

A DISTRIBUTIONAL SURVEY OF NORTH CAROLINA MAMMALS

DAVID S. LEE
JOHN B. FUNDERBURG JR.
MARY K. CLARK



Occasional Papers of the
North Carolina Biological Survey
1982-10



PUBLICATIONS OF THE NORTH CAROLINA BIOLOGICAL SURVEY

The occasional publications of the North Carolina Biological Survey are devoted to scientific papers in various disciplines within the general fields of botany and zoology. Publications to be issued at irregular intervals include collections of short papers, book-length studies, and proceedings of symposia sponsored by the Survey.

Biological Survey publications are distributed by the North Carolina State Museum of Natural History, P.O. Box 27647, Raleigh, N.C. 27611.

ELOISE F. POTTER

Editor

© 1982 by the North Carolina Biological Survey and the
North Carolina State Museum of Natural History.

A Division of the North Carolina Department of Agriculture
James A. Graham, Commissioner

A DISTRIBUTIONAL SURVEY OF NORTH CAROLINA MAMMALS

DAVID S. LEE
JOHN B. FUNDERBURG JR.
MARY K. CLARK

Occasional Papers of the
North Carolina Biological Survey
1982-10



DEDICATED
TO THE MEMORY OF
Frederick S. Barkalow Jr.
27 February 1915 — 22 June 1982

On 22 June 1982, Frederick S. Barkalow Jr. died of a heart attack at Cape Hatteras. "Dr. B.," as he was known to hundreds of students and colleagues, was a life-long sportsman, conservationist, and teacher. During his career, many honors and awards recognized his dedication to these fields. These honors included being the first member elected to the North Carolina Wildlife Conservation Hall of Fame for his lifetime of dedicated service to wildlife conservation. He was one of only four people outside the federal government to be awarded a Citation for Public Service by the U.S. Department of Interior. In 1980, the F. S. Barkalow Distinguished Lectureship was established at North Carolina State University in his honor by the North Carolina Conservation Education Foundation and the N.C.S.U. Chapter of the Wildlife Society.

I have known and admired "Dr. B." since shortly after he arrived in North Carolina in 1947. Whatever else he was involved in, "Dr. B." considered himself first and foremost a mammalogist. No matter where he was or what he was doing, he would always gladly drop everything to discuss some mammal problem with his colleagues. It was always one of Fred's dreams to write *The Mammals of North Carolina*, and to that end he built a tremendous collection of mammals and associated data files. However, his dedication to the broader fields of wildlife conservation and environmental issues prevented him from achieving that goal.

This book, which was prepared with the object of getting people interested in providing information about the mammals in their areas of the state, is aimed at the same objective, a definitive book on the mammals of North Carolina. It combines all of the information acquired by "Dr. B." and his students with the information in the museum files and, in a very real sense, represents a continuation of Fred Barkalow's goal. We, therefore, dedicate this volume to his honor in recognition of his contributions to our knowledge of the mammals of the state.

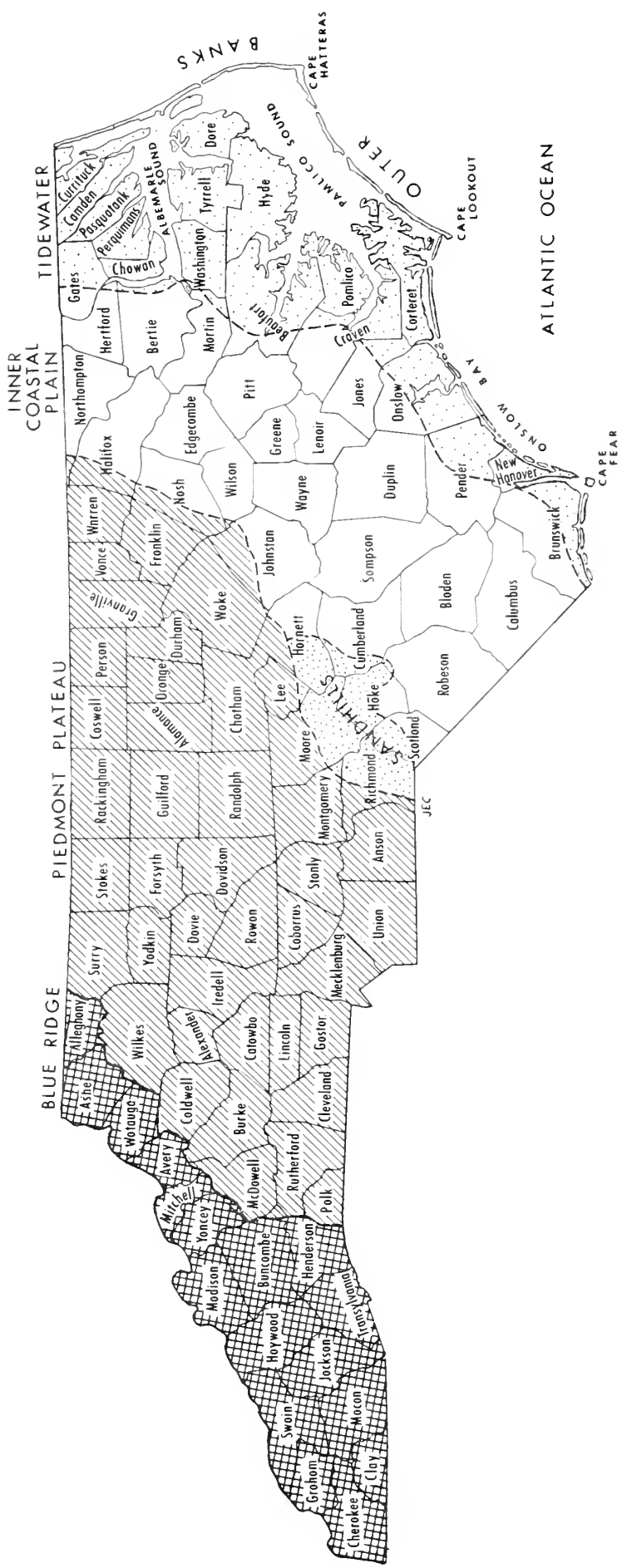
J. B. FUNDERBURG JR.



A DISTRIBUTIONAL SURVEY OF NORTH CAROLINA MAMMALS

CONTENTS

Introduction	5
Comments Concerning Maps and Species Accounts	5
Needs for Additional Study	6
A Brief History of Mammal Study in North Carolina	6
Extirpated, Endangered, and Threatened Mammals in North Carolina	7
Plant Community — Mammal Associations	9
Zoogeography of North Carolina Mammals	18
Selected References	20
A List of the Recent Mammals of North Carolina	21
Species Accounts and Range Maps	
Marsupials: Opossums	24
Insectivores: Shrews and Moles	24
Chiroptera: Bats	30
Lagomorpha: Rabbits	38
Rodentia: Rodents	40
Carnivora: Carnivores	54
Pinnipedia: Seals	61
Sirenia: Sea Cows	62
Artiodactyla: Even-toed Ungulates	62
Additional Introductions	64
Literature Cited	65
Acknowledgments	68
Glossary	69



A Distributional Survey of North Carolina Mammals

DAVID S. LEE, JOHN B. FUNDERBURG JR., AND MARY K. CLARK

Abstract. There are 108 species of mammals currently recognized as occurring in North Carolina and its adjacent offshore waters. Seventy-nine of these are terrestrial and 29 are marine. This represents the largest mammalian diversity of any state in the eastern United States, and one of the largest in the country. Four of the land species are known to be extirpated and one marine form, the Atlantic population of the Gray Whale, is extinct. Five species occurring in the state are exotic. Annotated lists and distributional maps of nearly all species, excluding cetaceans, are presented. In spite of considerable advances in knowledge, this is the first attempt to identify and document the mammal fauna in North Carolina in over 20 years. Included are first North Carolina reports for four species: *Sylvilagus aquaticus*, *Peromyscus polionotus*, *Canis latrans*, and *Balaenoptera acutorostrata*.

The status and distribution of many rare or peripheral species are redefined. A brief history of local mammalian studies and a zoogeographic sketch of the fauna are provided. Detailed accounts of North Carolina's cetaceans will appear in a forthcoming paper.

INTRODUCTION

There are at least 75 native and 5 exotic species of terrestrial mammals known from North Carolina, constituting the largest state mammal fauna along the East Coast. Including the 29 marine mammals, it is one of the largest in the country. Despite this impressive diversity, the mammals of North Carolina have received relatively little study and, compared to other vertebrates, there are still obvious, major gaps in our knowledge of this group. Few active field mammalogists have resided in North Carolina, and the several previous attempts at statewide surveys have, over the years, all been conducted by the staff of the North Carolina State Museum. During the last 6 years the museum staff has been making a systematic effort to compile literature and museum records for all the mammal species in the state. Additionally, we have spent a considerable amount of time actively collecting in the field and recording information from fur sheds, road kills, questionnaires, knowledgeable individuals, and other sources too various to list.

The major goal of this paper is to document geographical distribution. However, information on habitat preference, relative abundance, and occasionally other aspects of natural history is presented when available.

A secondary goal of this publication is to inform people of the sparseness of our knowledge of our mammal fauna, in the hope that interested persons will be inspired to help fill the gaps. Areas most in need of study should be readily apparent both on regional and species levels. Information provided here is restricted to mammals in North Carolina; biological studies done on these species in other states are not included. People desiring general information of this type are referred to the Selected References.

Marine mammals are not treated in the present survey because James G. Mead and others are preparing a companion work on the cetaceans of North Carolina, to be published in this same series.

In the future we hope to publish a definitive book on the mammals of North Carolina. Persons aware of significant distributional information or additions to the general biology of mammal species found in North Carolina are urged to notify the North Carolina State Museum at Raleigh and to deposit voucher specimens in appropriate museums. The State Museum hopes that the range maps and basic data in this distributional survey will encourage zoology students and amateur mammalogists to conduct systematic field studies and to call upon the staff for assistance in documenting and publishing significant new information.

Comments Concerning the Maps and Species Accounts

In each species account we have attempted to discuss distribution, relative abundance, and habitat relationships. Reference is made to information on the breeding biology or other aspects of natural history only if published data are available for North Carolina populations *per se*.

The scientific name (genus, species, and often subspecies) is followed by the last names of the authors of the species, the person or persons who originally discovered and described it. An author's name in

parentheses indicates that the form is currently recognized in a taxon other than that in which it was originally described. The common name of each species appears below its scientific name.

The state maps denote precise records of occurrence of specimens recorded for North Carolina and the smaller North American maps illustrate the total known native range of each species (modified from Hall 1981). Dots indicate museum records, sightings reported by reliable observers, and literature records that seem unquestionable. Two or more records in close proximity are plotted with a single dot. Information on the source of each dot is on file at the North Carolina State Museum. Occasionally only the county in which the species was reported is available. Such records are noted with a capital C. When two or more subspecies occur in the state, dashed lines delineate the approximate range of each race.

Needs for Additional Study

With the exception of the major game and fur-bearing species, few North Carolina mammals have been studied in detail. For some species various aspects of their biology have been investigated in other states, but we cannot assume that all populations within a species respond in the same way to environmental demands, which may vary widely throughout the total range. Gaps in our basic understanding of habitat preference, abundance, and population cycles are vast, and it would be redundant to discuss them species by species.

In the past, most local lists of the mammals of state parks and other such areas of special interest as well as lists given in environmental assessments have come, at least in part, from generalizations, field guides, and older literature. Because of this, our lack of information, often masked by misinformation, has been self-perpetuating.

Comments on relative abundance are always somewhat subjective, and the same criteria for a top-order predator cannot be used for a mouse, or for a conspicuous game mammal and a shrew. Nevertheless, attempts do need to be made to examine and compare relative abundance in some systematic fashion. Terms used to indicate relative abundance are: *abundant* — of regular occurrence in large numbers; *common* — of regular occurrence but limited abundance; *fairly common* — in regular occurrence but in moderate numbers; *uncommon* — widely distributed but in small numbers; and *rare* — seldom encountered in optimum habitat and occurring only in a limited number of places in the state. These terms necessarily imply somewhat different absolute numbers in different species and are used with due consideration of habits and conspicuousness. If we are to remain concerned about endangered, threatened, and rare mammals, there must be some yardsticks against which we can measure population trends. Thus, quantitative population indexes are much needed.

Mammal study is further hampered by problems with collecting and preparing specimens. There are few other major groups of animals where both collection and preparation are so time consuming. It is not unusual for a hundred carefully set traps to catch not a single specimen. Mammals are difficult to observe in the field, and their signs are read accurately only by the most skilled and experienced naturalists. Because of this, mammals have not had the appeal to students or amateur naturalists that other vertebrate groups have had.

A Brief History of Mammal Study in North Carolina

A review of the literature dealing with major aspects of our knowledge of the mammals of this state will place the present distributional survey in perspective. The earliest organized account of North Carolina mammals was C. S. Brimley's 32-page "A Descriptive Catalogue of the Mammals of North Carolina, Exclusive of the Cetacea." The printed publication date for this account was 1905, but it actually did not appear until March 1908. It was revised and updated from 1944 to 1946 as a series of 18 installments in "Carolina Tips." This revision included the cetaceans. During the years between the two editions of Brimley's work, the only major paper published was "The Mammals of the Great Smoky Mountains," by Edwin and Roy Komarck (1938). Although most of the records in this paper were from Tennessee, some data on North Carolina mammals were included. Since 1938 a number of papers dealing with montane mammals have appeared (Conaway and Howell 1953; Handley 1971; Johnston 1967; Linzey and Linzey 1968, 1971, 1973; Odum 1949; Smith et al. 1974; and Whitaker et al. 1975). Although our knowledge of the distribution and abundance of montane mammals is far from complete, the Appalachian Mountains are certainly the most intensively studied area of the state.

In 1942 and 1952 some attention was given to coastal mammals when William Engels wrote on the vertebrate faunas of Ocracoke Island and Shackleford Banks, two of North Carolina's famed Outer Banks. Smith, Funderburg, and Quay provided an updated checklist of the state's mammals in 1960. Although various elements of our fauna have been included in taxonomic revisions of specific groups,

general publications, and separate papers, the only additional regional paper to appear since 1960 was a 1965 summary of records for marine mammals occurring from Cape Hatteras to Georgia, by Caldwell and Golley. In 1977 the North Carolina State Museum published the proceedings of a symposium on endangered and threatened plants and animals of the state (Cooper et al. 1977). The chapter on mammals (Lee and Funderburg 1977) summarized our current understanding of the status of the rarer elements of our fauna.

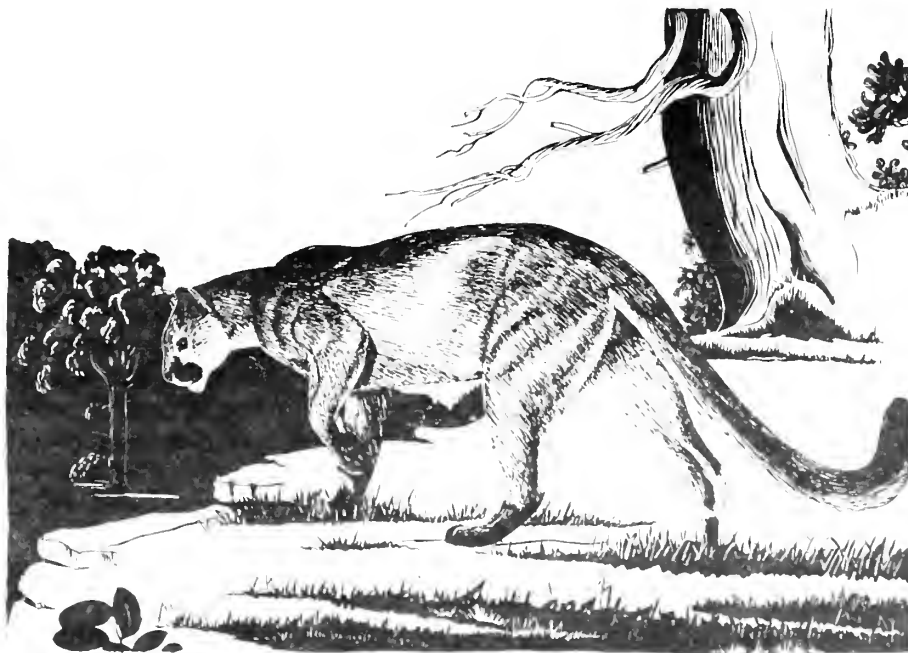
Whitaker and others (1975) recently documented the occurrence of the Water Shrew in Clay County, Lee and Marsh (1978) provided information on the range expansion of the Brazilian Free-tailed Bat into the southeastern portion of the state, and Robinson and Lee (1980) commented on range expansion of the Groundhog. With these exceptions, our knowledge of the distribution of North Carolina's terrestrial mammal fauna has increased little during the several decades since Brimley's original listings.

Extirpated, Endangered, and Threatened Mammals in North Carolina

Some of the more conspicuous elements of our mammal heritage have already been lost. The Buffalo (American Bison) disappeared from North Carolina in the 1760s, thus becoming the first species of animal or plant known to have been extirpated from the state in historic times. It has left behind only its name, which is shared by about 50 scattered features and sites. Buffalo were apparently still common in the late 1720s when Colonel William Byrd surveyed the line that now separates North Carolina and Virginia, for he noted their presence several times in his journals. Numbers of Buffalo were still present in the state in the 1750s, but by 1765 William Bartram reported that "the buffaloe, once so very numerous, is not at this day to be seen in this part of the country." All he mentioned were the remains of a Buffalo lick and "heaps of the white, gnawed bones of the ancient buffaloe."

Other large mammals followed the Buffalo. The American Elk was extirpated by hunting, disappearing by the late 1700s. The Gray Wolf could still be found in the more remote sections of the state until the late 1890s and early 1900s. A report of a wolf killed in 1933 was the last record of this species in North Carolina. The mountain and piedmont populations of the White-tailed Deer were totally hunted out by the beginning of this century, and the last native Beaver was apparently trapped in 1897. Deer and Beaver were reintroduced in the 1930s. There is some reason to suspect that the Porcupine and Fisher may have once occurred in the mountainous portions of North Carolina, but their presence in historic times cannot be substantiated. Additionally, the Gray Whale, which no longer exists in the Atlantic, occurred in North Carolina waters during colonial times. James G. Mead, United States National Museum, has records from this state of four Gray Whale skulls, two of which are now in the collections of the North Carolina State Museum.

The loss of these species, and the potential loss of others, should be viewed as something more than an obvious decline of species diversity. As variety decreases, we move toward an orderly but comparatively monotonous uniformity. Extirpation pursued to its extreme would leave us with a handful of introduced



species in addition to a few native forms with wide ecological tolerances. In the past much of man's extermination of animals seemed inevitable and even desirable. Today, however, with growing respect for environmental ethics, many would no longer agree that an increase in deer herds is adequate compensation for the disappearance of the Panther (Mountain Lion) or the extirpation of the American Elk and American Bison. Even some of our extant species now survive in such modest numbers, like the Manatee, or are managed at densities so far below the potential carrying capacity of the available habitat, like the Black Bear, that they contribute very little to their environments as populations.

Species that may or do still occur in North Carolina and are considered endangered include: Indiana Bat, Panther, and Manatee. Several marine mammals are also recognized as federally endangered, but these are outside the scope of this survey.

The Northern Flying Squirrel, the single species listed by Lee and Funderburg (1977) as threatened, is the only local mammal that occupies a small geographic area, is confined to a specialized habitat, and exhibits a documented decrease in range. Habitat alteration, combined with direct ecological competition from a close relative, the Southern Flying Squirrel, creates a real threat to this form.

The Black Bear was placed in the category of special concern by the mammal committee working on the 1977 symposium. Although its range and numbers have certainly declined in historic times, the bear does not appear to be in immediate danger of extirpation because of regulations and management practices of the North Carolina Wildlife Resources Commission; however, its long-range survival is certainly threatened by continued disappearance of habitat.

The symposium's list of mammal species whose status is undetermined is quite substantial. All of the undetermined species are rare. Several are probably threatened with extirpation, but we cannot document this possibility. The terrestrial species listed by the 1977 symposium as having an undetermined status include:

Dismal Swamp Short-tailed Shrew	Rafinesque's Big-eared Bat
Pygmy Shrew	Brazilian Free-tailed Bat
Long-tailed Shrew	Snowshoe Hare
Dismal Swamp Southeastern Shrew	New England Cottontail
Water Shrew	Fox Squirrel (mountain population)
Hairy-tailed Mole	Rock Vole
Southeastern Bat	Dismal Swamp Meadow Vole
Gray Bat	Southeastern Wood Rat
Keen's Bat	Bog Lemming (2 races)
Small-footed Bat	Least Weasel
Little Brown Bat	

Only the Brazilian Free-tailed Bat should be removed from the above list at this time. Recent observations (Lee and Marsh 1978) indicate that it is more widespread than formerly believed. On the other hand, the Old-field Mouse and Swamp Rabbit probably should be added because they are both very rare in North Carolina. The Old-field Mouse may be threatened within the state.

Five of the mammals listed are of concern only at the subspecies level. Other populations of the same species in the state are not believed to be in danger. Two of the five, *Sorex longirostris fisheri* (Southeastern Shrew) and *Blarina brevicauda telmalestes* (Short-tailed Shrew) are Dismal Swamp endemics. Both the Dismal Swamp subspecies and the Appalachian subspecies of the Southern Bog Lemming are listed, and in North Carolina *Microtus pennsylvanicus nigrans* (Meadow Vole) occurs only in the Dismal Swamp. A southeastern race of the Wood Rat, which enters North Carolina only in the extreme southeastern corner of the state, and a race of the Fox Squirrel, which is restricted to a few counties in the southwestern mountains, were also listed as undetermined. Nevertheless, some researchers believe that all Fox Squirrel populations in the state are threatened.

Protecting the habitats of North Carolina's rare mammals is a valid strategy for maintaining populations. However, land acquisition and laissez faire policies alone may not be sufficient to perpetuate many of the terrestrial species discussed in this report. Some of the peripheral forms display very narrow ecological tolerances and often occur only in ecotonal habitats. These and other species associated with particular successional stages of plant communities may need careful management if viable populations are to be maintained (Lee and Cooper 1976). Many of our rare species appear to be safe because they occur in national parks, national forests, and other areas that are relatively free from development. This apparent security may ultimately become a problem if the effects of natural shifts in plant communities and of encroaching competition from close relatives or ecological equivalents remain unknown. Basic research is urgently needed on habitat requirements, feeding habits, and reproductive biology to provide adequate guidance for instituting active management programs for North Carolina's rare animals.

PLANT COMMUNITY - MAMMAL ASSOCIATIONS

Because of its latitudinal position on the North American Continent and its 500-mile-long east-west axis, North Carolina possesses a diverse plant community structure. Elevational gradients, successional patterns, soil types, water tables, natural fires, saline waters, salt spray, and other factors have ordered these plant communities in a complex mosaic. Over the years various descriptions and explanations of the relationships between the communities have appeared. For the purpose of explaining generalized mammal - plant community relationships, we have chosen to use B. W. Wells's pioneering interpretation of the 1920s (Wells 1924). We feel that this best complements our understanding of the ecological distribution of North Carolina's mammals at this time.

The characteristic floras listed here are mostly based on plants used by Wells to define his plant communities. The mammal and plant lists are not intended to be inclusive. Mammals listed under each community type have been observed or collected by us in these communities within the state.

Beach Dunes

The seaside dunes that occur on the outer fringe of the coastal counties are best developed along the southeastward facing coast south of Cape Hatteras. The well-drained humus-free soil of the dunes and the strong wind-driven salt spray make this community a xerophytic one even though rainfall is abundant. On older dunes, lying back from the primary ones, the salt spray is less pronounced, and woody shrubs, maritime forests, and mixed hardwood forests often form.

Primary Dunes

Characteristic flora: Sea Oats, *Uniola paniculata*; Sea Rocket, *Cakile* sp.; Salt-meadow Cord Grass, *Spartina patens*; Seaside Evening Primrose, *Oenothera humifusa*; Dune Spurge, *Euphorbia polygona*; Sea Elder, *Iva imbricata*; Spanish Bayonet, *Yucca* sp.; Seaside Goldenrod, *Solidago sempervirens*; and *Croton punctatus*.

Characteristic mammal fauna: Eastern Cottontail, House Mouse. (Occasional: Eastern Mole, Meadow Vole, Gray Fox.)

Forested Back-lying Dunes

Characteristic flora: Live Oak, *Quercus virginiana*; Wax Myrtle, *Myrica cerifera*; Yaupon, *Ilex vomitoria*; Hercules'-club, *Zanthoxylum clava-herculis*; Palmetto, *Sabal minor*; Cabbage Palmetto, *S. palmetto*; Loblolly Pine, *Pinus taeda*; and various oak-juniper and pine-maple associations.

Characteristic mammal fauna: Eastern Mole, Gray Squirrel, Cotton Mouse, White-footed Mouse, Gray Fox, White-tailed Deer. (Occasional: Opossum, Marsh Rabbit, Eastern Wood Rat, Raccoon.)

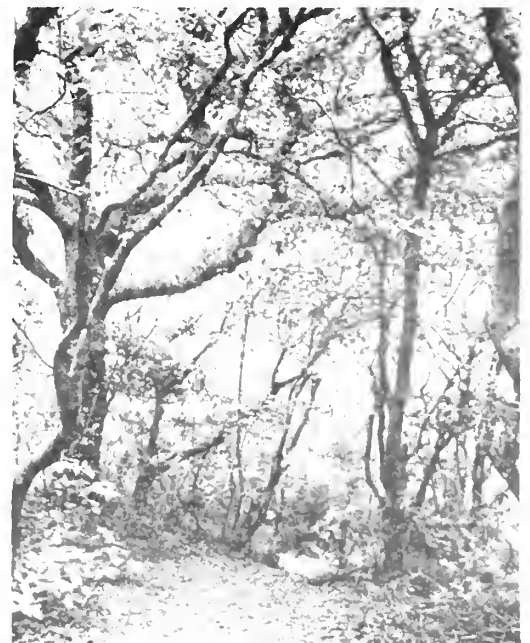


Fig. 1. Beach Dunes: primary dunes (left) and forested back-lying dunes (right), Dare County.

Salt Marsh

In many coastal areas extensive salt marshes occur. Most shallow, protected tidal zones provide areas for marshes to develop. The type of marsh at a given site, each characterized by distinct species of grasses and rushes, results from the degree of flooding and the salt content of the water. Basically Salt-marsh Cord Grass (*Spartina alterniflora*) persists in areas flooded by daily tidal rhythm. Those flooded only by spring tides are dominated by Salt-meadow Cord Grass (*S. patens*). Areas that are the least saline and flooded irregularly by storms are characterized by Black Needle Rush. On high islands in the marsh, thickets of shrubs and trees often grow. Winding through the marshes are numerous tidal creeks as well as isolated pools and salt pans.

Characteristic flora: Cord Grasses, *Spartina alterniflora* and *S. patens*; Black Needle Rush, *Juncus roemerianus*; Tall Panic Grass, *Panicum virgatum*; Glasswort, *Salicornia* sp.; Sea Lavender, *Limonium* sp.; and Sea Ox-eye, *Borrchia frutescens*.

Characteristic mammal fauna: Least Shrew, Rice Rat, Meadow Vole, Muskrat, Nutria, Raccoon, Mink, River Otter. (Occasional: Marsh Rabbit.)

Freshwater Marsh and Shallow Open Water

These habitats occur throughout North Carolina but are most characteristic of the eastern portion of the state. Freshwater marshes border sounds, lakes, and slow streams; form in isolated, poorly drained depressions; or result from Beaver dams. Both marshes and open waters can be natural or man-made. Marshes are dominated by emergent, nonwoody vegetation, whereas the shallow-water communities either lack vegetation or support plants that are completely submerged or have leaves floating on the surface. These two plant communities are treated as one because their mammal faunas overlap to such an extent that separate listings would be redundant.

Characteristic flora (marsh): Cat-tails, *Typha latifolia* and *T. angustifolia*; Arrowheads, *Sagittaria* sp., Pickerelweed, *Pontederia cordata*; Wild Rice, *Zizania aquatica*; Parrot-feather, *Myriophyllum* sp.; Lizard's Tail, *Saururus cernuus*; and various species of *Juncus* and *Scirpus*. Woody vegetation such as willows and alders also occurs.

Characteristic flora (shallow water): Spatter-dock (*Nuphar*), Pondweed (*Potamogeton*); Bladderwort (*Utricularia*), Tapegrass (*Vallisneria americana*), and other aquatic plants such as Eel-grass, *Zostera marina*, and Pickerelweed.

Characteristic mammal fauna: Beaver, Rice Rat, Meadow Vole, Muskrat, River Otter, Raccoon, Mink. (Occasional: Southeastern Shrew, Short-tailed Shrew, Harvest Mouse, White-footed Mouse, Southern Bog Lemming, Nutria.)

Pocosins and Carolina Bays

Extensive pocosins and widely scattered Carolina bays are found throughout much of the eastern half of the coastal plain and locally in the remainder of the coastal plain and Sandhills. Thickets of evergreen shrubs with scattered trees grow on undrained, humus-filled, water-saturated soils that are chiefly sandy but may be muck or peat. Standing surface water to a depth of several inches is commonly present. This community can maintain itself in the presence of frequent fires, and in some areas may persist because of them. The community is quickly restored after fire from the underground stem structure. In 1981 and 1982 we conducted intensive mammal surveys in these communities in Dare and Hoke Counties (Lee, Clark, and Funderburg 1982; Clark and Potter 1982). These studies represent the first attempt to document the fauna of pocosins and Carolina bays.

Characteristic flora: Varies considerably with soil type and amount of disturbance. Dominant shrubs are Bitter Gallberry, *Ilex glabra*, and Wax Myrtle, *Myrica cerifera*. Other characteristic woody plants include Angle-stem Fetter-bush, *Pieris floribunda*; Bamboo, *Smilax laurifolia*; Leucothoe, *Leucothoe axillaris*; Sweet Gallberry, *Ilex coriacea*; Zenobia, *Zenobia pulverulenta*; Leather-leaf, *Cassandra calyculata*; Loblolly Bay, *Gordonia lasianthus*; Sweet Pepperbush, *Clethra alnifolia*; Red Bay, *Persea borbonia*; Sweet Bay, *Magnolia virginiana*; and Titi, *Cyrilla racemiflora*. Conspicuous in some areas are Cane, *Arundinaria gigantea*; Pond Pine, *Pinus serotina*; Red Maple, *Acer rubrum*; Black Gum, *Nyssa sylvatica*; Bald Cypress, *Taxodium distichum*; and White Cedar, *Chamaecyparis thyoides*.

Characteristic mammal fauna: Short-tailed Shrew, Marsh Rabbit, Gray Squirrel, Rice Rat, Cotton Mouse, Golden Mouse, Gray Fox, Black Bear, Raccoon, White-tailed Deer. (Occasional: Southeastern Shrew, White-footed Mouse, Mink, Bobcat.)



Fig. 2. Salt marsh, Carteret County.



Fig. 3. Freshwater marsh, Hoke County.



Fig. 4. Carolina bay, Hoke County.

Swamp Forest

Swamp forests are found throughout the coastal plain, particularly along the humus-rich flood plains of major river drainages, and on a smaller scale on the borders of lakes and ponds. The enlarged, buttressed bases of large trees are indications of the soft, water-saturated substrate in which they grow. This habitat is a water-influenced subclimax of the pine-oak mesophytic forest. The periodic flooding and limited number of food plants (or at least seasonally limited food crops) make permanent colonization by most mammals impossible; thus most species are in low densities and sporadically distributed. Few North Carolina studies have been conducted in true swamp forest. One season of extensive trapping was undertaken in northeastern North Carolina (Platania and Lee 1978).

Characteristic flora: Black Gum, *Nyssa sylvatica*; Tupelo Gum, *Nyssa aquatica*; Bald Cypress, *Taxodium distichum*; White Cedar, *Chamaecyparis thyoides*; Red Maple, *Acer rubrum*; and Ash, *Fraxinus* sp. Lesser plants that are usually conspicuous include Cross Vine, *Anisostichus capreolata*; Cane, *Arundinaria gigantea*; Virginia Chain-Fern, *Woodwardia virginica*; Royal Fern, *Osmunda regalis*; and Spanish Moss, *Tillandsia usneoides*.

Characteristic mammal fauna: Gray Squirrel, Cotton Mouse, Beaver, Raccoon, Gray Fox. (Occasional: Opossum, Southeastern Shrew, Star-nosed Mole, Rafinesque's Big-eared Bat, Marsh Rabbit, Golden Mouse, Rice Rat, Black Bear, White-tailed Deer.)

Savanna

Fire-dominated open savanna habitats are essentially confined to the southeastern area of the state. Scattered pines persist but do not dominate the level landscape. Humus-rich, sandy soils underlain with non-draining subsoils cause conditions of periodic flooding and drought. In these boglike habitats most of North Carolina's insectivorous plants and many native orchids grow profusely. While botanically fascinating, this habitat occupies such a small portion of the total acreage of the state that so far as we know it has little influence on the state's overall fauna. Because the mammals of this habitat have not been studied adequately, the list below is of expected species.

Characteristic flora: Toothache Grass, *Ctenium aromaticum*; various insectivorous plants, particularly the Yellow Trumpet, *Sarracenia flava*; Three Awn Grasses (Wire Grasses), *Aristida* sp.; and other low xerophytic, herbaceous species too numerous to list.

Expected mammal fauna: Carolina Short-tailed Shrew, Southeastern Shrew, Seminole Bat, Eastern Cottontail, Harvest Mouse, Cotton Rat, Raccoon, White-tailed Deer.

Sand Ridges

Locally in the southeastern portion of the state and throughout the Sandhills region is a well-defined subclimax community associated with well-drained, coarse-sand soil. The surface of the soil is normally a white layer because the humus is washed out by rain. This, in turn, results in reflection of light and heat, an important factor in determining the vegetation. This habitat spreads across much of the coastal plain of the southeastern United States, reaching its northern limit in southeastern North Carolina. Fire is an important agent in maintaining the open canopy of this community. The mammal fauna of the sand ridges has been investigated intensively on the Biological Survey's 1,700-acre study area in western Hoke County (Clark and Potter 1982).

Characteristic flora: Long-leaf Pine, *Pinus palustris*; Turkey Oak, *Quercus laevis*; and Three Awn Grass (Wire Grass), *Aristida stricta*.

Characteristic mammal fauna: Least Shrew, Southeastern Shrew, Eastern Mole, Red Bat, Eastern Cottontail, Fox Squirrel, Southern Flying Squirrel, White-footed Mouse, Bobcat, White-tailed Deer. (Occasional: Carolina Short-tailed Shrew, Eastern Pipistrelle, Seminole Bat, Cotton Rat, Pine Vole, Red Fox, Raccoon.)

Old Fields, Roadsides, and Meadows

Disturbed upland habitats maintained in early stages of succession occur throughout the state. Mammal diversity and biomass increase as the community progresses from the pioneering Crab Grass and Bermuda Grass through the final stage where Broom-Straw dominates. Shortly after this, young



Fig. 5. Swamp forest,
Martin County.



Fig. 6. Sand ridge,
Hoke County.



Fig. 7. Old field,
Hoke County.

pinus and sumacs appear, but they have little effect on the mammal fauna until they become so dense that they shade out the sun-adapted herbs.

Characteristic flora (in order of typical successional appearance): Crab Grass, *Digitaria sanguinalis*; Bermuda Grass, *Cynodon dactylon*; Horseweed, *Erigeron canadensis*; Dog-fennel, *Eupatorium capillifolium*; Asters, *Aster* sp.; and Broom-Straw, *Andropogon* sp. The plant communities vary considerably because of differences in soil moisture, humus, and mineral content.

Characteristic mammal fauna: Southeastern Shrew, Eastern Mole, Eastern Cottontail, Woodchuck, Old-field Mouse, Cotton Rat, Pine Vole, Eastern Harvest Mouse, Red Fox, White-tailed Deer. (Occasional: Opossum, Least Shrew, Short-tailed Shrew, White-footed Mouse, House Mouse, Meadow Jumping Mouse, Raccoon, Least Weasel, Striped Skunk.)

Upland Mesophytic Forest

Various seral stages of the middle-latitude deciduous forest occur throughout most of the state up to elevations of nearly 6,000 feet. In the east the drier sandy soils support more pines, but west of the fall line broadleaved woody plants and numerous shade-tolerant herbs dominate, at least in areas that are not lumbered periodically. The following plant associations dominate in subcommunities that occur in North Carolina (modified from Wells 1924).

Rhododendron - Alder: Mountain balds.

Red Oak: Chiefly between 4,000 and 5,000 feet.

American Chestnut - Black Oak: Chiefly between 2,500 and 5,000 feet.
(Chestnut is no longer a dominant tree.)

White Oak - Southern Red Oak: Fertile soils below 3,000 feet.

River Birch - American Sycamore: Flood plains.

Black Willow - Alder: Stream borders.

Red Maple - Beech: Climax community below 5,500 feet on fertile soils.

Black Jack Oak - Post Oak: Sterile soils.

Sweet-gum - Red Maple: Various situations.

Loblolly Pine: Subclimax in sterile soils.

Characteristic flora: Various oaks, maples, and pines with a subcanopy of trees, shrubs, and shade-tolerant herbs. Extreme variations in the appearance of the community result from local differences in elevation, soil fertility, soil moisture, and maturity of forest.

Characteristic mammal fauna: Except in the western portion of the state where the influence of mountain species is apparent, the various upland mesophytic forests have a rather uniform fauna, although densities of certain species may vary considerably with availability of food plants. Opossum, Short-tailed Shrews, Eastern Mole, Eastern Cottontail, Eastern Chipmunk, Gray Squirrel, Southern Flying Squirrel, White-footed Mouse, Raccoon, Striped Skunk, Bobcat, White-tailed Deer. (Occasional: Hairy-tailed Mole, New England Cottontail, Woodchuck, Deer Mouse, Golden Mouse, Wood Rat, Jumping Mice, Spotted Skunk, Long-tailed Weasel, Gray Fox.)



Fig. 8. Upland mesophytic forest, Watauga County.



Fig. 9. Boreal forest,
Yancey County.

Boreal Forest

Above 5,000 feet on cold mountain summits in the extreme western portion of the state are the boreal spruce-fir forests. Also included for the purposes of this study are the Hemlock, White Pine, and Rhododendron forests of lower elevations. In ravines and other sheltered areas, these plant communities dominate, blocking out the typical stages of the upland mesophytic forest. The mammals of the true boreal forest are also found in these situations, and to a lesser extent in the various cove hardwoods where ample ground cover exists.

Characteristic flora: Fraser's Fir, *Abies fraseri*; Red Spruce, *Picea rubens*; Mountain Ash, *Sorbus americana*; Mountain Rosebay, *Rhododendron catawbiense*; and dense, damp ground cover dominated by Mountain Fern Moss, *Hylocomium splendens*, and Common Wood Sorrel, *Oxalis acetosella*.

Characteristic mammal fauna: Extremely rich. Masked Shrew, Smoky Shrew, Short-tailed Shrew, Eastern Chipmunk, Red Squirrel, Northern Flying Squirrel, Deer Mouse, Gapper's Red-backed Vole, Woodland Jumping Mouse, Spotted Skunk. (Occasional: Long-tailed Shrew, Hairy Mole, Star-nosed Mole, Hoary Bat [breeding], New England Cottontail, Woodchuck, Rock Vole, Black Bear, Striped Skunk, White-tailed Deer.)

Cities and Other Highly Developed Areas

Although cities and other urban areas are not natural communities, they do provide habitats for many animals. Because of the limited predation, some species such as the Gray Squirrel often exist in densities seldom duplicated in natural communities. Some mammals in fact are so numerous in urban areas that they become real pests. At any rate, cities affect mammal populations and thus cannot be discounted.

Characteristic flora: Variable, but normally dominated by planted ornamentals and exotic weed species.

Characteristic mammal fauna: Opossum, Evening Bat, Big Brown Bat, Gray Squirrel, Norway Rat, House Mouse, Raccoon. (Occasional: Eastern Mole, Brazilian Free-tailed Bat, Eastern Cottontail, Southern Flying Squirrel, Black Rat.)

Successional Communities/Ecotones

More important to the distribution of small mammals than the plant community types outlined above are the various seral stages of succession. Many of our native mammals are more closely tied to these successional stages than they are to geographic boundaries. The development of a dense forest canopy provides conditions for one set of woodland mammals whereas earlier stages of forest development with a

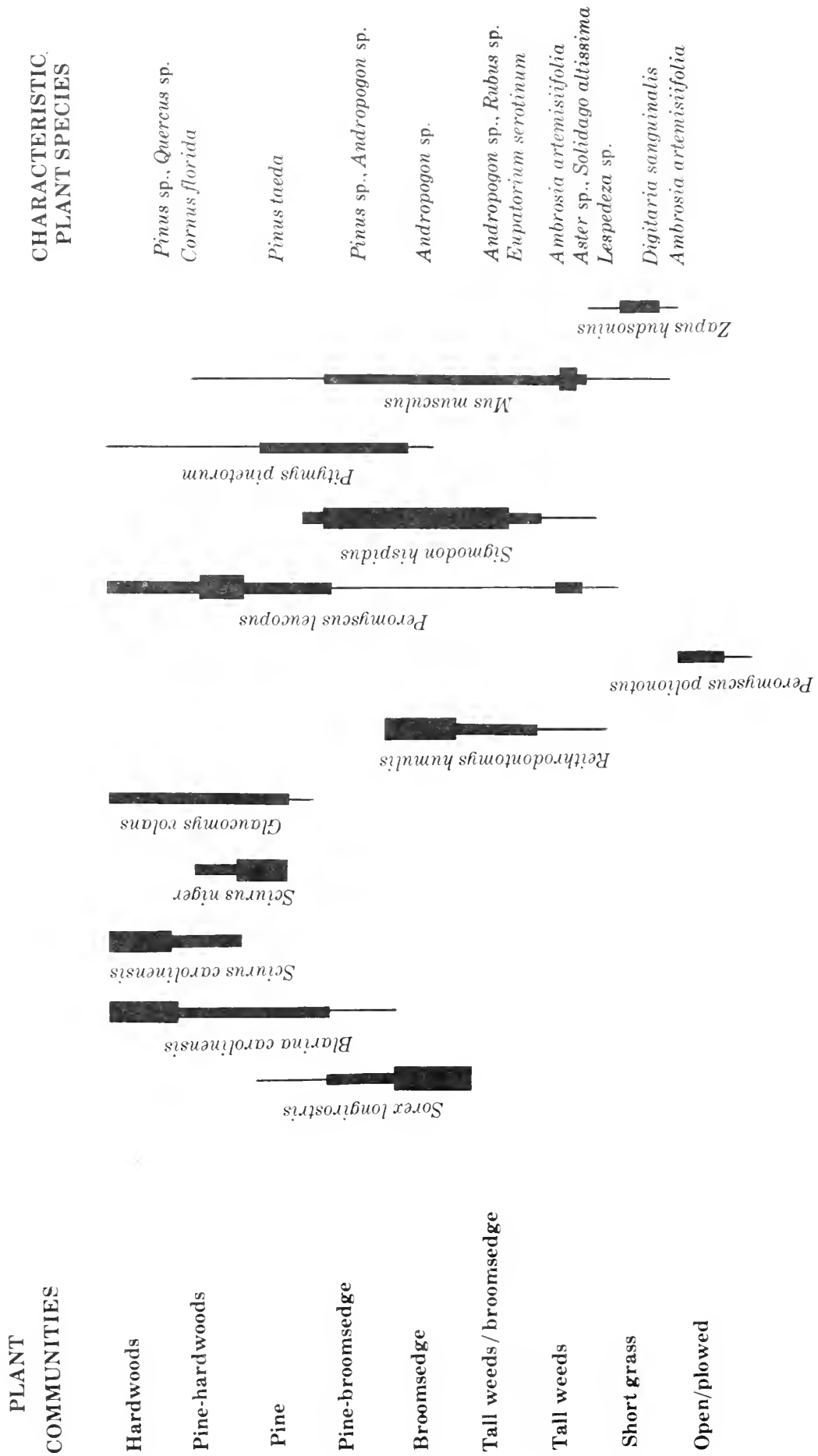


Fig. 10. Relative abundance is exhibited by thickness of bars for selected species of small upland mammals in chronological, seral successional stages in piedmont and upper coastal-plain communities.

partly open canopy provide for quite a different fauna. Thick subcanopy and shrub zones may restrict foraging Screech Owls and other potential predators allowing for dense populations, but a mature forest heavily littered with organic debris may do the same. Figure 10 illustrates the hypothetical relative abundance of small upland mammals as they would be distributed across a chronological spectrum of successional stages ranging from open field to climax hardwood community.

The ecotonal areas between major plant communities or successional stages of the same community are normally rich in species diversity, and populations of certain species are often high. The relationship of "edge effect" to species occurrence is simply illustrated in Figure 11. Not only are species present from both abutting communities but also some are present that characterize the ecotone, or edge. This phenomenon is well known in birds and is equally important to mammals even though the effects are not as apparent to casual observers. Ecotones can be gradual, occurring over many miles; relatively sharp, as can be seen on mountain slopes where altitudinal changes have a marked influence on plant communities; or only a few yards wide, such as the edges of marshes and swamps, where a difference of a few inches in elevation greatly influences the effect of the water table on plants.

Successional stages as well as ecotones can be influenced by land clearing and mowing or plowing cycles. Utility and highway rights-of-way usually have several simultaneously maintained stages of succession as well as sharp ecotonal effects.

As an example, in an area of the coastal plain where a hardwood forest comes in contact with a swamp forest one could expect to find both the White-footed Mouse and its lowland counterpart the Cotton Mouse. Clearing a section of land through fire, windstorm, or other natural causes, or by human activities, would break the natural canopy of the two forest types. Light reaching the forest floor would provide growing conditions for honeysuckle and other vines and create a habitat for Golden Mice. Thus three related species could be expected in a relatively small area, whereas in continuous stands of any of these vegetative types only one would be expected.

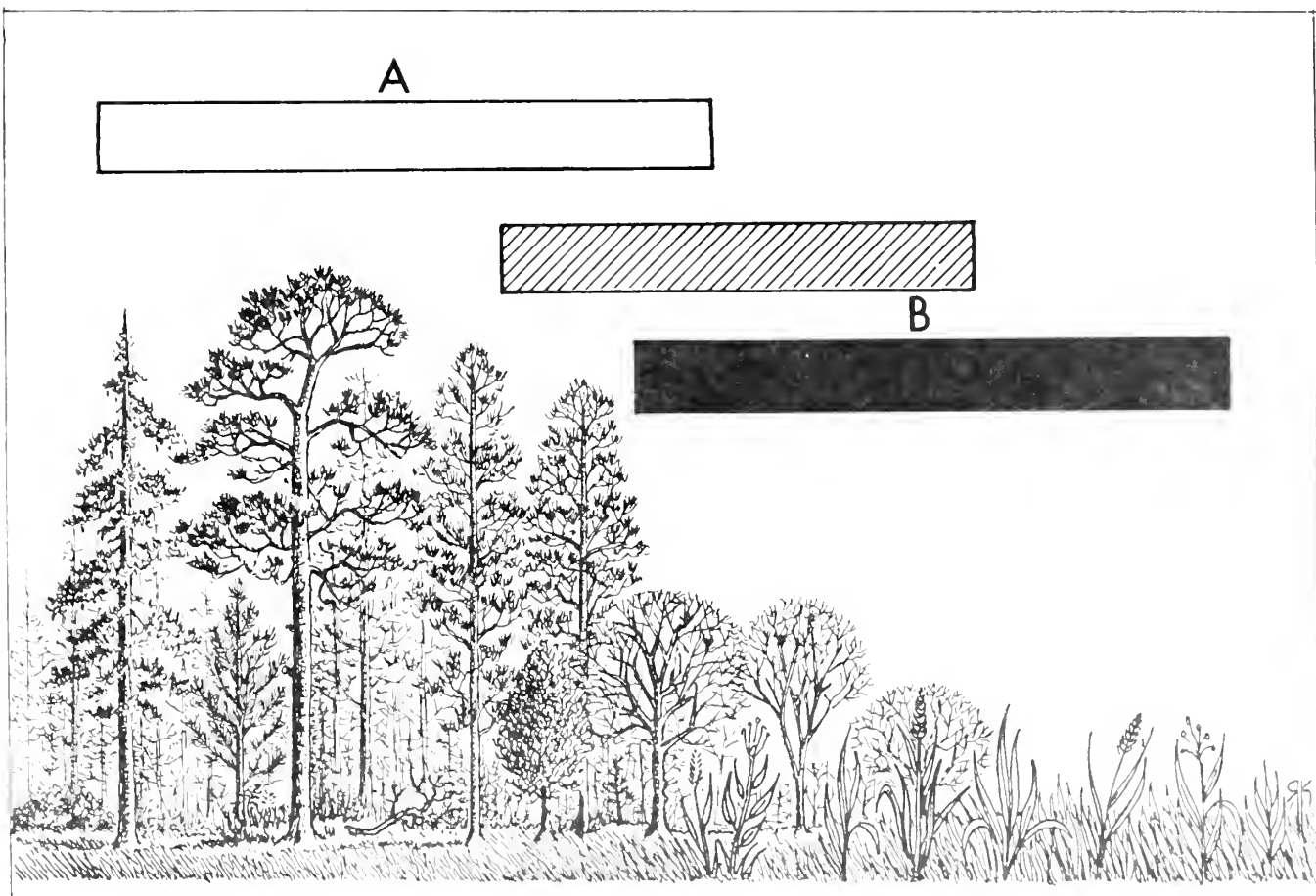


Fig. 11. Ecotonal areas provide not only habitat for species of both adjoining communities (A and B shown light and dark) but also for species that specialize in edge habitats (diagonal striping).

ZOOGEOGRAPHY OF NORTH CAROLINA MAMMALS

Although the zoogeography of North Carolina's mammals has not been addressed on a statewide level, many of the regional studies previously discussed contained some information on this subject, and zoogeographic considerations were discussed by the organizers of the state biological survey (Brimley and Sherman 1908, Brimley 1913). The only extensive zoogeographic treatment is a work by Handley (1971) on Appalachian mammalian geography. In his paper Handley includes some discussion on the zoogeography of areas adjacent to the Appalachians, and readers are directed to this study. The discussion that follows is brief and intended only to give the reader a basic appreciation for the wide geographic origin and diversity of the mammals in the state.

Relatively few of the terrestrial mammals in North Carolina are distributed throughout the state. Most of these are species with a wide spectrum of ecological tolerances and habitat selections, such as Opossum, Red Bat, Gray Squirrel, and Raccoon. Others are aquatic or semi-aquatic species that are distributed throughout most of the state's river basins (e.g. Muskrat, Mink, and River Otter).

There are several species which, although nearly statewide in distribution, are absent from the highest elevations (Least Shrew, Eastern Cottontail, Eastern Harvest Mouse, White-footed Mouse, and Gray Fox). Some of these species are replaced by high-elevation counterparts.

Mountain Fauna/Northern Element

In the southern Appalachians the state's terrestrial mammalian fauna is most diverse. This regional fauna is composed largely of boreal mammals whose ancestors were displaced southward with the advance of glaciers. Their descendants have survived until present times only in cool upland habitats. Examples of mammals in this category, including some represented by an endemic southern Appalachian race (marked *), are: Masked Shrew, Smoky Shrew, Hairy-tailed Mole, several species of *Myotis*, Deer Mouse, and Red-backed Vole*. Two species found in the western part of the state, New England Cottontail and Long-tailed Shrew*, are Appalachian endemics ranging northward to New England. Most of the species in this boreal/Appalachian element reach the southern limit of their known distribution in North Carolina and adjacent Tennessee.

Many of the Appalachian endemics presently exist in the southern Appalachians as isolated relict populations. Several of these are also represented by endemic subspecific races (marked *). These include the Water Shrew*, Long-tailed Shrew*, Pigmy Shrew, Northern Flying Squirrel*, Rock Vole*, Southern Bog Lemming, and Least Weasel.

The Spotted Skunk is unique in that it is the only species clearly of southern/southwestern origin that has invaded the southern Appalachians. Although many species occur only in the mountains and others only on the coastal plain, only one species, the Eastern Chipmunk, occurs widely in the mountains and piedmont but not in the coastal plain. Essentially an upland form, it also occurs throughout the western piedmont and eastward to Chapel Hill and Raleigh in the eastern piedmont. Throughout the piedmont its distribution is spotty. It may be extremely common at one site though completely absent in seemingly identical habitats only one-half mile away.

Coastal Plain/Southern Element

In the southeastern corner of North Carolina and, to a lesser extent, along the entire coastal plain, a distinctive southern element enters the state. All these species essentially reach the northern limit of their distribution in North Carolina, with a few others barely entering extreme southeastern Virginia. Examples of these southern species include the Southeastern Bat, Seminole Bat, Brazilian Free-tailed Bat, Marsh Rabbit, Cotton Mouse, the coastal-plain race of the Wood Rat, and the Florida Manatee.

Dismal Swamp

Several races of small mammals in North Carolina are found only in the Dismal Swamp area. *Sorex longirostris fisheri* is a Dismal Swamp endemic replaced by the nominate form of the Southeastern Shrew in adjacent areas. *Microtus pennsylvanicus nigrans* is also replaced by the more widespread Meadow Vole; but, unlike other mammals confined to the Dismal Swamp in our area, it also occurs on the lower Delmarva Peninsula. The two other Dismal Swamp endemics, *Synaptomy cooperi helaletes* (Southern Bog Lemming) and *Blarina brevicauda telmaletes* (Short-tailed Shrew), represent disjunct populations separated from the main range of the species.

Other Distributional Patterns

The Star-nosed Mole and Big-eared Bat are unique, occurring in both the coastal plain and the mountains but being absent from the piedmont. While there are numerous examples of plants and other

animals that have similar distributional patterns, no other mammals have this hiatus at this latitude. Present-day populations of the Black Bear are essentially confined to the mountains and coastal plain, but this distribution simply reflects the disappearance of the bear from parts of the state where sizable refuges no longer exist.

Two mammals that occur in the southwestern portion of the state, the Swamp Rabbit and the midwestern race of Fox Squirrel, are actually lowland Mississippi Basin forms that invaded the state along the Tennessee River Valley.

Even though many species could be considered peripheral in North Carolina, most of these extend a considerable distance into the state before reaching the extreme limits of their natural distribution. The many Appalachian forms, which occur in North Carolina only in the extreme western portion of the state, are, as previously discussed, part of a continuous band of glacially displaced boreal species. Although some are now relicts or semi-relicts, they are not in the true sense peripheral. The only species that seem to enter barely into North Carolina, extending only a few miles across state lines, are Swamp Rabbit and Old-field Mouse (both reported in this paper for the first time for the state), the coastal-plain race of the Wood Rat, and perhaps the normal summering population of the Florida Manatee.

Tension Zones

Along a weakly defined front at elevations between 3000 and 5000 feet in the southern Appalachians is a broad tension zone where, in several instances, closely related species replace or partly replace each other. This does not exclude the existence of sites or habitats where two related forms may co-exist. Some examples of such lowland-highland ecologically equivalent species include:

Southeastern Shrew	- Masked Shrew
Eastern Mole	- Hairy-tailed Mole
Eastern Cottontail	- New England Cottontail
Southern Flying Squirrel	- Northern Flying Squirrel
Meadow Jumping Mouse	- Woodland Jumping Mouse

There are other tension zones, but they are on a broader level, such as found in the Short-tailed Shrew complex and in intergrade zones between various forms of the same species.

Range Expansions/Migration and Vagrants

While there is a great deal of public concern for many vanishing species, most people are not aware that several native mammals are actually expanding ranges and increasing their populations. In the last decade the Brazilian Free-tailed Bat has invaded the southeastern portion of the state (Lee and Marsh 1978). The Groundhog has appeared in the piedmont and coastal plain since the 1930s (Robinson and Lee 1980). Although the Coyote and Red Fox have been stocked in North Carolina, some individuals probably arrived in parts of the state by natural dispersal as well (this paper). Beaver and White-tailed Deer were greatly reduced in range and numbers in the late 1800s, but have now recolonized nearly all of their former range, through both natural expansion and restocking.

Three species of North Carolina mammals are essentially winter visitors that migrate into the state: Silver-haired Bat, Hoary Bat, and Harbor Seal. (Undoubtedly several cetaceans are also in this category.) The two bats may be occasional summer residents in the western portion of the state. Migratory summer residents include the Seminole Bat, Evening Bat, and Florida Manatee.

Some mammals recorded from the state appear to be vagrants (Gray Bat and Hooded Seal). Others have been reported in the literature as occurring as far south as North Carolina, but we are unable to substantiate these records (Snowshoe Hare, Porcupine, and Fisher). If these latter species ever occurred in the state within historic times, they have long been extirpated. Because there are no valid records of these three species, they have not been recognized as part of the North Carolina fauna and further discussion seems inappropriate. We mention them here only as a matter of record.

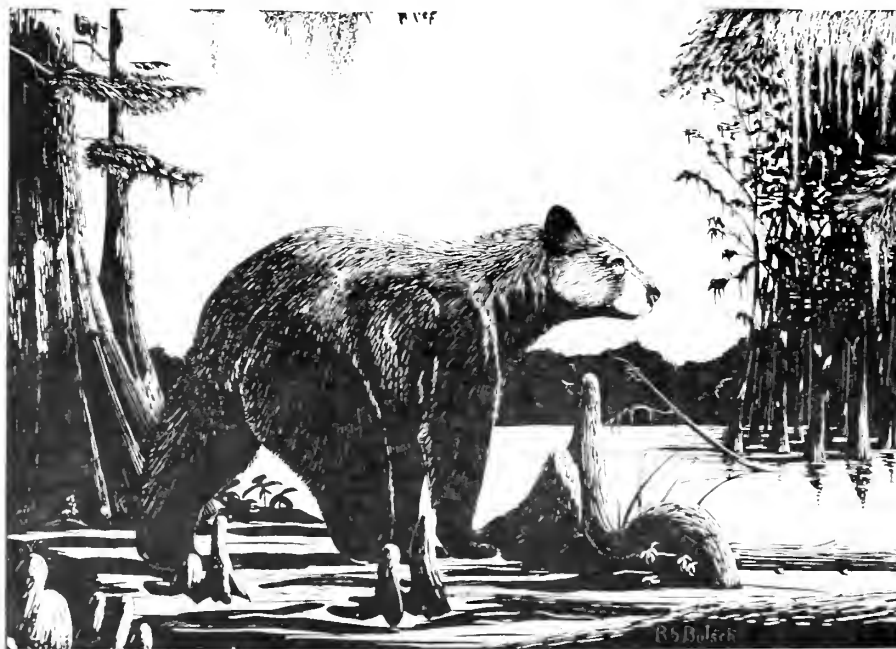
Hypothetical and Exotic Species

The only nonmarine mammal species that is likely to be added to the state's fauna is the Yellow Bat, which undoubtedly occurs here even though it has not yet been found. This migratory bat is a southern species, and there are several records from states north of North Carolina.

In addition to various feral domestic mammals, such as dogs, house cats, and horses, which are established to varying degrees in different parts of the state, and the stocked species listed on page 64, the following exotic species appear at this time to be so well established that they have become a permanent part of our fauna: Black Rat, Norway Rat, House Mouse, Nutria, Coyote (although some Coyotes may have appeared in North Carolina as a result of a natural eastward range expansion), and European Wild Boar.

SELECTED REFERENCES

- Blair, W. F., A. P. Blair, P. Brodkorb, F. R. Cagle, and G. A. Moore. 1957. *Vertebrates of the United States*. McGraw-Hill Book Co., Inc., New York. 819 pages.
- Barbor, R. W., and W. H. Davis. 1969. *Bats of America*. University Press of Kentucky, Lexington. 286 pages.
- Burt, W. H., and R. P. Grossenheider. 1976. *A Field Guide to the Mammals*. Houghton Mifflin Co., Boston. 289 pages.
- Caldwell, D. K., and F. B. Golley. 1965. Marine mammals from the coast of Georgia to Cape Hatteras. *Journal of the Elisha Mitchell Scientific Society* 81:24-32.
- Glass, B. P. 1973. *A Key to the Skulls of North American Mammals*. Department of Zoology, Oklahoma State University, Stillwater. 59 pages.
- Hall, E. R. 1981. *The Mammals of North America*. Vol. I and II. Second edition. John E. Wiley and Sons, New York. 1,181 pages + 90-page index.
- Hamilton, W. J., Jr., and J. O. Whitaker. 1979. *Mammals of the Eastern United States*. Cornell University Press, Ithaca, N.Y. 346 pages.
- Journal of Mammalogy*. Published quarterly by the American Society of Mammalogists, 1041 New Hampshire Street, Lawrence, Kansas 66044.
- Leatherwood, S., D. K. Caldwell, and H. E. Winn. 1976. *Whales, Dolphins and Porpoises of the North Atlantic. A Guide to Their Identification*. NOAA Technical Report NMFS CIRC-396. U.S. Government Printing Office, Washington, D.C. 176 pages.
- Lee, D. S., and J. B. Funderburg. 1977. Mammals: Introduction and Species Accounts. Pages 385-408 in *Endangered and Threatened Plants and Animals of North Carolina*, J. E. Cooper, S. S. Robinson, and J. B. Funderburg, editors. North Carolina State Museum of Natural History, Raleigh.
- Linzey, A. V., and D. W. Linzey. 1971. *Mammals of the Great Smoky Mountains National Park*. University of Tennessee Press, Knoxville. 114 pages.
- Murie, O. J. 1954. *A Field Guide to Animal Tracks*. Houghton Mifflin Co., Boston. 374 pages.
- Walker, E. P., and J. L. Paradiso. 1975. *Mammals of the World*. Vol. I and II. Third edition. The Johns Hopkins University Press, Baltimore, Maryland. 1500 pages.



A LIST OF THE RECENT MAMMALS OF NORTH CAROLINA

Marsupials: Opossums (1)

Opossum, *Didelphis virginiana*

Insectivores: Shrews and Moles (12)

Masked Shrew, *Sorex cinereus*
Southeastern Shrew, *Sorex longirostris*
Water Shrew, *Sorex palustris*
Smoky Shrew, *Sorex fumeus*
Long-tailed Shrew, *Sorex dispar*
Pygmy Shrew, *Microsorex hoyi*
Short-tailed Shrew, *Blarina brevicauda*
Carolina Short-tailed Shrew, *Blarina carolinensis*
Least Shrew, *Cryptotis parva*
Hairy-tailed Mole, *Parascalops breweri*
Eastern Mole, *Scalopus aquaticus*
Star-nosed Mole, *Condylura cristata*

Chiroptera: Bats (15)

Little Brown Bat, *Myotis lucifugus*
Southeastern Bat, *Myotis austroriparius*
Gray Bat, *Myotis grisescens*
Keen's Bat, *Myotis keenii*
Indiana Bat, *Myotis sodalis*
Small-footed Bat, *Myotis liebii*
Silver-haired Bat, *Lasionycteris noctivagans*
Eastern Pipistrelle, *Pipistrellus subflavus*
Big Brown Bat, *Eptesicus fuscus*
Red Bat, *Lasiurus borealis*
Seminole Bat, *Lasiurus seminolus*
Hoary Bat, *Lasiurus cinereus*
Evening Bat, *Nycticeius humeralis*
Rafinesque's Big-eared Bat, *Plecotus rafinesqueii*
Brazilian Free-tailed Bat, *Tadarida brasiliensis*

Lagomorpha: Rabbits (4)

Marsh Rabbit, *Sylvilagus palustris*
Eastern Cottontail, *Sylvilagus floridanus*
New England Cottontail, *Sylvilagus transitionalis*
Swamp Rabbit, *Sylvilagus aquaticus*

Rodentia: Rodents (29)

Eastern Chipmunk, *Tamias striatus*
Woodchuck (Ground Hog), *Marmota monax*
Gray Squirrel, *Sciurus carolinensis*
Fox Squirrel, *Sciurus niger*
Red Squirrel, *Tamiasciurus hudsonicus*
Southern Flying Squirrel, *Glaucomys volans*
Northern Flying Squirrel, *Glaucomys sabrinus*
Beaver, *Castor canadensis*
Rice Rat, *Oryzomys palustris*
Eastern Harvest Mouse, *Reithrodontomys humulis*
Deer Mouse, *Peromyscus maniculatus*
Old-field Mouse, *Peromyscus polionotus*
White-footed Mouse, *Peromyscus leucopus*
Cotton Mouse, *Peromyscus gossypinus*
Golden Mouse, *Ochrotomys nuttalli*

Hispid Cotton Rat, *Sigmodon hispidus*
Eastern Wood Rat, *Neotoma floridana*
Gapper's Red-backed Vole, *Clethrionomys gapperi*
Meadow Vole, *Microtus pennsylvanicus*
Rock Vole, *Microtus chrotorrhinus*
Pine Vole, *Microtus pinetorum*
Muskrat, *Ondatra zibethicus*
Southern Bog Lemming, *Synaptomys cooperi*
Black Rat, *Rattus rattus* (exotic)
Norway Rat, *Rattus norvegicus* (exotic)
House Mouse, *Mus musculus* (exotic)
Meadow Jumping Mouse, *Zapus hudsonius*
Woodland Jumping Mouse, *Napaeozapus insignis*
Nutria, *Myocaster coypus* (exotic)

Carnivora: Carnivores (14)

Coyote, *Canis latrans*
Gray Wolf, *Canis lupus* (extirpated)
Red Fox, *Vulpes fulva*
Gray Fox, *Urocyon cinereoargenteus*
Black Bear, *Ursus americanus*
Raccoon, *Procyon lotor*
Least Weasel, *Mustela nivalis*
Long-tailed Weasel, *Mustela frenata*
Mink, *Mustela vison*
Spotted Skunk, *Spilogale putorius*
Striped Skunk, *Mephitis mephitis*
River Otter, *Lutra canadensis*
Panther, *Felis concolor* (extirpated)
Bobcat, *Lynx rufus*

Pinnipedia: Seals (2)

Harbor Seal, *Phoca vitulina*
Hooded Seal, *Cystophora cristata*

Sirenia: Sea Cows (1)

Florida Manatee, *Trichechus manatus*

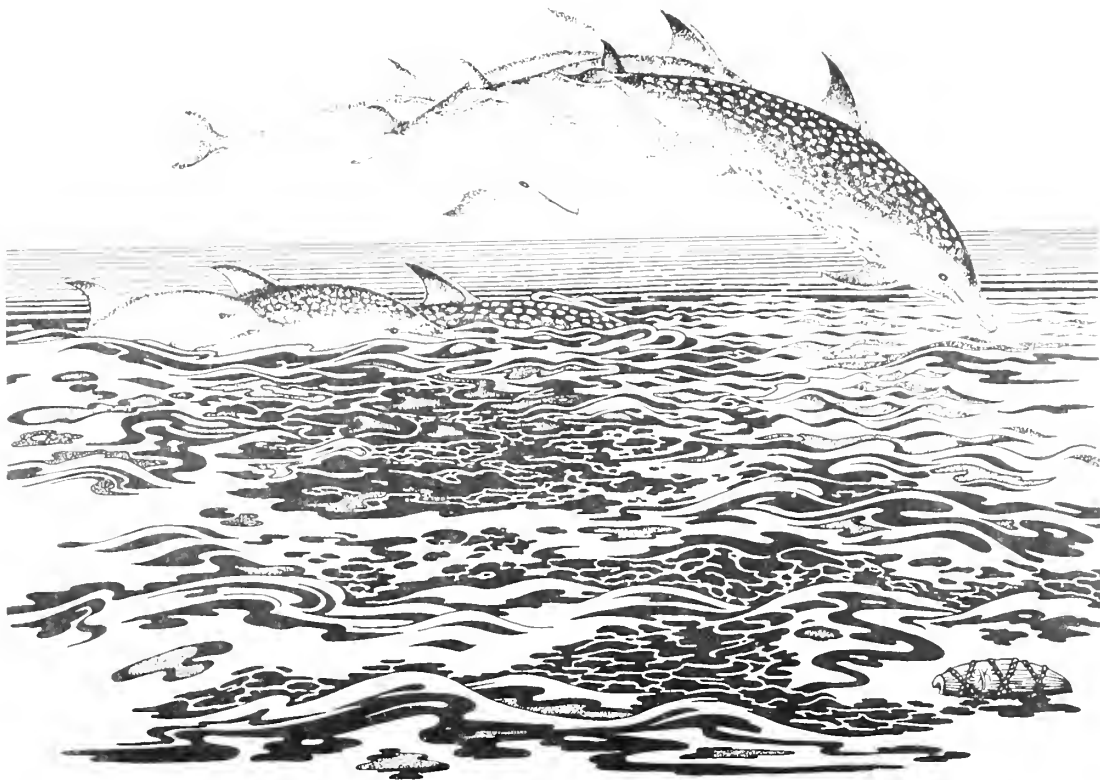
Artiodactyla: Even-toed Ungulates (4)

European Wild Boar, *Sus scrofa* (exotic)
American Elk (Wapiti), *Cervus canadensis* (extirpated)
White-tailed Deer, *Odocoileus virginianus*
American Bison, *Bison bison* (extirpated)

Cetacea: Whales and Porpoises (26)

As previously mentioned, a separate detailed account of the whales and porpoises is to be published as a companion paper. The following cetaceans are known from North Carolina, either from beach strandings or observations in waters off the coast. This list is modified from one prepared by Lee and Funderburg (1977) and probably does not include all marine forms that occur in our area. The Blue Whale, *Balaenoptera musculus* (Linnaeus), included on the 1977 list, does not appear on this one. The species probably occurs as a stray in North Carolina waters; however, there are no valid records between Cape Cod and Louisiana.

Cetacean taxonomy and distribution are still in a state of some confusion. The scientific and common names presented here were compiled from various sources. James G. Mead, U.S. National Museum, provided comments that were useful in preparation of this list.



Minke Whale, *Balaenoptera acutorostrata* Lacepede

First report for North Carolina: Lee sighted several individuals off Oregon Inlet on 4 April 1978. No North Carolina specimens.

Sei Whale, *Balaenoptera borealis* Lesson

Fin Whale, *Balaenoptera physalus* (Linnaeus)

Saddleback Dolphin, *Delphinus delphis* Linnaeus

Gray Whale, *Eschrichtius robustus*

This species has been extinct in the North Atlantic since colonial times. There are four unpublished records of skulls from North Carolina (USNM, NCSM).

Right Whale, *Eubalaena glacialis* (Borowski)

Short-finned Pilot Whale, *Globicephala macrorhyncha* Gray

Atlantic Pilot Whale, *Globicephala melaena* (Traill)

Grampus, *Grampus griseus* (G. Cuvier)

Pygmy Sperm Whale, *Kogia breviceps* (Blainville)

Dwarf Sperm Whale, *Kogia simus* (Owen)

Humpback Whale, *Megaptera novaeangliae* (Borowski)

Dense-beaked Whale, *Mesoplodon densirostris* (Blainville)

Antillean Beaked Whale, *Mesoplodon europaeus* (Gervais)

True's Beaked Whale, *Mesoplodon mirus* True

Killer Whale, *Orcinus orca* (Linnaeus)

Harbor Porpoise, *Phocoena phocoena* (Linnaeus)

Sperm Whale, *Physeter catodon* Linnaeus

False Killer Whale, *Pseudorca crassidens* (Owen)

Striped Dolphin, *Stenella coeruleoalba* (Meyen)

Bridled Dolphin, *Stenella frontalis* (G. Cuvier)

No North Carolina specimens. Taxonomic status of most local *Stenella* needs clarification.

Spinner Dolphin, *Stenella longirostris* Gray

Atlantic Spotted Dolphin, *Stenella plagiodon* (Cope)

Rough-toothed Dolphin, *Steno bredanensis* (G. Cuvier)

Two confirmed records from North Carolina. The Museum of Vertebrate Zoology at Berkeley has two jaws that were from animals taken at Frisco in 1915, and the USNM has three specimens stranded at Corolla in 1976.

Atlantic Bottlenosed Dolphin, *Tursiops truncatus* (Montague)

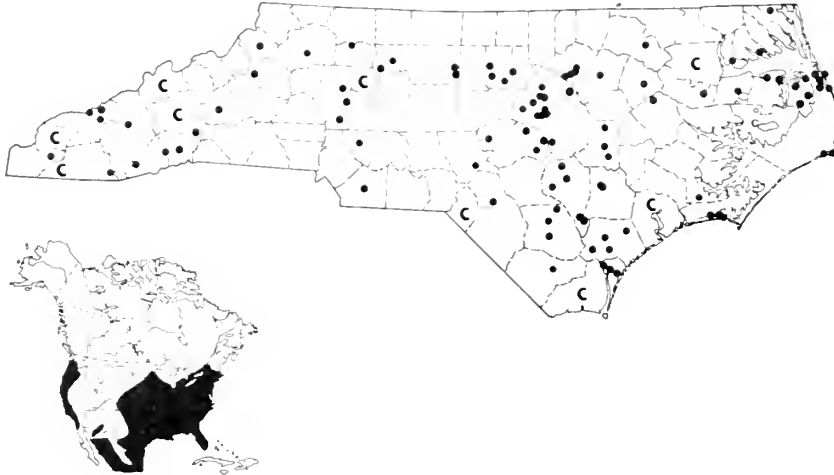
Goosebeaked Whale, *Ziphius cavirostris* G. Cuvier

MARSUPIALS: Opossums

Didelphis virginiana virginiana Kerr

Opossum

Nearly statewide in distribution and common in a wide range of habitats. Rare or absent on certain barrier Islands and at high elevations in the mountains. Several distinct color phases occur in North Carolina with the most variation apparently occurring in the southeastern portion of the state.

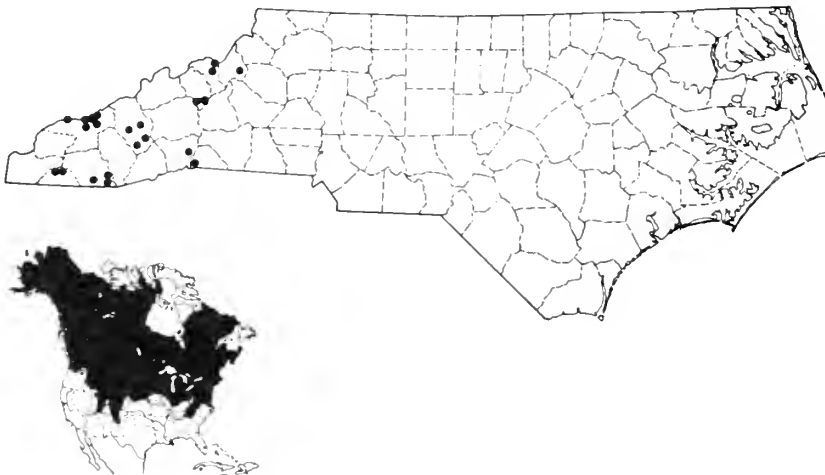


INSECTIVORES: Shrews and Moles

Sorex cinereus cinereus Kerr

Masked Shrew

Common in mountains. South of central Virginia this shrew is confined to the Appalachians. In North Carolina it is known only from elevations above 2000 feet. Although it is not as habitat specific as some other *Sorex* occurring in the state, the Masked Shrew does not seem to use as wide a spectrum of habitats here as it does farther north. Normally common in forested areas with good ground cover, *S. cinereus* apparently prefers drier and more open areas than does *S. fumeus*. Masked Shrews are often trapped in mole runs.

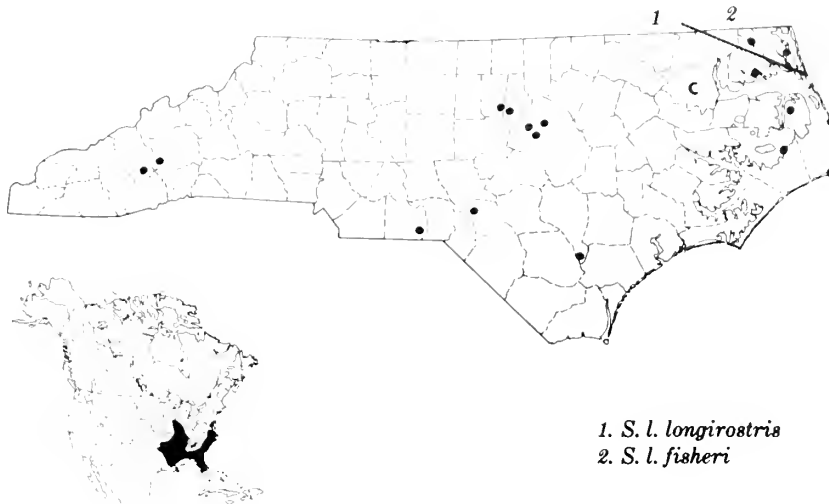


Sorex longirostris longirostris Bachman

Sorex longirostris fisheri Merriam

Southeastern Shrew

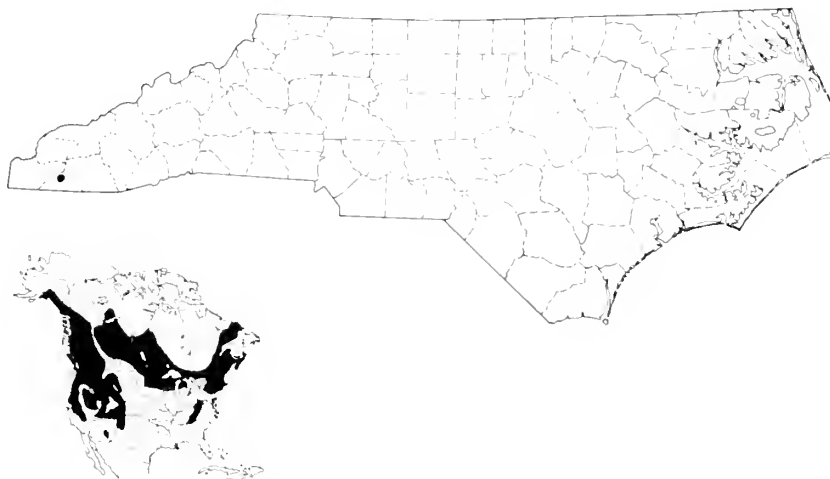
Seldom common though widely distributed. Appears to be absent in mountains at elevations above 1700 feet. In the Dismal Swamp *S. l. longirostris* is replaced by *S. l. fisheri*. Normally encountered in damp edges of woodlands and in fields with thick growths of grasses and sedges, the Southeastern Shrew is most often found around edges of ponds and marshes where suitable cover is present.



Sorex palustris punctulatus Hooper

Water Shrew

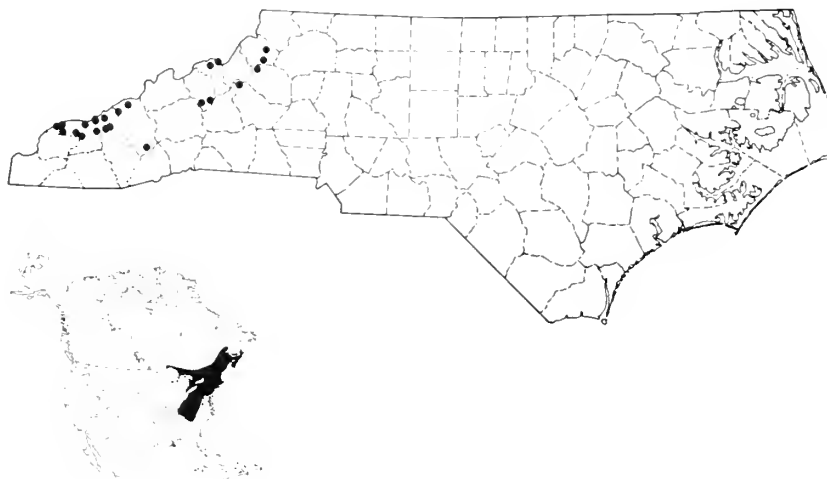
Rare; Clay County. Although known since the early 1950s from the Great Smoky Mountains National Park in Sevier County, Tennessee (Conaway and Pfitzer 1952), the Water Shrew was not recorded from North Carolina until recently (Whitaker et al. 1975). Presently this species is known only from a 200-yard section of upper Fires Creek in Clay County. Because Water Shrews are difficult to trap, current information does not necessarily reflect their true distribution and abundance in the southern Appalachians.



Sorex fumeus fumeus Miller

Smoky Shrew

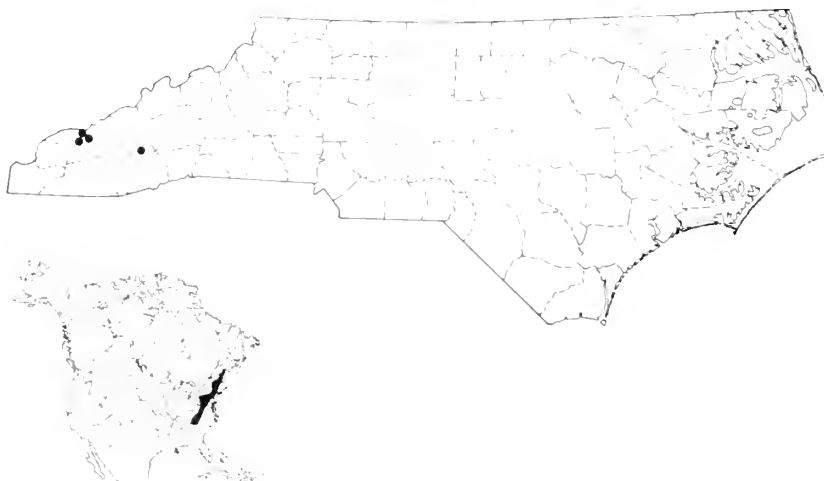
Common in moist evergreen forests with adequate ground cover at high elevations in the mountains; less common in deciduous woodlands. *Sorex fumeus* reaches its southeastern limit of distribution in the North Carolina and Georgia mountains. More geographically restricted than *S. cinereus*, the Smoky Shrew is found at high densities in optimum habitat. Typically found in and around moss-covered logs, rock outcrops, and talus, this species is seldom encountered more than a few inches from cover.



Sorex dispar blitchi Schwartz

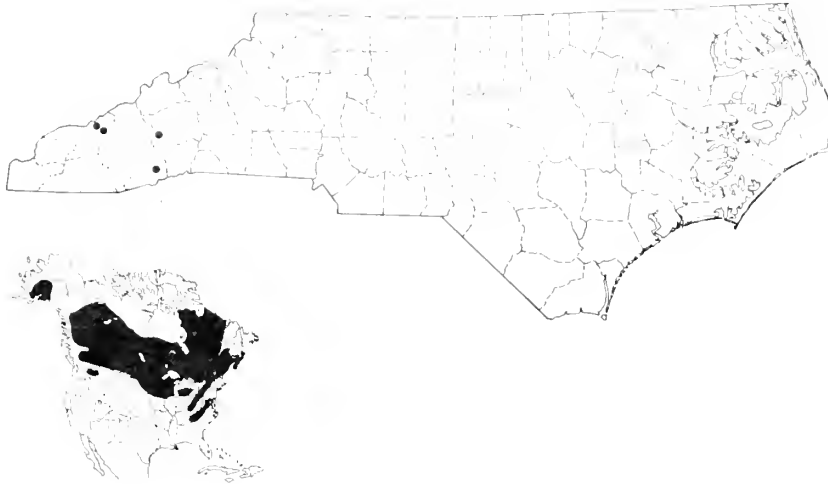
Long-tailed Shrew

All records from mountains at elevations above 4500 feet. An Appalachian endemic that reaches the southern limit of its distribution in the mountains of North Carolina, the Long-tailed Shrew is known from only four localities in the state. Because this species is normally found only deep in rock crevices and talus slopes in cool, moist shaded areas, it is difficult to trap and probably is more common and widespread than these few records indicate.



Pygmy Shrew

Exact range and abundance undetermined. This disjunct eastern race of *M. hoyi* is known only from a narrow corridor in Maryland (two records, Lee 1974), Virginia (two records, Handley and Patton 1947), North Carolina (two records—1928 and 1941, Lee and Funderburg 1977) and Georgia (Wharton 1968). In North Carolina the Pygmy Shrew is apparently confined to mountain woodlands. The species is poorly represented in collections everywhere, probably because it is not as susceptible to conventional trapping techniques as other shrews. Apparently it lives beneath leaf litter and seldom ventures above the surface.



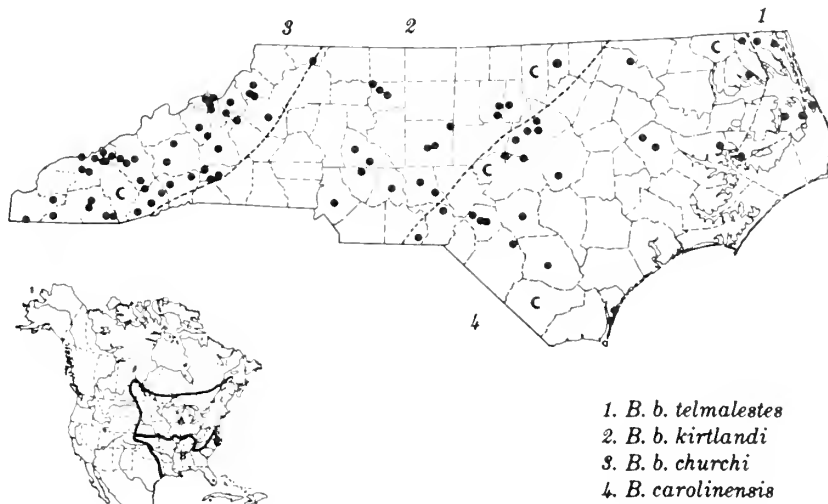
Blarina brevicauda telmalestes (Merriam)

Blarina brevicauda kirtlandi Bole and Moulthrop

Blarina brevicauda churchi Bole and Moulthrop

Short-tailed Shrew

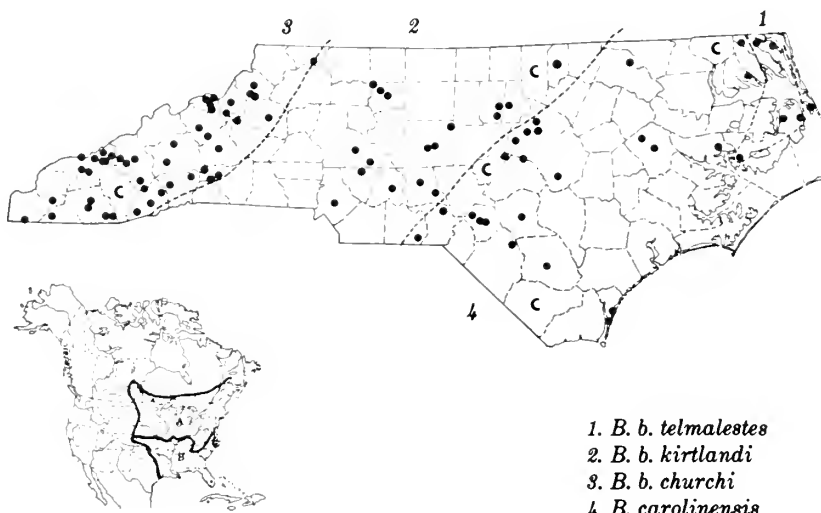
Common in woodland habitats in the western piedmont and mountains. Less common in fields and meadows. A disjunct race, *B. b. telmalestes*, is known from the Dismal Swamp region where it inhabits semi-aquatic swampy places with thick undergrowth. Until recently this race was regarded as a distinct species, while the following species, *B. carolinensis*, was regarded as a small coastal-plain race of *B. brevicauda*. The exact transition zone between these two species is not well defined for North Carolina. Hybridization is at best limited and perhaps nonexistent in the state, and to date we are not aware of any sites where the two species are sympatric. *Blarina b. churchi*, the largest of our *Blarina*, is confined to high elevations, whereas *B. b. kirtlandi* occupies lower elevations in the mountains and is found throughout the upper piedmont.



Blarina carolinensis Bachman

Carolina Short-tailed Shrew

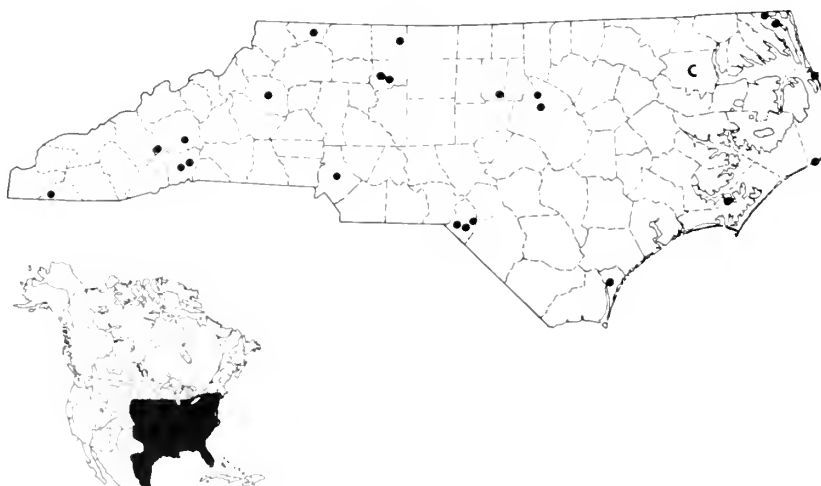
Often common in forests and thickets; occasionally found in fields when adequate cover exists. This is a small coastal-plain and lower-piedmont counterpart of *B. brevicauda*. Exact western limits of range in North Carolina have not been determined for *B. carolinensis*.



Cryptotis parva parva (Say)

Least Shrew

Seldom abundant. Nearly statewide in distribution; perhaps absent from elevations above 2800 feet. Least Shrews are characteristic in a wide range of habitats including salt- and freshwater marshes, damp fields, and occasionally cultivated fields. This species tends to prefer more open situations than do the *Blarina*.



Parascalops breweri (Bachman)

Hairy-tailed Mole

Relatively common in shaded, moist soil in mountains. In North Carolina, where it reaches the southern limit of its distribution, the Hairy-tailed Mole is confined to mountainous areas above 2000 feet in elevation. Typically found in open woodlands, it also occurs in habitats similar to those occupied by the Eastern Mole. The Hairy-tailed Mole is considerably more common than the Star-nosed Mole.

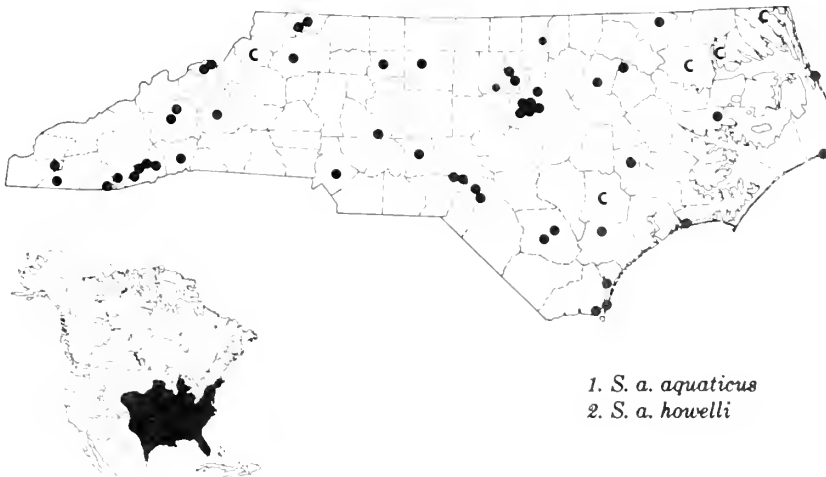


Scalopus aquaticus aquaticus (Linnaeus)

Scalopus aquaticus howelli Jackson

Eastern Mole

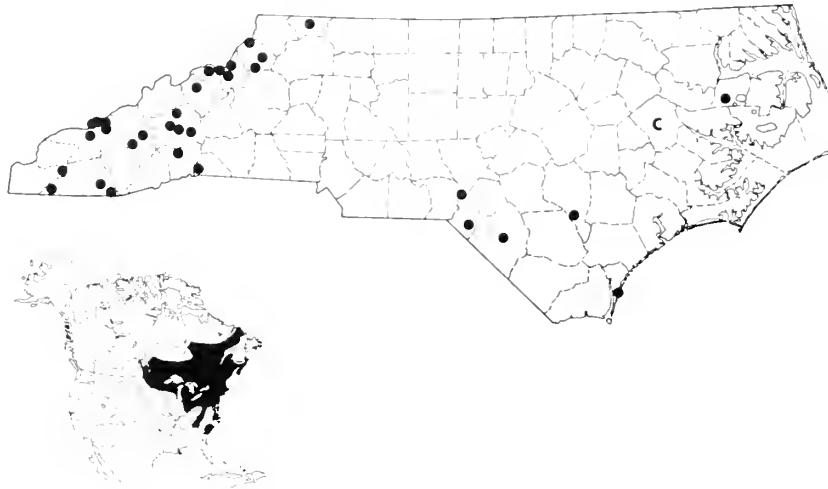
Common and widespread. The Eastern Mole is found statewide in a variety of habitats ranging from secondary beach dunes to lawns, pastures, fields, and most upland woods. This species avoids the wet soils preferred by the Star-nosed Mole as well as the boreal habitats above 4500 feet preferred by the Hairy-tailed Mole. *Scalopus a. howelli* is found throughout most of the state, whereas the slightly larger *S. a. aquaticus* occurs in the mountains.



Condylura cristata parva Paradiso

Star-nosed Mole

Known from scattered localities in the mountains and coastal plain; generally uncommon to rare. Absence of records from the piedmont is certainly not an artifact of collecting. The Star-nosed Mole is normally limited to damp areas around springs, creek bottoms, and bogs. Its scattered colonies appear to be populated at relatively low densities.

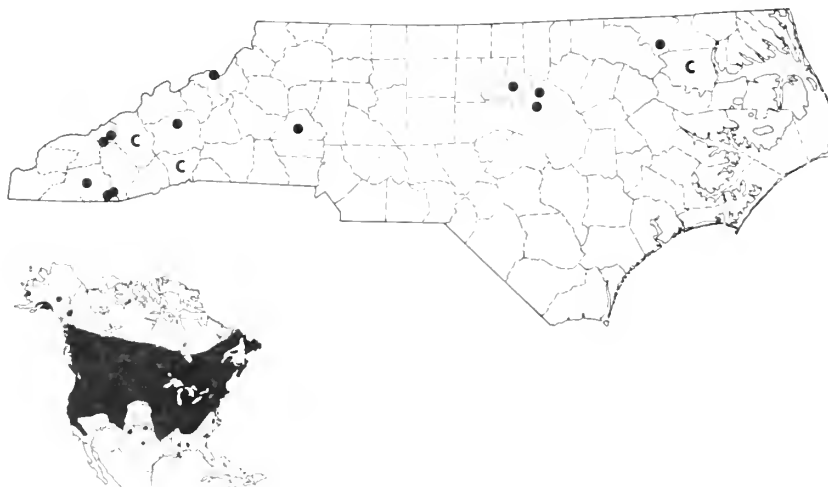


CHIROPTERA: Bats

Myotis lucifugus lucifugus (LeConte)

Little Brown Bat

Exact range and abundance undetermined. There are surprisingly few authentic records of this bat from North Carolina. As far as we can determine, it is confined mostly to the mountains south of the Potomac River Basin. Although there are numerous references to Little Brown Bats being statewide in distribution in North Carolina, this certainly is not the case. Nearly all reports are of misidentified *Nycticeius*. There is one verified coastal-plain record (Davis and Rippey 1968), and we have found one colony near Raleigh. In the warmer months, these bats normally inhabit buildings, and in winter they hibernate in caves and mines. The species is known to be migratory, but the nature and extent of its migratory movements in North Carolina are presently unknown.



Myotis austroriparius austroriparius (Rhoads)

Southeastern Bat

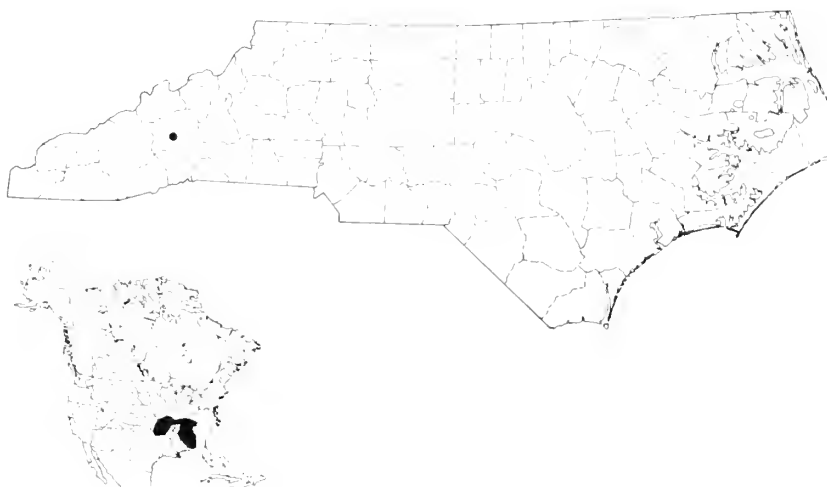
Resident. In North Carolina this species was for a long time known from a single specimen collected 30 miles north of Wilmington from under a boat dock on the Cape Fear River on 26 July 1953 (Davis and Rippey 1968). This was the only record from the state, and the species was assumed to be a vagrant because the known range was well south of this locality. Most surprising is a colony of several thousand individuals living in an abandoned warehouse in northern Wake County. This site was discovered independently by us and David Webber, UNC Wilmington. Webber is currently studying this colony, and we have documented residence from all months of the year. The Wake County site is the northernmost site of regular occurrence for the species along the Atlantic seaboard, the next closest being in southeastern Georgia.



Myotis grisescens A. H. Howell

Gray Bat

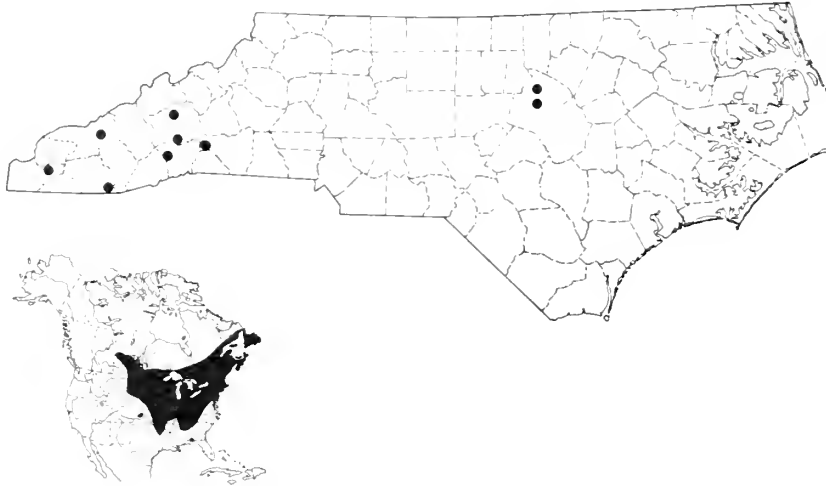
Vagrant. One individual banded in Tennessee was recovered in October 1968 in Asheville, Buncombe County (Tuttle and Robertson 1969). Because this locality is outside the known range of the species, the specimen is assumed to have been a vagrant. This bat is an obligate year-round cave dweller, which emerges to feed primarily over large bodies of water. It is possible that unreported populations occur, or formerly occurred, in the North Carolina portion of the Tennessee River drainage.



Myotis keenii septentrionalis (Trouessart)

Keen's Bat

Apparently rare in North Carolina. Essentially confined to mountains, but confirmed from Wake County (Brimley 1944-46, NCSM records 1981). Known to hibernate in caves and mines, *M. keenii* may also use them as a night roost during feeding forays. This is one of several species known to swarm around cave entrances in late summer. Normally, Keen's Bat hides in hollow trees and buildings during the warmer months.



Myotis sodalis Miller and G. M. Allen

Indiana Bat

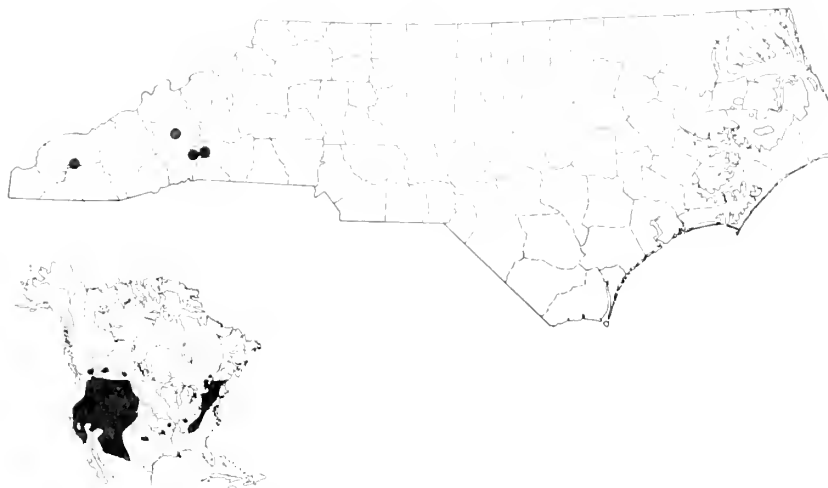
Rare, confined to mountains. Few if any North Carolina caves offer suitable wintering habitat, and no major hibernacula are known. Nevertheless, Indiana Bats were known to hibernate in moderate numbers on the Tennessee side of the Great Smoky Mountains National Park (Linzey and Linzey 1968), and summering individuals disperse widely. Their habit of roosting under loose bark and foraging in the canopy above small creeks makes it difficult to survey their summer distribution. Currently we are aware of only six verified records of this endangered bat from North Carolina, only one of which was cave-associated (Adams 1950).



Myotis liebii (Audubon and Bachman)

Small-footed Bat

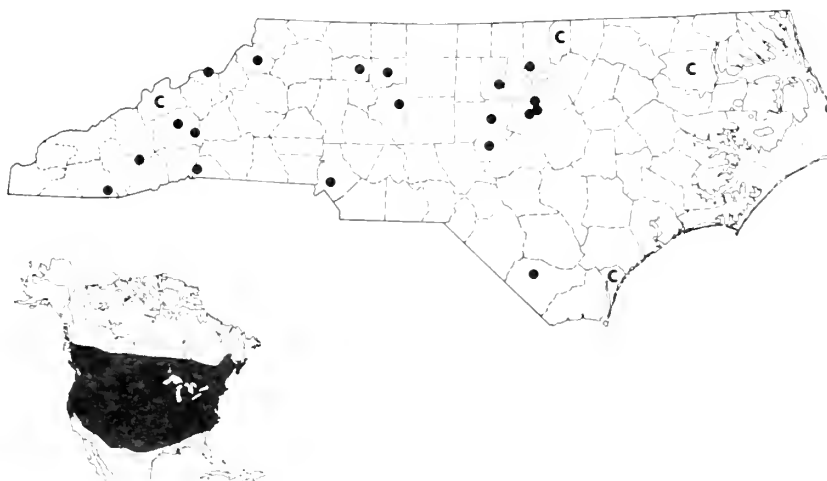
Rare and seemingly confined to the mountain region, where it probably reaches the southern limit of its range. *Myotis liebii* has been recorded from three mountain localities (Adams 1950). The only recent specimen is from Swain County in 1954. Typically, this bat inhabits cave entrances and mines in winter (late November through early March) and hollow trees or buildings in summer. Little is known about the Small-footed Bat in the eastern United States.



Lasionycter noctivagans (LeConte)

Silver-haired Bat

Common migrant and winter resident statewide. May occur as an uncommon summer resident from Winston-Salem west. Normally solitary, this bat feeds over water near woodlands. It hibernates and roosts in a variety of shelters but usually in crevices in trees (Brimley 1897). The Silver-haired Bat does not inhabit caves. When found in buildings, it is usually in open sheds and garages. A slow-flying bat, it flies repeatedly over the same course and may actively feed in winter.



Pipistrellus subflavus (F. Cuvier)

Eastern Pipistrelle

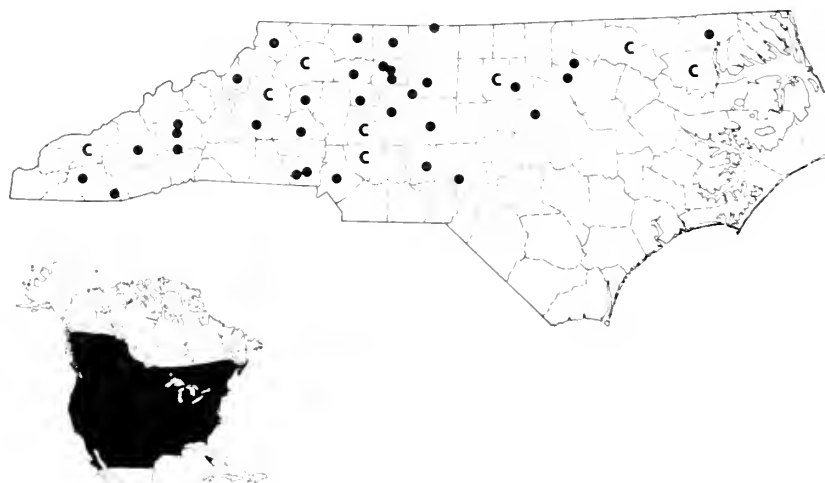
More or less statewide but certainly least common in the eastern portion of the state. Most frequently found wintering in moist caves and mines, the Eastern Pipistrelle also roosts in trees. Seldom if ever is it found in buildings. Normally solitary, it feeds at treetop levels along edges of forests. Feeding flights are erratic and cover a small area.



Eptesicus fuscus fuscus (Palisot de Beauvois)

Big Brown Bat

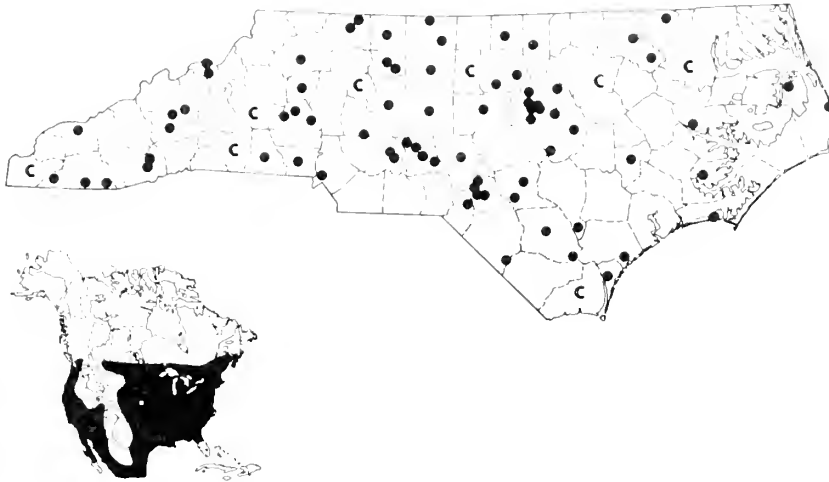
Common and probably statewide although we have few coastal-plain records. Because Big Brown Bats are not tolerant of roost temperatures above 95 ° F and are essentially nonmigratory, the scarcity of records for this species from the coastal plain is probably not an artifact of insufficient collecting. This bat is the most common one encountered in cities, but small colonies can be found in almost any type of man-made shelter where bats are not overly disturbed. When hibernating in caves, individuals remain near entrances where temperatures and humidity are lowest.



Lasiurus borealis borealis (Muller)

Red Bat

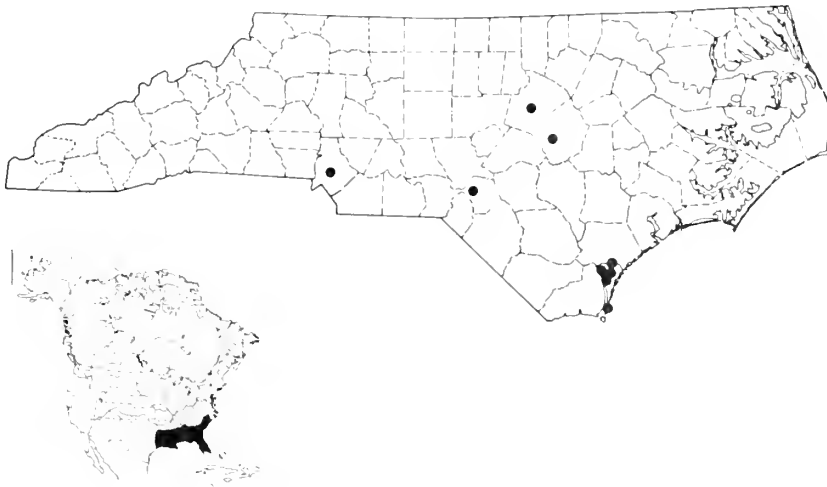
Abundant throughout the state. Often seen during warmer months feeding an hour or more before dusk, the Red Bat normally flies about 25 to 30 feet above the ground along the edges of clearings, or above woodland roads. It flies back and forth along the same course repeatedly in a somewhat erratic pattern. This species seems to be most commonly associated with mixed pine-hardwood forest.



Lasiurus seminolus (Rhoads)

Seminole Bat

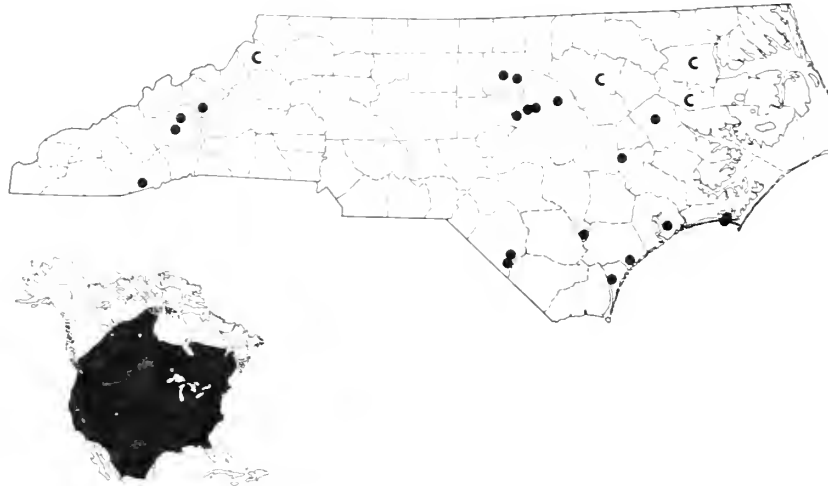
Known in the state from only a few localities. All collections from summer. The Seminole Bat was first reported from North Carolina in the mid-1950s (Barkalow and Adams 1955, Barkalow and Funderburg 1960). Since that time only single 1963 and 1980 specimens had come to our attention, but in the summer of 1981-82 Bill Adams collected several of many specimens he observed feeding over water in southeastern North Carolina. We have a single 1982 summer specimen record from the Sandhills as well. Because the species is known to wander northward in late summer (Barbour and Davis 1969), the residence status of the North Carolina individuals is unknown. We assume the Seminole Bat is a breeding resident at least in the southeastern counties but can offer no explanation for the paucity of records. This bat normally forages over open areas.



Lasiurus cinereus cinereus (Palisot de Beauvois)

Hoary Bat

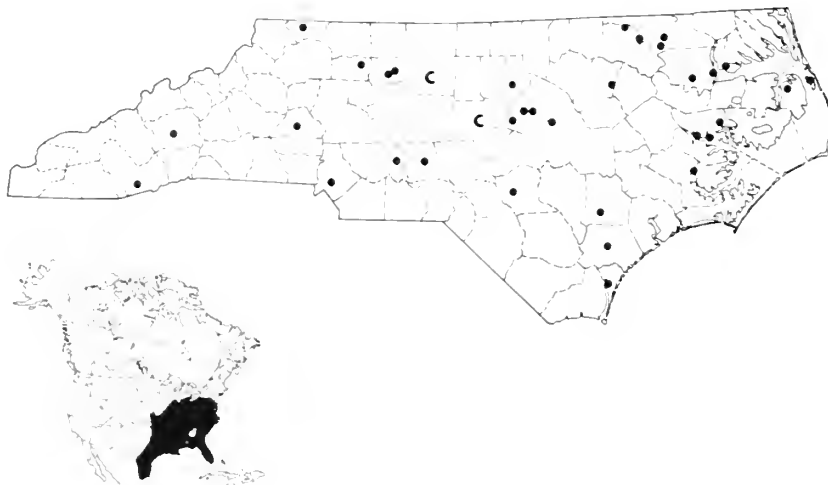
Not uncommon and apparently statewide as a winter visitor and a spring and fall migrant. Earliest fall record 28 September; latest spring occurrence 17 April. Individuals are active on mild winter nights and are presumed to be feeding (DSL, pers. obser.). Seven sight records during the summer on Mount Mitchell (DSL) suggest small breeding populations at high elevations.



Nycticeius humeralis humeralis (Rafinesque)

Evening Bat

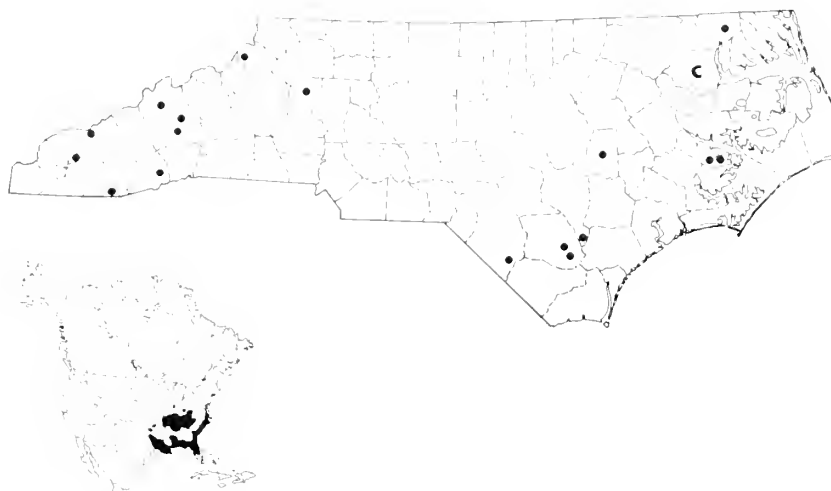
Common to abundant statewide summer resident. Perhaps the most abundant bat in North Carolina. Migrates out of North Carolina in fall. Earliest spring record 22 March; latest fall record 15 September. Not a cave-dwelling species, the Evening Bat is typically found in large colonies in buildings. It also lives in hollow trees. This species emerges early in evening and flies more slowly and less erratically than most of our native bats.



Plecotus rafinesqueii (Lesson)

Rafinesque's Big-eared Bat

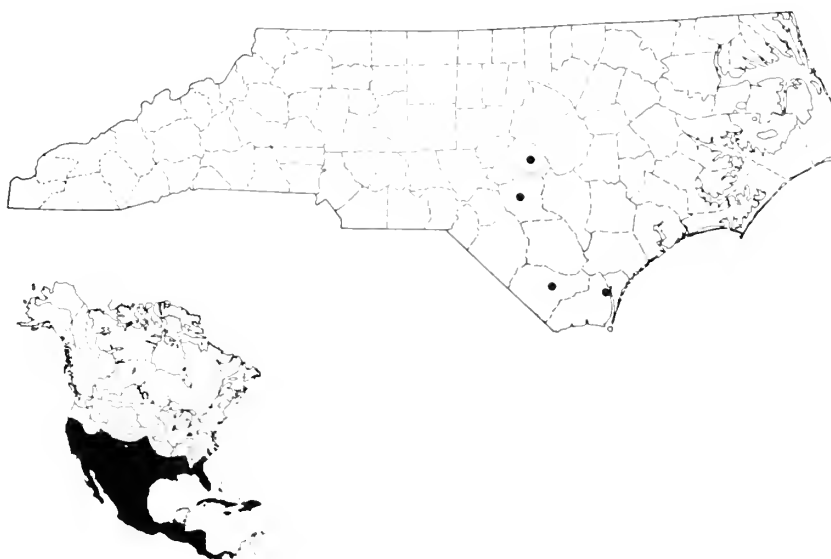
Extremely rare and sporadically distributed in forested sections in mountains and coastal plain. Not normally found in caves, this species prefers dimly lit rooms of dilapidated houses, where it roosts in small colonies. It seldom inhabits buildings because it is extremely intolerant of human disturbances. This agile flyer emerges only after dark. Only two records of this bat are available since the 1950s, and the current status of the species in North Carolina is entirely unknown.



Tadarida brasiliensis cynocephala (LeConte)

Brazilian Free-tailed Bat

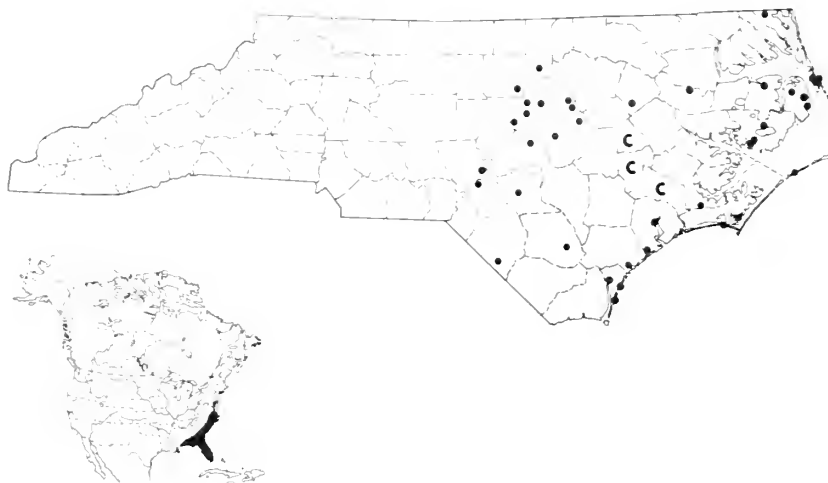
Status undetermined. Lee and Marsh (1978) recently documented a range expansion of this species into southeastern North Carolina. The eastern species is not migratory and normally lives in moderate to large colonies in buildings. Currently there are no summer records. Although there is little doubt that this bat breeds in North Carolina, this needs to be confirmed. It is anticipated that Free-tailed Bats will eventually become widespread throughout the southern portion of the coastal plain.



Sylvilagus palustris palustris (Bachman)

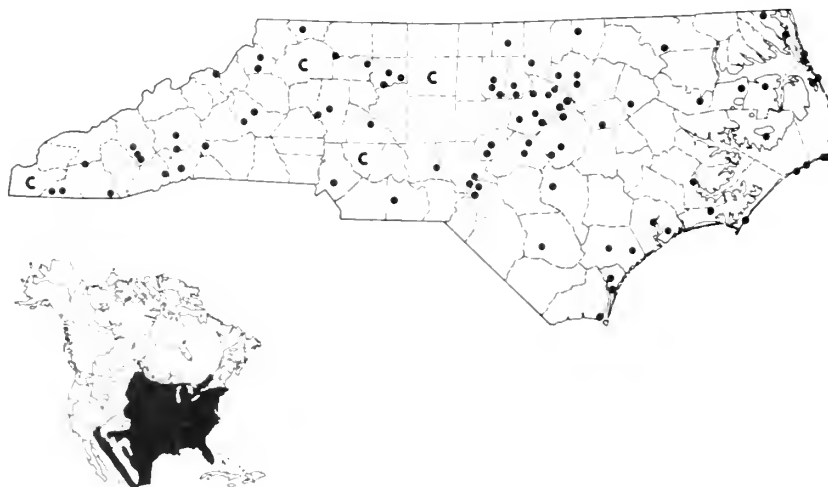
Marsh Rabbit

Common throughout coastal plain and ascending onto lower piedmont along major river basins. The Marsh Rabbit lives in a wide variety of open and wooded wetland habitats. It occurs on some barrier islands.

*Sylvilagus floridanus mallurus* (Thomas)

Eastern Cottontail

Common to abundant throughout the state in open fields, brushlands, and edges of woodlands. Known from elevations up to at least 4200 feet and probably occurs on most if not all of our barrier islands. This rabbit is replaced by *S. transitionalis* in certain successional stages at the higher elevations, and it is seldom encountered in the swamps or marsh habitats preferred by *S. palustris*. *Sylvilagus floridanus alacer* and probably other races have been introduced. The extent and success of these introductions or their effects on the gene pool of the native stock are unknown.



Sylvilagus transitionalis (Bangs)

New England Cottontail

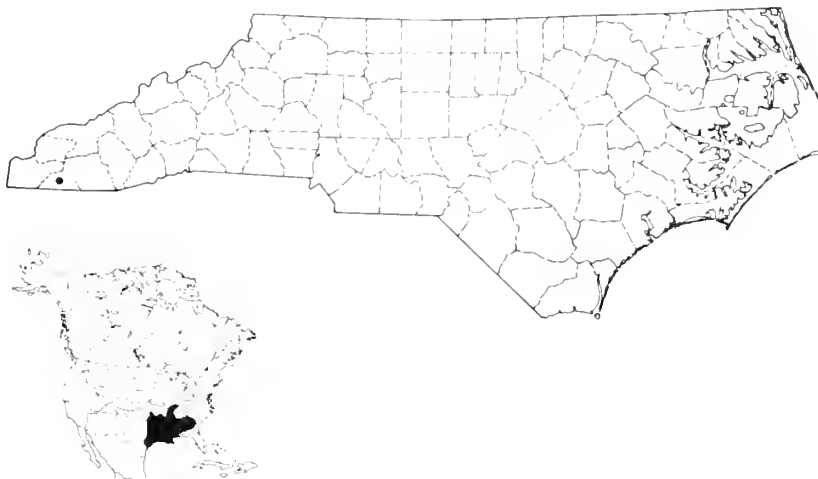
Confined to western counties at moderate to high elevations. Although generally considered uncommon, this rabbit has a rather low profile because of its preference for dense thickets. Recent studies indicate that this species may be abundant in certain successional stages of clearcuts in the national forests in the western part of the state. In fact, except around towns and farms, it may be by far the most abundant rabbit in many areas. Few hunters and wildlife biologists recognize this cryptic species in the field, and most people are not even aware of its existence. To the trained observer, it appears browner than the Eastern Cottontail when seen in the field.



Sylvilagus aquaticus

Swamp Rabbit

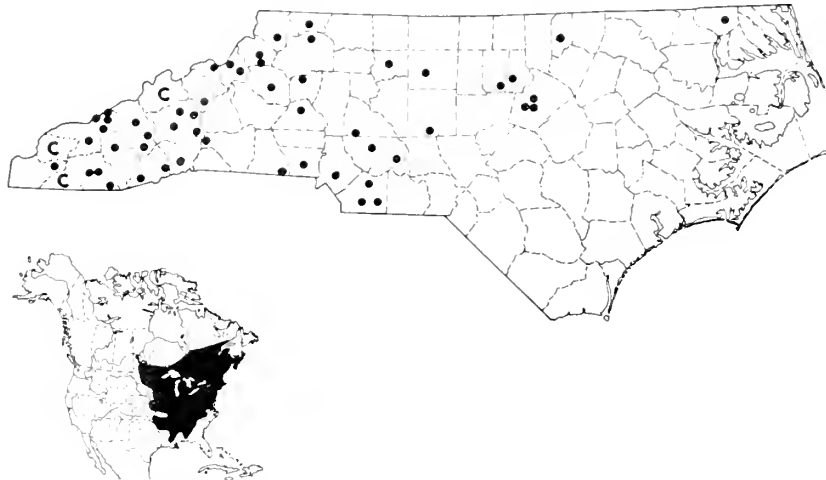
Hall (1951), Hall and Kelson (1958), and others indicate southwestern South Carolina as the northernmost reported occurrence of the Swamp Rabbit in the eastern extreme of its range. This is based on records of Sherman (1939) from about 3 miles SE of Westminster, Oconee County, and about 5 miles W of Iva, Anderson County. The Charleston Museum has a specimen collected near Clemson, Oconee County, which is apparently the source of Golley's (1966) record for this county. We recently discovered in the collection of the North Carolina State Museum (NCSM 843) a male specimen of *S. aquaticus* from Clay County, N.C., which was erroneously labeled *S. floridanus*. This specimen was collected on 18 August 1956, 11 miles E of Hayesville by Tom Beadles (total length 429 mm, tail vertebrae 49 mm, hind foot 96 mm, ear 63 mm, weight 1042 g; skull not saved). The specimen appears to be molting into adult summer pelage, but no other information is available. This represents the northernmost station of occurrence for the species and the first report of the Swamp Rabbit from North Carolina



Tamias striatus striatus (Linnaeus)

Eastern Chipmunk

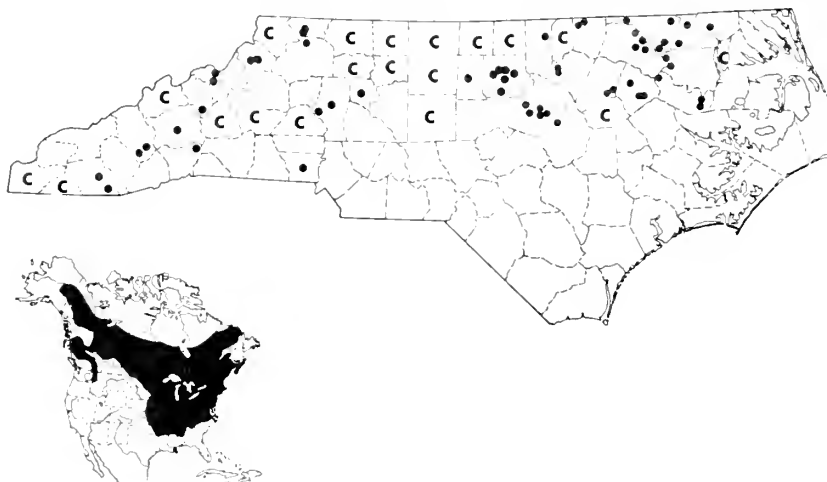
Common to abundant throughout mountains and in many scattered western-piedmont localities. Semi-disjunct populations in Research Triangle area and northeastern part of state. Typically in wooded hillsides with rocks, tangles of rhododendron roots, or other cover, the Eastern Chipmunk avoids woodlands with dense ground cover. Occasionally, it becomes a pest in yards, injuring landscape plants.



Marmota monax monax (Linnaeus)

Woodchuck

Historically confined to the mountains; now found in piedmont and coastal plain. Robinson and Lee (1980) documented the Woodchuck's successful invasion of the piedmont and upper coastal plain along the Roanoke and other rivers in the northeastern portion of the state. The spread of this species is a result of natural dispersal along highway and utility rights-of-way and through deliberate release (Orange County, 1950s). Abandoned farmlands, hedgerows, and river levees provide ample habitat for the still-expanding populations. Woodchucks have been observed in the mountains to at least the 5500-foot elevation.



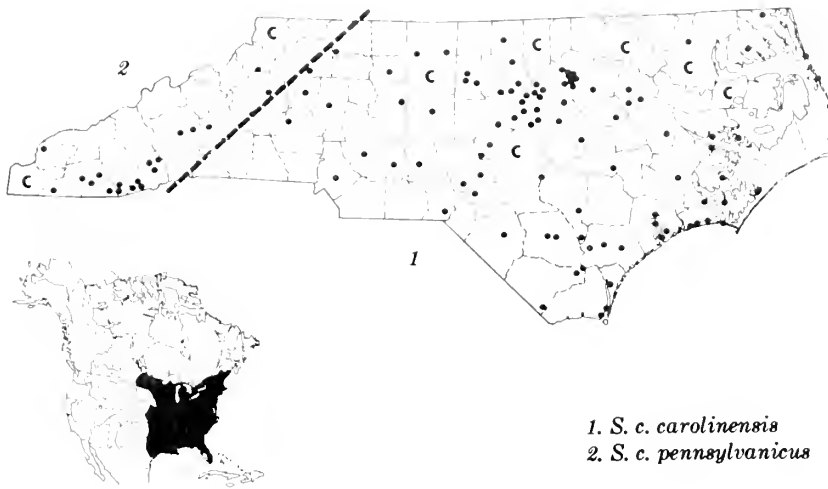
Sciurus carolinensis carolinensis Gmelin

Sciurus carolinensis pennsylvanicus Ord

Gray Squirrel

Common statewide, but rare at high elevations. Found in a variety of woodland habitats as well as in suburban and urban areas with mature trees, the Gray Squirrel in some instances may become a minor

pest. *Sciurus c. carolinensis* is found throughout most of the state, including forested portions of barrier islands, but *S. c. pennsylvanicus* replaces it in the mountains. The zone of intergradation and its extent in North Carolina have yet to be established. Studies on the biology of this squirrel conducted in the 1960s by F. S. Barkalow Jr., North Carolina State University, make this one of the most extensively studied species in the state.

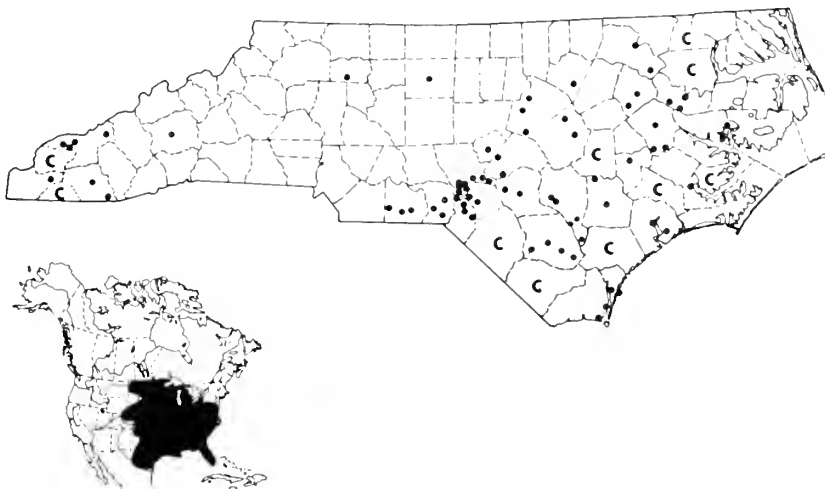


1. *S. c. carolinensis*
2. *S. c. pennsylvanicus*

Sciurus niger niger Linnaeus

Fox Squirrel

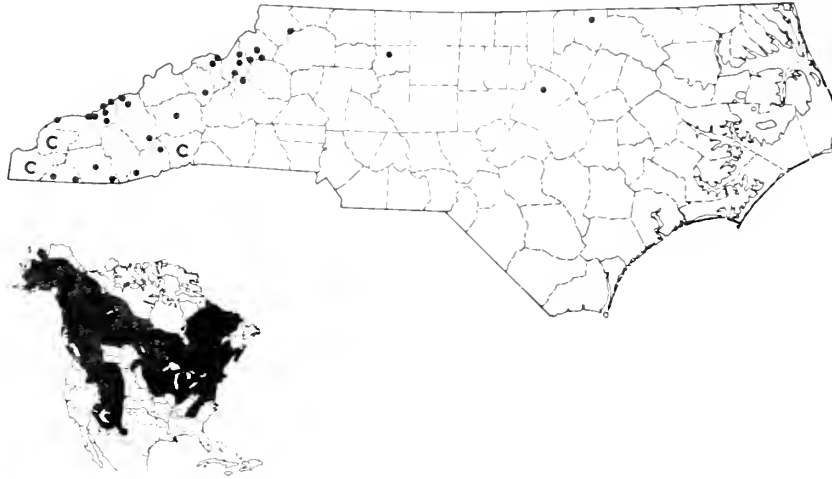
Occurs sporadically throughout the coastal plain and in extreme eastern piedmont. Although the Fox Squirrel is known from several open woodland habitats, sustaining populations occur only in open, fire-maintained Longleaf and Loblolly Pine forests. Presently the only substantial populations are found in the Sandhills. This species is absent from barrier islands and the Dismal Swamp region. Mountain populations of the Fox Squirrel appear to be disjunct, very localized, and low in density (Lee and Funderburg 1977). The only North Carolina mountain specimens of a Fox Squirrel (with adequate data) available to us is a male taken near Andrews, Cherokee County, on 12 November 1947 (NCSM 1874), and sent to the museum by Malcom Edwards. This specimen appears closest to *S. n. rugiventer*. In our files is a letter that accompanied another specimen sent to the museum in August 1909. Taken "seven miles from Bushnell, Swain Co.," the specimen was apparently lost. Although the Komareks (1938) did not report *S. niger* from the Great Smoky Mountains National Park, Linzey and Linzey (1971) mention sight records from five stations within the area. The limits of distribution of the three races of *S. niger* occurring in the southern Appalachians are not well defined, but *S. n. rufiventer* is known from at least as far east as Campbell and Lincoln Counties in eastern Tennessee (Kellogg 1939). The other race, *S. n. bachmani*, does not appear to be present in North Carolina. It is assumed that the Cherokee County specimen is from a population that migrated eastward through the bottomlands associated with the Tennessee River system.



Tamiasciurus hudsonicus abieticola (A. H. Howell)

Red Squirrel

Essentially confined to mountainous habitats, being most common in hemlock, fir, and spruce forests. Often abundant and conspicuous at high elevations. Recently Red Squirrels have appeared around Winston-Salem (P. Weigl, pers. comm.), but the origin of this population is unknown. One sight record is available for Hemlock Bluffs State Park in Wake County (Martoff, pers. comm., 1975), and one specimen record is from Vance County. This latter record was believed to be the result of a release (Brimley 1944-46), but Red Squirrels are known from piedmont counties in Virginia (Handley and Patton 1947). Repeated searches and inquiries of residents of the North Carolina piedmont localities indicate that the species is not established outside the mountains.



Glaucomys volans volans (Linnaeus)

Southern Flying Squirrel

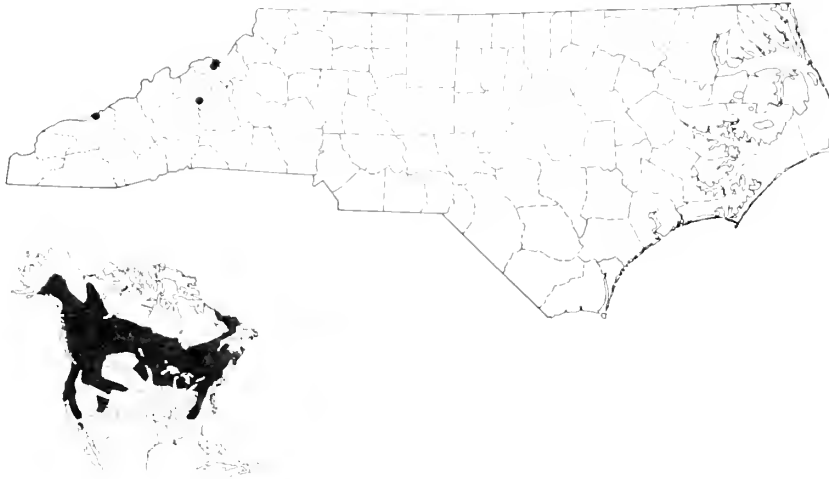
Nearly statewide and common in most mature hardwood and mixed pine-hardwood habitats. Southern Flying Squirrels probably are present in most environments inhabited by Gray Squirrels. Seemingly not present on most barrier islands, *G. volans* formerly was replaced at high elevations by the Northern Flying Squirrel. Frequently found in bird houses, abandoned buildings, and attics, flying squirrels occasionally become pests, getting into homes and stored food.



Glaucomys sabrinus coloratus Handley

Northern Flying Squirrel

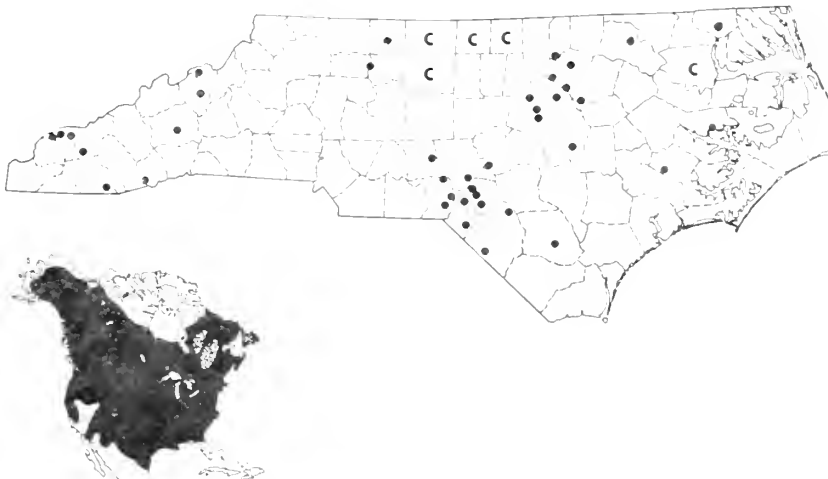
A rare southern Appalachian race known from only four isolated mountain areas in North Carolina and adjacent eastern Tennessee and southwestern Virginia. In North Carolina this species has been recorded only from Roan Mountain (extant, but rare), Mount Mitchell (probably extirpated by mid-1960s), and the Great Smoky Mountains (status unknown). Normally confined to mixed hardwoods between 4000 and 6000 feet, *G. sabrinus* may have been replaced by *G. volans* in certain areas that have been lumbered (Weigl 1968, 1977).



Castor canadensis carolinensis Rhoads

Beaver

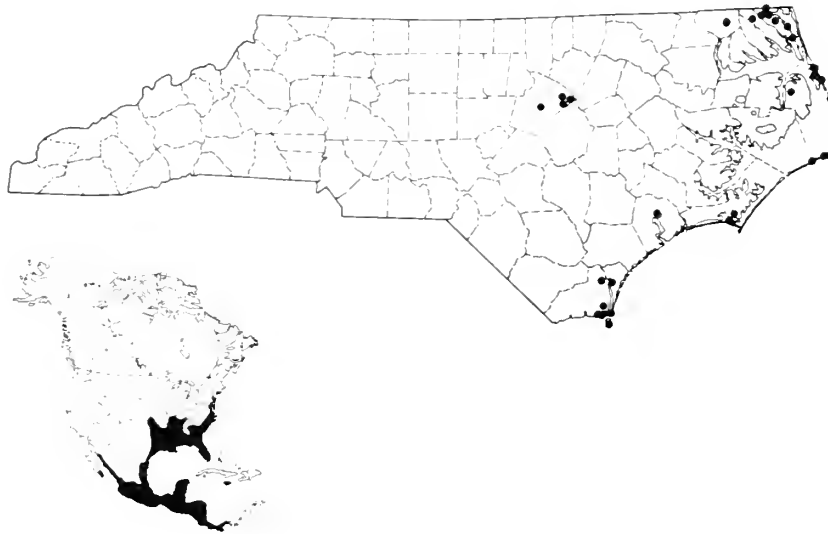
Apparently statewide but uncommon and scattered on outer coastal plain and absent from tidewater. Indiscriminate, unregulated trapping eliminated Beavers from the state by the early 1900s. The last documented record was from Stokes County in 1897 (Brimley 1944-46). In 1938, thirty beavers from Pennsylvania were stocked in Richmond County. Later they were stocked in other portions of the state, and in the 1960s a deliberate attempt was made to import *C. c. carolinensis*, the original native stock, from Alabama. Currently, Beavers are widespread and in some areas, because of damming and tree damage, are becoming pests.



Oryzomys palustris palustris (Harlan)

Rice Rat

Occurs throughout coastal plain and in Wake County, at least, ascends onto the lower piedmont plateau. Often common in marshes and other open habitats with an abundance of grasses and sedges, the Rice Rat normally occupies wetter areas than our cotton rats or voles.



Reithrodontomys humulis humulis (Audubon and Bachman)

Eastern Harvest Mouse

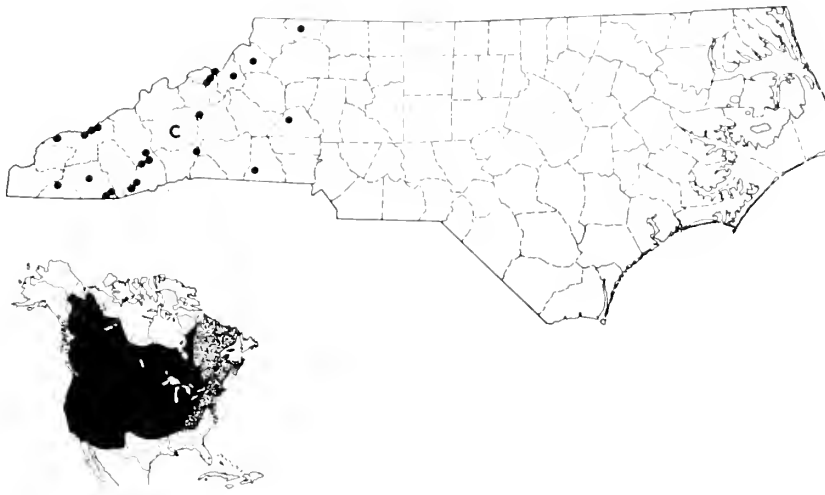
Uncommon but apparently occurs statewide or nearly so. Rare above 2000 feet and absent from high elevations. Several barrier-island records. The Eastern Harvest Mouse lives in pastures and old fields, especially those dominated by Broom-Straw with scattered patches of bare ground. A Wake County population was intensively studied by Kaye (1960).



Peromyscus maniculatus nubiterrae Rhoads

Deer Mouse

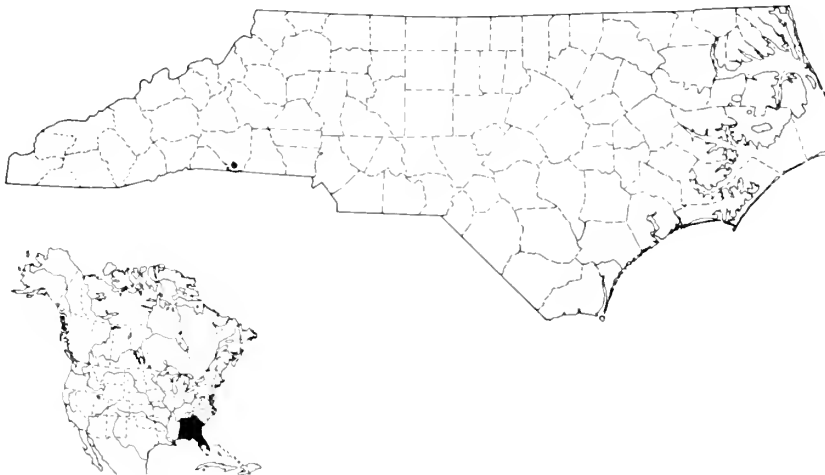
Confined to mountains where it lives in a variety of woodland habitats above 2000 feet. Most common in moist evergreen forests with an abundance of rocks, logs, and other cover, *P. maniculatus* may occur sympatrically with *P. leucopus* in some areas.



Peromyscus polionotus colemani Schwartz

Old-field Mouse

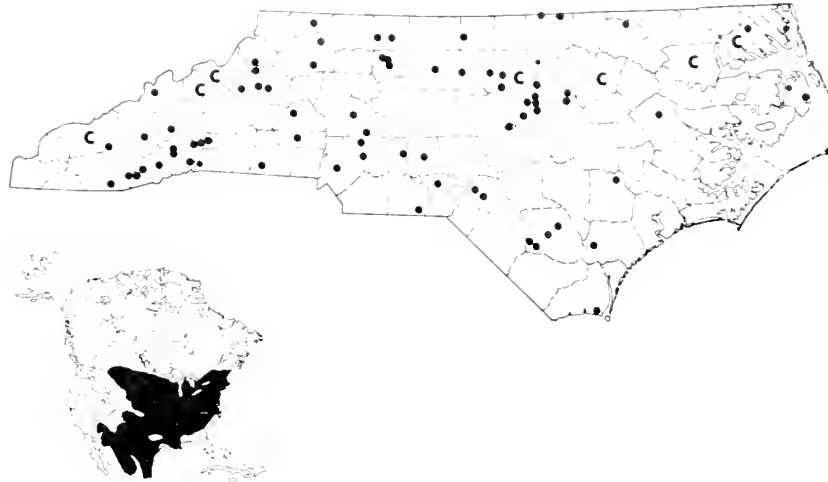
Known only from Rutherford County. Although Schwartz (1954) in his description of *P. p. colemani* reported this mouse from as far north as Spartanburg County, South Carolina, no records were available for North Carolina in spite of its documented occurrence within a few miles of the state line. In December 1976 we excavated one adult and two immature (NCSM 2561-62) Old-field Mice from a burrow on State Road 1111, 0.4 mile NE of the Broad River, 2 miles SW of Harris, Rutherford County, N.C. Randy Moore and Chris Marsh, North Carolina State Museum, returned to the same site on 15 January 1977 and collected a single adult male (NCSM 2531). To date this site represents the northernmost station and the only known North Carolina locality for the species. This is the first reported occurrence for *P. p. colemani* in the state.



Peromyscus leucopus leucopus (Rafinesque)

White-footed Mouse

Found throughout the state in a wide variety of woodland and ecotonal habitats. This species is least common at high altitudes, where it is partly replaced by *P. maniculatus*, and in the wetter coastal-plain forests, where it is partly replaced by *P. gossypinus*. Perhaps the most abundant mammal in North Carolina, the White-footed Mouse occasionally becomes a minor pest in rural homes.



Peromyscus gossypinus gossypinus (LeConte)

Cotton Mouse

Throughout lower coastal plain and Sandhills. The Cotton Mouse is found in dry to moist woodlands, but it is most abundant in swamps and alluvial forests. This species is known from one locality on the Outer Banks (Buxton Woods at Cape Hatteras, Dare County).

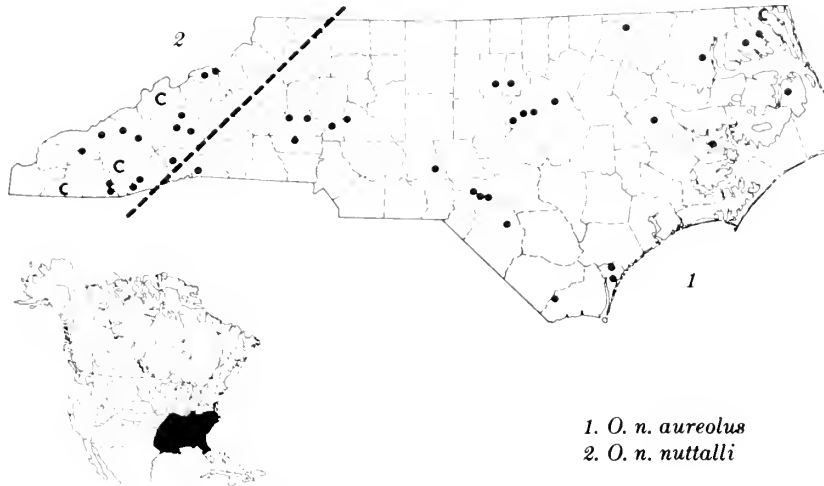


Ochrotomys nuttalli aureolus (Audubon and Bachman)

Ochrotomys nuttalli nuttalli (Harlan)

Golden Mouse

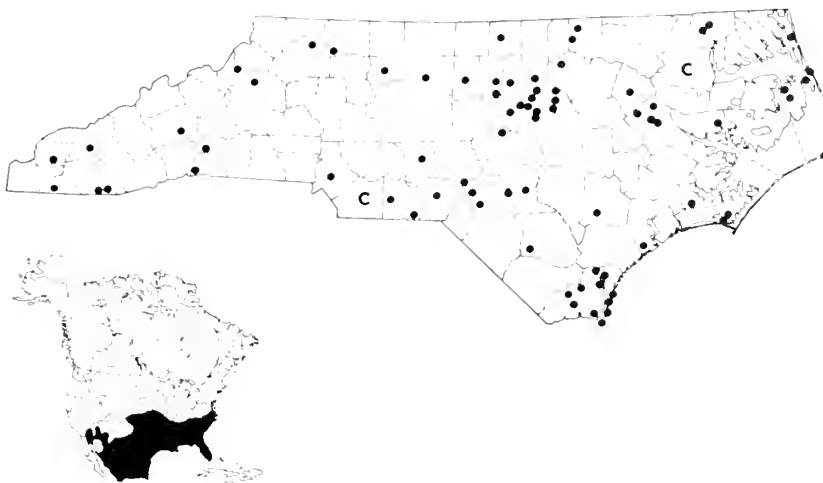
Statewide and often common near the edges of damp woodlands where thickets of vines and other cover exist. The area of intergradation between *O. n. aureolus* in the eastern section of the state and the more western form, *O. n. nuttalli*, is poorly defined but probably is largely along the fall line. Golden Mice often construct nests several feet above ground in honeysuckle or other vines.



Sigmodon hispidus komareki Gardner

Hispid Cotton Rat

Abundant throughout most of the state wherever suitable habitat occurs. This species is known from several barrier islands. In the western portion of the state, it is rare at elevations above 3000 feet. Hispid Cotton Rats live in fields, pastures, hedgerows, marshes, open woodlands with thick herbaceous ground cover, and a wide variety of edge habitats. Bunn (1941) studied habitat requirements of this species.



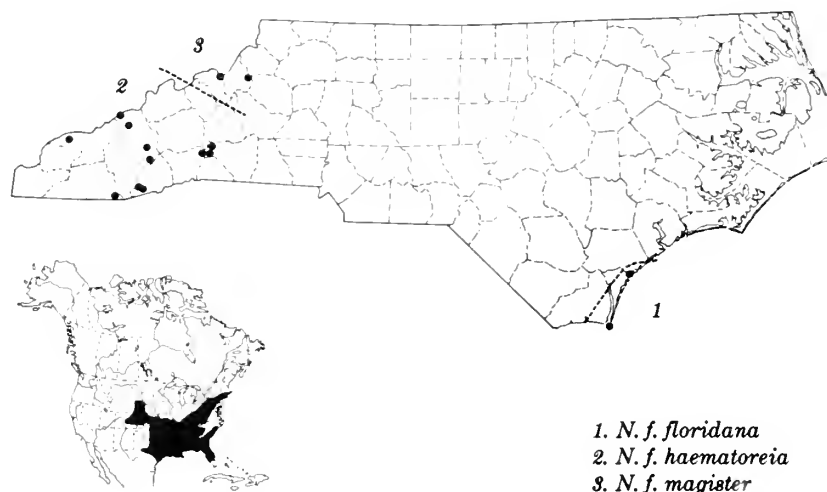
Neotoma floridana floridana (Ord)

Neotoma floridana haematoreia Howell

Neotoma floridana magister Baird

Eastern Wood Rat

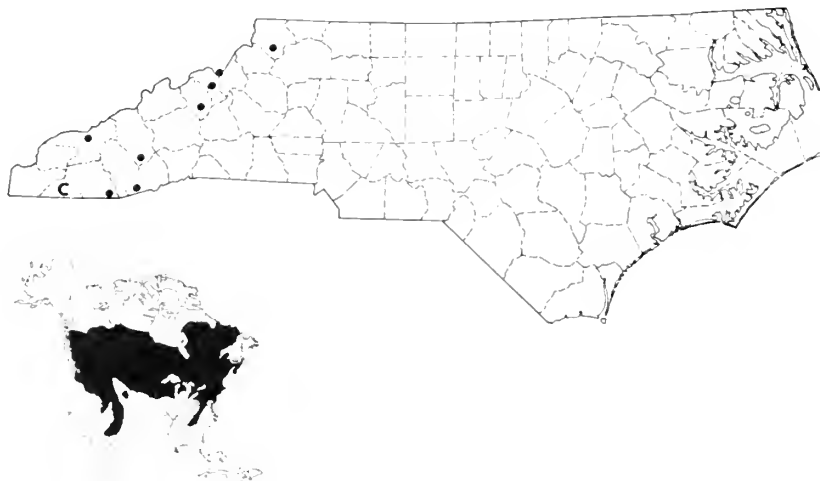
Primarily in mountains; fragmented distribution. Three races of the Wood Rat occur in North Carolina. *Neotoma f. floridana* is known only from Baldhead Island in Burnswick County and from southeastern Pender County. This latter site near Scotts Hill (NCSM specimen records) is the only existing population of this race known north of Charleston, South Carolina, and the northernmost record for the coastal plain. It consists of only a few individuals, but they were still present in early 1982. The Baldhead population is apparently extirpated. The other two races are mountain forms and occur in rocks, cliffs, cave entrances, abandoned cabins, well houses, and other places where they can find shelter. Their zone of intergradation is poorly defined. They live in small loosely organized colonies where they may occasionally be common. Their "pack rat" nests are conspicuous.



Clethrionomys gapperi carolinensis (Merriam)

Gapper's Red-backed Vole

Limited to elevations above 2500 feet. Although this species reaches the southern limit of its eastern distribution in extreme northern Georgia, it is quite abundant in optimum habitat. Most frequently associated with boreal evergreen forest with heavy ground cover, it is also found on mountain balds and in rhododendron thickets along creeks. This subspecies is endemic to the southern Appalachians.

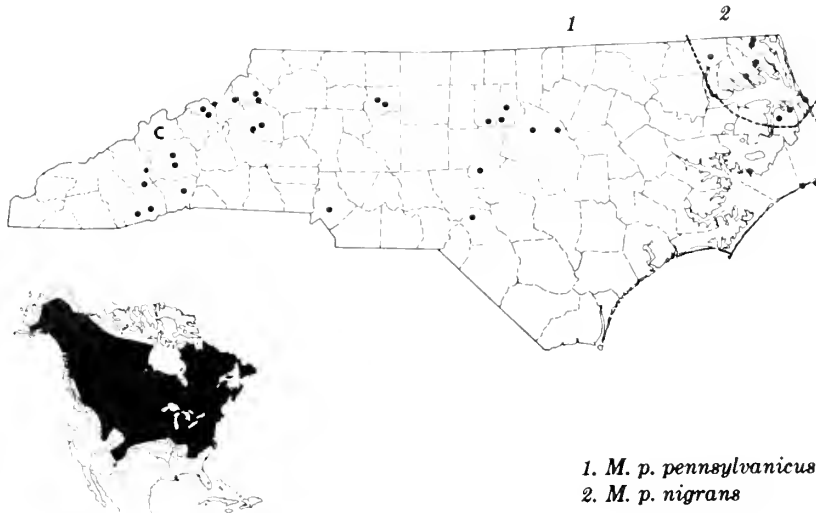


Microtus pennsylvanicus pennsylvanicus (Ord)

Microtus pennsylvanicus nigrans Rhoads

Meadow Vole

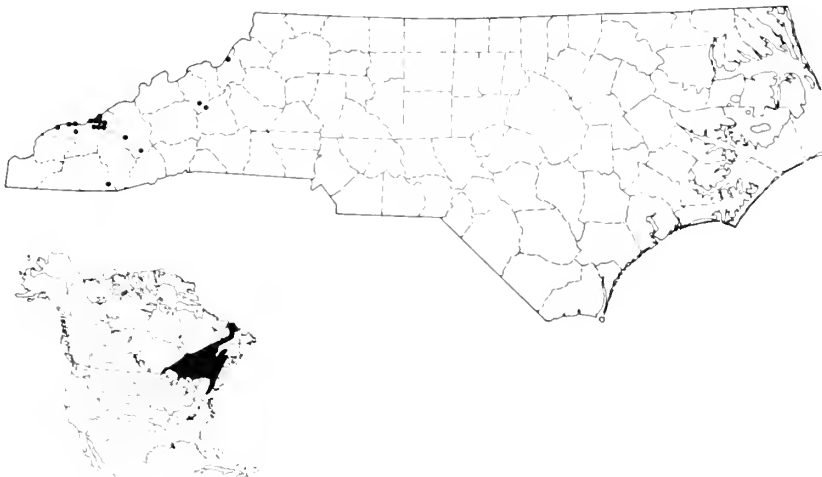
Nearly statewide. The nominate race occurs throughout the piedmont and mountains where it is seldom encountered above 4000 feet. In the coastal plain it is scattered and probably absent from the southern counties. *Microtus p. nigrans* is found on the lower Delmarva peninsula as well as in the Dismal Swamp region of North Carolina and Virginia. The species is generally common to rare in a wide range of habitats, from marshes and old fields to open woodlands. It normally prefers a moisture gradient intermediate between those selected by cotton and rice rats.



Microtus chrotorrhinus carolinensis Komarek

Rock Vole

Confined to elevations above 3800 feet in the mountains. The Rock Vole reaches the southern limit of known distribution at Highlands, Macon County. Outside the Great Smoky Mountains National Park it is rare and localized with many sites represented by a single specimen. Typically found in talus and other rocky habitats in coniferous boreal forests, it is also recorded from rocky fields and pastures. This species is usually sympatric with Red-backed Voles.



Microtus pinetorum pinetorum (LeConte)

Pine Vole

Apparently statewide. Scattered and uncommon in open, mixed woodlands and along forest margins, Pine Voles are more common in dry, open fields. Occasionally they become pests in suburban gardens and in orchards, where they gnaw on bark and roots to an extent that they seriously damage the plants. Because of this latter aspect, Pine Voles are currently being researched by North Carolina State University personnel. Additionally, Paul (1966) and Boyette (1966) investigated the ecology, population parameters, reproductive biology, and behavior of the Pine Vole in North Carolina.

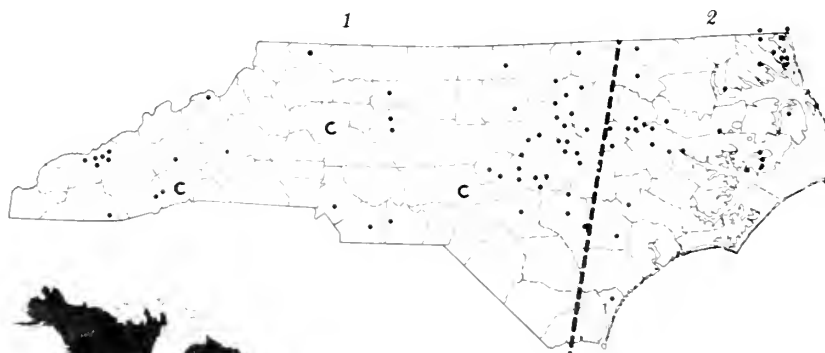


Ondatra zibethicus zibethicus (Linnaeus)

Ondatra zibethicus macrodon (Merriam)

Muskrat

Statewide in distribution and locally abundant in both coastal and inland marshes, farm ponds, and shallow areas of lakes and impoundments. *Ondatra z. macrodon* is found throughout much of the coastal plain (Funderburg 1961), and the nominate subspecies occurs in the mountains and piedmont. This rodent is one of the state's most important fur-bearers.



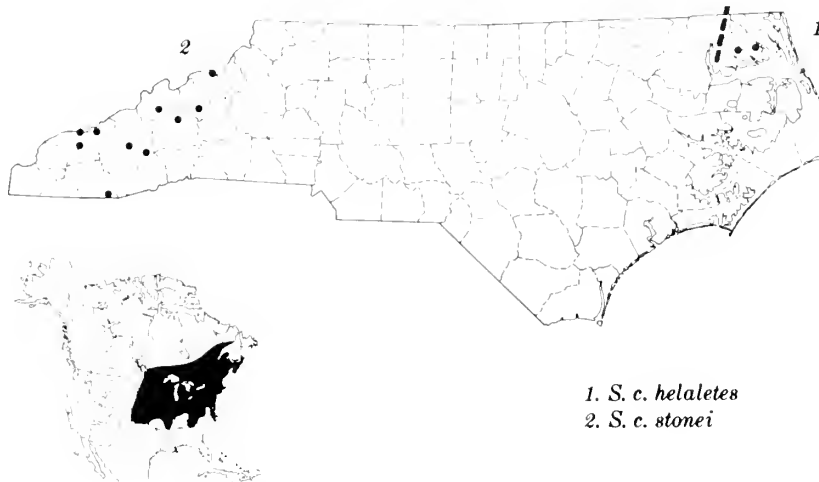
1. *O. z. zibethicus*
2. *O. z. macrodon*

Synaptomys cooperi helaletes Merriam

Synaptomys cooperi stonei Rhoads

Southern Bog Lemming

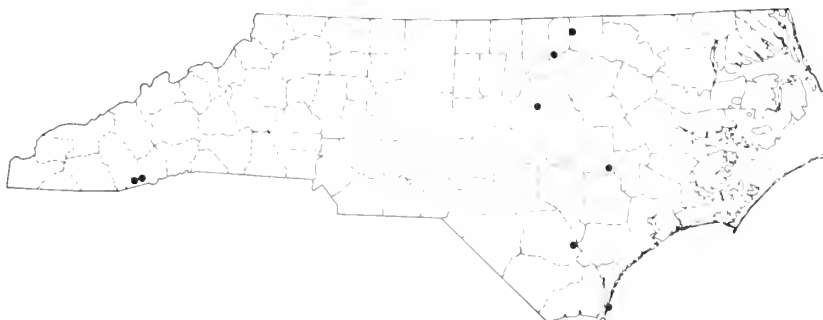
Rare and localized. In North Carolina this rodent is known from the mountains where it reaches the southern limits of its range and from a disjunct race, *S. c. helaletes*, in the Dismal Swamp. The only recent specimens of the latter population are a skull found in a Barn Owl pellet in 1979 near Elizabeth City (NCSM) and collections made by Rose (1981) in the Dismal Swamp region of North Carolina and Virginia. These records represent the first documentation of the existence of this race since 1896. The species is adapted to damp meadows and bogs with minimal woody vegetation, and populations seem to disappear when more advanced successional stages are reached. Most known colonies occur in areas encompassing only a few acres. The species no longer exists at many isolated sites where draining and other land use have accelerated natural successional development. This rodent is seldom common even in areas where optimum habitats persist.



Rattus rattus (Linnaeus)

Black Rat

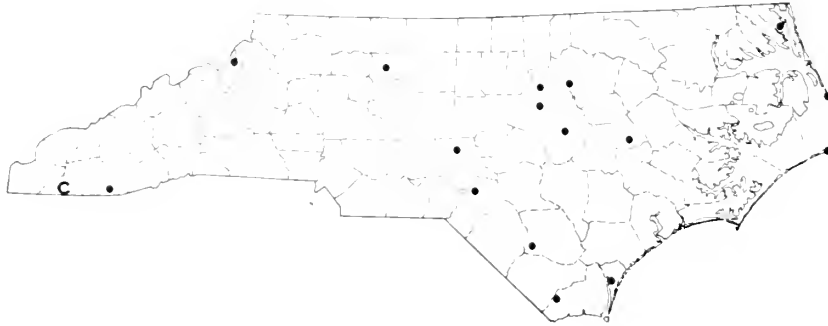
Exotic and now cosmopolitan, most common in tropical areas; originally confined to Europe. Although it may be expected anywhere in the state, the Black Rat today is uncommon and very localized in North Carolina. It has been largely replaced by the exotic Norway Rat, *R. norvegicus*. Although Black Rats are normally found around man-made structures, they often build nests in trees. Three subspecies have been introduced in North America. The only extant populations we are aware of are in and around Wilmington, where the species probably is constantly reintroduced from incoming ships, and perhaps still on Ocracoke Island (see Engels 1942).



Rattus norvegicus (Berkenhout)

Norway Rat

Exotic, now cosmopolitan; originally restricted to Europe. Statewide, or nearly so. This species may be a common pest in cities, at dumps, and around farm buildings. Occasionally it is found along stream banks or in open habitats where some cover exists. Norway Rats occur in low densities in the Hatteras Island salt marshes.



Mus musculus Linnaeus

House Mouse

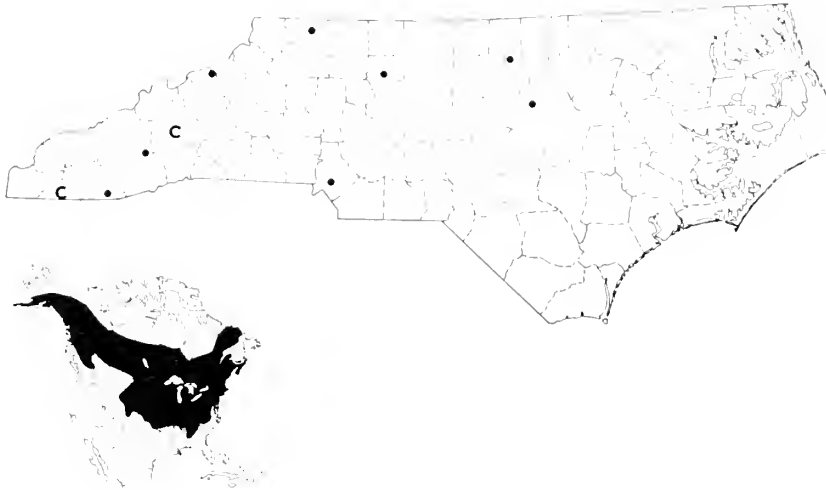
Exotic; native to Europe but well established in most parts of North America. Common to abundant in many disturbed or open habitats throughout the state, the House Mouse often becomes a pest in houses and other buildings.



Zapus hudsonius americanus (Barton)

Meadow Jumping Mouse

Rare to uncommon in piedmont and mountains where it occurs at least to 3000 feet. This species inhabits both woodlands and open habitats where there is thick ground cover. It typically is found near running water and seems to prefer open moist habitats. In North Carolina this species and the Woodland Jumping Mouse are the only mice that hibernate.



Napaeozapus insignis roanensis (Preble)

Woodland Jumping Mouse

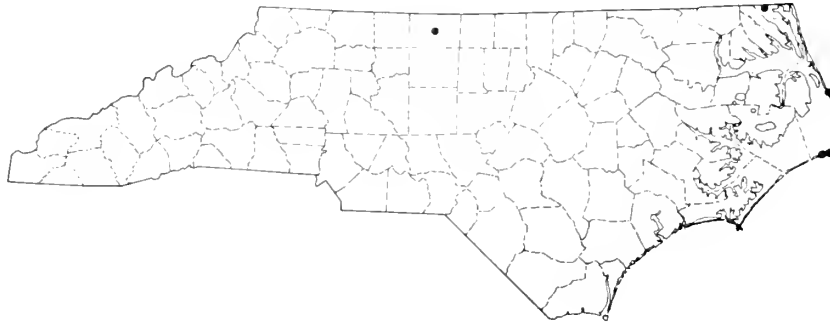
Locally abundant in mountains. In the southern portions of its range, this mouse is restricted to high altitudes in the southern Appalachians. It has not been recorded below 2800 feet in North Carolina. Locally abundant in moist, cool, open woodlands, and rhododendron thickets, the Woodland Jumping Mouse normally prefers rocky areas near water. Certainly it is more widespread than our few scattered locality records suggest. Like the Meadow Jumping Mouse, this species hibernates through the colder months.



Myocaster coypus bonariensis (E. Geoffroy St. Hilaire)

Nutria

Exotic. Originally released on the Outer Banks near Hatteras in 1941 (Quay 1959), because of its potential as profitable fur-bearer, the species had spread north to Avon by 1950 and to Pea Island by 1957. This South American rodent is also present in moderate numbers in the Currituck marshes, apparently having spread south from stocking efforts in the Chesapeake marshes. Presently it is localized in a few tidewater areas. We are aware of only one inland record (Rockingham County, 1978, NCSM files), but assume that the Nutria will eventually become established in inland farm ponds as it has in other states. Foods and feeding habits of the Nutria in North Carolina were studied by Milne (1963).

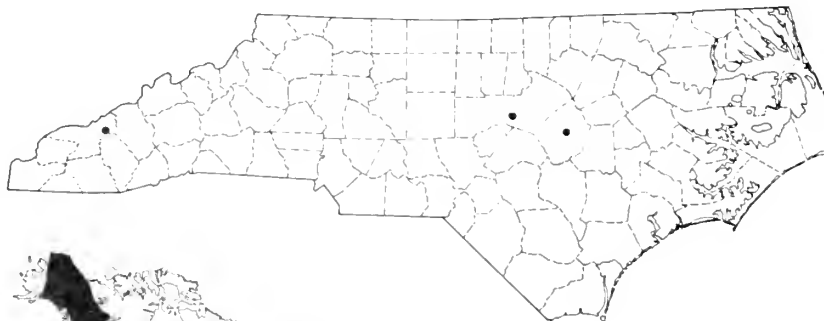


CARNIVORA: Carnivores

Canis latrans Say

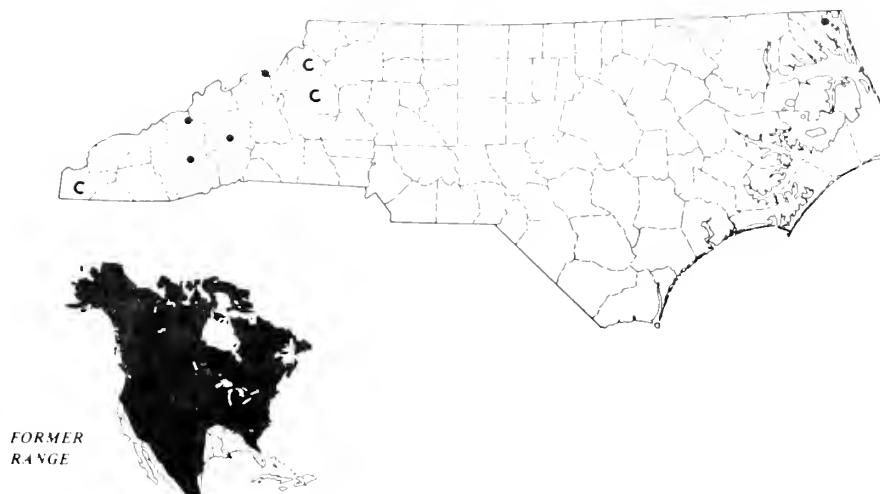
Coyote

Introduced by fox hunters; perhaps also arrived in state through natural eastward dispersal along power-line and highway rights-of-way. Specimens available are directly attributed to known releases in the North Carolina piedmont. Although the Coyote has long been considered an established member of our resident fauna, this represents the first written documentation of *C. latrans* in North Carolina. It is assumed that the species will quickly become common and widespread as it has in other eastern states, where extensive land clearing now provides suitable habitats. (Specimens examined: NCSM 1945, New Hill, Wake County, 14 February 1970, male, total length 1255 mm, tail vertebrae 395 mm, hind foot 200 mm, ear 116 mm; NCSM 2450, Smithfield, Johnston County, 22 January 1955, male, no measurements taken.)



Gray Wolf

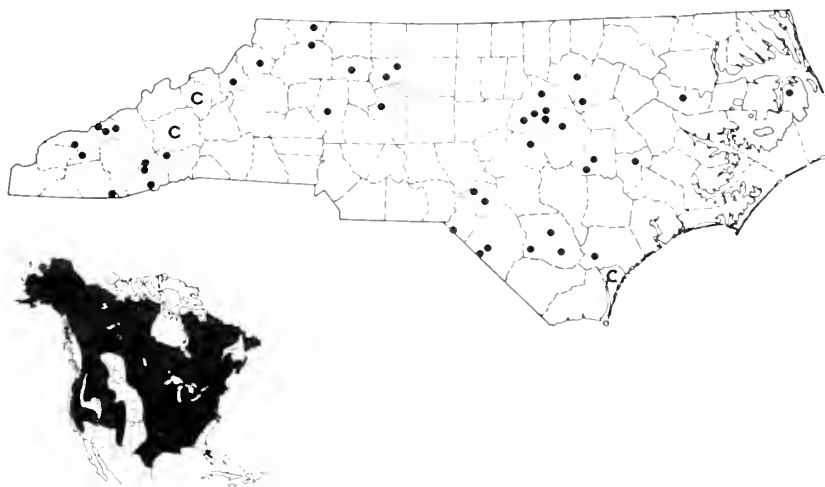
Extirpated. Based on bounty records and place names, wolves probably ranged over most, if not all, of North Carolina in colonial times. The last official record is from Haywood County in 1887 (Smith et al. 1960), although wolves probably persisted in the more remote sections of the state until the early 1900s. There is one unverified report of one killed in 1933 (Lee and Funderburg 1977). It is possible, but unsubstantiated, that the Red Wolf, *C. niger*, may have ranged northward along the lower Atlantic coastal plain into North Carolina. The northernmost record in the east is for Charleston, South Carolina. We are not aware of the existence of any North Carolina wolf specimens in collections.



Vulpes fulva fulva (Desmarest)

Red Fox

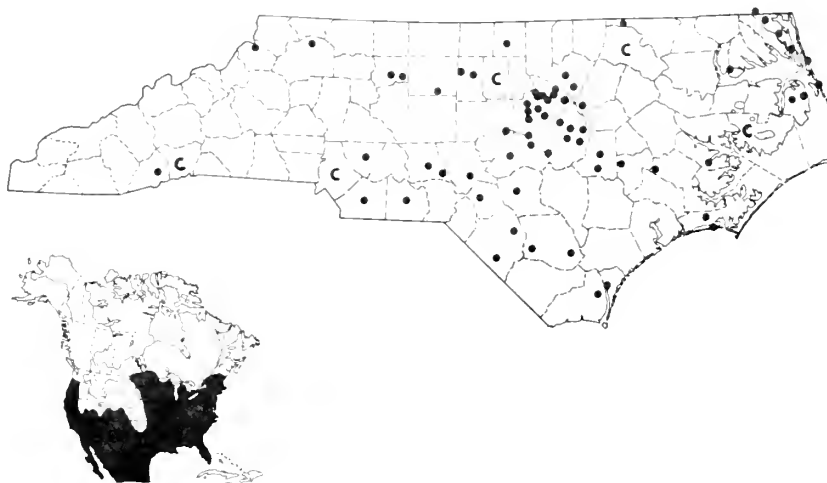
Currently statewide or nearly so. Recent appearance of the Red Fox on the coastal plain is a result of deliberate stocking by fox hunters and perhaps of natural expansion into cleared lands. Unlike the Gray Fox, the Red Fox is a resident of open fields, hedge rows, and forest edges. *Vulpes f. regalis* was stocked in the upper piedmont and mountains from 1953 to 1955 from animals captured in North Dakota, Minnesota, Iowa, and Nebraska. The original appearance of Red Foxes in the eastern United States is perhaps from imported animals brought to this country by colonial fox hunters, from midwestern animals invading the east after lands were cleared, or both. It is almost certain that this fox was not present in North Carolina in pre-colonial times.



Urocyon cinereoargenteus cinereoargenteus (Schreber)

Gray Fox

Probably statewide, although there are no records from above 4000 feet in the western part of the state. Found throughout most woodland communities as well as in bushy scrubs, the Gray Fox is most common in alluvial forests. It is common on the large barrier islands.



Ursus americanus americanus Paltas

Black Bear

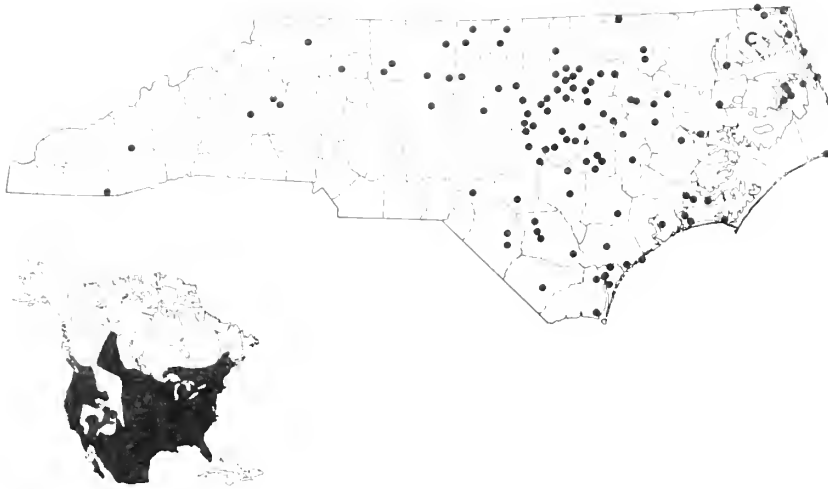
Formerly statewide. The Black Bear's present range is mostly confined to the mountains and lower coastal plain. Occasionally wandering individuals are encountered in other areas. The total North Carolina population is estimated to be about 2000 individuals (N. C. Wildlife Resources Commission files, 1977). Although the bear is still considered to be a game species and is legally hunted, many North Carolina biologists consider the continued existence of this species in the state to be threatened. This is because of extensive habitat loss and continued persecution in the remaining areas of adequate habitat.



Procyon lotor lotor (Linnaeus)

Raccoon

Statewide throughout a variety of habitats but most typically in marshes, swamps, and alluvial forests. Rare at elevations above 3800 feet. Common in urban and suburban areas wherever shelter is available. Between 1952 and 1955, three additional races were stocked in North Carolina; *P. l. hirtus* into Surry County, stock from Iowa; *P. l. solutus* into the piedmont and mountains, stock from South Carolina; and *P. l. elucus* into the piedmont and mountains, stock from Florida. We assume these introductions were of such limited numbers that they had little genetic impact on the native population.



Mustela nivalis allegheniensis (Rhoads)

Least Weasel

Confined to mountains where it most often occurs in open fields. Elevation records are above 1600 feet. This weasel probably is more common than our few widely scattered records indicate, in spite of the fact that most localities are represented by a single specimen. Barkalow (1967) reviewed the distributional information on four North Carolina records.



Mustela frenata noveboracensis (Emmons)

Long-tailed Weasel

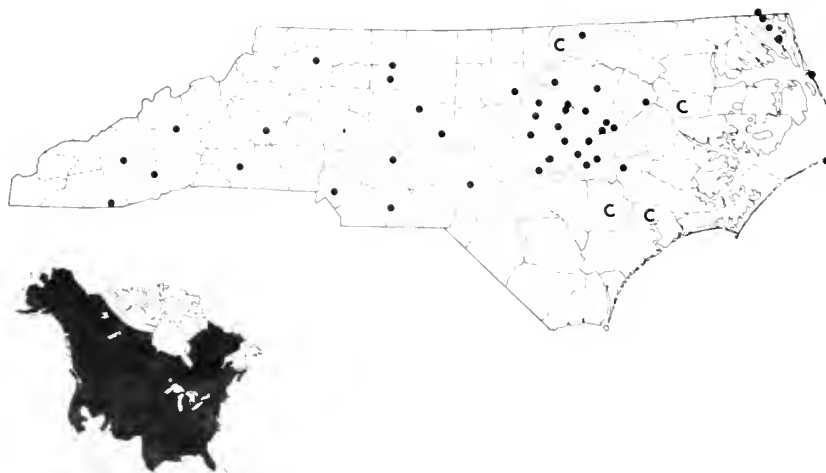
Uncommon throughout state. This weasel is normally found in most woodland habitats with suitable cover. In mountains, it occurs at all elevations.



Mustela vison mink Peale and Palisot de Beauvois

Mink

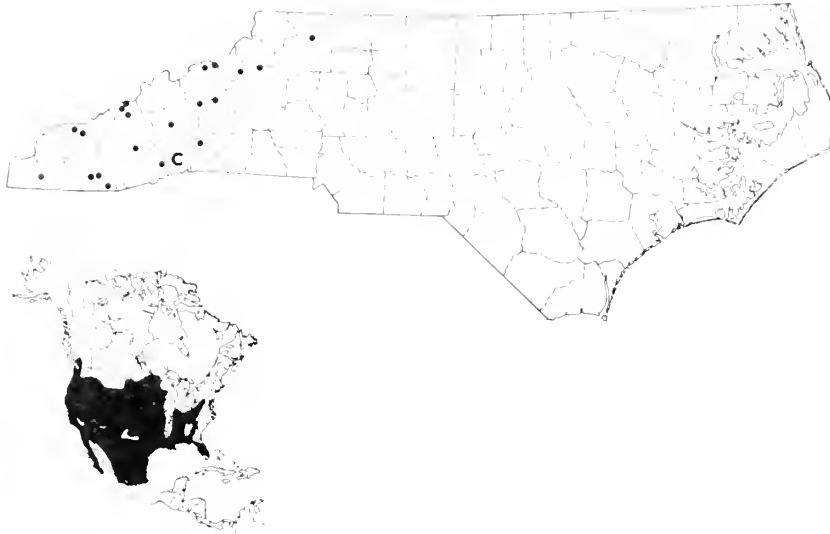
Statewide. This fur-bearer occurs throughout the state in association with a wide variety of aquatic habitats. Normally seen along streams and near the margins of lakes, ponds, and marshes, Mink are more common and widespread than our few records indicate.



Spilogale putorius putorius (Linnaeus)

Spotted Skunk

Widely distributed at high elevations (above 1250 feet) in the mountains. The Spotted Skunk is relatively common in open mountain forests where talus, cliffs, and other den sites offer ample protection. Spotted Skunks often occur at higher densities than do Striped Skunks.



Mephitis mephitis elongata Bangs

Striped Skunk

More or less statewide. The general opinion is that the Striped Skunk is to some degree continuously distributed throughout the Atlantic seaboard states. In North Carolina, there is a conspicuous hiatus in the range with no recent records of occurrence for relatively large areas. We assume that various diseases periodically eliminate skunks over sizable portions of their range. Apparently absent from most if not all barrier islands since historical times, the Striped Skunk is common at all elevations in the mountains and often occupies the same habitats as the Spotted Skunk

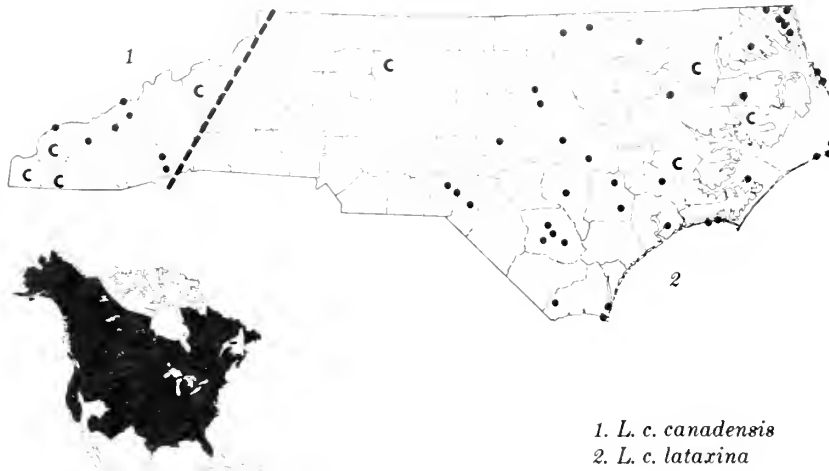


Lutra canadensis canadensis (Schreber)

Lutra canadensis lataxina F. Cuvier

River Otter

Apparently distributed throughout the state in colonial times. Today the River Otter is most common in tidewater areas, estuaries, and sounds; but it is also distributed along lower reaches of major river basins. It often travels across land or follows streams and creeks seasonally to visit farm ponds and lakes. Least common in the western portion of the state, the River Otter is not now expected to occur at high elevations. The abundance status and biology of this species are currently under study at North Carolina State University. Two races occur in the state. The form in the western portion, *L. c. canadensis*, and its zones of contact with the eastern subspecies, *L. c. lataxina*, are not well documented by specimens.



Felis concolor cougar Kerr

Panther

Possibly extirpated from the state. Based on old bounty records and places named for Panthers, this cat appears to have originally occurred throughout the state (NCSM file records). Rumors persist of the presence of individuals in various areas, but to date these have not been confirmed (Lee 1977). The possibility of released "pet" animals further compounds the problems in assessing the current status of the Panther. It is quite likely that the Florida race, *F. c. coryi*, formerly occurred, or perhaps still occurs, in the southeastern region of the state. We are not aware of the existence of any North Carolina specimens. The last seemingly valid records were of individuals killed in the 1880s (Brimley 1944-46). Although this cat has many common names (e.g. Cougar, Mountain Lion), "Panther" (originally "painter") was used exclusively in North Carolina prior to its extirpation.

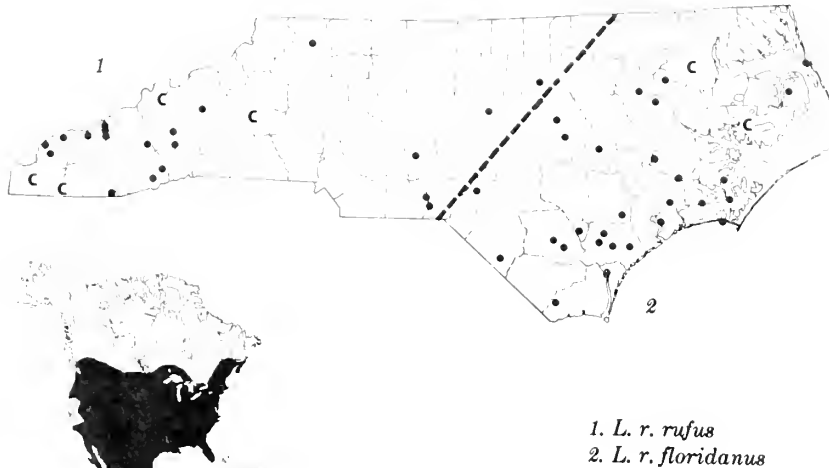


Lynx rufus rufus (Schreber)

Lynx rufus floridanus Rafinesque

Bobcat

Widely distributed throughout much of the state wherever extensive wooded tracks persist. Still locally common in some areas. *Lynx r. floridanus* occurs in the southern coastal plain; however, the zone of intergradation with *L. r. rufus*, which is found in the rest of the state, is presently unknown.



PINNIPEDIA: Seals

Phoca vitulina concolor Dekay

Harbor Seal

Unusual but seemingly regular coastal visitor, winter through early spring. The museum receives reports of these seals nearly every year. All individuals examined by us have been yearlings, and we know of no adults from the state. Most records are from the ocean side of barrier islands. Many of the seals encountered are sick or injured, suggesting that they were carried south by long-shore currents and that few return northward in the spring.

Cystophora cristata (Erxleben)

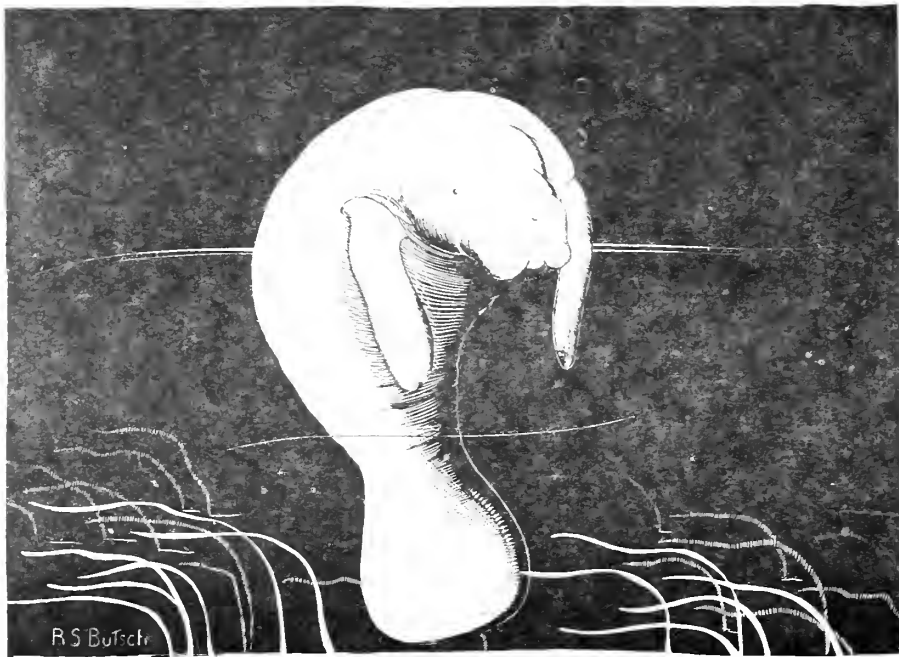
Hooded Seal

Vagrant. There are only two coastal reports for the Hooded Seal in North Carolina: 20 November 1944, Morehead City, Carteret County (Brimley 1944, NCSM 383); August 1910, North Banks Beach (county ?) (U.S. National Museum Publication 172631). An unusual vagrant, this seal is not normally expected south of New England in the western Atlantic.

Trichechus manatus latirostris (Harlan)

Florida Manatee

Extremely rare summer visitor; formerly a summer resident. Coastal North Carolina represents the northern limit of the historical summer range of the Manatee (Brimley 1931, Campbell 1977). Browne and Lee (1977) and Lee (1976) commented on the possible present-day occurrence in extreme southeastern North Carolina. During the winter most individuals migrate to southern Florida, but a few winter in and around freshwater springs in north-central Florida. Recently, Manatees have found winter refuge in heated effluents from power plants in north Florida. In the winter of 1977-78, a severely cold winter combined with a mechanical failure at a power plant caused heavy mortality in Florida's northernmost wintering population. Since then we have not received any additional sight reports of this endangered species in North Carolina. The most recent record for the Carolinas is of one found dead at Hilton Head, South Carolina, in the summer of 1978. An adult was found in Virginia in the fall of 1980.



ARTIODACTYLA: Even-toed Ungulates

Sus scrofa scrofa Linnaeus

Wild Boar

Exotic game species established in several western counties. Typically found in open forests at high elevations. About 1920 perhaps as many as a hundred animals escaped from a private hunting preserve on Hooper's Bald, Graham County. A second release took place in the 1940s in Green River Cove, Polk County (Hamnett and Thornton 1953). Some crossbreeding between the "Russian" Wild Boar stock and feral domestic pigs has taken place. Herds of boars often do considerable damage to stands of wild flowers and other natural vegetation.

Cervus canadensis canadensis (Erxleben)

American Elk

Extirpated. Formerly found in mountains and northwestern piedmont, but eliminated by hunting pressures by the late 1700s. There are few documented dates or locations of occurrence for the state. Presumably a woodland form, the elk in North Carolina perhaps frequented mountain balds and other natural clearings. In 1912 the species (apparently *C. c. nelsoni*) was introduced in the western part of the state, but the stocking was not successful.

Odocoileus virginianus virginianus (Zimmermann)

White-tailed Deer

Now more or less statewide. Absent from most barrier islands. Normally frequents open woodlands and adjacent brushy and open fields, power-line rights-of-way, and other disturbed habitats. By the turn of the century hunting pressure had all but eliminated the White-tailed Deer from the state. Remnant populations persisted on the Dare County mainland, in the Green Swamp, and in the Pisgah National Forest. A restocking and management program by the North Carolina Wildlife Resources Commission has been extremely successful, and deer are now found nearly statewide and in many areas are extremely abundant. Although *O. v. virginianus* was the race originally found in North Carolina, the widespread stocking of *O. v. borealis* makes subspecific recognition meaningless. Nevertheless, it is interesting to note that the deer in the Green Swamp area are small, indicating that perhaps the original native gene pool may still dominate in that region.

Bison bison bison (Linnaeus)

American Bison

Extirpated. Formerly throughout the western part of the state. There are few definite date or locality records for the state. Apparently still common between 1720 and 1750, the American Bison had totally disappeared by 1765 (Lee and Funderburg 1977). This is the first species of animal known to have been extirpated by man from North Carolina. The eastern "woodland bison," called Buffalo by early settlers, lived in small scattered herds and did not dominate its habitat as did the plains-dwelling form. Eight bison were restocked in Graham County in 1912, but the reintroduction was not successful.

ADDITIONAL INTRODUCTIONS

The following species have been stocked but either have not become established or exist in small numbers in such localized areas that they should not be considered as part of the fauna of the state. Feral domestic species are not included.

Lepus californicus Gray

Black-tailed Jack Rabbit

Stocked in Wilkes, Surry, Yancey, Catawba, and Nash Counties from 1951 through 1954; from Kansas and Idaho. Subspecies: *L. c. deserticola* Mearns.

Ursus sp. Linnaeus

Brown Bear

Eight of these animals, from Russia, were stocked in the Hooper's Bald Game Preserve, Graham County, in 1921.

Dama dama Linnaeus

Fallow Deer

Approximately 10 were stocked on the Mount Mitchell Wildlife Management Area in the 1940s. One was killed in Alexander County in the fall of 1956.

Odocoileus hemionus (Rafinesque)

Mule Deer

Six Mule Deer, from Colorado, were introduced in 1912 on Hooper's Bald Game Preserve in Graham County.

Dasypus novemcinctus Linnaeus

Nine-banded Armadillo

Although armadillos are not established in North Carolina, a modest number have found their way into the southeastern part of the state where they have been released by interstate travelers who discover that the unique "pets" they captured in Georgia and Florida can claw their way through boxes, bags, and other containers. Most winters are too severe for armadillos to survive this far north. We include this species in these accounts simply to clarify its status.



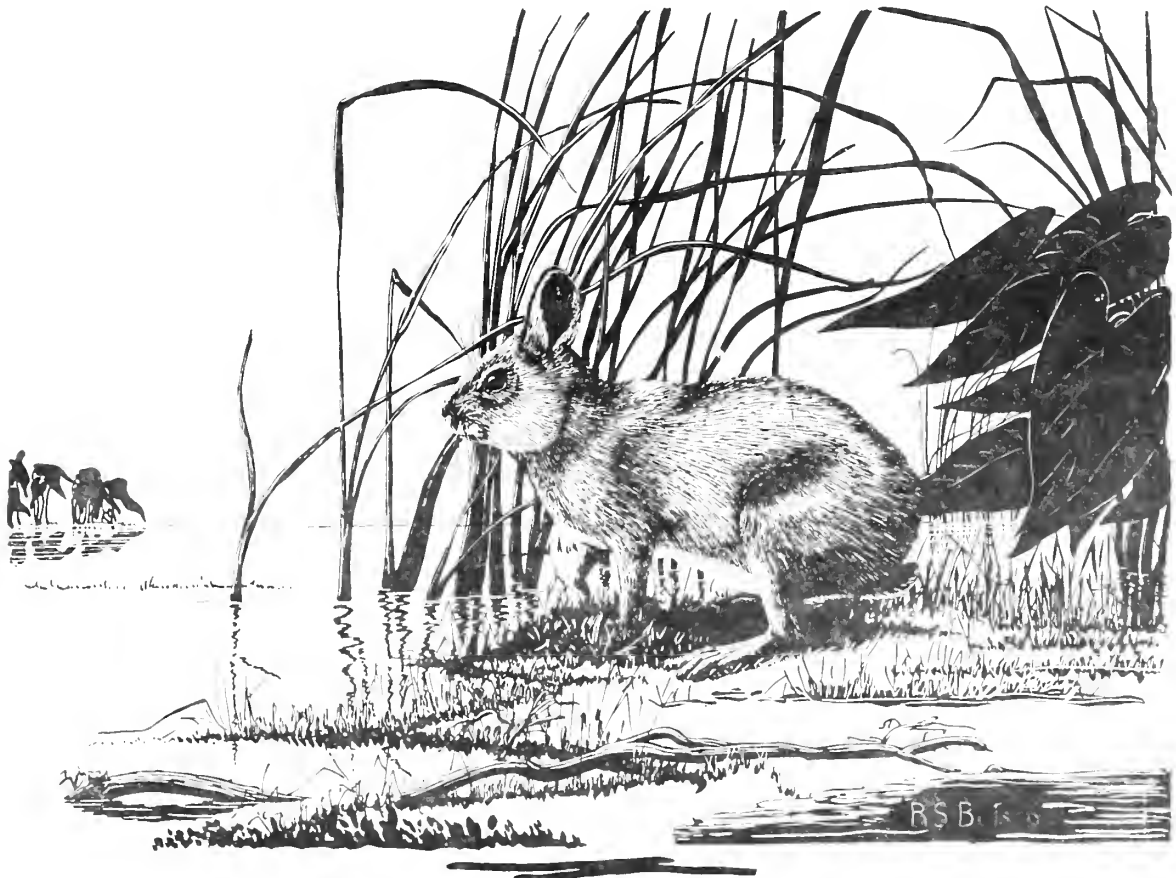
LITERATURE CITED

- Adams, D. A. 1950. *Myotis subulatus leibii* in North Carolina. *Journal of Mammalogy* 31:97-98.
- Barbour, R. W., and W. H. Davis. 1969. *Bats of America*. University Press of Kentucky, Lexington. 286 pages.
- Barkalow, F. S., Jr. 1967. Range extension and notes on the Least Weasel in North Carolina. *Journal of Mammalogy* 48:488.
- Barkalow, F. S., Jr., and D. A. Adams. 1955. The Seminole Bat, *Lasiurus seminolus* in North Carolina. *Journal of Mammalogy* 36:453-454.
- Barkalow, F. S., Jr., and J. B. Funderburg Jr. 1960. Probable breeding and additional records of the Seminole Bat in North Carolina. *Journal of Mammalogy* 41:394-395.
- Boyette, J. G. 1966. A behavioral study of the Pine Mouse, *Pitymys pinetorum pinetorum* (LeConte) [now *Microtus pinetorum*]. Unpublished M.S. thesis, North Carolina State University, Raleigh.
- Brimley, C. S. 1897. An incomplete list of the mammals of Bertie County, North Carolina. *American Naturalist* 31:237-239.
- Brimley, C. S. 1905 [1908]. A descriptive catalogue of the mammals of North Carolina, exclusive of the Cetacea. *Journal of the Elisha Mitchell Scientific Society* 21:1-32.
- Brimley, C. S. 1913. Zoogeography, a study of life zones. *Journal of the Elisha Mitchell Scientific Society* 29:10-27.
- Brimley, C. S. 1944-1946. *The Mammals of North Carolina*. 18 installments. Carolina Tips. Carolina Biological Supply Co., Elon College, N.C.
- Brimley, C. S., and Franklin Sherman Jr. 1908. Notes on the life zones in North Carolina. *Journal of the Elisha Mitchell Scientific Society* 24:14-22.
- Brimley, H. H. 1931. The Manatee in North Carolina. *Journal of Mammalogy* 12:320-321.
- Browne, M. M., and D. S. Lee. 1977. Current status of the Manatee in North Carolina. *Abstract. ASB Bulletin* 24(2):40.
- Bunn, C. I. 1941. An investigation of Cotton Rat habitat requirements. Unpublished M.S. thesis, North Carolina State University, Raleigh.
- Caldwell, D. K., and F. B. Golley. 1965. Marine mammals from the coast of Georgia to Cape Hatteras. *Journal of the Elisha Mitchell Scientific Society* 81:24-32.
- Campbell, H. W. 1977. *Trichechus manatus* Linnaeus. Pages 396-397 in *Endangered and Threatened Plants and Animals of North Carolina*. J. E. Cooper, S. S. Robinson, and J. B. Funderburg, editors. North Carolina State Museum of Natural History, Raleigh.
- Clark, M. K., and E. F. Potter. 1982. Third annual breeding bird foray: Hoke County, N.C. *Chat* 46:29-37.
- Conaway, C. H., and J. C. Howell. 1953. Observations on the mammals of Johnson and Carter Counties, Tennessee, and Avery County, North Carolina. *Journal of the Tennessee Academy of Science* 28:53-61.
- Conaway, C. H., and D. W. Pfitzer. 1952. *Sorex palustris* and *Sorex dispar* from the Great Smoky Mountains National Park. *Journal of Mammalogy* 33:106-108.
- Cooper, J. E., S. S. Robinson, and J. B. Funderburg, editors. 1977. *Endangered and Threatened Plants and Animals of North Carolina*. North Carolina State Museum of Natural History, Raleigh. i-xvi + 444 pages.
- Davis, W. H., and C. L. Rippy. 1968. Distribution of *Myotis lucifugus* and *M. austroriparius* in the southeastern United States. *Journal of Mammalogy* 49:113-117 (2 figures).
- Engels, W. L. 1942. Vertebrate fauna of North Carolina coastal islands: I. Ocracoke Island. *American Midland Naturalist* 28:273-304.
- Engels, W. L. 1952. Vertebrate fauna of North Carolina coastal islands: II. Shackleford Banks. *American Midland Naturalist* 47:702-742.
- Funderburg, J. B. 1961. Virginia Muskrat in southeastern North Carolina. *Journal of Mammalogy* 42:268.
- Golley, F. B. 1966. *South Carolina Mammals*. Contributions of the Charleston Museum, 15. xiv + 181 pages; 90 figures, 4 tables.
- Hall, E. R. 1951. A synopsis of the North American Lagomorpha. *University of Kansas Publications* 5(10):119-202.
- Hall, E. R., and K. R. Kelson. 1959. *The Mammals of North America*. Volumes I and II. Ronald Press Co., New York. 1,083 pages + 79-page index.
- Hamnett, W. L., and D. C. Thornton. 1953. *Tar Heel Wildlife*. North Carolina Wildlife Resources Commission, Raleigh. 98 pages; illustrations, maps.



- Handley, C. O., Jr. 1971. Appalachian mammalian geography—Recent Epoch. Pages 263-303 in The Distributional History of the Biota of the Southern Appalachians, Part III: Vertebrates. P. C. Holt, editor. Research Division Monograph 4, Virginia Polytechnic Institute and State University, Blacksburg.
- Handley, C. O., Jr., and C. P. Patton. 1947. Wild Mammals of Virginia. Virginia Commission of Game and Inland Fisheries, Richmond. 220 pages.
- Johnston, D. W. 1967. Ecology and distribution of mammals at Highlands, North Carolina. Journal of the Elisha Mitchell Scientific Society 83(2):88-98.
- Kaye, S. V. 1960. A study of the Eastern Harvest Mouse, *Reithrodontomys humulis* (Audubon and Bachman). Unpublished M.S. thesis, North Carolina State University, Raleigh.
- Kellogg, R. 1939. Annotated list of Tennessee mammals. Proceedings of the U.S. National Museum 86:245-303.
- Komarek, E. V., and R. Komarek. 1938. Mammals of the Great Smoky Mountains. Bulletin of the Chicago Academy of Science 5(6):137-162.
- Lee, D. S. 1974. A second Pigmy Shrew from Maryland. Chesapeake Science 14(1):60.
- Lee, D. S. 1976. Manatees: mermaids in distress. Wildlife in North Carolina 40(2):8-9.
- Lee, D. S. 1977. Unscrambling rumors: the status of the Panther in North Carolina. Wildlife in North Carolina 41(7):6-9.
- Lee, D. S., and J. E. Cooper. 1976. Endangered species: problems associated with habitat protection. Abstract. ASB Bulletin 23:74.
- Lee, D. S., and J. B. Funderburg. 1977. Mammals. Pages 385-408 in Endangered and Threatened Plants and Animals of North Carolina. J. E. Cooper, S. S. Robinson, and J. B. Funderburg, editors. North Carolina State Museum of Natural History, Raleigh.
- Lee, D. S., J. B. Funderburg, and M. K. Clark. 1982. A Preliminary Survey of the Mammals of Mainland Dare County, North Carolina. Report for U.S. Fish and Wildlife Service. Contract No. 14-16-0004-81-056.
- Lee, D. S., and C. Marsh. 1978. Range expansion of the Brazilian Free-tailed Bat into North Carolina. American Midland Naturalist. 100(1):240-241.
- Linzey, A. V., and D. W. Linzey. 1971. Mammals of the Great Smoky Mountains National Park. University of Tennessee Press, Knoxville. 114 pages.
- Linzey, D. W., and A. V. Linzey. 1968. Mammals of the Great Smoky Mountains National Park. Journal of the Elisha Mitchell Scientific Society 84(3):384-414.
- Linzey, D. W., and A. V. Linzey. 1973. Notes on food of small mammals from Great Smoky Mountains National Park, Tennessee-North Carolina. Journal of the Elisha Mitchell Scientific Society 89:6-14.
- McKeever, S. 1949. The ecological succession of small mammals in relation to upland plant communities at Raleigh, North Carolina. Unpublished M.S. thesis, North Carolina State University, Raleigh.
- Milne, R. C. 1963. A habitat description and evaluation, semiquantitative food habit analysis, and population study of the Nutria, *Myocastor coypus* (Molina) Kerr, on Hatteras Island, North Carolina. Unpublished M.S. thesis, North Carolina State University, Raleigh.
- Odum, E. P. 1949. Small mammals of the Highlands (North Carolina) Plateau. Journal of Mammalogy 30(20):179-192.
- Paul, J. R. 1966. Observations on the ecology, populations, and reproductive biology of the Pine Vole, *Microtus pinetorum*, in North Carolina. Report of Investigations No. 20, Illinois State Museum: 1-28.

- Quay, T. L. 1959. The Birds, Mammals, Reptiles, and Amphibians of Cape Hatteras National Seashore Recreational Area. Unpublished report for U.S. Department of the Interior.
- Robinson, S. S., and D. S. Lee. 1980. Recent range expansion of the Groundhog, *Marmota monax*, in the Southeast (Mammalia: Rodentia). *Brimleyana* 3:43-48.
- Rose, R. K. 1981. *Synaptomys* not extinct in the Dismal Swamp. *Journal of Mammalogy* 60(4):844-845.
- Schwartz, A. 1954. Oldfield Mice, *Peromyscus polionotus*, of South Carolina. *Journal of Mammalogy* 35:561-569.
- Sherman, F. 1939. The Swamp Rabbit (*Sylvilagus aquaticus aquaticus*) in the South Carolina. *Journal of Mammalogy* 20(2):259.
- Smith, C. R., J. Giles, M. E. Richards, J. Nagel, and D. W. Yambert. 1974. The mammals of north-eastern Tennessee. *Journal of the Tennessee Academy of Science* 49(3):88-94.
- Smith, E. R., J. B. Funderburg, and T. L. Quay. 1960. A Checklist of North Carolina Mammals. North Carolina Wildlife Resources Commission, Raleigh. 19 pages.
- Tuttle, M. D., and P. B. Robertson. 1969. The Gray Bat, *Myotis grisescens*, east of the Appalachians. *Journal of Mammalogy* 50:370.
- Warton, Charles H. 1968. First records of *Microsorex hoyi* and *Sorex cinereus* from Georgia. *Journal of Mammalogy* 49:158.
- Weigl, P. D. 1968. The distribution of the flying squirrels *Glaucomys volans* and *G. sabrinus*: an evaluation of the competitive exclusion idea. Unpublished Ph.D. dissertation, Duke University, Durham, N.C.
- Weigl, P. D. 1977. *Glaucomys sabrinus coloratus* Handley. Pages 398-399 in *Endangered and Threatened Plants and Animals of North Carolina*. J. E. Cooper, S. S. Robinson, and J. B. Funderburg, editors. North Carolina State Museum of Natural History, Raleigh.
- Wells, B. W. 1924. Major Plant Communities of North Carolina. Technical Bulletin No. 25, N.C. Agricultural Experiment Station, Raleigh.
- Whitaker, J. O., Jr., G. S. Jones, and D. D. Pascal Jr. 1975. Notes on mammals of the Fires Creek area, Nantahala Mountains, North Carolina, including their ectoparasites. *Journal of the Elisha Mitchell Scientific Society* 91(1):13-17.



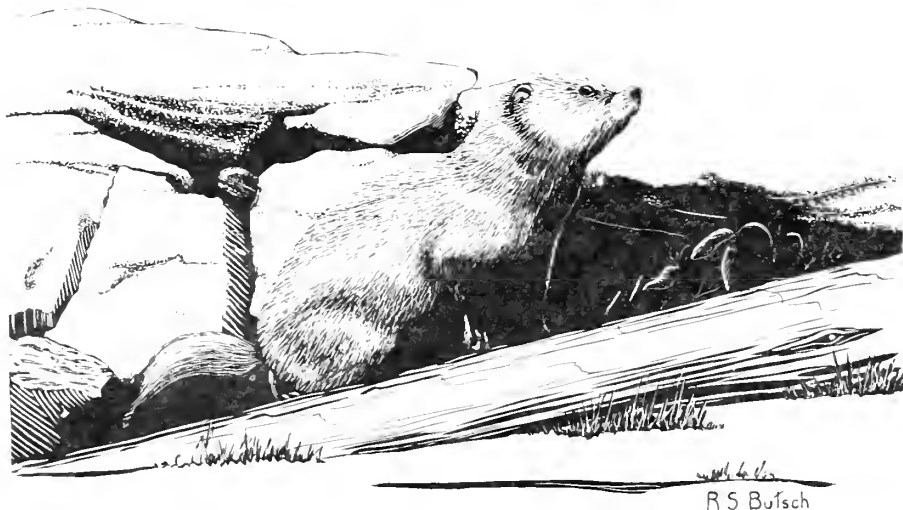
ACKNOWLEDGMENTS

Numerous museum curators and others provided access to their records for North Carolina material: Sydney Anderson, American Museum of Natural History; Joseph Bailey, Duke University; Fred Barkalow and Stan Atwood, North Carolina State University; Donald P. Christian, Michigan State University; Peter Dalby, University of Virginia; Donald H. DeFoe, Great Smoky Mountains National Park; Navar L. Elliott, Charlotte Nature Museum; Robert D. Fisher, National Fish and Wildlife Laboratory, National Museum of Natural History; Lawrence R. Heaney, Museum of Natural History, University of Kansas; Emmet T. Hooper, University of Michigan; Samuel F. Howe, Academy of Natural Sciences of Philadelphia; J. C. Howell and Michael R. Pelton, University of Tennessee; Robert Izor, Field Museum of Natural History, Chicago; Ralph Jordan, Tennessee Valley Authority; James Parnell, University of North Carolina, Wilmington; M. Edith Rutzmoser, Museum of Comparative Zoology, Harvard University; Ben Sanders, U. S. Forest Service; Duane A. Schlitter, Carnegie Museum of Natural History, Pittsburgh; Richard Stout, Schiele Museum of Natural History, Gastonia; Merlin Tuttle, Milwaukee Public Museum; Robert Wayne Van Devender, Appalachian State University; and Peter Weigl, Wake Forest University.

Additionally Steven P. Platania, Eloise F. Potter, William Adams, Peter T. Hertl, Alvin Braswell, and David Stephan all provided many useful specimen records. Thomas Quay read and commented on an earlier draft of this paper. Fran Reese, Chris Marsh, and Steven P. Platania, all assisted in assemblage of some of the data presented herein.

R. S. Butsch and R. Kuhler prepared the illustrations.

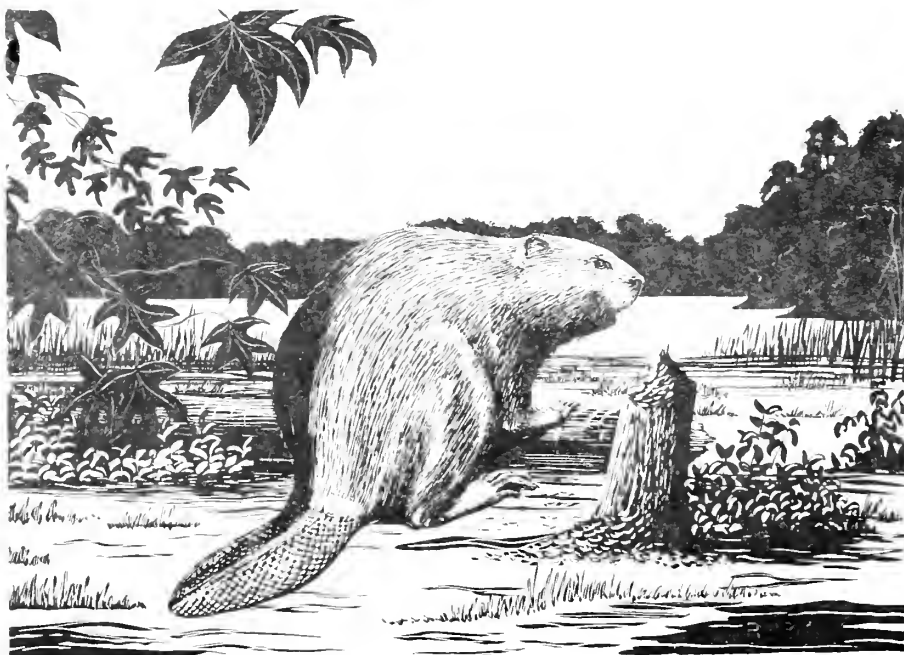
We thank all of the above mentioned individuals and institutions for their contributions to this study.



GLOSSARY

- ALLUVIAL.** Of, pertaining to, or composed of alluvium, which is any sediment deposited by flowing water. An *alluvial forest* is a plant community growing on a flood plain formed from alluvial deposits.
- BOREAL.** Northern. Boreal forests of North America are represented by spruce-fir and northern hardwood plant communities in the southern Appalachian Mountains. These are sometimes referred to as Canadian-zone forests.
- CANOPY.** The open or closed situation in a forest created by the relative distance between the longest branches of the tallest trees. If these branches touch or overlap, the canopy is closed.
- CETACEANS.** Aquatic mammals belonging to the order Cetacea, whales and porpoises.
- COMMUNITY.** A group of plants and animals living in a specific region under relatively similar conditions; usually named for the dominant plant or plants. A *climax community* is one that has reached a stable, self-perpetuating stage after having developed through a succession of *seral stages*.
- CONIFEROUS.** Composed of cone-bearing trees, usually evergreens such as pines, hemlocks, or cedars.
- CRYPTIC SPECIES.** Two or more species that are so similar in appearance that they are difficult to separate even in hand.
- DECIDUOUS.** Not permanent; falling off or shedding at a specific stage of growth.
- ECOSYSTEM.** A plant and animal community together with the physical environment, considered as a complete unit.
- ECOLOGICAL TOLERANCE.** The capacity to endure a range of environmental relationships.
- ECOTONE.** A transitional community formed by the overlapping of two distinct communities or ecosystems. Ecotones usually have a richer flora and fauna than either of the adjacent habitats.
- ENDANGERED, FEDERALLY.** Under the Endangered Species Act of 1973, a species in danger of extinction; included in or being considered for the List of Endangered Fauna or Endangered and Threatened Plant Species of the United States; a species whose immediate survival is in jeopardy.
- ENDEMIC.** Having a restricted distribution; native or confined to a particular area.
- ESTUARY.** A coastal ecosystem where fresh water (rivers) and salt water (oceans) meet.
- EVERGREEN.** Having foliage that remains green all year.
- EXOTIC.** A species not native to a particular region (in this paper, North America).
- EXTINCT.** No longer existing in living form anywhere on earth.
- EXTIRPATED.** No longer existing in living form within a distinct region, though living populations exist elsewhere on earth.
- GEOGRAPHICALLY RESTRICTED.** Unable to disperse because of the structure of a region. The range is limited by the presence of mountain ranges, deserts, oceans, or other natural barriers.
- GRADIENT.** The slope or degree of inclination.
- HABITAT.** The type of environment where an organism lives. *Optimum habitat* is the best or most favorable environment for a particular organism. *Ecotonal habitat* is the area where two adjacent habitats overlap, creating a species-rich transitional community. *Habitat preference* is the selecting of one specific environment over another.
- HERBACEOUS.** Vegetation lacking woody tissue and completely dying down after flowering.
- HIATUS.** A separation, gap, or missing section; in this paper, a broad gap in the geographical range of a species.
- HIBERNATE.** To be in a state of inactivity in response to adverse environmental conditions.
- HIBERNACULUM** (plural, hibernacula). The place occupied by an organism or group of organisms while experiencing a period of inactivity.
- HYBRID.** The offspring resulting from a cross between genetically different parents.
- HYBRIDIZATION.** The process of producing offspring from two different species.
- INTERGRADATION.** The blending of two recognized races of a single species.

- ISLANDS, BARRIER.** Long, narrow sand reefs that run parallel to and relatively close to the coastline.
- LEVEE.** A raised embankment along a river; may be natural or man-made.
- MESOPHYTIC.** A moderately moist environment.
- MIGRANT.** An animal that moves from one area to another on a seasonal schedule.
- OBLIGATE.** Able to survive in only one environment.
- PELAGE.** The coat of a mammal consisting of hair, fur, or other soft covering, as distinct from bare skin.
- RESIDENT.** A nonmigratory species.
- SERIAL STAGE.** One group of organisms or one community in the succession of communities leading to a recognized type of climax community.
- SPECIMEN RECORD.** An occurrence supported by a collected, preserved, and properly housed individual usually with data on its age, sex, weight, measurements, and other pertinent characteristics.
- SYMPATRIC.** Coexisting geographically without inbreeding.
- TALUS.** A sloping mass of natural debris (rocks, rock fragments), often at the base of a hill or cliff.
- TAXON.** A group of organisms constituting a distinct unit of the system of classification in established categories.
- THREATENED, FEDERALLY.** Species that are likely to become endangered under Endangered Species Act of 1973 (Public law 93-205).
- VAGRANT.** An animal that wanders from one area to another by chance.
- VISITOR.** A nonresident species temporarily occurring outside its breeding range or preferred habitat. Some species are more or less regular visitors to areas surrounding their normal ranges.
- XEROPHYTIC.** A moisture-deficient environment.



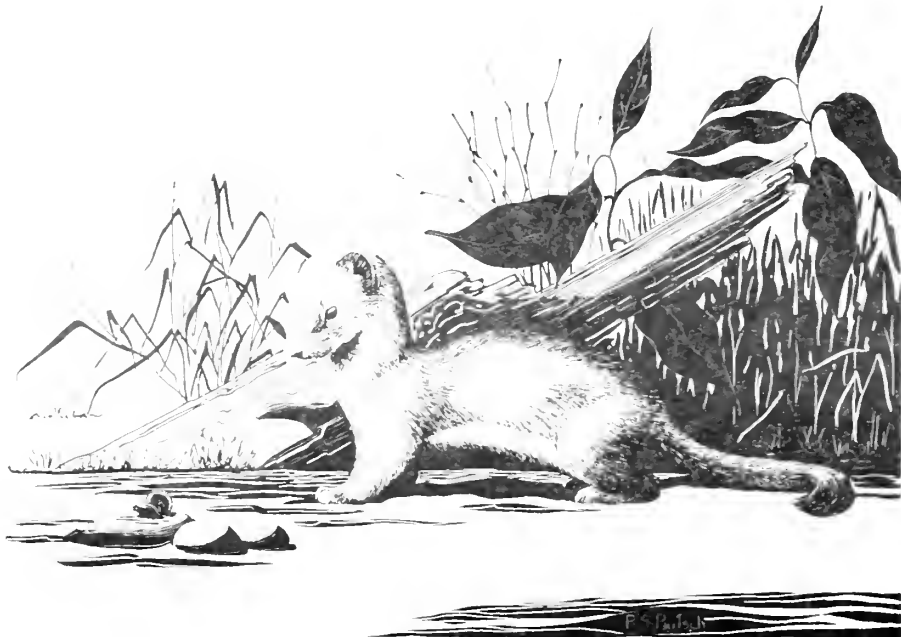
NOTES

THE NORTH CAROLINA BIOLOGICAL SURVEY
(North Carolina State Museum, Plant Protection, State Farms,
Research Farms, and Resource Development Divisions)

John B. Funderburg, Director
Howard M. Singletary, Assistant Director
David S. Lee, Chief
Eloise Potter, Editor
Insect Survey — James F. Greene, Coordinator
Plant Protection — Robert D. Sutter, Coordinator
Field Operations — William M. Palmer, Coordinator

NORTH CAROLINA STATE MUSEUM

Research and Collections, John E. Cooper, Chief
Ornithology — David S. Lee, Curator
Gilbert S. Grant
Mammalogy — John B. Funderburg, Curator
Mary K. Clark
Herpetology, Ichthyology — William M. Palmer, Curator
Alvin L. Braswell
Invertebrate Zoology — Rowland M. Shelley, Curator
John C. Clamp
Paleontology — Vincent P. Schneider, Curator
Geology — Ronald Yadusky, Curator
Margaret Yadusky, Curator



CONTRIBUTIONS OF THE NORTH CAROLINA BIOLOGICAL SURVEY — 1981

- Lee, David S., and William M. Palmer. Records of the Leatherback Turtle, *Dermochelys coriacea* (Linnaeus), and other marine turtles in North Carolina waters. *Brimelyana* No. 5:95-106. 1981-1
- Potter, Eloise F. Effects of cool weather on nestling behavior and development in the Yellow-billed Cuckoo. *The Chat* 45(1):15-16. 1981-2
- Lee, David S. Specimen record of the Black-bellied Whistling-Duck from Carteret County, N.C. *The Chat* 45(2):41-42. 1981-3
- Irvin, Wayne E., and John Conners. Specimen record of a Smith's Longspur from Chatham County, N.C. *The Chat* 45(2):46. 1981-4
- Potter, Eloise F., and David S. Lee. Contributions of the North Carolina State Museum of Natural History and the North Carolina Biological Survey, 1884 - 1980. Special publication of the North Carolina Biological Survey. 1981-5
- Potter, Eloise F., and Gail T. Whitehurst. Cowbirds in the Carolinas. *The Chat* 45(3):57-68. 1981-6
- Lee, David S., and Mary Kay Clark. Common Terns foraging over land. *The Chat* 45(3):73. 1981-7
- Platania, Steven P., and Mary Kay Clark. Rough-winged Swallows nesting in coastal North Carolina. *The Chat* 45(4):100-102. 1981-8
- Braswell, Alvin L. Distribution and feeding behavior of *Necturus lewisi* (Brimley). Abstract. 67th Annual Meeting of the American Society of Ichthyologists and Herpetologists. 1981-9
- Lee, David S., and Steven P. Platania. Observations on the natural history of the Glassy Darter, *Etheostoma vitreum*. Abstract. 67th Annual Meeting of the American Society of Ichthyologists and Herpetologists. 1981-10
- Lee, David S., Steven P. Platania, Carter R. Gilbert, Richard Franz, and Arnold Norden. A revised list of the freshwater fishes of Maryland and Delaware. *Southeastern Fishes Council Proceedings* 3(3): (10 pages). 1981-11
- Shelley, Rowland M., and Alvin L. Braswell. Host record for the leech *Placobdella nuchalis* Sawyer and Shelley (Rhynchobdella: Glossiphoniidae). *Journal of Parasitology* 67(5):748. 1981-12
- Lee, David S., D. B. Wingate, and H. W. Kale II. Records of tropicbirds in the North Atlantic and upper Gulf of Mexico, with comments on field identification. *American Birds* 35(6):887-890. 1981-13
- Clamp, John C. *Ellobiophrya conviva* sp. n., a commensal of marine ectoprocts, and a revision of the family Ellobiophryidae (Ciliophora, Peritricha). *Journal of Protozoology* 29(2):149-156. 1981-14
- Funderburg, John B. Ecological distribution of Seaside Sparrows along the Carolina coast. A re-evaluation. Abstract. *Southeastern Coastal and Estuarine Birds: A Conference*. Baruch Institute, University of South Carolina. Page 5. 1981-15
- Lee, David S., and Steven P. Platania. Seasonal occurrence of gulls and terns in North Carolina's offshore waters. Abstract. *Southeastern Coastal and Estuarine Birds: A Conference*. Baruch Institute, University of South Carolina. Page 7. 1981-16
- Platania, Steven P., and David S. Lee. Deep body temperatures of ocean-foraging Procellariiformes, Charadriiformes, and other seabirds. Abstract. *Southeastern Coastal and Estuarine Birds: A Conference*. Baruch Institute, University of South Carolina. Page 10. 1981-17
- Lee, David S. Studies of seasonal distribution and abundance of seabirds, marine mammals, and marine turtles in the Cape Hatteras area, 1980-81. Project completion report on file at National Fish and Wildlife Laboratory, New Orleans Field Station, Bell Chasse, Louisiana (14-16-0009-80-044). 1981-18
- Lee, David S., and Ray E. Ashton. Use of ⁶⁰Co tags to determine activity patterns of freshwater fishes. *Copeia* 1981(3):709-711. 1981-19
- Shelley, Rowland M. A new xystodesnird milliped genus and three new species from piedmont South Carolina (Polydesmida: Xystodesmidai). *Proceedings of the Biological Society of Washington* 94(4):949-967. 1981-20
- Fussell, John O., III, T. L. Quay, and R. J. Hader. Sooty Tern nest found near Cape Lookout, N.C. *American Birds* 35(2):236. 1981-21

