler

(Dendroica fusca)



178904

Predicted present

Predicted absent

State boundary

Blue Grosbeak

(Guiraca caerulea)

179145

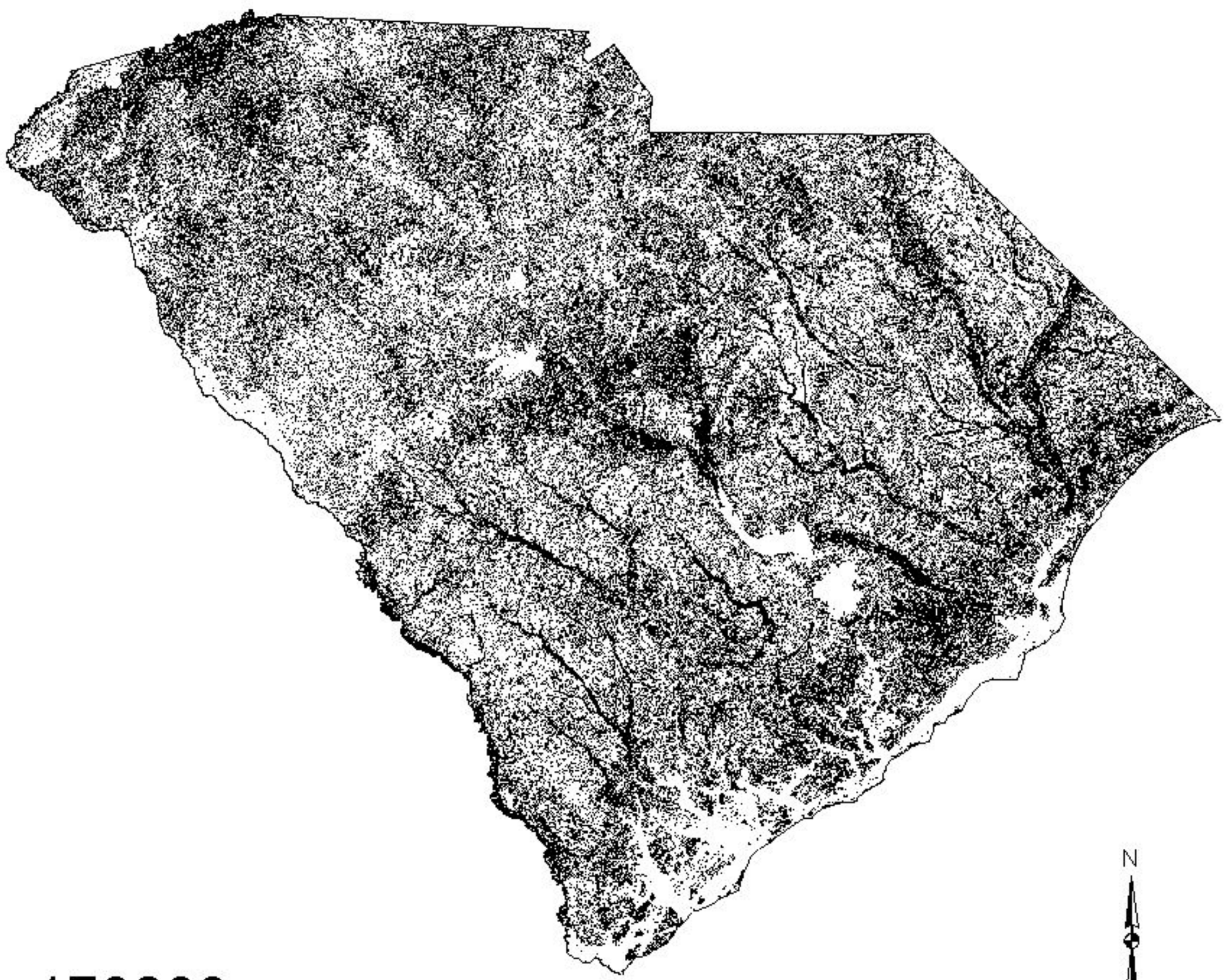
Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Blue Jay
(Cyanocitta cristata)



179680

Predicted present

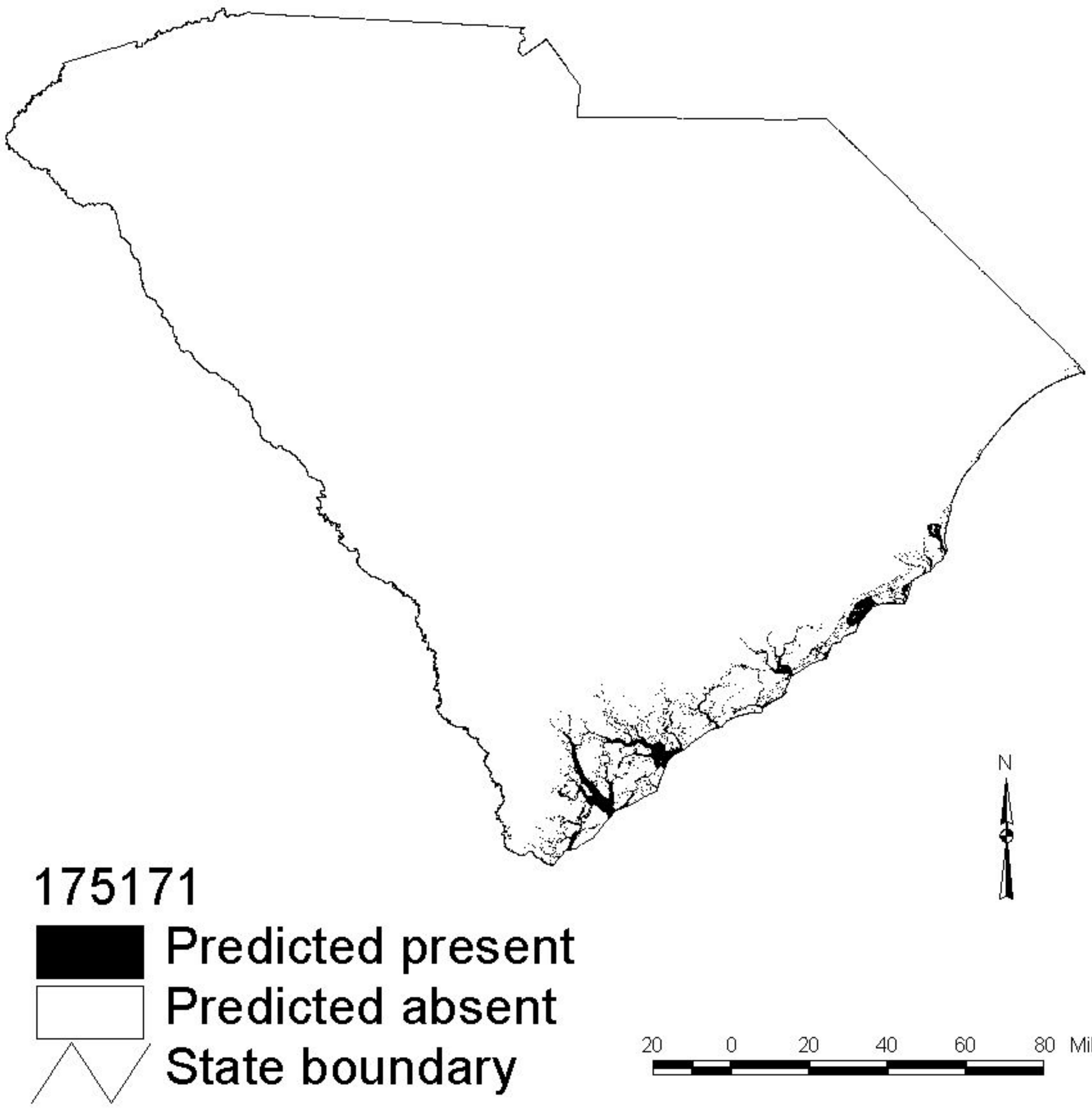
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Black Scoter

(Melanitta nigra)



175171

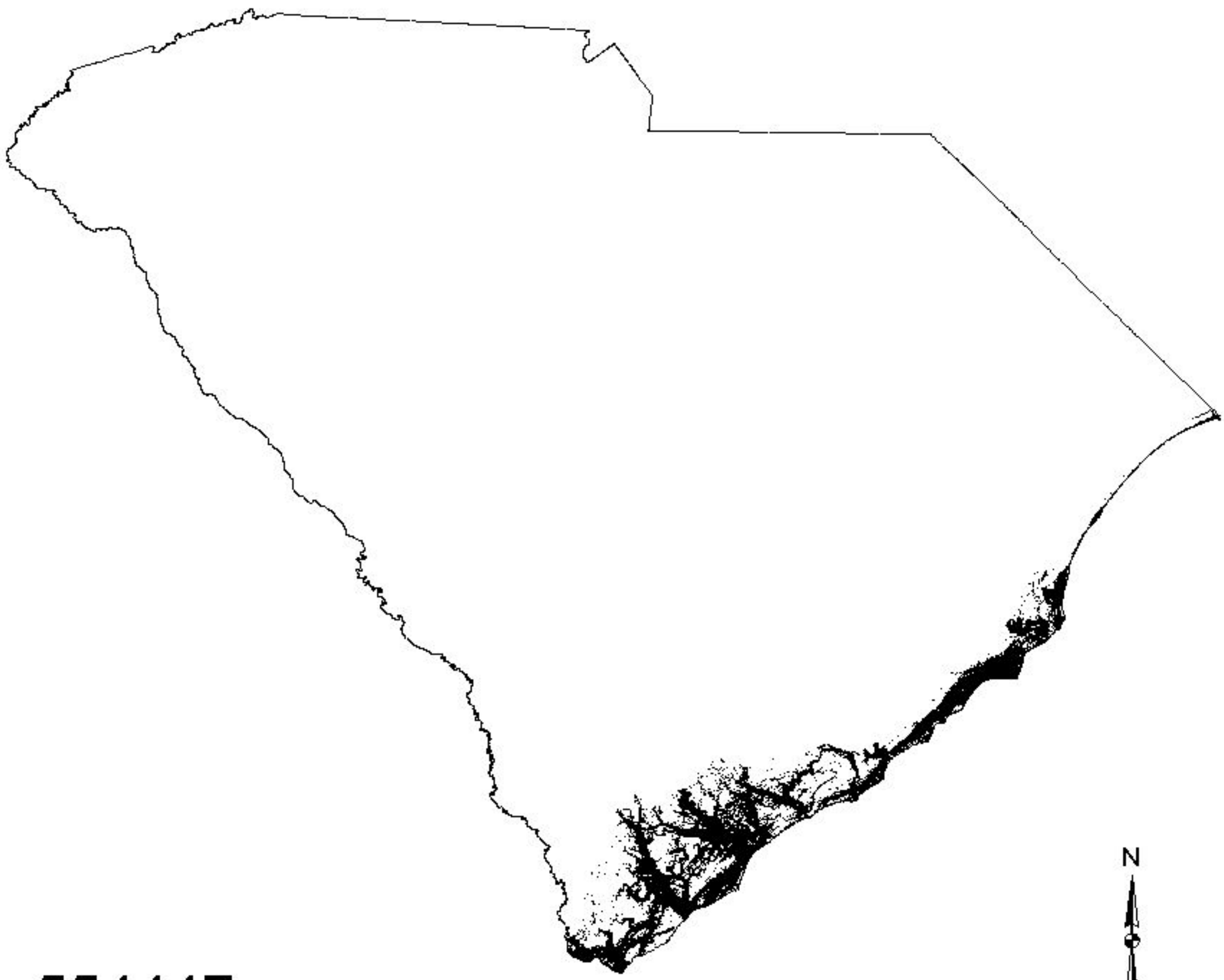
Predicted present

Predicted absent

State boundary

Black Skimmer

(Rynchops niger)



554447

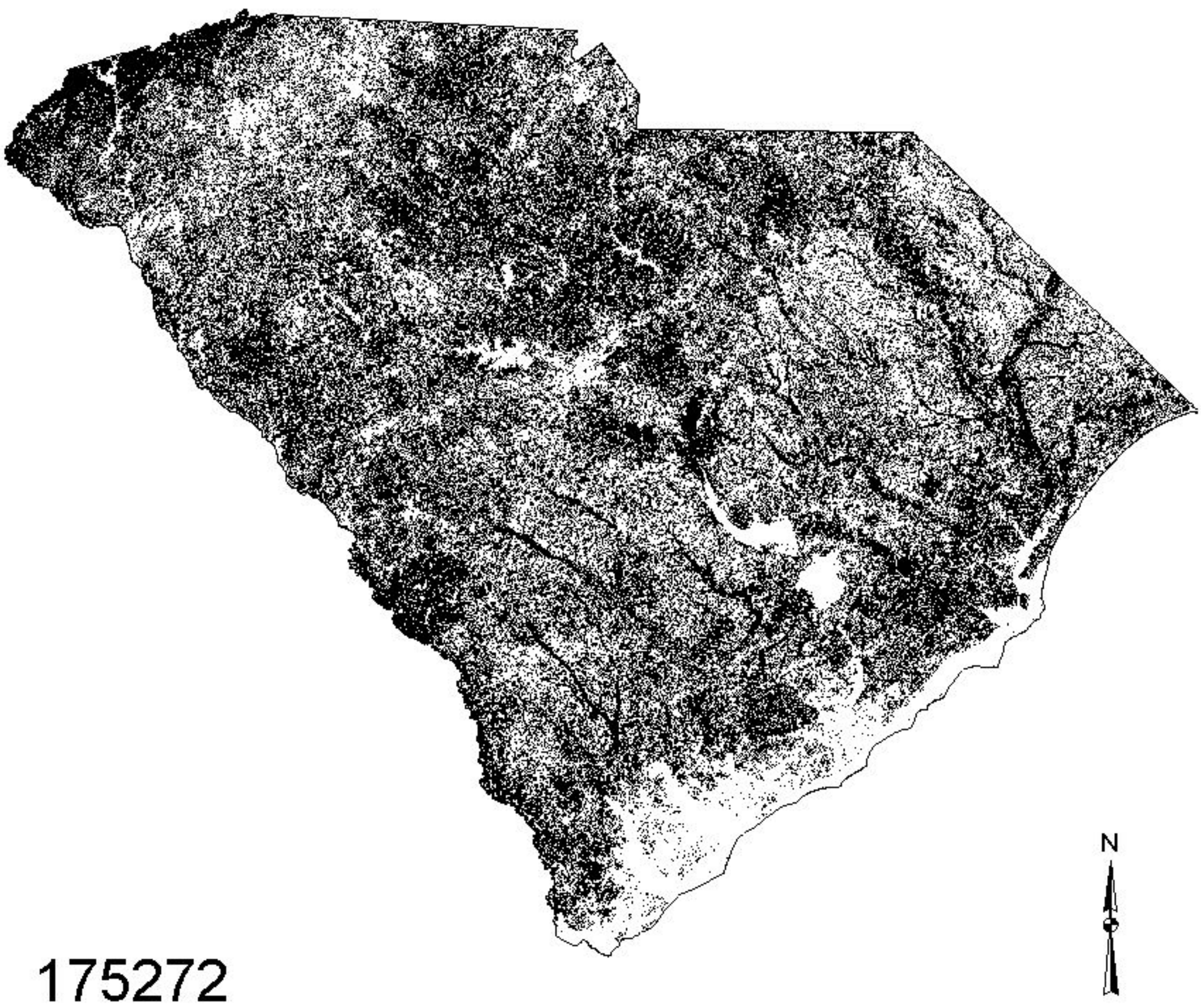
Predicted present

Predicted absent

State boundary

Black Vulture

(Coragyps atratus)



175272

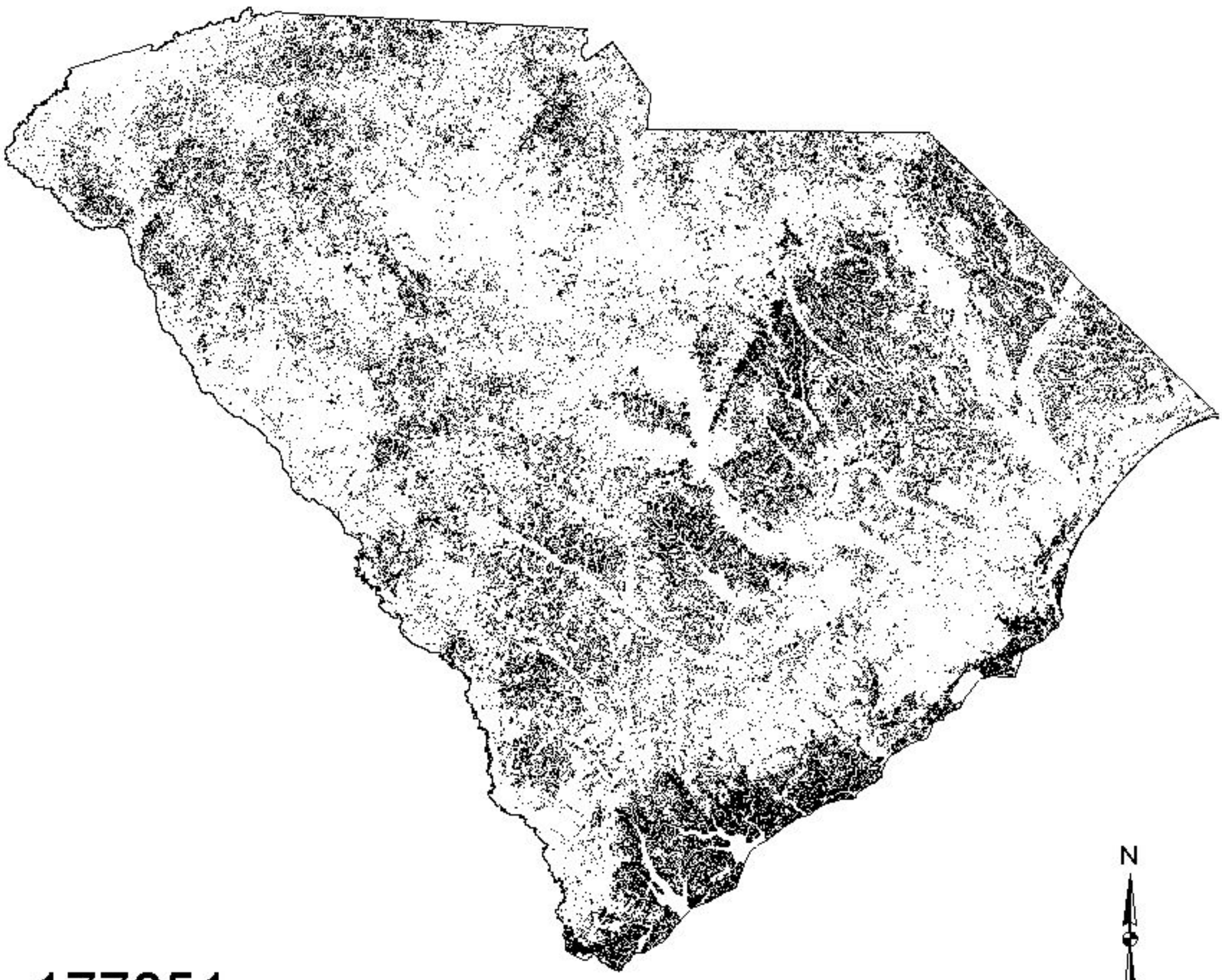
Predicted present

Predicted absent

State boundary

Barn Owl

(Tyto alba)



177851

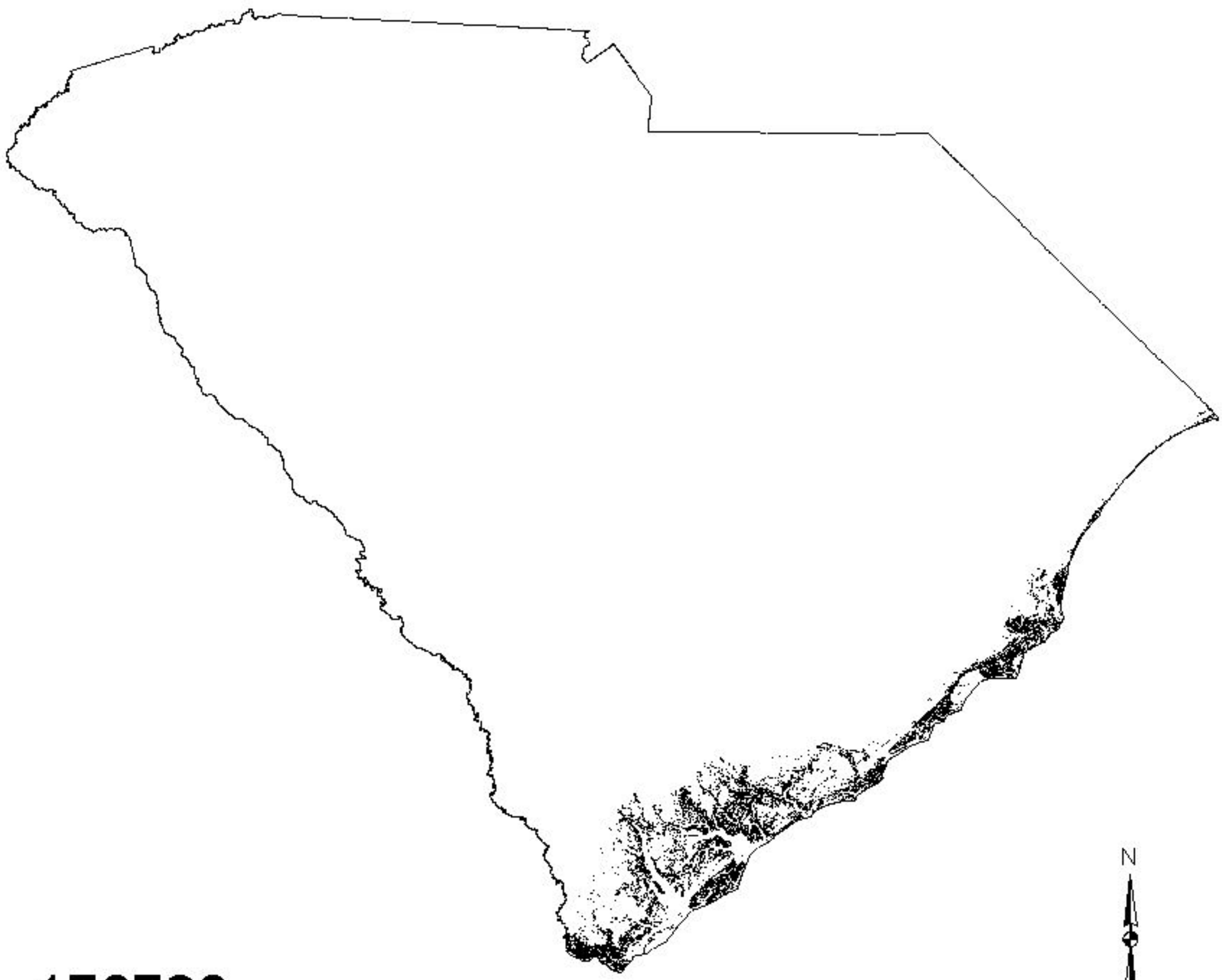
Predicted present

Predicted absent

State boundary

Black-necked Stilt

(Himantopus mexicanus)



176726

Predicted present

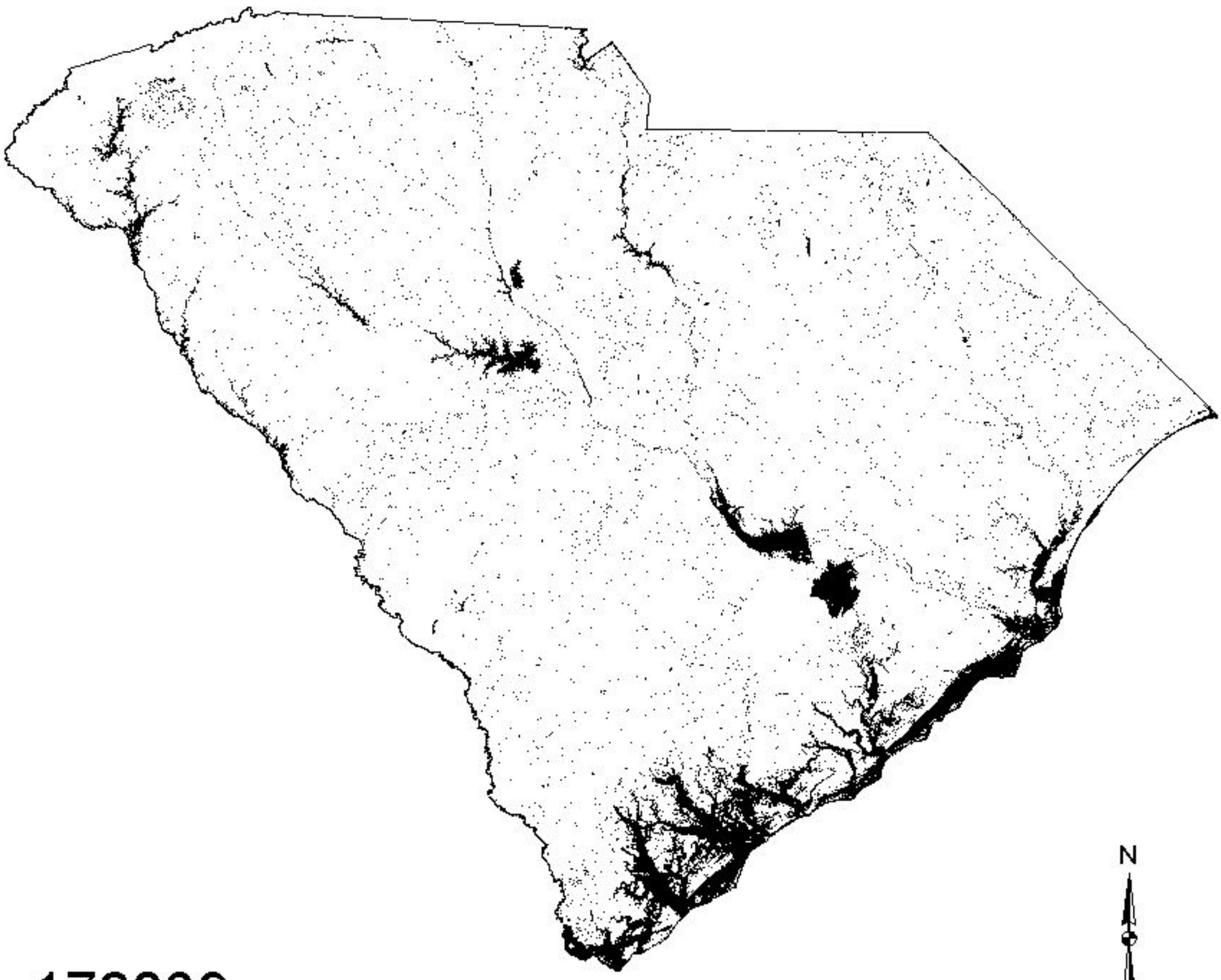
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Bonaparte's Gull

(Larus philadelphia)



176839

Predicted present

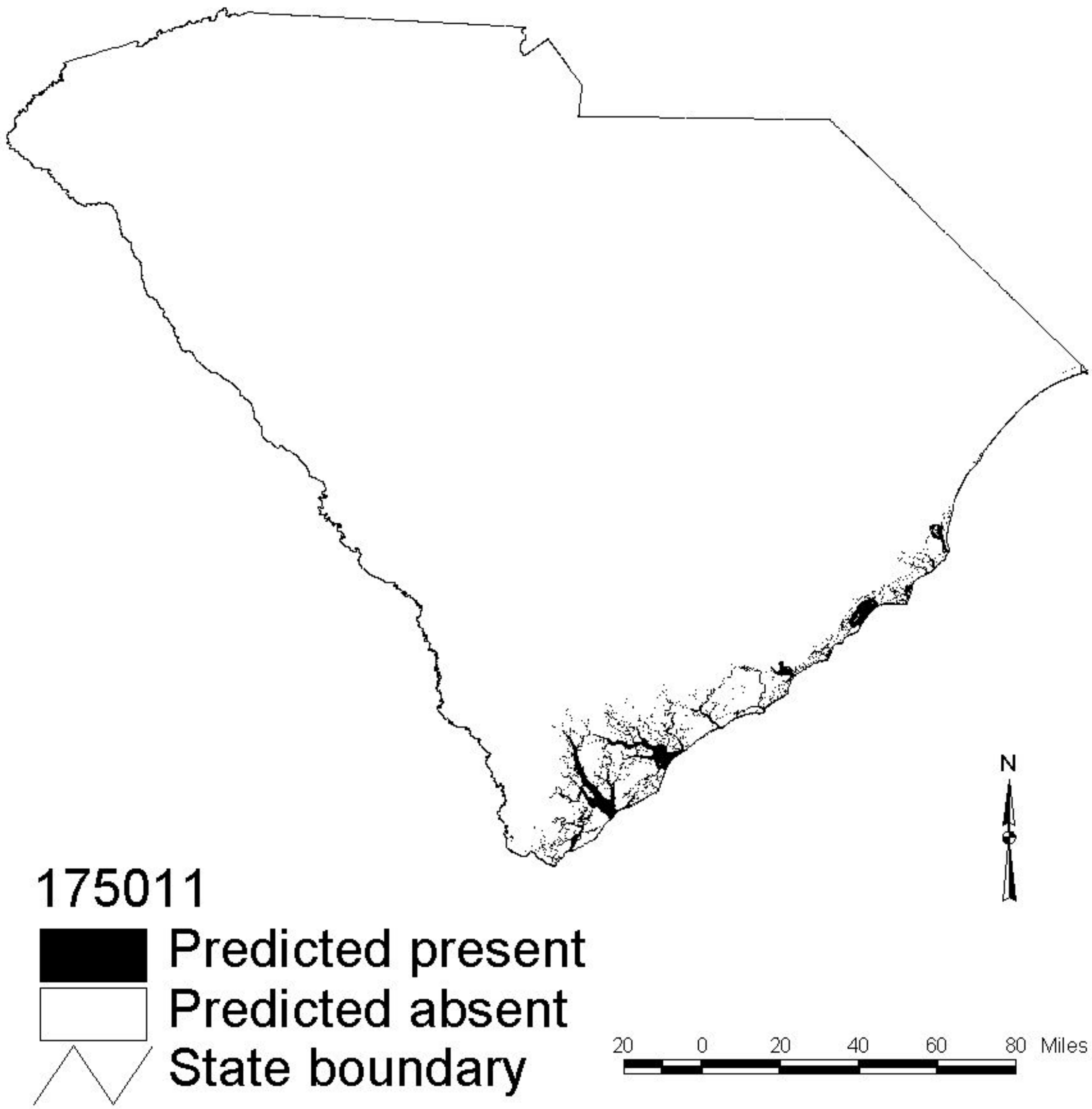
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Brant

(Branta bernicla)



175011

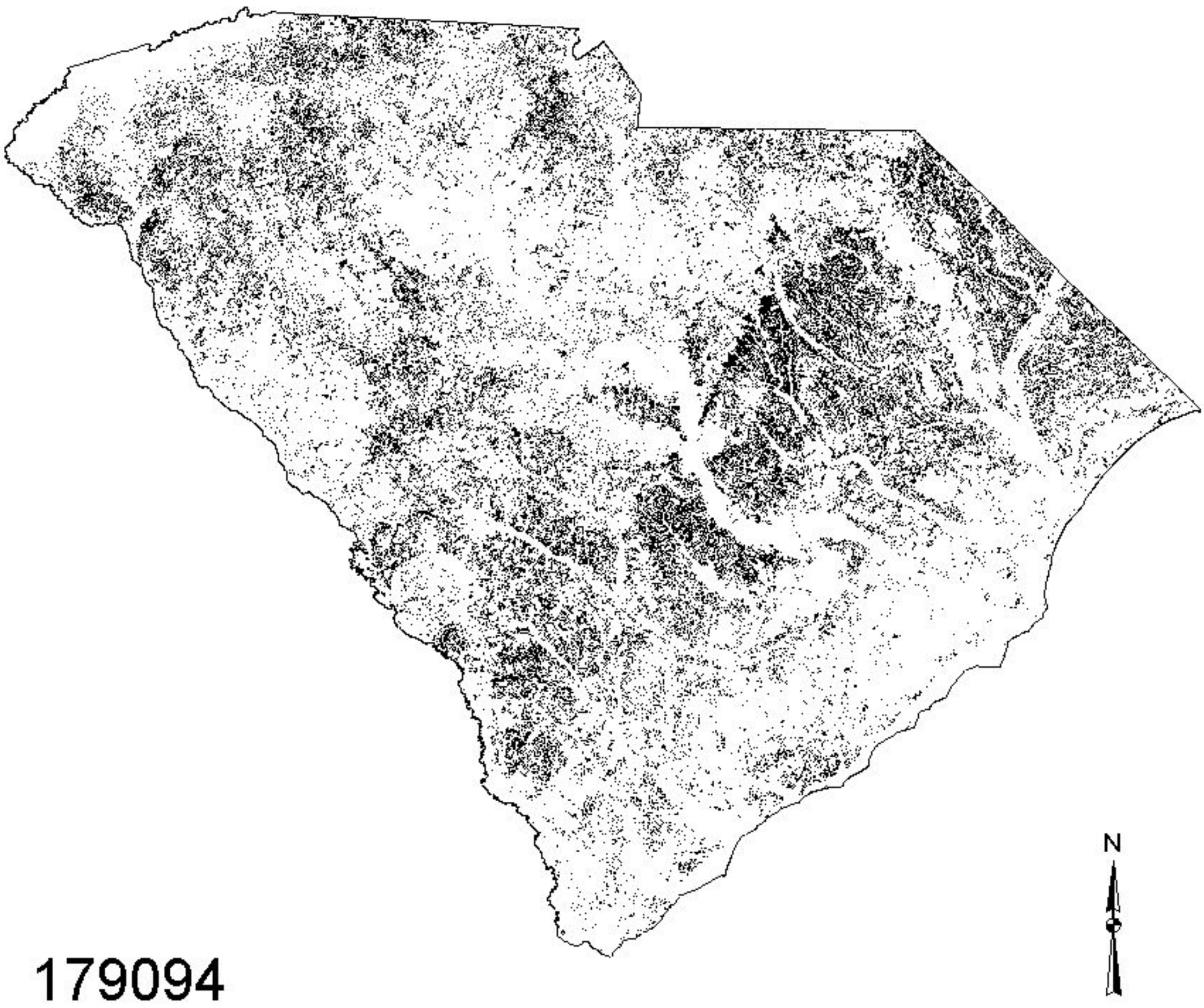
Predicted present

Predicted absent

State boundary

Brewer's Blackbird

(Euphagus cyanocephalus)



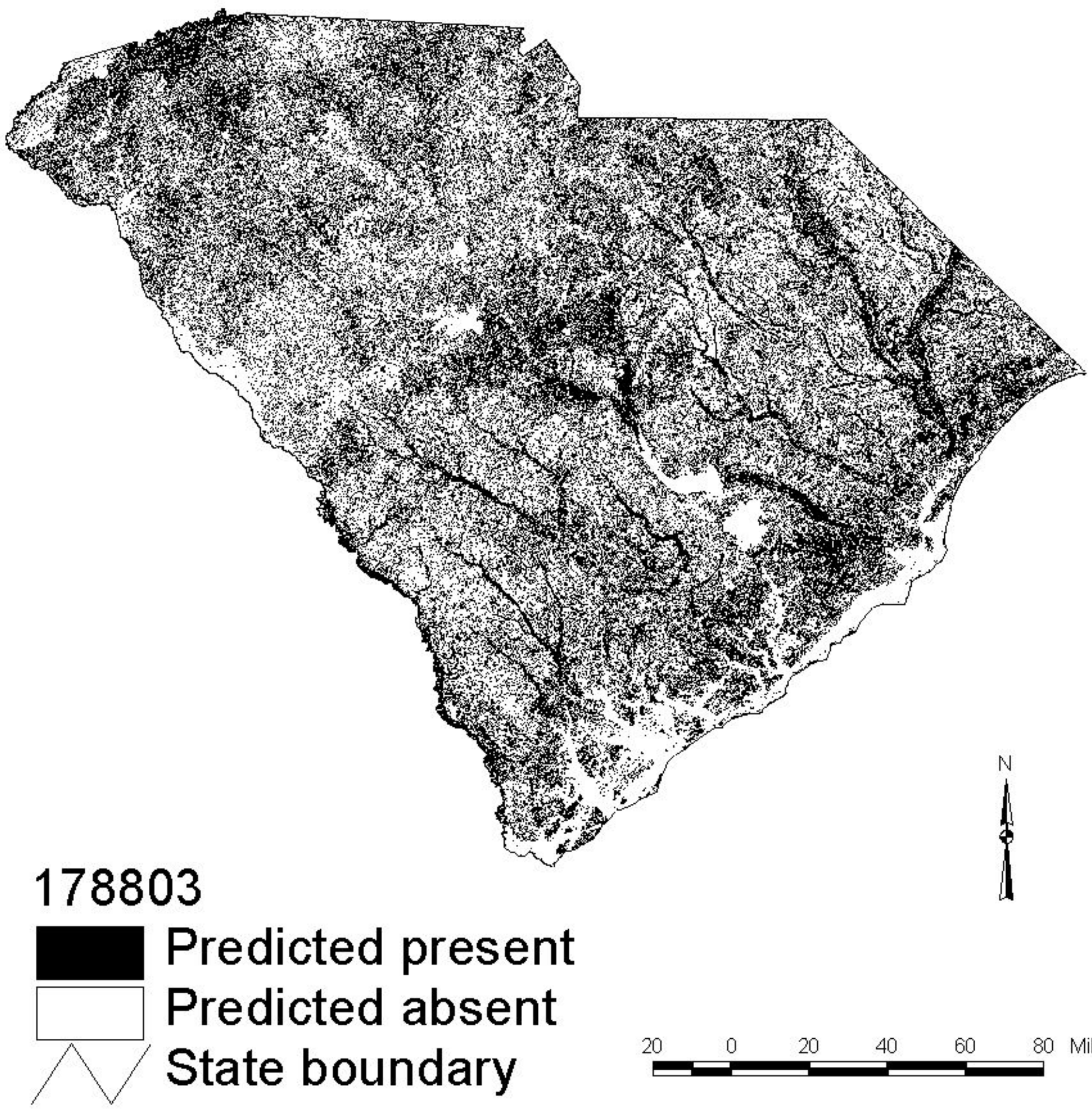
179094

Predicted present

Predicted absent

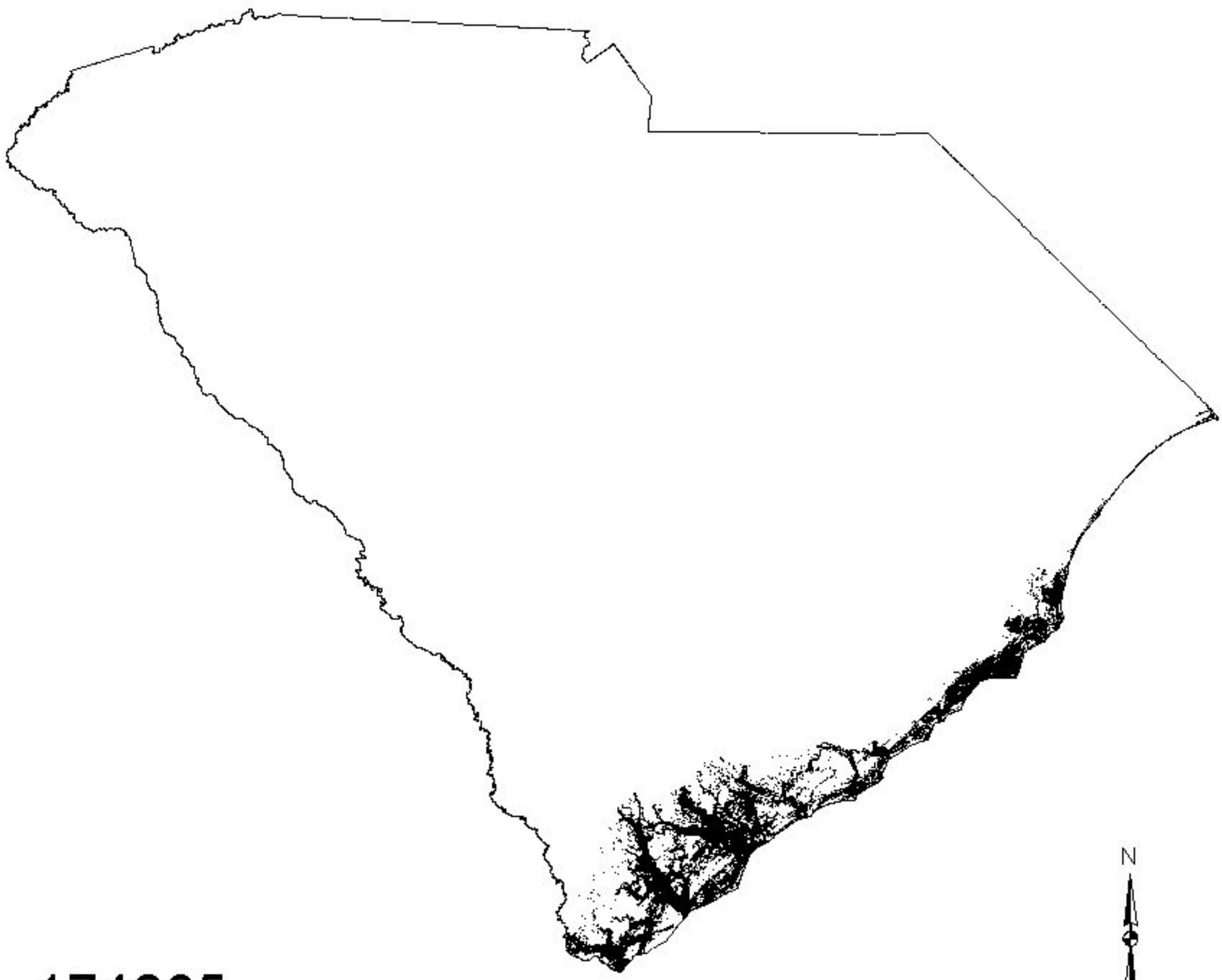
State boundary

Brown Creeper
(Certhia americana)



Brown Pelican

(Pelecanus occidentalis)



174685

Predicted present

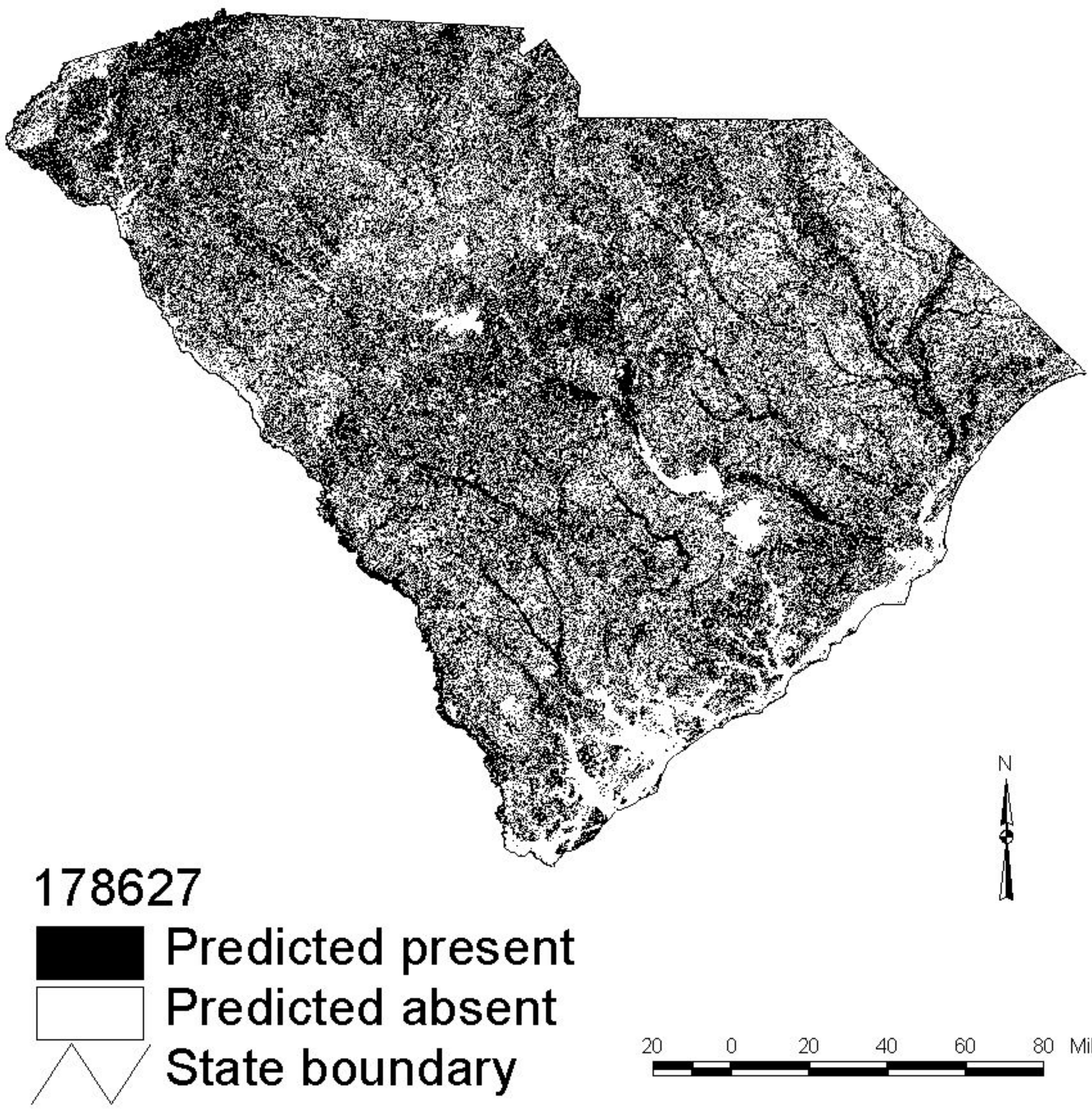
Predicted absent

State boundary

20 0 20 40 60 80 Miles

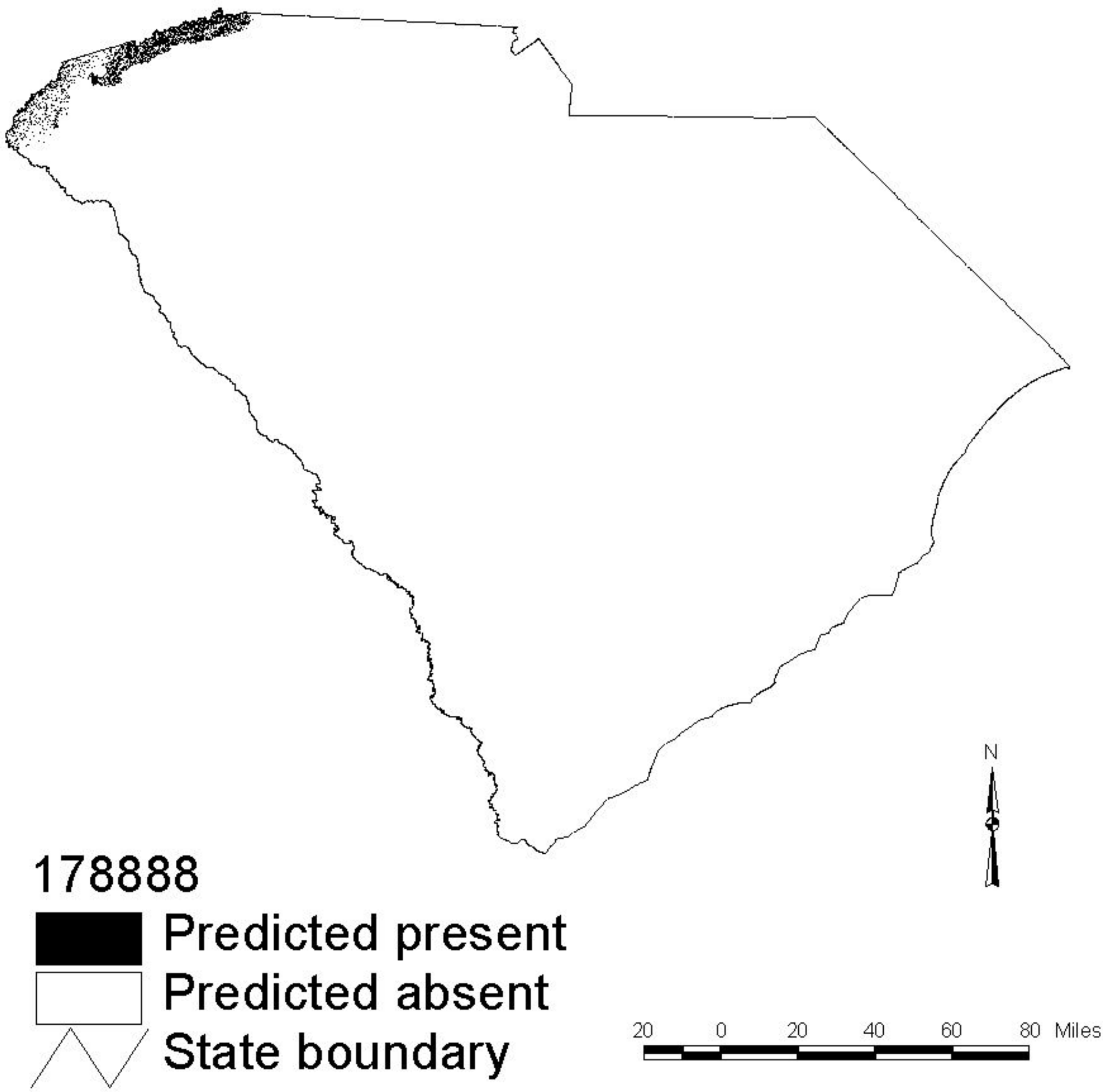
Brown Thrasher

(Toxostoma rufum)



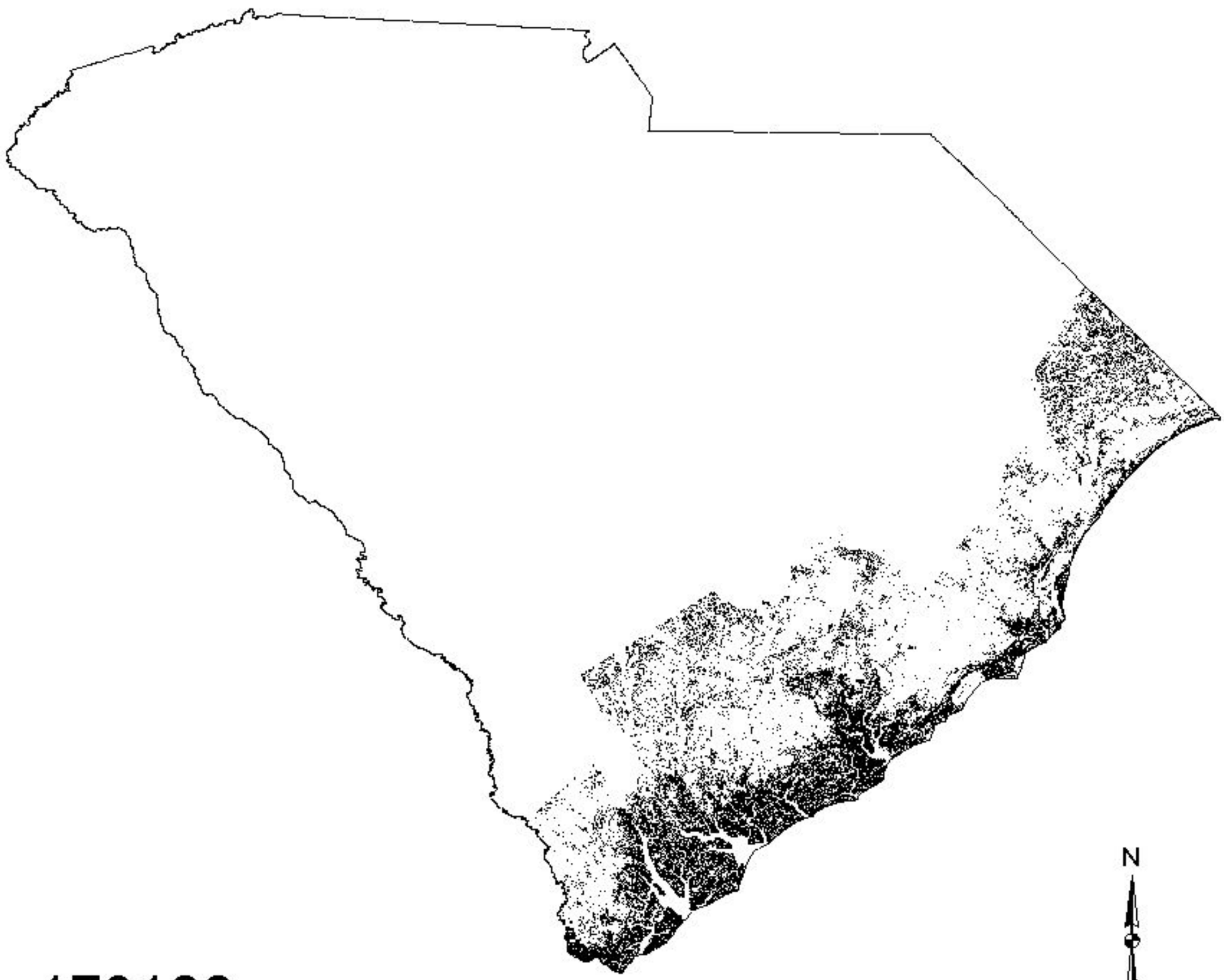
Black-throated Blue Warbler

(Dendroica caerulescens)



Boat-tailed Grackle

(Quiscalus major)



179108

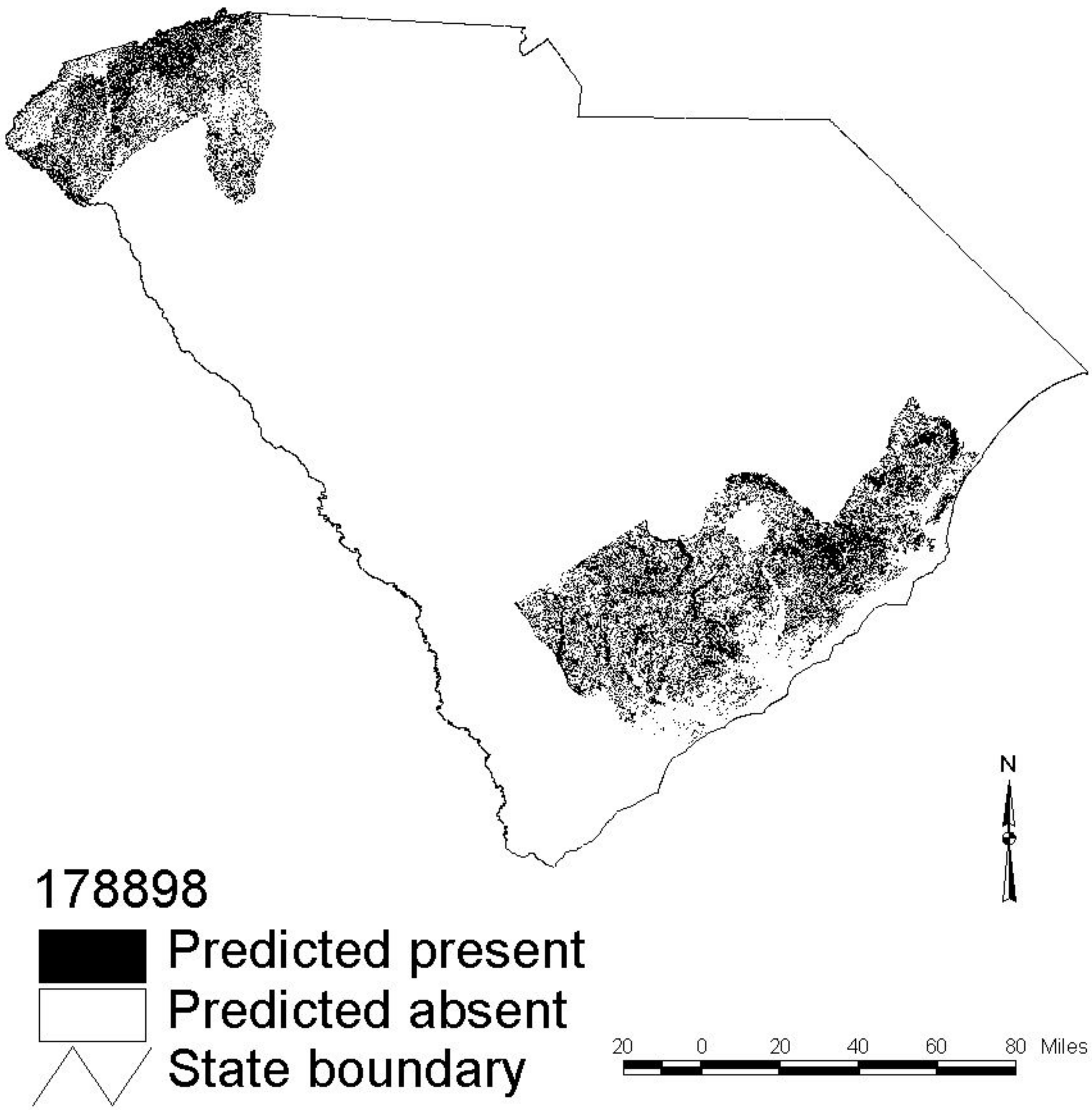
Predicted present

Predicted absent

State boundary

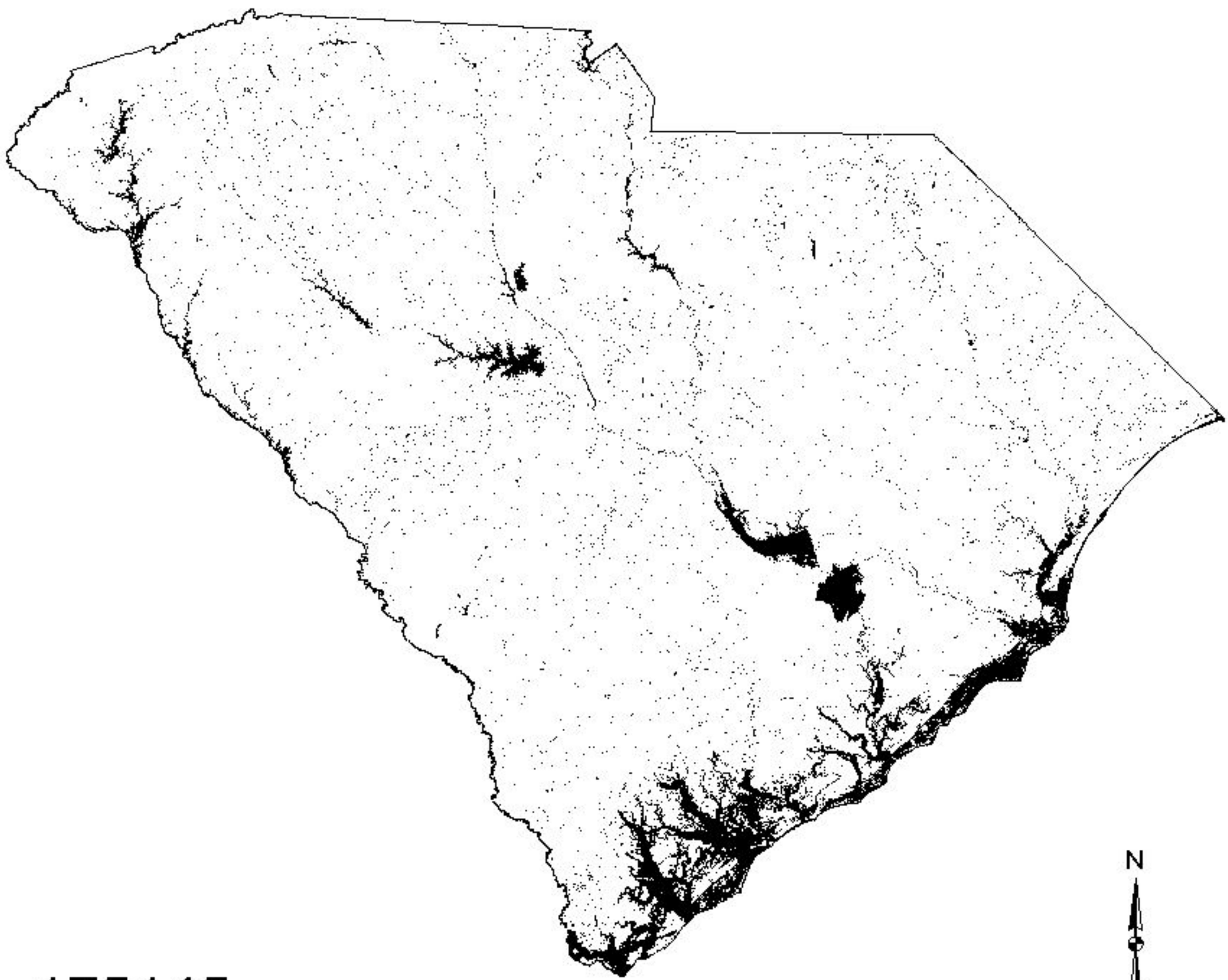
Black-throated Green Warbler

(Dendroica virens)



Bufflehead

(Bucephala albeola)



175145

Predicted present

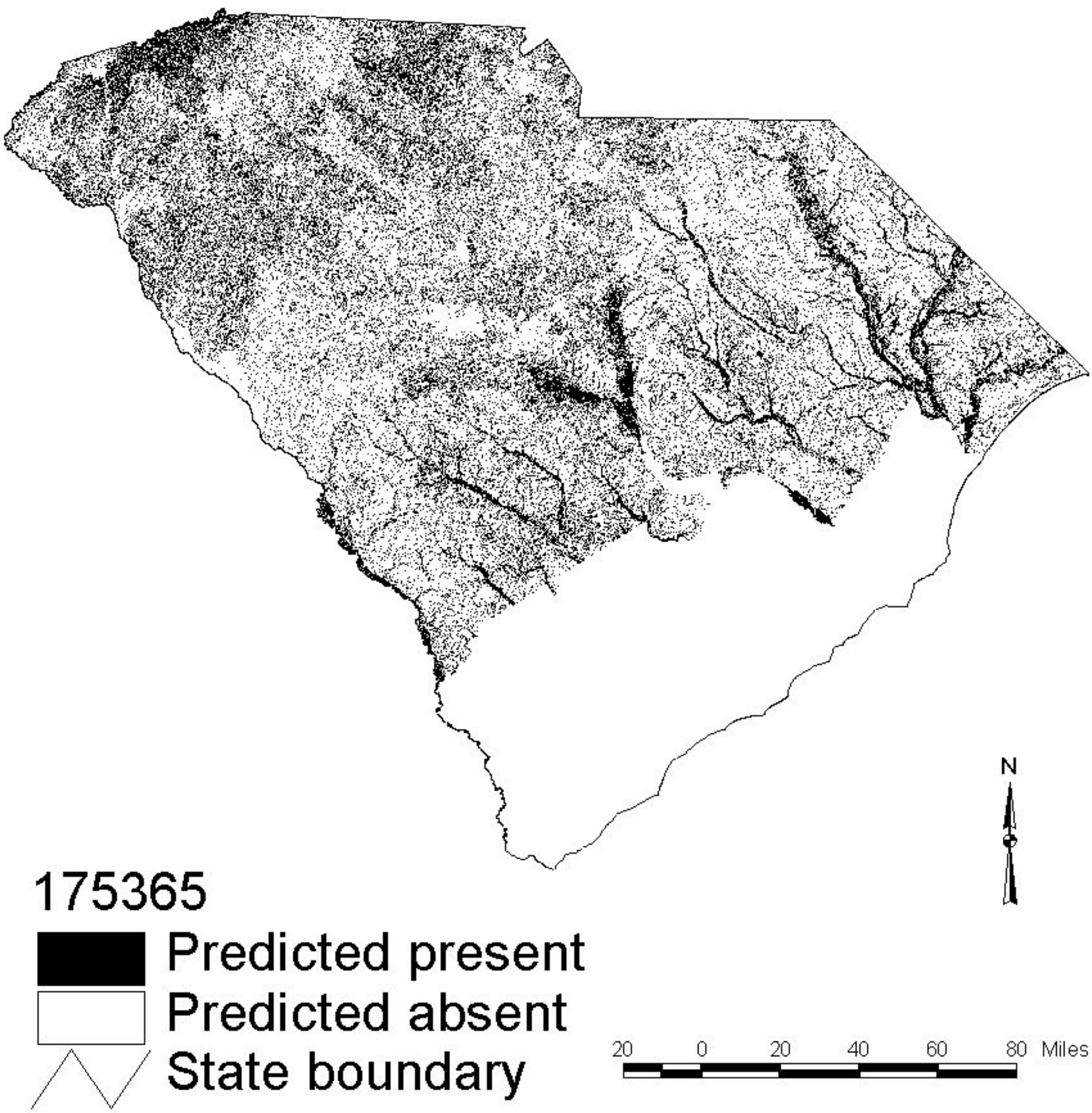
Predicted absent

State boundary

20 0 20 40 60 80 Miles

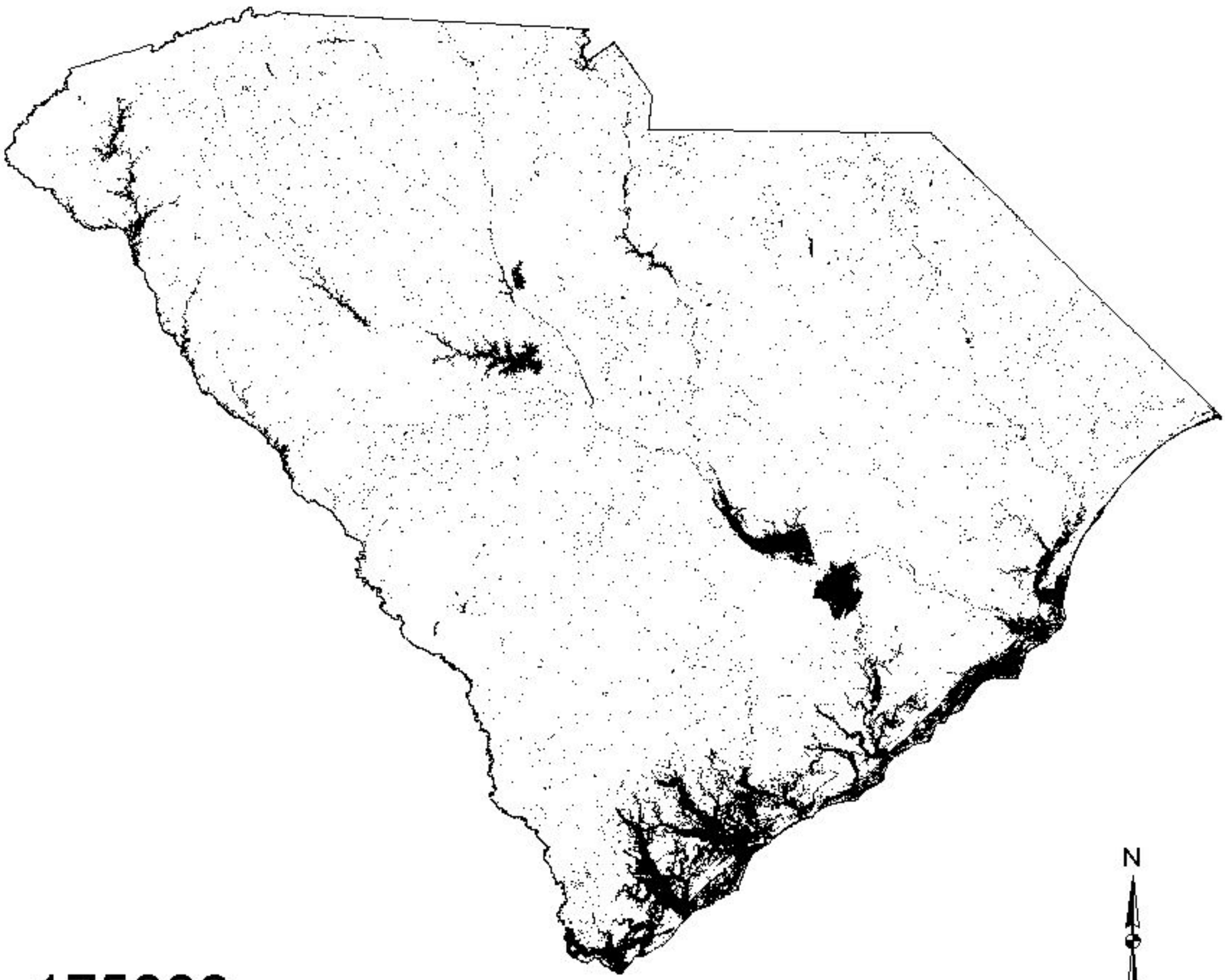
Broad-winged Hawk

(Buteo platypterus)



Blue-winged Teal

(Anas discors)



175086

Predicted present

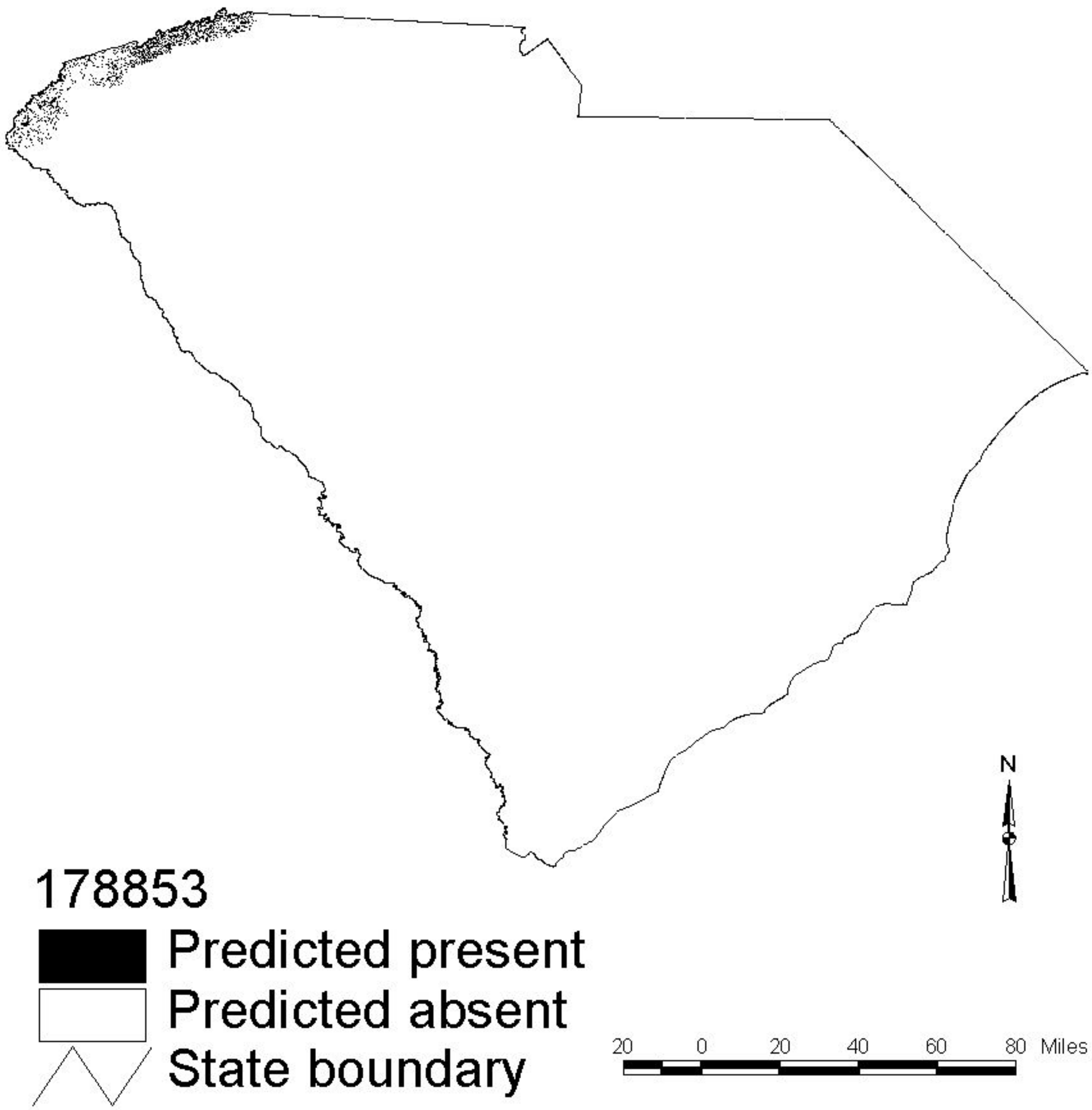
Predicted absent

State boundary

20 0 20 40 60 80 Miles

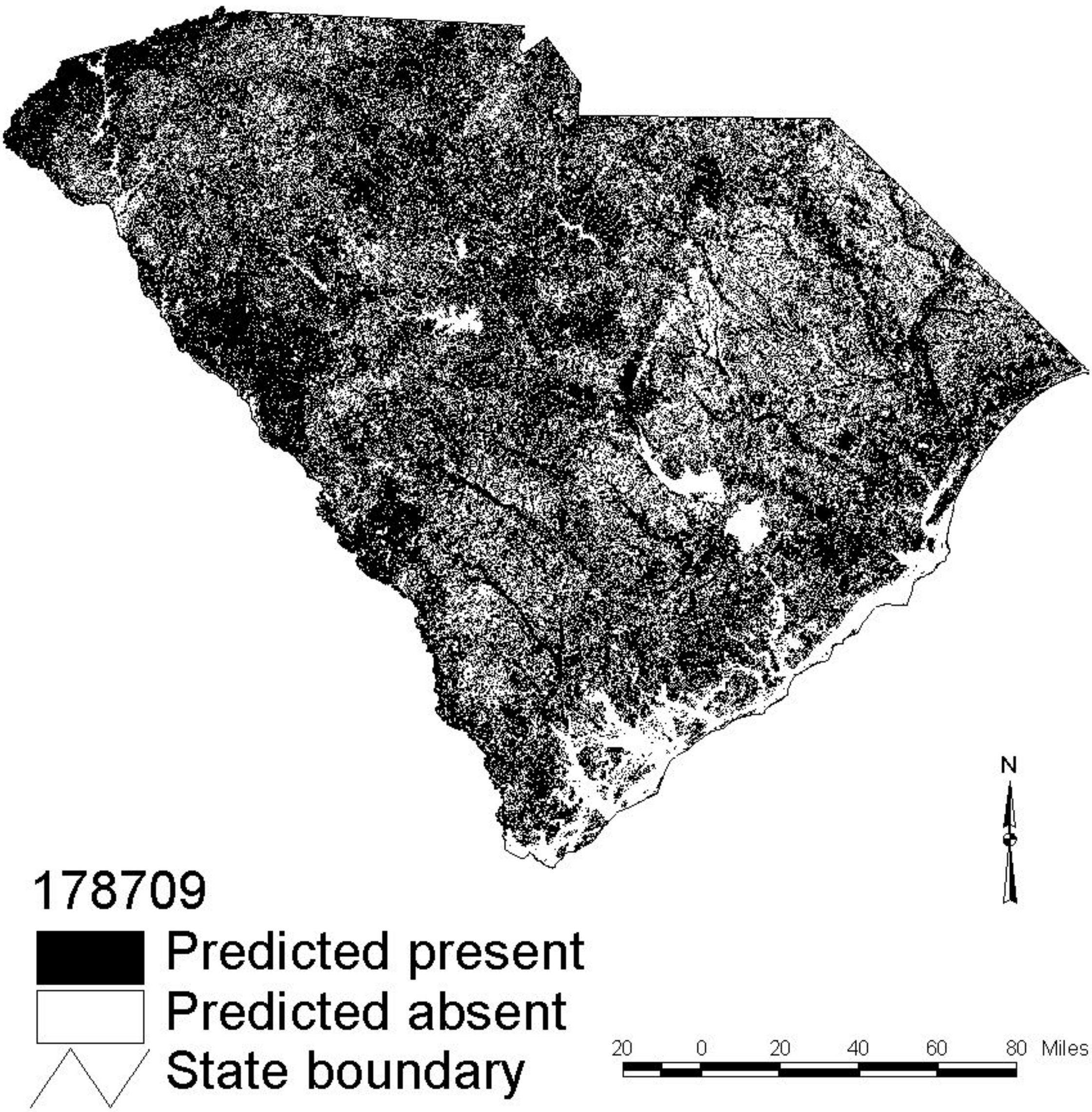
Blue-winged Warbler

(Vermivora pinus)



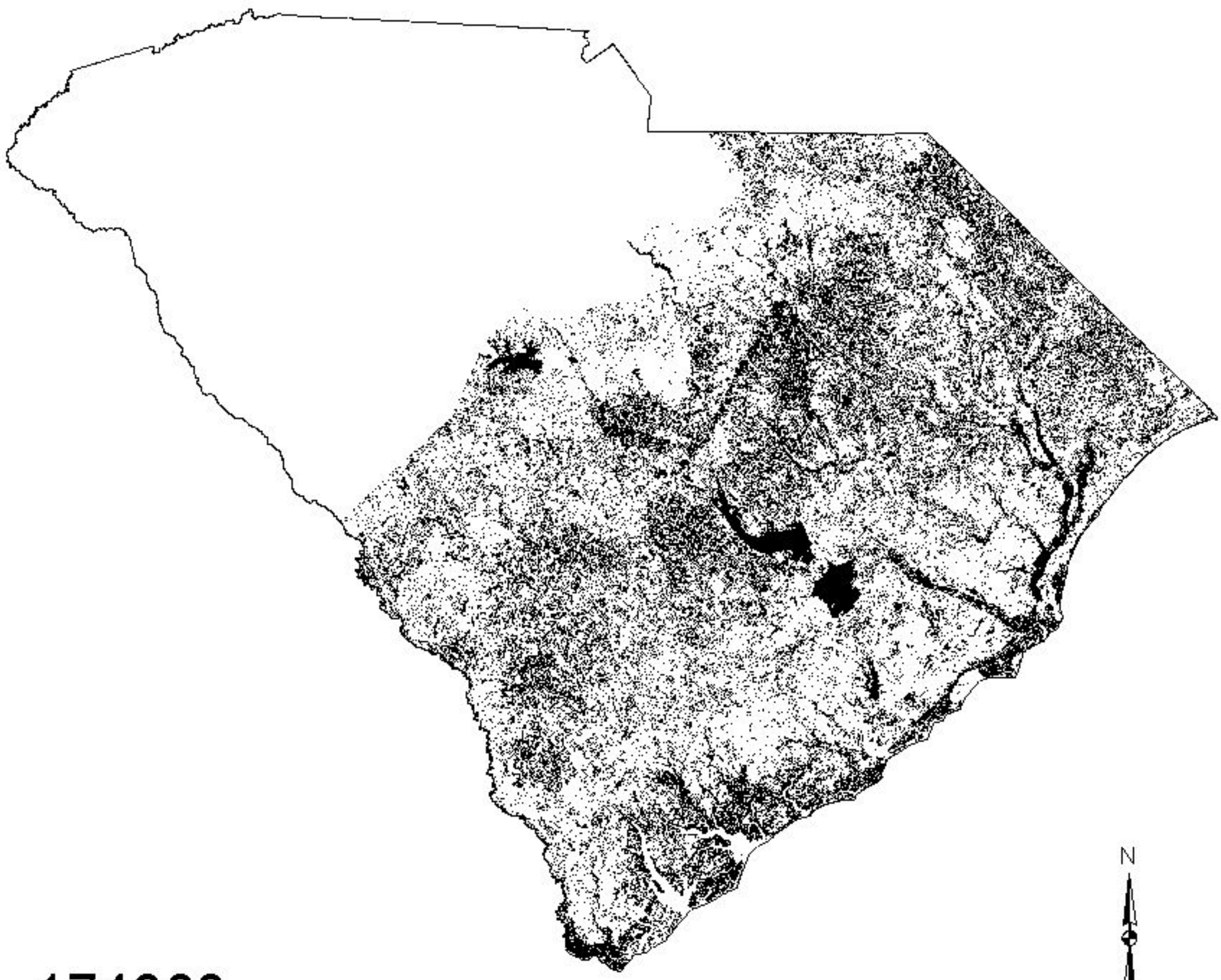
Carolina Chickadee

(Parus carolinensis)



Cattle Egret

(Bubulcus ibis)



174803

Predicted present

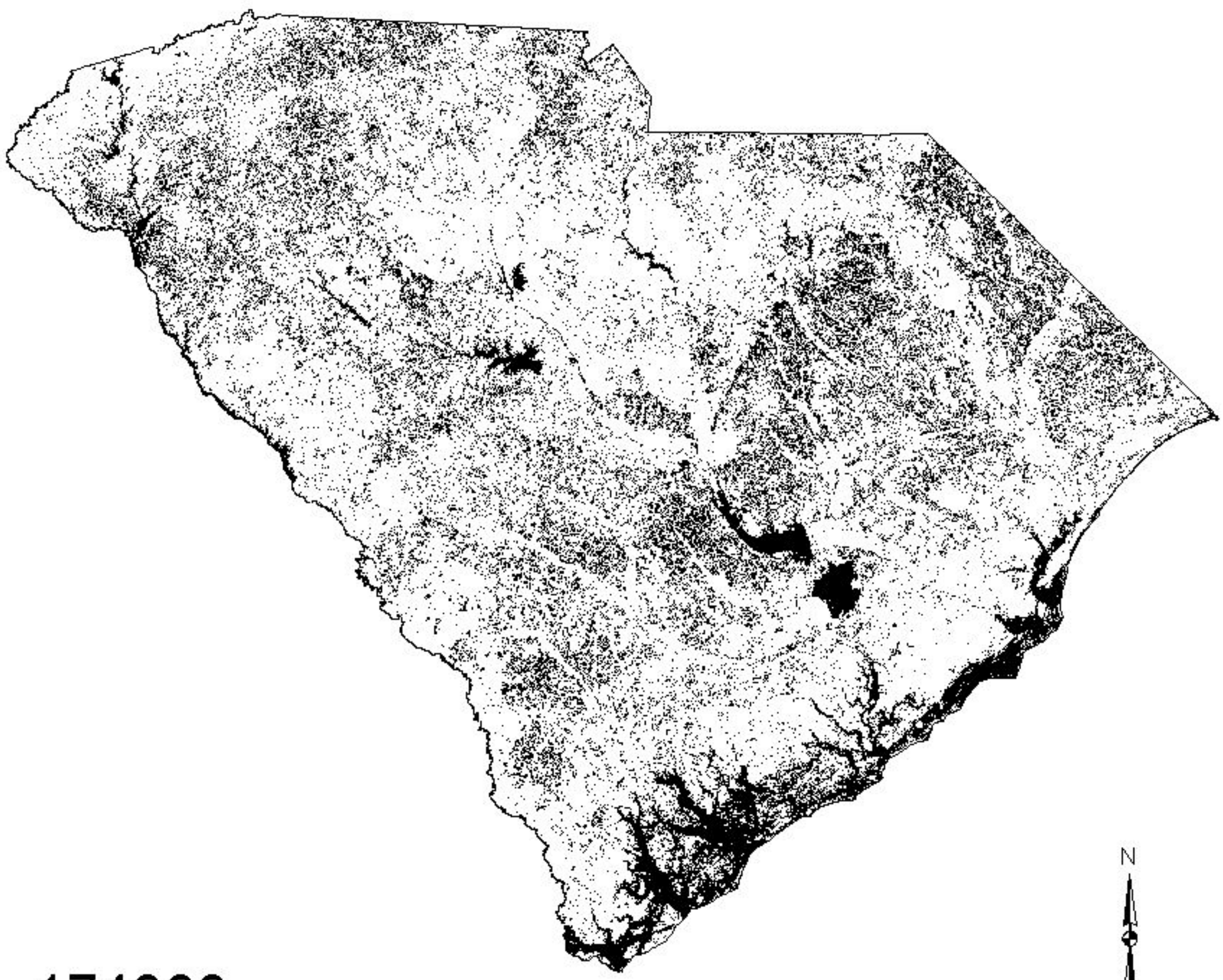
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Canada Goose

(Branta canadensis)



174999

Predicted present

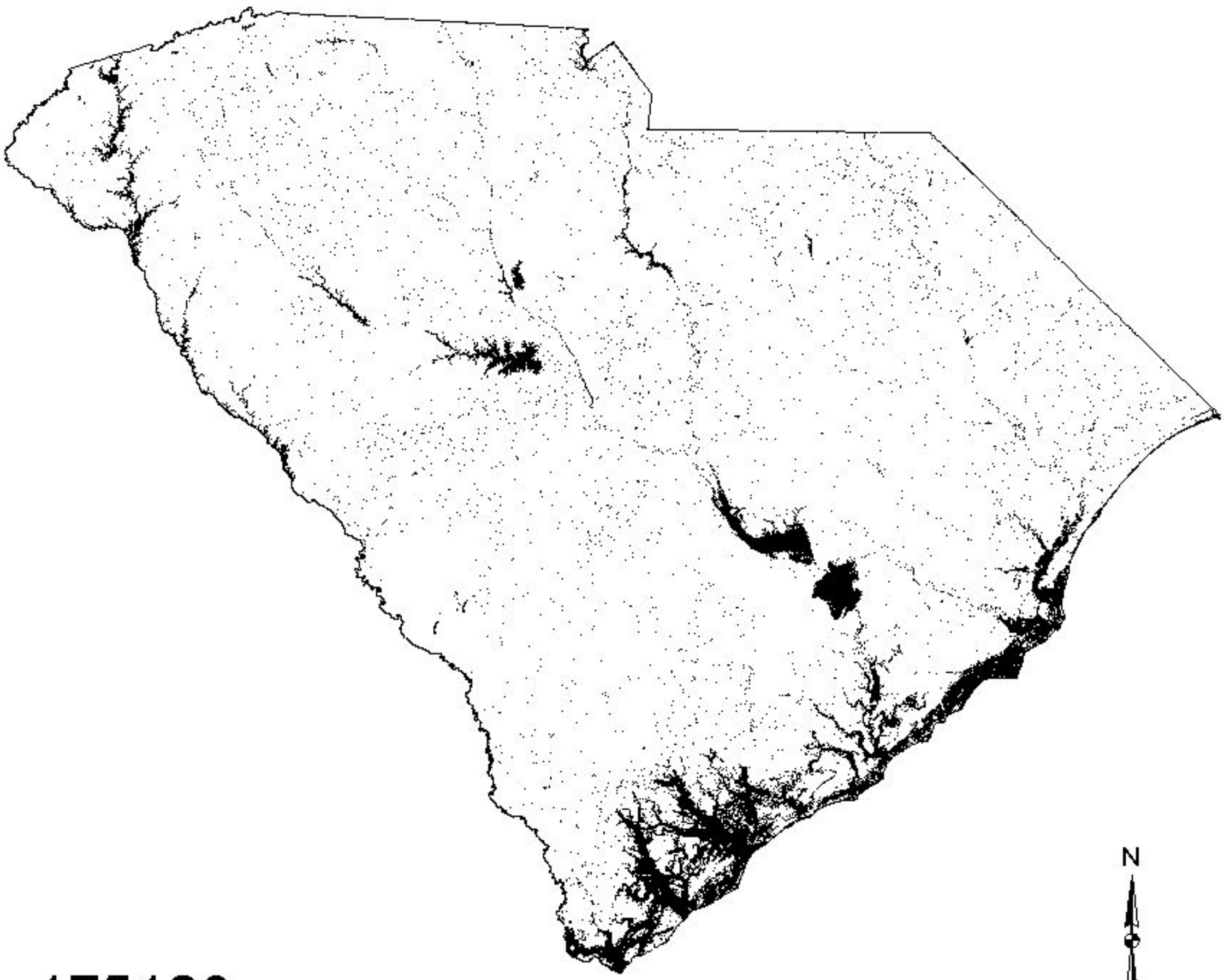
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Canvasback

(Aythya valisineria)



175129

Predicted present

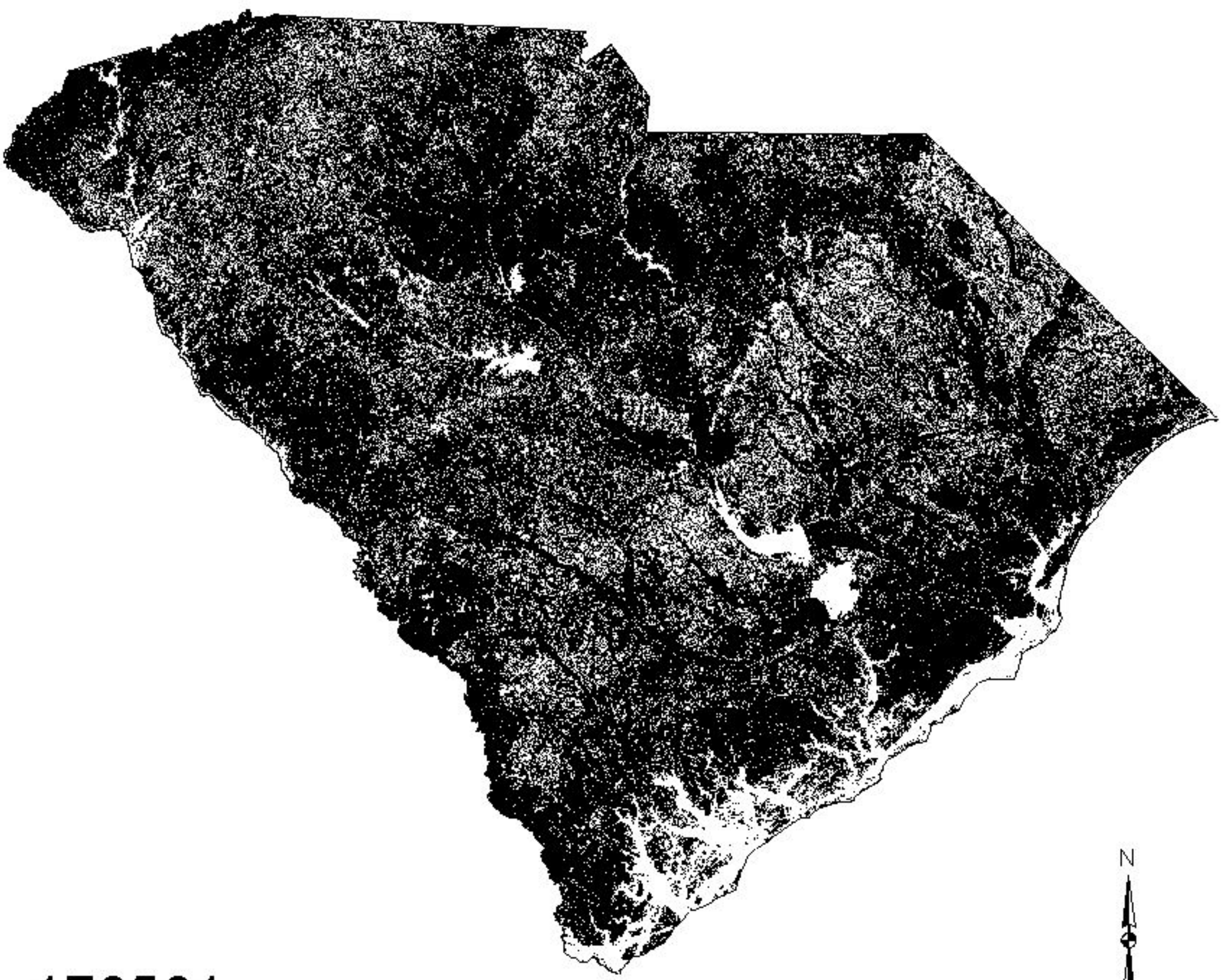
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Carolina Wren

(Thryothorus ludovicianus)



178581

Predicted present

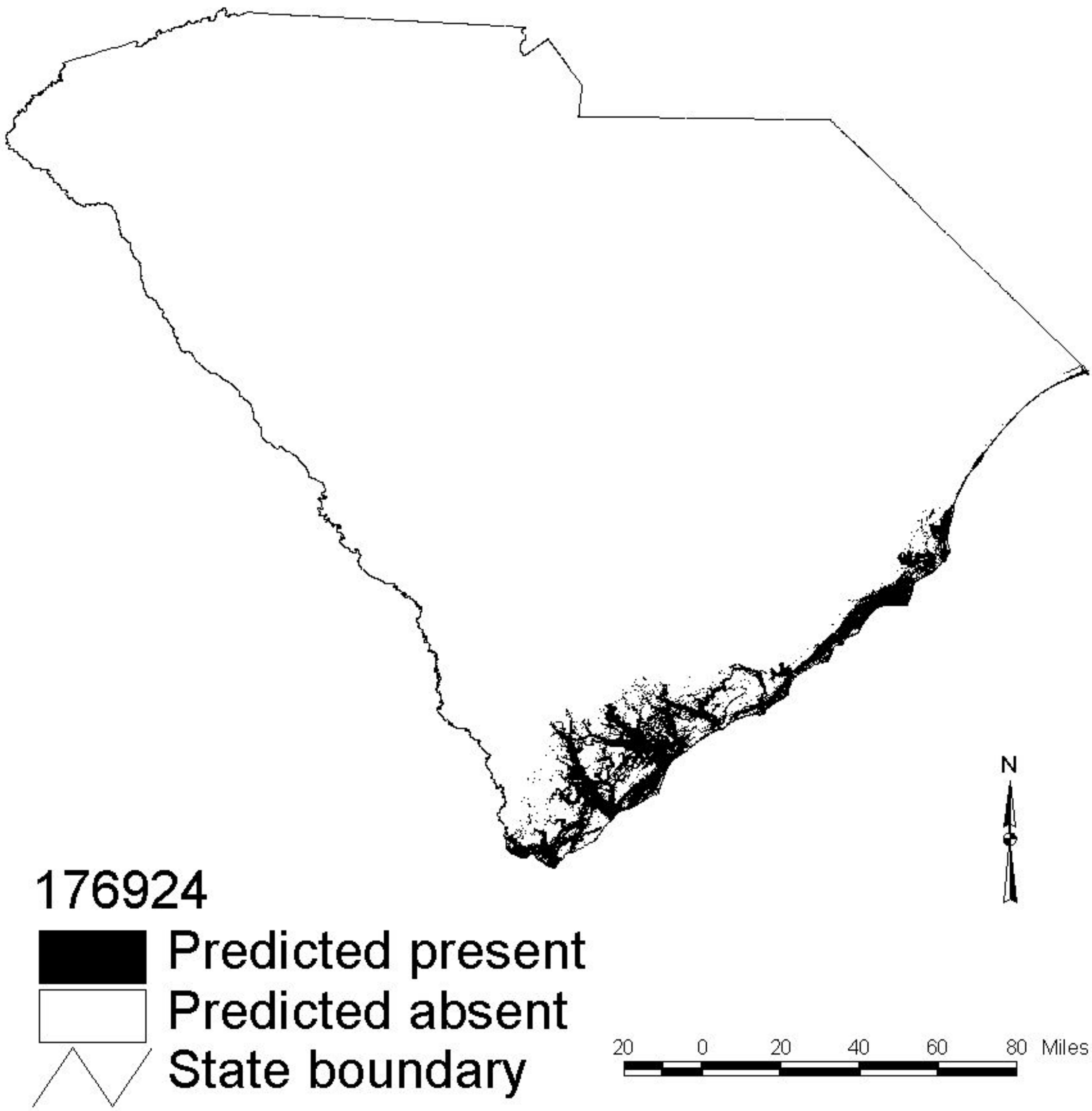
Predicted absent

State boundary

20 0 20 40 60 80 Miles

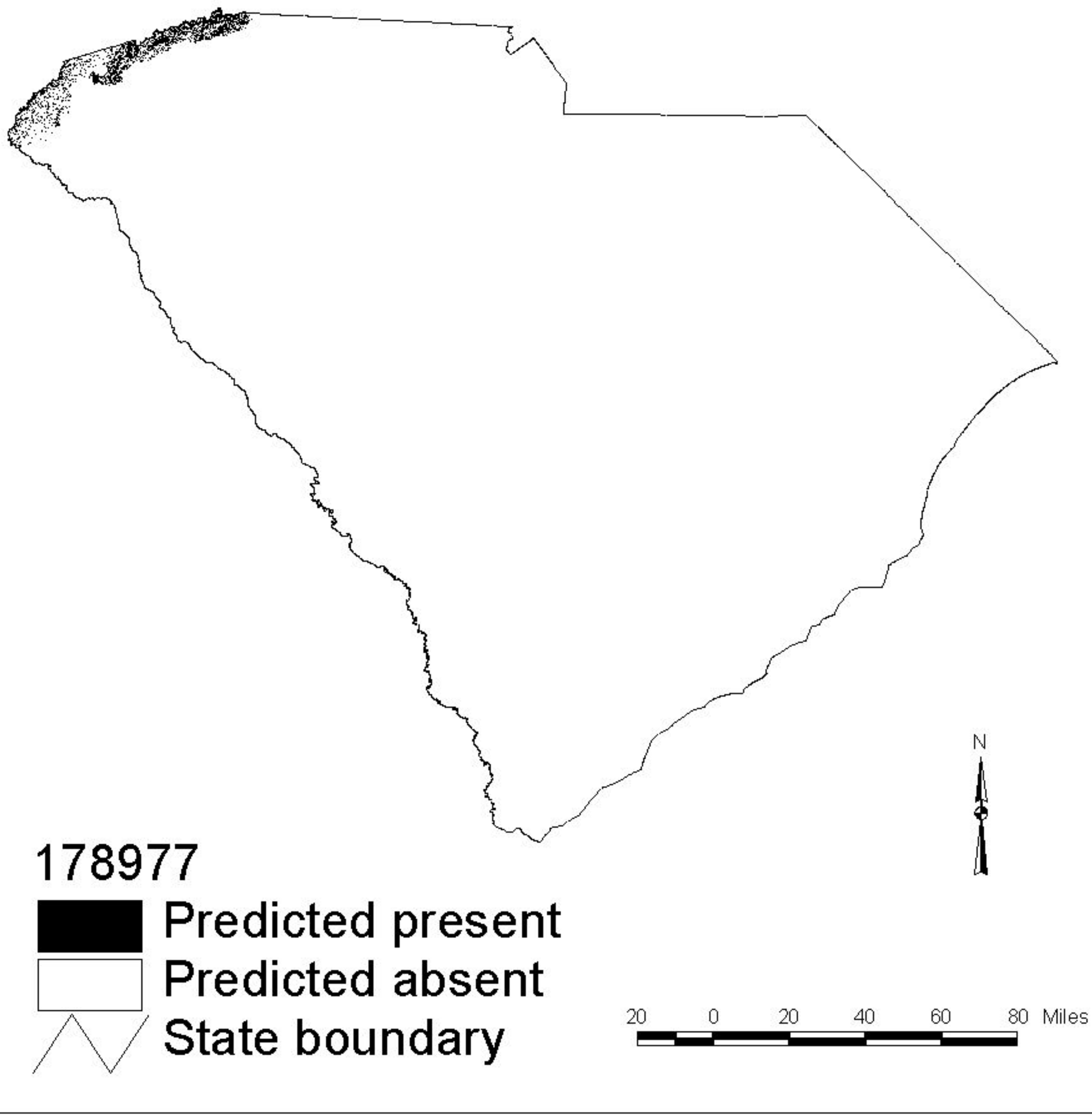
Caspian Tern

(Sterna caspia)



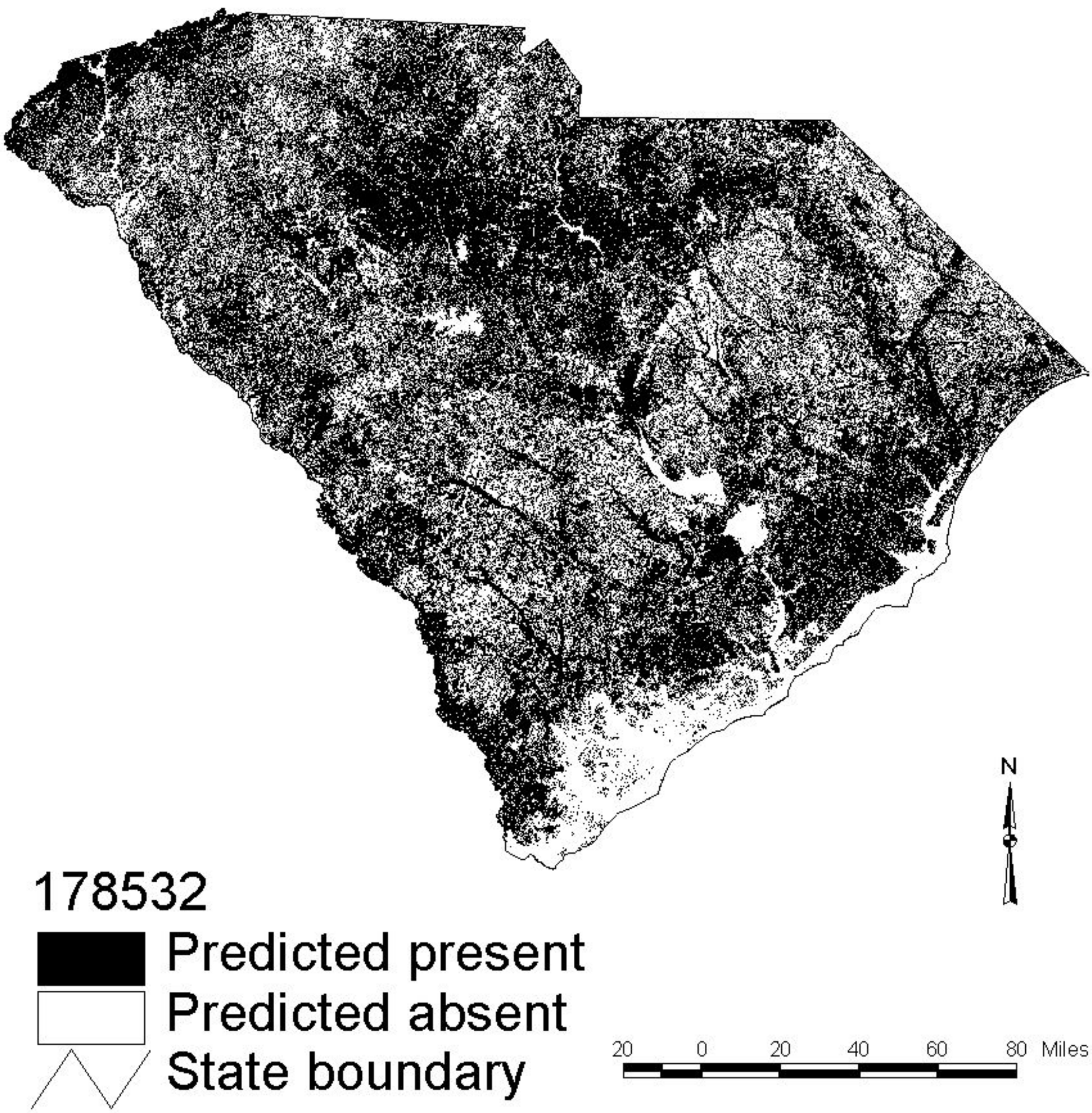
Canada Warbler

(Wilsonia canadensis)

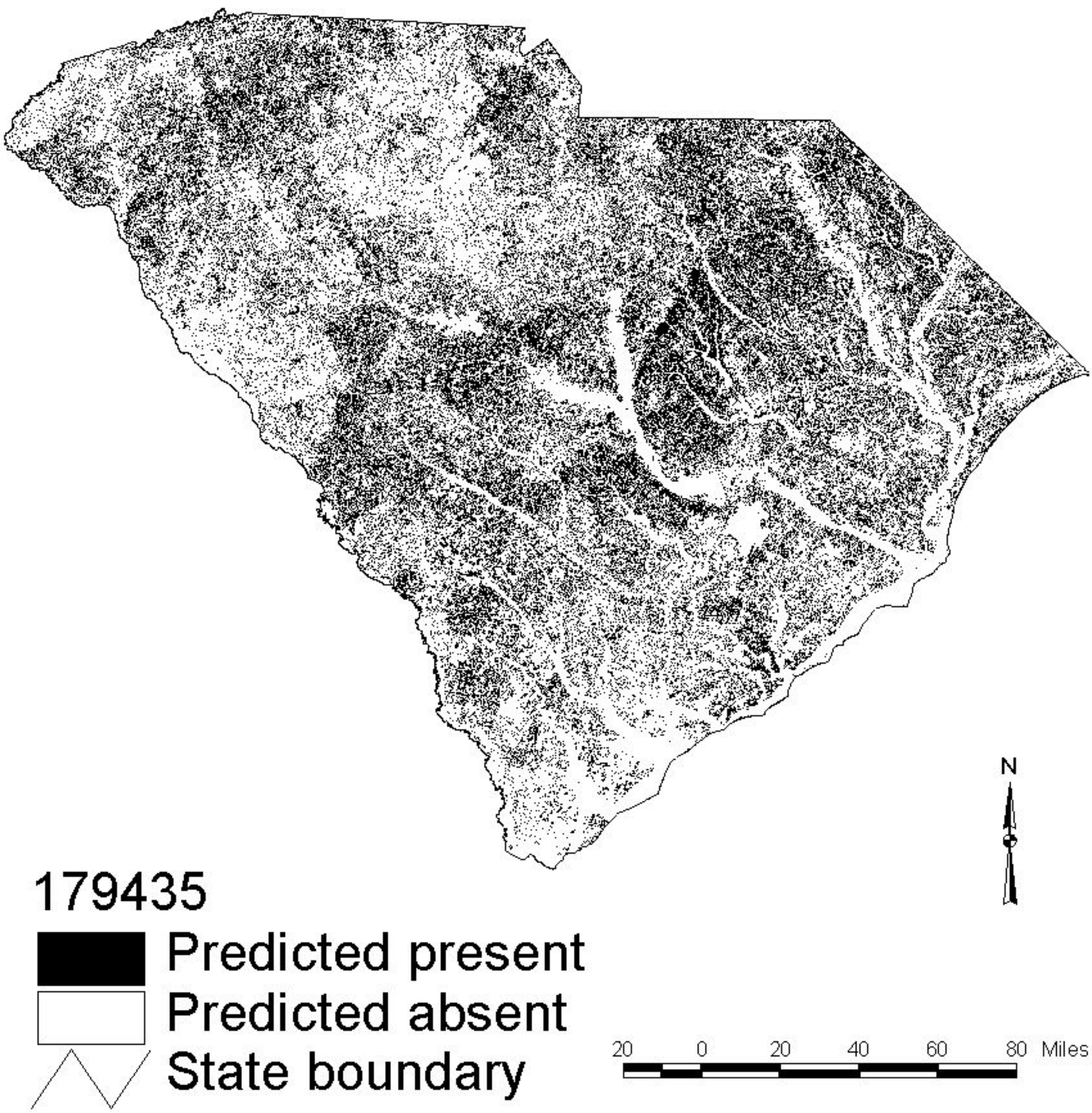


Cedar Waxwing

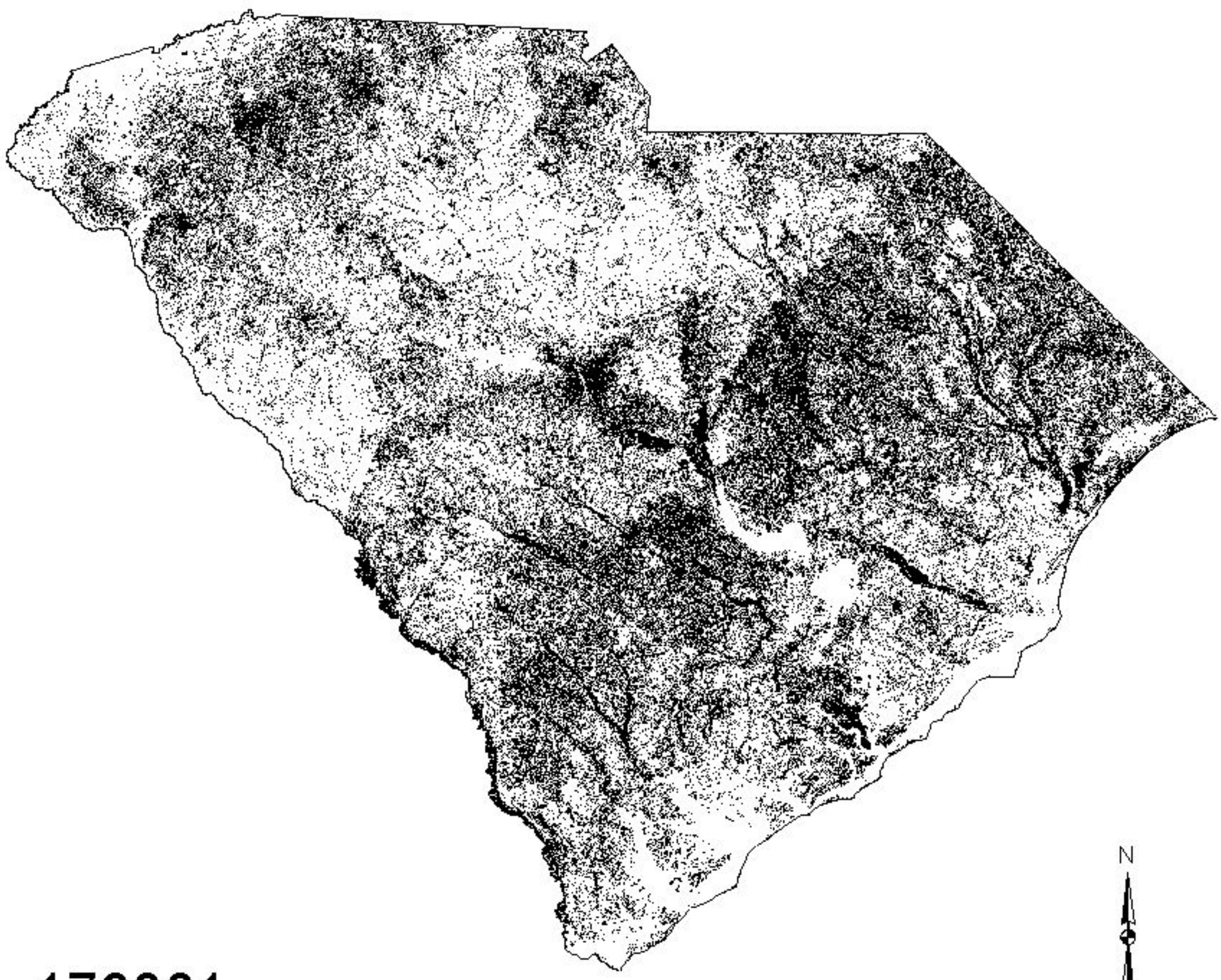
(Bombycilla cedrorum)



Chipping Sparrow
(Spizella passerina)



Chimney Swift
(Chaetura pelagica)



178001

Predicted present

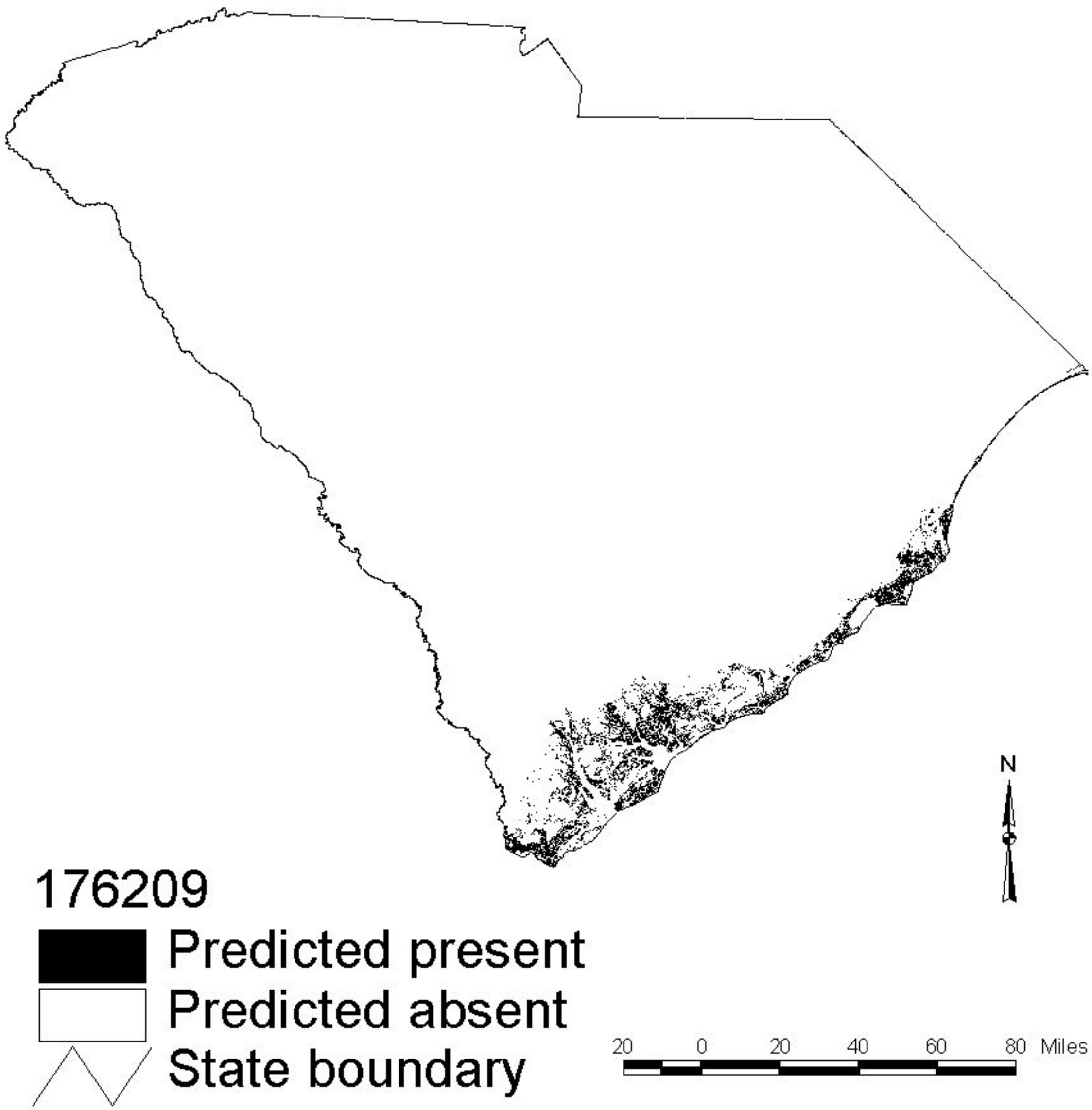
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Clapper Rail

(Rallus longirostris)



176209

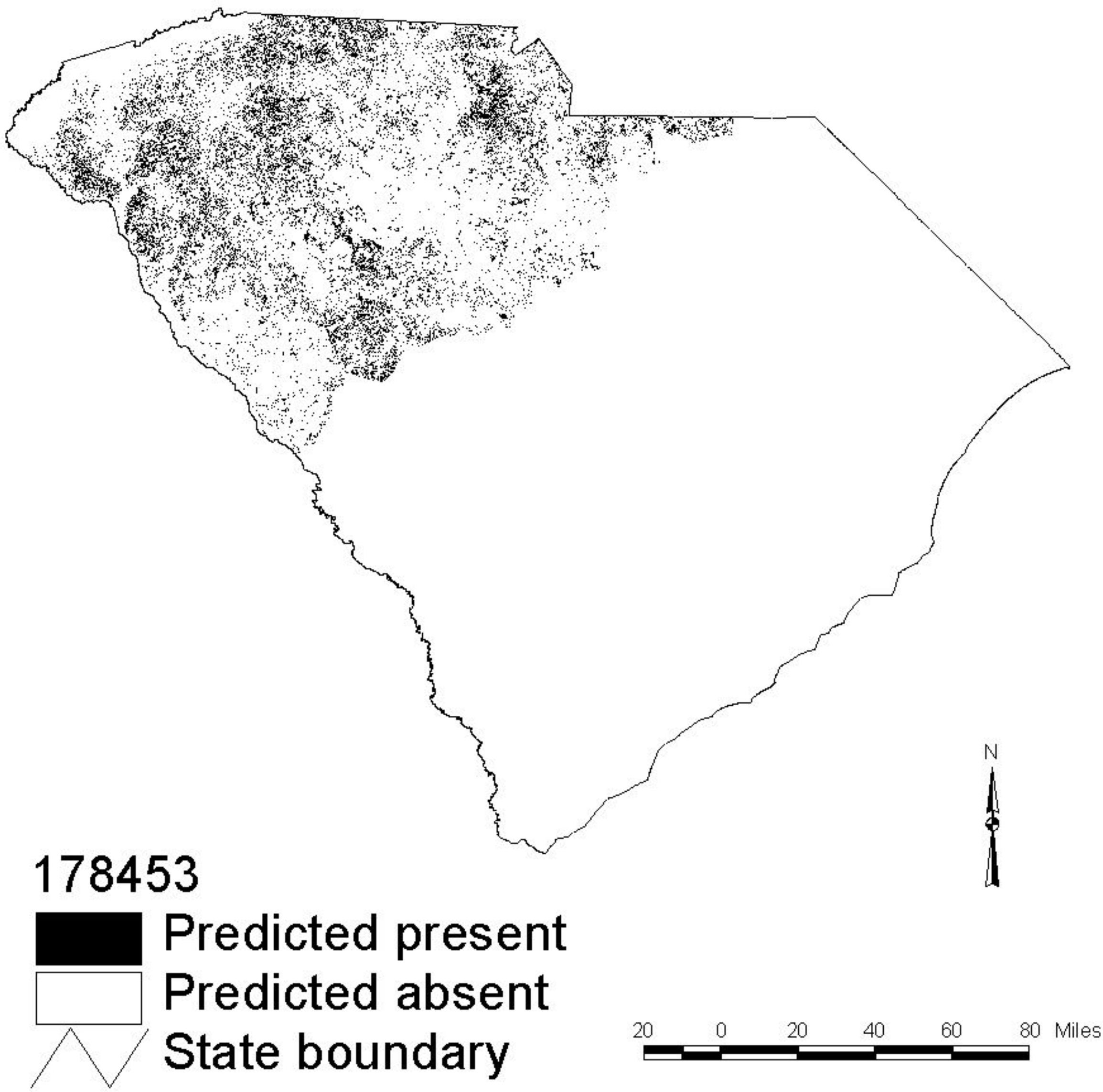
Predicted present

Predicted absent

State boundary

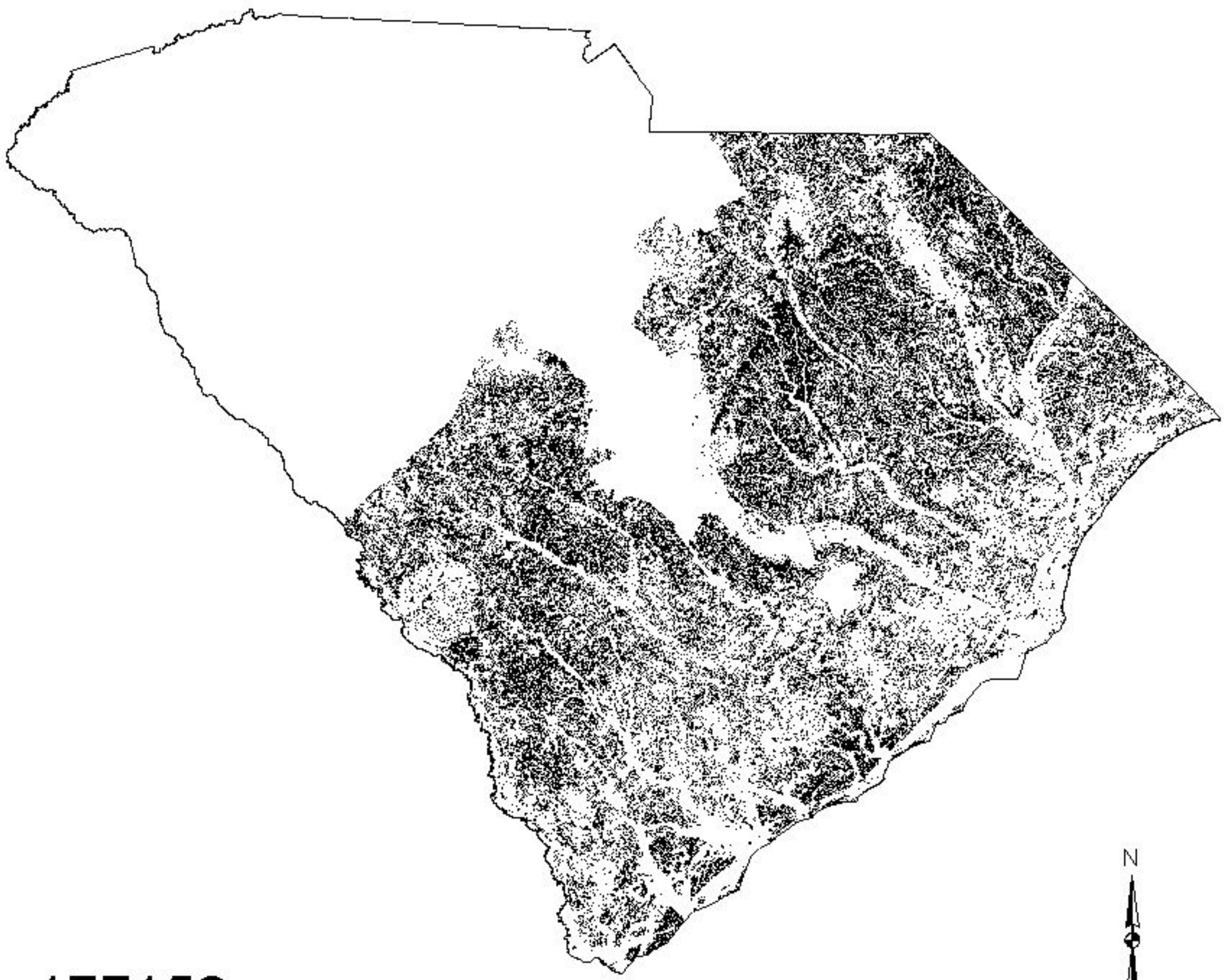
Cliff Swallow

(Hirundo pyrrhonota)



Common Ground-dove

(Columbina passerina)



177152

Predicted present

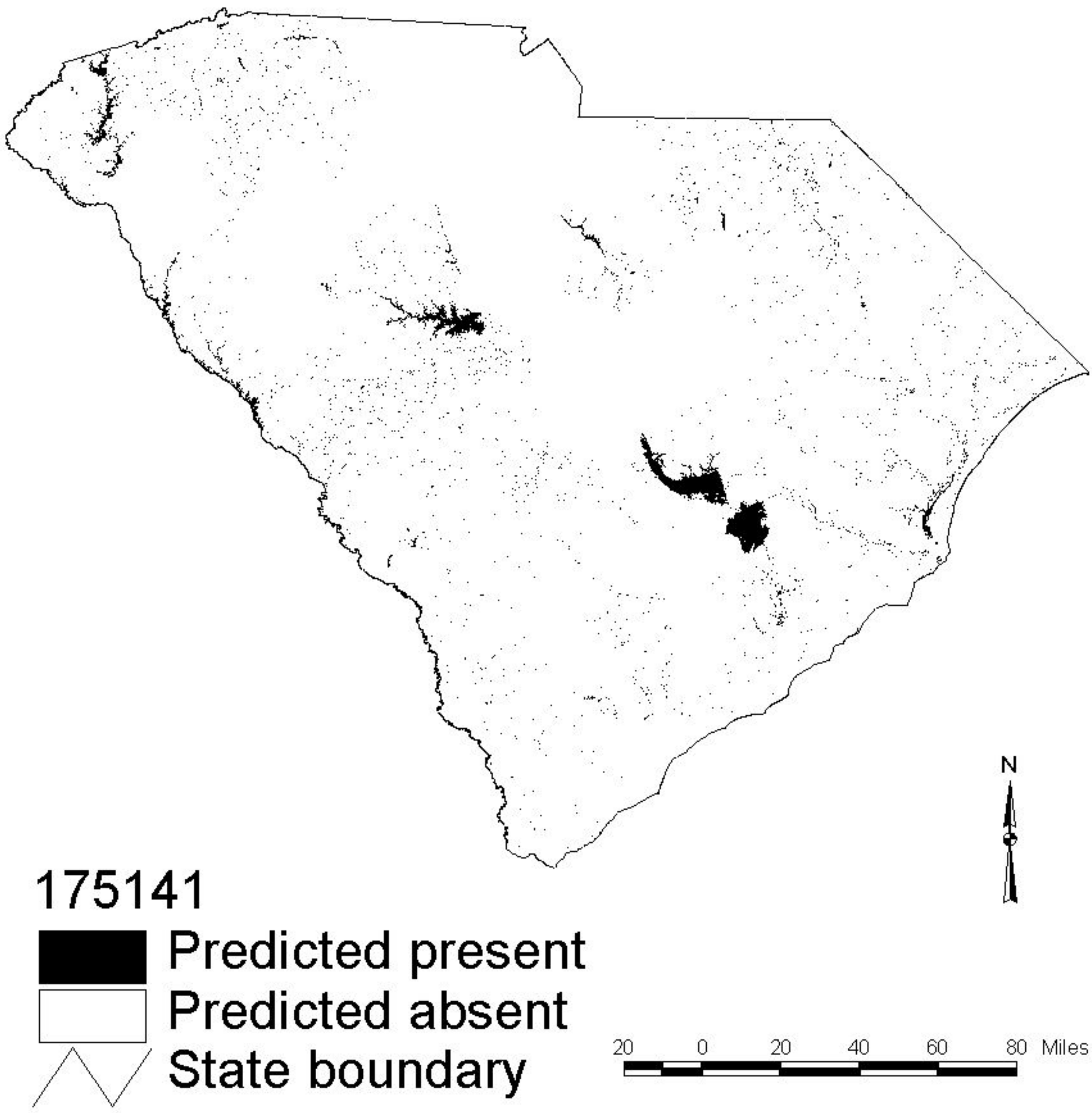
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Common Goldeneye

(Bucephala clangula)



Common Grackle

(Quiscalus quiscula)

179104

Predicted present

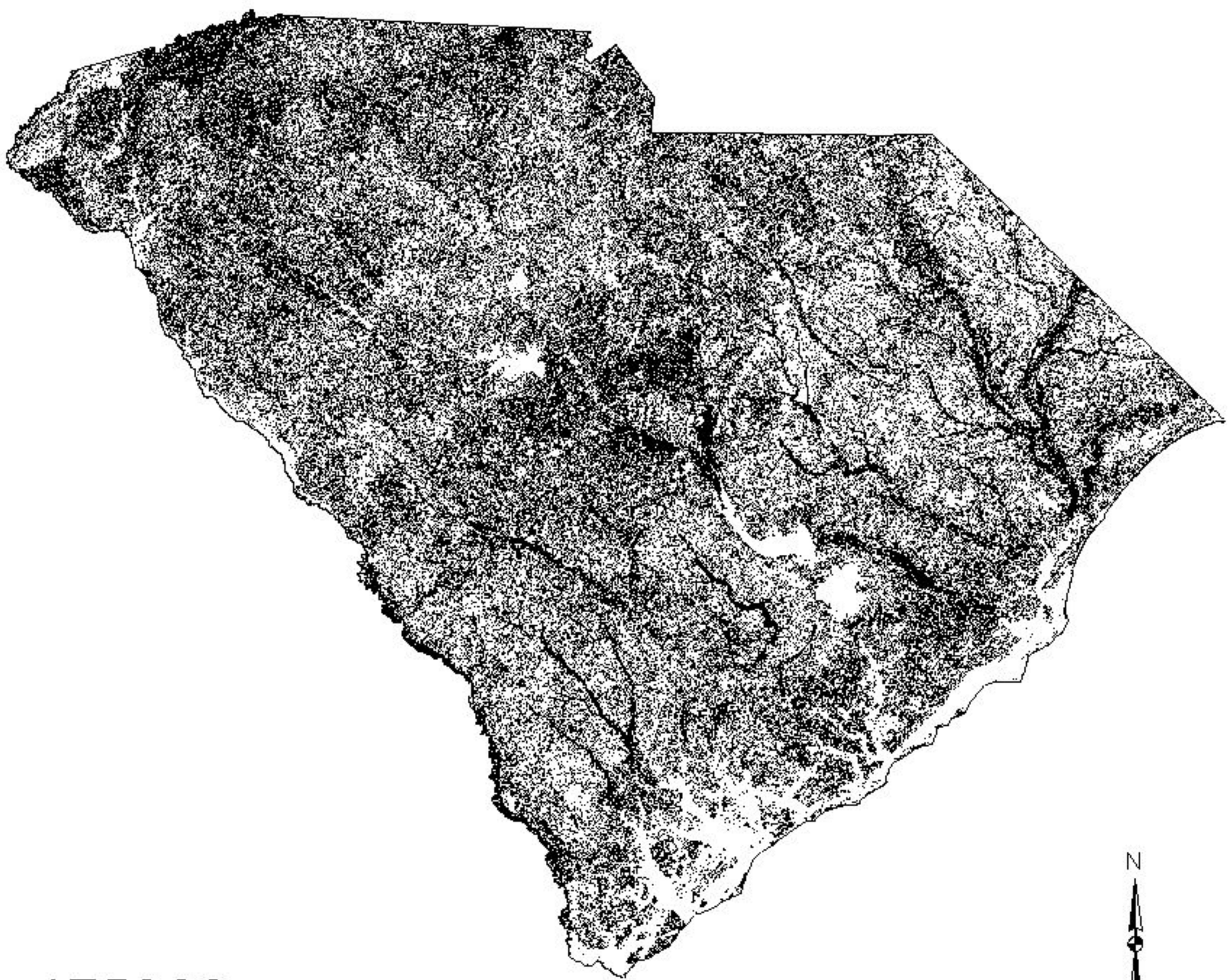
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Cooper's Hawk

(Accipiter cooperii)



175309

Predicted present

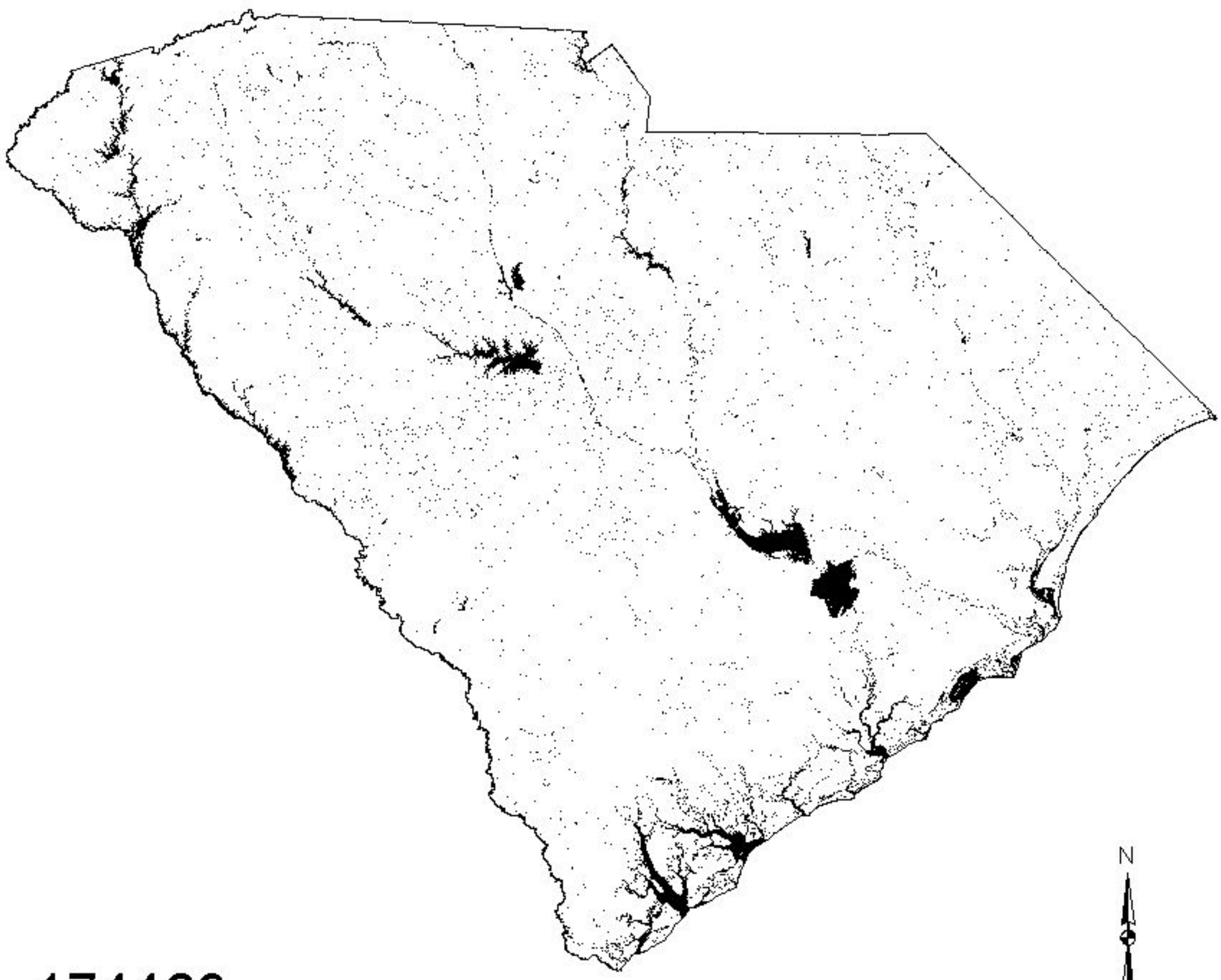
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Common Loon

(Gavia immer)



174469

Predicted present

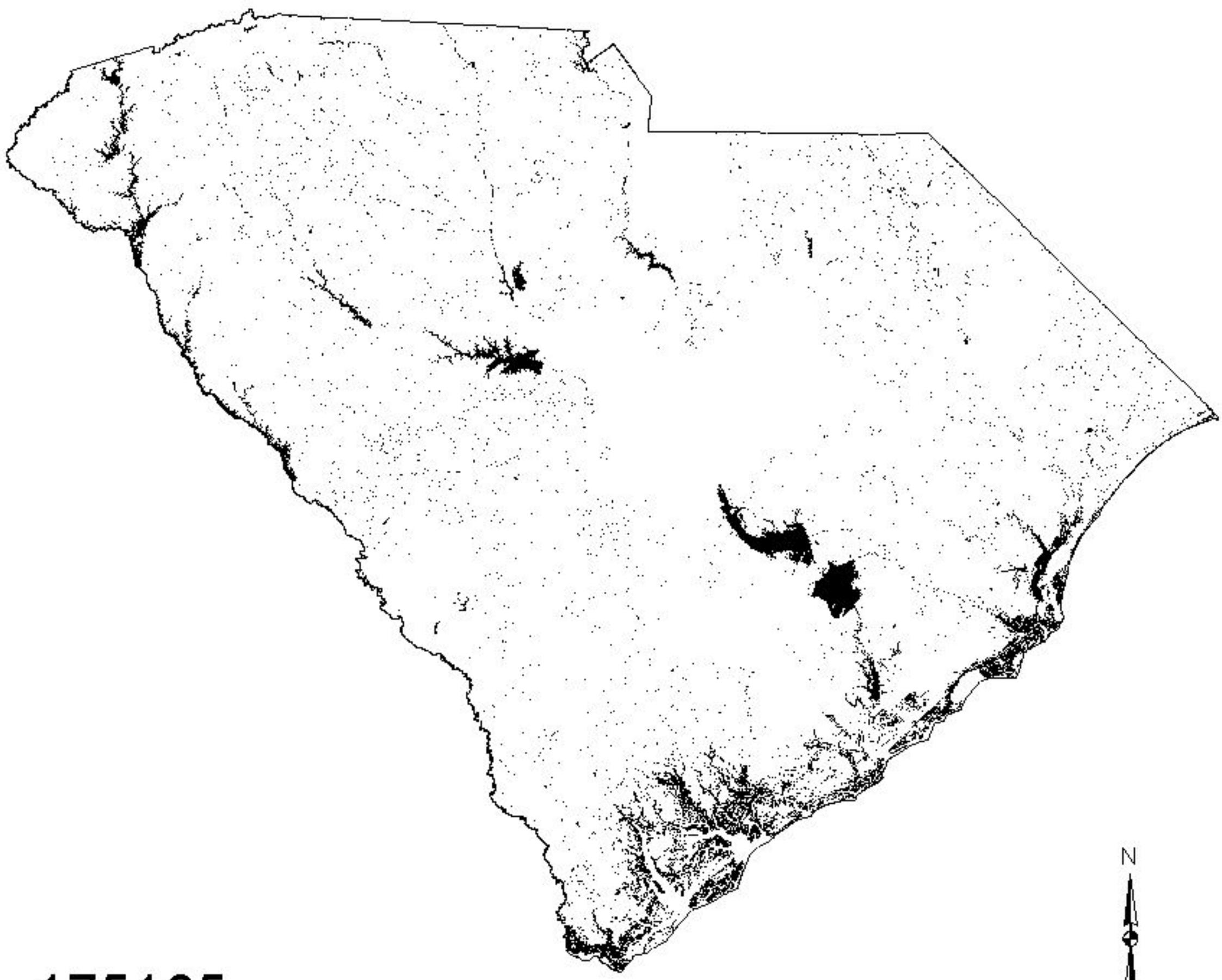
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Common Merganser

(Mergus merganser)



175185

Predicted present

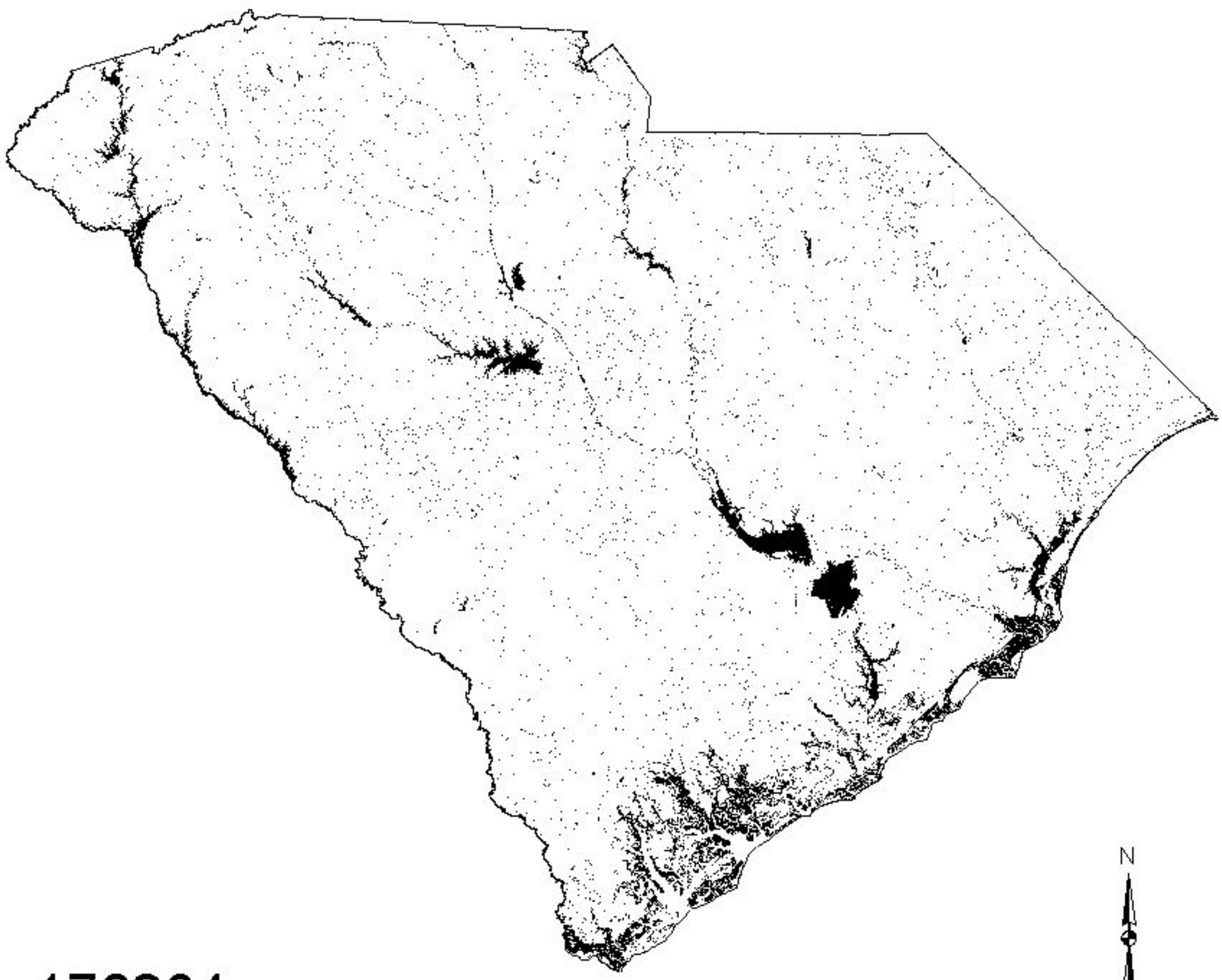
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Common Moorhen

(Gallinula chloropus)



176284

Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Common Nighthawk

(Chordeiles minor)

177979

Predicted present

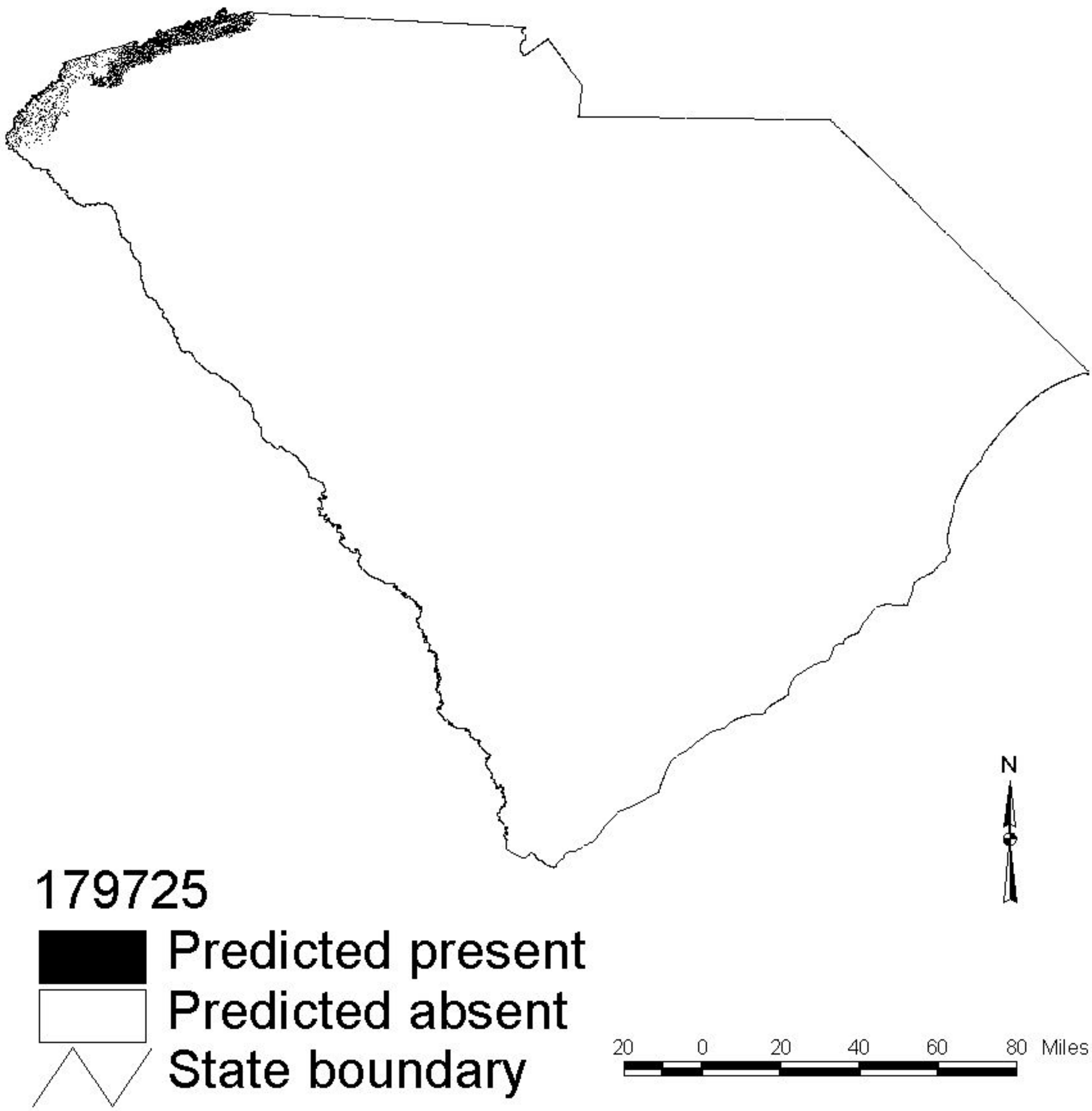
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Common Raven

(Corvus corax)



179725

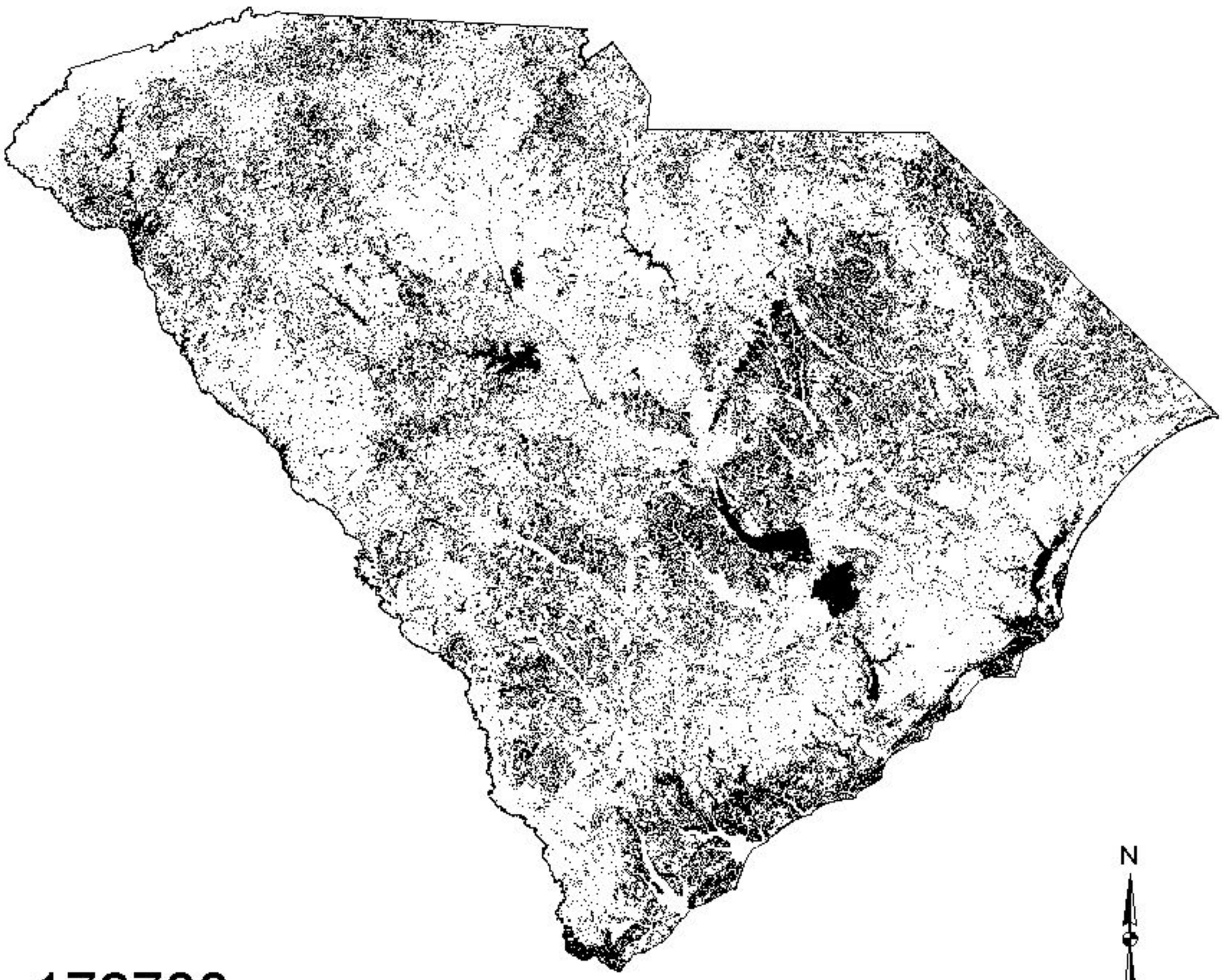
Predicted present

Predicted absent

State boundary

Common Snipe

(Gallinago gallinago)



176700

Predicted present

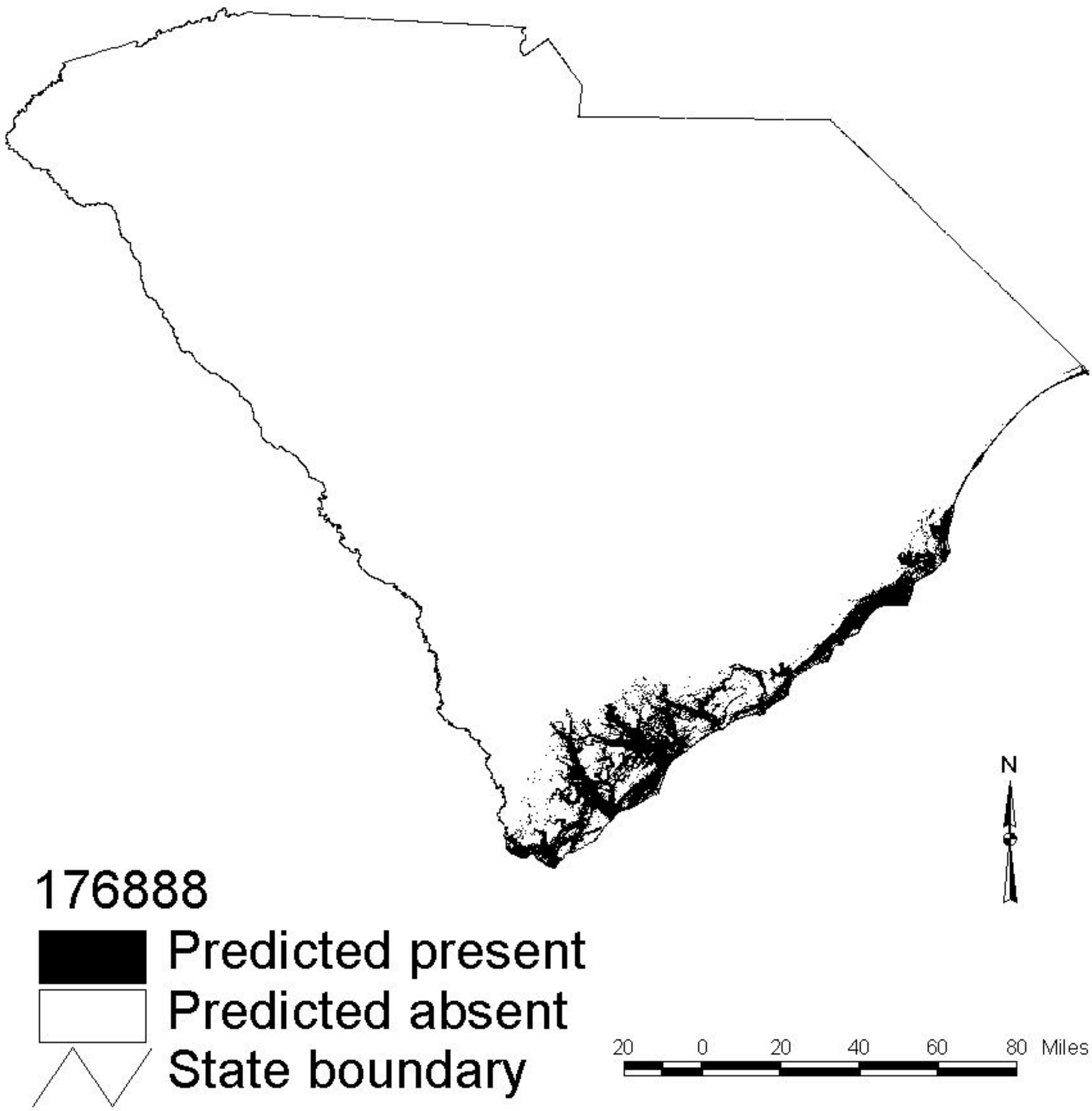
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Common Tern

(Sterna hirundo)



Common Yellowthroat

(Geothlypis trichas)

178944

Predicted present

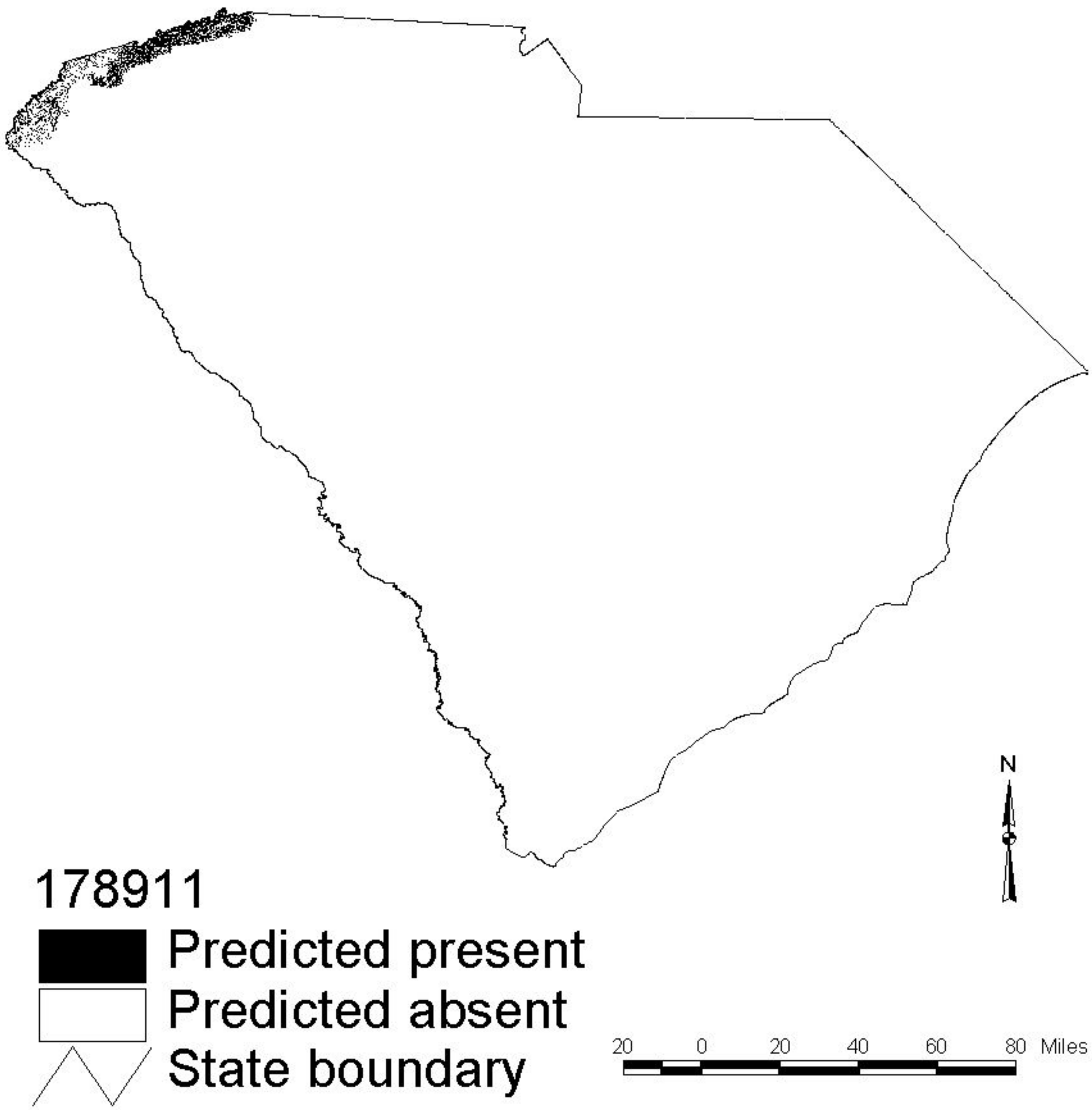
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Chestnut-sided Warbler

(Dendroica pensylvanica)



178911

Predicted present

Predicted absent

State boundary

Chuck-will's-widow

(Caprimulgus carolinensis)

177960

Predicted present

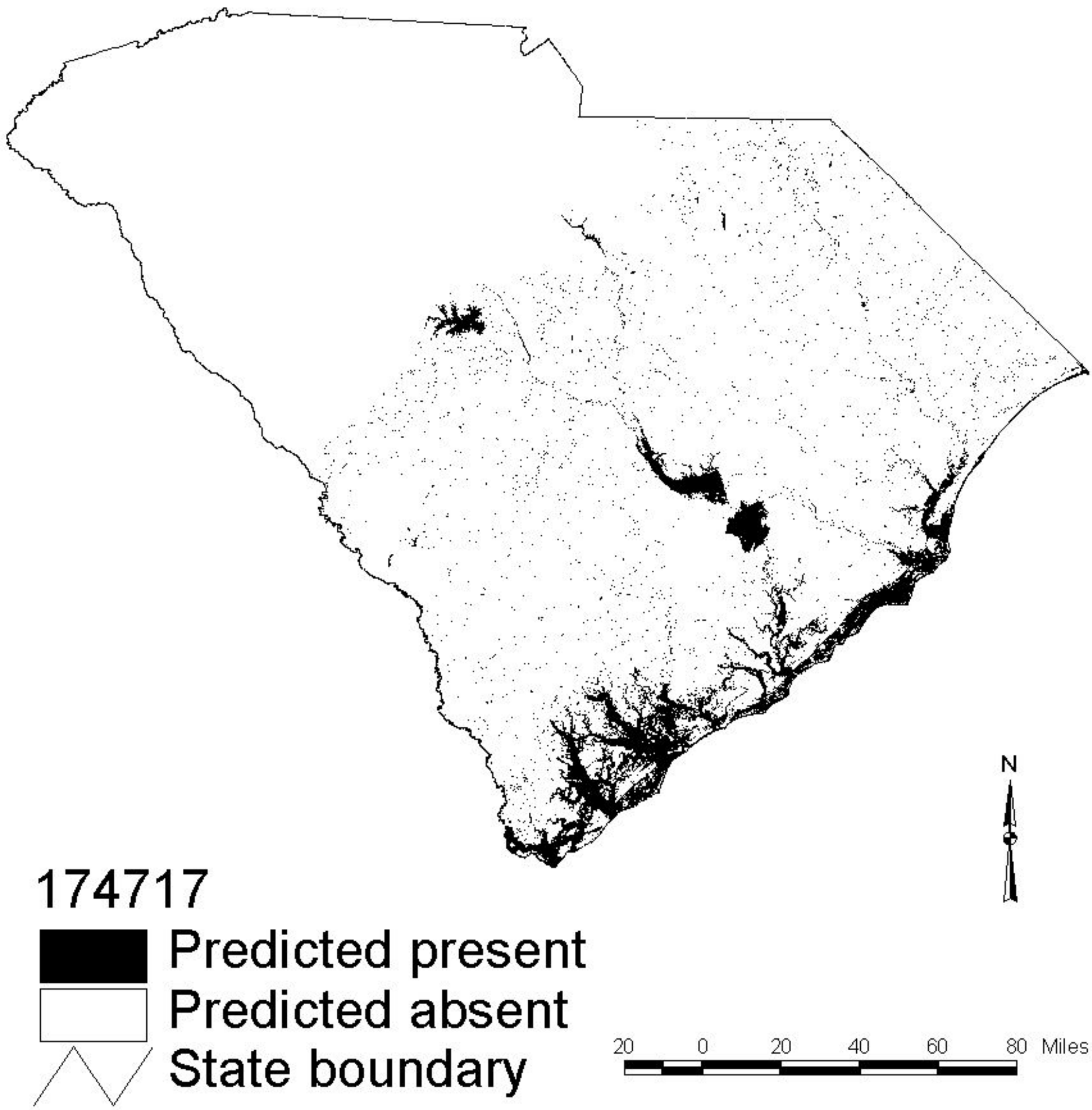
Predicted absent

State boundary

20 0 20 40 60 80 Miles

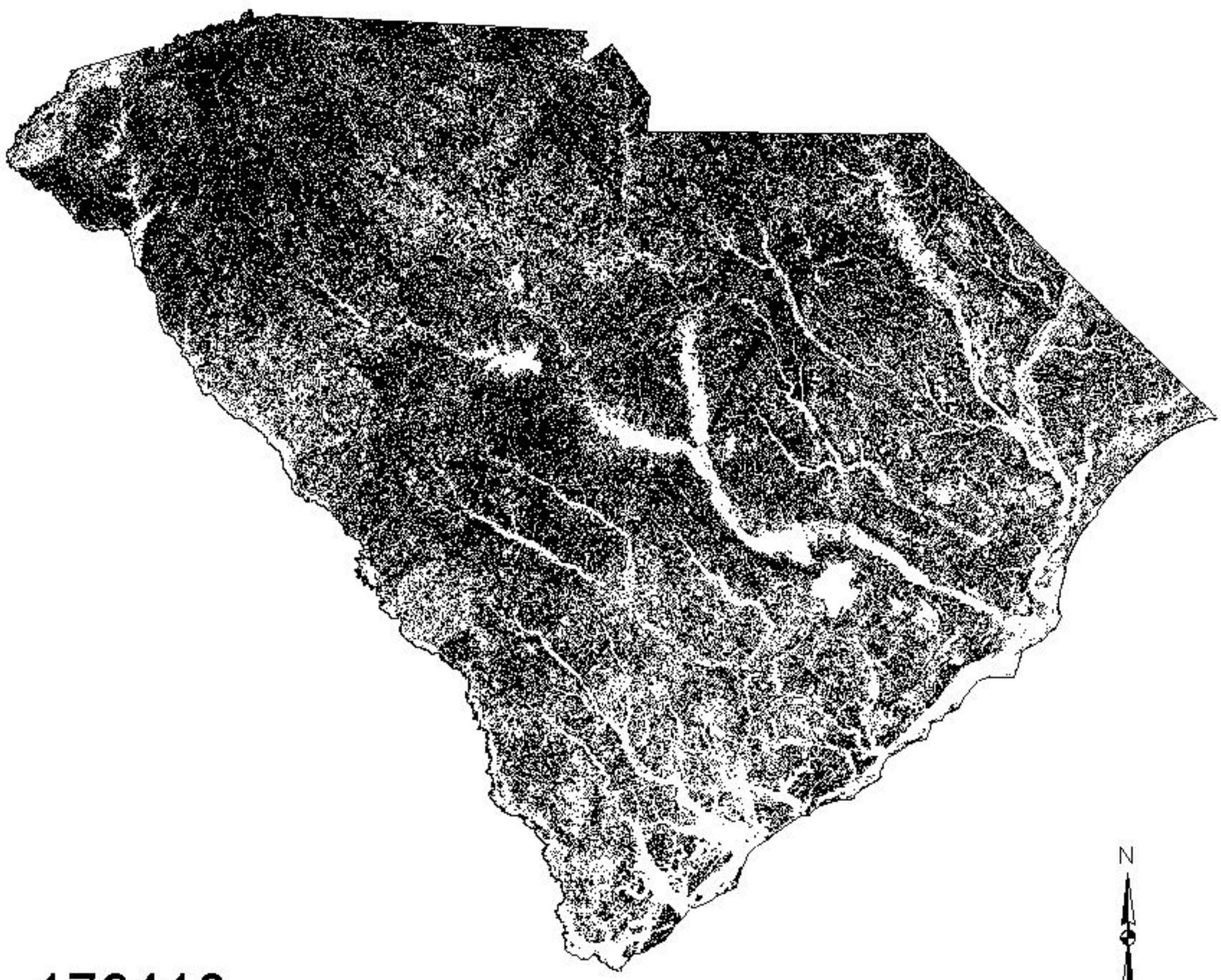
Double-crested Cormorant

(Phalacrocorax auritus)



Dark-eyed Junco

(Junco hyemalis)



179410

Predicted present

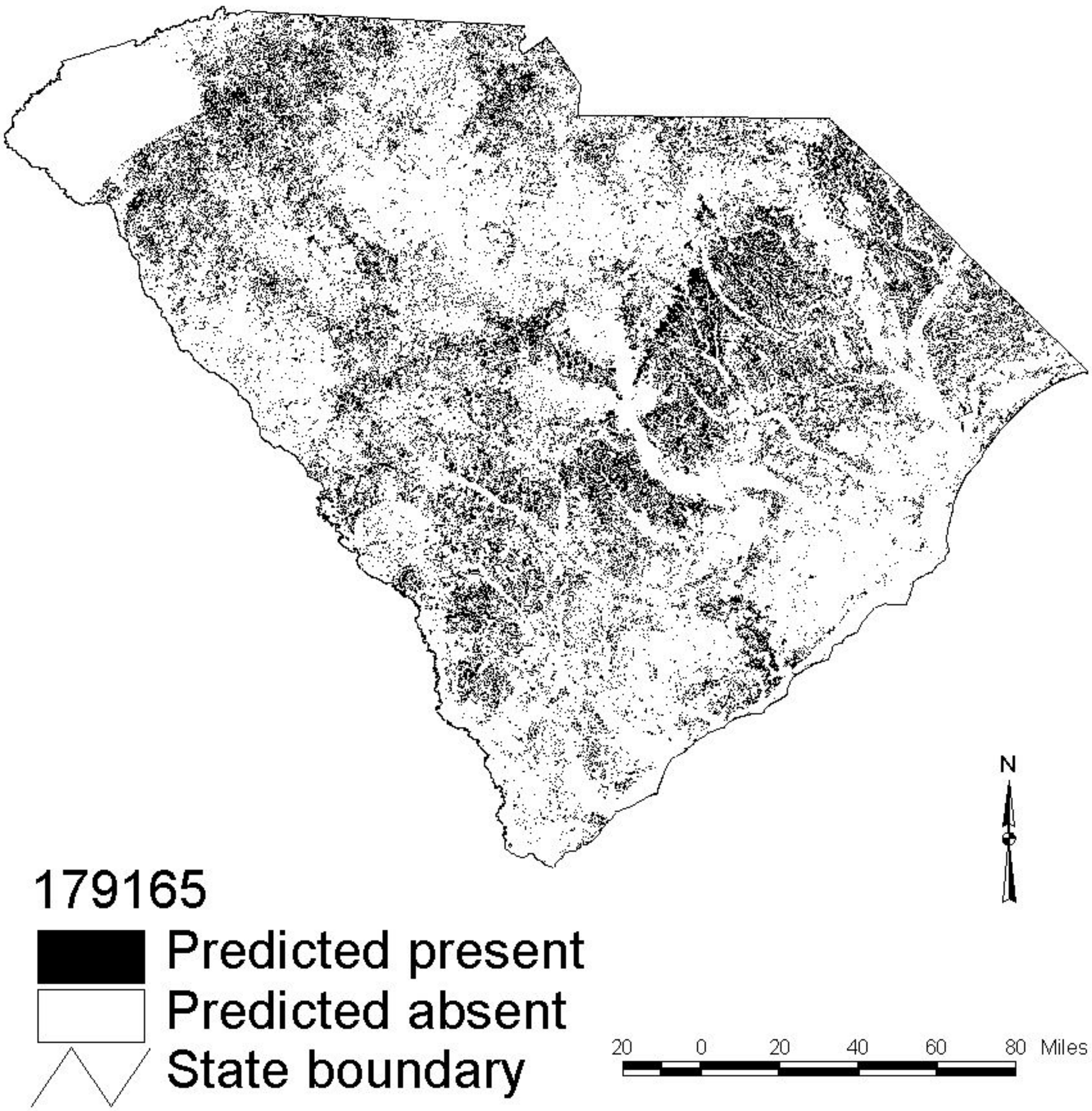
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Dickcissel

(Spiza americana)



Downy Woodpecker

(Picoides pubescens)

178259

Predicted present

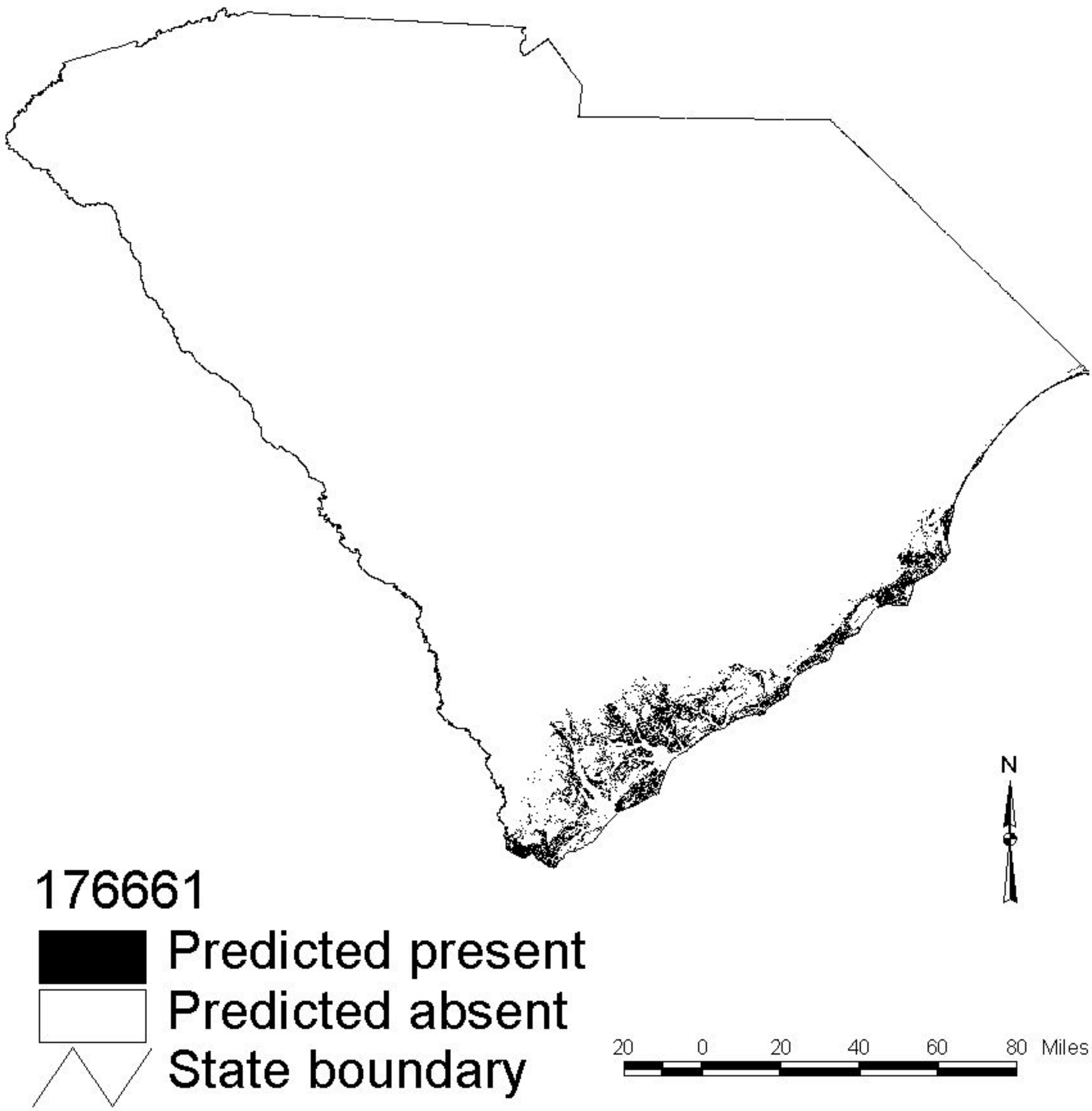
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Dunlin

(Calidris alpina)



176661

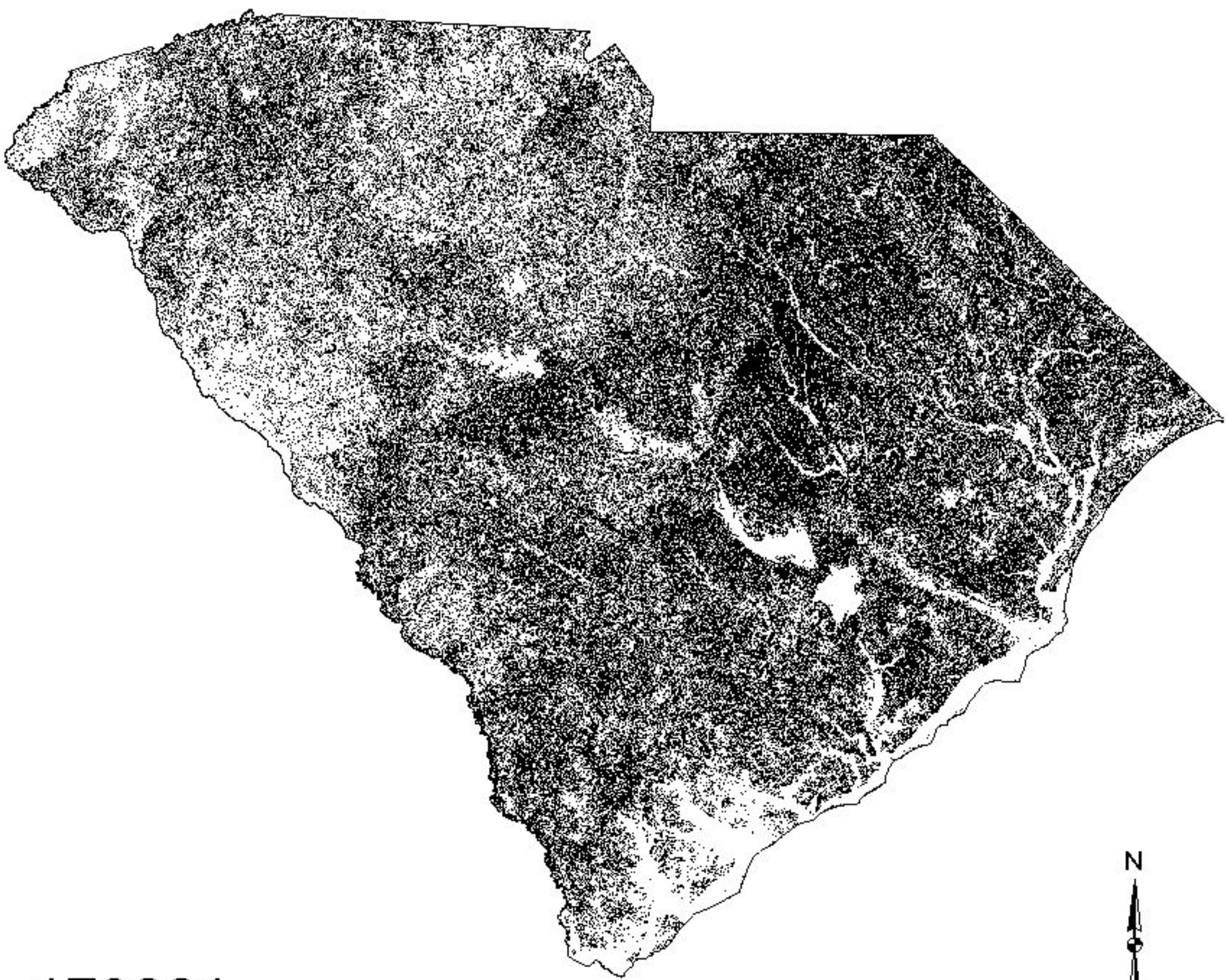
Predicted present

Predicted absent

State boundary

Eastern Bluebird

(Sialia sialis)



179801

Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Eastern Kingbird

(Tyrannus tyrannus)

178279

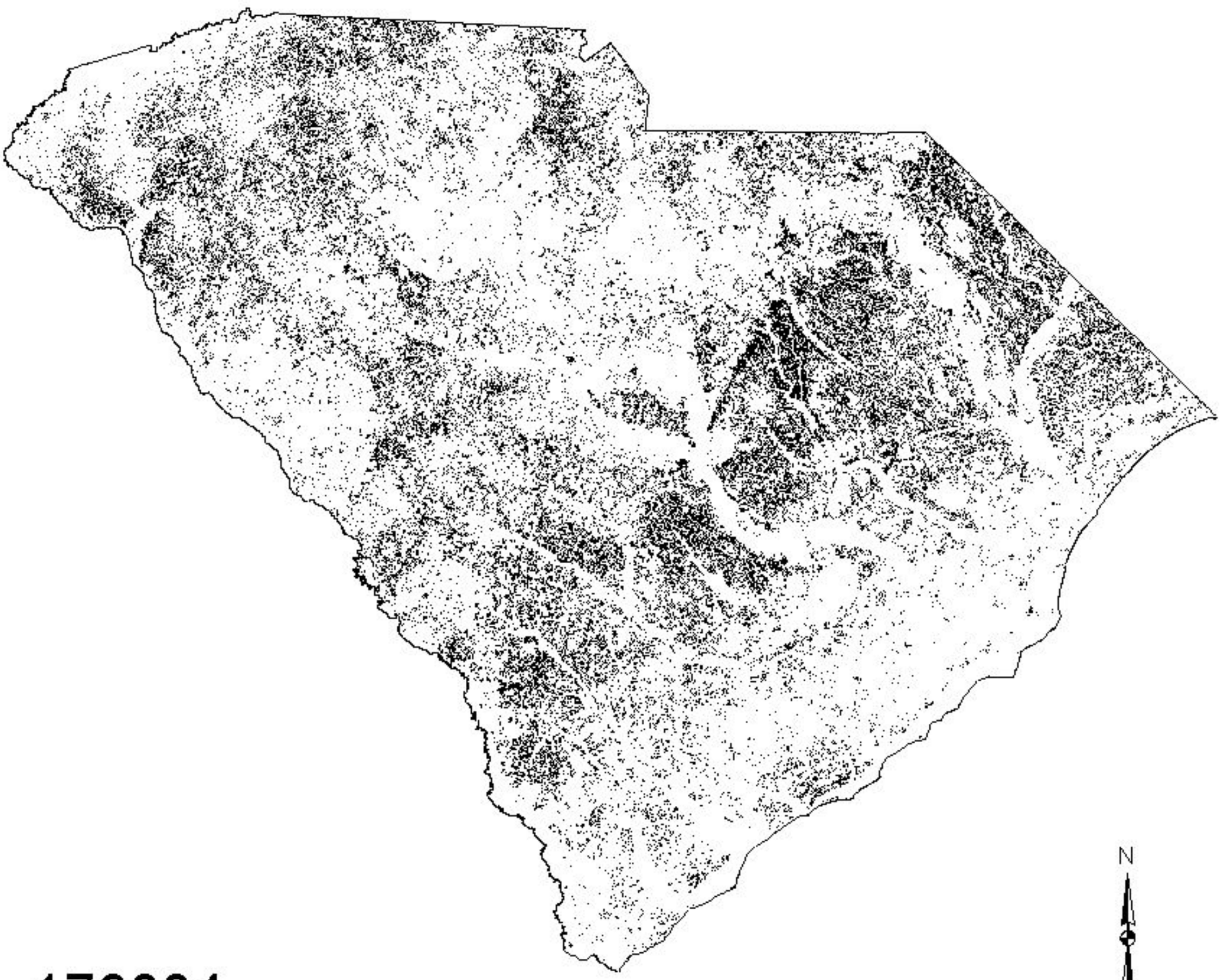
Predicted present

Predicted absent

State boundary

Eastern Meadowlark

(Sturnella magna)



179034

Predicted present

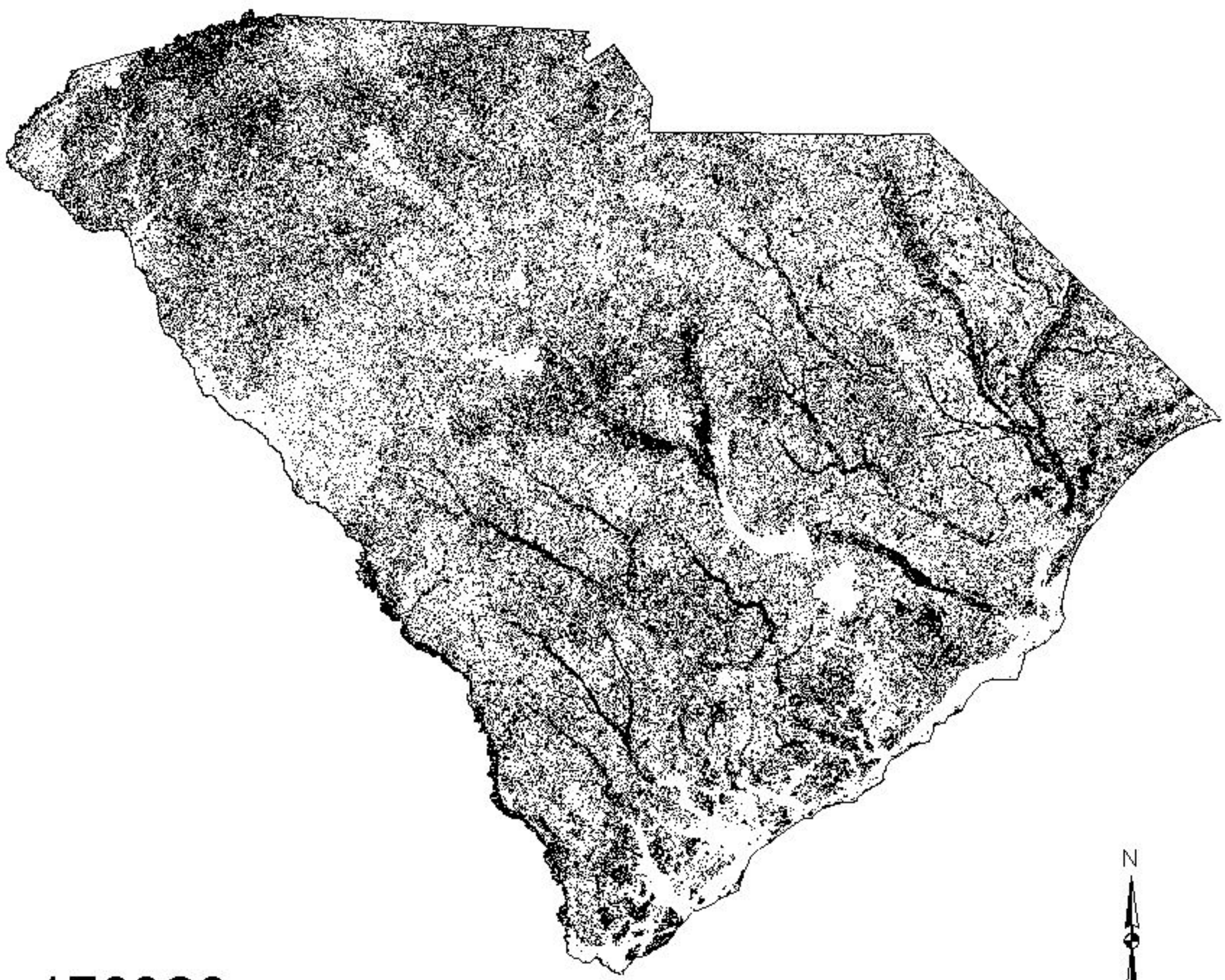
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Eastern Phoebe

(Sayornis phoebe)



178329

Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Eastern Screech-owl

(Otus asio)

177856

Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Eastern Towhee

(Pipilo erythrophthalmus)

179276

Predicted present

Predicted absent

State boundary

Eastern Wood-pewee

(Contopus virens)

178359

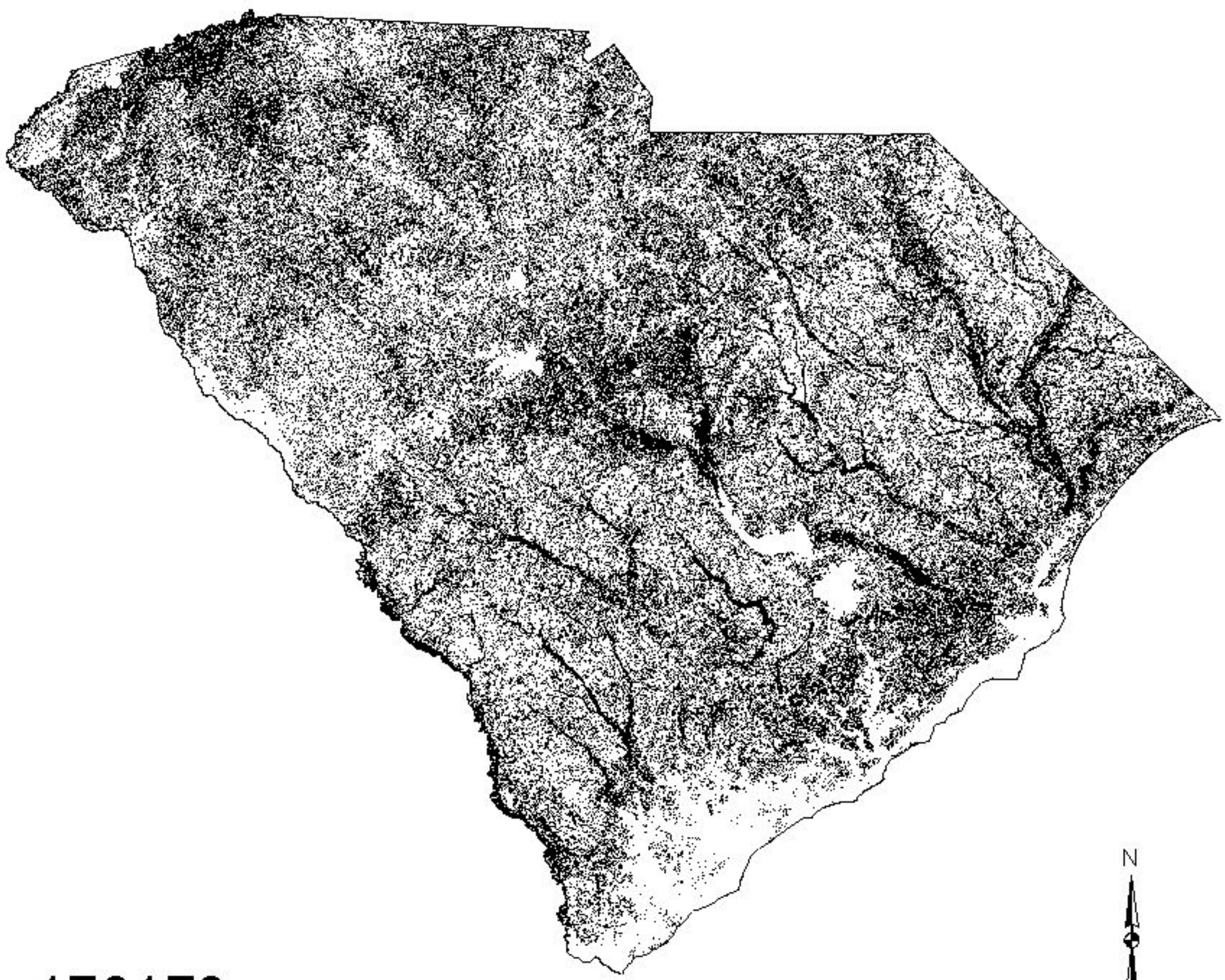
Predicted present

Predicted absent

State boundary

Evening Grosbeak

(Coccothraustes vespertinus)



179173

Predicted present

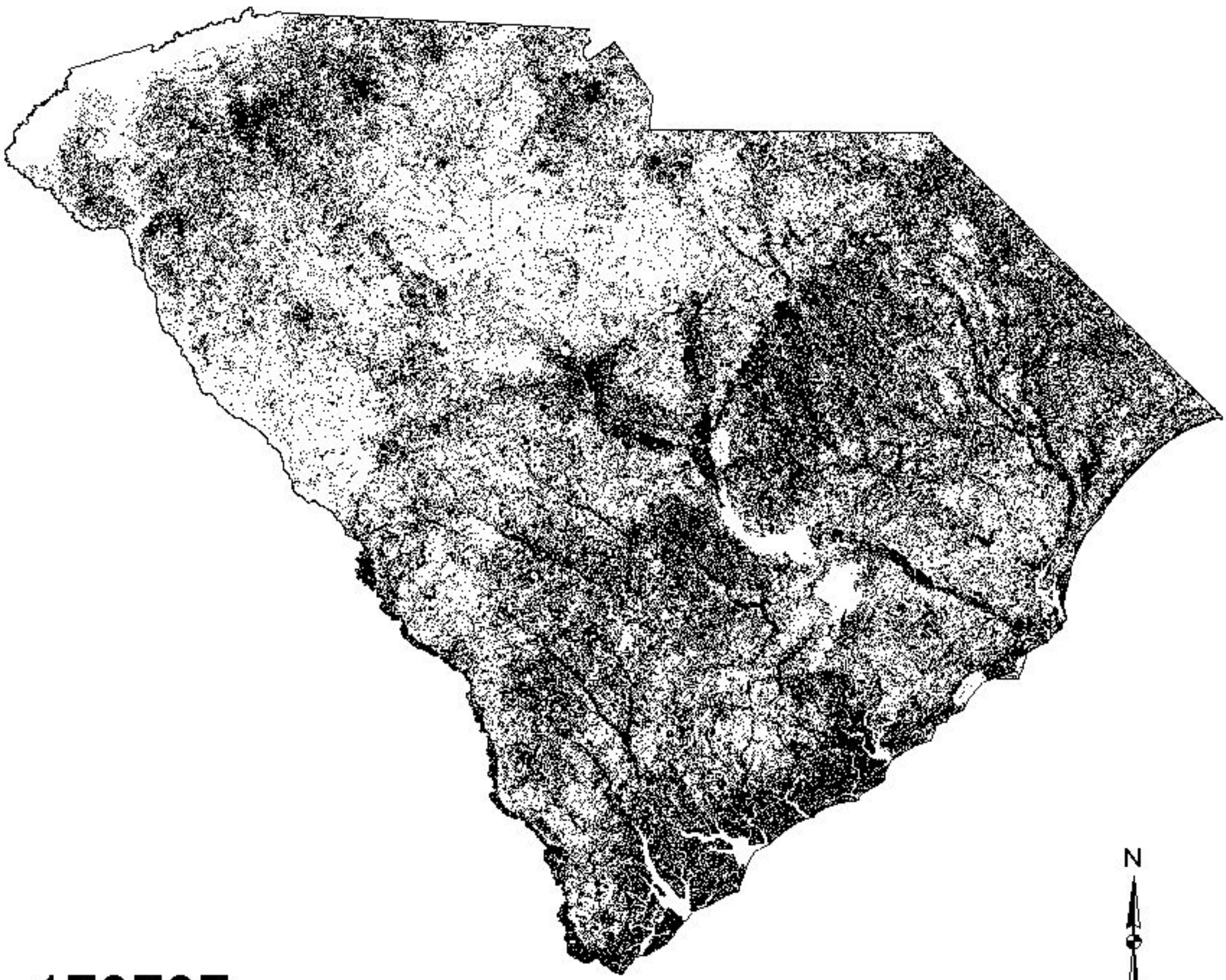
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Fish Crow

(Corvus ossifragus)



179737

Predicted present

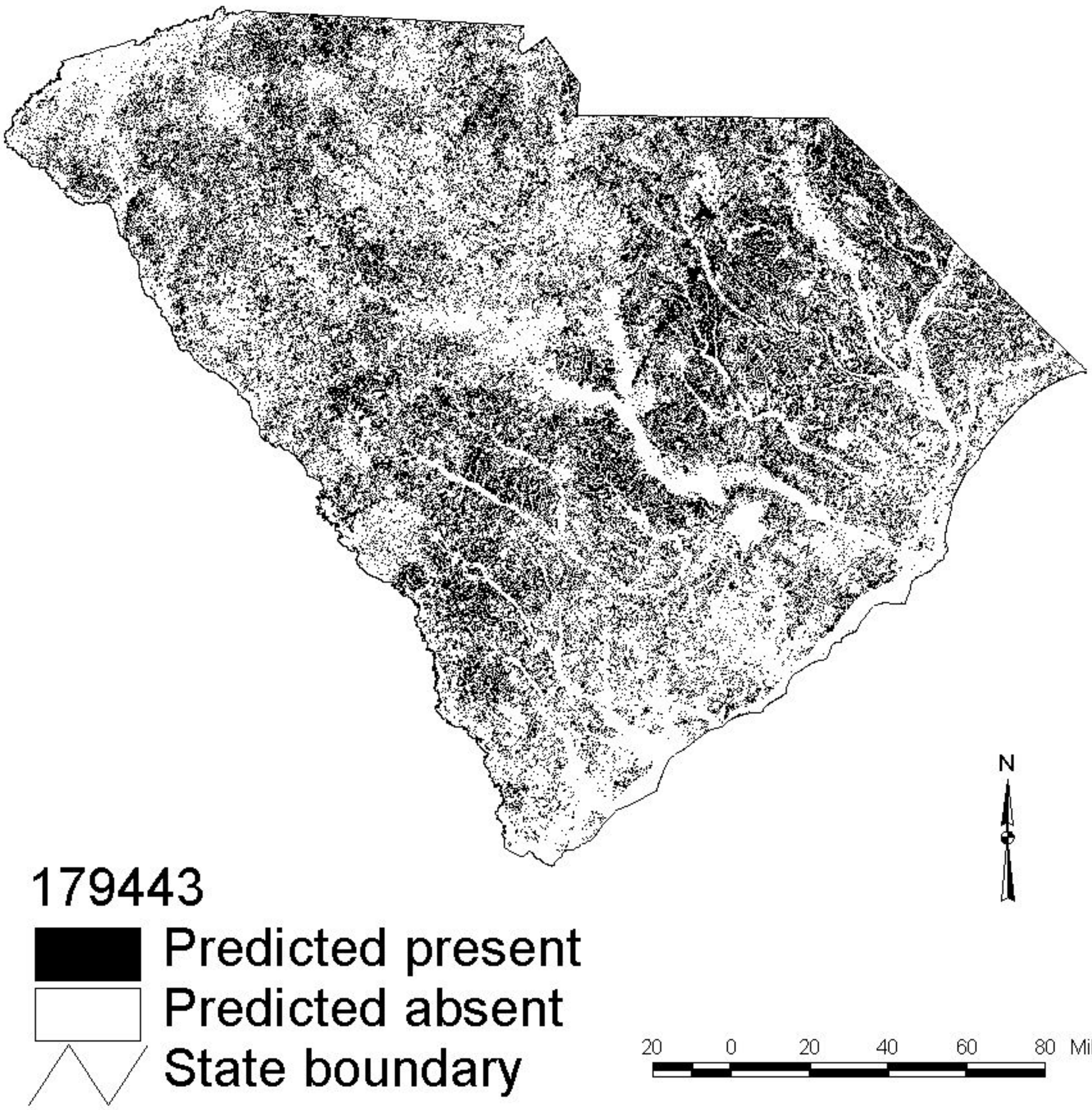
Predicted absent

State boundary

20 0 20 40 60 80 Miles

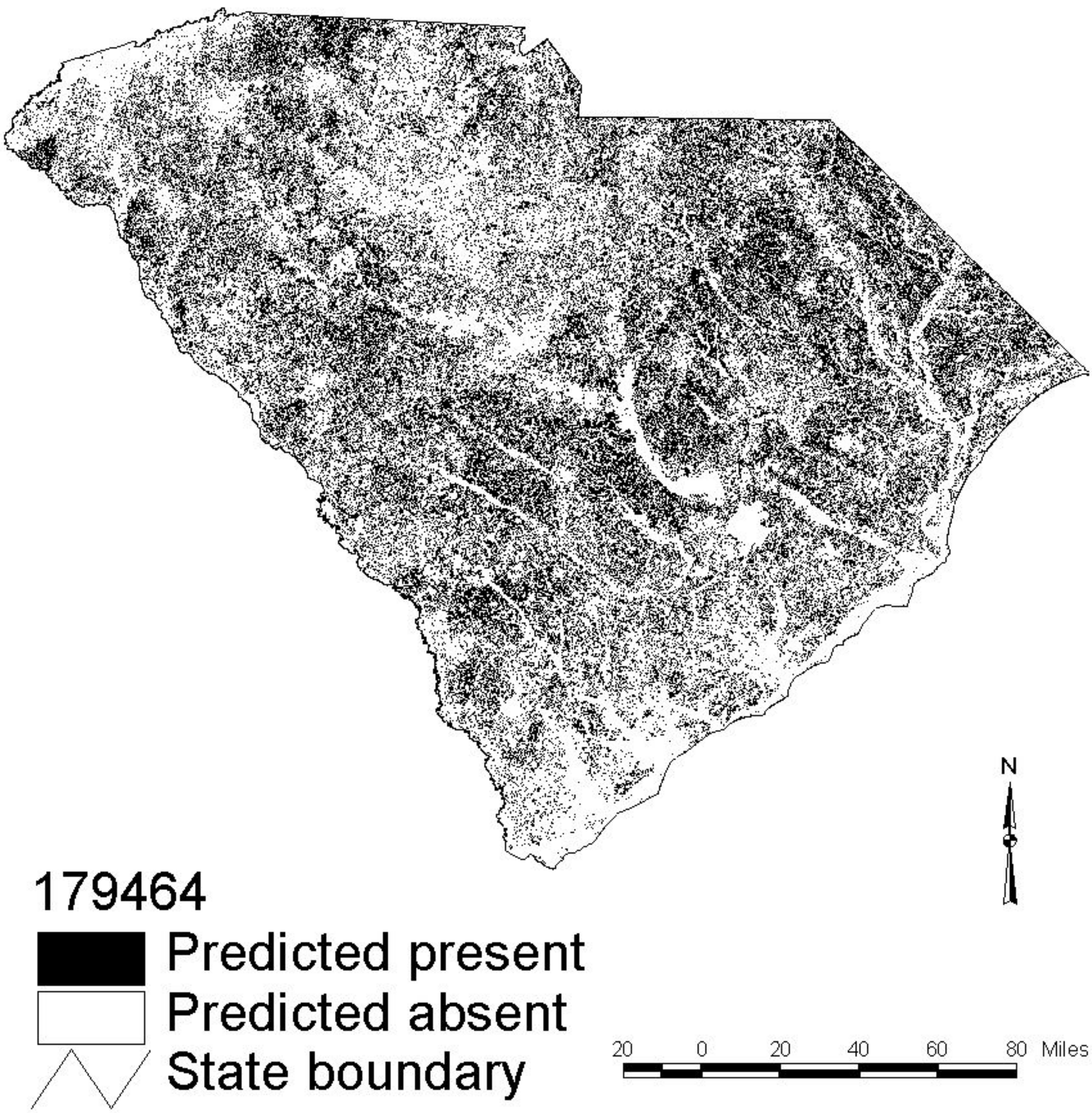
Field Sparrow

(Spizella pusilla)



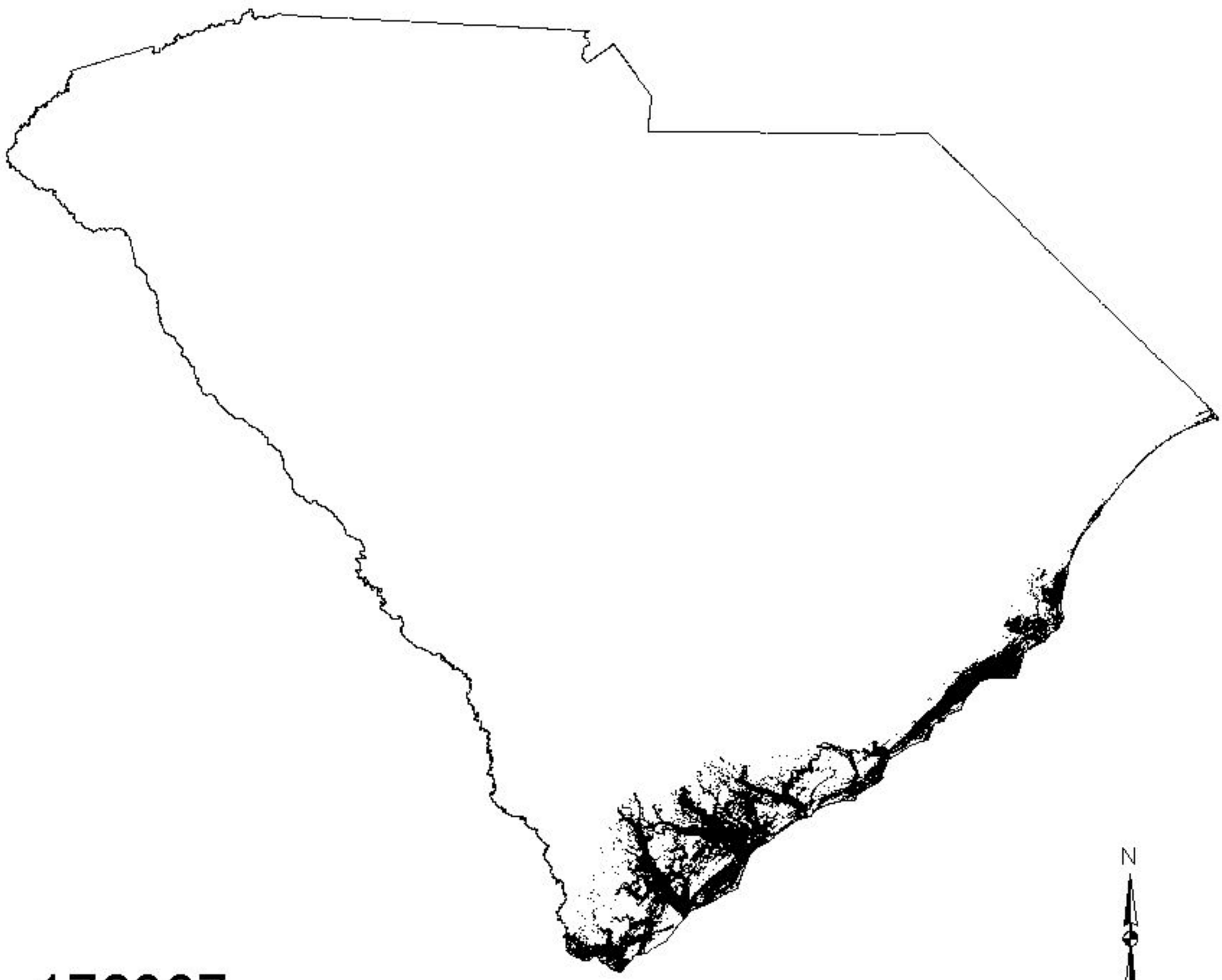
Fox Sparrow

(Passerella iliaca)



Forster's Tern

(Sterna forsteri)



176887

Predicted present

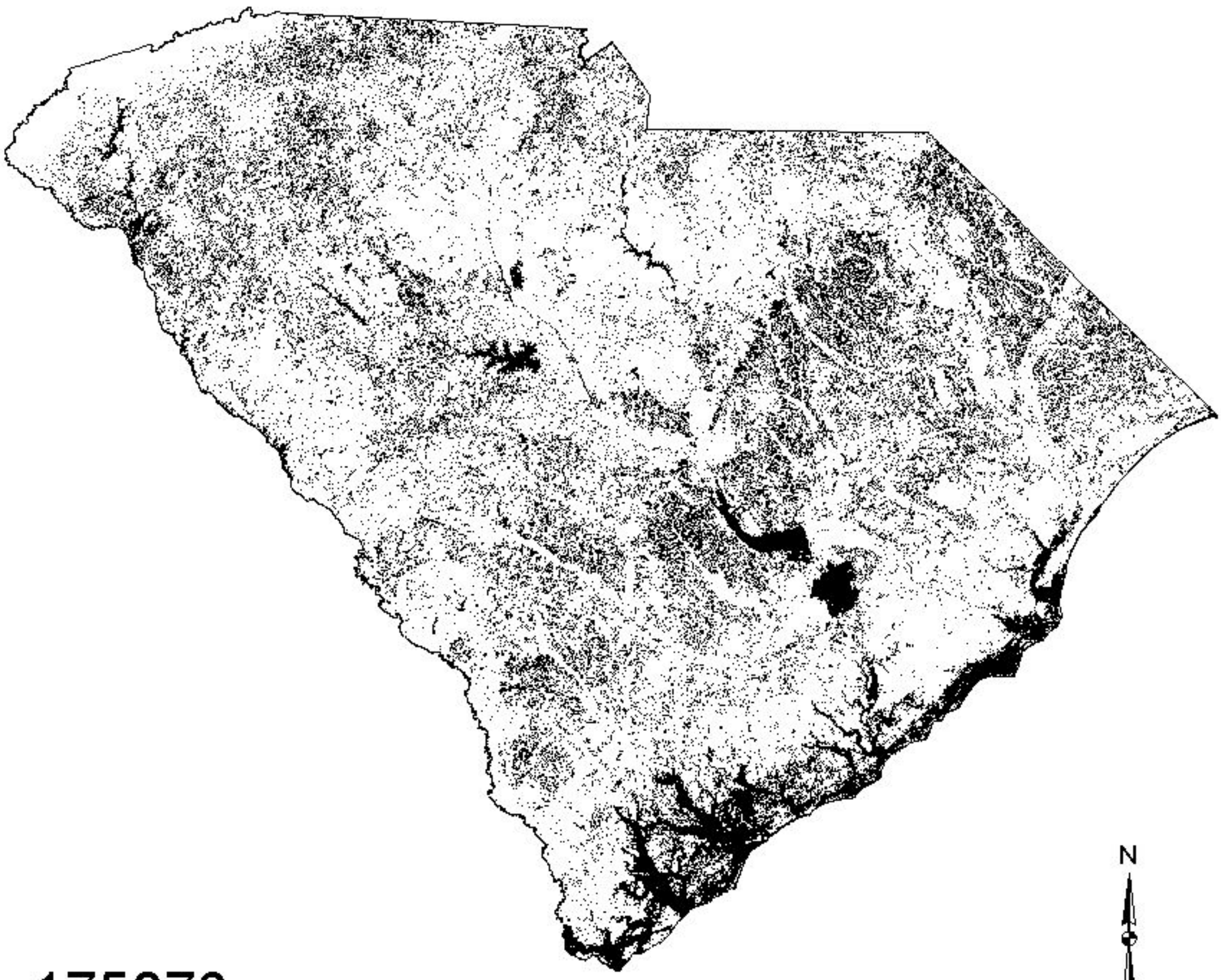
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Gadwall

(Anas strepera)



175073

Predicted present

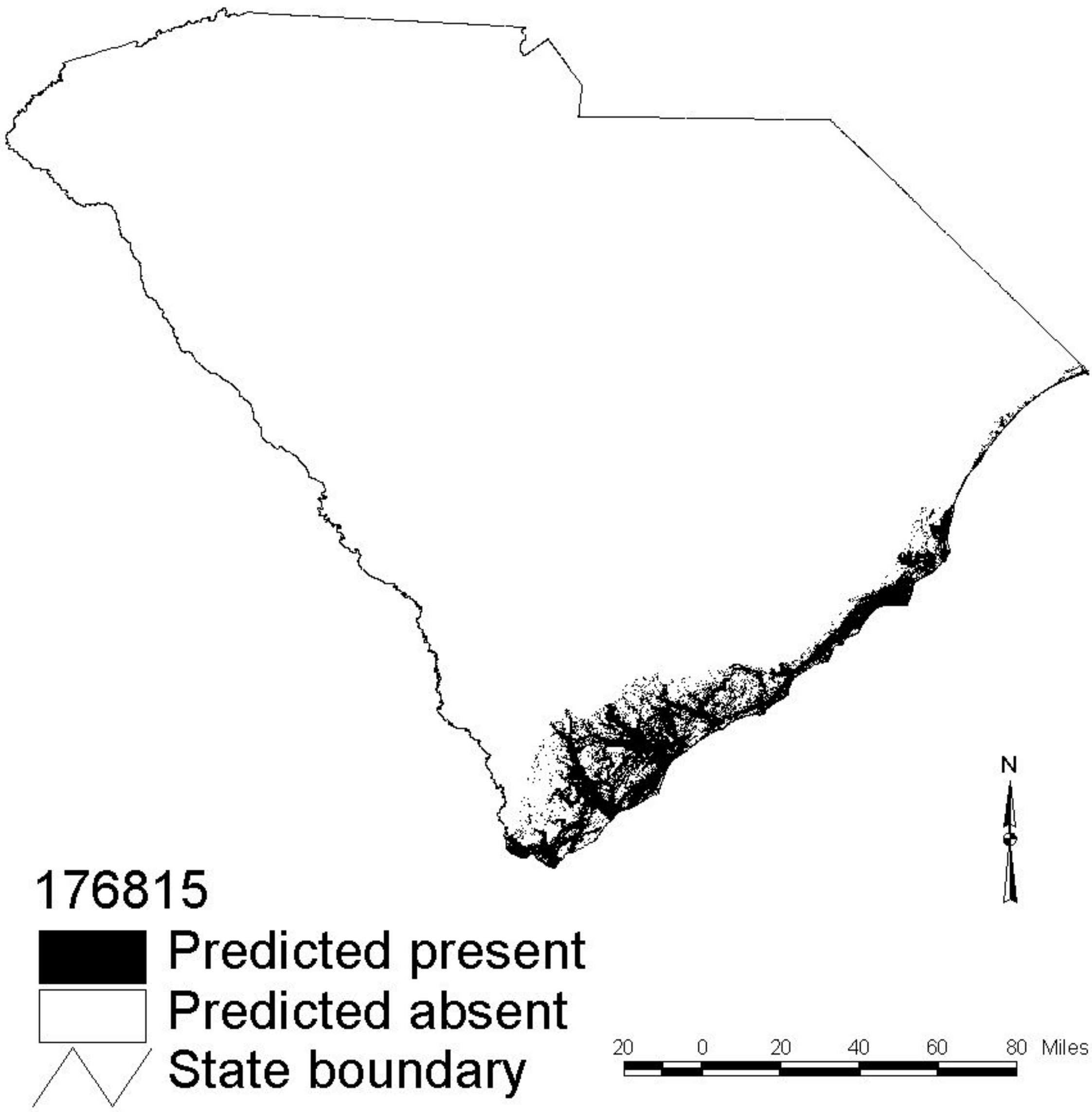
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Great Black-backed Gull

(Larus marinus)



176815

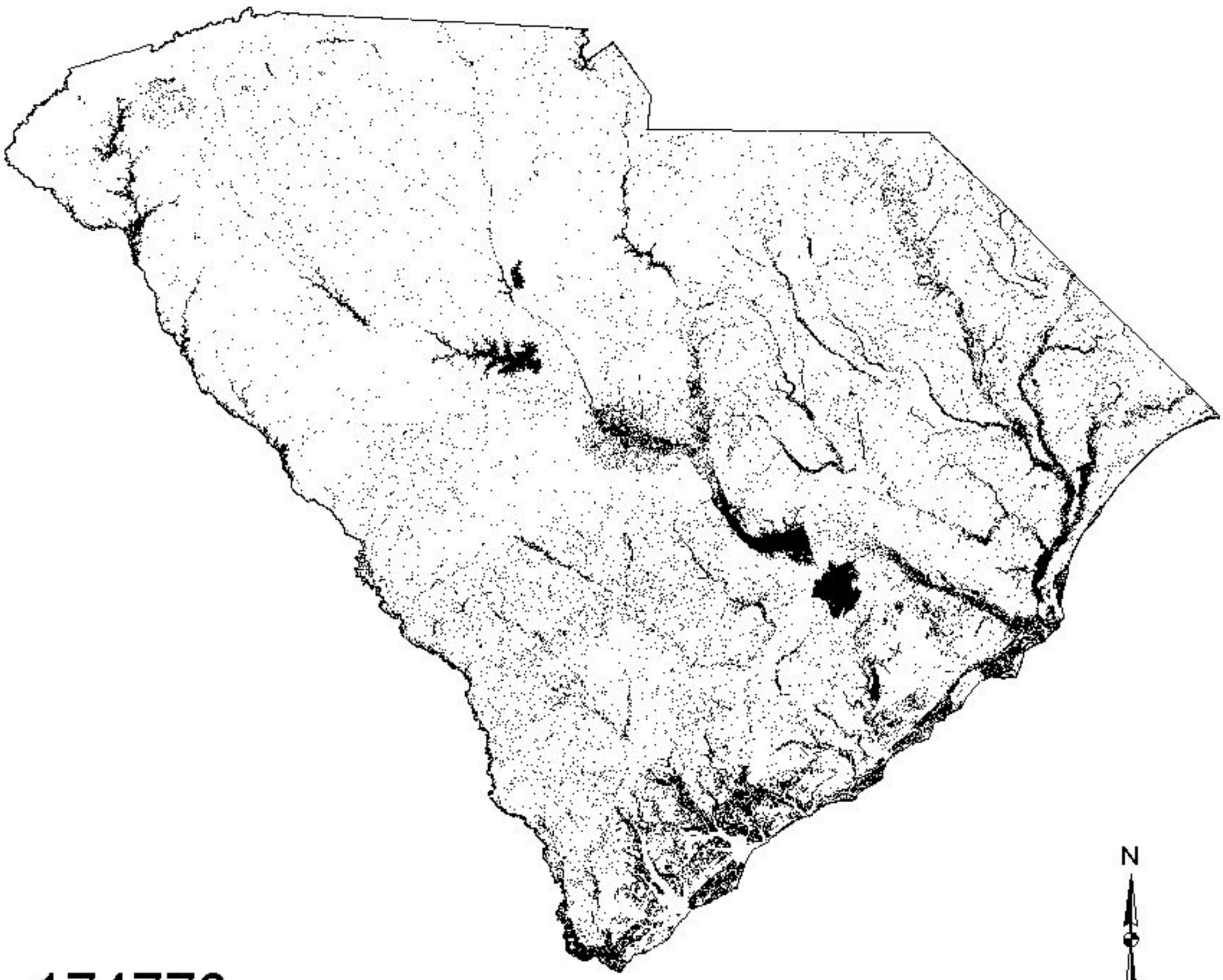
Predicted present

Predicted absent

State boundary

Great Blue Heron

(Ardea herodias)



174773

Predicted present

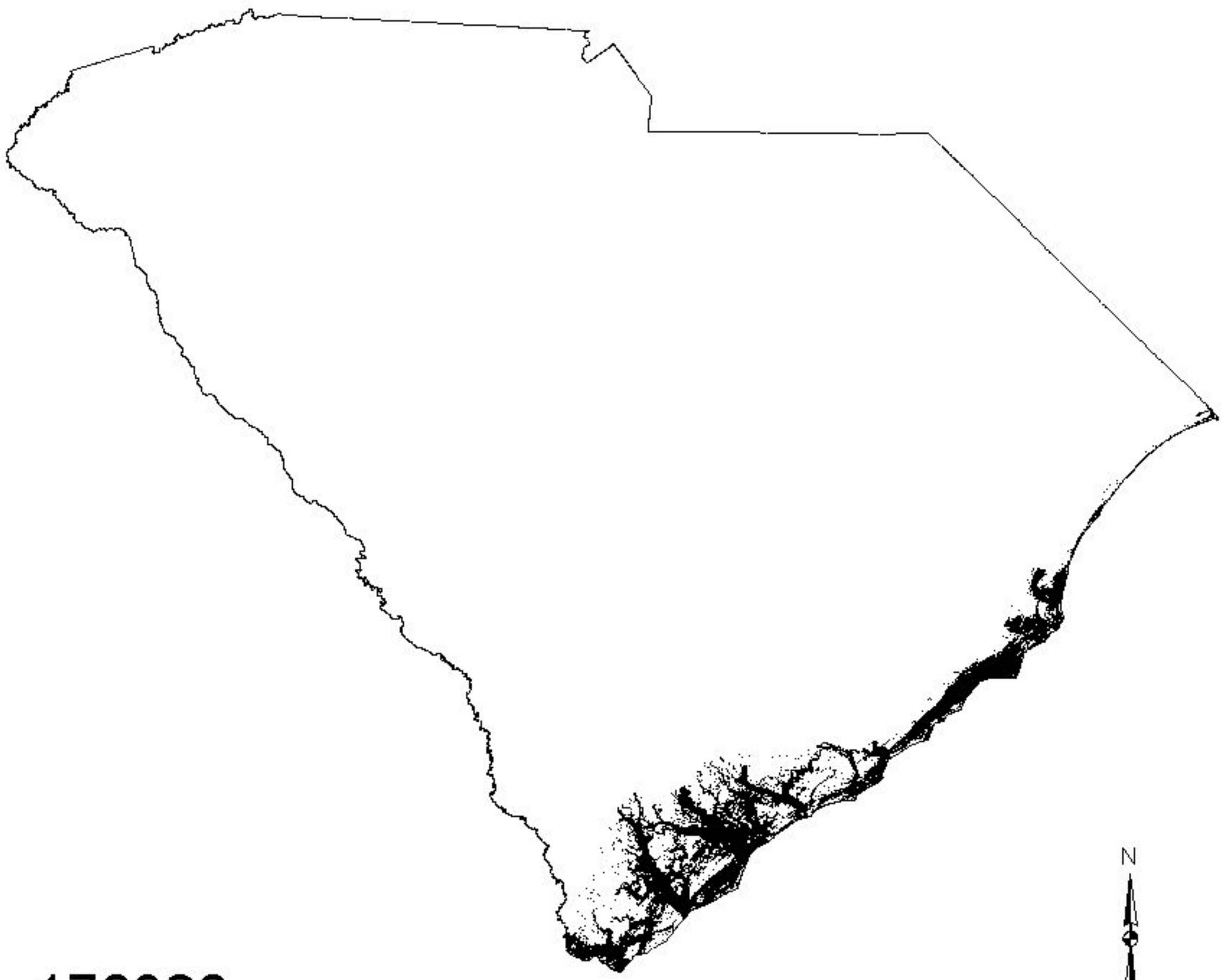
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Gull-billed Tern

(Sterna nilotica)



176926

Predicted present

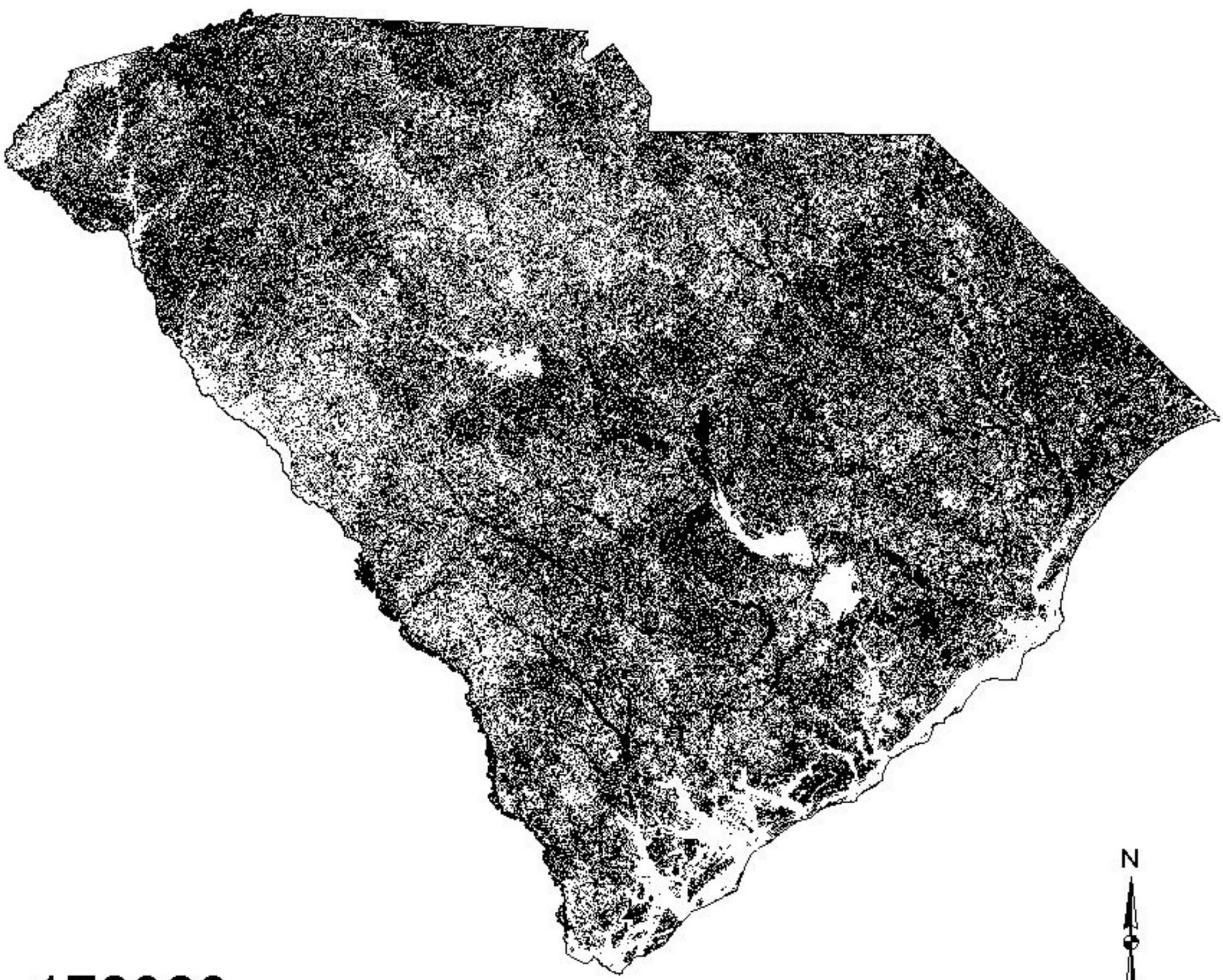
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Great Crested Flycatcher

(Myiarchus crinitus)



178309

Predicted present

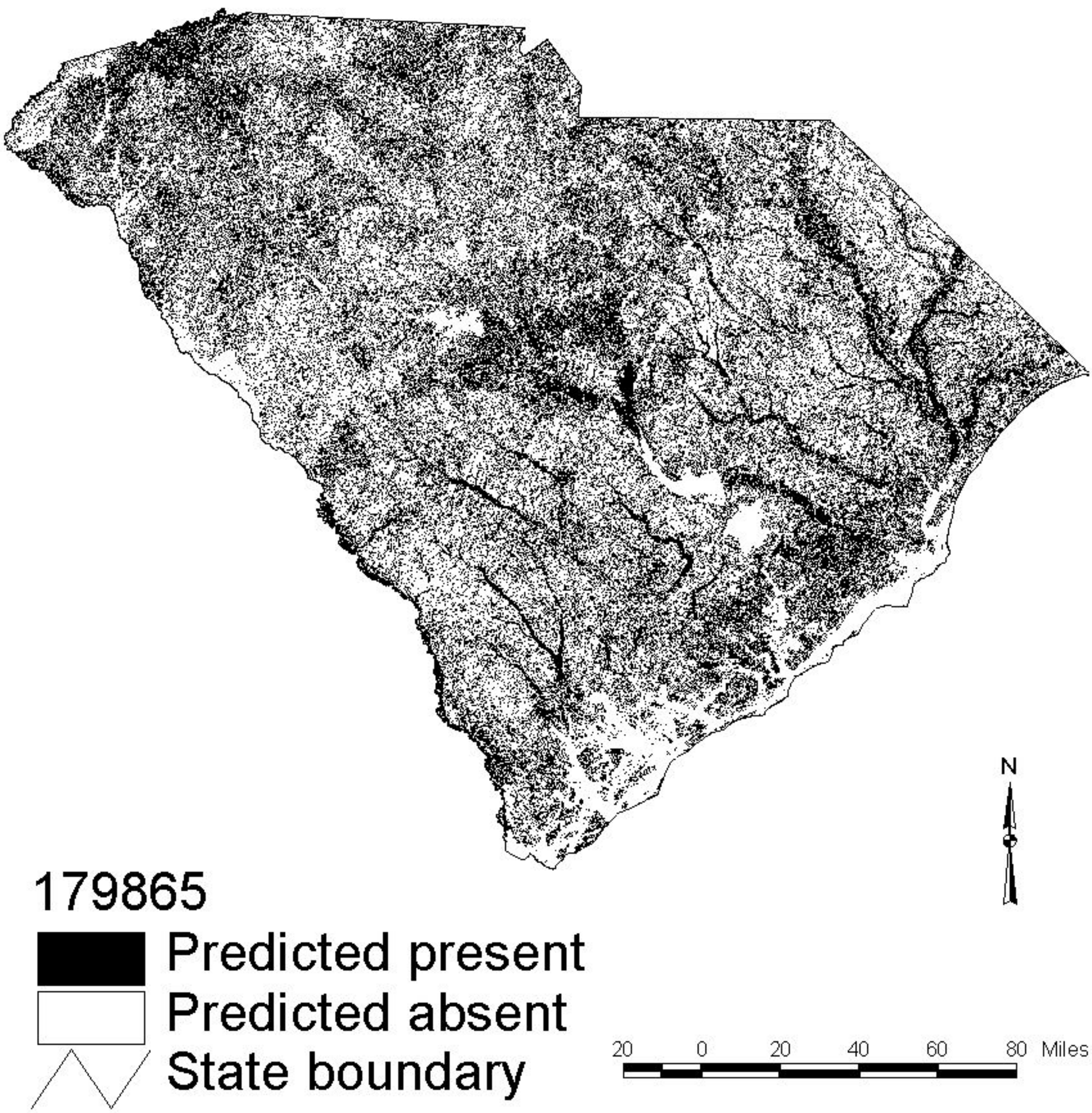
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Golden-crowned Kinglet

(Regulus satrapa)



Great Horned Owl

(Bubo virginianus)

177884

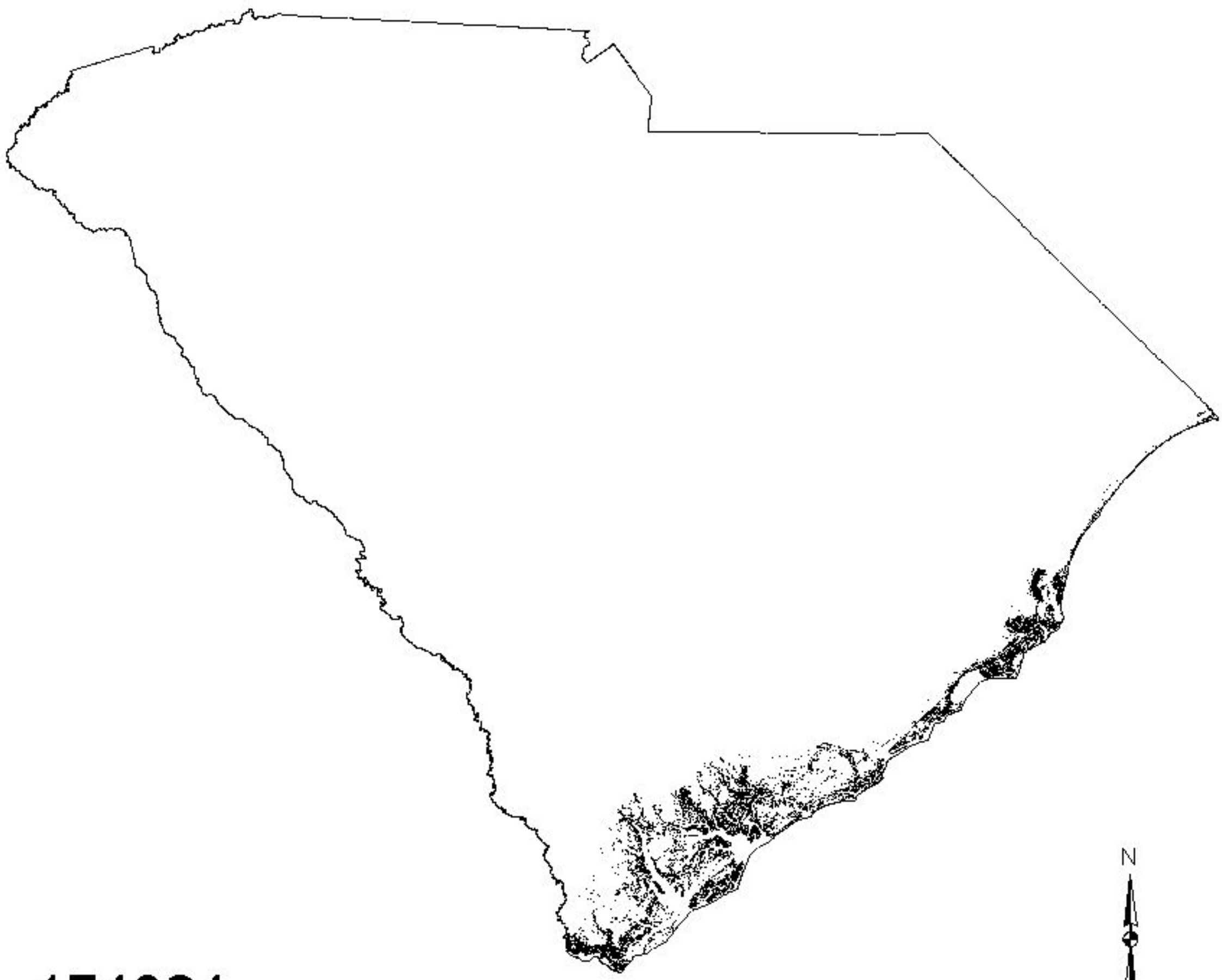
Predicted present

Predicted absent

State boundary

Glossy Ibis

(Plegadis falcinellus)



174924

Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Gray Catbird

(Dumetella carolinensis)

178625

Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Gray Catbird

(Dumetella carolinensis)

178625

Predicted present

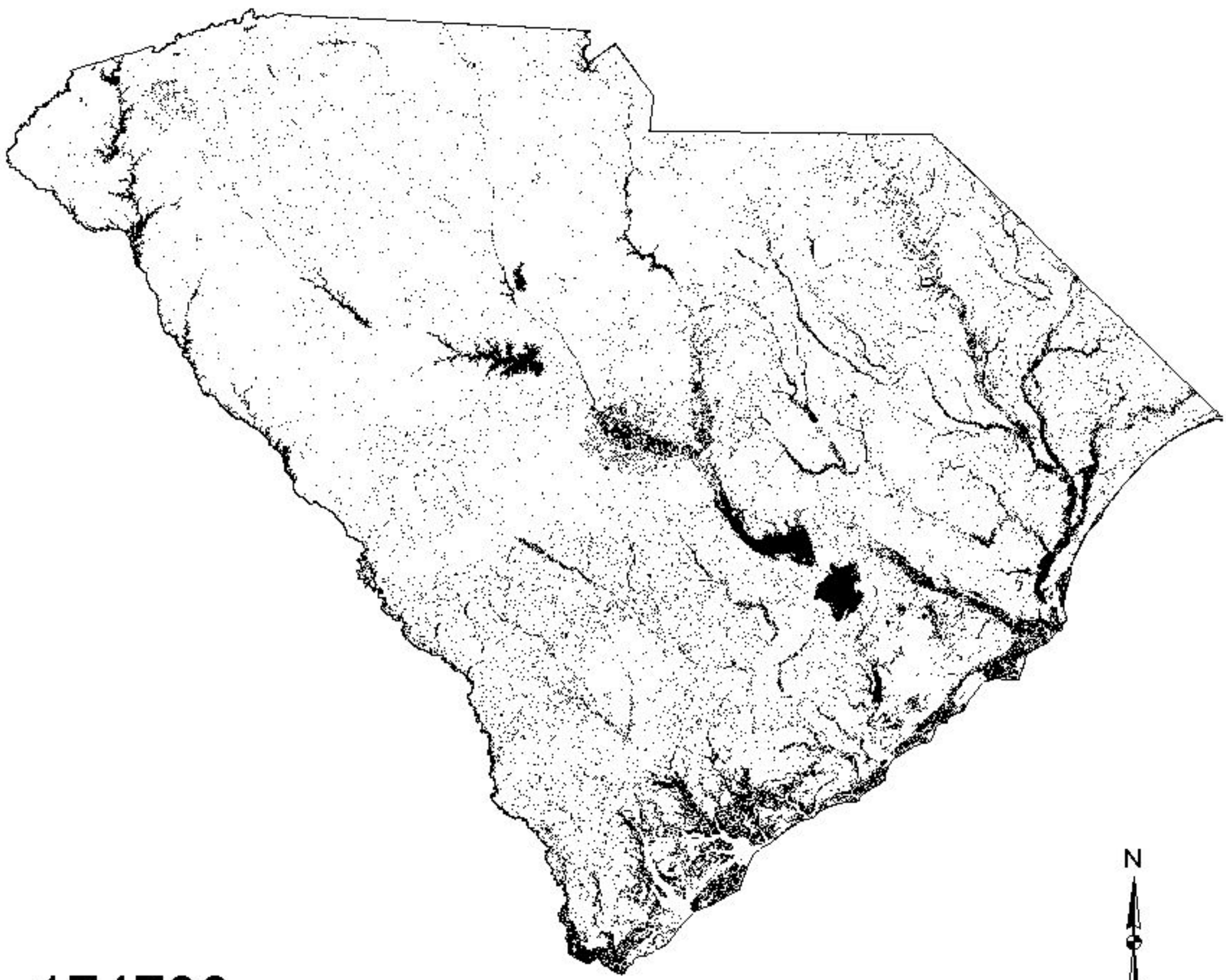
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Green Heron

(Butorides virescens)



174793

Predicted present

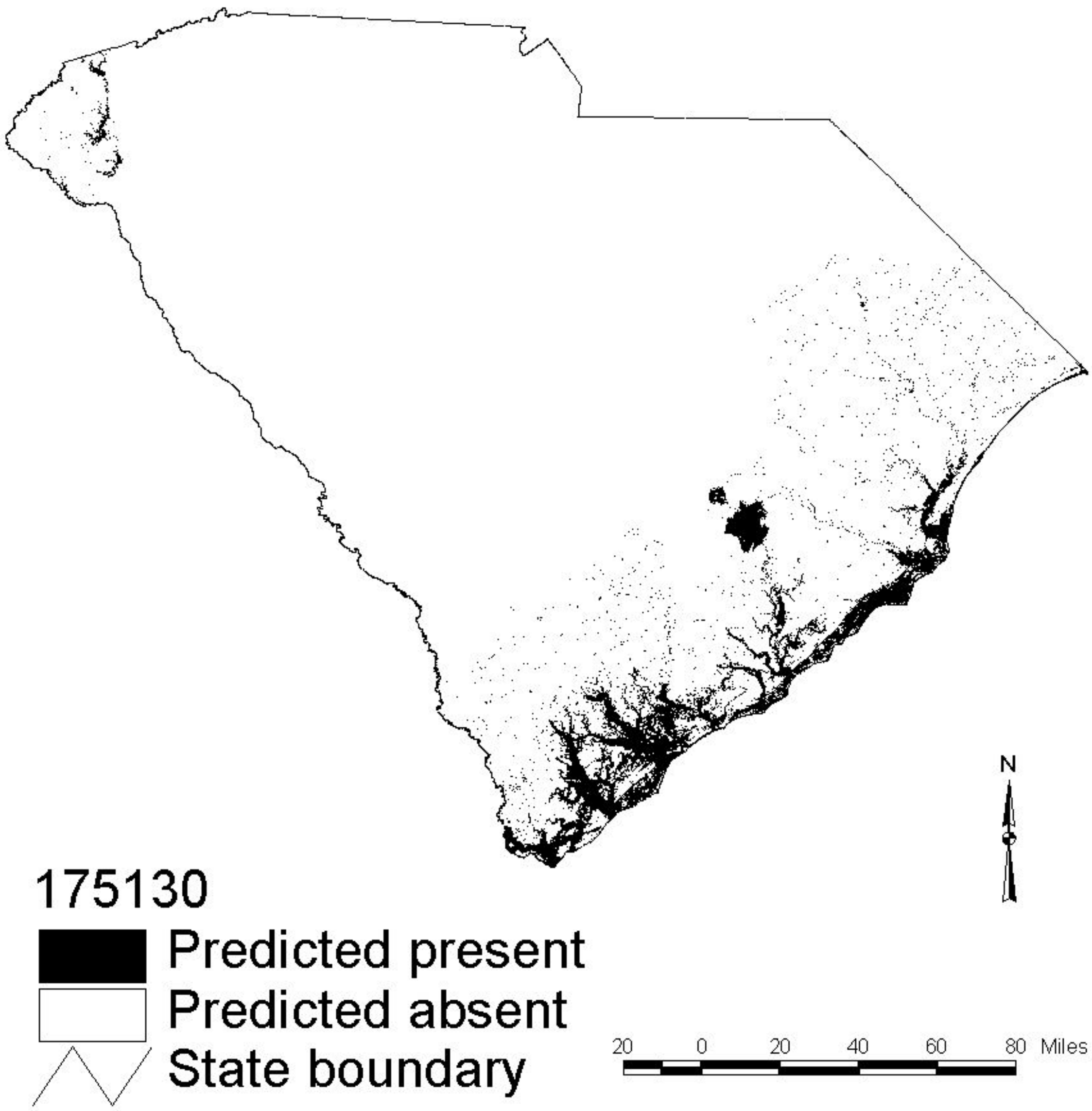
Predicted absent

State boundary

20 0 20 40 60 80 Miles

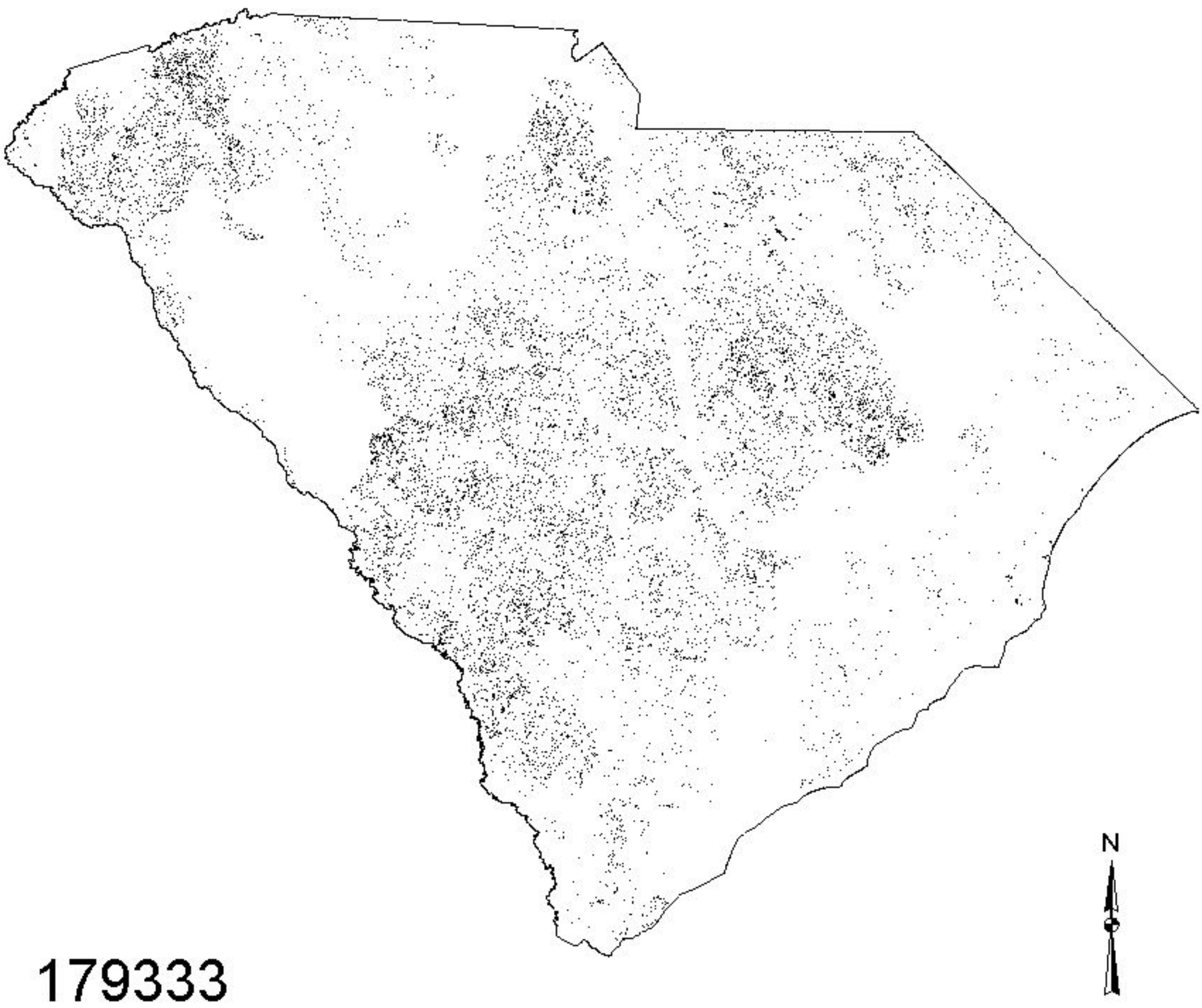
Greater Scaup

(Aythya marila)



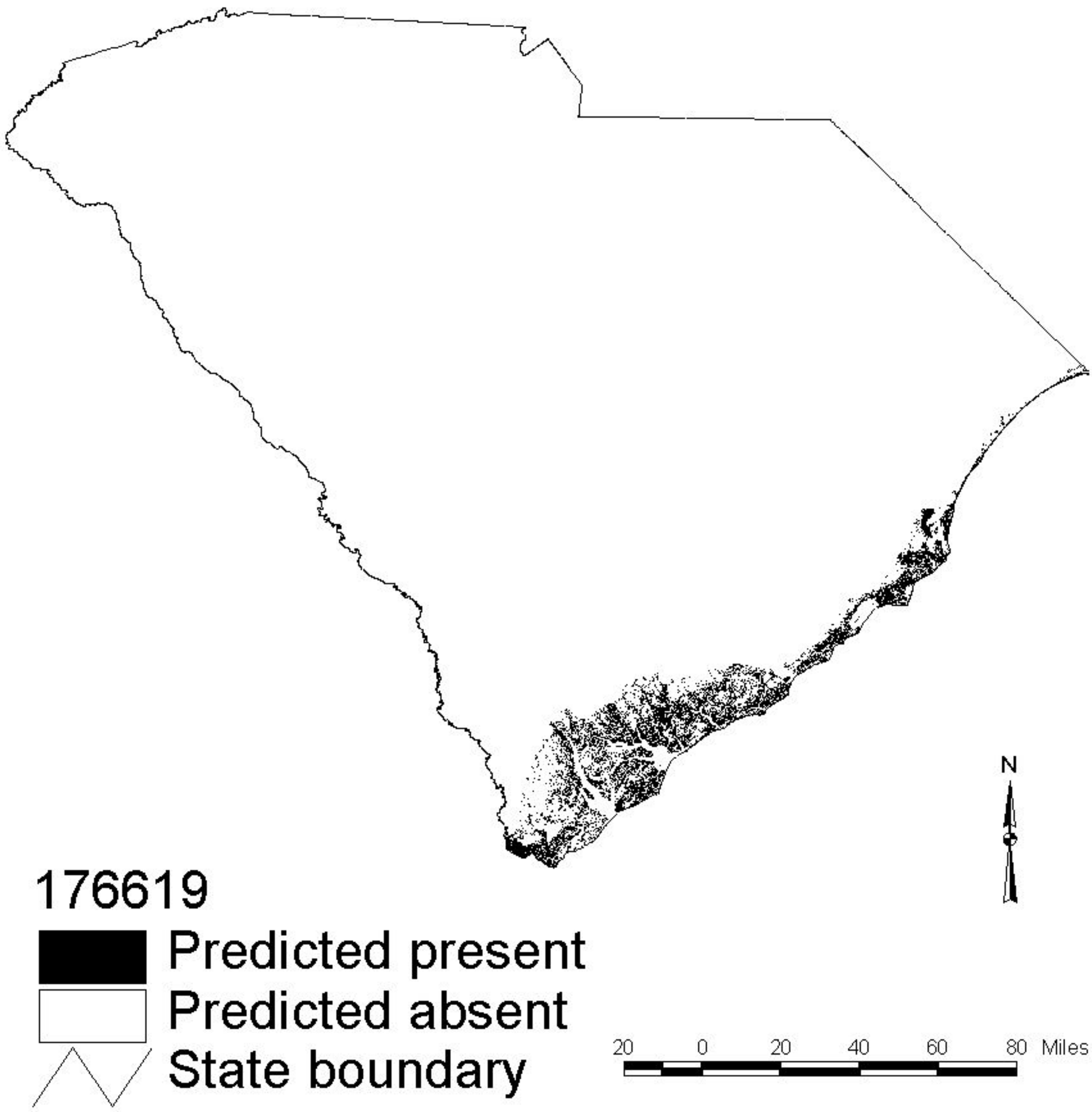
Grasshopper Sparrow

(Ammodramus savannarum)



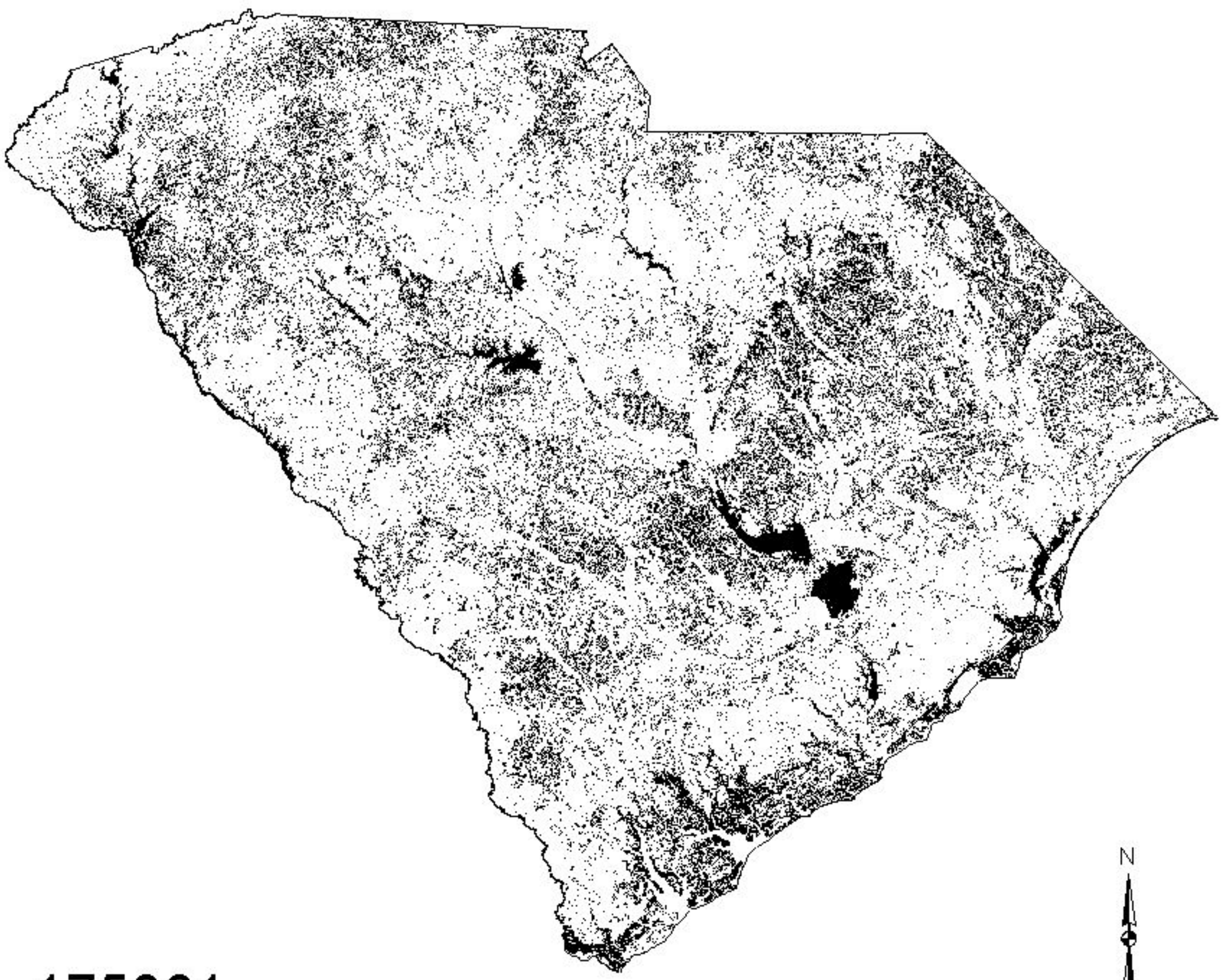
Greater Yellowlegs

(Tringa melanoleuca)



Green-winged Teal

(Anas crecca)



175081

Predicted present

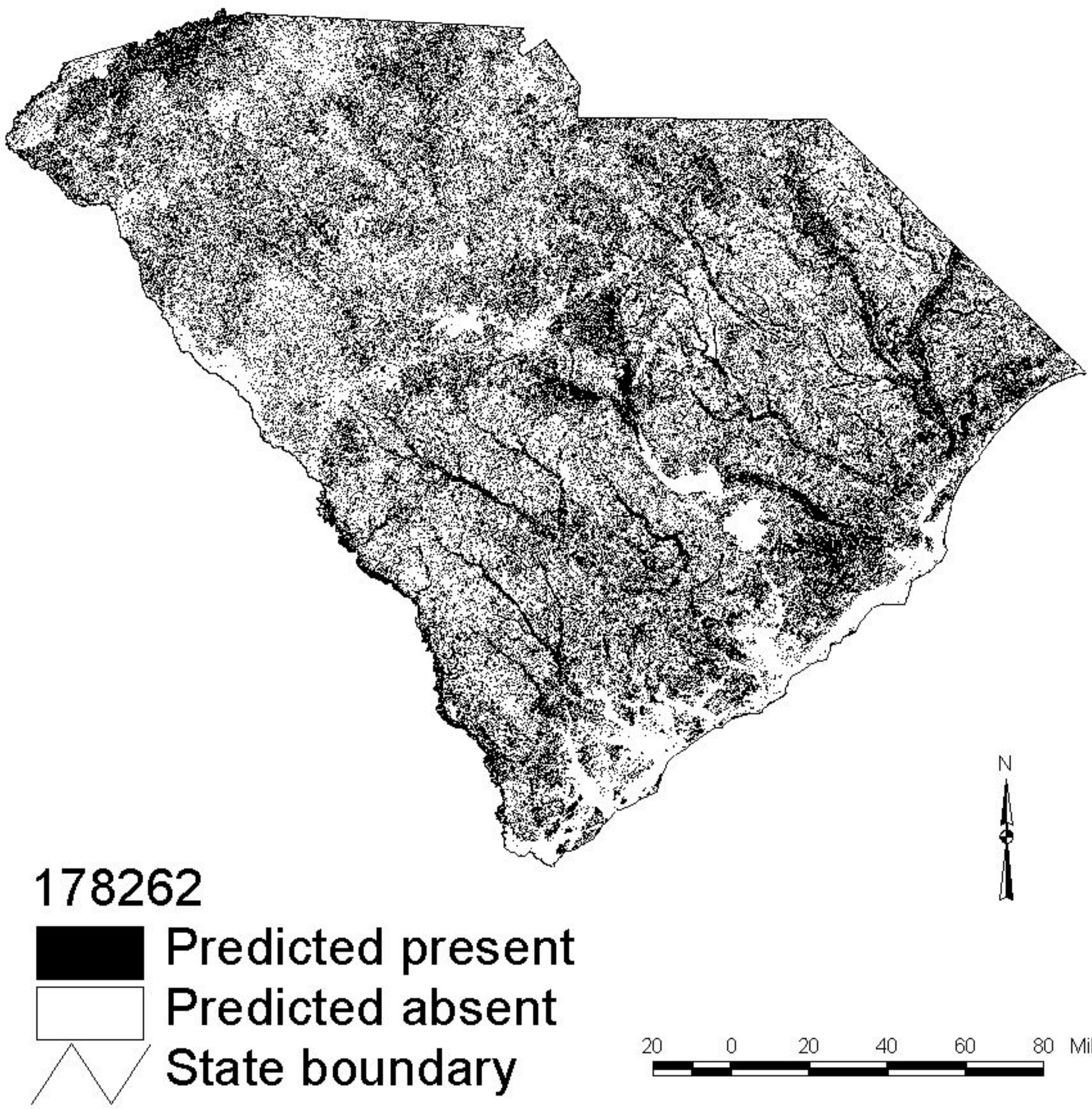
Predicted absent

State boundary

20 0 20 40 60 80 Miles

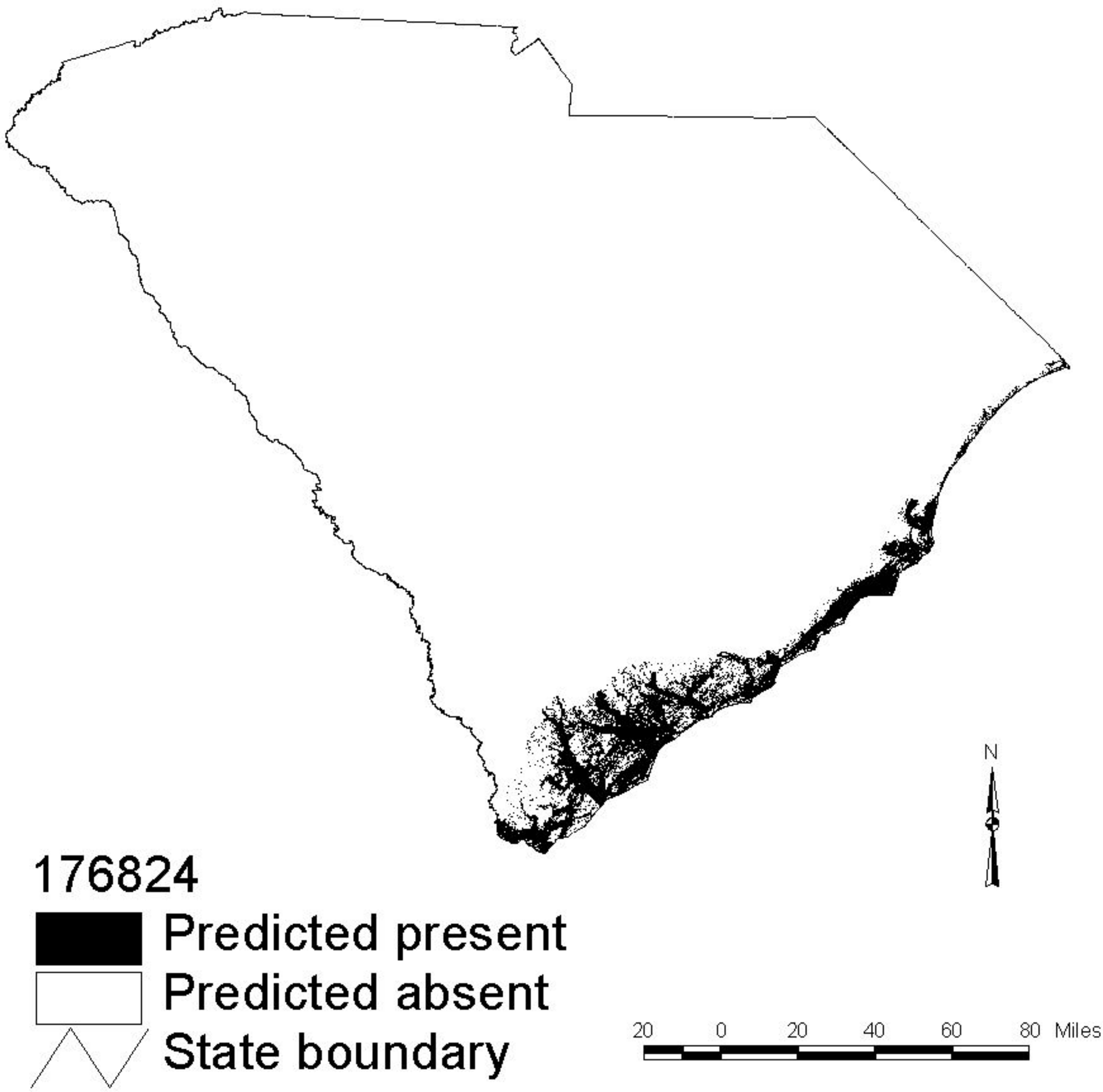
Hairy Woodpecker

(Picoides villosus)



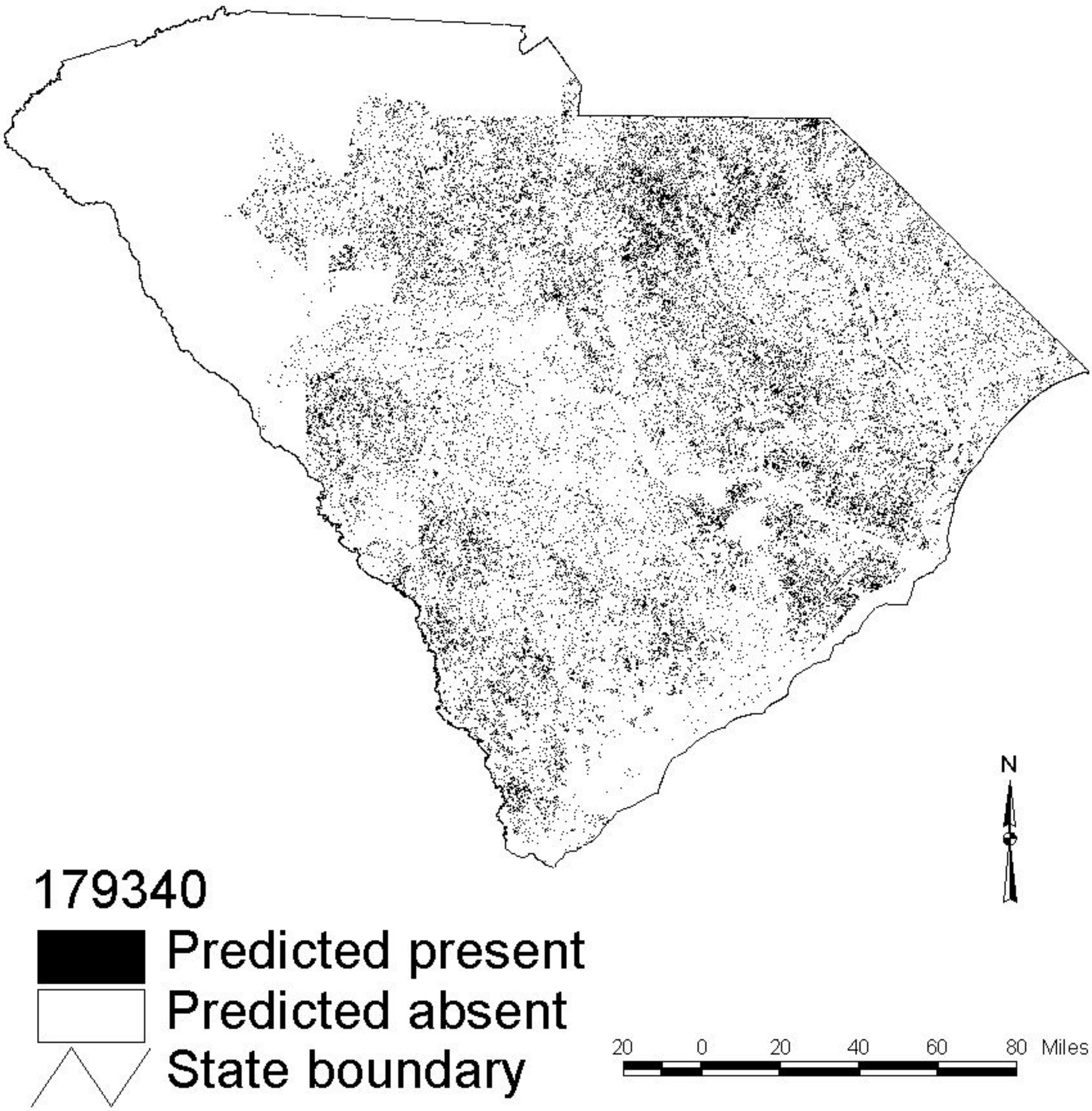
Herring Gull

(Larus argentatus)



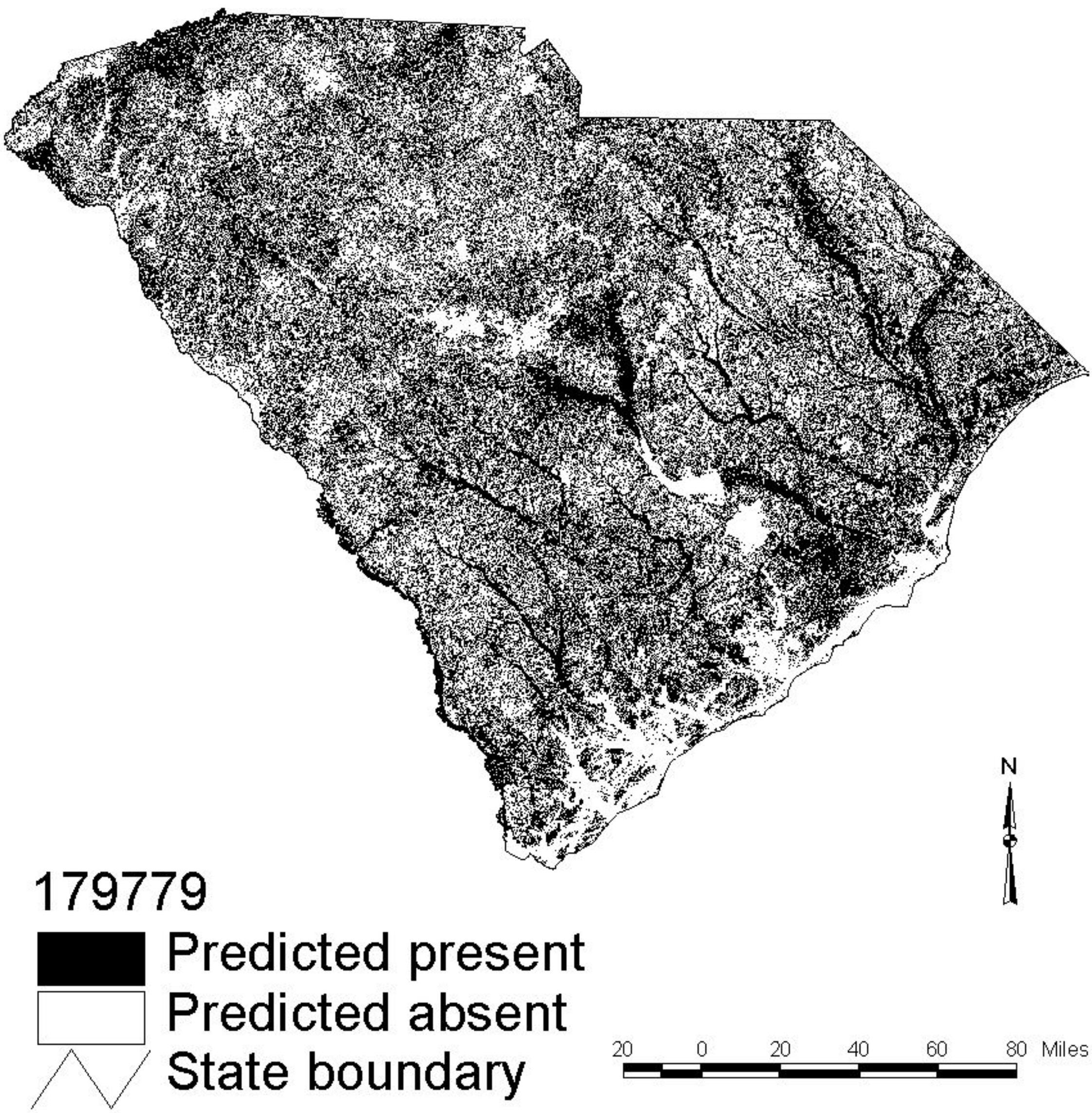
Henslow's Sparrow

(Ammodramus henslowii)



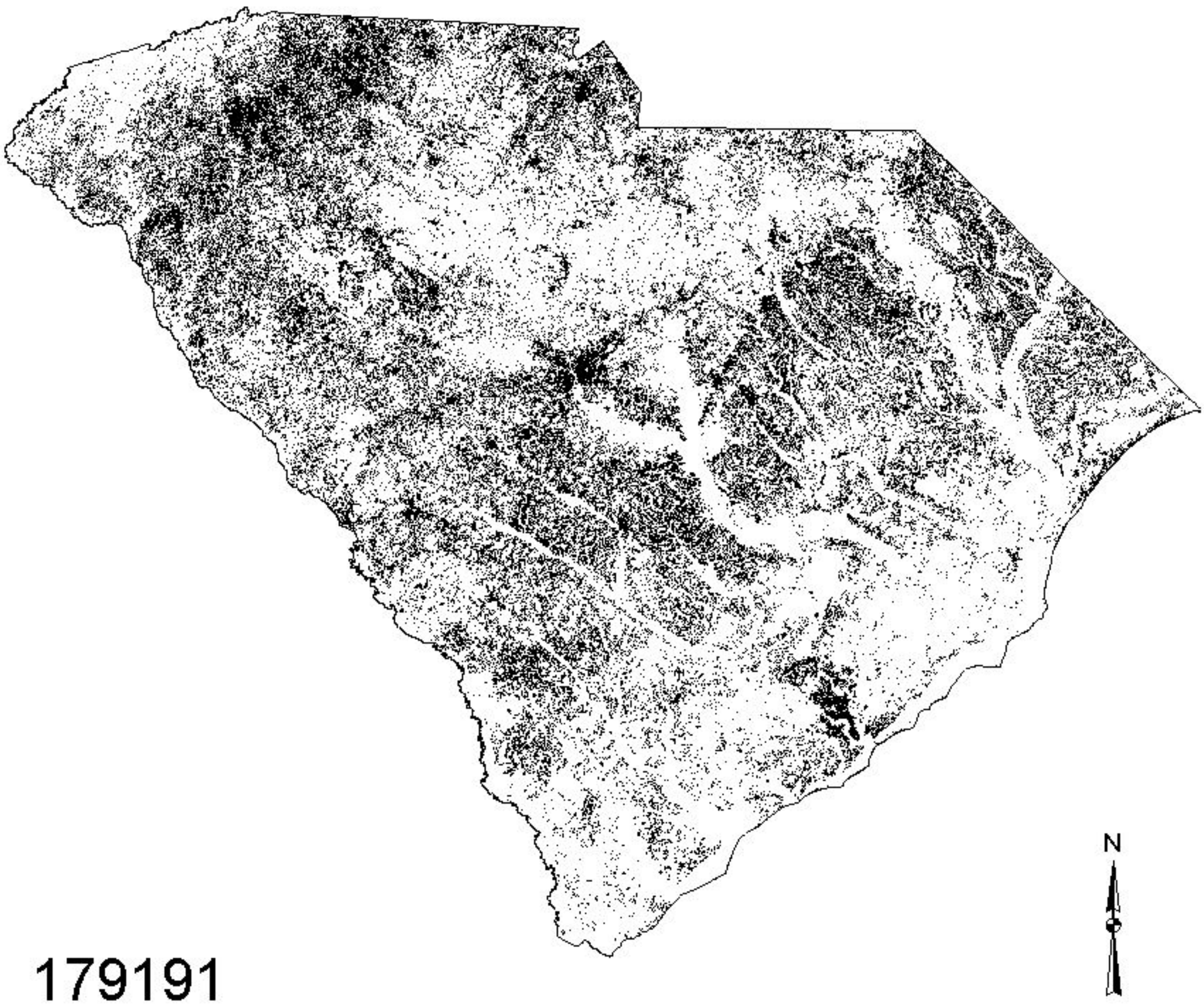
Hermit Thrush

(Catharus guttatus)



House Finch

(Carpodacus mexicanus)



179191

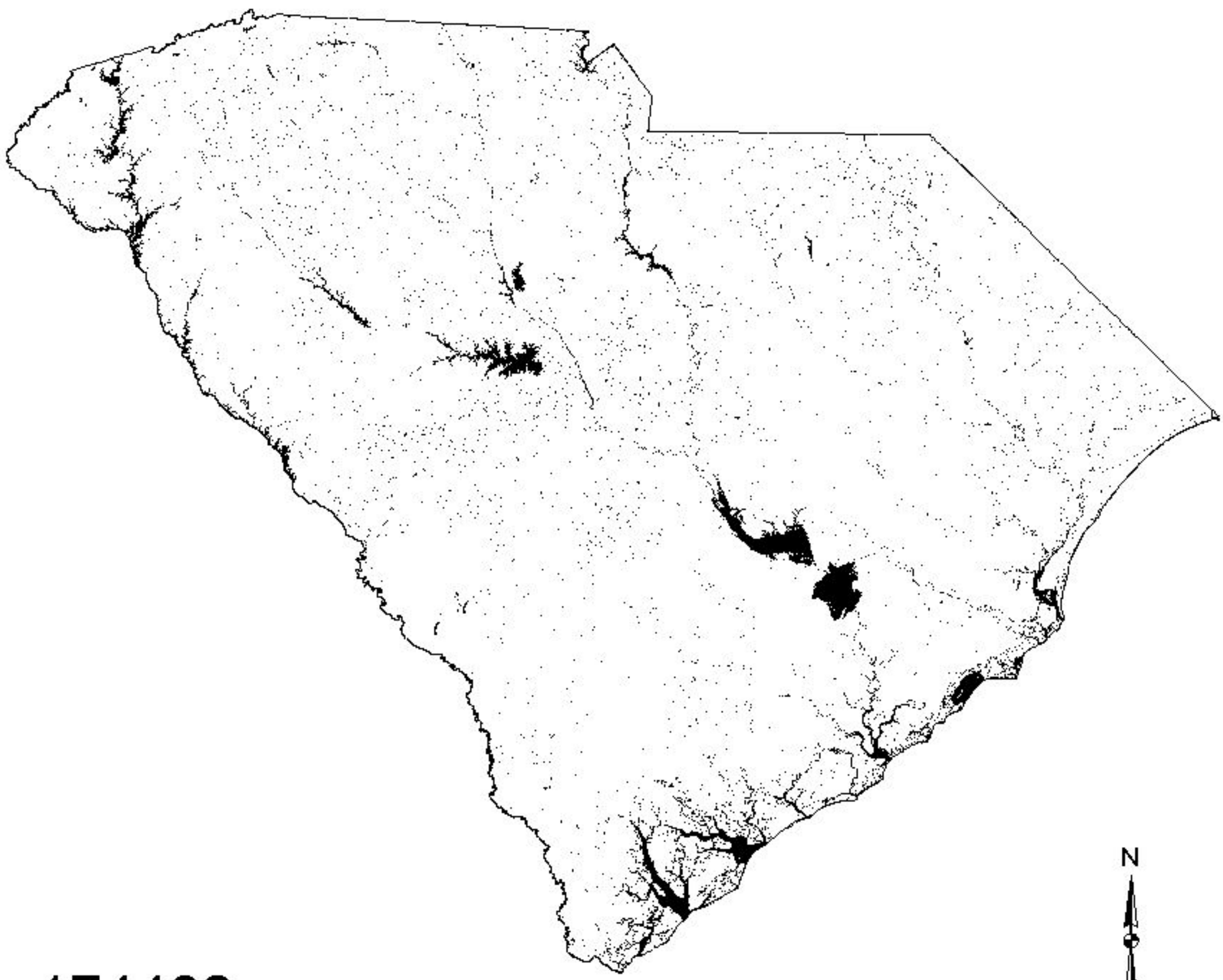
Predicted present

Predicted absent

State boundary

Horned Grebe

(Podiceps auritus)



174482

Predicted present

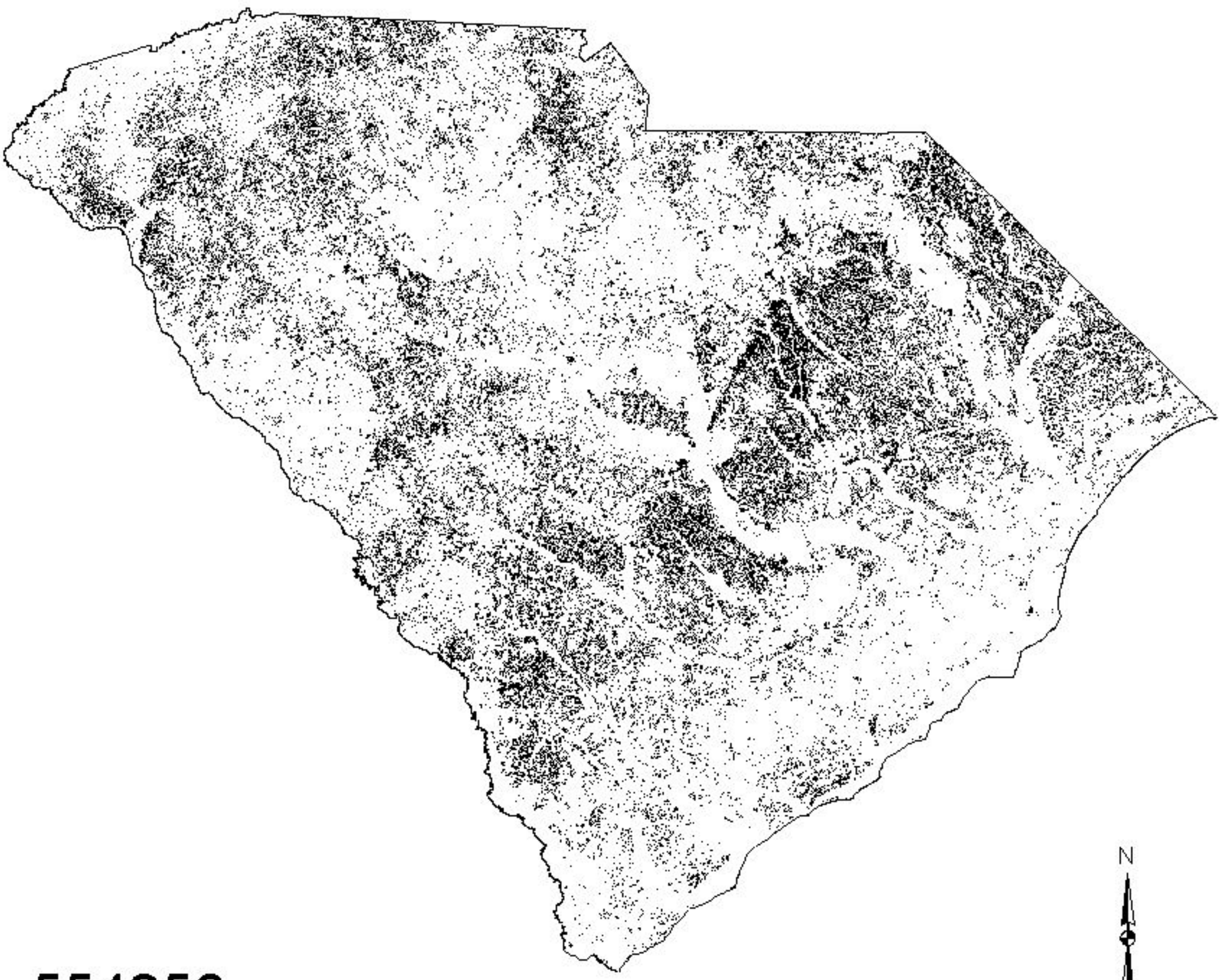
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Horned Lark

(Eremophila alpestris)



554256

Predicted present

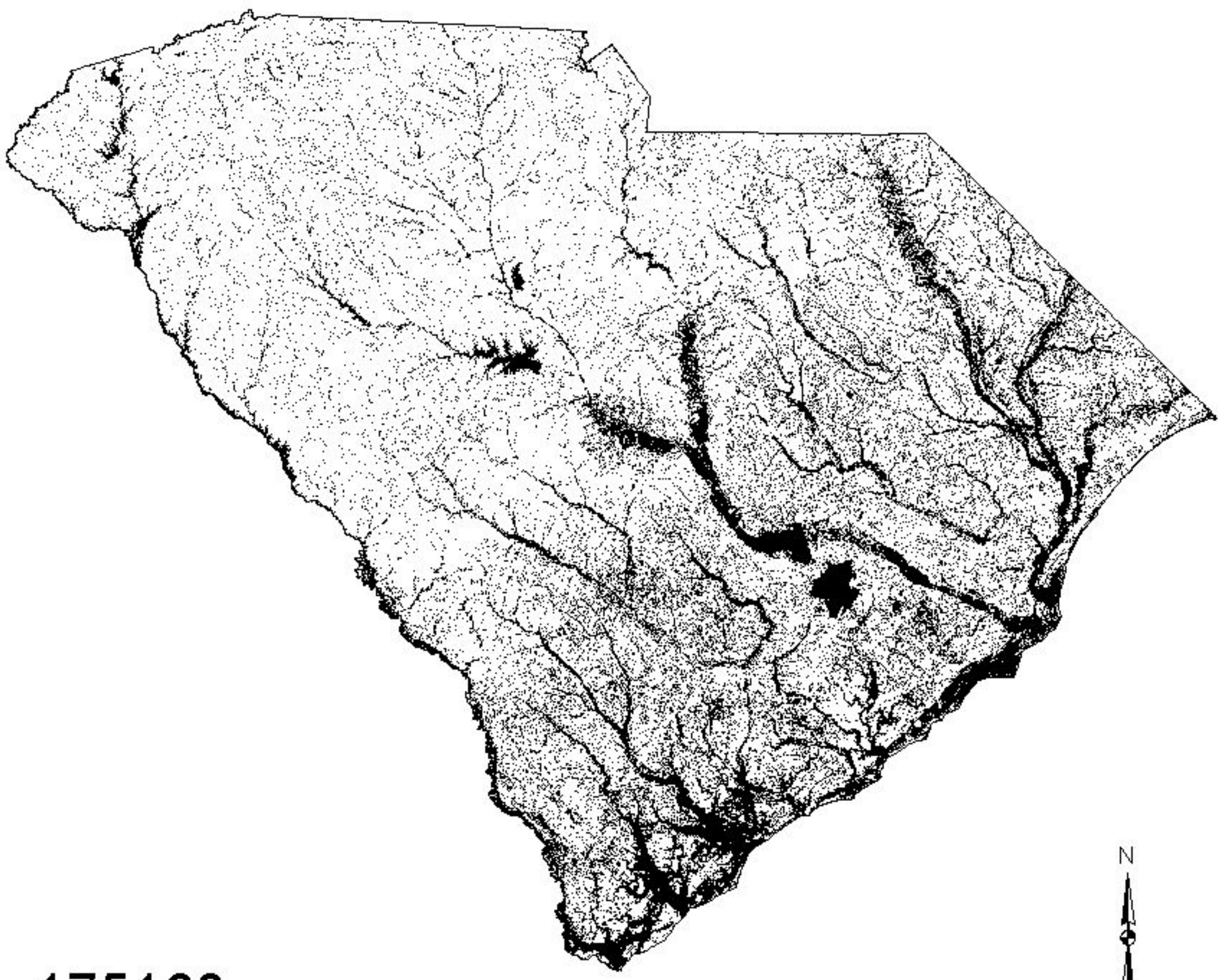
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Hooded Merganser

(Lophodytes cucullatus)



175183

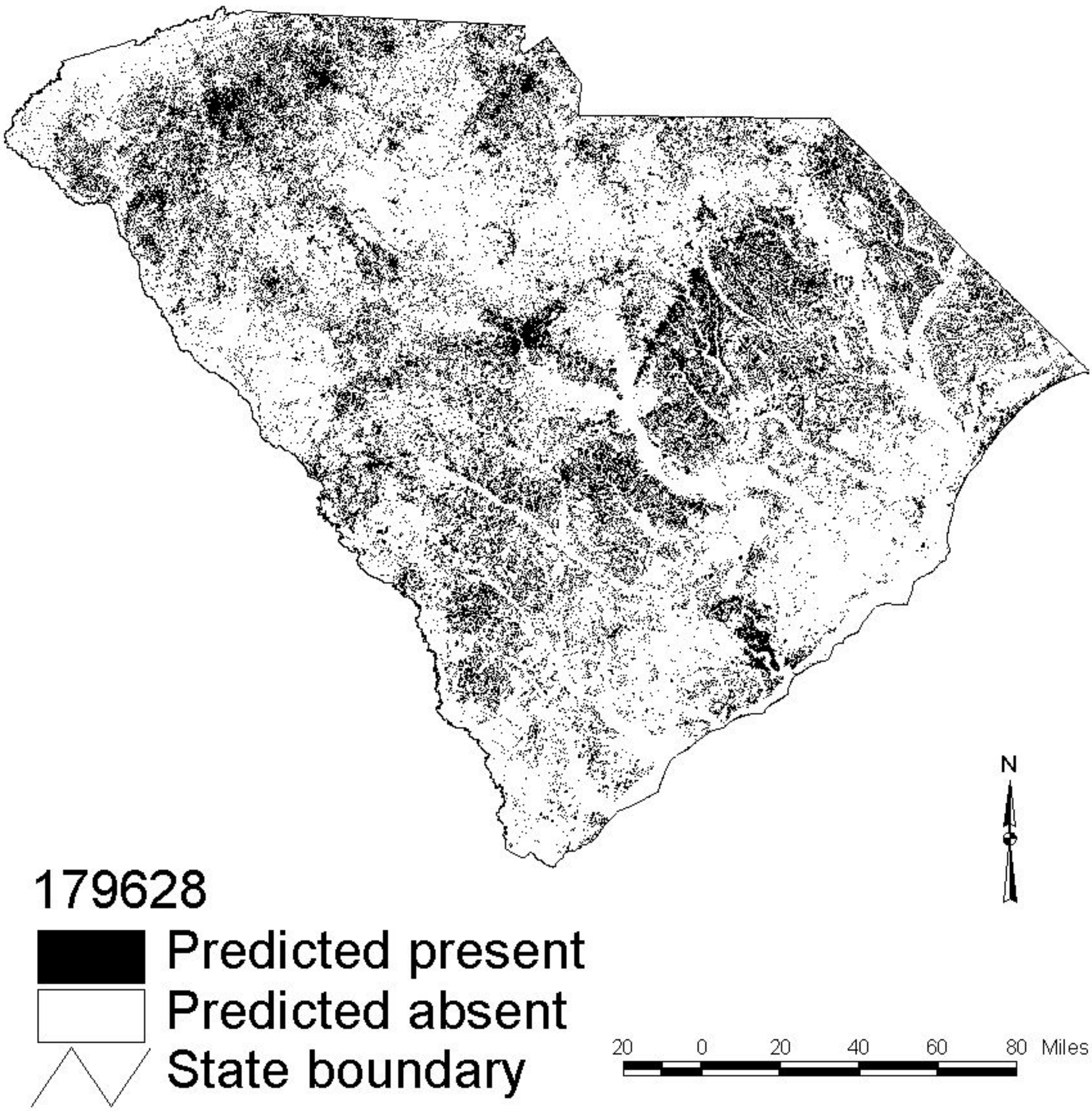
Predicted present

Predicted absent

State boundary

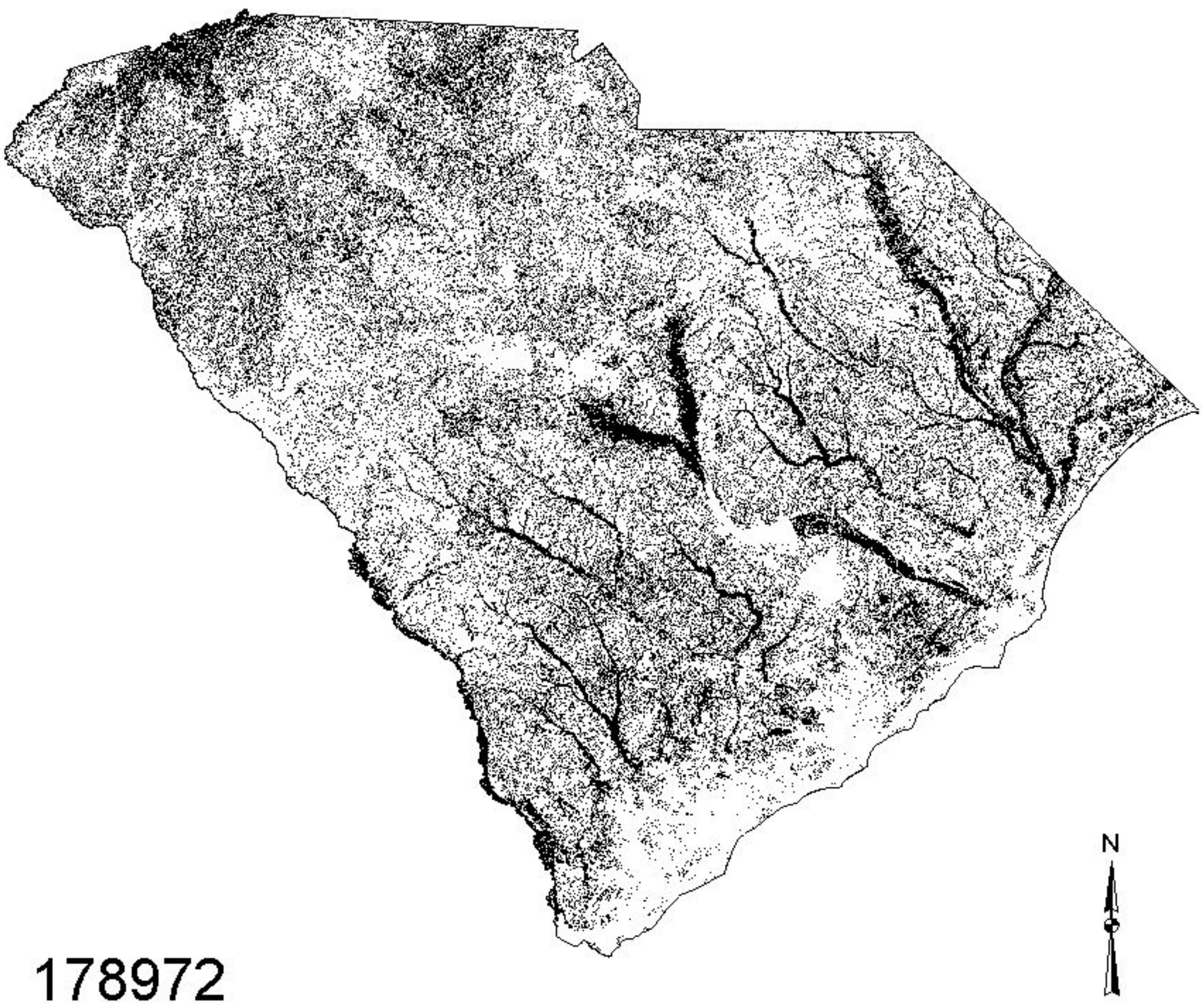
House Sparrow

(Passer domesticus)



Hooded Warbler

(Wilsonia citrina)



178972

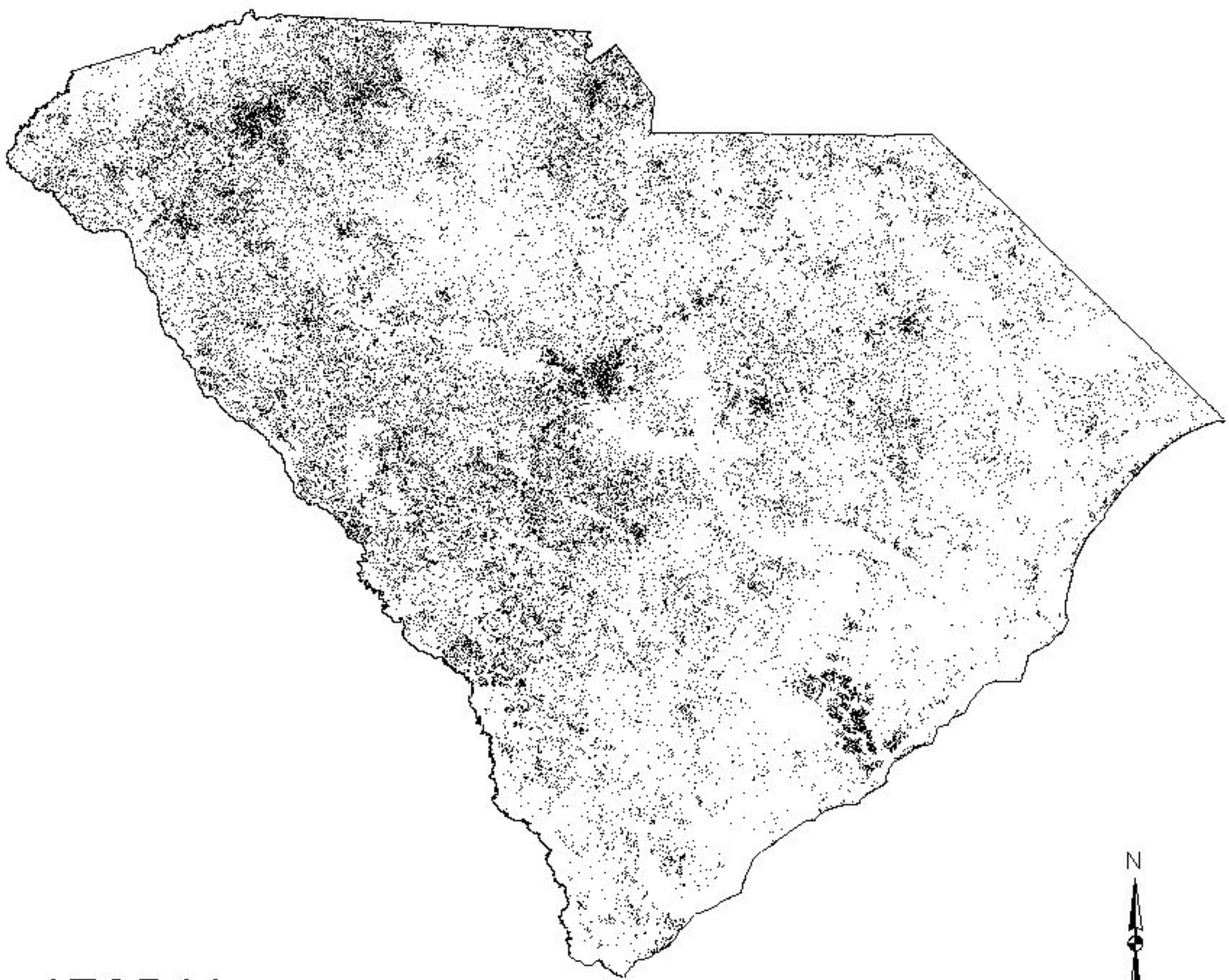
Predicted present

Predicted absent

State boundary

House Wren

(Troglodytes aedon)



178541

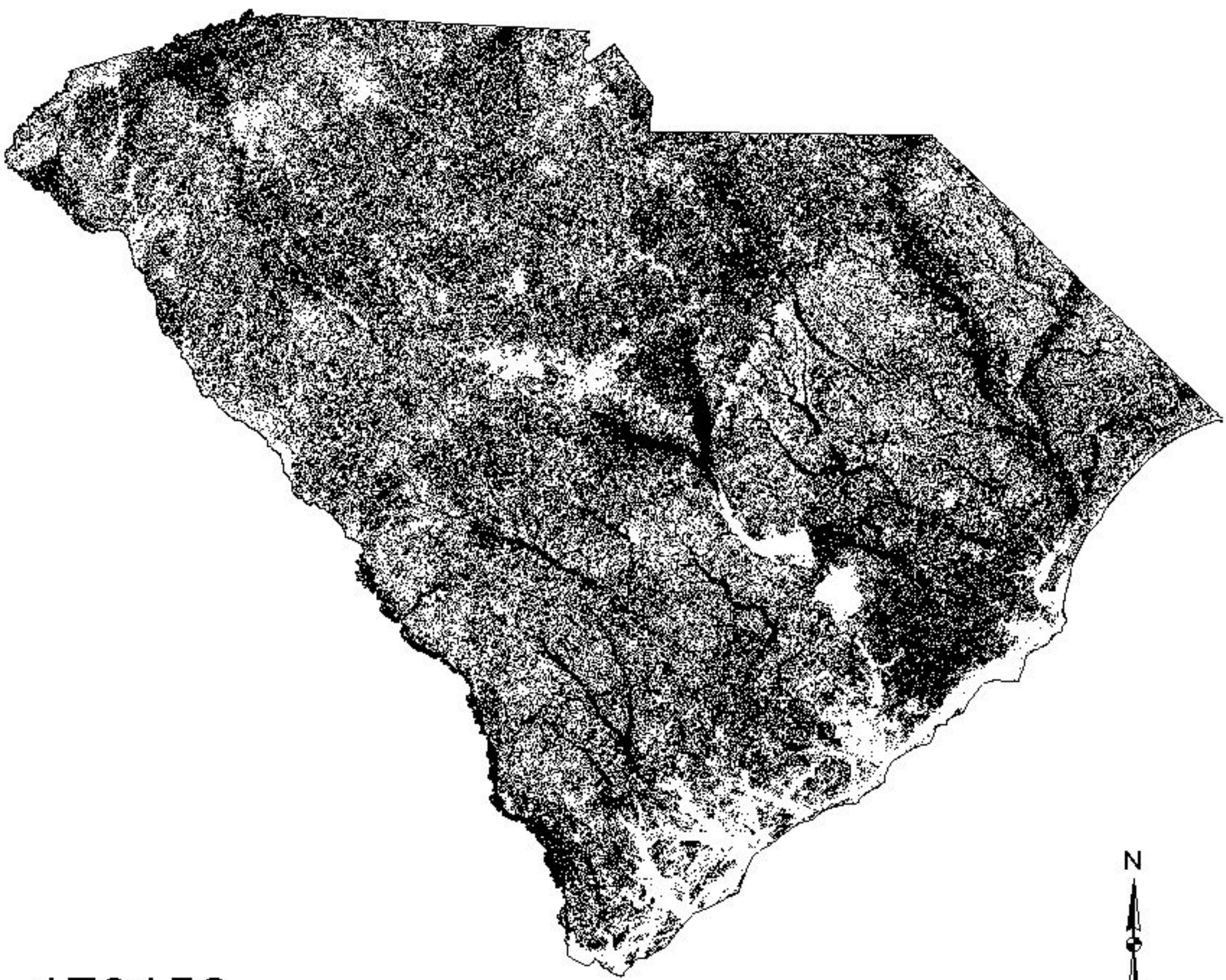
Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Indigo Bunting
(Passerina cyanea)



179150

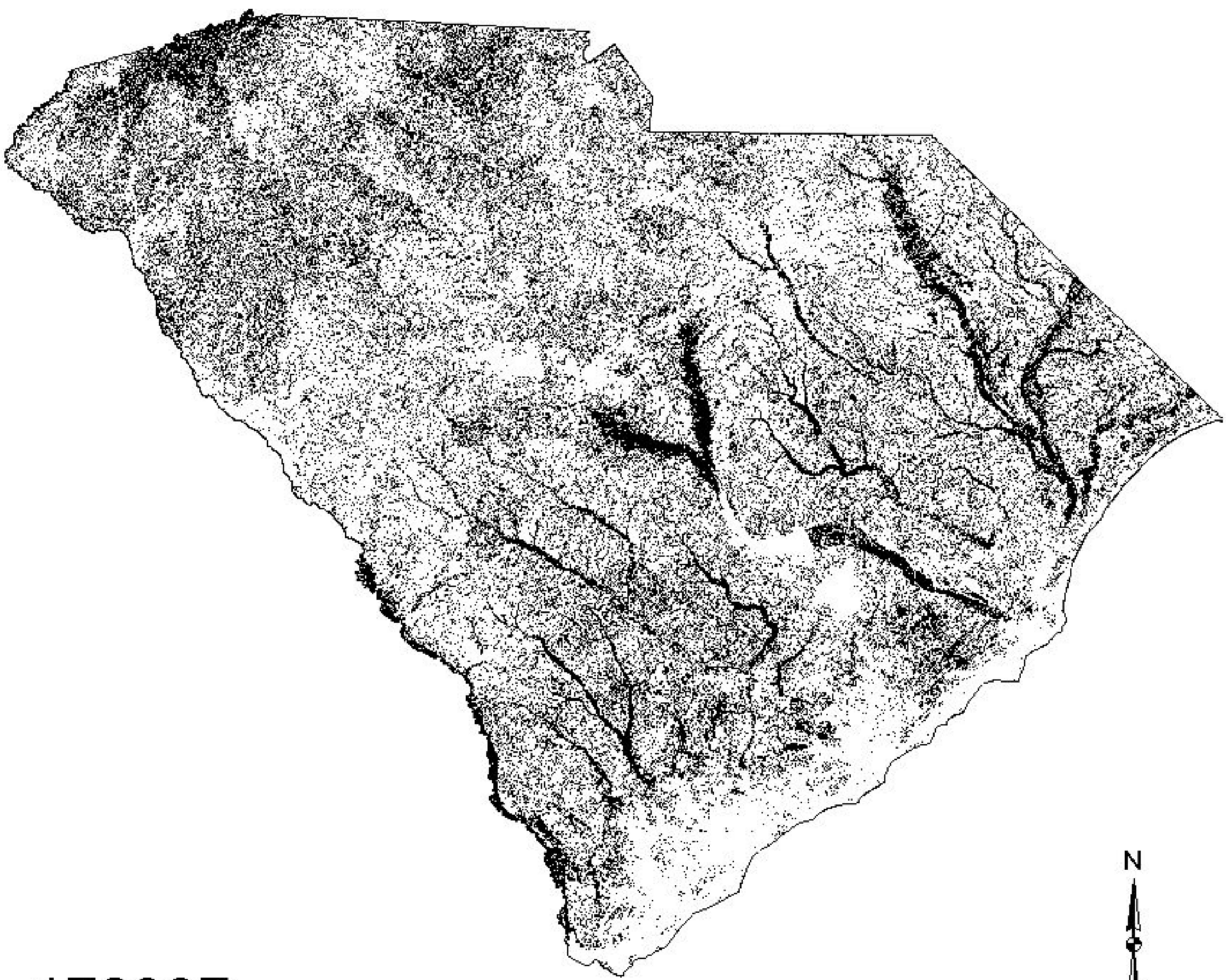
Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Kentucky Warbler
(Oporornis formosus)



178937

Predicted present

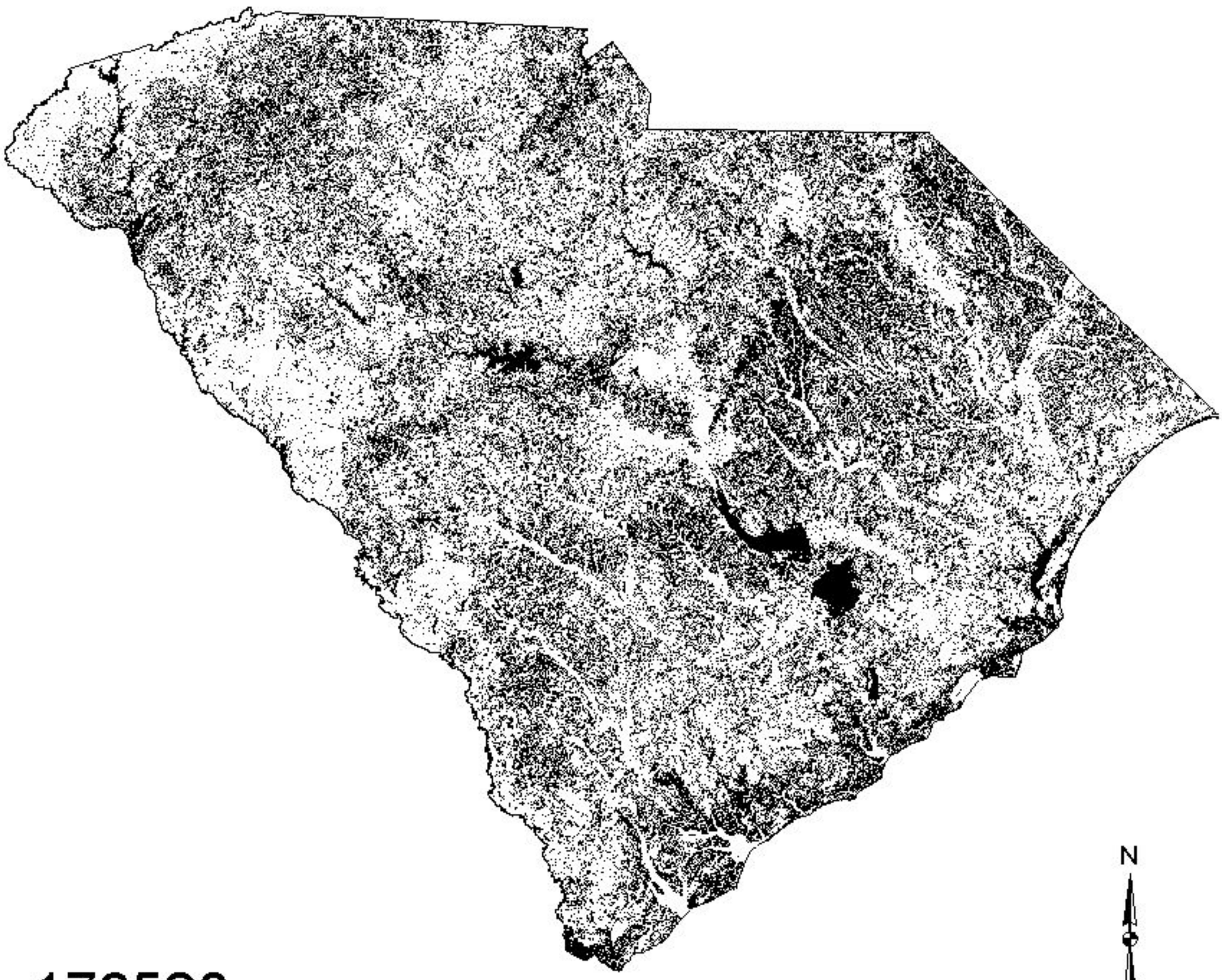
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Killdeer

(Charadrius vociferus)



176520

Predicted present

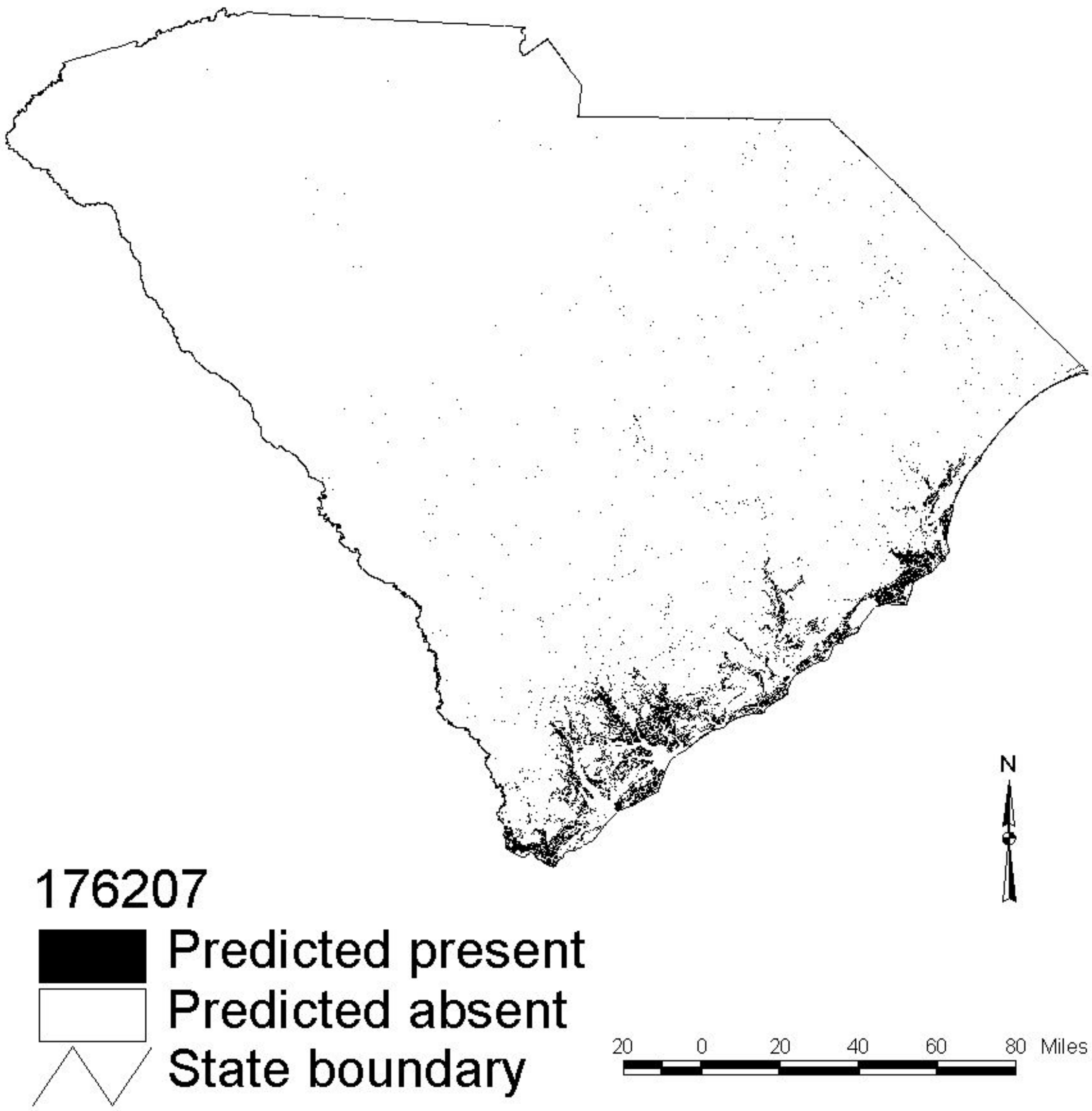
Predicted absent

State boundary

20 0 20 40 60 80 Miles

King Rail

(Rallus elegans)



176207

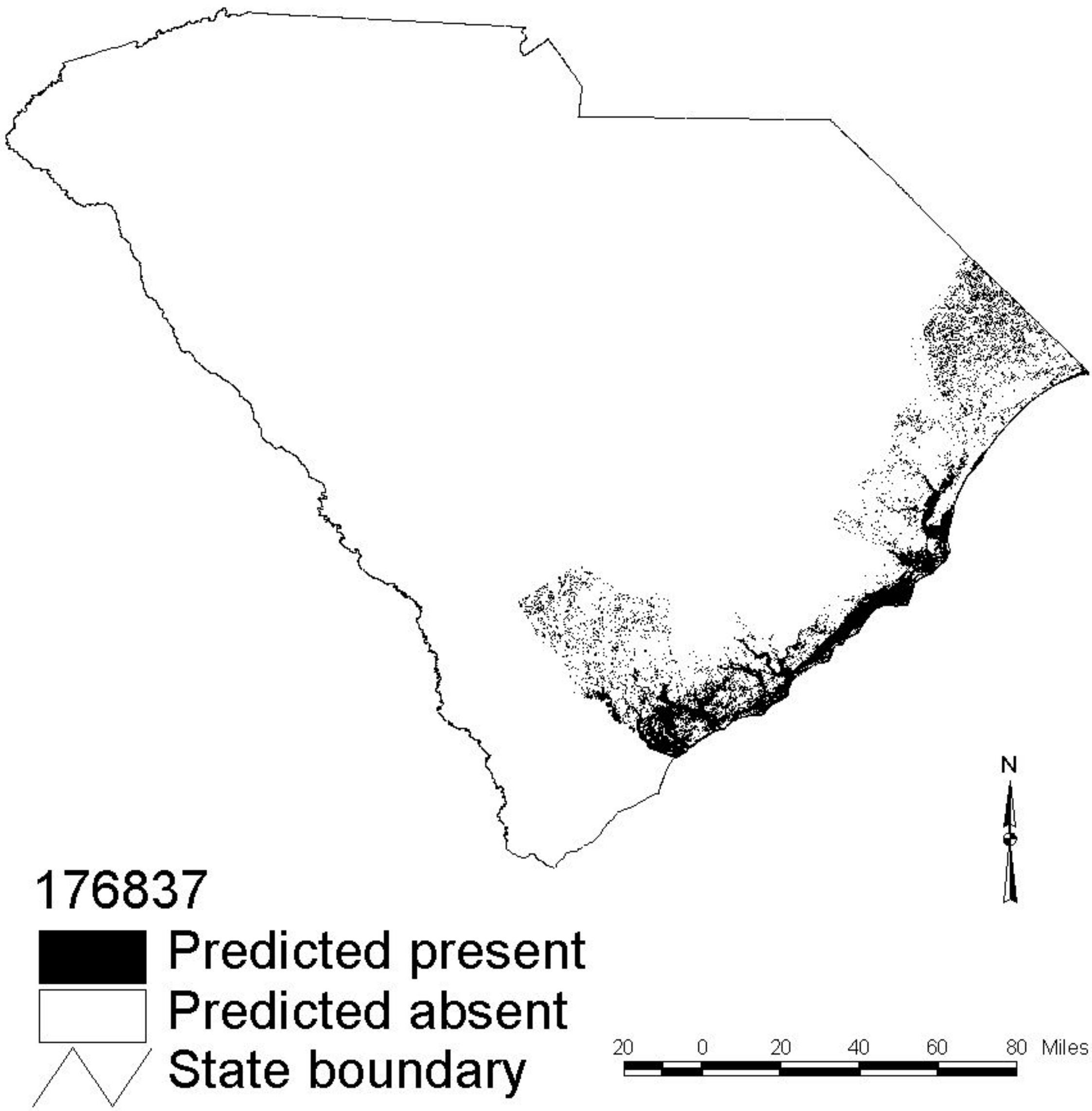
Predicted present

Predicted absent

State boundary

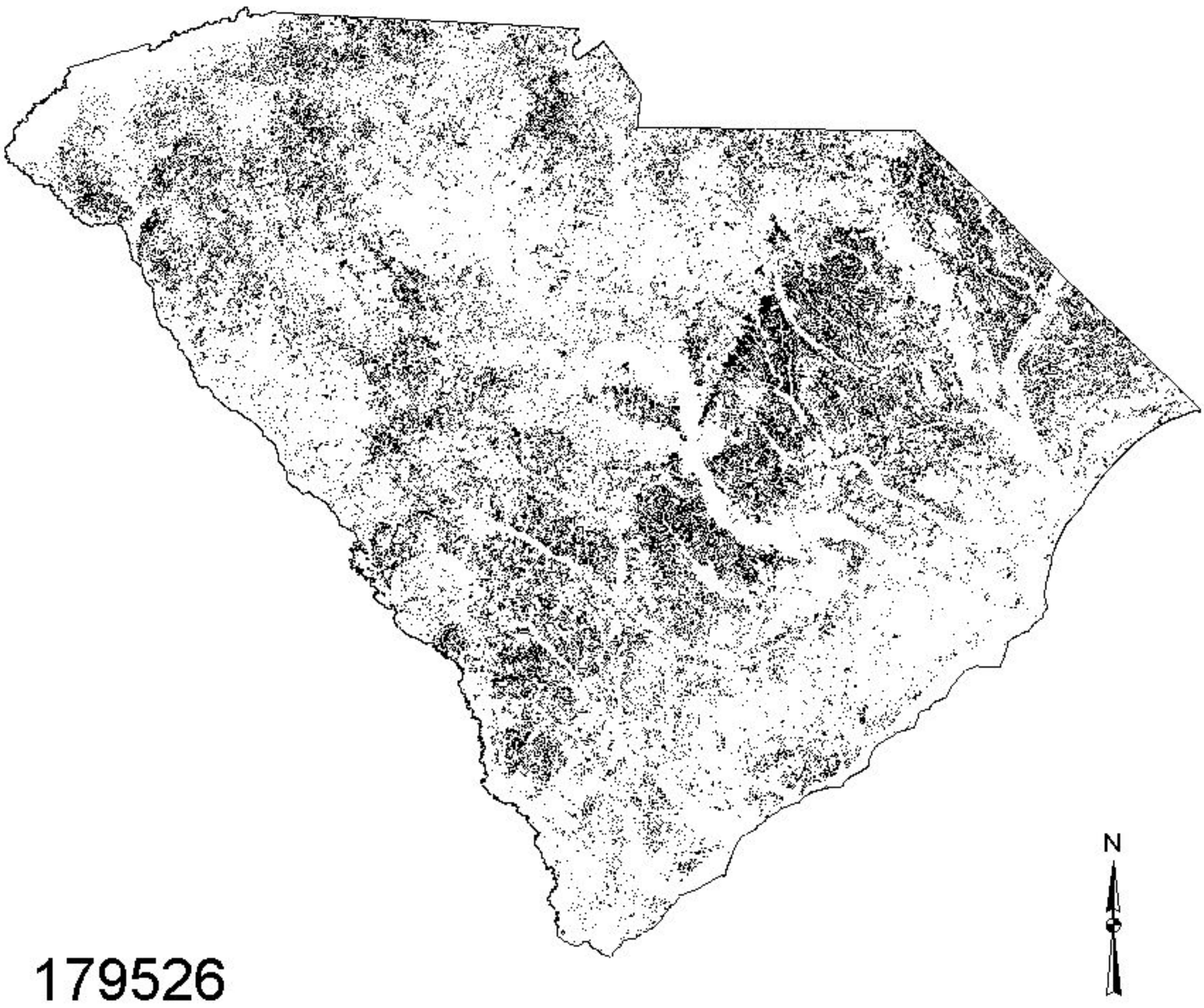
Laughing Gull

(Larus atricilla)



Lapland Longspur

(Calcarius lapponicus)



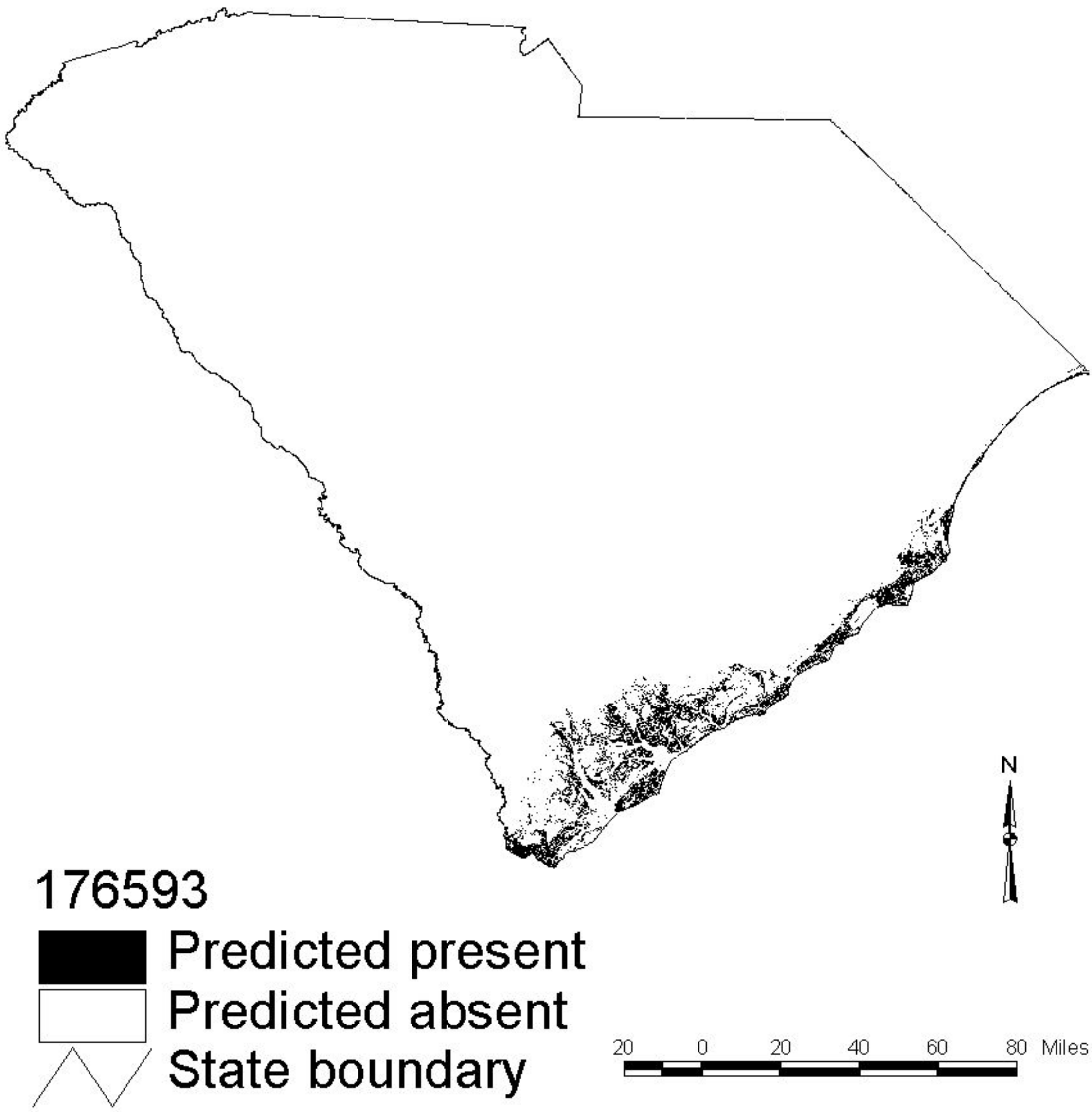
179526

Predicted present

Predicted absent

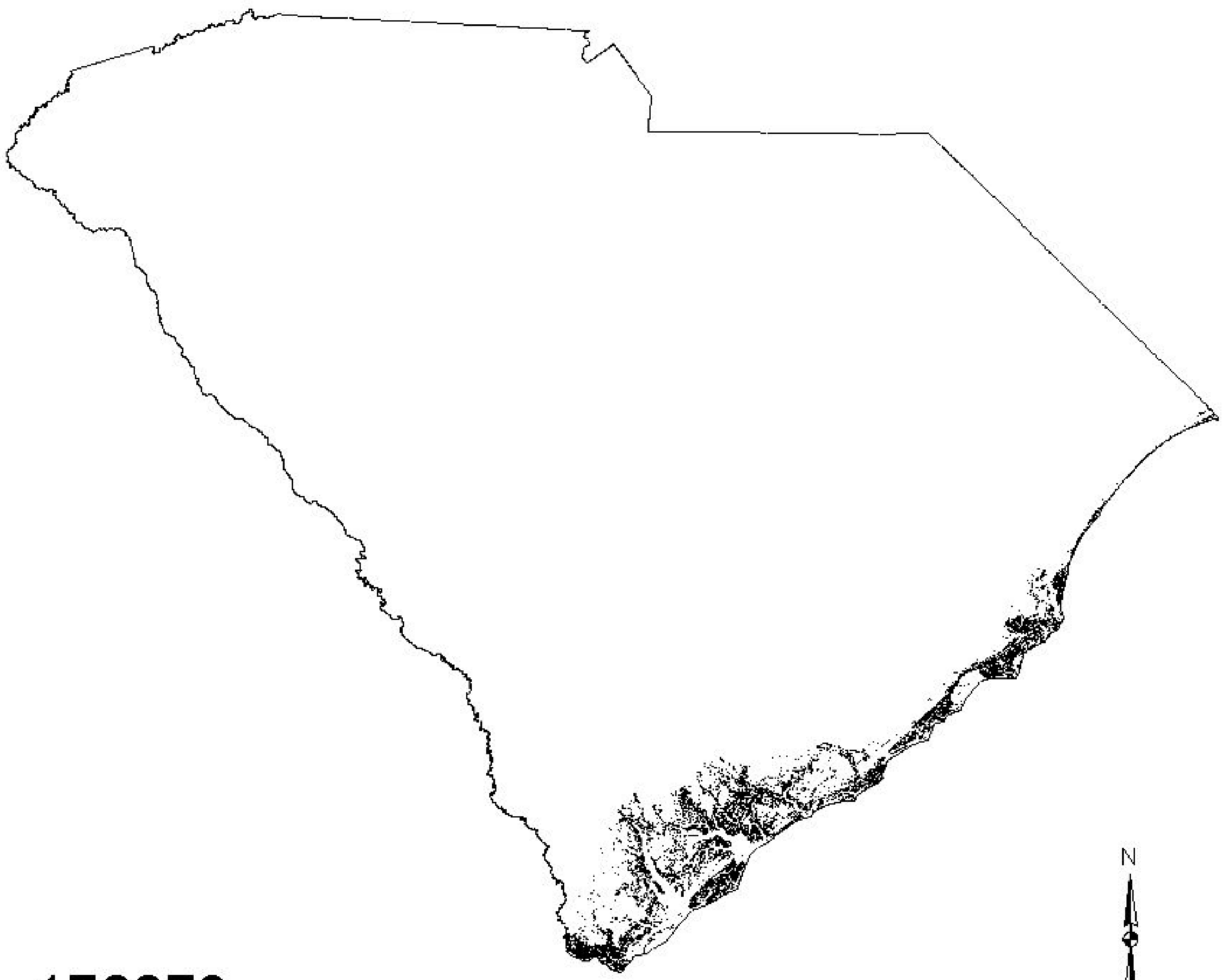
State boundary

Long-billed Curlew
(Numenius americanus)



Long-billed Dowitcher

(Limnodromus scolopaceus)



176679

Predicted present

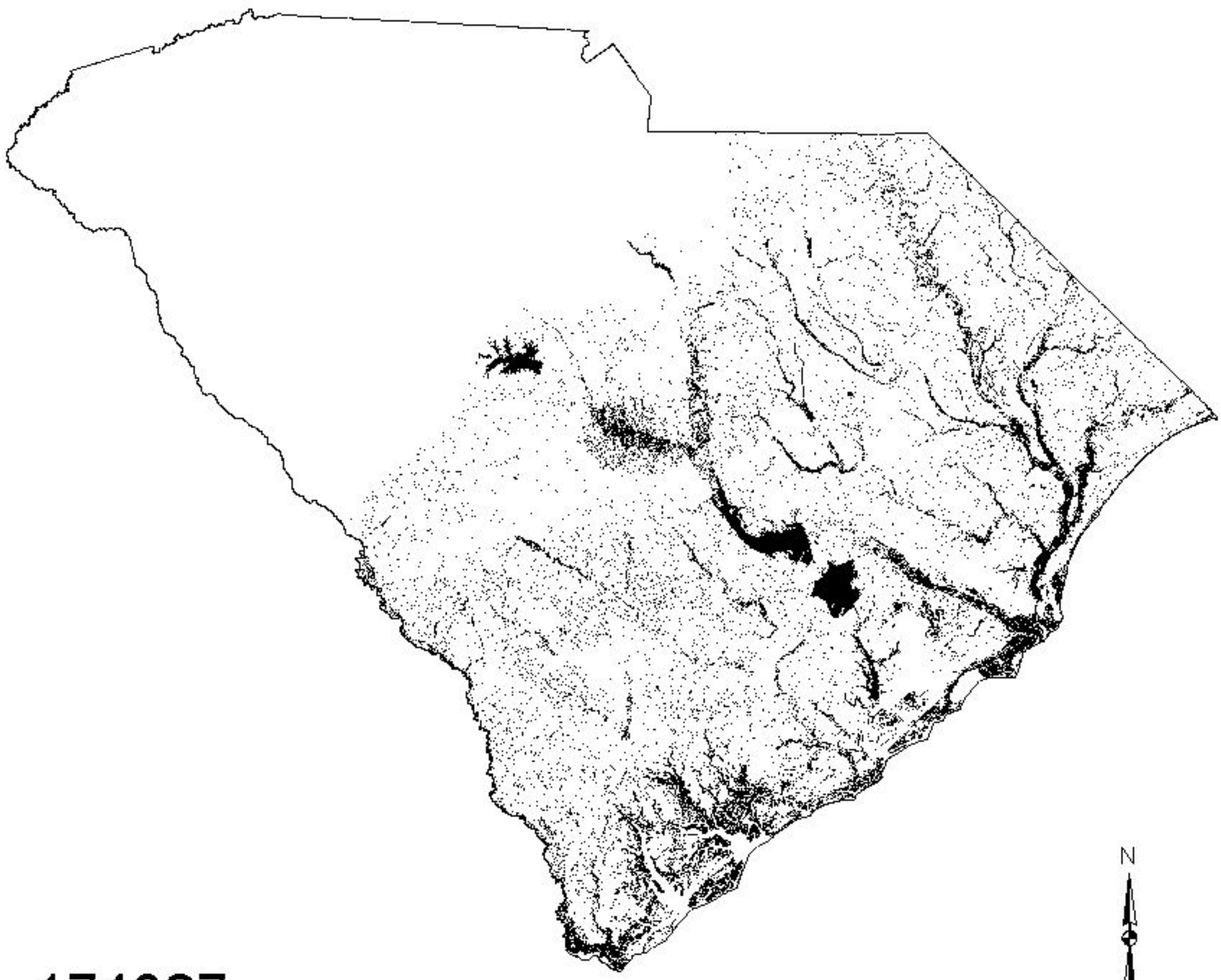
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Little Blue Heron

(Egretta caerulea)



174827

Predicted present

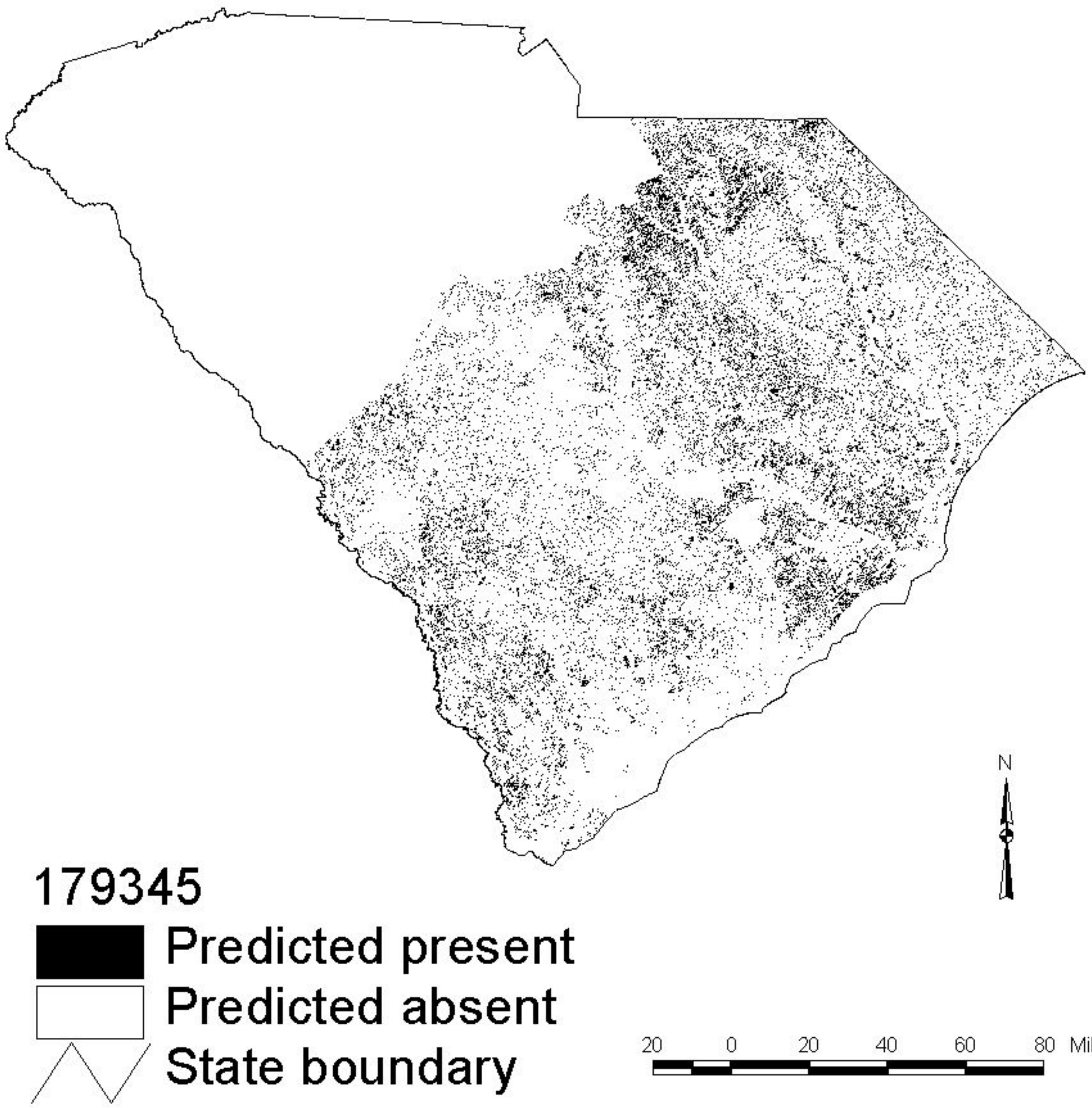
Predicted absent

State boundary

20 0 20 40 60 80 Miles

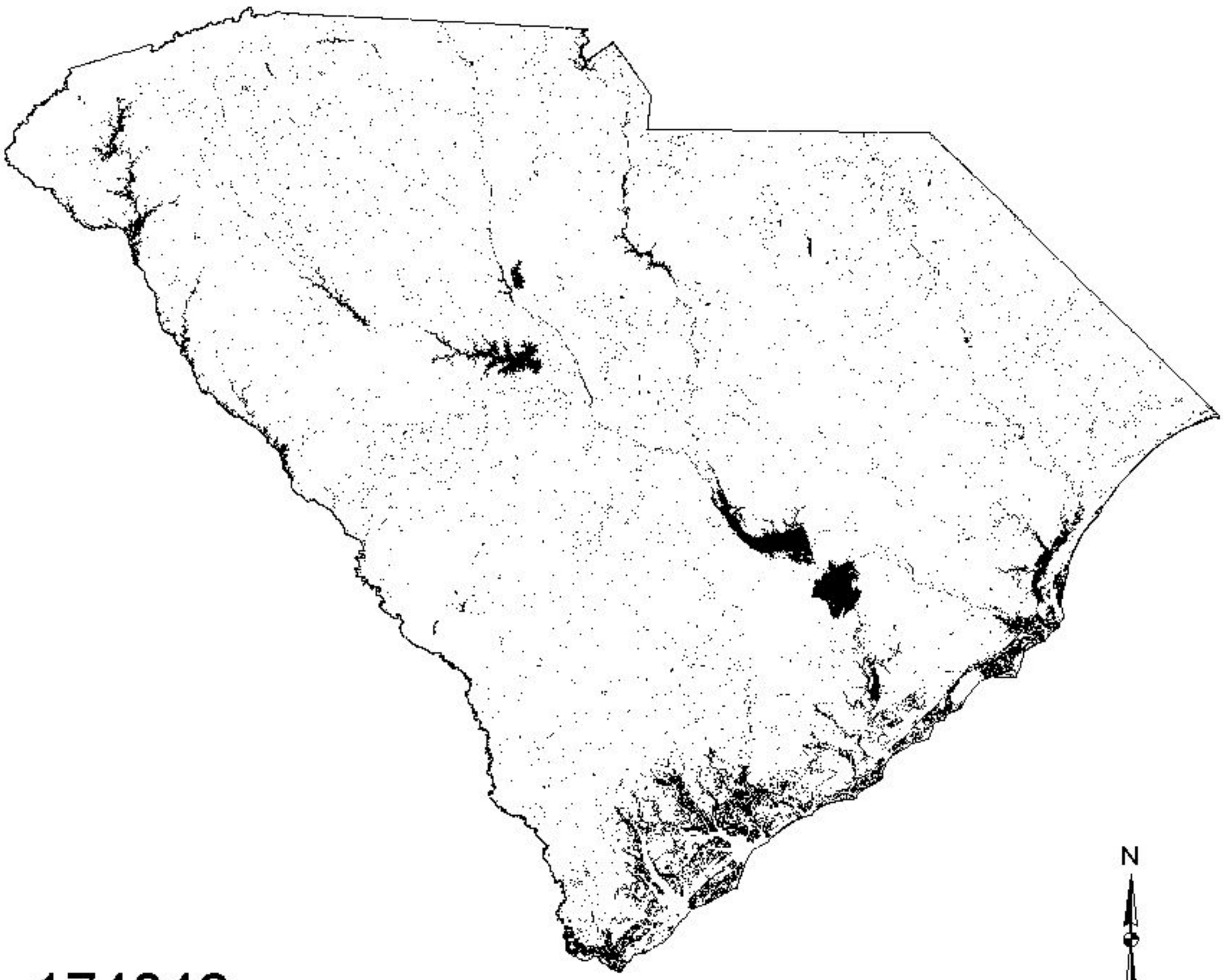
Le Conte's Sparrow

(Ammodramus leconteii)



Least Bittern

(Ixobrychus exilis)



174846

Predicted present

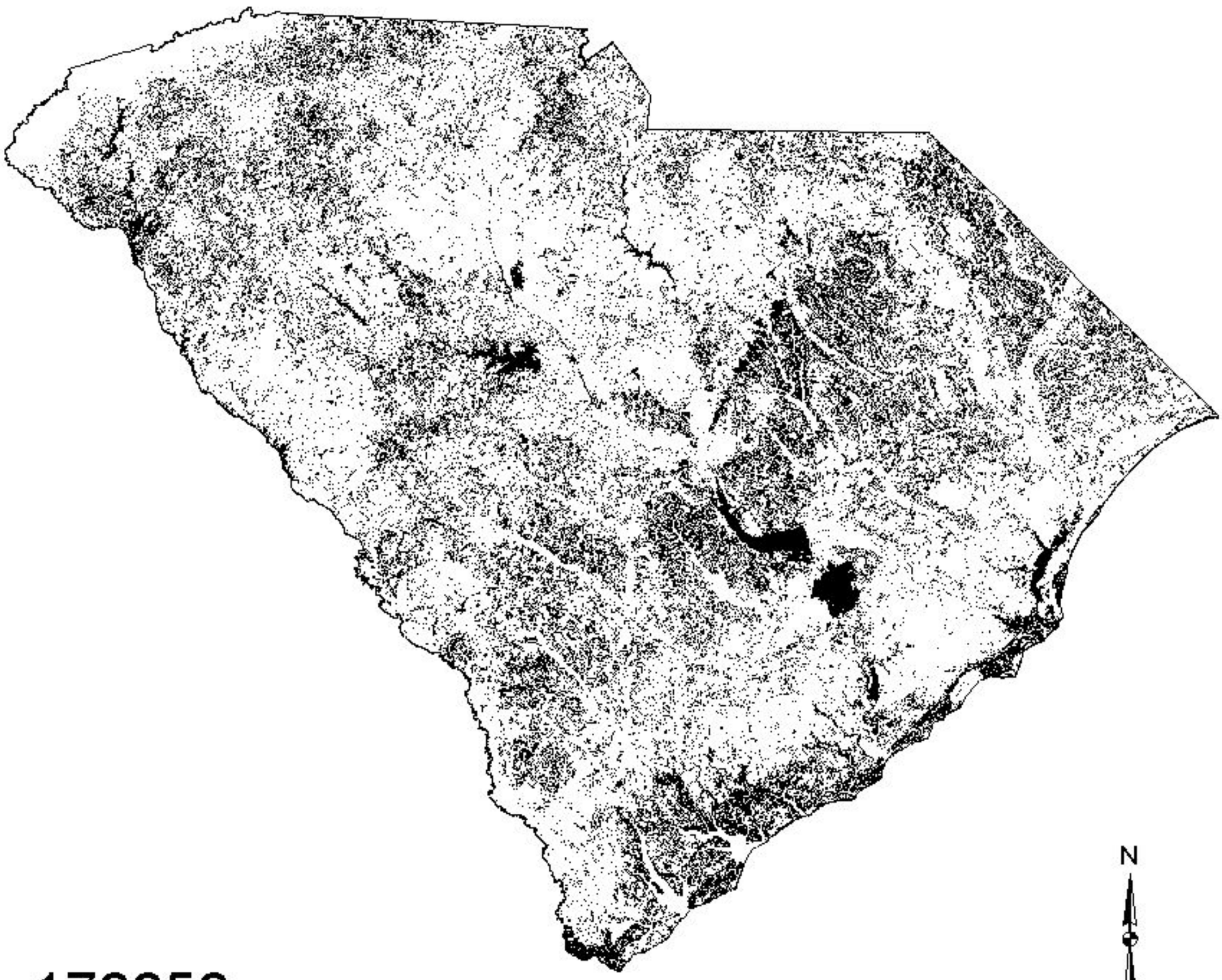
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Least Sandpiper

(Calidris minutilla)



176656

Predicted present

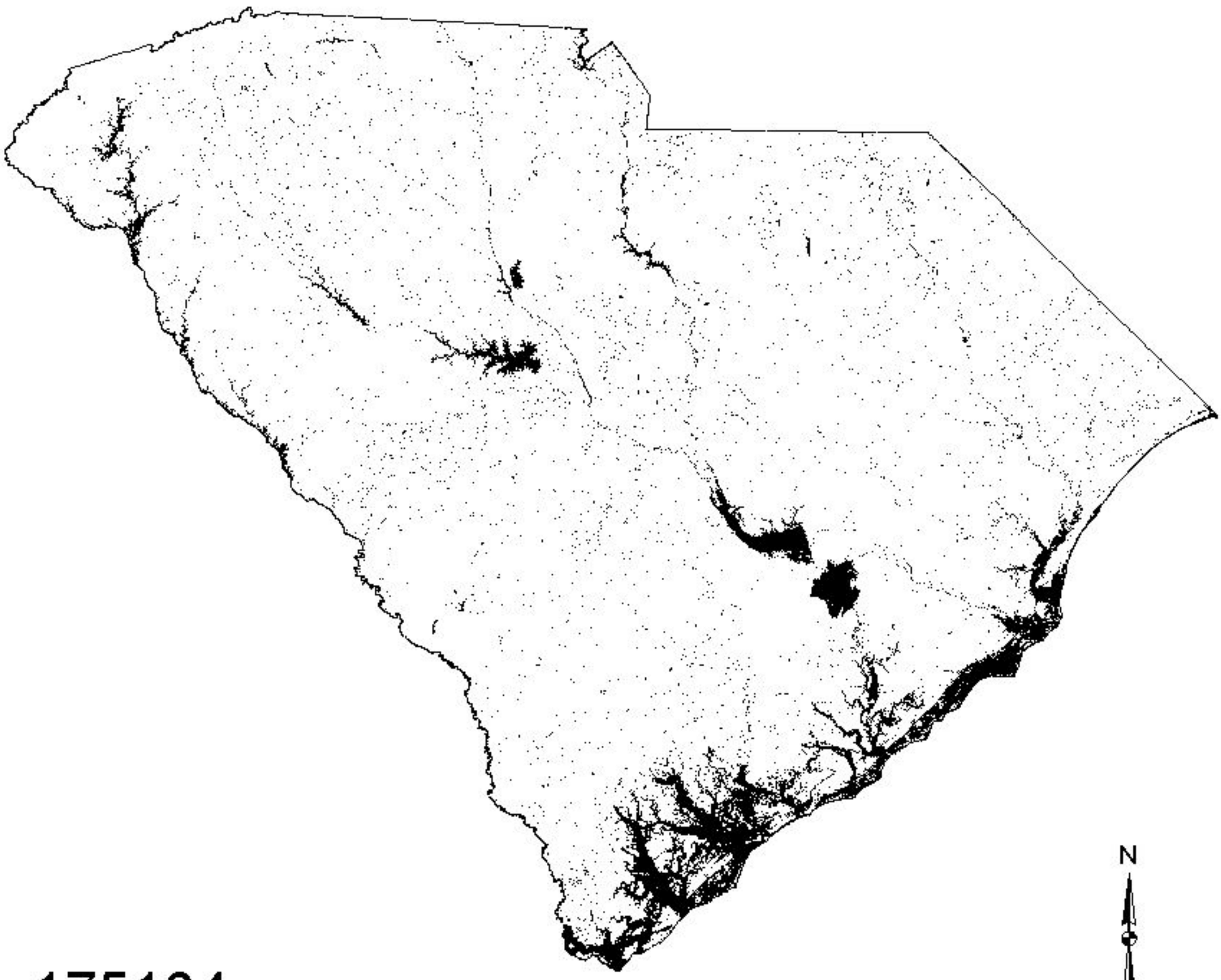
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Lesser Scaup

(Aythya affinis)



175134

Predicted present

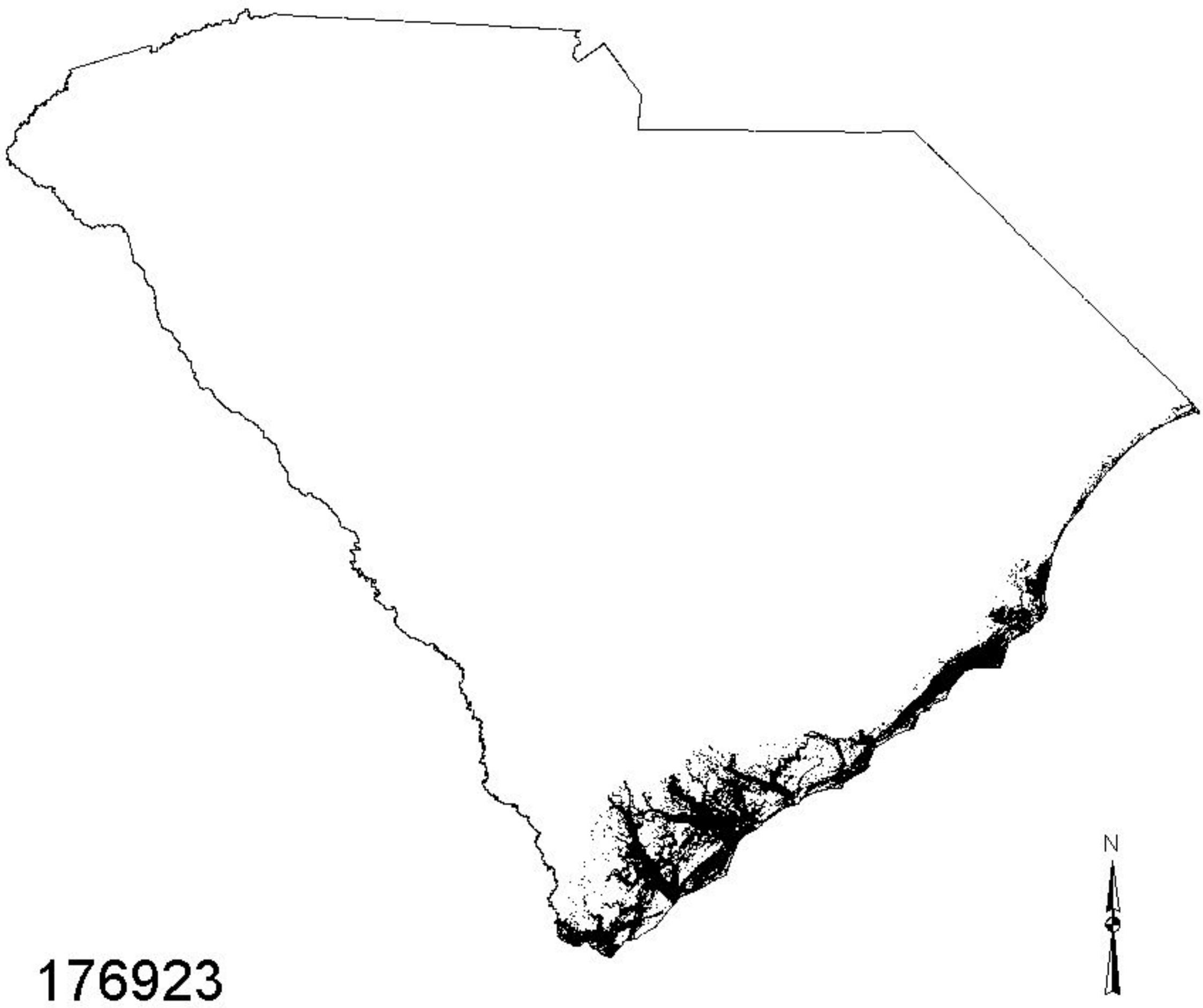
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Least Tern

(Sterna antillarum)



176923

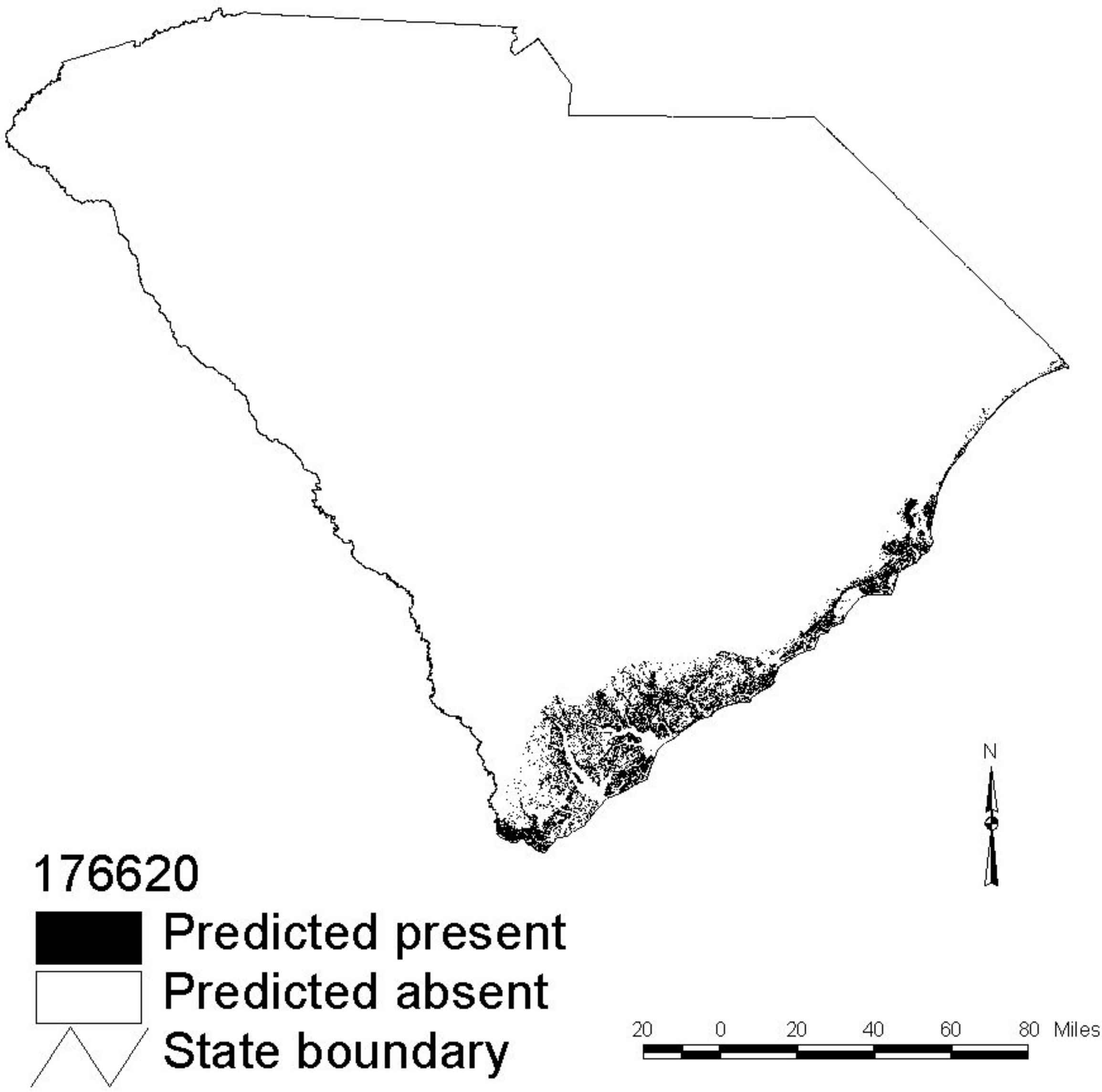
Predicted present

Predicted absent

State boundary

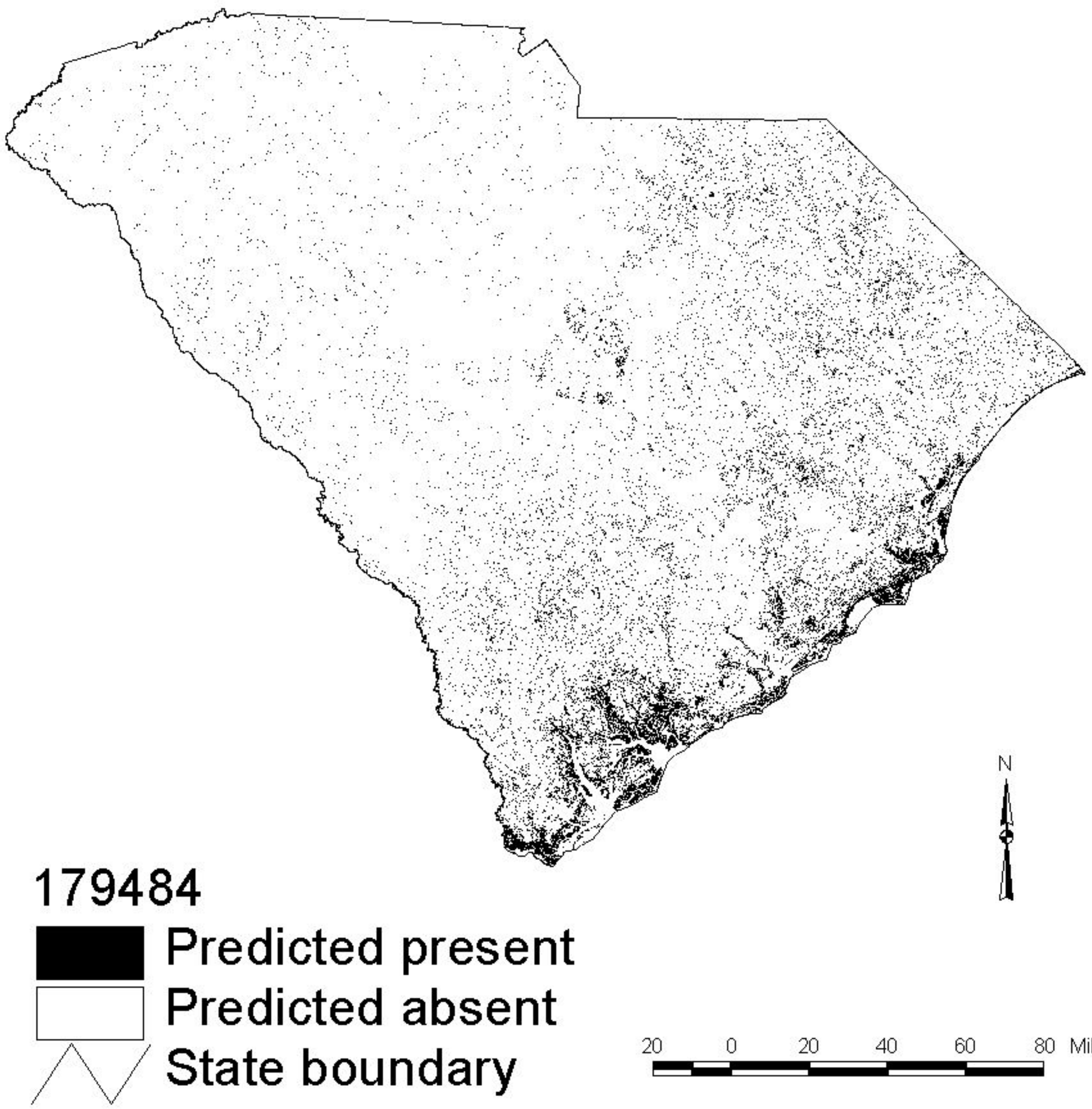
Lesser Yellowlegs

(Tringa flavipes)

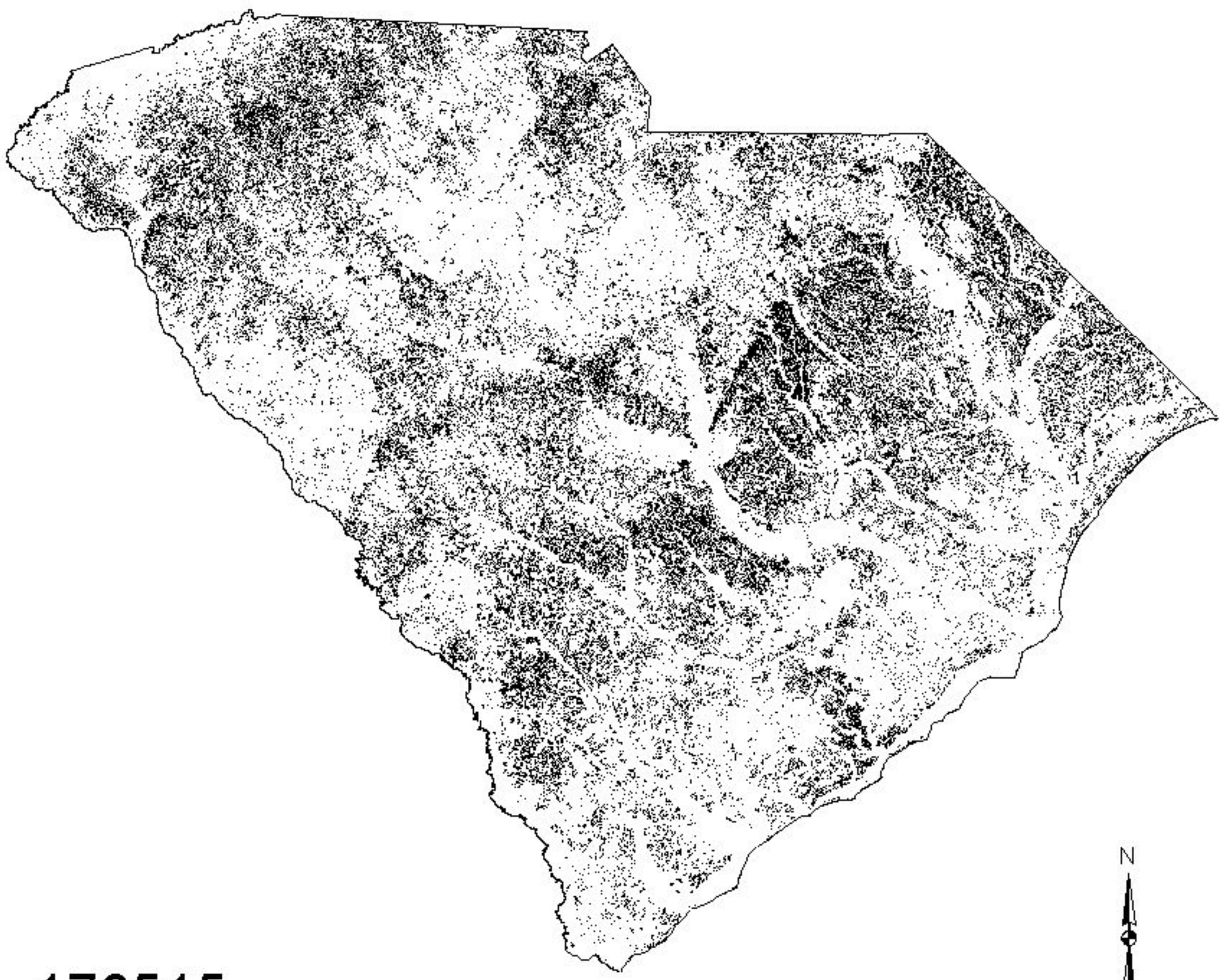


Lincoln's Sparrow

(Melospiza lincolnii)



Loggerhead Shrike
(Lanius ludovicianus)



178515

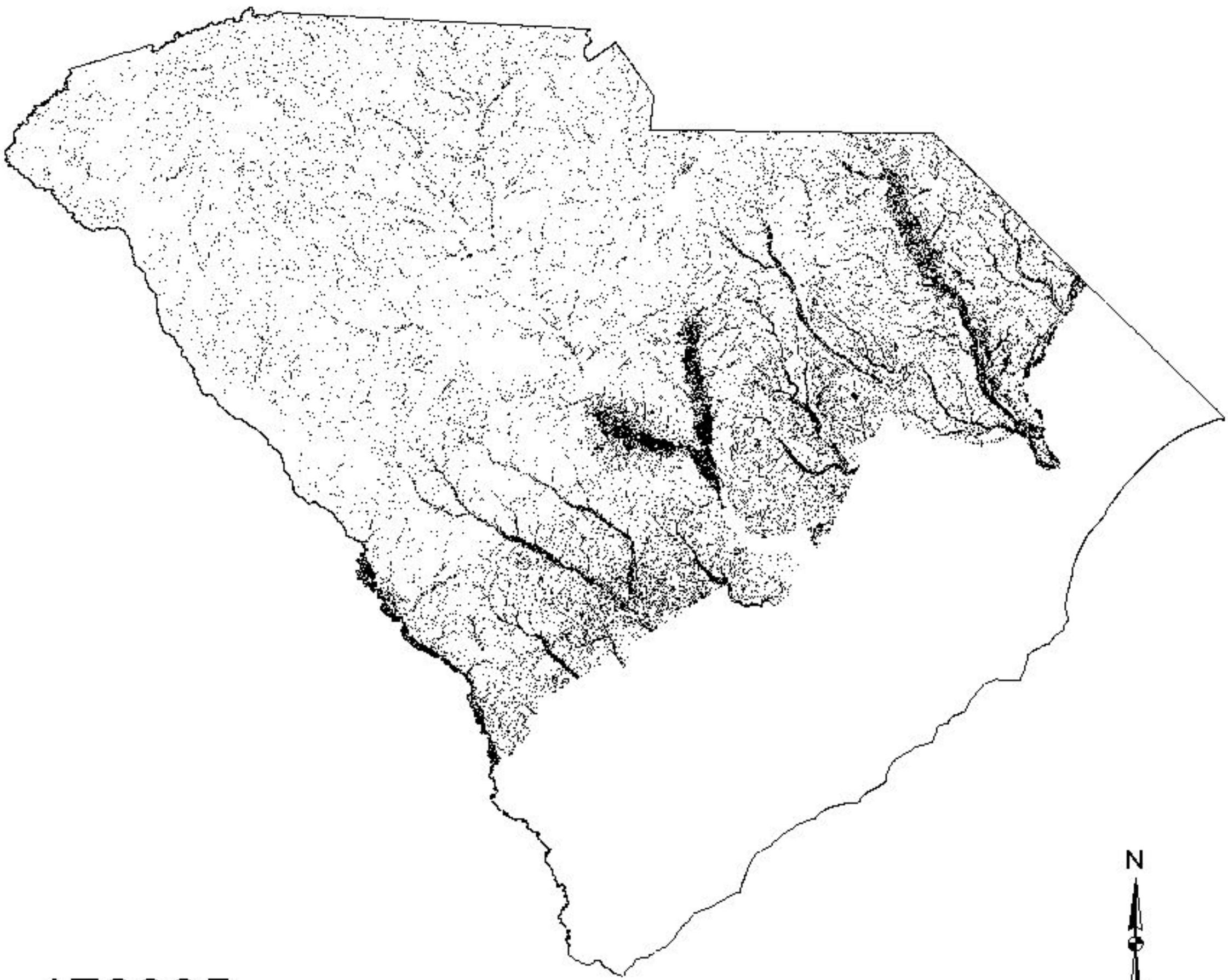
Predicted present

Predicted absent

State boundary

Louisiana Waterthrush

(Seiurus motacilla)



178935

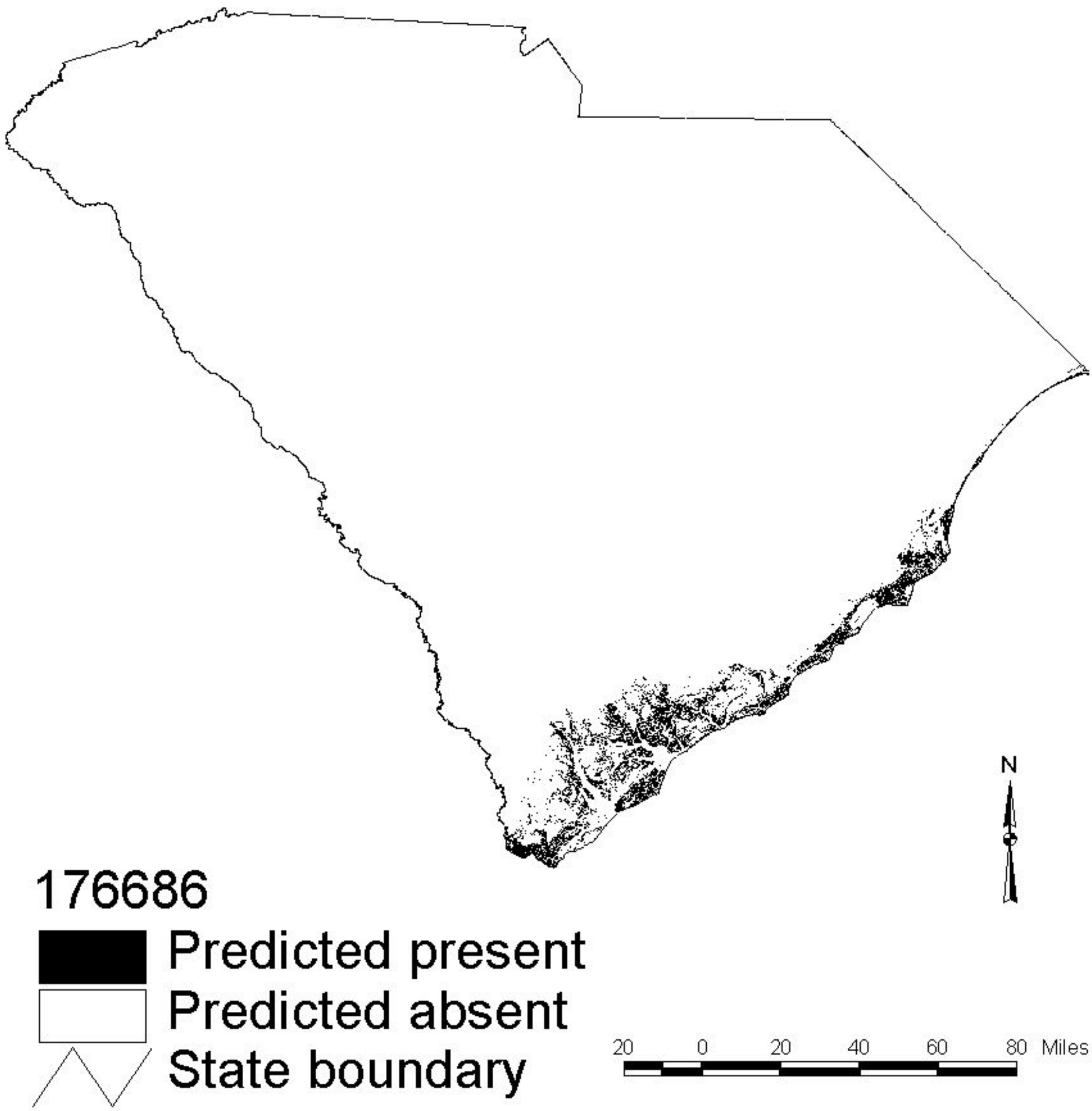
Predicted present

Predicted absent

State boundary

Marbled Godwit

(Limosa fedoa)



176686

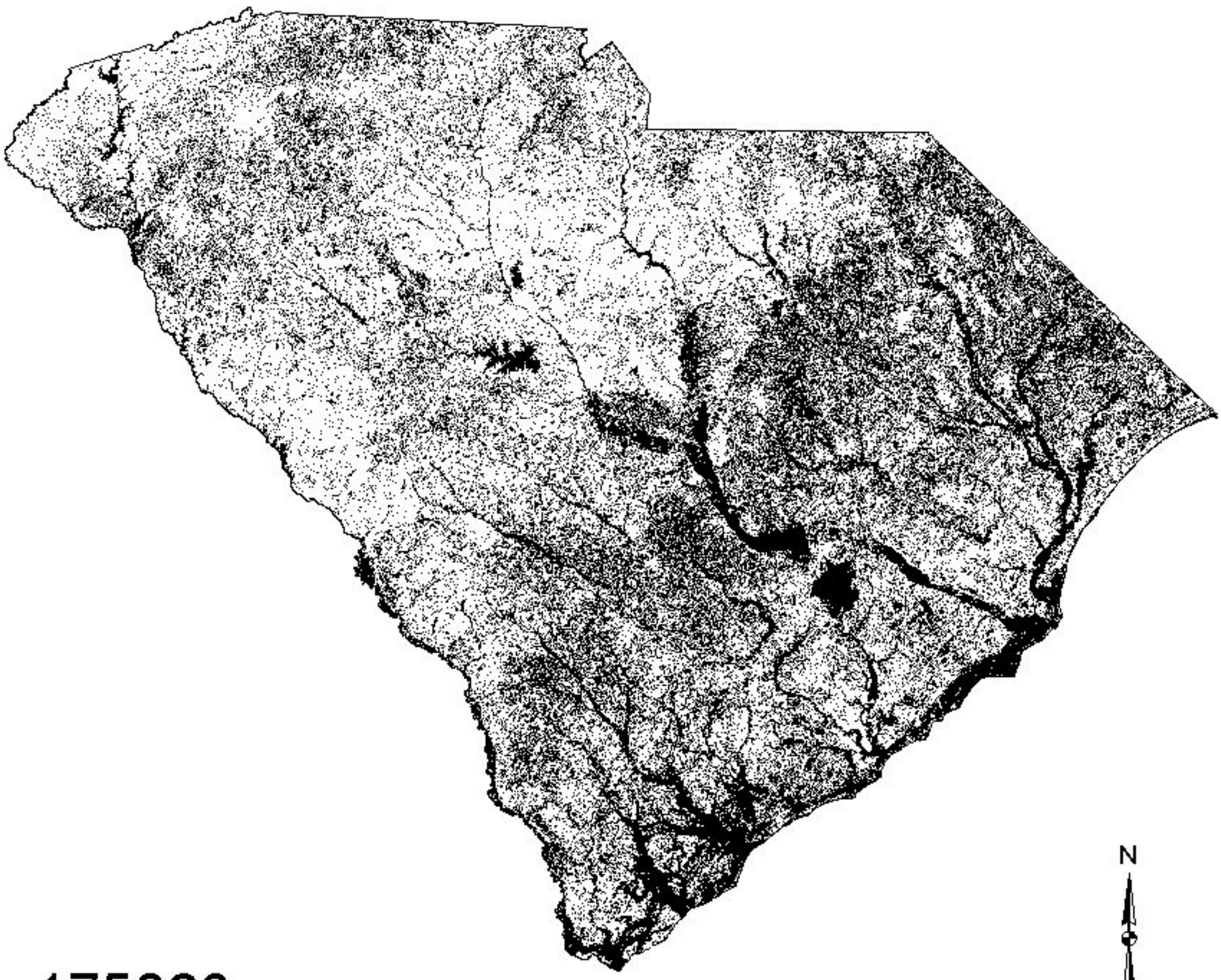
Predicted present

Predicted absent

State boundary

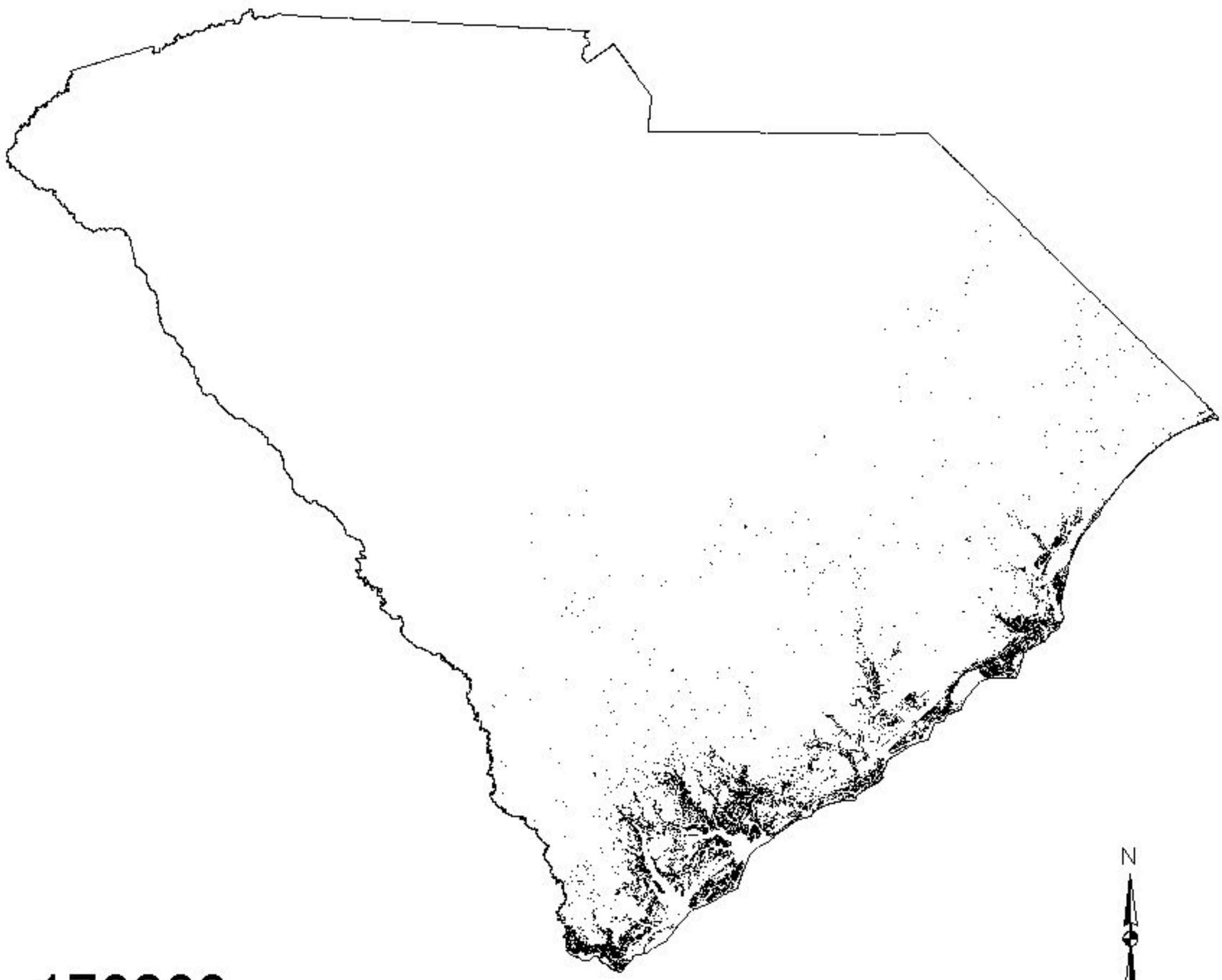
Mallard

(Anas platyrhynchos)



Marsh Wren

(Cistothorus palustris)



178608

Predicted present

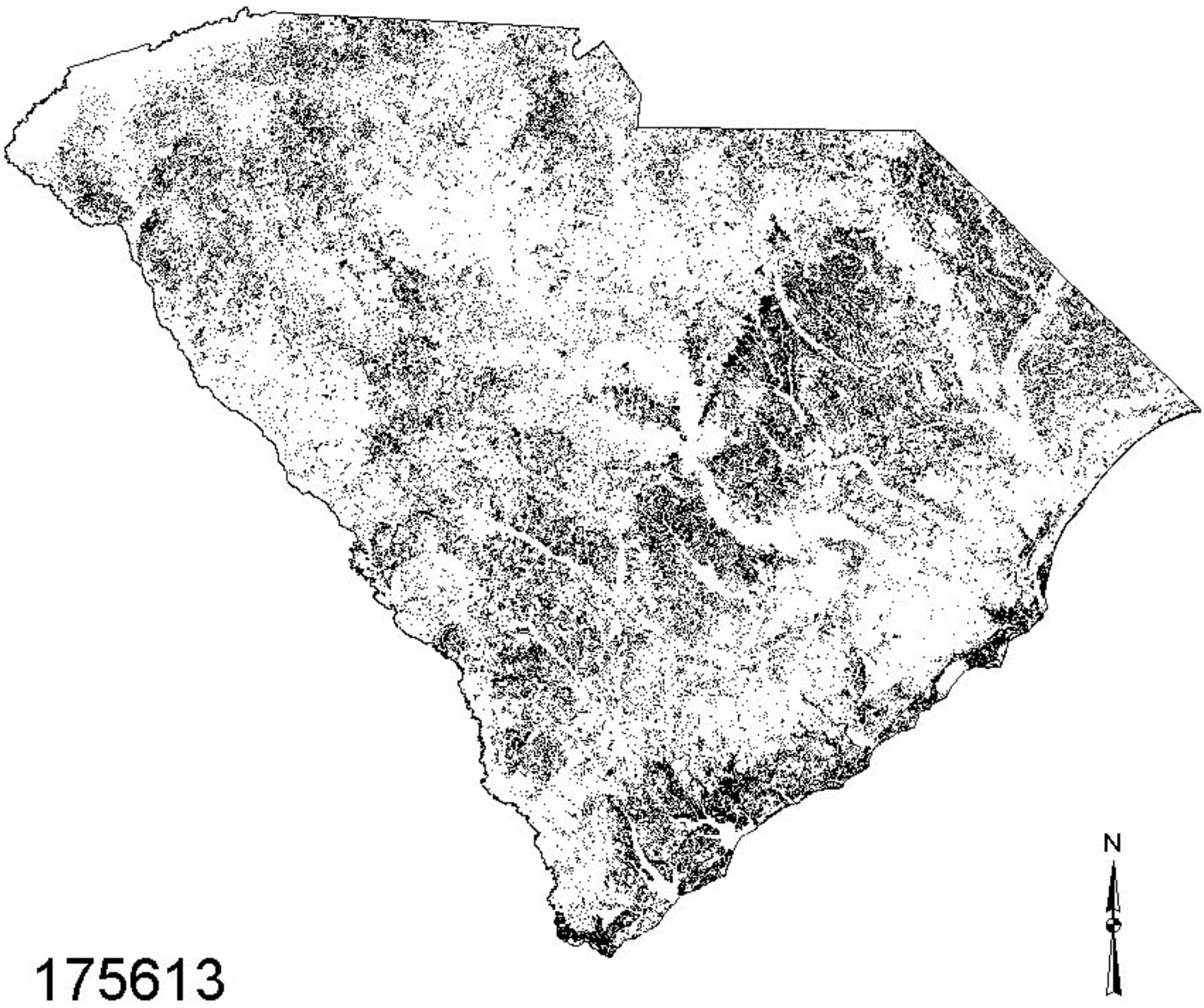
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Merlin

(Falco columbarius)



175613

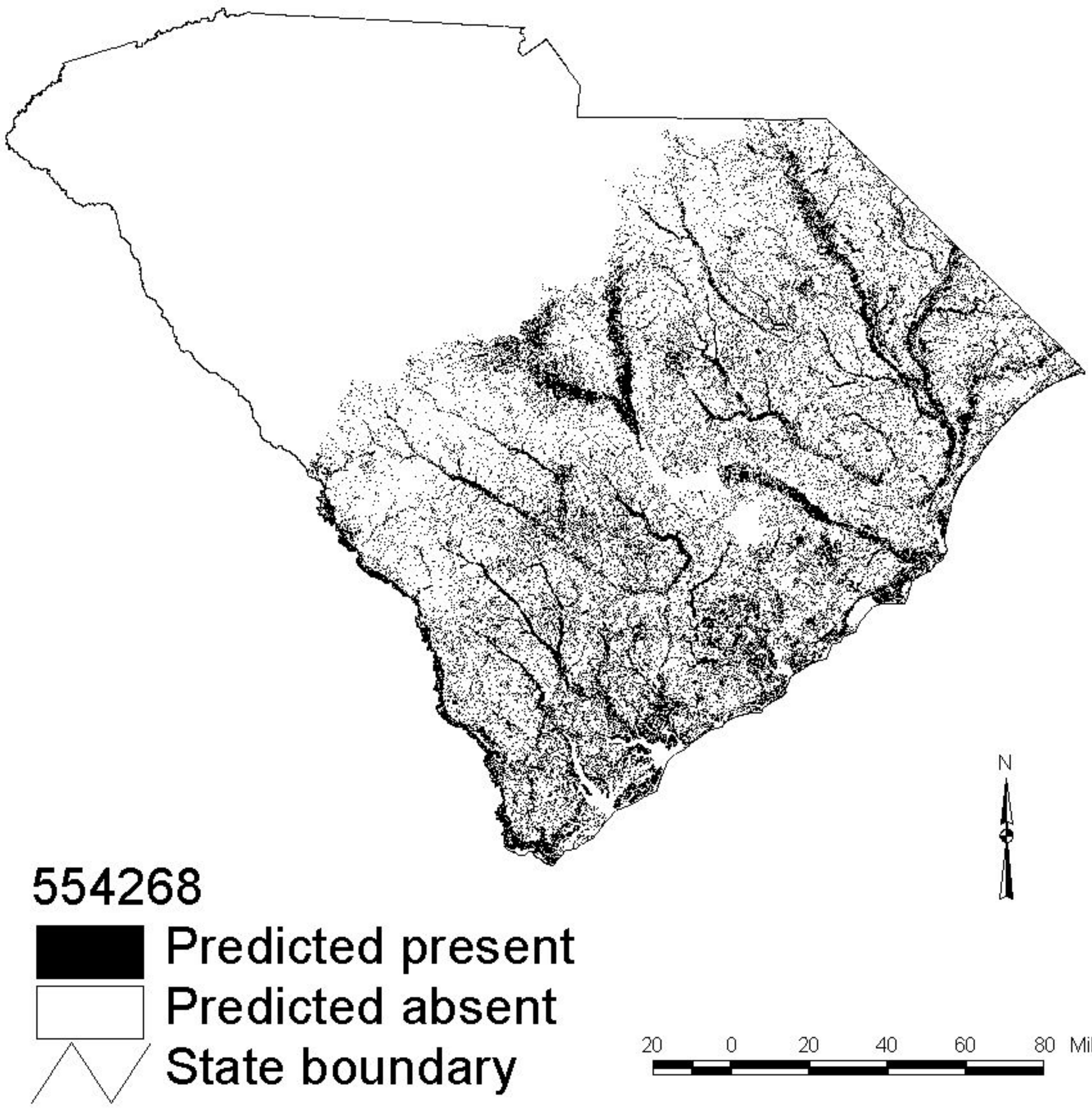
Predicted present

Predicted absent

State boundary

Mississippi Kite

(Ictinia mississippiensis)



Mourning Dove

(Zenaida macroura)

177125

Predicted present

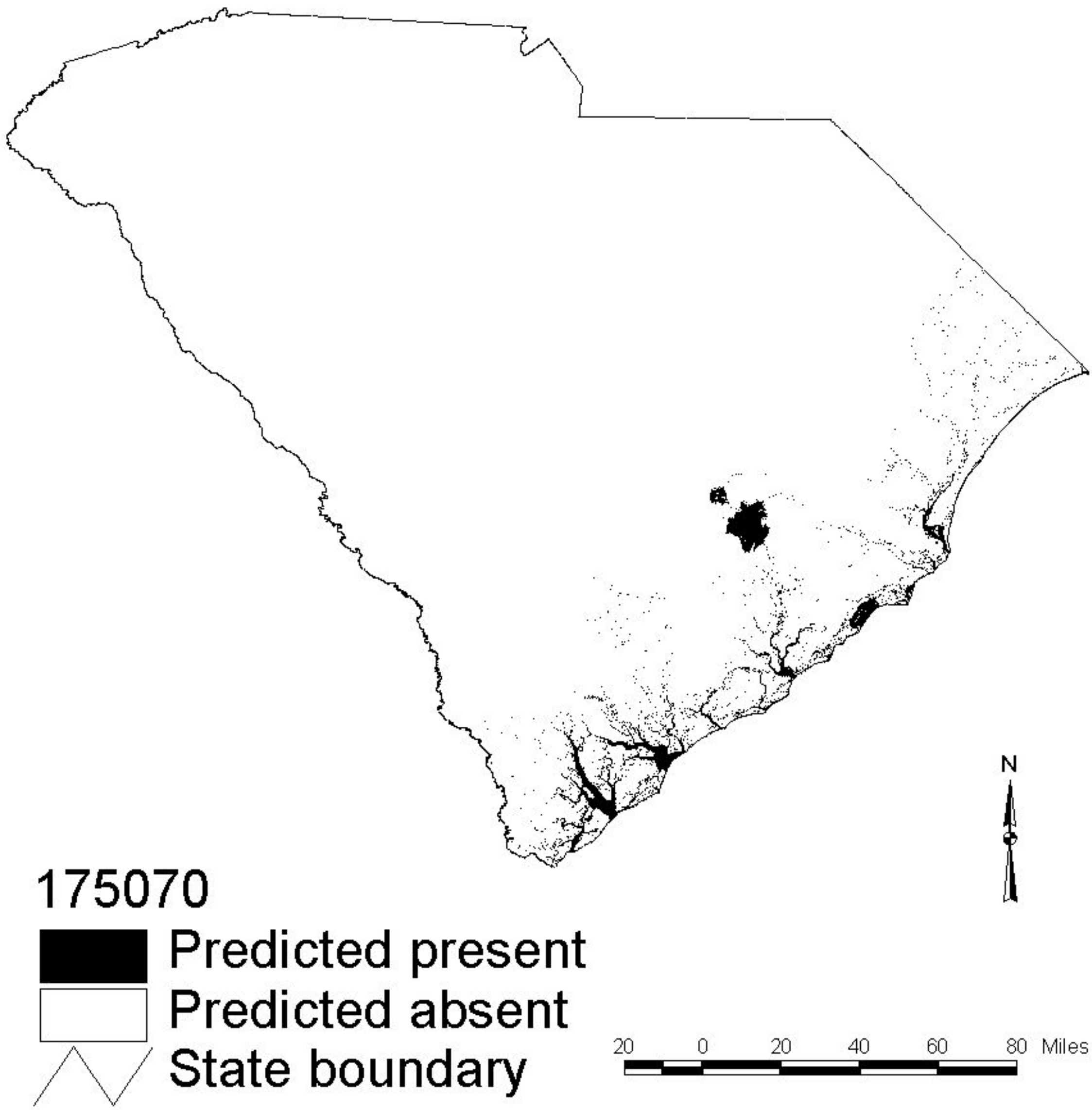
Predicted absent

State boundary

20 0 20 40 60 80 Miles

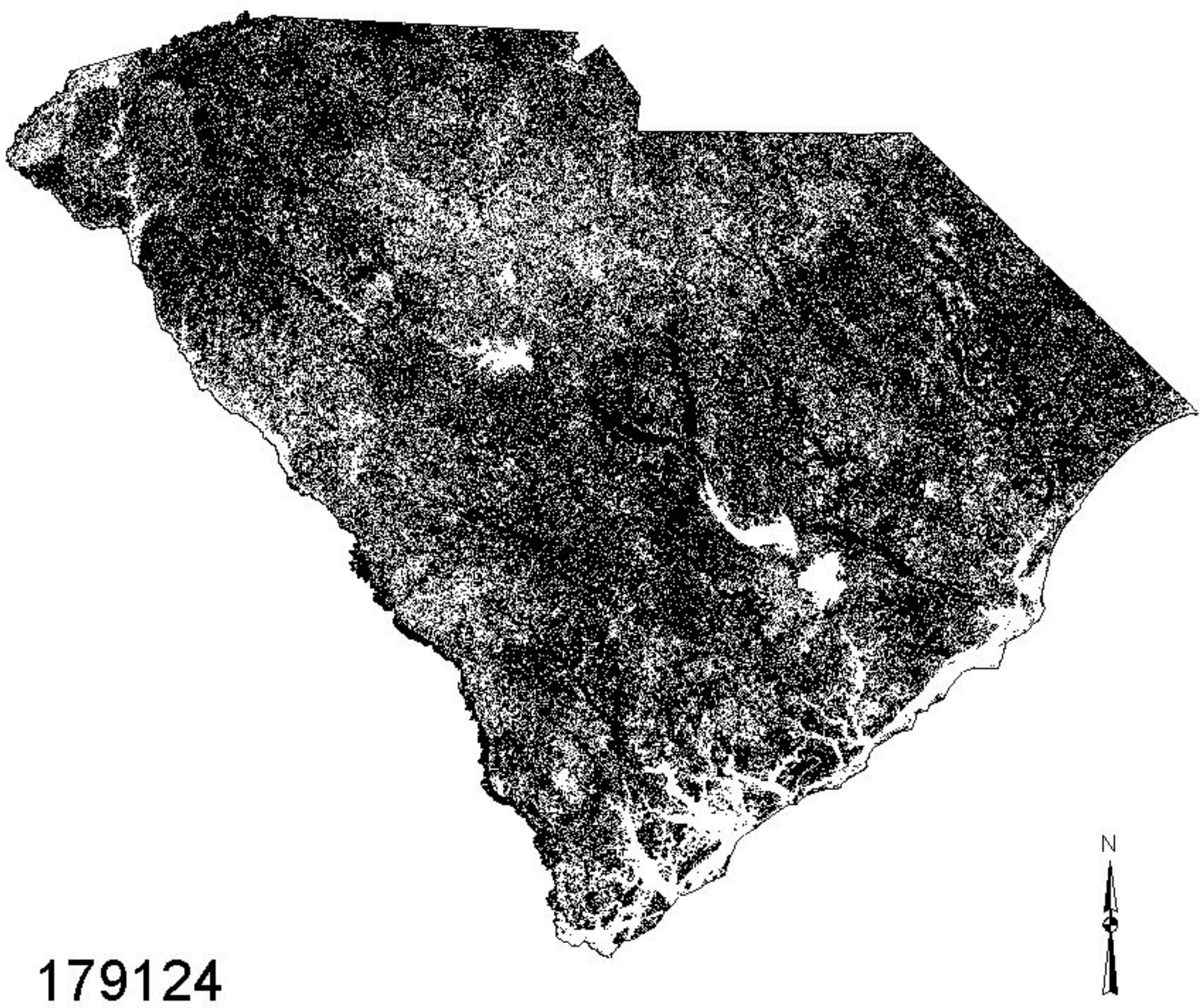
Mottled Duck

(Anas fulvigula)



Northern Cardinal

(Cardinalis cardinalis)



Northern Flicker

(Colaptes auratus)

178154

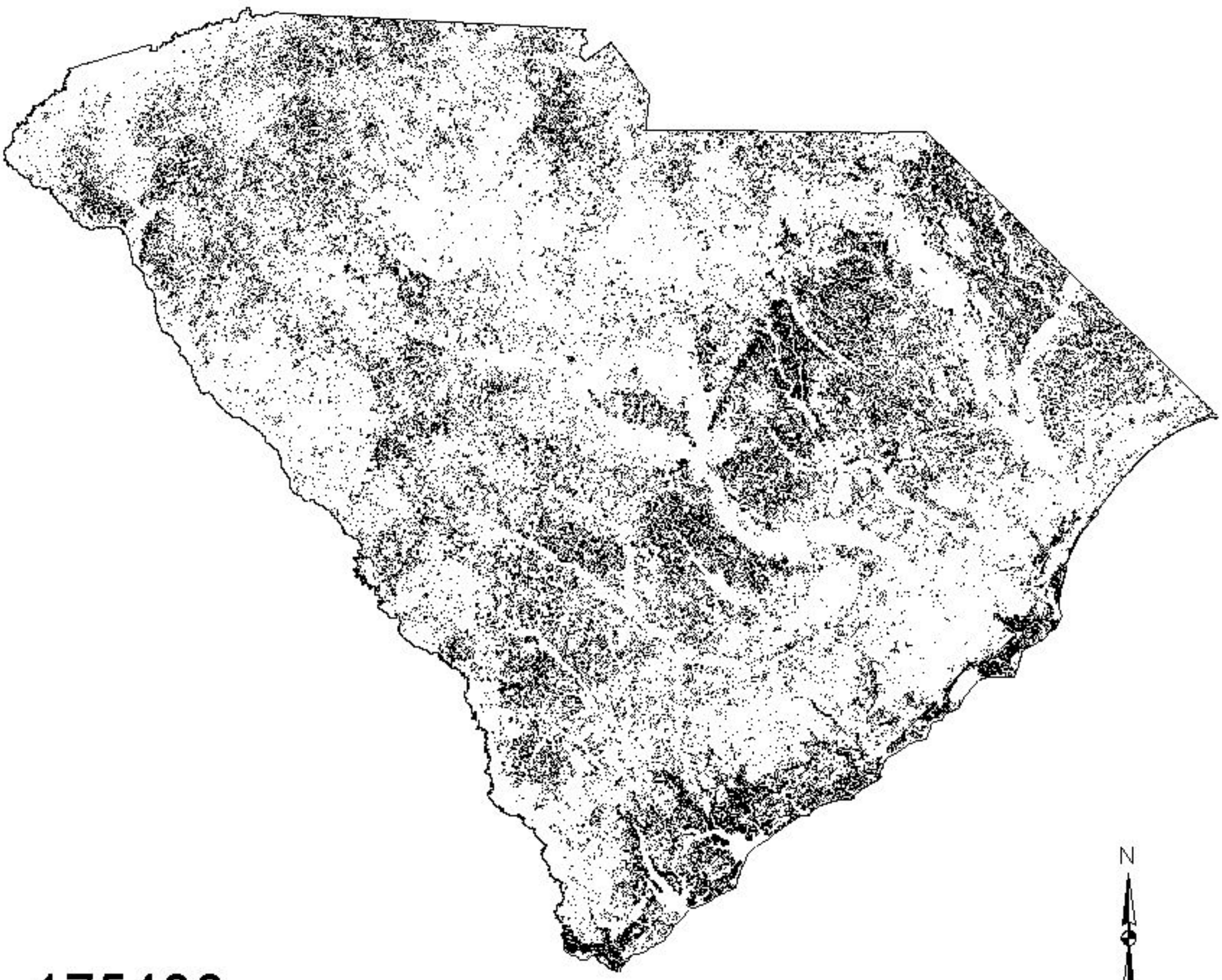
Predicted present

Predicted absent

State boundary

Northern Harrier

(Circus cyaneus)



175430

Predicted present

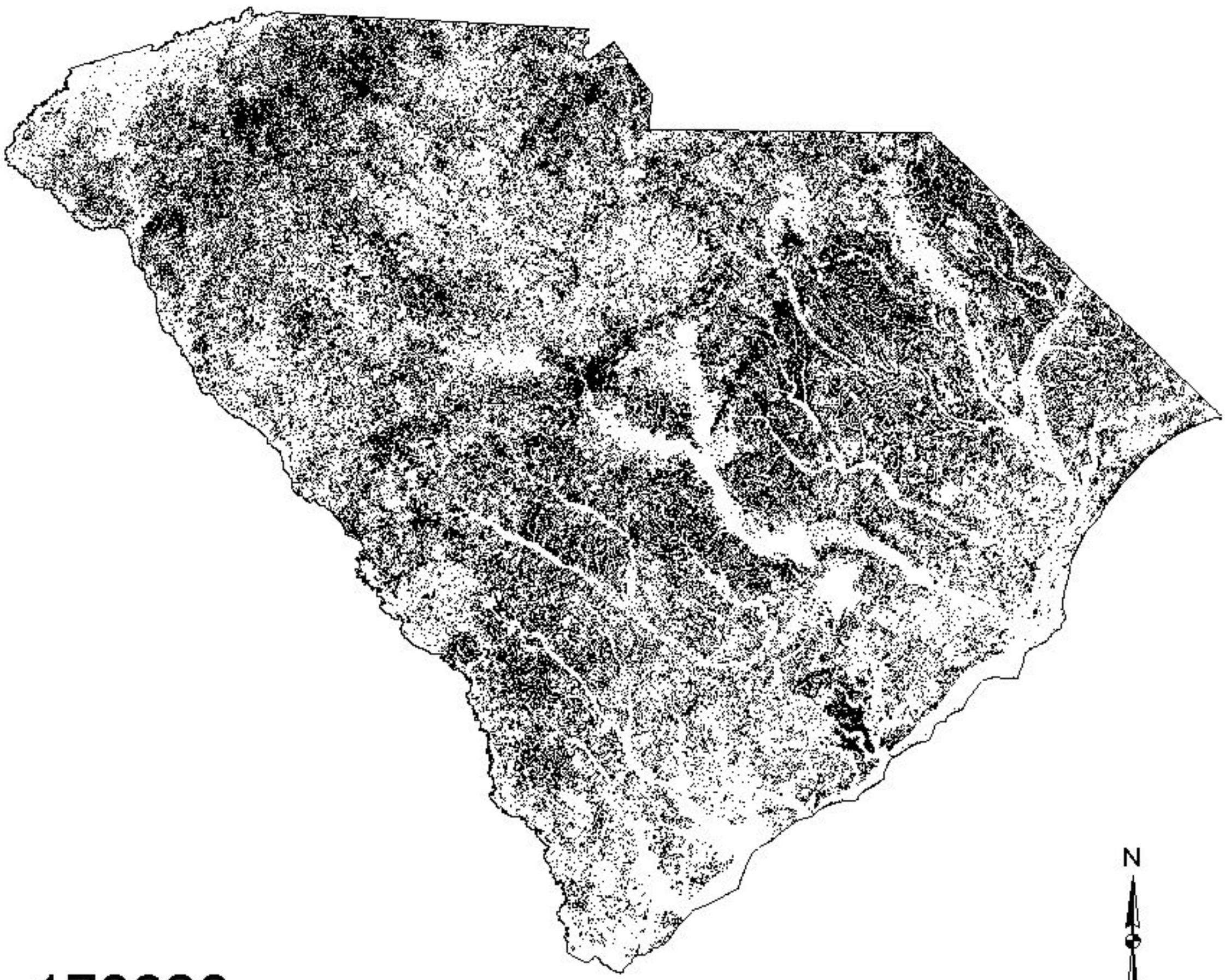
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Northern Mockingbird

(Mimus polyglottos)



178620

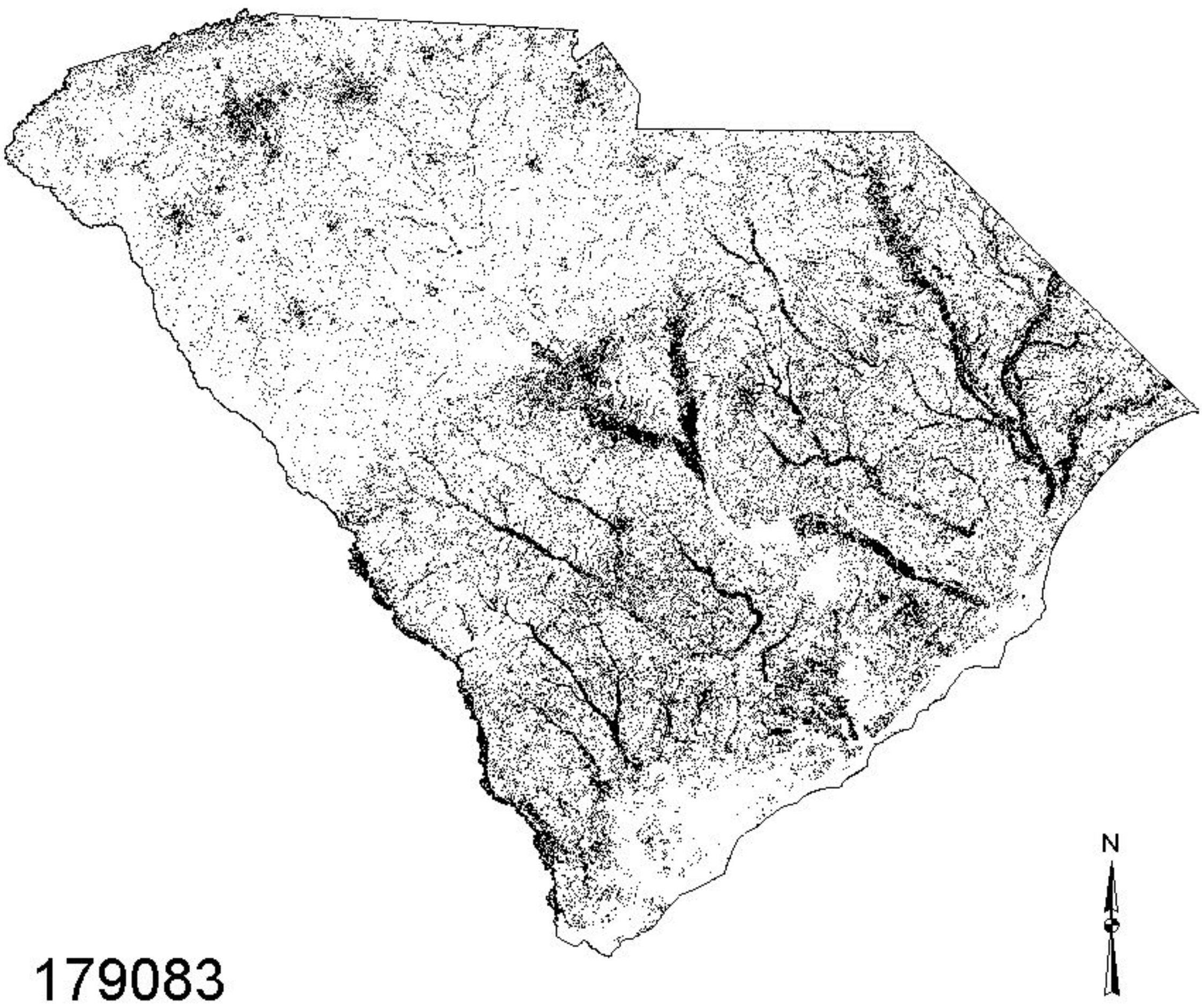
Predicted present

Predicted absent

State boundary

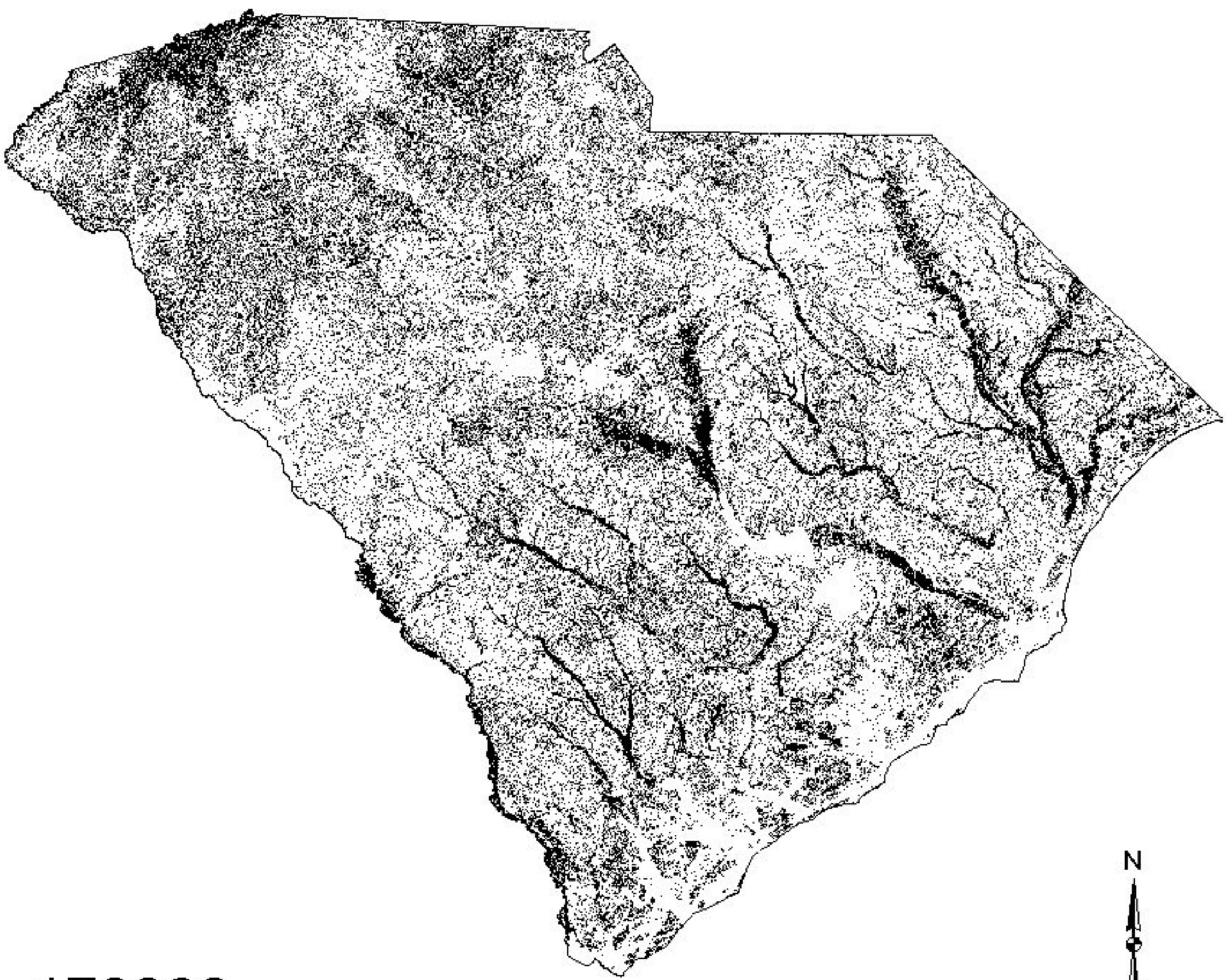
Baltimore Oriole

(Icterus galbula)



Northern Parula

(Parula americana)



178868

Predicted present

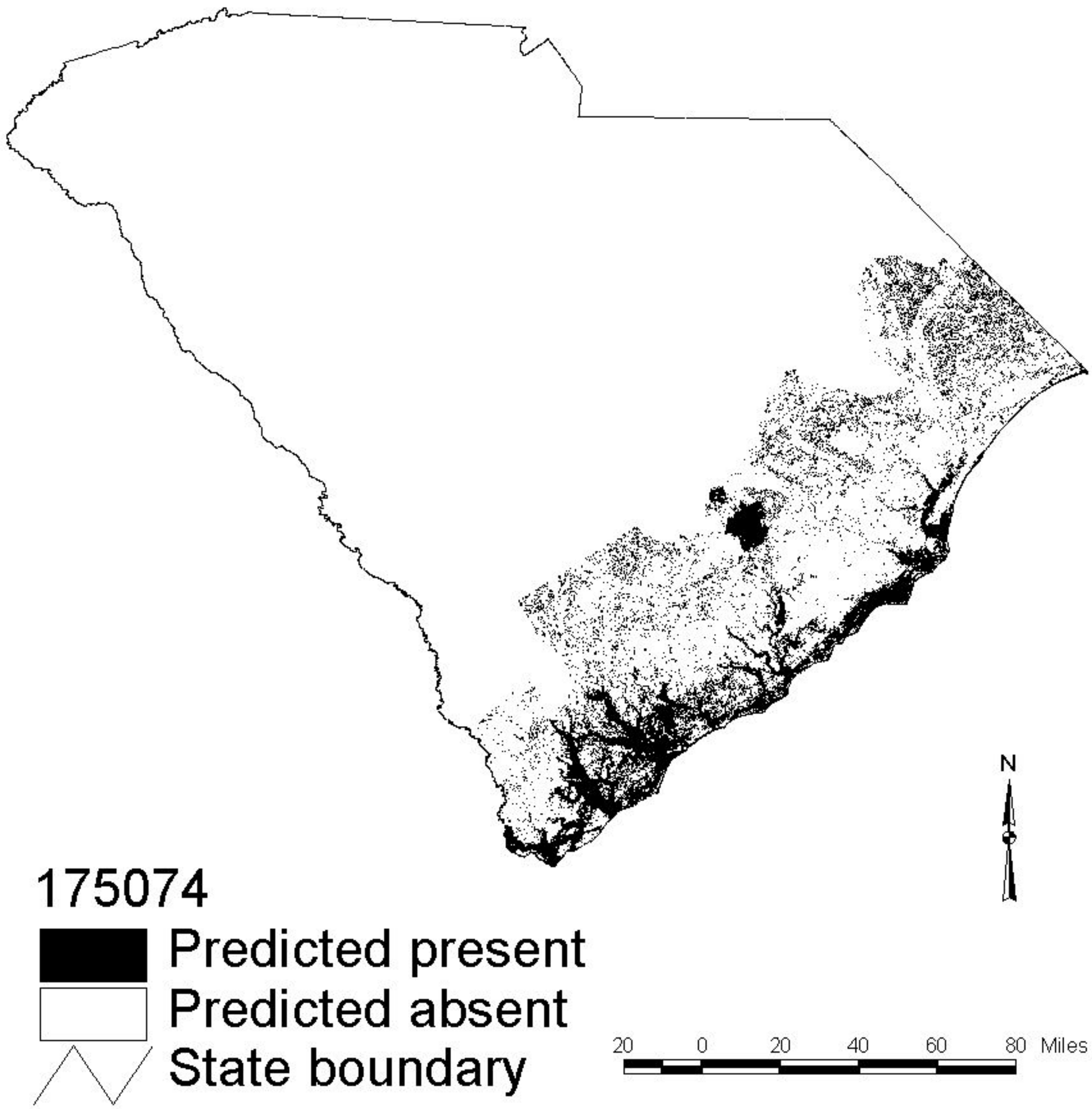
Predicted absent

State boundary

20 0 20 40 60 80 Miles

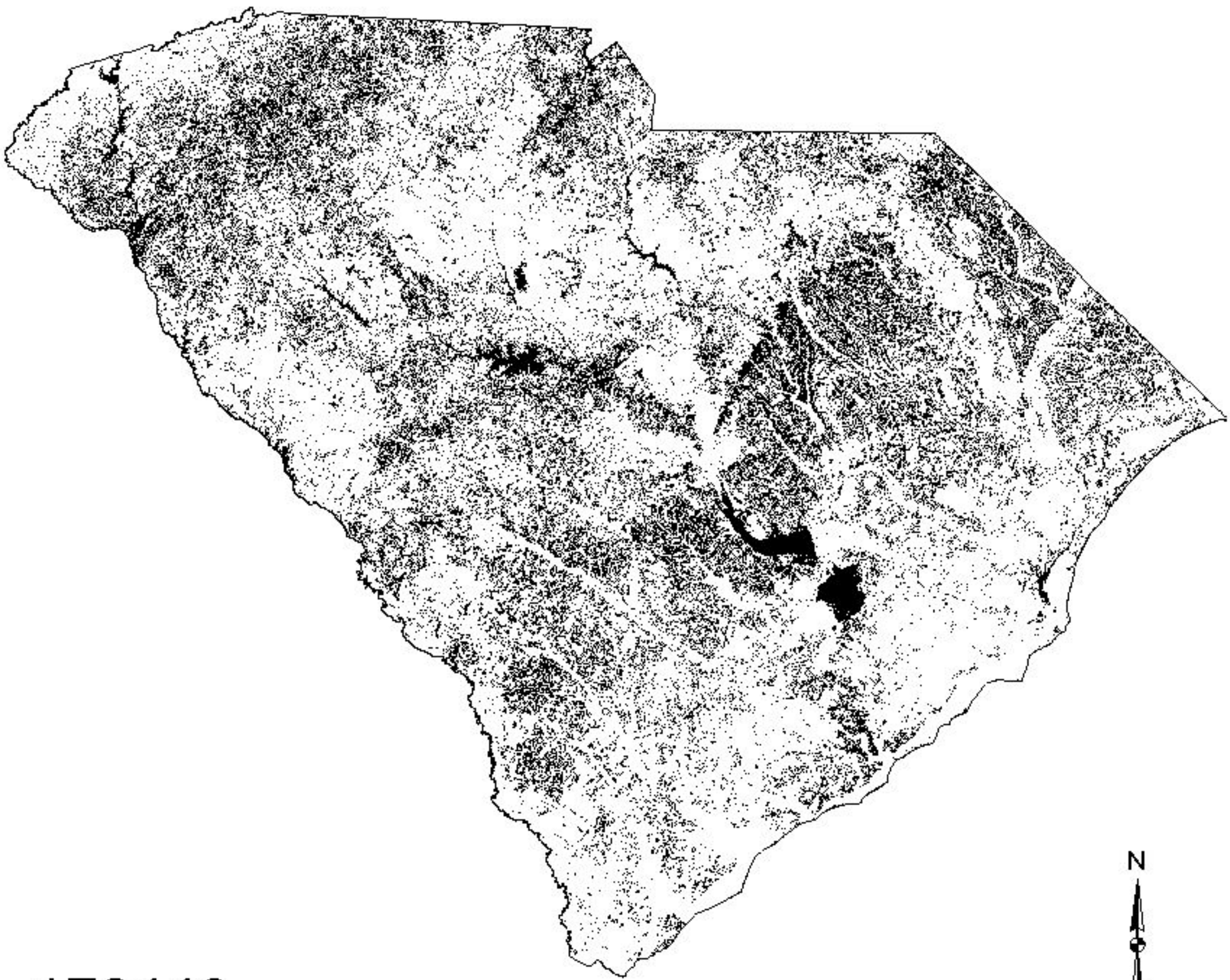
Northern Pintail

(Anas acuta)



Northern Rough-winged Swallow

(Stelgidopteryx serripennis)



178443

Predicted present

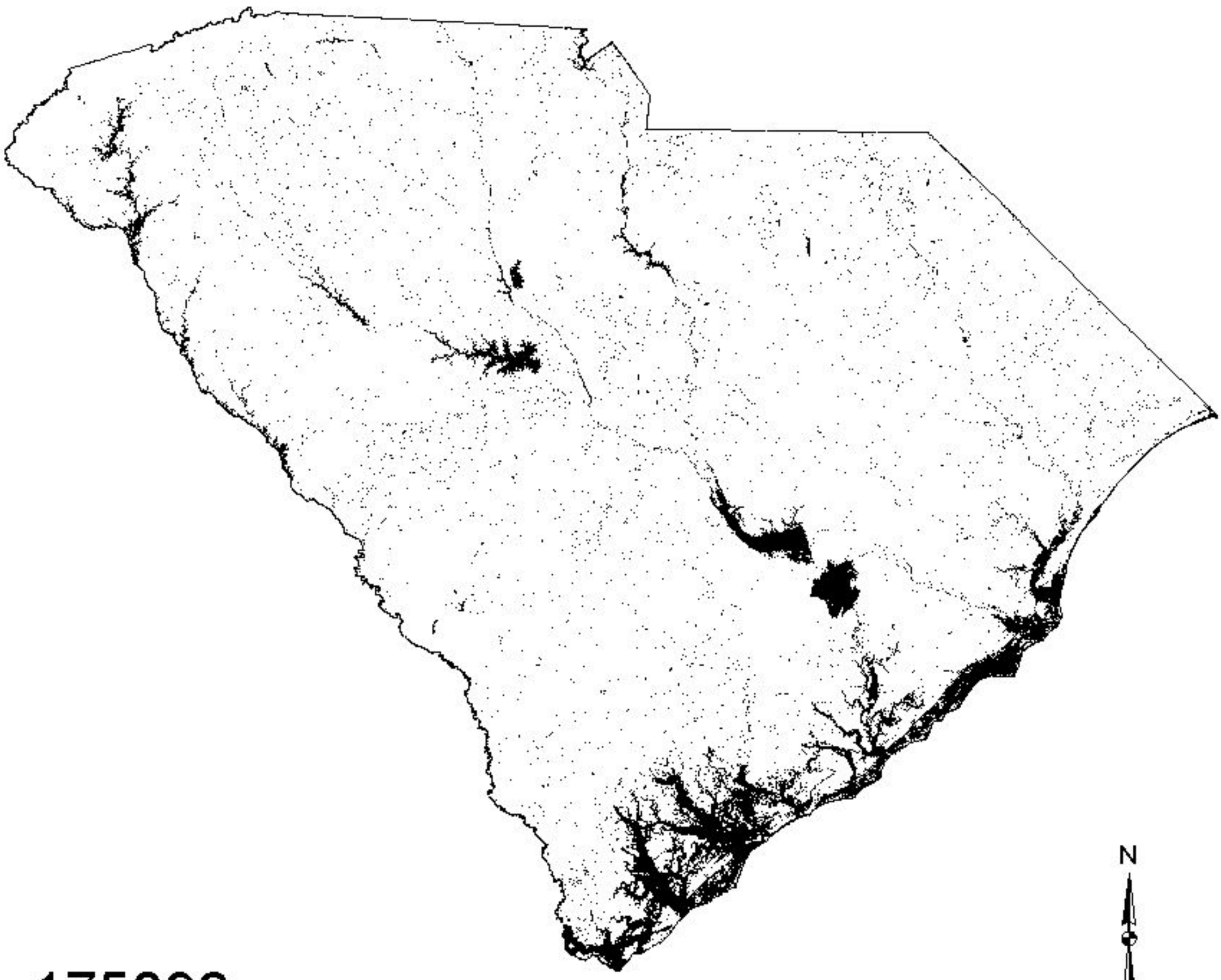
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Northern Shoveler

(Anas clypeata)



175096

Predicted present

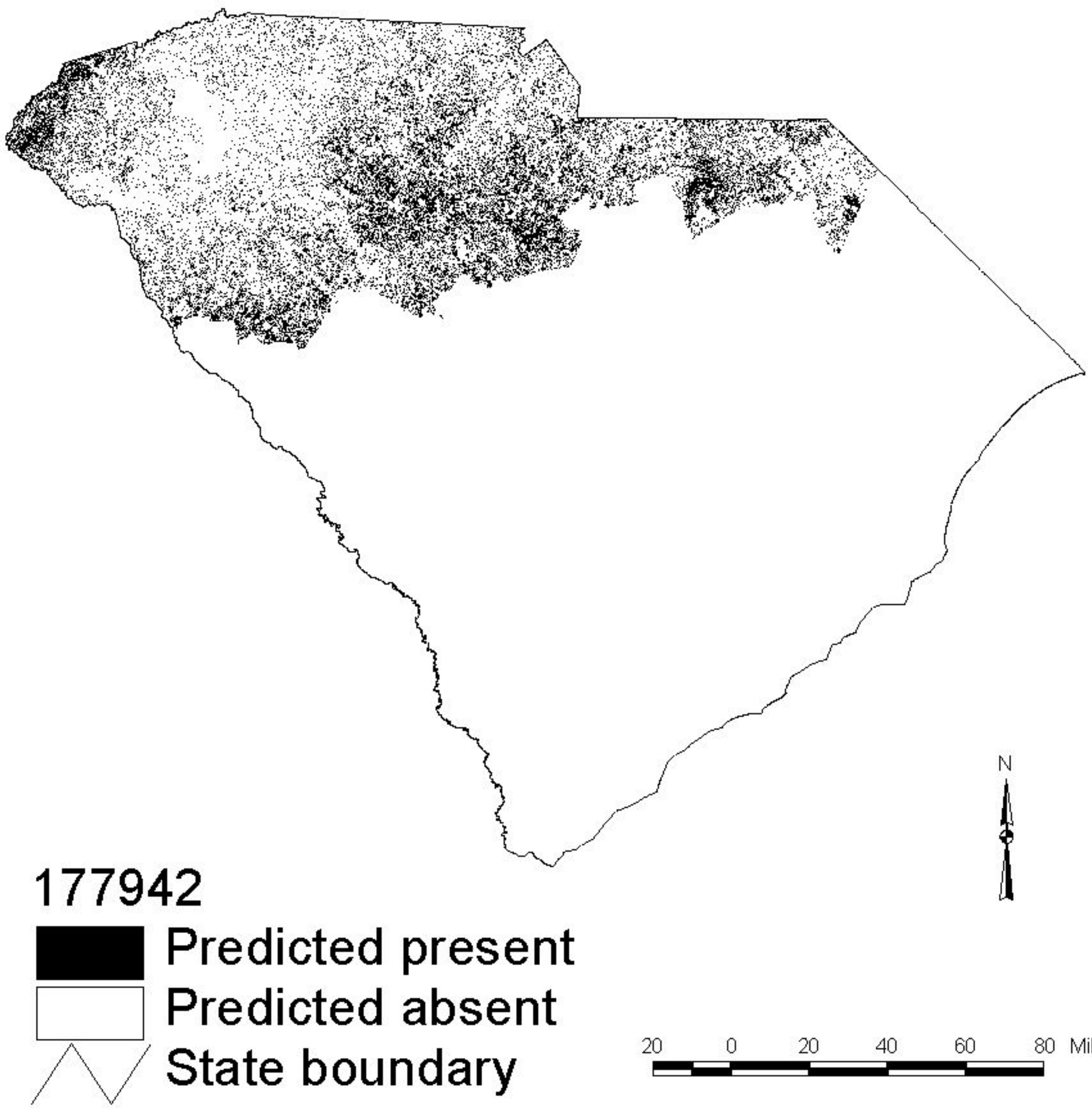
Predicted absent

State boundary

20 0 20 40 60 80 Miles

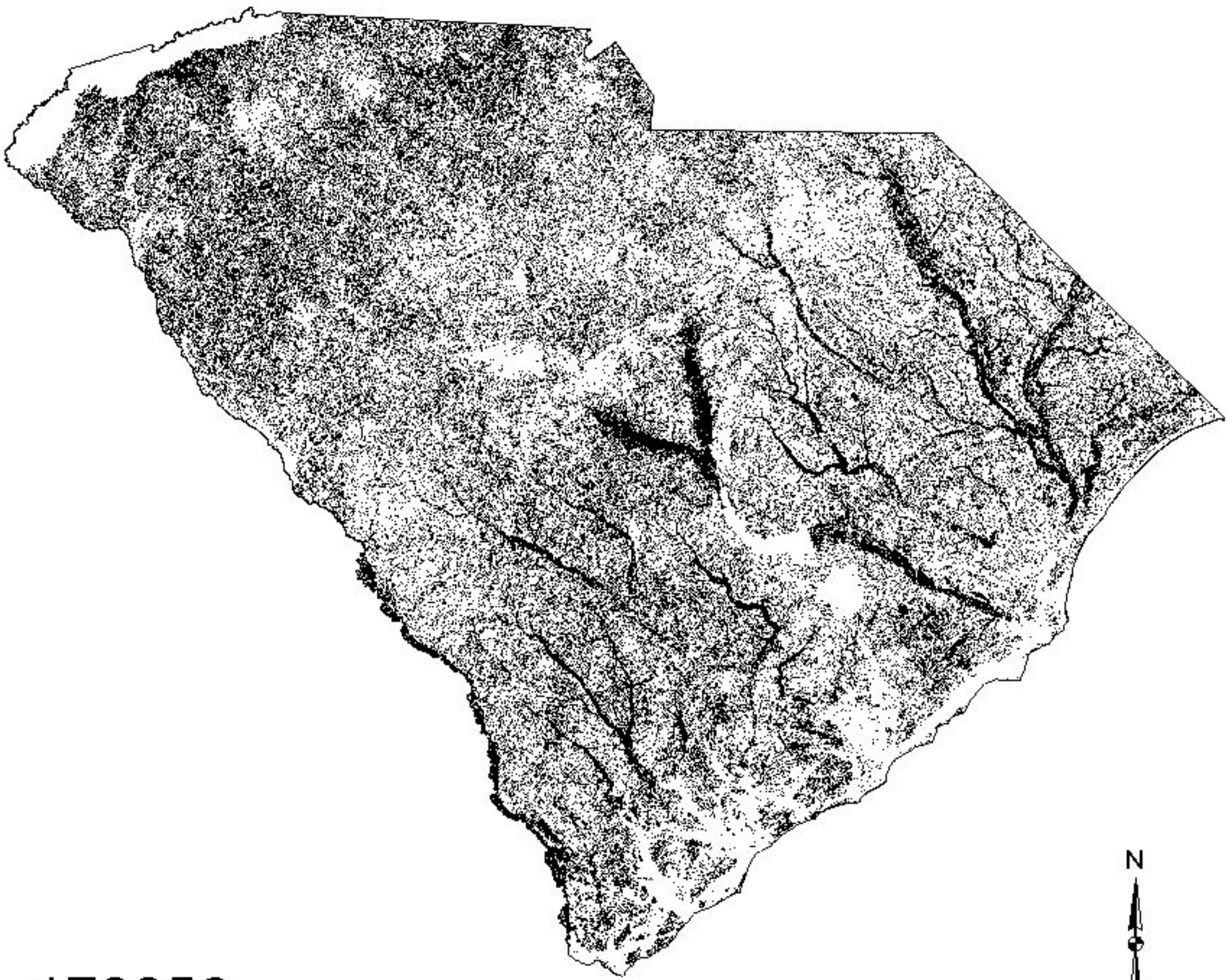
Northern Saw-whet Owl

(Aegolius acadicus)



Orange-crowned Warbler

(Vermivora celata)



178856

Predicted present

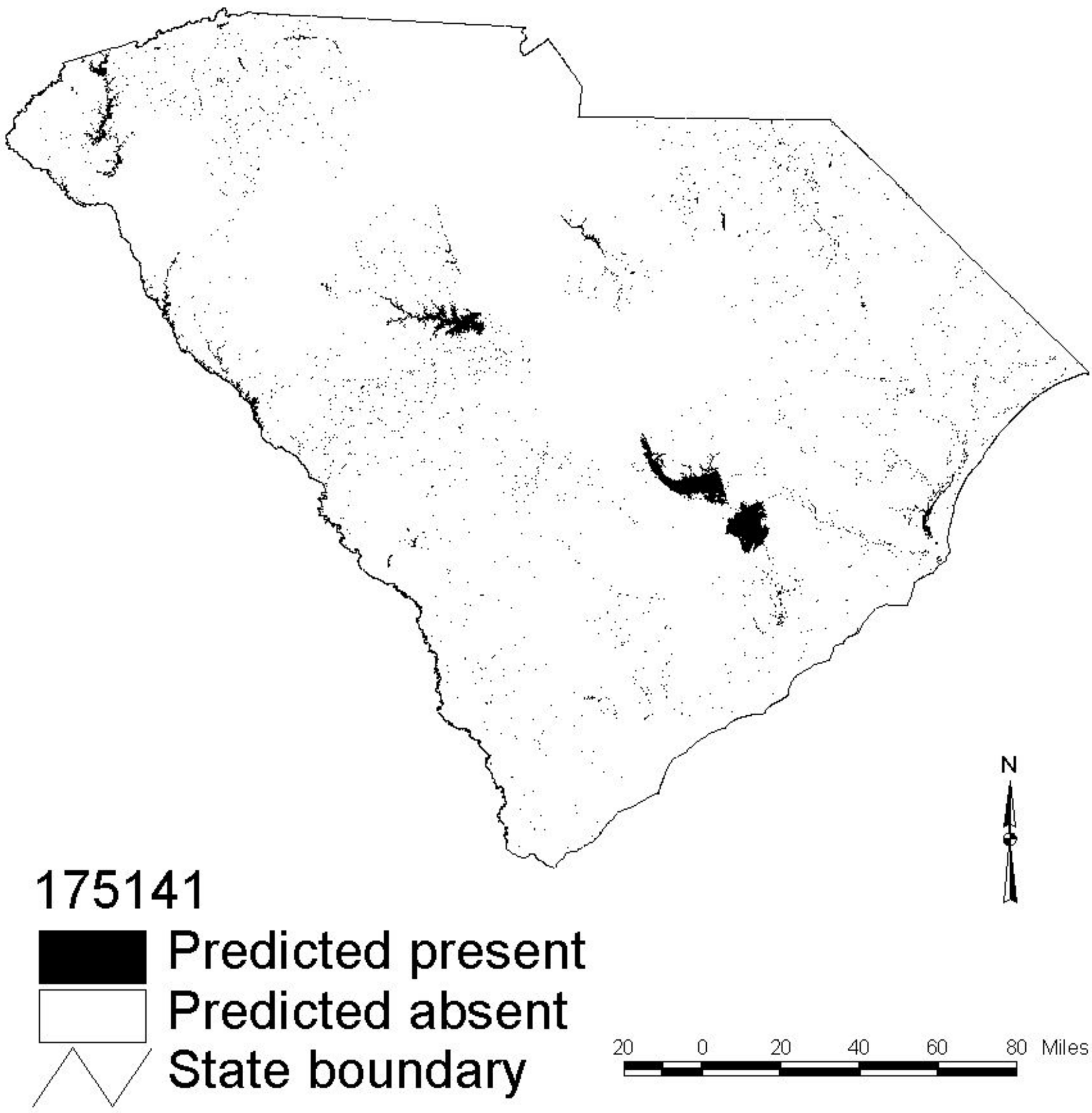
Predicted absent

State boundary

20 0 20 40 60 80 Miles

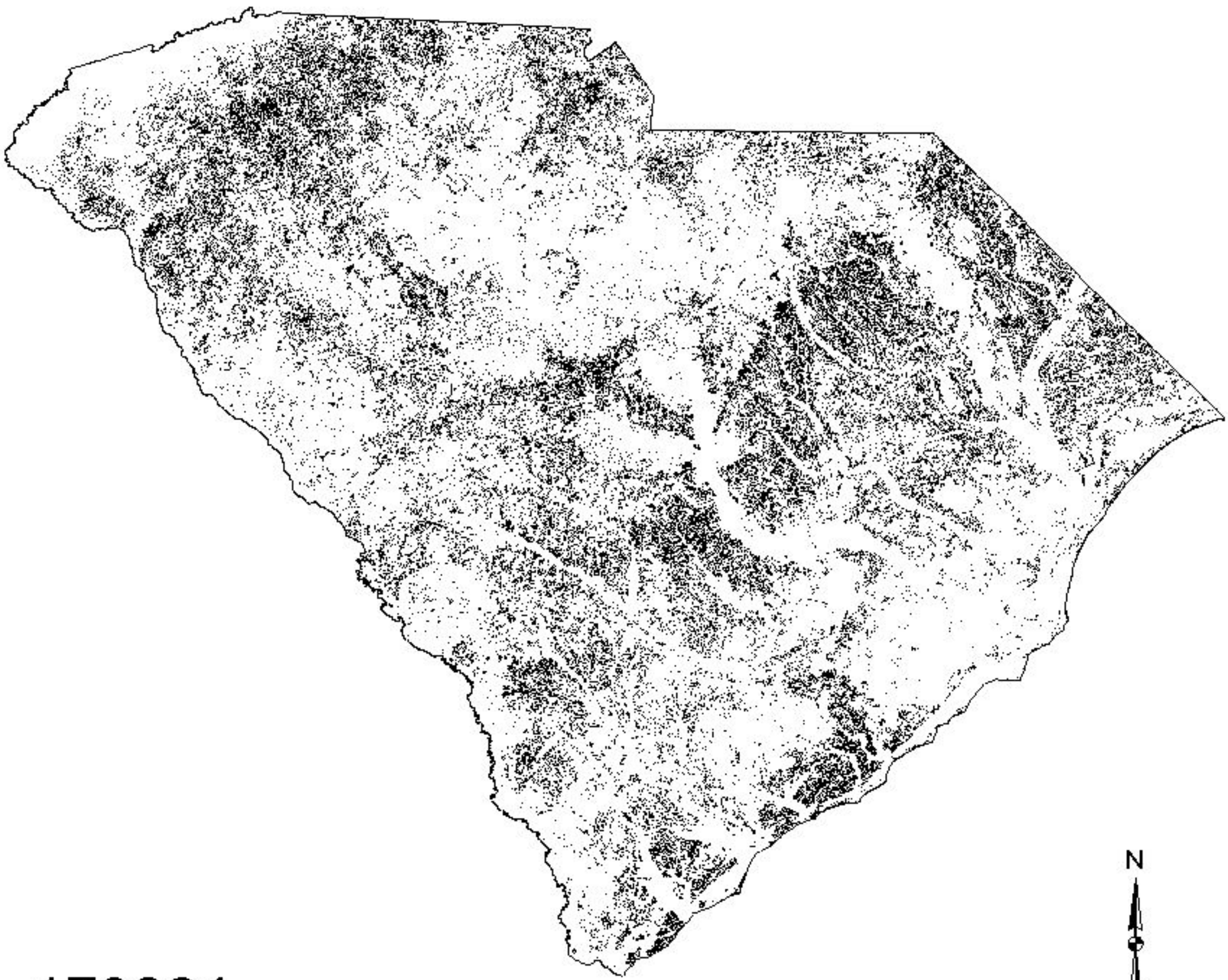
Common Goldeneye

(Bucephala clangula)



Orchard Oriole

(Icterus spurius)



179064

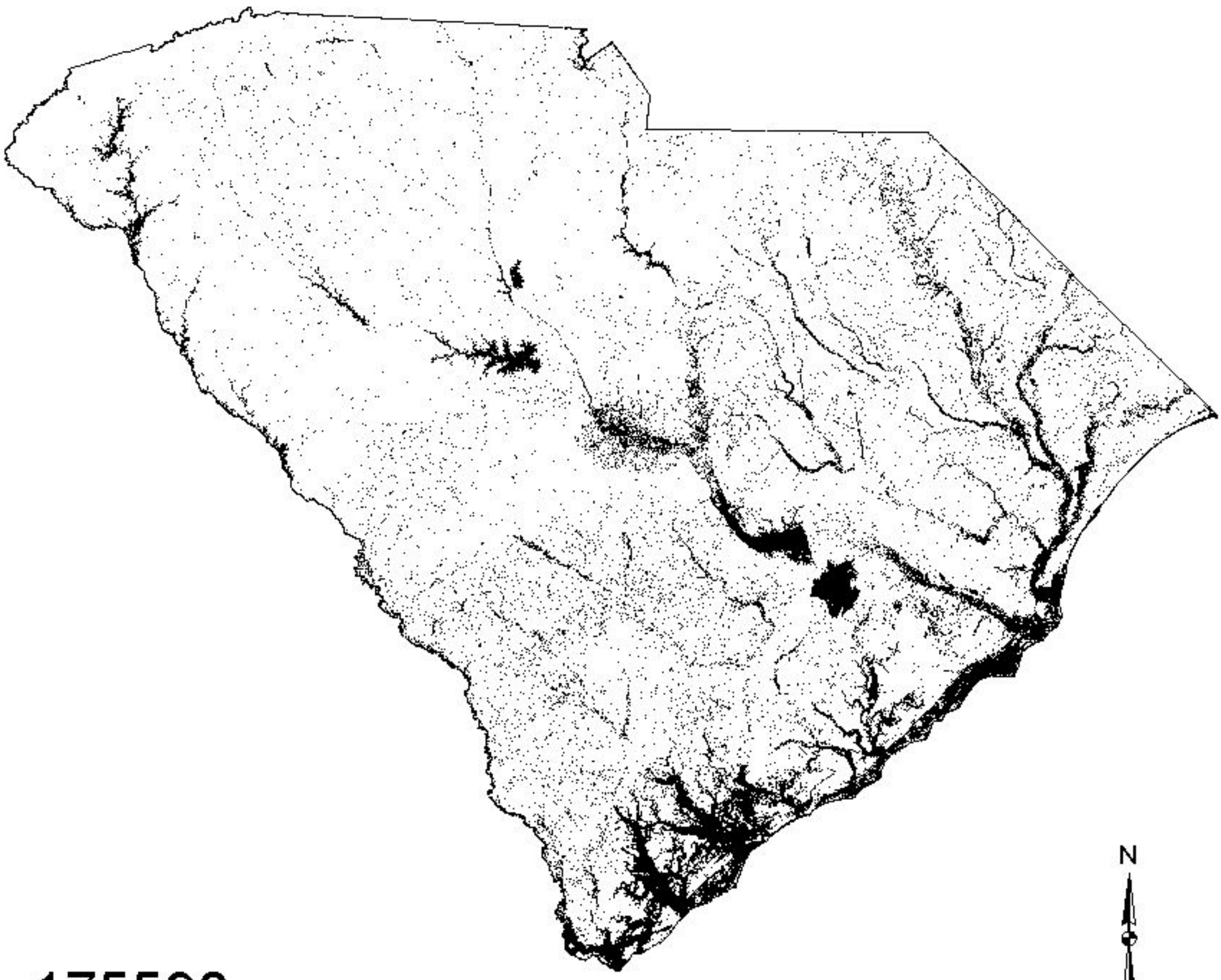
Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Osprey
(Pandion haliaetus)



175590

Predicted present

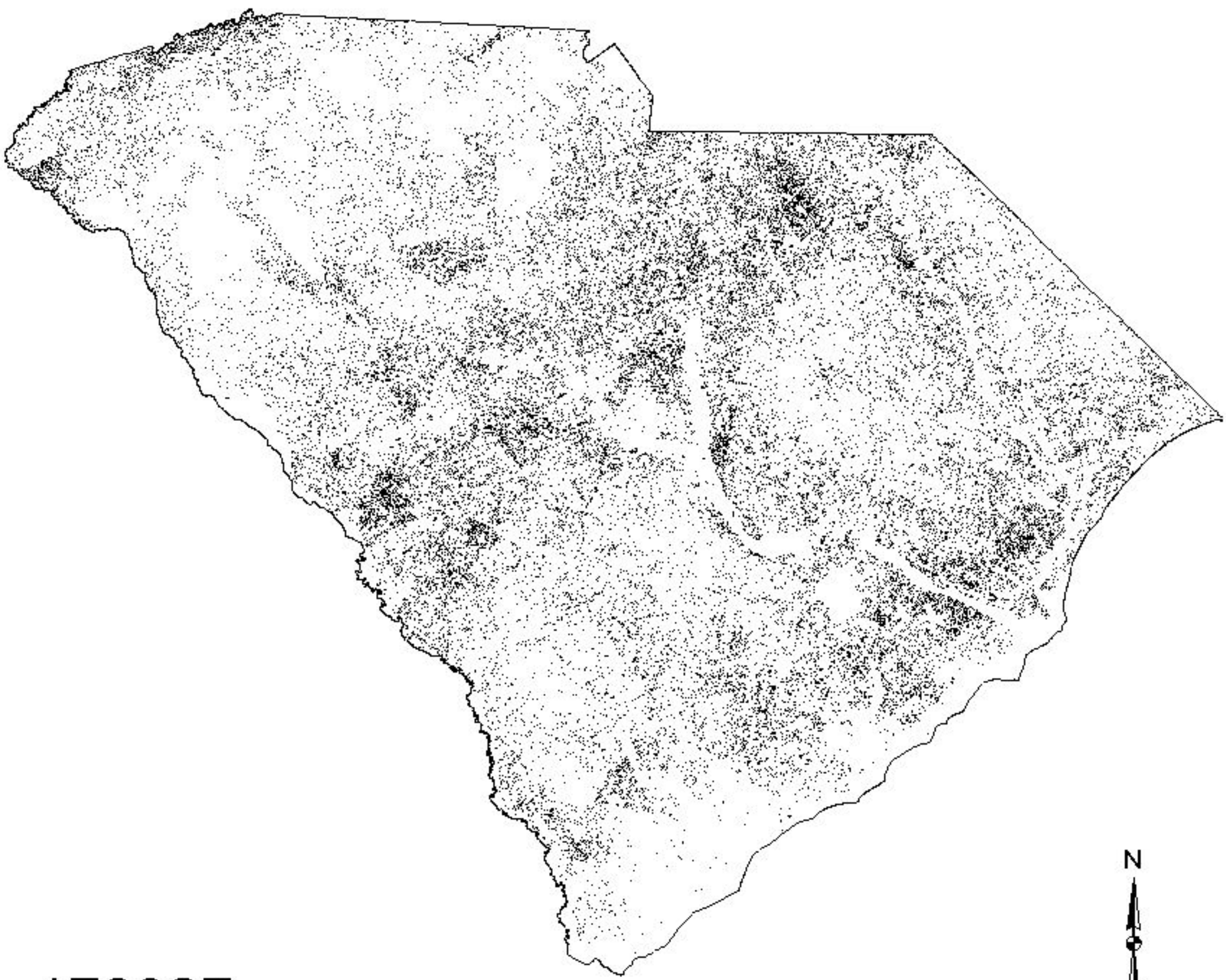
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Ovenbird

(Seiurus aurocapillus)



178927

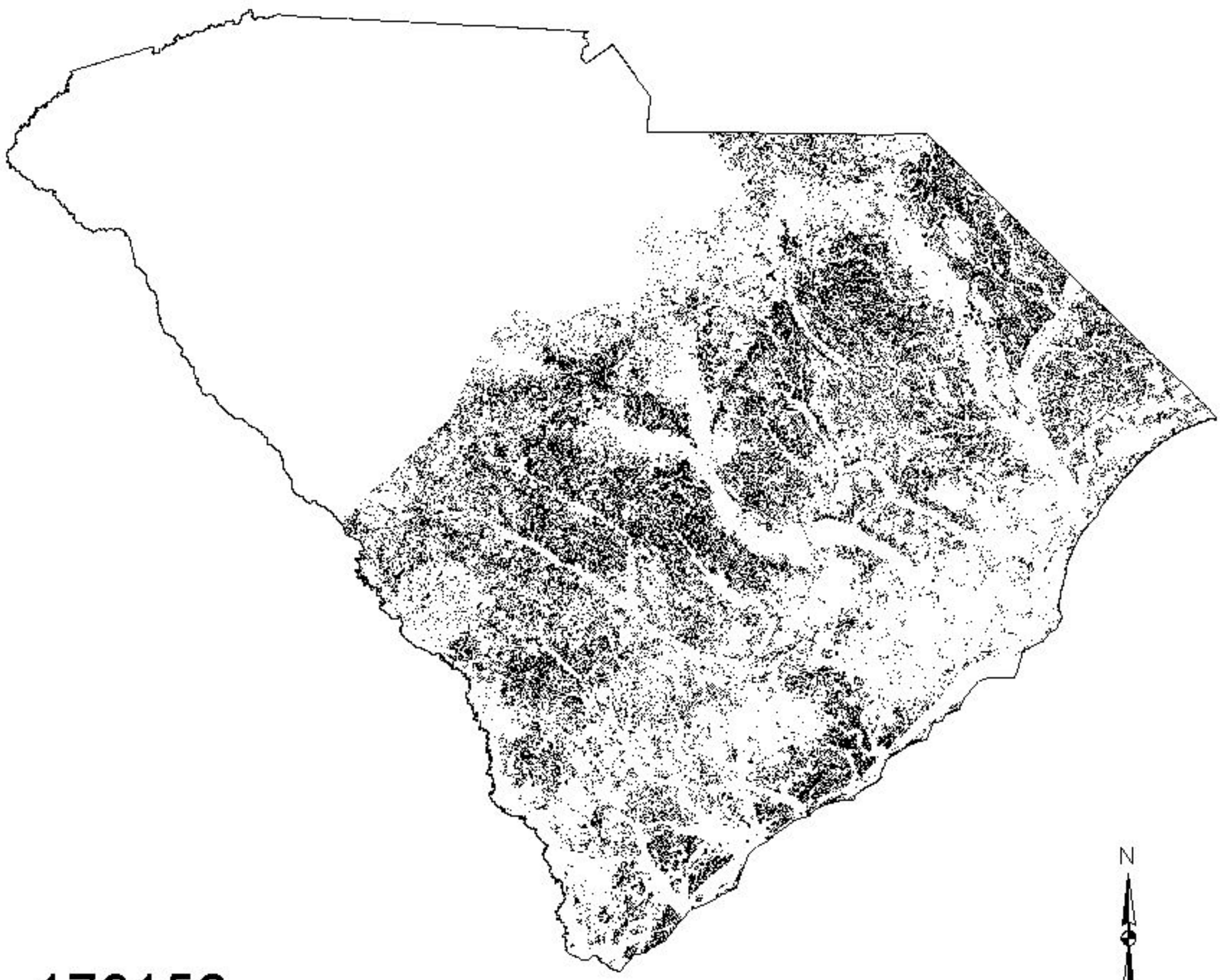
Predicted present

Predicted absent

State boundary

Painted Bunting

(Passerina ciris)



179156

Predicted present

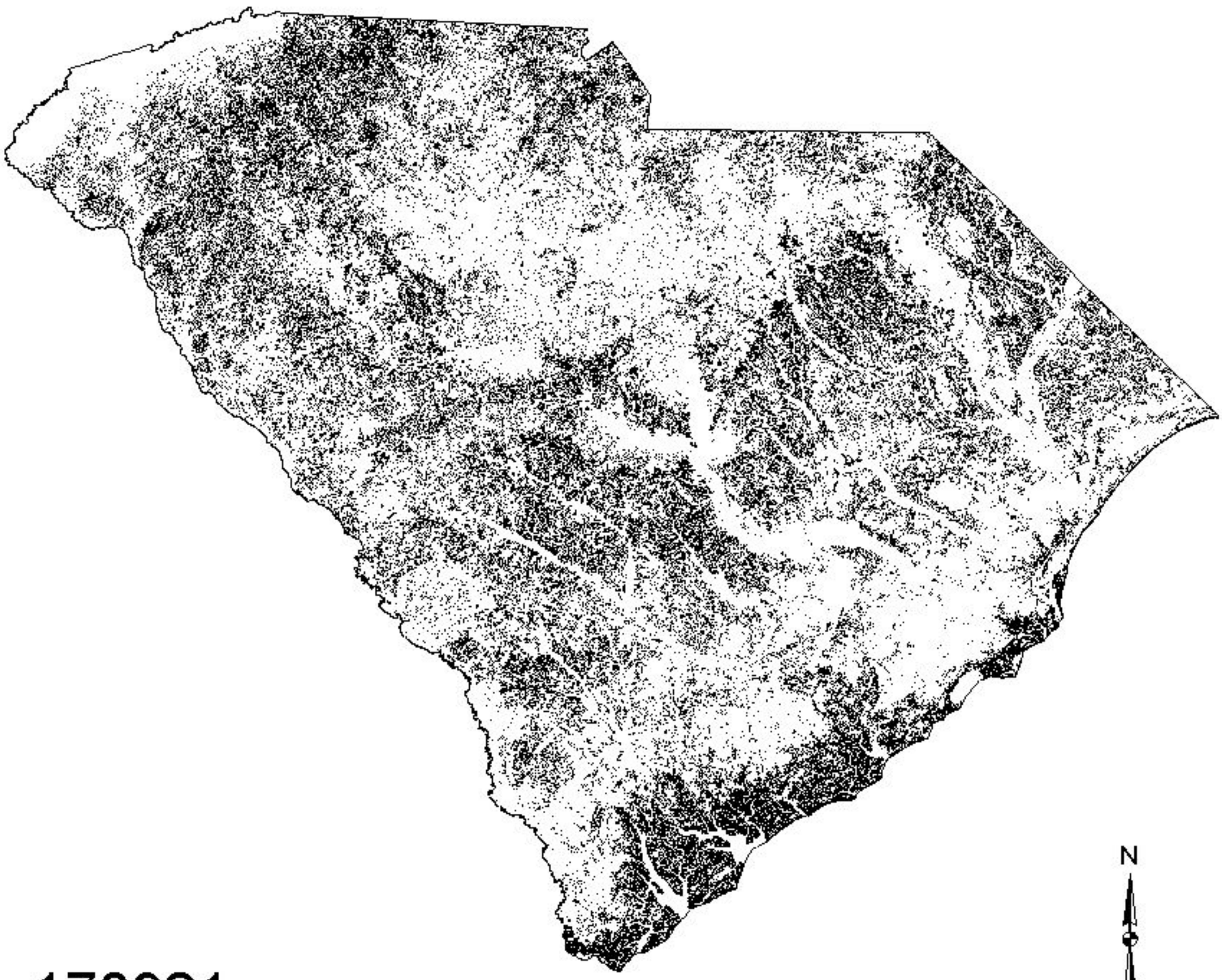
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Palm Warbler

(Dendroica palmarum)



178921

Predicted present

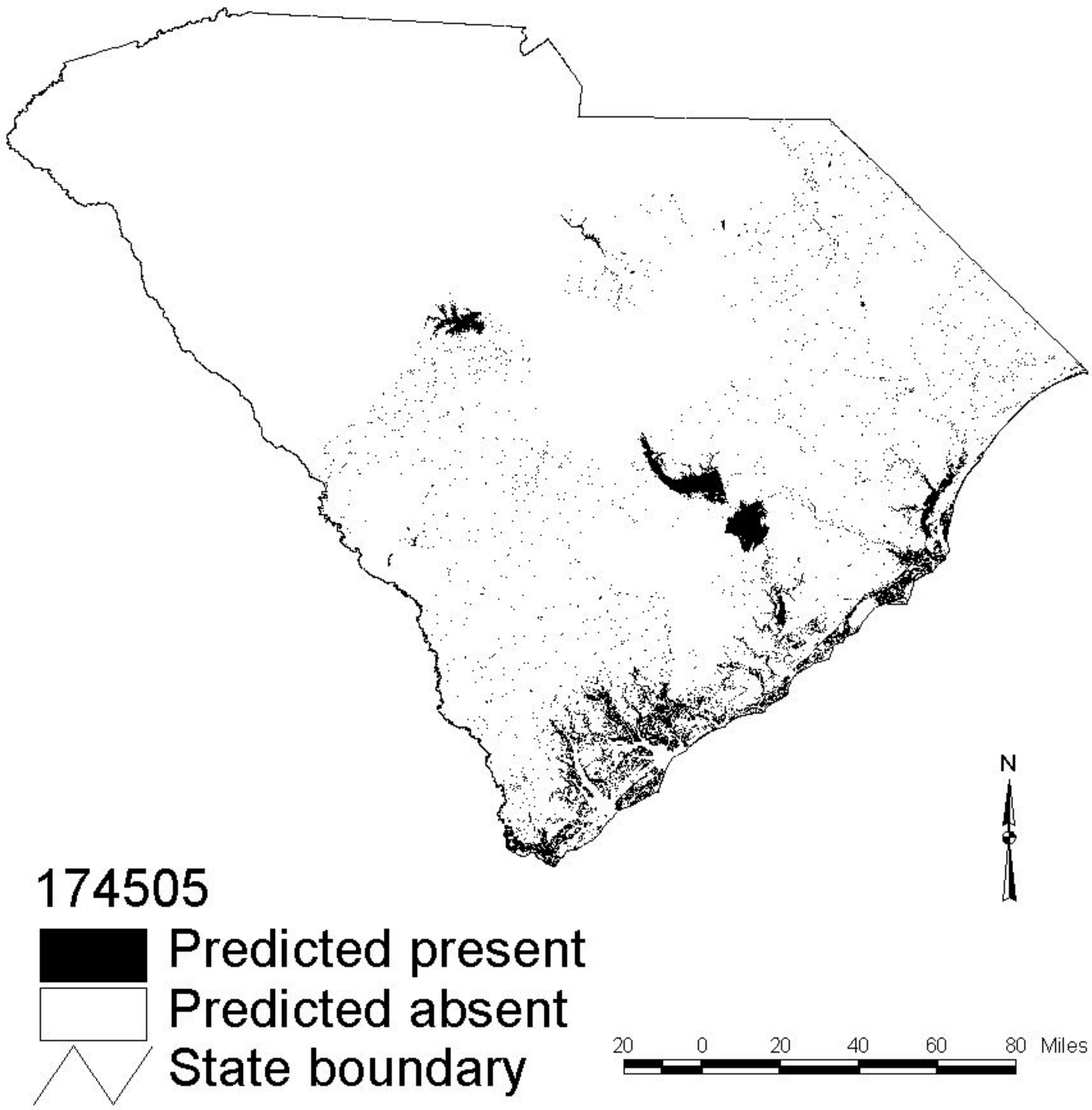
Predicted absent

State boundary

20 0 20 40 60 80 Miles

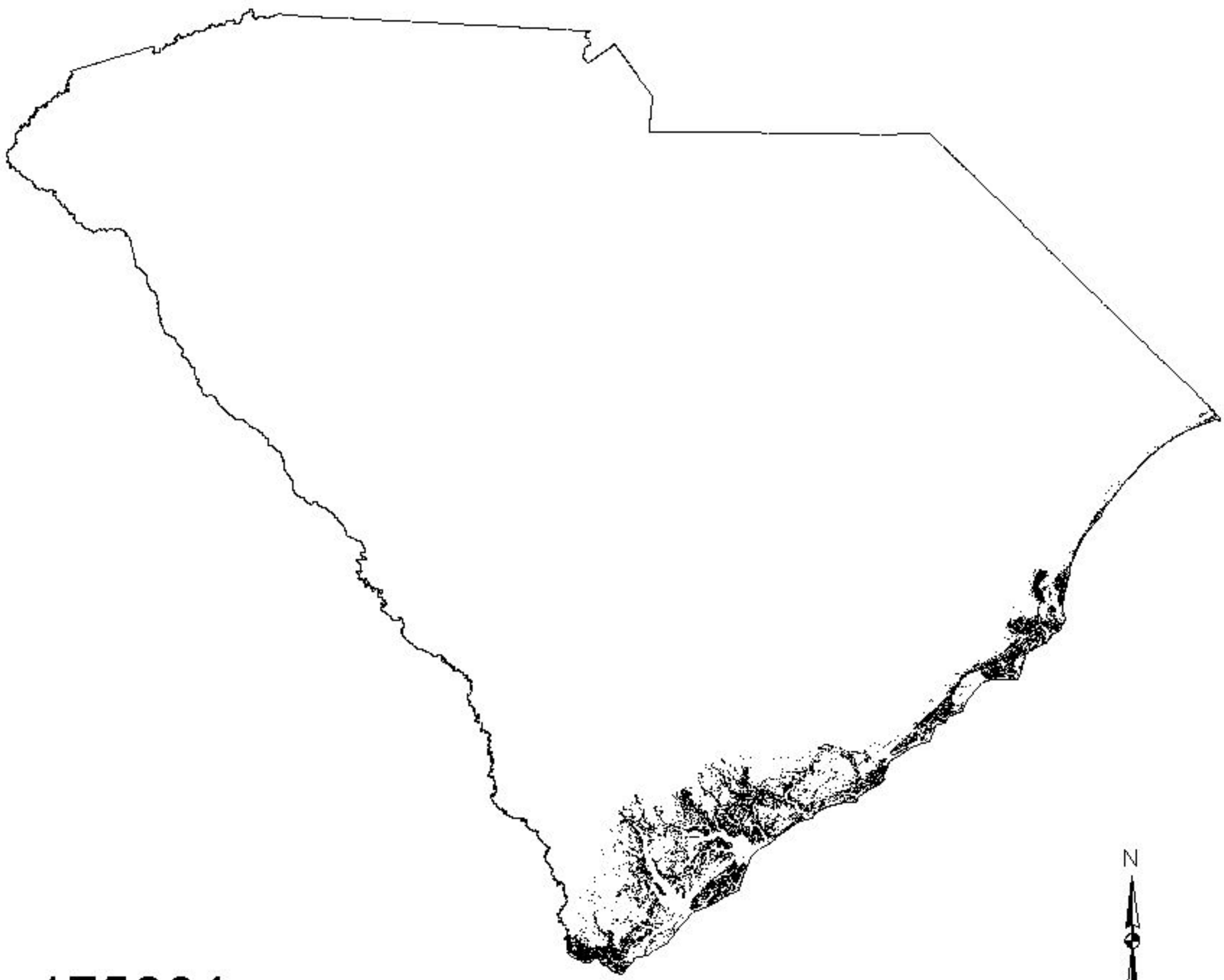
Pied-billed Grebe

(Podilymbus podiceps)



Peregrine Falcon

(Falco peregrinus)



175604

Predicted present

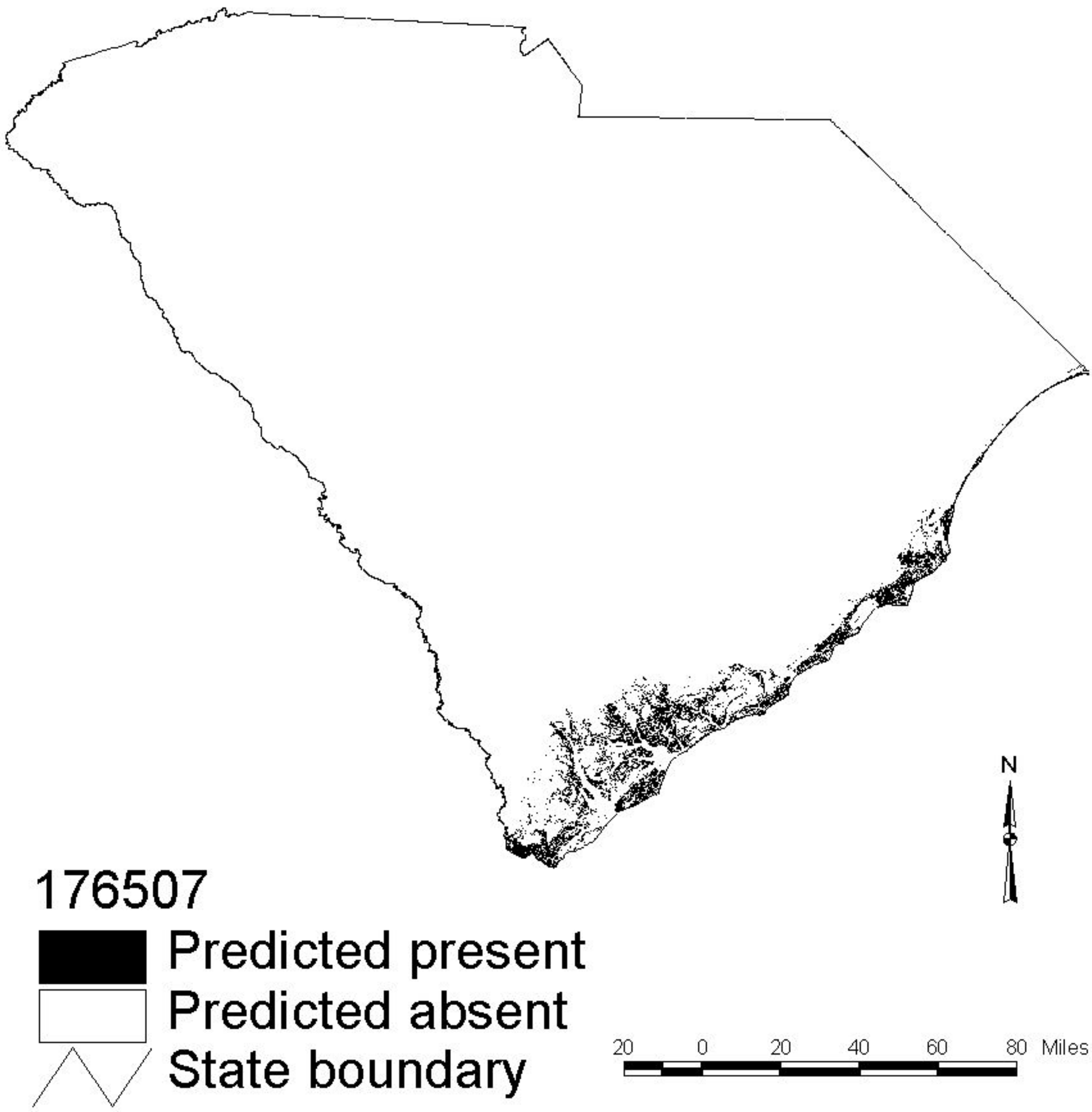
Predicted absent

State boundary

20 0 20 40 60 80 Miles

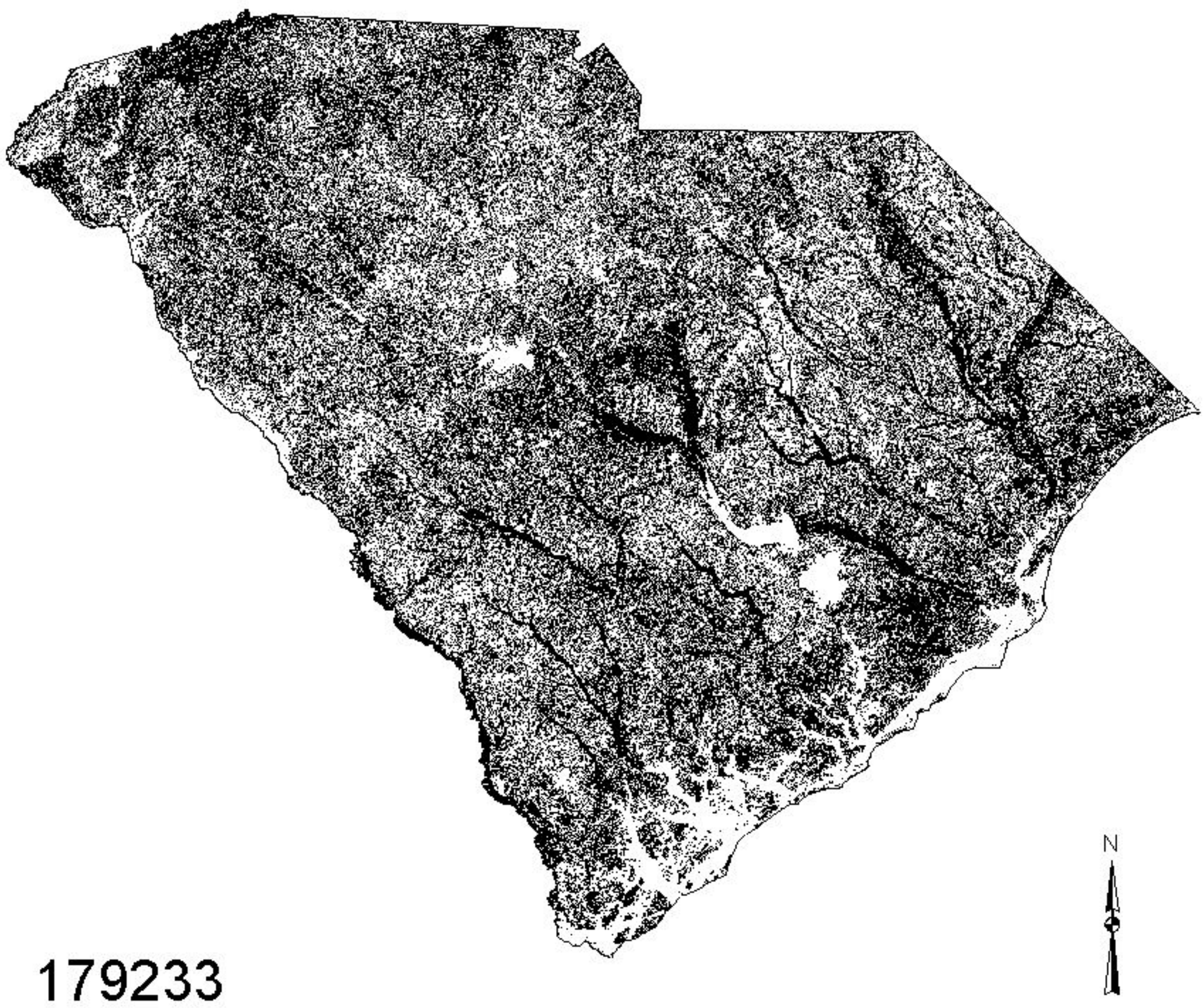
Piping Plover

(Charadrius melodus)



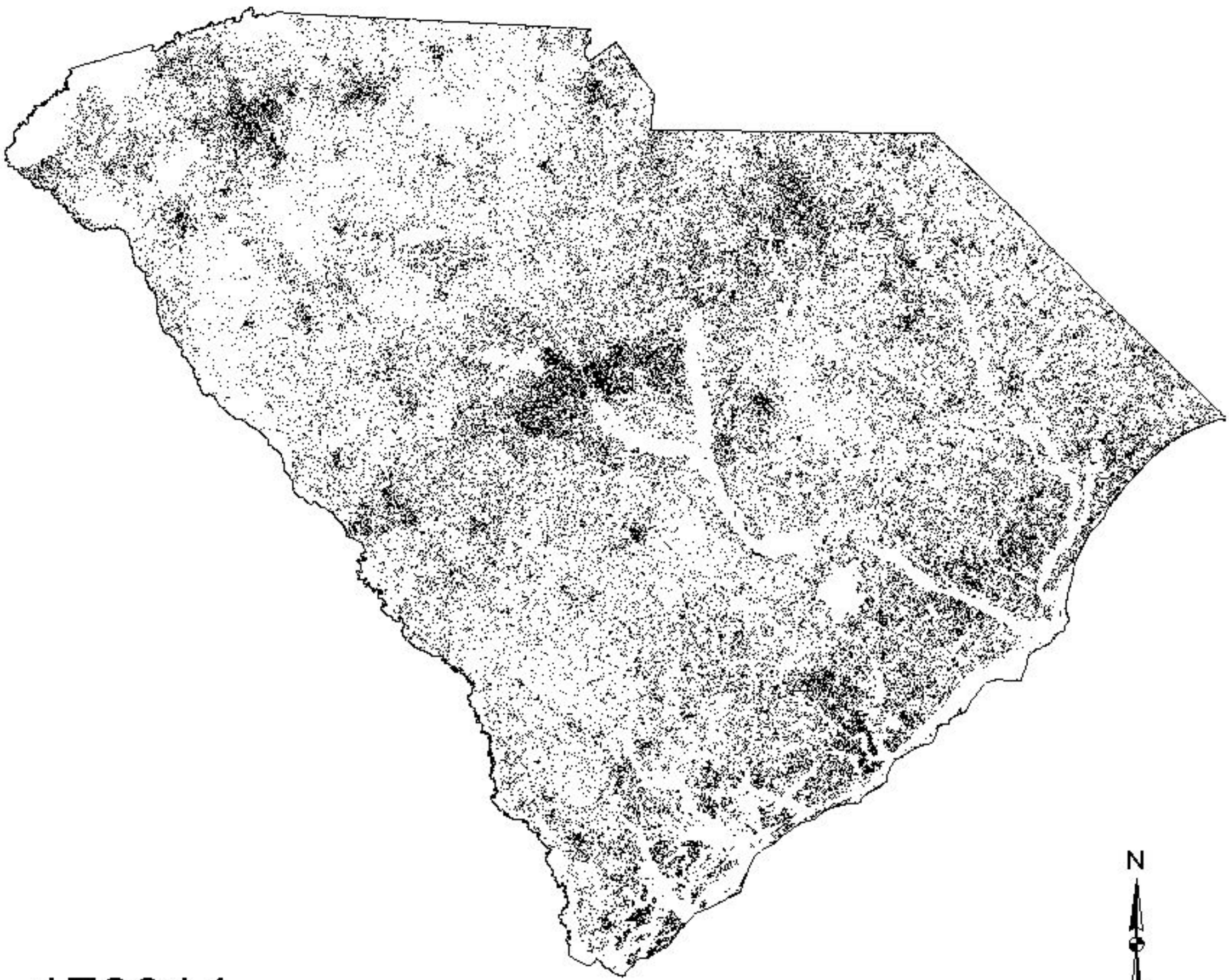
Pine Siskin

(Carduelis pinus)



Pine Warbler

(Dendroica pinus)



178914

Predicted present

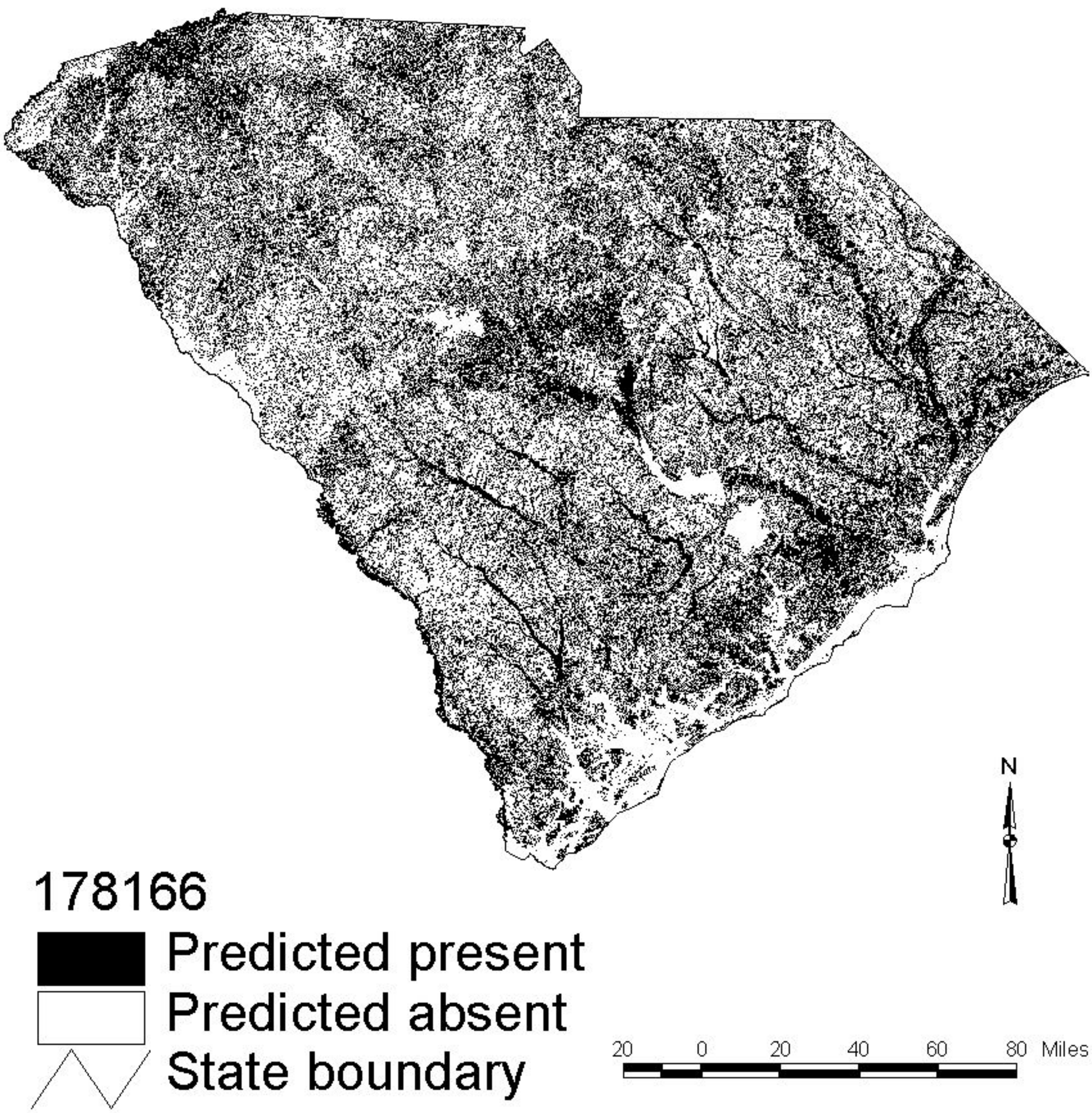
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Pileated Woodpecker

(Dryocopus pileatus)



Prairie Warbler

(Dendroica discolor)

178918

Predicted present

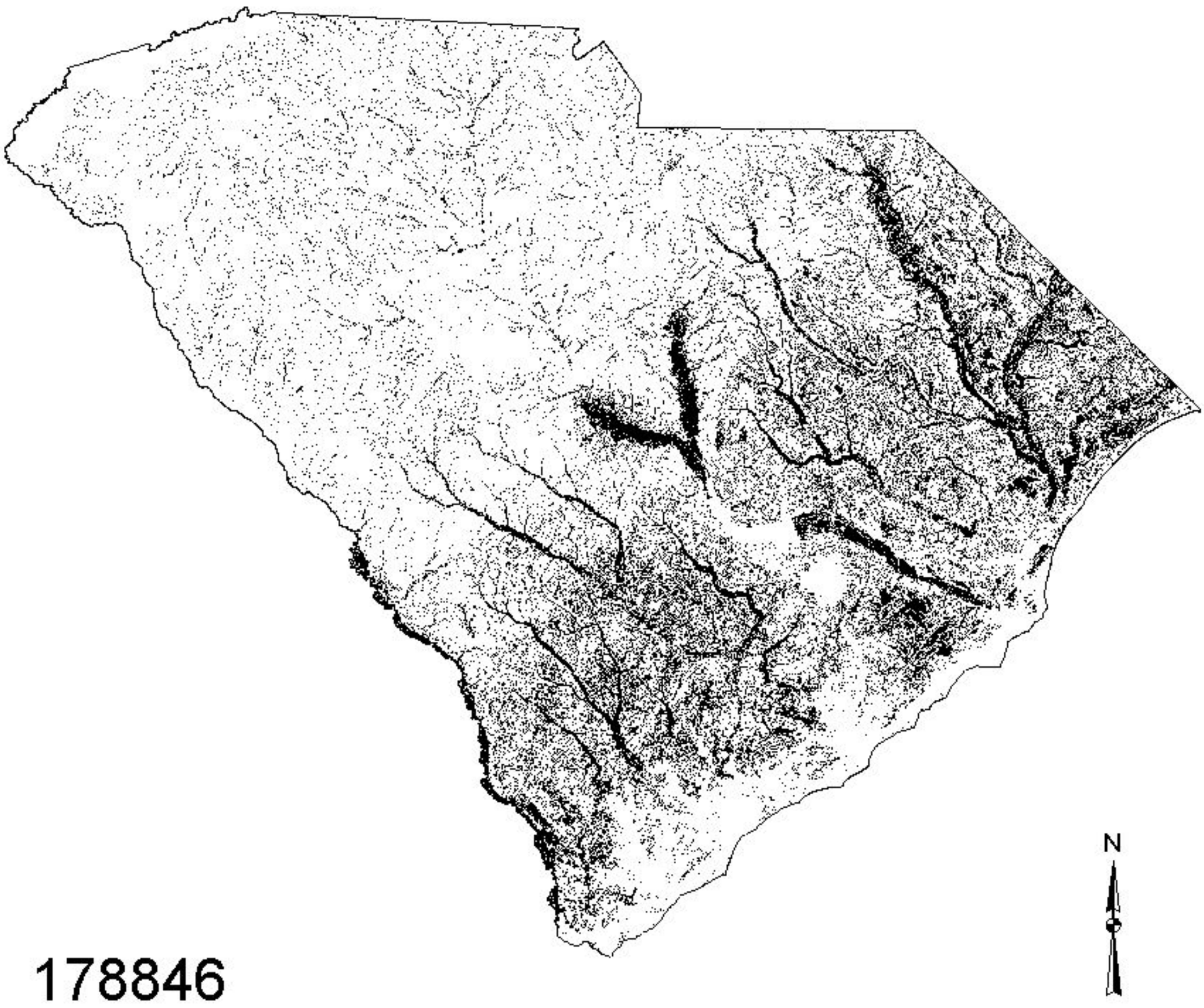
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Prothonotary Warbler

(Protonotaria citrea)



Purple Finch

(Carpodacus purpureus)

179186

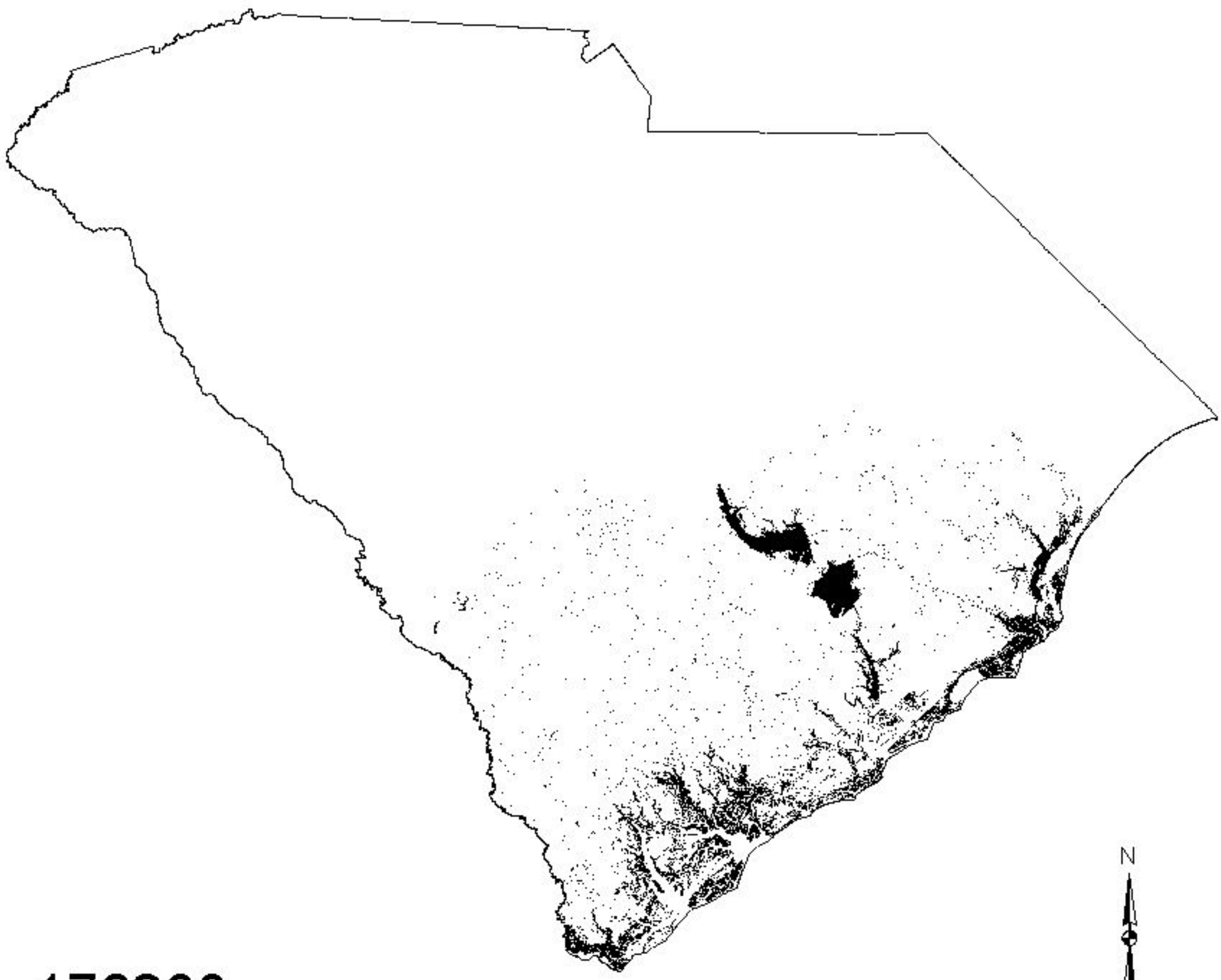
Predicted present

Predicted absent

State boundary

Purple Gallinule

(Porphyrula martinica)



176280

Predicted present

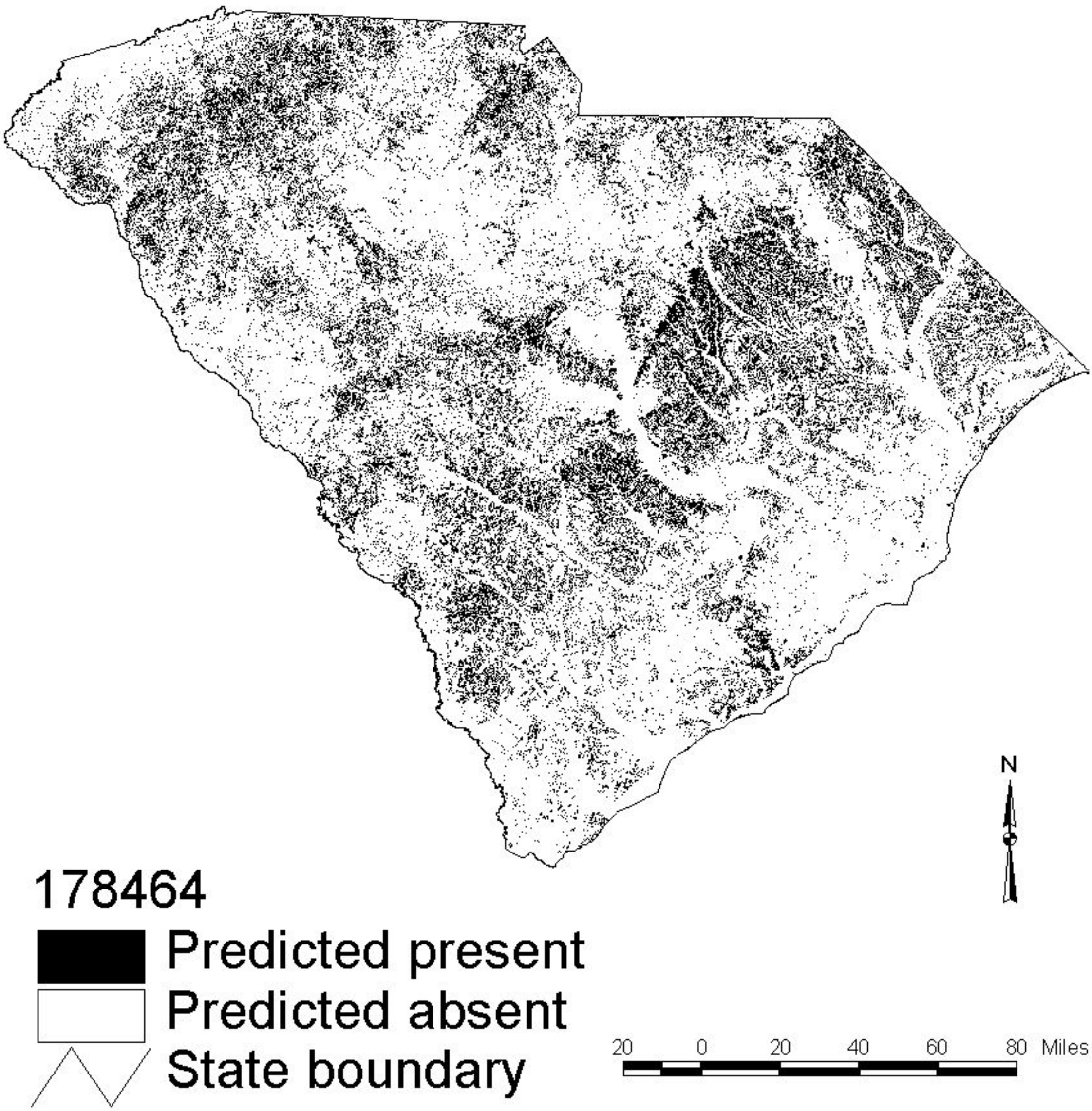
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Purple Martin

(Progne subis)



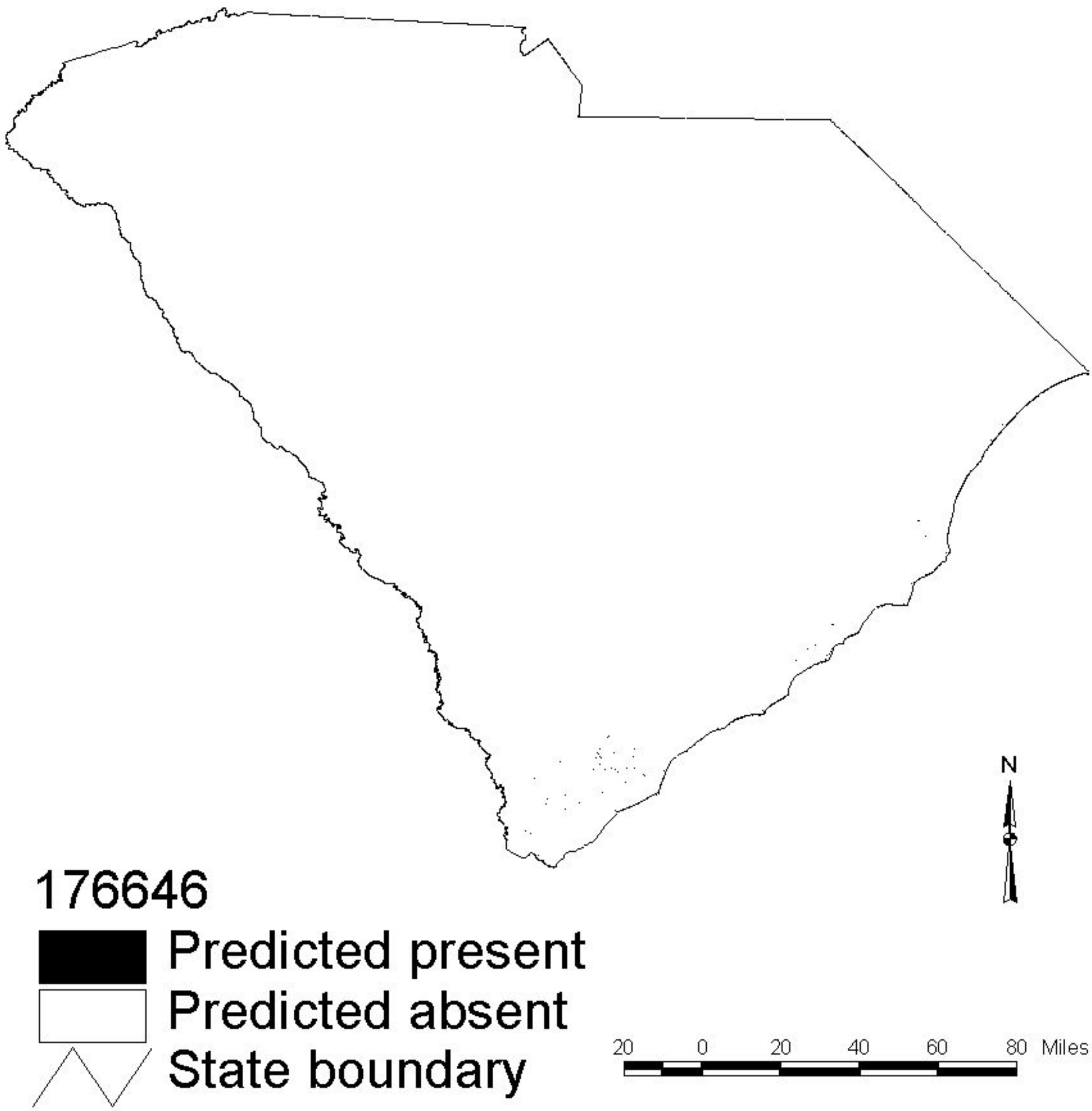
178464

Predicted present

Predicted absent

State boundary

Purple Sandpiper
(Calidris maritima)



176646

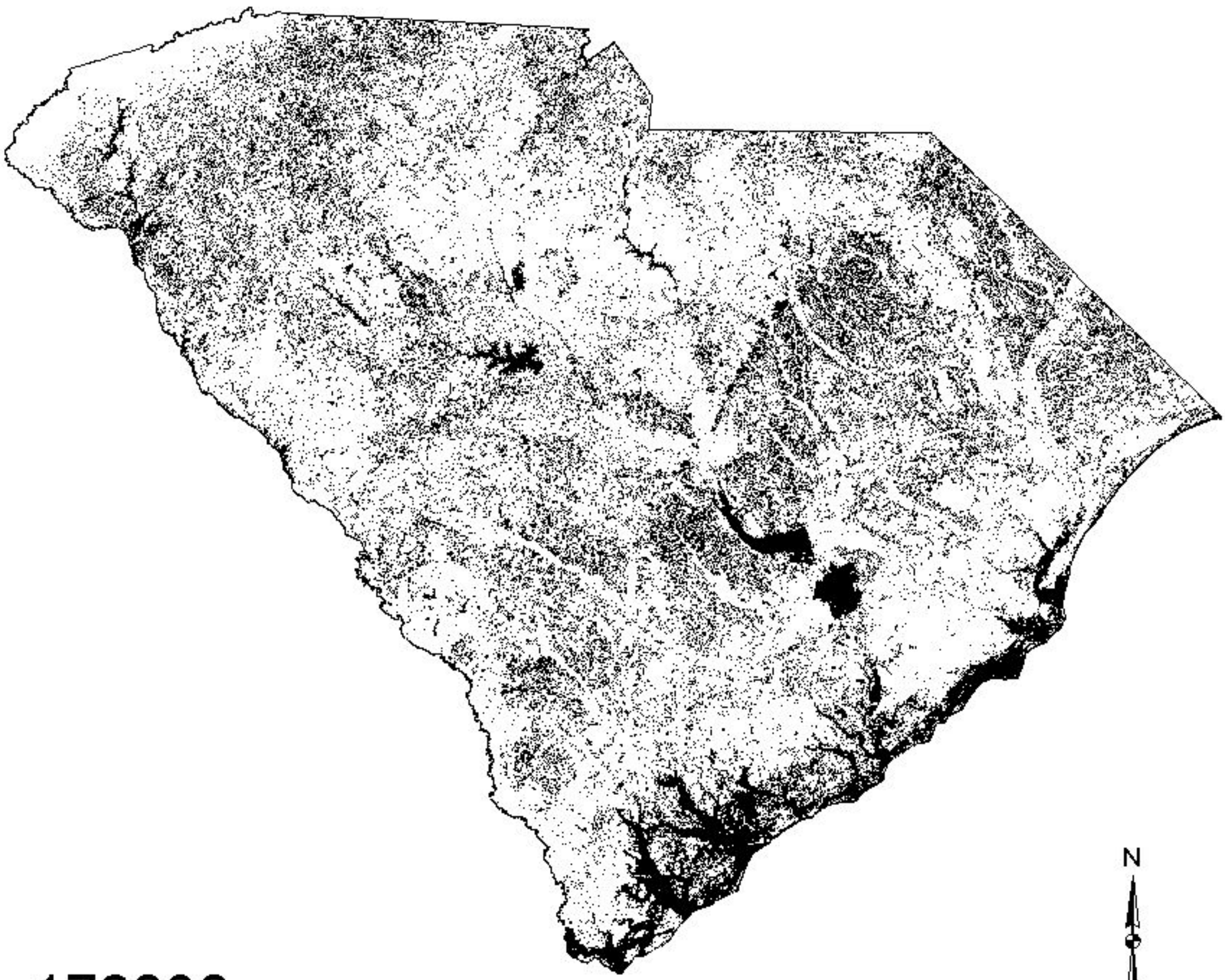
Predicted present

Predicted absent

State boundary

Ring-billed Gull

(Larus delawarensis)



176830

Predicted present

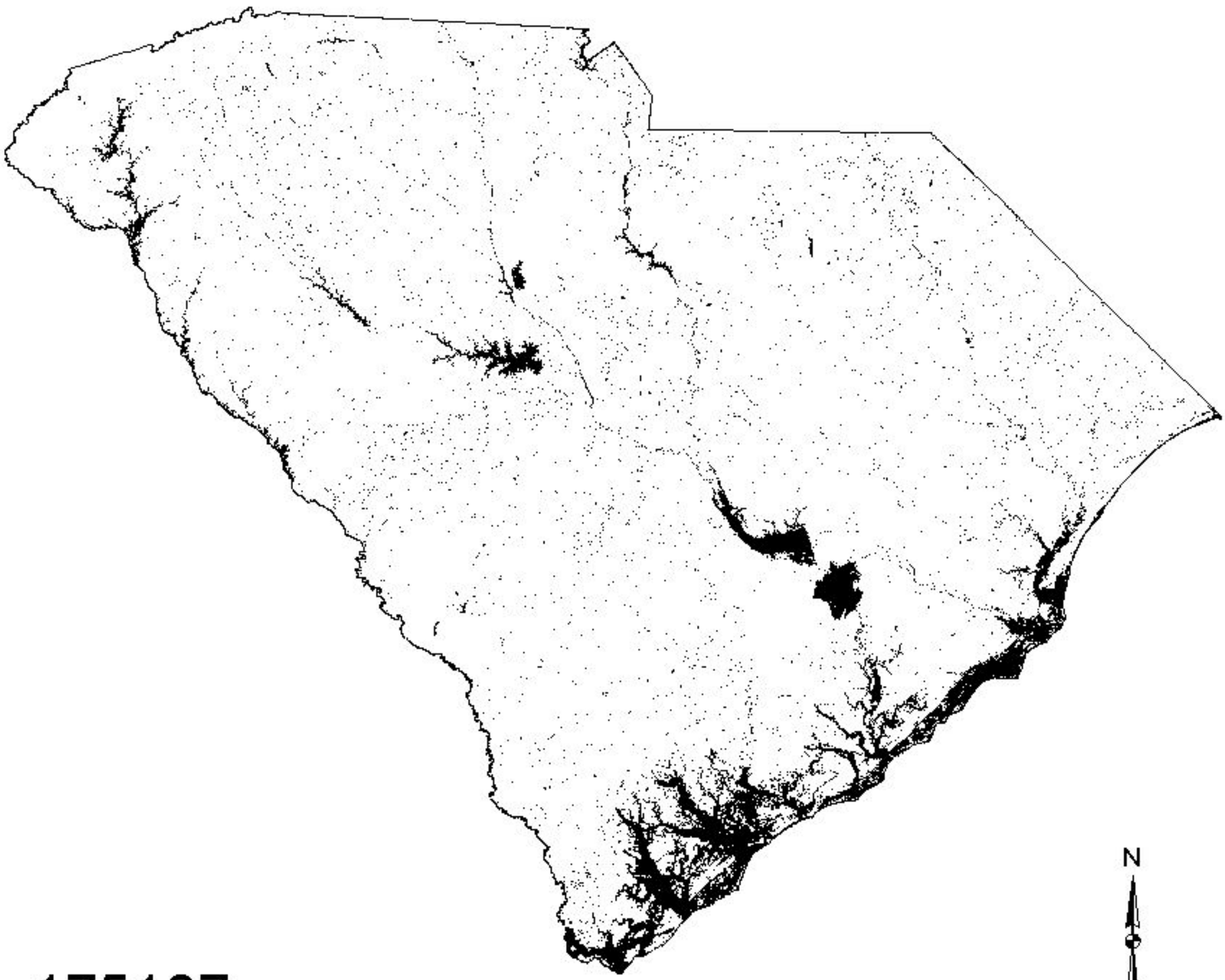
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Red-breasted Merganser

(Mergus serrator)



175187

Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Red-bellied Woodpecker

(Melanerpes carolinus)

178195

Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Ruby-crowned Kinglet
(Regulus calendula)

179870

Predicted present

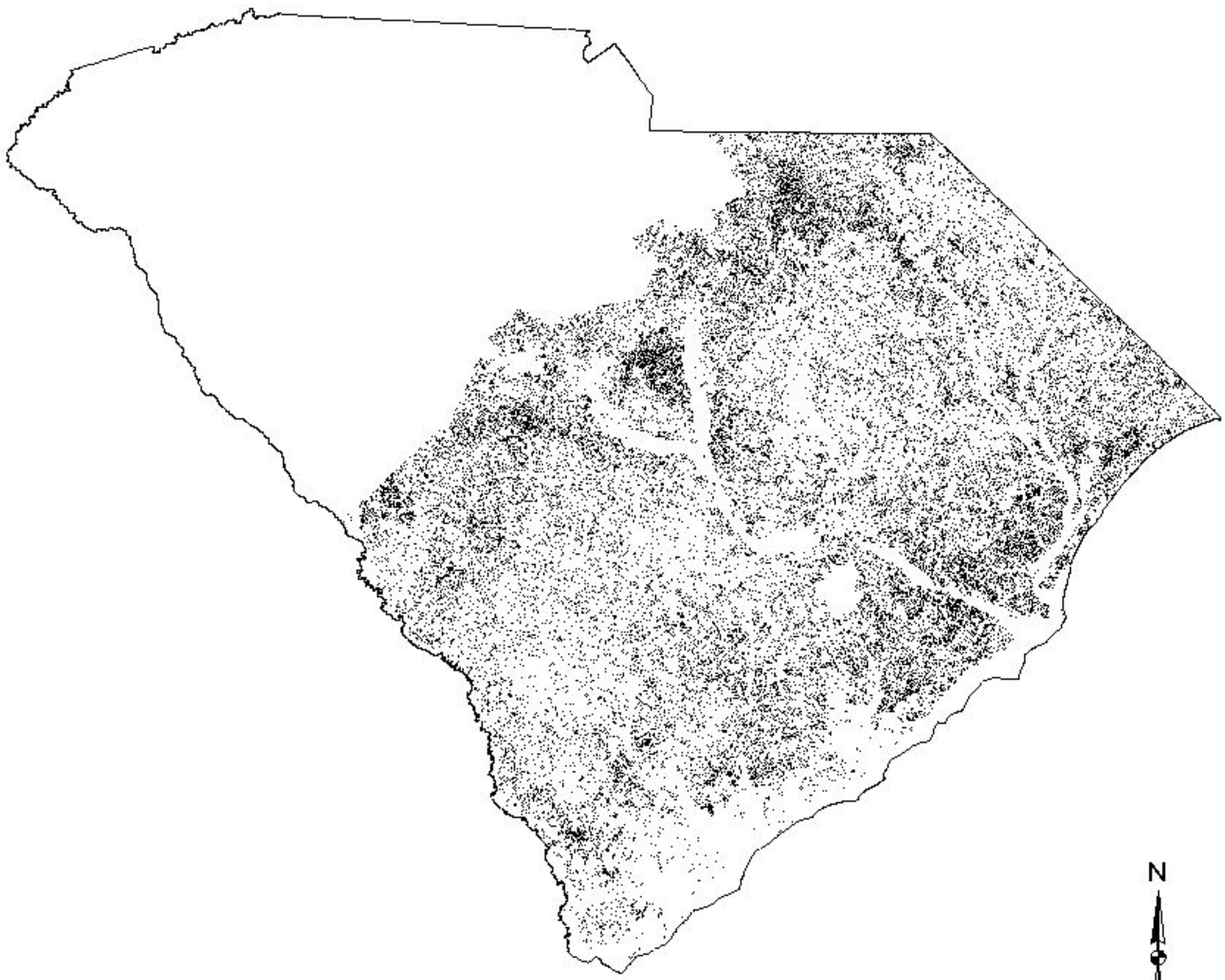
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Red-cockaded Woodpecker

(Picoides borealis)



178257

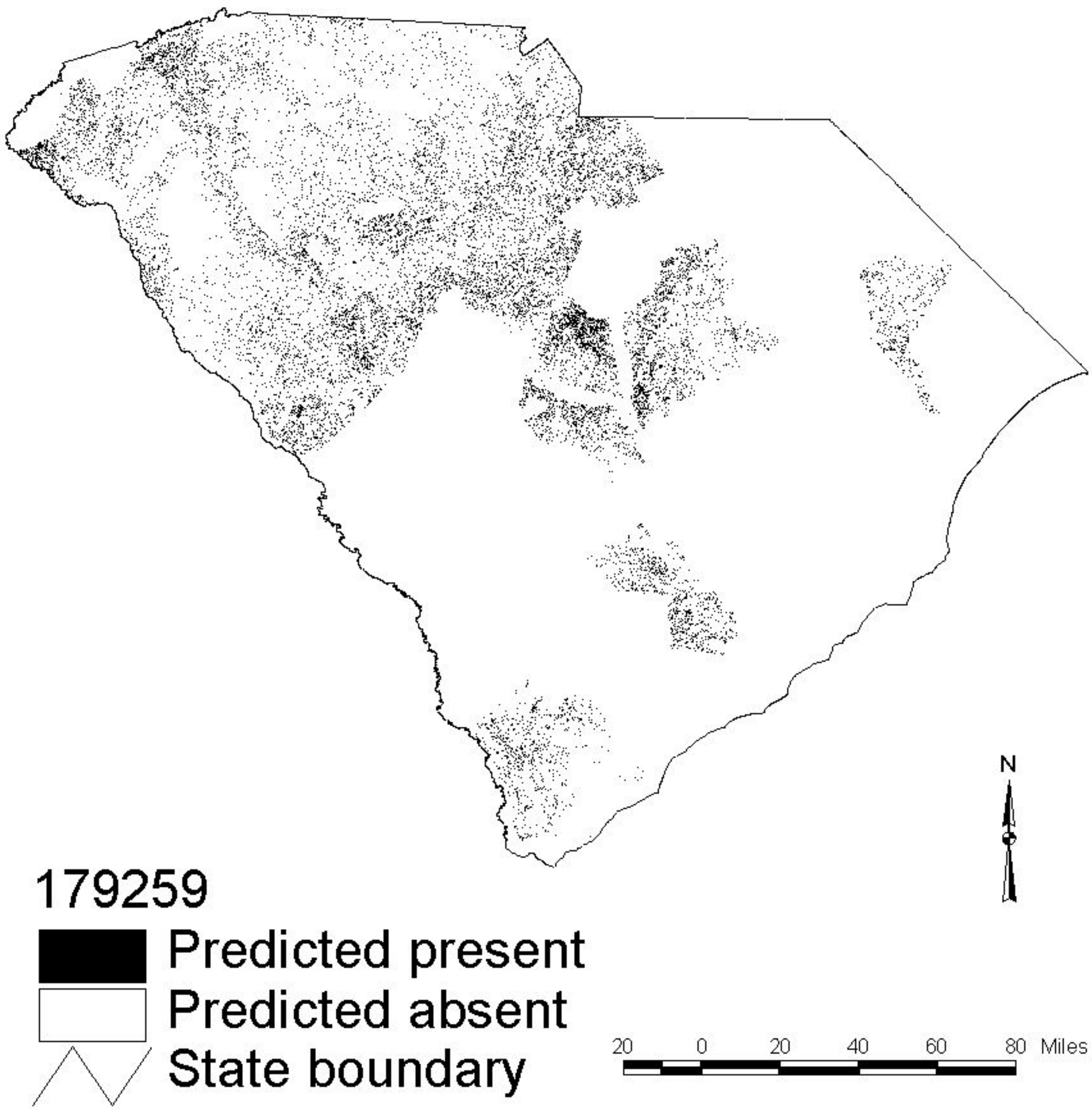
Predicted present

Predicted absent

State boundary

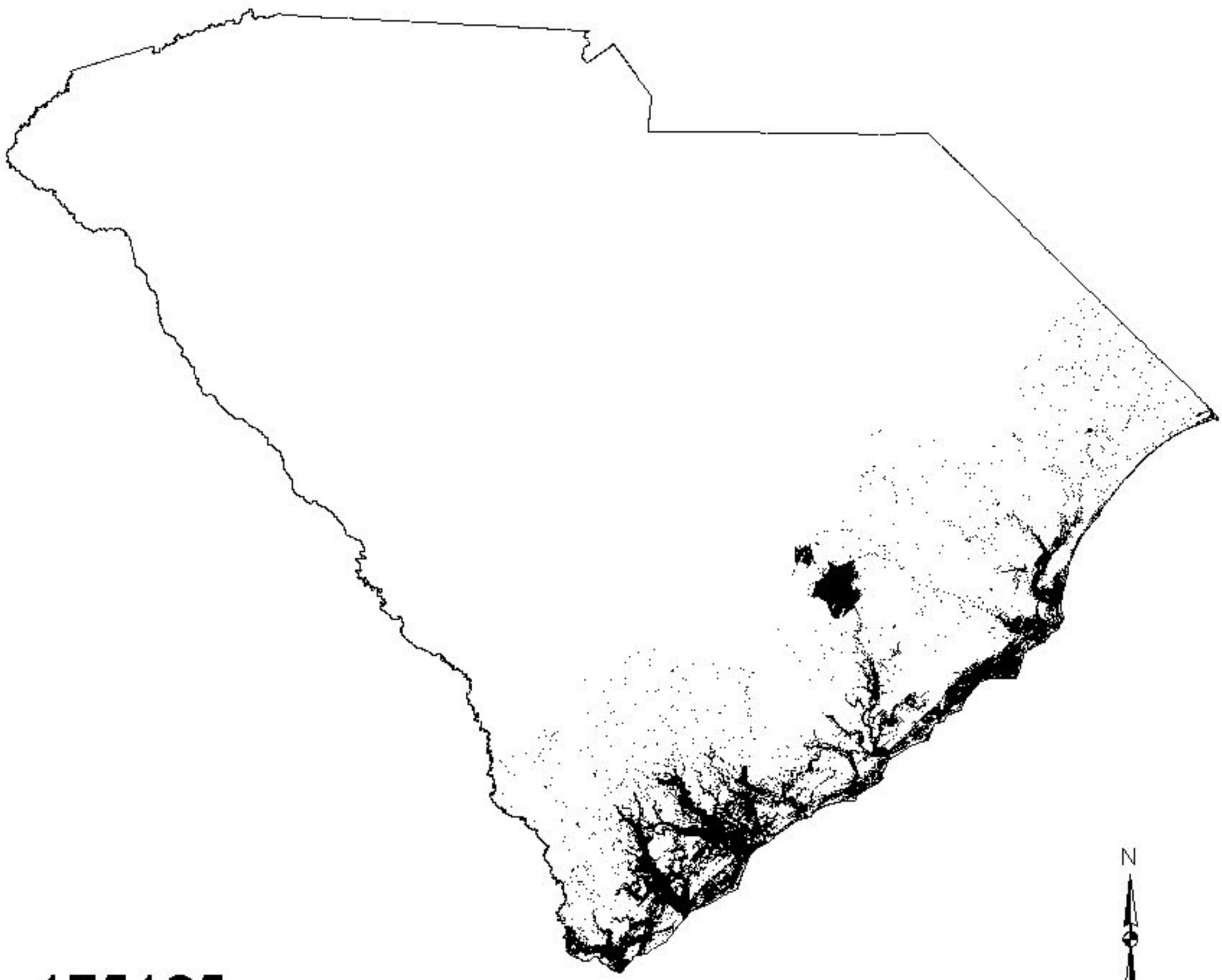
Red Crossbill

(Loxia curvirostra)



Redhead

(Aythya americana)



175125

Predicted present

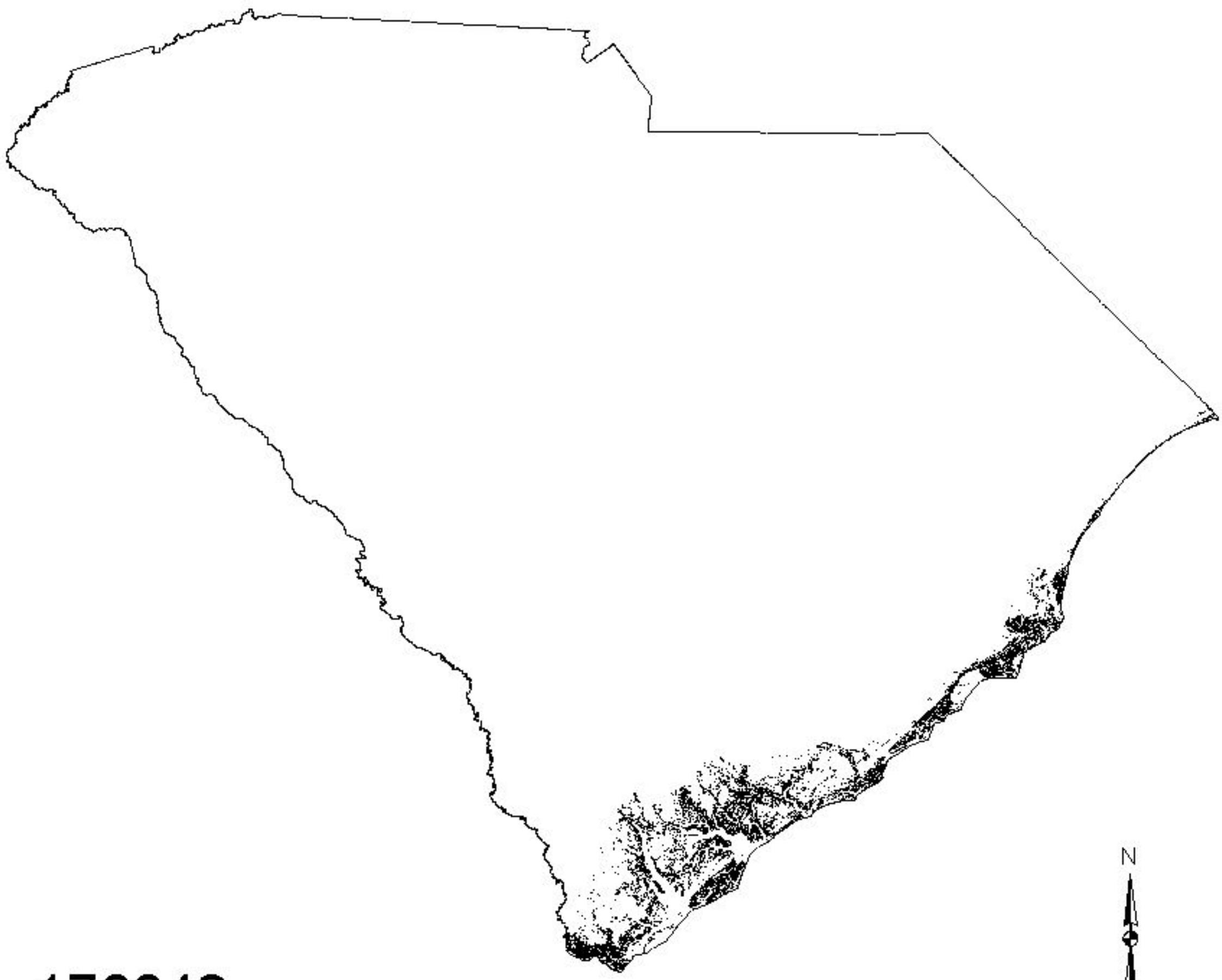
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Red Knot

(Calidris canutus)



176642

Predicted present

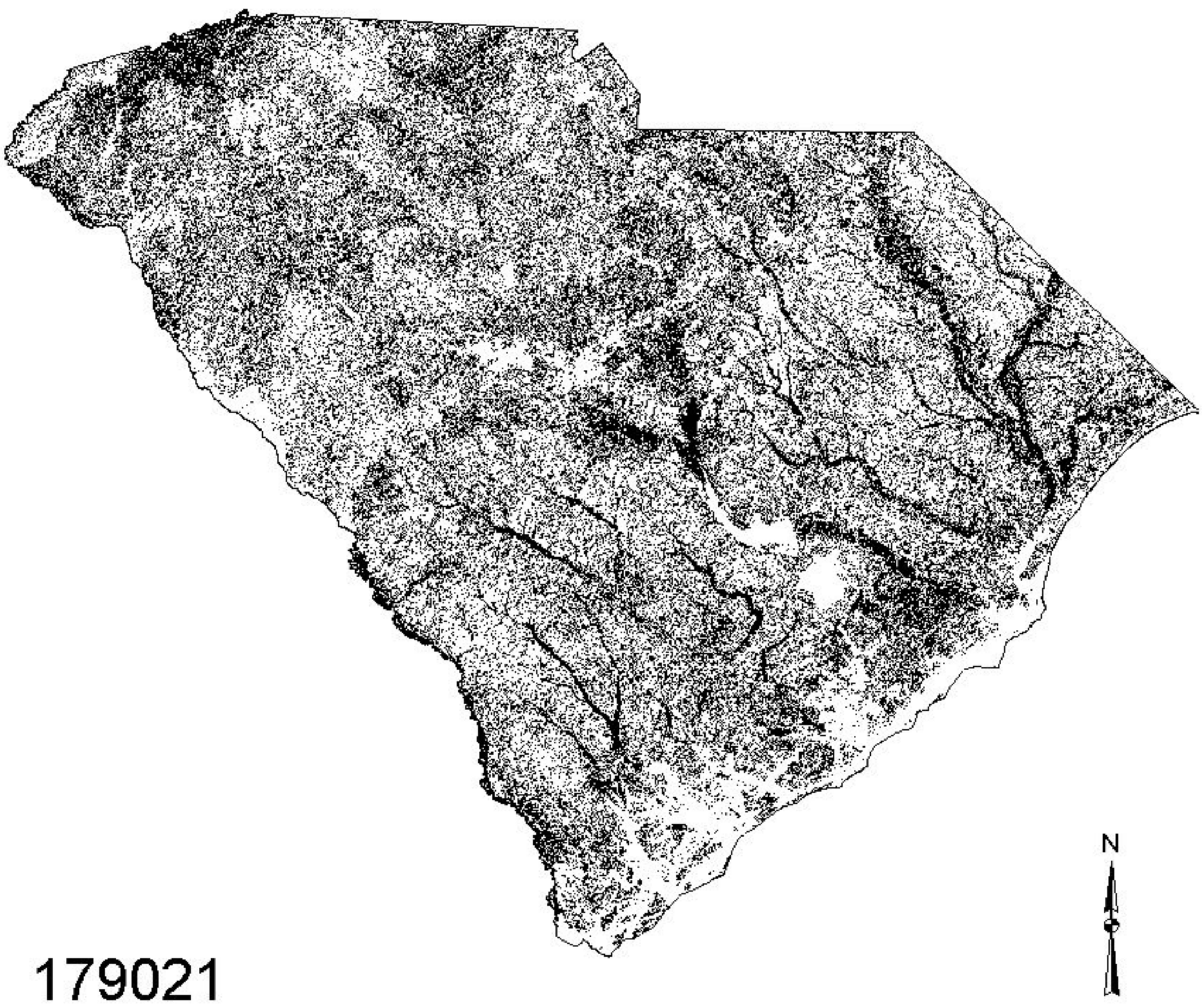
Predicted absent

State boundary

20 0 20 40 60 80 Miles

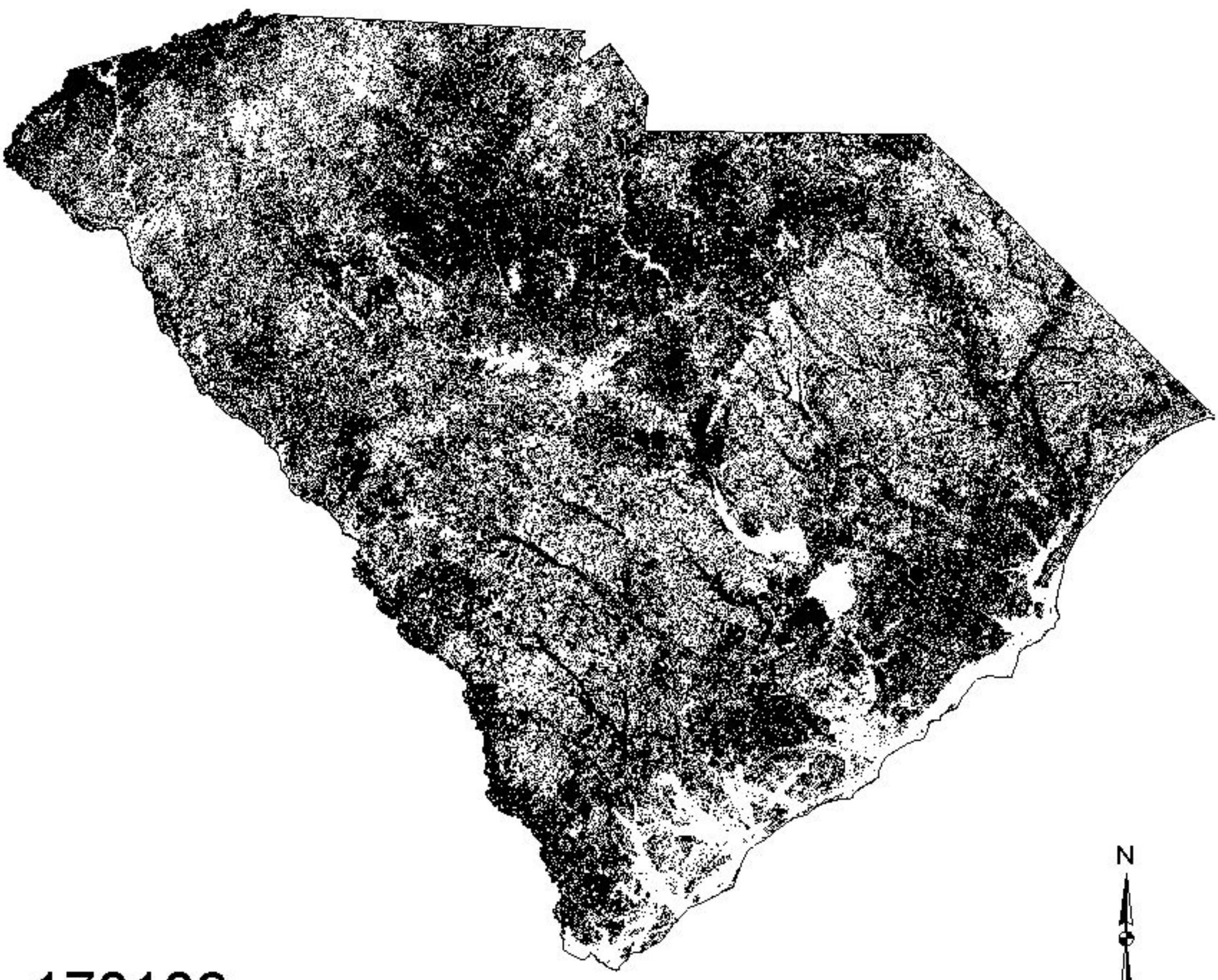
Red-eyed Vireo

(Vireo olivaceus)



Red-headed Woodpecker

(Melanerpes erythrocephalus)



178186

Predicted present

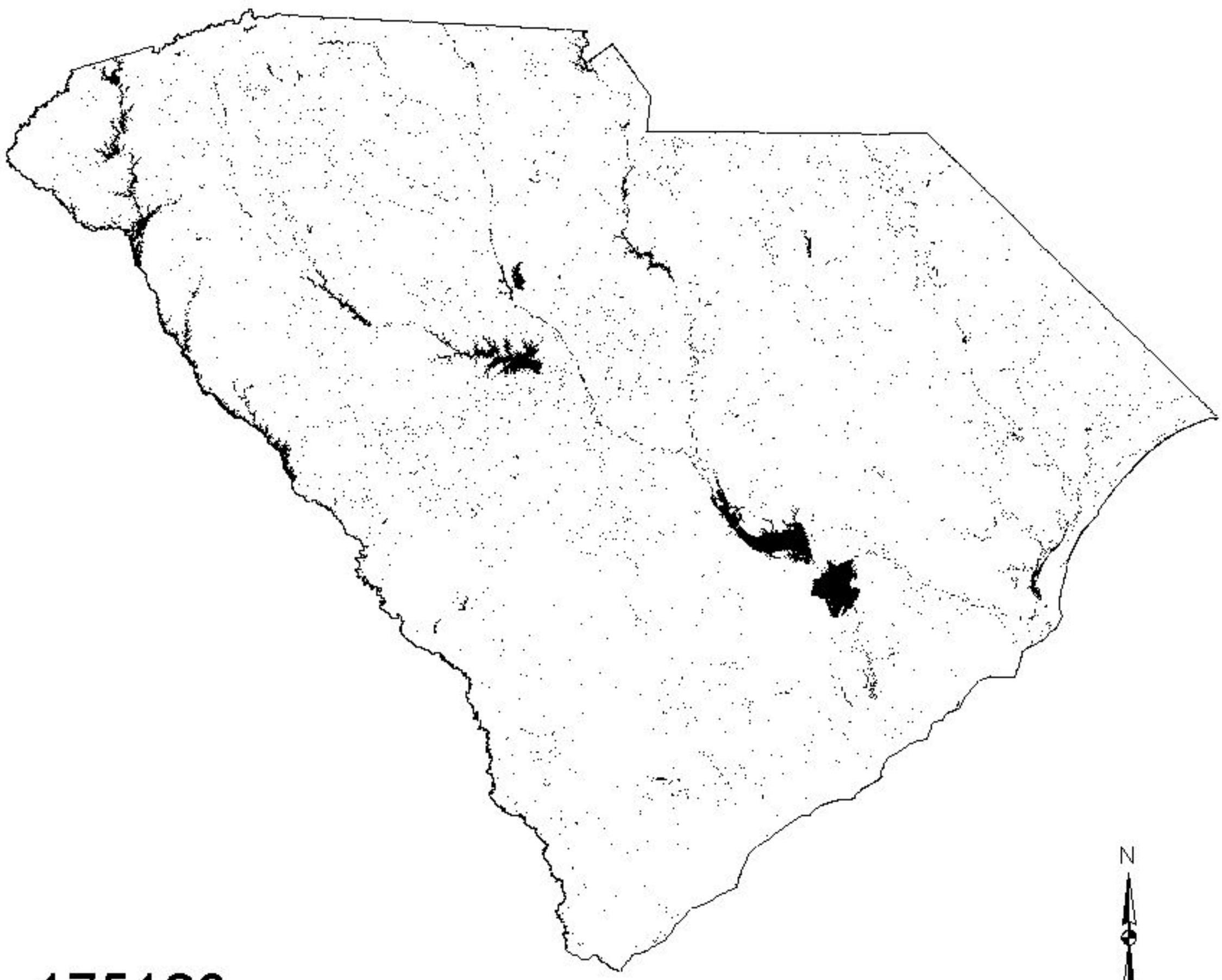
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Ring-necked Duck

(Aythya collaris)



175128

Predicted present

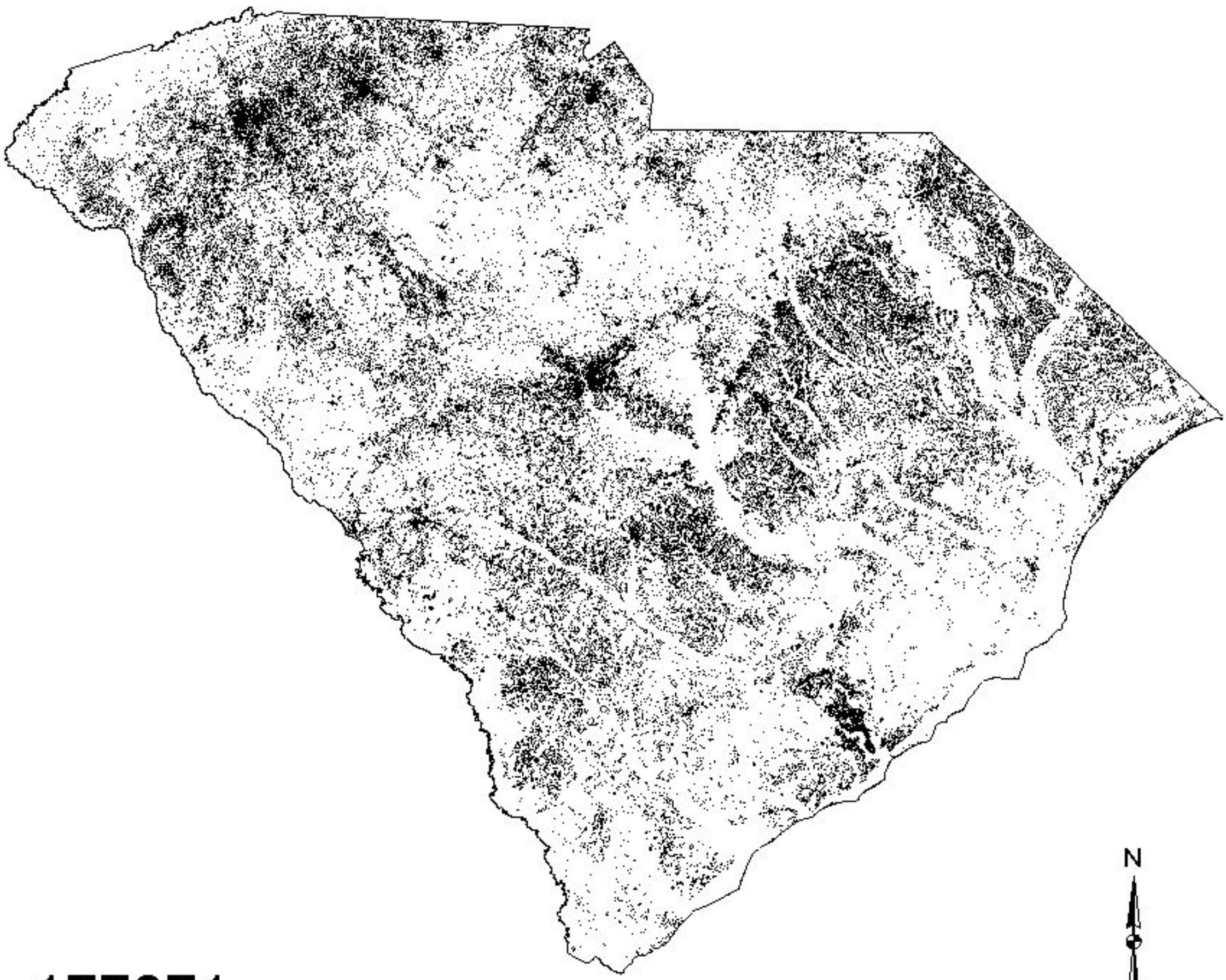
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Rock Dove

(Columba livia)



177071

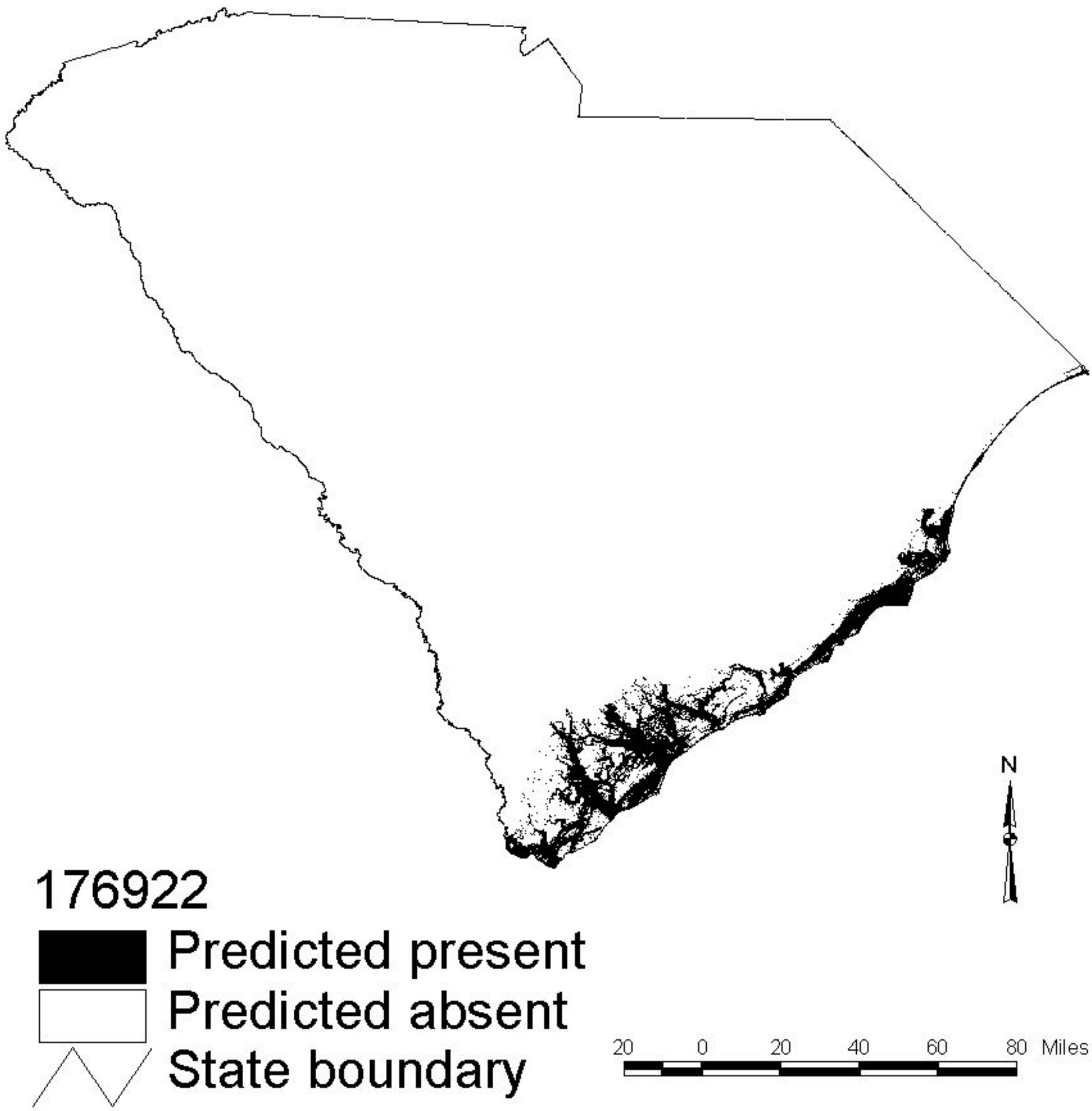
Predicted present

Predicted absent

State boundary

Royal Tern

(Sterna maxima)



176922

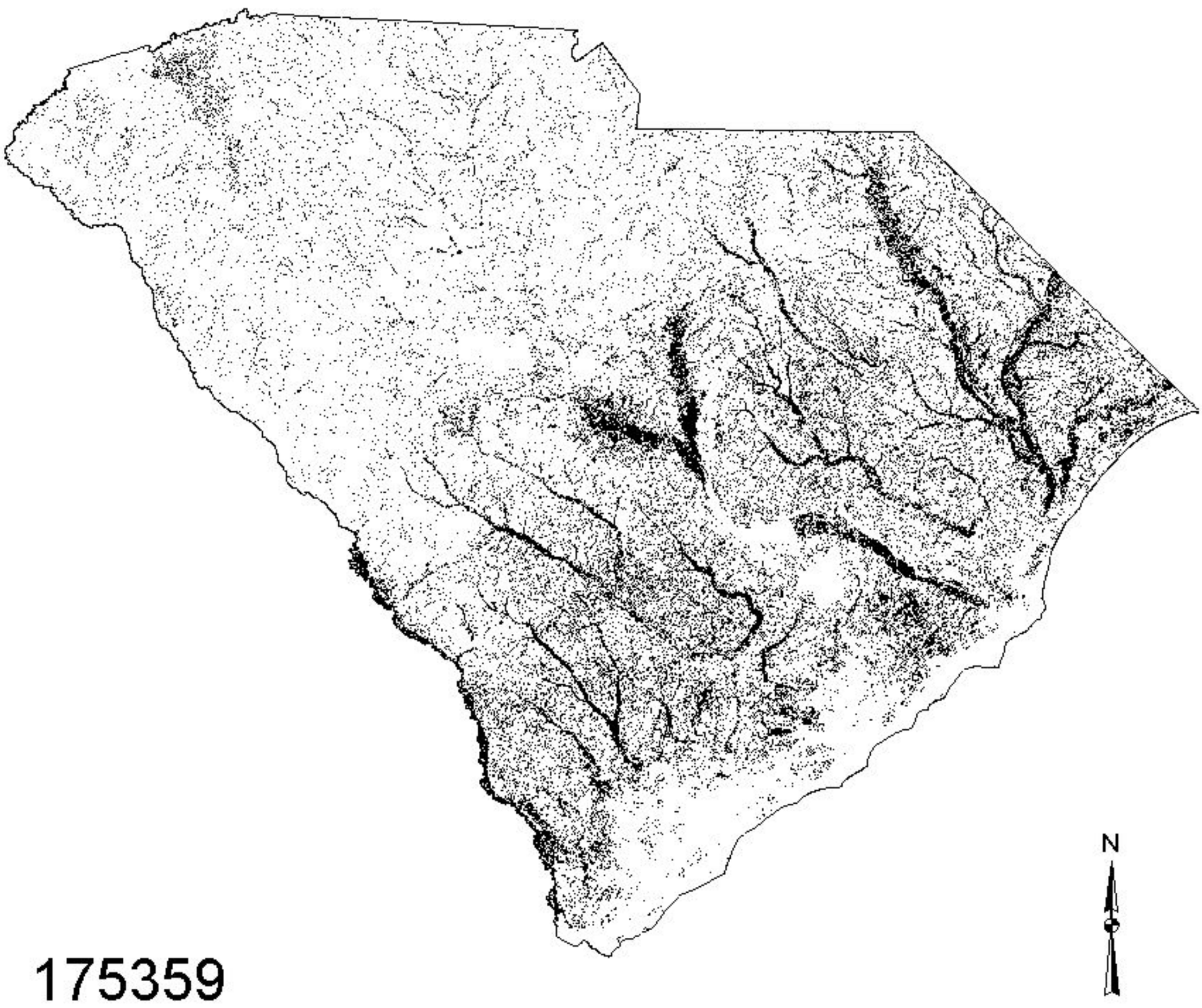
Predicted present

Predicted absent

State boundary

Red-shouldered Hawk

(Buteo lineatus)



Red-tailed Hawk

(Buteo jamaicensis)

175350

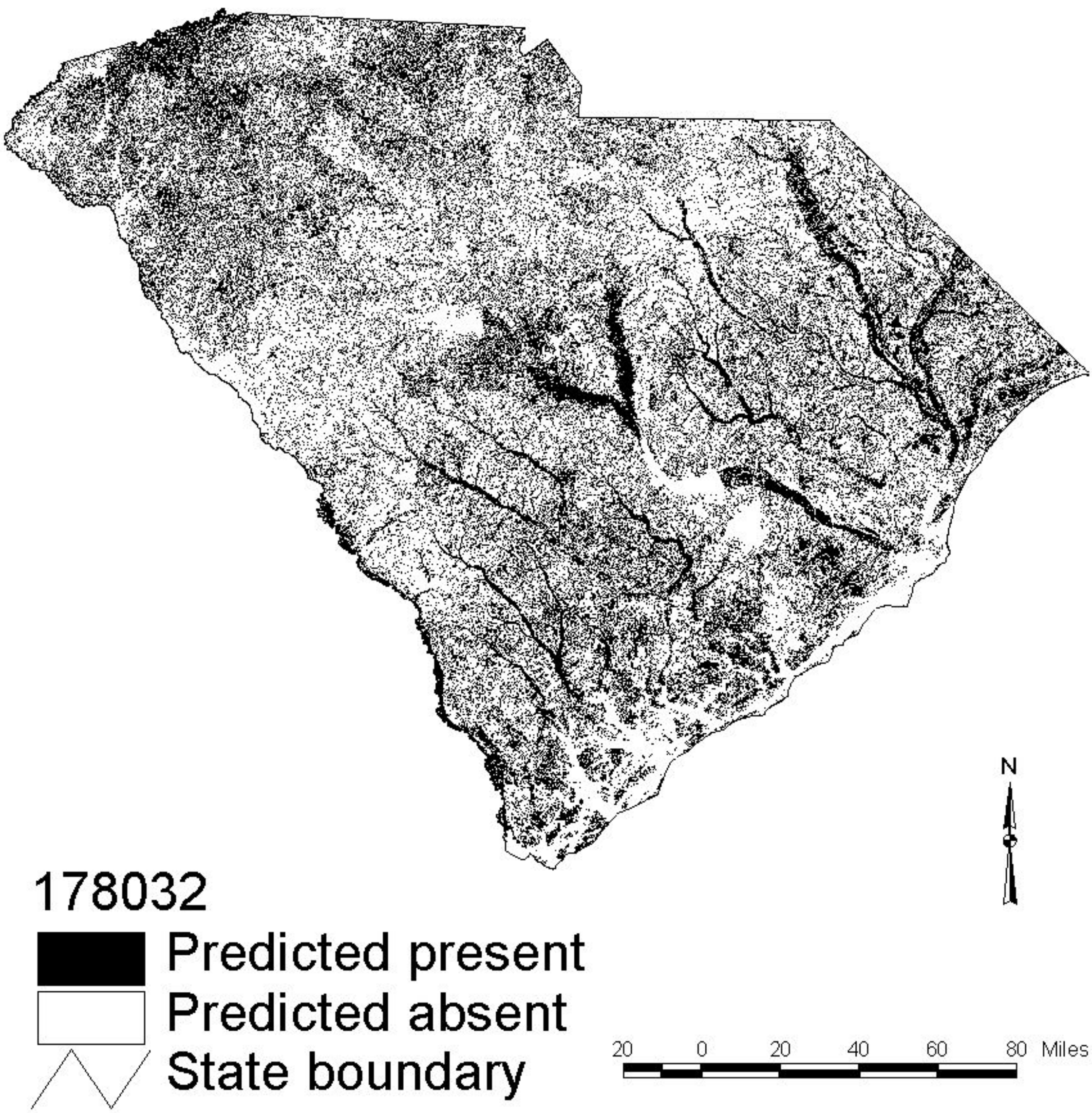
Predicted present

Predicted absent

State boundary

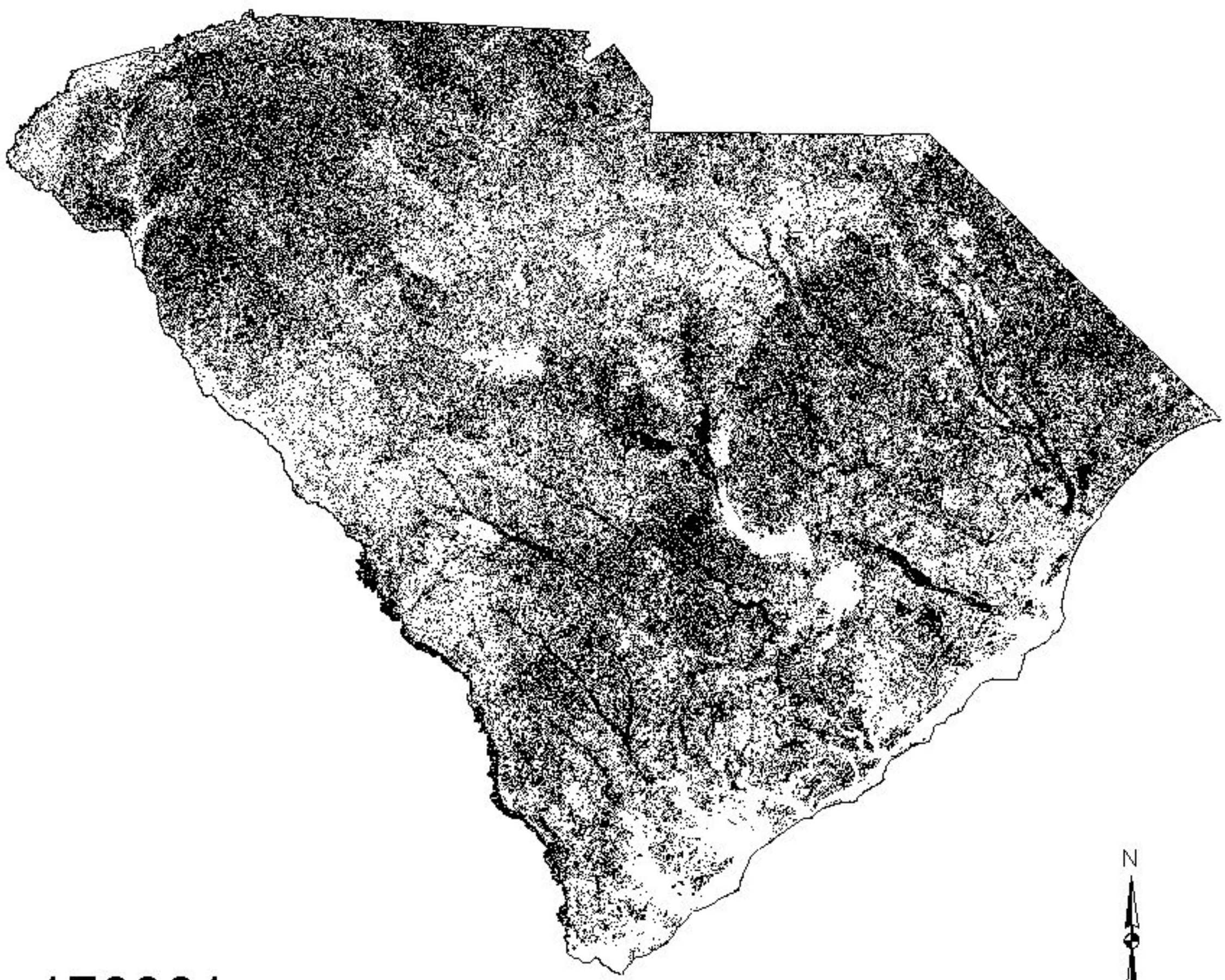
Ruby-throated Hummingbird

(Archilochus colubris)



Rusty Blackbird

(Euphagus carolinus)



179091

Predicted present

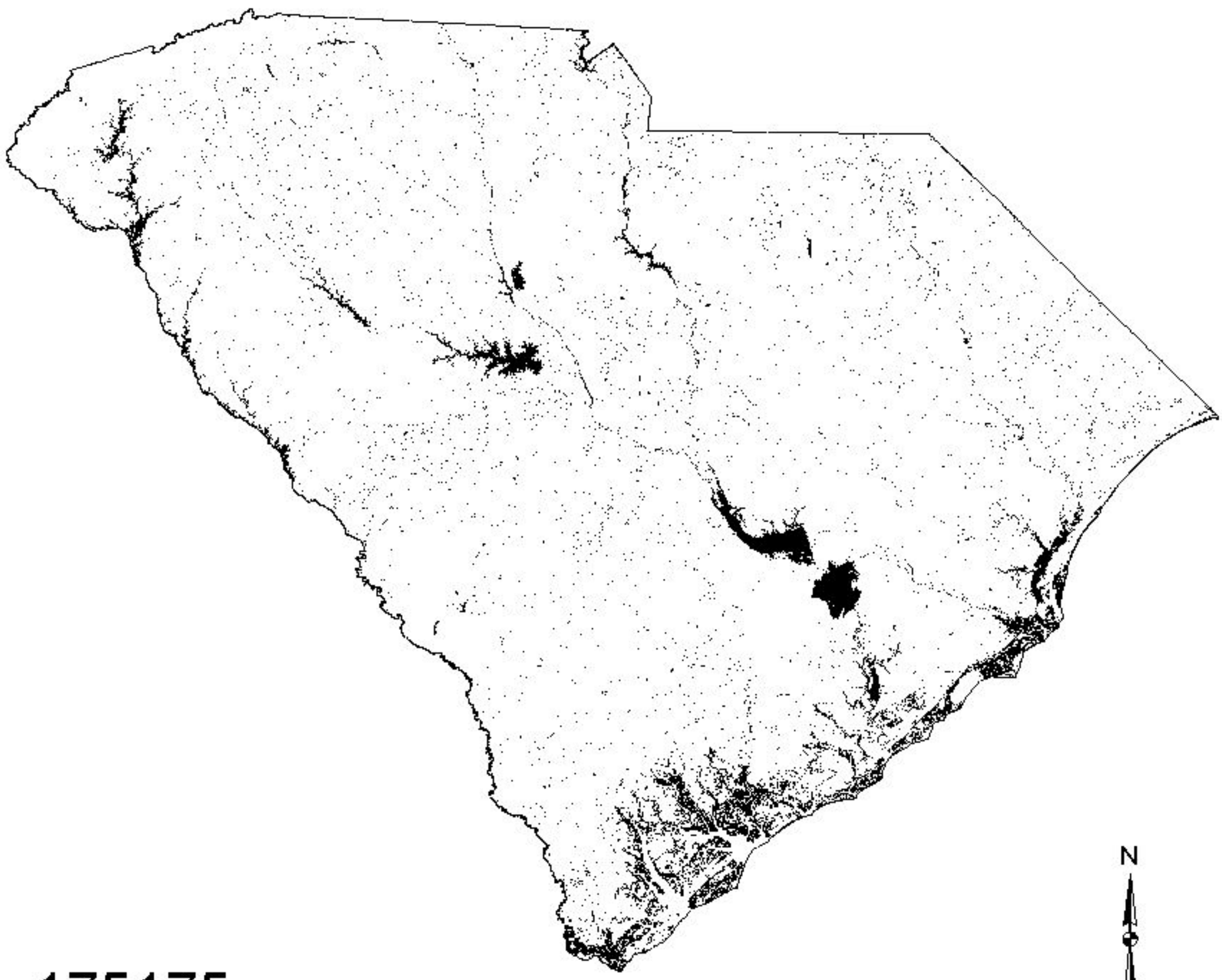
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Ruddy Duck

(Oxyura jamaicensis)



175175

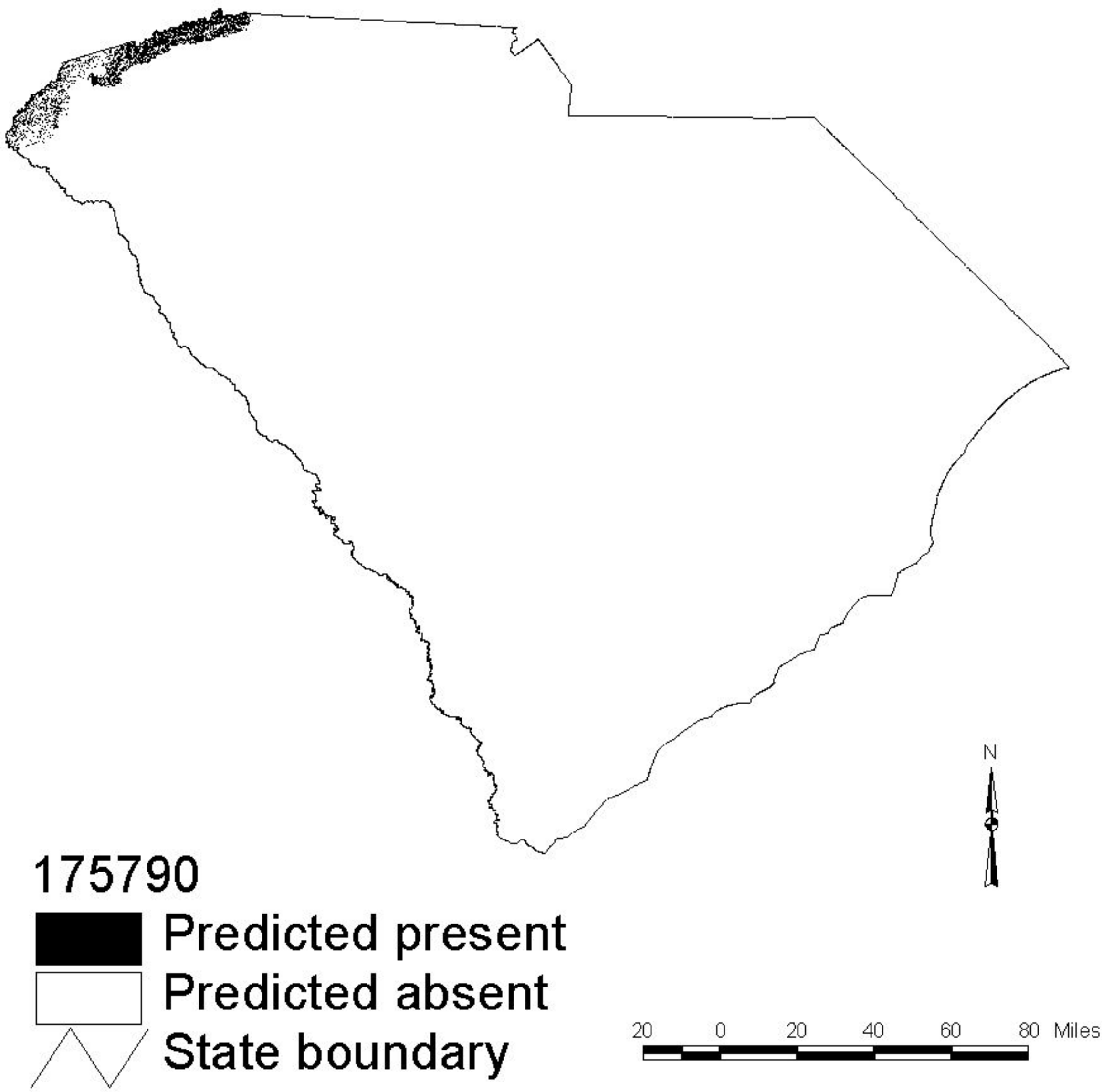
Predicted present

Predicted absent

State boundary

Ruffed Grouse

(Bonasa umbellus)



175790

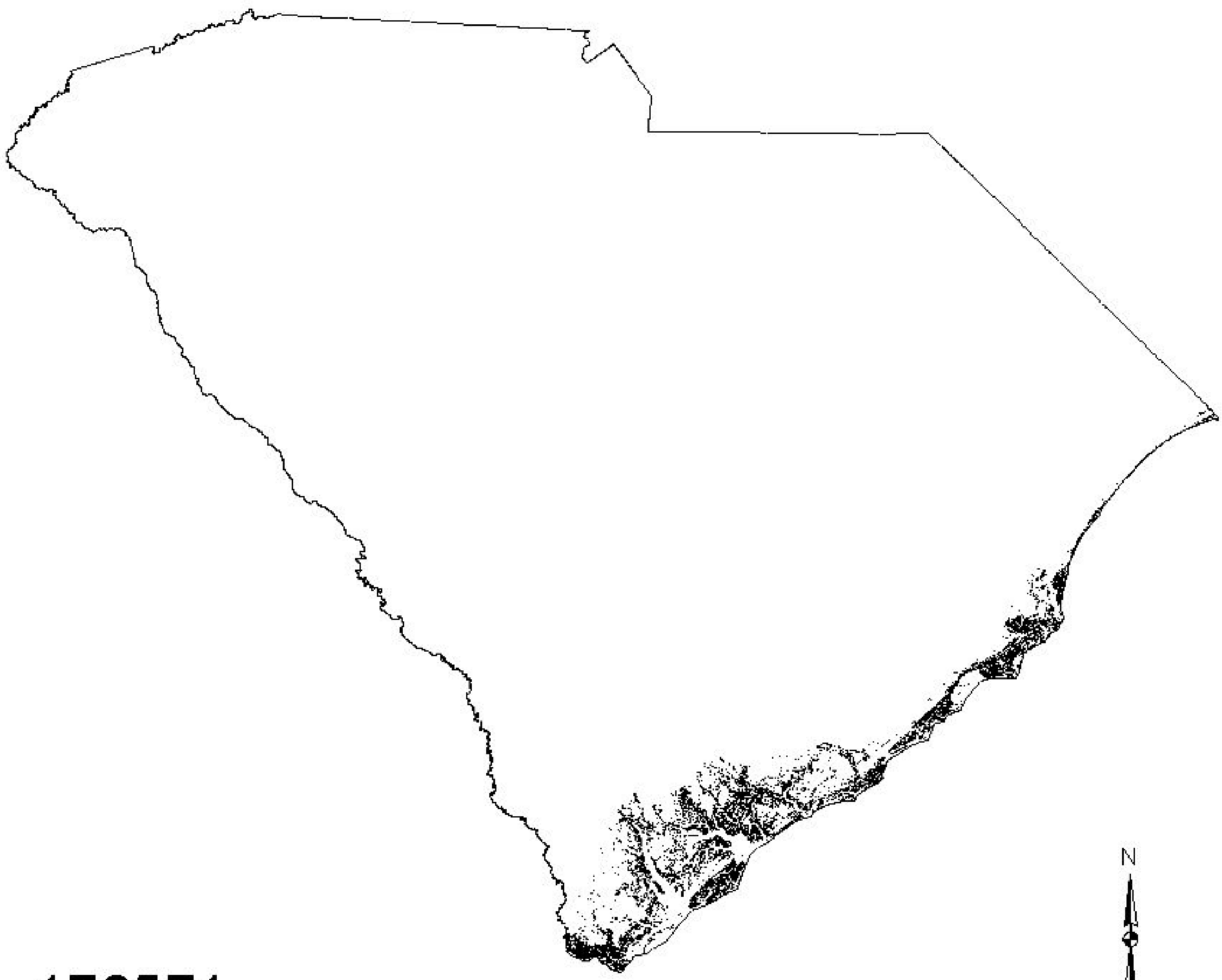
Predicted present

Predicted absent

State boundary

Ruddy Turnstone

(Arenaria interpres)



176571

Predicted present

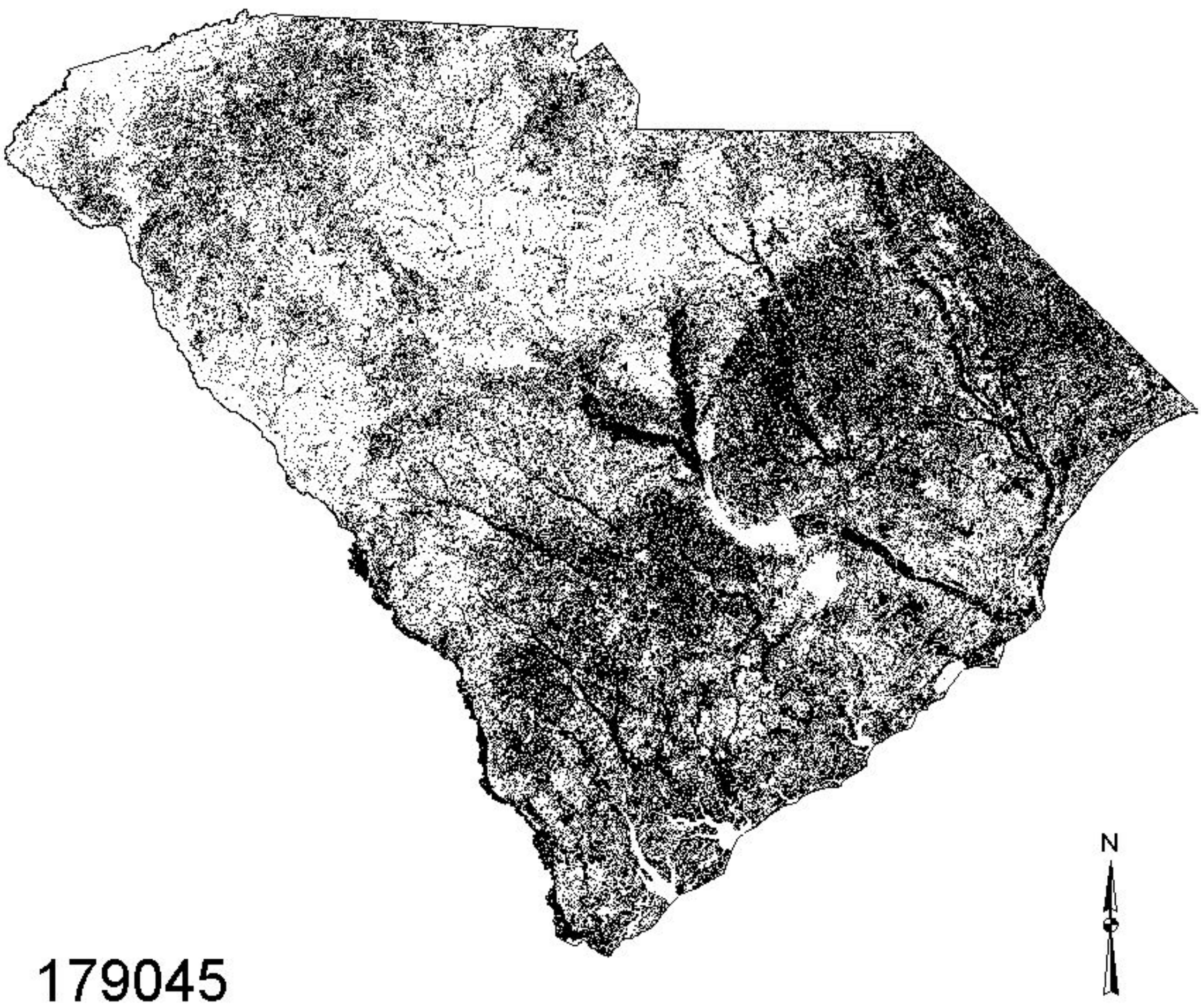
Predicted absent

State boundary

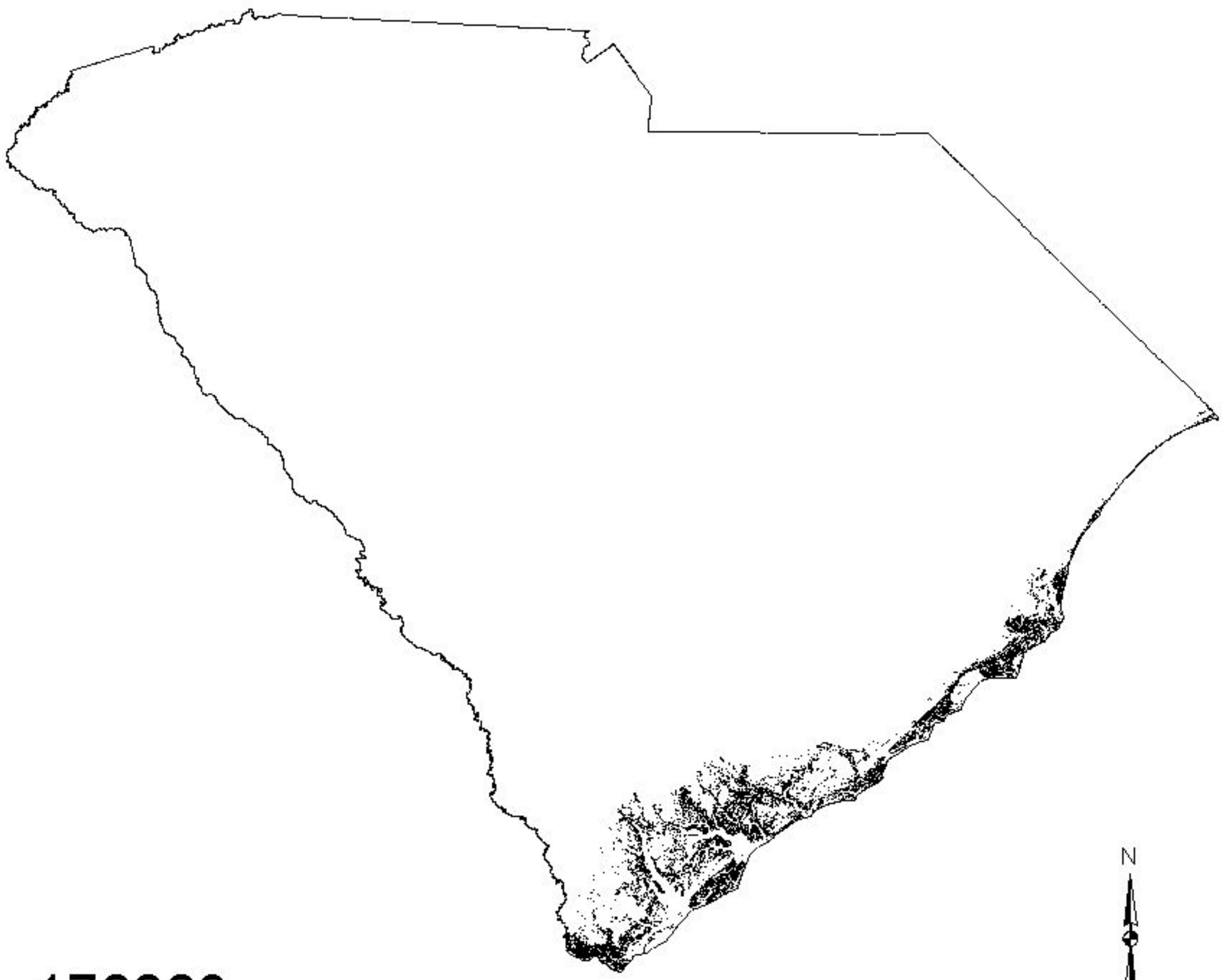
20 0 20 40 60 80 Miles

Red-winged Blackbird

(Agelaius phoeniceus)



Sanderling
(Calidris alba)



176669

Predicted present

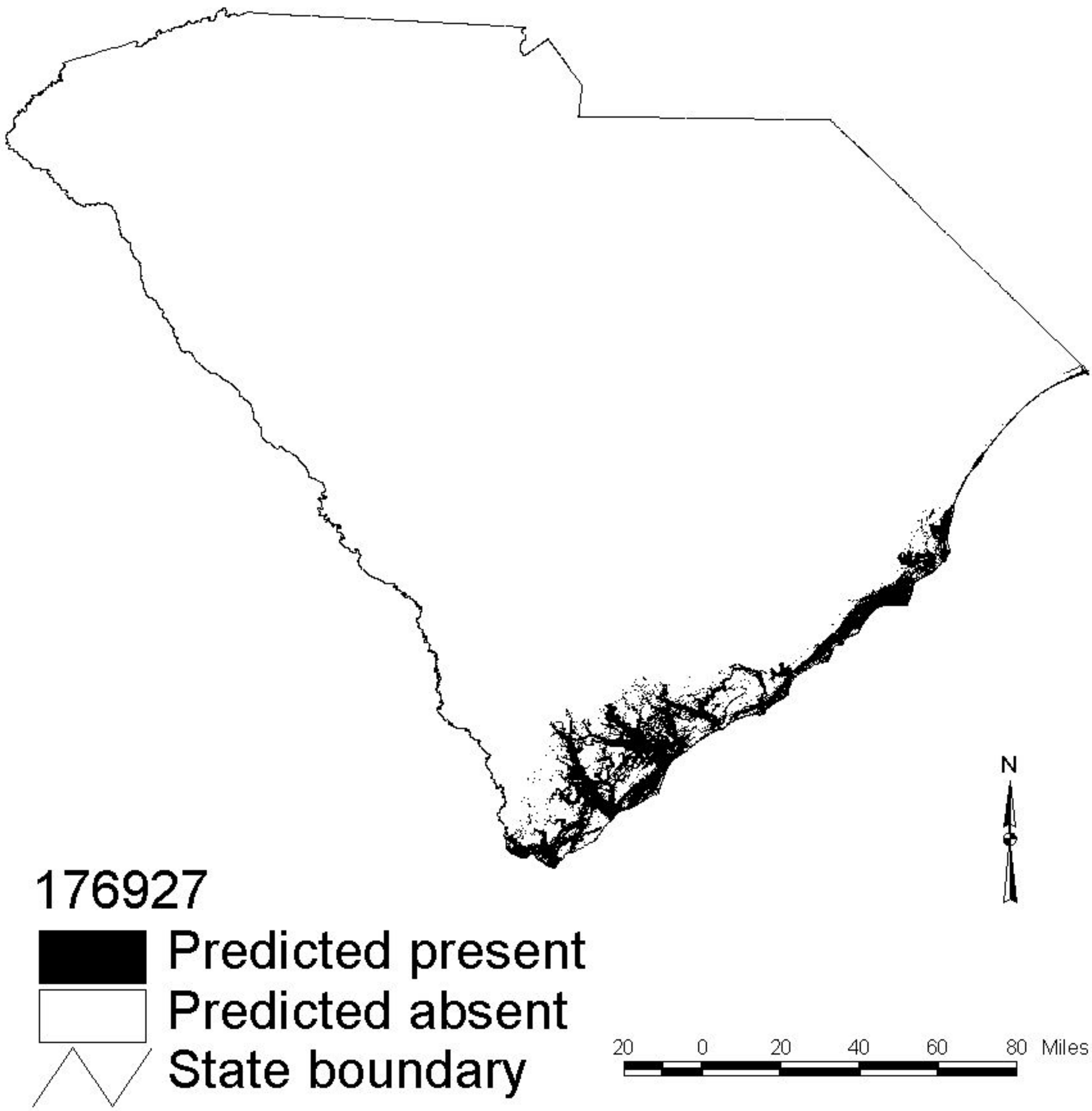
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Sandwich Tern

(Sterna sandvicensis)



176927

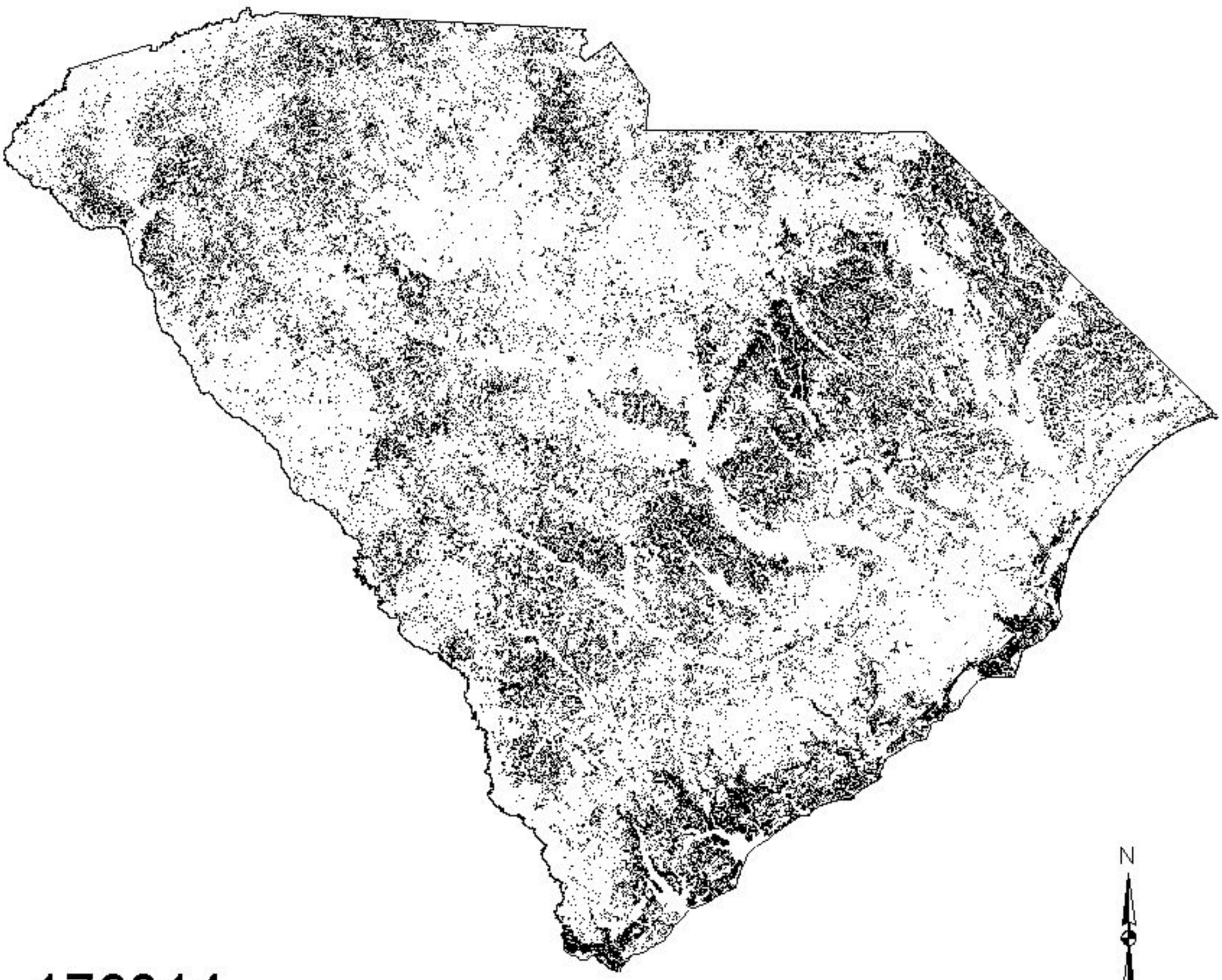
Predicted present

Predicted absent

State boundary

Savannah Sparrow

(Passerculus sandwichensis)



179314

Predicted present

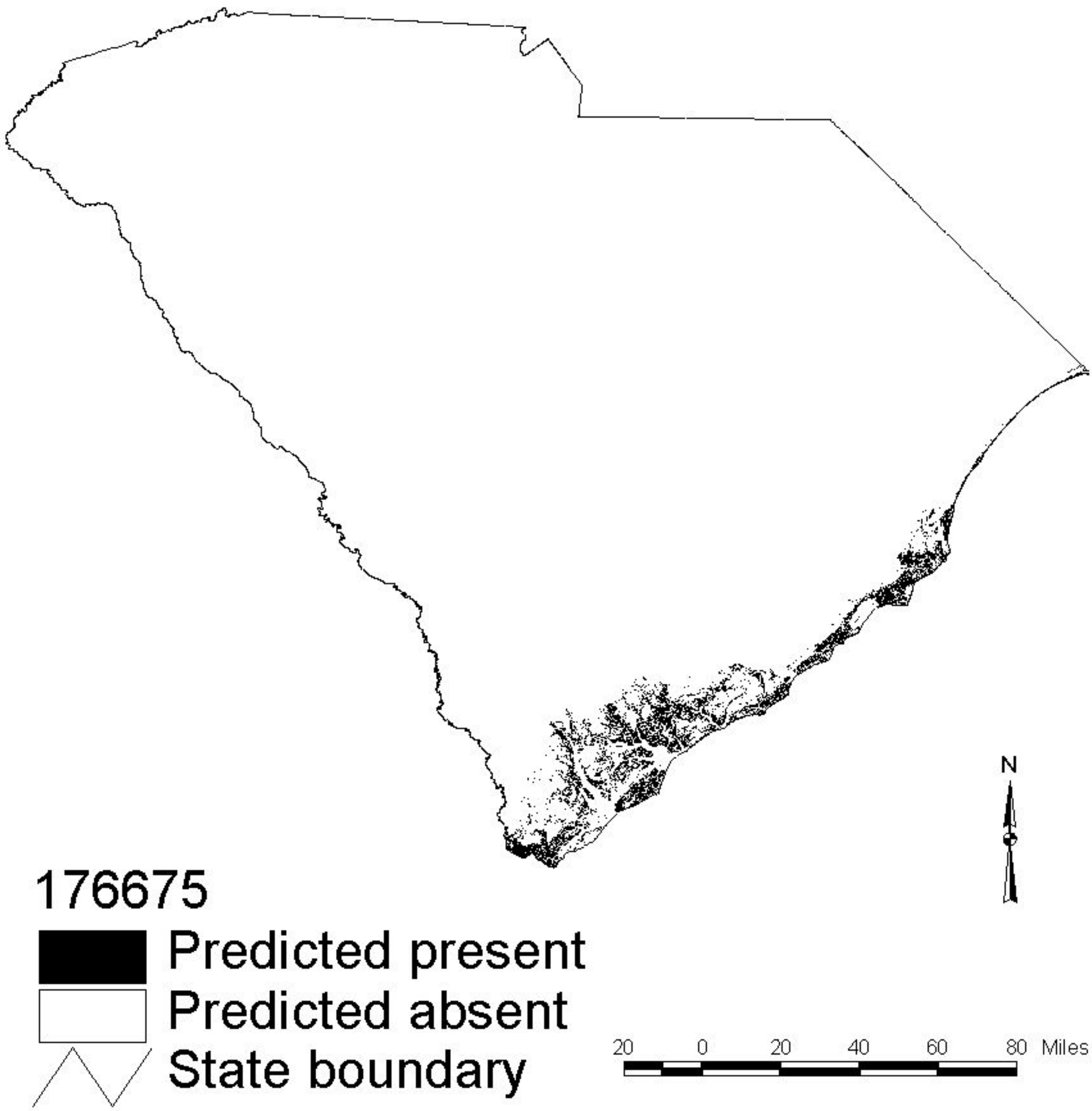
Predicted absent

State boundary

20 0 20 40 60 80 Miles

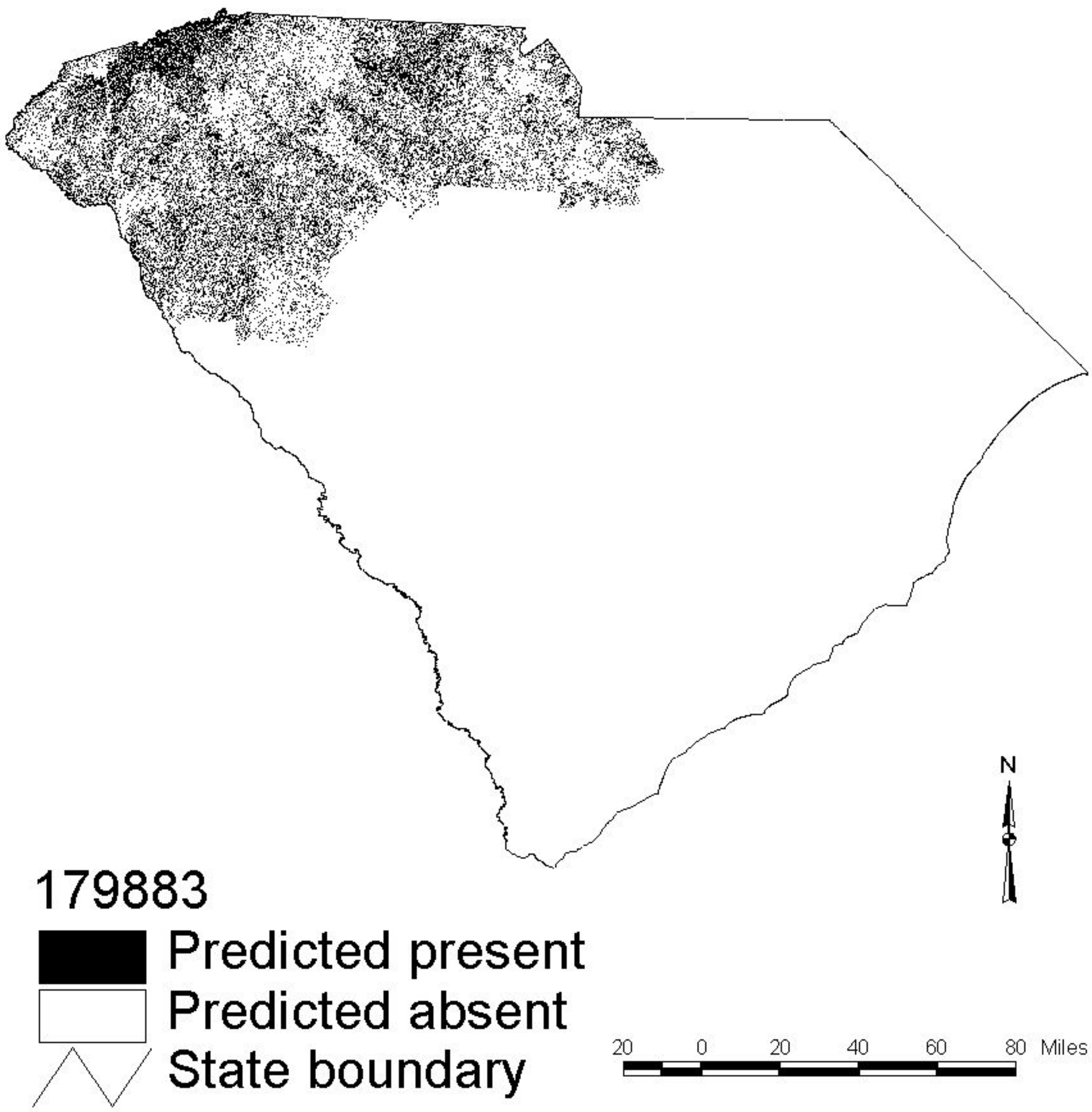
Short-billed Dowitcher

(Limnodromus griseus)



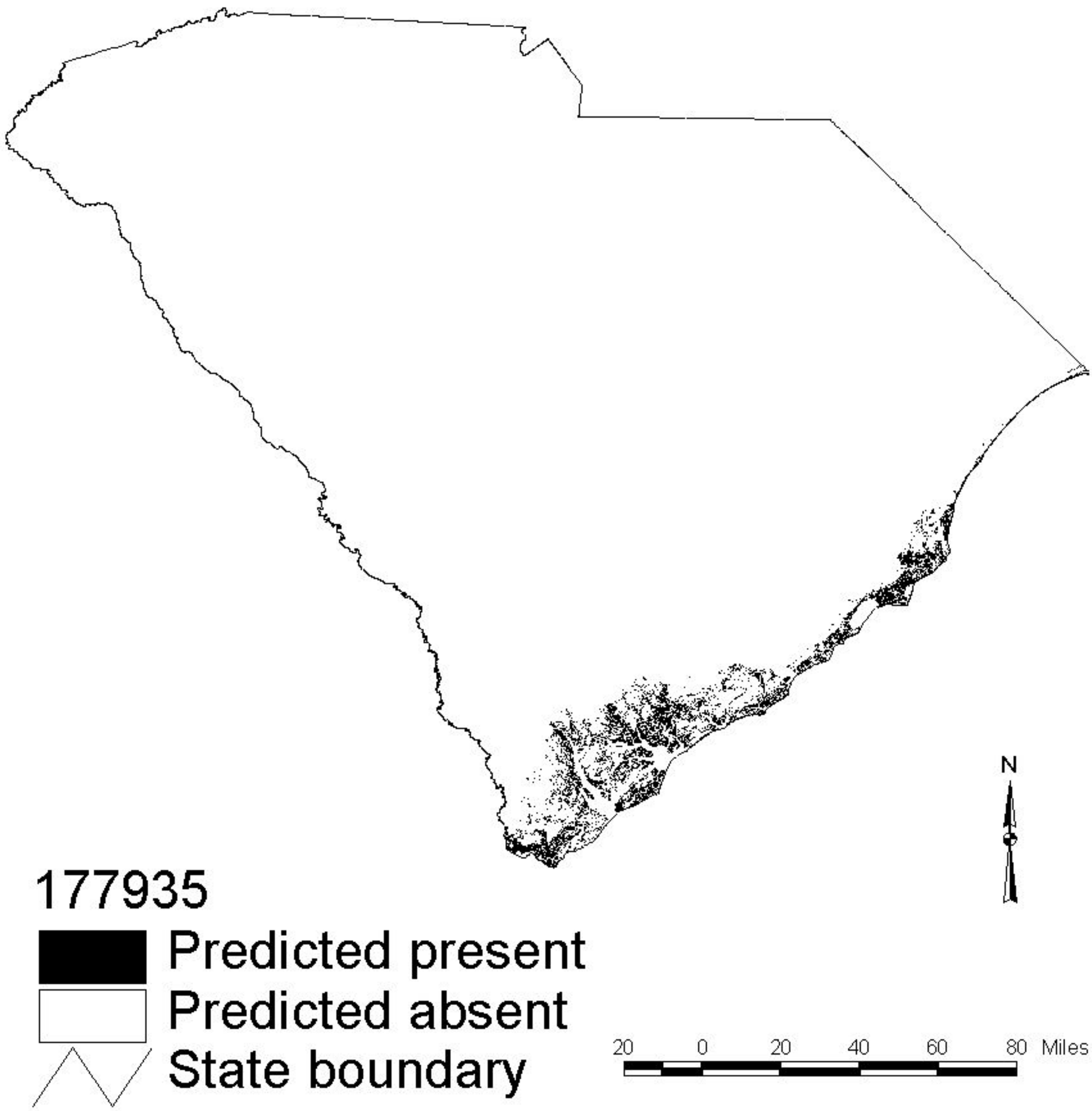
Scarlet Tanager

(Piranga olivacea)



Short-eared Owl

(Asio flammeus)



177935

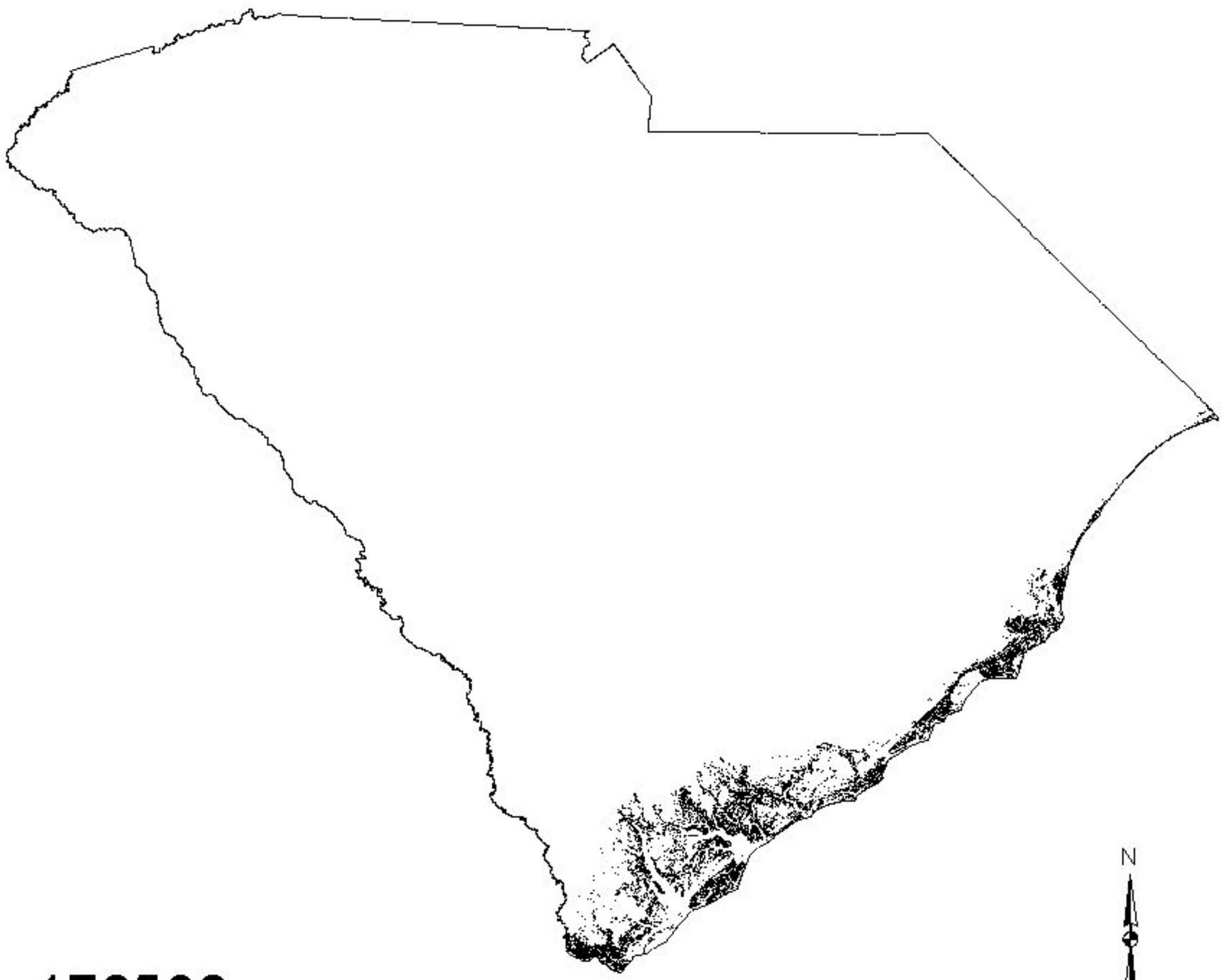
Predicted present

Predicted absent

State boundary

Semipalmated Plover

(Charadrius semipalmatus)



176506

Predicted present

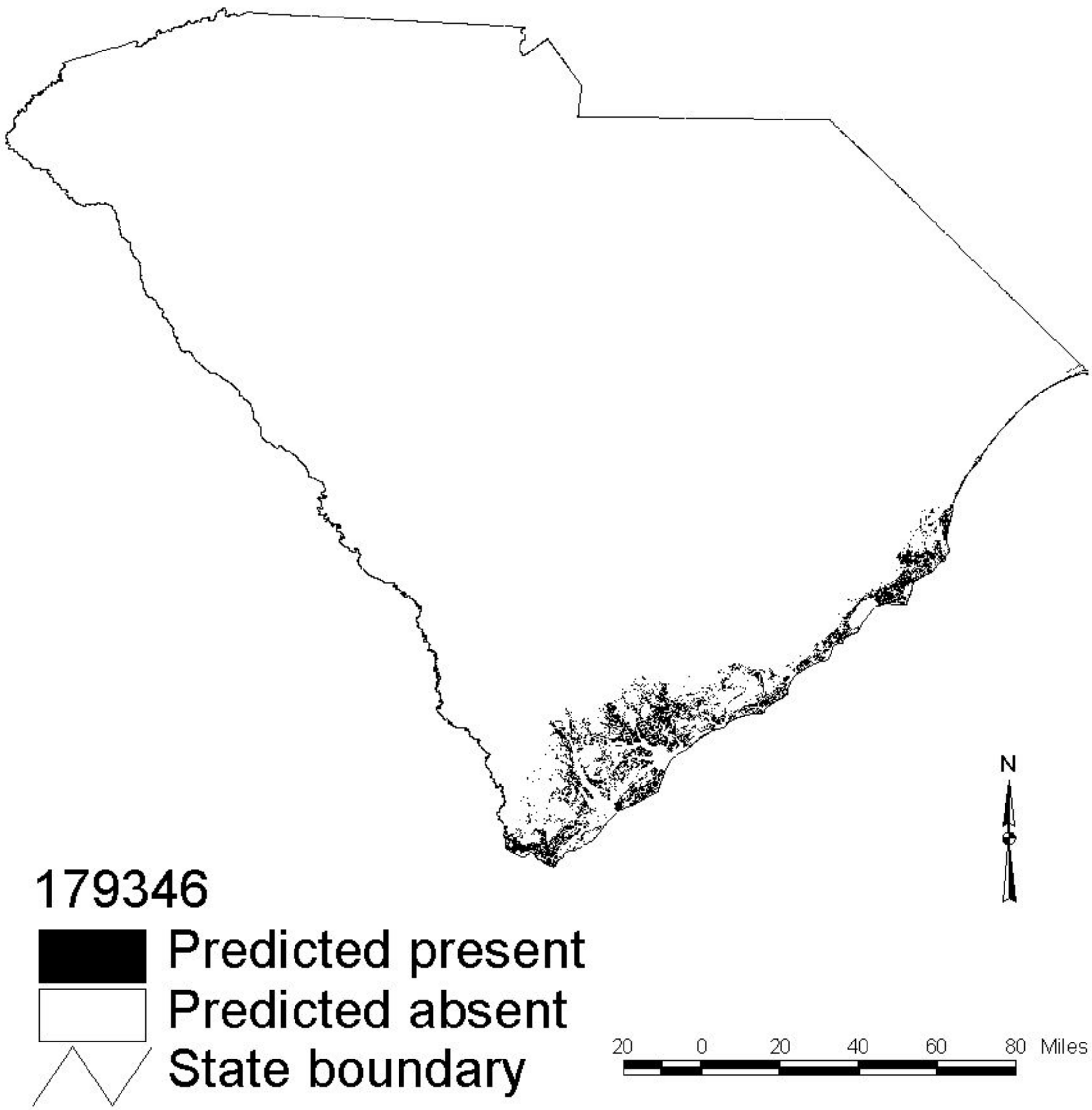
Predicted absent

State boundary

20 0 20 40 60 80 Miles

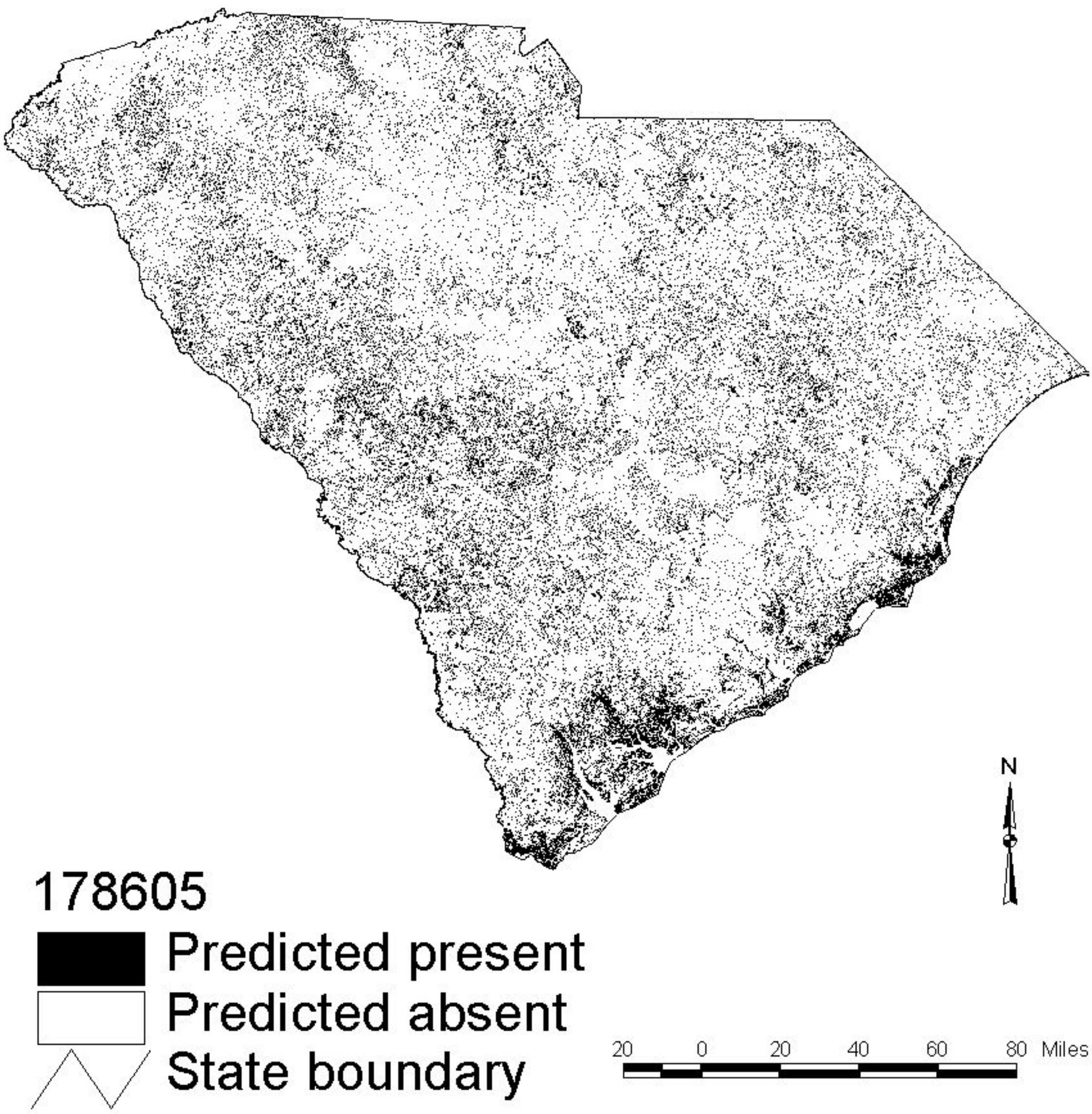
Seaside Sparrow

(Ammodramus maritimus)



Sedge Wren

(Cistothorus platensis)



Snow Bunting

(Plectrophenax nivalis)

179532

Predicted present

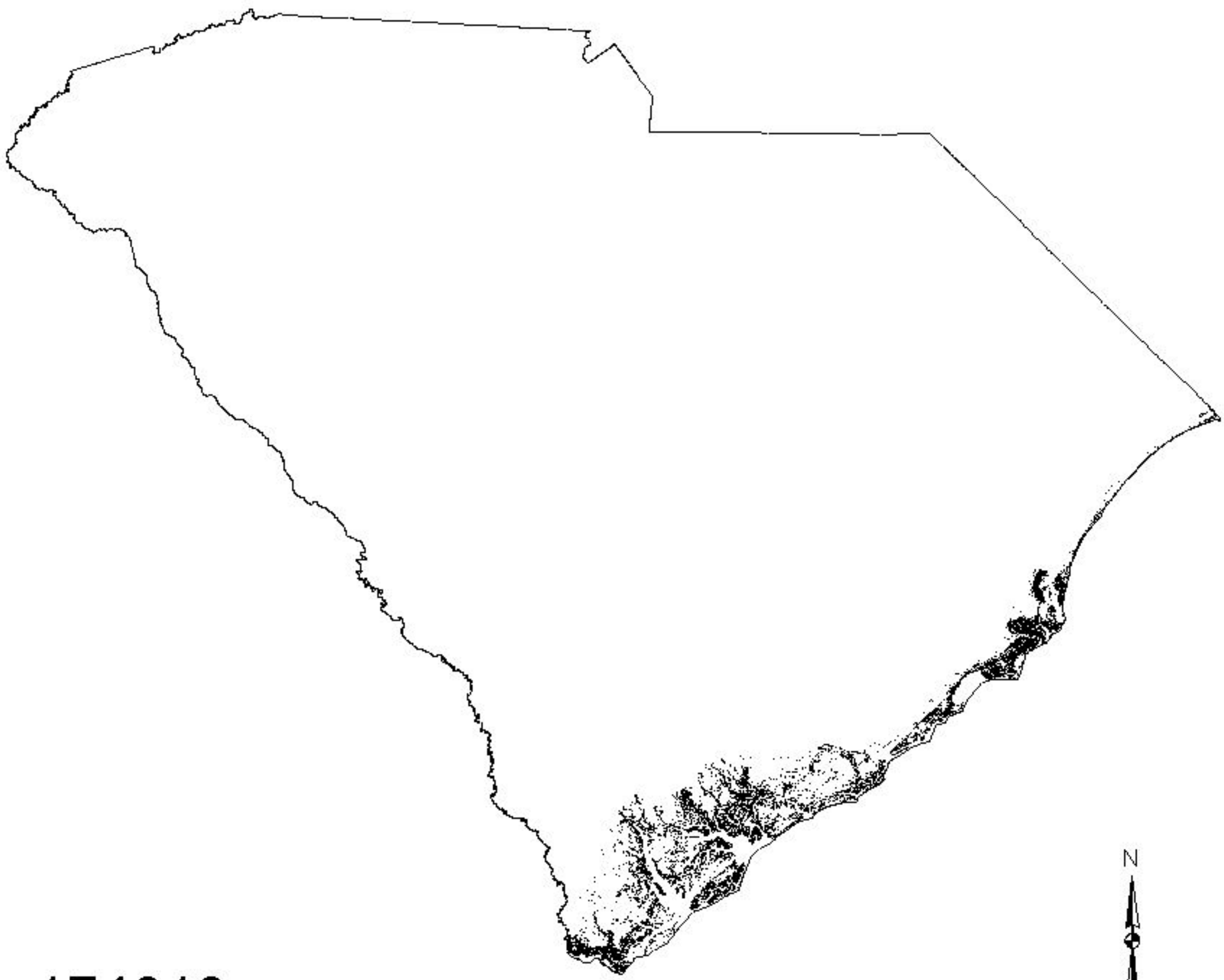
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Snowy Egret

(Egretta thula)



174813

Predicted present

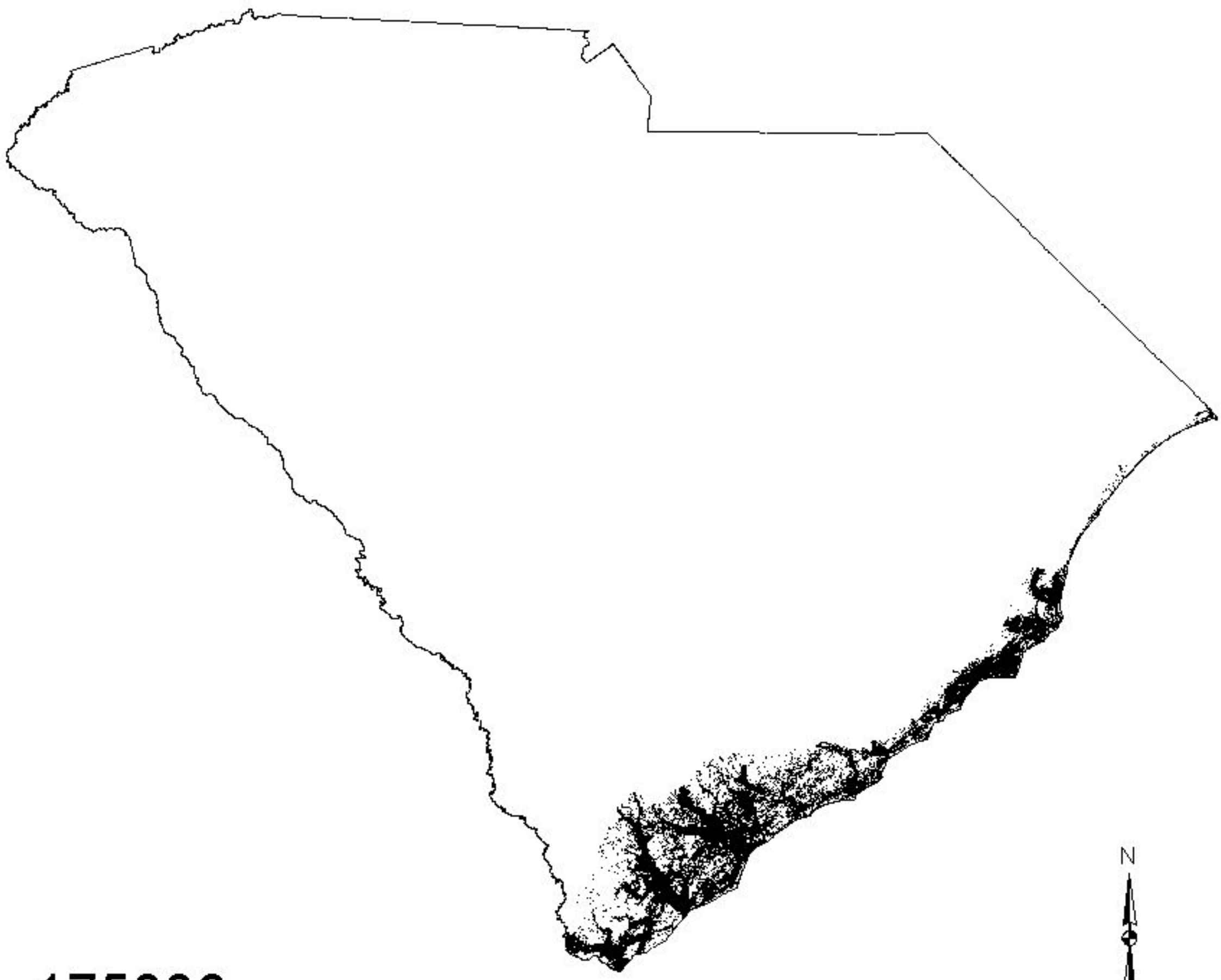
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Snow Goose

(Chen caerulescens)



175038

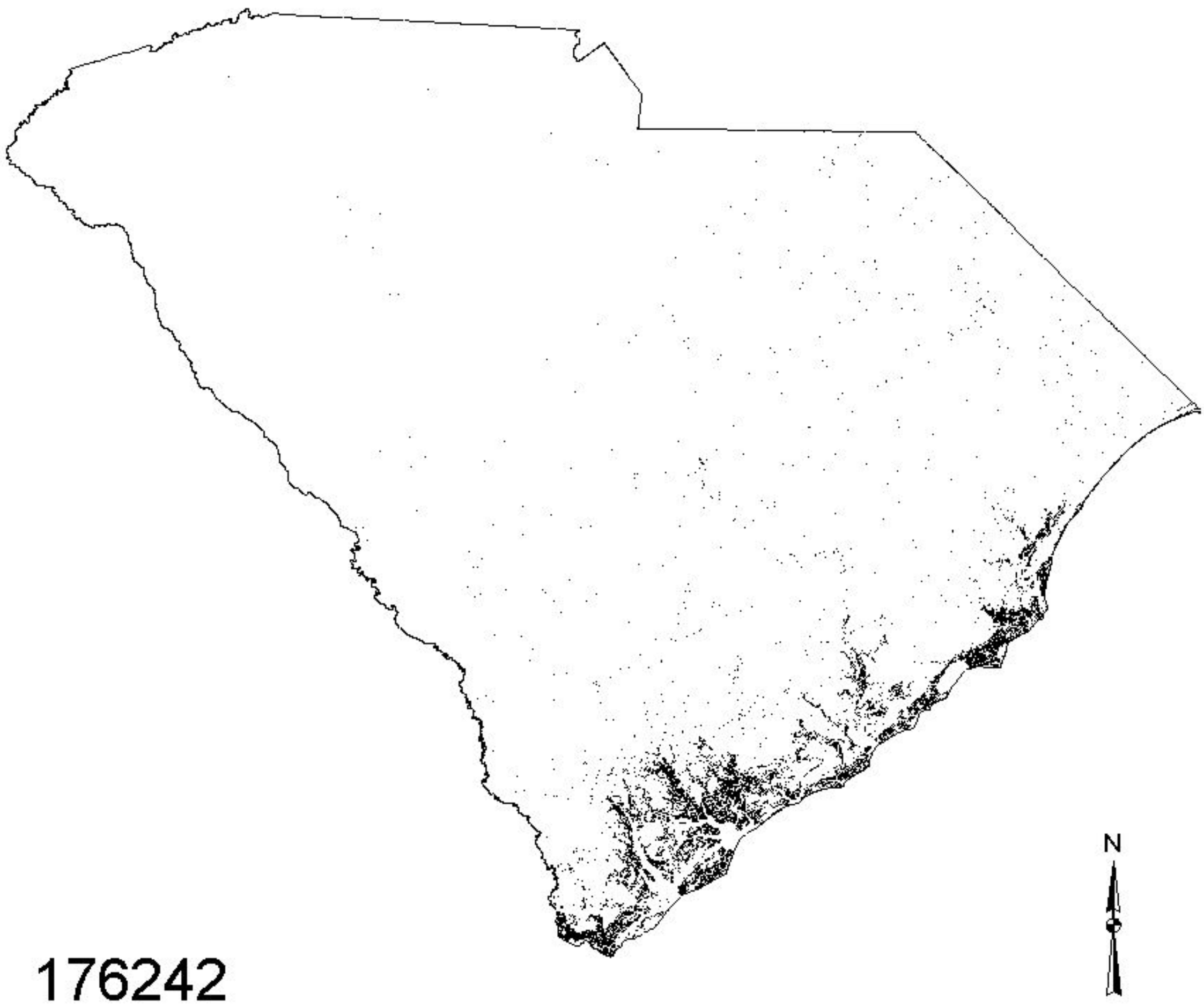
Predicted present

Predicted absent

State boundary

Sora

(Porzana carolina)



Song Sparrow

(Melospiza melodia)

179492

Predicted present

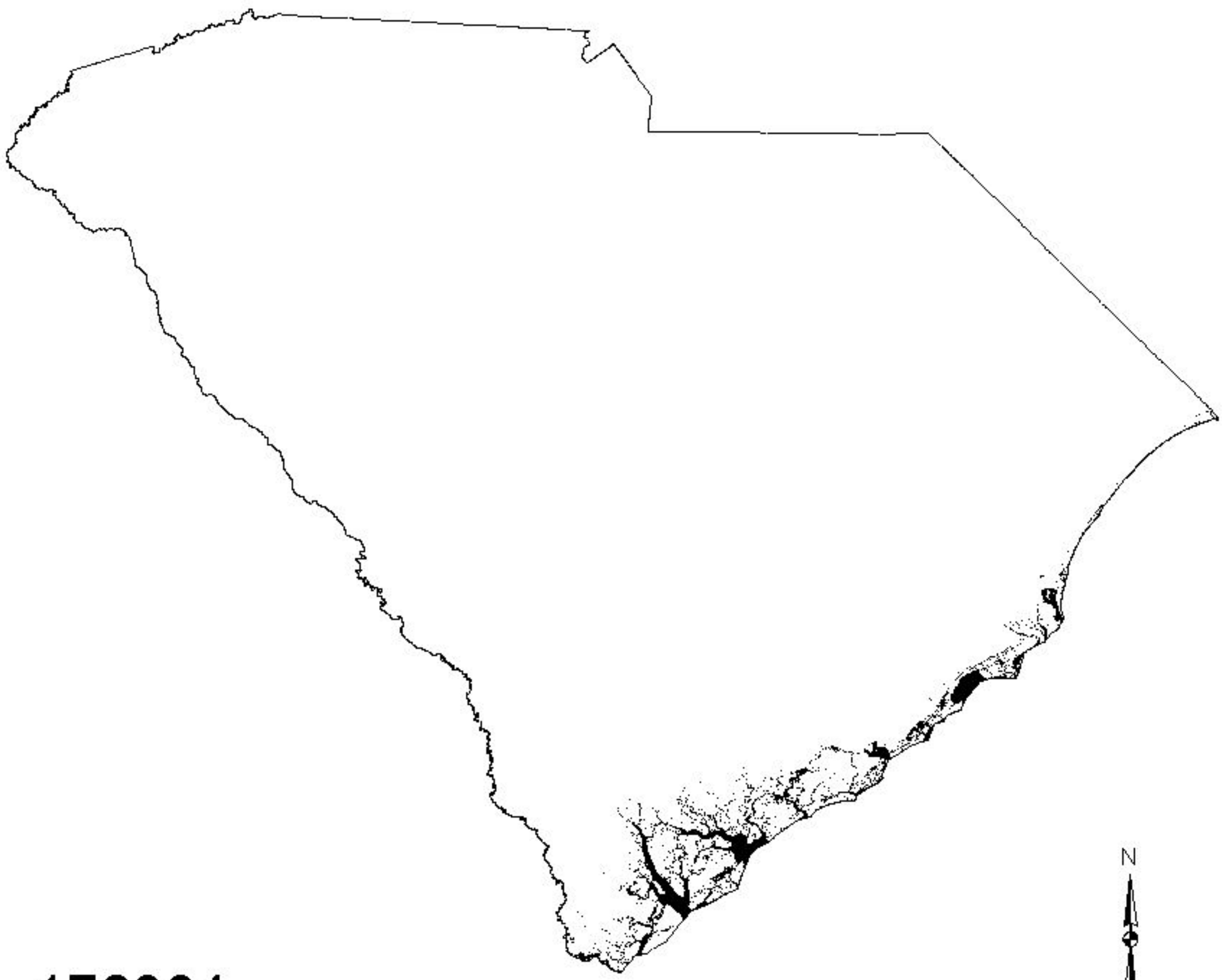
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Sooty Tern

(Sterna fuscata)



176894

Predicted present

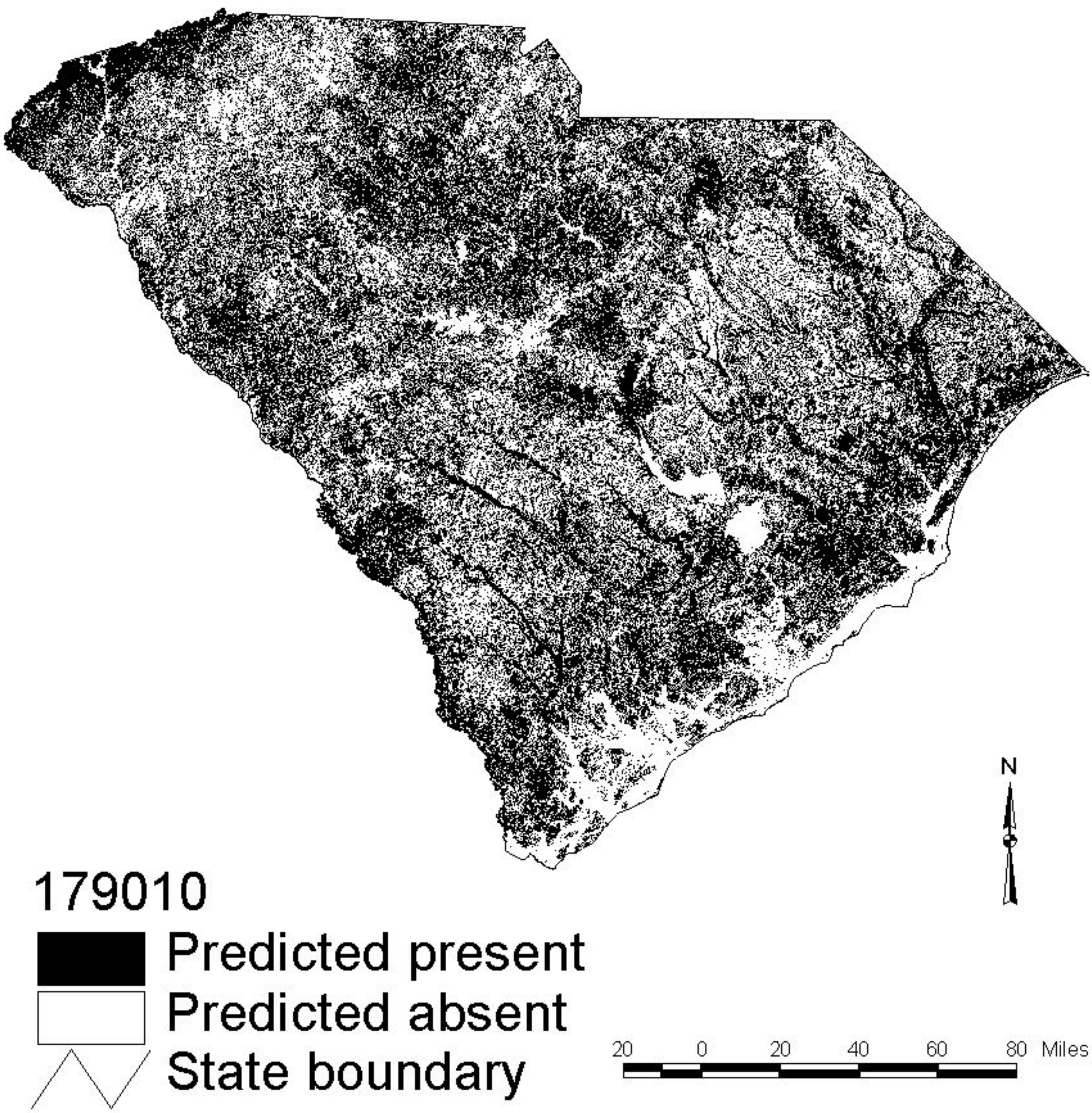
Predicted absent

State boundary

20 0 20 40 60 80 Miles

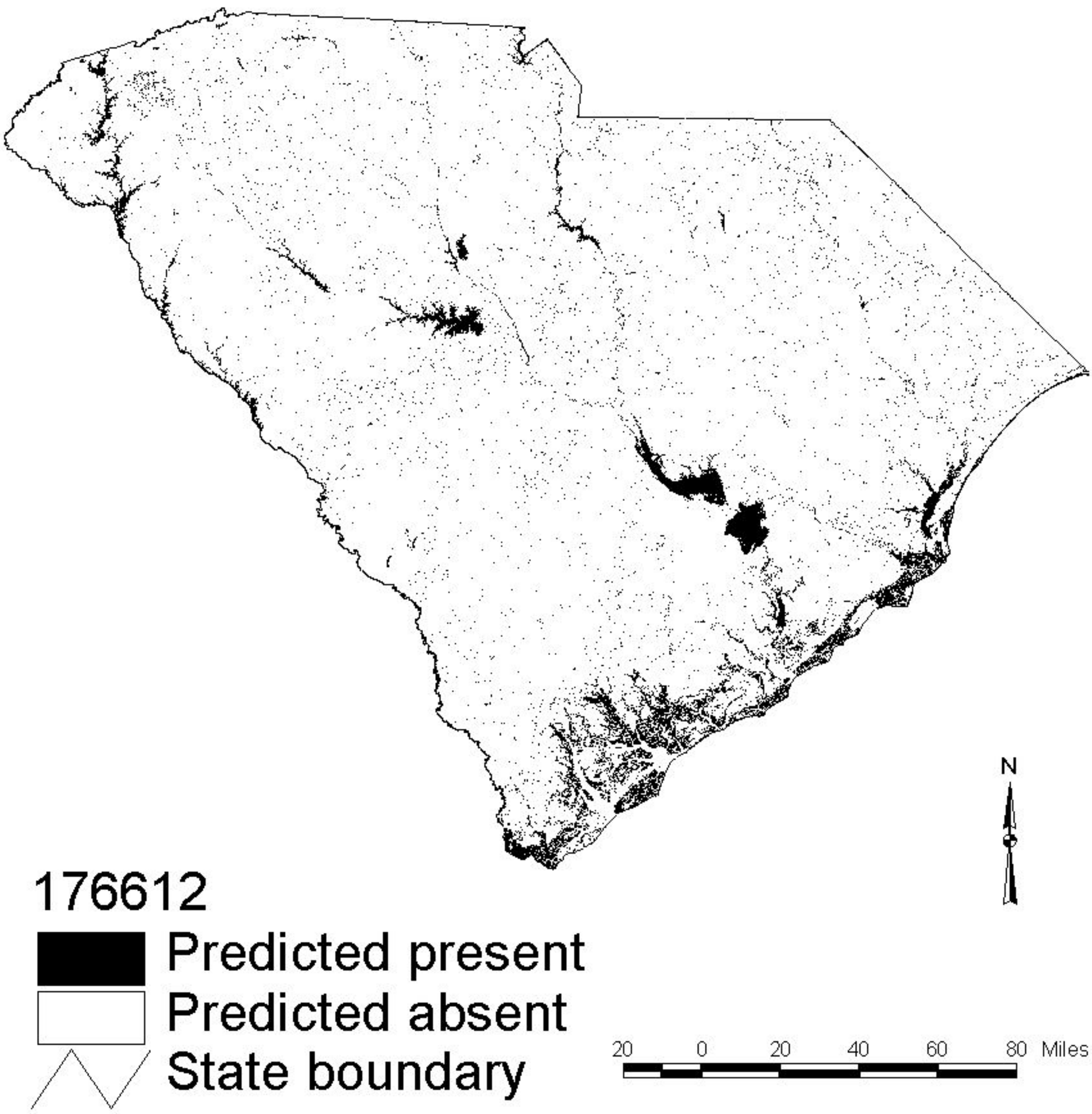
Blue-headed Vireo

(Vireo solitarius)



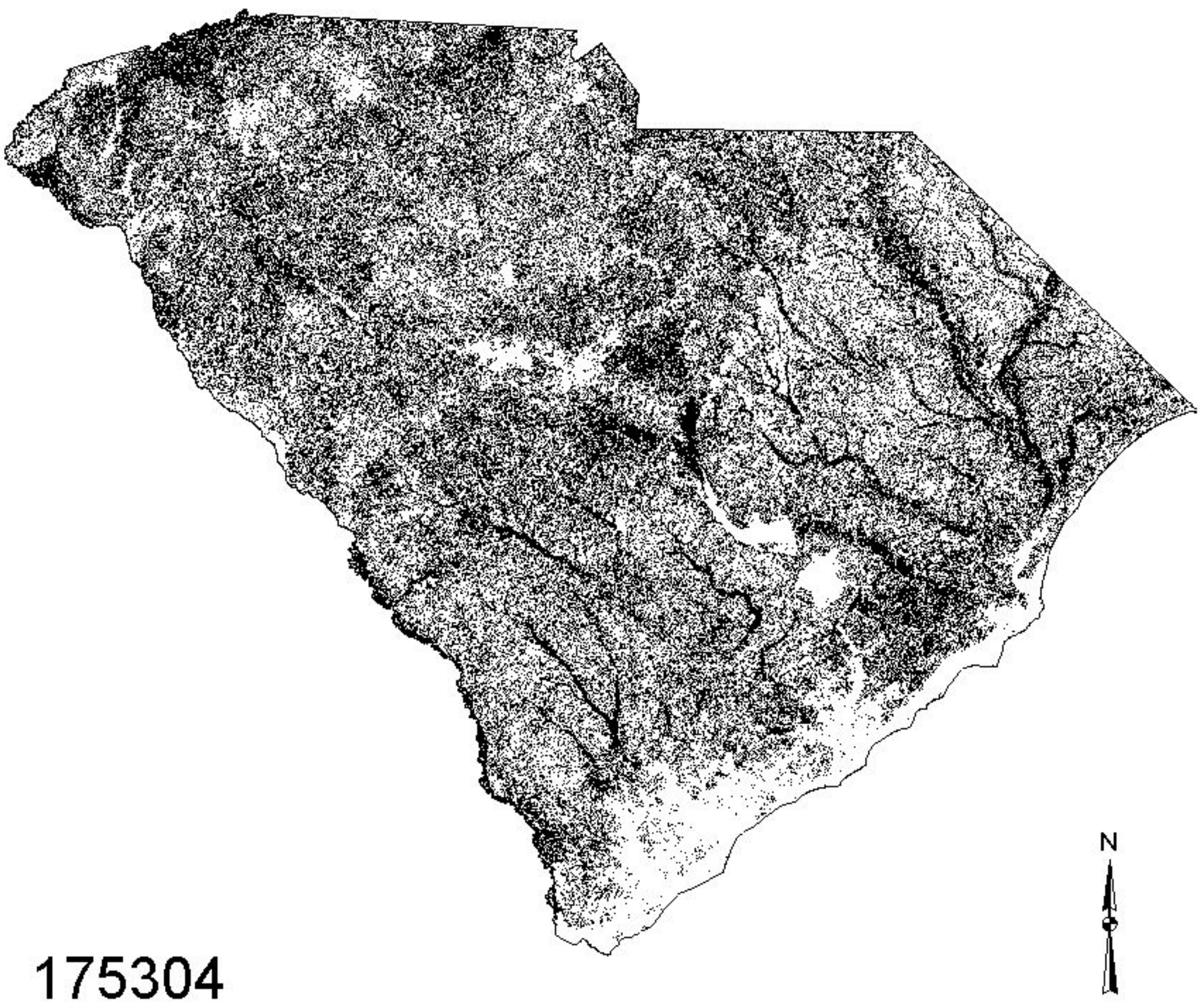
Spotted Sandpiper

(Actitis macularia)



Sharp-shinned Hawk

(Accipiter striatus)



175304

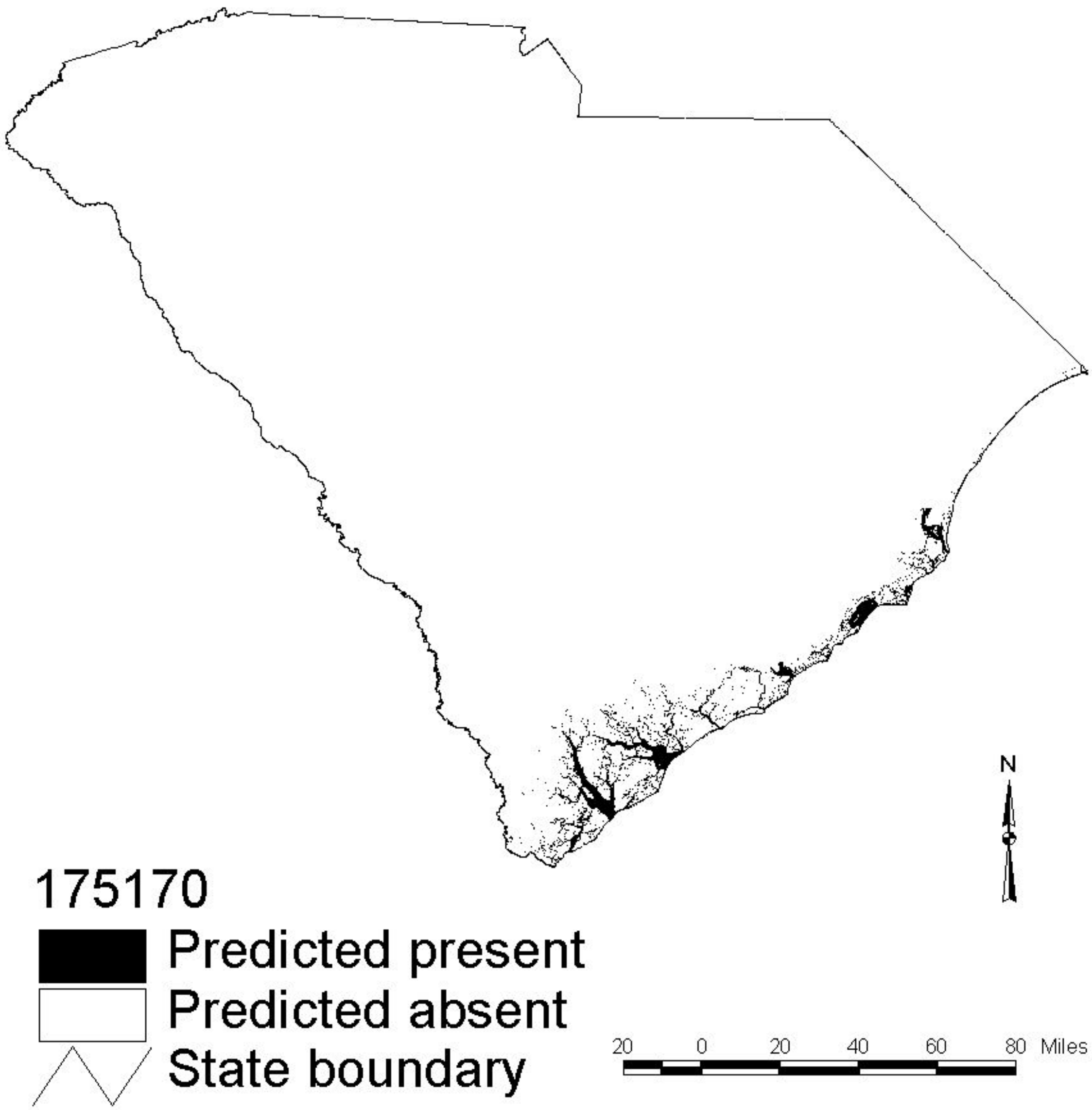
Predicted present

Predicted absent

State boundary

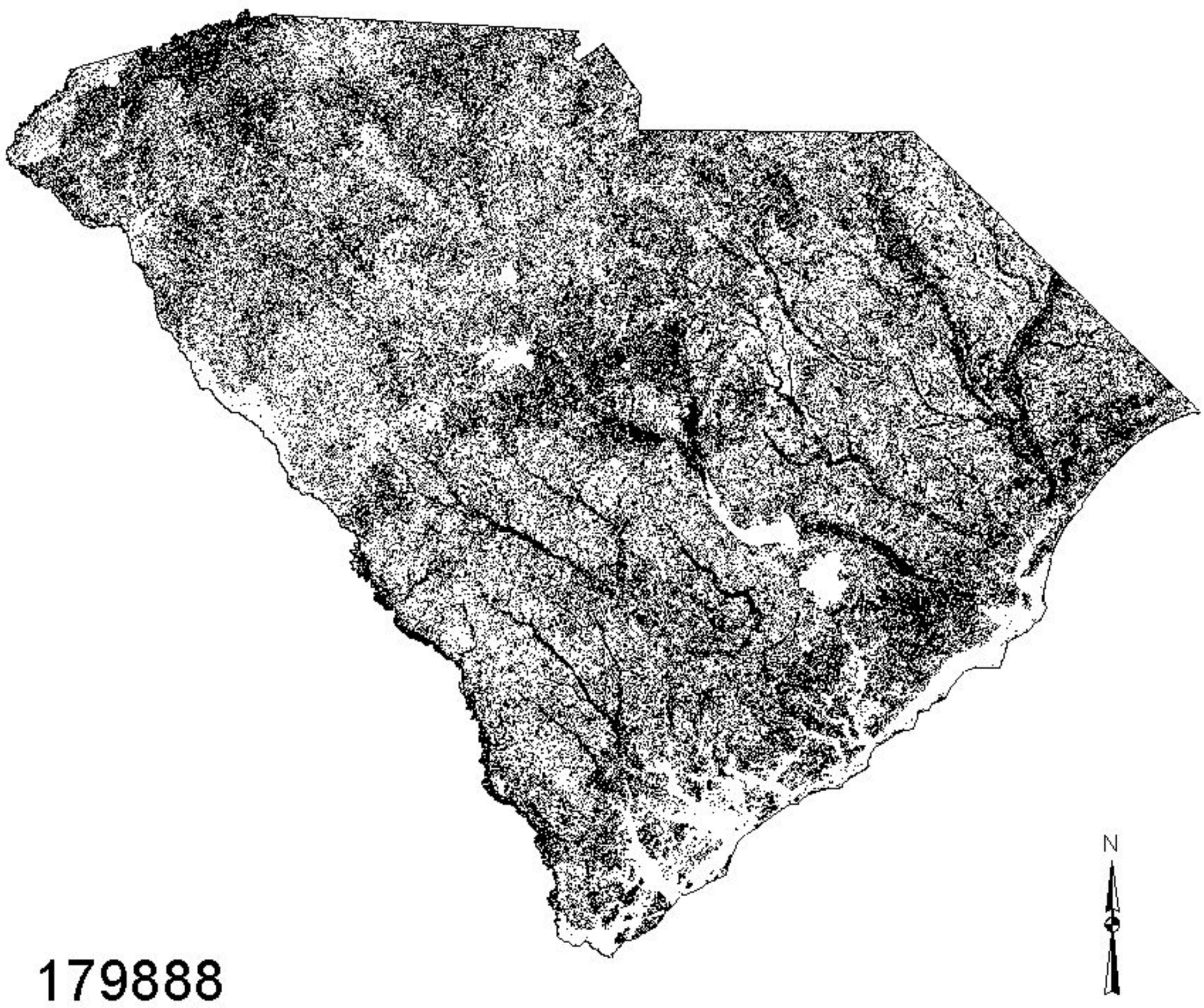
Surf Scoter

(Melanitta perspicillata)



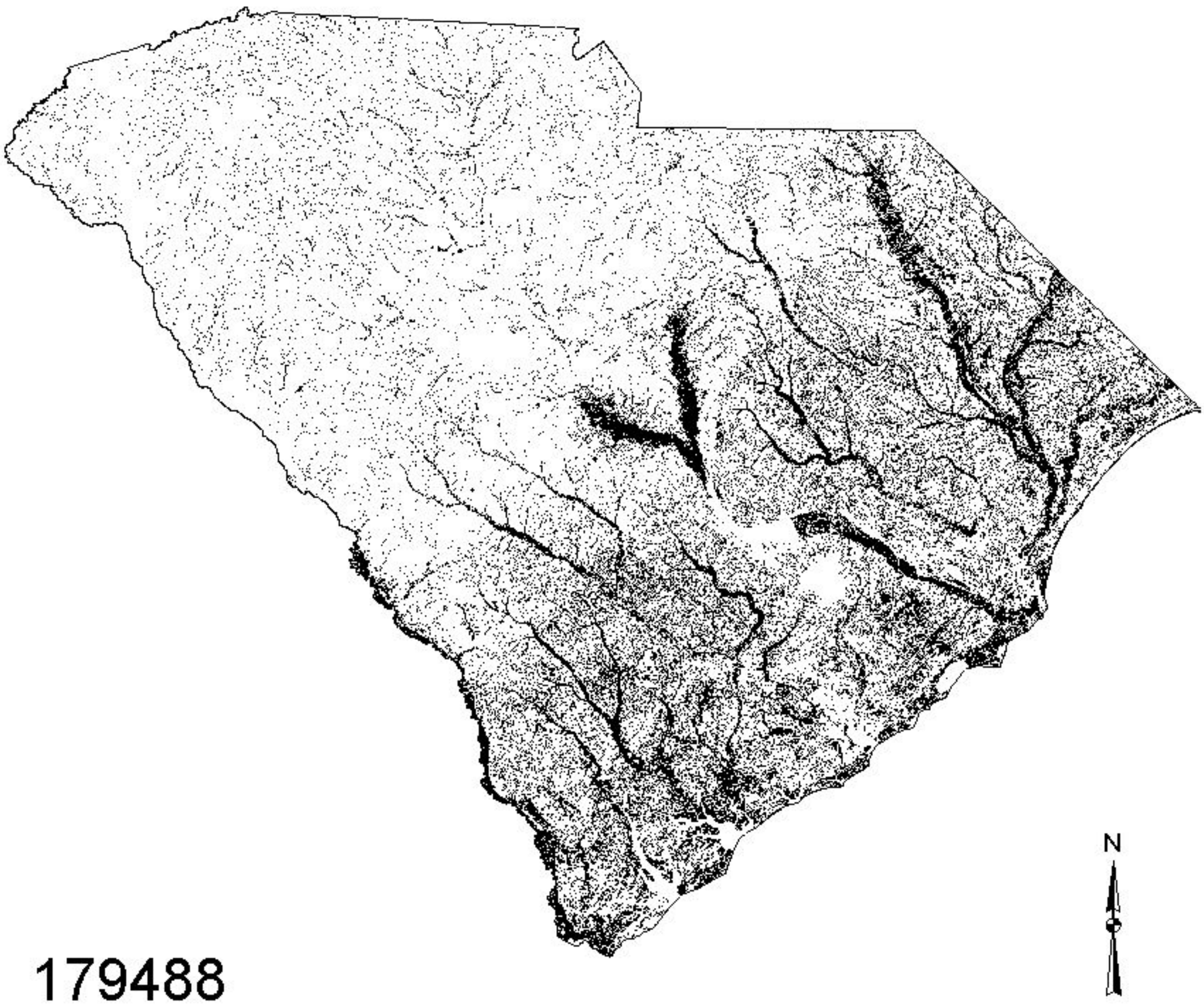
Summer Tanager

(Piranga rubra)



Swamp Sparrow

(Melospiza georgiana)



179488

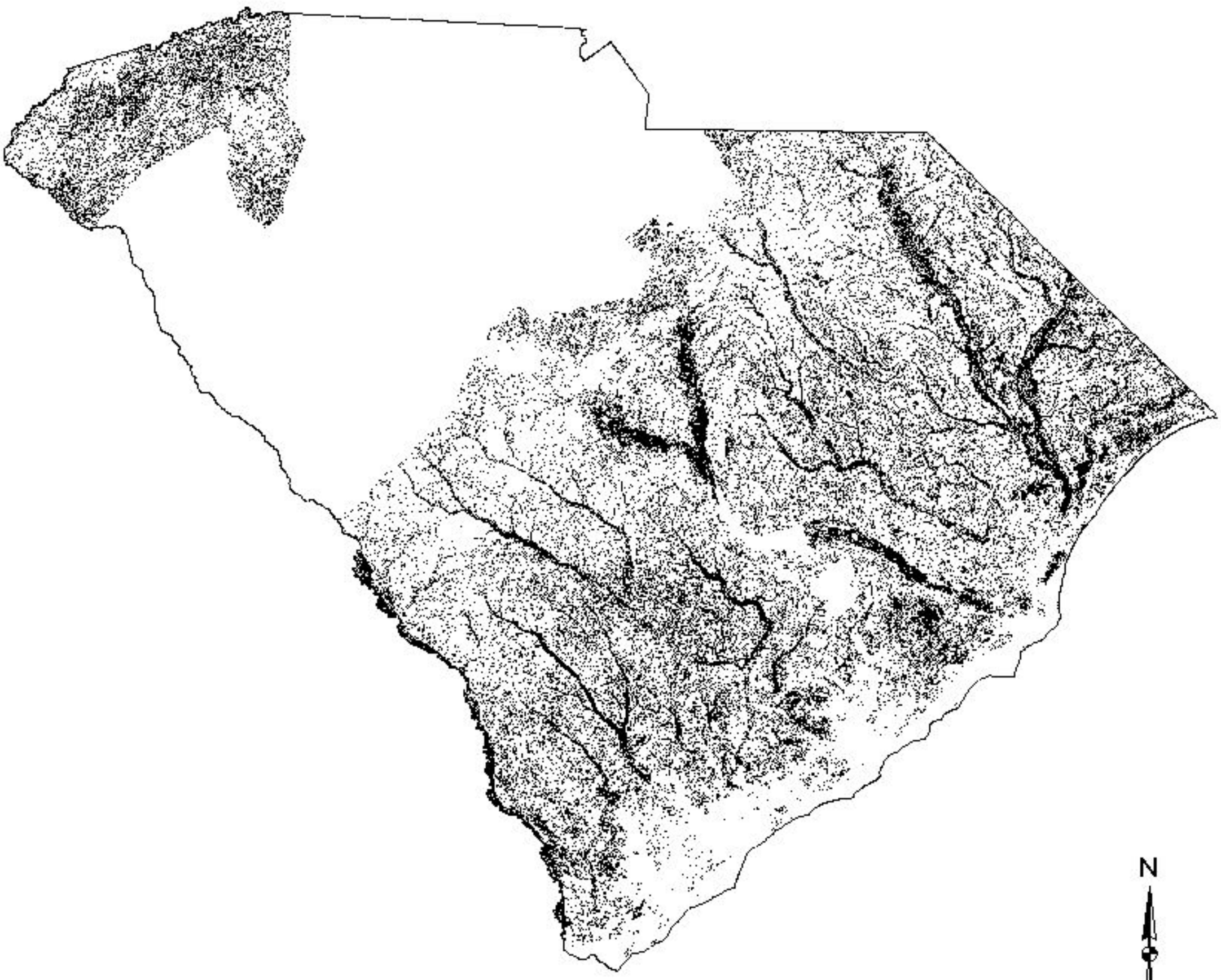
Predicted present

Predicted absent

State boundary

Swainson's Warbler

(Limnothlypis swainsonii)



178848

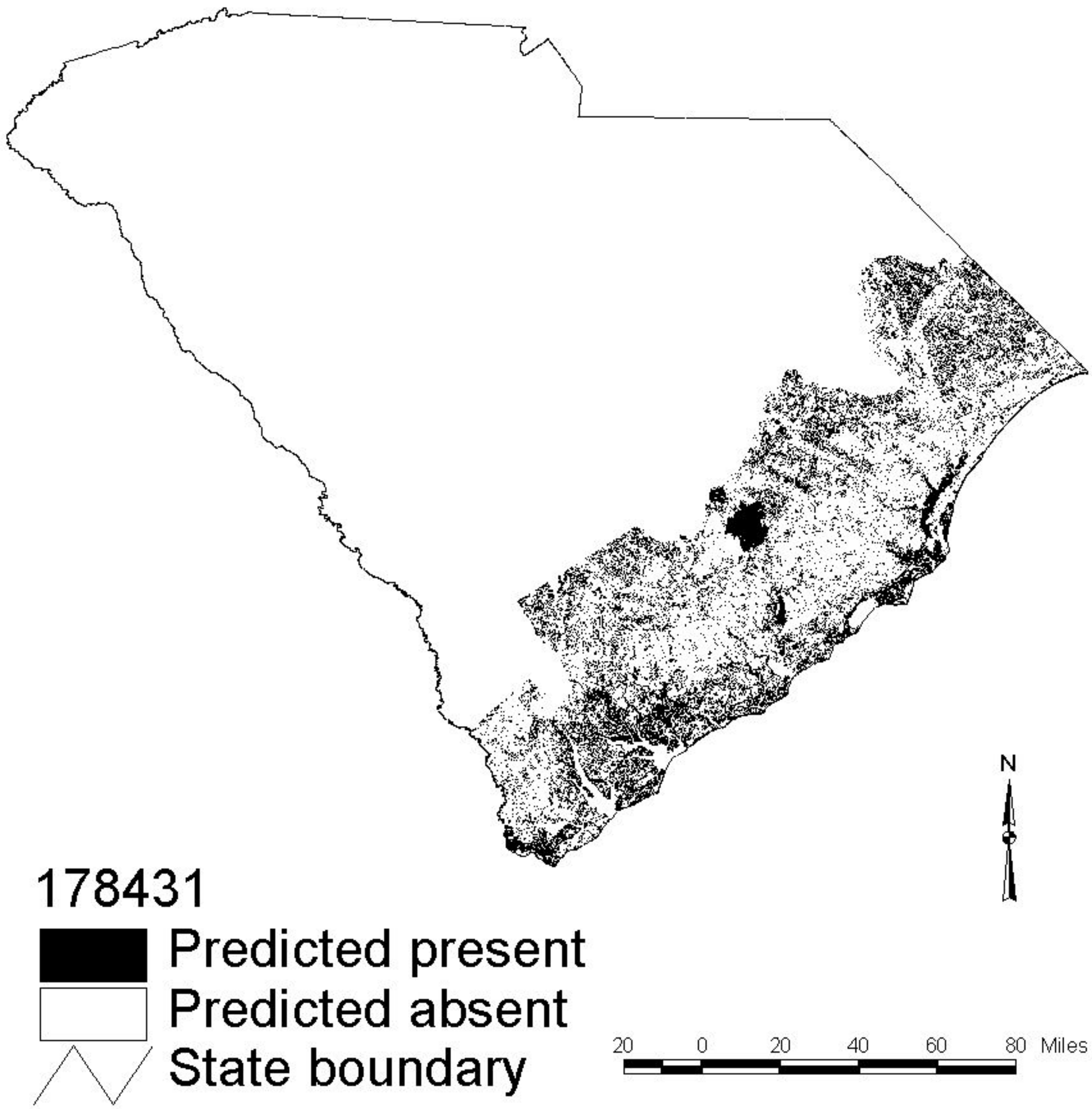
Predicted present

Predicted absent

State boundary

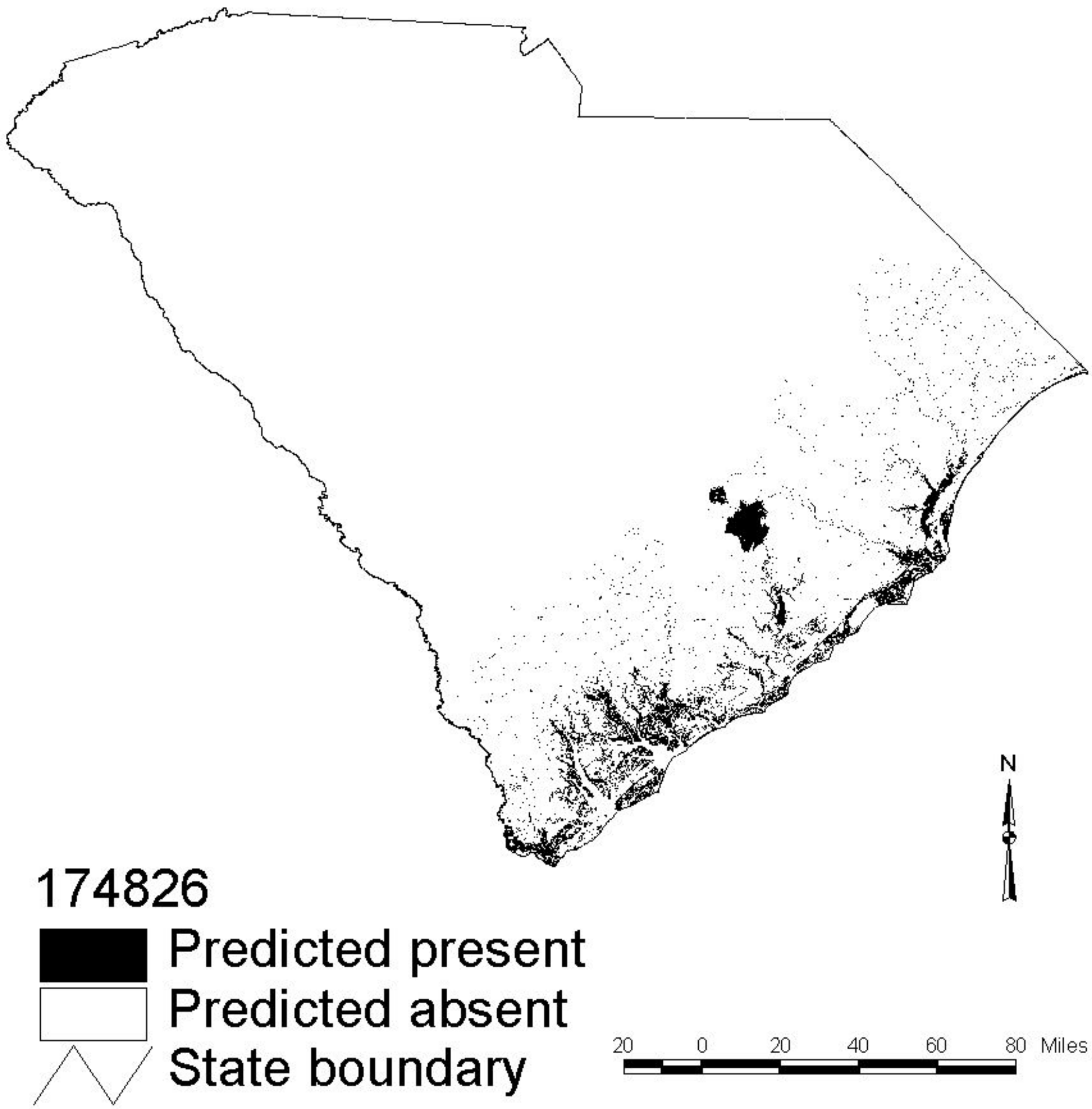
Tree Swallow

(Tachycineta bicolor)



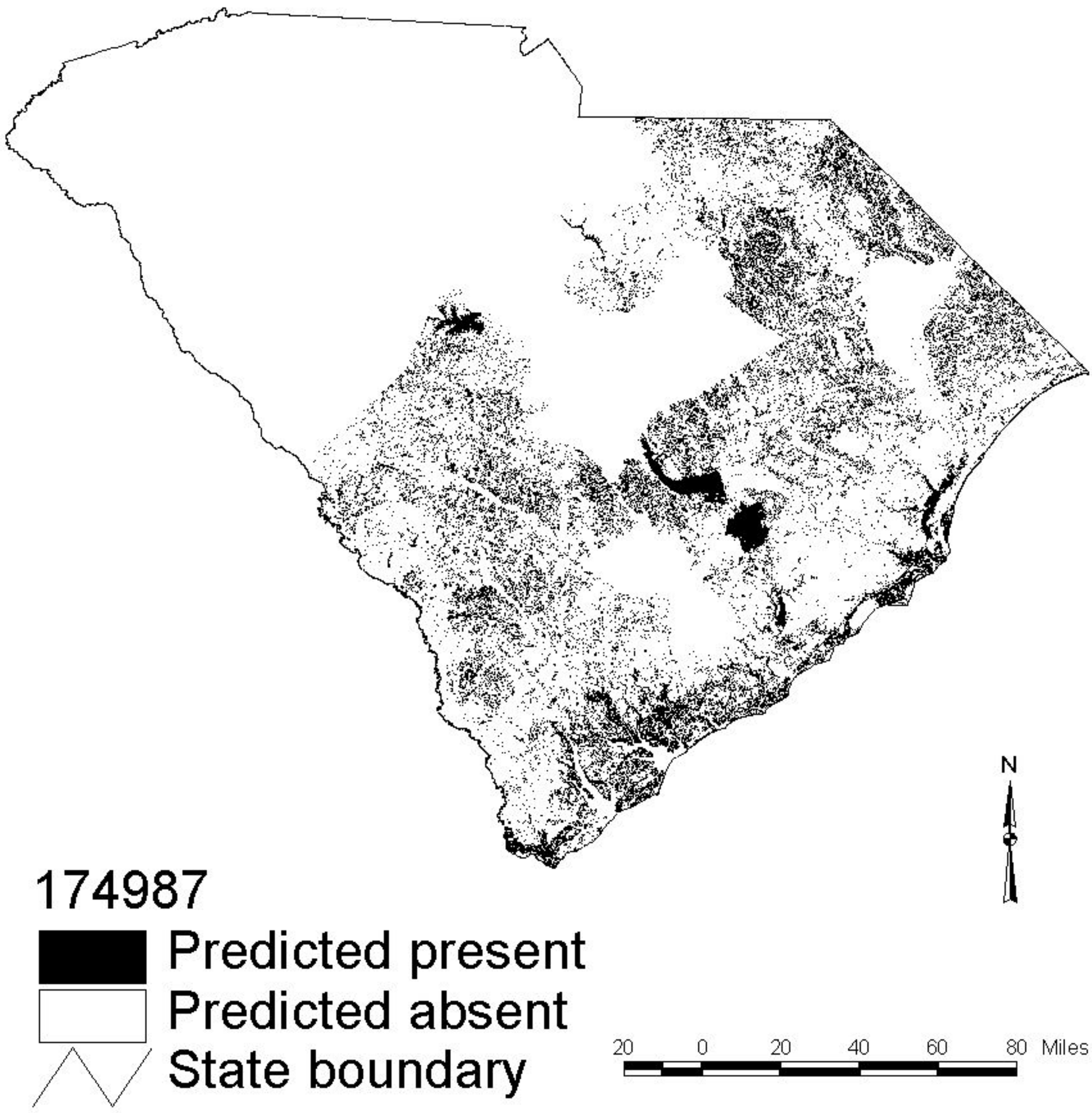
Tricolored Heron

(Egretta tricolor)



Tundra Swan

(Cygnus columbianus)



174987

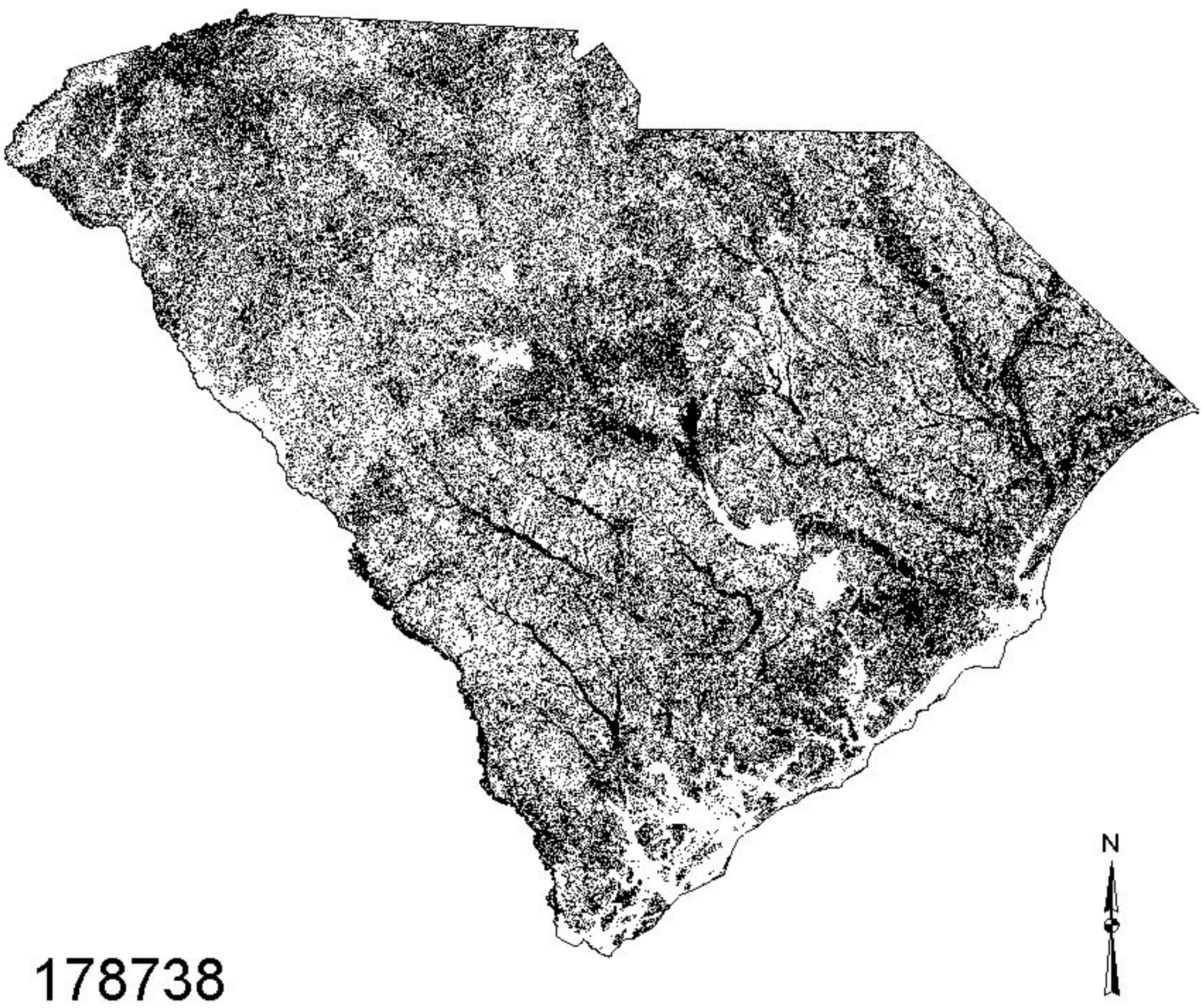
Predicted present

Predicted absent

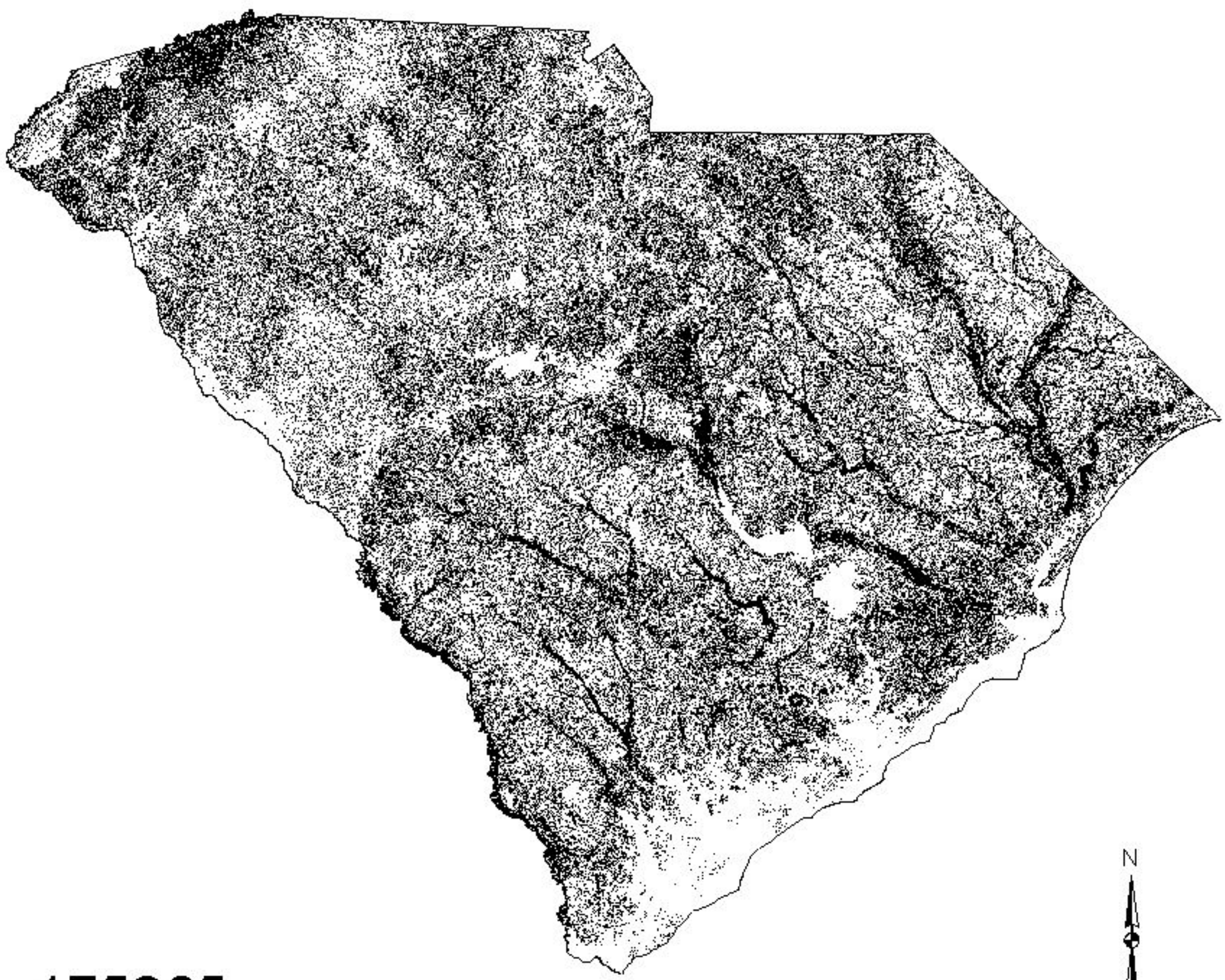
State boundary

Tufted Titmouse

(Parus bicolor)



Turkey Vulture
(Cathartes aura)



175265

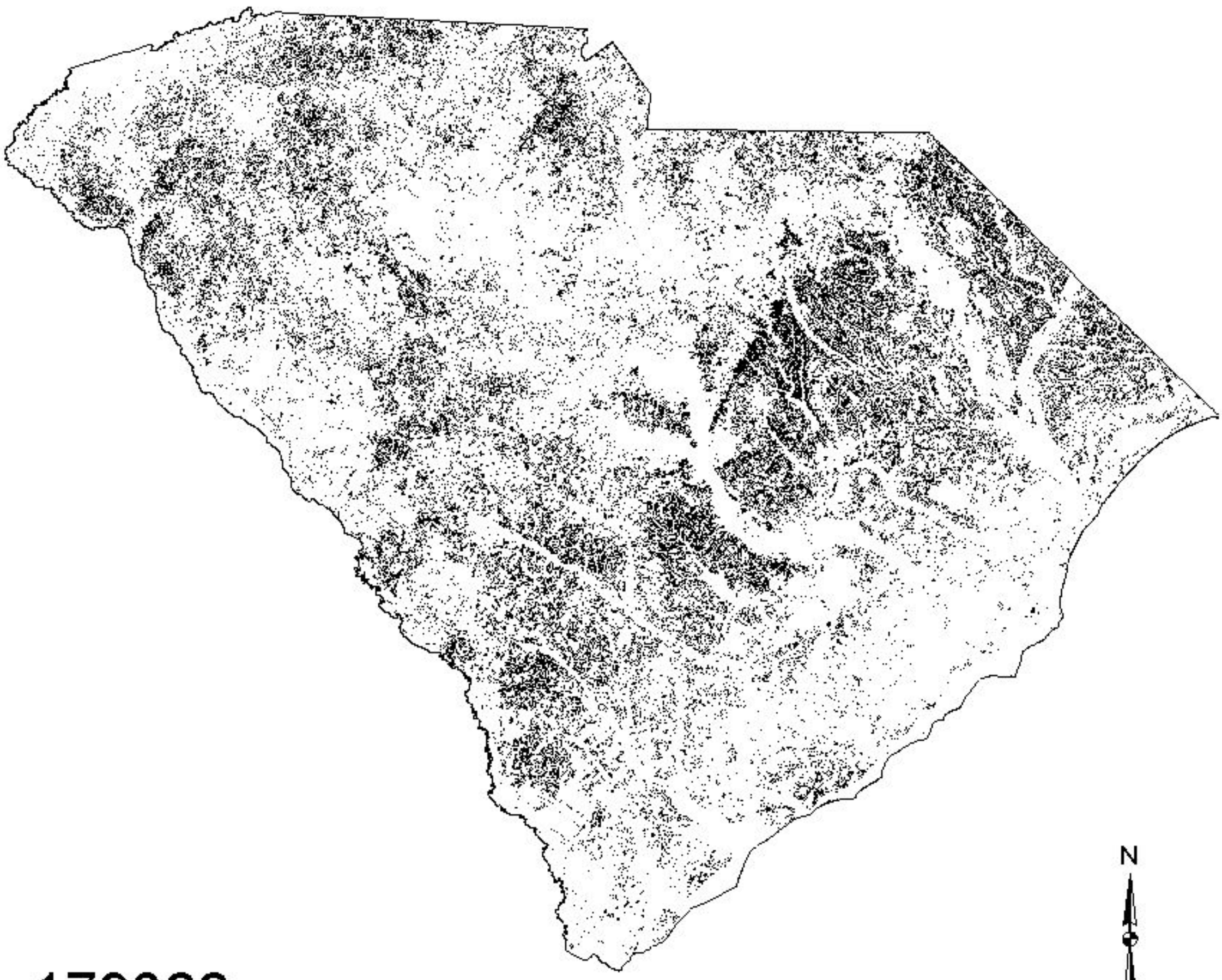
Predicted present

Predicted absent

State boundary

Vesper Sparrow

(Pooecetes gramineus)



179366

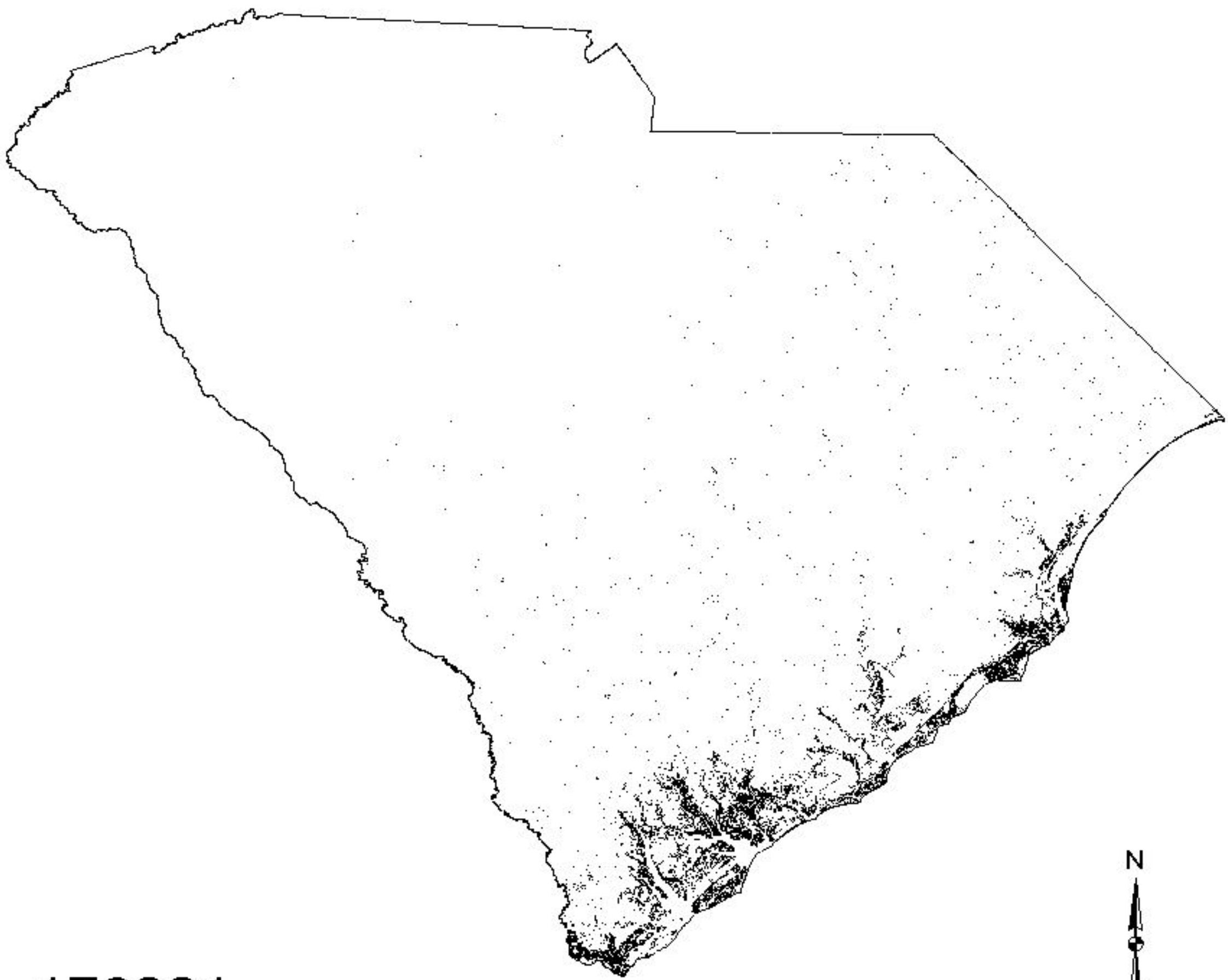
Predicted present

Predicted absent

State boundary

Virginia Rail

(Rallus limicola)



176221

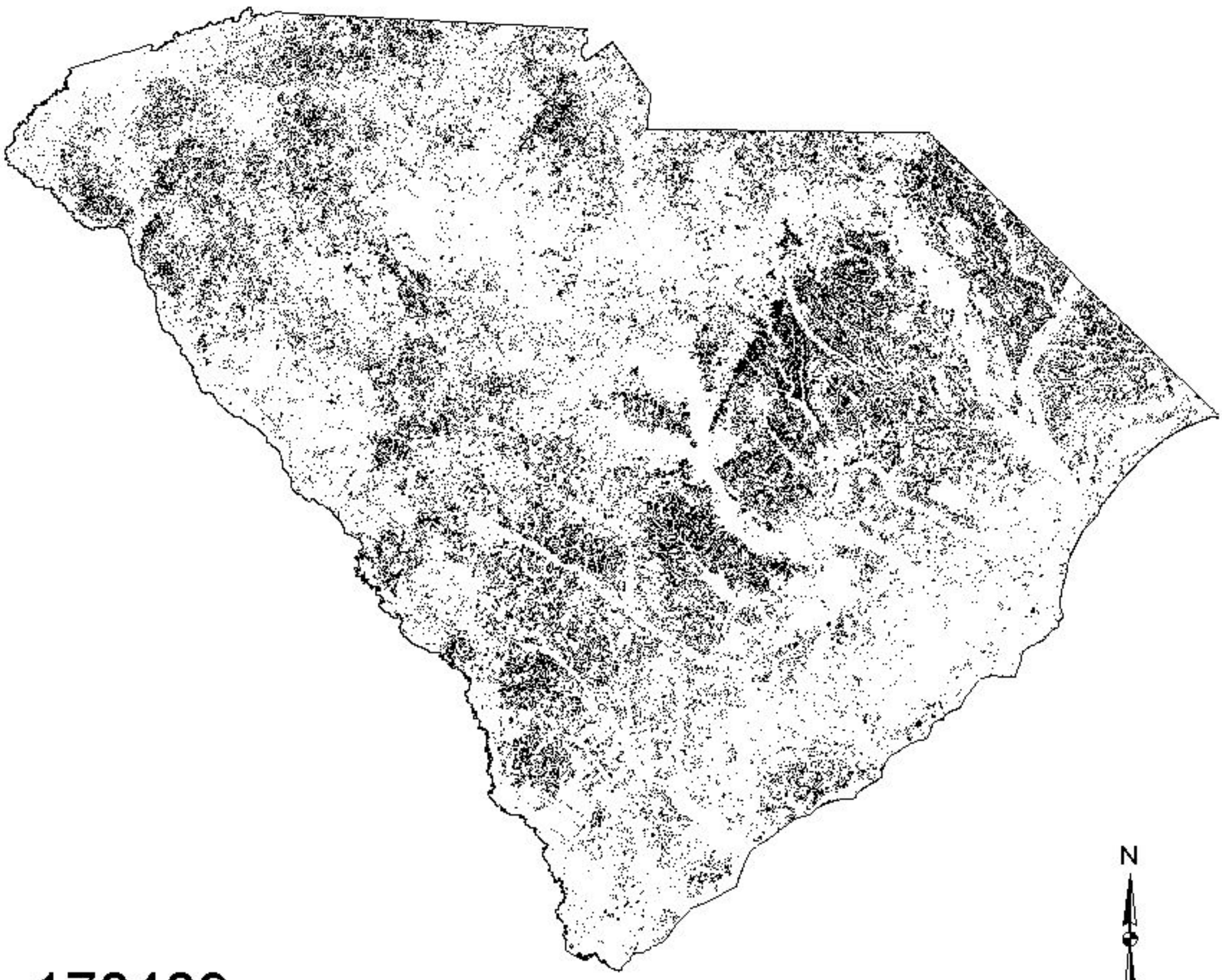
Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Water Pipit
(Anthus spinoletta)



178489

Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

White-breasted Nuthatch

(Sitta carolinensis)

178775

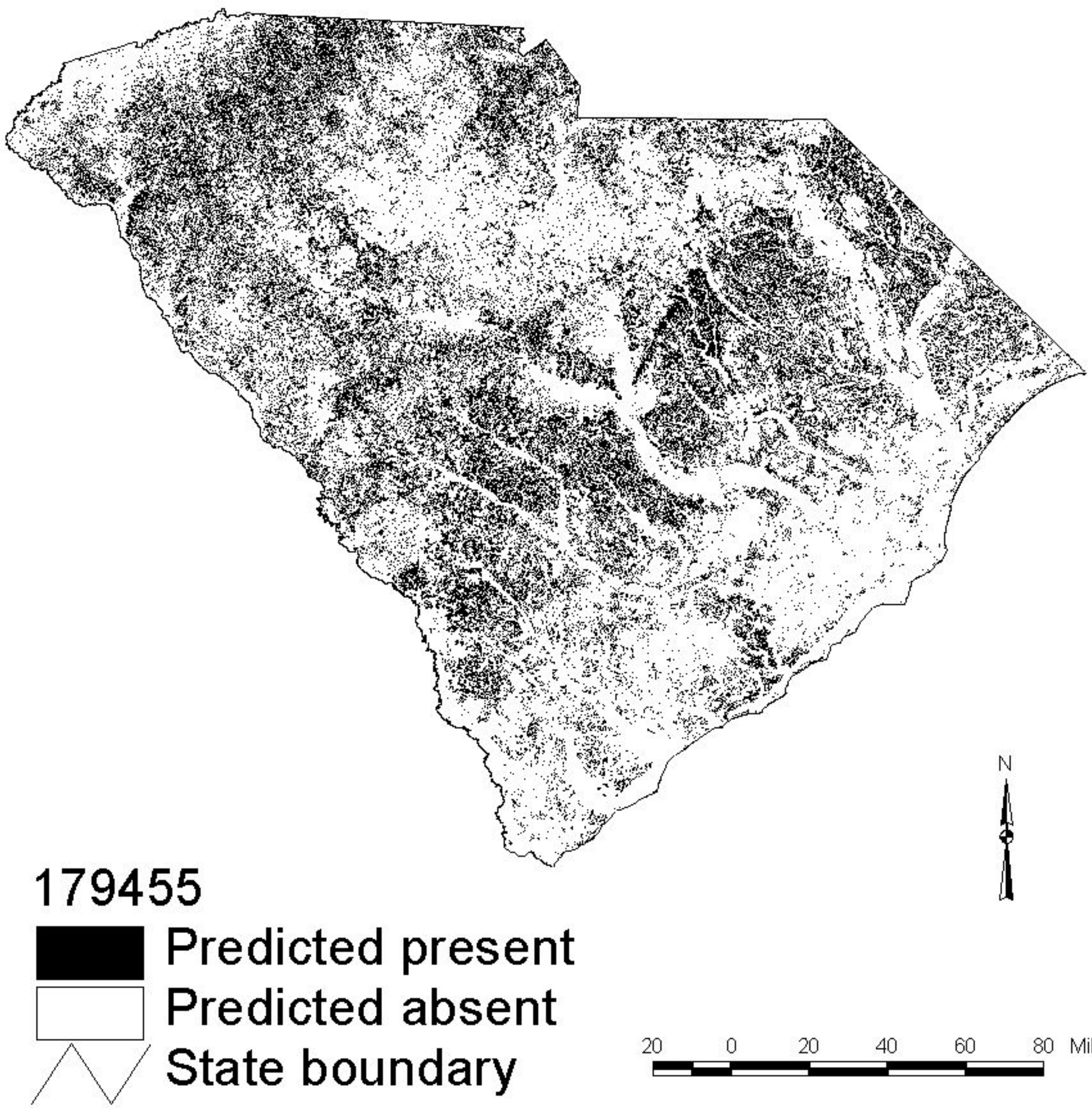
Predicted present

Predicted absent

State boundary

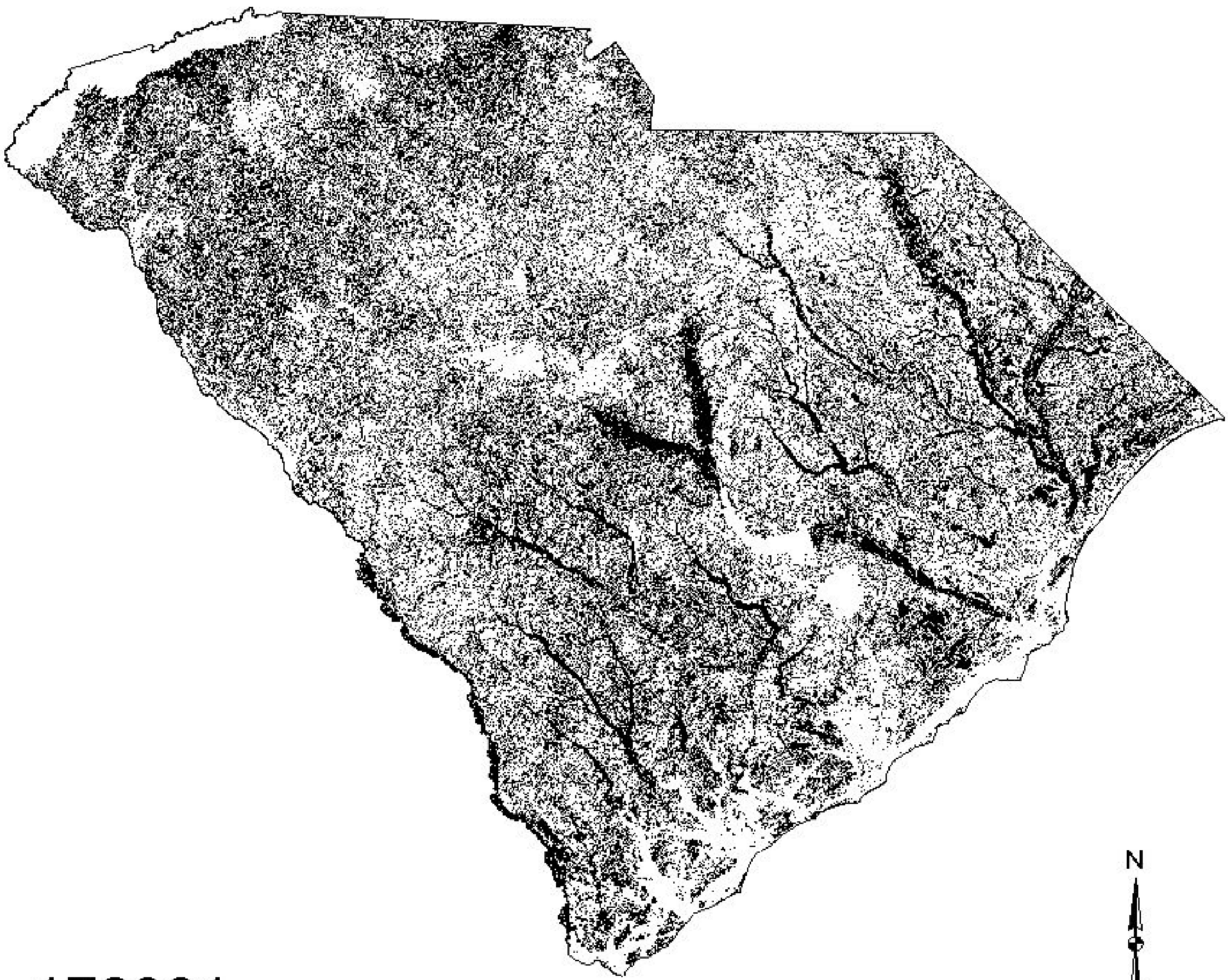
White-crowned Sparrow

(Zonotrichia leucophrys)



White-eyed Vireo

(Vireo griseus)



178991

Predicted present

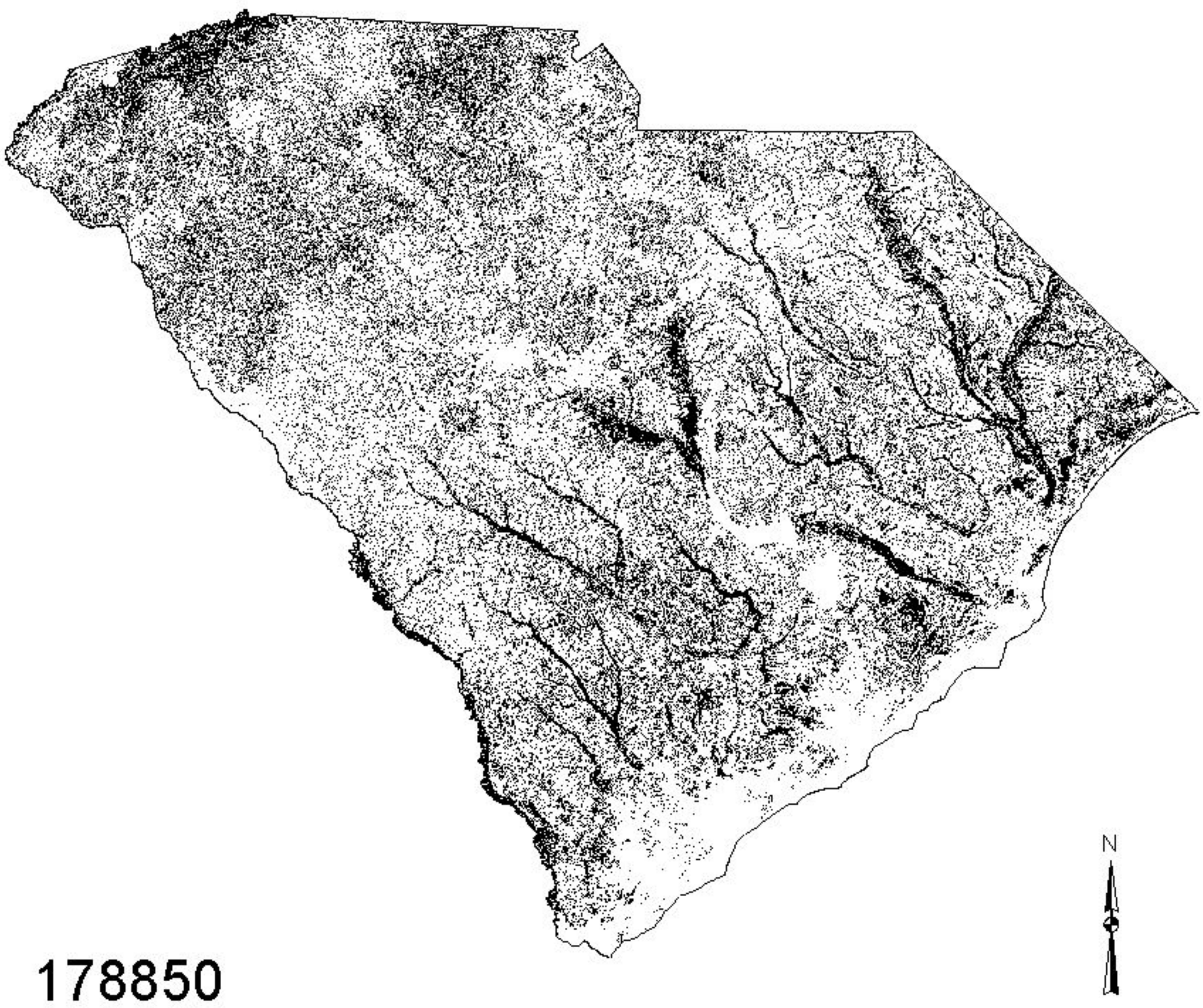
Predicted absent

State boundary

20 0 20 40 60 80 Miles

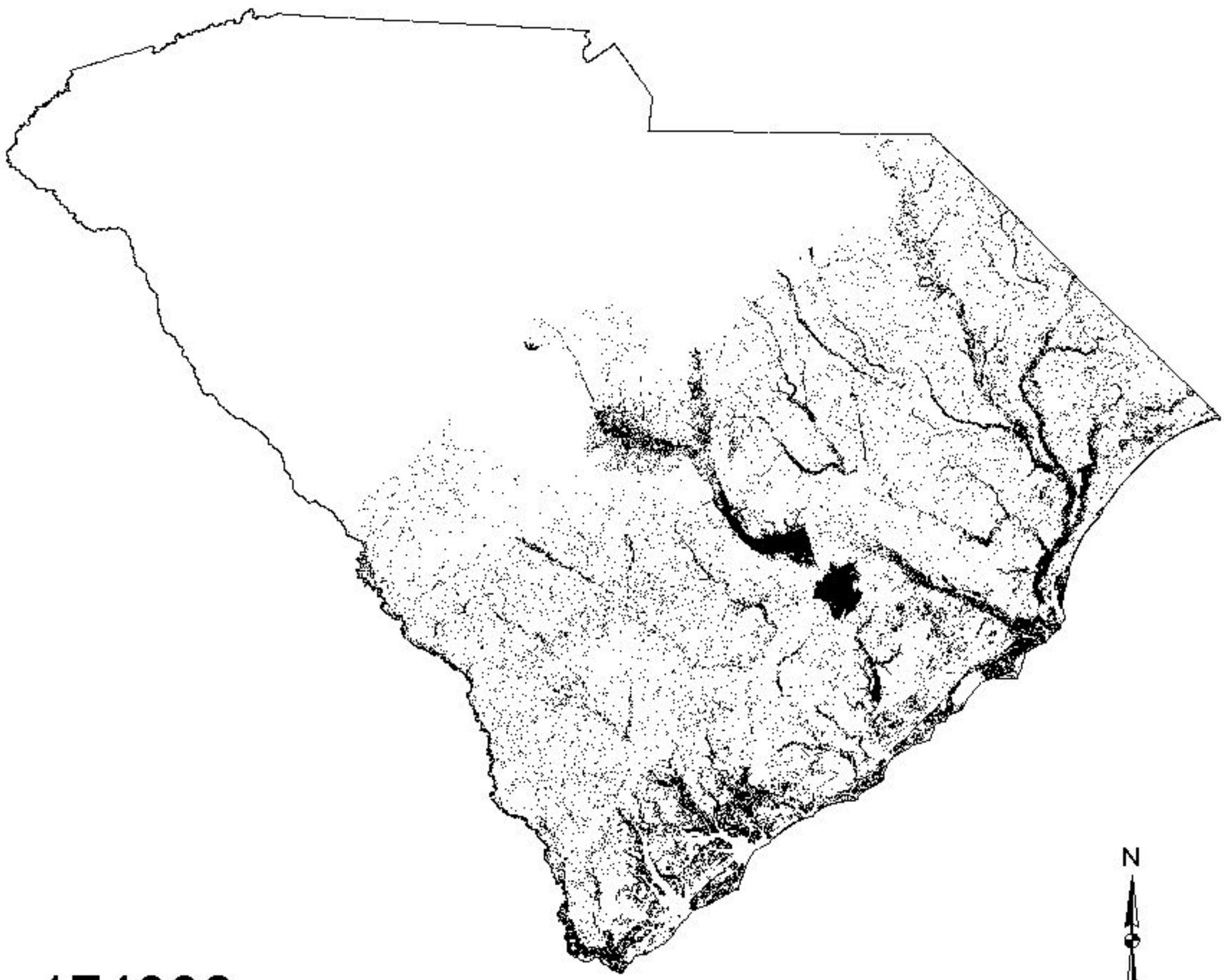
Worm-eating Warbler

(Helmitheros vermivorus)



White Ibis

(Eudocimus albus)



174930

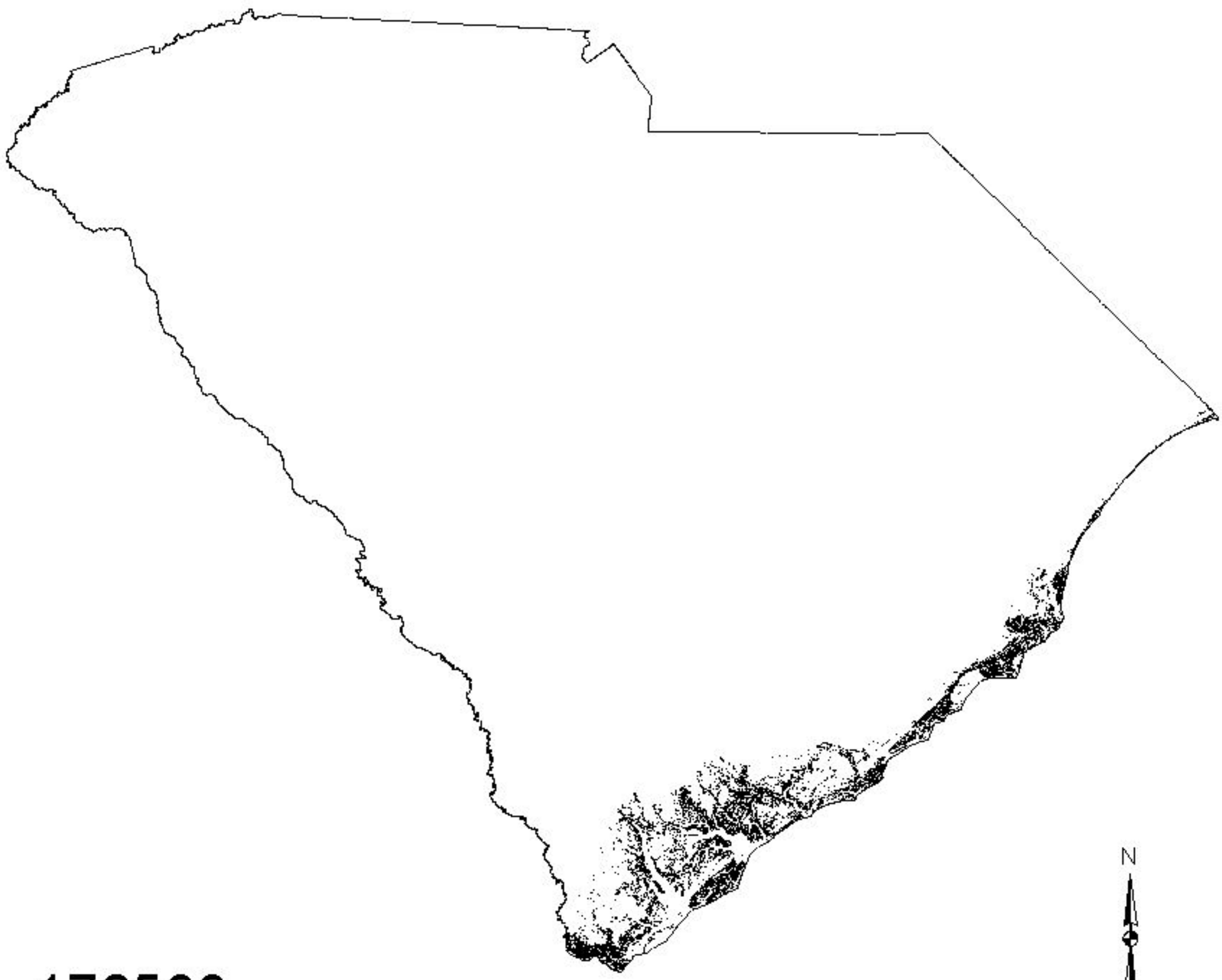
Predicted present

Predicted absent

State boundary

Whimbrel

(Numenius phaeopus)



176599

Predicted present

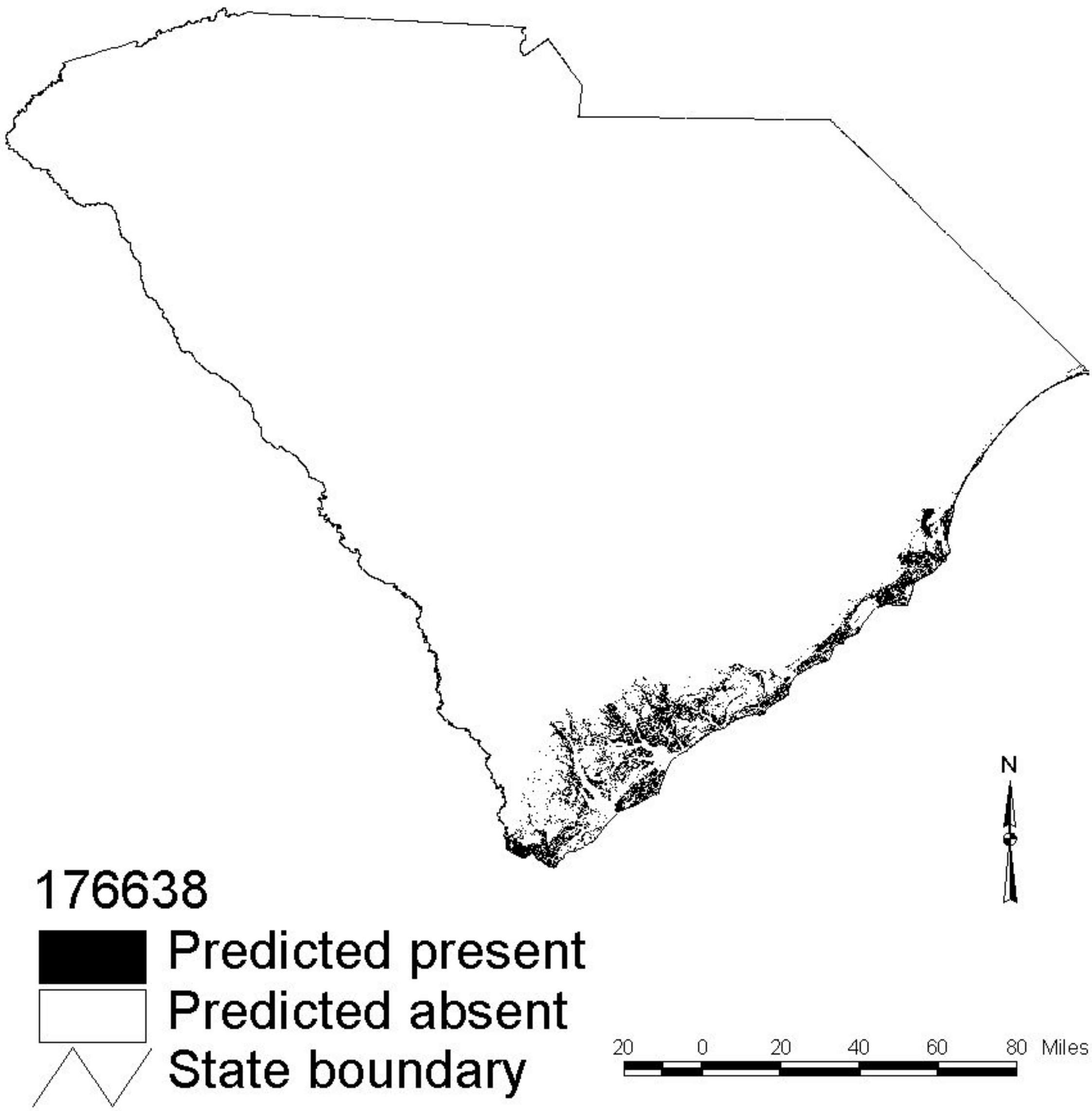
Predicted absent

State boundary

20 0 20 40 60 80 Miles

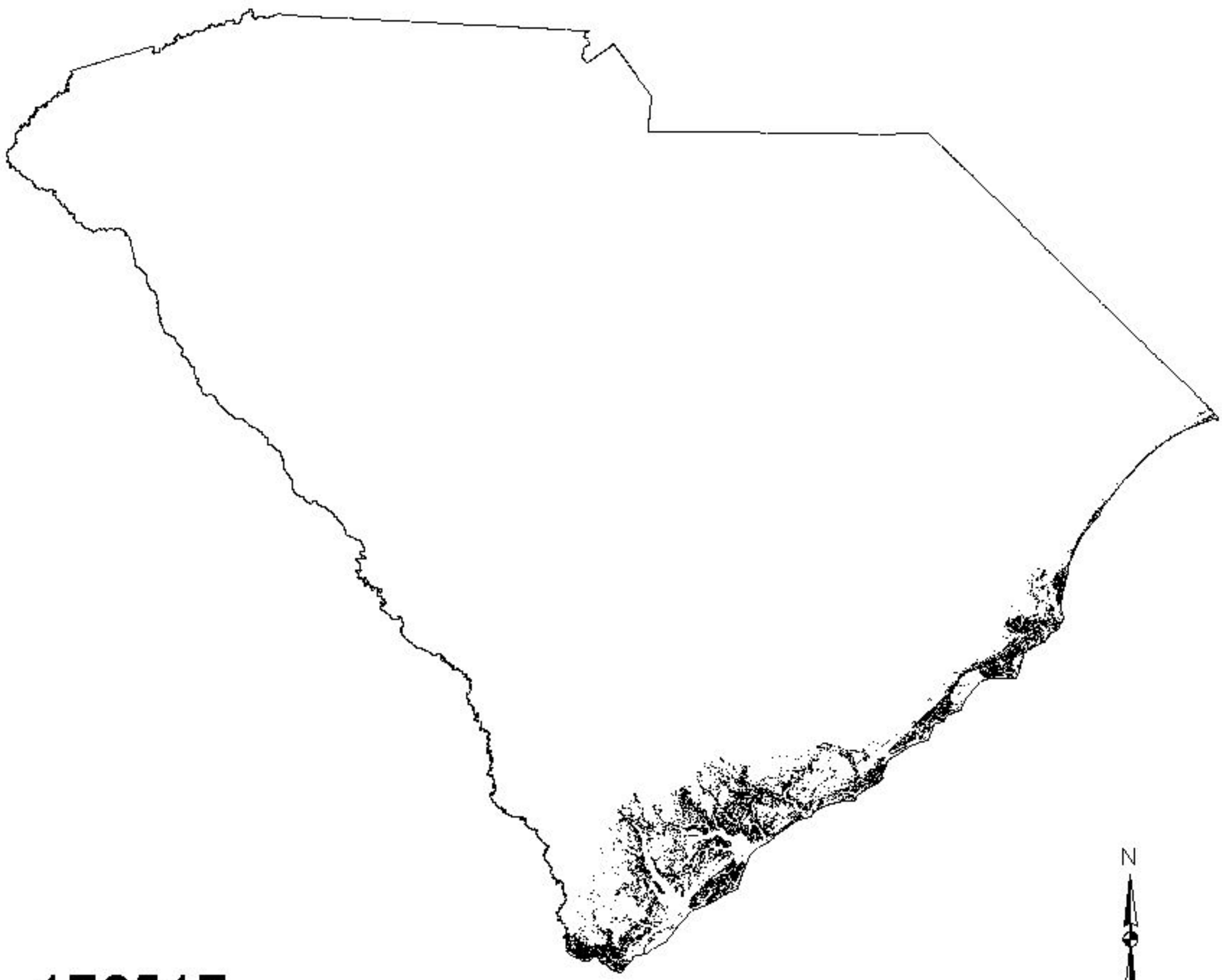
Willet

(Catoptrophorus semipalmatus)



Wilson's Plover

(Charadrius wilsonia)



176517

Predicted present

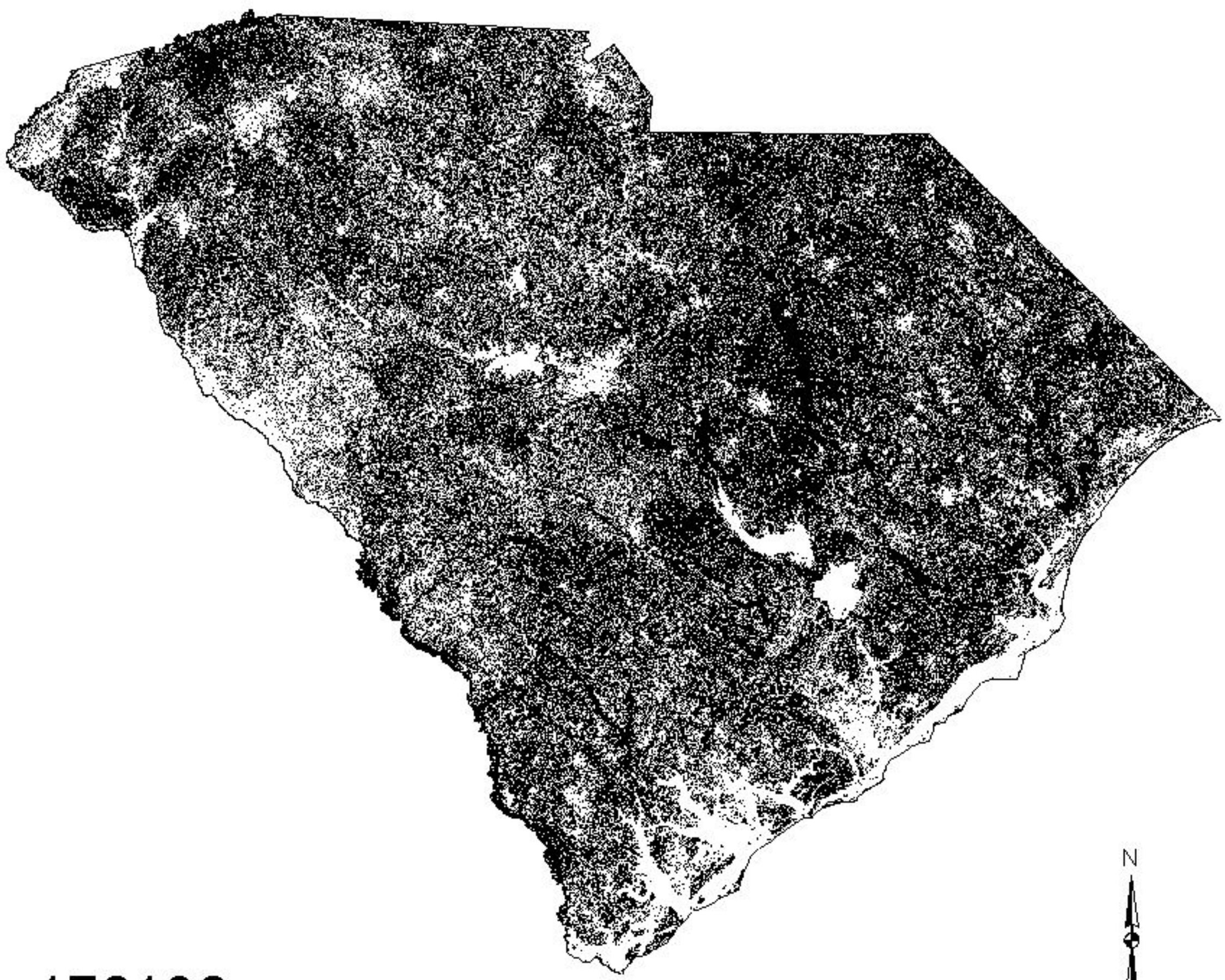
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Wild Turkey

(Meleagris gallopavo)



176136

Predicted present

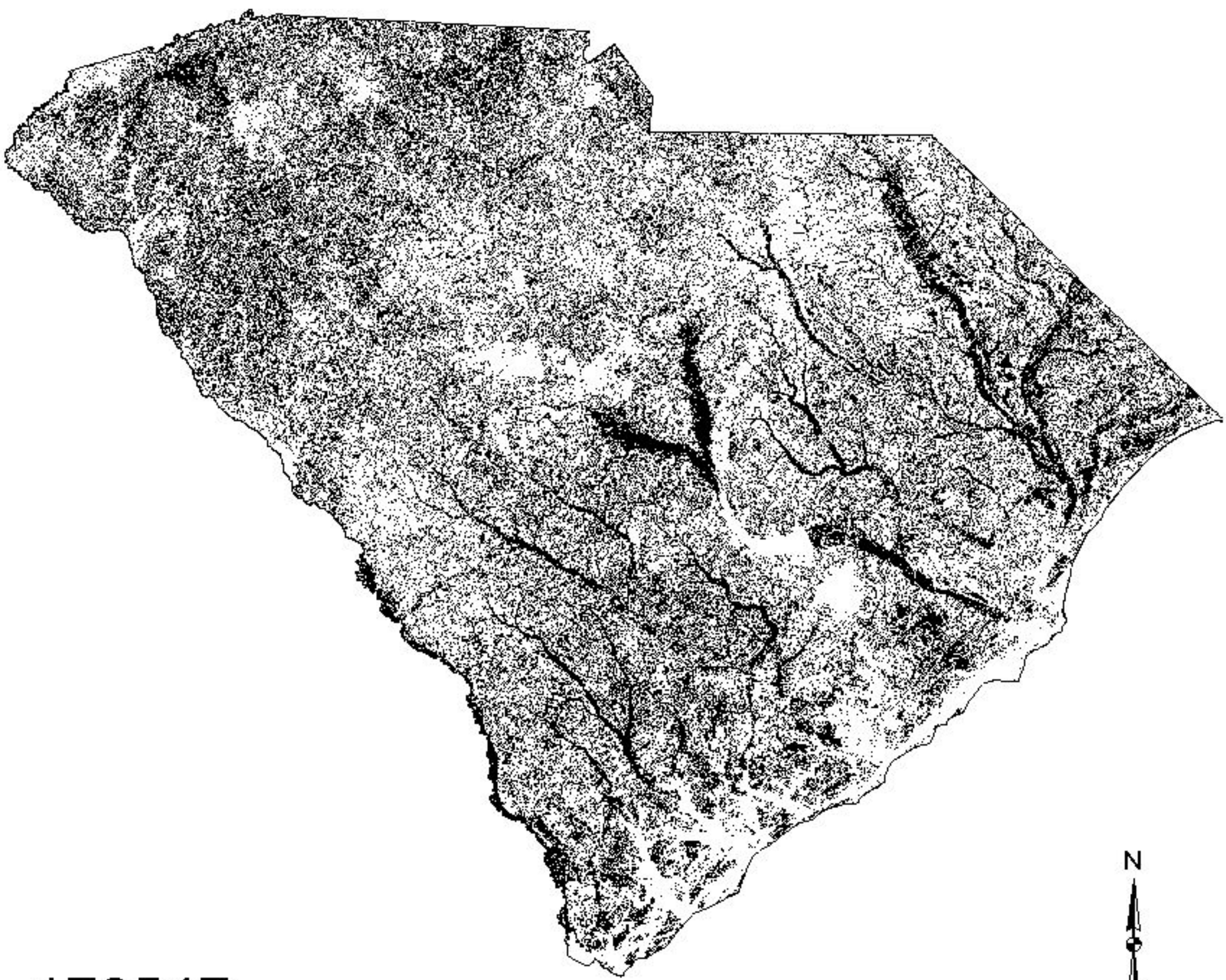
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Winter Wren

(Troglodytes troglodytes)



178547

Predicted present

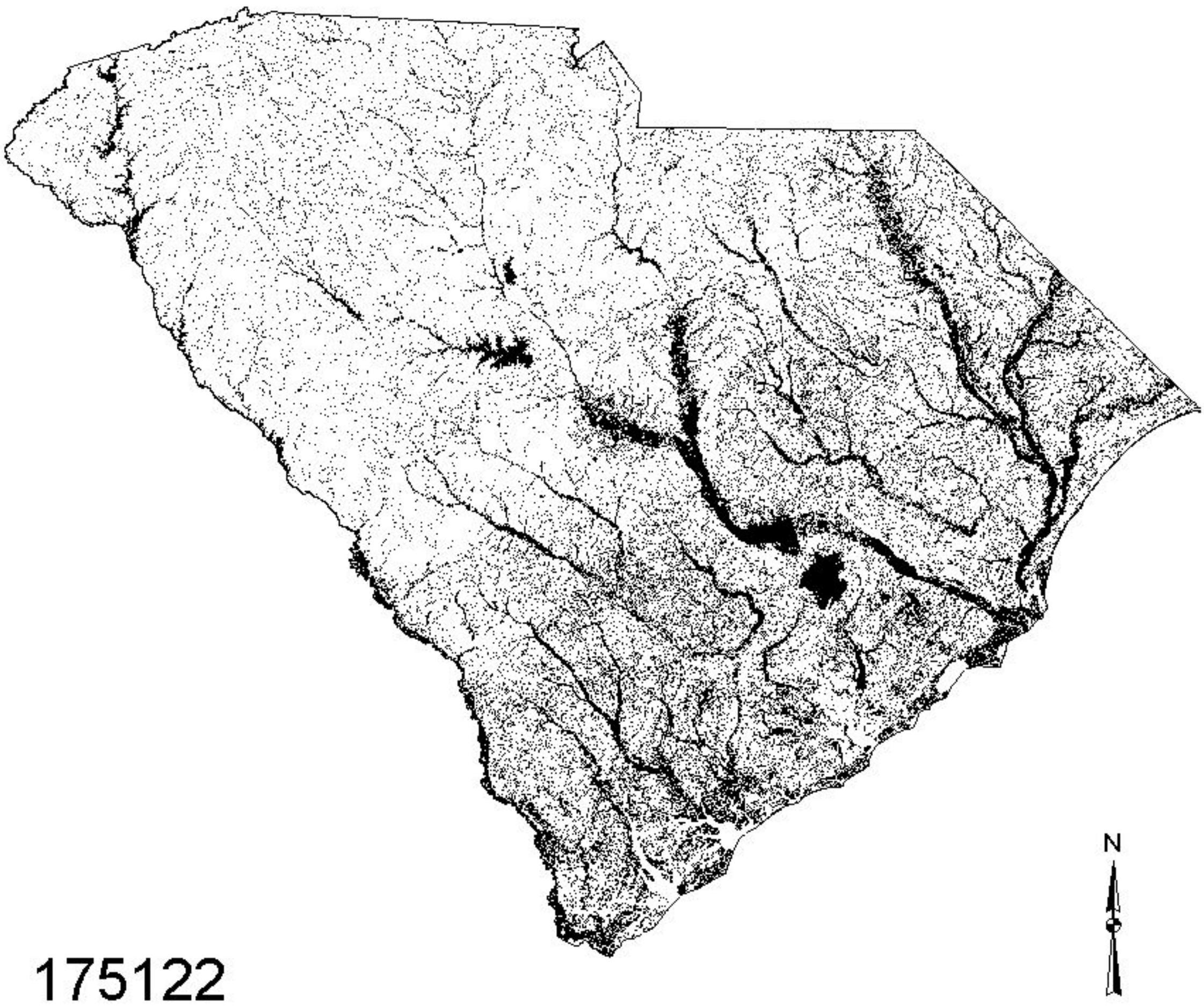
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Wood Duck

(Aix sponsa)



175122

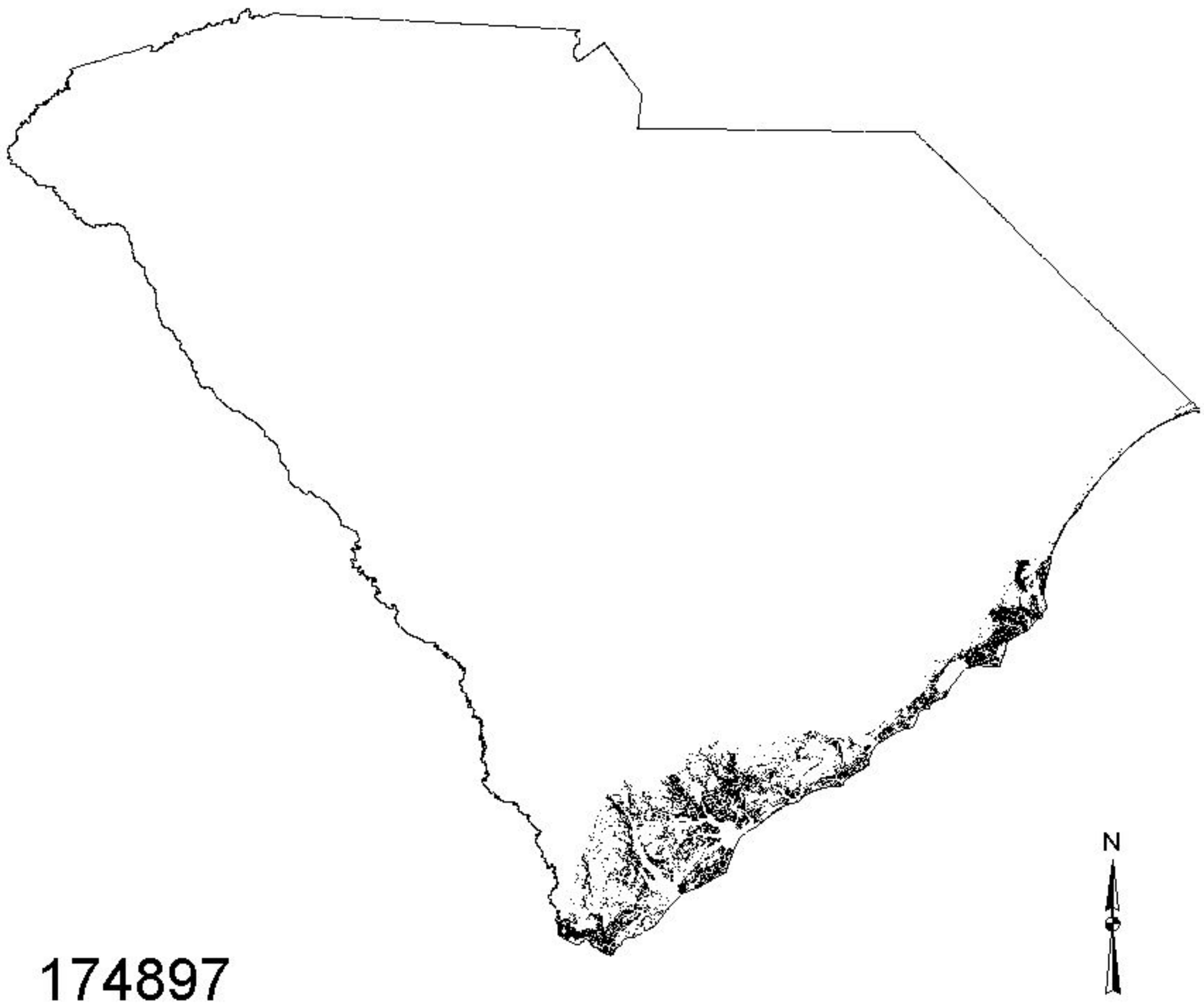
Predicted present

Predicted absent

State boundary

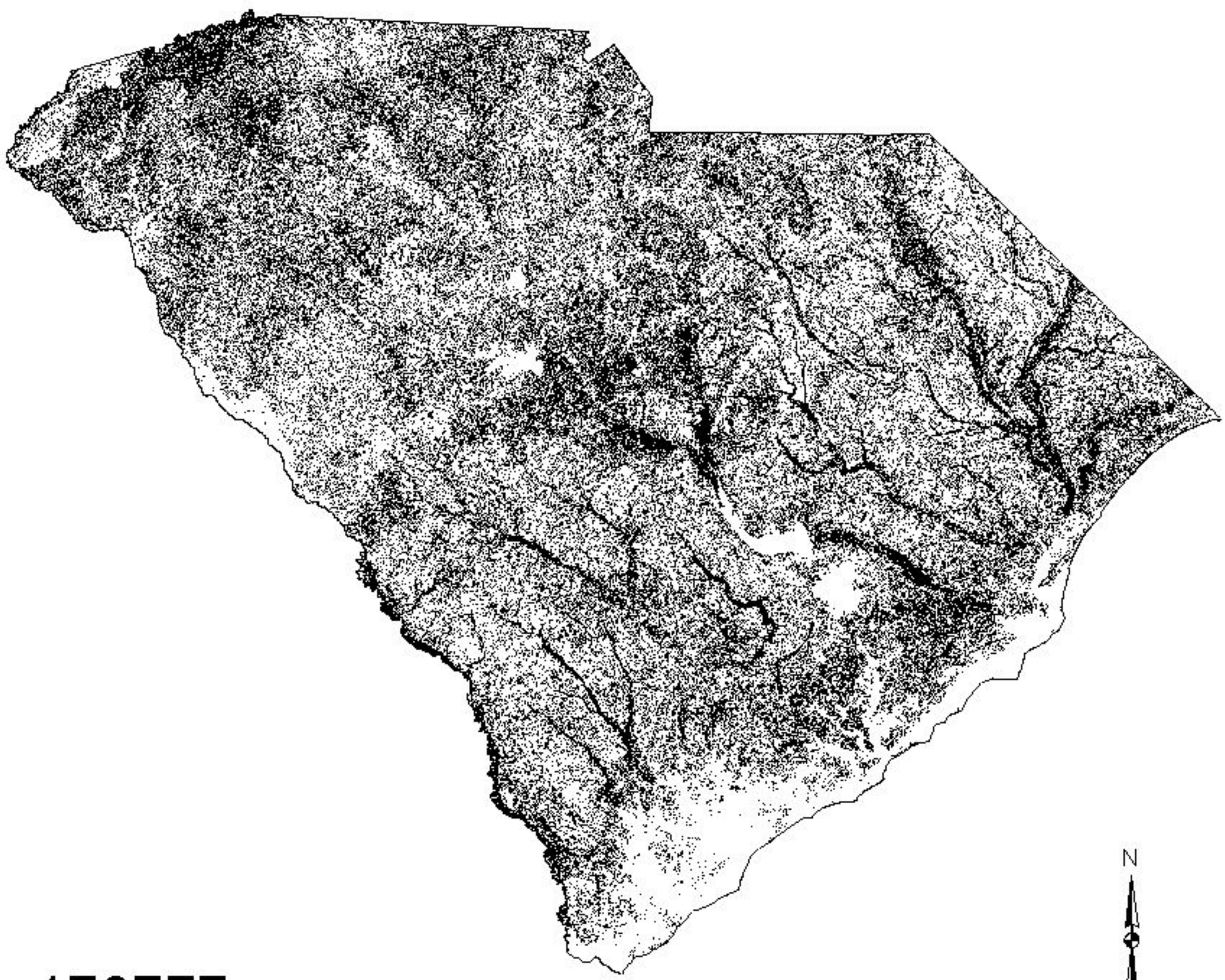
Wood Stork

(Mycteria americana)



Wood Thrush

(Hylocichla mustelina)



179777

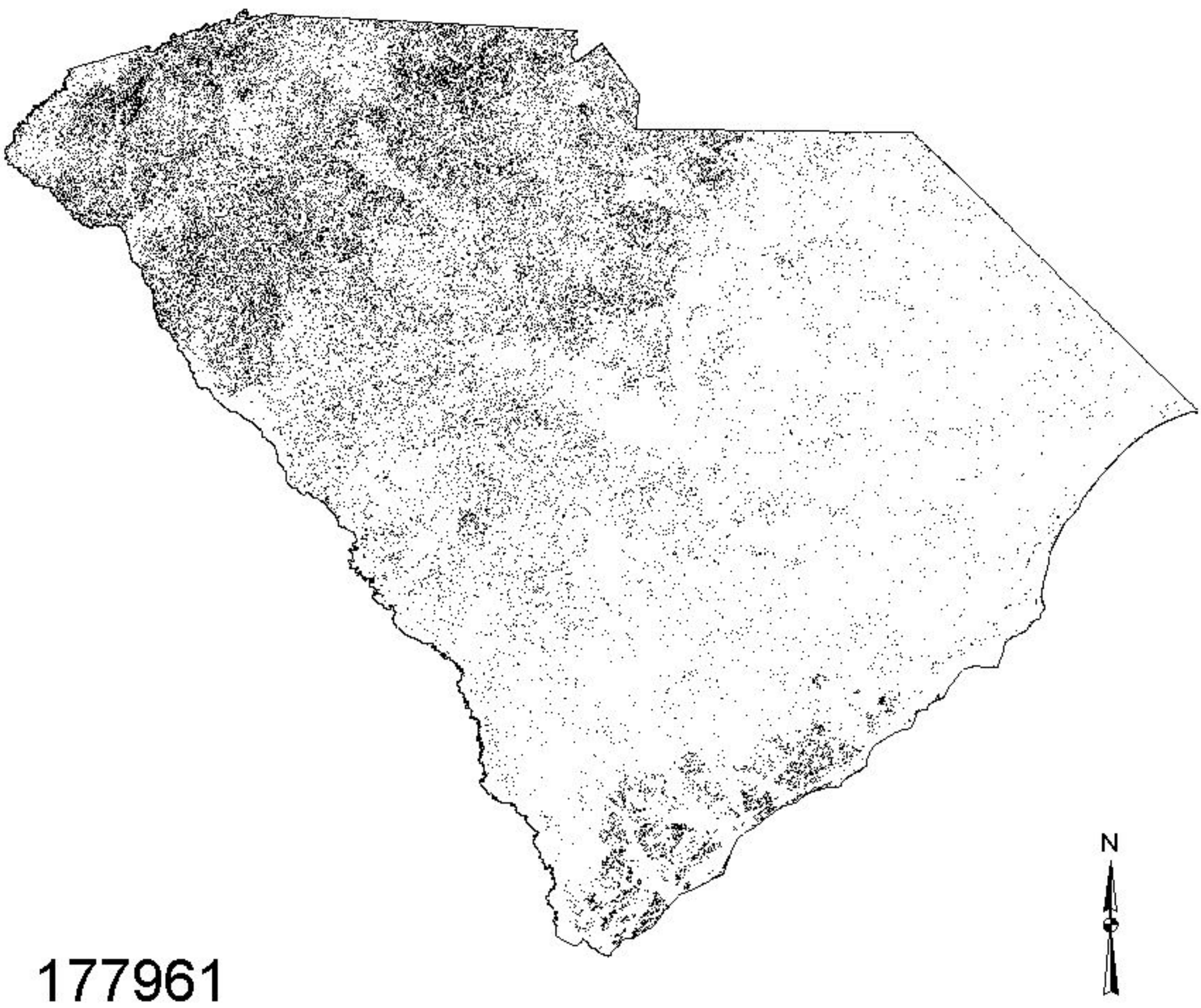
Predicted present

Predicted absent

State boundary

Whip-poor-will

(Caprimulgus vociferus)



177961

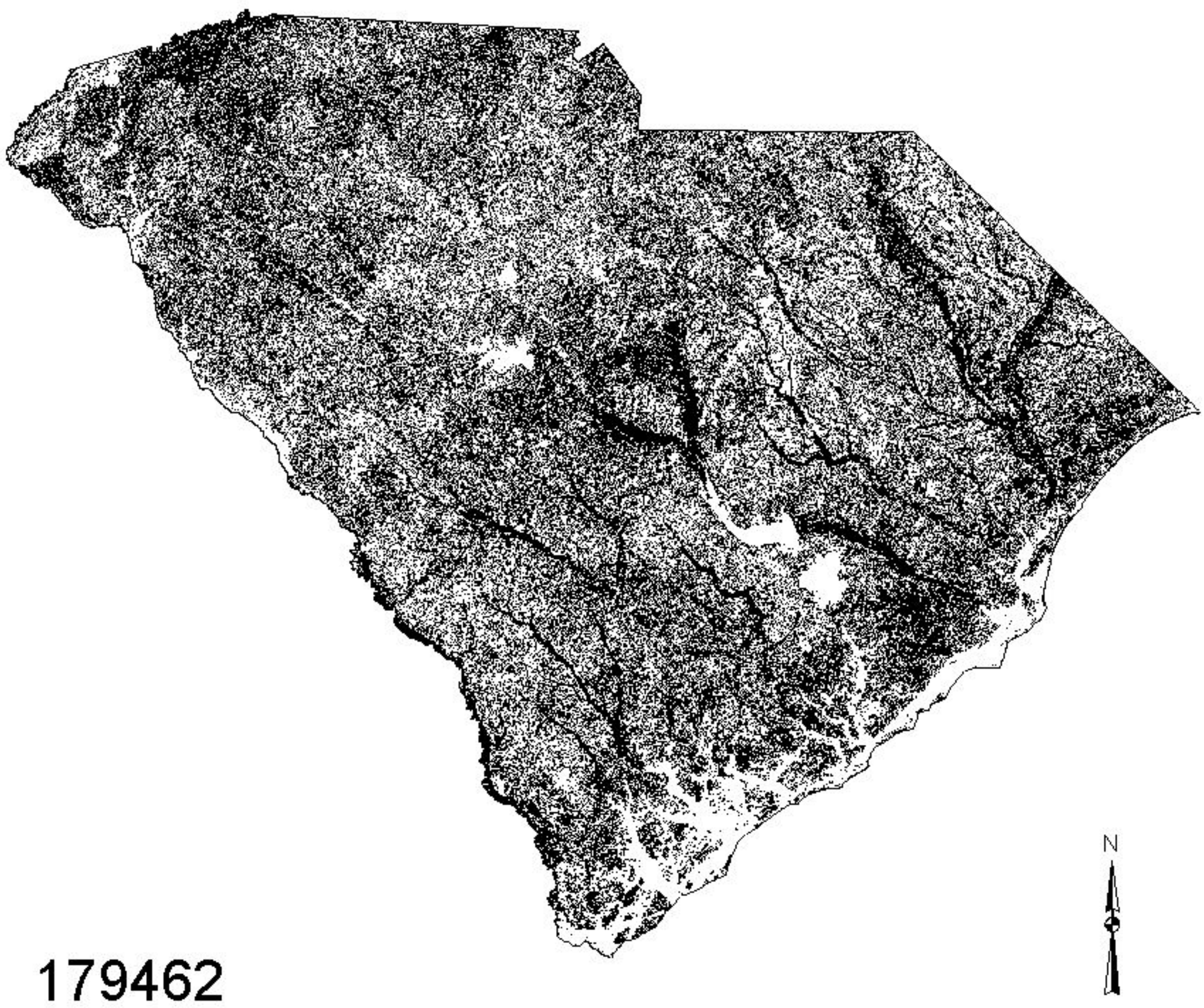
Predicted present

Predicted absent

State boundary

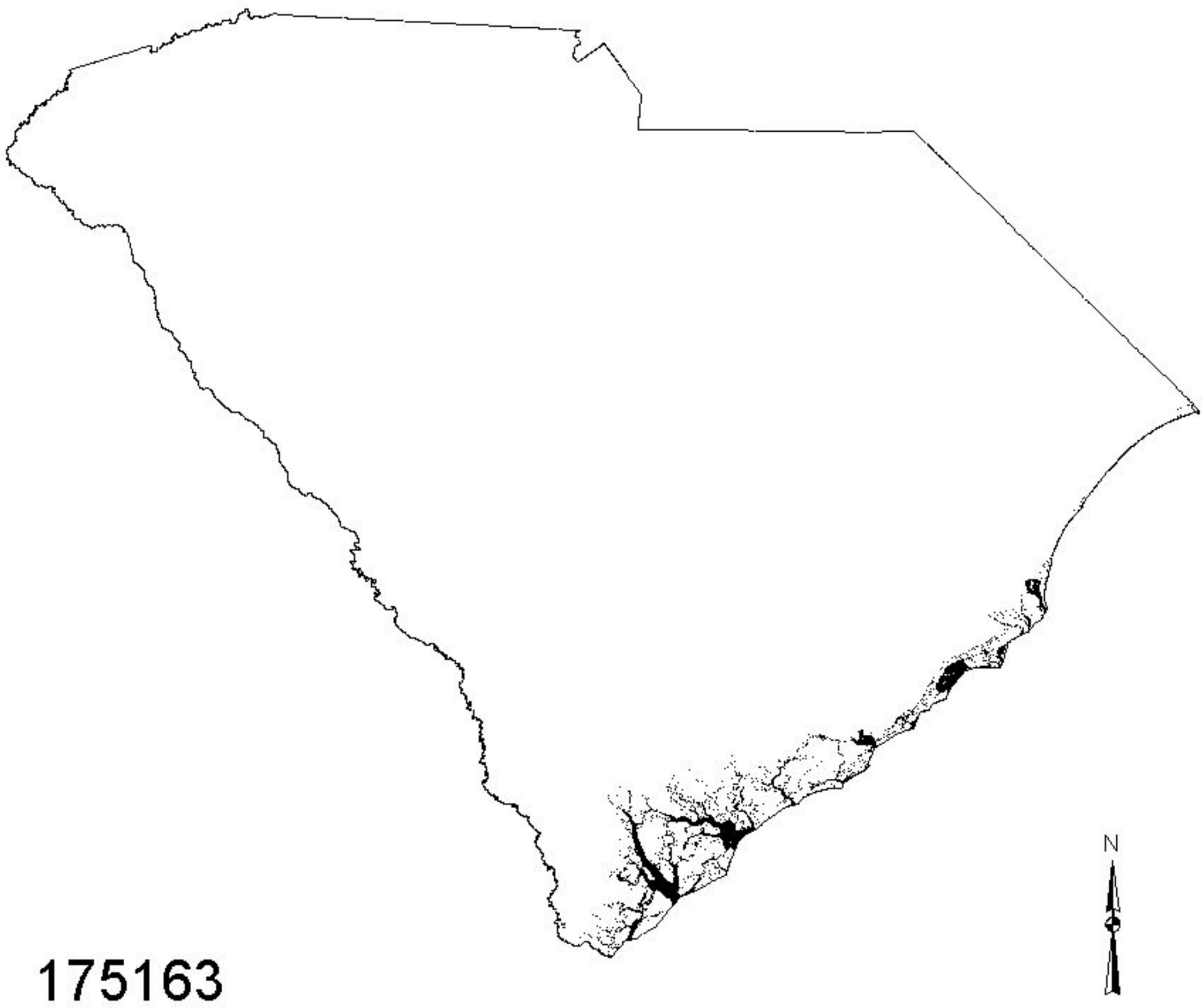
White-throated Sparrow

(Zonotrichia albicollis)



White-winged Scoter

(Melanitta fusca)



175163

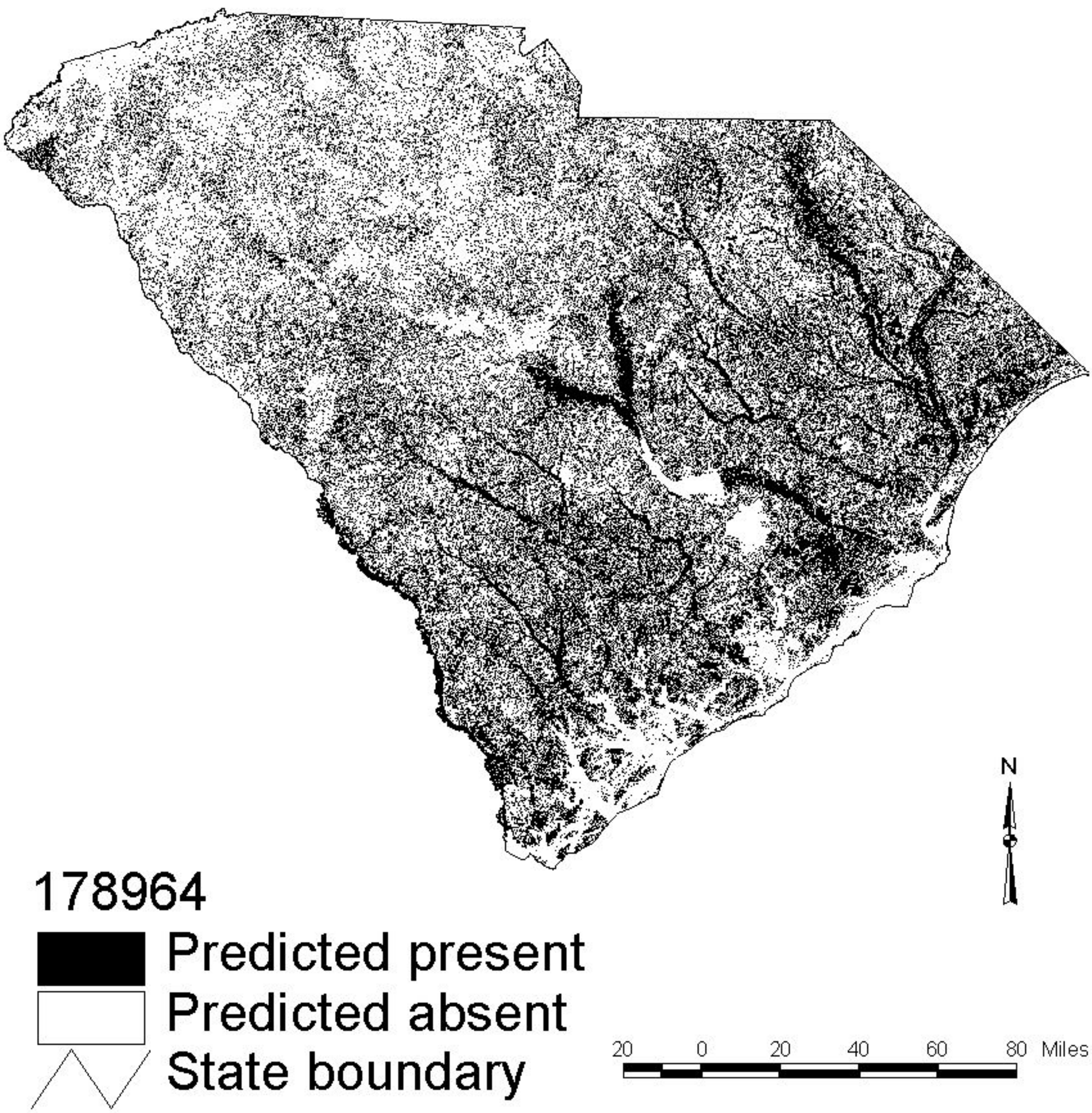
Predicted present

Predicted absent

State boundary

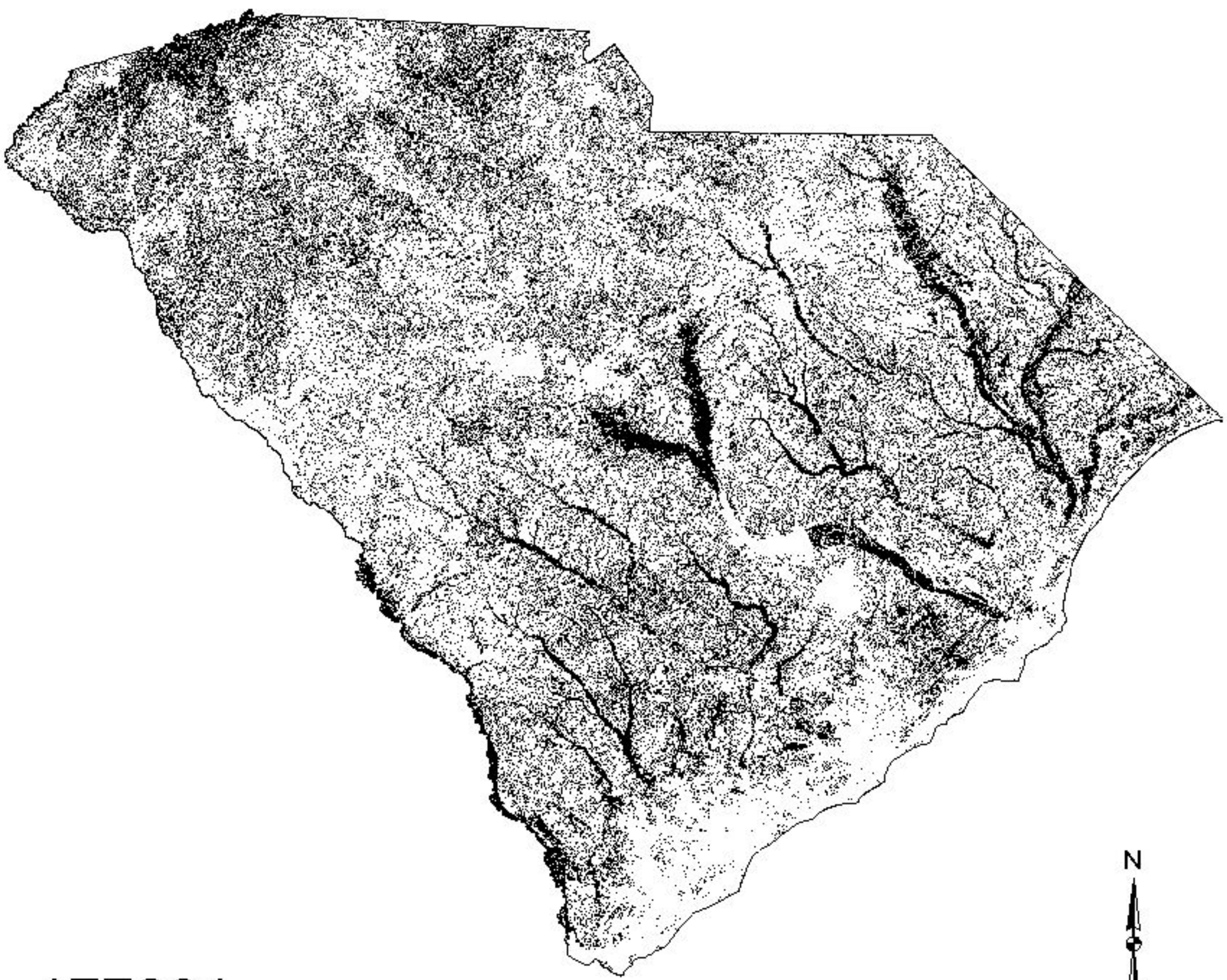
Yellow-breasted Chat

(Icteria virens)



Yellow-billed Cuckoo

(Coccyzus americanus)



177831

Predicted present

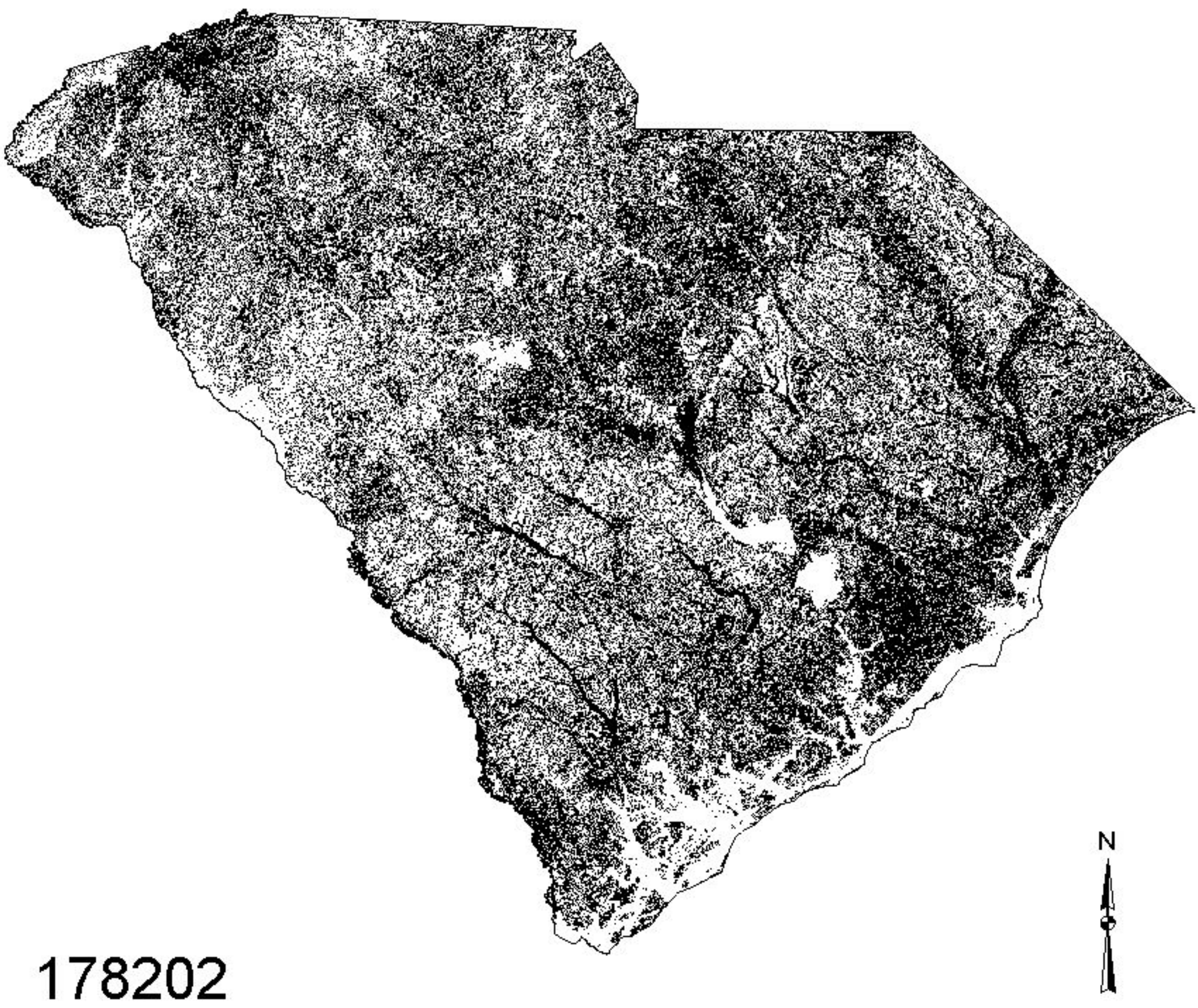
Predicted absent

State boundary

20 0 20 40 60 80 Miles

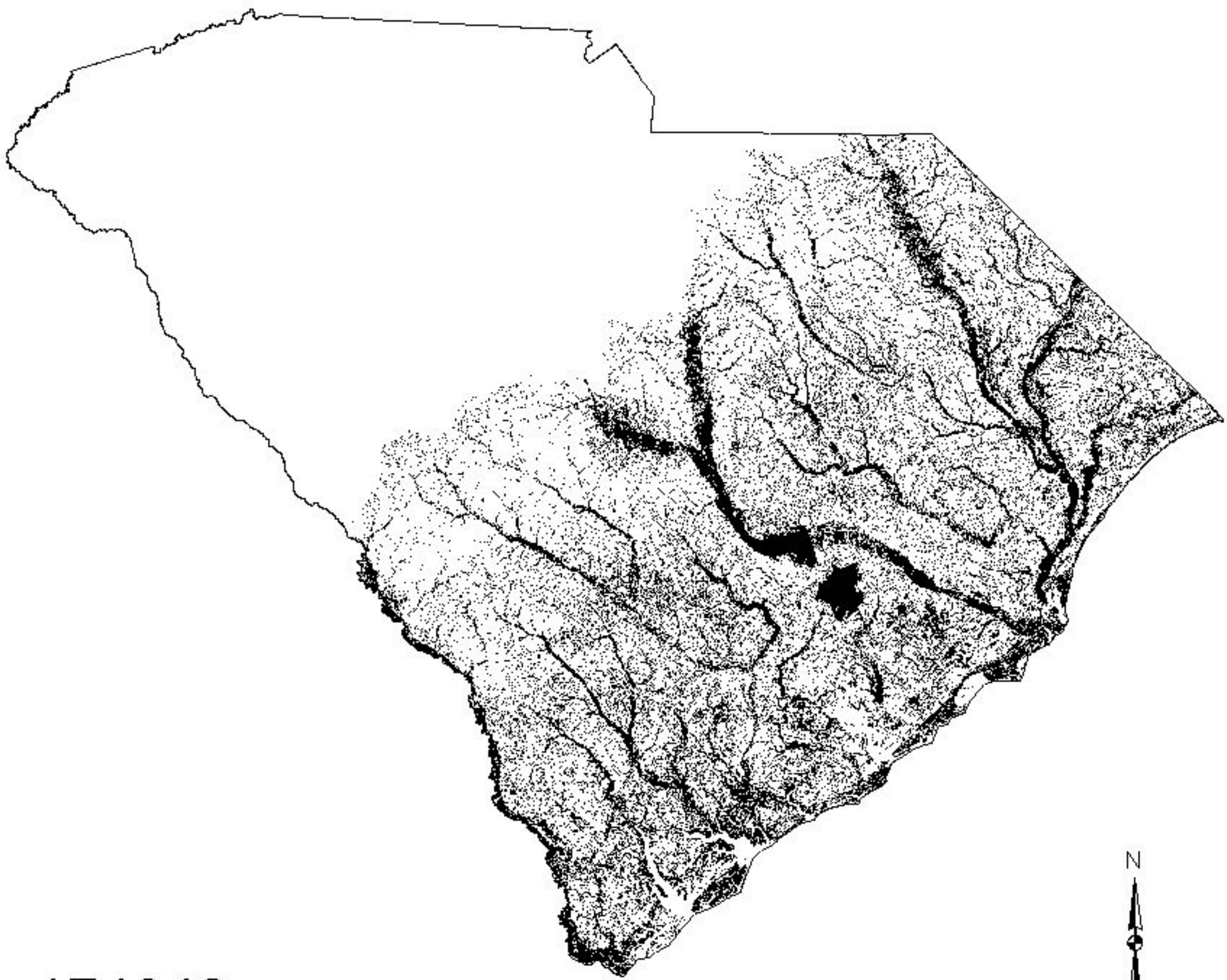
Yellow-bellied Sapsucker

(Sphyrapicus varius)



Yellow-crowned Night-heron

(Nyctanassa violacea)



174842

Predicted present

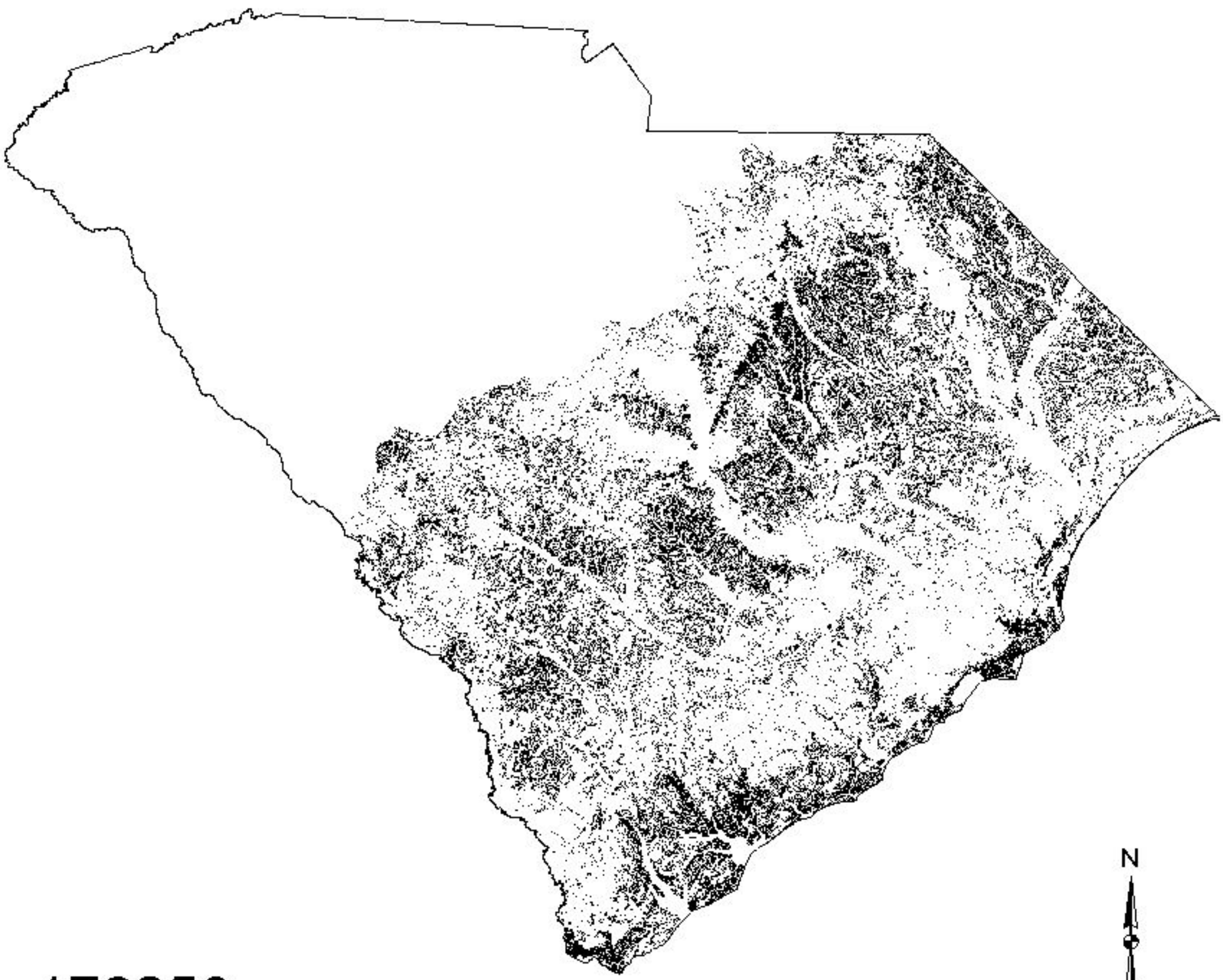
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Yellow Rail

(Coturnicops noveboracensis)



176259

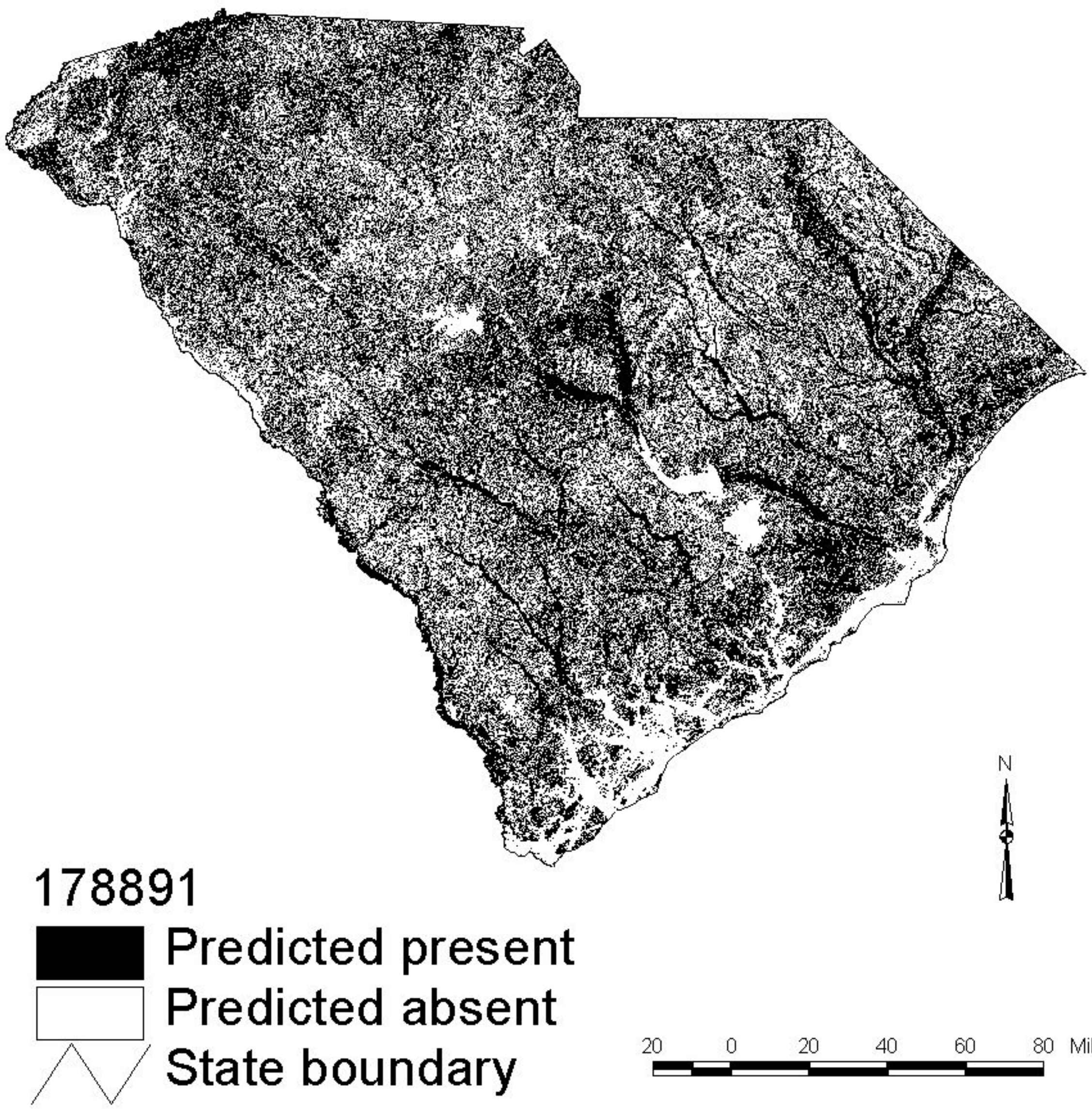
Predicted present

Predicted absent

State boundary

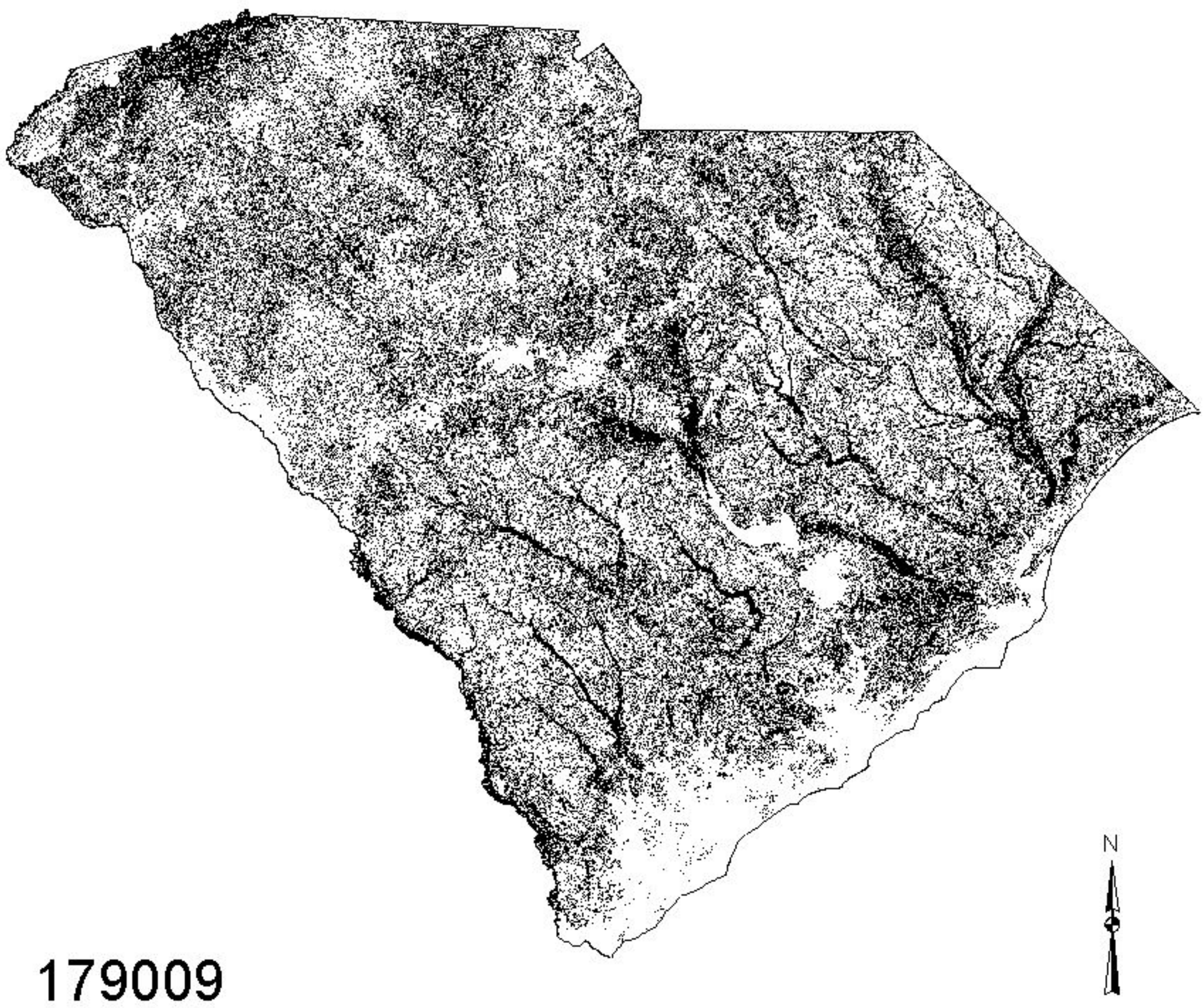
Yellow-rumped Warbler

(Dendroica coronata)



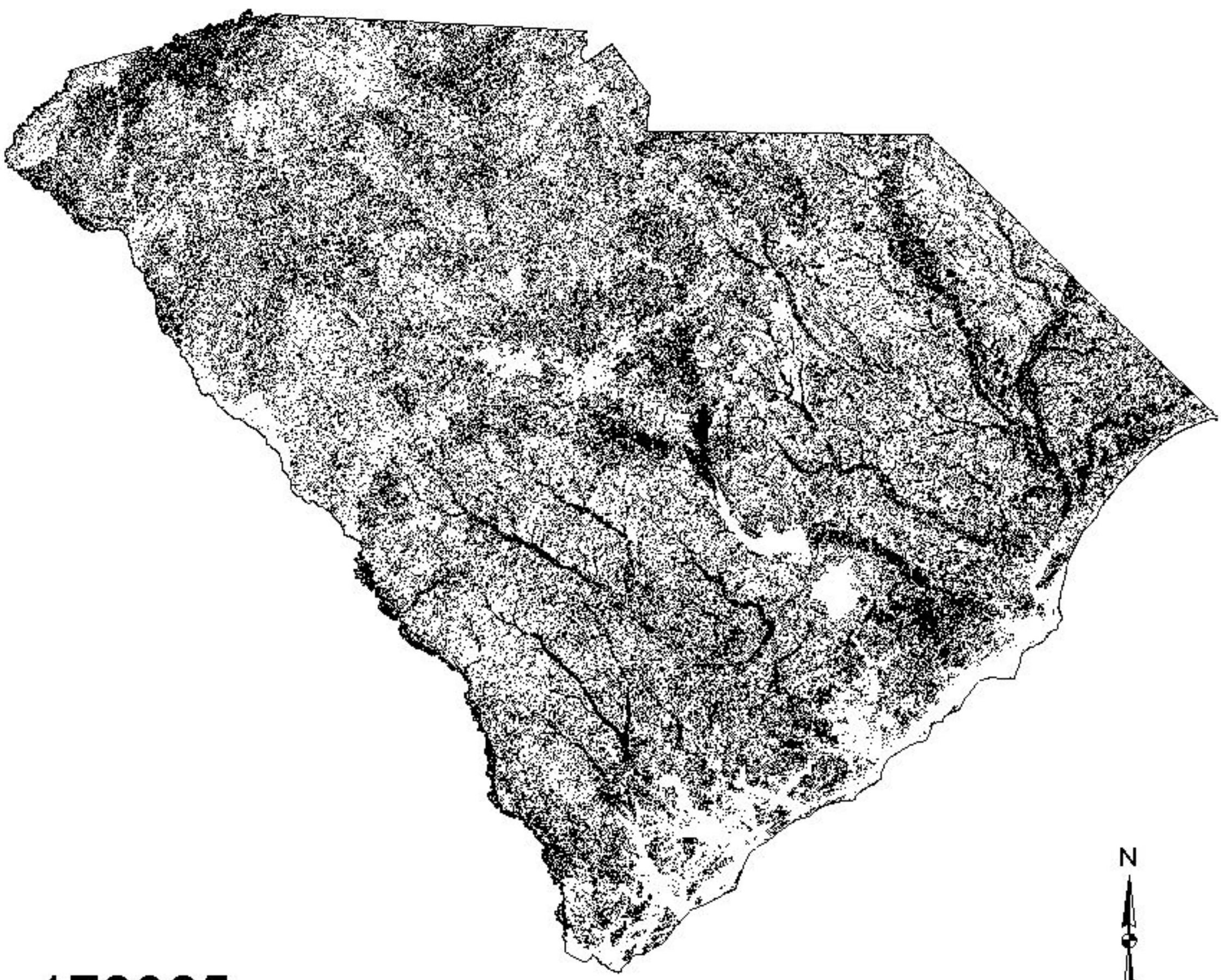
Yellow-throated Vireo

(Vireo flavifrons)



Yellow-throated Warbler

(Dendroica dominica)



178905

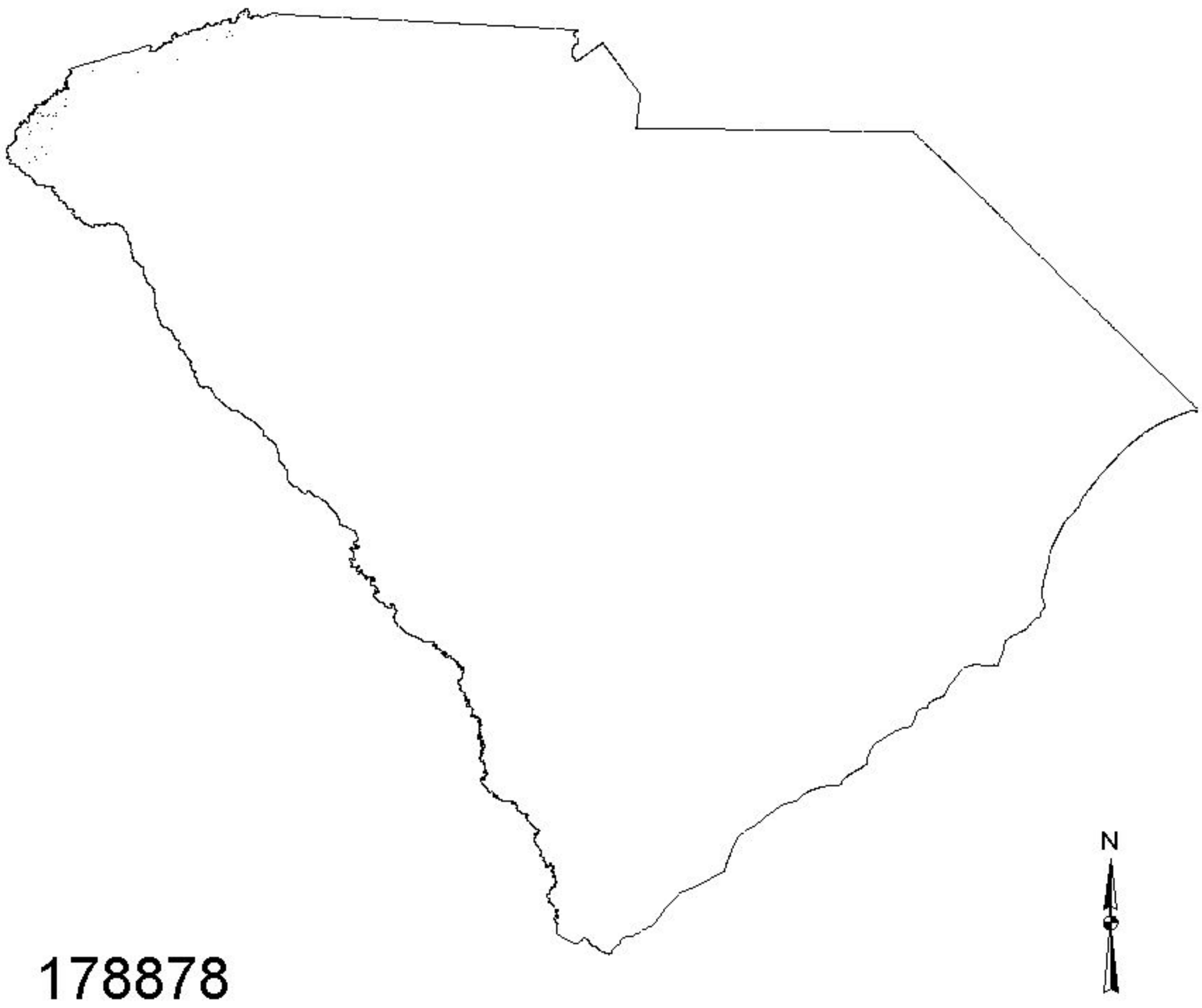
Predicted present

Predicted absent

State boundary

Yellow Warbler

(Dendroica petechia)



178878

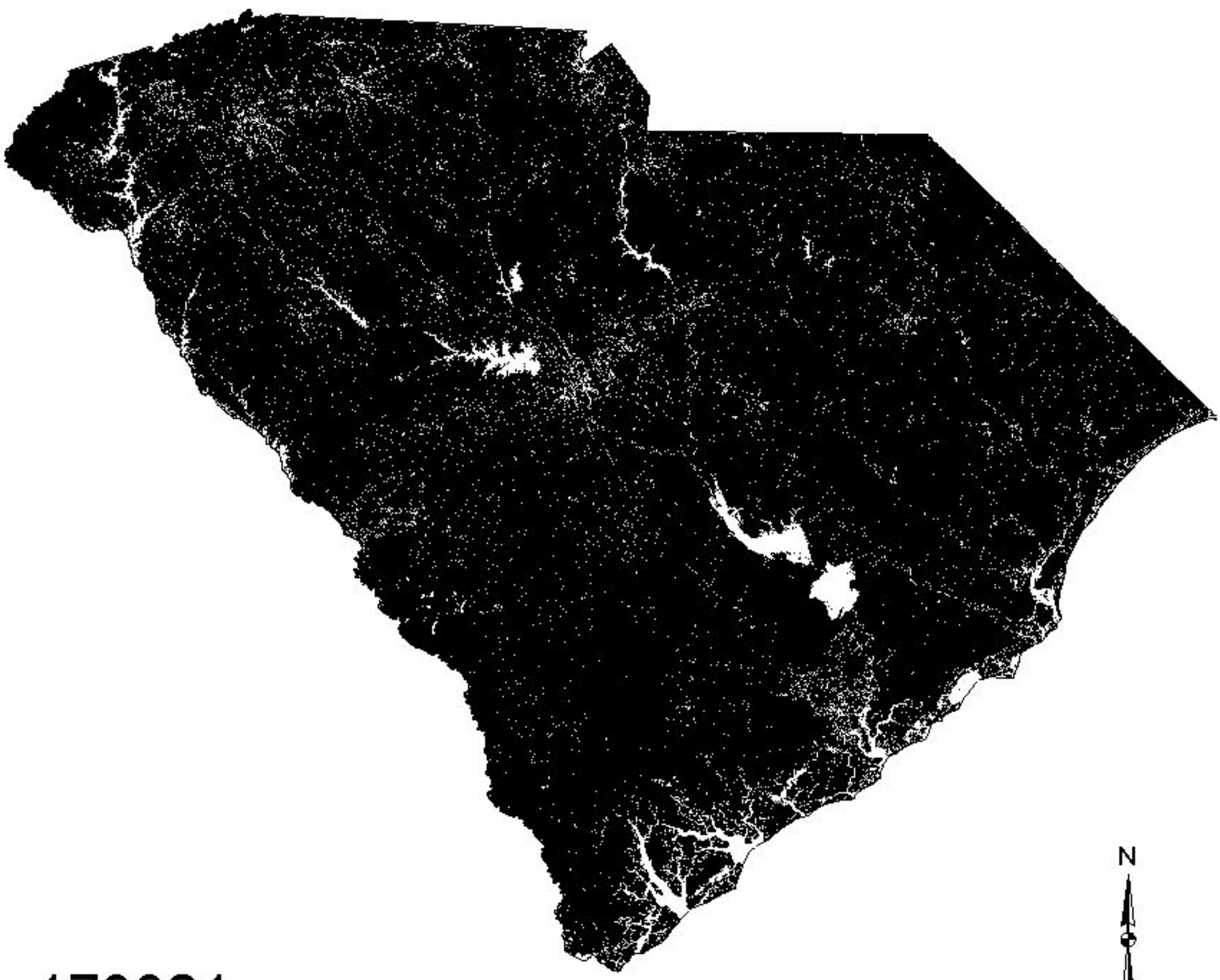
Predicted present

Predicted absent

State boundary

Virginia Opossum

(Didelphis virginiana)



179921

Predicted present

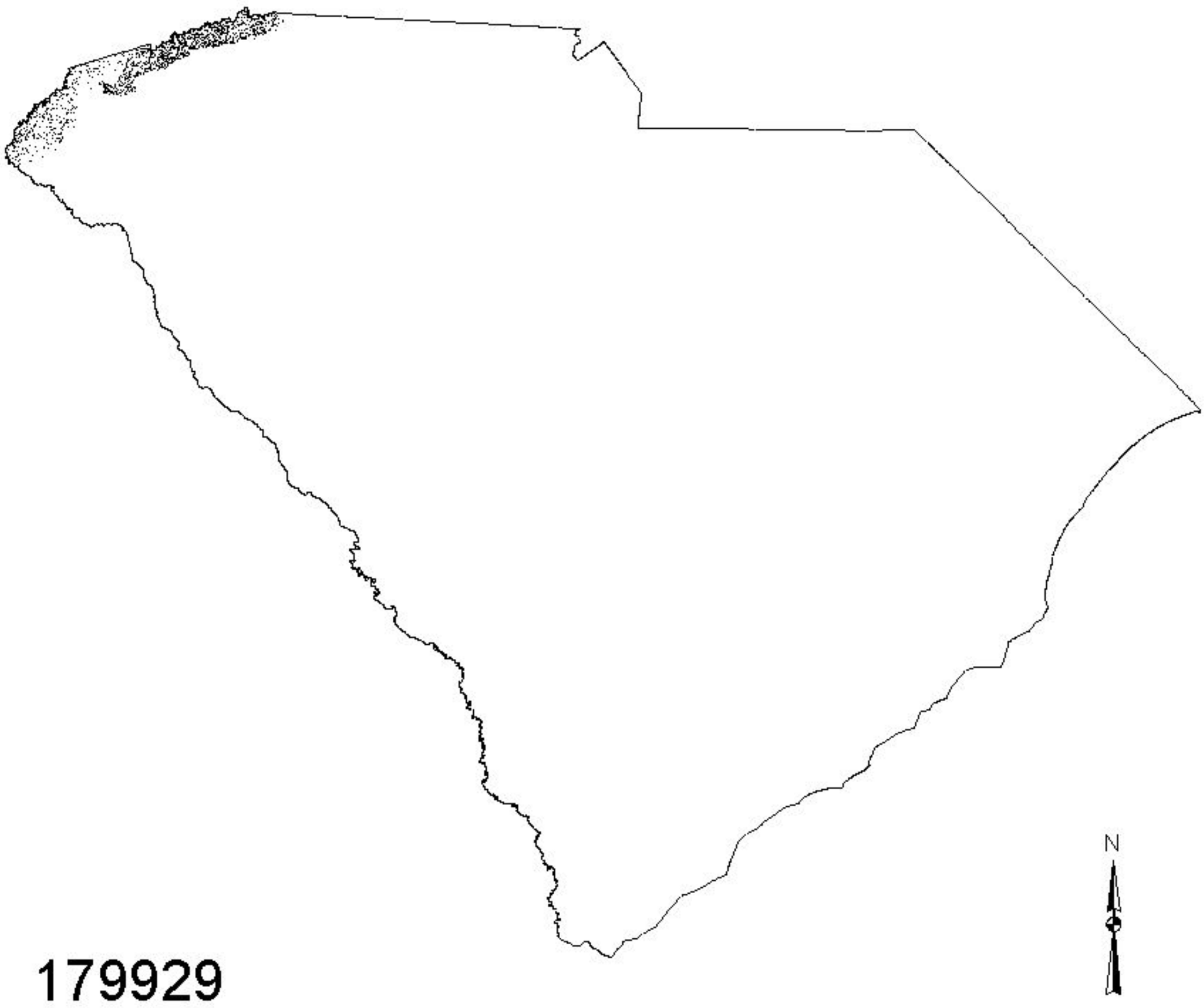
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Masked Shrew

(Sorex cinereus)



179929

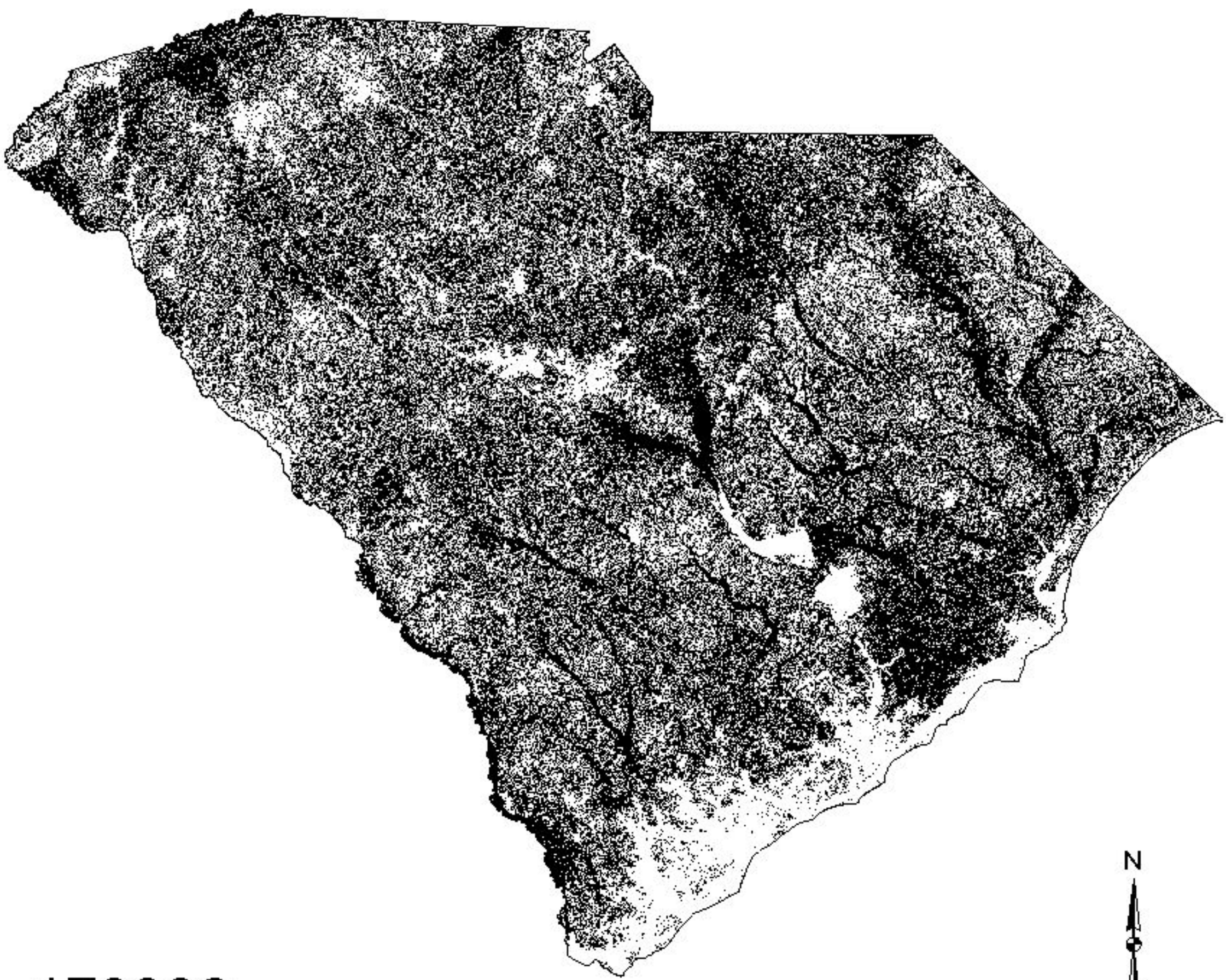
Predicted present

Predicted absent

State boundary

Southeastern Shrew

(Sorex longirostris)



179936

Predicted present

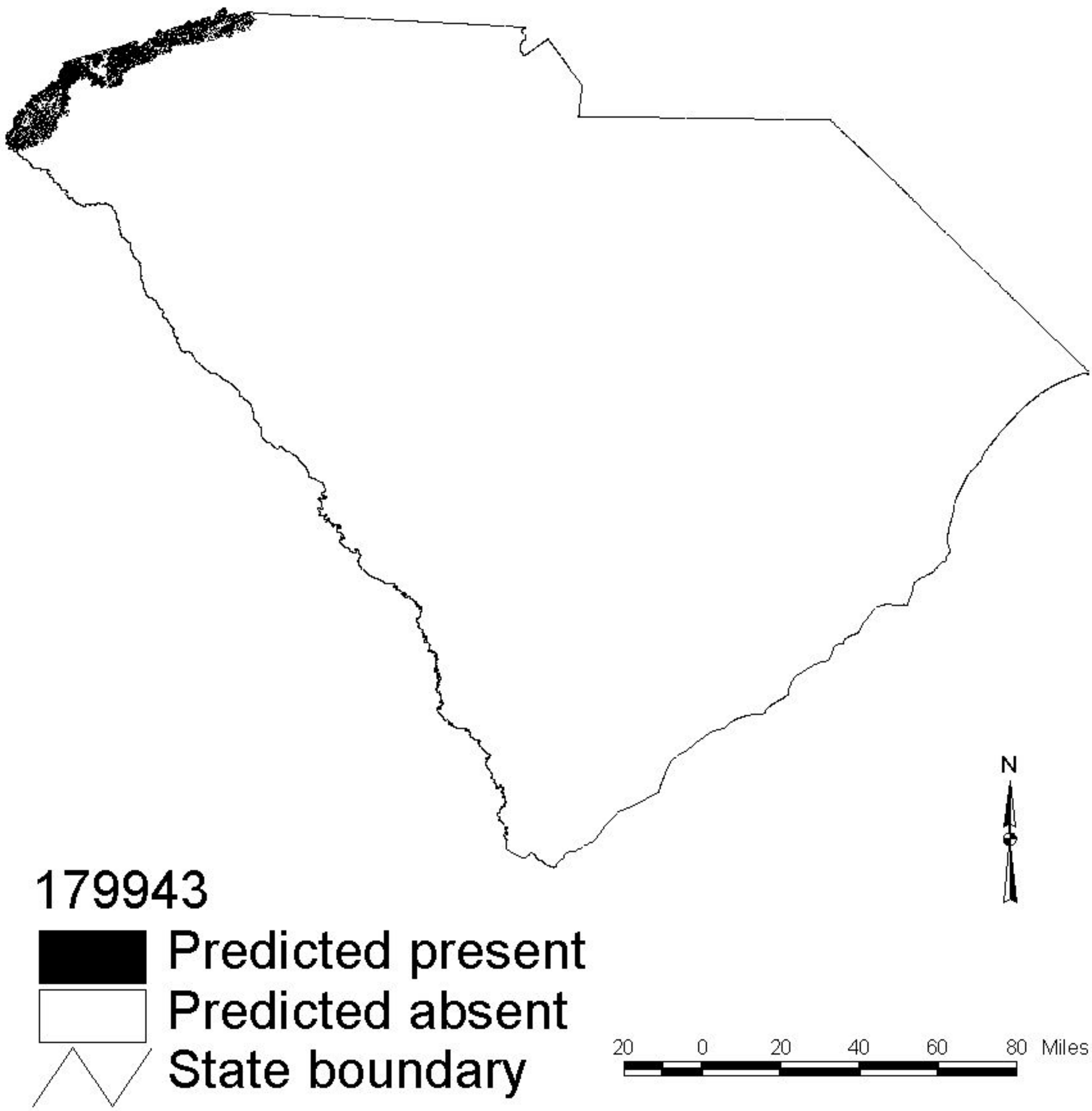
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Smoky Shrew

(Sorex fumeus)



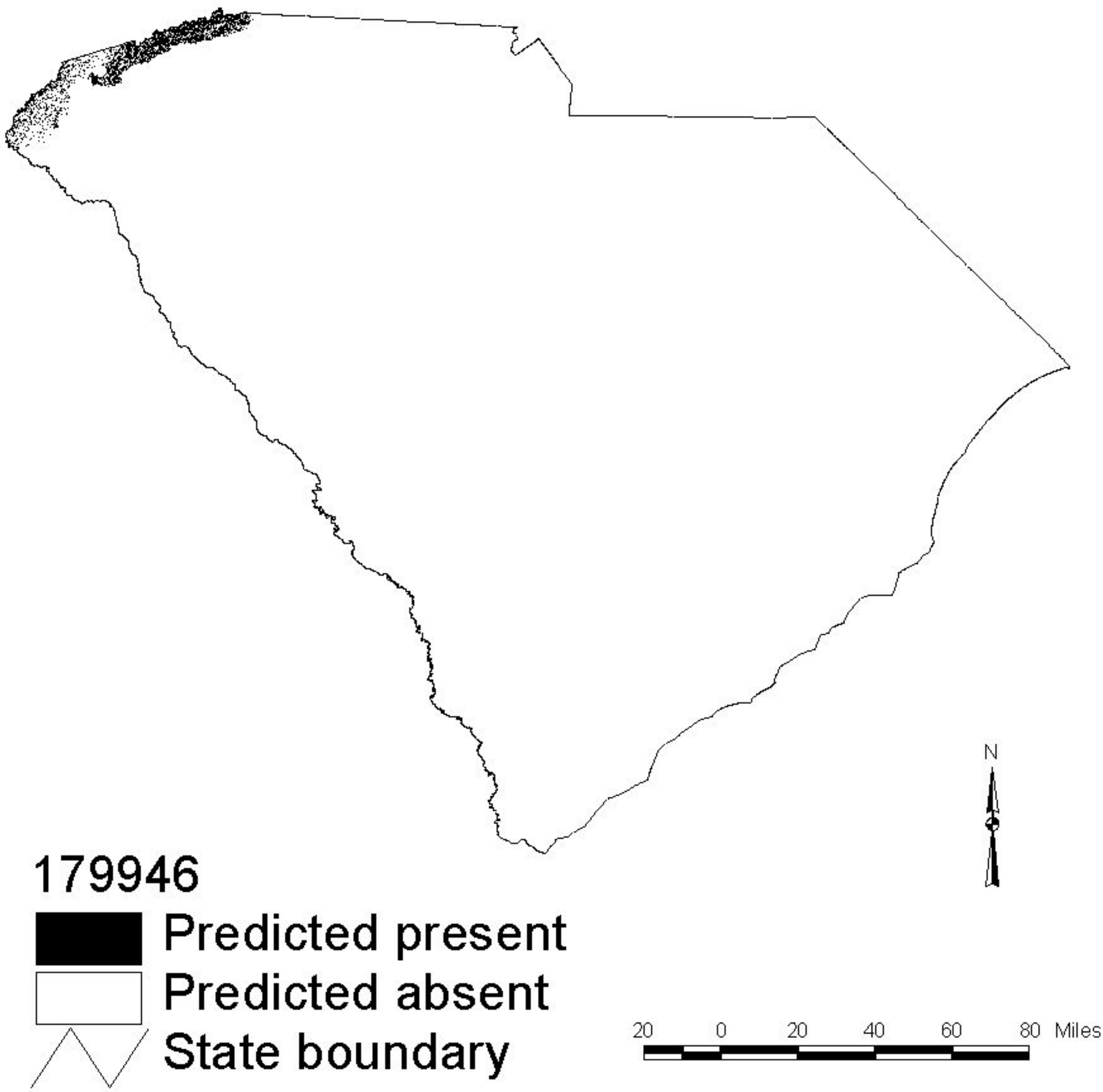
179943

Predicted present

Predicted absent

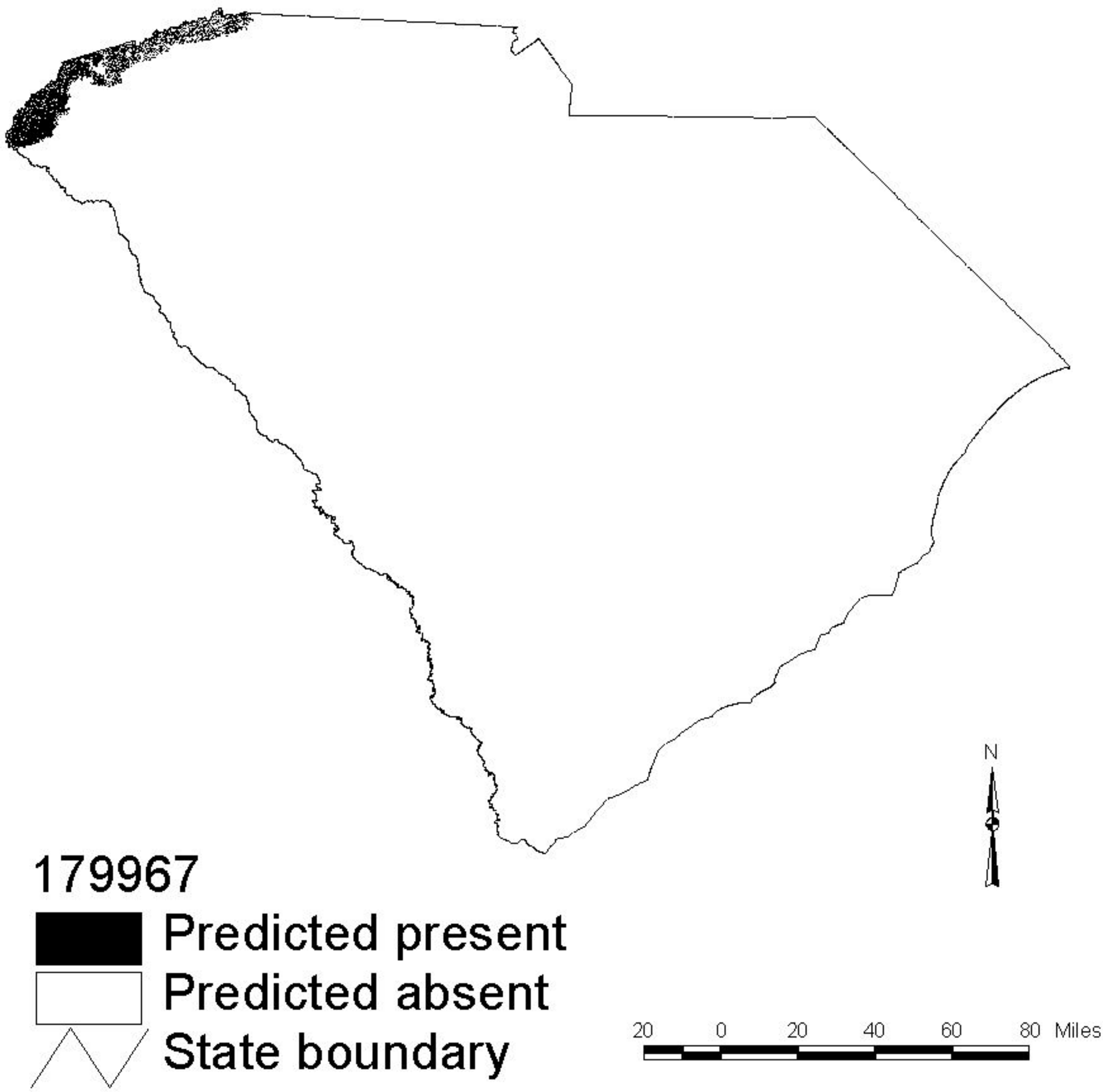
State boundary

Pygmy Shrew
(Sorex hoyi)



Northern Short-tailed Shrew

(Blarina brevicauda)



179967

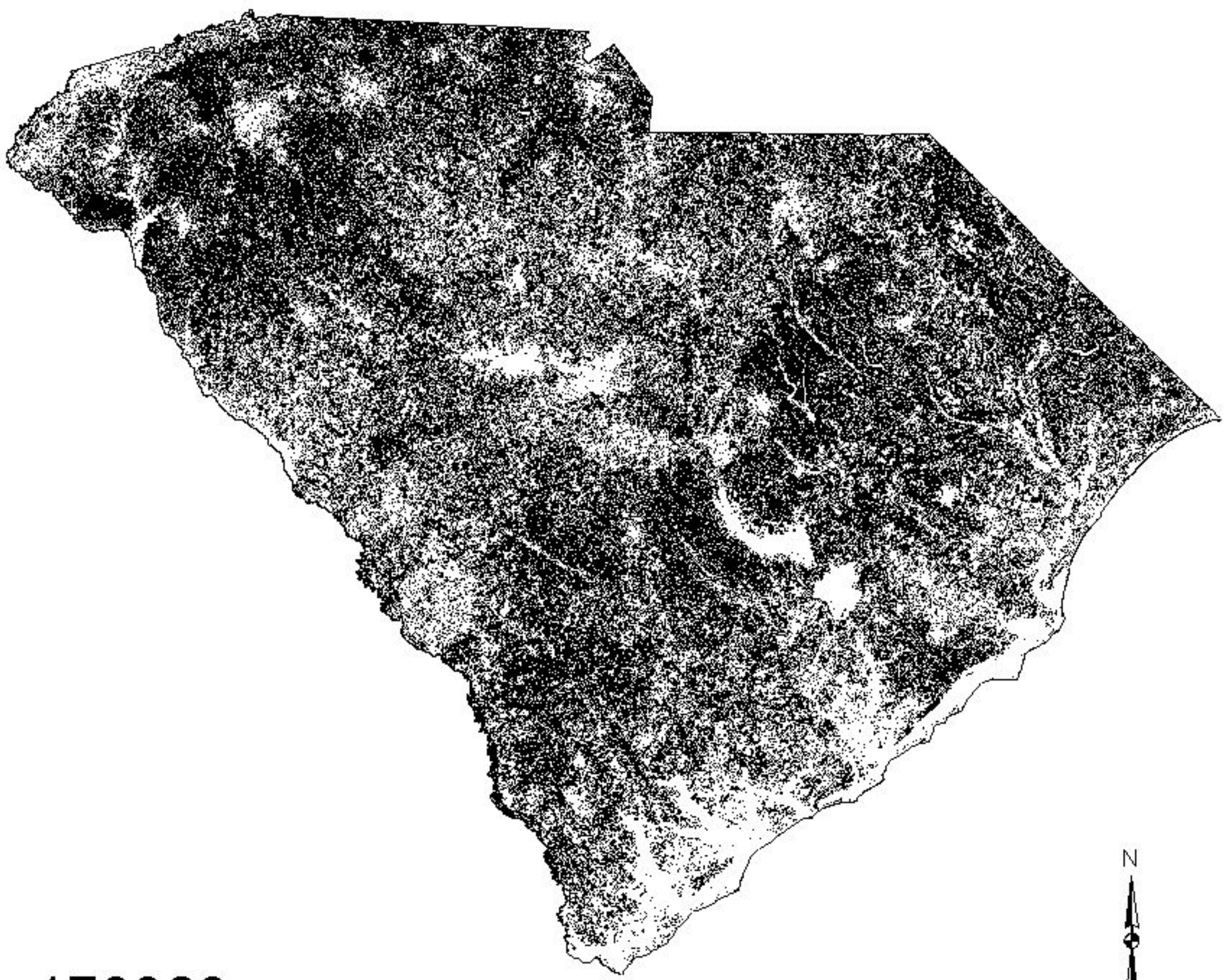
Predicted present

Predicted absent

State boundary

Carolina Short-tailed Shrew

(Blarina carolinensis)



179968

Predicted present

Predicted absent

State boundary

20 0 20 40 60 80 Miles

Least Shrew

(Cryptotis parva)

179971

Predicted present

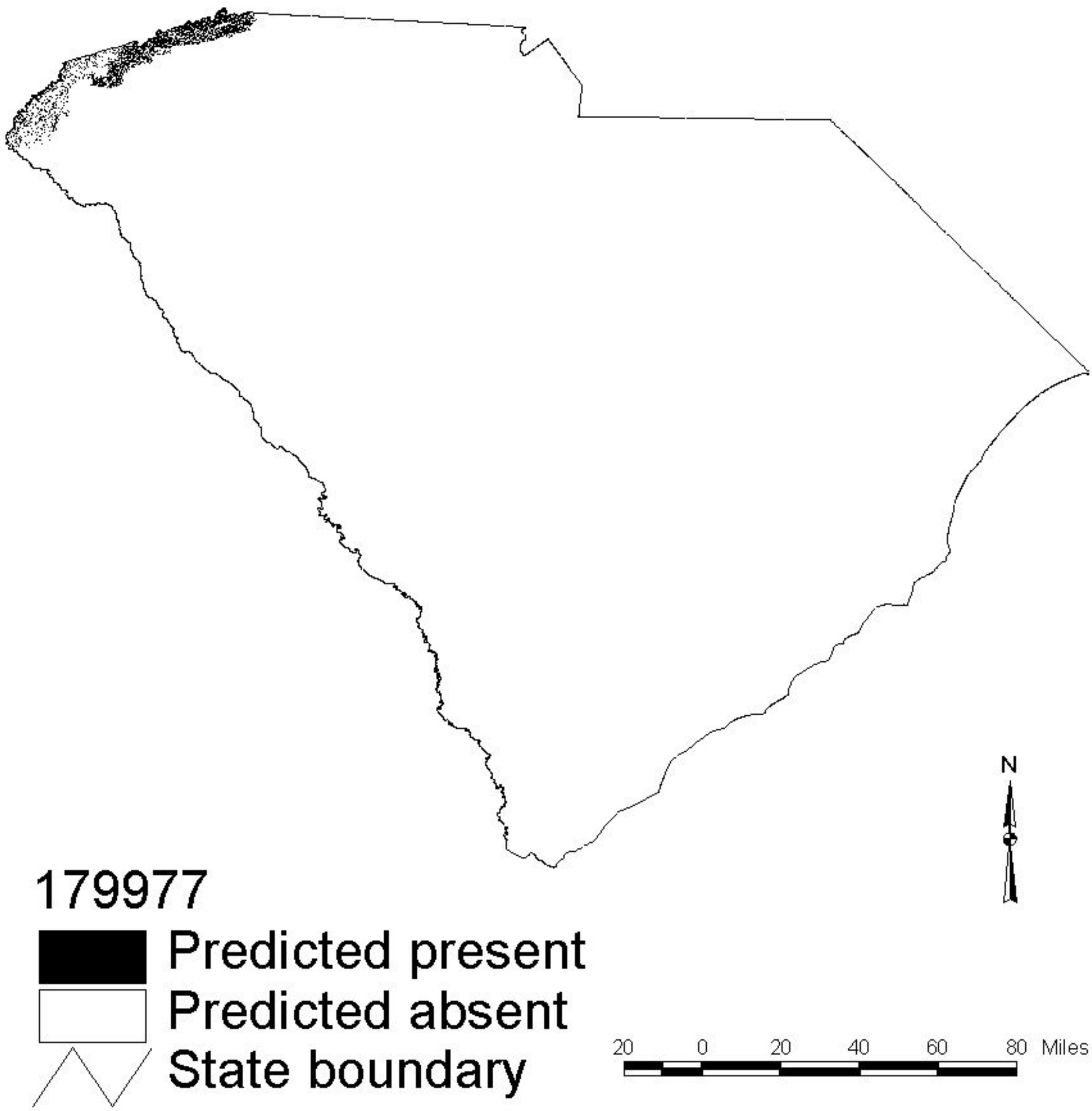
Predicted absent

State boundary

20 0 20 40 60 80 Miles

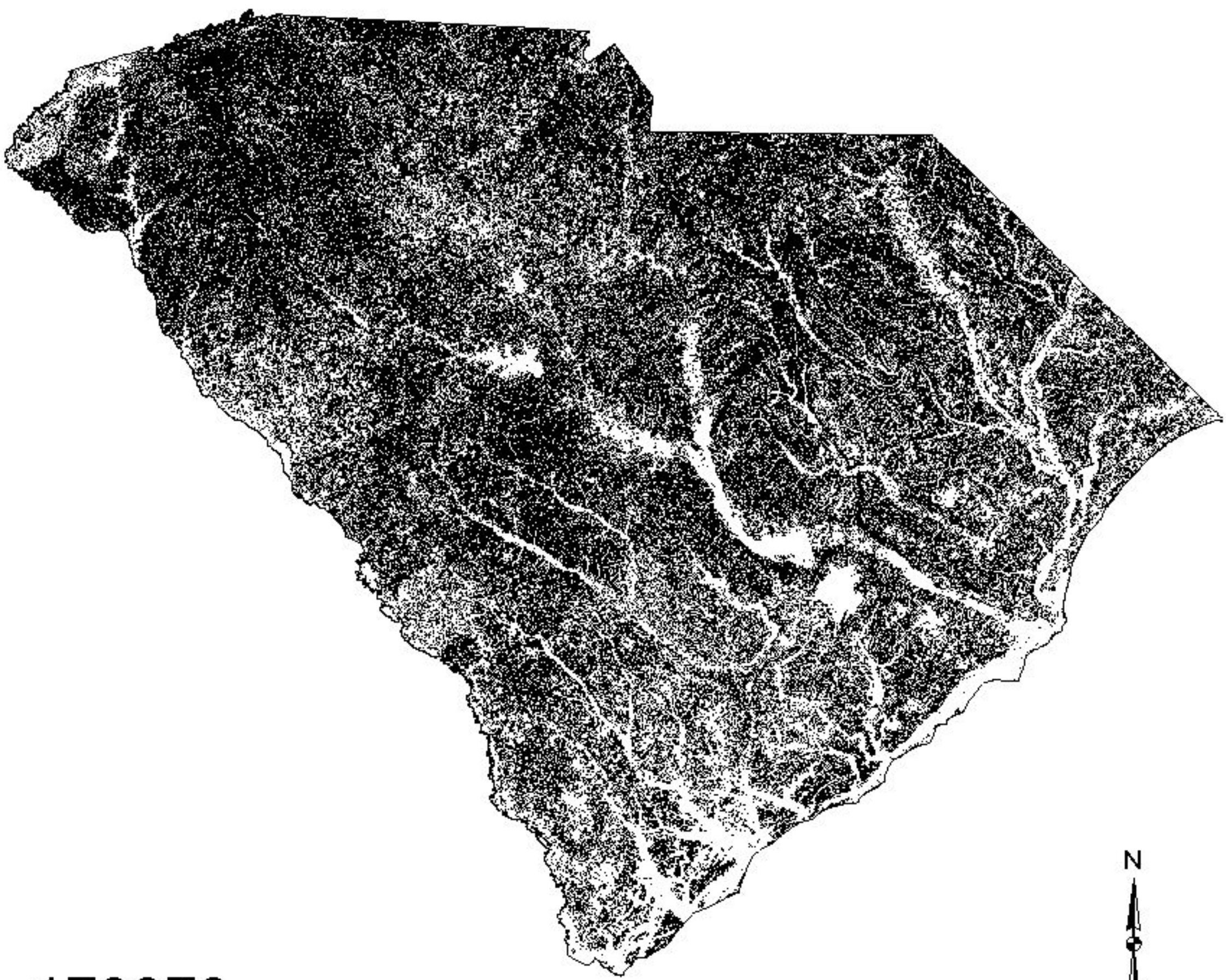
Hairy-tailed Mole

(Parascalops breweri)



Eastern Mole

(Scalopus aquaticus)



179979

Predicted present

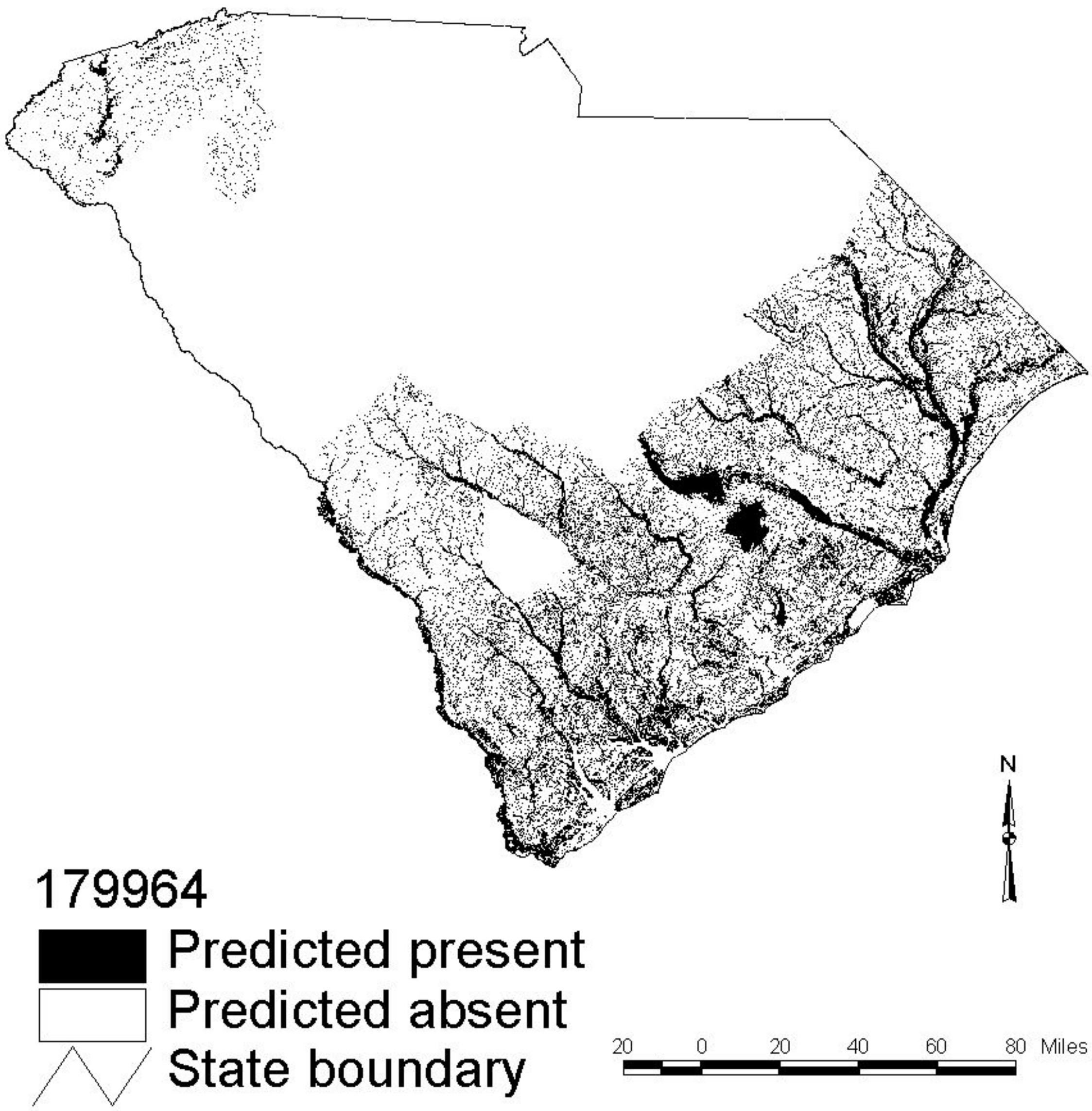
Predicted absent

State boundary

20 0 20 40 60 80 Miles

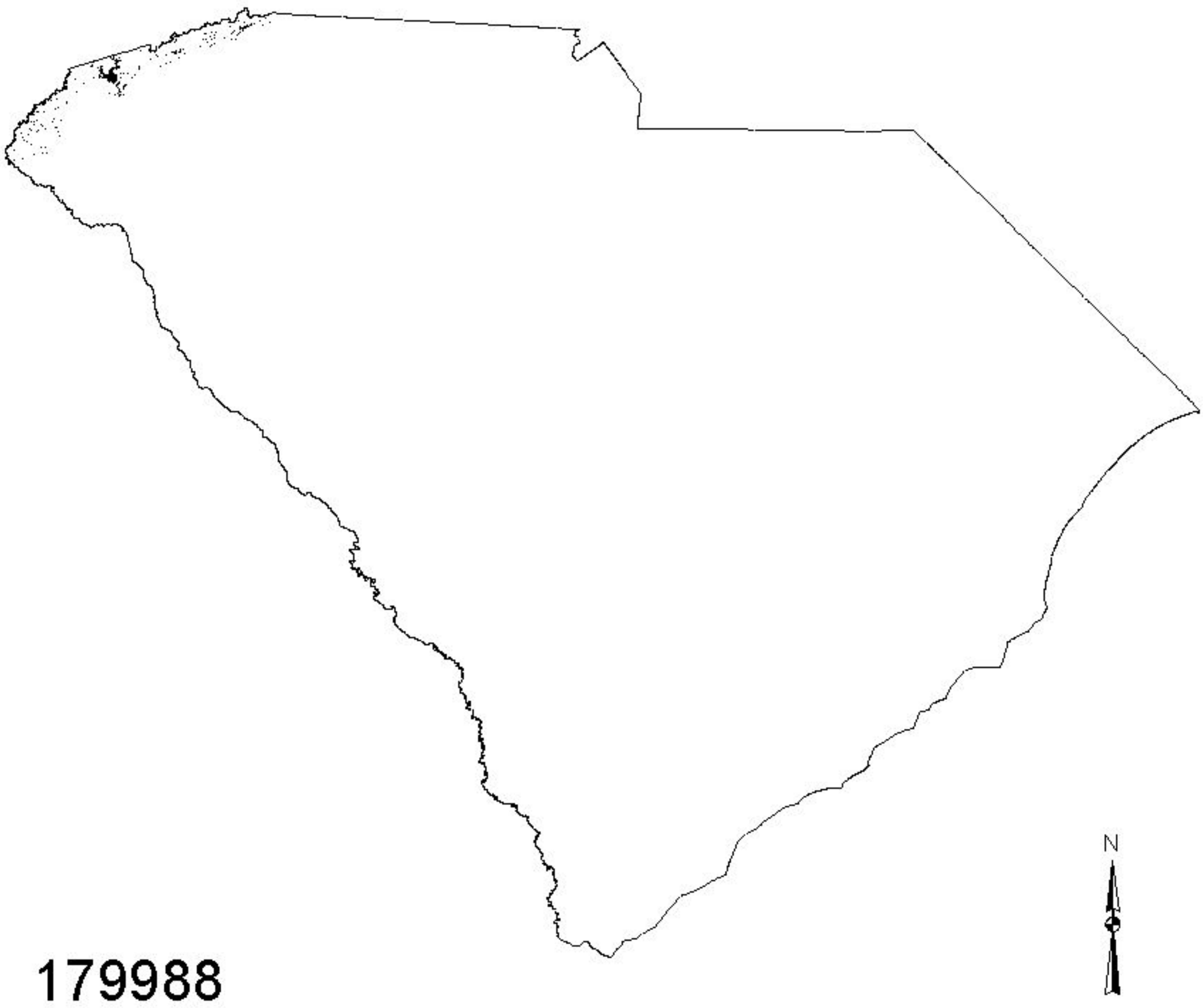
Star-nosed Mole

(Condylura cristata)



Little Brown Myotis

(Myotis lucifugus)



179988

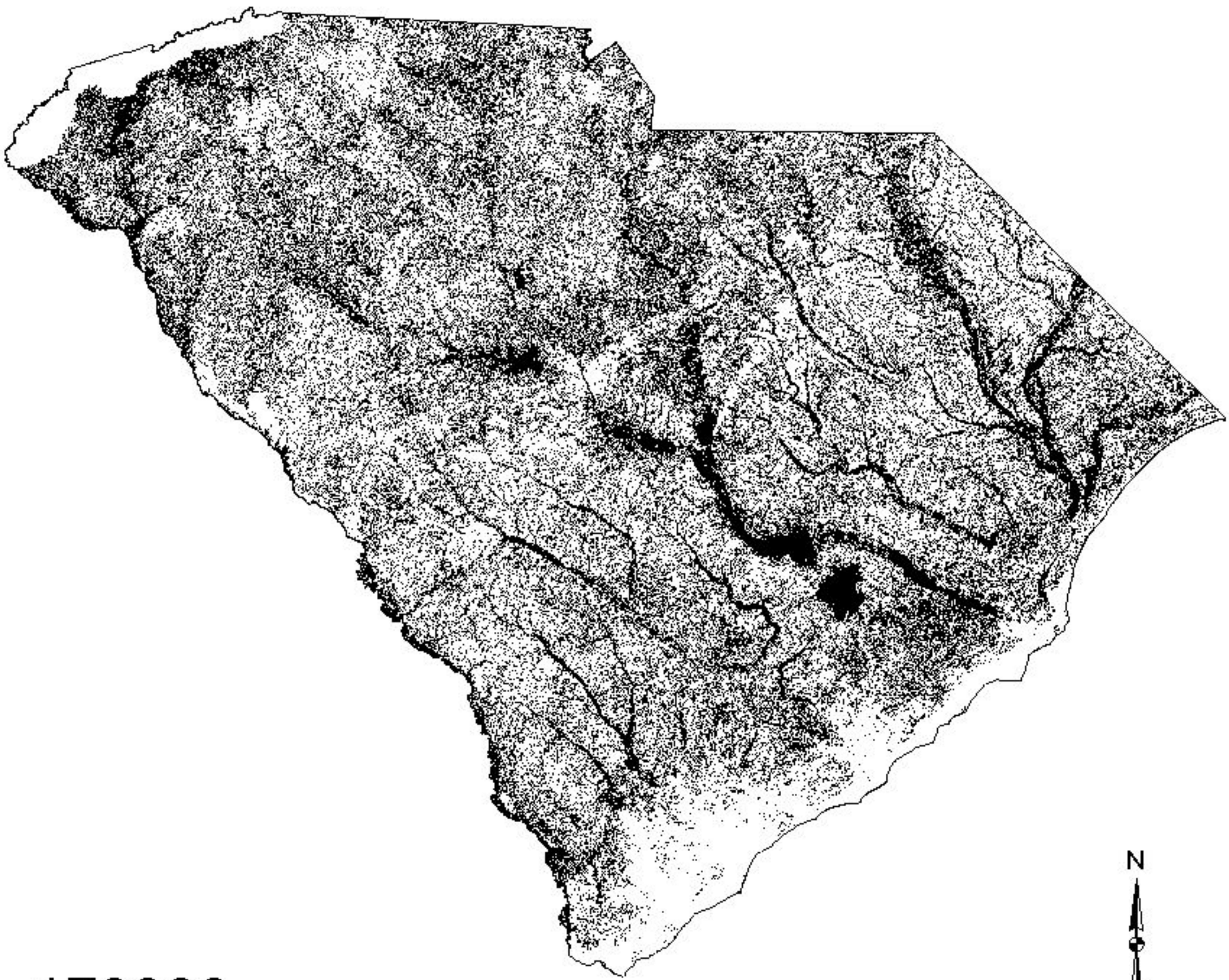
Predicted present

Predicted absent

State boundary

Southeastern Myotis

(Myotis austroriparius)



179993

Predicted present

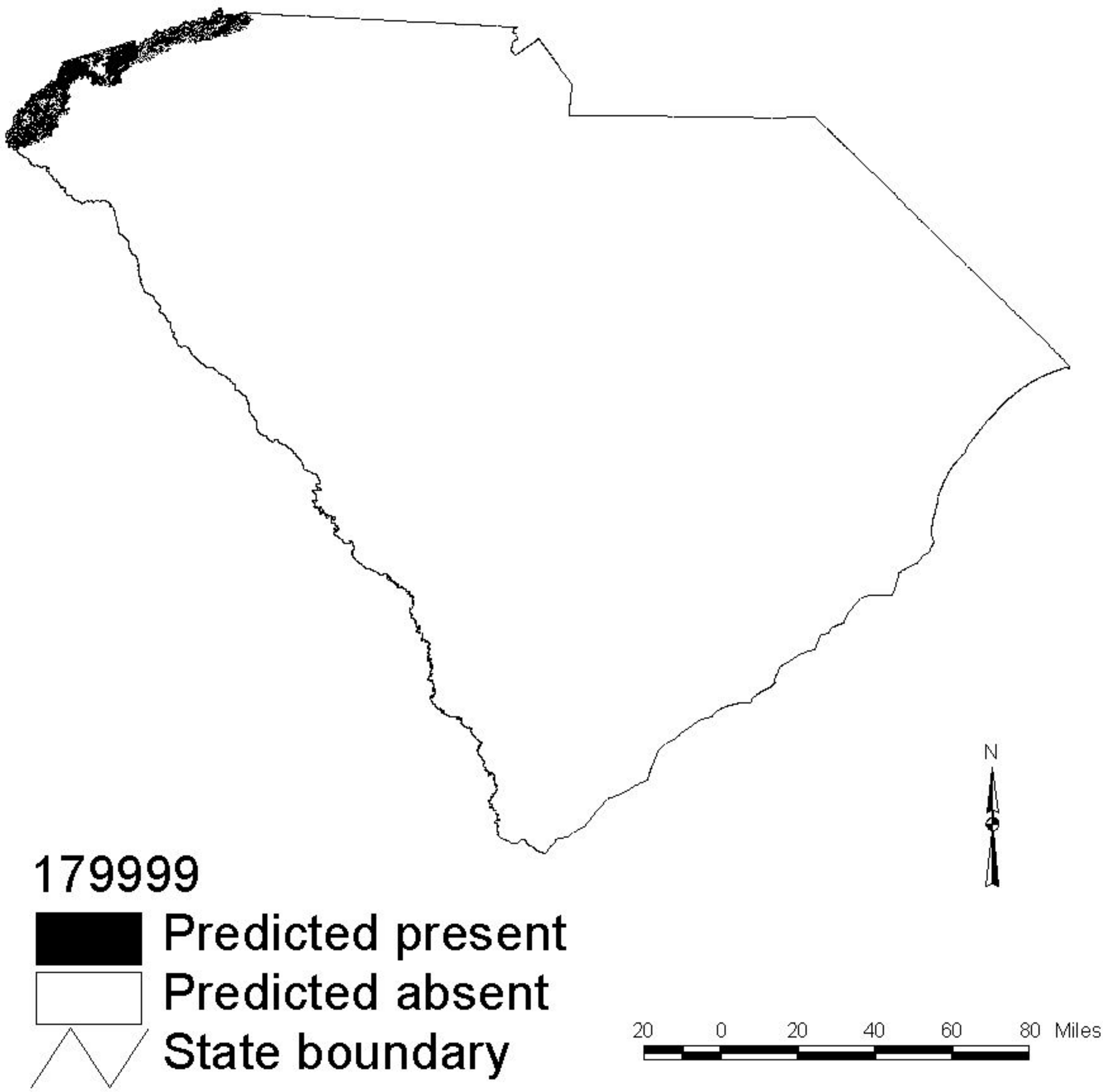
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Eastern Small-footed Myotis

(Myotis leibii)



179999

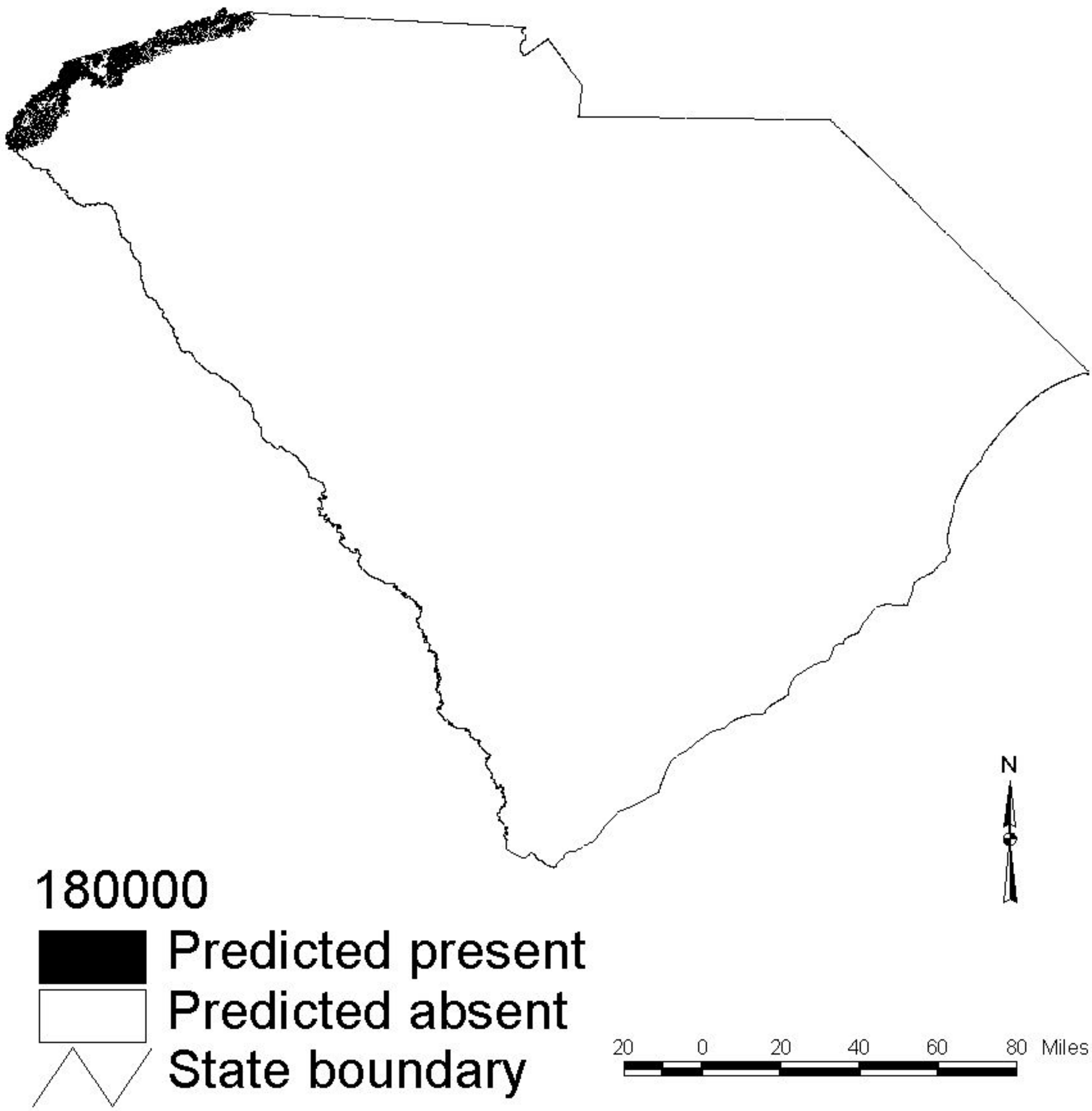
Predicted present

Predicted absent

State boundary

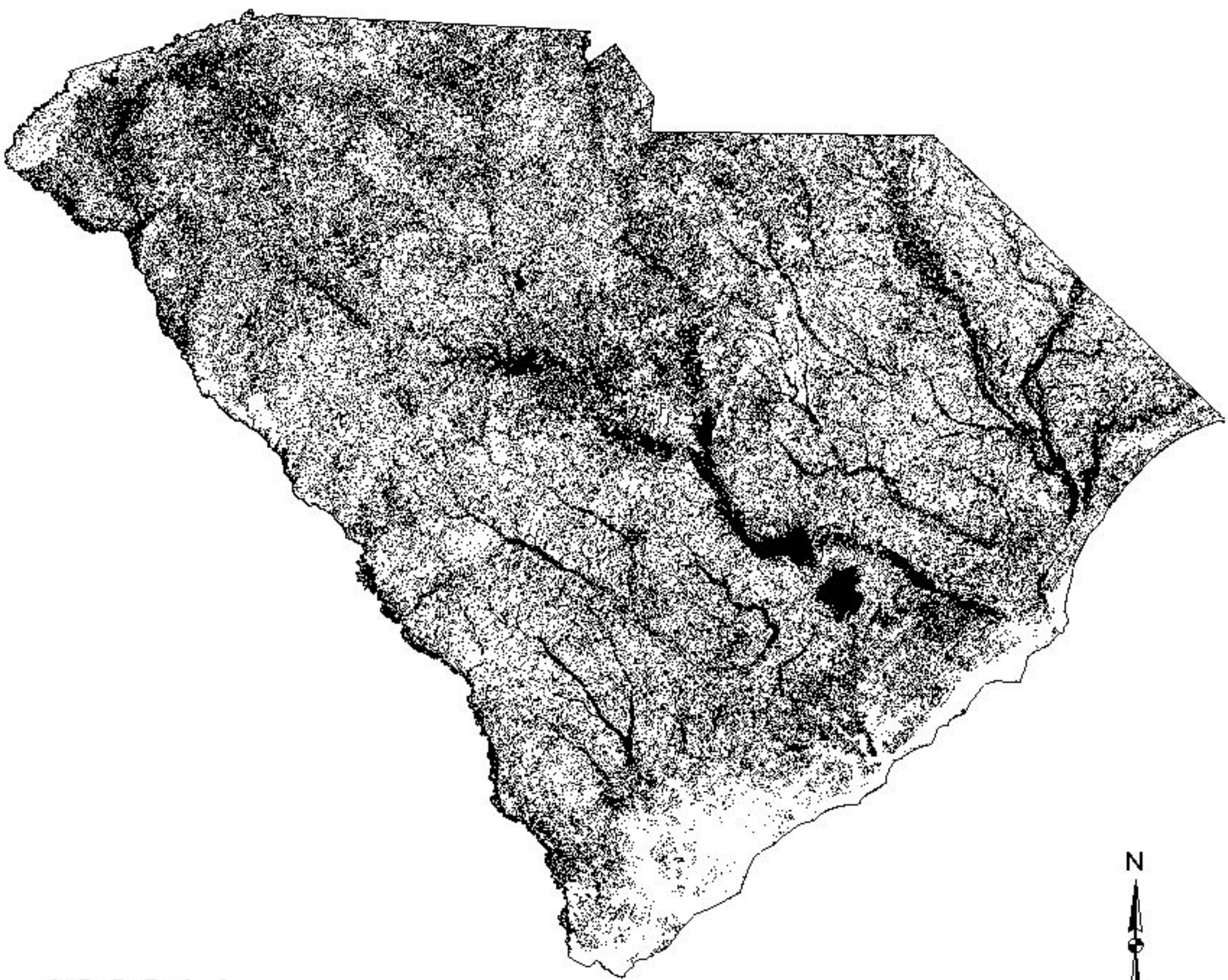
Northern Long-eared Myotis

(Myotis septentrionalis)



Silver-haired Bat

(Lasionycteris noctivagans)



180014

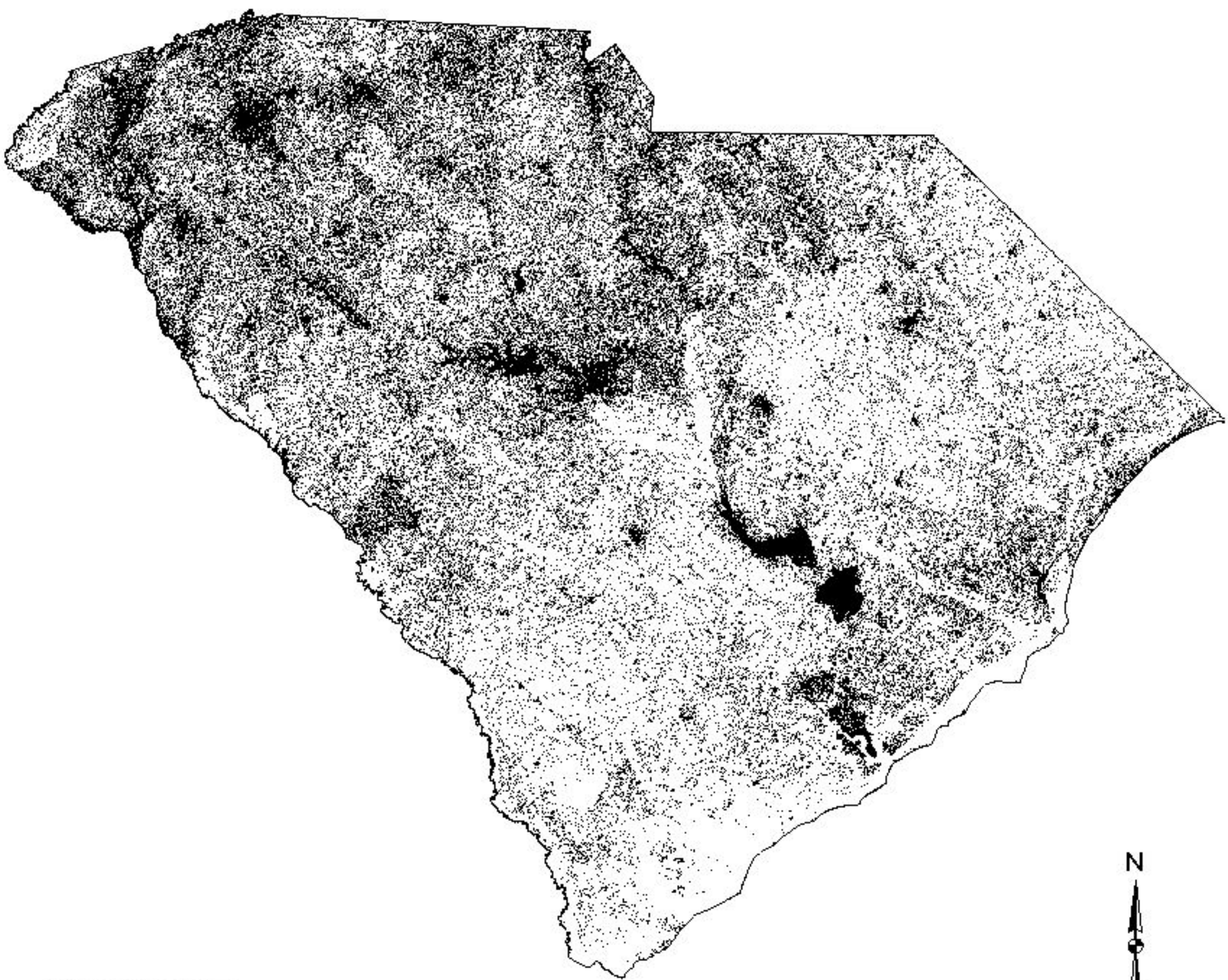
Predicted present

Predicted absent

State boundary

Eastern Pipistrelle

(Pipistrellus subflavus)



180025

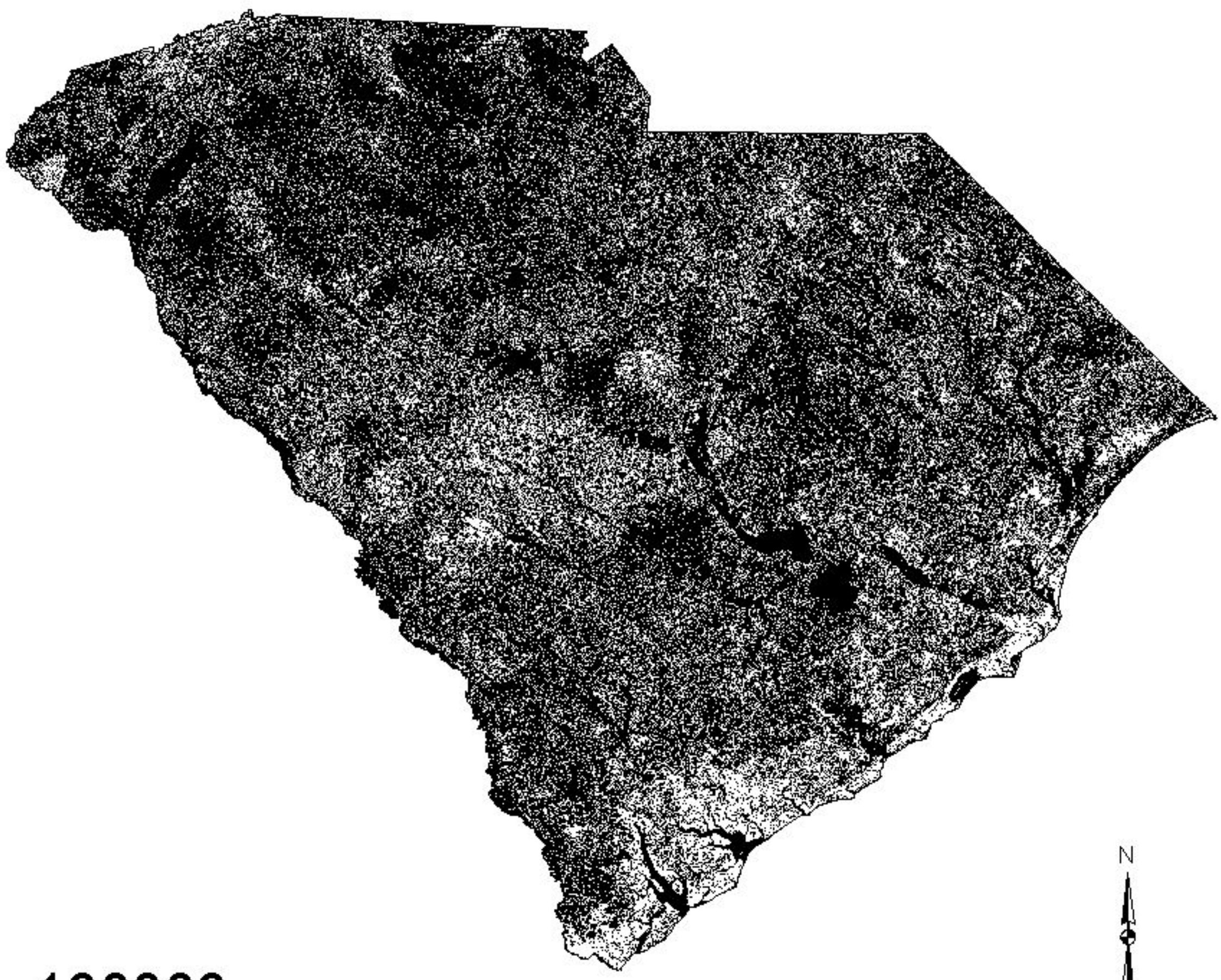
Predicted present

Predicted absent

State boundary

Big Brown Bat

(Eptesicus fuscus)



180008

Predicted present

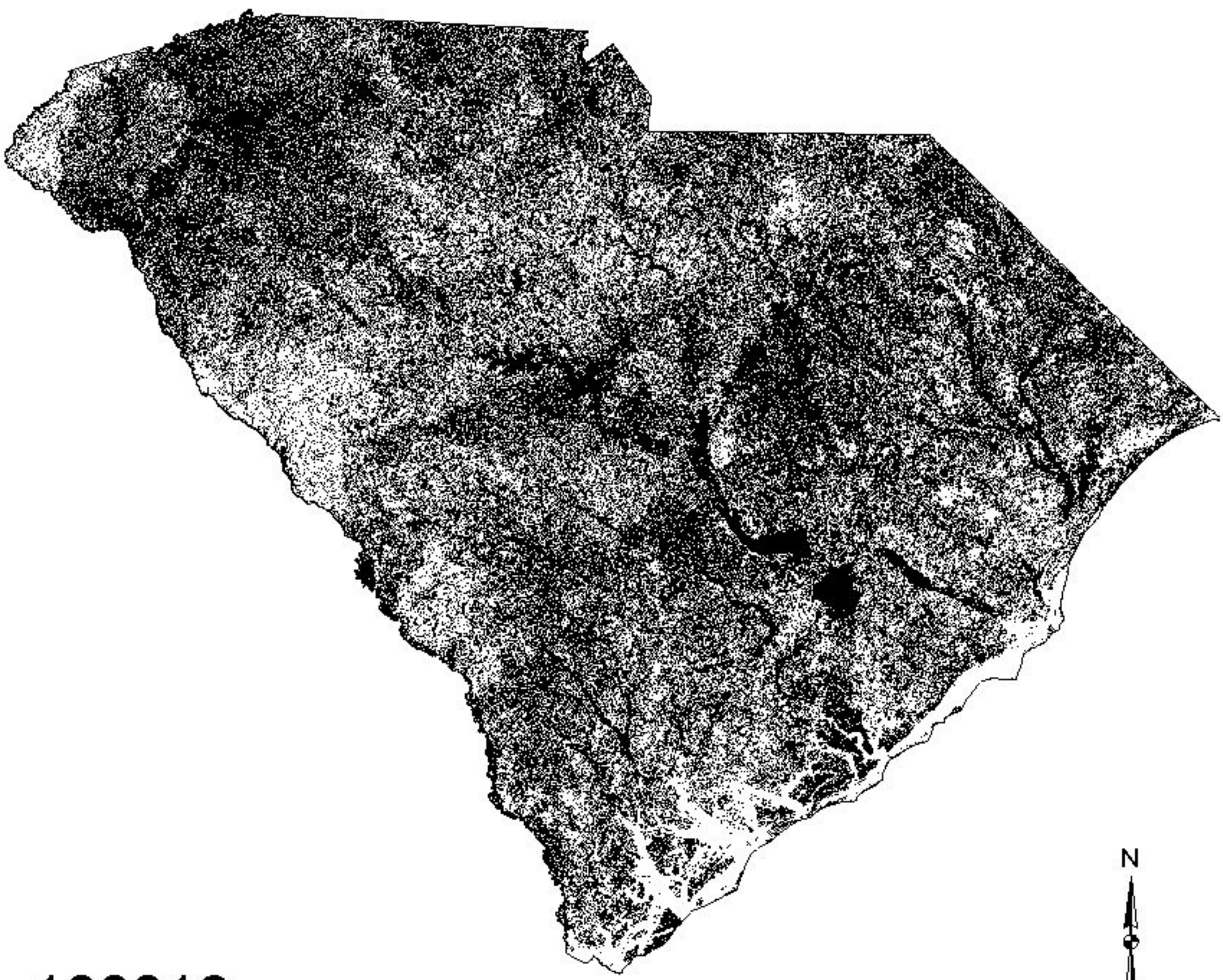
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Eastern Red Bat

(Lasiurus borealis)



180016

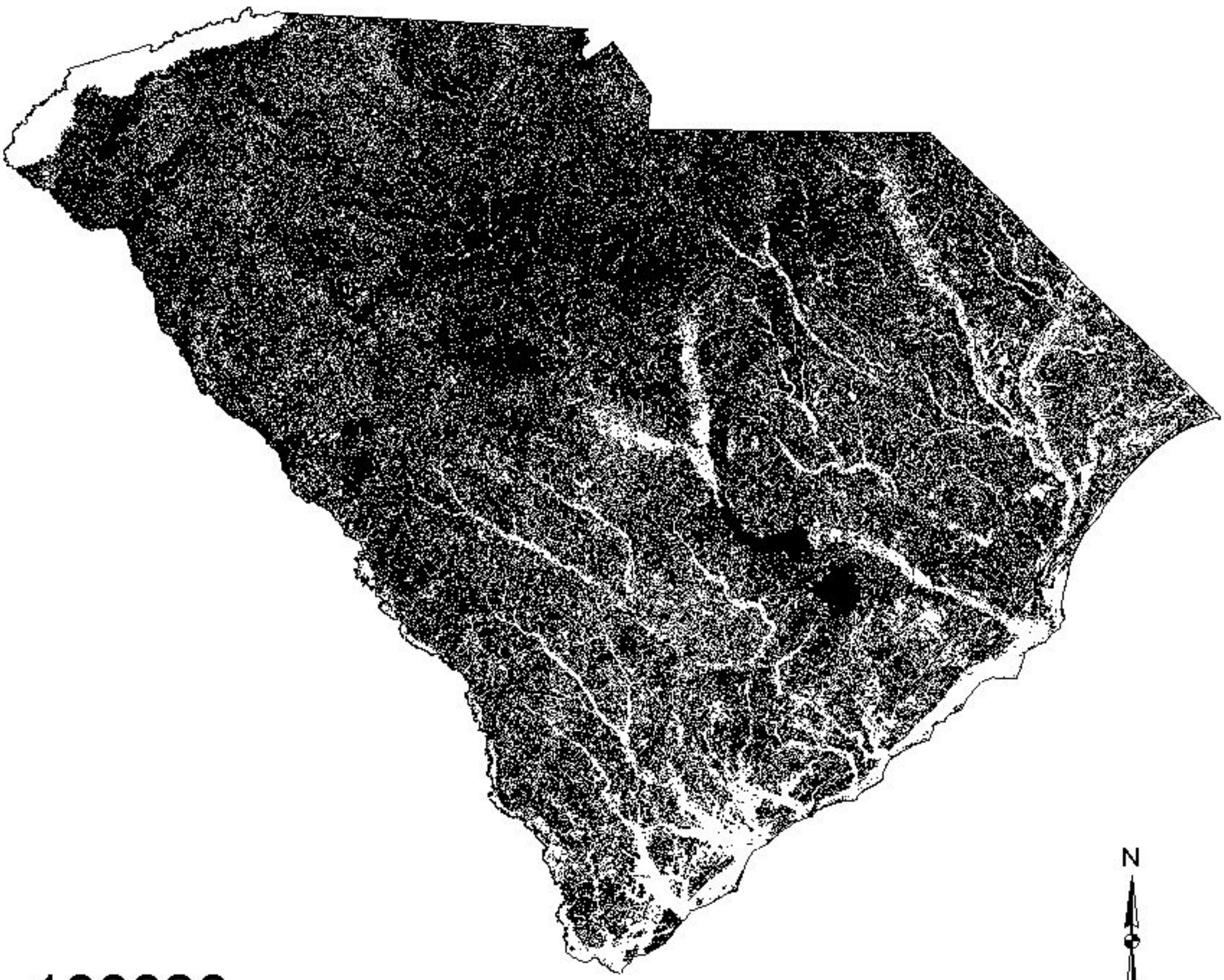
Predicted present

Predicted absent

State boundary

Seminole Bat

(Lasiurus seminolus)



180020

Predicted present

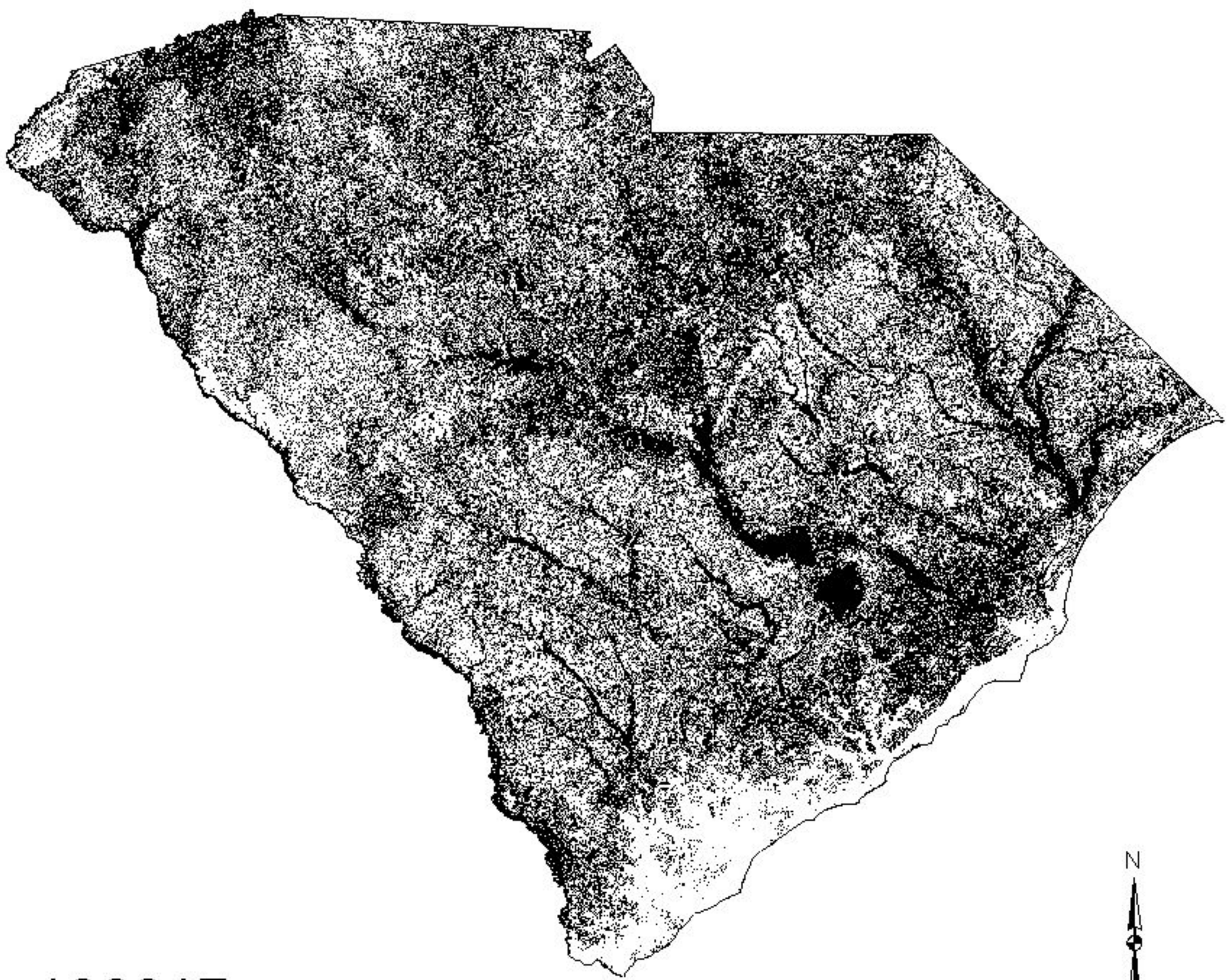
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Hoary Bat

(Lasiurus cinereus)



180017

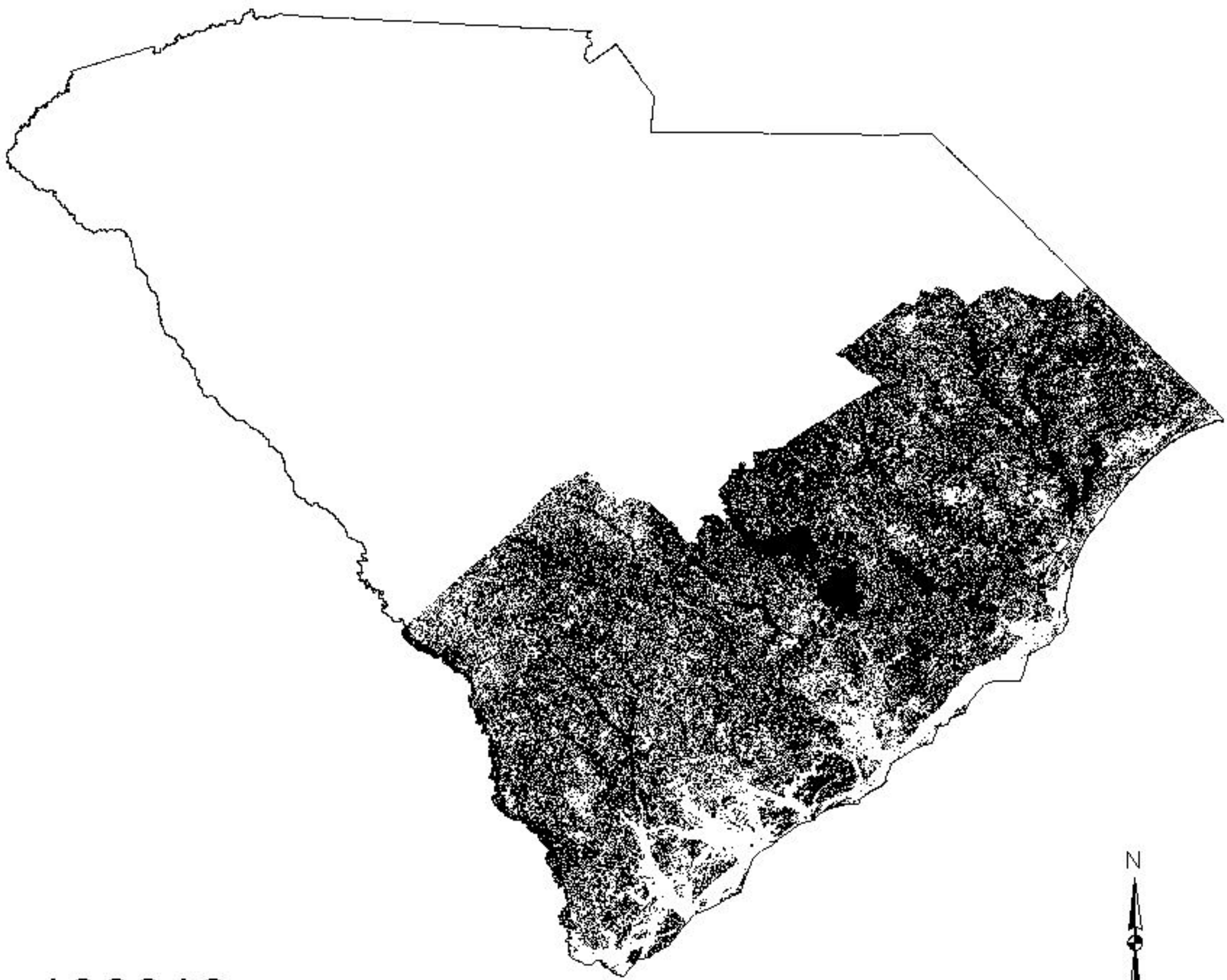
Predicted present

Predicted absent

State boundary

Northern Yellow Bat

(Lasiurus intermedius)



180019

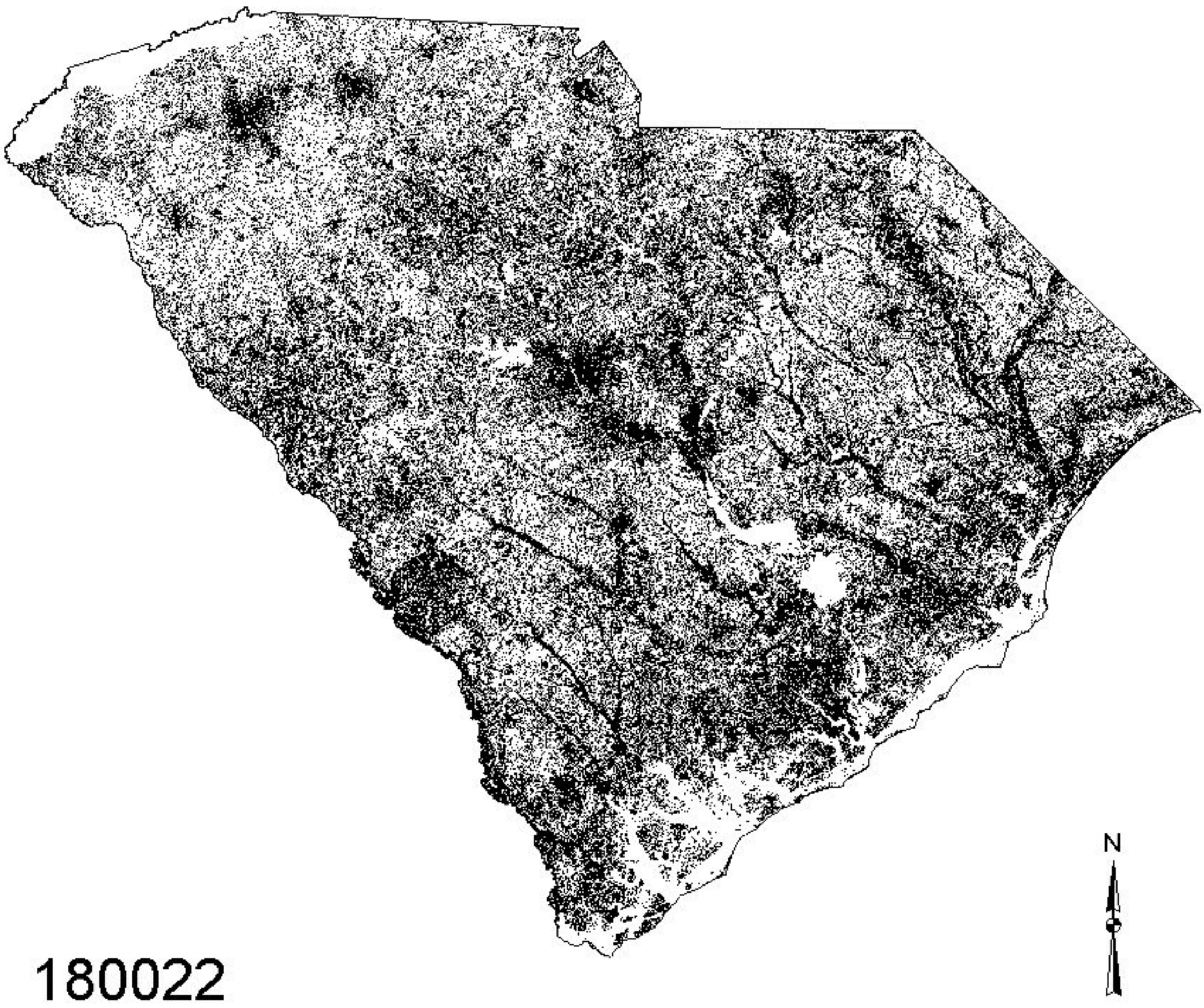
Predicted present

Predicted absent

State boundary

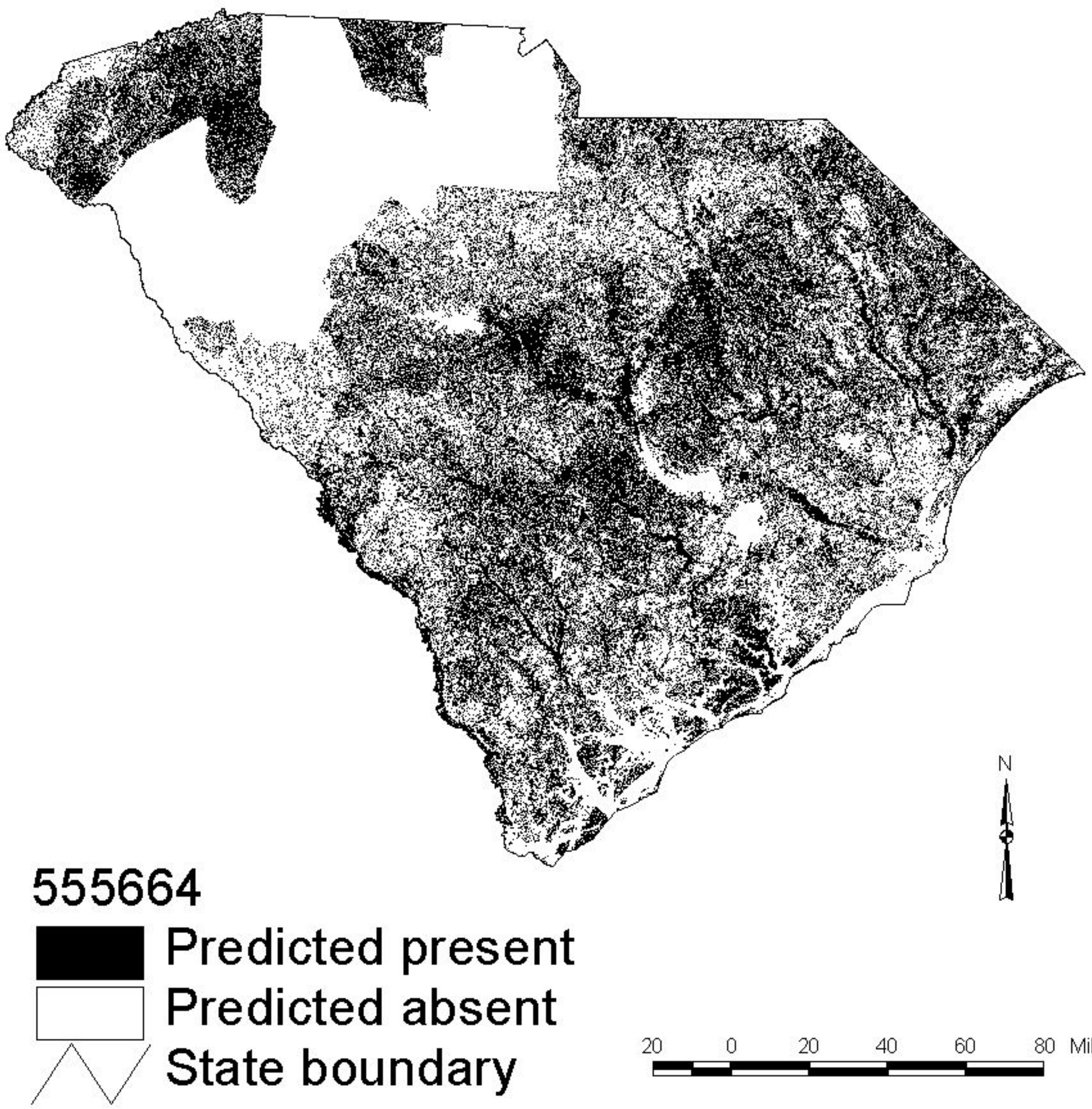
Evening Bat

(Nycticeius humeralis)



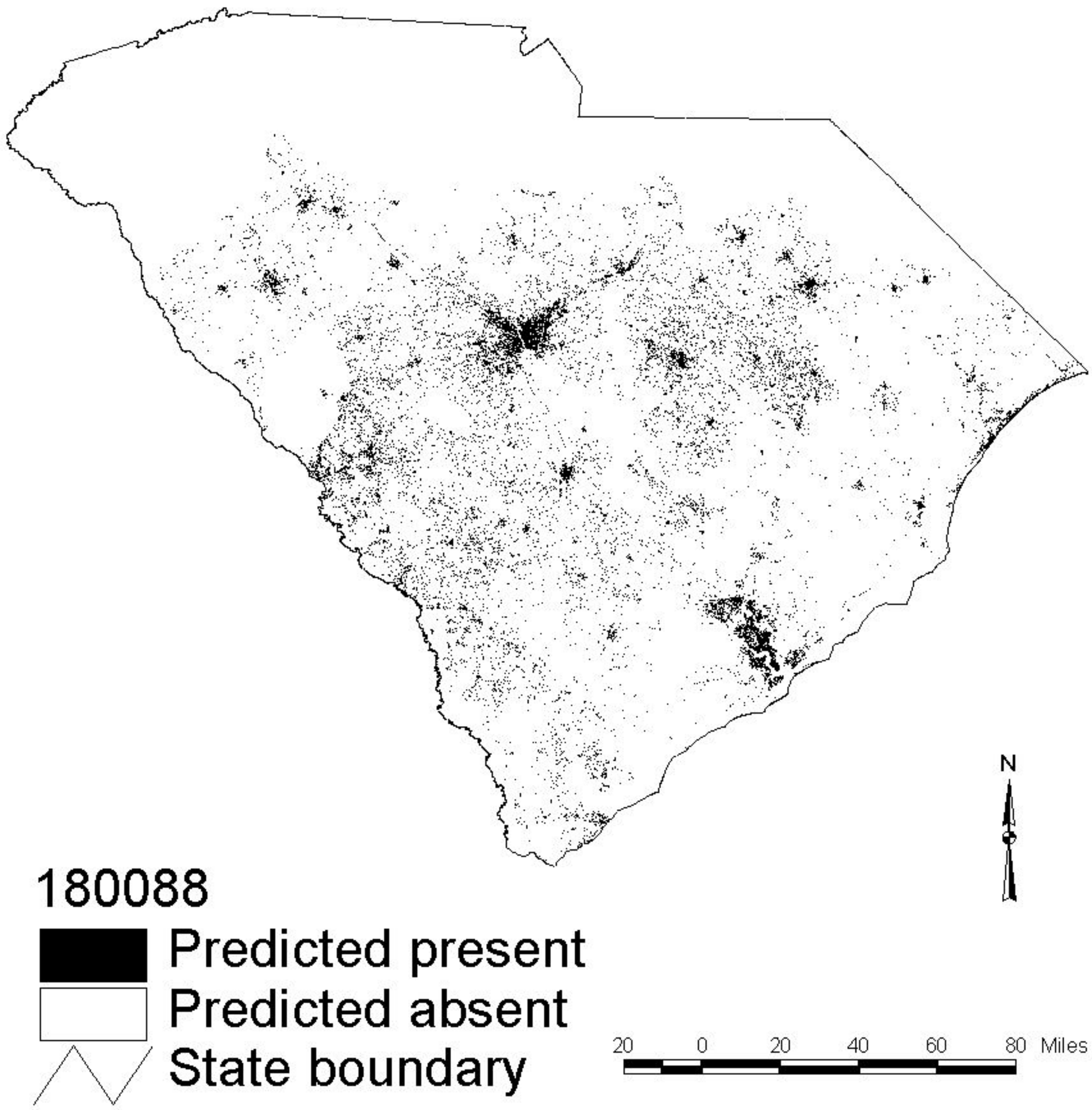
Rafinesque's Big-eared Bat

(Corynorhinus rafinesquii)



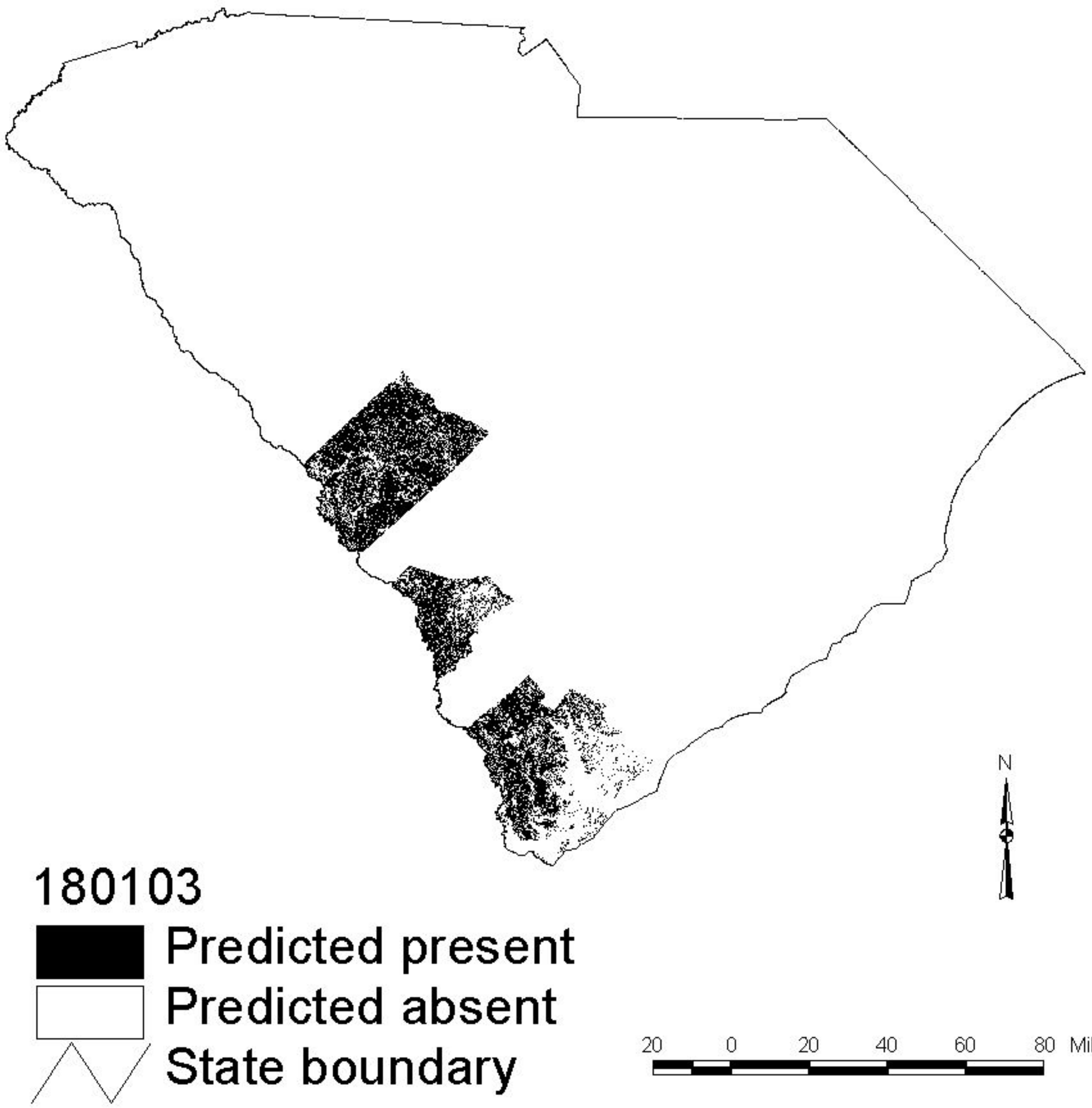
Brazilian Free-tailed Bat

(Tadarida brasiliensis)



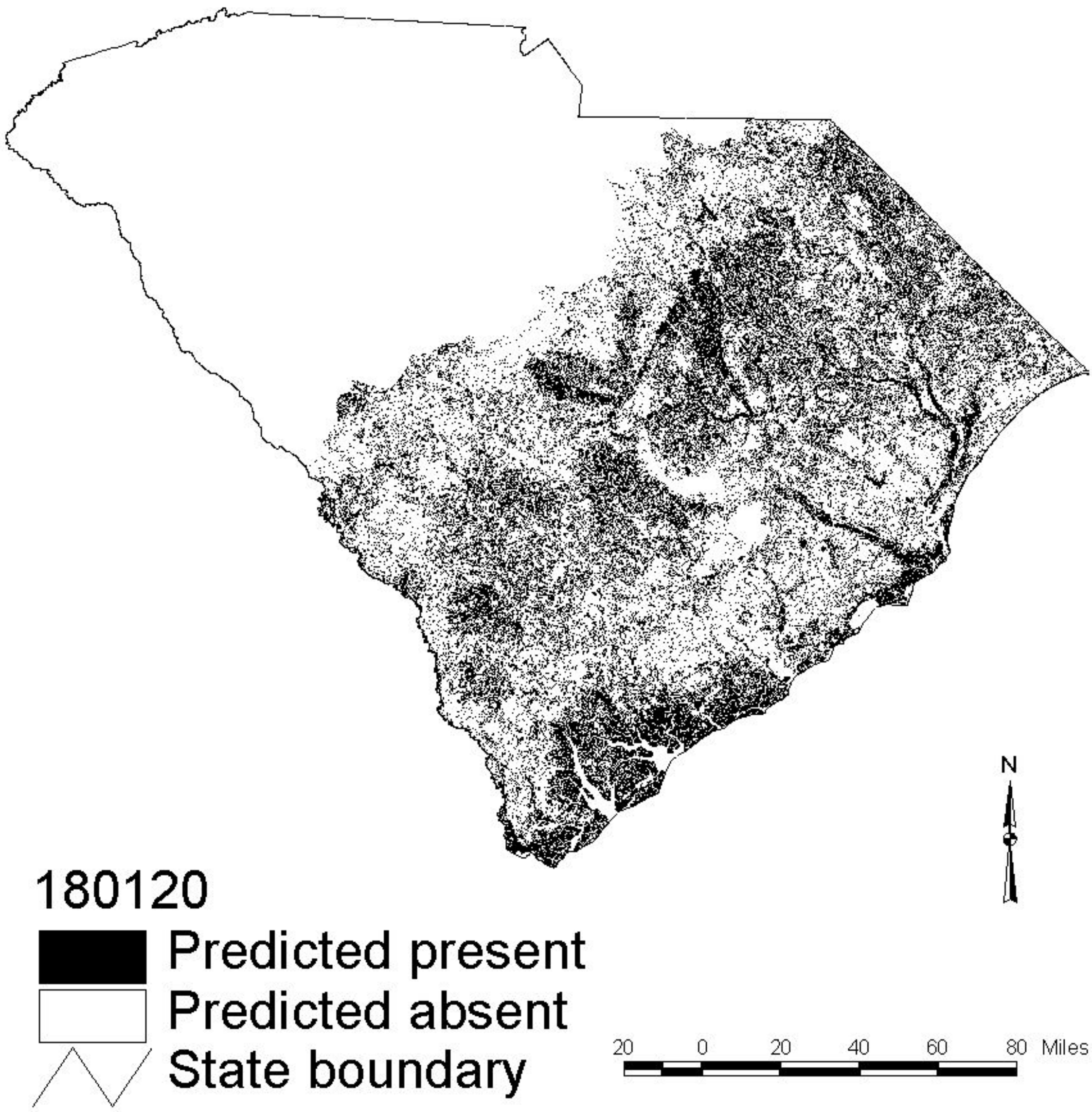
Nine-banded Armadillo

(Dasypus novemcinctus)



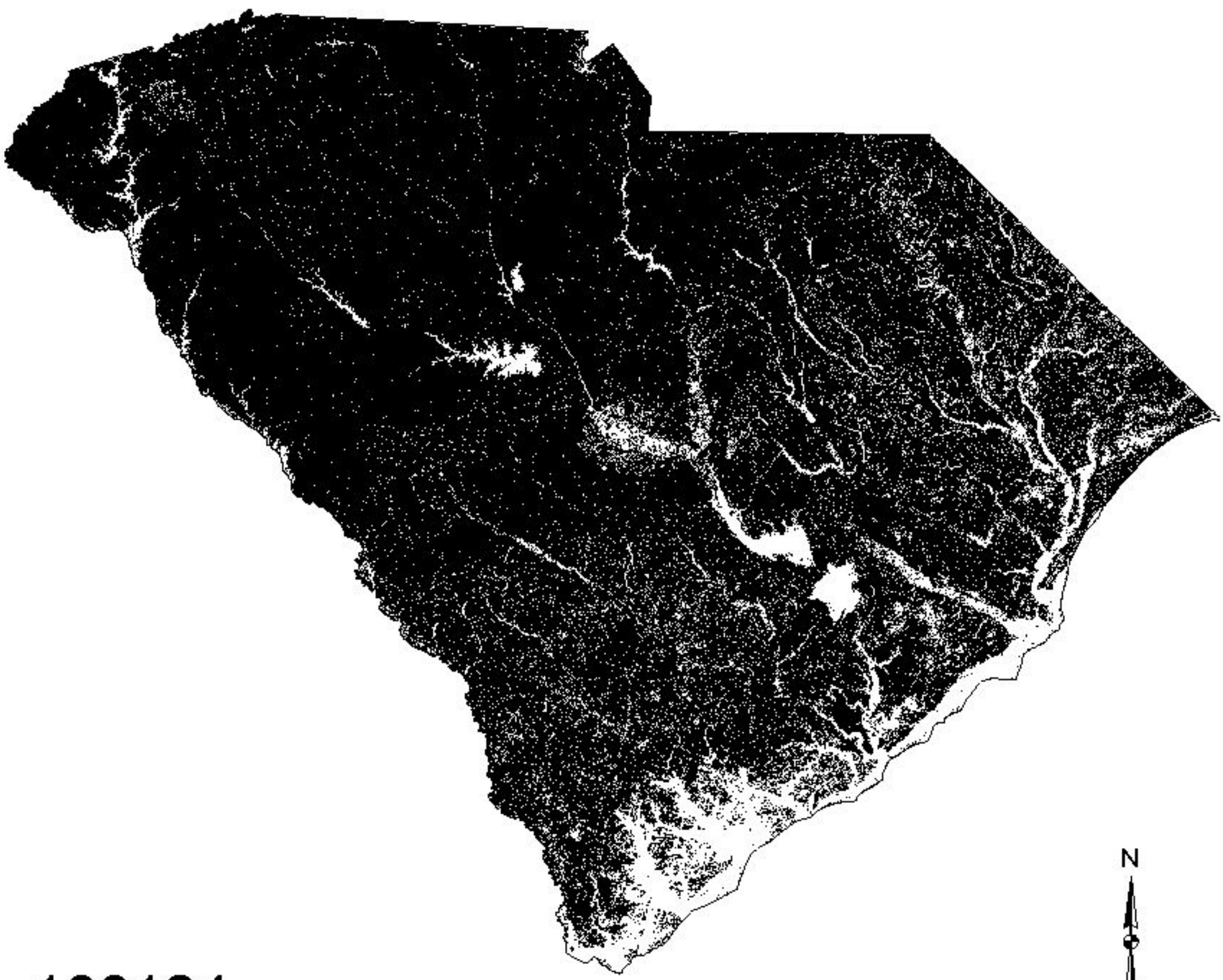
Marsh Rabbit

(Sylvilagus palustris)



Eastern Cottontail

(Sylvilagus floridanus)



180124

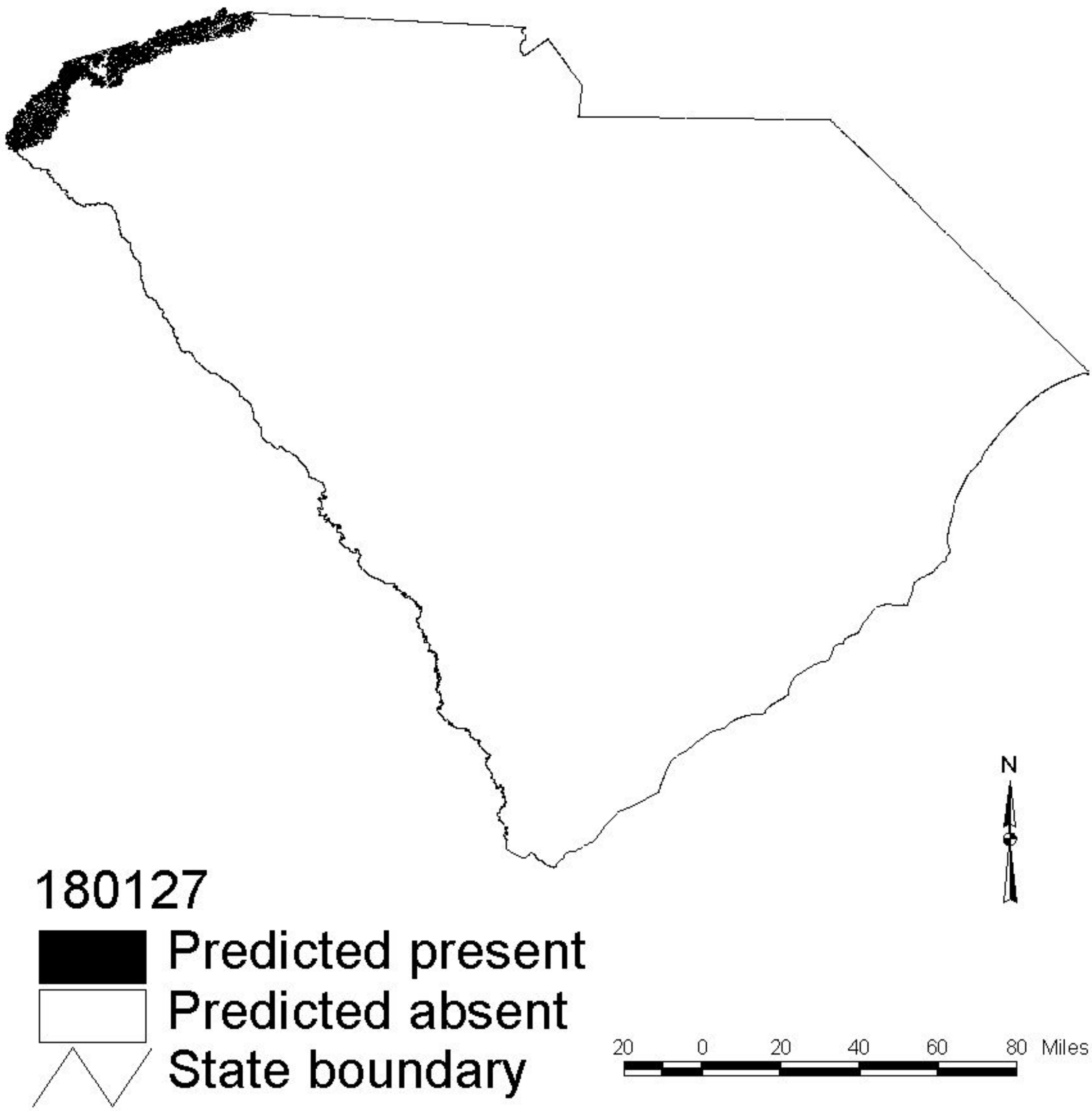
Predicted present

Predicted absent

State boundary

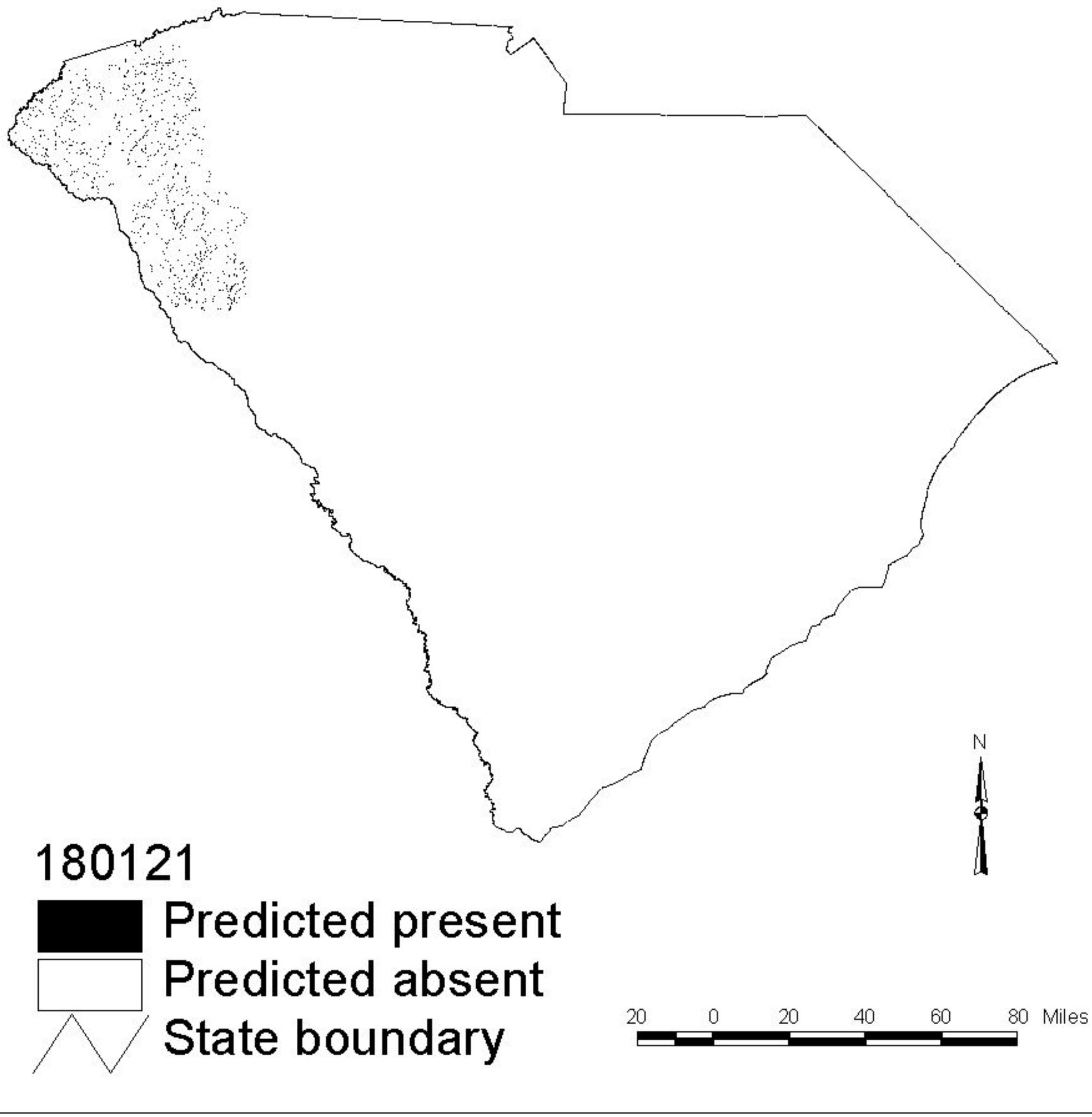
New England Cottontail

(Sylvilagus transitionalis)



Swamp Rabbit

(Sylvilagus aquaticus)



180121

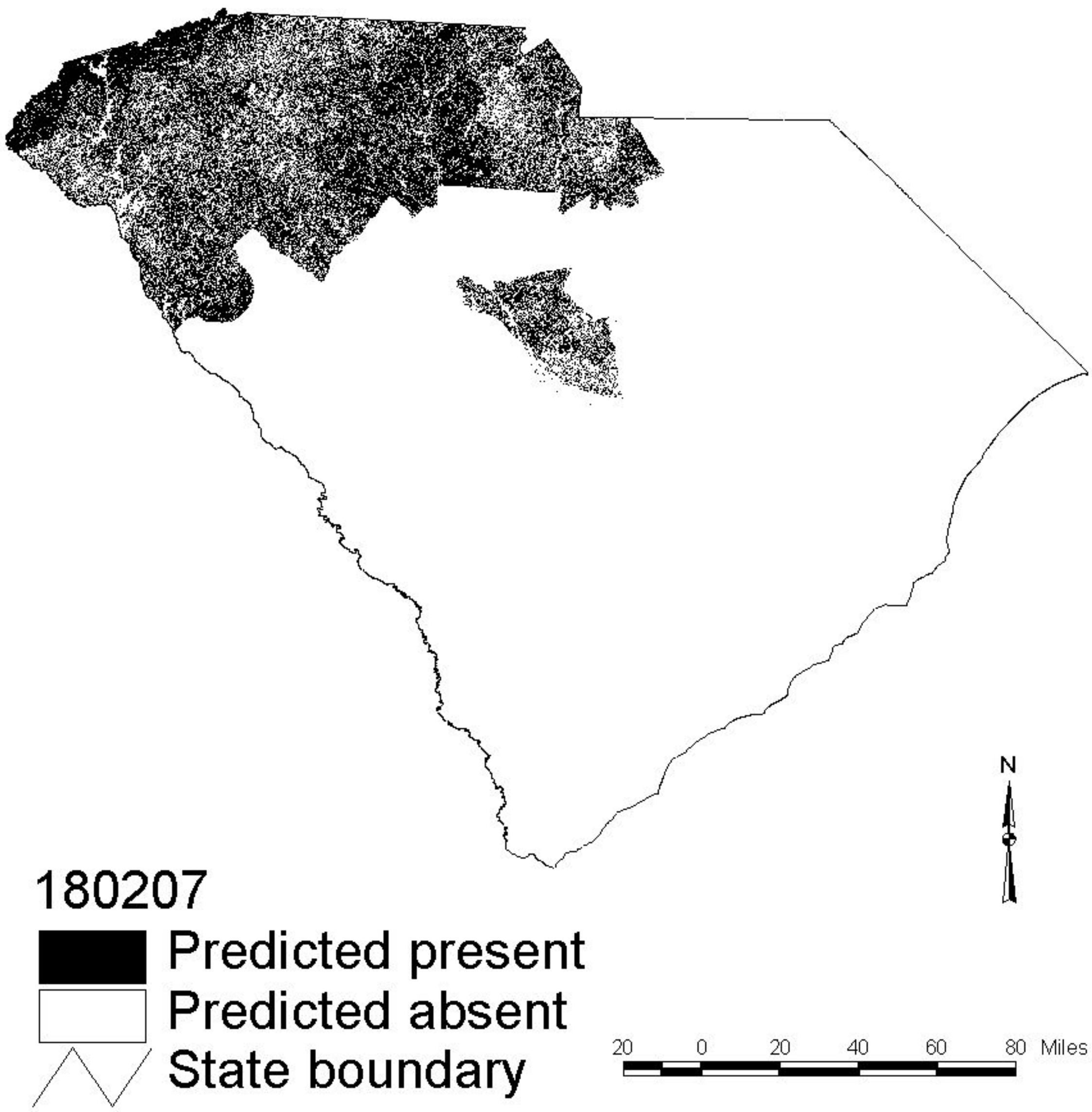
Predicted present

Predicted absent

State boundary

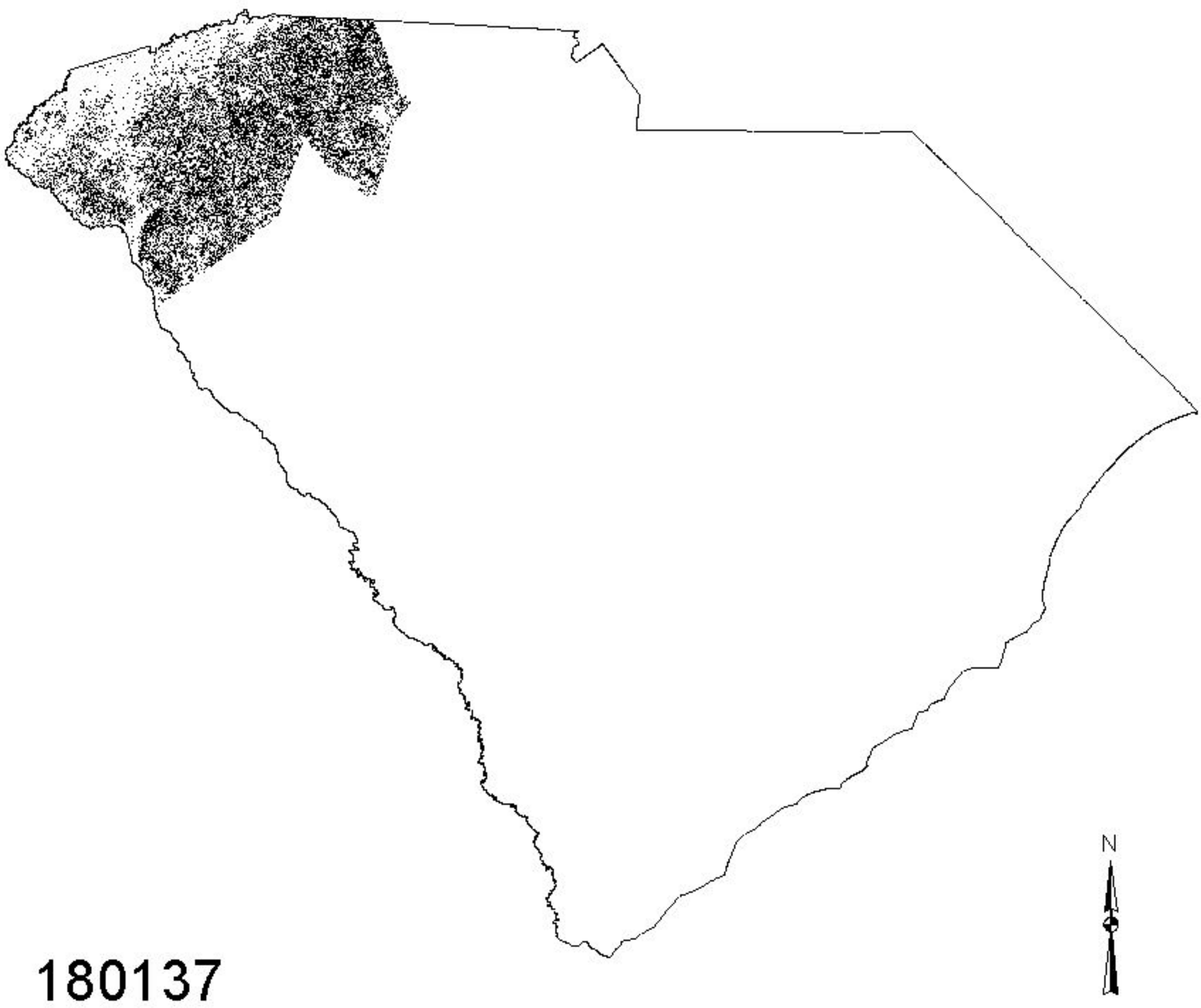
Eastern Chipmunk

(Tamias striatus)



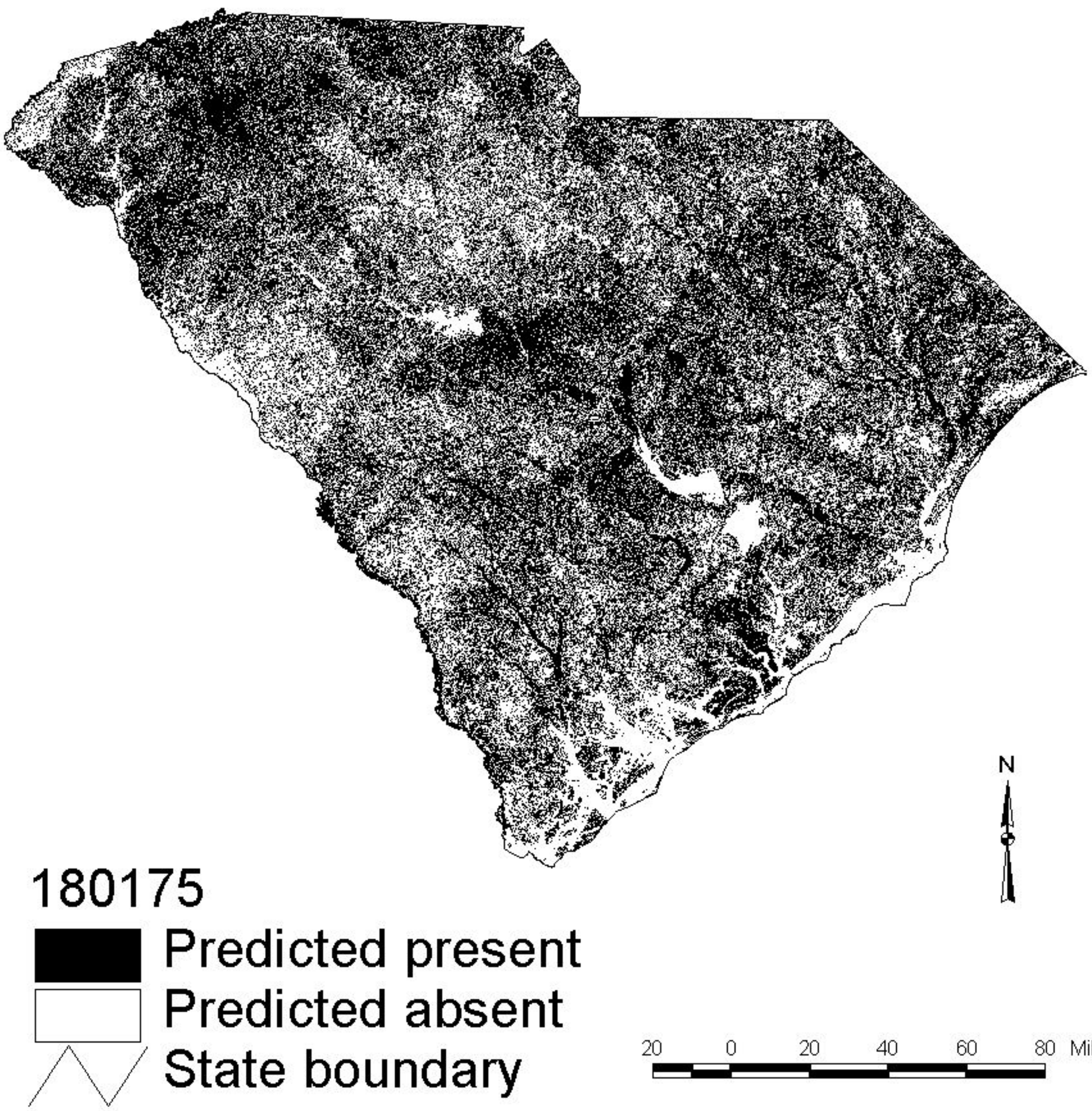
Woodchuck

(Marmota monax)



Eastern Gray Squirrel

(Sciurus carolinensis)



Eastern Fox Squirrel

(Sciurus niger)

180172

Predicted present

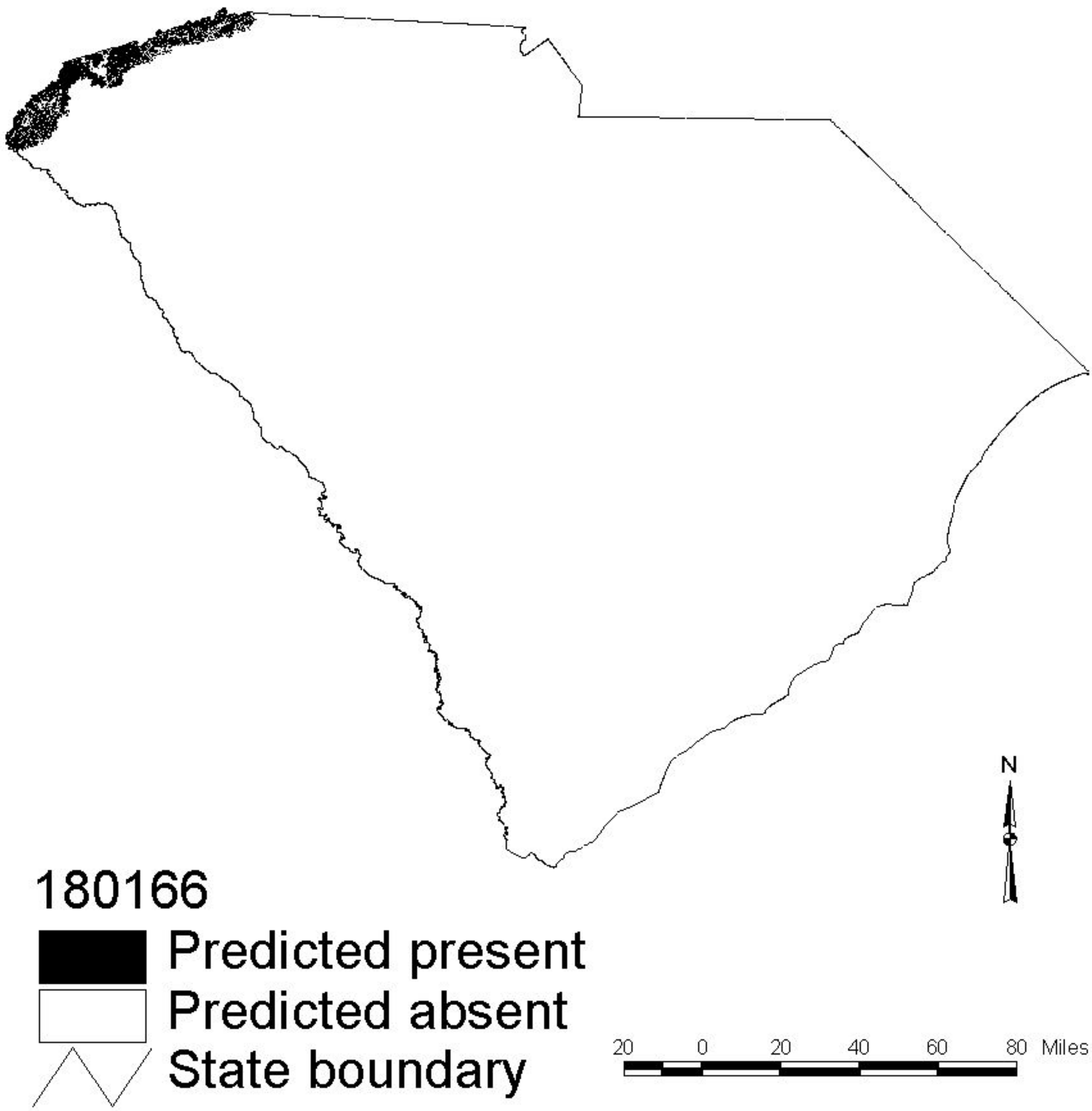
Predicted absent

State boundary

20 0 20 40 60 80 Miles

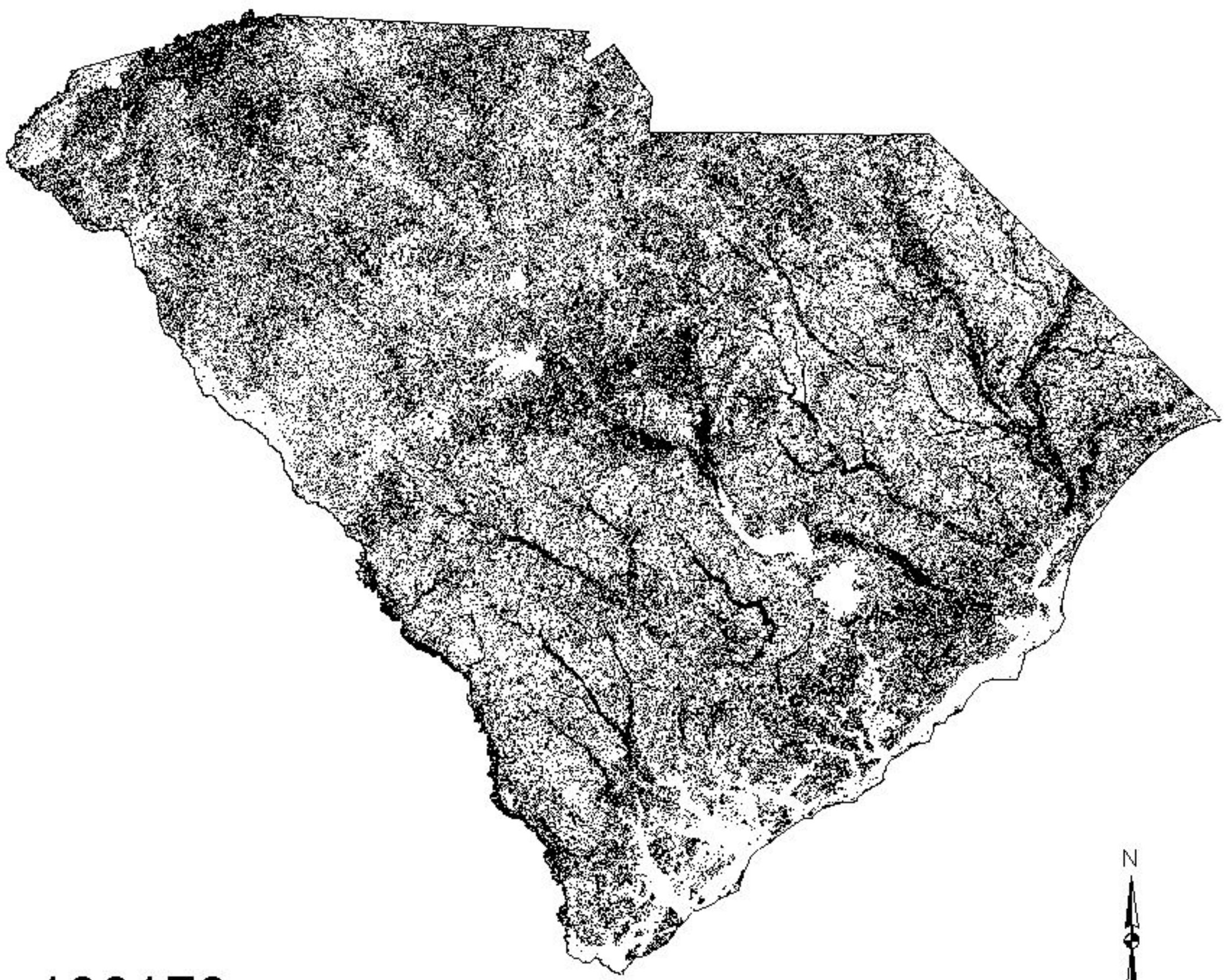
Red Squirrel

(Tamiasciurus hudsonicus)



Southern Flying Squirrel

(Glaucomys volans)



180170

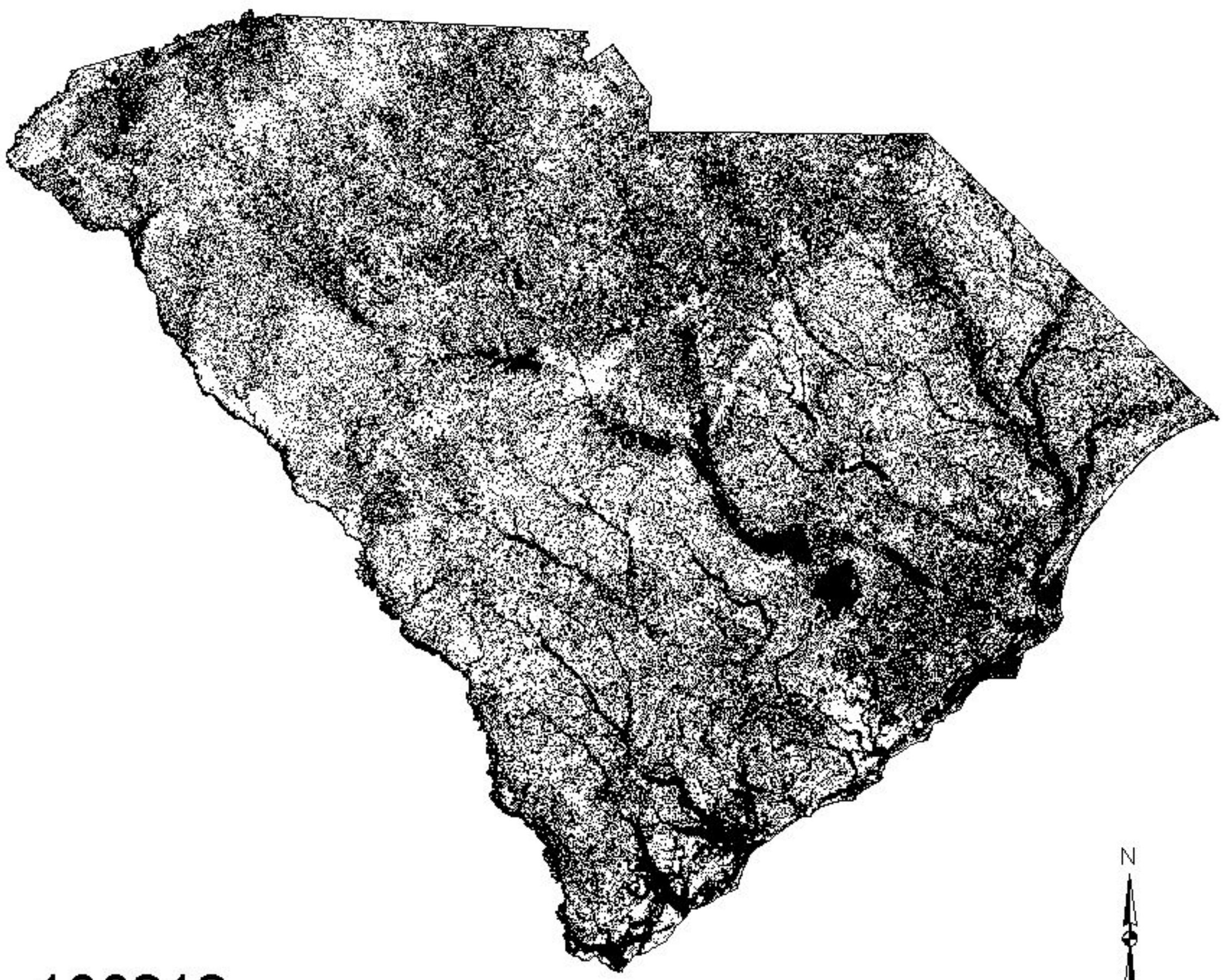
Predicted present

Predicted absent

State boundary

American Beaver

(Castor canadensis)



180212

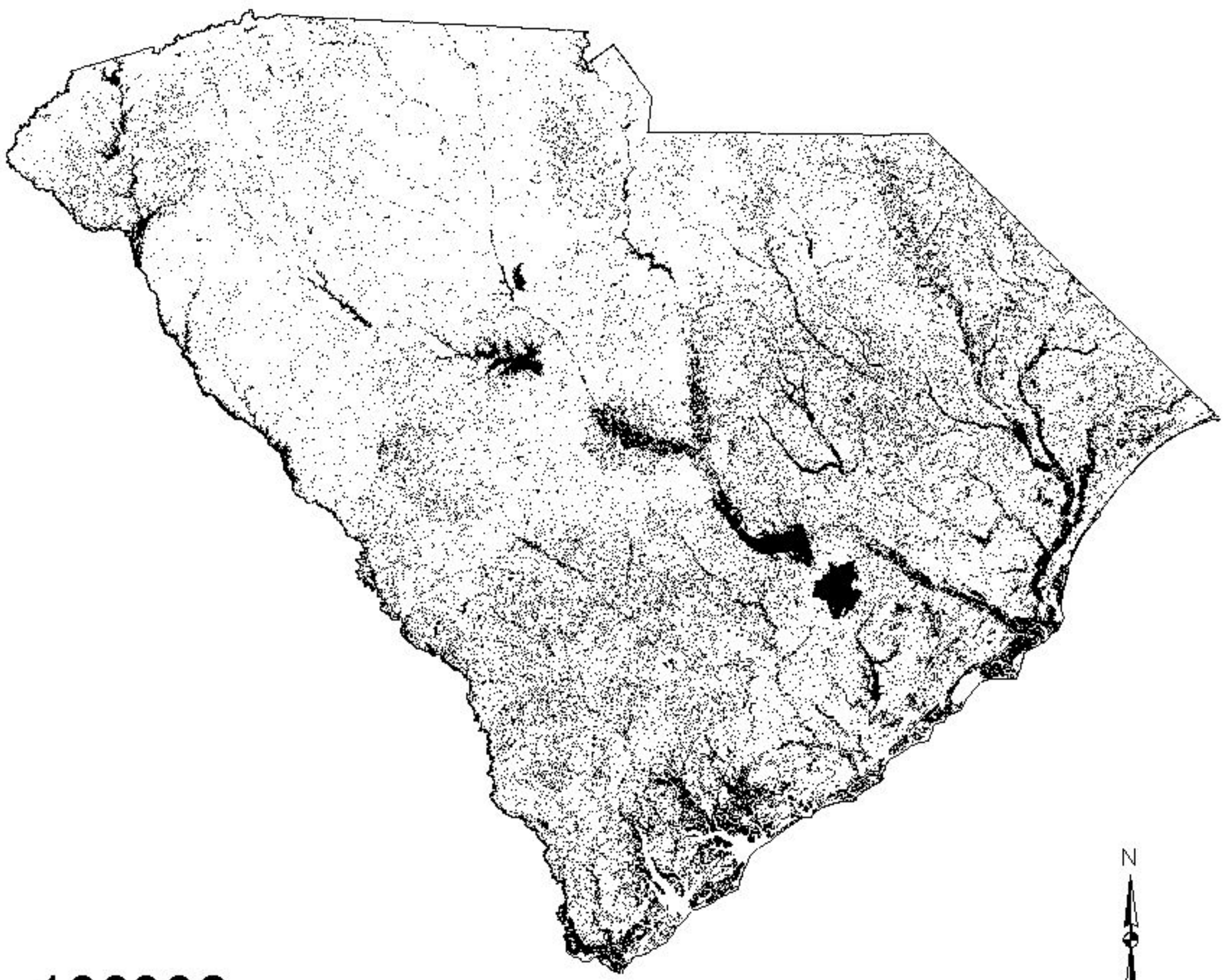
Predicted present

Predicted absent

State boundary

Marsh Rice Rat

(Oryzomys palustris)



180336

Predicted present

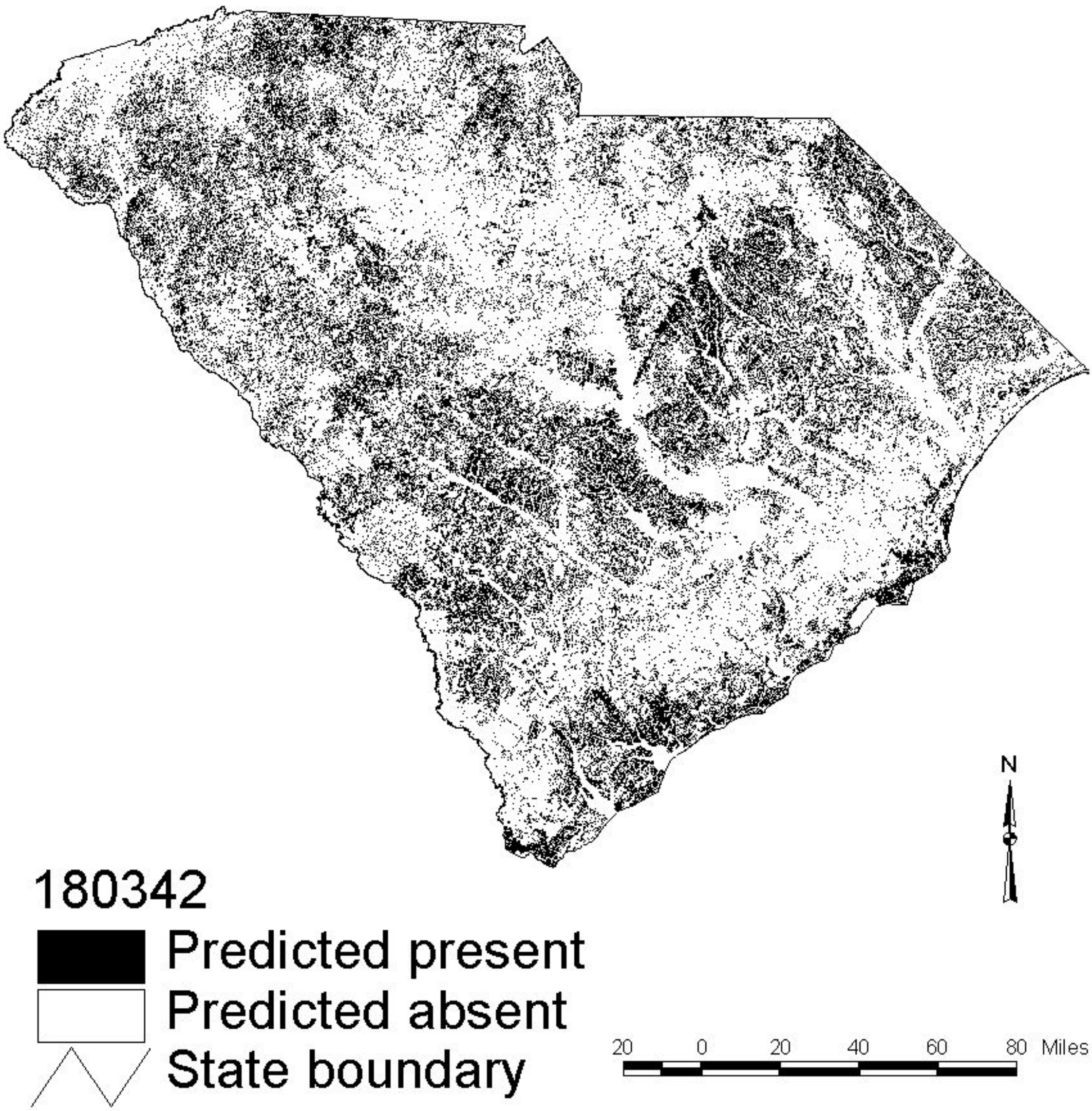
Predicted absent

State boundary

20 0 20 40 60 80 Miles

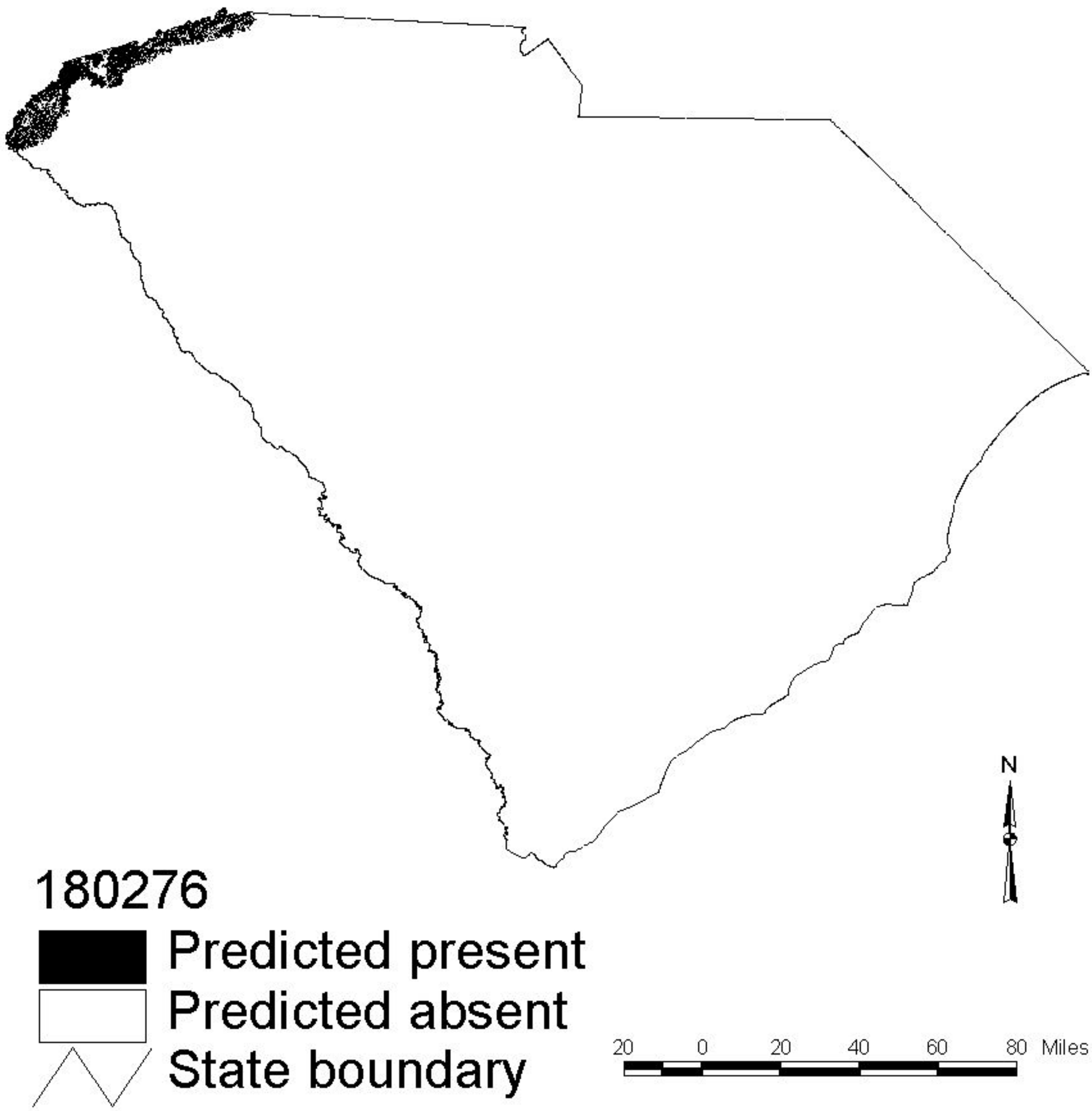
Eastern Harvest Mouse

(Reithrodontomys humulis)



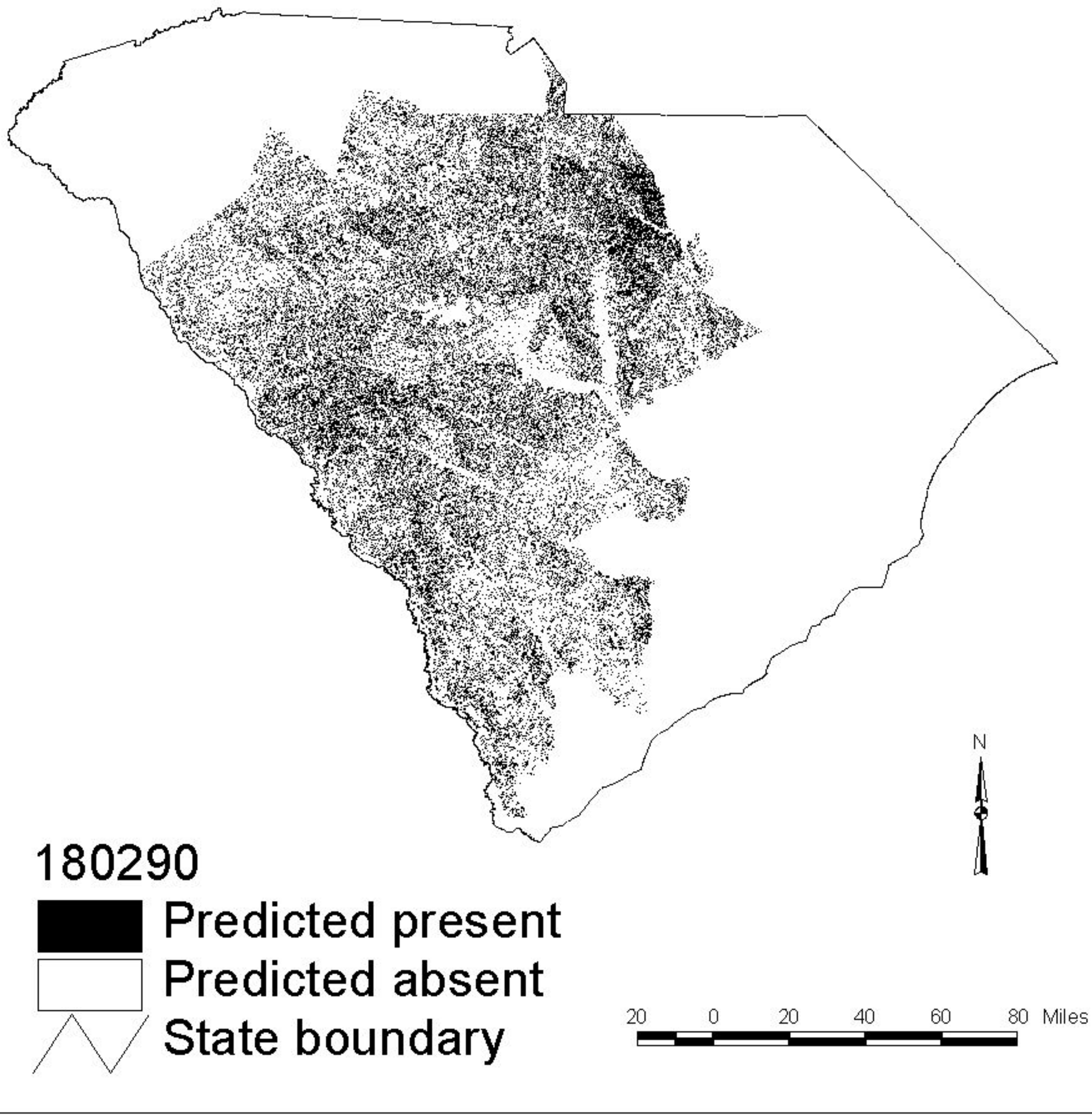
Deer Mouse

(Peromyscus maniculatus)



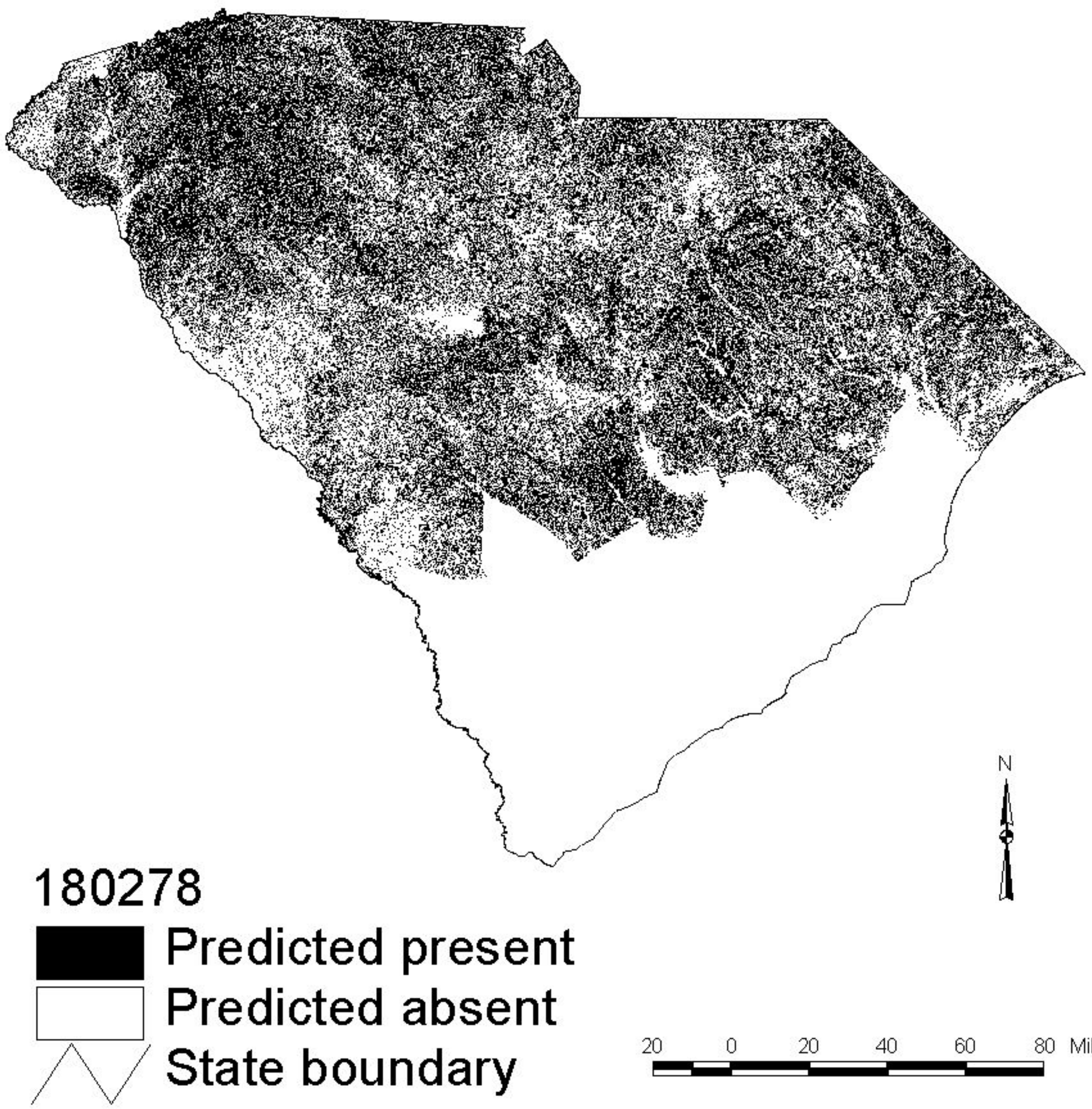
Oldfield Mouse

(Peromyscus polionotus)



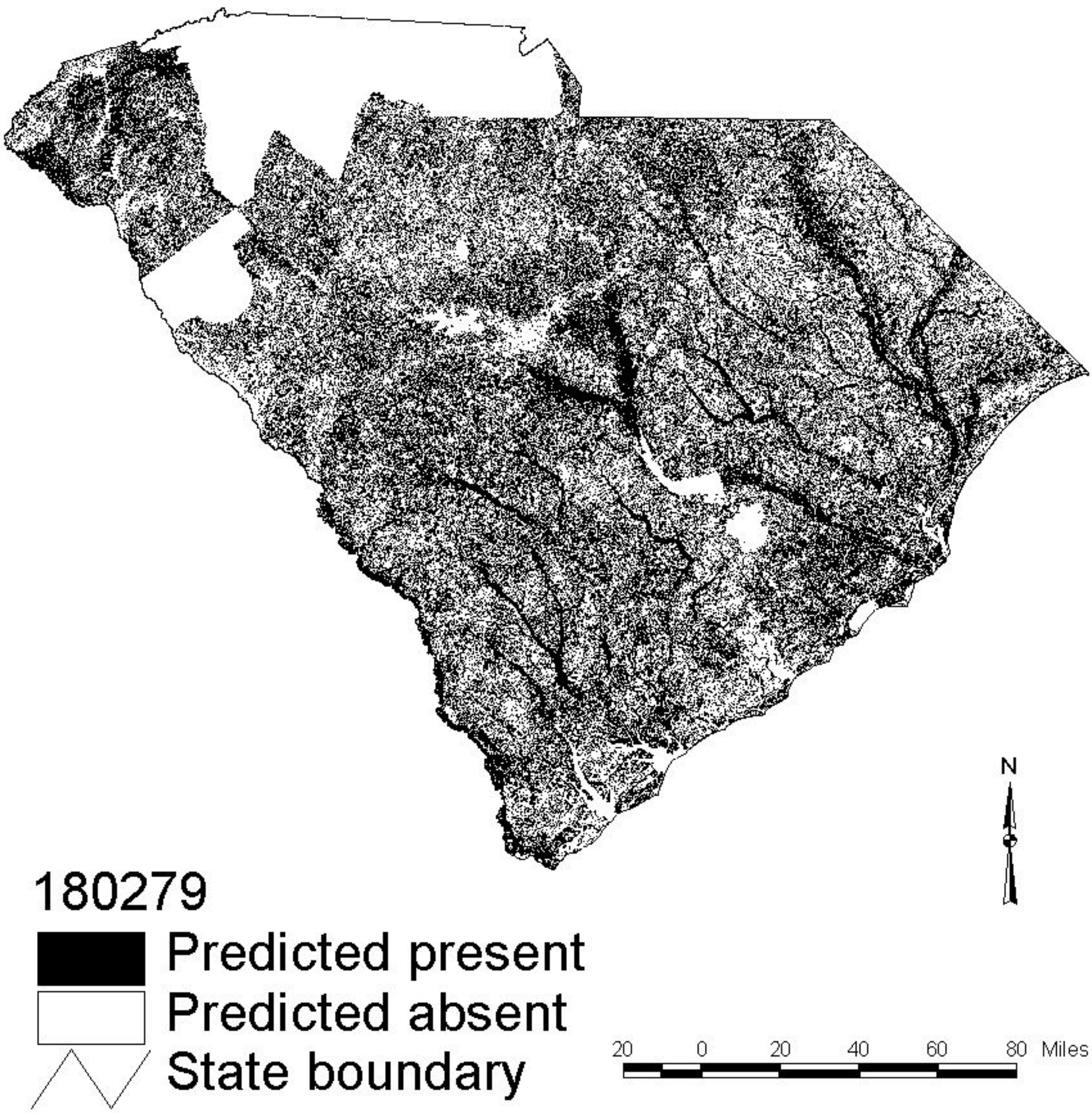
White-footed Mouse

(Peromyscus leucopus)



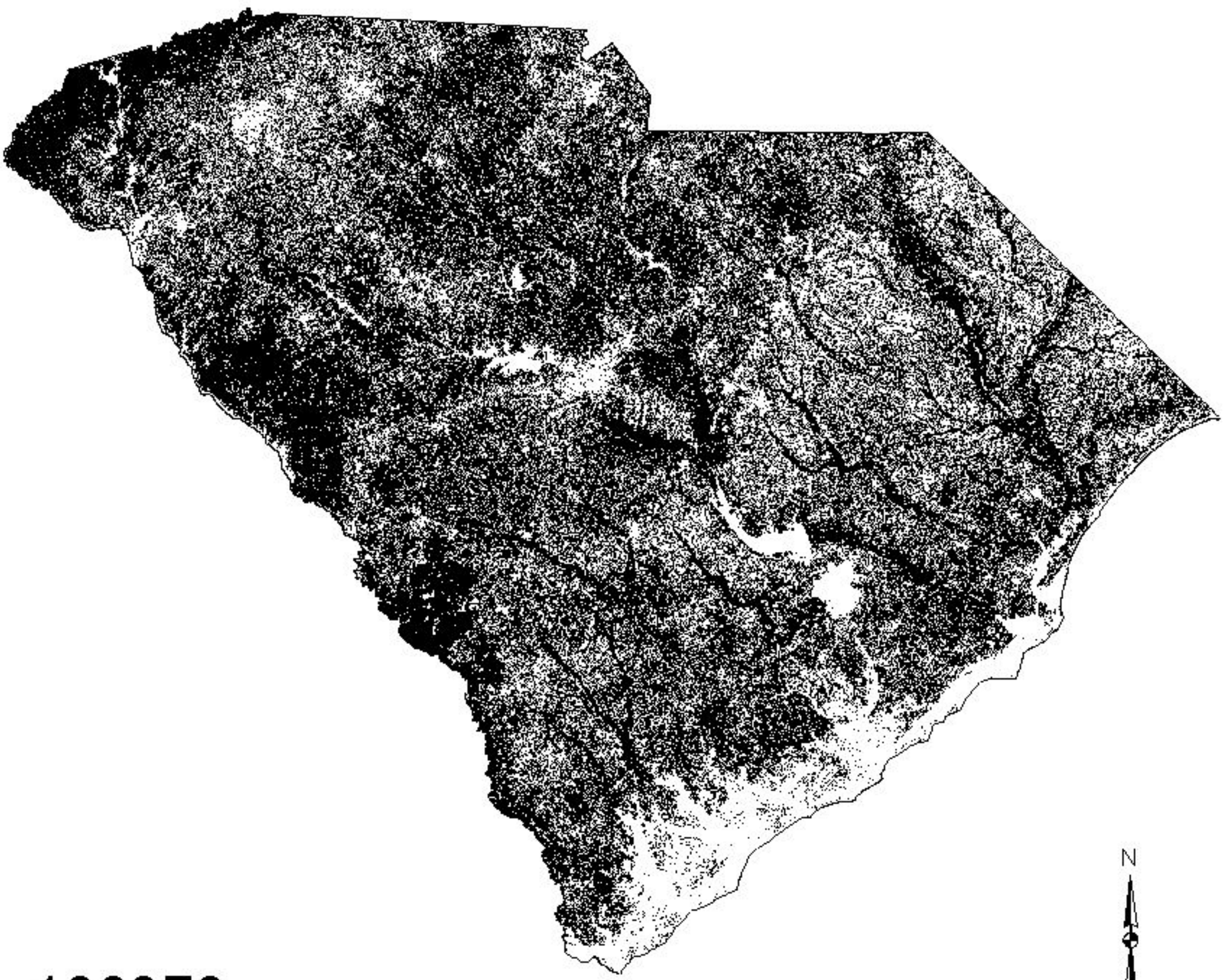
Cotton Mouse

(Peromyscus gossypinus)



Golden Mouse

(Ochrotomys nuttalli)



180379

Predicted present

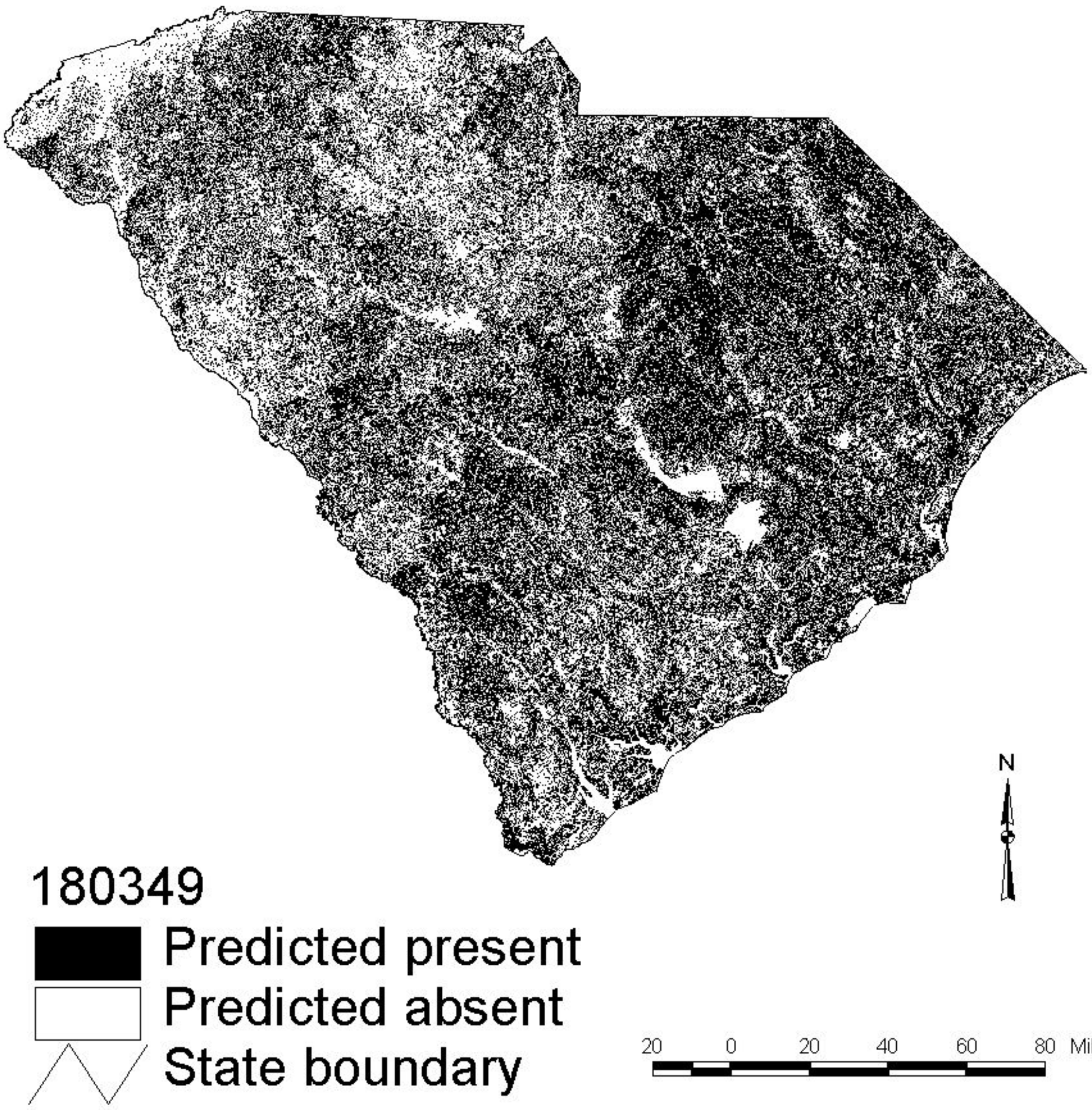
Predicted absent

State boundary

20 0 20 40 60 80 Miles

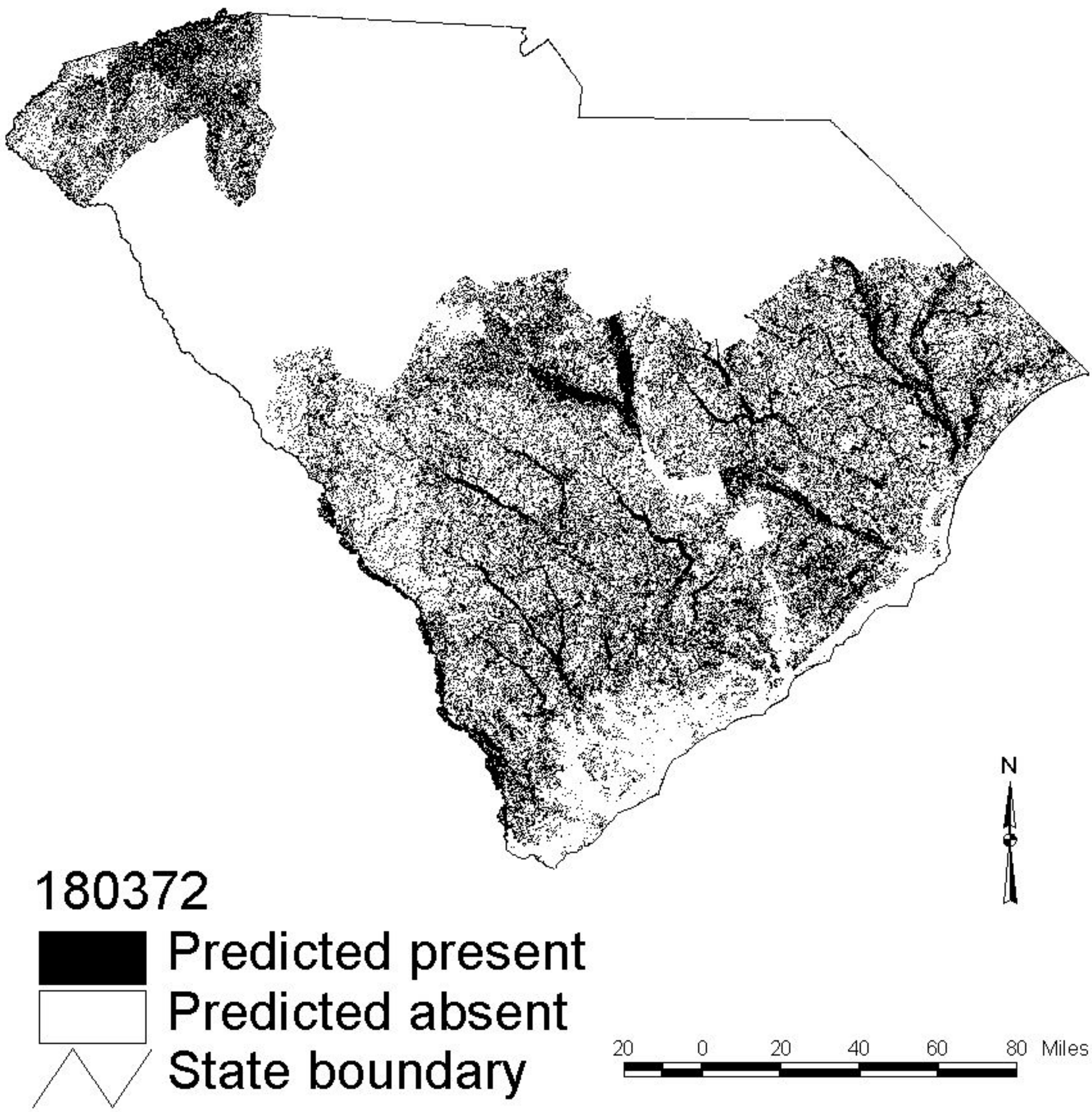
Hispid Cotton Rat

(Sigmodon hispidus)



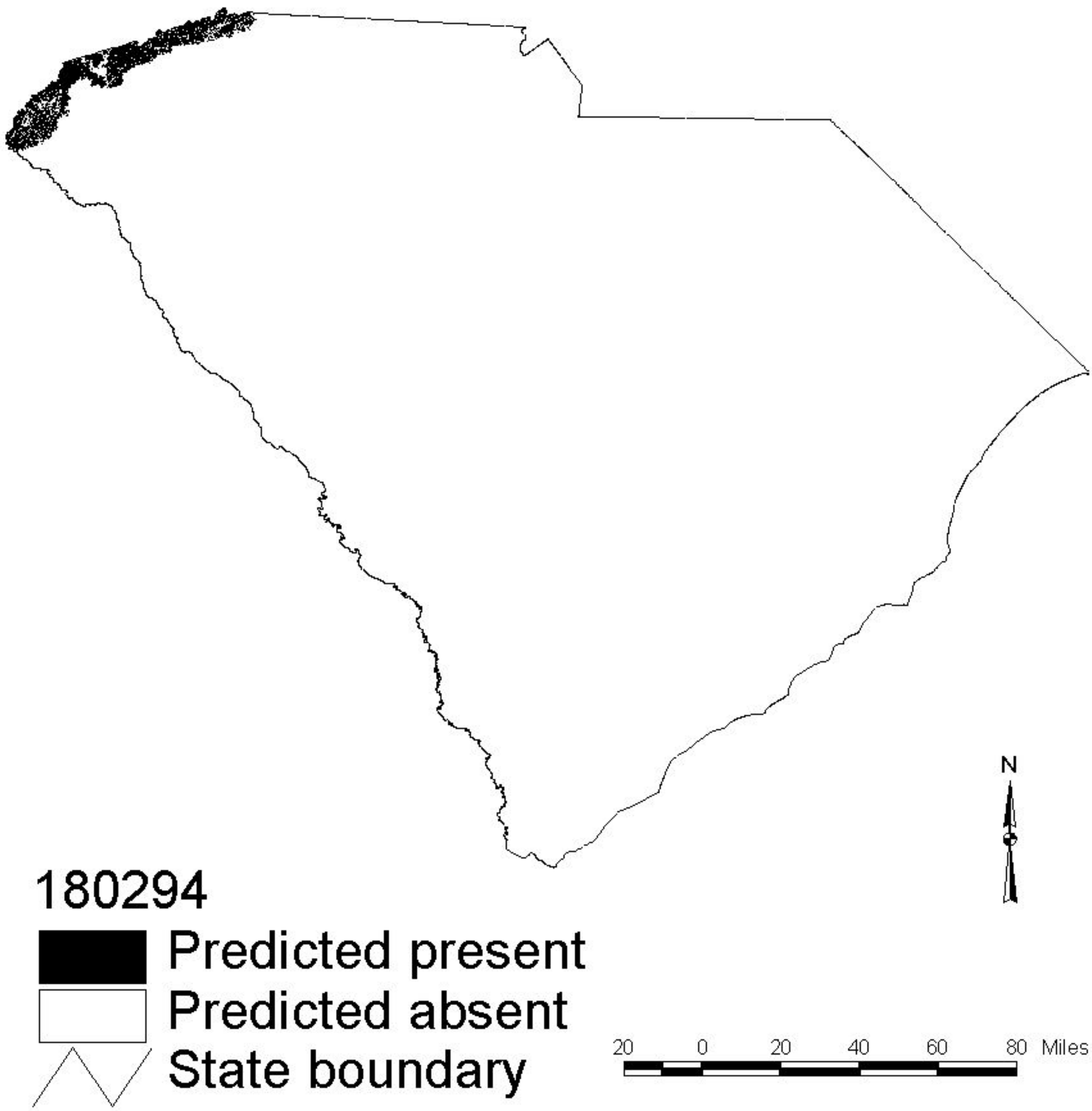
Eastern Woodrat

(Neotoma floridana)



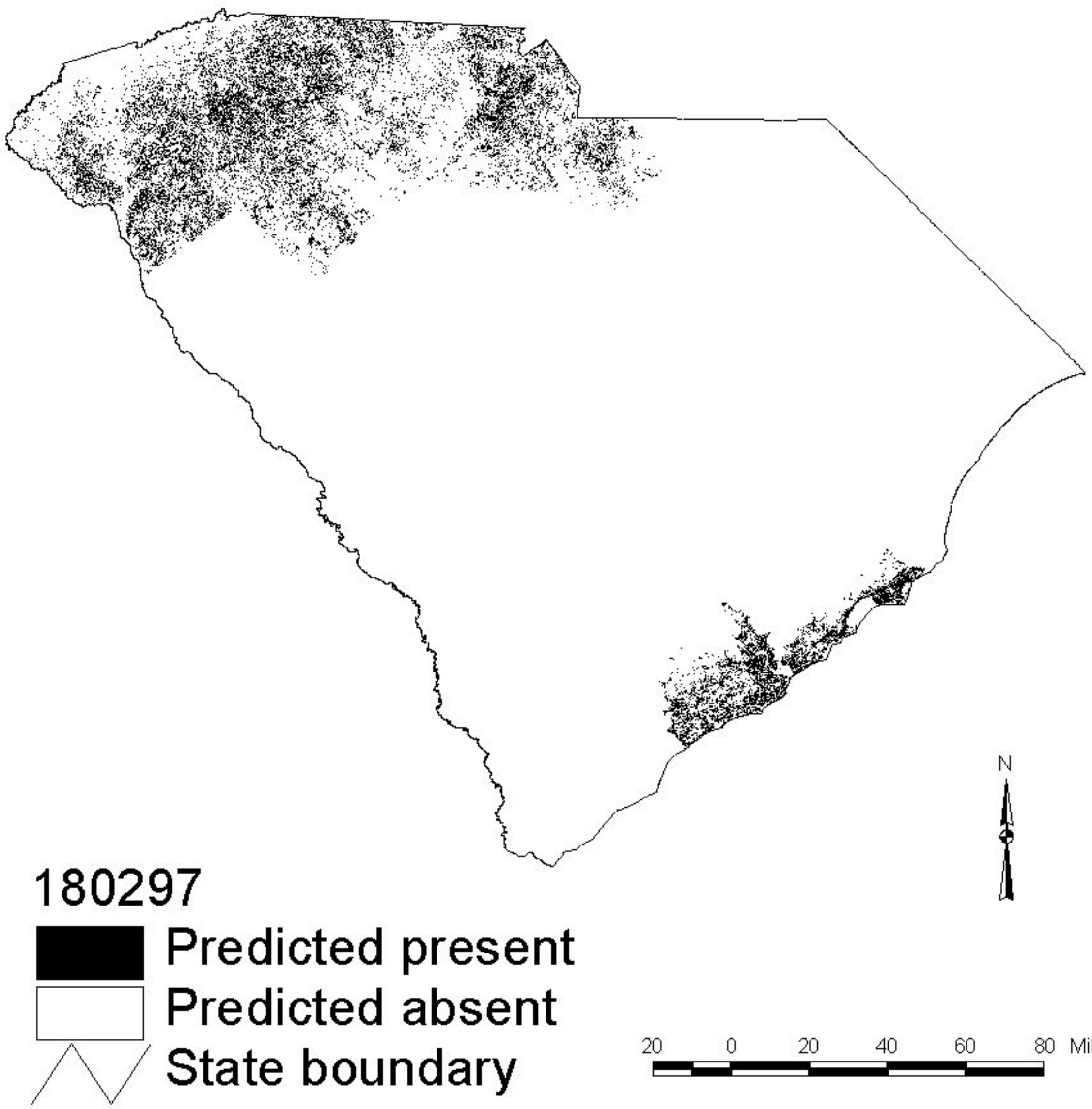
Southern Red-backed Vole

(Clethrionomys gapperi)



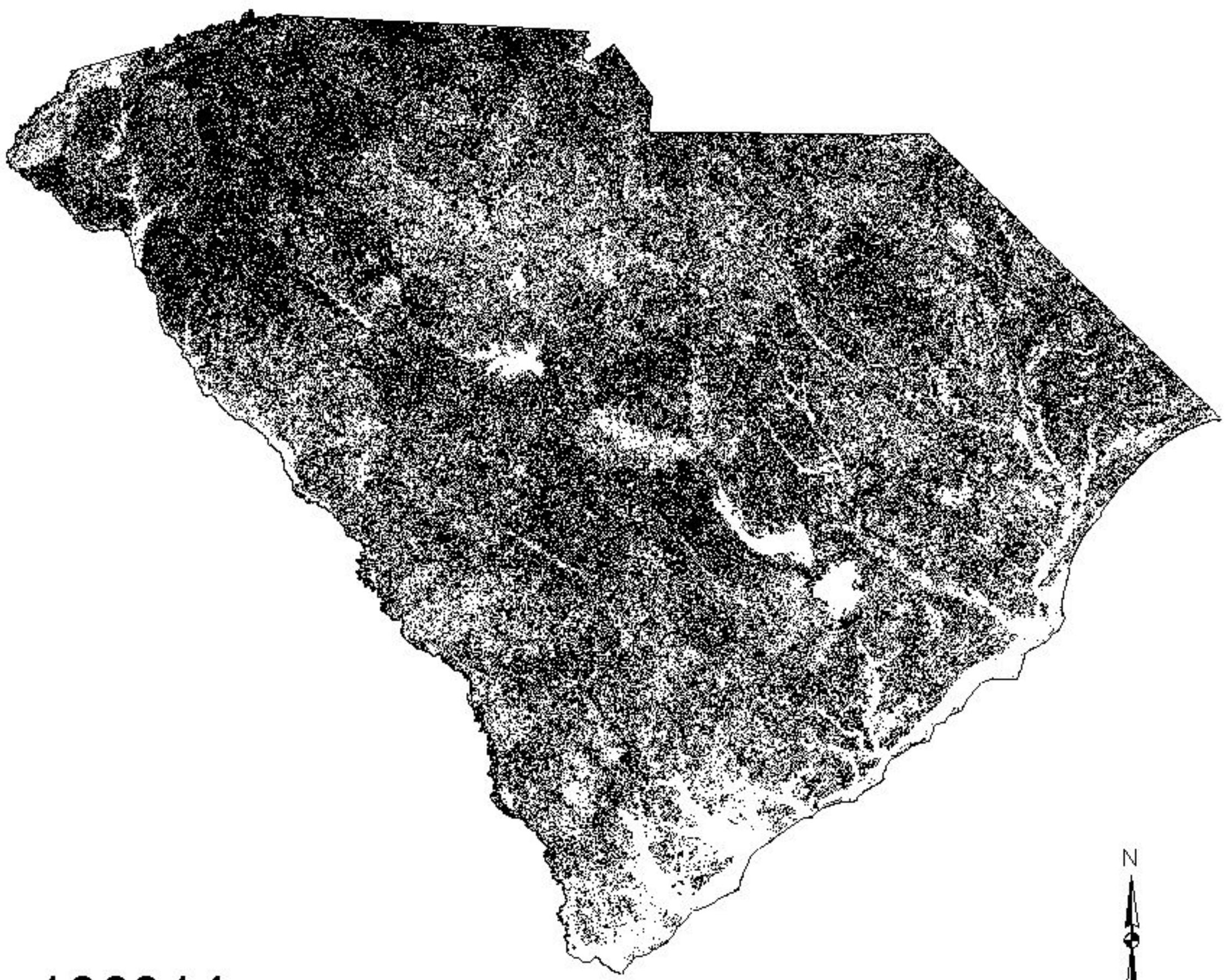
Meadow Vole

(Microtus pennsylvanicus)



Woodland Vole

(Microtus pinetorum)



180314

Predicted present

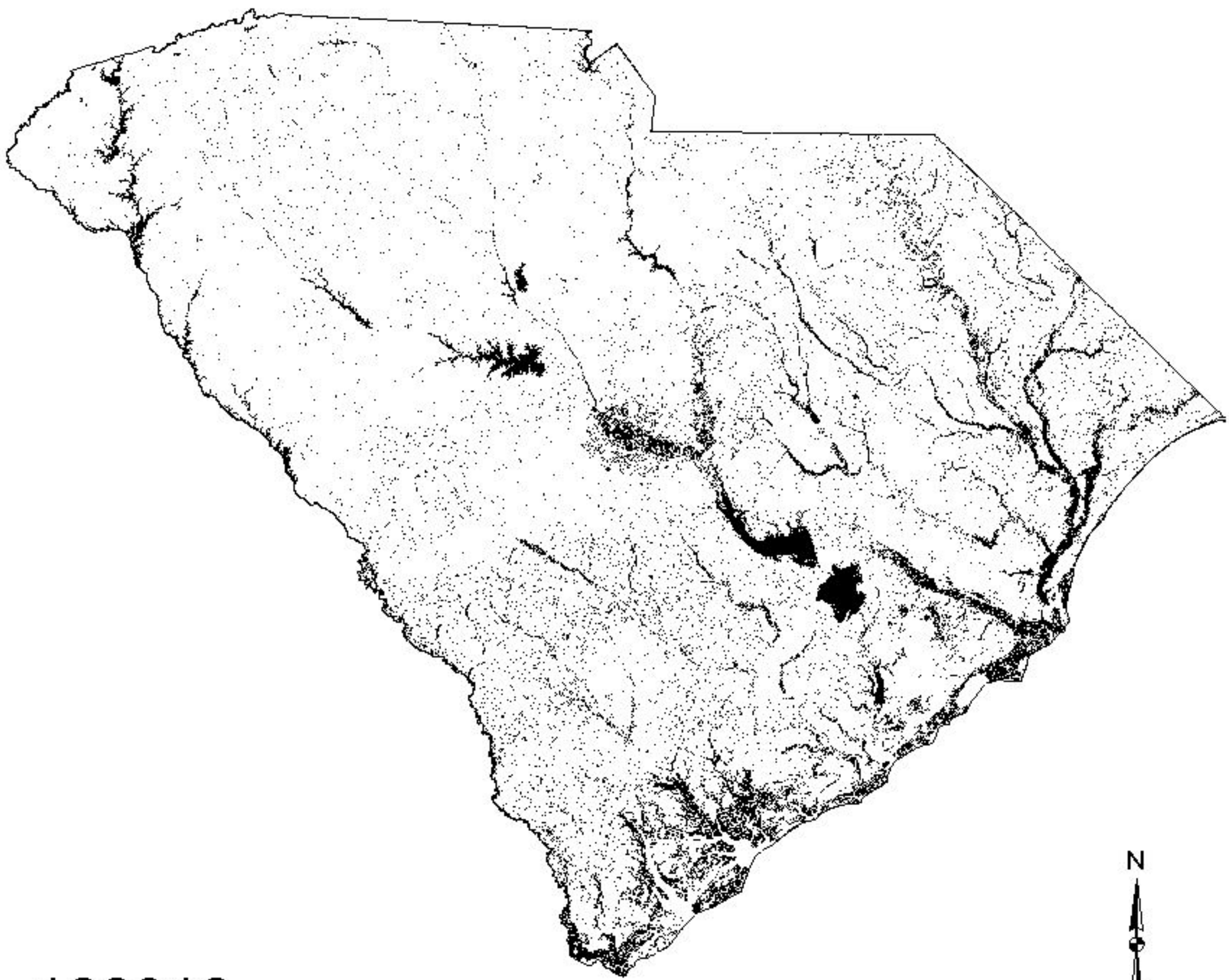
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Muskrat

(Ondatra zibethicus)



180318

Predicted present

Predicted absent

State boundary

Black Rat

(Rattus rattus)

180362

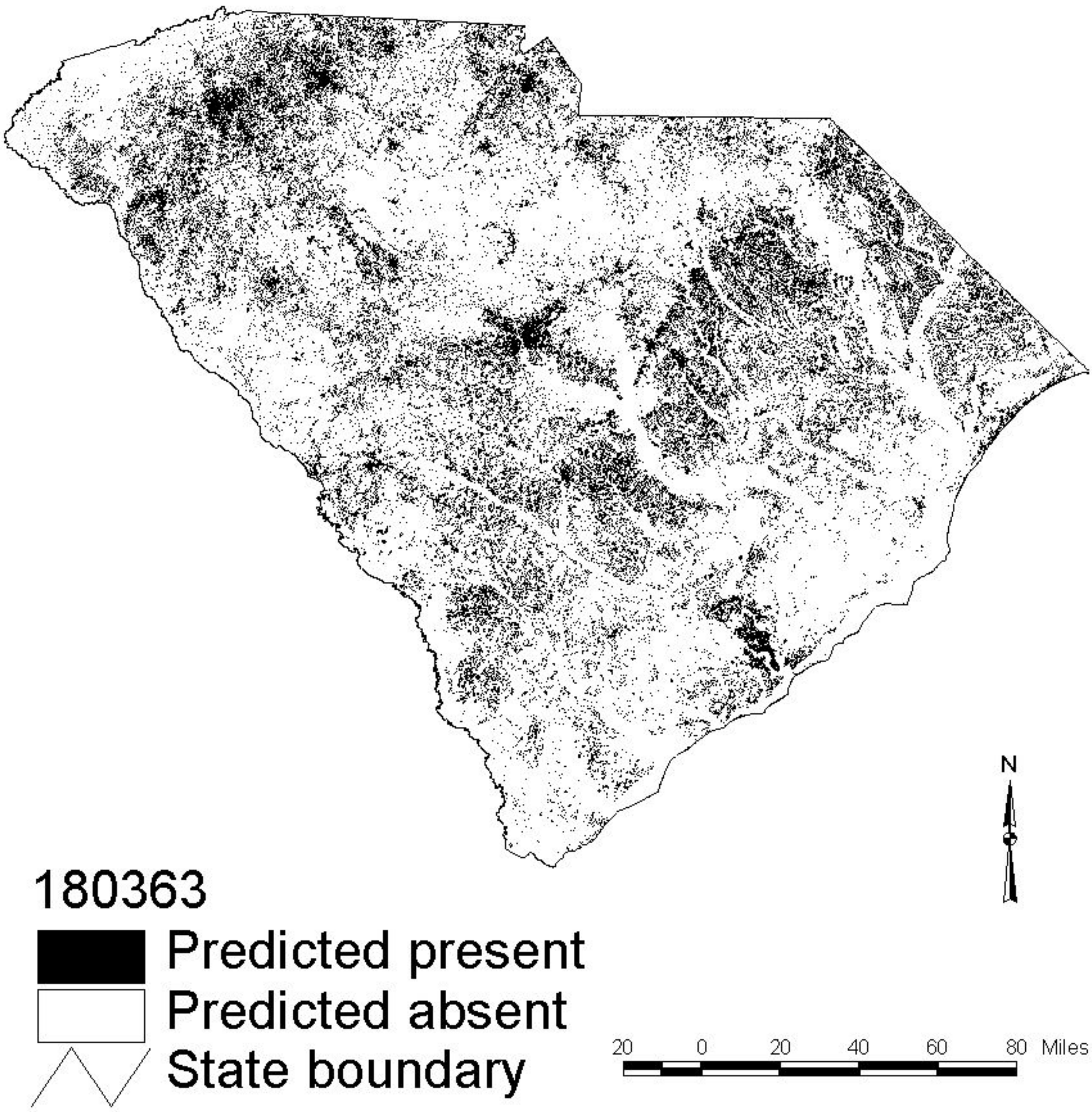
Predicted present

Predicted absent

State boundary

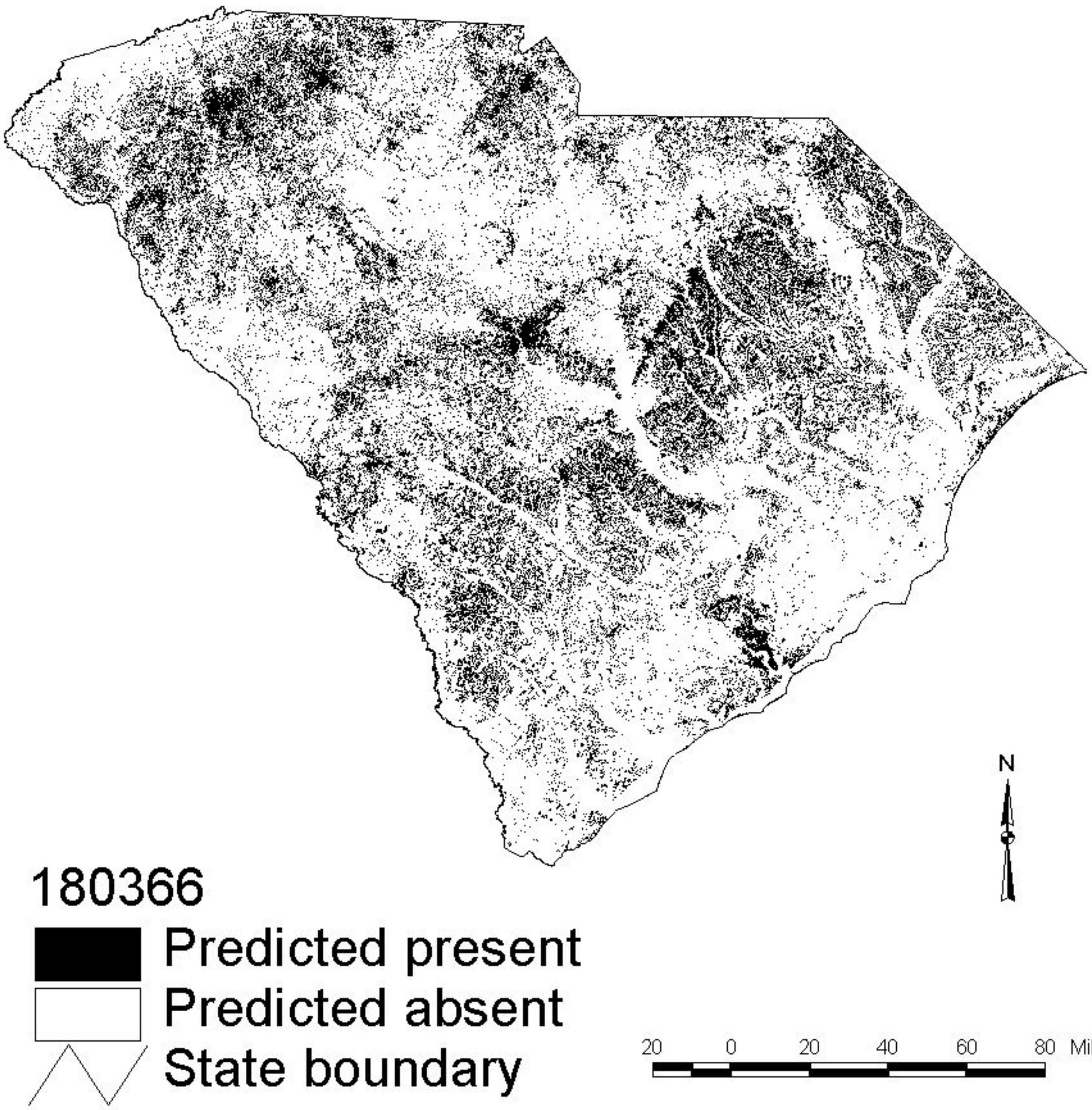
Norway Rat

(Rattus norvegicus)



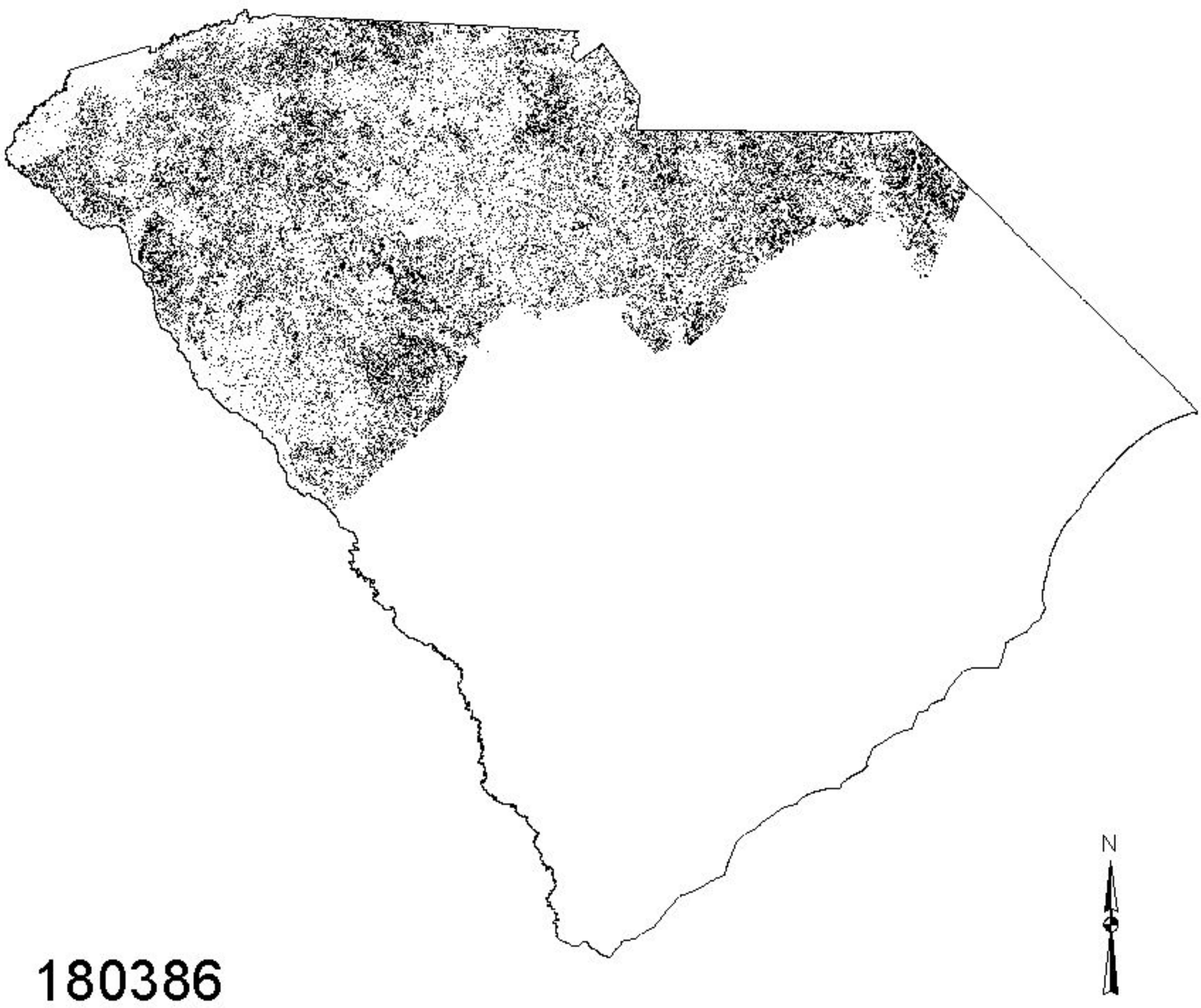
House Mouse

(Mus musculus)



Meadow Jumping Mouse

(Zapus hudsonius)



180386

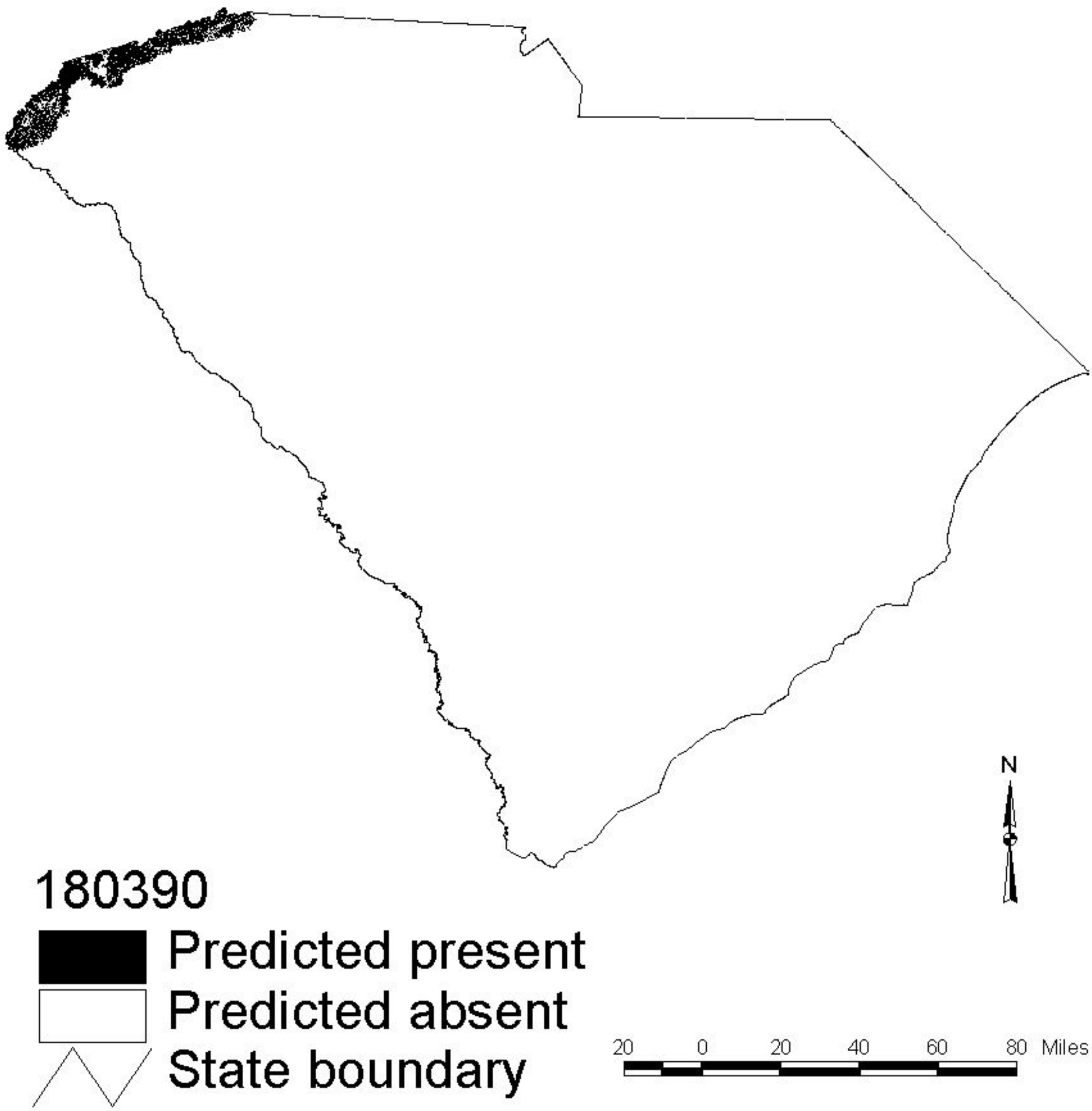
Predicted present

Predicted absent

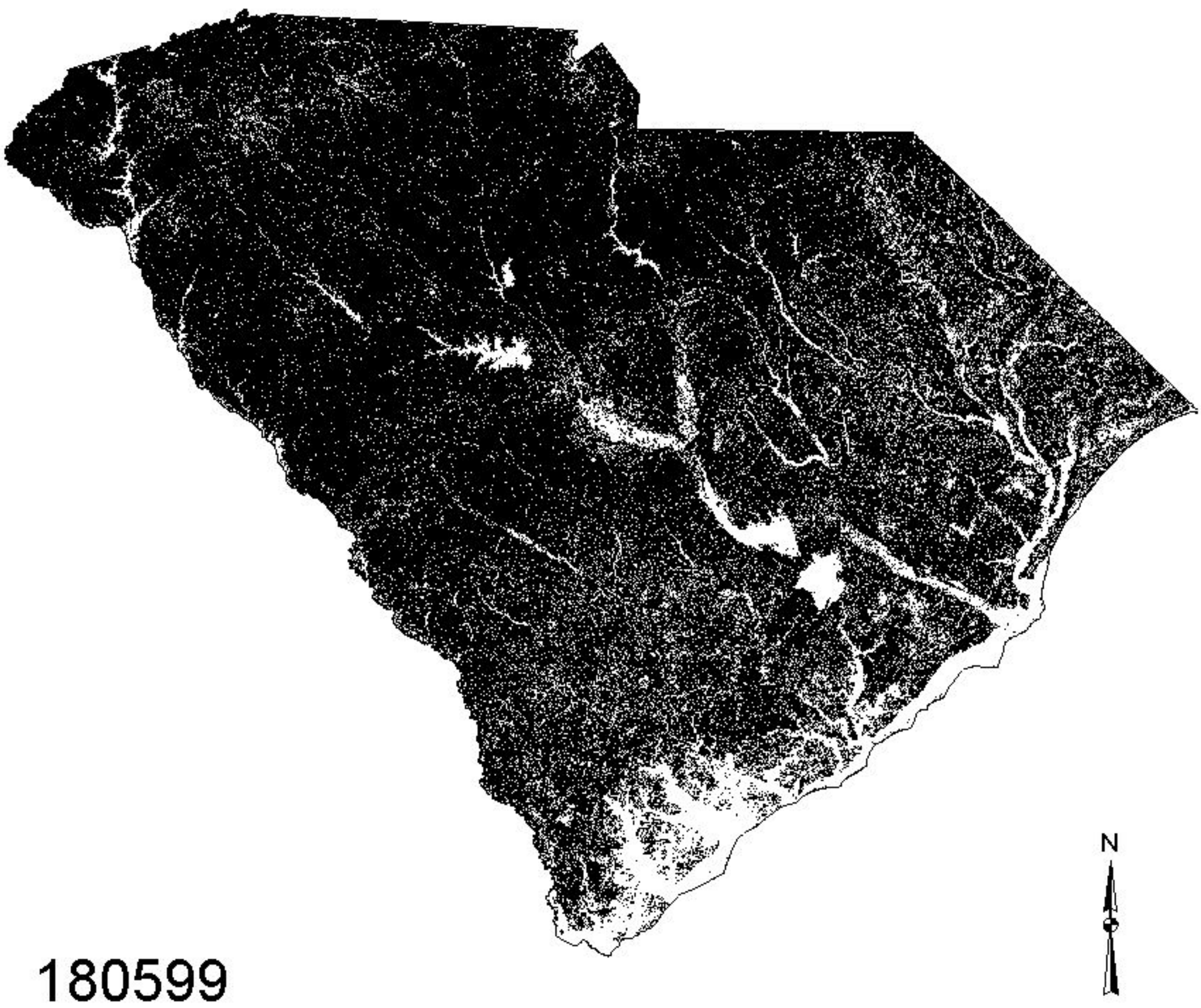
State boundary

Woodland Jumping Mouse

(Napaeozapus insignis)

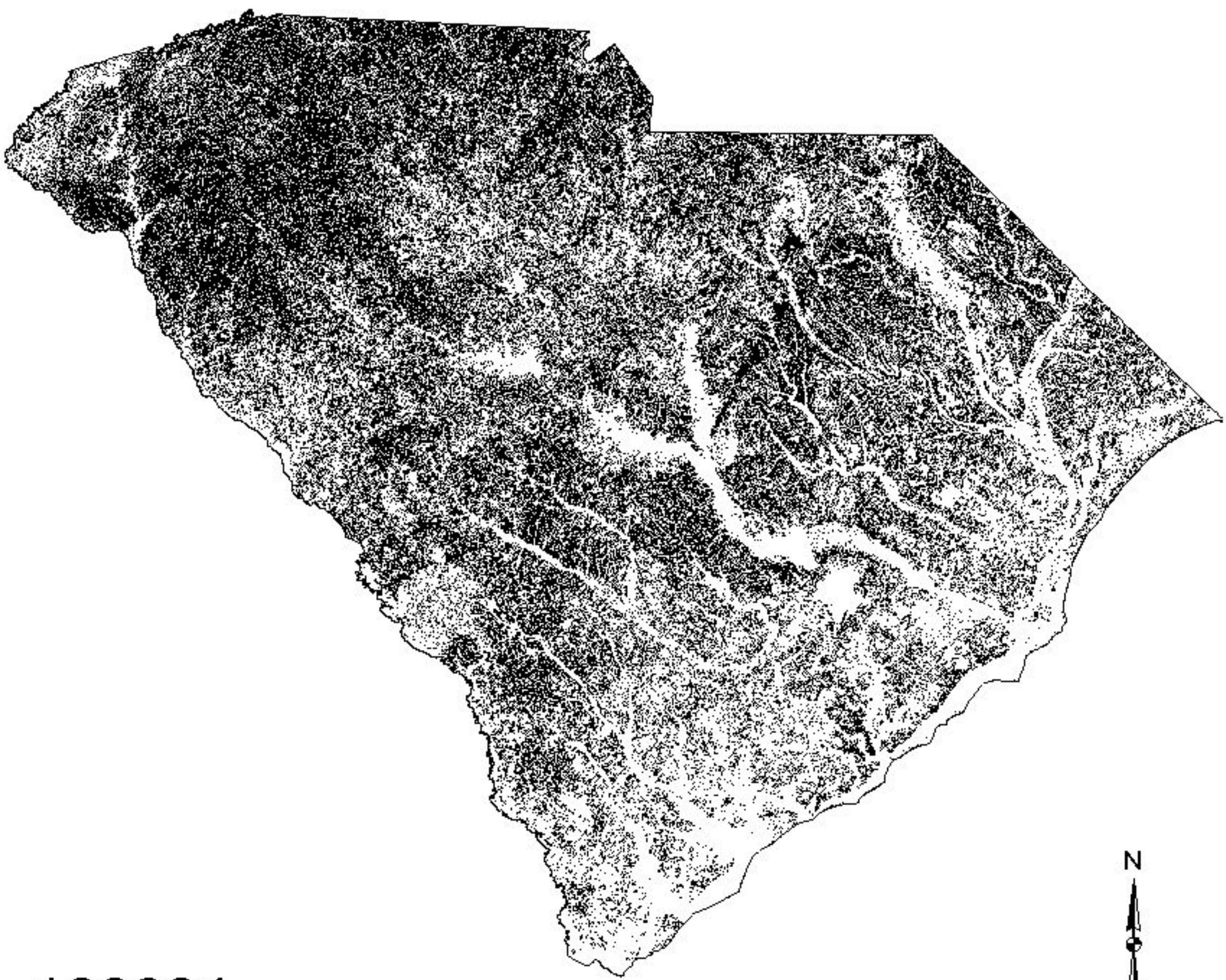


Coyote
(Canis latrans)



Red Fox

(Vulpes vulpes)



180604

Predicted present

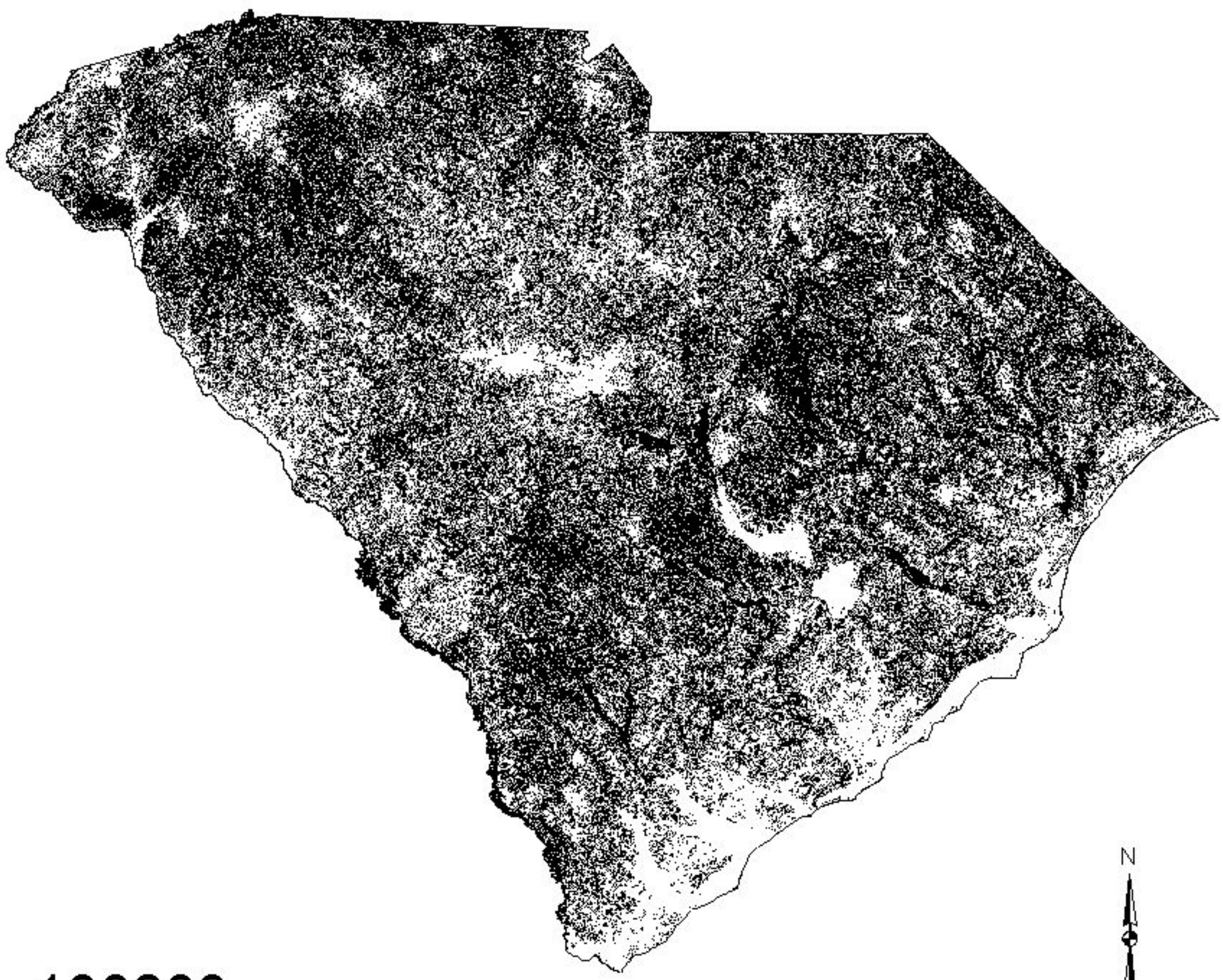
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Common Gray Fox

(Urocyon cinereoargenteus)



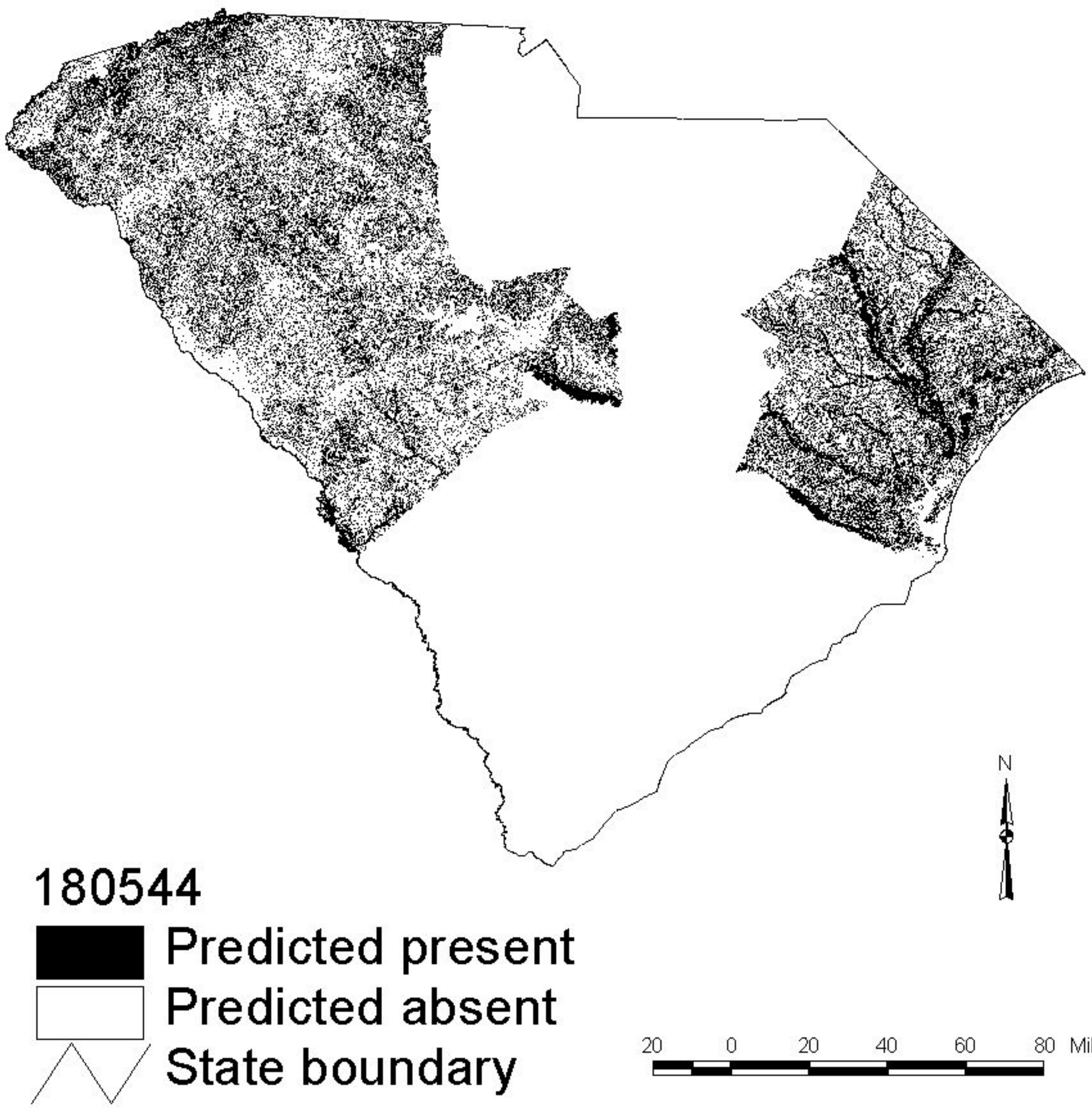
180609

Predicted present

Predicted absent

State boundary

Black Bear
(Ursus americanus)



Common Raccoon

(Procyon lotor)

180575

Predicted present

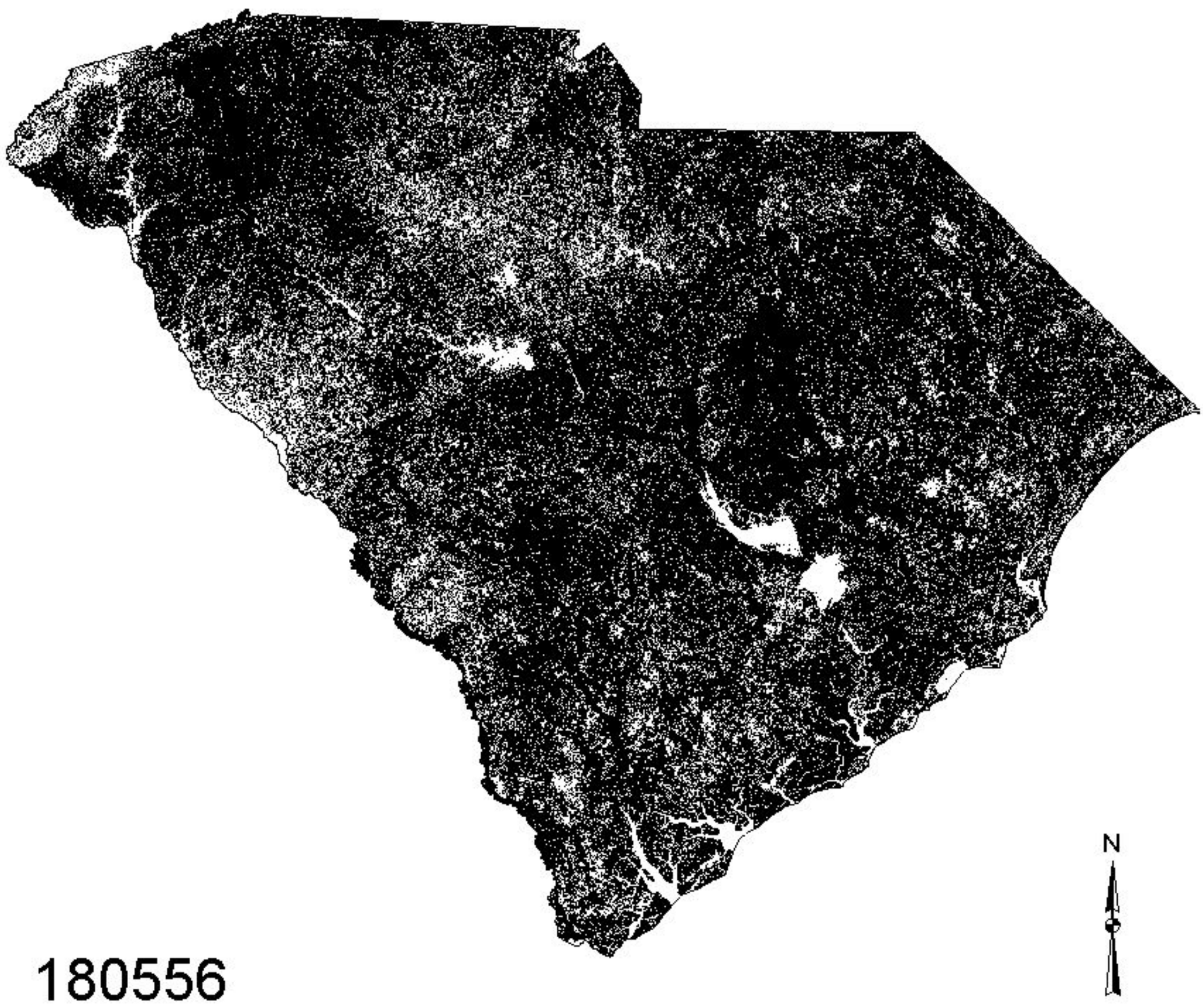
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Long-tailed Weasel

(Mustela frenata)



180556

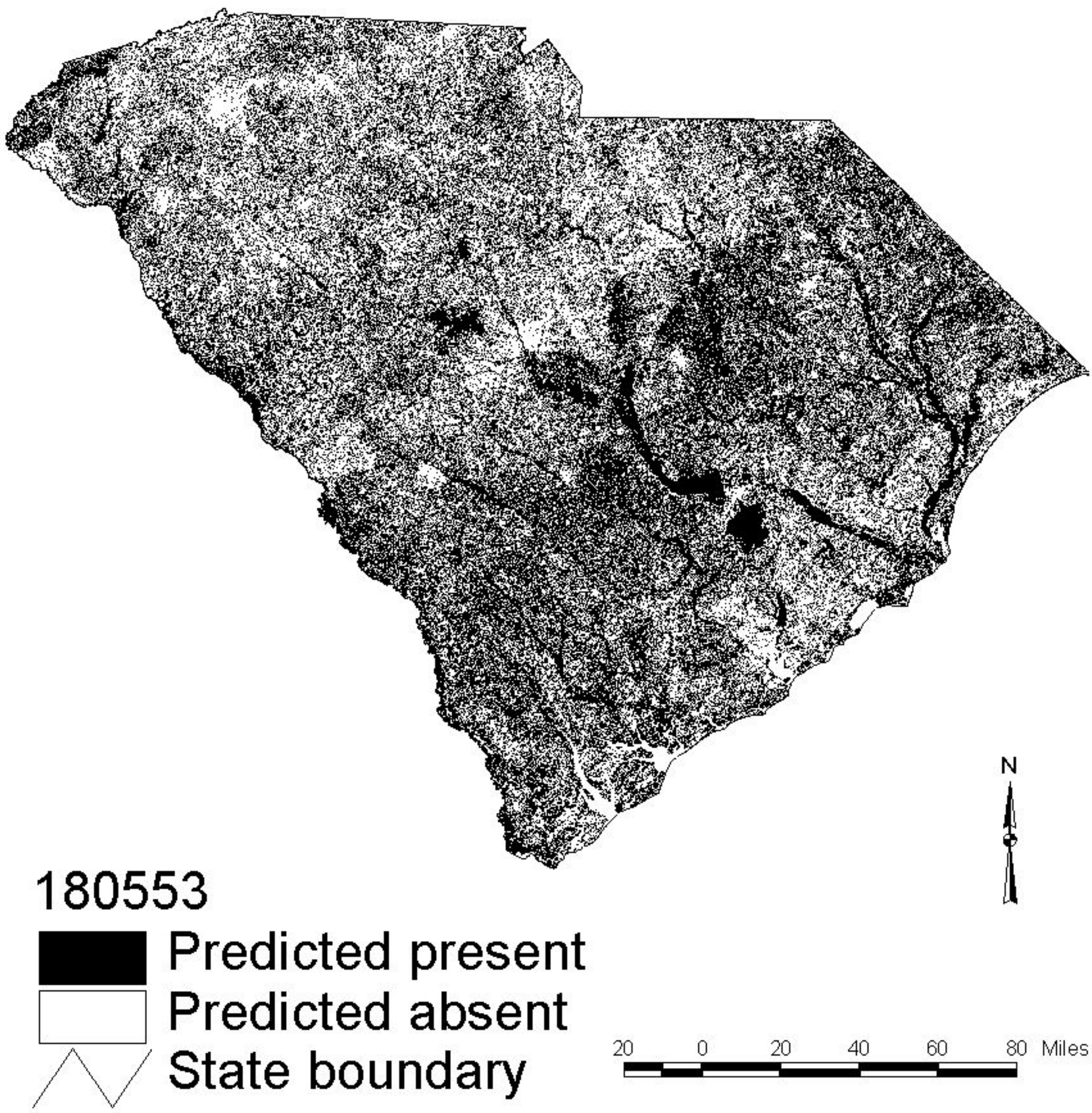
Predicted present

Predicted absent

State boundary

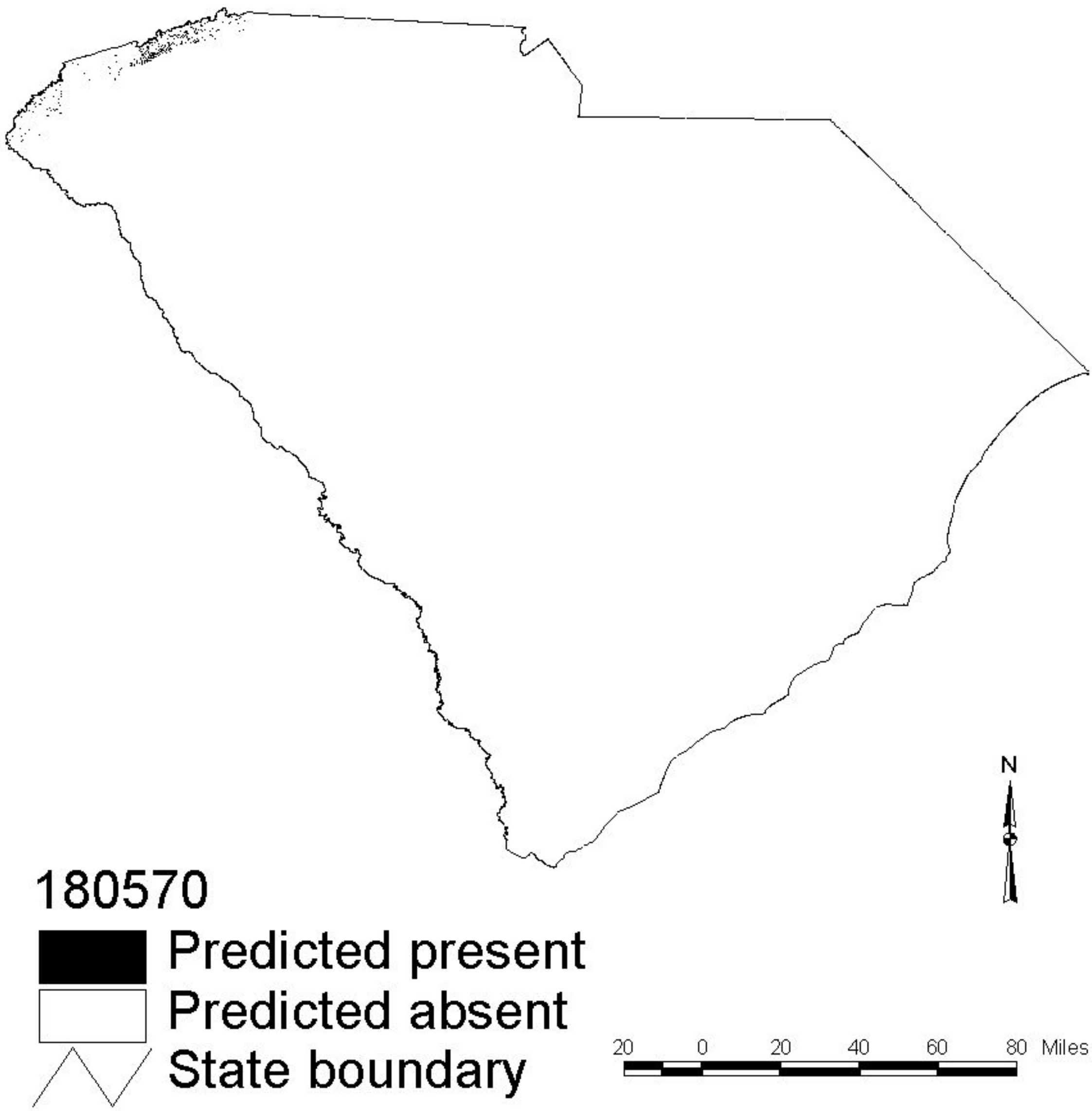
Mink

(Mustela vison)



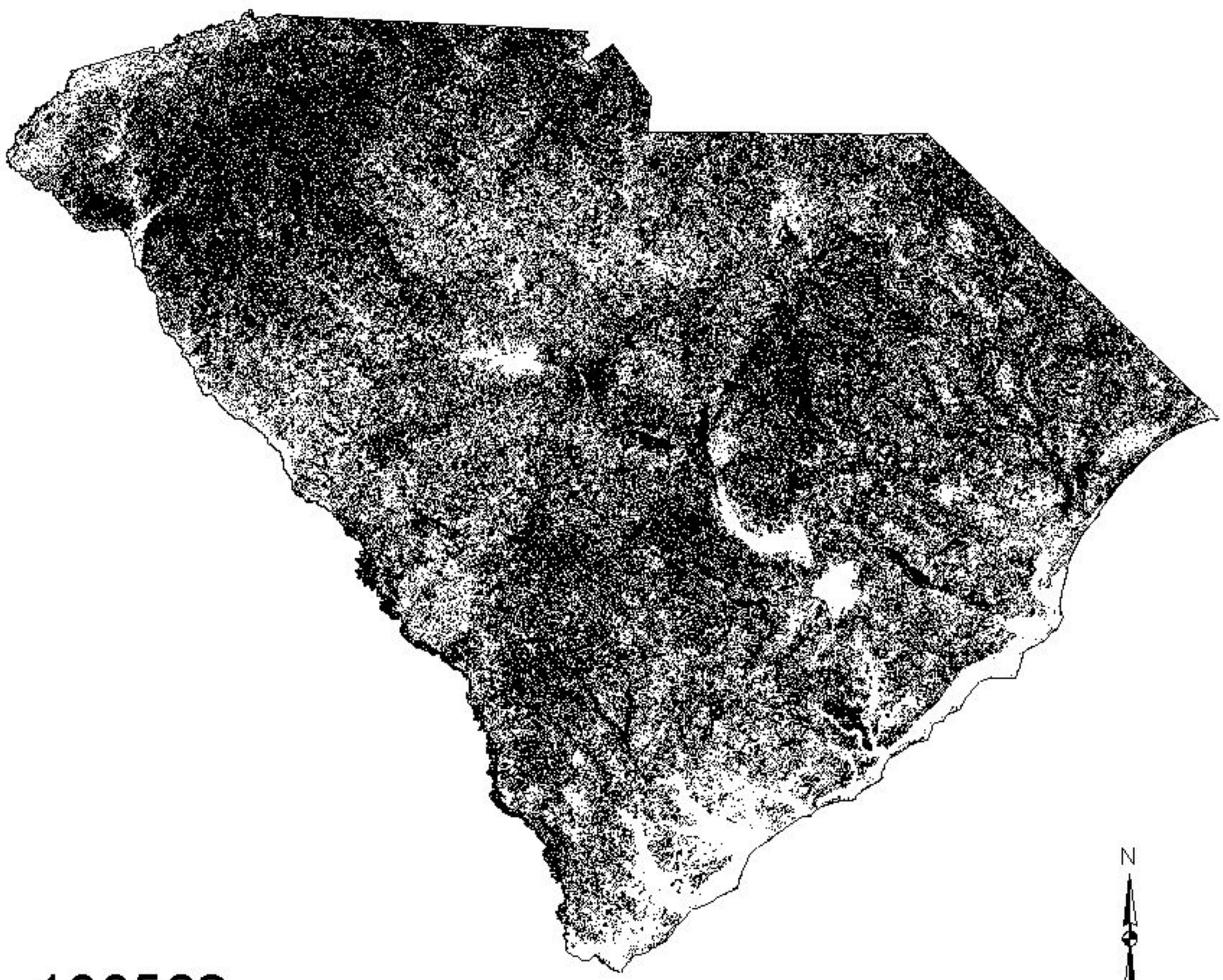
Eastern Spotted Skunk

(Spilogale putorius)



Striped Skunk

(Mephitis mephitis)



180562

Predicted present

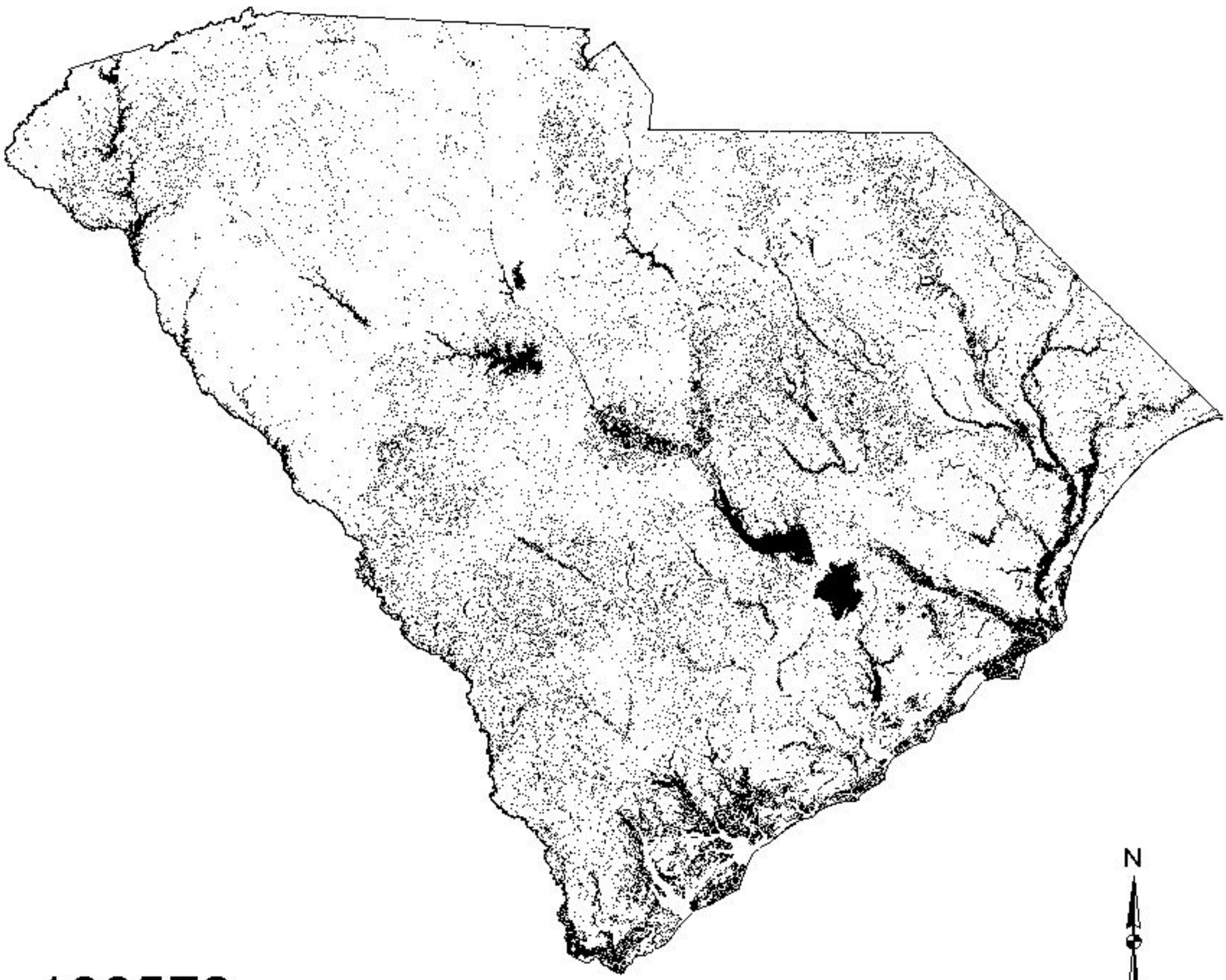
Predicted absent

State boundary

20 0 20 40 60 80 Miles

Northern River Otter

(Lutra canadensis)



180572

Predicted present

Predicted absent

State boundary

Bobcat

(Lynx rufus)

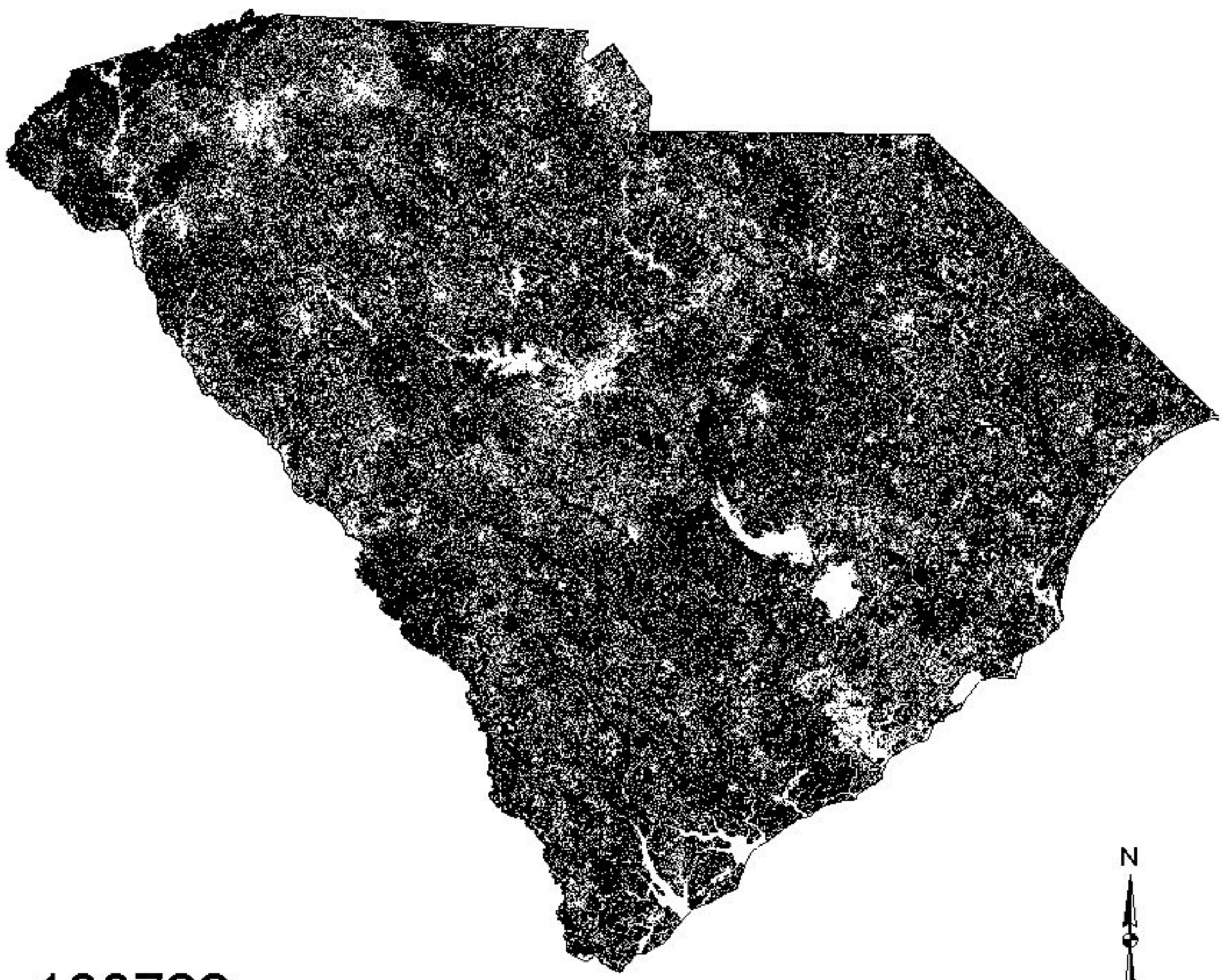
180582

Predicted present

Predicted absent

State boundary

Feral Pig
(Sus scrofa)



180722

Predicted present

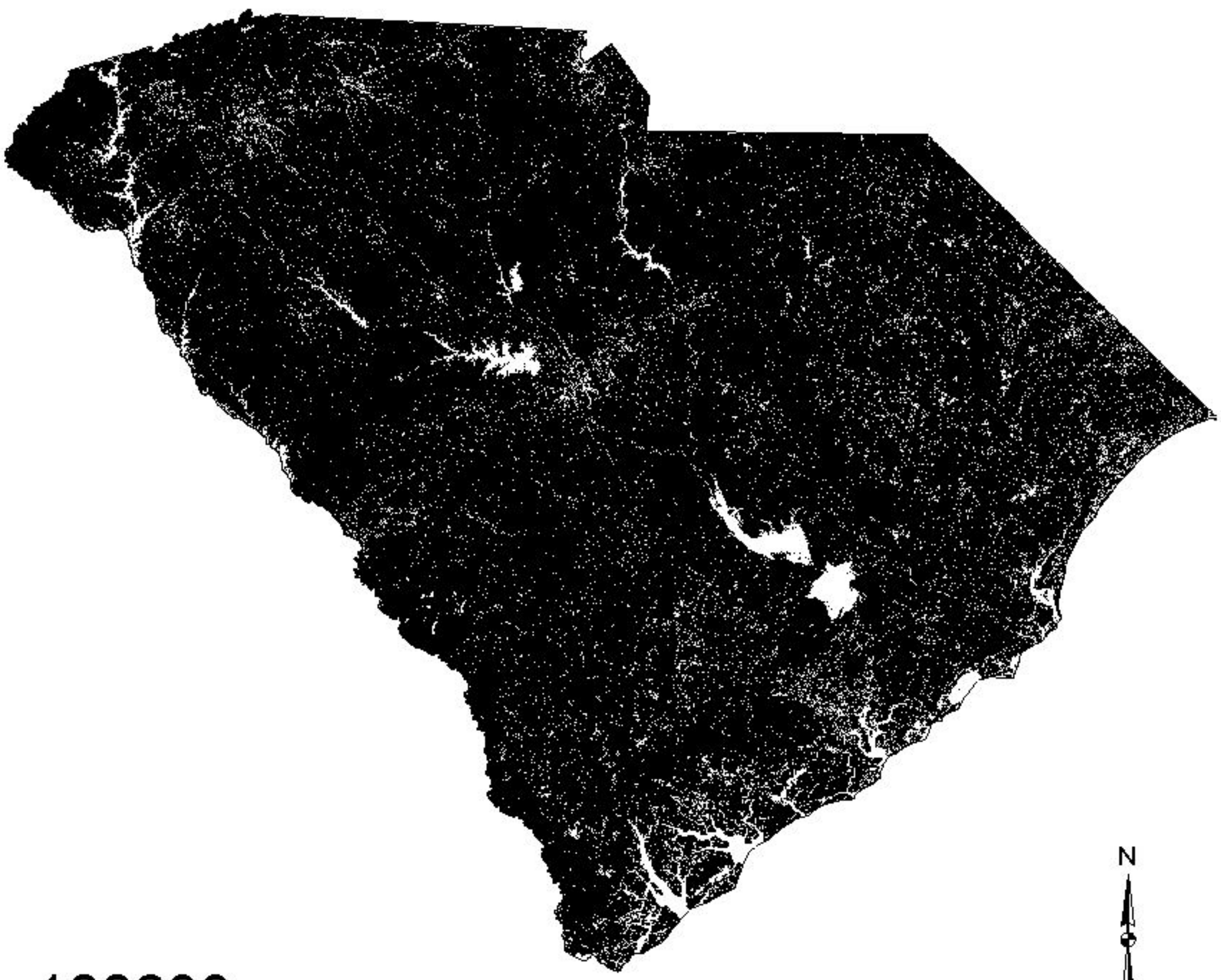
Predicted absent

State boundary

20 0 20 40 60 80 Miles

White-tailed Deer

(Odocoileus virginianus)



180699

Predicted present

Predicted absent

State boundary